Greenvale Enterprises Pty Ltd

REMLAP RANCH RESORT, MYALUP

Consultative Environmental Review

711.455(941) LEP
Copy A

Department of
Environmental Protection
Library

951608/1

VOST DAMES & MOORE

711.455(941)
DAM
951608A

LIBRARY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WESTRALIA SQUARE
141 ST. GEORGE'S TERRACE, PERTH

Greenvale Pty Ltd

REMLAP RANCH RESORT, MYALUP

CONSULTATIVE ENVIRONMENTAL REVIEW

LePROVOST DAMES & MOORE

LDM Ref: 30978-001-367 (R579, Rev.1)
[JPS/DK:177-9383/PER: LDMR038]
15 November 1995

AN INVITATION TO COMMENT ON THIS CER

The Environmental Protection Authority (EPA) invites people to make a submission on this Consultative Environmental Review (CER).

Greenvale Enterprises Pty Ltd proposes to establish a permanent water wetland/lagoon at the site of an existing, highly-modified seasonal dampland. The artificially created lagoon is designed to incorporate islands and peripheral zones with indigenous native vegetation, and to provide waterbird habitat. The dampland is a designated 'lake' under the provisions of the Swan Coastal Plain (Lakes) Environmental Protection Policy. The wetland to be created will form the centrepiece to the Remlap Ranch Resort development which is proposed to include 64 strata lots of various sizes for residential, short-stay chalet accommodation, camp accommodation, equestrian and tennis facilities in a rural atmosphere.

Comments from Government Agencies and the public will assist the EPA to prepare an assessment report in which it will make a recommendation to Government.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action, including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless specifically marked confidential, and may be quoted in full or in part in each report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the workload for an individual or group, as well as increase the pool of ideas and information. If you form a small group (up to 10 people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguard or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that the issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the CER;
- attach any factual information you may wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name;
- address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is:

8 January 1996.

Submissions should be addressed to:

The Chairman,
Environmental Protection Authority,
Westralia Square,
141 St George's Terrace,
PERTH WA 6000.

Attention: Kim Martin

REMLAP RANCH RESORT, MYALUP

CONSULTATIVE ENVIRONMENTAL REVIEW

Report to : Greenvale Enterprises Pty Ltd
c/- The Palmer Group
33 Cathedral Avenue
AUSTRALIND
Western Australia 6230

by : LeProvost Dames & Moore
South Shore Centre
85 The Esplanade
SOUTH PERTH
Western Australia 6151
A.C.N. 003 293 696
Telephone: 09 474 1933
Facsimile: 09 367 6780

15 November 1995

LDM Ref: 30978-001-367
JPS/DK:177-0383/PER [LDMR038]

Report No. R579 (Rev. 1)

Table of Contents

Table of Contents (cont'd)

Table of Contents (cont'd)

LIST OF TABLES

LIST OF FIGURES

Table of Contents (cont'd)

LIST OF VIEWS

LIST OF APPENDICES

EXECUTIVE SUMMARY

THIS DOCUMENT

This document is a Consultative Environmental Review (CER) of a proposal to develop land located at Lot 7 Old Coast Road, Myalup. The purpose of this development is to provide short stay accommodation and equestrian facilities centred around an artificial lagoon in a rural setting. The level of assessment was determined by the Environmental Protection Authority (EPA) under the provisions of the *Environmental Protection Act* 1986.

THE PROPONENT

The proponent is Greenvale Enterprises Pty Ltd. The Proponent's representative is Mr Stephen Palmer of The Palmer Group of 33 Cathedral Avenue, Australind, Western Australia 6230.

THE PROPOSAL

The proposal involves the creation of 64 strata lots of various sizes for residential, short stay chalet accommodation, camp accommodation, equestrian and tennis facilities in a rural atmosphere. The short stay chalets will be centred around the artificially created lagoon. The artificial lagoon will be created within the EPP Lakes dampland occurring on the site. The lagoon design aims to enhance the current EPP Lakes dampland environmental value and incorporates an increased proportion of native vegetation and waterbird habitat.

The primary objective of the proposal is to protect and maximise environmental values occurring within the site to provide a development in which both short and long term minimal environmental effect occurs.

THE PROJECT SITE

The project site is located at Lot 7 Old Coast Road, Myalup. Myalup is located approximately 120 km south of Perth and approximately 35 km north of Bunbury. The site is composed of the following elements:

- a degraded EPP Lakes dampland located in the central swale of the site currently used for the agistment of horses and cattle grazing;
- a western flat to undulating portion of the site that is currently also used for the agistment of horses and cattle grazing; and
- a ridge along the eastern boundary where previously sand mining has occurred.

PRINCIPAL ENVIRONMENTAL CONCERNS

The principal concerns identified as being associated with the proposal (refer also Appendix A: EPA Guidelines) are as follows:

- the need to demonstrate that enhanced ecological values of the EPP protected lake would be achieved;
- the protection of groundwater and lake water quality;
- avoidance of groundwater use impacts on other users adjacent to the site;
- acceptable sewage drainage and stormwater disposal;
- no detrimental effects of excavated spoil disposal, including control of sediments and nutrients;
- an acceptable level of impact on flora and fauna during construction and operation of facilities;
- suitable monitoring to ensure maintenance of appropriate water quality standards; and
- appropriate short- and long-term management commitments provided by the proponent.

ENVIRONMENTAL IMPACTS

The main environmental outcomes associated with the development are expected to include:

- a permanent waterbody with defined boundaries will be established, and significant wetland functions restored to the site;
- decreased potential for nutrient contamination of groundwater, as the proposed lagoon and resort will have a low nutrient status in comparison to the present high nutrient status of the existing agricultural dampland;
- a significant increase in wetland habitat value and diversity will be established;
- no net loss of native vegetation, and increased protection of the remaining vegetation after the development is completed;
- considerably increased visual quality, recreational and tourism resource potential; and
- an increased resilience of the broader wetland system located to the north.

- use of groundwater from the superficial formations, but at rates of abstraction approved by the Western Australian Water Authority (WAWA), and effects on other groundwater users expected to be minimal.

An overall summary of the environmental effects of the project and the proposed management responses and predicted outcomes are presented in Table 1 (page vii).

MANAGEMENT REQUIREMENTS

Management programmes have been designed to address potential environmental impacts and maintain the environmental integrity of the development associated with:

- construction management:
- lagoon construction;
- building construction;
- drainage and runoff potential;
- nutrient and irrigation use; and
- general works.
- long-term management:
- general management provisions;
- groundwater and lake water quality monitoring programme;
- nutrient and irrigation use; and
- lagoon habitat.

The proponent has accepted responsibility for a range of impacts associated with the project and is committed to implement the monitoring and management programmes as identified, to the satisfaction of the appropriate authorities.

CONCLUSION

The proposal provides a unique opportunity to enhance the EPP Lakes dampland and restore significant wetland processes to the site, whilst maximising visual, recreation and tourism potential.

The primary objective of the proposal is to protect and maximise environmental values occurring within the site to provide a development in which both short- and long-term minimal environmental effect occurs.

TABLE 1

SUMMARY OF ADVICE TO THE ENVIRONMENTAL PROTECTION AUTHORITY

CATEGORY	TOPIC OF CONCERN	PRESENT STATUS	PROPOSED ACTION	PROPOSED MANAGEMENT	PREDICTED OUTCOME
Physical	Groundwater Abstraction	Current use low-moderate	To utilise WAWA approved total of 38,800 L per annum. Additional bore to be installed.	Use of dry landscaping techniques and planting of native species. Groundwater levels to be monitored.	No groundwater use impacts on other users adjacent to the site. Water use within allowable limits.
	Spoil Disposal	None	Lagoon to be created with a cut and fill operation. Spoil spread and compacted over proposed development areas. Topsoil separately stockpiled and reused.	Runoff and sediment contained in lagoon basin. Spoil area levelled and seeded. Use of silt traps as appropriate. Suspended solids settled out.	No erosion or sedimentation.
	Drainage and Stormwater Disposal	Soils possess high permeability and assist infiltration of rainfall. No current need for stormwater disposal.	Incorporation of water sensitive urban design principles to reduce runoff.	Groundwater and lake water quality monitored.	Drainage and runoff effects to be minimal.
	Modification/loss of EPP Lakes dampland through creation of lagoon.	Dampland extremely degraded. In reality dry pasture for most of the year.	Creation of lagoon to simulate natural wetland processes and function as a self-maintaining aquatic system.	Landscaping of islands and banks to be suitably graded to allow establishment of fringing vegetation and littoral zones. Preservation and replanting of vegetation as required.	Net gain - a significantly enhanced permanent wetland feature created.

TABLE 1

SUMMARY OF ADVICE TO THE ENVIRONMENTAL PROTECTION AUTHORITY

CATEGORY	TOPIC OF CONCERN	PRESENT STATUS	PROPOSED ACTION	PROPOSED MANAGEMENT	PREDICTED OUTCOME
Biological	Habitat loss	Marginal existing habitat value.	Diverse habitats to be created.	Additional native planting. Controlled human use and access of wetland surrounds. Permanent on-site management present.	Substantial gain in habitat.
	Loss of native flora	Predominance of pasture and nuisance species.	Preservation of some suitable native species as appropriate.	Additional planting as required using indigenous species.	Substantial net increase in fringing wetland species.
	Fauna	Marginal benefit during spring/early summer.	Permanent waterbody with island refuges and vegetated littoral zones.	Controlled human use of surrounds. Permanent on-site management.	Increase in waterbird usage. Possible introduction-colonisation by other fauna e.g. long necked tortoise.
Social	Landscape Values	Open seasonal pasture landscape - no significant value.	Creation of tourist attraction centred on vegetated wetland.	Ongoing management of improvements.	Creation of landscape interests. Net gain in visual landscape value.
	Recreation/Public Access	Restricted private land.	Creation of access and public facilities.	Ongoing management presence.	Net increase in recreation and controlled public access.

JPS/DK:177-9353/PER [LDMR038\3097B001\R579REPT1.DOC]

TABLE 1

SUMMARY OF ADVICE TO THE ENVIRONMENTAL PROTECTION AUTHORITY

CATEGORY	TOPIC OF CONCERN	PRESENT STATUS	PROPOSED ACTION	PROPOSED MANAGEMENT	PREDICTED OUTCOME
Pollution	Groundwater and lake water contamination	Relatively high concentrations of total iron and total phosphorus present in groundwater	Creation of well vegetated (fringing and littoral zone) wetland feature to act as nutrient sink.	Efficient use of fertilisers through appropriate landscaping. Monitoring of water (groundwater and lagoon) quality.	Nutrient contamination expected to be minimal.
	Effluent Disposal	Not applicable	Installation of advanced environmentally benign package waste treatment systems. Alcoa red mud amended irrigated disposal area west of lagoon.	Ongoing management.	No contamination from effluent disposal or nil contamination of either surface or groundwater.

1 INTRODUCTION

1.1 THIS DOCUMENT

This document is a Consultative Environmental Review (CER) which has been prepared by LeProvost Dames and Moore on behalf of Greenvale Enterprises Pty Ltd to develop land located at Lot 7 Old Coast Road, Myalup. The purpose of this development is to provide short stay accommodation and equestrian facilities centred around an artificial lagoon in a rural setting. The level of assessment was determined by the Department of Environmental Protection (DEP) under the provisions of the *Environmental Protection Act* 1986.

This document contains a description of the existing environment, a description of the proposed development, identification and assessment of environmental effects associated with the project, and a management programme to minimise the potential effects of the project on the environment.

1.2 THE PROPONENT

The Proponent is Greenvale Enterprises Pty Ltd, who currently operate the abutting Remlap Stud Ranch in association with EMU TECH Tourist and Farm Facility. The Proponent's representative is Mr Stephen Palmer of The Palmer Group of 33 Cathedral Avenue, Australind, Western Australia 6230.

1.3 THE PROPOSAL

The Proponent's objective is to construct and operate an environmentally compatible tourism and short-stay accommodation development, offering equestrian and tennis activities, centred around an artificial lagoon in a rural atmosphere. The proposal site is Lot 7 Old Coast Road, Myalup, Western Australia. Myalup is located approximately 120 km south of Perth and approximately 35 km north of Bunbury. Figure 1 shows the location of the proposed site. The development aims to benefit both the Proponent and the local community whilst maintaining and enhancing the natural values of the environment.

1.4 CURRENT ZONING

The land is currently zoned 'General Farming' under the Shire of Harvey Town Planning Scheme No. 10. The development was approved by the Shire of Harvey and, prior to issue of strata titles, requires rezoning amendments to the scheme by the Ministry for Planning (MfP). The rezoning documents were forwarded to the DEP for comment and a CER level of assessment for the proposal was set by the Environmental Protection Authority (EPA). No further decisions may be taken to advance the proposal until environmental approval is given by the Minister for the Environment.

The proposed amendment to the Shire Town Planning Scheme No. 10 (Amendment 56) was advertised in the Government Gazette on 11 March 1994 for the purpose of:

(1) rezoning of Lot 7 Old Coast Road Myalup from 'General Farming' to 'Restricted use - Short Stay Chalet Park, Stables, Residential Accommodation, Recreation and Horse Agistment';

(2) amending the Scheme Text by adding to Appendix 7 - Schedule of Restricted Uses, Lot 7 Old Coast Road Myalup, and restricting the use of the land to permit Short Stay Chalet Park, Stables, Residential Accommodation, Recreation and Horse Agistment; and

(3) amending the Scheme Map accordingly.

1.5 ENVIRONMENTAL PROTECTION AUTHORITY GUIDELINES

Draft guidelines were provided by the DEP in September 1994 to assist in the preparation of the CER.

The principal concerns identified as being associated with the proposal are as follows:

- the need to demonstrate that enhanced ecological values of the EPP protected lake would be achieved;
- the protection of groundwater and lake water quality;
- avoidance of groundwater use impacts on other users adjacent to the site;
- acceptable sewage, drainage and stormwater disposal;
- no detrimental effects of excavated spoil disposal, including control of sediments and nutrients;
- an acceptable level of impact on flora and fauna during construction and operation of facilities;
- suitable monitoring to ensure maintenance of appropriate water quality standards; and
- appropriate short- and long-term management commitments provided by the proponent.

1.6 ENVIRONMENTAL PROTECTION (SWAN COASTAL PLAIN LAKES) POLICY 1992, AND BULLETINS 685/686

Wetland environments of the Swan Coastal Plain are biologically rich ecosystems widely under pressure from surrounding residential, agricultural and industrial land use. As a

result the Environmental Protection Authority (EPA) prepared the Environmental Protection (Swan Coastal Plain Lakes) Policy (Lakes EPP). The EPP nominates lakes specified to be protected from impacts associated with land use change. The EPP specifically prohibits the unauthorised filling, mining, and polluting of nominated wetlands. The criteria for the inclusion of a 'wetland' into the policy was that the wetland should have standing water (at least 1,000 m^2) as at the first week of December 1992. The wetlands are shown on the Land Administration Miscellaneous Plan 1815.

The Remlap dampland was surveyed by the EPA in the first week of December 1992. It met the water permanency criteria and was subsequently listed for inclusion into the Lakes EPP. Site inspections conducted by Gutteridge Haskins Davey Pty Ltd in June 1994 and Dames & Moore in February and May to June 1995 revealed that no portion of the designated EPP wetland area contained standing water at these particular times.

In 1993 the EPA simultaneously released Bulletin 685 Strategy for the Protection of Lakes and Wetlands of the Swan Coastal Plain and Bulletin 686 "A Guide To Wetland Management in the Perth and Near Perth Swan Coastal Plain Area". This documents a wetland evaluation method in conjunction with management objectives to be used by land-use planners, managers and the general community. The wetland evaluation method is based on the principle that wetlands have a number of natural and human use attributes which can be assigned a score which, when added together, determines the environmental value of the wetland. A two dimensional process taking account of the natural and human use attribute scores is then applied to place the wetland into one of five management categories requiring different management priorities. The management categories are as follows:

- High conservation; these wetlands score highly on both natural and human use attributes.
- Conservation; these wetlands primarily score highly on the natural attributes scale.
- Conservation and recreation; these wetlands primarily score highly on the human use scale.
- Resource enhancement; these wetlands score moderately on both natural and human use attributes.
- Multiple use; these wetlands score poorly on both natural and human use attributes.

1.7 STUDIES CONDUCTED

The following consulting groups have provided input to the project:

- LeProvost Dames & Moore - botanical survey, wetland enhancement design, environmental impact assessment, design of management programme, Public Consultation Programme, design and production of CER;

- Dames & Moore - shallow soil and groundwater investigation;
- Thompson Taylor & Burrell Pty Ltd - project management, planning and design. Approvals from the Department of Conservation and Land Management (CALM) for buffer width and use of State forest for riding trails;
- Durrant and Waite Pty Ltd - design and engineering of sewage treatment and effluent disposal. Approvals have now been approved from the Health Department and Western Australian Water Authority (WAWA) for proposed wastewater effluent disposal strategy;
- Gutteridge Haskins & Davey Pty Ltd - design and engineering of water supply system, and to obtain a groundwater abstraction licence from the WAWA and appropriate Health Department approvals;
- Bamford Consulting Ecologists - waterbird survey; and
- Drake Consulting - planning and design.

2 PROJECT HISTORY

An informal assessment proposal to describe the rehabilitation of the degraded dampland on the site was prepared by Gutteridge Haskins & Davey Pty Ltd on July 1994. The document aimed to illustrate that the conservation status of the dampland could be increased through rehabilitation. This was illustrated through assessment of the current wetland and that of the future rehabilitated dampland using EPA Bulletin 374 "A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area". It was found that the current dampland was category "M" Multiple Use and that a future rehabilitated dampland could achieve category "R" Resource Enhancement.

The purpose of the July 1994 document was to bypass the need for formal assessment from the DEP through a two tiered approval process comprising first, the rehabilitation of the dampland and second, the resort development.

This approach was rejected by the DEP primarily because the dampland is a designated lake under the provisions of the Swan Coastal Plain (Lakes) Environmental Protection Policy ('Lakes EPP').

3 THE EXISTING ENVIRONMENT

3.1 THE PHYSICAL AND BIOLOGICAL ENVIRONMENT

3.1.1 Topography

The site is generally flat to undulating with a surface elevation of 8 to 10 m Australian Height Datum, rising to a ridge of about 20 m elevation along the eastern boundary. A shallow swale, in which a dampland exists, lies along the western side of the ridge (Figure 2).

Prior to the formation of the Lakes EPP, the swale and dampland was filled with substrate from the surrounding banks.

3.1.2 Geomorphology and Soils

The site comprises two geomorphic units which relate to the topography. The low lying dampland and remaining land west of the site belongs to the Yoongarillup Plain and the eastern ridge belongs to the Spearwood Dune System (Department of Conservation and Environment, 1980).

The Yoongarillup Plain extends longitudinally parallel to the coast between Mandurah and Bunbury. It is about 5 km wide on average, with the Quindalup Dune System to the west, and the Spearwood Dune System to the east (Semeniuk, 1990). The Yoongarillup Plain is characterised by shallow yellow and brown sands over marine limestone. The Spearwood Dune System occurring on the site is characterised by deep yellow sands over limestone associated with the Karrakatta Association.

Within the site are several soil types associated with each geomorphic unit, as follows:

The Yoongarillup Plain comprises the following two soil types:

- Ya: Light brown and light orange mottled sand grading to beige sand then light grey sand with depth. This soil type is situated on the western plain of the site; and

- Yb: Light grey brown sand grading to light grey sand with depth. This soil type is situated in the central dampland swale of the site.

The Spearwood Dune System is composed of the following soil type representative of the Karrakatta Association:

- Sa: Light brown sand grading to light orange yellow sand then beige sand with depth. This soil type is situated on the eastern ridge of the site.

Figure 3 shows the distribution of soil types identified within the site.

Phosphorus Retention Index (PRI) values are generally constant across the site and classified as possessing "very weak to weakly adsorbing phosphorus properties" (Allen & Jeffery, 1990). These soils were identified as being highly permeable and capable of retaining minimal phosphorus loads.

A comprehensive shallow soil and groundwater investigation is provided in Appendix B.

3.1.3 Hydrogeology

The site comprises two hydrogeological formations in vertical succession (Deeney, 1989). The superficial formations occur from ground level to 30 m depth below the surface, and upon the ridge occur to a depth of 40 m below ground level. The Leederville Formation occurs from a depth of 30 to 150 m below ground level. The superficial formations are of Quaternary age and consist mainly of sand overlying calcarenite (Tamala Limestone). The Leederville Formation is of Cretaceous age and is composed of interbedded sandstone, siltstone and shale. The natural groundwater flow of the superficial formation is west and approximately 1,200 m^2/day.

Groundwater levels across the site during May to June 1995 were close to ground level and varied according to topography. The levels can be summarised as follows:

- within the plain and western perimeter of the site, levels range from 1.5 m to 3.0 m below ground level;
- within the plain and bordering the western side of the dampland, levels range from 2.5 m to 4.0 m below ground level;
- within the swale and dampland of the site, levels range from +0.3 to 0.5 m;
- along the rise of the ridge and bordering the eastern side of the dampland, levels range from 0.5 m to 2.0 m and below GL; and
- upon the ridge and bordering the eastern side of the dampland, levels range from 3.0 m to 4.5 m below GL.

Baseline groundwater quality results were sampled in June 1995. These indicate that, except for pH in Borehole BH2 (Figure 3) and total iron concentrations in all boreholes, all parameters analysed (pH, electrical conductivity, total iron, nitrate-nitrogen, total nitrogen and total phosphorus) are within Australian Drinking Water Guidelines (National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand, 1994). Total iron concentrations within the site are well above the level specified in Drinking Water Guidelines, but can be easily removed through aeration to achieve potability.

No criteria exist for total phosphorus in groundwater, although concentrations present on the eastern side of the dampland have the potential to cause eutrophication in shallow

open water bodies. Eutrophication occurring within the proposed artificial wetland is however unlikely as phosphorus will be retained in wetland vegetation, and general algal growth will be limited (excluding N_2-fixing blue-green algae) by the low levels of total nitrogen present in the groundwater. The source of phosphorus may be attributed to fertiliser applications associated with State forest pine plantation and agriculture surrounding the proposed site.

3.1.4 Dampland

The existing wetland on the site occurs as a seasonally waterlogged dampland. Wetland assessments conducted by Gutteridge Haskins Davey in June 1994 and Dames & Moore in February 1995 confirmed that the Remlap dampland is highly degraded and occurs within the Multiple Use category.

The highly degraded state of the Remlap dampland is primarily due to past landfilling and long standing livestock grazing. Past landfilling (previous to the release of Lakes EPP) would have significantly altered the hydrological balance of the site, permanently changed the ecology and dramatically lowered fauna/flora species diversity. The present low species diversity of the Remlap dampland was confirmed by the vegetation survey conducted in May 1995 by LeProvost Dames & Moore, and the waterbird review conducted in June 1995 by Bamford Consulting Ecologists, Sections 4.5 to 4.6. The Remlap dampland is part of a larger linear wetland system, the majority of which is relatively intact and has only been subject to a low level of grazing.

It is estimated from aerial photographs and site inspections that at least 50% of the Remlap dampland has been modified, and the natural vegetation cover decreased by approximately 50%.

The only current human use value of the Remlap dampland is livestock grazing. In its degraded state the dampland rates low aesthetically, and is of no recreational, educational or scientific value.

3.1.5 Vegetation

The property comprises degraded vegetation of the Yoongarillup Association, including a wetland vegetation association and several woodland associations. The degraded state of the vegetation can be attributed to livestock grazing, filling of the Remlap dampland and past sand mining. Figure 4 shows the location and area of the wetland association and surrounding woodland associations. Figure 5 shows, in greater detail, the location and area of species occurring within the wetland association. Views A and B show an eastern and western aerial view of the site. Views C and D show a ground level east to west and north to south orientation of the dampland vegetation.

The wetland association features a closed thicket of *Agonis linearifolia, Astartea fascicularis, Eucalyptus rudis, Melaleuca rhaphiophylla* and *Oxylobium lanceolatum* towards the eastern side of the wetland on the rise of the swale. On the eastern boundary of the wetland is a belt of the Common Bracken Fern *Pteridium aquilinum*. Located in

the centre of the wetland, and subject to waterlogging during winter, is a belt of scattered trampled *Juncus pallidus*, *Juncus* aff. *holoschoenus*, *Lepidosperma* aff. *longitudinale* and the bulrush *Typha orientalis* interspersed with pasture. A few mature *Melaleuca rhaphiophylla* and *Eucalyptus calophylla* also occur within this central region of the wetland.

Surrounding the wetland the following woodland associations occur:

- between the wetland and the eastern boundary of Lot 7 exists a remnant woodland of *Agonis flexuosa*, *Banksia attenuata* and *Eucalyptus calophylla* occurs;
- between the wetland and south west to the Old Coast Road the vegetation is predominantly pasture and contains scattered *Agonis flexuosa*, *Eucalyptus calophylla* and *Eucalyptus marginata*;
- to the east of Lot 7 occurs the State Forest pine plantation.
- the northern portion of the wetland system becomes progressively less degraded, and features vegetation similar to that found within the Remlap Stud dampland; and
- the vegetation to the north-west of the site comprises a dense stand of *Agonis flexuosa*, *Eucalyptus calophylla* and *Melaleuca rhaphiophylla*. The wetter portions of this area feature a stand of *Agonis flexuosa* and *Melaleuca rhaphiophylla*.

3.1.6 Fauna

A site fauna survey was not conducted because of the degraded nature of the wetland. However from advice received and examination of aerial photography, the dampland site may support some water bird use in winter. Black swans are known to breed in seasonal wetlands located in agricultural land.

A report commissioned from Bamford Consulting Ecologists is provided in Appendix C.

3.2 SOCIAL ENVIRONMENT

The proposed site is set in broadacre pastoral/grazing country beside State Forest pine plantation, and is currently used for the agistment of horses and cattle grazing. The nearest settlement is Myalup Beach approximately 10 km to the west.

Adjacent land use includes:

- private farm properties are adjacent to the north and south;
- a State pine plantation to the east of the property;
- an emu farm and cattle grazing property to the south;

- Remlap Horse Stud and pasture growing to the west; and
- grazing properties and market gardens to the north.

A small flora and fauna reserve (C24472; C61 in EPA System Six report) occurs approximately 4 km to the north and Lake Preston/Yalgorup National Park (C54 in System Six report) is situated approximately 2 km to the west.

There are no registered Aboriginal sites on the property.

4 PROJECT DESIGN DESCRIPTION

4.1 INTRODUCTION

This section details the project objectives, likely environmental effects, and the way the project has been designed, or will be managed, to overcome environmental effects. The proposal comprises three main elements:

(i) artificial lagoon design;
(ii) land based facilities; and
(iii) utilities (waste treatment and effluent disposal, water supply, electricity and communications and road access).

Figure 6 shows the proposed Strata Development Plan.

A description of the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992 and wetland assessment (Bulletin 686 "A Guide To Wetland Management in the Perth and Near Perth Swan Coastal Plain Area") is included to provide an explanation of the opportunities and constraints associated with creation of the lagoon.

4.2 LAGOON DESIGN

4.2.1 Introduction

The artificial lagoon will be created within the perimeter of the existing degraded dampland. The aim is to enhance, increase and restore conservation, recreation and aesthetic wetland values. The design of the lagoon features three islands which will be vegetated with species of the Yoongarillup Plain and landscaped to provide a habitat for waterbirds. The central island will be connected to both shores of the lagoon by a pedestrian bridge. The justification for creating an artificial wetland is presented in the following paragraphs.

Natural wetlands of the Swan Coastal Plain are biologically productive ecosystems, and valued for both their diverse flora/fauna and conservational recreation values. However it is estimated that up to 85% of all wetlands have been altered to some degree by urbanisation and agriculture, particularly through filling, nutrient enrichment and groundwater abstraction. Prior to European settlement most wetlands along the Swan Coastal Plain contained low concentrations of nutrients. Those wetlands which still retain low nutrient status are highly valuable systems in comparison to the majority of eutrophied wetlands now occurring.

By comparison, artificial wetlands initially offer low biological complexity, primarily because of low concentrations of available phosphorous. However artificial wetlands can be designed and managed to maximise ecological values, simulate natural wetland functions and contribute to the remaining stock of low nutrient wetland systems in the

Swan Coastal Plain. The proposed Remlap artificial lagoon has been designed with the intention of maximising biological functions and creating a balanced 'self maintaining' wetland body.

4.2.2 Morphology and Bathymetry

The lagoon will be elliptical in shape and aligned to reflect the position of the existing dampland and its associated vegetation. The three islands will feature shallow banks for wading birds, and be shaped to encourage littoral growth and provide a waterbird habitat (Figure 7). The central island will be accessible to visitors and feature a boardwalk and wooden bridge connecting both shores of the lagoon (Figure 8). Maximum depth of the lagoon will be 2 m, with an irregularly contoured bottom to simulate a natural wetland bathymetry and increase habitat diversity. The banks of the lagoon will be graded to encourage growth of appropriate fringing vegetation (Figure 9). Refuge 'boxes' for long-necked tortoises will be incorporated into the banks located under chalet verandahs.

The underlying design principles are to:

- establish a 'green' wetland habitat linkage running centrally through the lagoon, thereby providing a wildlife corridor and forming a viable extension to the existing linear wetland system (Figure 9);
- provide a mechanism for nutrient uptake and utilisation; and
- provide a noise and privacy barrier between chalets.

To encourage invertebrate activity and growth, an organic litter of approximately 0.2 m will be applied to selected portions of the lagoon bottom. Invertebrate activity will assist in maintaining good water quality and provide a food source for waterbirds.

4.2.3 Vegetation Habitat and Landscape Value

Construction of the lagoon will be undertaken in such a way so as to conserve as much of the present vegetation as possible, and to encourage colonisation by additional plant species common to the Yoongarillup Plain.

The dense thicket comprising *Agonis flexuosa, Astartea fascicularis, Eucalyptus rudis, Melaleuca rhaphiophylla* and *Oxylobium lanceolatum* (Figure 5) will be conserved and contribute to the formation of the islands and fringing vegetation. This vegetation will contribute to nutrient uptake in the new waterbody and will be supplemented with additional planting of shrubs and trees common to the Yoongarillup Association. Increased density of vegetation will also provide privacy from chalets on the opposite side of the lagoon.

During construction topsoil will be appropriately stockpiled, and *Juncus pallidus, Juncus* aff. *holoschoenus* and *Lepidosperma* aff. *longitudinale* will be removed and replanted in newly created wading and fringing zones. This approach will help maintain the

microbiological integrity of the topsoil and assist the growth and establishment of additional planting. Sedges, reeds and rushes typical of the Yoongarillup Association will be included to encourage greater species diversity.

Melaleuca rhaphiophylla together with suitable understorey species will be planted around the shoreline between each chalet. This will provide a shaded littoral zone, shade over chalets in summer months, privacy between chalets, and contribute to nutrient stripping and biological productivity. It will also provide a vegetated barrier intercepting surface runoff flowing into the lagoon. In the open areas located at both northern and southern ends of the lagoon further dense growth of shrub and tree species of the Yoongarillup Association will be encouraged. This planting programme should result in an estimated 50% of the lagoon perimeter supporting fringing vegetation. Figure 10 indicates the suggested design approach to the layout of the chalet frontage and fringing lagoon vegetation design.

The mature lagoon design should therefore result in a substantial increase in the combined area of permanent wetland and fringing vegetation compared to the extent of the current Remlap dampland vegetation.

The final lagoon should result in a significant increase in species and habitat diversity, and provide a waterbird sanctuary that will simulate original ecological wetland functions, and be aesthetically pleasing.

4.2.4 Recreational Value

Passive recreational use and control access to the central island will be provided through the construction of a boardwalk and wooden trestle bridge connecting both shores of the lagoon. The boardwalk and bridge will provide an opportunity to observe wildlife. No swimming or direct water contact activities will be permitted.

4.2.5 Water Balance and Water Quality

Environmental concerns associated with the newly created lagoon include increased evapotranspiration and possible groundwater contamination should high nutrient levels occur.

The effects of evapotranspiration on groundwater levels in the region is expected to be minimal. It is estimated that water levels in the lake will vary seasonally up to 0.3 m. A network of six monitoring bores have been installed and groundwater levels will be monitored regularly. Seasonal water level change will result in an increased proportion of exposed littoral fringe (as water levels drop) providing waterbirds with additional wading habitat.

Baseline nutrient groundwater quality data for the site, as detailed in Section 3.3, indicates both low concentrations of both nitrate-nitrogen and total nitrogen. Concentrations of total phosphorus present in groundwater on the eastern side of the Remlap dampland have the potential to cause eutrophication in shallow water bodies.

Eutrophication occurring within the created lagoon is unlikely as phosphorus will be retained in the wetland vegetation and general algal growth will be limited (excluding N_2-fixing blue-green algae) by the low levels of total nitrogen present in the groundwater.

To assess the performance of the newly created lagoon water quality will be monitored, taking into account the criteria indicated in Table 2.

TABLE 2

WATER QUALITY CRITERIA PROPOSED FOR ARTIFICIAL LAGOON

INDICATOR	UNITS	RANGE SPECIFIED
pH	-	6.5-9.0
Electrical Conductivity	$\mu S.cm^{-1}$	<1,500
Dissolved Oxygen	mg/L	>6 (80-90% saturation)
Total Phosphorus	µg/L	5-50
Total Nitrogen	µg/L	100-500
Chlorophyll-a	µg/L	2-10

Notes: All criteria from the Australian Water Quality Guidelines for Fresh and Marine Waters

Likewise groundwater quality will be monitored taking into account the criteria indicated in Table 3.

TABLE 3

WATER QUALITY CRITERIA PROPOSED FOR GROUNDWATER

INDICATOR	UNITS	RANGE SPECIFIED
pH	-	6.5-8.5*
Electrical Conductivity	-	2350**
Nitrate-Nitrogen	mg/L	10*
Total Nitrogen	µg/L	5-50#
Total Phosphorus	µg/L	100-500#

Notes: * Australian Drinking Water Guidelines
** Analabs Untreated Water Potability Criteria
# Australian Water Quality Guidelines for Fresh and Marine Waters

4.2.6 Relationship to External Wetland System

The existing Remlap dampland is an extension to and part of a larger, linear wetland system. The wetlands to the north are of higher conservation value, have less degraded vegetation associations and feature open water areas.

The proposed artificial lagoon should add to the overall conservation value of the wetland system, and contribute to its overall resilience. An increased area, through restoration of vegetation common to the Yoongarillup Plain will be established. The potential spread of weed species (*Typha orientalis* and pasture species) from the current Remlap dampland further north should be reduced. The new wetland should support increased waterbird use and contribute to the overall fauna of the larger wetland system.

Regional groundwater flow from east to west effectively eliminates the possibility of any future nutrient contamination on the Remlap site extending northwards to affect the larger wetland system. The creation of the lagoon will result in increased evapotranspiration, but the effects are expected to be extremely localised.

In summary, it is expected that the lagoon will add to, and support, the overall ecological capacity of the larger wetland system.

4.2.7 Environmental and Ecological Assessment of Mature Lagoon

The environmental quality and ecological value of the lagoon will be significantly greater than the current Remlap dampland. The restored environmental value of the lagoon should achieve the required level of Resource Enhancement specified in EPA Bulletin 686 (A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area). The increased environmental values of the proposed lagoon can be summarised as follows:

- the proposed lagoon will be a permanent waterbody with defined boundaries. Excavation of the dampland will restore significant wetland function to the site;

- the proposed lagoon will have a lower nutrient status compared to the present high nutrient status of the existing agricultural wetland. Nutrient removal will be achieved through conservation and retention of existing wetland vegetation, intensive planting to provide a nutrient stripping capacity, and the use of bioMax (or similar) advanced waste treatment systems which produce a low nutrient concentration effluent. In comparison, the current Remlap dampland has a low capacity to efficiently strip nutrients and features soils with a low phosphorus adsorbing capabilities;

- the proposed lagoon will feature a significant increase in habitat diversity in comparison to the current Remlap dampland. This will be achieved by establishing shallow wading banks, fringing vegetation and stable littoral zones. A wildlife corridor will be created through the positioning of three islands and 'end' vegetated areas. Additional planting of species common to the Yoongarillup Plain and not currently found within the Remlap dampland will

further add to environmental value of the lagoon, and create both shaded and open littoral zones; and

- the proposed lagoon will provide markedly increased visual quality and recreational resource potential to the site.

4.3 LAND-BASED FACILITIES

The proposed development also includes the creation of 64 strata lots of various sizes for residential, short stay chalet accommodation, camp accommodation, equestrian and tennis facilities. The chalets will be located around the newly created lagoon. The proposed arrangement of the strata lots is as follows, and shown in Figure 6:

- twelve large lots identified as Lots 1 to 10, 63 and 64 ranging in size from 8150 m^2 to 1.82 ha. The dwellings on each will average three bedrooms;
- fifty smaller lots, identified as Lots 11 to 60, of approximately 1,200 m^2 on which will be constructed a three bedroom dwelling to a standard design;
- one residential building with dormitory type accommodation for up to 40 persons, identified as Lot 61;
- one tennis camp with dormitory type accommodation for up to 40 persons, identified as Lot 62; and
- one administration building and managers residence, located on the eastern boundary of the proposed irrigation area between Lots 7 and 8.

The 50 smaller Lots 11 to 60 will be situated in groups of five to seven around the lagoon. It is intended that each be separated by pockets of vegetated *Melaleuca rhaphiophylla* and other Yoongarillup Association shrubs and trees. The chalets will be of an environmentally sensitive design, and feature either a verandah deck or finger jetty extending to the edge of the lagoon. The chalet structures will be set back to a suitable distance from the shore to allow littoral growth on the banks of the lagoon to establish.

The tennis courts and group accommodation bunkhouses will be constructed on raised land along the eastern boundary of the site.

The 12 larger lots (1 to 10, 63 and 64) are located away from, and to the west of, the lagoon. No standard dwelling design constraints exist for these lots and horses will be permitted on these blocks.

To minimise nutrient contamination and water usage it is proposed that dry landscaping using appropriate native species be used wherever possible, and particularly in the immediate vicinity of the lagoon shoreline. Mature trees already existing on the site will be retained where possible. To enhance nutrient retention and prevent nutrient contaminated runoff entering the lagoon, shallow vegetated swales will be positioned between each chalet to intercept surface run off from the grassed and hard paved

'garden' areas at the rear of the chalets. Owners of the 10 larger lots will be encouraged to use native plants and slow release fertilisers. Figure 12 indicates a suitable design approach to the proposed chalet landscaping.

Irrigated areas will include the tennis courts, rear gardens of each chalet, landscaping associated with the tennis camp, equestrian centre and residential building. Deep rooted turf is recommended which possesses low water and nutrient requirements. The horse agistment area may require pasture improvement through fertiliser application and some summer irrigation. As this area is west of the lagoon no impact on the wetland is expected.

The common irrigation area for disposal of treated wastewater effluent will feature intensive planting of suitable plant species to nutrients total nitrogen with total phosphorus being retained by the amended soils. Access to this area will be restricted in accordance with public health provisions.

A CALM designated fire break of 100 m separates the closest buildings along the eastern boundary to the State Forest pine plantation.

4.4 UTILITIES

4.4.1 Water Supply

The water supply for the development will be provided by a new bore into the superficial groundwater aquifer. A licence will be obtained from WAWA for extraction from the superficial aquifer. An allocation of 4,000 litres per hectare of property is expected to be made available by WAWA. This equates to approximately 38,800 kL of water per annum for the Remlap property which is adequate for all intended uses.

The water would be treated to meet the guidelines set by the Australian Water Resources Council, the National Health and Medical Research Council and the requirements of the Health Department of Western Australia. Treatment would consist of a package water treatment plant to remove iron, and chlorination to remove bacteria. The water from the treatment plant would be stored in tanks on site and then piped to each of the development units and lots.

A report commissioned by Gutteridge Haskins & Davey, on which the above is based, is provided in Appendix D.

4.4.2 Waste Treatment and Effluent Disposal

Waste treatment for the site will be serviced by either a bioMax Aerobic Wastewater Treatment System determined according to dwelling density or an acceptable equivalent treatment system with similar environmental performance. bioMax AWTS are five tank modular concrete systems designed for in-line flow from primary treatment, aeration,

classification, disinfection and pump-out which significantly reduce nutrient output to groundwater. The bioMax AWTS packages proposed for the following lots are:

- Lots 1 to 10, 63 and 64 will be serviced by septic tank and leach drain or bioMax C10 AWTS;
- the wastewater collection from each dwelling on Lots 11 to 60 will be divided into four groups of Lots 11 to 22, Lots 23 to 35, Lots 36 to 48 and Lots 49 to 60. Each of these groups of dwellings will have its own common effluent collection system discharging into its own pump station and then to its own treatment plant. The treatment plants proposed are bioMax C60 AWTS designed to process up to 10,800 L/day;
- the tennis camp dormitory accommodation located on Lot 62 will be serviced by a bioMax C50 AWTS capable of processing up to 9,000 L/day;
- the residential dormitory accommodation located on Lot 61 will be serviced by a bioMax C50 AWTS capable of processing up to 9,000 L/day; and
- the manager's residence and administration building located on the eastern boundary of the irrigation area between Lots 7 and 8 would be serviced by bioMax C10 AWTS capable of processing up to 1,800 L/day.

To ensure groundwater contamination by nutrients is minimal the following two effluent disposal methods are proposed for Lots 1 to 10 and all other lots.

4.4.2.1 Lots 1 to 10, 63 and 64

Lots 1 to 10, 63 and 64 serviced by bioMax C10 AWTS would require a discrete garden bed area of 150 m^2 for irrigation disposal purposes. The soils in these areas should be friable, well drained with a minimum groundwater clearance from the top of the irrigation disposal pad to the highest known groundwater of 900 mm. Owners of these lots will be encouraged to plant their garden beds with effective nutrient retaining vegetation to prevent nutrient loss to groundwater.

4.4.2.2 All Other Lots

The grouped strata Lots of 11 to 22, 23 to 35, 36 to 48 and 49 to 60, tennis camp dormitory, residential dormitory, administration building and managers residence would dispose their wastewater to the common irrigation area located between Lots 7 and 8. The size of the disposal area is based on the Health Department of WA irrigation application rate of 10 L/m^2. As the combined effluent from the lots above and the managers residence and administration building is 53,331 L/day the according area is 5,333 m^2, which is half the area allocated in the proposed disposal area and more than adequate to service disposal of the combined wastewater produced. The disposal area is located west of the lagoon to ensure minimal contamination of the lagoon.

As the soils are highly permeable within the site, to prevent phosphorus loss from the disposal area Alcoa 'Red Mud' soil amendment is proposed. Using the current criteria of 30 m^3 of Alcoa 'Red Mud' per 1,800 L of wastewater, 889 m^3 of amending soil would be required for 53,331 L/day, which is the estimated combined flow from the dwellings on Lots 11 to 60, the residential dormitory accommodation located on Lot 61, the tennis camp dormitory accommodation located on Lot 62 and the administration and managers residence located on the eastern side of the irrigation area.

The Alcoa 'Red Mud' will be applied as a 'wedge' (i.e. undiluted layer) and covered with topsoil. Planting of effective nutrient stripping vegetation will further enhance nutrient removal from groundwater. Effluent nutrient concentrations from the bioMax systems measure from 28 to 40 mg/L for total nitrogen and 7 to 18 mg/L for total phosphorus. In combination with soil amendment and nutrient retaining vegetation approximately 99% of total phosphorus and significant proportions of total nitrogen (approximately 50% or more) are removed.

This common irrigation area will have restricted access to reduce likelihood of microbiological contamination and irrigation (drippers or sprays as appropriate) times are likely to be early morning and evening. The planting of dense nutrient retaining vegetation will discourage use of this area.

A report commissioned by Durrant & Waite Pty Ltd, on which the above is based, is provided in Appendix E.

4.4.3 Road Access

Road access to the development will be via an extension of the existing EmuTech Restaurant and Park road connecting to Old Coast Road. Roads to be built to service the chalets and dwellings on larger lots are as follows:

- a road located between Lots 1 to 10;
- a road located along the western side of the lagoon; and
- a road located along the eastern side of the lagoon.

The roads will be constructed of crushed limestone to encourage the infiltration of rainfall and reduce runoff potential.

5 ENVIRONMENTAL EFFECTS

The environmental effects of the proposal are addressed in the following sections:

5.1 THE ESTABLISHMENT OF ENHANCED ECOLOGICAL VALUES OF THE LAKES EPP DAMPLAND

The current Remlap dampland will be modified to create an artificial lagoon. The environmental quality and ecological value of the lagoon will be significantly greater than the current Remlap dampland, and should comfortably achieve the criteria for Resource Enhancement indicated in EPA Bulletin 686 (A Guide to Wetland Management in the Perth and Near Perth Swan Coastal Plain Area). The environmental values of the lagoon can be summarised as follows:

- a permanent waterbody with defined boundaries will be established, and a significant wetland function will be restored to the site;
- the proposed lagoon will have a low nutrient status in comparison to the present high nutrient status of the existing agricultural dampland, and hence potential for nutrient contamination of groundwater will be markedly reduced;
- a significant increase in wetland habitat value and diversity will be established;
- considerably increased visual quality and recreational resource potential will be established; and
- the overall physical extent, and therefore resilience of the broader wetland system will be increased.

5.2 GROUNDWATER AND LAKE WATER QUALITY PROTECTION

The main potential impact on groundwater and lake water quality is nutrient contamination and enrichment.

The likelihood of nutrient contamination of groundwater or lake water is considered minimal due to the incorporation of the following design principles:

- the proposed lagoon bathymetry will have a maximum depth of only 2 m which will promote wind mixing and tend to discourage nuisance algal growth, and avoid anoxic conditions in the water column;
- nutrients entering the lagoon will be minimised through the implementation of 'Best Management Practices' involving the establishment of fringing vegetation and shallow well vegetated littoral zones. The mature lagoon should support

approximately double the biomass of vegetation currently existing on the Remlap dampland, therefore significantly increasing nutrient removal;

- the use of dry landscaping techniques, on the majority of the site, using species common to the Yoongarillup Association, will significantly reduce nutrient requirements;

- the use of bioMax AWTS (or similar environmentally acceptable waste treatment system) will significantly limit nutrient output within the development;

- locating a common waste disposal irrigation area west of the lagoon, and incorporating soil amendment and nutrient retaining vegetation. This should achieve a 99% adsorption of total phosphorus and significant utilisation of total nitrogen.

5.3 MONITORING PROPOSALS TO ENSURE MAINTENANCE OF APPROPRIATE WATER QUALITY STANDARDS

A network of six monitor bores has been established. Groundwater and lake water quality will be monitored quarterly to Australian Water Quality Guidelines for Fresh and Marine Waters and Australian Drinking Water Guidelines as detailed in Section 4.6.4., for a period of three years following construction after which a review and report is to be prepared to show that there are minimal fluctuations in the parameters.

5.4 GROUNDWATER USE IMPACTS ON OTHER USERS ADJACENT TO THE SITE

The WAWA will provide a licence for 38,800 kL per annum which will adequately service all intended activities in the proposal. The use of dry landscaping and native species will significantly reduce the amount of water that would otherwise be consumed. The creation of the lagoon will marginally increase evapotranspiration in the region. These combined effects of all water use are not expected to impact upon other users in the area.

The impact of abstraction on other users adjacent to the site and the lagoon can be quantified through approximating the daily 'worst case full capacity' abstraction rate and predicting the associated drawdown in the superficial aquifer.

Daily 'worst case full capacity' abstraction rate of the Remlap Ranch Resort during as summer period of 200 days is calculated as below.

The Remlap Ranch Resort will reside 350 persons at full capacity.

- 72 chalets and residential lots = 14 persons per dwelling = 288 persons;
- tennis camp and residential building = 40 persons;
- administration = 20 persons;
- total approximation 350 persons at full capacity;

- 350 persons use 200 L/day each excluding irrigation = total 70 kL/day; and
- at full capacity use 25,550 kL/year with 70 kL per day.

'Worst case full capacity' abstraction rate as used to predict drawdown on the superficial aquifer is 200 kL/day, to allow for irrigation.

The drawdown is calculated using the Theis equation below:

$$Sw = \frac{Q}{4\pi T} W(u)$$

Sw = drawdown (m)
Q = discharge (kL//day)
W(u) = well function (dimensionless), derived from tables of W(u) against u

where $u = \frac{r^2 S}{4T t}$

T = transmissivity (m^2/day)
s = specific yield (dimensionless)
r = radius (m)
t = time (days)

$$Sw = \frac{200 \quad 3.125}{4\pi \; 500}$$
$$= 0.1m$$

The predicted drawdown in the superficial aquifer is illustrated in Figure 13. The impact of the 'worst case full capacity' abstraction rate during a summer period of 200 days is predicted to be a drawdown of 0.1 m, 200 m from the production bore, and a drawdown of 0.2 m, 35 m from the production bore. Water levels in the lagoon are predicted to decline 0.15 m. At 'worst case full capacity' this is not expected to affect significantly other users in the area or water levels in the lagoon.

In the event the adjacent pine plantation is harvested, the impact of an expected rise of the water table can be quantified through approximating the daily pine plantation abstraction and predicting the associated rise of the superficial aquifer.

The rise of the water table directly beneath the pine plantation is calculated assuming 20% of the annual average rainfall will be available for recharge to the superficial aquifer, with average specific yield of 0.25 m (20% is assumed from similar studies on the Swan Coastal Plain).

$$\frac{recharge\% \;\; x \;\; annual\ average\ rainfall}{specificyield} = \frac{0.2 \;\; x \;\; 0.872}{0.25} = 0.70m$$

To produce a 'reversed' drawdown contour plot the daily abstraction of the adjacent pine plantation during a summer period of 200 days is approximated at 55 kL and 'reversed' drawdown calculated using the equation above (as used to predict drawdown from the proposed production bore). The 'reversed' drawdown of the superficial aquifer is illustrated in Figure 14.

In the event the adjacent pine plantation is harvested, water levels in the lagoon are predicted to rise approximately 0.2 m. This is not expected to impact upon the biological and recreational quality of the lagoon.

5.5 SEWAGE, DRAINAGE AND STORMWATER DISPOSAL

The potential for nutrient contamination of groundwater through sewage treatment and waste disposal using the bioMax AWTS or an equivalent system, is expected to be minimal.

5.5.1 Health Department of Western Australia Effluent Discharge Standards

As part of the Health Department of WA (HDWA) approval, the bioMax or other equivalent systems are required to meet a 20.30 effluent discharge standard i.e. 20 mg/L BOD_5 and 30 mg/L SS. With regard to microbiological standards, the HDWA standard for effluent discharge is <10 thermotolerant coliforms per 100 mL.

BOD_5

Experience of effluent sampling by Durrant & Waite and HDWA from the bioMax systems has shown that when systems are loaded at or below their design hydraulic and organic loading the units will produce an effluent quality of the order, 8-12 mg/L BOD. This translates to an organic load of 0.8 kg BOD_5/d or 1.5 kg/ha/d.

Microbiological

Random sampling by Durrant & Waite Pty Ltd and HDWA has demonstrated that when systems are loaded at or below their design hydraulic and organic loading the units maintain a free residual chlorine level of 0.5 mg/L which is sufficient to disinfect the effluent to meet the <10 thermotolerant coliforms per 100 mL.

Total P

We would estimate that approximately 0.37 kg TP/d or 253 kg/ha/yr will be discharged onto the site.

Using data from Gerritse (1990), it is estimated that 'domestic' effluent applied at a rate of 233 kg/ha/yr discharged onto 302[3]/1,800 L of Alcoa 'Red Mud' will maintain a PRI of >20 for at least 10 years. Advice has been received that this is an extremely cautious estimate.

Given that the application rate estimates for this project is similar, a life expectancy of a PRI>20 will be at least 10 years (also refer to 'Assumptions' below).

Total N

We would estimate that approximately 1.5 kg TN/ha/d will be discharged onto the site.

Assumptions

(1) All of the above effluent discharge estimates are based on maximum hydraulic, organic and nutrient loads supplied 365 days per year.

(2) The loading rates per hectare are based on the HDWA minimum application rate of 10 L/m^2/d, i.e. 53,331 L discharged over 5,333 m^2. The figures could be halved if the effluent is discharged over the total area available for effluent irrigation - 1.1 ha.

(3) The estimates do not take into account any reductions in N & P loadings due to other than 'normal' household practices taking place. (Full laundry activities are unlikely).

(4) Any claims in relation to the special soil properties of the Alcoa 'Red Mud' (i.e. nutrient removal, heavy metals removal, bacterial attenuation) are primarily based on those presented by "Ecomax Wastewater Treatment Systems" who supply the amending soil material proposed for this project.

5.5.2 Stormwater Disposal

Stormwater runoff will be minimised and recharge to the aquifer maximised due to the following:

- lots and roads to feature grassed swale drains, culverts and dispersion into landscaped areas;
- roads will be of crushed limestone construction to aid the infiltration of rainfall; and
- runoff from the roofs of buildings will be collected into holding tanks and dispersed onto landscaped areas.

5.6 EFFECTS OF EXCAVATED SPOIL DISPOSAL, INCLUDING CONTROL OF SEDIMENTS AND NUTRIENTS

The excavated spoil from the dampland would be spread and compacted over the proposed development areas, with any runoff and sediment created in the process contained in the lagoon basin. These areas would then be seeded to prevent erosion and allow uptake of nutrients present in the soil. Silt traps would be used during construction to prevent transfer of material into adjoining areas. The topsoil would be stockpiled and stabilised with sedges, reeds and shrubs to be replanted from the Remlap dampland. This will assist in the retention of nutrients and protection of the microbiological integrity of the soil.

The potential for nutrient contamination of groundwater will be minimal.

5.7 LOSS AND IMPACT ON FLORA AND FAUNA DURING CONSTRUCTION AND MAINTENANCE OF FACILITIES

The effect on flora and fauna during construction and maintenance of facilities will be minimised.

Construction of the new lagoon will involve either retention or replanting of existing vegetation whenever possible. With additional planting of appropriate species, a substantial net gain in wetland vegetation is expected in the long term.

During construction, fauna will find refuge in those areas of dampland vegetation being retained. Following construction, the provision of greater habitat diversity should encourage water bird use,
and allow other fauna present on the site to recolonise the new environments created.

5.8 SHORT- AND LONG-TERM MANAGEMENT UNDERTAKINGS

The development is designed to enhance environmental values of the site, both in the short and long term, through application of the following planning and design aspects of the proposal:

- the lots are strata titled and a formal management arrangement will be established to maintain the natural and man-made elements of the development;
- the lots are separated into groups, to be serviced by individual bioMax AWTS (or similar waste treatment system), which will allow the proponent to construct the development in stages; and
- the lagoon is designed to simulate natural wetland processes and function largely as a self-maintaining system.

6 ENVIRONMENTAL MANAGEMENT PROGRAMME

The proposed development has the potential to provide significant tourism resource and restore conservation values of the EPP Lake within the site, for the benefit of the Shire of Harvey and the broader community. Although potential environmental effects associated with the project are resolved through the environmentally sensitive design, appropriate ongoing management is required to ensure there are no adverse environmental impacts during either the construction phase or long term operation phase.

6.1 CONSTRUCTION MANAGEMENT PLAN

Management requirements for the construction phase of the development are discussed under the following headings:

- lagoon construction;
- building construction;
- drainage and runoff potential;
- nutrient and irrigation use; and
- general works.

6.1.1 Lagoon Construction

Construction of the lagoon will involve the following:

- the design and construction of the lagoon applying the guidelines and principles specified in this document;
- the lagoon will be constructed by a cut and fill operation;
- any runoff and sediment created during construction to be contained within the Remlap proposal site;
- soil excavated from the lagoon will be spread and compacted over proposed development areas and stabilised with vegetation;
- the use of silt traps on drainage lines to reduce erosion;
- the preservation of existing vegetation wherever possible;
- removal and stockpiling of topsoil, sedges and reeds for replanting;
- additional planting of species common to the Yoongarillup Association to achieve vegetative cover of approximately two thirds of the lagoon shoreline (including islands);

- landscaping of islands and banks to be suitably graded to allow establishment of fringing vegetation, and a 'natural' littoral zone; and

- addition of a 0.2 m organic layer to selected parts of the bottom of the lagoon to encourage invertebrate activity.

6.1.2 Building Construction

To achieve a high quality development, the following approaches are proposed:

- built structures will be set back a minimum of 100 m from the boundary of the State forest pine plantation.

- integrated design principles/guidelines will be adopted for chalets, tennis dormitory, residential dormitory, administration and managers residence; and

- construction of chalets to be undertaken in stages.

6.1.3 Drainage Runoff Potential

To minimise runoff potential the following actions are proposed:

- swale drains and culverts to be incorporated along chalets and roads to contain and disperse runoff onto landscaped areas;

- collection of stormwater runoff from buildings to be dispersed in landscaped areas; and

- internal roads to be of crushed limestone construction which will assist infiltration of rainfall.

6.1.4 Nutrient and Irrigation Use

To avoid impacts on groundwater and lake water quality the following approaches are proposed:

- the retention of appropriate natural vegetation wherever possible and use of dry landscaping methods using species common to the Yoongarillup Association;

- the use of bioMax AWTS (or equivalent waste treatment system) for sewage treatment within the site;

- the amendment of soil and planting of nutrient retaining vegetation on the common effluent disposal area; and

- minimising areas of irrigated landscaping requiring high water use and fertiliser application.

6.1.5 General Works

To minimise noise and disturbance to surrounding residents it is proposed that:

- hours of construction be limited to times acceptable to Council.

6.2 LONG-TERM MANAGEMENT PLAN

Management requirements for the long term maintenance of the development are discussed under the following headings:

- general management provisions;
- groundwater and lake water quality monitoring programme;
- nutrient and irrigation use; and
- lagoon habitat.

6.2.1 General Management Provisions

To ensure the environmental quality of the development is maintained there will be a resort manager/caretaker will be appointed to ensure integrated and coordinated management of all environmental aspects of the development.

6.2.2 Groundwater and Lake Water Quality Monitoring Programme

Groundwater and lake water quality will be monitored as follows:

- monitoring of groundwater and lake water quality at quarterly intervals for a period of three years following construction; and

- monitoring of water levels to occur quarterly for a period of three years after construction to monitor any drawdown effects.

- deterioration in the water quality of the lagoon requiring management intervention will, in practical terms, be determined by observation as conditions deteriorate. Effective indicators will include:

    - the occurrence of algal blooms, and or a significant reduction in light penetration to the wetland waterbody due to excessive phytoplankton growth;
    - the occurrence of malodours and odour complaints; and
    - complaints of other nuisance symptoms (e.g. midges, weed growth, etc.).

Management response to severe water quality deterioration will include the following options:

(i) removal of algae by use of booms and skimmers, and thence removal from the site by appropriate means;

(ii) oxygenation (by bubble curtain, or aeration by other means, including fountain, air pump, etc.); or

(iii) alum dosing.

6.2.3 Nutrient and Irrigation Management

To ensure minimal impact on groundwater and lake water quality the following will be undertaken to reduce long-term nutrient loading and groundwater abstraction rates for the development:

- encourage owners of Lot 1 to 10 to minimise fertiliser applications and to plant appropriate native species;
- encourage dawn/dusk irrigation and for gardens and turf/pasture areas;
- use of slow release fertilisers; and
- additional landscape plantings to be species of the Yoongarillup Association wherever possible.

6.2.4 Lagoon Habitat Conservation

To protect and maintain the conservation value of the lagoon system for fauna and flora, while achieving high visual quality and providing passive recreation opportunities, the following will be undertaken:

- controlling public access to islands refuges; and
- provision of interpretative signs to inform visitors/occupiers of the value of wetland processes and conservation of fauna habitats.

6.3 PROJECT MANAGEMENT

Management of the project will be undertaken in two phases. The proponent will be responsible for the Construction Management Plan incorporating all the works nominated in this CER and additional design and construction work necessary to fulfil the zoning provisions and conditions of the strata approval until such time as the strata company comes into operation.

The use of a strata scheme to subdivide the site will bring into existence a strata company which can be used to ensure ongoing co-operative management of services such as sewerage, water supply, etc., and environmental commitments agreed to as part fo the CER assessment process. Implementation of the long term management plan will be the responsibility of the strata company and commence upon the strata company coming into existence.

7 COMMITMENTS

The proponent's objective is to create an environmentally sensitive short stay accommodation resort, centred around an artificial lagoon, that aims to enhance and restore conservation values. As a result, the proponent undertakes to abide by all undertakings and commitments provided in this CER.

The following commitments are made by the proponent for the construction, completion and ongoing management of the Remlap Resort development.

LAGOON CONSTRUCTION

(1) The lagoon will be designed and constructed according to the principles and guidelines specified in this document, to the satisfaction of the DEP.

(2) The proponent shall ensure that construction of the lagoon will be undertaken by a cut and fill operation employing appropriate site supervision and management procedures so as to minimise construction impacts (including noise, dust, erosion, spread of weeds, soil contamination), to the satisfaction of the DEP and the Shire of Harvey.

(3) At all times prior to, and during construction the proponent will ensure that existing natural vegetation is retained wherever possible and appropriate, with the advice of CALM and to the satisfaction of the DEP.

(4) The proponent undertakes to replace all native wetland vegetation removed by construction of the lagoon, using appropriate species (sedges, reeds, groundcover, shrubs and trees) of the Yoongarillup Association wherever possible, with the advice of CALM and to the satisfaction of the DEP.

(5) The proponent will ensure that at least 50% of the lagoon shoreline/perimeter is established with appropriate fringing vegetation, on the advice of CALM and to the satisfaction of the DEP.

(6) The proponent undertakes to landscape the islands and lagoon banks to an earthwork grade that is appropriate for the establishment of fringing vegetation, with the advice of CALM and to the satisfaction of the DEP.

(7) The proponent undertakes to amend selected portions of the newly excavated lagoon bottom with 0.2 m (approximate and indicative only) organic material (taken from the topsoil organic layer removed during construction) in order to encourage invertebrate colonisation and biological activity, with the advice of CALM and to the satisfaction of the DEP.

PROJECT MANAGEMENT

(8) The proponent undertakes to appoint a resort/property manager/caretaker upon completion of construction of the Remlap resort development (stage 2), to oversee post construction commitments and management undertakings. Project management of the lagoon construction phase (stage 1) will be directed by the owner/proponent of the property, with the advice of Consultants.

BUSHFIRE PREVENTION

(9) The proponent undertakes to implement a minimum 100 m development set-back from the State Forest pine plantation for all structures/buildings, to the satisfaction of CALM and the Bush Fires Board of Western Australia.

DRAINAGE RUNOFF POTENTIAL

(10) The proponent undertakes to ensure that, at the time of construction, swale drains and culverts shall be incorporated in appropriate positions (e.g. between chalets and roads, etc.), to the satisfaction of the DEP and the Shire of Harvey.

SEWAGE AND EFFLUENT DISPOSAL

(11) The proponent undertakes to install a bio Max AWTS (or equivalent treatment system) for sewage treatment within the site, to the satisfaction of the Health Department and the DEP.

(12) The proponent undertakes to amend the soil of the common effluent disposal area and plant with nutrient retaining vegetation, with the advice of the Health Department and to the satisfaction of the DEP.

GENERAL CONSTRUCTION WORKS

(13) The proponent undertakes that construction of the development will be limited to hours acceptable to Council.

HABITAT CONSERVATION

(14) The proponent undertakes to ensure that in the operation of the Remlap resort facility public access to the island habitats is either controlled or restricted as appropriate.

(15) The proponent undertakes to ensure that there will be preservation of existing vegetation, use of dry landscaping methods, and planting of species common to

the Yoongarillup Association throughout the site, wherever possible and as appropriate, with the advice of CALM and to the satisfaction of the DEP.

GROUNDWATER AND LAKE WATER QUALITY MONITORING PROGRAMME

(16) The proponent undertakes to monitor groundwater and lake water quality quarterly for a period of three years following completion of the development, and to present the findings of the monitoring to the WAWA and the DEP annually.

(17) The proponent undertakes to monitor water levels each quarterly period for three years following completion of the development, and present the findings to the WAWA annually.

(18) The proponent undertakes to prepare an Environmental Management Plan (EMP) for the management of the lagoon, and to submit the draft EMP to the DEP and CALM for approval prior to implementation. The proponent undertakes to implement the approved EMP, including:

- monitoring the water quality;
- implementing a contingency plan in the event that water quality in the wetland declines; and
- monitoring the success of vegetation establishment around the foreshore and on the islands,

to the satisfaction of the DEP with the advice of CALM.

8 REFERENCES

Allen, D. G., & Jeffery, R. C., 1990. *Methods for analysis of phosphorus in WA soils.* Chemistry Centre (Western Australia) Report No. 37.

Analabs, 1993. *Untreated Water Potability Criteria.* Analabs (Western Australia).

Davis, J. A., & Rolls, S. W., 1987. *A baseline biological monitoring programme for the wetlands of the Swan coastal Plain, Perth, WA.* Environmental Protection Authority, Western Australia, Bulletin 265: 80pp.

Davis, J. A., Rosich, R. S., Bradley, J. S., Growns, J. E., Schmidt, L. G., & Cheal, F., 1993. *Wetlands of the Swan Coastal Plain. Vol. 6: Wetland classification on the basis of water quality and invertebrate community data.* Environmental Protection Authority and Water Authority of Western Australia: pp.242.

Deeney, A. C., 1989. *Geology and groundwater resources of the superficial formations between Pinjarra and Bunbury, Perth Basin.* Geological Survey of Western Australia, Report 26, Professional Papers: pp.31-57.

Department of Conservation and Environment, 1980. *Atlas of natural resources, Darling System, Western Australia.* Department of Conservation and Environment, Western Australia: 85pp.

Department of Conservation and Environment, 1983. *Conservation Reserves for Western Australia: The Darling System - System 6.* Department of Conservation and Environment, Western Australia: 343pp.

Environmental Protection Authority, 1992. *Environmental Protection (Swan Coastal Plain Lakes) Policy.* Environmental Protection Authority, Western Australia.

Environmental Protection Authority, 1993. *A guide to wetland management in the Perth and near Perth Swan Coastal Plain area.* Environmental Protection Authority, Western Australia, Bulletin 686: 28pp.

Environmental Protection Authority, 1993. *Strategy for the protection of lakes and wetlands of the Swan Coastal Plain.* Environmental Protection Authority, Western Australia, Bulletin 685: 10pp.

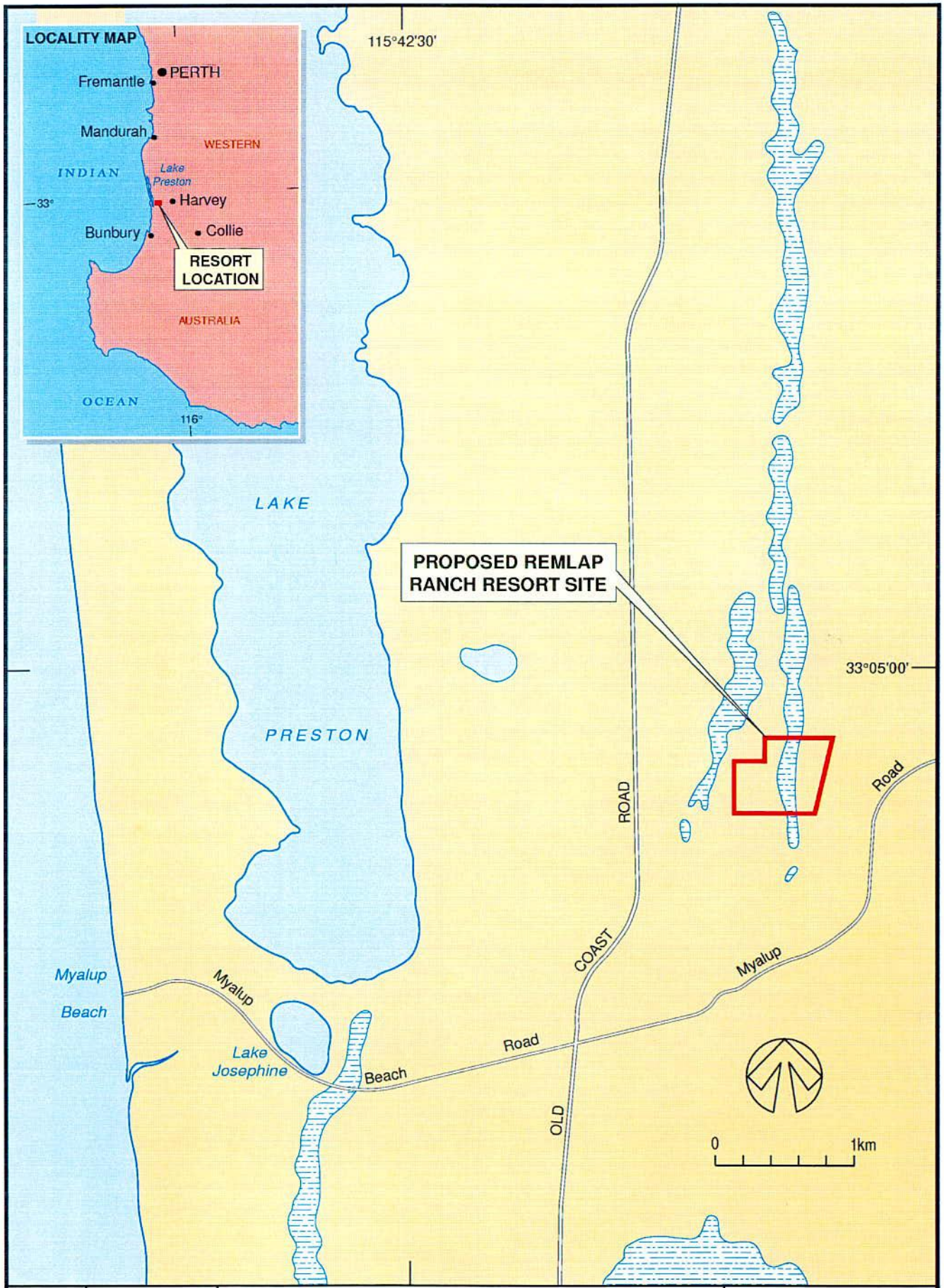
Grieve, B. J., & Blackall, W. E., 1975. *How to know Western Australian wildflowers.* University of Western Australia Press, Nedlands: 150pp.

Marchant, N. G., Wheeler, J. R., Bye, B. L., Bennett, E. M., Lander, N. S., & Macfarlane, T. D., 1987. *Flora of the Perth region.* Western Australian Herbarium, Department of Agriculture: 1080pp.

National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand, 1994. *Australian Drinking Water Guidelines.* National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand: 38pp.

Semeniuk, V., 1990. 'The geomorphology and soils of the Yoongarillup Plain in the Mandurah to Bunbury coastal zone, South-western Australia: a critical appraisal. *Journal of the Royal Society of Western Australia* 73: pp.1-7.

Figures



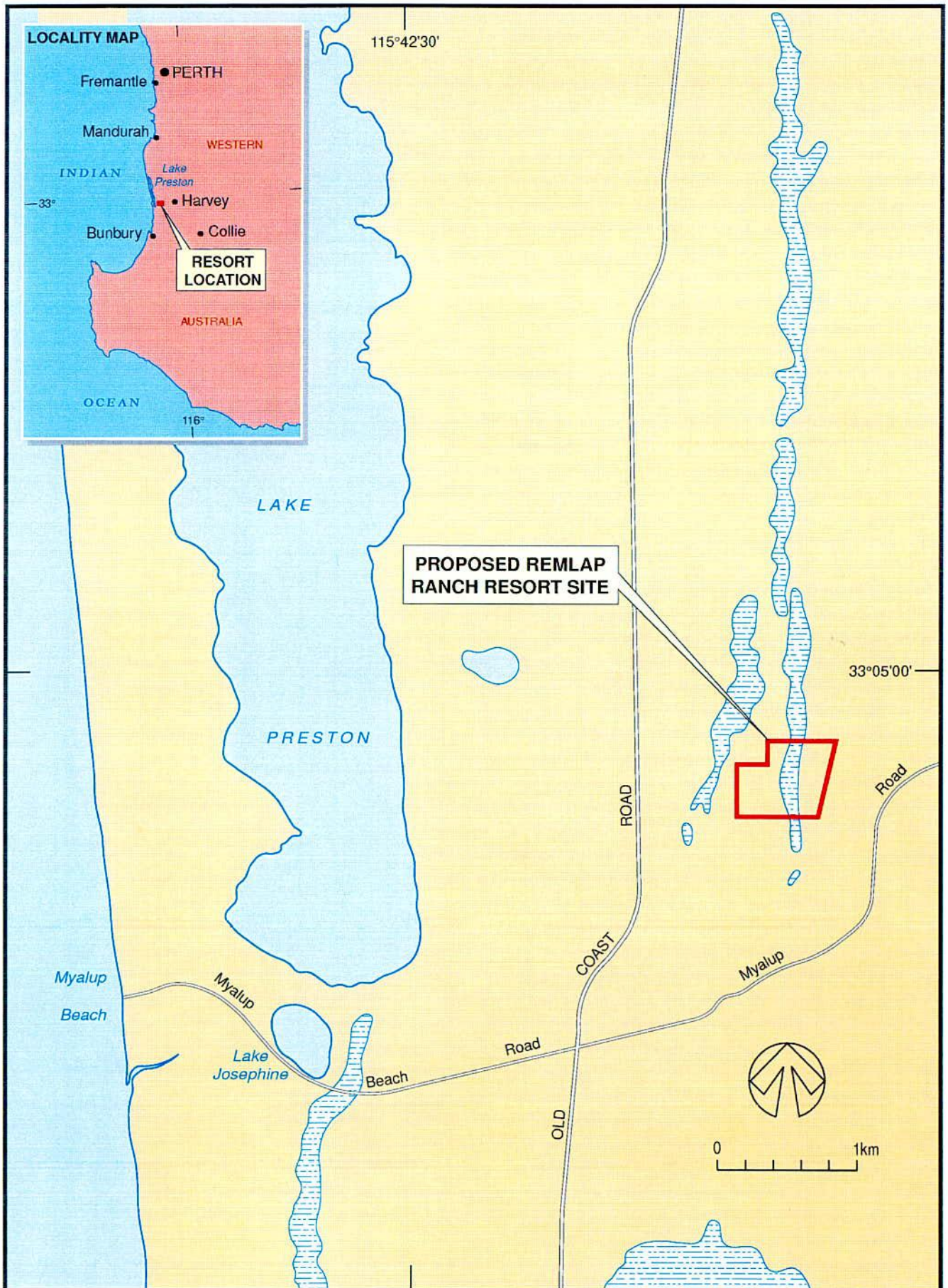
Job No.	30978-001-367	
Prep. By	JKB	18 Jul.'95
Chk'd. By	JPS	16 Oct 95
Rev. No.	0	08 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

LOCATION PLAN

Figure No.
1

LePROVOST DAMES & MOORE



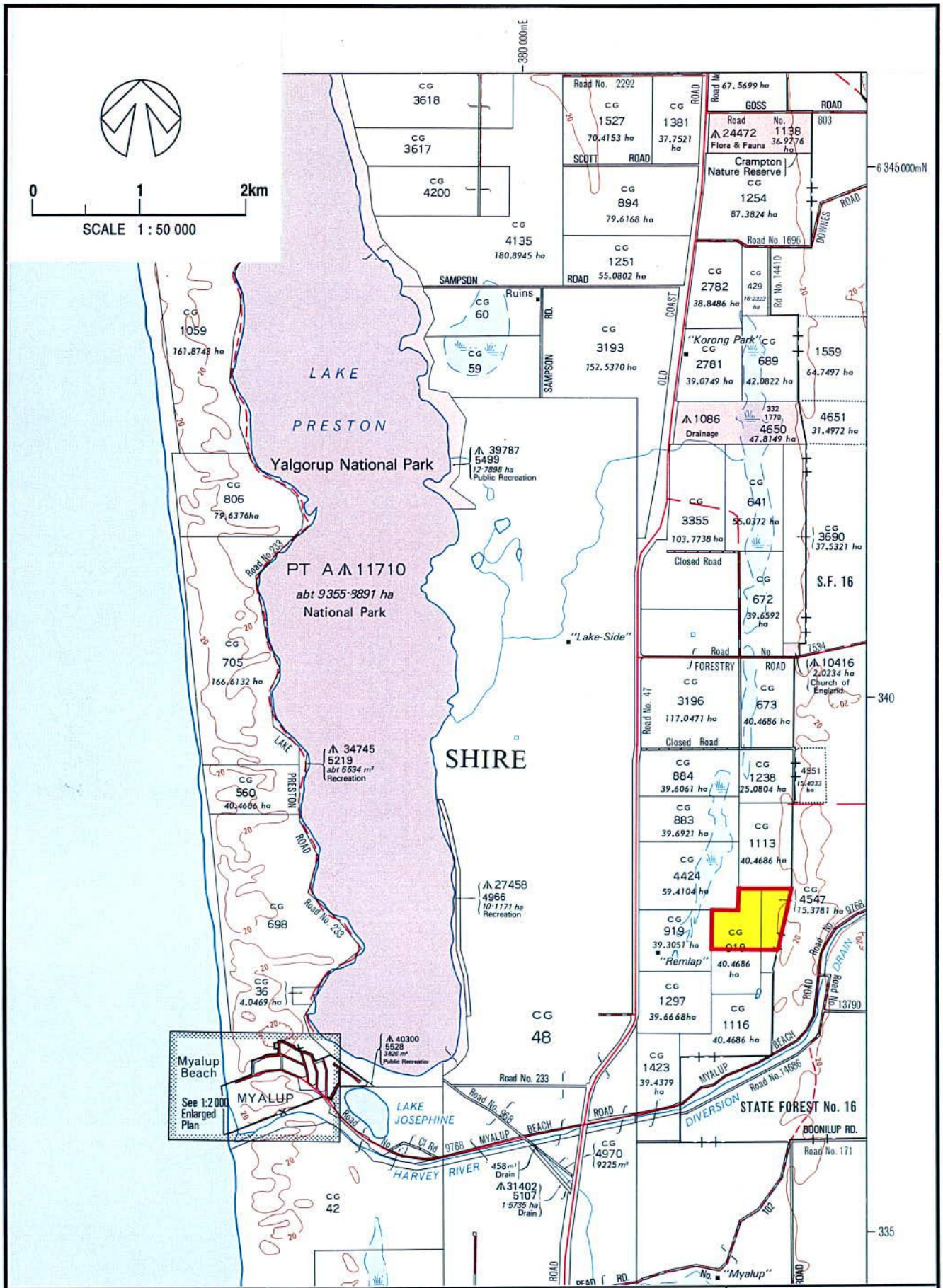
Job No.	30978-001-367	
Prep. By	JKB	18 Jul.'95
Chk'd. By	JPS.	16 Oct 95
Rev. No.	0	08 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

LOCATION PLAN

Figure No.
1

LePROVOST DAMES & MOORE



Job No.	30978-001-367	
Prep. By	JKB	04 Sep.'95
Chk'd. By	JPS.	16 Oct 95
Rev. No.	0	04 Sep.'95

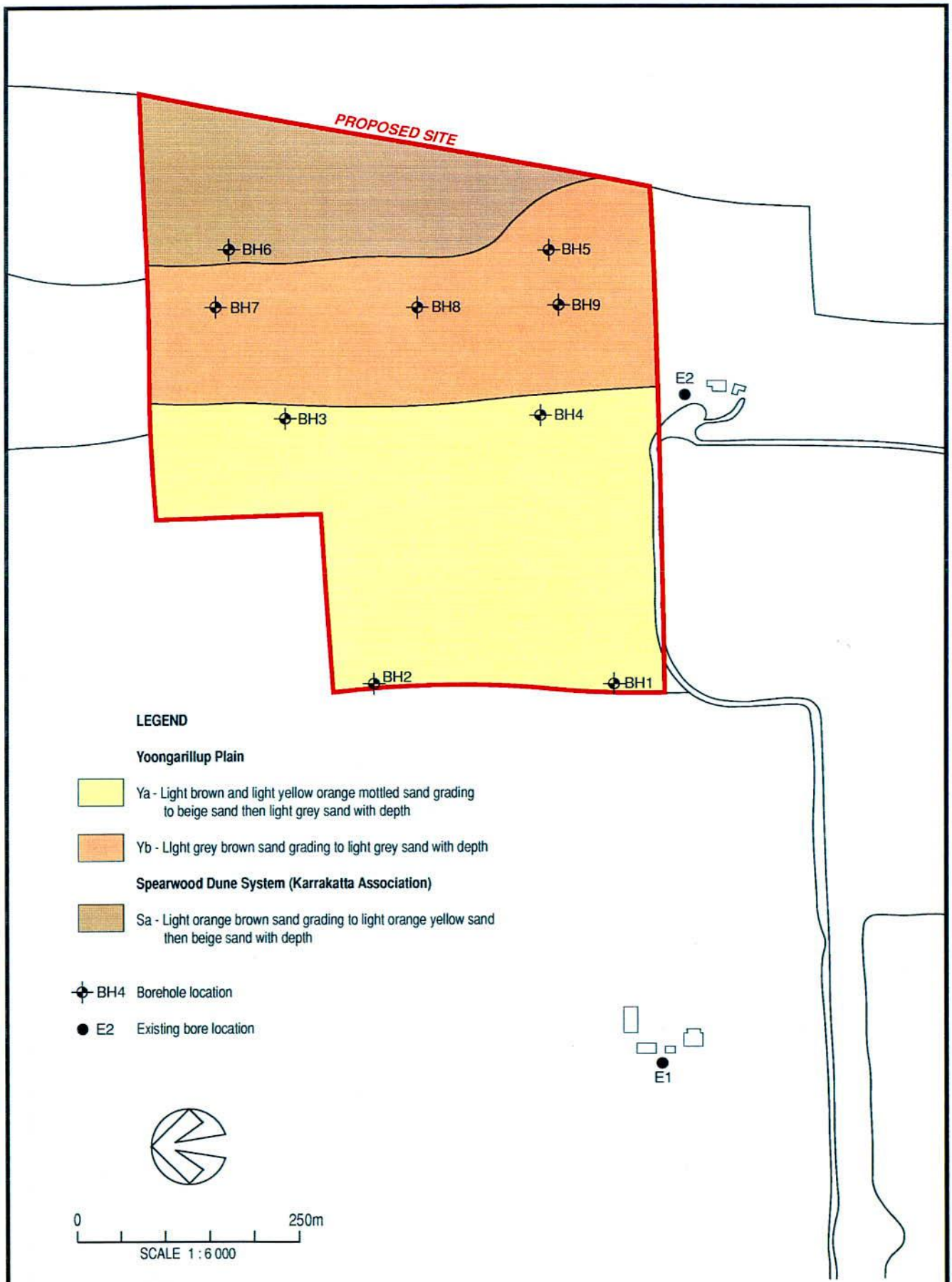
Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

TOPOGRAPHY AND CADASTRAL FEATURES

Figure No.

2

LePROVOST DAMES & MOORE



Job No.	30978-001-367	
Prep. By	JKB	18 Jul.'95
Chk'd. By	JPS	16 Oct 95
Rev. No.	0	16 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

SHALLOW SOIL ASSOCIATIONS

Figure No.
3

LePROVOST DAMES & MOORE

PROPOSED SITE

BH6 BH5 BH7 BH8 BH9 BH3 BH4 BH2 BH1

A B C D E1 E2

EMUTECH PROPERTY

OLD COAST ROAD

LEGEND

Vegetation Associations

- Dense stand of *Agonis flexuosa, Eucalyptus calophylla, Melaleuca rhaphiophylla*
- Dense stand of *Agonis flexuosa, Melaleuca rhaphiophylla*
- *Agonis flexuosa, Banksia attenuata, Eucalyptus calophylla* woodland
- Pasture with similar vegetation to Remlap dampland
- See figure 2 for detailed vegetation map
- Pasture with scattered *Agonis flexuosa, Eucalyptus calophylla, Eucalyptus marginata*
- State forest pine plantation

Topographic

- BH1 Borehole locaton
- E1 Existing bore location
- C Photograph site and direction
- Dam
- Seasonal Dampland/Wetland areas
- Sand mining

0 250m

SCALE 1 : 6 000

Job No.	30978-001-367	
Prep. By	JKB	18 Jul.'95
Chk'd. By	JS	16 Oct 95
Rev. No.	0	16 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

VEGETATION ASSOCIATIONS

Figure No.

4

LePROVOST DAMES & MOORE

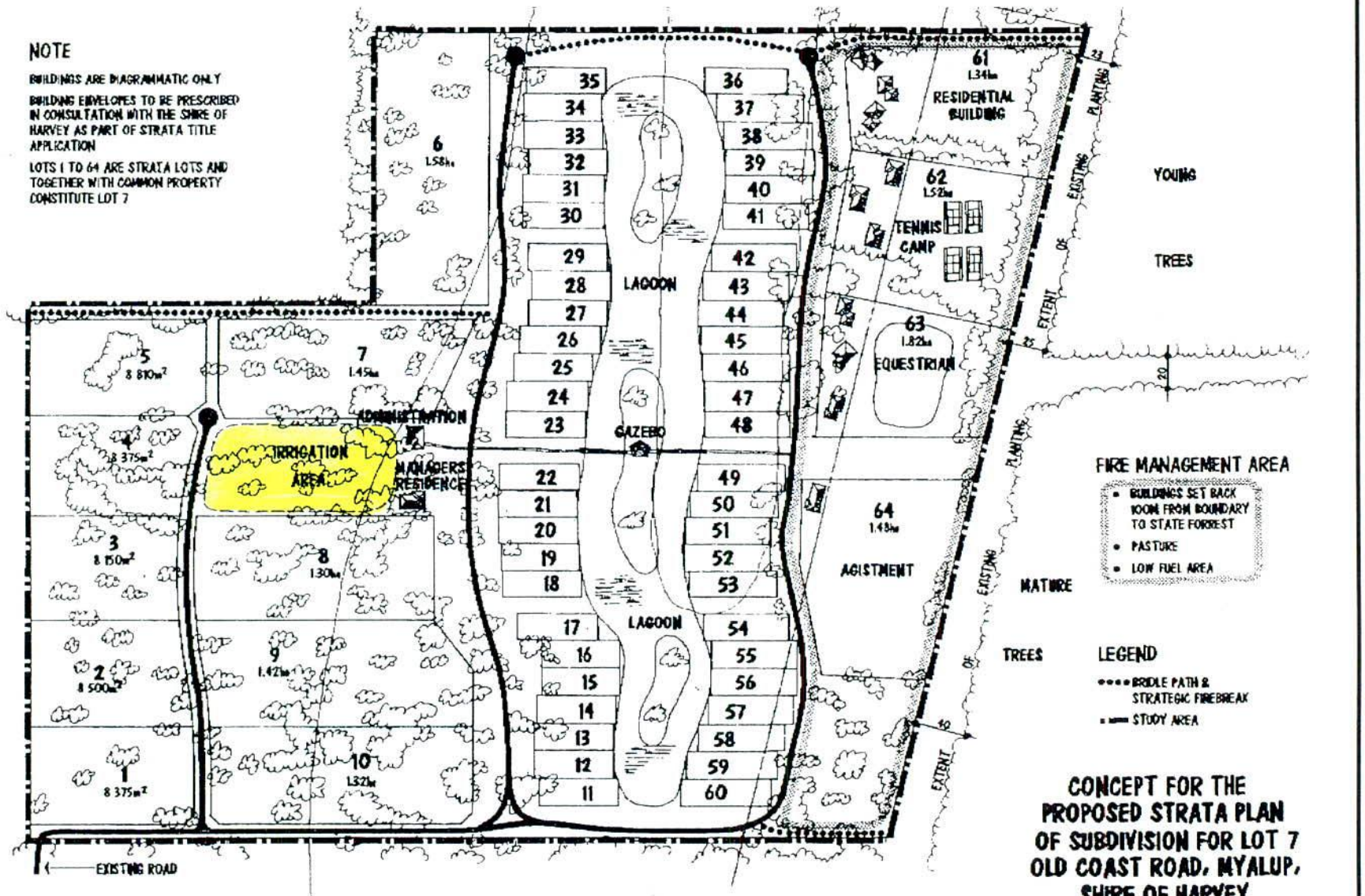
Job No.	30978-001-367
Prep. By	JKB 17 Jul.'95
Chk'd. By	JFS 16 Oct 95
Rev. No.	1 04 Sep.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

DAMPLAND VEGETATION

Figure No. 5

LePROVOST DAMES & MOORE



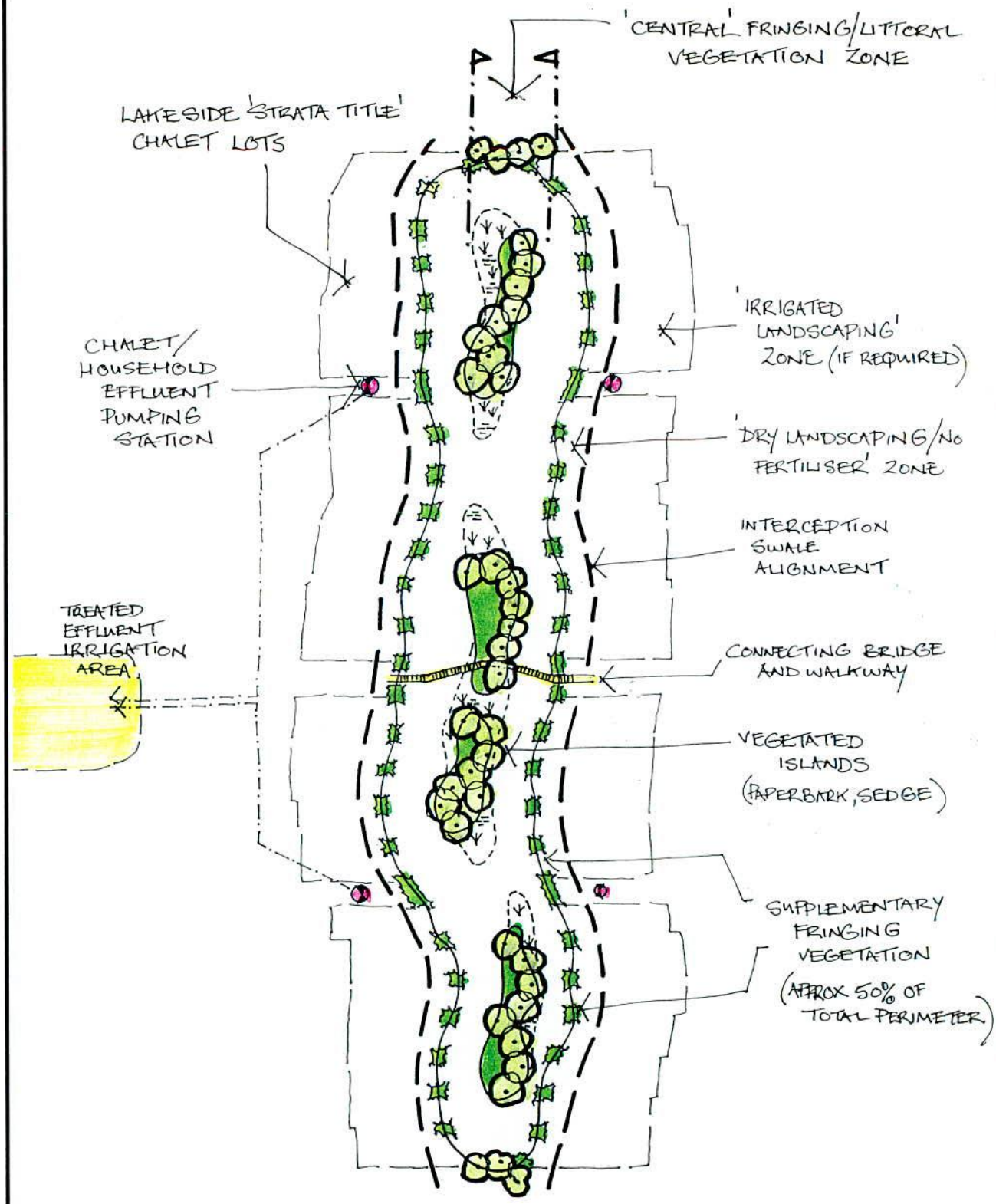
Job No.	30978-001-367
Prep. By	JS 08 Aug.'95
Chk'd. By	JPS
Rev. No.	0 11 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

PROPOSED STRATA/DEVELOPMENT PLAN

Figure No. 6

LePROVOST DAMES & MOORE



Job No.	30978-001-367	
Prep. By	JS	08 Aug.'95
Chk'd. By	JPS	16 Oct 95
Rev. No.	0	11 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

LAGOON DESIGN

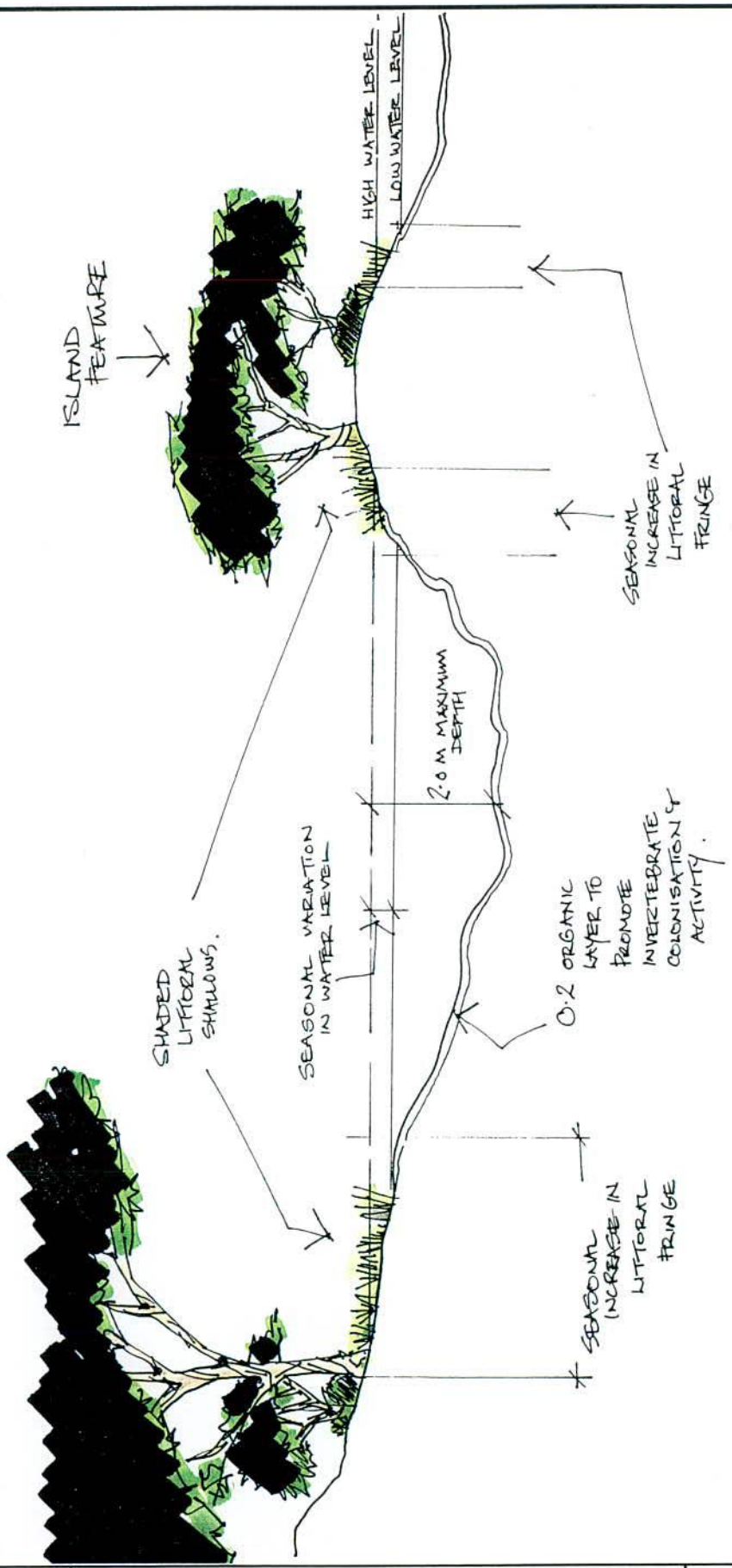
Figure No.
7

LePROVOST DAMES & MOORE

ISLANDS CREATED

- CONSERVING EXISTING YOONGARILLUP ASSOCIATION TREES/SHRUBS
- SUPPLEMENTARY 'WETLAND' VEGETATION

Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER	Figure No.
Prep. By	JS	08 Aug.'95		8
Chk'd. By	JS	16.08.95	BOARD WALK PEDESTRIAN BRIDGE AND ISLAND FORMATION	LePROVOST DAMES & MOORE
Rev. No.	0	11 Aug.'95		



Job No.	30978-001-367	
Prep. By	JS	08 Aug.'95
Chk'd. By	JS.	16 Oct 95
Rev. No.	0	11 Aug.'95

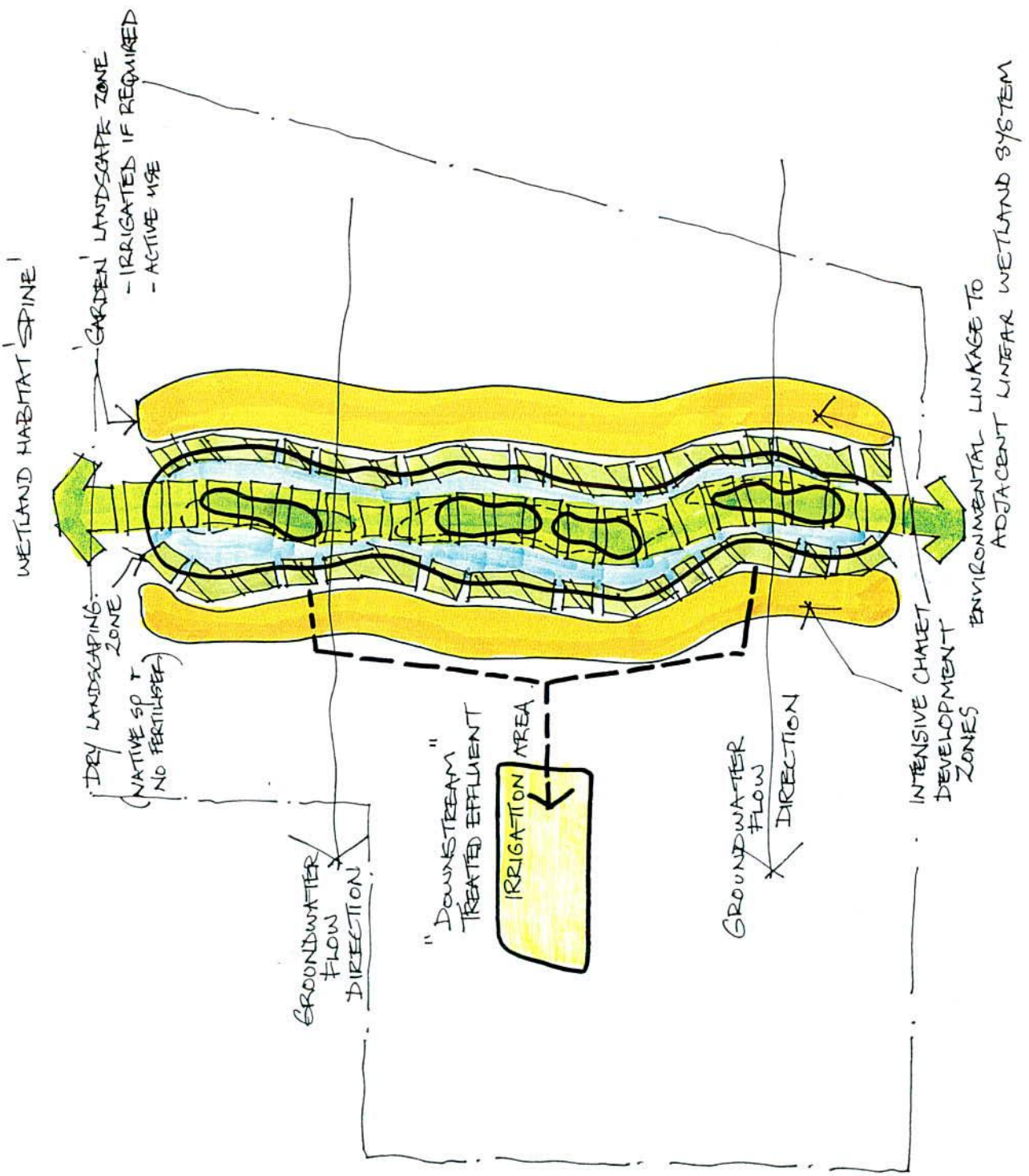
Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

LAGOON BATHYMETRY

Figure No.

9

LePROVOST DAMES & MOORE



Job No.	30978-001-367	
Prep. By	JS	08 Aug.'95
Chk'd. By	JS	16 Oct 95
Rev. No.	0	11 Aug.'95

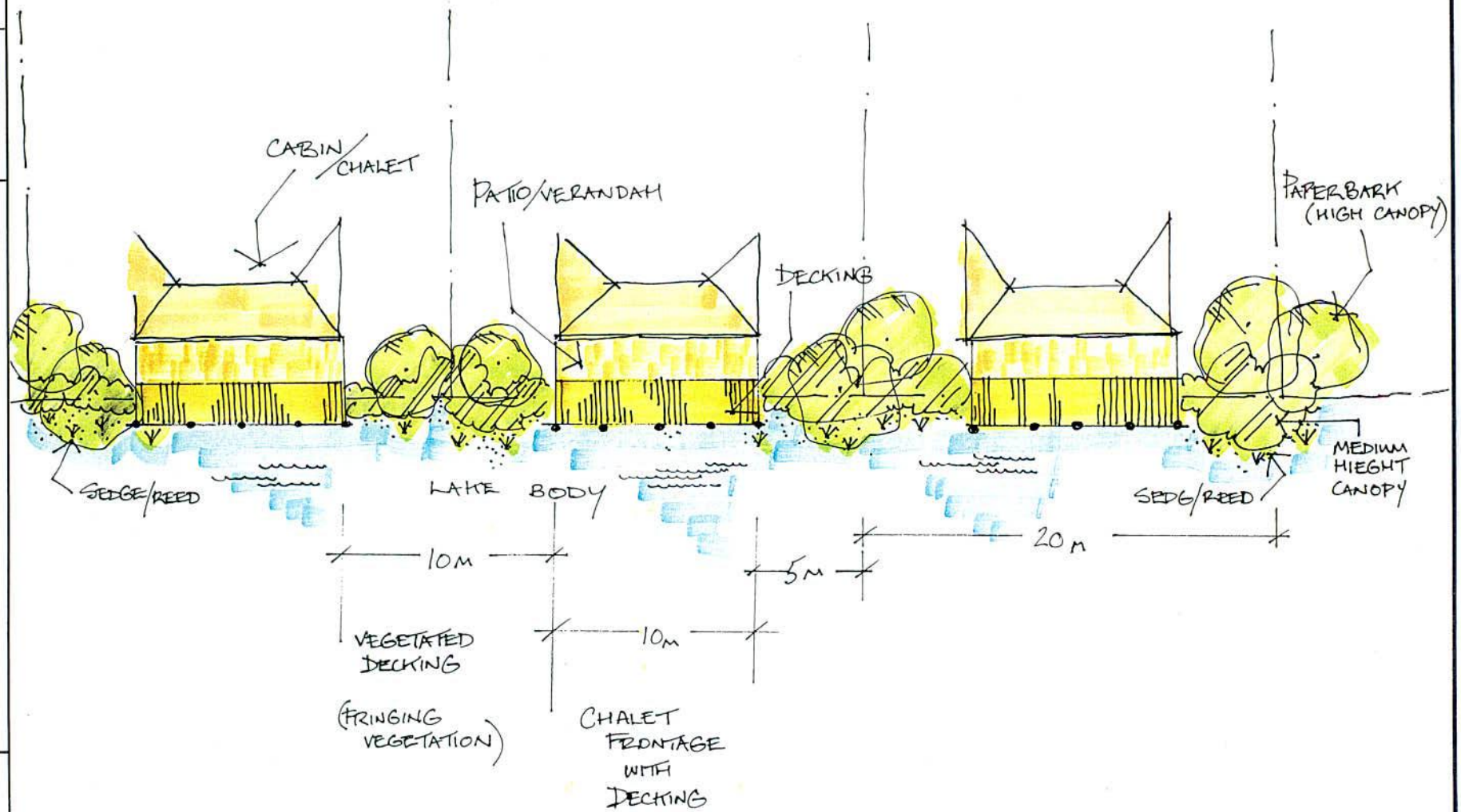
Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

"GREEN" HABITAT LINKAGE MECHANISM

Figure No.

10

LePROVOST DAMES & MOORE



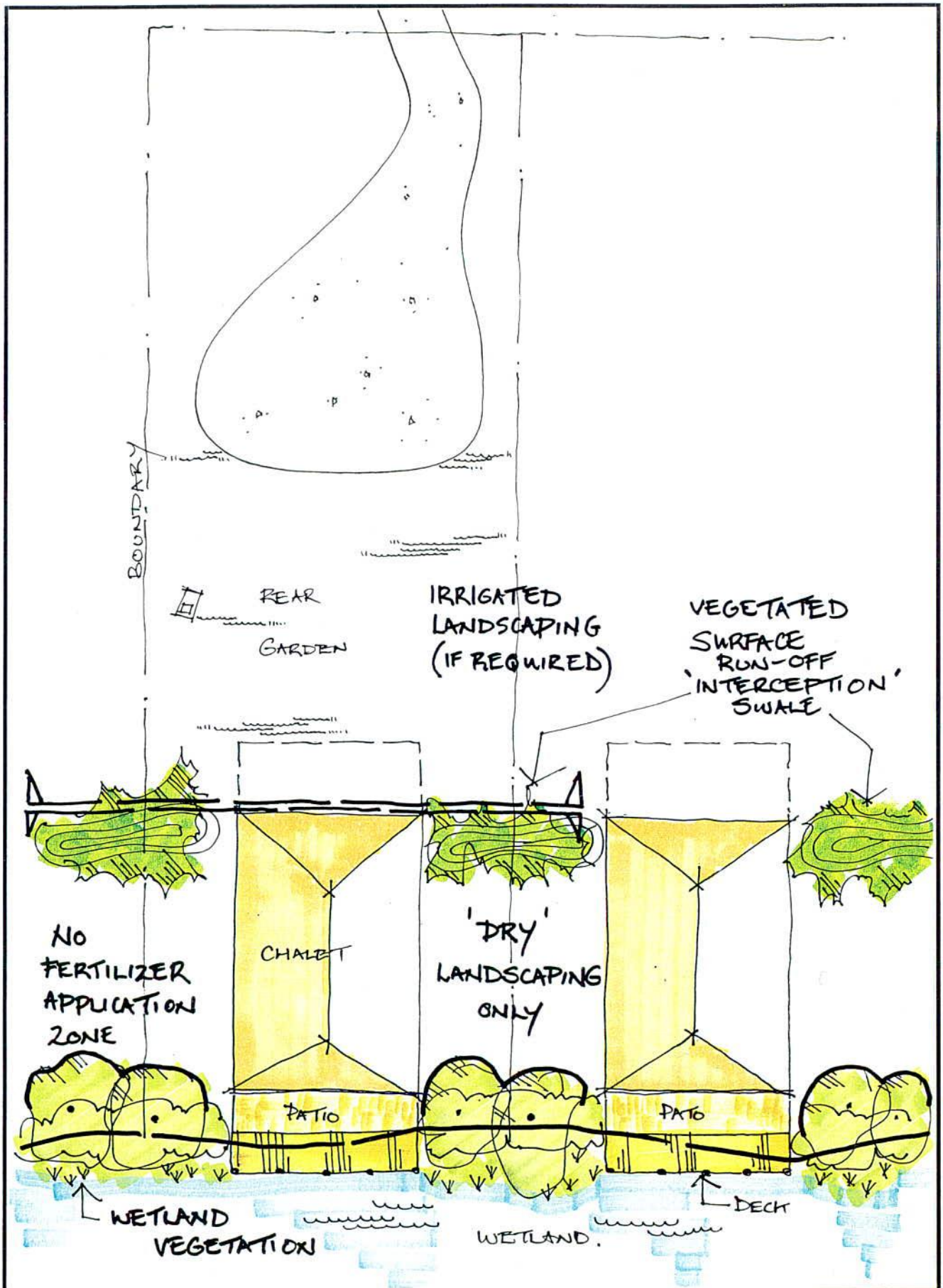
Job No.	30978-001-367
Prep. By	JS 08 Aug.'95
Chk'd. By	TS. 16 Oct 95
Rev. No.	0 11 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

CHALET FRONTAGE AND FRINGING VEGETATION

Figure No. 11

LePROVOST DAMES & MOORE

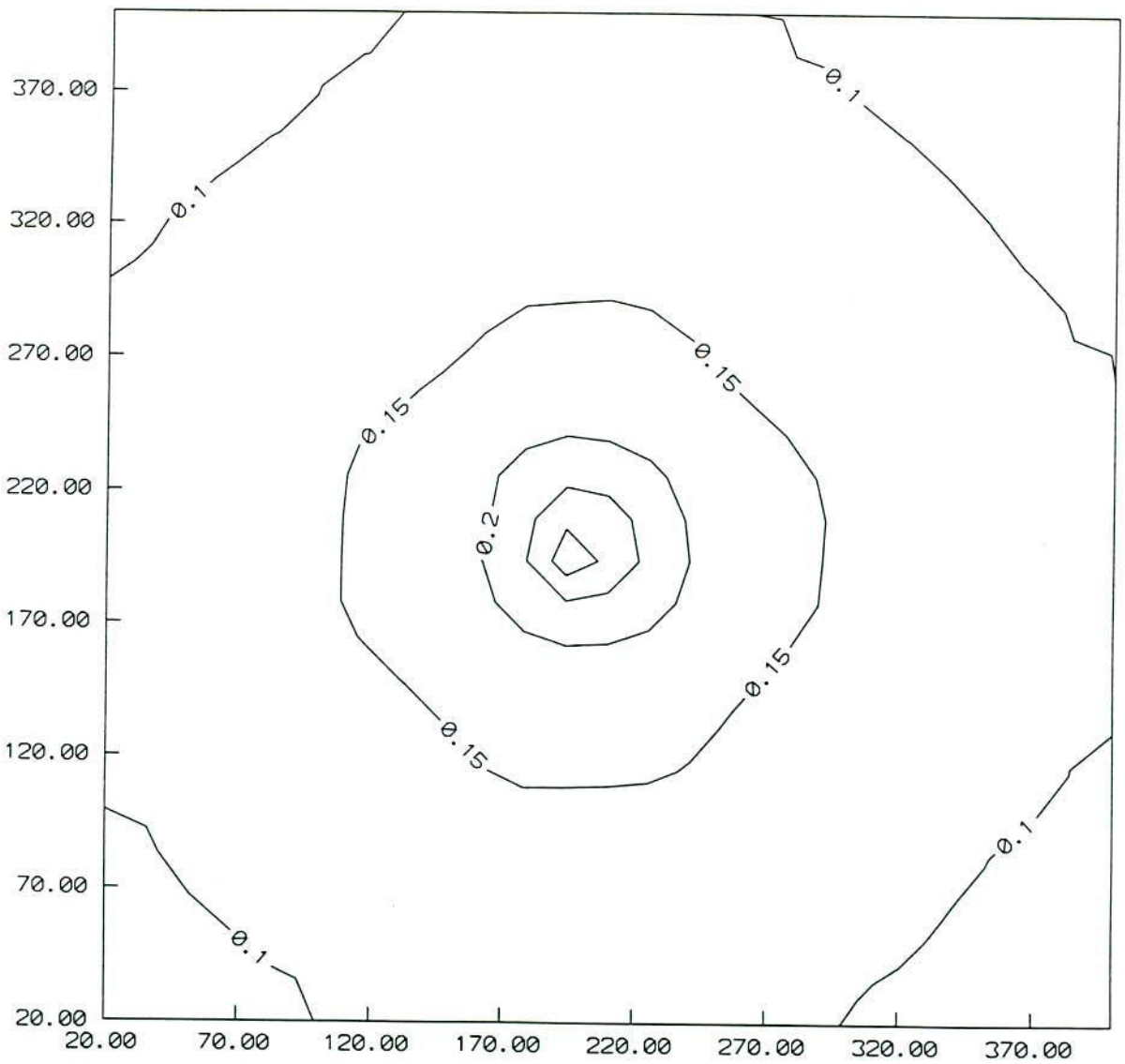


Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER CHALET LANDSCAPING
Prep. By	JS	08 Aug.'95	
Chk'd. By	JS	16 Oct 95	
Rev. No.	0	11 Aug.'95	

Figure No.

12

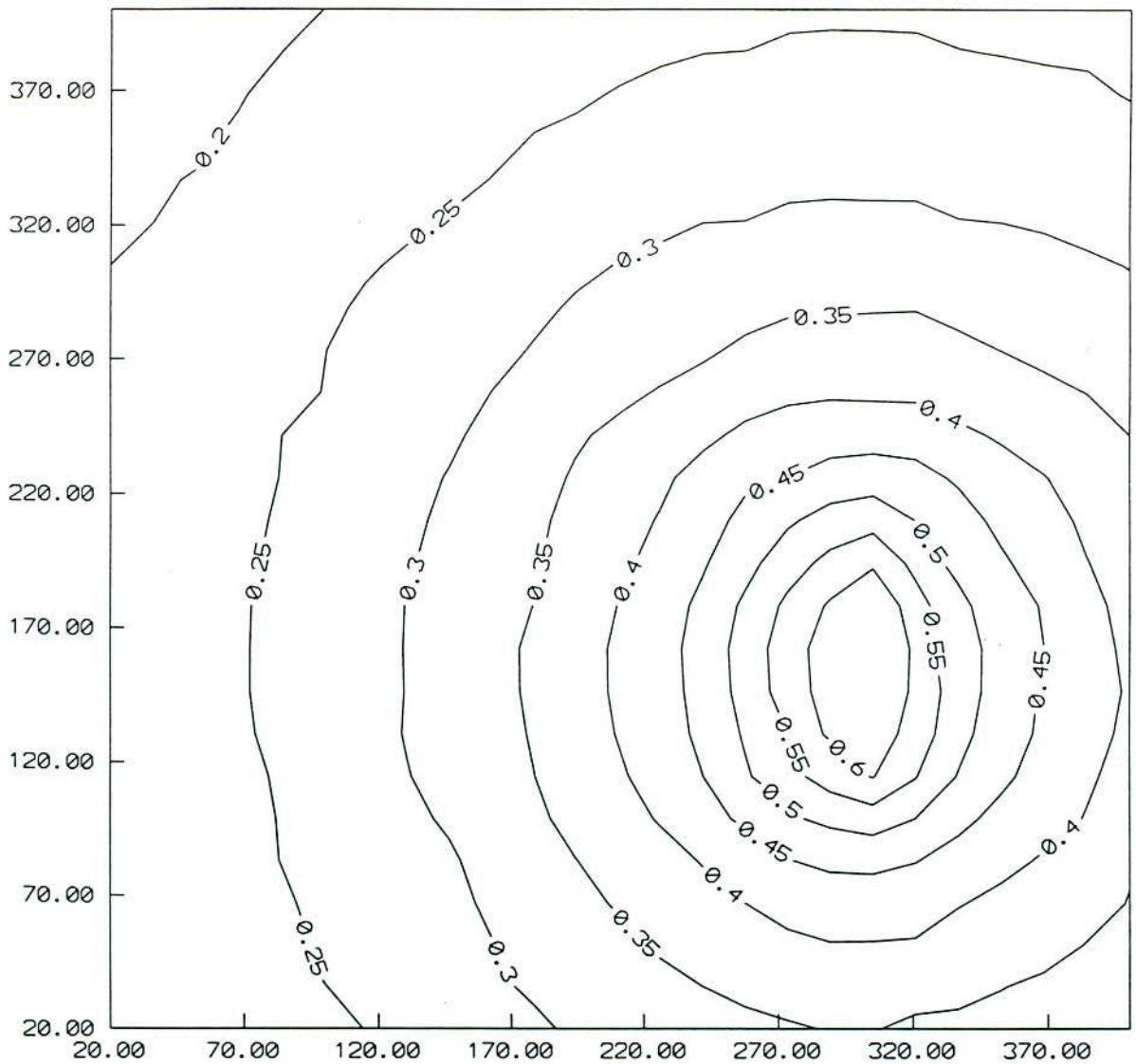
LePROVOST DAMES & MOORE



Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER PRODUCTION BORE DRAWDOWN OF SUPERFICIAL AQUIFER
Prep. By	JKB	16 Oct.'95	
Chk'd. By	JS	16.10.95	
Rev. No.	0	16 Oct.'95	

Figure No.
13

LePROVOST DAMES & MOORE



Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER	Figure No. 14
Prep. By	JKB	16 Oct.'95		
Chk'd. By	JS	16 Oct.'95	HARVESTED PINE PLANTATION FOREST REVISED DRAWDOWN OF SUPERFICIAL AQUIFER	LePROVOST DAMES & MOORE
Rev. No.	0	16 Oct.'95		

Views

LIST OF VIEWS

VIEW A	PROPOSED SITE, AERIAL VIEW WEST
VIEW B	PROPOSED SITE, AERIAL VIEW EAST
VIEW C	DAMPLAND VEGETATION, GROUND VIEW NORTH TO SOUTH
VIEW D	DAMPLAND VEGETATION, GROUND VIEW EAST TO WEST

Proposed Remlap Ranch Resourt Site

Job No.	30978-001-367	
Prep. By	JS	08 Aug.'95
Chk'd. By	JS	16 Oct 95
Rev. No.	0	11 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

PROPOSED SITE AERIAL VIEW WEST

View A

LePROVOST DAMES & MOORE

Proposed Remlap Ranch Resourt Site

Job No.	30978-001-367	
Prep. By	JS	08 Aug.'95
Chk'd. By	JS	16 Oct 95
Rev. No.	0	11 Aug.'95

Greenvale Enterprises Pty Ltd
REMLAP RANCH RESORT -CER

PROPOSED SITE AERIAL VIEW EAST

View B

LePROVOST DAMES & MOORE

Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER DAMPLAND VEGETATION GROUND VIEW NORTH TO SOUTH
Prep. By	JS	08 Aug.'95	
Chk'd. By			
Rev. No.	0	11 Aug.'95	

View C

LePROVOST DAMES & MOORE

Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER DAMPLAND VEGETATION GROUND VIEW EAST TO WEST
Prep. By	JS	08 Aug.'95	
Chk'd. By	JS	16/8/95	
Rev. No.	0	11 Aug.'95	

View D

LePROVOST DAMES & MOORE

Appendix A

EPA GUIDELINES FOR

CONSULTATIVE ENVIRONMENTAL REVIEW

GUIDELINES FOR THE CONSULTATIVE ENVIRONMENTAL REVIEW FOR THE SHORT STAY CHALET PARK AND EQUESTRIAN FACILITIES (REMLAP RANCH RESORT) - LOT 7 OLD COAST ROAD, MYALUP (Assessment No 828)

Overview

In Western Australia, all environmental reviews are about protecting the environment, which for this proposal means that the environmental values associated with the wetland system are protected.

These Guidelines have been prepared in response to a proposal forwarded to the Environmental Protection Authority (EPA) by Mr S Palmer to develop a short stay chalet park and equestrian facilities on Lot 7 Old Coast Road Myalup.

The primary purpose of the Consultative Environmental Review (CER) is to provide information on the proposal to the Environmental Protection Authority (EPA) within a local framework. The Authority will assess this information and then provide advice to the Government on the environmental acceptability of the proposal. An additional function of the CER is to communicate clearly with the public so that the EPA can obtain informed public comment. As such, environmental impact assessment is quite deliberately a public process. It also seeks to inform decision makers, to identify risks and minimise adverse environmental impacts, to achieve environmentally sound proposals through research, management and monitoring, and to manage potential conflict through the provision of the means for effective public participation.

It is the responsibility of the proponent to design and implement a proposal which protects the environment and to present this proposal for review by all interested members of the public. The proponent should describe what is proposed, discuss the potential environmental impacts of the proposal, and then describe how these environmental impacts are going to be managed so that the environment is protected.

These Guidelines have been prepared to assist the proponent in identifying issues which should be addressed within the CER. They are not intended to be exhaustive, and the proponent may consider that other issues should also be considered within the document.

The discussion in the CER should be concise, accurate, and easily understood. Specialist information should be included where it assists in the understanding of technical aspects of the proposal. Where possible, all information should be referenced. A copy of these Guidelines should be included in the CER.

Objectives of the CER

The CER should have the following objectives:

- to place this proposal in the context of the local environment;
- to explain the issues and decisions which led to the choice of this proposal at this location at this time;
- discuss the need for the proposal, including potential benefits of proposed dredging;
- to set out the environmental impacts that the proposal may have; and
- for each impact, to describe any environmental management steps the proponent believes would avoid, mitigate or ameliorate that impact.

The CER should focus on the major issues for the area and anticipate the questions that members of the public may raise. Data describing the environment should be directly related to

the discussion of the potential impacts of the proposal. Both should then relate directly to the actions proposed to manage those impacts.

Based on information available at this time, the primary issues of interest to the EPA relate to establishment of enhanced ecological values of the Environmental Protection Policy (EPP) protected lake, and water quality protection and management.

1. Justification:

- justification and objectives for the proposed development;
- an evaluation of alternatives, including location and alternative types/forms of development, and constraints associated with these; and
- justification of the preferred site.

2. Proposal

This should include a discussion of the following points:

- history of the proposal;
- status of the site;
- relevant statutory requirements and approvals;
- overall concept, location and layout;
- control, timing and staging of project;
- proposed land uses, land tenures, land zonings, and a clear distinction between boundaries of private and public land;
- regional and local planning context;
- extent and location of area of the EPP protected lake to be dredged;
- method of development of EPP protected lake (e.g. dredging, excavation, landfill);
- services and infrastructure including sewerage, drainage and water supply; and
- requirements for on-going water quality maintenance.

3. Existing Environment

While there should be a description of the main components on the existing environment related to the development site, emphasis should be placed on those aspects where impacts and management requirements are identified later in the CER. These include:

- local geology;
- local hydrogeology, including water quality, location of groundwater and direction of groundwater movement;
- terrestrial and wetland flora and fauna, including any declared rare flora or priority species;
- existing infrastructure, including services and drainage;
- description of existing communities in the vicinity of the proposed development;
- existing use of the are;
- historical, archaeological and ethnographic sites; and
- visual resource.

4. Key Environmental Impacts and Management

The potential impacts and their management for the development during the construction period and the longer term should be addressed, including the following specific issues:

- implementation of enhanced environmental objective for EPP protected lake;

- impact on surface and groundwater quality within the site as a result of development;
- details of on-going monitoring mechanisms to ensure maintenance of appropriate water quality standards;
- impact of disposal of spoil, including control of sediments and nutrients;
- impact on flora and fauna during construction and operation of facilities;
- impact on historical, archaeological and ethnographic sites;
- groundwater use and impacts on existing groundwater users on and adjacent to the site;
- sewage, drainage and stormwater management; and
- soil conservation management during development.

5. Public Participation and Consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the CER. It should describe the activities previously undertaken or proposed to be undertaken to promote public awareness and support for the proposal, the dates, groups and individuals involved, and the objectives of the activities.

Cross reference should be made with the description of the environmental management for the proposal which should clearly indicate how community concerns have been addressed. Where these concerns are dealt with via other departments or procedures, outside the Environmental Protection Authority process, these can be noted and referenced here.

6. Detailed list of Environmental Commitments

The commitments made by the proponent to protect the environment should be clearly defined and separately listed in the CER. Where an environmental problem has the potential to occur, there should be a commitment to rectify it. They should be numbered and take the form of:

(a) who will do the work;
(b) what the work is;
(c) when the work will be undertaken; and
(d) to whose satisfaction the work will be carried out.

All actionable and auditable commitments made in the body of the document should be numbered and summarised in this list.

Appendix B

SHALLOW SOIL AND GROUNDWATER INVESTIGATION

DAMES & MOORE

REPORT
REMLAP RANCH RESORT
SOIL AND GROUNDWATER INVESTIGATION
MAY/JUNE 1995
for
Greenvale Enterprises Pty Ltd

DAMES & MOORE

DAMES & MOORE
Ref: JKB:jnf\30978.002.366\DK:192-9288/PER
2 August 1995

Level 5, 85 The Esplanade
South Perth WA 6151
Ph: 09 367 8055
Fax: 09 367 6780
A.C.N. 003 293 696

DAMES & MOORE
SOUTH SHORE CENTRE, 85 THE ESPLANADE, SOUTH PERTH, WA 6151
TELEPHONE: 09-367 8055 FACSIMILE: 09-367 6780

14 August 1995

Greenvale Enterprises Pty Ltd
c\- The Palmer Group
33 Cathedral Avenue
AUSTRALIND WA 6230

Attention: Mr Stephen Palmer

Dear Mr Palmer,

REMLAP RANCH RESORT, MYALUP
SOIL AND GROUNDWATER INVESTIGATION
MAY/JUNE 1995

We are pleased to present our report detailing the soil and groundwater investigation conducted at the proposed Remlap Ranch Resort site for the period of May to June 1995.

Please do not hesitate to contact us should you have any queries regarding this report.

Yours sincerely
DAMES & MOORE

R.J. McGowan
Consultant-in-Charge
Geoscience & Environmental Engineering

TABLE OF CONTENTS

TABLE OF CONTENTS (*cont'd*)

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

REPORT
REMLAP RANCH RESORT
SOIL AND GROUNDWATER INVESTIGATION
MAY/JUNE 1995
for
Greenvale Enterprises Pty Ltd

1.0 INTRODUCTION

Dames and Moore has been retained by Greenvale Enterprises Pty Ltd (Greenvale Enterprises) to conduct a shallow soil and groundwater investigation of the proposed Remlap Ranch Resort site to determine:

- the configuration and depth of the water table;
- stratigraphy of the uppermost part of the superficial formations;
- phosphorus retention index (PRI) values for the soil and;
- baseline nutrient and total iron concentrations in the groundwater.

The baseline data will enable assessment of the soil capability providing information for the following aspects of the design of the development:

- the nutrient management programme;
- creation and maintenance of artificial wetlands; and
- site drainage.

2.0 SCOPE

The agreed scope of work was defined in the proposal by Dames and Moore dated 7 April 1995 as follows:

- drilling, soil logging and installation of six observation bores to an average depth of 6m;
- drilling and soil logging of three investigation boreholes to depth of 4m;
- analysis of PRI from a soil sample above the water table within each borehole;
- monitoring of water levels from all observation bores;

- analysis of water samples from three observation bores for pH, electrical conductivity, total phosphorus, total nitrogen, nitrate (NO_3-N) and total iron; and
- analysis of pH and electrical conductivity from the two existing bores surrounding the proposed site.

3.0 METHODS

3.1 MONITOR BORE INSTALLATION

Six observation and three investigation bores were drilled at nine locations during 30 May 1995. Sites were chosen initially through aerial photograph interpretation and then by ground truthing to provide a broad representation of the soil and groundwater conditions present at shallow depths. Figure 1 shows the location of the bores.

The observation and investigation holes were drilled to depths from 4 to 7m and observation monitor bores constructed using a Gemco auger drilling rig. Soils were logged and sampled at 1m intervals, taken off the auger flights of the drilling rig. The observation bores were constructed from 50mm Class 9 uPVC bore casing, slotted from about 0.5m below the water table to total depth, and the annular space backfilled from ground level to total depth with 1.6-3.2mm siliceous gravel pack. After completion, each observation bore was developed by airlifting for a maximum period of one hour. The bore construction allows the observation bores to be used for groundwater sampling. Soil description and construction logs of the bores are provided in Appendix A.

3.2 PHOSPHORUS RETENTION INDEX ANALYSIS

A soil sample from above the water table in each borehole was analysed for PRI. High PRI values are usually obtained from soils with high concentrations of clay, iron and aluminium oxides, iron and aluminium organo-complexes, and calcium carbonate. In all boreholes samples were taken from a depth of 1m.

Analyses were performed by Analabs by the test method described in the Chemistry Centre (WA), Report of Investigation No. 37, "Methods for Analysis of Phosphorus in Western Australian Soils" using a 1:20 w/v sample to 10mg P/l 0.02M KCl extraction.

3.3 GROUNDWATER LEVELS

Depths to groundwater were measured in all monitor bores on 31 May and 9 June 1995. The boreholes have not yet been surveyed and referenced to Australian Height Datum.

3.4 GROUNDWATER SAMPLING AND ANALYSIS FROM MONITOR BORES

Groundwater samples were taken on 9th June 1995 from the northern observation bores running east to west within the site comprising MB2, MB3 and MB6 and analysed for pH, electrical conductivity, total phosphorus, total nitrogen, NO_3-N and total iron. Each observation bore was purged of three volumes of water by means of a Grundfos MP1 submersible sampling pump, and a sample taken when the electrical conductivity and pH had stabilised. Samples were preserved with sulphuric acid in the field and then stored in ice until arrival at the laboratory.

Sample analysis was performed by Analabs and to the procedures as follows:

- pH and conductivity by meter;
- total phosphorus by acid digestion/colorimetric;
- total nitrogen by digest/distillation/titration/spectrophotometry/colorimetric;
- NO_3-N by spectrophotometry; and
- total iron by acid digest/AAS analysis.

3.5 GROUNDWATER SAMPLING AND ANALYSIS FROM EXISTING BORES

pH and electrical conductivity measurements in the field were taken from both existing bores on the site on during the 9 June 1995. Bore 1 is located adjacent to the stallion box near the Remlap Stud house and Bore 2 is located adjacent to the Emutech restaurant. Figure 1 shows the location of both bores.

The construction details for each bore (Palmer, pers. comm., 1995) are as follows:

- Bore 1 is 12 years old and approximately 18m deep with water drawn from 6m. A 1m to 1.3m rise of the water table is experienced throughout the year; and
- Bore 2 is 8 years old and is approximately 12m deep.

Neither bore shows a seasonal decline in water supply or deterioration in water quality.

4.0 RESULTS

4.1 SOIL CHARACTERISTICS

The site comprises two geomorphic units which relate to the topography. The lower lying dampland and remaining land west of the site belongs to the Yoongarillup Plain and the eastern ridge belongs to the Spearwood Dune System (Department of Conservation & Environment, 1980). The Yoongarillup Plain extends longitudinally parallel to the coast between Mandurah and Bunbury, is about 5km wide on average, and is sandwiched between the Quindalup Dune System to the west, and the Spearwood Dune System to the west (Semeniuk, 1990). The Yoongarillup Plain is characterised by shallow yellow and brown sands over marine limestone. The Spearwood Dune System occurring on the site is represented by the Karrakatta Association which is characterised by deep yellow sands over limestone.

On the project site there are several soil types within each geomorphic element of the Yoongarillup Plain and the Spearwood Dune System:

The Yoongarillup Plain comprises the following two soil types:

- Ya: Light brown and light yellow-orange mottled sand grading to beige sand then light grey sand with depth. This soil type was intersected in Boreholes BH1, BH2, BH3 and BH4 and occurs on the western plain of the site.

- Yb: Light grey-brown sand grading to light grey sand with depth. This soil type was intersected in Boreholes BH5, BH7, BH8 and BH9 and occurs in the central dampland swale of the site.

The Spearwood Dune System is composed of the following soil type representative of the Karrakatta Association:

- Sa: Light orange-brown sand grading to light orange-yellow sand then beige sand with depth. This soil type was intersected in Borehole BH6 and occurs on the eastern ridge of the site.

Figure 1 shows the locations of the soil types within the Yoongarillup Plain and the Spearwood Dune System. Logs for each borehole are provided in Appendix A. The areas shown for each soil type are an approximation obtained from borehole data and air photograph interpretation; better definition can only be obtained by more investigation boreholes.

4.2 PHOSPHORUS RETENTION INDEX VALUES

PRI analysis for each borehole are provided is Table 1. Laboratory certificates of the PRI analyses for the sample from each borehole are provided in Appendix B.

TABLE 1

PHOSPHORUS RETENTION INDEX VALUES (PRI), 30 MAY 1995

Borehole (Depth sampled)	Geomorphic Element, Soil Description	PRI
BH1 (1m)	Yoongarillup Plain Ya, SAND, beige grey	0.9
BH2 (1m)	Yoongarillup Plain Ya, SAND, mottled light yellow/light brown	5.6
BH3 (1m)	Yoongarillup Plain Ya, SAND, mottled light orange yellow/light brown	5.5
BH4 (1m)	Yoongarillup Plain Ya, SAND, slightly mottled light orange/light brown	1.5
BH5 (1m)	Yoongarillup Plain Yb, SAND, light grey brown	1.0
BH6 (1m)	Karrakatta Association Sa, SAND, light orange brown	2.4
BH7 (1m)	Yoongarillup Plain Yb, SAND, slightly silty, grey brown	<0.5
BH8 (1m)	Yoongarillup Plain Yb, SAND, light grey	2.9
BH9 (1m)	Yoongarillup Plain Yb, slightly silty, dark grey brown	4.7

PRI values were constant across the site and classified as possessing very weakly to weakly adsorbing phosphorus properties (Allen and Jeffrey, 1990). Slight variation occurred across the site depending upon the content of iron and aluminium oxides present in the soil.

Generally those soils which contain a higher percentage of clay, iron oxides and aluminium oxides exhibit stronger phosphorus adsorbing properties. Those soils which contain a low percentage of clay, iron oxide and aluminium oxide exhibit weaker phosphorus adsorbing properties, as found in the Yoongarillup Plain and Spearwood Dune System soil types.

4.3 GROUNDWATER LEVELS

Depth to groundwater data for 31 May and 9 June 1995 are provided in Table 2.

TABLE 2

GROUNDWATER LEVELS, 31 MAY AND 9 JUNE 1995

Borehole	Water Level (m, below ground level), 31 May 1995	Water Level (m, below ground level), 9 June 1995
BH1	2.21	2.15
BH2	2.31	2.22
BH3	3.38	3.25
BH4	3.05	2.95
BH5	1.84	1.36
BH6	3.91	3.72

Some variation occurs between the two measurements of groundwater levels. Groundwater levels measured on 31 May 1995 may not be entirely representative of the water table as levels may not have recovered fully to their true level after drilling.

Monthly rainfall for Bunbury was 139.4mm in May and 95.0mm in June. The May rainfall was thus slightly higher than the long-term average of 128mm, and the June rainfall only about half of the average of 183mm. The first week of June was quite wet, however, so that the water table measurements are probably about normal for this time of year.

Groundwater levels across the site were close to ground level and each borehole varied depending on topography. The levels can be summarised as follows:

- Within the plain and western perimeter of the site, (Boreholes BH1 and BH2), levels range from 1.5m to 3.0m below ground level.

- Within the plain and bordering the western side of the dampland, (Boreholes BH3 and BH4), levels range from 2.5m to 4.0m below ground level.

- Within the swale and dampland of the site, (Boreholes BH7, BH8 and BH9), levels range from +0.3m to 0.5m.

- Along the rise of the ridge and bordering the eastern side of the dampland, (Borehole BH5), levels range from 0.5m to 2.0m.

- Upon the ridge and bordering the eastern side of the dampland, (Borehole BH6), levels range from 3.0 to 4.5m.

4.4 GROUNDWATER QUALITY OF OBSERVATION BORES

Groundwater quality results are provided in Table 3 for the parameters pH, electrical conductivity, total phosphorus, total nitrogen, NO_3-N and total iron for samples taken from Boreholes BH2, BH3 and BH6 on 9 June 1995. Laboratory certificates of the groundwater quality analyses for Boreholes BH2, BH3 and BH6 are provided in Appendix C.

TABLE 3

WATER QUALITY RESULTS OBSERVATION BORES, 9 JUNE 1995

Parameter	Unit	Detection Limit	BH2	BH3	BH6	Guidelines
pH	-	-	6.30	6.60	8.10	6.5-8.5*
Electrical Conductivity	umho/cm	-	220	500	440	2350**
Total Iron	mg/L	0.05	5.65	1.35	9.0	0.3*
Nitrate-Nitrogen (NO_3-N)	mg/L	0.1	<0.1	<0.1	0.5	10*
Total Nitrogen	mg/L	0.05	0.55	0.40	0.80	ns
Total Phosphorus	mg/l	0.05	<0.05	<0.05	1.80	ns

Notes: * Australian Drinking Water Guidelines 1994.
** Analabs Untreated Water Potability Criteria.
ns not specified.

The groundwater results indicate that all parameters analysed on samples from Boreholes BH2, BH3 and BH6 are within Australian Drinking Water Guidelines, except for pH in Borehole BH2.

Total iron concentrations for all boreholes within the site are well above the level specified in the Australian Drinking Water Guidelines (National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand, 1994). Borehole BH6 is significantly higher than both BH2 and BH3.

No Australian criteria exist for total nitrogen in groundwater, although all borehole concentrations are low.

The total phosphorus concentration present in BH6 has the potential to cause eutrophication in shallow open water bodies. Eutrophication occurring within the proposed artificial wetland is unlikely as phosphorus will be retained in the wetland vegetation and algal growth will be limited by the low levels of total nitrogen present in the groundwater.

All concentrations of pH, total iron, nitrate, total nitrogen and total phosphorus were found to be higher in Borehole BH6. The lower concentrations in Boreholes BH2 and BH3 are a result of the wetland vegetation retaining nutrients and ions as the groundwater flow moves from east to west.

Design of the artificial wetland will incorporate and encourage growth of wetland vegetation present to increase phosphorus uptake and utilisation.

4.5 GROUNDWATER QUALITY OF EXISTING BORES

Groundwater quality results for the parameters pH and electrical conductivity analysed in the existing Bores 1 and 2 and sampled on 9 June 1995 are provided in Table 4.

TABLE 4

WATER QUALITY RESULTS EXISTING BORES, 9 JUNE 1995

Parameter	Unit	Detection Limit	Existing Bore 1	Existing Bore 2	Guidelines
pH	-	-	8.1	8.9	6.5-8.5*
Electrical Conductivity	umho/cm	-	700	600	2350**

Notes: * Australian Drinking Water Guidelines 1994.
** Analabs Untreated Water Potability Criteria.

The groundwater results indicate that both pH and electrical conductivity concentrations are within Australian Drinking Water Guidelines and Analabs Untreated Water Potability Criteria, except for pH values in existing bore 2. This may cause scale and taste problems.

5.0 DISCUSSION

5.1 LAND CAPABILITY

The land capability of the site depends upon the topography, soil type, soil permeability, phosphorus adsorbing properties and groundwater levels. This can be summarised as follows:

- Both soil types occurring within the Yoongarillup Plain and Karrakatta association on the site are highly permeable and assist the infiltration of rainfall. Inundation occurs as an expression of the groundwater and is the result of low lying topography. This is present as a dampland located in the swale of the site. The soils of the site have very weak to weak phosphorus adsorption capability and so will retain minimal or relatively small phosphorus loads.

5.2 NUTRIENT MANAGEMENT IMPLICATIONS

Due to minimal or little clay content, very weak to weak phosphorus adsorbing capability and high permeability of the soils there is possible risk of phosphorus leaching through to the groundwater. Minimising the potential likelihood of phosphorus leaching through to the groundwater could be effectively addressed by the following recommendations:

- An effective waste treatment system, comprising design and siting of effluent disposal, is currently being commissioned by Durant and Waite Pty Ltd to reduce phosphorus output.

- The use of soil amendment on those areas likely to be subject to effluent and fertiliser use. This would increase the phosphorus retention capability of the soil and inhibit phosphorus leaching through to the groundwater.

- The design of the artificial wetland will incorporate and encourage growth of wetland vegetation present to increase phosphorus uptake and utilisation. This will reduce phosphorous leaching through to the groundwater and also possible eutrophication in the future artificial wetland.

5.3 WATER SUPPLY ISSUES

The concentration of total iron in the groundwater samples from the site are in excess of Australian Drinking Water Guidelines. Excess iron present in groundwater can be effectively removed through aeration. Gutteridge Haskins Davey Pty Ltd have been commissioned and are currently investigating and designing the water supply and purification system most effective for groundwater iron removal on the site.

6.0 REFERENCES

Allen, D.G. and Jeffery, R.C. (1990). "Methods for analysis of phosphorus in WA soils." Chemistry Centre (WA) Report No. 37.

Analabs (1993). "Untreated water Potability Criteria". Analabs (WA).

Department of Conservation & Environment (1980). "Atlas of natural resources, Darling System, Western Australia." Department of Conservation and Environment (WA) 85pp.

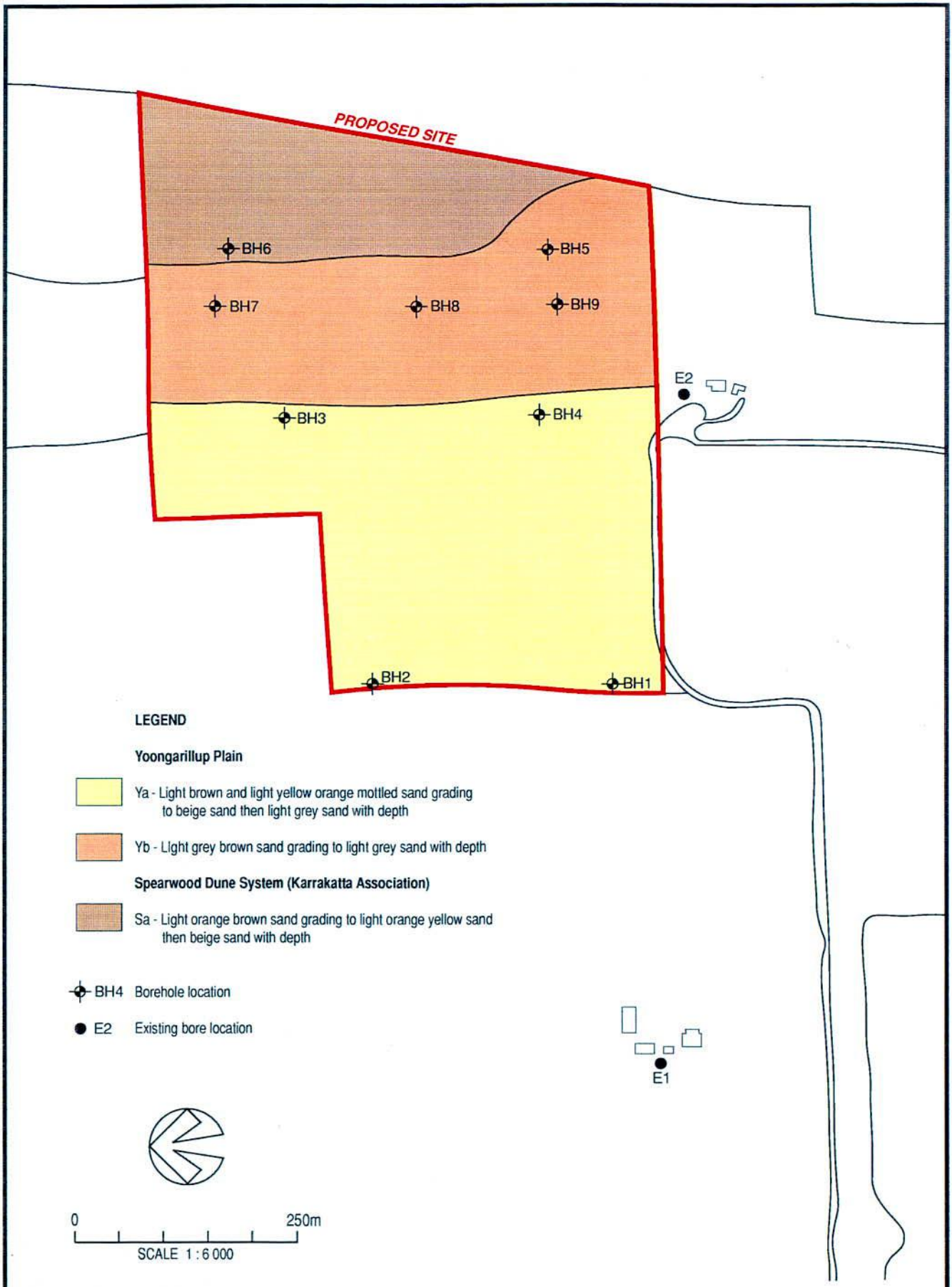
National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand (1994). "Australian Drinking Water Guidelines." National Health and Medical Research Council and Agricultural and Resource Management Council of Australia and New Zealand 38pp.

Semeniuk, V. (1990). "The geomorphology and soils of the Yoongarillup Plain in the Mandurah to Bunbury coastal zone, South-western Australian: a critical appraisal". J R Soc W Aust 73:1-7pp.

* * *

Yours faithfully
DAMES & MOORE

J.K. Becher
Environmental Scientist



Job No.	30978-001-367		Greenvale Enterprises Pty Ltd REMLAP RANCH RESORT -CER SHALLOW SOIL ASSOCIATIONS
Prep. By	JKB	18 Jul.'95	
Chk'd. By	JRS	16 Oct 95	
Rev. No.	0	06 Sep.'95	

Figure No.
1

DAMES & MOORE

APPENDIX A

BH1 TO BH9 BOREHOLE LOGS, 30 MAY 1995

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

CLIENT : GREENVALE ENTERPRISES

BORE No. BH1

SHEET 1 OF 1

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	MONITORING	N : E :		

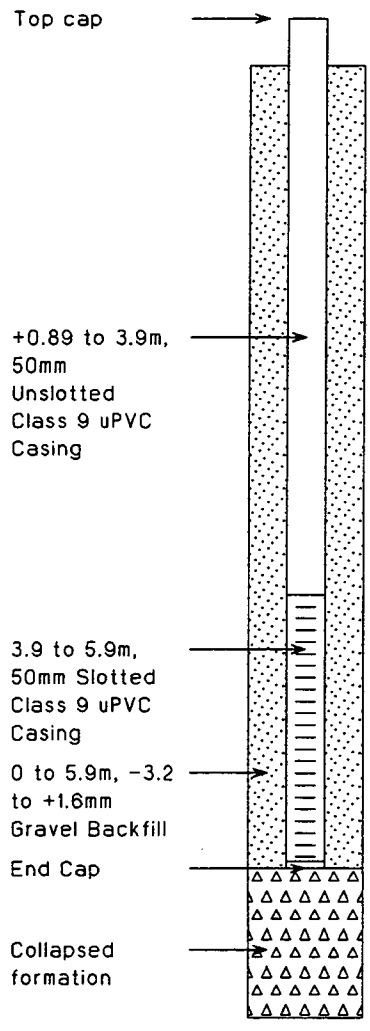
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, bgl)	2.21
TOTAL CASED DEPTH (m)	5.9	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	3.9-5.9
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along fence line.

DRILLING COMPANY : BUNBURY BORING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 10.30am:30/5/95
DATE/TIME COMPLETED : 11.00am:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg C)	R.L. (m)
	0	**SAND**, peaty (10-15%), dark grey, fine to medium quartz grains, moderately to well sorted, sub angular.					
	1	**SAND**, beige grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	2	**SAND**, beige, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	3	**SAND**, light grey to light yellow mottled slightly, fine to medium quartz grains, well to moderately sorted, sub angular to sub rounded.					
	4						
	5	**SAND**, light grey, fine to medium quartz grains, moderately sorted , sub angular to sub rounded.					
	6						
	7	**BOREHOLE COMPLETED AT 7.0m.**					
	8						
	9						

Data : BH1
Script : DUNS-BCR

BORE COMPLETION REPORT

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	10.30am:30/5/95
APPROVED BY		

PROJECT: REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

BORE No. BH2

SHEET 1 OF 1

CLIENT: GREENVALE ENTERPRISES

DRILLING RIG: GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD: AUGER	MONITORING	N:		
		E:		

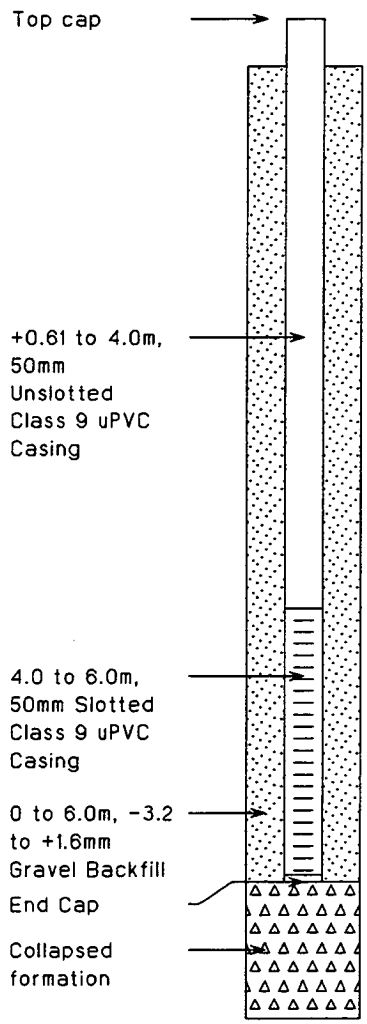
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m bgl)	2.31
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m bgl)	4.0-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along fence line.

DRILLING COMPANY: BUNBURY BORING
DRILLER: C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED: 11.00am:30/5/95
DATE/TIME COMPLETED: 11.45am:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg.C)	R.L. (m)
	0	**SAND**, peaty (10-15%), dark grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	1	**SAND**, mottled light yellow/ light brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	2	**SAND**, mottled yellow/light brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	3	**SAND**, light beige brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	4	**SAND**, light grey/light yellow mottled slightly, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	5	**SAND**, light grey, fine to medium quartz grains, moderately sorted , sub angular to sub rounded.					
	6	**SAND**, slightly silty, light grey, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	7	**BOREHOLE COMPLETED AT 7.0m.**					
	8						
	9						

Data : BH2
Script : DUNS-BCR

BORE COMPLETION REPORT

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	11.00am:30/5/95
APPROVED BY		

PROJECT : **REMLAP RANCH RESORT, MYALUP**
GROUNDWATER INVESTIGATION

CLIENT : GREENVALE ENTERPRISES

BORE No. **BH3**

SHEET 1 OF 1

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	MONITORING	N : E :		

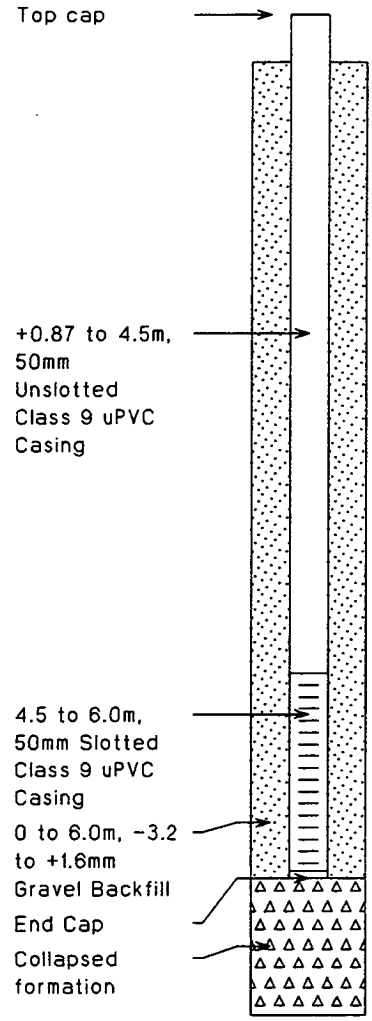
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, bgl)	3.38
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	4.5-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along north-western side of wetland.

DRILLING COMPANY : BUNBURY BORING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 11.45am:30/5/95
DATE/TIME COMPLETED : 12.15am:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg. C)	R.L. (m)
	0	**SAND**, peaty (10-15%), dark grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	1	**SAND**, light orange yellow/light brown mottled, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	2						
	3	**SAND**, light orange, fine to medium quartz grains, moderately to well sorted, sub rounded.					
	4	**SAND**, light orange, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	5	**SAND**, beige, fine to medium quartz grains, moderately sorted , sub angular to sub rounded.					
	6	**SAND**, light grey beige, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	7	**BOREHOLE COMPLETED AT 7.0m.**					
	8						
	9						

Data : BH3
Script : DUNS-BCR

BORE COMPLETION REPORT

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	11.45am:30/5/95
APPROVED BY		

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

CLIENT : GREENVALE ENTERPRISES

BORE No. BH4

SHEET 1 OF 1

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	MONITORING	N : E :		

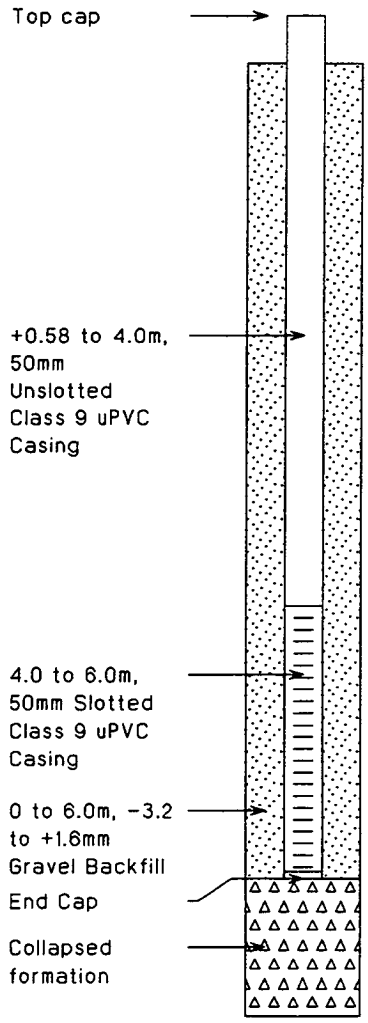
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, bgl)	3.05
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	4.0-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along south-western side of wetland.

DRILLING COMPANY : BUNBURY BORING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 03.00pm:30/5/95
DATE/TIME COMPLETED : 03.50pm:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg.C)	R.L. (m)
	0	**SAND**, peaty (10%), dark grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	1	**SAND**, light orange/light brown slight mottles, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	2	**SAND** light orange, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	3	**SAND**, cream orange, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	4	**SAND**, beige, fine to coarse quartz grains, moderately sorted, sub angular to sub rounded.					
	5	**SAND**, grey beige, fine to coarse quartz grains, moderately sorted , sub angular to sub rounded.					
	6	**SAND**, light grey, fine to coarse quartz grains, moderately sorted, sub angular to sub rounded.					
	7	**BOREHOLE COMPLETED AT 7.0m.**					
	8						
	9						

Data : BH4
Script : DUNS-BCR

BORE COMPLETION REPORT

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	03.00pm:30/5/95
APPROVED BY		

PROJECT: REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

BORE No. BH5

SHEET 1 OF 1

CLIENT: GREENVALE ENTERPRISES

DRILLING RIG: GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD: AUGER	MONITORING	N:		
		E:		

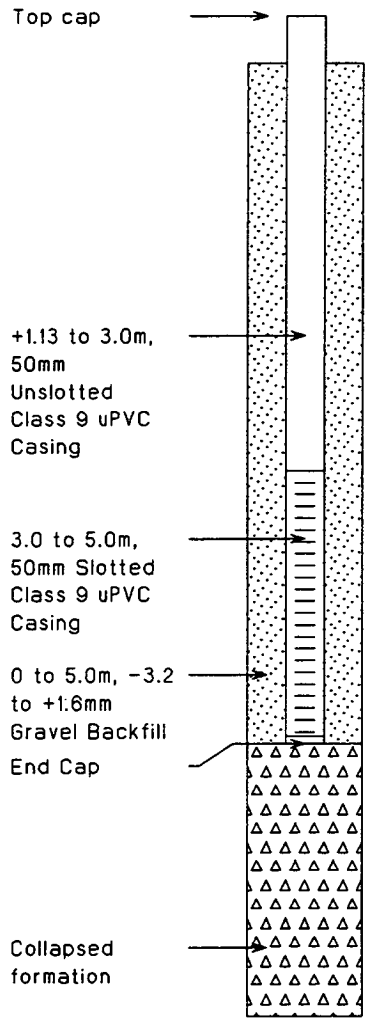
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, bgl)	1.84
TOTAL CASED DEPTH (m)	5.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	3.0-5.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: remnant Marri, Peppermint, Banksia woodland.

DRILLING COMPANY: BUNBURY BORING
DRILLER: C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED: 02.15pm:30/5/95
DATE/TIME COMPLETED: 03.00pm:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg. C)	R.L. (m)
	0	**SAND**, peaty (20%), dark grey black/light brown mottles, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	1	**SAND**, light grey brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	2						
	3						
	4	**SAND**, light grey, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	5	5.0m, grades to containing medium to coarse shell fragments.					
	6	**SAND**, light grey, fine to coarse quartz grains, moderately sorted, sub angular to sub rounded. Contains some shell fragments.					
	7	7.0m, grades to fine to medium quartz grains.					
	8	**BOREHOLE COMPLETED AT 7.0m.**					
	9						

Data: BH5
Script: DUNS-BCR

BORE COMPLETION REPORT

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	02.15pm:30/5/95
APPROVED BY		

PROJECT: REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

BORE No. BH6

SHEET 1 OF 1

CLIENT: GREENVALE ENTERPRISES

DRILLING RIG: GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD: AUGER	MONITORING	N:		
		E:		

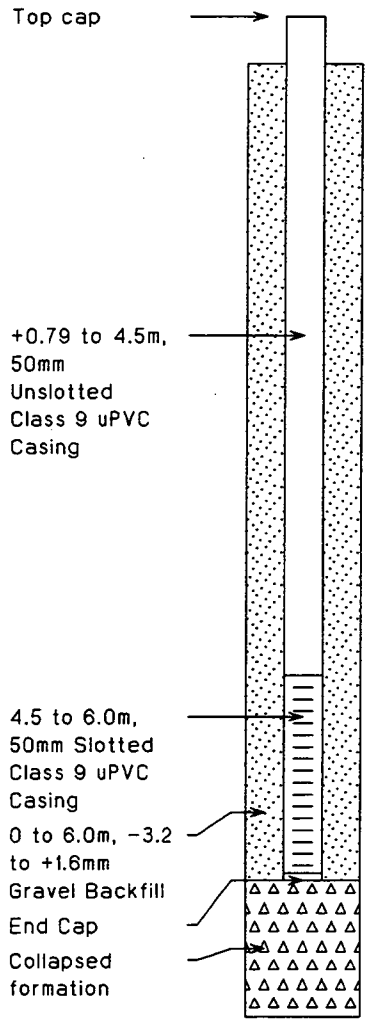
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, bgl)	3.91
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	4.5-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: remnant Marri, Peppermint, Banksia woodland.

DRILLING COMPANY: BUNBURY BORING
DRILLER: C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED: 01.30pm:30/5/95
DATE/TIME COMPLETED: 02.15pm:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG | DEPTH (m) | LITHOLOGICAL DESCRIPTION | GEOLOGICAL UNIT | AIRLIFT YIELD (m3/day) | CONDUCTIVITY (uS/cm) | TEMPERATURE (deg C) | R.L. (m)

0 — **SAND**, peaty (10-15%), dark grey black/light brown yellow mottles, fine to medium quartz grains, well sorted, sub angular to sub rounded.

1 — **SAND**, light orange brown, fine to medium quartz grains, well sorted, sub angular to sub rounded.

2

3 — **SAND**, light orange yellow, fine to medium quartz grains, well sorted, sub angular to sub rounded.

4

5 — **SAND**, beige, fine to medium quartz grains, moderate to well sorted, sub angular to sub rounded. Contains some ilmenite grains.

6 — 6.0m, grades to cream beige.

7 — **SAND**, beige, fine to coarse quartz grains, moderately to poorly sorted, sub angular to sub rounded. Contains some ilmenite grains.

BOREHOLE COMPLETED AT 7.0m.

8

9

Data: BH6
Script: DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	01.30pm:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

CLIENT : GREENVALE ENTERPRISES

BORE No. BH7

SHEET 1 OF 1

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	INVESTIGATION	N : E :		

TOTAL DRILLED DEPTH (m)	4.0	STATIC WATER LEVEL (m, btoc)	
TOTAL CASED DEPTH (m)		DATE OF MEASUREMENT	
MINIMUM CASING DIAMETER (mm)		OPEN INTERVAL (m, bgl)	
MINIMUM SCREEN DIAMETER (mm)			

ADDITIONAL NOTES

1. Above ground conditions: remnant Marri, Paperbark, Tea Tree, sedges and reeds. Situated at north along line of wetland.

SCHEMATIC BORE CONSTRUCTION

DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg. C)	R.L. (m)
0	SAND/PEAT, (peat 40%, sand 60%), dark grey, sand; fine to medium quartz grains, well sorted, sub rounded. Water table evident.					
1	SAND, slightly silty, grey brown, fine to medium quartz grains, moderately to well sorted, sub rounded.					
2						
3	SAND, slightly silty, light grey, fine to medium quartz grains, moderately to well sorted, sub rounded.					
4	BOREHOLE COMPLETED AT 4.0m.					
5						
6						
7						
8						
9						

DRILLING COMPANY : BUNBURY BORING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 12.15pm:30/5/95
DATE/TIME COMPLETED : 12.30pm:30/5/95

Data : BH7
Script : DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	12.15pm:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

BORE No. **BH8**

SHEET 1 OF 1

CLIENT : GREENVALE ENTERPRISES

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	INVESTIGATION	N :		
		E :		

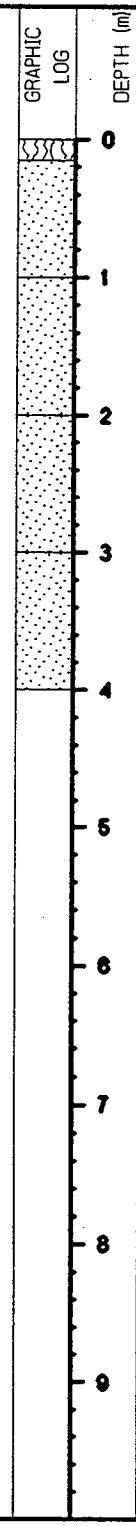
TOTAL DRILLED DEPTH (m)	4.0	STATIC WATER LEVEL (m, btoc)	
TOTAL CASED DEPTH (m)		DATE OF MEASUREMENT	
MINIMUM CASING DIAMETER (mm)		OPEN INTERVAL (m, bgl)	
MINIMUM SCREEN DIAMETER (mm)			

ADDITIONAL NOTES

1. Above ground conditions: remnant Marri, Paperbark, Tea Tree, sedges and reeds. Situated in centre, along line of wetland on property.

DRILLING COMPANY : BUNBURY BORING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 04.20pm:30/5/95
DATE/TIME COMPLETED : 04.30pm:30/5/95

SCHEMATIC BORE CONSTRUCTION



LITHOLOGICAL DESCRIPTION

PEAT, dark brown, roots/plant material. Water table evident.

SAND, light grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.

BOREHOLE COMPLETED AT 4.0m.

GEOLOGICAL UNIT | AIRLIFT YIELD (m3/day) | CONDUCTIVITY (uS/cm) | TEMPERATURE (deg. C) | R.L. (m)

Data : BH8
Script : DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	04.20pm:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

CLIENT : GREENVALE ENTERPRISES

BORE No. BH9

SHEET 1 OF 1

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	INVESTIGATION	N : E :		

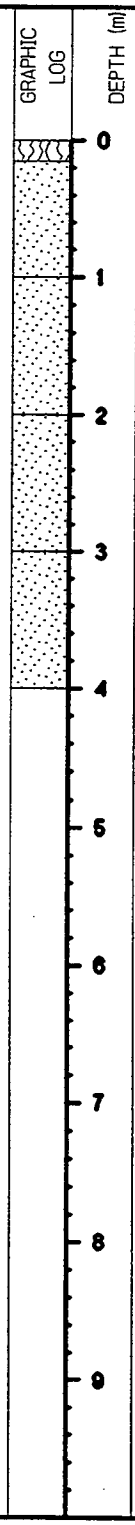
TOTAL DRILLED DEPTH (m)	4.0	STATIC WATER LEVEL (m, btoc)	
TOTAL CASED DEPTH (m)		DATE OF MEASUREMENT	
MINIMUM CASING DIAMETER (mm)		OPEN INTERVAL (m, bgl)	
MINIMUM SCREEN DIAMETER (mm)			

ADDITIONAL NOTES

1. Above ground conditions: remnant Marri, Paperbark, Tea Tree, sedges and reeds. Situated south along line of wetland on property.

DRILLING COMPANY : BUNBURY BORING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 04.00pm:30/5/95
DATE/TIME COMPLETED : 04.20pm:30/5/95

SCHEMATIC BORE CONSTRUCTION



LITHOLOGICAL DESCRIPTION

PEAT, sandy (30-40% sand), dark grey, sand: fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded. Water table evident.

SAND, slightly silty, dark brown grey, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.

SAND, light grey, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.

BOREHOLE COMPLETED AT 4.0m.

GEOLOGICAL UNIT | AIRLIFT YIELD (m3/day) | CONDUCTIVITY (uS/cm) | TEMPERATURE (deg C) | R.L. (m)

Data : BH9
Script : DUNS-BCR

BORE COMPLETION REPORT

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	04.00pm:30/5/95
APPROVED BY		

APPENDIX B

PHOSPHORUS RETENTION INDEX (PR1) RESULTS, 30 MAY 1995

Analabs

Analabs Pty. Ltd.
ACN 004 591 664
50 Murray Rd. Welshpool
Western Australia 6106.
P.O. Box 210, Bentley, W.A. 6102
Telephone: (619) 458 7999
Telex: AA 92560
Facsimile: (619) 458 2922

LABORATORY REPORT

CLIENT: Dames & Moore

ADDRESS: South Shore Centre, 85 The Esplanade, South Perth, WA, 6151

ATTENTION: Jenny Bechner

SAMPLES: 9 x Soil Samples **SAMPLES RECEIVED:** 1/6/95

OUR REFERENCE: 104760.09.24898 **YOUR REFERENCE:** RO550/30978-001-367

RESULTS:

Nine (9) soil samples were received for determination of phosphorus retention index (PRI). Samples were air dried then screened to pass a 2mm sieve prior to analysis of this <2mm fraction.

Analysis was performed to the procedures of the test method appearing in the Chemistry Centre, Report of Investigation No. 37, "Methods for Analysis of Phosphorus in Western Australian Soils". (1:20 w/v sample to 10 mg P/l 0.02M KCl extraction).

All results are reported on the enclosed table.

PETER BAMFORD
Principal Environmental Scientist

DATE: 9 June 1995

CLIENT: Dames & Moore (Myalup) **OUR REFERENCE:** 104760.09.24898
PROJECT NO: RO550

MISCELLANEOUS ANALYSIS

1M-BH7 1M-BH7

Your Reference	1M-BH1	1M-BH2	1M-BH3	~~1M-BH4~~	~~1M-BH4~~
	30/5/95	30/5/95	30/5/95	30/5/95	30/5/95
Our Reference	24898-1	24898-2	24898-3	24898-4	24898-4 Rpt
Sample Type	Soil	Soil	Soil	Soil	Soil
Units	ml/g	ml/g	ml/g	ml/g	ml/g
Phosphorus Retention Index	0.9	5.6	5.5	<0.5	<0.5

1M-BH4

Your Reference	1M-BH5	1M-BH6	~~1M-BH7~~	1M-BH8	1M-BH8
	30/5/95	30/5/95	30/5/95	30/5/95	30/5/95
Our Reference	24898-5	24898-6	24898-7	24898-8	24898-8 Rpt
Sample Type	Soil	Soil	Soil	Soil	Soil
Units	ml/g	ml/g	ml/g	ml/g	ml/g
Phosphorus Retention Index	1.0	2.4	1.5	3.0	2.8

Your Reference	1M-BH9				
	30/5/95				
Our Reference	24898-9				
Sample Type	Soil				
Units	ml/g				
Phosphorus Retention Index	4.7				

APPENDIX C

GROUNDWATER QUALITY RESULTS, 9 JUNE 1995

Analabs

Analabs Pty. Ltd.
ACN 004 591 664
50 Murray Rd. Welshpool
Western Australia 6106.
P.O. Box 210, Bentley, W.A. 6102
Telephone: (619) 458 7999
Telex: AA 92560
Facsimile: (619) 458 2922

LABORATORY REPORT COVERSHEET

DATE: 23 June 1995

TO: Dames & Moore
South Shore Centre
85 The Esplanade
SOUTH PERTH WA 6151

D & M			
Register No..	16-95-181		
Date:	27-6-95		
Addressee	Info	Action	Copy
JKB			
File:			
Actioned by:			

ATTENTION: Jenny Becher

YOUR REFERENCE: 170

OUR REFERENCE: 104760.09.24990

SAMPLES RECEIVED: 13/6/95

DESCRIPTION: Three (3) water samples were received for analysis.

NATA REGISTRATION NO: **1712**

JANICE VENNING
Supervisor - Waters

PETER BAMFORD
Principal Environmental Scientist

THIS DOCUMENT MUST NOT BE REPRODUCED EXCEPT IN FULL

Analabs

CLIENT: Dames & Moore **OUR REFERENCE:** 104760.09.24990
PROJECT NO: 170

METHODOLOGY

Abbreviation	Method	Analabs Method Reference
O & G (grav)	Oil and Grease - Solvent Extraction/Gravimetric.	PEW 500
O & G (FTIR)/Hydrocarbons (IR)	Oil and Grease - Solvent Extraction/FTIR.	PEW 500
General Water Analysis		
Metals (Total)	Acid Digest/AAS analysis	PEMM
pH	Meter	PEW 001
Conductivity	Meter	APHA 2510 B
TDS(grav)	Total Dissolved Solids-Gravimetric	PEW 002
TDS(calc)	Total Dissolved Solids-0.64 x Conductivity	APHA 2510 B
Nitrate-Nitrogen	Spectrophotometry	PEW 011
Ammoniacal-Nitrogen	Distillation/Titration	PEW 010
Total Phosphorus	Acid Digestion/Colourimetric	PEW 014
Sulphate	Gravimetric or in-house chromatography	PEW 013/PEW 034
Chloride	Titration or in-house chromatography	PEW 008
Bicarbonate	Titration	APHA 2320 B
Carbonate	Titration	APHA 2320 B
Total Suspended Solids(TSS)	Total Suspended Solids-Gravimetric	PEW 003
BOD	Biochemical Oxygen Demand	PEW 018
COD	Chemical Oxygen Demand	PEW 028
Total Solids	Dried @ 103-105°C	PEW 009
Phenols	Distillation/Colourimetric	PEW 003
Sulphide	Titration	APHA 4500 $S^{2-}E$
Thiocyanate	Colourimetric	PEW 025
Ferrous Iron	Colourimetric	APHA 3500 Fe D
Ortho Phosphate (soluble reactive phosphorus)	Spectrophotometer	PEW 015
Kjeldahl nitrogen	Digest/Distillation/Titration	PEW 012
Free cyanide	Colourimetric	PEW 023
Weak acid dissociable cyanide	Distillation/Colourimetric	PEW 026
Total cyanide	Distillation/Colourimetric	PEW 021/PEW 023
NIS	Solvent Extraction/AAS analysis	PEW 030
MBAS	Solvent Extraction/Colourimetric	PEW 029
Fluoride	Selective Ion Electrode	PEW 027
Metals	AAS analysis	PEMM
Metals	ICP-OES	GI 201
Metals	ICP-MS	GS 201
Cations/Anions % difference	$\frac{(\Sigma \text{ Cations} - \Sigma \text{ Anions})}{(\Sigma \text{ Cations} - \Sigma \text{ Anions})} \times 100$	1030 F

Analabs

CLIENT: Dames & Moore
PROJECT NO: 170

OUR REFERENCE: 104760.09.24990

CERTIFICATE OF ANALYSIS

SAMPLE : BH2, BH6, BH3

CHEMICAL DATA

PARAMETERS			SAMPLE IDENTIFICATION		
			BH2	BH6	BH3
pH			6.30	8.10	6.60
Conductivity @ 25°C		(μmho/cm)	220	440	500
Total Iron	Fe	(mg/l)	5.65	9.0	1.35
Nitrate-Nitrogen	NO_3-N	(mg/l)	<0.1	0.5	<0.1
Total Nitrogen		(mg/l)	0.55	0.80	0.40
Total Phosphorus	P	(mg/l)	<0.1	1.80	<0.1

Appendix C

WATERBIRDS SURVEY

BAMFORD CONSULTING ECOLOGISTS

CONSERVATION VALUE FOR WATERBIRDS:

Remlap

Prepared for: LePROVOST DAMES & MOORE
85 The Esplanade,
South Perth, 6151

Prepared by: M.J. & A.R. Bamford,
CONSULTING ECOLOGISTS.
23 Plover Way,
Kingsley, 602617/04/'95

BACKGROUND

We have been asked to provide information and comments on the conservation value for waterbirds of the Remlap site. The site includes wetlands and the value of these wetlands for waterbirds may need to be considered during development.

The main source of information for this project was unpublished data collected by the Royal Australasian Ornithologists Union (RAOU), including data from waterbird projects and data from the RAOU's National Parks Project. Published reports based on these data were also accessed and included Jaensch et al. (1988) and Storey et al. (1993).

Common names, scientific names and taxonomic order used in this report are taken from Blakers et al. (1984).

No RAOU data are available for the site and a site inspection was not carried out. From verbal descriptions and examination of aerial photographs, it may be used by some waterbirds when inundated in winter. Black Swans are known to breed in seasonal wetlands located in agricultural land.

REFERENCES

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). The Atlas of Australian Birds. Melbourne University Press.

Jaensch, R.P., Vervest, R.M. and Hewish, M.J. (1988). Waterbirds in Nature Reserves of South-Western Australia 1981-1985: Reserve Accounts. RAOU Report No.30.

Jaensch, R., Merrifield, J. and Raines, J. (1993). Waterbirds of South-Western Australia: highest numbers counted, 1981-1992. Western Australian Bird Notes No. 68, supplement.

Storey, A.W., Vervest, R.M., Pearson, G.B. and Halse, S.A. (1993). Wetlands of the Swan Coastal Plain, Vol. 7. Waterbird usage of Wetlands of the Swan Coastal Plain. Water Authority of Western Australia.

Appendix D

WATER SUPPLY ISSUES

GUTTERIDGE, HASKINS & DAVEY PTY LTD

Gutteridge Haskins & Davey Pty Ltd

CONSULTING ENGINEERS•ENVIRONMENTAL SCIENTISTS & PLANNERS•PROJECT MANAGERS
A.C.N. 008 488 373

Facsimile

17 Spencer Street, Bunbury WA 6230, PO Box 1009 Bunbury, WA 6231 Australia
Telephone (097) 218 722 Facsimile (097) 911 535

DATE	24/7/95			FAX No	09-367 6780
TO	Dames & Moore				
ATTENTION	Jenny Becker				
FROM	Wayne Edgelow				
SUBJECT	Remlap Redelopment				
PROJECT				JOB No	0090/72/37
REPLY REQUIRED: YES		NO		TOTAL PAGES INCLUDING THIS ONE	

Apperoled comments as requested.

Wayne

D & M PERTH
Register No. 17-25-788
Date: 25-7-95

Addressee	Info	Action	Copy
J Becker			

Stamped by

DRAINAGE RUNOFF MANAGEMENT

Drainage runoff from the lots and roads will be handled by a combination of grassed swale drains, culverts and dispersion into landscaped areas.

The roads will be of limestone construction that will generally follow the contour of the land and will remain flush with the ground surface.

Concentration of the flows by the roads will be avoided to reduce the impact on the flows in comparison to existing conditions.

Runoff from the roofs of structures will be either collected into tanks or dispersed into garden areas.

Minimising overland flow will aid in maximising recharge to the existing shallow aquifers.

LAGOON CONSTRUCTION

The Lagoon will be constructed by a cut and fill operation to create the Lagoon Basin.

Topsoil and grasses will be initially stripped and stockpiled for respreading over earthworked areas.

Soil excavated from the lagoon will be spread and compacted over the proposed development areas. The material is sandy in nature and is generally suitable for fill.

Any runoff and sediment created during the process would be contained within the lagoon basin.

Silt traps would be provided during construction to prevent transfer of materials into adjoining areas.

The lagoon would be unlined and its level would be maintained by the natural groundwater levels of the area.

WATER SUPPLY

The water demands of the development will be serviced by providing a new bore into the superficial groundwater aquifer.

This water will then be treated in a package water treatment plant to remove unacceptable levels of iron.

Treatment will be supplemented with Chlorination to remove the risk of

any bacterial contamination.

A license for the bore would be obtained from WAWA for extraction from the superficial aquifer. An allocation of 4,000kl per ha of property is generally made available by WAWA. For this property that would make available approximately 38,800kl of water per annum. more than adequate to serve the demands of the development.

The water would be treated to meet the guidelines set by the Australian Water Resources Council (AWRC) and the National Health and Medical Research Council (NH&MRC) and the requirements of the health department of Western Australia.

The water from the treatment plant would be stored in tanks on site and then piped to each of the development units and each of the lots.

Pressure would be maintained in the reticulation with hydropneumatic boosters.

Gutteridge Haskins & Davey Pty Ltd

CONSULTING ENGINEERS • ENVIRONMENTAL SCIENTISTS & PLANNERS • PROJECT MANAGERS
A.C.N. 008 488 373

17 Spencer Street, Bunbury WA 6230, PO Box 1009 Bunbury, WA 6231 Australia
Telephone (097) 218 722 Facsimile (097) 911 535

Facsimile

DATE 3/8/95				FAX No 09 367 6780	
TO Dames & Moore					
ATTENTION Jenny Becher					
FROM Mark Causey					
SUBJECT Remlap Stud.					
PROJECT				JOB No 0090/72/37	
REPLY REQUIRED: YES		NO	✓	TOTAL PAGES INCLUDING THIS ONE	4

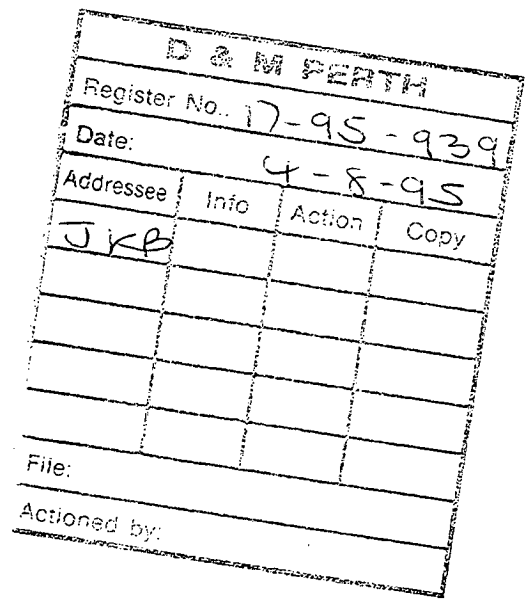
Jenny.

Please find attached our water options report.

I hope this answers a lot of your queries.

Regards

Mark



1 INTRODUCTION

Gutteridge Haskins & Davey Pty Ltd have been commissioned by Steve Palmer to investigate and report on costs and constraints of various water supply development options for Lot 7, Remlap Stud.

This report presents the findings of these investigations.

2 WATER SUPPLY OPTIONS CONSIDERED

Two options were considered for provision of a water supply to the site including:

- Supply from Myalup
- Local Groundwater bore
- Individual rainwater tanks and pressure pump.

The option of a supply from Myalup involved connecting to the existing Myalup town borefield, this option was discarded as the borefield site is some 5km from the proposed development site. Transfer mains would be excessive.

The second option of supply from a local bore involved construction of a duty and standby ground water bore, in which supply is extracted from the superficial aquifer.

For the second option various sub options were investigated discussion of which is as follows.

The third option of supply involves a separate rainwater tank and pressure pump for each chalet. This option proposes to use the lagoon water for gardens and toilets.

Costs are presented in Table 1.

3 DISCUSSION

3.1 Option 2

At present the resort is designed for approximately 62 services with an anticipated demand of 3.5kl/d/service with a peaking factor of 3.2.

The range in elevation of the lot to be supplied was the most critical factor in the concept planning stage. The proposed site is relatively flat with no single point commanding the entire site.

This means that either a conventional elevated tank or a Hydro-pneumatic booster (pressure vessel) is necessary to ensure that adequate pressure is achieved in the reticulation network.

Each pump station would comprise of a duty and standby pump.

3.1.1 Conventional Elevated Tank

This option involves ground water being treated and stored in a ground tank. The water is then pumped from the ground tank into an elevated tank to supply the necessary head in the reticulation. Water gravitates from the elevated tank into the reticulation network.

The bore pumps are governed by the water level in the ground tank and must be equivalent to the peak day's demand rate. The elevated pumps are governed by the water level in the elevated tank and must be capable of meeting the peak instantaneous demand.

The capacity of the ground tank is equivalent to the daily demand of the site minus the elevated tank storage. This provides operating storage to balance peak demands and about 12 hours emergency storage to maintain supply during periods of failure.

The capacity of the elevated tank is equivalent to one hour supply at the peak demand rate.

3.1.2 Hydro-pneumatic Booster

This option is in principle the same as the elevated tank option. However, a Hydro-pneumatic Booster replaces the elevated tank components.

The pump configuration remains the same as the previous option.

The Hydro-pneumatic Booster pumps are governed by the pressure in the pressure vessel and must be capable of meeting the peak instantaneous demand.

The ground water tank increases slightly to account for no reserve storage being stored in an elevated tank.

3.2 Option 3

At present the chalets are designed for approximately 62 services with an anticipated demand of 0.4 kl/d/chalet with a peaking factor of 3.

This option comprises of a separate ground tank and pressure pump to be constructed for each chalet. These components will need to be larger for the Equestrian Centre, Residential Dormitory building and the Tennis Camp.

For staging purposes costs can be incurred on a per chalet basis.

4 CONSTRAINTS

Due to the relative size of the capital assets there is limited scope and benefit to staging of the water supply components in option 2.

During the early stages of development and during winter tank levels will need to be run down to ensure that turnover of the tank occurs. An over the top inlet will reduce the problem of turnover.

Treatment costs can vary depending on the ground water quality on site. Sampling and testing was undertaken to determine the potability of the water supply (results are attached). The results indicate there is a high iron content and one of the samples had a fecal coliform and high bacteria count.

Discussion with various manufacturers indicate waste treatment will cost from $35,000.00 to $60,000.00. The cheapest option is to use a Cumry Catalytic Filter (CB6) supplied by Fluid Equipment Company Pty Ltd. This includes break tank, supply booster, chlorination and associated civil works including backwash retention basin.

Appendix E

SEWAGE TREATMENT AND EFFLUENT DISPOSAL

DURRANT AND WAITE PTY LTD

REMLAP PROJECT

Proposed Strata Subdivision Lot 7 Old Coast Road, Myalup

bioMax Aerobic Wastewater Treatment System (AWTS)

Durrant & Waite PTY LTD
Suite 1/231 Balcatta Road, Balcatta
PH: 345 3071 Fax : 345 3171

1. Proposal

The proposal involves the creation of 64 strata lots of various sizes for residential and short stay chalet type accommodation and camp accommodation. The composition of the lots is as follows.

1.1 There will be ten large lots identified on attachment 1 as lots 1-10 ranging in size from 8150 m^2 to 1.58 ha. The dwellings on each will average three bedrooms.

1.2 There will be 50 smaller lots, identified as lots 11-60, of approximately 1,200 m^2 on which will be constructed a three bedroom dwelling.

1.3 1 x tennis camp with dormitory type accommodation for up to 40 persons (Lot 61).

1.4 1 x residential building with dormitory type accommodation for up to 40 persons (Lot 62).

1.5 1 x administration building + managers residence.

1.6 1 x residential dwelling (3 bedroom) on Lot 63, identified as "Equestrian".

1.7 1 x residential dwelling (3 bedroom) on Lot 63, identified as "Agistment".

2. Hydraulic Load

2.1 The ten large lots identified as Lots 1-10 and Lots 63 & 64, assuming each has a three bedroom dwelling and using Health Department of WA criteria of 761 L/d/dwelling, will each an have individual treatment and disposal system.

2.2 Strata Lots 11-60. The estimated hydraulic load is based on the assumption that each dwelling is three bedroom. Using Health Department of WA criteria, this is estimated at 761 L/d.

It is proposed to group the dwellings into a common effluent disposal system and treatment plant for each group of dwellings ie.

Strata Lots 11-22	12 dwellings x 761 L/d	=	9,132 L/d
Strata Lots 23-35	13 dwellings x 761 L/d	=	9,893 L/d
Strata Lots 36-48	13 dwellings x 761 L/d	=	9,893 L/d
Strata Lots 49-60	12 dwellings x 761 L/d	=	9,132 L/d

2.3 Tennis camp dormitory accommodation (Lot 61).

Assume 40 persons x 180 L/person		=	7,200 L/d

2.4 Residential building dormitory accommodation(Lot 62).
Assume 40 persons x 180 L/person = 7,200 L/d

2.5 Managers residence + administration building.
Assume 3 bedroom dwelling @ 761 L/d plus, say 4 persons in administration building @ 30 L/person = 120 L + 761 L = 881 L/d

3. Wastewater Treatment Plants

3.1 Strata Lots 1-10, Lots 63&64, single dwellings with individual on-site disposal systems, either conventional (septic tank and leach drain) or alternative ie. bioMax C10 AWTS.

3.2 The wastewater collection from each dwelling on lots 11-60 will be divided into four groups ie. dwellings on lots 11-22, lots 23-35, lots 36-48, lots 49-60. Each of these groups of dwellings will have its own common effluent collection system discharging into its own pump station and thence to their own treatment plant. The treatment plants proposed are bioMax C60 AWTS designed to process up to 10,800 L/d (refer Item 2.2 above).

The bioMax C60 is a five tank modular concrete system designed for in-line flow from primary treatment, aeration, clarification, disinfection and pump-out.

3.3 Tennis camp dormitory accommodation (Lot 62). A bioMax C50 AWTS would be suitable for this building. It is a five tank modular concrete system capable of processing up to 9,000 L/d and designed for in-line flow from primary treatment, aeration, clarification, disinfection and pump-out.

3.4 Residential dormitory accommodation building (Lot 61). A bioMax C50 AWTS would be suitable for this building. It is a five tank modular concrete system capable of processing up to 9,000 L/d and designed for in-line flow from primary treatment, aeration, clarification, disinfection and pump-out.

3.5 Managers residence and administration building could be served by the same treatment and disposal system ie. bioMax C10 capable of processing up to 1,800 L/d.

4. Wastewater Disposal Areas

4.1 The dwellings on lots 1-10, Lots 63&64, if using bioMax C10 AWTS, would require a discrete garden bed area of 150 m^2 set aside for irrigation disposal purposes. The soils should be friable, well drained with a minimum groundwater clearance from the top of the irrigation disposal pad to the highest known groundwater of 900 mm.

Soil profiles have been conducted at various locations across the lots to identify soil type, depth to groundwater, and PRI capability.

Those west of the lagoon are identified on Attachment 1 and marked BH 1 - BH 4.

Soil on these lots has been identified as sand to a depth of 7 m. (Refer Attachment 2, Dames & Moore site reports).

Depth to the highest known groundwater level varies from 3.25 m at BH 3 to 2.2 m at BH 2 (measured at 9/6/95). (Refer Attachment 3, Dames & Moore site report).

PRI of the soil varies between 1.5 mL/g BH 4 to 5.6 mL/g BH 2. (Refer Attachment 4, Analabs Report to Dames & Moore).

4.2 Attachment 1 highlights an area of approximately 1.1 ha as "Irrigation area". This is a discrete non trafficable area that will be suitably demarcated to preclude public access.

Strata lots 11-22, as indicated above in 3.2, will served by a single bioMax AWTS with the processed wastewater being reticulated onto the common irrigation disposal area. Similarly, lots 23-35, lots 36-48 and lots 49-60 will be served by their own bioMax AWTS disposing their wastewater to the common irrigation area.

Using Health Department of WA criteria the size of the disposal area is based on an irrigation application rate of 10 $L/m^2/d$. Accordingly, for the respective groups of dwellings areas of 990 m^2; 915 m^2; 990 m^2 and 915 m^2 will be required.

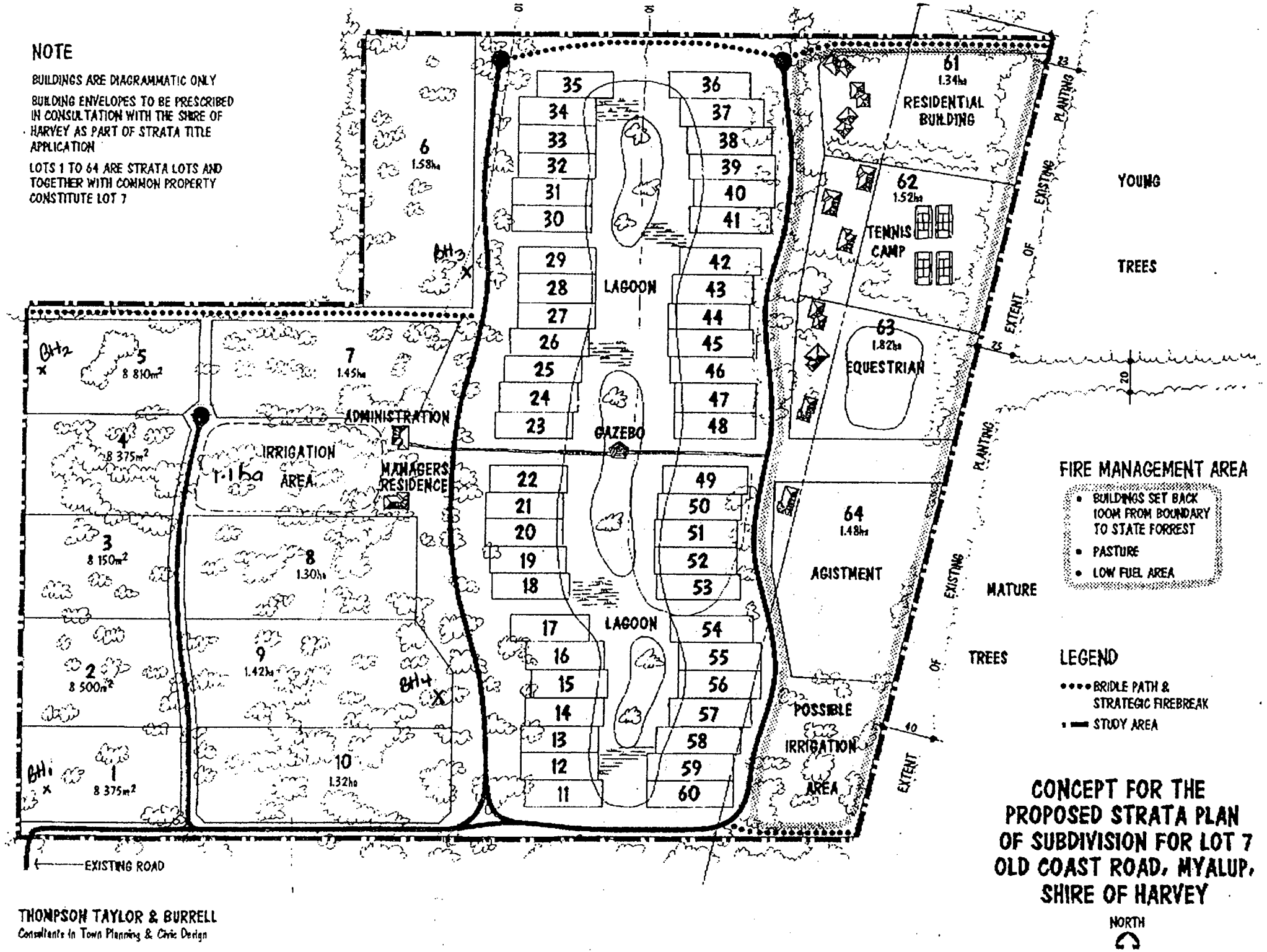
The soil profile, depth to groundwater and PRI are as previously outlined in 4.1 above.

While it is has been established that the groundwater flow is in a westerly direction, and therefore away from the "Lagoon", to minimise any nutrient loss from the disposal area it is proposed to incorporate the use of soil amendment.

Using the current criteria of 30 m^3 of Alcoa "Red Mud" per 1800 L of wastewater, it would be reasonable to extrapolate that 634 m^3 of amending soil would be required for 38,050 L, which is the estimated combined flow from the dwellings on lots 11-60.

4.3 Tennis camp dormitory building. An area of 720 m^2 will be required for disposal of wastewater from this facility. This will be located in the same area as 4.2 above. The use of amending soil will also be incorporated into the disposal area (approx. 120 m^3).

4.4 Residential dormitory building. The disposal area and amending soil requirements as per 4.3 above.


NOTE
BUILDINGS ARE DIAGRAMMATIC ONLY
BUILDING ENVELOPES TO BE PRESCRIBED IN CONSULTATION WITH THE SHIRE OF HARVEY AS PART OF STRATA TITLE APPLICATION
LOTS 1 TO 64 ARE STRATA LOTS AND TOGETHER WITH COMMON PROPERTY CONSTITUTE LOT 7
6 1.58ha
BH3
61 1.34ha RESIDENTIAL BUILDING
62 1.52ha TENNIS CAMP
63 1.82ha EQUESTRIAN
64 1.48ha AGISTMENT
35 36 34 37 33 38 32 39 31 40 30 41
29 42 28 43 27 44 26 45 25 46 24 47 23 48
LAGOON
GAZEBO
22 49 21 50 20 51 19 52 18 53
17 54 16 55 15 56 14 57 13 58 12 59 11 60
LAGOON
BH2
5 8 810m²
7 1.45ha
ADMINISTRATION
4 8 375m²
IRRIGATION AREA 1.1ha
MANAGERS RESIDENCE
3 8 150m²
8 1.30ha
2 8 500m²
9 1.42ha
BH4
BH1
1 8 375m²
10 1.32ha
POSSIBLE IRRIGATION AREA
EXISTING ROAD
YOUNG TREES
EXISTING PLANTING
EXTENT OF
MATURE TREES
EXISTING PLANTING
EXTENT OF
25
20
40
FIRE MANAGEMENT AREA
• BUILDINGS SET BACK 100M FROM BOUNDARY TO STATE FORREST
• PASTURE
• LOW FUEL AREA
LEGEND
BRIDLE PATH & STRATEGIC FIREBREAK
STUDY AREA
CONCEPT FOR THE PROPOSED STRATA PLAN OF SUBDIVISION FOR LOT 7 OLD COAST ROAD, MYALUP, SHIRE OF HARVEY
NORTH
THOMPSON TAYLOR & BURRELL
Consultants in Town Planning & Civic Design

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

BORE No. BH1

SHEET 1 OF 1

CLIENT : GREENVALE ENTERPRISES

DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	MONITORING	N :		
		E :		

TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, btoc)	3.10
TOTAL CASED DEPTH (m)	5.9	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	3.9-5.9
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

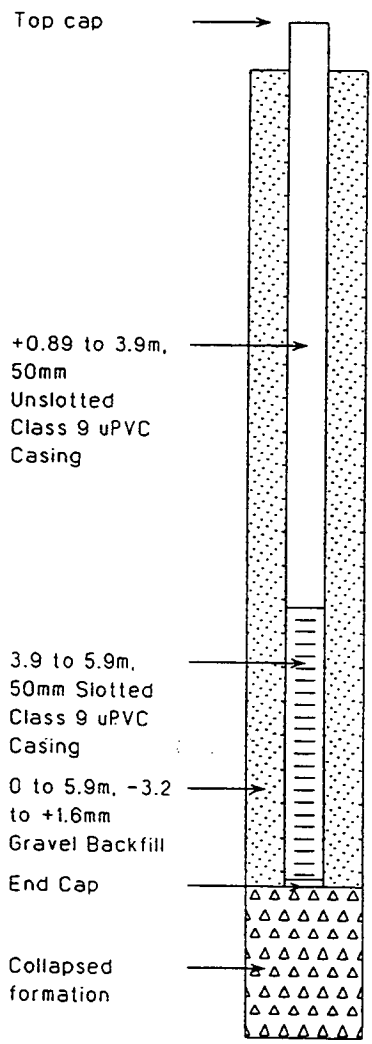
1. Above ground conditions: pasture, situated along fence line.

DRILLER : C. GERDEI / J. NICOLSON

DATE/TIME COMPLETED : 11.00am:30/5/95

DATE/TIME COMMENC : 10.30am:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg.C)	R.L. (m)
	0	SAND, peaty (10-15%), dark grey, fine to medium quartz grains, moderately to well sorted, sub angular.					
	1	SAND, beige grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	2	SAND, beige, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	3	SAND, light grey to light yellow mottled slightly, fine to medium quartz grains, well to moderately sorted, sub angular to sub rounded.					
	4						
	5	SAND, light grey, fine to medium quartz grains, moderately sorted , sub angular to sub rounded.					
	6						
	7	BOREHOLE COMPLETED AT 7.0m.					
	8						
	9						

Data : BH1

Script : DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	10.30am:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

PROJECT : REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

CLIENT : GREENVALE ENTERPRISES

BORE No. BH2

SHEET 1 OF 1

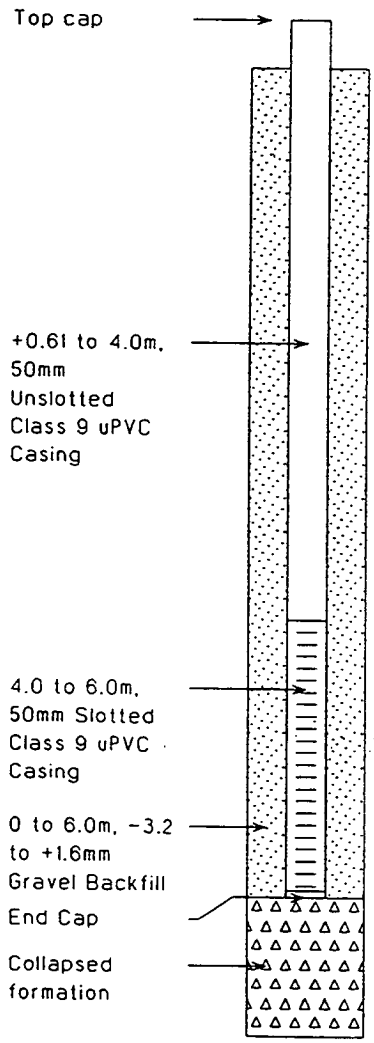
DRILLING RIG : GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD : AUGER	MONITORING	N :		
		E :		

TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, btoc)	2.92
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	4.0-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along fence line.

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg C)	R.L. (m)
	0	SAND, peaty (10-15%), dark grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	1	SAND, mottled light yellow/ light brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	2	SAND, mottled yellow/light brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	3	SAND, light beige brown, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	4	SAND, light grey/light yellow mottled slightly, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	5	SAND, light grey, fine to medium quartz grains, moderately sorted , sub angular to sub rounded.					
	6	SAND, slightly silty, light grey, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	7	BOREHOLE COMPLETED AT 7.0m.					
	8						
	9						

DRILLING COMPANY : GUNBURI DRILLING
DRILLER : C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED : 11.00am:30/5/95
DATE/TIME COMPLETED : 11.45am:30/5/95

Data : BH2
Script : DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	11.00am:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

PROJECT: REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

CLIENT: GREENVALE ENTERPRISES

BORE No. BH3

SHEET 1 OF 1

DRILLING RIG: GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD: AUGER	MONITORING	N:		
		E:		

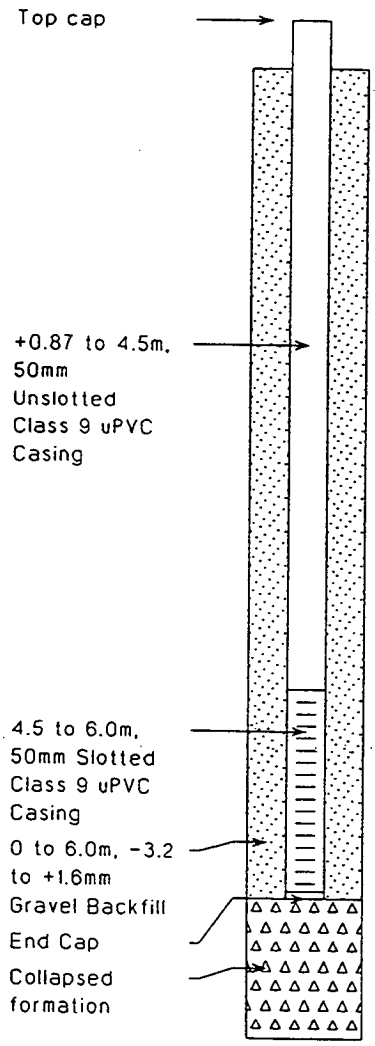
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, btoc)	4.25
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	4.5-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along north-western side of wetland.

DRILLING COMPANY: BUNBURY BORING
DRILLER: C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED: 11.45am:30/5/95
DATE/TIME COMPLETED: 12.15am:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg.C)	R.L. (m)
	0	SAND, peaty (10-15%), dark grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	1	SAND, light orange yellow/light brown mottled, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	2						
	3	SAND, light orange, fine to medium quartz grains, moderately to well sorted, sub rounded.					
	4	SAND, light orange, fine to medium quartz grains, moderately to well sorted, sub angular to sub rounded.					
	5	SAND, beige, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	6	SAND, light grey beige, fine to medium quartz grains, moderately sorted, sub angular to sub rounded.					
	7	BOREHOLE COMPLETED AT 7.0m.					
	8						
	9						

Data: BH3
Script: DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	11.45am:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

PROJECT: REMLAP RANCH RESORT, MYALUP
GROUNDWATER INVESTIGATION

BORE No. BH4

SHEET 1 OF 1

CLIENT: GREENVALE ENTERPRISES

DRILLING RIG: GEMCO	BORE STATUS	CO-ORD'S OF COLLAR	R.L. OF COLLAR	DATUM
DRILLING METHOD: AUGER	MONITORING	N:		
		E:		

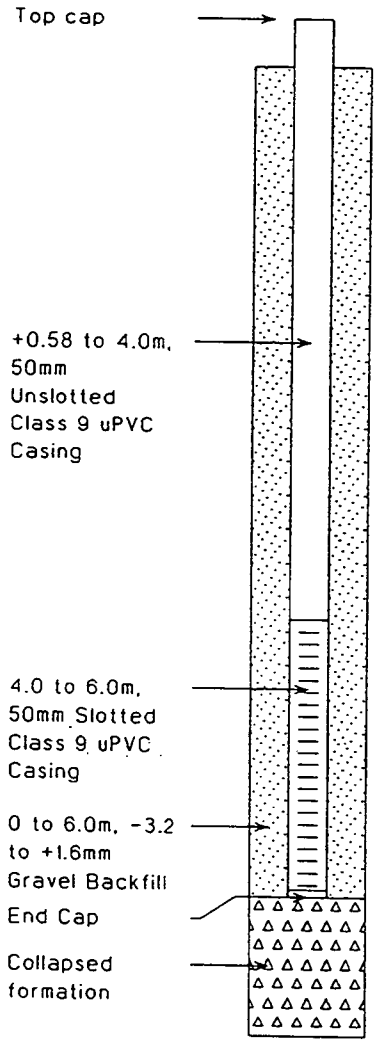
TOTAL DRILLED DEPTH (m)	7.0	STATIC WATER LEVEL (m, btoc)	3.63
TOTAL CASED DEPTH (m)	6.0	DATE OF MEASUREMENT	31/5/95
MINIMUM CASING DIAMETER (mm)	50mm	OPEN INTERVAL (m, bgl)	4.0-6.0
MINIMUM SCREEN DIAMETER (mm)	50mm		

ADDITIONAL NOTES

1. Above ground conditions: pasture, situated along south-western side of wetland.

DRILLING COMPANY: DUNBURY BORING
DRILLER: C. GERDEI / J. NICOLSON
DATE/TIME COMMENCED: 03.00pm:30/5/95
DATE/TIME COMPLETED: 03.50pm:30/5/95

SCHEMATIC BORE CONSTRUCTION



GRAPHIC LOG	DEPTH (m)	LITHOLOGICAL DESCRIPTION	GEOLOGICAL UNIT	AIRLIFT YIELD (m3/day)	CONDUCTIVITY (uS/cm)	TEMPERATURE (deg. C)	R.L. (m)
	0	SAND, peaty (10%), dark grey, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	1	SAND, light orange/light brown slight mottles, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	2	SAND light orange, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	3	SAND, cream orange, fine to medium quartz grains, well sorted, sub angular to sub rounded.					
	4	SAND, beige, fine to coarse quartz grains, moderately sorted, sub angular to sub rounded.					
	5	SAND, grey beige, fine to coarse quartz grains, moderately sorted, sub angular to sub rounded.					
	6	SAND, light grey, fine to coarse quartz grains, moderately sorted, sub angular to sub rounded.					
	7	BOREHOLE COMPLETED AT 7.0m.					
	8						
	9						

Data: BH4
Script: DUNS-BCR

JOB No. 30978-001-366		DATE
LOGGED BY	JKB	03.00pm:30/5/95
APPROVED BY		

BORE COMPLETION REPORT

CLIENT: Dames & Moore (Myalup) **OUR REFERENCE:** 104760.09.24898
PROJECT NO: RO550

MISCELLANEOUS ANALYSIS

1M-BH7 1M-BH7

Your Reference	1M-BH1	1M-BH2	1M-BH3	~~1M-BH4~~	~~1M-BH4~~
	30/5/95	30/5/95	30/5/95	30/5/95	30/5/95
Our Reference	24898-1	24898-2	24898-3	24898-4	24898-4 Rpt
Sample Type	Soil	Soil	Soil	Soil	Soil
Units	ml/g	ml/g	ml/g	ml/g	ml/g
Phosphorus Retention Index	0.9	5.6	5.5	<0.5	<0.5

1M-BH4

Your Reference	1M-BH5	1M-BH6	~~1M-BH7~~	1M-BH8	1M-BH8
	30/5/95	30/5/95	30/5/95	30/5/95	30/5/95
Our Reference	24898-5	24898-6	24898-7	24898-8	24898-8 Rpt
Sample Type	Soil	Soil	Soil	Soil	Soil
Units	ml/g	ml/g	ml/g	ml/g	ml/g
Phosphorus Retention Index	1.0	2.4	1.5	3.0	2.8

Your Reference	1M-BH9				
	30/5/95				
Our Reference	24898-9				
Sample Type	Soil				
Units	ml/g				
Phosphorus Retention Index	4.7				

Table 1: Groundwater Levels, 31 May and 9 June 1995.

Borehole	Water Level (m, below ground level), 31 May 1995	Water Level (m, below ground level), 9 June 1995
BH1	2.21	2.15
BH2	2.31	2.22
BH3	3.38	3.25
BH4	3.05	2.95
BH5	1.84	1.36
BH6	3.91	3.72

LIBRARY
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WESTRALIA SQUARE
141 ST. GEORGE'S TERRACE, PERTH