STRUCTURE PLAN REPORT

Avoca Farm
Narembeen

November 2011

GRAY&LEWIS
LAND USE PLANNERS

Prepared by Gray & Lewis Landuse Planners for the Shire of Narembeen

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ENDORSEMENT PAGE

This structure plan is prepared under the provisions of Shire of Narembeen Town Planning Scheme No. 2.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

04 April 2013

In accordance with Schedule 2, Part 4, Clause 28 (2) and refer to Part 1, 2. (b) of the *Planning and Development (Local Planning Schemes) Regulations 2015.*

Date of Expiry: **19 October 2035**

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List of Figures & Attachments

Report file name	Report Status	Date
V1 Structure Plan Report November 2011	Version 1	30 November 2011

1.0 INTRODUCTION

Narembeen is situated approximately 286 kilometres from Perth in the Wheatbelt and is predominantly an agricultural region with the main agricultural areas being cereal cropping, cattle and sheep.

The Shire of Narembeen purchased a 321.5 hectare farming property adjoining the town of Narembeen in 1996. The property is known as 'Avoca Farm' and is located immediate west of town, and bordered to the south by the Bruce Rock Narembeen Road.

A Structure Plan has been developed for a portion of Avoca Farm having regard for the physical features of the land, surrounding road network, established and approved subdivision in the immediate locality, and land capability. This Structure Plan is lodged to comply with the existing zoning and Town Planning Scheme requirements.

A Draft Structure Plan has undergone preliminary assessment and comment by the Western Australian Planning Commission (WAPC). The Structure Plan has been reviewed by Gray & Lewis to respond to comments by the WAPC.

2.0 SITE DETAILS

2.1 Legal Description

The subject land is described as Lot 16224 on Plan 16224 comprised within Certificate of Title Volume 2046 Folio 541.

Lot 16224 is approximately 317.9 hectares and is owned by the Shire of Narembeen.

2.2 Location

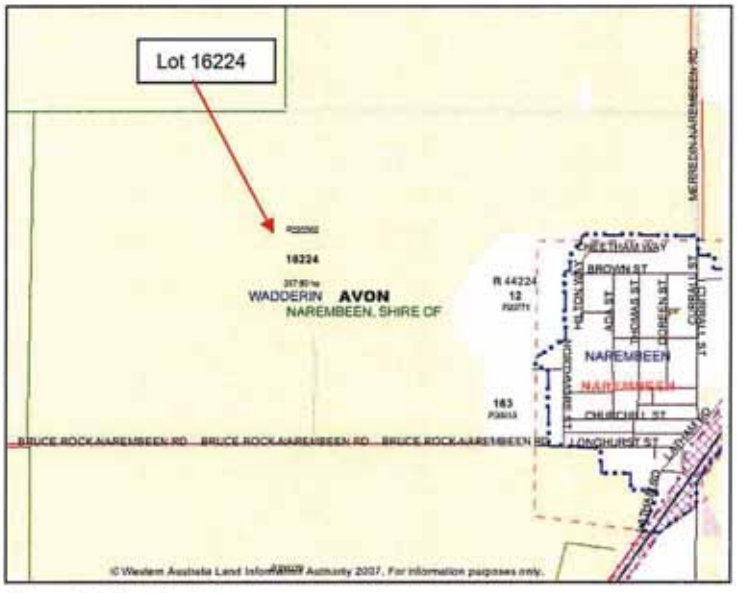

Figure 1 – Location Plan

Narembeen has many local attractions, and is within easy driving distance of Wave Rock.

The subject lot is located to the immediate north and west of the Narembeen townsite and established residential area.

Avoca Farm has excellent access to local services and shops located in the Narembeen townsite – refer Figure 1.

3.0 STATUTORY FRAMEWORK

3.1 Shire of Narembeen Town Planning Scheme No 2

3.2.1 Zoning

The majority of Lot 16224 is zoned 'Rural Enterprise' zone under the Shire of Narembeen Town Planning Scheme No. 2 ('the Scheme'). Lot 163 Bruce Rock Narembeen Road is also zoned 'Rural Enterprise' zone and is subject to future planning.

The eastern portion of Lot 16244 has been successfully re-zoned to 'Residential Development' zone under Amendment 4 to the Scheme allow for future residential subdivision north of Cheetham Way (subject to a Structure Plan) - refer Figure 2.

Amendment 4 introduced new scheme provisions for structure plans outlining requirements for preparation of a structure plan, procedures (including advertising) and a requirement that structure plans be endorsed by the Western Australian Planning Commission (WAPC).

Amendment 4 was approved by the Minister for Planning on the 11 July 2011.

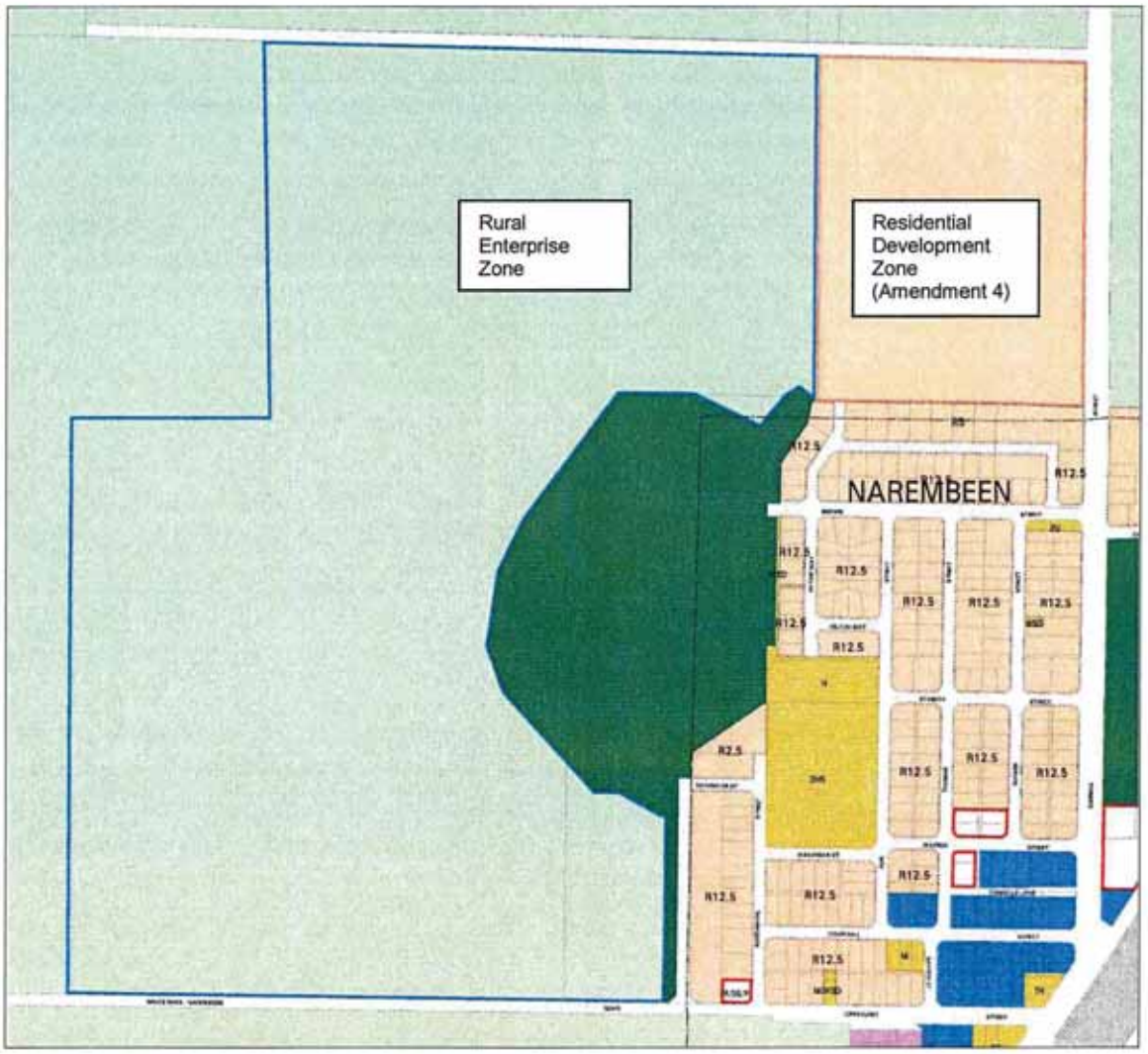

Figure 2 – Extract Town Planning Scheme No 2

3.2.2 Statutory requirements

The objective of the Rural Enterprise zone is to *'provide for the establishment of land uses which are complementary to the economic, social and environmental characteristics of the town of Narembeen and the region, which promote and facilitate investment opportunities, and encourage research into matters such as agronomy, salinisation of soil and water, noxious weeds and animal breeding.'*

The Rural Enterprise zone allows for a range of landuses including Special Rural.

The objectives of the Residential Development zone as outlined in Clause 4.2 of the Scheme are:

- *To allow for the progressive development of land for predominately residential purposes together with compatible uses.*
- *To retain the single house as the predominant form of residential development and maintain flexibility to cater for a variety of housing choice and future housing needs.*
- *To allow for incidental non-residential uses only where the local amenity is not adversely affected.*
- *To ensure that subdivision occurs in a co-ordinated manner and has regard for other future subdivisions in the area.*

Under Clause 4.16 of the Scheme, a Structure Plan is required to guide future development and subdivision in the Residential Development zone. The Structure Plan area also covers land to the west to ensure an overall co-ordinated approach is taken.

Clause 4.17.4 of Town Planning Scheme No. 2 outlines the requirements for the preparation of Structure Plans generally. The Scheme includes requirements for a detailed plan, information on characteristics of the site (such as soils and topography), land capability and a written report.

This Local Structure Plan has been prepared in accordance with the Scheme requirements and to meet the applicable objectives of the Residential Development zone and Rural Enterprise zone.

The Scheme also outlines the process for dealing with Structure Plans including public advertising, adoption by the Shire and referral to the Western Australian Planning Commission for endorsement.

4.0 STRATEGIC FRAMEWORK

4.1 Relevant State Planning Policies

State planning policies are prepared and adopted by the WAPC under statutory procedures set out in Part 3 of the Planning and Development Act 2005. The process of preparing a state planning policy also includes public consultation and consideration by the Planning Minister and the Governor.

The WAPC and local governments must have regard to the provisions of state planning policies when making decisions on planning matters including Structure Plans.

There a wide range of state planning policies which guide subdivision and development.

There is no need to replicate the detail of information contained in State Planning Policies within this Structure Plan report, however the most relevant policies are listed below for ease of reference:

- State Planning Policy 2 – Environment and Natural Resources
- State Planning Policy 2.5 – Agricultural and Rural Landuse Planning
- State Planning Policy 2.9 – Water Resources
- State Planning Policy 3 – Urban Growth and Settlement
- State Planning Policy 3.1 – Residential Design Codes
- State Planning Policy 3.6 – Developer Contributions for Infrastructure

In addition to the above, it is recognised that the WAPC has released Draft Structure Plan Preparation Guidelines to assist in preparation of structure plans.

4.2 Relevant Local Planning documents

4.2.1 Townsite Expansion Strategy

The Shire of Narembeen has adopted a Townsite Expansion Strategy as an interim measure to provide strategic planning guidance for the future development and expansion of the Narembeen townsite until such time as a local planning strategy is prepared.

The Strategy recognises that '*in common with many small Wheatbelt towns in Western Australia, the Shire of Narembeen faces the challenge of providing employment opportunities and retaining businesses to sustain modest population growth. The Shire currently experience a shortage of housing and provision of new quality housing continues to be a major problem. There is also a deficiency of certain trades people and the development of a vibrant and sustainable town is an important catalyst to attract new residents to the town.* '

The Strategy recognises residential expansion north of Cheetham Way will occur in the short term (Area 4). It also identifies potential future Special Rural development to occur within Avoca Farm to the west (Area 5), subject to land capability assessment and a Structure Plan.

Figure 3 – Extract of Townsite Expansion Strategy

The Townsite Expansion Strategy was 'noted' by the Western Australian Planning Commission on the 1 July 2009 (WAPC Ref: 853/4/21/2).

5.0 EXISTING AND SURROUNDING LANDUSE

5.1 Existing Landuse

The subject land has been predominantly cleared and historically has been used for rural purposes including cropping and grazing. The lot contains some scattered trees with no understorey. Rehabilitation planting has occurred and will be retained in open space.

There is a farmhouse and associated outbuildings on the subject land - Figure 4.

Figure 4 – Existing landuse

5.2 Surrounding Context (Zoning and Landuses)

Land to the north generally consists of larger properties zoned 'Farming' and used for typical agricultural activities.

The land immediate east forms part of the Narembeen townsite and is residential. The Shire has already successfully subdivided stages 1 and 2 of land in Cheetham Way and has sold all of the lots except for one (WAPC: 133947).

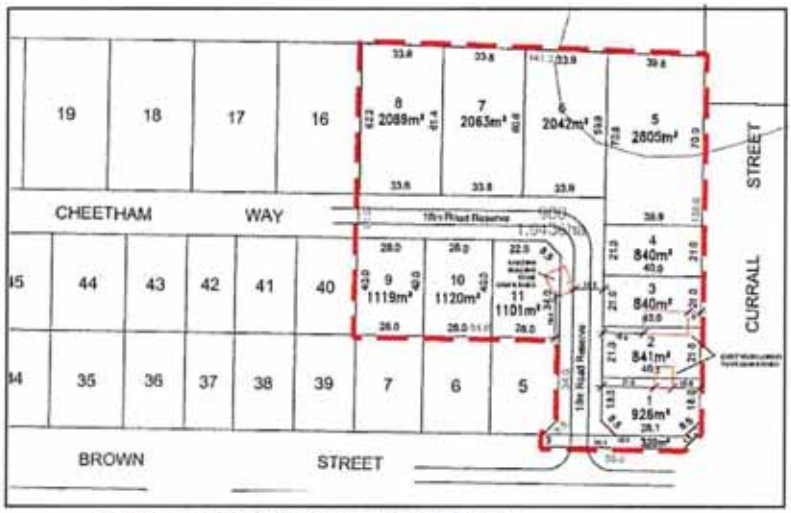

Figure 5 – Stage 3 Cheetham Way subdivision

The Shire obtained subdivision approval and is progressing (stage 3) on Lot 900 in Cheetham Way to meet short term demand (WAPC: 143894).

The Shire intends to proceed with additional residential lots north of Cheetham Way, once this Structure Plan is endorsed by the WAPC. Release of residential lots will occur according to demand.

6.0 ENVIRONMENTAL CHARACTERISTICS

6.1 Soil Conditions

A detailed Land Capability Assessment has been prepared by Land Assessment Pty Ltd - Attachment 1.

For ease of reference summary information on soils is included in this structure plan report, however should be read in conjunction with the Land Capability Assessment report.

The soils have been classified in accordance with the Department of Agriculture's WA Soil Group nomenclature (Schoknecht 2002) and the landforms according to categories described in its Land Evaluation Standards document (van Gool et al 2005).

Detailed mapping of land units (soil-landform types) has been compiled for the proposed Residential and Special Rural areas to the north and north west of Narembeen. Land units are areas with relatively homogeneous conditions in relation to soils and landform, hence land management requirements.

The soils within the study area are predominantly alkaline as a result of high carbonate content. However, within the lower-lying terrain (unit K1) adjacent to the western side of the lake, Site 11 is noteworthy because the deeper subsoil was found to have neutral to slightly acid pH. This suggests seasonally high levels of the underlying acidic ground water have reached this part of the soil profile to neutralise the otherwise carbonate-rich material.

'Land capability' is a term used to express the ability of natural attributes of the land to meet the physical requirements of a proposed form of use with minimal risk of degradation to soil or water resources.

The soil types and land capabilities are summarised below:

Land Unit	Planning Considerations
K1	Lower lying, imperfect to poorly drained soils and possibly subject to flooding under extreme events. Deeper subsoil conditions suggest the presence of saline groundwater at about 1.5m depth in winter months.
K2	This unit occurs within the proposed sewered residential area with similar, though slightly more elevated, terrain to adjacent existing townsite area. Foundation conditions for housing and roads and can be expected to be comparable and the land is not considered to be susceptible to flooding. Given the low gradient and slowly permeable soils, careful attention to the design of stormwater drainage systems is required.
B1	Imperfectly drained shallow loamy duplex soils with calcareous subsoil and slow permeability restrict the effectiveness of conventional septic tanks and leach drain systems for on-site effluent disposal.
B2	Moderately well drained loamy earths are generally suitable for on-site effluent disposal using conventional septic tank and leach drain systems. Use of elevated (partially inverted) leach drains may be necessary in some areas if clayey subsoils are encountered at shallower depth.
B3	Imperfectly drained loamy earths with salt affected topsoil. Calcareous subsoil clays can disperse when wet, causing reduced permeability for on-site effluent disposal. Avoid these localised areas for on-site effluent disposal where possible or address through the use of alternative treatment units.
B4	Imperfectly drained clay soils with calcareous subsoil and slow permeability restrict the effectiveness of conventional septic tanks and leach drain systems for on-site effluent disposal.
B5	Gilgai (mounds and depressions) microrelief within this area indicates the presence of expansive clays and unfavourable conditions for house foundations. This area should be subject to site-specific engineering evaluation of house foundations.
V	This unit encompasses the relatively recently established vegetation, and riparian remnants, fringing the western side of Lake Walker and extending in a broad wedge over both sides of the seasonal watercourse that enters the northern side of the lake. Retention of all landcare plantings is recommended to protect the watercourse and Lake Walker from impacts of adjacent development, and to provide a landscape buffer between urban and rural-residential areas.

The soil types overlaid with aerial photography are shown in Figure 6 overpage. The most prominent soils to note for Structure Planning are K1 (as an area to be avoided for on site effluent disposal) and B1 (as an area which requires engineering examination at building stage). Both the K1 and B1 soils are mapped on the Structure Plan, and larger lot sizes incorporated to recognise constraints.

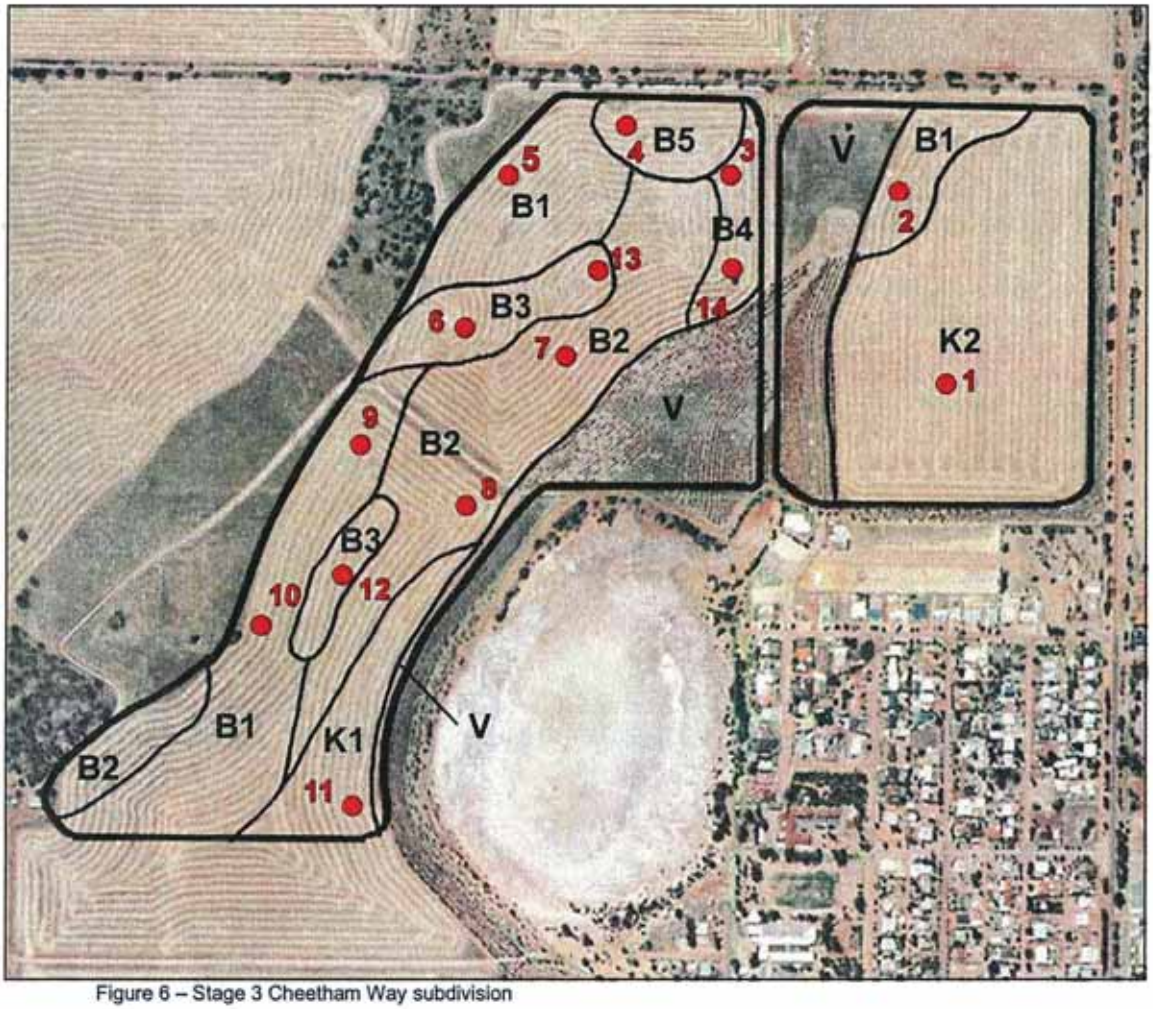

Figure 6 – Stage 3 Cheetham Way subdivision

It should be noted that the Land Capability Assessment highlights that the B1, B2 and B3 soils are imperfectly to moderately drained. Effluent disposal in these areas has been discussed with Land Assessment Pty Ltd (Martin Wells) who confirmed that partially inverted leach drains may be adequate, however if required Alternative Treatment Units (ATU's) can be employed. The Land Capability Assessment takes a cautious approach due to the need for Health Department approval.

Land Assessment has recommended that the Structure Plan (and report) highlight that ATU's may be required at development stage and the type of on site effluent disposal be dealt with at development stage. It is not recommended that effluent disposal be restricted only to ATU's and that the Structure Plan should allow flexibility for further on site analysis at development stage.

6.2 Groundwater

Information on depth to groundwater beneath the study area is important in relation to the capability of the land for unsewered rural-residential development.

A groundwater study undertaken by the Department of Agriculture (Nott 2011) as part of the 'Rural Towns Program' to address concerns over groundwater levels and salinity within Narembeen townsite provides relevant information on the depth to watertable.

This investigation included the installation of a number of piezometers across the townsite and adjacent areas.

Sufficient depth to watertable occurs beneath the lower colluvial slopes north-west of the town (Bendering soil-landscape system) to meet environmental and public health criteria relating to siting domestic wastewater disposal systems.

In relation to the lower lying terrain (Kellerberrin soil-landscape system) the groundwater study data showed the entire built up area of the Narembeen town has a watertable between 2 and 3m below the surface (likely to be higher during a sequence of wet years) and acid groundwater with a salinity at least half that of seawater.

Given the gradually increasing land surface level for the proposed future residential area directly north of town depth to groundwater should not be limiting in relation to installation of services associated with the proposed sewered residential development in this part of the study area.

6.3 Vegetation

The Structure Plan area study area has been almost totally cleared to facilitate previous agricultural land use activity.

The existing vegetation cover fringing Lake Walker and the seasonal watercourse extending northwards (part of the Wadderin-Wogarl drainage catchment) is largely the result of a rehabilitation initiative of the Narembeen Land Conservation District Committee (LCDC) and the Shire of Narembeen.

Species planted here are reported by the LCDC to include Salt Gum (*Eucalyptus salicola*), Red Morrel (*E longicornis*), Merrit (*E celastroides or E flocktoniae*?), Broomebush (*Melaleuca uncinata*), Swamp Sheoak (*Casuarina obesa*) Salt Bush (*Atriplex spp*) and Samphires (*Haloscarcia spp*). There is also a number of mallee species planted within the northern portion of the weakly incised drainage depression separating the proposed Residential and Special rural areas.

The replanted vegetation within the study area is of environmental value in terms of providing habitat for local fauna and avifauna, as well as protecting Lake Walker from adverse impact of nutrients within drainage from adjacent land. In a townsite expansion context they are also of aesthetic and passive recreational value, and serve to clearly separate or buffer the proposed residential areas from Special Rural (Rural-Residential) areas.

All rehabilitation planting areas are proposed to be retained in public open space in the Structure Plan.

7.0 EXISTING ROAD NETWORK

There is an existing driveway access from Bruce Rock Narembeen Road into Lot 16224 which has historically served the old Avoca farm buildings.

The subdivision in Cheetham Way / Brown Street has been designed to allow road links to the north to service the residential component of the structure plan.

8.0 SITE AND CONTEXT ANALYSIS MAP

A Context and Site analysis can be effectively illustrated on one plan as a number of elements associated with the proposed Structure Plan design have been predetermined (such as the need to link with roads to the south in Cheetham Way). This approach is consistent with Appendix 1 of Liveable Neighbourhoods whish states '*Context and site mapping may be undertaken together or separately*'.

The purpose of context analysis is to connect and integrate Structure Planning for the land with surrounding developed areas and future planned subdivision. A Context and Site analysis plan has been prepared to;

- Identify contours and topography
- Identify vegetation or rehabilitation plantings to be retained in open space
- Land capability constraints
- The need to maintain buffers to Reserve 44224
- Surrounding zones and residential development
- Opportunities for road links
- Important walktrails and firebreak areas
- The surrounding road network and established residential areas.

The site analysis involved detailed assessment of the land and its immediate surrounds - Figure 7.

9.0 PROPOSED STRUCTURE PLAN

9.1 Background

The Shire has successfully carried out residential subdivision in Cheetham Way and Brown Street located immediate south of the Structure Plan area. The Shire is proceeding with stage 3 of the Cheetham Way subdivision and would like to also pursue an additional row of residential lots to the north of Cheetham Way.

A Structure Plan is required to guide future subdivision for the 'Residential Development' zone north of Cheetham Way, and for future Special Rural lots in Avoca Farm.

Council originally adopted a broad Outline Development Plan / Structure Plan for Avoca farm at its meeting held in April 2010. At the time the Shire of Narembeen Town Planning No 2 did not contain any specific requirements for Structure Plans.

The plan was advertised for public comment concurrently with Scheme Amendment No 4. During advertising two submissions were received raising issues such as the need to maintain walkways around the salt lake, lot sizes, open space areas etc. Some of the issues raised were valid and warranted a review of the plan.

Figure 7

SITE CONTEXT AND ANALYSIS MAP

NAREMBEEN TOWNSITE
NAREMBEEN

LEGEND
SUBJECT LAND

N
0 250m
SCALE 1:7500 @ A3

GRAY & LEWIS
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perth@graylewis.com.au

JOB REFERENCE: 100762 DATE: 10th NOVEMBER 2011

Gray & Lewis reviewed the plan and provided two different options for Council consideration. Council adopted an Option 1 plan in December 2010. The adopted plan was lodged with the WAPC seeking their endorsement. The WAPC processed Amendment 4 first, and then undertook a preliminary assessment of the Avoca farm plan.

9.2 Structure Plan

A revised Structure Plan has been developed to take into account modifications requested by the Western Australian Planning Commission (WAPC) as part of the Commissions preliminary assessment.

The Commission has requested that the Structure Plan comply with new scheme provisions for structure plans which were introduced as part of Scheme Amendment 4, which has been gazetted. This includes preparation of a Structure Plan report and conducting new formal public advertising.

9.2.1 Structure Plan Design

The proposed Structure Plan has been designed having regard for the existing road network, approved subdivision in Cheetham Way, the need to retain walk trails, land capability, topography and other relevant planning considerations such suitable public open space.

The residential densities proposed in the Structure Plan aim to achieve flexibility, variety and still achieve compatibility with subdivision to the south which has already been approved.

The Proposed Structure Plan is included as Figure 8.

The proposed Structure Plan design seeks to:

- Allow for staged release of future residential lots to the north of Cheetham Way accordingly to demand and to cater for future population and community needs.

- Retain a low R20 density for expansion of future residential subdivision north of Cheetham Way. The R20 density will allow for minimum lot sizes ranging between 440m^2 with an average of 500m^2. The R20 density is proposed in recognition that the Shire seeks to maintain flexibility for future residential subdivision, and can incorporate lots larger than the prescribed minimum if required to suit market demand. Scope for smaller lot sizes to the north allows potential to reduce the service costs per lot and provide greater housing choice.

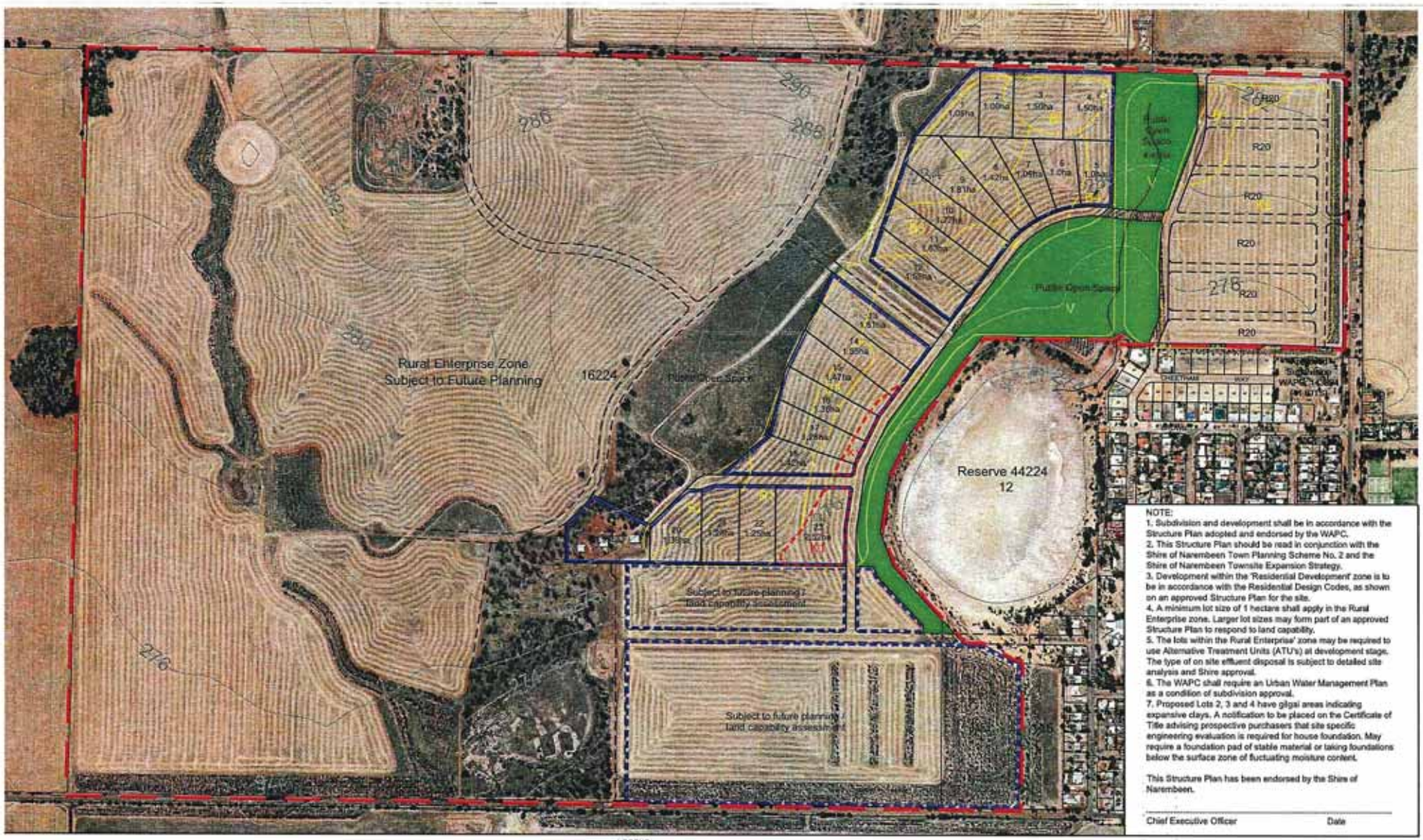
- Incorporate existing rehabilitation plantings on the land into public open space which will provide separation between planned special rural lots to the west and residential lots in the east portion of the structure plan area.

- Provide opportunities for diversity in dwelling types and housing choice by catering for future residential and introducing larger lifestyle lots. The larger lots have been orientated so that new dwellings can overlook the salt lake on Reserve 44224.

- Provide permeability and connecting road linkages to the surrounding network and maintain walking links throughout.

- Provide separation and a road buffer to Reserve 44224.

- Incorporate larger lots as required to respond to land capability.



STRUCTURE PLAN (Avoca Farm)

NAREMBEEN TOWNSITE
NAREMBEEN

JOB REFERENCE: 100762 DATE: 5th AUGUST 2011

LEGEND
- SUBJECT LAND
- RESIDENTIAL R20
- PUBLIC OPEN SPACE
- RURAL ENTERPRISE ZONE
- 'K1' AREA IDENTIFIED IN LAND CAPABILITY REPORT AS LOW LYING WITH POSSIBLE SHALLOW GROUNDWATER, AREA TO BE AVOIDED FOR ON SITE EFFLUENT DISPOSAL

N
0 250m
SCALE 1:7500 @ A3

Figure 8

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9.2.2 Residential Density

The proposed Structure Plan has a designated density of R20 for land to the north of Cheetham Way contained in the Residential Development zone. The Shire has an overarching objective for the plan to maintain as much flexibility as possible for future subdivision and to minimise the need for future modifications to the adopted Structure Plan and unnecessary costs.

The R20 density will provide flexibility for future subdivision and the land will be developed by the Shire and released according to demand. At this juncture it is anticipated that the Shire will continue to release residential lots in small stages of approximately 10 lots at a time. The costs of sewer and servicing is a major consideration for future development.

The total lot yield is dependent on finalising a subdivision design which requires separate approval of the Western Australian Planning Commission.

There is potential for some grouped dwelling development in the 'Residential Development' zone in the future if required. The Residential design Codes allow for a reduction of minimum sites areas for aged and single person accommodation.

Densities in the Shire are currently limited to R12.5 and R5. The Residential R20 density will result in a sound blend and mixture of available dwelling choices to cater for future community needs. The R20 density will also the Shire to maximise use of infrastructure and reduce the costs per lot for development.

9.2.3 Road access

The subdivision in Cheetham Way was specifically designed to allow for residential expansion and road links to the north. The Shire will proceed with residential subdivision north of Cheetham Way, and extend existing road links.

As residential development expands, there will be future opportunities to extend the road network to service the proposed larger lifestyle lots west of the salt lake.

9.2.4 Public Open Space

The Structure Plan will be provided with Public Open Space strategically placed in between the residential development zone and rural enterprise zone. This will provide visual separation between the urban environment and larger lifestyle lots. The public open space has largely been determined by the desire to retain rehabilitation planting that has been undertaken on the land.

9.2.5 Water Management and drainage

Initially the Commission requested that the structure plan be accompanied by a Local Water Management Strategy during the preliminary assessment at a state planning level. The Shire had objections to the request as it would have involved extensive monitoring, expense, time delays and involve significant Shire resources and project viability.

The WAPC has informally agreed not to require a LWMS 'up front' following liaison with the Department of water. The WAPC will impose conditions on future subdivision approvals requiring lodgement of an Urban Water Management Plan, however that can be examined as part of detailed engineering stormwater and drainage design.

9.2.6 Servicing

The Shire has engaged Voran (Consultant Engineers) to prepare design, drawings and costs estimates for Stage 3 of the Cheetham Way / Brown Street Residential Subdivision Narembeen.

Services in Cheetham Way will be extended to the north. As in the case of existing subdivision, the Shire will require detailed engineering advice on servicing for future subdivision release in the structure plan area.

10.0 FUTURE SUBDIVISION AND STAGING

Future subdivision will be guided by the Structure Plan which requires public advertising, final adoption by the Shire of Narembeen (with or without modifications) and endorsement by the Western Australian Planning Commission (WAPC). Although the WAPC has provided preliminary comment on the plan, their assessment will be finalised when it is re-lodged formally seeking their approval.

It should be noted that separate subdivision applications will need to be lodged for WAPC approval to progress development of the structure plan area in stages

11.0 CONCLUSION

The Structure Plan will facilitate future town expansion and staged gradual subdivision creating new housing opportunities in Narembeen compatible with the existing established subdivision pattern to south.

Due to the close proximity to the Narembeen townsite, future lots in the structure plan will have excellent access to a wide range of existing services and infrastructure. These are likely to continue to improve over time through continued good governance and the leadership of the Shire of Narembeen.

The proposed Structure Plan is consistent with the Shire of Narembeen Local Planning Strategy, objectives of the City's Local Planning Scheme for the Residential Development zone and Rural Enterprise zone, and connects into the approved subdivision in Cheetham Way / Brown Street.

ATTACHMENT 1

Land Capability Assessment

LAND CAPABILITY ASSESSMENT

NAREMBEEN TOWNSITE EXPANSION AREAS

SHIRE OF NAREMBEEN

for

GRAY & LEWIS

Land Use Planners

on behalf of

SHIRE OF NAREMBEEN

LAND ASSESSMENT PTY LTD
5/27 York Street, SUBIACO WA 6008
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Report No. 1001 FEBRUARY 2010

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APPENDICES

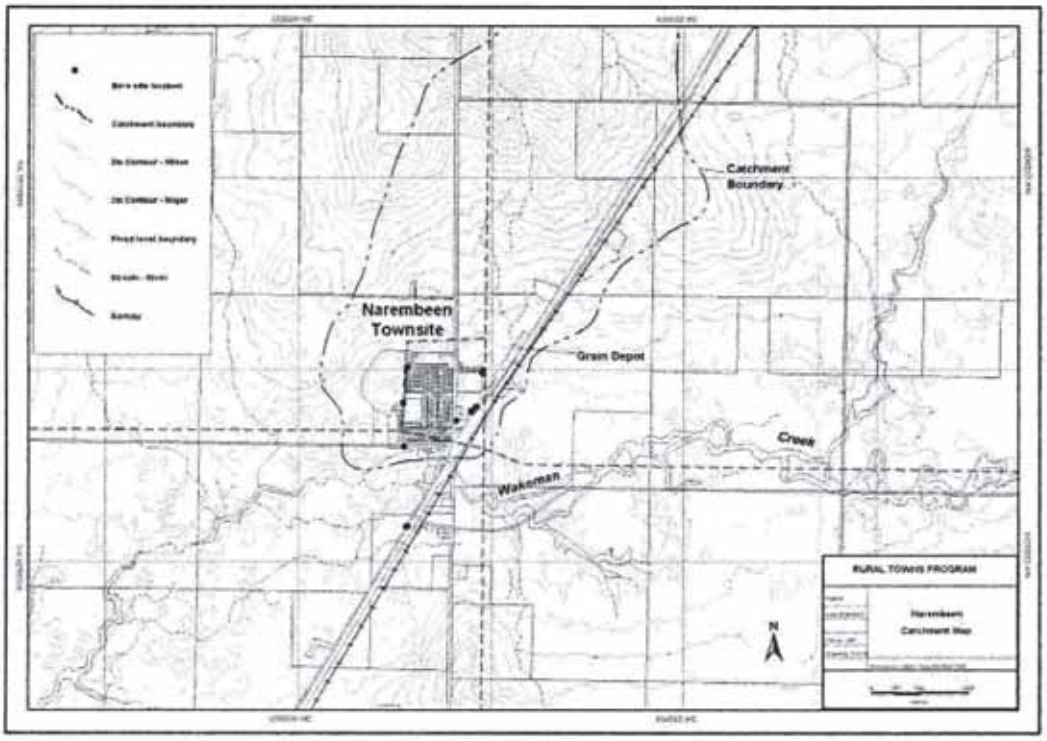
1.0 BACKGROUND

Narembeen is the major town in the Narembeen Shire. It is located 282 km east of Perth and 65 km south of Merredin within the lower central portion (Lockhardt regional drainage system) of the Avon River Basin. Narembeen occurs in the lower landscape of the Wadderin-Wogarl drainage catchment, a tributary of the Wakeman Creek (Figure 1). Current land use in the surrounding area is predominantly wheat in rotation with pastures or lupins.

In 1996 the Shire purchased a 321.5 ha faming property, 'Avoca' , adjoining the town in order to accommodate future residential expansion directly to the north, and to establish a 'Rural Enterprise Zone' over the remainder to the west. Planning consultants Gray and Lewis have prepared a Townsite Expansion Plan showing a number of 'planning areas' and outlining associated planning issues and requirements (Figure 2).

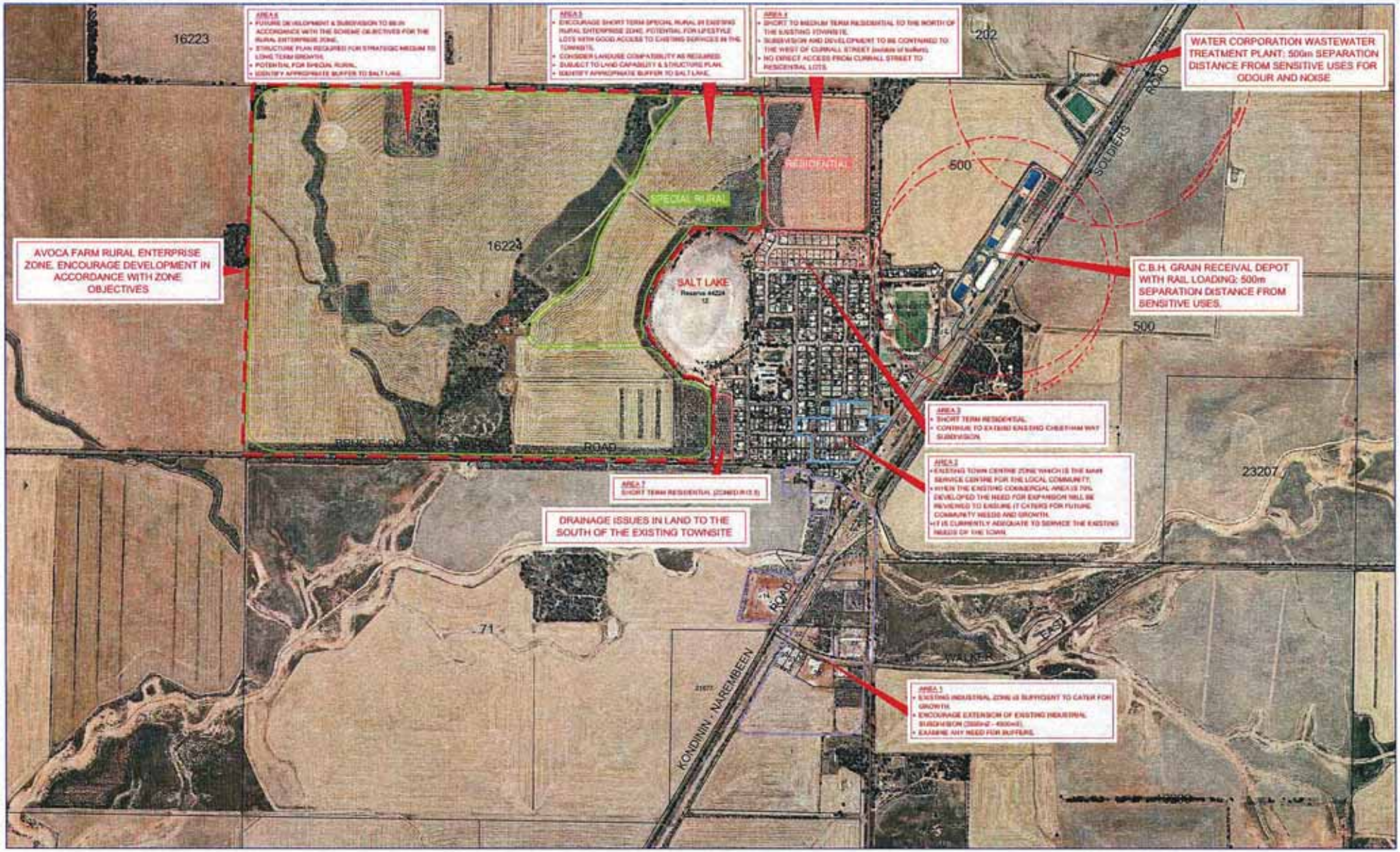
The Townsite Expansion Plan identifies two areas to accommodate future expansion of the town's population. Area No 4 is earmarked for a northwards expansion of the existing townsite under a sewered residential development scenario. Area No 5, beyond Lake Walker and to the north west of town, is earmarked for Special Rural (rural-residential) development. This would not be connected to sewerage but is intended to be provided with scheme water.

The Townsite Expansion Plan requires the preparation of a Structure Plan and information of the nature and capability of the subject in order to facilitate development. Environmental consultants, Land Assessment Pty Ltd, have been engaged by the Shire to undertake the land capability assessment. This assessment focuses on addressing the suitability of the soil and landform conditions within the proposed 'Special Rural' area in terms of the requirements of the Draft Country Sewerage Policy (Government of Western Australia 1999) relating to on-site wastewater disposal.



Source: Nott (2001)

FIGURE 1. LOCATION OF NAREMBEEN WITHIN THE LOCAL (WADDERIN-WOGARL) DRAINAGE CATCHMENT.



TOWNSITE EXPANSION PLAN
NAREMBEEN

JOB REFERENCE: 100368

N

SCALE 1:15 000 @ A3

13 AUGUST 2008

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2.0 ENVIRONMENTAL SETTING

2.1 Physiography and Geology

Narembeen occurs within the 'Northern Zone of Ancient Drainage'. This zone covers an ancient peneplain formed on the granites and gneisses of the Yilgarn Block, and extending northward from a line from Brookton through Corrigin and on to the edge of the area cleared for agriculture. Within this zone, chains of salt lakes occur in broad flat valleys representing ancient drainage systems that now only function as connected waterways in very wet years.

The Narembeen townsite area is underlain by recrystallised granitoids (adamellite and granodiorite) and to the west of the town is an extensive area of foliated and banded gneiss (Muhling and Thom 1979). Both rock types occur commonly as 'basement rock' across the Avon River basin. The basement rock is intruded by a number of mafic and ultra-mafic dykes (including several dolerite-gabbro dykes to the immediate north and west of Narembeen town).

Colluvial and in-situ weathering products of the basement rocks, and the residuals of a lateritic duricrust that may have once covered a large area around Narembeen, are largely responsible for the current distribution of soils in the landscape. There are also lenses of alluvial sand, silt and clay sediment on the drainage plains, and deposits of calcrete and associated wind blown (aeolian) deposits in the vicinity of salt lakes, that influence the nature and capability of the soils.

2.2 Soil - Landscapes

Soil-landscape mapping, at an appropriate scale in relation to a proposed land-use, provides the base data for land capability assessment. Figure 3 overleaf shows broad-scale mapping by the Department of Agriculture and Food (Verboom and Galloway 2004) identifying the study area as containing portions of two soil landscape systems;

Bendering system - representing the gently to very gently inclined colluvial slopes associated with outcrops of basement rocks and dolerite dykes to the west and north-west of Lake Walker, and

Kellerberrin system – representing the valley floors and footslopes on alluvial and minor colluvial surfaces near the lake and to the north east.

The majority of the land is part of the Bendering system where uplands tend to be dominated by rocky, often mafic, soil interspersed with lateritic-sandplain and mid to lower slope soils have a complex, mosaic-like distribution of soils. Soil formed in the more mafic colluvium on smooth lower slopes, such as those within the proposed 'special rural' area, have loamy surfaces with clayey, alkaline and sodic subsoil (locally referred to as Salmon Gum Red Soil and Gimlet Soil). Loamy gradational soils (Rocky Red Loam) surrounding rock outcrops occur north-west of the study area.

Figure 3 shows two components of the Bendering system within the subject land, Bn3u and Bn3. Bn3u is most extensive and represents an area of mid to lower colluvial slopes with undifferentiated soils. Lesser portions of the study area, in the north-western corner, are part of Bn3d, an area of irregular undulating terrain associated with outcropping dolerite and diorite dykes.

The less extensive lower-lying terrain in proximity to Lake Walker, and north of the existing townsite, is part of the Kellerberrin (Kb) system, component 3ns. This is an area of valley floors and footslopes where calcareous aeolian deposits blanket older alluvial & minor colluvial surfaces. The dominant soils

are described as calcareous loamy earths and heavy red and grey calcareous soils, and with few loamy duplexes that are calcareous at depth. Where these soils exhibit red powdery topsoil conditions they contain a high percentage of lime and are locally referred to as 'Morrel soils'. They are often dispersive and sodic – soil conditions that can impede water movement and root growth.

As a result of the relatively broad scale of the Department's survey and mapping, the soil-landscape systems and their components shown in Figure 3 encompass a variety of soil and landform conditions. Further differentiation requires site-specific field survey work.

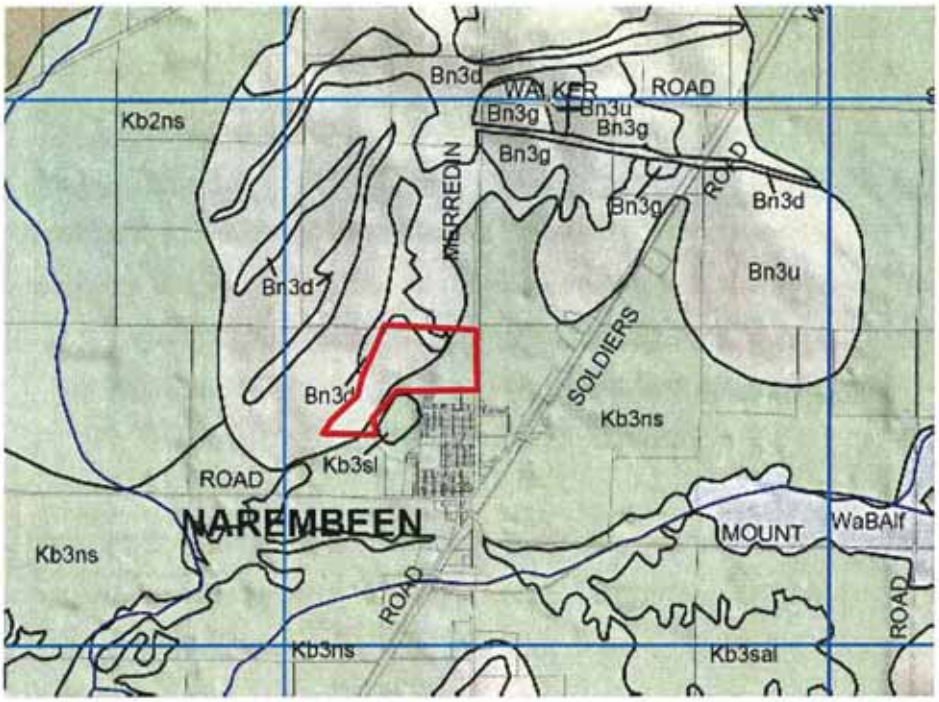


FIGURE 3. SOIL LANDSCAPE MAPPING*

Bendering 3 undifferentiated phase
Bn3u - Gently undulating colluvial slopes with very little outcrop, dominated by alkaline duplexes under Mallee woodlands and heavy lower slope soils with Salmon Gum and Gimlet woodlands.

Bendering 3 dolerite phase
Bn3d - Irregularly undulating country between Narembeen and Kondinin where dolerite and diorite dykes outcrop, forming red to brown clayey, well structured, usually calcareous soils vegetated by York Gum woodland.

Kellerberrin 3 non-saline phase
Kb3ns – Areas of reddish, powdery surfaced, "Morrel soils", often adjacent to salt lakes.

* **Source**: Verboom and Galloway (2004). Corrigin area land resources survey.

2.3 Groundwater and Salinity

Information on depth to groundwater beneath the study area is important in relation to the capability of the land for unsewered rural-residential development. Consideration of depth to watertable is relevant to the requirements of the Health Regulations and the Draft Country Sewerage Policy (Government of Western Australia 1999). Under the *Treatment of Sewage and Disposal of Effluent and Liquid Waste*) Regulations relating to conventional septic tank and leach drain systems, the depth to watertable from the underside of a wastewater disposal system shall be a minimum of 1.2 metres. Furthermore, environmental protection guidelines (EPA 2008) suggest a minimum 2 m clearance should be considered.

It is recognised that site engineering works (import of soil fill material, or in some cases, drainage) can change the effective depth to watertable, and that alternative on-site treatment and disposal systems (as approved by the Health Department) do have a lesser minimum depth to watertable criteria. However, irrespective of the type of on-site system proposed, the Draft Country Sewerage Policy stipulates that the land should have a minimum depth to watertable from the natural ground surface of at least 0.5 metres.

A groundwater study undertaken by the Department of Agriculture (Nott 2001) as part of the 'Rural Towns Program' to address concerns over groundwater levels and salinity within Narembeen townsite provides relevant information on the depth to watertable. This investigation included the installation of a number of piezometers across the townsite and adjacent areas (Figure 4). A cross section diagram illustrating resulting data for a north-south transect across part of the proposed Special Rural area and the existing townsite is included here as Figure 5.

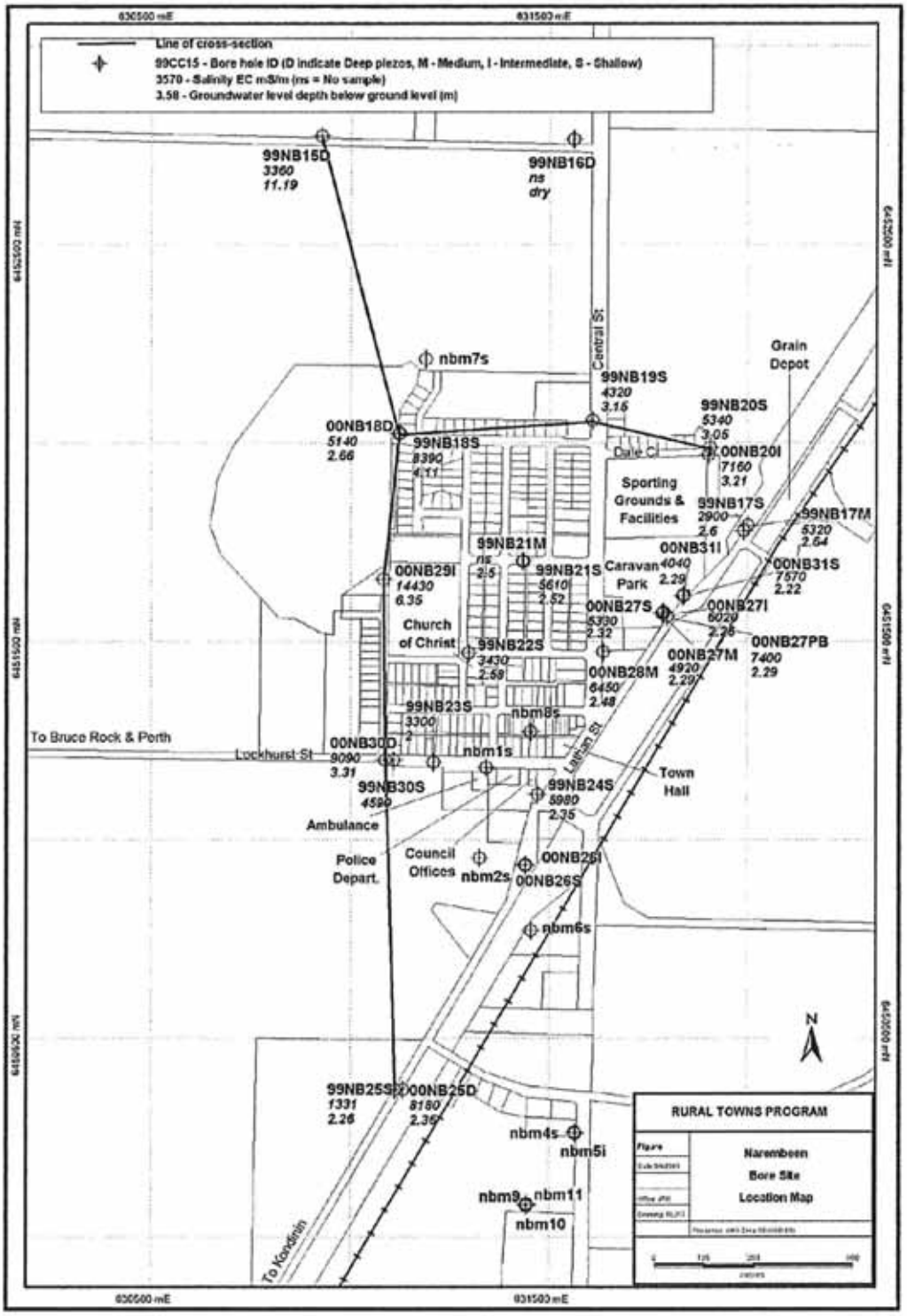


FIGURE 4. LOCATIONS OF PIEZOMETERS AND CROSS-SECTIONS*

* **Source:** Nott R. (2001) *Groundwater study of the Narembeen townsite*

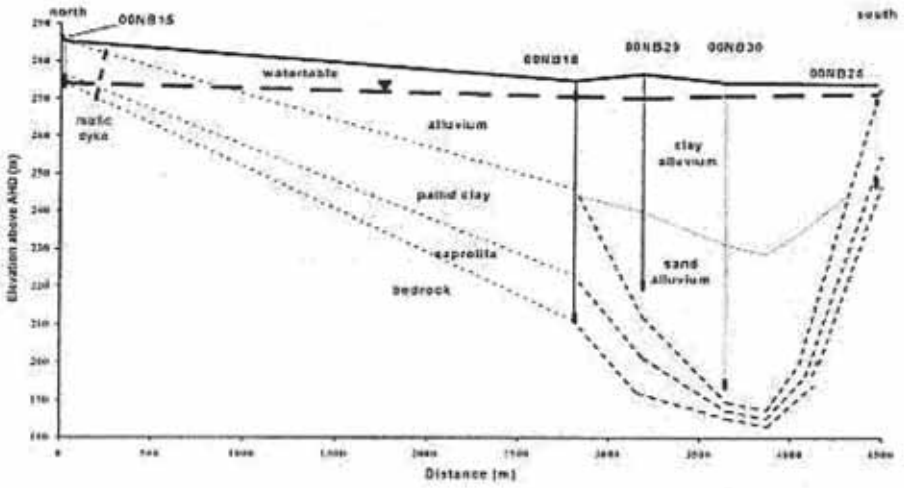


FIGURE 5. NORTH TO SOUTH CROSS-SECTION THROUGH STUDY AREA* (location shown in Figure 4).

* **Source:** Nott R. (2001) *Groundwater study of the Narembeen townsite*

Figure 5 shows sufficient depth to watertable occurs beneath the lower colluvial slopes north-west of the town (Bendering soil-landscape system) to meet environmental and public health criteria relating to siting domestic wastewater disposal systems. This is based on depth to watertable results from bores 99NB15D (11.2 m depth) and 0018D / 99NB18S (2.5 m depth) along the transect line shown in Figure 4.

In relation to the lower-lying terrain (Kellerberrin soil-landscape system) the groundwater study data showed the entire built-up area of the Narembeen town has a watertable between 2 and 3 m below the surface (likely to be higher during a sequence of wet years) and acid groundwater with a salinity at least half that of seawater. Across the townsite groundwater elevations in the piezometers fell about 2 m over about 1100 m from north-east to south-west, but the lowest levels were in the deep piezometers on the north western side of the town, near the lake (Nott 2001).

Given the gradually increasing land surface level for the proposed future residential area directly north of town (Area 4 in Figure 2) depth to groundwater should not be limiting in relation to installation of services

associated with the proposed sewered residential development in this part of the study area.

In relation to management options to address the potential for increasing groundwater levels and associated salinity within the existing townsite Nott (2001) recommends various measures to reduce groundwater recharge. These include encouraging residents to

- avoid overwatering of gardens ;
- replace some of their imported water supplies with water harvested from their own hard surfaces (roofs, driveways);
- prevent surface water from ponding in areas where it may contribute to recharge; and
- grow perennials on any bare land.

For the subject land, being the slopes directly above the townsite, the effectiveness of these measures depends on the degree of connection between groundwater systems below the slopes, the townsite itself; and the valley floor downslope of the townsite. Although this degree of connection cannot be quantified by Nott (2001), potentially beneficial recharge reduction measures can be implemented within a rural-residential development context.

2.4 Flooding

The topography of the town area is extremely flat, with a slope of less than 0.5 per cent. Despite this, Wakeman creek to the south of town (Figure 1) regularly flows during winter and for several months following significant rainfall events (Nott 2001).

Water within Wakeman creek drains slowly westwards into the Lockhart salt lake chain, a system without regular flow. However, a significant flow event occurred during January 2000, linking the ephemeral salt lake chains. A significant volume of this water moved though the Wakeman Creek, flooding agricultural businesses at the south end of Narembeen (Nott 2001).

In an earlier flood study (Sinclair Knight and Partners 1987) it was concluded that the main source of floods in Narembeen is the Wakeman Creek catchment which extends 70 km to the east of the town.

The smaller Wadderin-Wogarl drainage catchment extending to the north of Narembeen (including the proposed townsite expansion areas) was considered to make relatively minor contributions to flooding. Sinclair Knight and Partners (SKP) concluded that surface water runoff from this agricultural catchment either ponds in Lake Walker to the west of the town, or is channeled around it and into the Wakeman Creek.

The extent of any flood risk to the west of the town, and particularly within the southern portion of the proposed 'Special Rural' area (Area 5 in Figure 2), was not specifically addressed in the SKP study. However a subsequent report, *Drainage Study for Narembeen Townsite* (Voran Consultants 1995), shows the predicted extent of a 1:100 year flood based on data from the SKP work. Within the western portion of the existing townsite the predicted level for such an event is approximately 275.4 m AHD.

Examination of 2 m interval contour mapping over the area west of town, that is available through Landgate's SLIP (*Shared Land Information Platform – NRM Interface* http://spatial.agric.wa.gov.au/slip), indicates the southern portion of the proposed 'Special Rural' area closest to Lake Walker has a similar elevation and therefore might be considered susceptible to flood in a 1: 100 year event.

It should be noted however that this flood risk interpretation is based on a simple extrapolation of contour data, and does not represent a definitive assessment by an appropriately qualified hydrologist. Nevertheless it would be appropriate to exercise caution when planning any rural-residential development in this area by ensuring lot sizes are sufficiently large to enable future residences to be sited outside and upslope from the flatter terrain adjacent to the lake.

2.5 Vegetation

The study area (Areas 4 and 5 as shown within Figure 2) has been almost totally cleared to facilitate previous agricultural land-use activity. The original native vegetation is described by Beard (1980) as a 'Medium woodland' dominated by York gum (*Eucalyptus loxophleba*), salmon gum (*E salmonophloia*) and gimlet (*E salubris*).

The existing vegetation cover fringing Lake Walker and the seasonal watercourse extending northwards (part of the Wadderin-Wogarl drainage catchment) is largely the result of a rehabilitation initiative of the Narembeen Land Conservation District Committee (LCDC) and the Shire of Narembeen.

Species planted here are reported by the LCDC to include Salt Gum (*Eucalyptus salicola*), Red Morrel (*E longicornis*), Merrit (*E celastroides* or *E flocktoniae*?), Broombush (*Melaleuca uncinata*), Swamp Sheoak (*Casuarina obesa*) Salt Bush (*Atriplex spp*) and Samphires (*Haloscarcia spp*). There is also a number of mallee species planted within the northern portion of the weakly incised drainage depression separating the proposed Residential and Special Rural areas (Areas 4 and 5 as shown in Figure 2).

The replanted vegetation within the study area is of environmental value in terms of providing habitat for local fauna and avifauna, as well as protecting Lake Walker from adverse impacts of nutrients within drainage from adjacent land. In a townsite expansion context they are also of aesthetic and passive recreational value, and serve to clearly separate or buffer the proposed residential areas from special rural (rural-residential) areas.

3.0 SITE INVESTIGATION

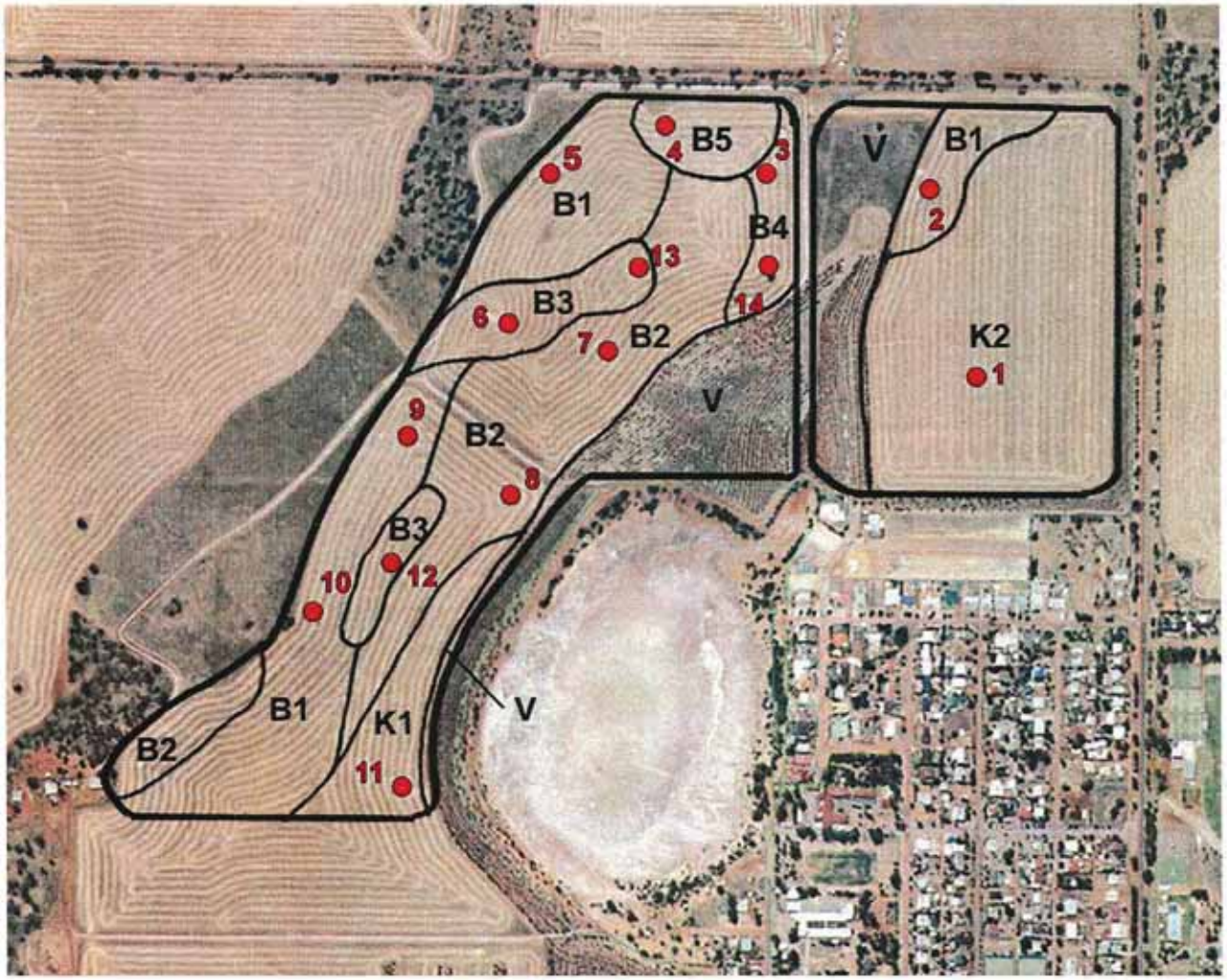
3.1 Land Unit Mapping

Using the broad-scale soil-landscape mapping in Figure 3 as an initial framework, soil and landform conditions within the subject land were determined from aerial photo interpretation followed by field survey work conducted during January 11-13, 2010. Soils were described at 14 pit sites excavated using Shire machinery, and a number of additional soil observations were made through vehicular transects.

Soil samples were taken for post-survey analysis of pH and salinity. These analyses were conducted using a Hanna Instruments Combined pH / salinity meter. EC1:5 soil / water values were converted to estimates of ECe (saturation extract) using Department of Agriculture (2004) conversion factors based on soil texture groups.

The soils were then classified in accordance with the Department of Agriculture's WA Soil Group nomenclature (Schoknecht 2002) and the landforms according to categories described in its Land Evaluation Standards document (van Gool et al 2005). Slope gradients were measured using a hand-held inclinometer and correlated with 2 m interval contour mapping available through Landgate's SLIP (*Shared Land Information Platform – NRM Interface* http://spatial.agric.wa.gov.au/slip).

The resulting more-detailed mapping of land units (soil-landform types) within the proposed Residential and Special Rural areas to the north and north west of Narembeen (Planning Areas 4 and 5 respectively) is shown overleaf in Figure 6. Land units are areas with relatively homogeneous conditions in relation to soils and landform, and hence land management requirements. Photographs illustrating site conditions follow Figure 6.



Land Unit	Description
Kellerberin System - *Valley floors and footslopes on alluvial and minor colluvial surfaces.*	
K1	Red loamy earths with calcareous subsoil; imperfect to poorly drained; within valley floor, over alluvial deposits.
K2	Brown loamy earths with calcareous subsoil; moderately well drained; within very gentle footslopes over colluvial deposits.
Bendering System – *Gently to very gently inclined colluvial slopes associated with outcrops of basement rocks and dolerite dykes.*	
B1	Alkaline red or brown shallow loamy duplex soils with calcareous subsoil; imperfectly drained
B2	Red loamy earths; commonly gravelly or stony; moderately well drained.
B3	Red or brown loamy earths with saline topsoil; imperfectly drained.
B4	Red / brown clays; imperfectly drained
B5	Grey/brown clays with gilgai microrelief; imperfect to poorly drained
V	**Vegetated area** – incorporating waterway and 'landcare' tree plantings.

●1 **Soil Pit Site**

Land Unit Mapping

Scale approx 1:10 000

Figure 6

Land unit K2 –Residential expansion area north of existing townsite (view to NE).

Land unit B2 - Mid to lower slopes near site 7 with extensive vegetation buffer downslope.

Land unit B1 – gently sloping upper (NW) portion of Special Rural area.

Land unit K1 – flat southern portion of Special Rural Area (with tree buffer fringing salt-lake)

Within the study area the flatter terrain (< 1 % gradient) occurs on the valley flats (Kellerberrin land units K1 and K2). Land unit K1 near the south-eastern corner of Lake Walker has a topographic low point of around 274 m AHD. Land unit K2 to the north of the townsite ranges in elevation from around 276 m AHD near the edge of the existing developed area, to around 282 m AHD at the north-eastern corner of the proposed residential extension.

The colluvial slopes (Bendering land units B1 – B5) rise upwards from the north-western side of the lake and are gently inclined (1 – 4 % gradient). This area ranges in elevation from about 276 mAHD near the lake end of the track bisecting the slope (see aerial photo image within Figure 6) up to a high point of 286 m AHD in the north-western corner of the mapped area.

Table 1 overleaf provides a brief description of the eight delineated land units and Table 2 then shows a summary of observations from the 14 pit sites. Further appreciation of site conditions can be gained by reference to the soil profile descriptions and associated photographs in Appendix A.

The site summary in Table 2 contains an estimated permeability figure (for the nominal 60 – 90 cm depth layer within the soil where, under natural conditions, a leach drain would be installed). This estimate is based on consideration of soil texture and structure in accordance with indicative rates listed in Table 4.2 A1 of the National Standards document for On-site Domestic Wastewater Management (AS/NZS 1547:2000 – see Appendix B).

The soils within the study area are predominantly alkaline as a result of high carbonate content. However, within the lower-lying terrain (unit K1) adjacent to the western side of the lake, Site 11 is noteworthy because the deeper subsoil was found to have neutral to slightly acid pH. This suggests seasonally high levels of the underlying acidic groundwater have reached this part of the soil profile to neutralise the otherwise carbonate-rich material.

With the exception of areas of land unit B3 (sites 6, 12 and 13), surface soils are not significantly affected by salinity, although higher levels of salt can occur deeper within the soil profile.

TABLE 1. LAND UNIT DESCRIPTIONS

Land Unit	Description
Kellerberrin System - *Valley floors and footslopes on alluvial and minor colluvial surfaces.*	
K1	Red loamy earths with calcareous subsoil; imperfect to poorly drained; within valley floor, over alluvial deposits.
K2	Brown loamy earths with calcareous subsoil; moderately well drained; within very gentle footslopes over colluvial deposits.
Bendering System – *Gently to very gently inclined colluvial slopes associated with outcrops of basement rocks and dolerite dykes.*	
B1	Alkaline red or brown shallow loamy duplex soils with calcareous subsoil; imperfectly drained.
B2	Red loamy earths; commonly gravelly or stony; moderately well drained.
B3	Red or brown loamy earths with saline topsoil; imperfectly drained.
B4	Red / brown clays; imperfectly drained.
B5	Grey/brown clays with gilgai microrelief; imperfect to poorly drained.
V	**Vegetated area** – incorporating waterway and 'landcare' tree plantings.

TABLE 2. SITE SUMMARY TABLE

Site No	WA Soil Group	Qualifier / Comments	Landform	Soil Landscape	Site Drainage status	Inferred Subsoil Permeability	Land Unit
1	***Brown loamy earth***	***(alkaline with calcareous subsoil***	Valley flat < 1 %	Kb3ns	Moderately well - Imperfect	0.12 – 0.5 m/d	K2
2	***Alkaline red shallow loamy duplex***	***(calcareous subsoil)***	Lower slope approx 1 %	Bn3d	Imperfect	0.06 – 0.5 m/d	B1
3	***Red/brown non-cracking clay***	***(alkaline, calcareous subsoil).***	Lower slope 2 - 3 %	Bn3d	Imperfect	0.06 – 0.5 m/d	B4
4	***Grey/brown non-cracking clay.***		Undulating mid-slope (gilgai) 3 - 4 %	Bn3u	Imperfect - poor	0.06 – 0.5 m/d	B5
5	***Brown shallow loamy duplex***	***(alkaline, calcareous subsoil).***	Upper slope 3 - 4 %	Bn3u	Imperfect	< 0.06 m/d	B1
6	***Red loamy earth***	***(saline/gravel)***	Mid-slope 4 %	Bn3u	Imperfect	0.06 – 0.12 m/d	B3
7	***Red loamy earth***	***(non saline /stony)***	Lower slope 2 - 3%	Bn3u	Moderately well	0.06 – 0.12 m/d	B2
8	***Red loamy earth***	***(gravelly)***	Lower slope 1 - 2 %	Bn3u	Moderately well - Imperfect	0.06 – 0.12 m/d	B2
9	***Brown shallow loamy duplex soil***	***(alkaline, calcareous subsoil).***	Mid to upper slope; 3 %	Bn3u	Imperfect	0.06 – 0.12 m/d	B1
10	***Alkaline red shallow loamy duplex***	***(calcareous subsoil)***	Upper slope 3 - 4 %	Bn3u	Imperfect	0.06 – 0.12 m/d	B1
11	***Red loamy earth***	***(calcareous subsoil)***	Valley flat < 1 %	Kb3ns	Imperfect - poor	0.06 – 0.12 m/d	K1
12	***Red loamy earth***	***(saline; calcareous subsoil)***	Mid-lower slope; 3 %	Bn3u	Imperfect	Approx 0.06 m/d	B3
13	***Brown loamy earth***	***(saline; calcareous subsoil)***	Mid-lower slope; 3 %.	Bn3u	Moderately well - Imperfect	0.06 – 0.12 m/d	B3
14	***Red/ brown non-cracking clay***	***alkaline, calcareous subsoil***	Lower slope 2 – 3 %	Bn3u	Imperfect	< 0.06 m/d	B4

3.2 Land Capability Considerations

'Land capability' is a term used to express the ability of natural attributes of the land to meet the physical requirements of a proposed form of use with minimal risk of degradation to soil or water resources. A general method for capability assessment has been developed by the Department of Agriculture (Wells and King 1989, van Gool et al 1998) and forms the basis for the comments within Table 3 below, relating to the land units depicted in Figure 6.

TABLE 3: LAND CAPABILITY - PLANNING CONSIDERATIONS

Land Unit	Planning Considerations
K1	Lower lying, imperfect to poorly drained soils and possibly subject to flooding under extreme events. Deeper subsoil conditions suggest the presence of saline groundwater at about 1.5 m depth in winter months. Best avoided for on-site effluent disposal with houses located upslope and further away from the tree plantings fringing Lake Walker. Larger (hobby farm) lot sizes may be required to achieve this.
K2	This unit occurs within the proposed sewered residential area with similar, though slightly more elevated, terrain to adjacent existing townsite area. Foundation conditions for housing and roads can be expected to be comparable and the land is not considered to be susceptible to flooding. Given the low gradient and slowly permeable soils, careful attention to the design of stormwater drainage systems is required. The 'morrel soils' are also powdery when dry and susceptible to wind erosion. Dust suppression may need to be considered during land development to protect amenity of existing residents in close proximity.
B1	Imperfectly drained shallow loamy duplex soils with calcareous subsoil and slow permeability restrict the effectiveness of conventional septic tanks and leach drain systems for on-site effluent disposal. Although unit B1 within the proposed 'special rural' area is gently sloping and sufficiently elevated above watertable to enable permeability issue to be addressed through partially inverted leach drains, the use of alternative treatment units with effluent disposal via irrigation to a pad of imported soil material is preferable.

Land Unit	Planning Considerations
B2	Moderately well drained loamy earths are generally suitable for on-site effluent disposal using conventional septic tank and leach drain systems. Use of elevated (partially inverted) leach drains may be necessary in some areas if clayey subsoils are encountered at shallower depth.
B3	Imperfectly drained loamy earths with salt affected topsoil. Calcareous subsoil clays can disperse when wet, causing reduced permeability for on-site effluent disposal. Avoid these localised areas for on-site effluent disposal where possible. Otherwise address through the use of partially inverted leach drains (within house foundation pad) or, preferably, use of alternative treatment units with effluent disposal via irrigation to a pad of imported soil material. Saline surface soil may hinder the establishment of lawn and garden areas.
B4	Imperfectly drained clay soils with calcareous subsoil and slow permeability restrict the effectiveness of conventional septic tanks and leach drain systems for on-site effluent disposal. This unit occurs within the lower slopes of the proposed 'special rural' area and use of alternative treatment units with effluent disposal via irrigation to a pad of imported soil material is preferable to conventional septic tanks and leach drains.
B5	Gilgai (mounds and depressions) microrelief within this area indicates the presence of expansive clays and unfavourable conditions for house foundations. This area should either be avoided for house location or allowed for in the design of foundations. Subject to site–specific engineering evaluation, this allowance can be made by placing a foundation pad of stable material over it or by taking foundations below the surface zone of fluctuating moisture content. Soil permeability is inadequate for on-site effluent disposal.
V	This unit encompasses the relatively recently established vegetation, and riparian remnants, fringing the western side of Lake Walker and extending in a broad wedge over both sides of the seasonal watercourse that enters the northern side of the lake. Retention of all landcare plantings is recommended to protect the watercourse and Lake Walker from impacts of adjacent development, and to provide a landscape buffer between urban and rural-residential areas.

Given the similarity of the proposed residential expansion area (north-east of Lake Walker) to the adjacent portion of the existing Narembeen townsite, and the intention to extend scheme sewerage to this area, the key consideration here is the avoidance of flood risk and management of surface drainage to avoid waterlogging. In addition, and depending on seasonal conditions, the powdery soil surface predisposes the area to a risk of wind erosion and the creation of a dust nuisance during site disturbance.

Within the proposed 'special rural' area, to the west and north-west of Lake Walker, the focus of capability assessment has been on the ability of soils to meet the requirements of the Health Department and the Government's Draft Country Sewerage Policy for on-site effluent disposal. For areas outside the Perth Metropolitan region, the Draft Country Sewerage Policy (Govt of Western Australia 1999) articulates the public health and environmental requirements relating to the location of on-site domestic wastewater disposal systems*. This includes criteria on lot sizes, soil conditions, depth to groundwater, and setbacks from waterbodies.

*** On-site Effluent Disposal Systems**

Conventional Wastewater Treatment Systems These systems incorporate two septic tanks and either two leach drains or four soak wells. The septic tanks enable anaerobic digestion of solid and liquid wastes into an effluent which is discharged into the ground via the leach drains or soak wells).

Alternative Wastewater Treatment Systems. Various types of alternative treatment units are approved for use in WA by the Health Department (refer Attachment C). Aerobic Treatment Units incorporate an aeration process to aid in the breakdown of waste to an effluent, which is then further treated through chlorination before being discharged either by surface irrigation, sub-soil drippers or leach drains. Nutrient retentive leaching systems utilise septic tanks for anaerobic digestion of solid and liquid wastes with the effluent then being discharged through an amended soil (usually contained within leach drains) designed to strip the effluent of nutrients (particularly phosphorus).

Nutrient (P) retentive systems are generally recommended in areas where there are particular environmental concerns relating to water quality and the in-situ soils have a very low ability to retain phosphorus. This is not the case within the Narembeen area. Aerobic Treatment Units must be serviced regularly to ensure that they are operating effectively. The maintenance protocol is set down in the *Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units* (Department of Health 2001).

Under the Draft Country Sewerage Policy the minimum lot size applicable for unsewered rural-residential development at Narembeen is 2000m^2. This area is sufficient to accommodate a residence and associated on-site effluent disposal area (nominal 150 m$^{2)}$ for either a conventional or alternative wastewater disposal system. However in many cases rural-residential lots need to be larger to meet market demand for land to accommodate some small-scale rural pursuits (hobby farming) in addition to a residence. Rural-residential lot sizes on the outskirts of townsites are therefore commonly in the range of 1 – 4 ha.

For the subject land it would make sense to provide a range of lot sizes with those at the smaller end of the spectrum in the northern, and more elevated, portion of 'Special Rural' Area 5, grading into larger lots up to 4 ha progressing southwards. In this manner there would be a gradual transition from 'rural living' lots near the proposed residential expansion (Area 4) to some more substantial 'hobby farming' lots on the lower and more gently sloping southern portion that is separated from the existing townsite by Lake Walker.

A critical factor under the Draft Country Sewerage Policy relating to land capability is the highest level of the watertable. Health Department criteria listed in Appendix 1 of the policy include the statement; *irrespective of the type of on-site wastewater disposal system proposed, the land should have a minimum depth to the seasonal or permanent watertable from the natural ground surface of at least 0.5 metres.* This condition precludes the use of engineering measures such as land filling to achieve appropriate clearances from the underlying watertable (2m for conventional wastewater treatment systems and generally less than 1 m for alternative treatment systems approved by the Health Department).

Subject to meeting depth to watertable criteria, and within nutrient retentive loamy or clayey soils, setback requirements are generally 50 m from wetlands and 30 m from seasonally active watercourses.

Soil permeability is also important with rates of less than 25 mm/hour (< 0.6 m/day) generally considered unsuitable for conventional leach drain systems located within the natural soil. This limitation is commonly overcome however through the use of partially inverted leach drains (i.e. leach drains partly enclosed within imported soil material placed over the natural soil to ensure less permeable clayey subsoil layers are avoided) or through the use of Health Department approved 'alternative treatment units'.

Depending on the size of new lots within the proposed 'special rural' area, the potential for rural pursuits (hobby farming) as a supplementary activity to its residential purpose, is a lesser component of the future land use scenario. Any future form of hobby farming is unlikely to extend beyond those activities currently permitted under the 'rural' zoning category, and grazing with a modest number of livestock is the most likely rural pursuit. However in order to prevent land degradation occurring as a result of overstocking, it may be appropriate to introduce control measures into the Town Planning Scheme to enable the Shire to reduce stocking rates in rural-residential holdings if and when there is a clear risk of degradation about to occur.

4.0 CONCLUSIONS

4.1 Land capability

Figure 7 overleaf summarises the planning considerations and recommendations for the study area arising from land capability assessment.

Area 4

The proposed residential area (Area 4) to the north of the existing townsite is considered to be physically suitable for this purpose because:

- Site observations and reference to soil-landscape mapping show soil and landform conditions within Area 4 are comparable to those in adjacent areas of the existing developed townsite;.

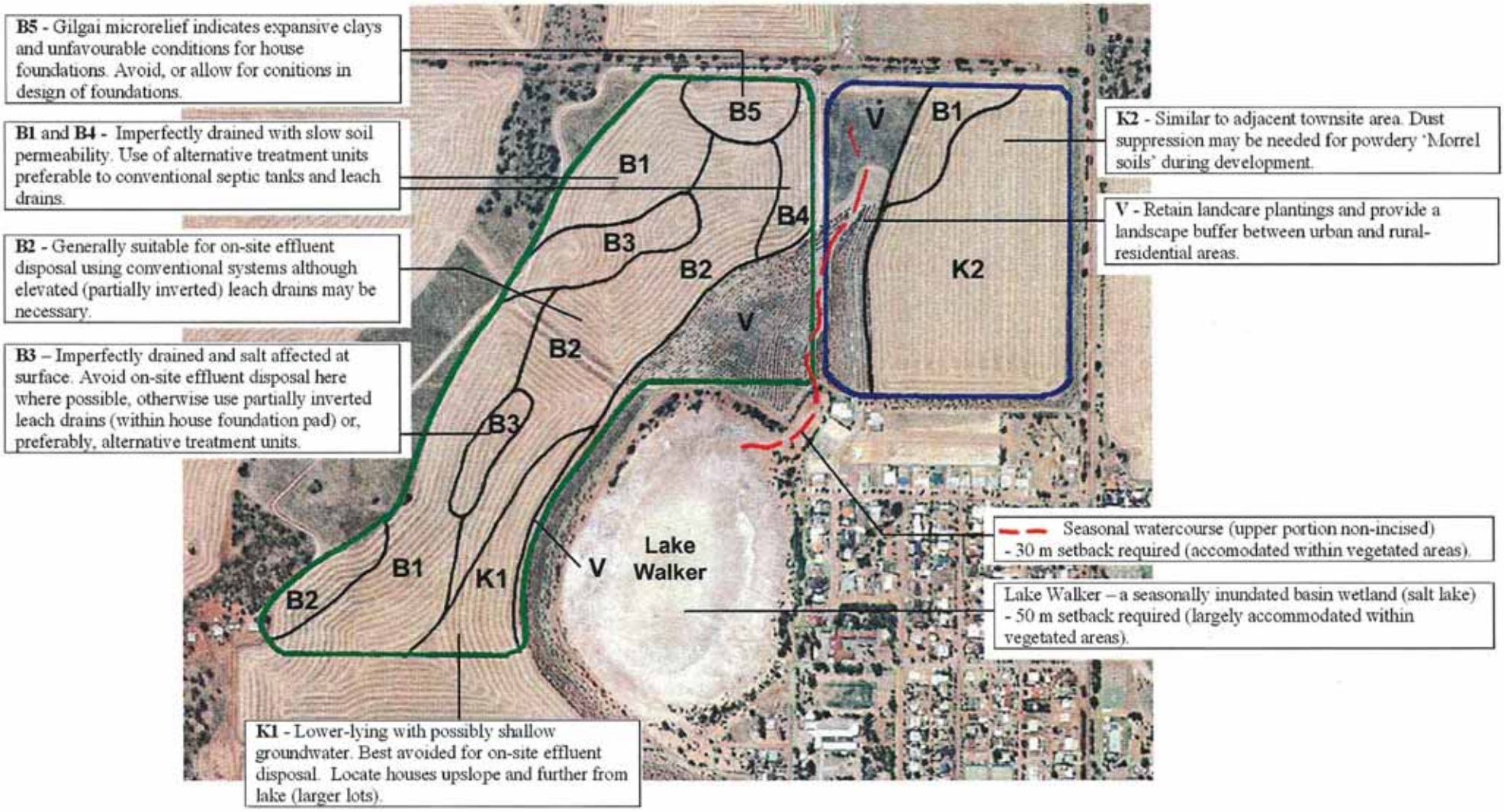
- The land is not susceptible to flooding;

- Depth to groundwater should not be limiting for installation of services associated with the proposed sewered residential development; and

- Although the powdery nature of the topsoil predisposes the land to a dust generation issue this is a seasonal nuisance matter that can be addressed through appropriate timing and management of site works.

Area 5

The proposed special rural area (Area 5) to the north-west of the town, and west of Lake Walker, contains soils with only a 'fair – low' capability for unsewered rural-residential development. This is due to slow permeability within the commonly calcareous clay subsoils and, in a smaller area (unit B5), poor soil conditions for house foundations. These limitations can however be satisfactorily addressed.



Planning Considerations

Scale approx 1:10 000

Figure 7

- It is an area located close to the townsite and its services, yet separated or 'buffered' from it by Lake Walker and its associated fringing vegetation.

- The area is slightly elevated and provides attractive views towards town and over the revegetation 'corridor' which separates it from the future residential expansion area (Area 4).

- Potentially beneficial recharge reduction measures, such as establishment of perennial vegetation and harvesting of rainwater runoff, can be implemented within a rural-residential development context.

The southern portion of Area 5 closest to Lake Walker is potentially susceptible to a high watertable and localised flooding. It is therefore appropriate to exercise caution when planning any future rural-residential development here by ensuring affected lots (containing unit K1) are sufficiently large to enable houses to be sited upslope from the flatter terrain adjacent to the lake.

4.2 Lot sizes & staging of development

The absolute minimum lot size applicable for unsewered rural-residential development near Narembeen is 2000m^2. However it is likely that some lots need to be larger to meet market demand for land to accommodate small-scale rural pursuits (hobby farming) in addition to a residence. A range of 1 – 4 ha is suggested to enable flexibility if location of buildings, and ability to achieve a 'semi rural' atmosphere.

It would make sense to provide a range of lot sizes with those at the smaller end of the spectrum in the northern, and more elevated, portion of 'Special Rural' Area 5, grading into larger lots progressing southwards. In this manner there would be a gradual transition from 'rural living' lots near the proposed residential expansion (Area 4) to some more substantial 'hobby farming' lots

on the lower southern portion that is separated from the existing townsite by Lake Walker.

Given the Shire's indication of priority for residential lots and cost effective provision of services, development would logically occur in three stages as follows; Area 4 first, followed by northern part of Area 5 (down to existing walkway extending from the north-western side of Lake Walker), and the southern portion of Area 5 thereafter.

Vegetation

The replanted vegetation fringing the lake and in the corridor extending north eastwards on either side of the seasonal watercourse, is of environmental value in terms of providing habitat for local fauna and avifauna, as well as protecting Lake Walker from adverse impacts of nutrients within drainage from adjacent land. In a townsite expansion context it is also of aesthetic and passive recreational value, and serves to clearly separate or buffer the proposed residential area (4) from the special rural (rural-residential) area (5).

Setbacks

The following minimum setbacks should be applied to on-site effluent disposal systems; 50 m from the wetland (Lake Walker) and 30 m from the seasonally active watercourse. Given the existing extent and strategic location of rehabilitated vegetation within the study area, the design of lots within the adjacent cleared land should not be affected.

Stocking Rates and Potential Land Degradation

As a preventative measure against land degradation within any future hobby farm portion of Area 5 it may be appropriate to introduce measures into the Town Planning Scheme (if not already present) to enable the Shire to control stocking rates for livestock in this area, or to enforce de-stocking in the event of a clear risk of imminent land degradation.

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APPENDIX A

SOIL PIT DESCRIPTIONS* AND SITE PHOTOGRAPHS

* Refer to end of Appendix for qualification of pH and Salinity categories

Site Number: 1 631527E; 6452473N	Soil landscape - unit Kellerberrin 3ns (**K2**)	**Landform:** Valley flat < 1 % gradient

WA Soil Group: ***Brown loamy earth (alkaline with calcareous subsoil)***

Depth (cm)	Description
0 – 10	Brown (7.5YR 4/3) **fine sandy loam,** weak structure with rough ped fabric; clear boundary to
10 – 60	Brown (7.5YR 4/4) **clay loam fine sandy**; moderate polyhedral structure with rough ped fabric; moderately alkaline (pH_w 8.8) and moderately saline (ECe 484 mS/m); gradual boundary to
60 – 90	Strong brown (7.5YR 4/6) **light clay**; strong polyhedral structure with rough ped fabric; slightly calcareous; few subangular calcareous gravels; clear boundary to
90 - 120	Reddish yellow (7.5YR 6/6) **light to medium clay**; with common distinct brown mottles, strong polyhedral structure with rough ped fabric; slightly calcareous; few subangular calcareous gravels; strongly alkaline (pH_w 9.2) and highly saline (ECe 1474 mS/m).

Site Drainage: Moderately well to imperfectly drained

Site Number: 2 631462E; 6452746N	Soil landscape - unit Bendering 3d (**B1**)	**Landform:** Lower slope approx 1 % gradient.

WA Soil Group: ***Alkaline red shallow loamy duplex soil (calcareous subsoil)***

Depth	Description
0 –10cm	Dark reddish brown (5YR 3/3) **loam**; strong subangular blocky structure with rough ped fabric; clear boundary to
10 – 30	Yellowish red (5YR 4/6) **light clay**; moderate polyhedral structure with rough ped fabric; moderately alkaline (pH_w 8.3) and non saline (ECe 130 mS/m); gradual boundary to;
30 – 40	Reddish yellow (5YR 6/6) **light clay**; moderate polyhedral structure with rough ped fabric; few calcareous inclusions; gradual boundary to;
40 – 65	Yellowish red (5YR 4/6) **medium clay**; moderate prismatic structure with rough ped fabric; common calcareous inclusions; clear boundary to;
65 – 140	Yellowish red (5YR 4/6) **heavy clay**; strong prismatic structure with rough ped fabric; many calcareous inclusions strongly alkaline (pH_w 9.3) and moderately saline (ECe 474 mS/m).

Site Drainage: Imperfectly drained

Site Number: 3 631236E; 6452750N	Soil landscape - unit Bendering 3d (**B4**)	**Landform:** Lower slope 2 - 3 % gradient.

WA Soil Group: ***Red/brown non-cracking clay (alkaline, calcareous subsoil).***

Depth	Description
0 –3cm	Dark brown (7.5YR 3/3) **loam fine sandy,** massive, earthy fabric, neutral (pH_w 7.7) and non saline (ECe 200 mS/m); clear to
3 – 15	Dark brown (7.5YR 3/4) **light clay**; moderate prismatic structure with rough ped fabric; gradual boundary to
15 - 35	Brown (7.5YR 4/4) **light clay**; moderate polyhedral structure with rough ped fabric; strongly alkaline (pH_w 9.1) and slightly saline (ECe 313 mS/m); gradual to
35- 50	Strong brown (7.5YR 4/6) **light clay**; with few faint dark brown mottles, moderate polyhedral structure with rough ped fabric; very few calcareous inclusions; gradual boundary to
50 -160	Reddish yellow (7.5YR 6/6) **medium clay**; with common faint brown mottles, strong polyhedral structure with rough ped fabric; common calcareous inclusions; strongly alkaline (pH_w 9.1) and extremely saline (ECe 2609 mS/m).

Site Drainage: Imperfectly drained

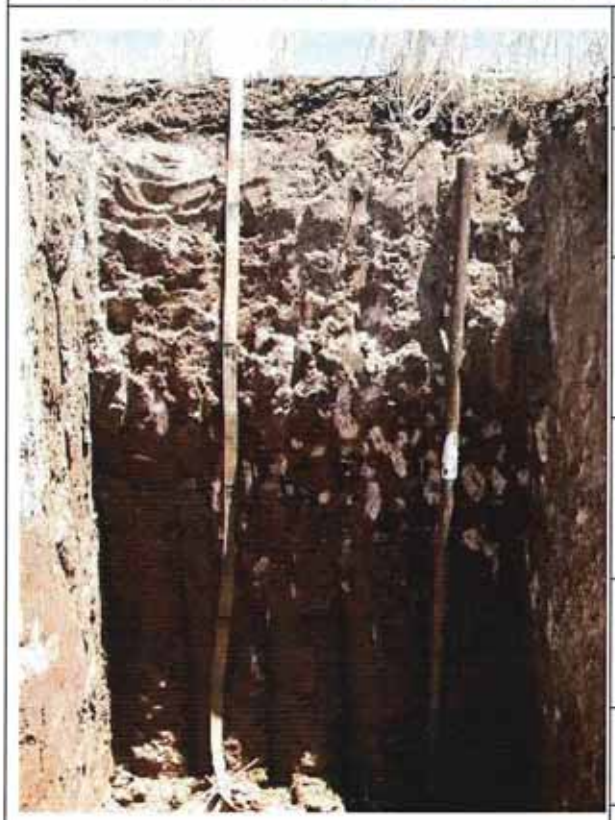
Site Number: 4 631094E; 6452842N	Soil landscape - unit Bendering 3u (**B5**)	**Landform:** Undulating mid-slope (gilgai) 3 - 4 % gradient.

WA Soil Group: ***Grey/brown non-cracking clay.***

Depth	Description
0 – 5cm	Brown (7.5YR 4/3) **loam fine sandy,** weak subangular blocky structure with rough ped fabric, moderately alkaline (pH_w 8.2) and slightly saline (ECe 206 mS/m); clear to
5 – 30	Brown (7.5YR 4/3) **light to medium clay**; moderate subangular blocky structure with rough ped fabric; very few small quartzitic gravels; gradual boundary to
30 - 60	Brown (7.5YR 4/4) **light to medium clay**; with common distinct pale mottles; moderate polyhedral structure, rough ped fabric; few calcareous inclusions; moderately alkaline (pH_w 8.9) and moderate saline (ECe 468 mS/m); gradual to
60- 120	Strong brown (7.5YR 4/6) **heavy clay**; with few faint grey mottles, strong polyhedral structure, rough ped fabric; gradual to
120-150	Strong brown (7.5YR 4/6) **light to medium clay**; with few faint yellowish brown mottles, moderate polyhedral structure with rough ped fabric.

Site Drainage: Imperfect - poorly drained

Site Number: 5 630893E; 6452774N	**Soil landscape - unit** Bendering 3u (**B1**)	**Landform:** Upper slope 3 - 4 % gradient



WA Soil Group: ***Brown shallow loamy duplex (alkaline, calcareous subsoil).***

Depth	Description
0–15 cm	Dark brown (10 YR 3/3) **loam fine sandy,** massive with earthy fabric, moderately alkaline (pH_w 8.1) and non saline (ECe 191 mS/m); clear boundary to
15 - 35	Yellowish brown (10YR 5/4) **light to medium clay**; with common distinct grey mottles, moderate polyhedral structure with rough ped fabric; common calcareous inclusions; gradual boundary to
35 – 65	Brown (7.5 YR 5/4) **light to medium clay**; common distinct grey mottles, moderate polyhedral structure, rough ped fabric; common calc inclusions; strongly alkaline (pH_w 9.4), highly saline (ECe 1548 mS/m);
65 – 120	Brown (7.5 YR 5/4) **medium clay**; with few faint grey and red mottles, moderate polyhedral structure with rough ped fabric; many calcareous inclusions;
120–160	Brown (7.5 YR 5/4) **light to medium clay;** mottled; less inclusions; strongly alkaline (pH_w 9.2), and saline (ECe 1820 mS/m).

Site Drainage: Imperfectly drained

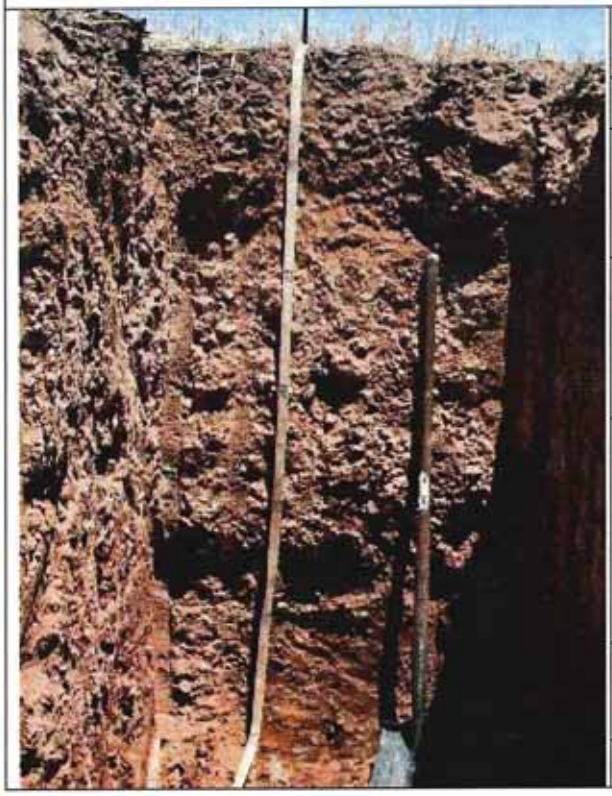
Site Number: 6 630873E; 6452579N	Soil landscape - unit Bendering 3u (**B3**)	**Landform:** Mid-slope 4 % gradient.

WA Soil Group: ***Red loamy earth (saline/gravel)***

Depth	Description
0– 10cm	Dark brown (7.5YR 3/4) **loam fine sandy**; massive, earthy fabric; neutral (pH_w 7.8) and extremely saline (ECe > 3999 mS/m);
10– 35	Reddish brown (5YR 4/4) **loam fine sandy**; weak polyhedral structure with rough ped fabric; few medium sized ferruginous gravels; gradual boundary to
35 - 70	Reddish brown (5YR 4/4) **sandy clay loam fine sandy**; massive with earthy fabric; many sub-rounded ferruginous gravels; moderately alkaline (pH_w 8.8) and extremely saline (ECe > 3999 mS/m); gradual boundary to
70 - 140	Reddish brown (5YR 4/4) **light clay**; with common distinct pale mottles; weak polyhedral structure with rough ped fabric; common medium to large gravels; gradual boundary to
140-210	Dark reddish brown (5YR 3/4) **light to medium clay**; with common dark mottles and common fine gravel. Moderately alkaline (pH_w 8.5) and extremely saline (ECe > 3999 mS/m).

Site Drainage: Imperfectly drained

Site Number: 7 630989E; 6452508N	Soil landscape - unit Bendering 3u (**B2**)	**Landform:** Lower slope 2 - 3% gradient



WA Soil Group: ***Red loamy earth (non saline /stony)***

Depth	Description
0–10 cm	Dark brown (7.5YR 3/4) **loam**; apedal, massive with earthy fabric; moderately alkaline (pH_w 8.1) and slightly saline (ECe 301 mS/m); clear boundary to
10 – 50	Dark reddish brown (5YR 3/4) **sandy clay loam fine sandy**; moderate polyhedral structure with rough ped fabric; common sub-rounded coarse quartzitic gravels; gradual boundary to
50 - 140	Reddish yellow (5YR 6/6) **gritty light clay**; moderate polyhedral structure, rough ped fabric; many sub-rounded coarse quartzitic stones and gravel with calcareous inclusions; strongly alkaline (pH_w 9.9) and slightly saline (ECe 293 mS/m); gradual boundary to
140- 190	Dark reddish brown (2.5 YR 3/4) saprolite (weathered rock).

Site Drainage: Moderately well drained

Site Number: 8 630878E; 6452323N	Soil landscape - unit Bendering 3u (**B2**)	**Landform:** Lower slope 1 - 2 % gradient.

WA Soil Group: ***Red loamy earth (gravelly)***

Depth	Description
0– 0 cm	Dark brown (7.5YR 3/4) **loam fine sandy**; massive, earthy fabric; clear boundary to
10 – 32	Reddish brown (5YR 4/4) **clay loam fine sandy**; weak polyhedral structure with rough ped fabric; strongly alkaline (pH_w 9.3) and slightly saline (ECe 314 mS/m); clear boundary to
32 - 60	Reddish brown (5YR 5/4) **light clay**; weak polyhedral structure with rough ped fabric; many sub-rounded medium sized gravels; gradual boundary to
60 - 100	Brown (7.5YR 5/4) **light clay**; moderate polyhedral structure, rough ped fabric; common sub-rounded medium to coarse gravels; strongly alkaline (pH_w 9.8) and slightly saline (ECe 381 mS/m); gradual boundary to
100- 180	Reddish brown (5YR 4/4) **light to medium clay**; moderate polyhedral structure, rough ped fabric; few sub-rounded gravels;
180+	Dark reddish brown (5 YR 3/4) saprolite (weathered rock)

Site Drainage: Moderately well to imperfectly drained

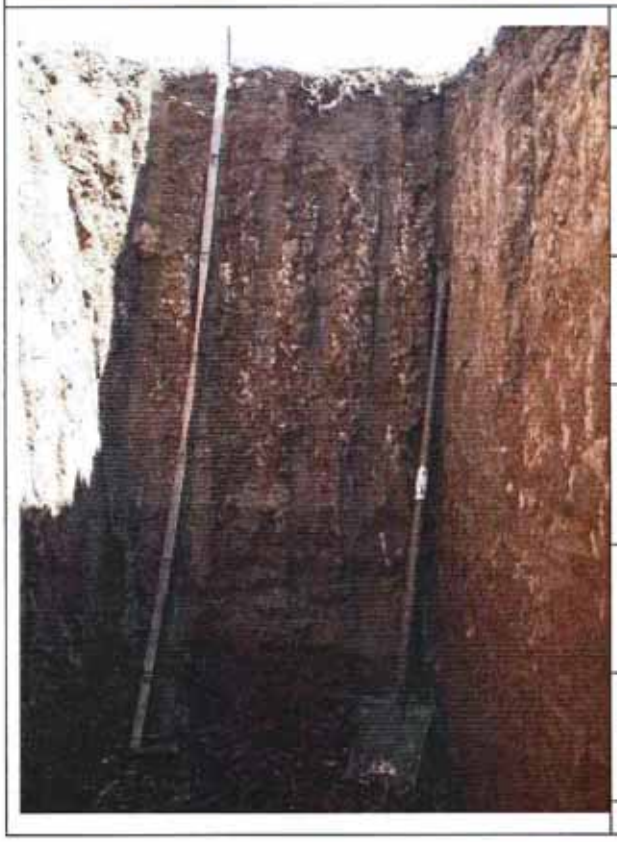
Site Number: 9 630707E; 6452392N	Soil landscape - unit Bendering 3u (**B1**)	**Landform:** Mid to upper slope; 3 % gradient.

WA Soil Group: ***Brown shallow loamy duplex soil (alkaline, calcareous subsoil).***

Depth	Description
0 –10cm	Very dark greyish brown (10YR 3/2) **clay loam fine sandy**; moderate polyhedral structure with rough ped fabric; clear boundary to
10 – 35	Dark yellowish brown (10YR 4/4) **light clay**; moderate polyhedral structure with rough ped fabric; few sub-rounded quartzitic gravels; strongly alkaline (pH_w 9.4) and slightly saline (ECe 291 mS/m); gradual boundary to
35 - 90	Yellowish brown (10YR 5/4) **light clay**; with common faint brown mottles; moderate polyhedral structure with rough ped fabric; many calcareous inclusions; gradual boundary to
90 - 200	Pale brown (10YR 6/3) **medium clay**; with common faint red and grey mottles; strong polyhedral structure with rough ped fabric; very strongly acid (pH_w 5.1) and extremely saline (ECe 3134 mS/m).

Site Drainage: Imperfectly drained

Site Number: 10 630589E; 6452139N	**Soil landscape - unit** Bendering 3u (**B1**)	**Landform:** Upper slope 3 - 4 % gradient.

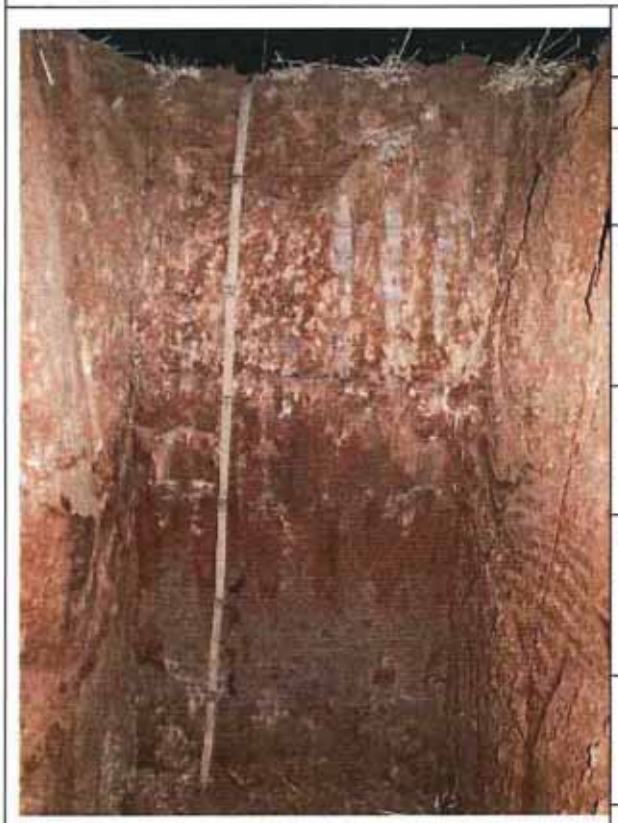


WA Soil Group: ***Alkaline red shallow loamy duplex (calcareous subsoil)***

Depth	Description
0– 10cm	Dark reddish brown (5YR 3/3) **clay loam**; moderate subangular blocky structure with rough ped fabric; neutral (pH_w 7.8) and non saline (ECe 198 mS/m); clear boundary to
10 – 30	Dark reddish brown (5YR 3/3) **light clay**; moderate polyhedral structure with rough ped fabric; few sub-rounded small quartzitic gravels; gradual boundary to;
30 - 80	Dark brown (7.5YR 3/3) **light clay**; moderate polyhedral structure with rough ped fabric; common gravels and calcareous inclusions; moderately alkaline (pH_w 8.8) and highly saline (ECe 1313 mS/m);
80 - 120	Brown (7.5YR 4/4) **light clay**; strong polyhedral structure with rough ped fabric; common sub-rounded gravels and calcareous inclusions; gradual boundary to
120-180	Brown (7.5YR 4/4) **gritty light to medium clay**; with common medium sized distinct grey mottles; strong polyhedral structure with rough ped fabric.

Site Drainage: Imperfectly drained

Site Number: 11 630721E; 6451910	**Soil landscape - unit** Kellerberrin 3ns (**K1**)	**Landform:** Valley flat < 1 % gradient

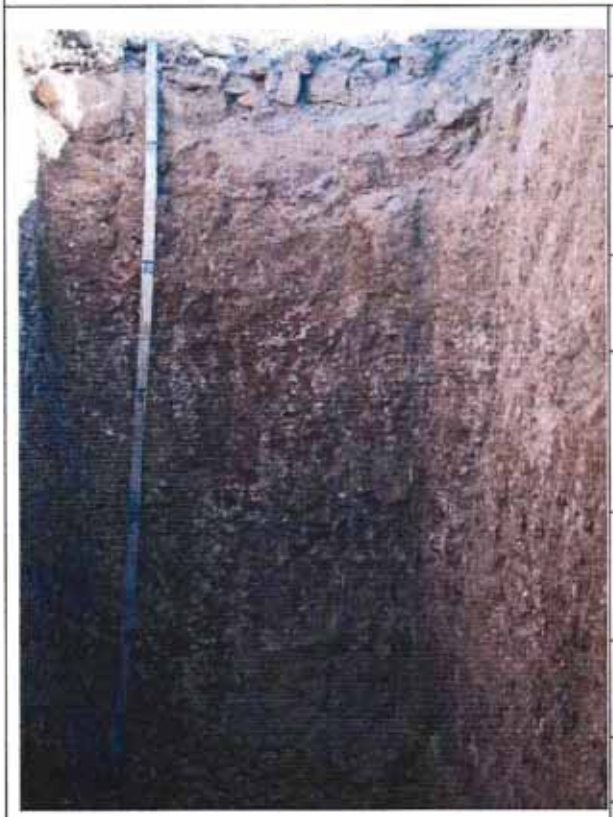


WA Soil Group: ***Red loamy earth (calcareous subsoil)***

Depth	Description
0 – 5 cm	Dark reddish brown (5YR 3/3) **sandy loam**; massive with earthy fabric; gradual boundary to
5 – 32	Dark reddish brown (5YR 3/4) **clay loam fine sandy**; moderate polyhedral structure with rough ped fabric; neutral (pH_w 7.9) and non saline (ECe 106 mS/m); gradual boundary to;
32 - 80	Yellowish red (5YR 4/6) **light clay**; moderate polyhedral structure with rough ped fabric; common calcareous inclusions; gradual boundary to;
80 -145	Red (2.5YR 4/6) **heavy clay**; with few faint grey mottles; moderate polyhedral structure with rough ped fabric; dense hard consistence; slightly acid (pH_w 6.1) and highly saline (ECe 948 mS/m); gradual to
145-200	Pinkish grey (7.5YR 6/2) **gritty light clay**; with common prominent red and yellow mottles; moderate polyhedral structure with rough ped fabric.

Site Drainage: Imperfect - poorly drained

Site Number: 12 630710E; 6452231N	Soil landscape - unit Bendering 3u (**B3**)	**Landform:** Mid-lower slope; 3 % gradient.



WA Soil Group: ***Red loamy earth (saline; calcareous subsoil)***

Depth	Description
0 –10cm	Dark brown (7.5YR 3/3) **loam fine sandy**; weak subangular blocky structure with rough ped fabric; neutral (pH_w 7.6) and extremely saline (ECe 1957 mS/m); clear to
10 – 40	Reddish brown (5YR 4/4) **clay loam fine sandy**; moderate prismatic structure with rough ped fabric; clear boundary to
40 - 70	Reddish brown (5YR 4/4) **light clay**; with common faint pale mottles; moderate polyhedral structure, rough ped fabric; common calcareous nodules; strongly alkaline (pH_w 9.4) saline (ECe 2070 mS/m);
70 – 110	Reddish brown (5YR 4/4) **medium clay**; common distinct brown mottles; moderate polyhedral structure, rough ped fabric; many calcareous nodules and inclusions;
110-155	Pink (5YR 7/4) **light to medium clay**; common distinct brown mottles; moderate polyhedral structure, many calc inclusions;
155-190	Light reddish brown (5YR 6/4) mottled clayey saprolite (weathered basement rock)

Site Drainage: Imperfect

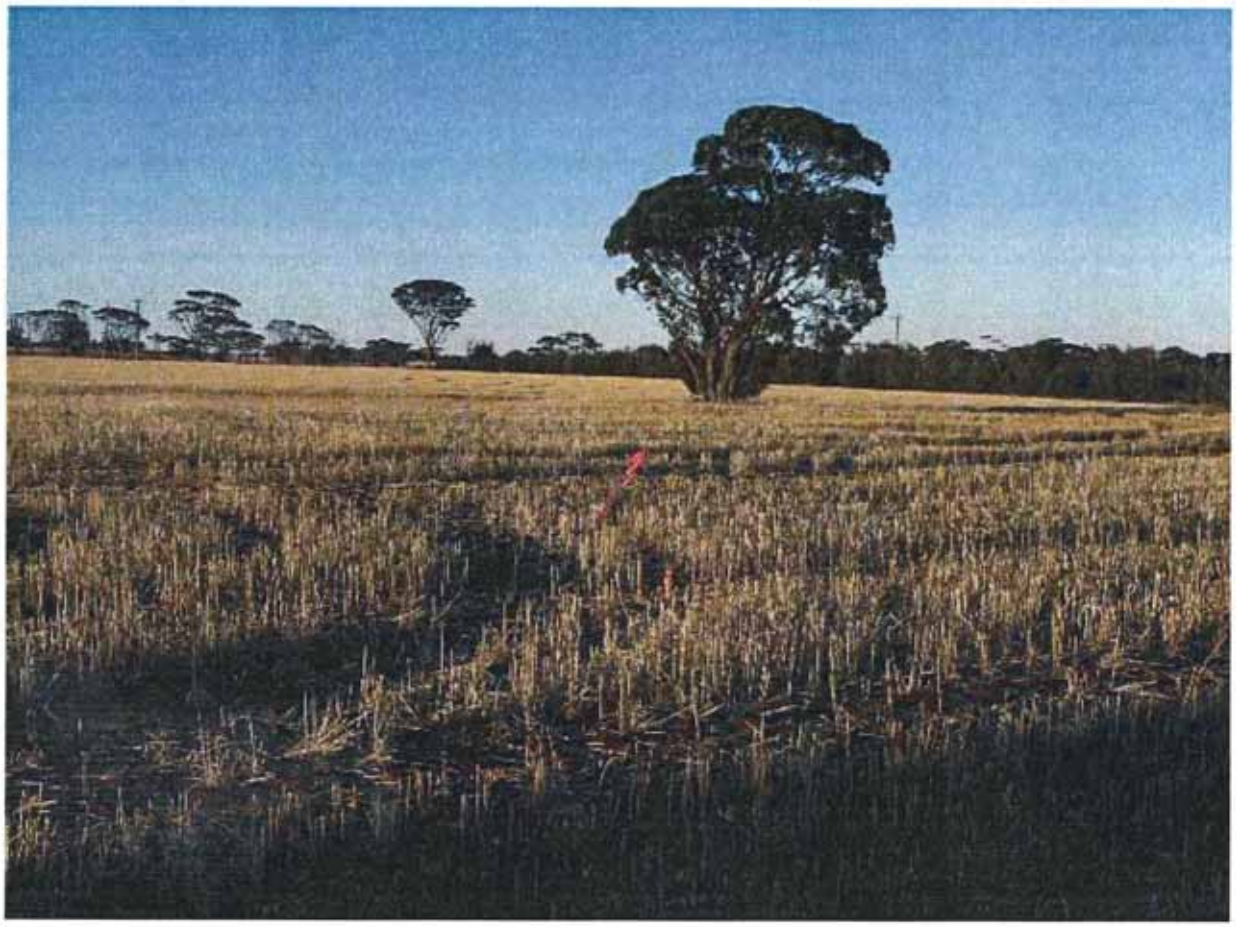
Site Number: 13 631024E; 6452644N	Soil landscape - unit Bendering 3u (**B3**)	**Landform:** Mid-lower slope; 3 % gradient.

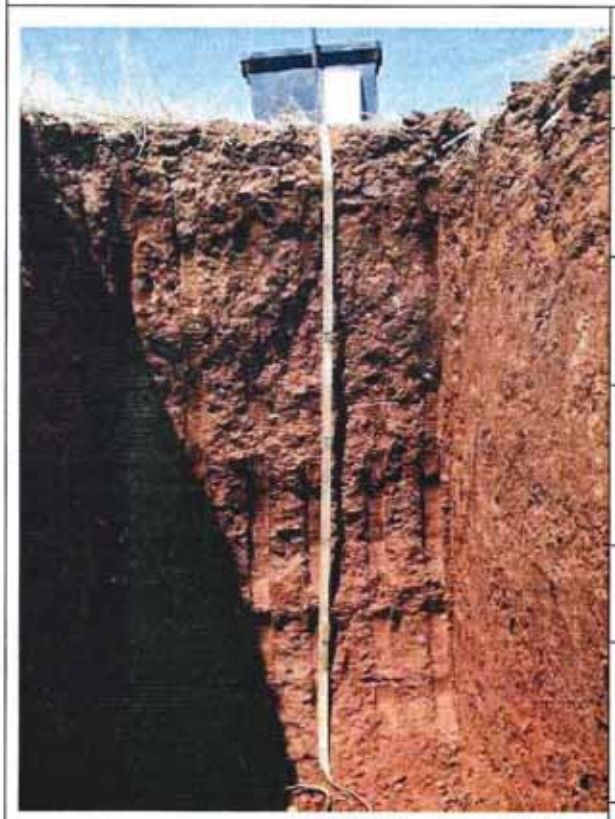
WA Soil Group: ***Brown loamy earth (saline; calcareous subsoil)***

Depth	Description
0–10 cm	Dark brown (7.5YR 3/3) **loam fine sandy**; apedal, massive with earthy fabric; moderately alkaline (pH_w 8.3) and extremely saline (ECe 3248 mS/m); clear to
10– 35	Dark brown (7.5YR 3/4) **sandy clay loam fine sandy**; weak polyhedral structure, rough ped fabric; clear boundary to
35 - 60	Reddish brown (5YR 4/4) **clay loam fine sandy**; moderate polyhedral structure with rough ped fabric; few sub-rounded gravels and calcareous inclusions; gradual to
60 - 140	Reddish brown (5YR 5/4) **light clay**; with common distinct yellow mottles; moderate polyhedral structure with rough ped fabric; few sub-rounded gravels and calcareous inclusions; moderately alkaline (pH_w 8.8) extremely saline (ECe 3192 mS/m).gradual
140-200	Reddish brown (5YR 4/4) **light to medium clay,** with few faint brown mottles; moderate polyhedral structure and calcareous inclusions.

Site Drainage: Moderately well to imperfectly drained

Site Number: 14 631218E; 6452599N	**Soil landscape - unit** Bendering 3u (**B4**)	**Landform:** Lower slope 2 – 3 % gradient.





WA Soil Group: ***Red/ brown non-cracking clay (alkaline, calcareous subsoil).***

Depth	Description
0 – 5 cm	Dark reddish brown (5YR 3/3) **loam**; moderate subangular blocky structure with rough ped fabric; slightly acid (pH_w 6.4) slightly saline (ECe 270 mS/m); clear to
5 – 25	Dark reddish brown (2.5YR 3/4) **moderate to heavy clay**; strong subangular blocky structure with rough ped fabric; few small manganiferous gravels; gradual boundary to
25 - 80	Red (2.5YR 4/6) **medium clay**; with few distinct pale mottles; moderate polyhedral structure, rough ped fabric; few calcareous inclusions; moderately alkaline (pH_w 8.8) highly saline (ECe 1490 mS/m); gradual to
80 – 160	Dark red (2.5YR 3/6) **medium clay**; moderate polyhedral structure, rough ped fabric; gradual boundary to
160-180	Dark red (2.5YR 3/6) saprolitic **light to medium clay**; with common distinct brown mottles; weak polyhedral structure, rough ped fabric; common Mn gravels; mod alkaline (pH_w 8.2), saline (ECe 2640mS/m).

Site Drainage: Imperfectly drained

QUALIFICATION OF PH AND SALINITY CATEGORIES

pH_w
Soil pH determined from a 1:5 soil / distilled water extract

Vsac -	Very strongly acid	< 5.3
Sac -	Strongly acid	5.3 – 5.6
Mac -	Moderately acid	5.6 – 6.0
Slac -	Slightly acid	6.0 – 6.5
N -	Neutral	6.5 – 8.0
Malk -	Moderately alkaline	8.0 – 9.0
Salk -	Strongly alkaline	> 9.0

ECe
Electrical conductivity undertaken using a Hanna Instruments Combined pH / salinity meter. EC1:5 soil / water values were converted to estimates of ECe (saturation extract) using Department of Agriculture (2004) conversion factors based on soil texture groups.

Salinity Rating
Salinity status categorized according to Moore (1998) as follows:

N –	Non saline	0 – 200 ECe mS/m
S –	Slightly saline	200 – 400 ECe mS/m
M –	Moderately saline	400 – 800 ECe mS/m
H –	Very saline	800 – 1 600 ECe mS/m
E –	Extremely saline	> 1 600 ECe mS/m

APPENDIX B

SCHEMA FOR DETERMINING INDICATIVE SOIL PERMEABILITY

Source: Standards Australia & Standards New Zealand (2000) - AS/NZS 1547 - *On-site Domestic Wastewater Management* Standards Association of Australia. Homebush, N.S.W.

TABLE 4.2A1
RECOMMENDED DESIGN LOADING RATES FOR TRENCHES AND BEDS

Soil category	Soil texture	Structure	Indicative permeability (K_{sat}) (m/d) (see Note 6)	Design loading rate (DLR) (see Notes 1, 2 and 3)			Indicative drainage class (see Note 9)
				Primary-treated effluent (see Note 4)		Secondary-treated effluent (see Note 5)	
				Conservative rate (mm/d) (see Notes 4 & 7)	Maximum rate (mm/d) (see Notes 4 & 8)	(mm/d)	
1	Gravels and sands	Structure-less (Massive)	>3.0	20 (see Note 10)	35 (see Note 10)	50 (see Note 10)	Rapidly drained
2	Sandy loams	Weakly structured	> 3.0	20	35	50	Well drained
		Massive	1.4 – 3.0	15	25	50	
3	Loams	High/ moderate structured	1.5 – 3.0	15	25	50	Moderately well drained
		Weakly structured or massive	0.5 – 1.5	10	15	30	
4	Clay loams	High/ moderate structured	0.5 – 1.5	10	10	30	Imperfectly drained
		Weakly structured	0.12 – 0.5	6	10	20	
		Massive	0.06 – 0.12	4	5	10	
5	Light clays	Strongly structured	0.12 – 0.5	5	8	12	Poorly drained
		Moderately structured	0.06 – 0.12	(see Note 11)	5	10	
		Weakly structured or massive	< 0.06	(see Note 11)	(see Note 11)	8	
6	Medium to heavy clays	Strongly structured	0.06 – 0.5	(see Note 11)	(see Note 11)	(see Note 11)	Very poorly drained
		Moderately structured	< 0.06	(see Note 11)	(see Note 11)	(see Note 11)	
		Weakly structured or massive	< 0.06	(see Note 11)	(see Note 11)	(see Note 11)	

NOTES TO TABLE 4.2A1:

1 The DLR in mm/day is to be used to size the horizontal bottom area of conventional trench and bed systems. (Refer to Paragraph 4.2A7.3.1 for comment on the relationship between bottom area and sidewall absorption mechanisms.)

2 Where loading rates of 10 mm/day or lower are required, it is critical that there is an even effluent loading over the design area.

3 The Design Loading Rates in Table 4.2A1 are based upon the best available information at the time of preparation of this Standard.

4 Primary-treated effluent is the discharge from conventional septic tanks and improved septic tanks (such as two-stage units and/or tanks fitted with solids-control filters). It includes all-waste, greywater and blackwater effluents.

5 Secondary-treated effluent has a quality equal to or better than 20 g/m^3 BOD_5 and 30 g/m^3 SS and typically is the effluent discharged from processes such as AWTS, sand filters, or wetlands.

6 The values of indicative permeability as K_{sat} are based on the movement of water, and not effluent, through the soil. They are estimates only and shall be used with caution in the determination of soil category and DLR.

7 Conservative Design Loading Rates must be used for beds (see Paragraph 4.2A7.2), for systems to be installed on steep sites and where other site and soil limitations are present. Conservative Design Loading Rates must always be used for primary-treated blackwater effluent.

8 Maximum Design Loading Rates may only be used where site and soil limitations are absent and where there is evidence that these rates can be effectively maintained without harm to the environment or without potential for failure of the system. Maximum Design Loading Rates may also be used for primary-treated greywater effluent and for improved primary effluent from modified septic tanks. (Refer to Clause 4.3.5.2.1.)

9 Indicative drainage classes listed are based on the assumption that drainage of water out of the soil is governed only by the indicative permeability and that external factors play no role.

10 The treatment capacity of the soil and not the hydraulic capacity of the soil or the growth of the clogging layer govern the effluent loading rate in Category 1 soil. Category 1 soils require special design and distribution techniques to help achieve even distribution of effluent over the full design surface (see Paragraph 4.5A4.2) for recommended discharge method). These soils have low nutrient retention capacities, often allowing accession of nutrients to groundwater.

11 To enable utilization of such soils for on-site wastewater disposal alternative systems (including ETA/ETS systems), special design requirements and distribution techniques and/or soil modification procedures will be necessary. For any alternative system designed for these soils, the effluent absorption rate shall be based upon soil permeability testing. Specialist soils advice and special design techniques will be required for clay dominated soils having dispersive (sodic) or shrink/swell behaviour. Such soils shall be treated as Category 6 soils. In some situations, these soils will preclude the use of an absorption only system design.

If $K_{sat} < 0.06$ m/d, a full water balance for the disposal area (including effective rainfall, run-off, evapo-transporation, (see Appendix 4.2D), can be used to calculate trench/bed size.

APPENDIX C

ALTERNATIVE TREATMENT SYSTEMS APPROVED FOR USE IN WESTERN AUSTRALIA
(as at JUNE 2009)

Source: Department of Health website (accessed August 11 2009)

Approved Alternative Effluent Disposal Systems

Aerobic Treatment Units

Aerobic Treatment Units (ATUs) are small ('package') wastewater treatment plants. Due to the treatment and disinfection process, the effluent from several systems may be used for garden irrigation. Some ATUs are also approved for Phosphorus removal. The listed systems have standard approval as domestic models (they may also be used in commercial situations). They are to be installed and operated in accordance with the *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974* and the ***Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATUs) Serving Single Dwellings.***

As the conditions of approval can vary between designs, persons interested in installing a particular ATU should confirm it meets their needs and discuss site requirements with the local government.

ATUs have regular service requirements (usually quarterly) and maintenance must be through an **Authorised person** or their staff/subcontractors.

More detailed information on ATUs is contained in the ***Aerobic Treatment Units*** **pamphlet** and the ***Code of Practice.***

AQUARIUS
(Phosphorus Removal)

Western Wastewater Treatments Pty Ltd
Unit 2/7 Collingwood Street
OSBORNE PARK WA 6017
Ph: 9244 5322
Fax: 9244 5711
Website: www.westernwastewater.com.au
Email: admin@westernwastewater.com.au

BIOCYCLE 5800

Jowa Group Pty Ltd
8 Lander Avenue
SHEIDOW PARK SA 5158
Ph: (08) 8381 9100
Fax: (08) 8381 9116
Website: www.biocyclejowagroup.com.au
Email: sales@biocyclejowagroup.com.au

BIOLYTIX FILTER (BF-6 Aerated)

Biolytix Technologies
PO Box 591
MALENY QLD 4552
Ph: (07) 5435 2700
Fax: (07) 5435 2701
Website: www.biolytix.com
Email: info@biolytix.com

BIOMAX PTY LTD
(Phosphorus Removal Option)

PO Box 462
MIDLAND DC WA 6936
Ph: 9250 7733
Fax: 9250 5844
Website: www.biomax.com.au
Email: biomax@iinet.net.au

BIOSYSTEM 2000

BioSystems 2000 Pty Ltd
3 Carlow Circle
WATERFORD WA 6152
Ph: 9450 2570
Fax: 9450 1635
Email: biosystems2000@yahoo.com.au

ENVIROCYCLE 10NR

Ebenezer Water
504A Great Eastern Highway
REDCLIFFE WA 6104
Ph: 9277 3331
Fax: 9277 3339
Website: www.envirocycle.com.au
Email: ewater@iinet.net.au

EVERHARD AQUA-NOVA

Allied Pumps (Perth Metro)
7-11 Beete Street
WELSHPOOL WA 6106
Ph: 9350 1000
Fax: 9356 5255
Email: ss.ap@multiline.com.au

GALVIN-TAYLEX CLEARWATER 90 COMPACT

Galvin Concrete & Sheetmetal Pty Ltd
Ph: 9302 2175
Website: www.galvins.com.au

- Clearwater Domestic Sewerage
  Ph: 9258 6933
- Australian Wastewater Solutions
  Ph: 0400 326 530
- Rodin Plumbing
  Ph: 0408 910 101

NOVACLEAR
(Phosphorus Removal)

EcoNova
23 Windsor Road
Nambour QLD 4560
Ph: (07) 5441 3569 or 1800 043 956
Fax: (07) 5441 3569
Website: www.econova.com.au
Email: info@econova.com.au

SEPTECH TURBOJET 2000

Icon-Septech Pty Ltd
Lot 265 Valencia Way
MADDINGTON WA 6109
Ph: (08) 9493 2352 or 1300 557 143
Fax: (08) 9493 2548
Website: www.icon-septech.com.au

TAYLEX CLEARWATER 90 & CLEARWATER 90 COMPACT

Clearwater Domestic Sewage
52 Railway Parade
WELSHPOOL WA 6106
Ph: 9258 6933
Fax: 9258 6944
Email: naiquip@iinet.net.au

- Note that ATUs that are approved for above ground irrigation can achieve Phosphorus removal by irrigation over a 30cm thick layer of an approved amended soil mix.

Amended Soil Effluent Disposal Systems

These Phosphorus (P) reducing systems have a conventional septic tank and leaching field ('leach drain') arrangement. The leaching field is contained within an approved amended soil which binds phosphates from the effluent.

ECOMAX
(Phosphorus Removal)

Ecomax Waste Management Systems Pty Ltd
Unit 2/13 Emplacement Crescent
HAMILTON HILL WA 6163
Ph: 9335 1600
Fax: 9335 1606
Website: www.ecomax.com.au
Email: ecomax@Bigpond.com.au

FILTREX WASTEWATER IRRIGATION SYSTEM
(Phosphorus Removal)

Filtrex Innovative Wastewater Solutions
PO Box 5122
BUNBURY WA 6231
Ph: (08) 9726 0118
Fax: (08) 9726 0117
Website: www.filtrex.com.au
Email: info@filtrex.com.au

More Information:

Water Unit
Environmental Health Directorate
Department of Health
PO Box 8172
PERTH BUSINESS CENTRE WA 6849

Telephone: 08 9388 4999
Facsimile: 08 9388 4910

http://www.public.health.wa.gov.au/cproot/1331/2/Approved Alternative Effluent Disposal Systems 08c31.pdf
Printed on: 22 June 2009

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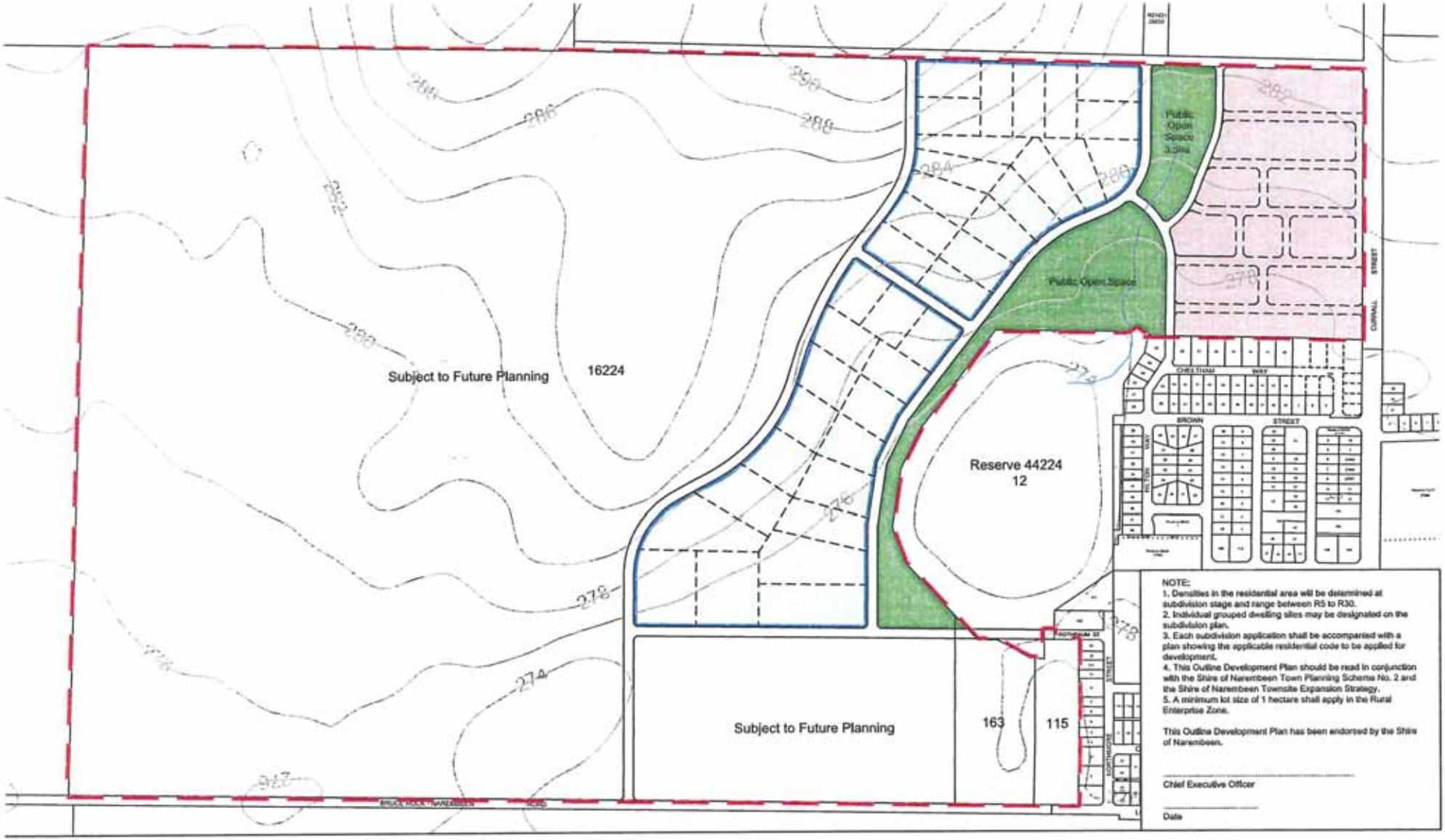
Produced by Environmental Health Directorate



OUTLINE DEVELOPMENT PLAN (Avoca Farm)

NAREMBEEN TOWNSITE
NAREMBEEN

LEGEND
- SUBJECT LAND
- RESIDENTIAL R5 - R30
- PUBLIC OPEN SPACE
- RURAL ENTERPRISE ZONE

N
0 250m
SCALE 1:7500 @ A3

GRAY & LEWIS
LAND USE PLANNERS
Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
F (08) 9474 1172
perth@graylewis.com.au

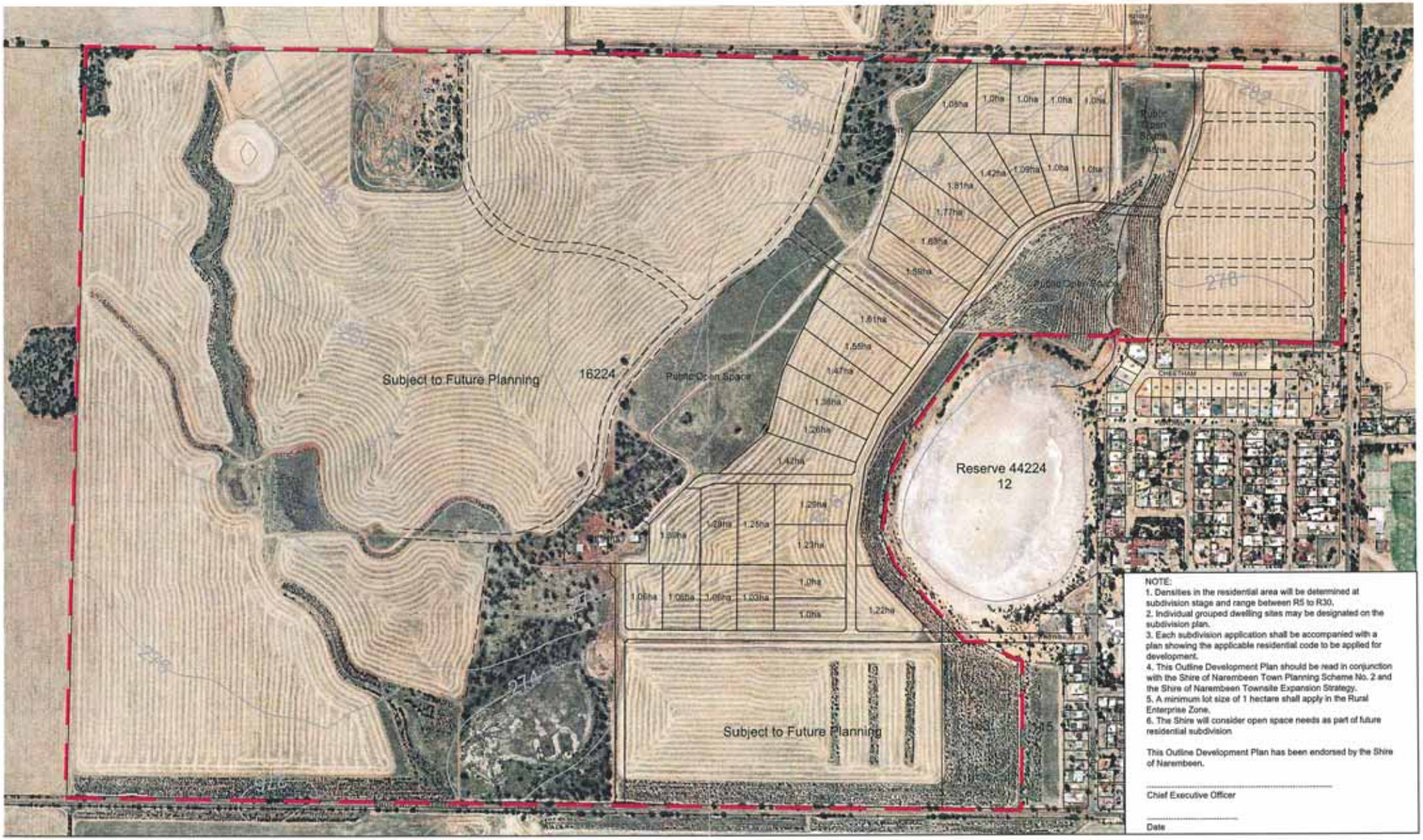
JOB REFERENCE: 100762 DATE: 22nd MARCH 2010

Attachment 3

Revised ODP adopted by Council

(Option 1)

December 2010



NOTE:
1. Densities in the residential area will be determined at subdivision stage and range between R5 to R30.
2. Individual grouped dwelling sites may be designated on the subdivision plan.
3. Each subdivision application shall be accompanied with a plan showing the applicable residential code to be applied for development.
4. This Outline Development Plan should be read in conjunction with the Shire of Narembeen Town Planning Scheme No. 2 and the Shire of Narembeen Townsite Expansion Strategy.
5. A minimum lot size of 1 hectare shall apply in the Rural Enterprise Zone.
6. The Shire will consider open space needs as part of future residential subdivision

This Outline Development Plan has been endorsed by the Shire of Narembeen.

.....
Chief Executive Officer

.....
Date

OPTION 1

OUTLINE DEVELOPMENT PLAN (Avoca Farm)

NAREMBEEN TOWNSITE
NAREMBEEN

LEGEND
SUBJECT LAND

N
0 250m
SCALE 1:7500 @ A3

GRAY & LEWIS
LAND USE PLANNERS

Suite 5, 2 Hardy Street
South Perth, WA 6151
T (08) 9474 1722
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perth@graylewis.com.au

JOB REFERENCE: 100762 DATE: 30th NOVEMBER 2010