Department of Regional Development and Lands

Living Lakes Project Stage 1: Part 1 Report

Feasibility Study in the Wheatbelt and Adjoining Regions

JDA Consultant Hydrologists

With

Advanced Choice Economics Pty Ltd

Land Assessment Pty Ltd

Woodgis Environmental Assessment and Management

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EXECUTIVE SUMMARY

The 'Liberal-National Government's Royalties for Regions 'Living Lakes' program proposes to enhance one or more existing lake systems to create permanent and accessible water bodies in the Wheatbelt and adjoining regions of Western Australia. Twenty-five lakes were initially nominated by community members and other interested parties in response to an expression of interest process lead by the Department of Regional Development and Lands (RDL). Five of these lakes were subsequently withdrawn. The aim of this report is to assess the remaining twenty nominations against the Living Lakes Plan objective and established selection criteria, providing a justification for a short-list of two or three lakes to be considered further for lake enhancement.

> ***Aim of the analysis****: To prioritise 20 community-nominated lakes in southern Western Australia in order of largest to smallest expected gain in social, recreational and economic opportunities for regional communities through enhancement to permanent and accessible water bodies.*

Multicriteria Analysis (MCA) is used to prioritise the 20 lakes. This involves scoring each lake against a set of 12 criteria, developed by the proponents (JDA Consultant Hydrologists) in collaboration with RDL. Some of these criteria are divided into a number of sub-criteria reflecting the need for some criteria to be measured in a number of ways. Initially, each criterion is given equal weighting with sub-criteria given a proportion of this weight, depending on the number of sub-criteria.

Criterion #	Criteria description
Criterion 1	Lake is in the wheatbelt or regions immediately surrounding
Criterion 2	Lake is within 50km of a town with a population of at least 50 people
Criterion 3	Lake is of social, recreational and/or economic importance
Sub-criterion 3i	*Size of lake*
Sub-criterion 3ii	*Expected improvement of social and recreational activities available at the lake*
Sub-criterion 3iii	*Expected improvement in business opportunities related to the lake*
Sub-criterion 3iv	*Expected improvement in current and potential future events to be held at the lake*
Sub-criterion 3v	*Distance to other lakes with continuous high social, recreational and economic opportunities*
Sub-criterion 3vi	*Proximity to other significant tourist, social and recreational opportunities*
Criterion 4	Lake is primarily contained on public land
Criterion 5	Lake is in an area with existing road or crown land access
Criterion 6	Lake is of a natural depth at full capacity that allows social or recreational use
Criterion 7	Lake is in an area where there are indications of community support for the development of the lake
Criterion 8	Wetland environmental status does not exclude lake enhancement
Criterion 9	Tourism potential
Criterion 10	Groundwater resources potential to fill part/all of lake
Criterion 11	Surface water potential resources to fill part/all of lake
Sub-criterion 11i:	*Some surplus exists of rainfall over evaporation*
Sub-criterion 11ii:	*A suitable water course may exist nearby for potential diversion of surface water runoff*
Criterion 12	Suitable landscape geomorphology and lake morphology
Sub-criterion 12i:	*Presence of an outlet channel*
Sub-criterion 12ii:	*Water permanence*
Sub-criterion 12iii:	*Size of lake/wetland*

Each lake is given a 'score' or 'rating' for each criterion (and sub-criterion where appropriate). This rating system is the same for each criterion and ranges between 0 and 4, where 0 indicates no impact and 4 indicates a strong positive impact. Each of these scores is multiplied by the criterion weight, and summed for all criteria, to obtain an overall impact score. The maximum score a lake can receive is 400 (indicating 100% success against all criteria). Each of the lakes is then given a ranking, where the lake with the maximum score is ranked highest (1), and the lake with the minimum score is ranked the lowest (20). The ranking of lakes based on standard criteria weights is shown below.

Ranking	Lake	Score	Score (%)
1	Yealering	313	78
2	Ewlyamartup	311	78
3	Towerrinning	308	77
4	Dumbleyung	290	73
5	Norring	285	71
6	Queerearrup	276	69
7	Blackwood River	271	68
8	Yornaning Dam	263	66
9	Baandee	246	61
9	Yenyening	246	61
11	Polaris	243	61
12	Flagstaff	243	61
13	Kuender	236	59
14	Nallan	228	57
15	Wagin Lakes	221	55
16	Nunijup	204	51
17	Brown	194	49
18	Bryde	175	44
19	Austin	169	42
20	Cairlocup	164	41

The Multicriteria Analysis short-lists three lakes, with similar scores, for further consideration in the Living Lakes Plan:

(1) Yealering (Score = 313),

(2) Ewlyamartup (Score = 311), and

(3) Towerrinning (Score = 308).

A sensitivity analysis is conducted on the criteria weights to determine the robustness of the ranking system. This is done systematically by first assigning equal weights to all sub-criteria. Then, another seven sensitivity analyses are conducted by assigning a higher weighting (30%) to one criteria and assigning the remaining weighting (70%) evenly to the other criteria. In general, the sensitivity analyses do not significantly affect the top ranked lakes. Yealering, Ewlyamartup and Towerrinning remain the first thee ranked lakes (although not in the same order) for five of the eight sensitivity analyses. Yealering retains its 1st rank for five of the eight sensitivity analyses, and drops to 3rd, 4th and 6th rank for the remaining three. Ewlyamartup retains its 2nd rank for five sensitivity analyses, rises to 1st rank for two, and

drops to 3rd rank for the remaining sensitivity analysis. Towerrinning retains its 3rd rank for three of the sensitivity analyses, rises to 1st for one, 2nd for three and 4th for one.

The ranking of all 20 nominated lakes provided in this report is shown to be robust, and can be used to decide on other lakes for consideration should the highest three ranking lakes be disqualified for any reason during the consideration process.

1. INTRODUCTION

1.1 Living Lakes Project Overview

The 'Liberal-National Government's Royalties for Regions 'Living Lakes' program proposes to enhance existing lake systems and create permanent and accessible water bodies in the Wheatbelt and adjoining regions, by using engineering solutions such as weirs, channels and canals. These natural lakes will be transformed into permanent living reservoirs that will re-establish the native flora and fauna and will attract people, industry, services and recreational facilities to the area. Living Lakes intends to offer another incentive to live in regional communities and an opportunity to diversify the economy of the area.

1.1.1 Lake Nomination Process

As part of Stage 1 of the initiative, the Department of Regional Development and Lands (RDL) undertook an Expressions of Interest (EOI) process, inviting community members and interested parties to nominate lakes for consideration. The EOI appeared in the West Australian and local regional papers covering the Wheatbelt and adjoining regions. A list of nominated lakes identified through the EOI process is presented at Table 1. Subsequent to this nomination process, 5 of the 25 nominated lakes were withdrawn by the nominators. Withdrawn lakes are indicated with an asterisk (*) in Table 1.

Table 1: Nominated lakes

	Lake	Region	Shire
A	Austin	Mid West	Cue
B	Baandee	Wheatbelt	Kellerberrin
C	Blackwood River	South West	Boyup Brook
D	Brown	Wheatbelt	Nungarin
E	Bryde	Great Southern	Kent
F	Cairlocup	Great Southern	Kent
G	Cemetery*	Wheatbelt	Lake Grace
H	Dumbleyung	Wheatbelt	Dumbleyung
I	Ewlyamartup	Great Southern	Katanning
J	Flagstaff	Great Southern	Woodanilling
K	Kuender	Wheatbelt	Lake Grace
L	Lake Grace North*	Wheatbelt	Lake Grace
M	Lake Grace South*	Wheatbelt	Lake Grace
N	Nallan	Mid West	Cue
O	Norring	Wheatbelt	Wagin
P	Nunijup	Great Southern	Cranbrook
Q	Polaris	Wheatbelt	Yilgarn
R	Queerearrup	Great Southern	Woodanilling
S	Stubbs (Newdegate)*	Wheatbelt	Lake Grace
T	Towerrinning	Wheatbelt	West Arthur
U	Wagin Lakes	Wheatbelt	Wagin
V	Wicherina Dam*	Mid West	Geraldton-Greenough
W	Yealering	Wheatbelt	Wickepin
X	Yenyening	Wheatbelt	Brookton
Y	Yornaning Dam	Wheatbelt	Cuballing

* Withdrawn lakes

1.1.2 Tender Process (Stages 1 and 2)

The Living Lakes plan proposes a two-step approach to creating 'Living Lakes' each of which shall be awarded via state government tender process.

- Stage 1 of the initiative will be to undertake a study to determine the feasibility, cost and benefit to the community of enhancing 2-3 existing lake systems to create permanent and accessible water bodies.

- Stage 2 of the initiative will involve the design of concept plans and costings for the re-development of lakes identified in Stage 1.

This report relates only to Stage 1 of the study which consists of two (2) parts. A Request to undertake Stage 2 of the study will be undertaken through a separate procurement process.

Stage 1 requires the undertaking of a feasibility study into enhancing existing lake systems into permanent water bodies. This stage aims to determine the cost benefit of using a program of creative

engineering solutions such as weirs, channels, canals or groundwater to turn these natural lakes into permanent living reservoirs.

1.1.3 JDA Awarded Stage 1

JDA Consultant Hydrologists (JDA) were awarded Stage 1 under contract to the Department of Regional Development and Lands. Documents were signed on July 18, 2011 with an agreed commencement date of August 1, 2011.

1.1.4 Amended Criteria for Stage 1 Part 1

The original contract specified 7 criteria for each lake to be assessed against. These were expanded to 12 criteria on September 9, 2011 by mutual agreement. Criteria details are discussed in detail in Section 4.

1.2 Scope of Report

Stage 1 of the study is divided into 2 parts. This report relates to Part 1 only.
Part 1 (Deliverable 1) – requires a desktop and consultation process.
In undertaking Part 1 of study JDA Consultant Hydrologists were required to:

- assess all 25 nominations against the Living Lakes Project objectives and established selection criteria.
- provide details of the 2-3 selected lakes upon which the study will be undertaken and an estimate of the costs for/and work required to complete the study of the lakes; and
- provide a summary of why the 2/3 lakes were selected and the other nominated lakes were not deemed to be the most suitable.

1.3 Report Layout

This report is structured as follows:

- Section 2 - presents a summary of information gathered for each nominated lake.
- Section 3 - explains the methodology and process employed to assess the lakes against each other.
- Section 4 – presents the selection criteria, introduces certain essential sub-criteria and expands on the scoring (or rating) process.
- Section 5 – discusses criteria weighting
- Section 6 – presents 12 tables, one for each assessment criteria. Rating results are presented for all lakes against each criterion.
- Section 7 – presents outcomes of the MCA process.
- Section 8 – presents conclusions.
- Section 9 – displays references.

2. NOMINATED LAKES – INFORMATION SUMMARY

Section 2 lists the information available for each of the nominated lakes at the time of reporting. These have been obtained from proponent applications and through research of extensive sources as described within Section 10 “References”. For details regarding references for specific data, please see the footnotes to tables in Section 6. Information for withdrawn lakes is included in Appendix A.

In addition, due to the ephemeral nature of many of the lake systems, the surface area for each lake and its catchment area are not always immediately obvious. The approach taken has been as follows:

Lake surface area

- Identify the lake boundary (when full) from aerial photograph imagery.
- Manually copy this lake boundary onto ArcGIS hydrology layers to produce a closed polygon.
- Use ArcGIS to determine the surface area of the polygon in hectares (ha).

Catchment area

Identify the river basin the lake lies within. Activate the ArcGIS layer which provides the most current definition of Western Australian catchments and sub-catchments, as provided by the Department of Water. Extract the sub-catchment area for each lake.

The location of each nominated lake relative to Western Australian townships is presented at Figure 1, overpage. Detailed catchment maps are presented elsewhere within the report.

Living Lakes Initiative Stage 1 On-line Survey Questionnaire

An on-line survey was developed jointly by JDA and RDL for distribution to proponents.

It was conducted using the Survey Monkey Platform (www.surveymonkey.com) and ran from 23 August to 14 September, 2011.

A copy of results of each survey questionnaire is provided as an electronic attachment to this report.

The survey results were used to inform various aspects of the MCA.

Figure 1 – Map showing location of the 25 nominated Lakes

2.1 Lake Austin (A)

Location

- Planning Region - Mid West
- NRM Region – Rangelands
- Catchment (sub-catchment) - Murchison (Sanford River)
- Shire - Cue
- Nearest Townships: Cue - Population Mt Magnet - Population
- Nearest town, 21 km away, is Cue with a population of 328 (2006).
- Second nearest town, 55 km away, is Mt Magnet with a population of 424 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 746km
- Distance from other major drive routes: 5km from Route 95

Public Land – Vesting and Access

- Vesting - Approximately 40 % is within Unallocated Crown Land (UCL) with remainder mostly under pastoral lease.
- Access - Central portion accessible via Great Northern Highway and northern portion via Lakeside Road (unsealed).

Environmental Status

- Regional NRM Significance - High
- Threatened Ecological communities (within 1 km) - 2 records
- Cultural Heritage Sites in vicinity - 3 records

Landscape geomorphology and lake morphology

- Very large (> 50,000 ha) seasonal lake
- Soil landscape – Austin system. “Gently undulating saline stony plains with scattered drainage foci and associated internal drainage lines”
- No obvious outlet point to provide opportunity for a detention structure although existing roads provide potential for detention structure for portion of lake.
- Bathymetry and Depth data - No data

Hydrogeology

- Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.

Surface Hydrology

- Catchment Area – 1500000 ha
- Lake Surface Area – 98000 ha
- Catchment Area / Lake Surface Area Ratio – 15
- Annual Rainfall – 232.7 mm
- Annual Evaporation – 3574 mm

Refer to Figure 2A for an aerial view of Lake Austin, Figure 3A for a catchment plan and Figure 4A for access details.

2.2 Lake Baandee (B)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Yilgarn)
- Shire - Kellerberrin
- Nearest town, 8 km away, is Doodlakine with a population of 191 (2006).

Social, Recreational and Economic Importance

- Currently used for canoeing, kayaking, caravan/camping, sailings, swimming, water-skiing and windsurfing

Evidence of Community Support

- Two Living Lakes Initiative Stage 1 On-line Survey Questionnaires completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” –245km
- Distance from other major drive routes: < 5km from Route 94

Public Land – Vesting and Access

- Vesting – Lake is Reserve 27145 vested in Local Government Authority for ‘Recreation; Sportsground; Waterway’
- Access - via Ski Lake road (unsealed) off Great Eastern Highway.

Environmental Status

- Regional NRM Significance - Moderate overall (ranking 3 out of 5 for environmental values)

Landscape geomorphology and lake morphology

- Large (> 250 ha) permanent lake.
- Lake Baandee has an outlet channel leading south-west to an adjacent lake within Unallocated Crown Land.
- Soil landscape – Wallambin system, Baandee subsystem; salt lake phase – “Seasonally dry playa lake”.
- Bathymetry and Depth - No data

Hydrogeology

- Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.

Surface Hydrology

- Catchment Area – 30000 ha
- Lake Surface Area – 250 ha
- Catchment Area / Lake Surface Area Ratio - 120
- Annual Rainfall – 310.5 mm
- Annual Evaporation – 2629 mm
- A definitive lake outflow channel exists

Refer to Figure 2B for an aerial view of Lake Baandee, Figure 3B for a catchment plan and Figure 4B for access details.

2.3 Blackwood River (C)

Location

- Planning Region - South West
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Middle)
- Shire - Boyup Brook
- Nearest town, 10 km away, is Boyup Brook with a population of 532 (2006).
- Second nearest town, 42 km away, is Bridgetown with a population of 2324 (2006).

Social, Recreational and Economic Importance

- Currently used for bird-watching, canoeing, kayaking, caravan/camping, fishing, rowing, swimming, walking and hiking.

Evidence of Community Support

- One Living Lakes Initiative Stage 1 On-line Survey Questionnaire completed
- No formal studies identified (pertaining directly to Terry Rd Crossing).

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 94km
- Distance from other major drive routes: 30km from Route 1

Public Land – Vesting and Access

- Vesting - Within Unallocated Crown Land (UCL).
  Access - via Terry Road (unsealed) and Reserve 2997 vested for ‘Common’ purpose.

Environmental Status

- Condition rating for this section of Blackwood River is C 1 (Multiple Use River) and it occurs in a highly cleared part of the catchment where wetland / watercourse values are mainly low to moderate (Pen 1997).

Landscape geomorphology and lake morphology

- Associated with main channel of the Blackwood River upstream from Terry Road crossing
- Section of permanent river.
- Soil landscape – Blackwood River system; Condinup subsystem – "River channel, flood plain and raised alluvial terraces".
- Bathymetry and Depth – No data.

Hydrogeology

- Blackwood River crossing at Terry's Road is located in a valley incised into Archaen igneous and metamorphic rocks with low permeability and storage potential.

Surface Hydrology

- Catchment Area – 950,000 ha
- Lake Surface Area – Not Applicable.
- Catchment Area / Lake Surface Area Ratio – Not Applicable.
- Annual Rainfall – 653.2 mm
- Annual Evaporation – 1366 mm
- A road crossing or weir structure presently exists at the site

Refer to Figure 2C for an aerial view of the Blackwood River at Terry Rd Crossing, Figure 3C for a catchment plan and Figure 4C for access details.

2.4 Lake Brown (D)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Yilgarn)
- Shire - Nungarin
- Nearest town, 22 km away, is Nungarin with a population of 142 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 294km
- Distance from other major drive routes: 45km from Route 94

Public Land – Vesting and Access

- Vesting - Within Reserve 24789 vested in WA Wildlife Authority for 'Conservation; Fauna; Protection of Flora'.
- Access - Northern portion via Brown South Road. Southern portion via Chandler Nungarin Road. through Reserve 21759 vested for 'Common' purpose.

Environmental Status

- Regional NRM Significance – Moderate overall (ranking 3 out of 5 for environmental values)

Landscape geomorphology and lake morphology

- Very large (> 3,500 ha) seasonal lake.
- Soil landscape – Wallambin System – "Salt lake chains within broad valley floor".
- Bathymetry and Depth - Bathymetrically mapped (Lane et al 2011) but no monitoring sites with depth data

Hydrogeology

- Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.

Surface Hydrology

- Catchment Area – 59000 ha
- Lake Surface Area – 3700 ha
- Catchment Area / Lake Surface Area Ratio - 16
- Annual Rainfall – 306.1 mm
- Annual Evaporation – 2807 mm
- No clear outlet channel exists from the lake

Refer to Figure 2D for an aerial view of Lake Brown, Figure 3D for a catchment plan and Figure 4D for access details.

2.5 Lake Bryde (E)

Location

- Planning Region - Great Southern
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Lockhart)
- Shire - Kent
- Nearest town, 44 km away, is Newdegate with a population of 276 (2006).

Social, Recreational and Economic Importance

- Currently used for moderate levels of social and recreational activities

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- Lake Bryde Recovery Catchment – various studies by, or for, Department of Environment and Conservation, and the Department of Agriculture and Food addressing improving water quality

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 45km
- Distance from other major drive routes: 45km from Route 107

Public Land – Vesting and Access

- Vesting - Within Reserve 48436 vested in Conservation Commission of WA for 'Agriculture; Conservation; Regeneration'.

- Access – via unmade road off Lake Bryde Road and through reserve with a vesting purpose incompatible with active recreational uses.

Environmental Status

- Wetland of National Significance - Listed under Directory of Important Wetlands (Environment Australia 2001) as Lake Bryde is part of the listed Lake Bryde - East Lake Bryde System.
- Biodiversity Recovery Catchment – Part of a program under the State Salinity Strategy to conserve and protect the range of species and ecosystems found within the valley of the Lake Bryde catchment that are at risk from increasing salinity.
- Regional NRM Significance – Moderate overall (ranking 4 out of 5 for environmental values).
- The lake bed plant community is a threatened ecological community (TEC). An interim recovery plan has been prepared (Hamilton-Brown and Blyth 2001) and long term monitoring of the effect of prolonged inundation and changes in salinity is in progress.
- .Threatened Flora (within 1 km) - Declared Rare Flora - Extant Taxa (1 record); Priority Two - Poorly Known Taxa (1 record)
- Cultural Heritage Sites in vicinity - 3 records

Landscape geomorphology and lake morphology

- Moderate sized (97 ha) seasonal fresh water lake (Halse et al 1993).
- Intermittently flooded wetland; internally draining
- No obvious outlet point to provide opportunity for a detention structure
- Soil landscape – Sharpe 2 Subsystem – part of a “level plain with many small salt lakes and some associated lunettes and dunes”.
- Bathymetrically mapped by DEC during 2002 (Lane et al 2011)
- Extensive depth and water quality data (Cale et al 2004) with depths 0 – 2 m (Lane et al 2011).

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 28000 ha
- Lake Surface Area – 68 ha
- Catchment Area / Lake Surface Area Ratio - 412
- Annual Rainfall – 357.4 mm
- Annual Evaporation – 2097 mm
- No clear outlet channel exists from the lake

Refer to Figure 2E for an aerial view of Lake Bryde, Figure 3E for a catchment plan and Figure 4E for access details.

2.6 Lake Cairlocup (F)

Location

- Planning Region - Great Southern
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Lockhart)
- Shire - Kent
- Nearest town, 42 km away, is Jerramungup with a population of 367 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 182km
- Distance from other major drive routes: 25km from Route 1

Public Land – Vesting and Access

- Vesting - Within Reserve 28324 vested in WA Wildlife Authority for ‘Conservation; Fauna; Protection of Flora’.
- Access – via unmade road or tracks off either Needilup Road North (to the east) or Dunnart Road (to the west).

Environmental Status

- Regional NRM Significance – Low overall (ranking 3 out of 5 for environmental values).
- Threatened Flora (within 1 km) - Priority One (1 record), Priority Two (1 record), Priority Three (4 records) – all Poorly Known Taxa

Landscape geomorphology and lake morphology

- Large (284 ha) hypersaline seasonal lake (Halse et al 1993).
- Soil landscape – Pingrup 3 Subsystem – wetland within area of “linear dunes, lunettes and sandplain”.
- Monitoring data indicate 0 - 0.8 m depth range. (Lane et al 2011).

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 4000 ha
- Lake Surface Area – 340 ha
- Catchment Area / Lake Surface Area Ratio - 12
- Annual Rainfall – 450.7 mm
- Annual Evaporation – 1839 mm

- No clear outlet channel exists from the lake

Refer to Figure 2F for an aerial view of Lake Cairlocup, Figure 3F for a catchment plan and Figure 4F for access details.

2.7 Lake Dumbleyung (H)

Location

- Planning Region - Wheatbelt
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Upper) - Colbinine River System
- Shire - Dumbleyung
- Nearest town, 7 km away, is Dumbleyung with a population of 223.

Social, Recreational and Economic Importance

- Currently used for bird-watching, canoeing/kayaking, sailing, swimming, walking/hiking, cycling and water-skiing.

Evidence of Community Support

- Three Living Lakes Initiative Stage 1 On-line Survey Questionnaires completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 1km

Public Land – Vesting and Access

- Vesting - Within Reserve 26664 (to west) and Reserve 26665 (to east) plus some UCL to south. Reserve 26665 is vested with the Local Government Authority for ‘Recreation’. Reserve 26664 is vested with National Parks and Nature Conservation Authority for ‘Conservation; Fauna; Protection of Flora’.
- Access - via Lake Road to the north, and possibly also via unmade roads off Wagin - Dumbleyung Road to the east, and Bullock Hills Road to the south.

Environmental Status

- Wetland of National Significance - Listed under Directory of Important Wetlands (Environment Australia 2001).
- Regional NRM Significance - a major drought refuge for many waterbirds, and a major moulting site for the Australasian shelduck (Pen 1997).
- It is the largest deep-water lake of south-western Australia (SWCC 2004).
- Cultural Heritage Sites in vicinity - 11 records

Landscape geomorphology and lake morphology

- Very large (5562 ha) semi-permanent (saline) lake (Halse et al 1993; Pen 1997).
- Wetland associated with broad floodplain that is part of an ancient drainage line within the Yilgarn Plateau (Pen 1997).

- In very wet periods water from Lake Dumbleyung exits to the west and flows through the system of lakes around Wagin and Woodanilling into the Beaufort River (Grein 1995; Pen 1997).
- Soil landscape –. Coblinine 4 Subsystem – "Lakes and swamps (saline and fresh) and associated lunettes, swales and dunes on aeolian and lacustrine deposits and alluvium over granitic rocks in the southern wheatbelt".
- Bathymetrically mapped by DEC during 1998/01 and monitoring data indicate 0 – 4.5 m depth range (Lane et al 2011).

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 17000 ha
- Lake Surface Area – 5560 ha
- Catchment Area / Lake Surface Area Ratio - 3
- Annual Rainfall – 391.1 mm
- Annual Evaporation – 1873 mm

Refer to Figure 2H for an aerial view of Lake Dumbleyung, Figure 3H for a catchment plan and Figure 4H for access details.

2.8 Lake Ewlyamartup (I)

Location

- Planning Region - Great Southern
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Upper) - Colbinine River System
- Shire - Katanning
- Nearest town, 17 km away, is Katanning with a population of 3,808 (2006).

Social, Recreational and Economic Importance

- Currently used for bird watching and caravanning. When water levels are sufficient, it is also used for canoeing/kayaking, sailing, swimming, water-skiing and windsurfing.

Evidence of Community Support

- One Living Lakes Initiative Stage 1 On-line Survey Questionnaire completed
- Katanning LCDC (2010) Restoring Lake Ewlyamartup – Engineering Concept Plan – a project directed by the Lake Ewlyamartup Working Group under the auspices of the Katanning Land Conservation District Committee.

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 70km
- Distance from other major drive routes: 20km from Route 120

Public Land – Vesting and Access

- Vesting - Within Reserve 16358 vested with the Local Government Authority for 'Recreation'.
- Access - via unsealed road off Langaweira Road (to the west).

Environmental Status

- Regional NRM Significance - Main environmental values relate to faunal populations, wildlife sanctuary, and habitat linkage (Pen 1997).
- Threatened Flora (within 1 km) - Priority Two - Poorly Known Taxa (1 record)
- Well known as an important place for waterbirds with two priority and eight migratory species currently listed (Katanning LCDC 2010)

Landscape geomorphology and lake morphology

- Moderate sized (88 ha) permanent lake (Katanning LCDC 2010).
- Single inlet / outlet point
- Soil landscape –. Coblinine 4 Subsystem – "Lakes and swamps (saline and fresh) and associated lunettes, swales and dunes on aeolian and lacustrine deposits and alluvium over granitic rocks in the southern wheatbelt".
- Bathymetry and Depth – No data.

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 4000 ha
- Lake Surface Area – 88 ha
- Catchment Area / Lake Surface Area Ratio - 45
- Annual Rainfall – 477.6 mm
- Annual Evaporation – 1826 mm
- A definite outflow channel exists

Refer to Figure 2I for an aerial view of Lake Ewlyamartup, Figure 3I for a catchment plan and Figure 4I for access details.

2.9 Lake Flagstaff (J)

Location

- Planning Region - Great Southern
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Upper) - Beaufort River System (Pen 1997)
- Shire - Woodanilling
- Nearest town, 21 km away, is Woodanilling with a population of 399 (2006).
- Second nearest town, 28 km away, is Wagin with a population of 1427 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 46km
- Distance from other major drive routes: 20km from Route 120

Public Land – Vesting and Access

- Vesting - Within Reserve 17254; vested for 'Government Requirements'.
- Access - via Flagstaff Road to the south or Ashwell Road to the east. Possibly also from the north via unmade road through Reserve 27609 although vesting is for ‘Conservation; fauna; protection of flora’ and hence probably incompatible.

Environmental Status

- Regional NRM Significance - Part of the ‘Beaufort Rivers Wetlands System North’ identified as an important wetland area (Pen 1997) but not specifically listed within SW Regional Strategy
- Supports a moderate number of waterbird species and is known to be an important wetland for black swans (Pen 1997).
- Main environmental values relate to floodplain, faunal populations, wildlife sanctuary, and habitat linkage (Pen 1997).
- “C” condition wetland - wetland connected to healthy bushland (Pen 1997).

Landscape geomorphology and lake morphology

- Moderate sized (223 ha) seasonal saline lake (Halse et al 1993).
- Part of a series of lakes, swamps and extensive floodplain along the broad floodway of the middle Beaufort River (Pen 1997).
- No obvious outlet point to provide opportunity for a detention structure
- Soil landscape – Norring 3 Subsystem – “Lakes and swamps with associated alluvial plains, small lunettes, dunes and swales on alluvial and aeolian deposits in the upper Blackwood River Catchment”.
- Monitoring data indicate 0 - 1.8 m depth range. (Lane et al 2011).

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 23000 ha
- Lake Surface Area – 223 ha
- Catchment Area / Lake Surface Area Ratio - 103
- Annual Rainfall – 461.7 mm
- Annual Evaporation – 1826 mm
- No clear outlet channel exists from the lake

Refer to Figure 2J for an aerial view of Lake Flagstaff, Figure 3J for a catchment plan and Figure 4J for access details.

2.10 Lake Kuender (K)

Location

- Planning Region - Wheatbelt

- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Lockhart)
- Shire - Lake Grace
- Nearest town, 19 km away, is Lake Grace with a population of 507 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Two Living Lakes Initiative Stage 1 On-line Survey Questionnaires completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 15km

Public Land – Vesting and Access

- Vesting - Within Reserve 18446 vested for 'Government Requirements'.
- Access – via Kulin – Lake Grace Road adjacent to western side of lake.

Environmental Status

- Regional NRM Significance – Not specifically assessed, but part of Lake Grace system which is Low overall (ranking 3 out of 5 for environmental values)
- Threatened Flora (within 1 km) - Priority Four - Poorly Known Taxa (1 record)
- Cultural Heritage Sites in vicinity – 28 records

Landscape geomorphology and lake morphology

- Moderate sized (approx 220 ha) seasonally dry saline playa lake
- No obvious outlet point to provide opportunity for a detention structure
- Soil landscape – Norring 3 Subsystem – "Lakes and swamps with associated alluvial plains, small lunettes, dunes and swales on alluvial and aeolian deposits in the upper Blackwood River Catchment".
- Bathymetry and Depth – No data

Hydrogeology

- Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.

Surface Hydrology

- Catchment Area – 35000 ha
- Lake Surface Area – 220 ha
- Catchment Area / Lake Surface Area Ratio - 159
- Annual Rainfall – 350.2 mm
- Annual Evaporation – 2096 mm
- No clear outlet channel exists from the lake

Refer to Figure 2K for an aerial view of Lake Kuender, Figure 3K for a catchment plan and Figure 4K for access details.

2.11 Lake Nallan (N)

Location

- Planning Region - Mid West
- NRM Region – Rangelands
- Catchment (sub-catchment) - Murchison (Sanford River)
- Shire - Cue
- Nearest town, 20 km away, is Cue with a population of 328 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified but Shire management plan in progress

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 806km
- Distance from other major drive routes: on from Route 95

Public Land – Vesting and Access

- Vesting - Appears to be within Unallocated Crown Land (UCL) or very broad road reserve but identified by Shire as within Reserve 20436 vested for ‘Parks and Recreation’.
- Access – via Great Northern Highway adjacent to western edge of lake.

Environmental Status

- Regional NRM Significance – High
- Threatened Flora (within 1 km) - Priority Four - Rare Taxa (1 record).

Landscape geomorphology and lake morphology

- Moderate sized (28 ha) seasonal lake.
- Bathymetry and Depth – No data.

Hydrogeology

- Located adjacent to a borefield in a calcrete aquifer that supplies fresh water to the town of Cue.

Surface Hydrology

- Catchment Area – 1700000 ha
- Lake Surface Area – 28 ha
- Catchment Area / Lake Surface Area Ratio - 60714
- Annual Rainfall – 232.7 mm
- Annual Evaporation – 3574 mm
- No clear outlet channel exists from the lake

Refer to Figure 2N for an aerial view of Lake Nallan, Figure 3N for a catchment plan and Figure 4N for access details.

2.12 Lake Norring (O)

Location

- Planning Region - Wheatbelt
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Upper) - Colbinine River System
- Shire - Wagin
- Nearest town, 20 km away, is Wagin with a population of 1,427 (2006).

Social, Recreational and Economic Importance

- Bird-watching, walking, hiking, cycling

Evidence of Community Support

- One Living Lakes Initiative Stage 1 On-line Survey Questionnaire completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 15km
- Distance from other major drive routes: 13km from Route 120

Public Land – Vesting and Access

- Vesting - Within Reserve 17253 vested in the Local Government Authority for ‘Recreation; Waterway’.
- Access - via North East Andrews Road (from the east), Watson Road (from the south) and either Pederick Road or Flagstaff Norring Road (from the west).

Environmental Status

- Regional NRM Significance - Part of the Wagin Lakes wetland system identified as an important wetland area (Pen 1997) and of regional significance (SWCC 2004)
- High numbers of waterfowl and important wetland for the Australasian shelduck (Pen 1997).
- Dl condition wetland – wetland / cleared lake surrounded by cleared land (Pen 1997).
- Generally valuable waterbird habitat despite salinization Pen 1997.
- Main environmental values relate to floodplain, faunal populations, wildlife sanctuary, and habitat linkage (Pen 1997).
- Cultural Heritage Sites in vicinity - 2 records

Landscape geomorphology and lake morphology

- Large (approx 700 ha) seasonal lake.
- Soil landscape – Norring 3 Subsystem – “Lakes and swamps with associated alluvial plains, small lunettes, dunes and swales on alluvial and aeolian deposits in the upper Blackwood River Catchment”.
- Very diffuse, if any, drainage outlet channels – although the lake is part of the Wagin Lakes wetland system within an extensive floodplain, discharging eventually into the Beaufort River.
- Bathymetry and Depth – No data.

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 7200 ha
- Lake Surface Area – 700 ha
- Catchment Area / Lake Surface Area Ratio - 10
- Annual Rainfall – 433.4 mm
- Annual Evaporation – 1873 mm
- No clear outlet channel exists from the lake.

Refer to Figure 2O for an aerial view of Lake Norring, Figure 3O for a catchment plan and Figure 4O for access details.

2.13 Lake Nunijup (P)

Location

- Planning Region - Great Southern
- NRM Region – South Coast
- Catchment (sub-catchment) - Kent (Bow River)
- Shire - Cranbrook
- Nearest town, 27 km away, is Cranbrook with a population of 280 (2006).
- Second nearest town, 41 km away, is Mt Barker with a population of 1761 (2006).

Social, Recreational and Economic Importance

- Skiing, swimming, BBQ facilities

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 161km
- Distance from other major drive routes: 14km from Route 30

Public Land – Vesting and Access

- Vesting - Within Reserve 1759 vested in the Local Government Authority for ‘Waterway’.
- Access - via unmade road or track off Stockyard Road and through Reserve 29175 which is vested with the Shire of Cranbrook for “Public Recreation’.

Environmental Status

- Assessed in a Wetlands Study for the Upper Kent Catchment (Green Skills 2003) as 'moderate' in terms of both Conservation and Management Priorities.
- Threatened Flora (within 1 km) - Declared Rare Flora - Extant Taxa (1 record); Priority Two - Poorly known taxa (1 record)

Landscape geomorphology and lake morphology

- Moderate sized (approx 76 ha) permanent lake with adjacent lunettes.
- Soil landscape – Kent system, Camballup subsystem wet Phase – "Lakes and swamps with lunettes on Tertiary alluvium, colluvium and sand with laterite, and quaternary lake and swamp deposits in the Frankland district".
- Bathymetry and Depth – No data

Hydrogeology

- Lake is located on the southern flank of the Stirling Range, where small supplies of fresh to brackish groundwater may be obtainable from alluvial sediments or weathered bedrock.

Surface Hydrology

- Catchment Area – 330 ha
- Lake Surface Area – 76 ha
- Catchment Area / Lake Surface Area Ratio - 4
- Annual Rainfall – 499.2 mm
- Annual Evaporation – 1651 mm
- No clear outlet channel exists from the lake.

Refer to Figure 2P for an aerial view of Lake Nunijup, Figure 3P for a catchment plan and Figure 4P for access details.

2.14 Lake Polaris (Q)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) – Avon (Yilgarn - Lake Julia)
- Shire - Yilgarn
- Nearest town, 1 km away, is Southern Cross with a population of 711 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire partially completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 371km
- Distance from other major drive routes: <5km from Route 94

Public Land – Vesting and Access

- Vesting - Mainly within 'Waterway'.
- Access – Nominated area is north of Great Eastern Highway from which access could be provided. Access also via Polaris Street (to the east) and both Canopus and Achernar Street s (to the west) with the latter passing through Reserve 9895 (vesting and purpose not yet known).

Environmental Status

- Regional NRM Significance - 'Low' overall (ranking of 3 out of 5 for environmental values) although nominated area is not actually part of Lake Polaris.
- Cultural Heritage Sites in vicinity - 1 record

Landscape geomorphology and lake morphology

- Seasonally waterlogged depression near a water filled mine void (proponent proposed water source).
- Soil landscape – Lake Deborah 1 system playa lake Phase – “Salt lakes”
- Bathymetry and Depth – No data.
- Nominated area is not actually part of Lake Polaris as shown within DEC’s Wetland Base, but is an obvious extension to it being part of a broad intermittent drainage pathway leading towards Lake Julia
- Possible use of existing roads to provide a detention structure for portion of wetland.

Hydrogeology

- Lake is located adjacent to an abandoned mine pit which is excavated to below the local water table, (a potential water source). This could be supplemented from other abandoned mine workings nearby.

Surface Hydrology

- Catchment Area – 460000 ha
- Lake Surface Area – 50 ha
- Catchment Area / Lake Surface Area Ratio - 9200
- Annual Rainfall – 306 mm
- Annual Evaporation – 2804 mm
- Nearby mine void (Fraser’s mine) proposed by nominating proponent as source of water.

Refer to Figure 2Q for an aerial view of Lake Polaris, Figure 3Q for a catchment plan and Figure 4Q for access details.

2.15 Lake Queerearrup (R)

Location

- Planning Region - Great Southern
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Upper) - Beaufort River System (Pen 1997)
- Shires - Woodanilling and Wagin
- Nearest town, 26 km away, is Woodanilling with a population of 399 (2006).
- Second nearest town, 29 km away, is Wagin with a population of 1427 (2006).

Social, Recreational and Economic Importance

- Some level of recreational use assumed

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 44km
- Distance from other major drive routes: 32km from routes 30 and 120

Public Land – Vesting and Access

- Vesting - Within Reserves 17255 and 29644 both vested in the Local Government Authority for ‘Recreation’.
- Access - via Queerearrup Road (to the south west).

Environmental Status

- Regional NRM Significance - Part of the ‘Beaufort River Wetlands System North’ identified as an important wetland area (Pen 1997) but not specifically listed within SW Regional Strategy
- Dl condition wetland - being a wetland / cleared lake surrounded by cleared land (Pen 1997).
- Main environmental values relate to floodplain, faunal populations, wildlife sanctuary, and habitat linkage (Pen 1997).

Landscape geomorphology and lake morphology

- Large (approx 430 ha) seasonal lake.
- Part of the Beaufort River - Wetlands System - North - a series of lakes , swamps and extensive floodplain along the broad floodway of the middle Beaufort River (Pen 1997).
- Soil landscape – Norring 3 Subsystem – “Lakes and swamps with associated alluvial plains, small lunettes, dunes and swales on alluvial and aeolian deposits in the upper Blackwood River Catchment”.
- Monitoring data indicate 0 – approx 3.1m depth range. (Lane et al 2011).

Hydrogeology

- Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 23000 ha
- Lake Surface Area – 430 ha
- Catchment Area / Lake Surface Area Ratio - 53
- Annual Rainfall – 461.7 mm
- Annual Evaporation – 1826 mm
- No clear outlet channel exists

Refer to Figure 2R for an aerial view of Lake Queerearrup, Figure 3R for a catchment plan and Figure 4R for access details.

2.16 Lake Towerrinning (T)

Location

- Planning Region - Wheatbelt
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Middle) within the extensive floodplain along the lower Arthur River.
- Shire - West Arthur
- Nearest town, 33 km away, is Darkan with a population of 203 (2006).

Social, Recreational and Economic Importance

- Bird-watching, canoeing/kayaking, caravanning/camping, horse-riding, picnicking, swimming, walking/hiking/cycling, water-skiing and windsurfing.

Evidence of Community Support

- Two Living Lakes Initiative Stage 1 On-line Survey Questionnaires completed
- Lake Towerrinning Strategic Management Plan (Shire of West Arthur 2008).

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 34km

Public Land – Vesting and Access

- Vesting - Within Reserve 24917 vested in Conservation Council of Western Australia for ‘Conservation of Fauna, Protection of Flora, Aquatic Sports’.
- Access - via Lake Towerrinning Road (to the south east).

Environmental Status

- Regional NRM Significance - Part of the ‘Arthur River Wetlands System’ identified as an important wetland area (Pen 1997) but not specifically listed within SW Regional Strategy
- Valuable waterbird habitat (Pen 1997).
- Main environmental values relate to uniqueness, floodplain, faunal populations, wildlife sanctuary, and habitat linkage (Pen 1997).

Landscape geomorphology and lake morphology

- Moderate sized (180 ha) brackish* permanent lake (Halse et al 1993).
- Soil landscape – Darkan 5 subsystem wet phase – “Swamps and lakes on alluvium over weathered granite or Eocene sediments in the Eastern Darling Range (Blackwood River Catchment) around Darkan”.
- Bathymetrically mapped during 1986 and long history of depth and water quality data (Cale et al 2004). Monitoring data indicate 0.5 - 3.8 m depth range. (Lane et al 2011).
  * Lake considered fresh until 1996, and in recent decades high water levels have reduced salinity and modifications to the outlet of the lake by the Department of Agriculture have further improved water quality by increasing lake volume and the potential for flushing (Cale et al 2004).

Hydrogeology

- Lake is located in the upper part of a major drainage line where a paleochannel may be present.

Surface Hydrology

- Catchment Area – 6000 ha
- Lake Surface Area – 179.5 ha
- Catchment Area / Lake Surface Area Ratio - 33
- Annual Rainfall – 550.4 mm
- Annual Evaporation – 1873 mm
- Some existing measures are in place to control water levels

Refer to Figure 2T for an aerial view of Lake Towerrinning, Figure 3T for a catchment plan and Figure 4T for access details.

2.17 Wagin Lake (U)

Location

- Planning Region - Wheatbelt
- NRM Region – South West
- Catchment (sub-catchment) - Blackwood (Upper) - Colbinine River System
- Shire - Wagin
- Nearest town, 2 km away, is Wagin with a population of 1,427 (2006).

Social, Recreational and Economic Importance

- Little current use

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 3km

Public Land – Vesting and Access

- Vesting - Wagin Lake is within Reserve 13279 vested in National Parks & Nature Conservation Authority for ‘Conservation; Fauna’.
- Access - via Andrews road (to the south east) or via Kunzell or King Streets (to the south west).

Environmental Status

- Regional NRM Significance - Part of the ‘Wagin Lakes wetland system’ identified as an important wetland area (Pen 1997) .
- Generally valuable waterbird habitat despite salinization Pen 1997.
- Main environmental values relate to floodplain, faunal populations, wildlife sanctuary, and habitat linkage (Pen 1997).
- Threatened Fauna (within 5 km)- 2 records for Mammals -Schedule 1 Fauna: Fauna that is rare or is likely to become extinct

Landscape geomorphology and lake morphology

- Moderate sized (50 ha) open seasonal lake (saline) - Halse et al 1993).

- Soil landscape – Norring 3 Subsystem – "Lakes and swamps with associated alluvial plains, small lunettes, dunes and swales on alluvial and aeolian deposits in the upper Blackwood River Catchment".
- Bathymetry and Depth – No data.

Hydrogeology

- Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.

Surface Hydrology

- Catchment Area – 2300 ha
- Lake Surface Area – 46 ha
- Catchment Area / Lake Surface Area Ratio - 50
- Annual Rainfall – 433.4 mm
- Annual Evaporation – 1873 mm
- No clear outlet channel exists.

Refer to Figure 2U for an aerial view of Wagin Lake, Figure 3U for a catchment plan and Figure 4U for access details.

2.18 Lake Yealering (W)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Main Avon)
- Shire - Wickepin
- Lake is less than 1km from Yealering with a population of 180 (2006).

Social, Recreational and Economic Importance

- Bird-watching, canoeing/kayaking, caravanning/camping, rowing, sailing, swimming, hiking, cycling, water-skiing, windsurfing, jet-skiing, barbecuing, with golf and water-skiing clubs nearby.

Evidence of Community Support

- One Living Lakes Initiative Stage 1 On-line Survey Questionnaire completed
- Department of Water (2006) *Upper Avon River Recovery Plan Section 20 – Yealering Lakes*

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 98km
- Distance from other major drive routes: 34km from Route 40

Public Land – Vesting and Access

- Vesting - Within Reserve 9610 vested in the Local Government Authority for 'Recreation; Waterway'
- Access – via Sewell Street (to the north).

Environmental Status

- Wetland of National Significance - Yealering is a component of the 775 ha 'Yealering Lakes System' that is listed under Directory of Important Wetlands (Environment Australia 2001).
- Regional NRM Significance – Moderate overall (with ranking 4 out of 5 for environmental values)

Landscape geomorphology and lake morphology

- Moderate sized (160 ha) permanent lake.
- Soil landscape – Coblinine 4 salt lake phase – "Salt lakes (and recently salinised freshwater lakes) within the Coblinine 4 Subsystem (an area of aeolian and lacustrine deposits and alluvium over granitic rocks in the southern wheatbelt".
- Part of connected sumplands located in a broad valley filled with alluvial (river derived) and lacustrian (lake derived) deposits ((Department of Water 2006).
- Monitoring data indicate 2.56 m maximum depth (Department of Water 2006).

Hydrogeology

- Lake is located in the upper reaches of an ancient drainage line where a paleochannel may be present. Such a paleochannel would have good prospects for providing saline groundwater.

Surface Hydrology

- Catchment Area – 2700 ha
- Lake Surface Area – 160 ha
- Catchment Area / Lake Surface Area Ratio - 17
- Annual Rainfall – 408 mm
- Annual Evaporation – 1896 mm
- A definite outflow channel exists, potentially suitable for regulation of flow.

Refer to Figure 2W for an aerial view of Lake Yealering, Figure 3W for a catchment plan and Figure 4W for access details.

2.19 Yenyening Lakes (X)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Salt River)
- Shires - Brookton and Beverley
- Nearest town, 31 km away, is Brookton with a population of 576 (2006).

Social, Recreational and Economic Importance

- Some recreational use evident.

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed

- Water and Rivers Commission (2003) *Yenyening Lakes Management Strategy 2002-2012* Water Resource Management Series 32 - and establishment of Yenyening Lakes Management Committee
- After clarification by proponent, it became clear that the two nominations referred to two separate lakes, one for what is tentatively understood to be locally referred to as 'Ski Lake' or 'West Lake' and accessed from the Shire of Beverley to the north, and the other for what is understood to be locally referred to as 'Ossigs Lake' or 'East Lake' and accessed from the Shire of Brookton to the south.

Tourism Potential

- Distance from Route 107 "Oceans to Outback" – 156km
- Distance from other major drive routes: 13km from Route 40

Public Land – Vesting and Access

- Vesting - Within Reserve 31837 vested in Conservation Council of Western Australia / Local Government Authority for 'Conservation of Fauna, Protection of Flora , Recreation'.
- Access – Ski Lake is accessed initially via Ski Road (to the north within Shire of Beverley) and then via an unmade road or track through private land.
- Ossig Lake is accessed via Blake Road (to the south within Shire of Brookton).

Environmental Status

- Environmental Status
- Regional NRM Significance – High overall (with ranking 4 out of 5 for environmental values)
- Cultural Heritage Sites in vicinity - 1 record

Landscape geomorphology and lake morphology

- Both lakes are part of an extensive system of moderate sized (< 120 ha each) saline seasonal lakes. (Halse et al 1993).

- Soil landscape – Wallambin system, Baandee salt lake phase – "Seasonally dry playa lakes on alluvial & aeolian deposits in the north-eastern wheatbelt"..

- A series of lakes within broad drainage floor (over a paleochannel) at junction of the zone of ancient drainage and the zone of rejuvenated drainage.

- Major lakes are separated by sandy rises, saline drainage floors and diffuse drainage lines.

- Water levels managed at Qualandary Crossing to maintain adequate water levels in the lakes for recreation and wildlife, while minimising back up of waters onto agricultural land, and ensuring the lakes continue to retain their natural function of flood detention.
- Beverley (Yenyening – Ski Lake) has been bathymetrically mapped by DEC during 2002/3 and monitoring data indicate 0 - 1.9 m depth range. (Lane et al 2011).

Hydrogeology

- Lakes are located on major ancient drainage lines. Very good prospects of groundwater availability.

Surface Hydrology

- Catchment Area – 13000 ha
- Lake(s) Surface Area – 75 ha (x 2)
- Catchment Area / Lake Surface Area Ratio - 173
- Annual Rainfall – 451.8 mm
- Annual Evaporation – 2004 mm
- Existing measures are in place to control discharges from the lakes system, at Qualandary Crossing.

Refer to Figure 2X for an aerial view of Yenyening Lakes, Figure 3X for a catchment plan and Figure 4X for access details.

2.20 Yornaning Dam (Y)

Location

- Planning Region - Wheatbelt
- NRM Region – South West
- Catchment (sub-catchment) - Murray (Hotham River)
- Shire - Cuballing
- Nearest town, 10 km away, is Cuballing with a population of 335 (2006).
- Second nearest town, 73km away, is Narrogin with a population of 4238 (2006).

Social, Recreational and Economic Importance

- Some level of recreational use assumed

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 76km
- Distance from other major drive routes: <5km from Route 120

Public Land – Vesting and Access

- Vesting - Within Reserve 5271 vested in Local Government Authority for ‘Recreation’.
- Access - via unsealed road off Yornaning Road and through Reserve 5271 which is vested in the Shire of Cuballing for ‘Recreation’.

Environmental Status

- No information of relevance identified

Landscape geomorphology and lake morphology

- Small permanent lake or reservoir formed by existing dam on Hotham River South Branch.
- Soil landscape – Dryandra system, Biberkine subsystem – “Valley floors and associated footslopes surrounded by gently undulating rises and low hills on alluvium and colluvium over granite, gneiss and occasionally dolerite in the zone of rejuvenated drainage, Murray River Catchment”.
- Bathymetry and Depth – No data.

Hydrogeology

- Yornaning Dam is on the south branch of the Hotham River, which is incised into Archaen igneous rocks with low aquifer potential.

Surface Hydrology

- Catchment Area – 55000 ha
- Lake Surface Area - 1.5 ha
- Catchment Area / Lake Surface Area Ratio - 36666
- Annual Rainfall - 512.4 mm
- Annual Evaporation – 1896 mm
- A significant dam wall currently exists at the site.

Refer to Figure 2Y for an aerial view of Yornaning Dam, Figure 3Y for a catchment plan and Figure 4Y for access details.

3. MULTIPLE CRITERIA ANALYSIS METHODOLOGY

Multicriteria Analysis (MCA), or Multiple Criteria Analysis, is a structured framework for investigating, analysing and resolving decision problems constrained by multiple objectives and criteria (Nijkamp et al. 1990). MCA is also known as a Planning Budget Sheet, Utility Value Analysis, Multiple-attribute Utility Analysis, Multi-objective Decision Support System, or Multicriteria Decision Modelling. Essentially all these names have the same meaning. It is used to appraise a discrete (individually separate) number of options against a set of criteria. In its basic form, an MCA model is comprised of a set of options for comparison, a set of evaluative criteria, a set of weights indicating the importance of those criteria, and a set of impact measures indicating how each option scores against each criterion. The MCA modelling framework is constrained by current knowledge, and can only be seen as providing indicative results to inform, rather than replace, the expert judgements of decision-makers. A brief description of MCA is provided below. For more information on the theory and processes of MCA, readers are referred to Hajkowicz et al. (2000).

The specific processes used to conduct MCA depends on the individual application, but can be summarised in a number of stages. These stages may be conducted sequentially or simultaneously. The decision stages are also highly iterative, with early stages being continually revisited as more information is generated in later stages. Belton and Vickers (1990) propose a cyclical process, emphasising that an MCA never 'finishes' with a correct solution but continually evolves as further information is generated. In prioritising lakes for enhancement under the ‘Living Lakes’ Plan, seven stages in the process can be highlighted.

Stage 1: Define the objectives and criteria - An objective is a statement relating to what decision-makers seek to achieve in a particular circumstance. The overarching objective can be subdivided into a hierarchy of sub-objectives. A criterion is a performance indicator that shows the extent to which sub-objectives can be achieved, and are placed at the 'fingertips' of the objectives hierarchy. The overarching objective, criteria and sub-criteria for this project are described in Section 4.

Stage 2: Assign weights to the criteria - These weights reflect the relative importance of each criterion to stakeholder groups, giving relatively important criteria a greater impact on the outcomes than relatively less important criteria. Ideally, weights should be derived through close interaction between the stakeholders and decision analysts. Where resources and time constraints exist, semi-hypothetical qualitative priority weightings are made. Criteria weights are defined in this report by the proponents (JDA Consultant Hydrologists) in collaboration with the stakeholder (RDL), and are presented in Section 5.

Stage 3: Identify the different options - These are a discrete set of options that represent the different choices available to the decision-maker. A standard MCA involves ranking these options in terms of how well they achieve the overarching objective, using the criteria as performance indicators. For this project, the options are the 25 lakes that were nominated by the community to RDL in 2010 through the public nomination process (and later reduced to 20 lakes due to 5 withdrawals). These different options (lakes) were described in Section 2.

Stage 4: Obtain impact measures - An impact measure is an assessment of an option's performance against a criterion. Impact measures may be qualitative or quantitative and can be obtained from existing

datasets, predictive models or expert judgements. The impact measures for this project have been elicited through a combination of scientific research, survey processes and expert judgement. These impact measures are presented in Section 6.

Stage 5: Create an effects table - Once the list of criteria and options has been created, and impact measures and weights have been estimated, the basic model for an MCA can be presented in an effects table. An example of the format for a standard MCA is presented in Table 2. It shows *m* number of criteria ($c_j=1, c_j=2, c_j=3, \ldots, c_j=m$), *m* number of weights ($w_j=1, w_j=2,, w_j=3, \ldots, w_j=m$), and *n* number of options ($o_i=1, o_i=2,, o_i=3, \ldots, o_i=n$). The $x_{i,j}$ values are measures that represent the impact of the *i*th option on the *j*th criterion. These measures can be expressed in different units although they may need to be standardised to common units depending on the particular methodology used. The effects table for this report is presented in a separate Excel Workbook.

Table 2: Standard model format of a multicriteria analysis

Criteria	Weights	Options				
		o_1	o_2	o_3	...	o_n
c_1	w_1	$x_{1,1}$	$X_{2,1}$	$X_{3,1}$	...	$X_{n,1}$
c_2	w_2	$X_{1,2}$	$X_{2,2}$	$X_{3,2}$	...	$X_{n,2}$
c_3	w_3	$X_{1,3}$	$X_{2,3}$	$x_{3,3}$	...	$X_{n,3}$
⋮	⋮	⋮	⋮	⋮		⋮
c_m	w_m	$X_{1,m}$	$X_{2,m}$	$X_{3,m}$	...	$X_{n,m}$

Stage 6: Rank the alternatives - There are many available algorithms that can be applied in order to rank the options against the criteria. These algorithms make use of the impact measures and the criteria weights to obtain an overall impact score for each option. The particular algorithm selected for an analysis depends on whether impact measures are qualitative or quantitative, and on decision-maker preferences. One of the most commonly applied techniques, the technique used here, is weighted summation. Weighted summation involves multiplying the impact measures by the weights, and then summing all the weighted impact measures for each option, to obtain an overall impact score as follows:

$$v_i = \sum_{j=1}^{m} s_{ij}.w_j \qquad (1)$$

where: v_i = the impact score of the *i*th option relative to the other options,

s_{ij} = the standardised value of x_{ij} (the impact measure for the *i*th option against the *j*th criterion), and

w_j = the weight of the *j*th criterion.

All the options can then be ranked, with the option corresponding to the highest impact score receiving a ranking of 1, and the option corresponding to the lowest impact score receiving the lowest ranking (e.g. if there are 20 options, the option corresponding to the lowest impact score receives a ranking of 20). The outcome of the ranking process for this report is presented in Section 7.

Stage 7: Perform sensitivity analysis - Weights and/or impact measures in the model are systematically varied to see how they impact on the overall ranking of the alternatives. This can help

account for uncertainty associated with weights and impact measures. A sensitivity analysis on the impact of the criteria weights on the ranking process is presented in Section 7.

4. LAKE SELECTION CRITERIA

The overarching objective of this MCA is to prioritise 20 community-nominated lakes in southern Western Australia in order of largest to smallest expected gain in social, recreational and economic opportunities for regional communities from enhancement to permanent and accessible water bodies.

To satisfy this overarching objective, it is assumed that expected gains from enhancement of the nominated lakes should:

a. have an impact on wheatbelt communities or regions immediately surrounding it (Criterion 1),

b. be easily accessible to rural populations (Criteria 2, 4 and 5),

c. provide significant social, recreational and economic opportunities (Criteria 3 and 6),

d. have strong community support (Criterion 7),

e. not have wetland environmental status that might preclude lake enhancement (Criterion 8),

f. have tourism potential (Criterion 3 and 9),

g. have sufficient water resources available to enhance water levels (Criteria 10 and 11), and

h. have suitable landscape geomorphology and lake morphology (Criterion 12).

A list of criteria with a range of associated impact measures that are used to assess each lake against this objective is provided in Table 3. The impact of lake enhancement on some criteria need to be measured in more than one way. Hence, some of the criteria have been subdivided into a number of sub-criteria. This does not mean that some criteria are more important than others. It does mean that there are a number of aspects to the criterion that need to be measured separately. Each sub-criterion is given an individual weight (see the following section) to make sure that criteria that are measured in a number of sub-criteria are not given undue weight in the MCA.

It should also be noted that in relation to size of the lake or wetland, this factor influences two of the selection criteria, but in separate ways. Firstly, the size of the lake or wetland influences Criteria 3i (social, recreational and/or economic importance) with a positive correlation between importance of the lake and increasing lake size. However in relation to its influence on Criteria 12iii (suitable landscape geomorphology and lake morphology) the practicality of water level enhancement is considered, and there is a negative correlation between the ability to maintain or increase water levels and increasing lake size.

The ratings for each lake are qualitative ratings of 0 to 4 for all criteria. A rating of 4 indicates a strong positive impact. A rating of 0 indicates no change to current conditions. A lake will be excluded altogether from the MCA if it scores a particular outcome for a sub-criterion. For example, lakes within 20km of other lakes with significant and similar opportunities will be excluded from the ranking. Additionally, some options do not include the full ratings range of 0 to 4. For example, for Criterion 1 "Lake is in the wheatbelt or regions immediately surrounding", each lake is either given a rating of 4 if it satisfies the criteria, or it is excluded from the MCA.

All scores are tabulated together later in the report, under Section 7 – Outcome of Selection Process. See Table 25.

Table 3: List of criteria used to prioritise lakes

Criterion #	Criteria	Sub-criterion #	Sub-criterion description	Rating Scale
1	Lake is in the wheatbelt or regions immediately surrounding	*1i*	Lake is in the wheatbelt or regions immediately surrounding	4 = located in the wheatbelt or regions immediately surrounding *Lakes not within the wheatbelt or regions immediately surrounding it are excluded.*
2	Lake is within 50km of a town with a population of at least 50 people	*2i*	Distance from a town with a population of at least 50 people	4 = 0 - 5km of a town of at least 50 people 2 = 6 - 30km from a town of at least 50 people 1 = 31 - 50km from a town of at least 50 people 0 = > 50km from a town of at least 50 people
3	Lake is of social, recreational and/or economic importance	*3i*	Size of the lake (A large lake is considered better for social/recreational uses)	4 = >300ha when full 3 = 100 – 299ha when full 2 = 10 – 99ha when full 1 = <10ha when full
		3ii	Expected improvement of social and recreational activities available at the lake	4 = significant improvement 3 = 2 = moderate improvement 1 = 0 = no improvement
		3iii	Expected improvement in business opportunities related to the lake	4 = significant improvement 3 = 2 = moderate improvement 1 = 0 = no improvement

Table 3. Continued

Criterion #	Criteria	Sub-criterion #	Sub-criterion description	Rating Scale
3 (continued)	Lake is of social, recreational and/or economic importance	*3iv*	Expected improvement in current and potential future events to be held at the lake	4 = significant improvement 3 = 2 = moderate improvement 1 = 0 = no improvement
		3v	Distance to other lakes with continuous high social, recreational and economic opportunities	4 = greater than 100km from another significant lake 3 = 70 - 100km from another significant lake 2 = 40 - 69km from another significant lake 1 = 20 - 39km from another significant lake *Lakes within 20km of other lakes with significant and similar opportunities are excluded.*
		3vi	Proximity to other significant tourist, social and recreational opportunities	4 = Significant opportunities within a 50km radius 3 = 2 = Moderate opportunities within a 50km radius 1 = 0 = No significant opportunities within a 50km radius

Table 3. Continued

Criterion #	Criteria	Sub-criterion #	Sub-criterion description	Rating Scale
4	Lake is primarily contained on public land	*4i*	The lake has appropriate vesting and purpose for active recreational use	4 = Lake is fully contained within public land where the vesting purpose is directly compatible with active recreational use of the waterbody (i.e. designated for 'Recreation' or similar, and all of the lake is likely to be usable). 3 = Lake is fully or predominantly contained within public land where the vesting purpose is possibly compatible with active recreational use of the waterbody (i.e. designated purpose does not include 'recreation' or similar but it is not overtly incompatible such as a 'Conservation' designation). 2 = Lake is predominantly contained within public land and the vesting purpose for part of the area is incompatible with active recreational use of the waterbody (i.e. part designated for 'Conservation' or similar, but part of the lake might be usable). 1 = Lake is fully contained within public land where the vesting purpose is incompatible with active recreational use of the waterbody (i.e. all of the area is designated for 'Conservation' or similar, and all of the lake likely to be unusable). 0 = Less than 50% of wetland area is contained within public land.
5	Lake is in an area with existing road or crown land access	*5i*	Adjoining access land has appropriate vesting and purpose for recreational use facilities	4 = Direct access via existing made road to the area of crown land containing the wetland/lake. 3 = Indirect access via existing made road to adjoining crown land where the vesting purpose is compatible with recreational use facilities. 2 = Indirect access via existing made road to adjoining crown land where the vesting purpose is possibly compatible with recreational use facilities. 1 = Indirect access via existing made road to adjoining crown land where the vesting purpose is incompatible with recreational use facilities. 0 = Access is via existing track or unmade road through private land.
6	Lake is of a natural depth at full capacity that allows social or recreational use	*6i*	Maximum recorded lake depth (metres). (Based on available data: if no data available score = 1)	4 = > 3m 3 = 1.5 – 3m 2 = 1 – 1.5m 1 = <1.0m or unknown

Table 3. Continued

Criterion #	Criteria	Sub-criterion #	Sub-criterion description	Rating Scale
7	Lake is in an area where there are indications of community support for the development of the lake	*7i*	Lake is in an area where there are indications of high community support for the development of the lake	4 = one or more surveys completed and significant studies conducted with consideration of active recreational use 3 = one or more survey completed and significant studies conducted without consideration of active recreational use 2 = one or more surveys completed or significant studies conducted with consideration of active recreational use 1 = one survey partially completed or significant studies conducted without consideration of active recreational use 0 = a survey was not completed and no significant studies available
8	Wetland environmental status does not exclude lake (water level) enhancement	*8i*	Recognition of listings of environmental significance	4 = Wetland, and areas in proximity, have no significant designated environmental status 3 = Areas in proximity contain some threatened ecological communities, or important flora, fauna or cultural sites, but the wetland is not designated to be of either regional or national importance (*default rating where data not yet available*). 2 = Wetland is designated to be of regional environmental significance within relevant Regional NRM (Natural Resource Management) Strategy, but is not of national significance. 1 = Wetland (or group to which it belongs) is designated to be of national significance within the Directory of Important Wetlands in Australia but its vesting purpose allows active recreational uses. 0 = Wetland (or group to which it belongs) is designated to be of national significance within the Directory of Important Wetlands in Australia and its vesting purpose is incompatible with active recreational use.
9	Tourism potential	*9i* *(Subcriteria 3iv-vi are also related to tourism)*	Potential for numbers of tourists to visit the enhanced site for social or recreational purposes (*tentative ratings kindly provided by Tourism WA*)	4 = very high tourism potential 3 = high tourism potential 2 = moderate tourism potential 1 = minor tourism potential 0 = very low tourism potential

Table 3. Continued

Criterion #	Criteria	Sub-criterion #	Sub-criterion description	Rating Scale
10	Groundwater resources potential to fill part/all of lake	*10i*	Sufficient groundwater resources to allow social and recreational use	4 = Probably major groundwater resource in near vicinity 2 = Possible major groundwater resource in near vicinity 1 = Possible minor groundwater resource in near vicinity 0 = No significant groundwater resource evident in vicinity
11	Surface water potential resources to fill part/all of lake	*11i*	Some surplus exists of rainfall over evaporation (based on rainfall and evaporation data for nearest Bureau of Meteorology station, usually at nearest town)	4 = Rainfall surplus over evaporation for 3 or more months of the year 3 = Rainfall surplus over evaporation for 2 months of the year 1 = Rainfall surplus over evaporation for 1 month of the year 0 = No reliable rainfall surplus over evaporation
		11ii	A suitable water course may exist nearby for potential diversion of surface water runoff	4 = A perennial stream exists within 2km of the lake 3 = A perennial stream may exist within 2 – 5 km of the lake 2 = An ephemeral stream may exist within 2km of the lake 1 = An ephemeral stream may exist within 2-5km of the lake 0 = No suitable stream exists nearby, or indeterminable

Table 3. Continued

Criterion #	Criteria	Sub-criterion #	Sub-criterion description	Rating Scale
12	Suitable landscape geomorphology and lake morphology	*12i*	Presence of an outlet channel (to possibly assist water level enhancement through containment i.e. installing a dam, bund or weir).	4 = Existing well defined outlet channel (may or may not already contain structural works) 3 = Outlet areas less defined but lake forms part of a chain which connects during flood events 2 = Outlet areas not able to be determined yet but lake apparently forms part of a chain which connects during flood events 1 = No discernible outlet –with wetland acting as sump
		12ii	Water permanence (affecting ability to maintain or increase water levels throughout the year)	4 = Permanent lake 3 = Semi-permanent lake (i.e. significant portion dries out seasonally) 2 = Seasonal (non-perennial or ephemeral lake/wetland area)
		12iii	Size of lake/wetland (affecting relative amount of water required to maintain or increase water levels and surface coverage) with rating scale based on consideration of descriptors and corresponding areas used in various data source publications including Pen (1997), Halse et al (1993) and South West Catchments Council; (2001)).	4 = Small lake/wetland (<20ha) 3 = Moderate lake/wetland (20 - 250ha) 2 = Large lake/wetland (250 - 1000ha) 0 = Very large lake/wetland (>1000ha)

5. CRITERIA WEIGHTING

Criteria weightings reflect the relative merit of each sub-criteria to the overarching objective. In this report, all sub-criteria weights add up to 100%. The standard criteria weights are presented in Table 4 below, and have been decided via judgements by the proponents (JDA Consulting Hydrologists) in collaboration with the stakeholder (RDL). The standard set of weights assumes equal weighting for each criteria (where sub-criteria are given equal proportions of the criteria weight). For example, Criterion 3 has six sub-criteria, with each sub-criteria given a weighting of “100 / 12 / 6 = 1.4”. As these weights are subjective measures, a sensitivity analysis is conducted in Section 7 to test the sensitivity of the ranking process to these weights.

Table 4: Criteria weights

Criterion number	Criterion	Sub-criterion number	Sub-criterion description	Sub-criterion weighting (Number between 1 and 100)	Criteria weighting (sum of sub-criterion weights for that criteria)
1	Lake is in the wheatbelt or regions immediately surrounding	*1i*	The lake is located within the core 'wheatbelt' target area in relation to planning and regional NRM areas	8.3	8.3
2	Lake is within 50km of a town with a population of at least 50 people	*2i*	Distance from a town with a population of at least 50 people	8.3	8.3
3	Lake is of continuous social, recreational and/or economic importance	*3i*	Size of the lake	1.4	8.3
		3ii	Expected improvement of social and recreational activities available at the lake	1.4	
		3iii	Expected improvement in business opportunities related to the lake	1.4	
		3iv	Expected improvement in current and potential future events to be held at the lake	1.4	
		3v	Distance to other lakes with high social, recreational and economic opportunities	1.4	
		3vi	Proximity to other significant tourist, social and recreational opportunities	1.4	
4	Lake is primarily contained on public land	*4i*	The lake has appropriate vesting and purpose for active recreational use	8.3	8.3
5	Lake is in an area with existing road or crown land access	*5i*	Adjoining access land has appropriate vesting and purpose for recreational use facilities	8.3	8.3
6	Lake is of a natural depth at full capacity that allows social or recreational use	*6i*	Maximum recorded lake depth (metres)	8.3	8.3

Table 4. Continued

Criterion number	Criterion	Sub-criterion number	Sub-criterion description	Sub-criterion weighting (Number between 1 and 100)	Criteria weighting (sum of sub-criterion weights for that criteria)
7	Lake is in an area where there are indications of community support for the development of the lake	*7i*	Lake is in an area where there are indications of high community support for the development of the lake	8.3	8.3
8	Wetland environmental status does not exclude lake enhancement	*8i*	Recognition of listings of environmental significance	8.3	8.3
9	Tourism potential	*9i*	Potential for numbers of tourists to visit the enhanced site for social or recreational purposes (tentative ratings kindly provided by Tourism WA)	8.3	8.3
10	Groundwater resources potential to fill part/all of lake	*10i*	Sufficient groundwater resources to allow social and recreational use	8.3	8.3
11	Surface water potential resources to fill part/all of lake	*11i*	Some surplus exists of rainfall over evaporation	4.2	8.3
		11ii	A suitable water course may exist nearby for potential diversion of surface water runoff	4.2	
12	Suitable landscape geomorphology and lake morphology	*12i*	Presence of an outlet channel	2.8	8.3
		12ii	Water permanence	2.8	
		12iii	Size of lake/wetland	2.8	
			Total:	**100**	**100**

6. LAKE PERFORMANCE AGAINST CRITERIA

The performance of each lake against each of the criteria is presented in this section. Each criterion is presented separately, with the performance of all lakes presented within the same table.

6.1 Criterion 1: Lake is in the wheatbelt or regions immediately surrounding

All lakes are assessed to be in the wheatbelt or regions immediately surrounding it, and are given a rating of 4.

Table 5: Ratings for Criterion 1

Map ID	Nominated Lake	Region	Shire	Criterion Rating
A	Austin	Mid West	Cue	4
B	Baandee	Wheatbelt	Kellerberrin	4
C	Blackwood River	South West	Boyup Brook	4
D	Brown	Wheatbelt	Nungarin	4
E	Bryde	Great Southern	Kent	4
F	Cairlocup	Great Southern	Kent	4
H	Dumbleyung Lake	Wheatbelt	Dumbleyung	4
I	Ewlyamartup	Great Southern	Katanning	4
J	Flagstaff	Great Southern	Woodanilling	4
K	Kuender	Wheatbelt	Lake Grace	4
N	Nallan	Mid West	Cue	4
O	Norring	Wheatbelt	Wagin	4
P	Nunijup	Great Southern	Cranbrook	4
Q	Polaris	Wheatbelt	Yilgarn	4
R	Queerearrup	Great Southern	Woodanilling	4
T	Towerrinning	Wheatbelt	West Arthur	4
U	Wagin Lakes	Wheatbelt	Wagin	4
W	Yealering	Wheatbelt	Wickepin	4
X	Yenyening	Wheatbelt	Brookton	4
Y	Yornaning Dam	Wheatbelt	Cuballing	4

6.2 Criterion 2: Lake is within 50km of a town with a population of at least 50 people

Each lake is given a rating of 0, 1, 2 or 4 according to the following scale:

4 = 0 - 5km of a town of at least 50 people

2 = 6 - 30km from a town of at least 50 people

1 = 31 - 50km from a town of at least 50 people

0 = > 50km from a town of at least 50 people

Table 6: Ratings for Criterion 2

Map ID	Nominated Lake	Nearest Township	Town Population[1]	Distance to Town by road (km)[2]	Criterion rating
W	Yealering	Yealering	180	0	4
Q	Polaris	Southern Cross	711	1	4
U	Wagin Lakes	Wagin	1,427	2	4
H	Dumbleyung Lake	Dumbleyung	223	7	2
B	Baandee	Doodlakine	191	8	2
C	Blackwood River	Boyup Brook	532	10	2
Y	Yornaning Dam	Cuballing	335	10	2
I	Ewlyamartup	Katanning	3,808	17	2
K	Kuender	Lake Grace	507	19	2
N	Nallan	Cue	328	20	2
O	Norring	Wagin	1,427	20	2
A	Austin	Cue	328	21	2
J	Flagstaff	Woodanilling	399	21	2
D	Brown	Nungarin	142	22	2
R	Queerearrup	Woodanilling	399	26	2
P	Nunijup	Cranbrook	280	27	2
X	Yenyening	Brookton	576	31	1
T	Towerrinning	Darkan	203	33	1
F	Cairlocup	Jerramungup	367	42	1
E	Bryde	Newdegate	441	44	1

References:

1. *Population = ABS census 2006 via Wikipedia*
2. *Road distances as calculated by whereis.com*

6.3 Criterion 3: Lake is of social, recreational and/or economic importance

This criterion is measured through six sub-criterion. Each lake's performance against each of these sub-criterion is described below.

Sub-criterion 3i: Size of lake

Each lake is given a rating of 1, 2, 3 or 4 according to the following scale:

4 = >300ha when full

3 = 100 – 299ha when full

2 = 10ha – 99ha when full

1 = <10ha when full

Table 7: Ratings for Criterion 3i

Map ID	Nominated Lake	Nearest Township	Surface area of lake when full (ha)[1]	Criterion rating
A	Austin	Cue	98,000	4
H	Dumbleyung Lake	Dumbleyung	5,560	4
D	Brown	Nungarin	3,700	4
X	Yenyening	Brookton	760	4
O	Norring	Wagin	700	4
R	Queerearrup	Woodanilling	430	4
F	Cairlocup	Jerramungup	340	4
B	Baandee	Doodlakine	250	3
J	Flagstaff	Woodanilling	223	3
K	Kuender	Lake Grace	220	3
T	Towerrinning	Darkan	180	3
W	Yealering	Yealering	160	3
I	Ewlyamartup	Katanning	88	2
P	Nunijup	Cranbrook	76	2
E	Bryde	Newdegate	68	2
Q	Polaris	Southern Cross	52	2
U	Wagin Lakes	Wagin	46	2
N	Nallan	Cue	28	2
Y	Yornaning Dam	Cuballing	2	1
C	Blackwood River	Boyup Brook	n/a (river)	1

1. *Methodology:*
   - *Identify the lake boundary (when full) from aerial photograph imagery (Google maps).*
   - *Manually copy this lake boundary onto ArcGIS hydrology layers to produce a closed polygon.*
   - *Use ArcGIS to determine the surface area of the polygon in hectares (ha).*

Sub-criterion 3ii: Expected improvement of social and recreational activities available at the lake

Each lake is given a rating of 0 - 4 according to the following scale:

4 = significant improvement

3 = moderate to significant improvement

2 = moderate improvement

1 = small improvement

0 = no improvement

Table 8: Ratings for Criterion 3ii

Map ID	Nominated Lake	Expected improvement of social and recreational activities available at the lake	Criterion rating
D	Brown	Little current use	4
I	Ewlyamartup	Can no longer water-ski since water levels dropped	4
K	Kuender	Significant improvements to bird-watching, canoeing, kayaking, rowing, sailing, water-skiing, windsurfing	4
N	Nallan	Little current use	4
U	Wagin Lakes	Little current use	4
E	Bryde	Some level of recreational use assumed	3
F	Cairlocup	Some level of recreational use assumed	3
H	Dumbleyung Lake	Facilities available but unused due to low water levels. Historically, when water levels were high, social and rec use was high.	3
O	Norring	Currently only used for hiking and bird-watching. Significant improvements in canoeing, kayaking, caravan/camping, rowing and sailing	3
X	Yenyening	Some water skiing occurs when seasons permit	3
A	Austin	Little current use	2
B	Baandee	Already some use, although can generally not water ski	2
C	Blackwood River	Survey indicated moderate improvement	2
J	Flagstaff	Survey indicated moderate improvement	2
P	Nunijup	Some level of recreational use assumed	2
Q	Polaris	Survey indicated moderate improvement	2
R	Queerearrup	Some level of recreational use assumed	2
T	Towerrinning	Survey indicated moderate improvement	2
W	Yealering	Already significant social and recreational use of the lake	2
Y	Yornaning Dam	Assumed to have some rec use and may be too small for significant use of boats	1

References: Living Lakes Initiative Stage 1 On-line Survey information, expert judgement

Sub-criterion 3iii: Expected improvement in business opportunities related to the lake

Each lake is given a rating of 0 - 4 according to the following scale:

4 = significant improvement

3 = moderate to significant improvement

2 = moderate improvement

1 = small improvement

0 = no improvement

Table 9: Ratings for Criterion 3iii

Map ID	Nominated Lake	Criterion rating
U	Wagin Lakes	4
D	Brown	3
H	Dumbleyung Lake	3
B	Baandee	2
C	Blackwood River	2
E	Bryde	2
I	Ewlyamartup	2
P	Nunijup	2
W	Yealering	2
X	Yenyening	2
Y	Yornaning Dam	2
A	Austin	1
F	Cairlocup	1
J	Flagstaff	1
K	Kuender	1
N	Nallan	1
O	Norring	1
Q	Polaris	1
R	Queerearrup	1
T	Towerrinning	1

References: Living Lakes Initiative Stage 1 On-line Survey information, expert judgement

Sub-criterion 3iv: Expected improvement in current and potential future events to be held at the lake

Each lake is given a rating of 0 - 4 according to the following scale:

4 = significant improvement

3 = moderate to significant improvement

2 = moderate improvement

1 = small improvement

0 = no improvement

Table 10: Ratings for Criterion 3iv

Map ID	Nominated Lake	Criterion rating
C	Blackwood River	4
H	Dumbleyung Lake	4
I	Ewlyamartup	4
U	Wagin Lakes	4
W	Yealering	4
B	Baandee	3
E	Bryde	3
K	Kuender	3
T	Towerrinning	3
A	Austin	2
D	Brown	2
F	Cairlocup	2
J	Flagstaff	2
N	Nallan	2
O	Norring	2
P	Nunijup	2
R	Queerearrup	2
X	Yenyening	2
Q	Polaris	1
Y	Yornaning Dam	1

References: Living Lakes Initiative Stage 1 On-line Survey information, expert judgement

Sub-criterion 3v: Distance to other lakes with high social, recreational and economic opportunities

Each lake is given a rating of 1 to 4 according to the following scale:

4 = greater than 100km from another significant lake

3 = 70 – 100km from another significant lake

2 = 40 – 69km from another significant lake

1 = 20 – 39km from another significant lake

Table 11: Ratings for Criterion 3v

Map ID	Nominated Lake	Distance to other lakes with high social, recreational and economic opportunities	Criterion rating
A	Austin	No significant lake nearby	4
B	Baandee	Non-recreational lakes: Shackleton Lakes, Cowcowing Lakes, Lake Wallambin	4
D	Brown	Non-recreational lakes: Lake Wallambin, Cowcowing Lakes, Lake Balandgie	4
E	Bryde	No significant lake nearby	4
F	Cairlocup	No significant lake nearby	4
I	Ewlyamartup	Travel 200km to water ski	4
N	Nallan	No significant lake nearby	4
Q	Polaris	No significant lake nearby	4
T	Towerrinning	Ewlyamartup 70km (also Norring)	3
Y	Yornaning Dam	Yealering 70km	3
C	Blackwood River	Cowan Dam 50km	2
H	Dumbleyung Lake	Norring 45km, Queerearrup 50km	2
K	Kuender	Lake Jilakin 40km	2
O	Norring	Lake Dumbleyung 45km	2
P	Nunijup	Lake Unicup 50km	2
R	Queerearrup	Lake Dumbleyung 50km	2
W	Yealering	Kondinin Lake 40km	2
X	Yenyening	Lake Mears 30km	2
J	Flagstaff	Queerearrup <5km	1
U	Wagin Lakes	Parkeyerring Lake <10km	1

References: Living Lakes Initiative Stage 1 On-line Survey information, expert judgement

Sub-criterion 3vi: Proximity to other significant tourist, social and recreational opportunities

Each lake is given a rating of 0 - 4 according to the following scale:

4 = significant opportunities within a 50km radius
3 = mod to significant opportunities within 50km
2 = moderate opportunities within a 50km radius
1 = small opportunities within a 50km radius
0 = no significant opportunities within a 50km radius

Table 12: Ratings for Criterion 3vi

Map ID	Nominated Lake	Proximity to other significant tourist, social and recreational opportunities	Criterion rating
C	Blackwood River	Blackwood River Park, Bridgetown Old Goal and Police Quarters, Greenbushes Loop, Bridgetown Jarrah Park, The Four Aces, wineries, olive and olive oil producers, tulip farm, Country Music Centres, Roo Gully Sanctuary.	4
J	Flagstaff	The Kodja Place, Kojonup Military Barracks, Piesse Memorial Statue, Wagin Historical Village, Giant Ram Tourist Park, Kojonup Rose Maze, Elverd Cottage, attractions at Wagin, Kojonup, Katanning	4
O	Norring	The Kodja Place, Kojonup Military Barracks, Piesse Memorial Statue, Wagin Historical Village, Giant Ram Tourist Park, Kojonup Rose Maze, Elverd Cottage, attractions at Wagin, Kojonup, Katanning	4
P	Nunijup	Wineries around Mt Barker, Mt Barker Hill Lookout, Banksia Farm Enterprises, St Werburgh's Chapel, attractions at Mt barker	4
R	Queerearrup	The Kodja Place, Kojonup Military Barracks, Piesse Memorial Statue, Wagin Historical Village, Giant Ram Tourist Park, Kojonup Rose Maze, Elverd Cottage, attractions at Wagin, Kojonup, Katanning	4
W	Yealering	Albert Facey House, Corrigin Dog Cemetery, Gorge Rock, Kulin Bush Races, attractions at Narrogin, Wickepin, Corrigin	4
Y	Yornaning Dam	Dryandra Woodland, Barna Mia (animal sanctuary), Albert Facey Homestead, Narrogin Old Courthouse Museum, attractions at Narrogin, Wickepin, Pingelly, Williams	4
U	Wagin Lakes	The Williams Woolshed, Dumbleyung Lake, Giant Ram Tourist Park, attractions at Williams, Wagin and Katanning	3
B	Baandee	Totadgin Dam Reserve, Kokerbin Rock, Hunts Well, attractions at Merredin, Kellerberrin, Tammin and Bruce Rock	2
D	Brown	Mangowine Homestead, Talgomine Reserve, attractions at Merredin and Mukinbudin	2
H	Dumbleyung Lake	Wagin Historical Village, Giant Ram Tourist Park, Katanning Historical Museum, attractions at Dumbleyung, Wagin, Katanning	2
T	Towerrinning	Kojonup Military Barracks, Kojonup Rose Maze, Elverd Cottage, other attractions at Kojonup	2
X	Yenyening	Avondale Discovery Farm, Mt Dale Walk Trail, Gwambygine Park, attractions at Beverly, Brookton, Pingelly, Quairading	2
A	Austin	The Granites, attractions at Mount Magnet and Cue	1
E	Bryde	Australian Inland Mission Hospital, Lake Grace Lookout, attractions at Lake Grace and Newdegate	1
F	Cairlocup	Yongergnow Australian Malleefowl Centre, attractions at Pingrup, Ongerup, Jerramungup	1
I	Ewlyamartup	Katanning Historical Museum, Piesse Memorial Statue, attractions at Katanning	1
K	Kuender	Australian Inland Mission Hospital, Lake Grace Lookout, Kulin Bush Races, Attractions at Kulin and Lake Grace	1
N	Nallan	Big Bell Ghost Town, Walga Rock, the Rotunda, attractions at Cue	1
Q	Polaris	Yilgarn History Museum, Mt Palmer, Golden Valley, attractions at Southern Cross	1

References: Living Lakes Initiative Stage 1 On-line Survey information, Tourism WA website

6.4 Criterion 4: Lake is primarily contained on public land

Each lake is given a rating of 0 to 4 according to the vesting and purpose as follows:

4 = Lake is fully contained within public land where the vesting purpose is directly compatible with active recreational use of the waterbody (i.e. designated for 'Recreation' or similar, and all of the lake is likely to be usable).

3 = Lake is fully or predominantly contained within public land where the vesting purpose is possibly compatible with active recreational use of the waterbody (i.e. designated purpose does not include 'recreation' or similar but it is not overtly incompatible such as a 'Conservation' designation).

2 = Lake is predominantly contained within public land and the vesting purpose for part of the area is incompatible with active recreational use of the waterbody (i.e. part designated for 'Conservation' or similar, but part of the lake might be usable).

1 = Lake is fully contained within public land where the vesting purpose is incompatible with active recreational use of the waterbody (i.e. all of the area is designated for 'Conservation' or similar, and all of the lake likely to be unusable).

0 = Less than 50% of wetland area is contained within public land.

Table 13: Ratings for Criterion 4

Map ID	Nominated Lake	Criterion rating
B	Baandee	4
I	Ewlyamartup	4
O	Norring	4
R	Queerearrup	4
T	Towerrinning	4
W	Yealering	4
Y	Yornaning Dam	4
C	Blackwood River	3
J	Flagstaff	3
K	Kuender	3
N	Nallan	3
P	Nunijup	3
Q	Polaris	3
H	Dumbleyung Lake	2
X	Yenyening	2
D	Brown	1
E	Bryde	1
F	Cairlocup	1
U	Wagin Lakes	1
A	Austin	0

References: 1. Landgate's MapViewer - on-line information relating to land tenure and aerial images.
2. DEC (2009). WetlandBase (an online State wetlands database). [www.dec.wa.gov.au/management-and-protection/wetlands/wetlandbase/view-wetlandbase-online]. - relating to land tenure and purpose for reserves containing or adjacent to wetlands.

6.5 Criterion 5 : Lake is in an area with existing road or crown land access

Each lake is given a rating of 0 to 4 according to the status of the adjoining access land's vesting and purpose as follows:

4 = Direct access via existing made road to the area of crown land containing the wetland/lake.

3 = Indirect access via existing made road to adjoining crown land where the vesting purpose is compatible with recreational use facilities.

2 = Indirect access via existing made road to adjoining crown land where the vesting purpose is possibly compatible with recreational use facilities.

1 = Indirect access via existing made road to adjoining crown land where the vesting purpose is incompatible with recreational use facilities.

0 = Access is via existing track or unmade road through private land.

Table 14: Ratings for Criterion 5

Map ID	Nominated Lake	Criterion rating
A	Austin	4
B	Baandee	4
C	Blackwood River	4
D	Brown	4
H	Dumbleyung Lake	4
I	Ewlyamartup	4
J	Flagstaff	4
K	Kuender	4
N	Nallan	4
O	Norring	4
Q	Polaris	4
R	Queerearrup	4
T	Towerrinning	4
U	Wagin Lakes	4
W	Yealering	4
Y	Yornaning Dam	4
P	Nunijup	3
X	Yenyening	2
E	Bryde	1
F	Cairlocup	1

References: Landgate's MapViewer - on-line information relating to land tenure and aerial images.

6.6 Criterion 6 : Lake is of a natural depth at full capacity that allows social or recreational use

Each lake is given a rating of 1 to 4 according to the following scale:

4 = Recorded maximum depth is > 3 metres

3 = Recorded maximum depth is 1.5 – 3 metres

2 = Recorded maximum depth is 1 – 1.5 metres

1 = Recorded maximum depth is <1.0 metre, or no data available

Table 15: Ratings for Criterion 6

Map ID	Nominated Lake	Criterion rating
H	Dumbleyung Lake[1]	4
R	Queerearrup[2]	4
T	Towerrinning[3]	4
E	Bryde[4]	3
J	Flagstaff[5]	3
W	Yealering[6]	3
X	Yenyening[7]	3
Y	Yornaning Dam[+]	3
O	Norring[#]	3
I	Ewlyamartup[#]	2
A	Austin[^]	1
B	Baandee[#]	1
C	Blackwood River[^]	1
D	Brown[^]	1
F	Cairlocup[8]	1
K	Kuender[^]	1
N	Nallan[^]	1
P	Nunijup[^]	1
Q	Polaris[^]	1
U	Wagin Lakes[^]	1

References:

1. *Bathymetrically mapped by DEC during 1998/01 and monitoring data indicate 0 – 4.5 m depth range (Lane et al 2011).*
2. *Monitoring data indicate 0 – approx 3.1m depth range. (Lane et al 2011).*
3. *Bathymetrically mapped during 1986 and long history of depth and water quality data (Cale et al 2004). Monitoring data indicate 0.5 - 3.8 m depth range. (Lane et al 2011).*
4. *Bathymetrically mapped by DEC during 2002 (Lane et al 2011)*
5. *Monitoring data indicate 0 - 1.8 m depth range. (Lane et al 2011).*
6. *Monitoring data indicate 2.56 m maximum depth (Department of Water 2006).*
7. *Beverley (Yenyening – Ski Lake) has been bathymetrically mapped by DEC during 2002/3 and monitoring data indicate 0 - 1.9 m depth range. (Lane et al 2011).*
8. *Monitoring data indicate 0 - 0.8 m depth range. (Lane et al 2011).*

 # Living Lakes Initiative Stage 1 On-line Survey information (2011) - depths not confirmed.

+ Constructed reservoir. Depth estimated to be ~ 3m

^ No information available

6.7 Criterion 7: Lake is in an area where there are indications of community support for development of the lake

Each lake is given a rating of 0 - 4 according to the following considerations.

4 = one or more surveys completed and significant studies conducted with consideration of active recreational use
3 = one or more survey completed and significant studies conducted without consideration of active recreational use
2 = one or more surveys completed or significant studies conducted with consideration of active recreational use
1 = one survey partially completed or significant studies conducted without consideration of active recreational use
0 = a survey was not completed and no significant studies available

Table 16: Ratings for Criterion 7

Map ID	Nominated Lake	Criterion rating
I	Ewlyamartup	4
T	Towerrinning	4
W	Yealering	4
X	Yenyening	4
E	Bryde	3
A	Austin	2
B	Baandee	2
C	Blackwood River	2
D	Brown	2
F	Cairlocup	2
H	Dumbleyung Lake	2
J	Flagstaff	2
K	Kuender	2
N	Nallan	2
O	Norring	2
P	Nunijup	2
Q	Polaris	2
R	Queerearrup	2
U	Wagin Lakes	2
Y	Yornaning Dam	2

References: Living Lakes Initiative Stage 1 On-line Survey Questionnaire Results and available reports:

- *Water and Rivers Commission (2003)*
- *Department of Water (2006)*
- *Katanning LCDC (2010)*
- *Shire of West Arthur (2008)*
- *Department of Environment and Conservation (2010)*

6.8 Criterion 8: Wetland environmental status does not exclude lake enhancement

Each lake is given a rating of 0 to 4 depending on the listings of environmental significance, as follows:

4 = Wetland, and area in proximity, has no significant designated environmental status

3 = Areas in proximity contain some threatened ecological communities, or important flora, fauna or cultural sites, but the wetland is not designated to be of either regional or national importance (default rating where data not yet available).

2 = Wetland is designated to be of regional environmental significance within relevant Regional NRM (Natural Resource Management) Strategy, but is not of national significance.

1 = Wetland (or group to which it belongs) is designated to be of national significance within the Directory of Important Wetlands in Australia but its vesting purpose allows active recreational uses.

0 = Wetland (or group to which it belongs) is designated to be of national significance within the Directory of Important Wetlands in Australia and its vesting purpose is incompatible with active recreational use.

Table 17: Ratings for Criterion 8

Map ID	Nominated Lake	Criterion rating
C	Blackwood River	3
J	Flagstaff	3
K	Kuender	3
P	Nunijup	3
Q	Polaris	3
Y	Yornaning Dam	3
A	Austin	2
B	Baandee	2
D	Brown	2
F	Cairlocup	2
I	Ewlyamartup	2
N	Nallan	2
O	Norring	2
R	Queerearrup	2
T	Towerrinning	2
U	Wagin Lakes	2
X	Yenyening	2
H	Dumbleyung Lake	1
W	Yealering	1
E	Bryde	0

References: Avon Water Assets, Cale et al. (2004), DEC (2009), Environment Australia (2001), Green Skills (2003), Grein (1995), Halse et al. (1993), Lane et al (2011), Pen (1997), South West Catchments Council (2001) and South West Catchments Council (2004).

6.9 Criterion 9: Tourism potential

Some aspects of tourism potential are covered in Criterion 3iv – vi (expected improvement in current and potential future events to be held at the lake, distance to other lakes with high social, recreational and economic opportunities, and proximity to other significant tourist, social and recreational opportunities). An additional tourism potential is included here as independently provided by Tourism WA. Lakes have been rated as follows:

4 = very high tourism potential

3 = high tourism potential

2 = moderate tourism potential

1 = minor tourism potential

0 = very low tourism potential

This was a high level assessment only. In light of this, Tourism WA "strongly recommend further analysis be done before any infrastructure investment is made based on this from a tourism development perspective" (*pers.com.* Hewitt, J. (email 10/10/2011) Tourism WA).

Table 18: Ratings for Criterion 9

Map ID	Nominated Lake	Criterion rating
T	Towerrinning	4
C	Blackwood River	3
H	Dumbleyung Lake	3
I	Ewlyamartup	3
N	Nallan	3
Y	Yornaning Dam	3
O	Norring	2
R	Queerearrup	2
W	Yealering	2
X	Yenyening	2
E	Bryde	1
A	Austin	0
B	Baandee	0
D	Brown	0
F	Cairlocup	0
J	Flagstaff	0
K	Kuender	0
P	Nunijup	0
Q	Polaris	0
U	Wagin Lakes	0

Reference: Tourism WA

6.10 Criterion 10: Groundwater resources potential to fill part or all of lake

Each lake is given a rating of 0 - 4 according to the following scale:

4 = Probably major groundwater resource in near vicinity

3 = Possible major groundwater resource in near vicinity

1 = Possible minor groundwater resource in near vicinity

0 = No significant groundwater resource evident in vicinity

Table 19: Ratings for Criterion 10

Map ID	Nominated Lake	Groundwater potential based on catchment area and nearby aquifer resources	Criterion rating
A	Austin	Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.	4
B	Baandee	Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.	4
D	Brown	Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.	4
E	Bryde	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
F	Cairlocup	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
H	Dumbleyung Lake	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
I	Ewlyamartup	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
J	Flagstaff	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
K	Kuender	Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.	4
N	Nallan	Located adjacent to a borefield in a calcrete aquifer that supplies fresh water to the town of Cue.	4
O	Norring	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
Q	Polaris	Lake is located adjacent to an abandoned mine pit which is excavated to below the local water table. This could be supplemented from other abandoned mine workings nearby.	4

Map ID	Nominated Lake	Groundwater potential based on catchment area and nearby aquifer resources	Criterion rating
R	Queerearrup	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
U	Wagin Lakes	Lake is located on major ancient drainage lines. Large supplies of saline to hypersaline water should be available from sand aquifers at the base of paleochannels, at depths from 80m to 120m.	4
X	Yenyening	Lake is located on major ancient drainage lines. Very good prospects of groundwater availability.	4
W	Yealering	Lake is located in the upper reaches of an ancient drainage line where a paleochannel may be present. Such a paleochannel would have good prospects for providing saline groundwater.	3
P	Nunijup	Lake is located on the southern flank of the Stirling Range, where small supplies of fresh to brackish groundwater may be obtainable from alluvial sediments or weathered bedrock.	1
T	Towerrinning	Lake is located in the upper part of a major drainage line where a paleochannel may be present.	1
C	Blackwood River	The Blackwood River crossing at Terry's Road is located in a valley incised into Archaen igneous and metamorphic rocks with low permeability and storage potential.	0
Y	Yornaning Dam	Yornaning Dam is on the south branch of the Hotham River, which is incised into Archaen igneous rocks with low aquifer potential.	0

Reference: Bureau of Mineral Resources, Geology and Geophysics (1970) Geological Map Series,1:250 000, expert judgement

6.11 Criterion 11: Surface water potential resources to fill part or all of lake

This criterion is measured through two sub-criteria. Each lake's performance against these sub-criteria is described below.

Sub-criterion 11i: Some surplus exists in the region of rainfall over evaporation

Each lake is given a rating of 0, 1, 3 or 4 according to the following scale:

4 = Rainfall surplus over evaporation for 3 or more months of the year

3 = Rainfall surplus over evaporation for 2 months of the year

1 = Rainfall surplus over evaporation for 1 month of the year

0 = No reliable rainfall surplus over evaporation

Table 20: Ratings for Criterion 11i

Map ID	Nominated Lake	No. Months of Rainfall (average) Surplus (compared to Evaporation)	Criterion rating
P	Nunijup	4	4
Y	Yornaning Dam	4	4
C	Blackwood River	3	4
T	Towerrinning	3	4
H	Dumbleyung Lake	2	3
I	Ewlyamartup	2	3
J	Flagstaff	2	3
O	Norring	2	3
R	Queerearrup	2	3
U	Wagin Lakes	2	3
W	Yealering	2	3
X	Yenyening	2	3
A	Austin	0	0
B	Baandee	0	0
D	Brown	0	0
E	Bryde	0	0
F	Cairlocup	0	0
K	Kuender	0	0
N	Nallan	0	0
Q	Polaris	0	0

References: www.bom.gov.au

Sub-criterion 11ii: A suitable water course may exist nearby for potential diversion of surface water runoff

Each lake is given a rating of 0 to 4 according to the following scale:

4 = A perennial stream exists within 2km of the lake

3 = A perennial stream may exist within 2 – 5 km of the lake

2 = An ephemeral stream may exist within 2km of the lake

1 = An ephemeral stream may exist within 2 – 5 km of the lake

0 = No suitable stream exists nearby, or indeterminable.

Table 21: Ratings for Criterion 11ii

Map ID	Nominated Lake	Criterion rating
C	Blackwood River	4
H	Dumbleyung Lake	2
I	Ewlyamartup	2
K	Kuender	2
O	Norring	2
T	Towerrinning	2
B	Baandee	1
D	Brown	1
E	Bryde	1
F	Cairlocup	1
J	Flagstaff	1
P	Nunijup	1
R	Queerearrup	1
W	Yealering	1
X	Yenyening	1
Y	Yornaning Dam	1
A	Austin	0
N	Nallan	0
Q	Polaris	0
U	Wagin Lakes	0

Note1: This initial assessment has been performed as a desktop study only.
Additional research may need to be undertaken after short-listing of lakes is complete.
References: www.maps.google.com.au

6.12 Criterion 12: Suitable landscape geomorphology and lake morphology

This criterion is measured through three sub-criteria. Each lake's performance against these sub-criteria is described below.

Sub-criterion 12i: Presence of an outlet channel (to possibly assist water level enhancement through containment i.e. installing a dam, bund or weir)

Each lake is given a rating of 1 to 4 according to the following scale:

4 = Existing well defined outlet channel (may or may not already contain structural works)
3 = Outlet areas less defined but lake forms part of a chain which connects during flood events
2 = Outlet areas not able to be determined yet but lake apparently forms part of a chain which connects during flood events
1 = No discernible outlet – with wetland acting as sump

Table 22: Ratings for Criterion 12i

Map ID	Nominated Lake	Criterion rating
B	Baandee	4
C	Blackwood River	4
F	Cairlocup	4
H	Dumbleyung Lake	4
Q	Polaris	4
R	Queerearrup	4
T	Towerrinning	4
W	Yealering	4
X	Yenyening	4
Y	Yornaning Dam	4
D	Brown	3
I	Ewlyamartup	2
O	Norring	2
A	Austin	1
E	Bryde	1
J	Flagstaff	1
K	Kuender	1
N	Nallan	1
P	Nunijup	1
U	Wagin Lakes	1

References: Aerial Imagery via Landgate / DAFWA SLIP (Shared Land Information Platform)

Sub-criterion 12ii: Water permanence (affecting ability to maintain or increase water levels throughout the year)

Each lake is given a rating of 2, 3 or 4 according to the following scale:

4 = Permanent lake

3 = Semi - permanent lake (i.e. significant portion dries out seasonally)

2 = Seasonal (non- perennial or ephemeral lake / wetland area).

Table 23: Ratings for Criterion 12ii

Map ID	Nominated Lake	Criterion rating
B	Baandee	4
C	Blackwood River	4
I	Ewlyamartup	4
P	Nunijup	4
T	Towerrinning	4
W	Yealering	4
Y	Yornaning Dam	4
H	Dumbleyung Lake	3
A	Austin	2
D	Brown	2
E	Bryde	2
F	Cairlocup	2
J	Flagstaff	2
K	Kuender	2
N	Nallan	2
O	Norring	2
Q	Polaris	2
R	Queerearrup	2
U	Wagin Lakes	2
X	Yenyening	2

References: DEC (2009), Lane et al. (2011), Cale et al. (2004), Halse et al. (1993, and aerial imagery via Landgate / DAFWA SLIP (Shared Land Information Platform) NRM (Natural Resource Management) interface; http://spatial.agric.wa.gov.au/slip/.

Sub-criterion 12iii: Size of lake / wetland (affecting relative amount of water required to maintain or increase water levels and surface coverage)

Each lake is given a rating of 0, 2, 3 or 4 according to the following scale:

4 = Small lake/ wetland (< 20 ha)

3 = Moderate lake/ wetland (20 – 250 ha)

2 = Large lake/ wetland (250 - 1000 ha)

0 = Very large lake/ wetland (< 1000 ha)

Table 24: Ratings for Criterion 12iii

Map ID	Nominated Lake	Criterion rating
C	Blackwood River	4
Q	Polaris	4
Y	Yornaning Dam	4
E	Bryde	3
I	Ewlyamartup	3
J	Flagstaff	3
K	Kuender	3
N	Nallan	3
P	Nunijup	3
T	Towerrinning	3
U	Wagin Lakes	3
W	Yealering	3
X	Yenyening	3
B	Baandee	2
F	Cairlocup	2
O	Norring	2
R	Queerearrup	2
A	Austin	0
D	Brown	0
H	Dumbleyung Lake	0

References: DEC (2009), Lane et al. (2011), Cale et al. (2004), Halse et al. (1993, and aerial imagery via Landgate / DAFWA SLIP (Shared Land Information Platform) NRM (Natural Resource Management) interface; http://spatial.agric.wa.gov.au/slip/.

7. OUTCOME OF SELECTION PROCESS

7.1 Multiple Criteria Analysis Effects

The impact measures for all lakes against all criteria are presented in Table 25 (overpage).

This set of scores is based on each of the 12 criteria being assigned equal weighting, as specified previously in Section 5 (at Table 4),

Table 25: Effects table showing impact measures for each lake against each criterion, criteria weights, impact scores and lake rankings

	Sub-criteria	Criterion weight (%)	A Austin	B Bakerdale	C Blackwood River	D Brown	E Bryde	F Carlocup	H Dumbleyung	I Ewlyamartup	J Flaptail	K Kumnder	N Nallan	O Norring	P Nunijup	Q Polaris	R Queenarup	T Towerining	U Wagin Lakes	W Yealering	X Yenyening	Y Yornaning Dam
1i	Lake is in the wheatbelt or regions immediately surrounding	8.3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2i	Distance from a town with a population of at least 50 people	8.3	2	2	2	2	1	1	2	2	2	2	2	2	2	4	2	1	4	4	1	2
3i	Size of the lake	1.4	4	3	1	4	2	4	4	2	3	3	2	4	2	2	4	3	2	3	4	1
3ii	Expected improvement of social and recreational activities available at the lake	1.4	2	2	2	4	3	3	3	4	2	4	4	3	2	2	2	2	4	2	3	1
3iii	Expected improvement in business opportunities related to the lake	1.4	1	2	2	3	2	1	3	2	1	1	1	1	2	1	1	1	4	2	2	2
3iv	Expected improvement in current and potential future events to be held at the lake	1.4	2	3	4	2	3	2	4	4	2	3	2	2	2	1	2	3	4	4	2	1
3v	Distance to other lakes with high social, recreational and economic opportunities	1.4	4	4	2	4	4	4	2	4	1	2	4	2	2	4	2	3	1	2	2	3
3vi	Proximity to other significant tourist, social and recreational opportunities	1.4	1	2	4	2	1	1	2	1	4	1	1	4	4	1	4	2	3	4	2	4
4i	The lake has appropriate vesting and purpose for active recreational use	8.3	0	4	3	1	1	1	2	4	3	3	3	4	3	3	4	4	1	4	2	4
5i	Adjoining access land has appropriate vesting and purpose for recreational use facilities	8.3	4	4	4	4	1	1	4	4	4	4	4	4	3	4	4	4	4	4	2	4
6i	Recorded maximum depth (m)	8.3	1	1	1	1	3	1	4	2	3	1	1	3	1	1	4	4	1	3	3	3
7i	Lake is in an area where there are indications of high community support for the development of the lake	8.3	0	2	2	0	1	0	3	4	0	2	0	2	0	1	0	4	0	4	2	0
8i	Recognition of listings of environmental significance	8.3	2	2	3	2	0	2	1	2	3	3	2	2	3	3	2	2	2	1	2	3
9i	Potential for numbers of tourists to visit the enhanced site for social or recreational purposes (per Tourism WA)	8.3	0	0	3	0	1	0	3	3	0	0	3	2	0	0	2	4	0	2	2	3
10i	Sufficient groundwater resources to allow social and recreational use	8.3	4	4	0	4	4	4	4	4	4	4	4	4	1	4	4	1	4	3	4	0
11i	Some surplus exists of rainfall over evaporation	4.2	0	0	4	0	0	0	3	3	3	0	0	3	4	0	3	4	3	3	3	4
11ii	A suitable water course may exist nearby for potential diversion of surface water runoff	4.2	0	1	4	1	1	1	2	2	1	2	0	2	1	0	1	2	0	1	1	1
12i	Presence of an outlet channel	2.8	1	4	4	3	1	4	4	2	1	1	1	2	1	4	4	4	1	4	4	4
12ii	Water permanence	2.8	2	4	4	2	2	2	3	4	2	2	2	2	4	2	2	4	2	4	2	4
12iii	Size of lake/wetland	2.8	0	2	4	0	3	2	0	3	3	3	3	2	3	4	2	3	3	3	3	4
	Weighted summed score		169	246	271	194	175	164	290	311	243	236	228	285	204	243	276	308	221	313	246	263
	Ranking		19	9	7	17	18	20	4	2	12	13	14	5	16	11	6	3	15	1	9	8

All lakes have been ranked using the procedure known as the weighted summation approach. For each lake, the impact measures are multiplied by the criterion weights, and summed for all criteria. The overall impact score obtained for each lake is then ranked, with the highest impact score receiving a ranking of 1, and the lowest impact score receiving a ranking of 20. Table 26 shows each lake sorted by highest ranking, and their associated impact score. This score is meaningless as an absolute number but can be used to compare across scores for other lakes (for example, to determine how close the second ranked lake scored compared with the first).

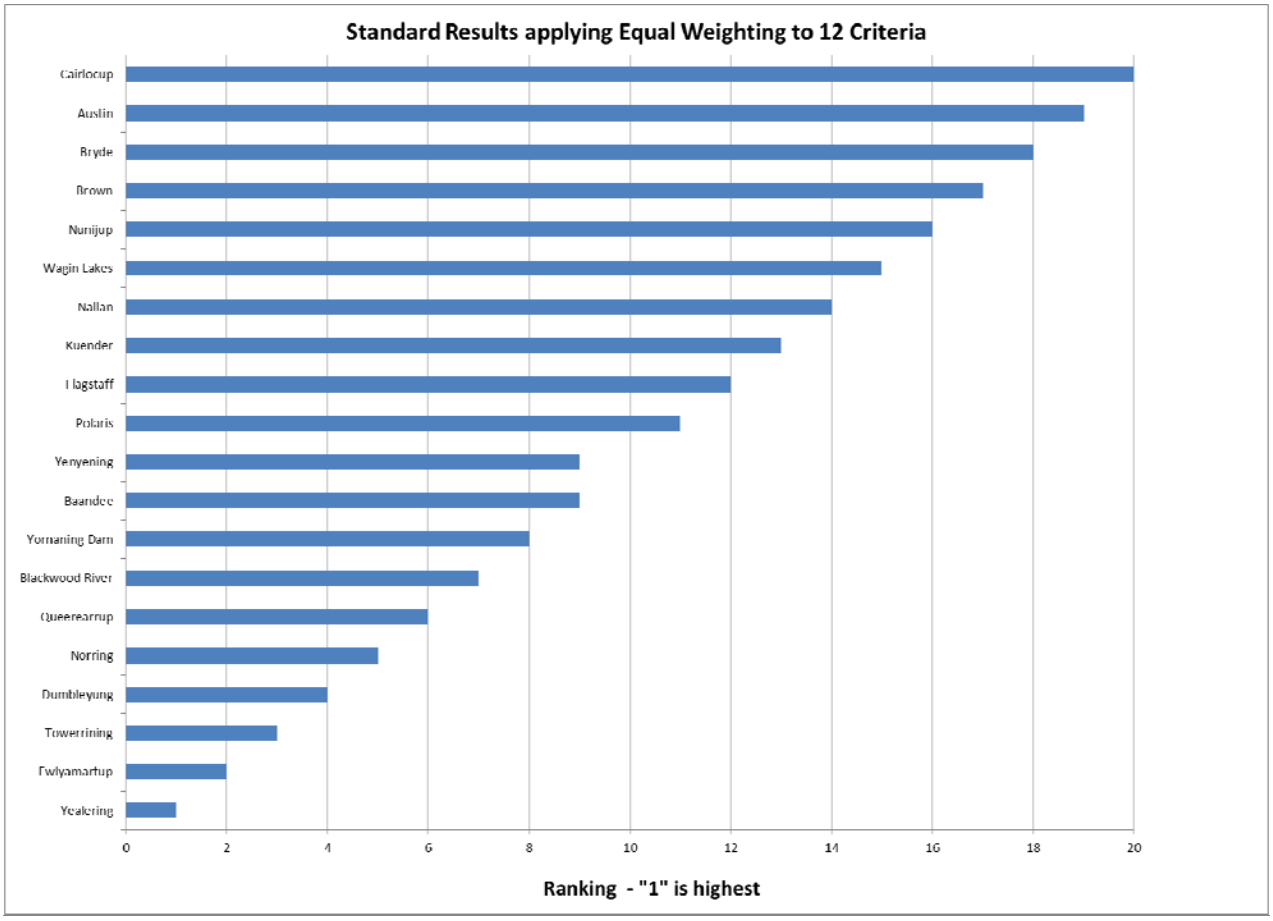
This ranking provides an indication of the relative benefits of the project. It is acknowledged that each of the lakes will have different enhancement capital costs and that the ranking based on benefits per dollar of capital costs should be considered when selecting a lake for enhancement from a short-listed set of lakes.

Table 26: Ranking of lakes using standard criteria weightings

Ranking	Lake	Score
1	Yealering	313
2	Ewlyamartup	311
3	Towerrinning	308
4	Dumbleyung	290
5	Norring	285
6	Queerearrup	276
7	Blackwood River	271
8	Yornaning Dam	263
9	Baandee	246
10	Yenyening	246
11	Polaris	243
12	Flagstaff	243
13	Kuender	236
14	Nallan	228
15	Wagin Lakes	221
16	Nunijup	204
17	Brown	194
18	Bryde	175
19	Austin	169
20	Cairlocup	164

Results are also presented graphically below.

Figure 5: Ranking of lakes using standard criteria weightings



Lake Yealering ranks highest at number 1, followed very closely by Ewlyamartup and Towerrinning.

Lake Cairlocup ranks lowest at number 20.

7.2 Ratification of Results

To test the robustness of this lake rating, a suite of sensitivity analyses have been conducted on alternative criteria weights. These include :

- SENSITIVITY ANALYSIS 1: Assign equal Weighting to all 20 Sub-criteria
- SENSITIVITY ANALYSIS 3: Assign 30% Weight to Social, Econ, Rec Importance
- SENSITIVITY ANALYSIS 4 & 5: Assign 30% Weight to Vesting & Lake Accessibility
- SENSITIVITY ANALYSIS 7: Assign 30% Weight to High Community Support
- SENSITIVITY ANALYSIS 8: Assign 30% Weight to Environmental Status
- SENSITIVITY ANALYSIS 9: Assign 30% Weight to Tourism Potential
- SENSITIVITY ANALYSIS 10 & 11: Assign 30% Weight to Water Availability
- SENSITIVITY ANALYSIS 12: Assign 30% Weight to Suitable Lake Morphology

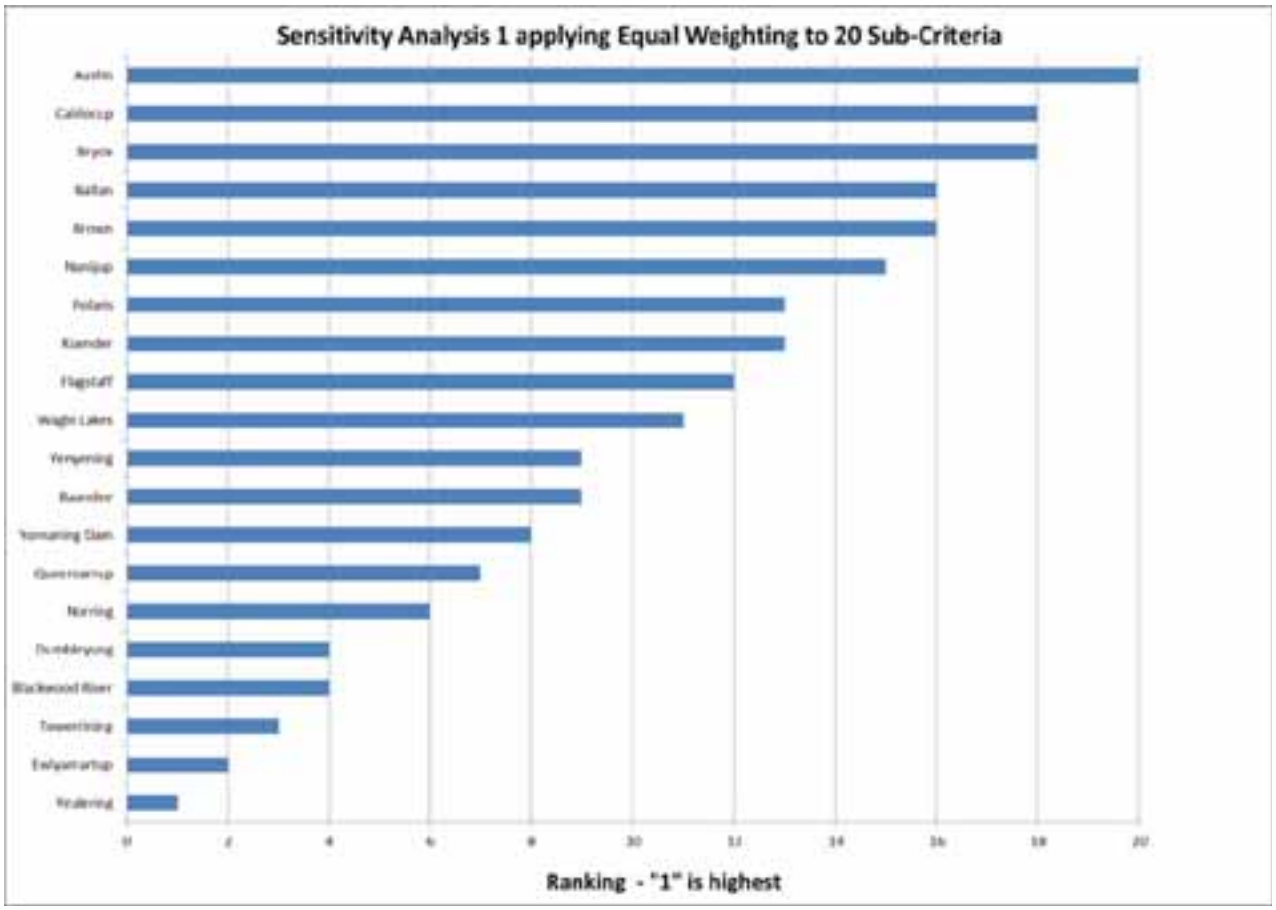
In each case, where 30% has been assigned to one criterion, the remainder (70%) is divided equally amongst the remaining sub-criteria.

Note that:

- *SENSITIVITY ANALYSIS 2 was not performed as it is not considered relevant to this process. (All lakes satisfy the fundamental requirement for location and proximity to townships).*
- *Similarly, SENSITIVITY ANALYSIS 6 is not considered relevant as it relates only to depth of water.*

Referring to Figure 2, Sensitivity Analysis 1 assigns equal Weighting to all 20 Sub-criteria.
This produces a set of results very similar to the Standard Criteria Weightings, with Lake Yealering ranking first, followed by Ewlyamartup and Towerrinning.

Figure 6: Sensitivity Analysis 1 applying Equal Weighting to 20 Sub-Criteria



The distribution of all Sensitivity Analyses weights is presented in Tables 28 and 29.
Results appear at the bottom of each table. These are reproduced graphically at Figure 4.

Table 27: Sensitivity Analyses 1 to 7

Sub-criterion number	Sub-criterion description	Equal Weighting on all 20 Sub-criteria SENSITIVITY ANALYSIS 1: Sub-criterion weighting	Criteria weighting	30% Weight on Social, Econ, Rec Importance SENSITIVITY ANALYSIS 3: Sub-criterion weighting	Criteria weighting	30% Weight on Vesting & Lake Accessibility SENSITIVITY ANALYSIS 4 & 5: Sub-criterion weighting	Criteria weighting	30% Weight on High Community Support SENSITIVITY ANALYSIS 7: Sub-criterion weighting	Criteria weighting
1i	Lake is in the wheatbelt or regions immediately surrounding	5.0	5.0	6.4	6.4	7.0	7.0	6.4	6.4
2i	Distance from a town with a population of at least 50 people	5.0	5.0	6.4	6.4	7.0	7.0	6.4	6.4
3i	Size of the lake	5.0	30.0	5.0	30.0	1.2	7.0	1.1	6.4
3ii	Expected improvement of social and recreational activities available at the lake	5.0		5.0		1.2		1.1	
3iii	Expected improvement in business opportunities related to the lake	5.0		5.0		1.2		1.1	
3iv	Expected improvement in current and potential future events to be held at the lake	5.0		5.0		1.2		1.1	
3v	Distance to other lakes with high social, recreational and economic opportunities	5.0		5.0		1.2		1.1	
3vi	Proximity to other significant tourist, cultural and recreational opportunities	5.0		5.0		1.2		1.1	
4i	The lake has appropriate vesting and purpose for active recreational use	5.0	5.0	6.4	6.4	15.0	15.0	6.4	6.4
5i	Adjoining access land has appropriate vesting and purpose for recreational use facilities	5.0	5.0	6.4	6.4	15.0	15.0	6.4	6.4
6i	Recorded maximum depth (m)	5.0	5.0	6.4	6.4	7.0	7.0	6.4	6.4
7i	Lake is in an area where there are indications of high community support for the development of the lake	5.0	5.0	6.4	6.4	7.0	7.0	30.2	30.0
8i	Recognition of listings of environmental significance	5.0	5.0	6.4	6.4	7.0	7.0	6.4	6.4
9i	Potential for numbers of tourists to visit the enhanced site for social or recreational purposes (per Tourism WA)	5.0	5.0	6.4	6.4	7.0	7.0	6.4	6.4
10i	Sufficient groundwater resources to allow social and recreational use	5.0	5.0	6.4	6.4	7.0	7.0	6.4	6.4
11i	Some surplus or net of rainfall over evaporation	5.0	10.0	3.2	6.4	3.5	7.0	3.2	6.4
11ii	A suitable water course may exist nearby for potential diversion of surface water runoff	5.0		3.2		3.5		3.2	
12i	Presence of an outlet channel	5.0	15.0	2.1	6.4	2.3	7.0	2.1	6.4
12ii	Water permanence	5.0		2.1		2.3		2.1	
12iii	Size of lake/wetland	5.0		2.1		2.3		2.1	
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Results

SENSITIVITY ANALYSIS 1: Ranking	Lake	SENSITIVITY ANALYSIS 3: Ranking	Lake	SENSITIVITY ANALYSIS 4 & 5: Ranking	Lake	SENSITIVITY ANALYSIS 7: Ranking	Lake
1	Yealering	1	Yealering	1	Yealering	1	Yealering
2	Pulyamenup	2	Pulyamenup	2	Pulyamenup	2	Pulyamenup
3	Towerrining	3	Dumbleyung	3	Towerrining	3	Towerrining
4	Blackwood River	4	Towerrining	4	Norring	4	Dumbleyung
4	Dumbleyung	5	Norring	5	Queerearrup	5	Norring
6	Norring	6	Queerearrup	6	Dumbleyung	6	Blackwood River
7	Queerearrup	7	Blackwood River	7	Yornaning Dam	7	Baandee
8	Yornaning Dam	8	Baandee	8	Blackwood River	8	Yenyening
8	Baandee	9	Yornaning Dam	9	Baandee	9	Kwinder
9	Yenyening	10	Yenyening	10	Polaris	10	Queerearrup
11	Wagin Lakes	11	Wagin Lakes	11	Flagstaff	11	Polaris
12	Flagstaff	12	Flagstaff	12	Kwinder	12	Yornaning Dam
13	Kwinder	13	Kwinder	13	Nallan	13	Flagstaff
13	Polaris	14	Nallan	14	Yenyening	14	Nallan
15	Nunijup	15	Polaris	15	Wagin Lakes	15	Wagin Lakes
16	Brown	16	Brown	16	Nunijup	16	Bryde
16	Nallan	17	Nunijup	17	Brown	17	Nunijup
18	Bryde	18	Bryde	18	Austin	18	Brown
19	Carrolup	19	Austin	19	Bryde	19	Austin
20	Austin	20	Carrolup	20	Carrolup	20	Carrolup
[illegible]	2%	[illegible]	2%	[illegible]	2%	[illegible]	3%

Table 28: Sensitivity Analyses 8 to 12

Sub-criterion number	Sub-criterion description	30% Weight on Environmental Status (Sensitivity Analysis 8): Sub-criterion weighting	Criteria weighting	30% Weight on Tourism Potential (Sensitivity Analysis 9): Sub-criterion weighting	Criteria weighting	30% Weight on Water Availability (Sensitivity Analysis 10 & 11): Sub-criterion weighting	Criteria weighting	30% Weight on Suitable Lake Morphology (Sensitivity Analysis 12): Sub-criterion weighting	Criteria weighting
1i	Lake is in the wheatbelt or regions immediately surrounding	6.4	6.4	6.4	6.4	7.0	7.0	6.4	6.4
2i	Distance from a town with a population of at least 50 people	6.4	6.4	6.4	6.4	7.0	7.0	6.4	6.4
3i	Size of the lake	1.1	6.4	1.1	6.4	1.2	7.0	1.1	6.4
3ii	Expected improvement of social and recreational activities available at the lake	1.1		1.1		1.2		1.1	
3iii	Expected improvement in business opportunities related to the lake	1.1		1.1		1.2		1.1	
3iv	Expected improvement in current and potential future events to be held at the lake	1.1		1.1		1.2		1.1	
3v	Distance to other lakes with high social, recreational and economic opportunities	1.1		1.1		1.2		1.1	
3vi	Proximity to other significant tourist, social and recreational opportunities	1.1		1.1		1.2		1.1	
4i	The lake has appropriate vesting and purpose for active recreational use	6.4	6.4	6.4	6.4	7.0	7.0	6.4	6.4
5i	Adjoining access land has appropriate vesting and purpose for recreational use facilities	6.4	6.4	6.4	6.4	7.0	7.0	6.4	6.4
6i	Recorded maximum depth (m)	6.4	6.4	6.4	6.4	7.0	7.0	6.4	6.4
7i	Lake is in an area where there are indications of high community support for the development of the lake	6.4	6.4	6.4	6.4	7.0	7.0	6.4	6.4
8i	Recognition of listings of environmental significance	30.0	30.0	6.4	6.4	7.0	7.0	6.4	6.4
9i	Potential for numbers of tourists to visit the enhanced site for social or recreational purposes (per Tourism WA)	6.4	6.4	30.0	30.0	7.0	7.0	6.4	6.4
10i	Sufficient groundwater resources to allow social and recreational use	6.4	6.4	6.4	6.4	10.0	10.0	6.4	6.4
11i	Some surplus exists of rainfall over evaporation	3.2	6.4	3.2	6.4	10.0	20.0	3.2	6.4
11ii	A suitable water course may exist nearby for potential diversion of surface water runoff	3.2		3.2		10.0		3.2	
12i	Presence of an outlet channel	2.1	6.4	2.1	6.4	2.3	7.0	10.0	30.0
12ii	Water permanence	2.1		2.1		2.3		10.0	
12iii	Size of lake/wetland	2.1		2.1		2.3		10.0	
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Results

Sensitivity Analysis 8: Ranking	Lake	Sensitivity Analysis 9: Ranking	Lake	Sensitivity Analysis 10 & 11: Ranking	Lake	Sensitivity Analysis 12: Ranking	Lake
1	Ewlyamartup	1	Towerrinning	1	Ewlyamartup	1	Yealering
2	Towerrinning	2	Ewlyamartup	2	Towerrinning	2	Towerrinning
3	Blackwood River	3	Dumbleyung	3	Yealering	3	Ewlyamartup
4	Yornaning Dam	4	Yealering	4	Dumbleyung	4	Blackwood River
5	Norring	5	Blackwood River	5	Norring	5	Yornaning Dam
6	Yealering	6	Yornaning Dam	6	Blackwood River	6	Dumbleyung
7	Queerearrup	7	Norring	7	Queerearrup	7	Queerearrup
8	Polaris	8	Queerearrup	8	Yornaning Dam	8	Baandee
9	Flagstaff	9	Nalyer	9	Yenyening	9	Norring
10	Kuender	10	Yenyening	10	Flagstaff	10	Polaris
11	Dumbleyung	11	Baandee	11	Baandee	11	Yenyening
12	Baandee	12	Polaris	12	Kuender	12	Flagstaff
13	Yenyening	13	Flagstaff	13	Wagin Lakes	13	Kuender
14	Nunijup	14	Kuender	14	Polaris	14	Nalyer
15	Nalyer	15	Wagin Lakes	15	Nunijup	15	Nunijup
16	Wagin Lakes	16	Bryde	16	Nalyer	16	Wagin Lakes
17	Brown	17	Nunijup	17	Brown	17	Carrolup
18	Austin	18	Brown	18	Bryde	18	Brown
19	Carrolup	19	Austin	19	Carrolup	19	Bryde
20	Bryde	20	Carrolup	20	Austin	20	Austin
Alexander's A N	8%	Alexander's A N	3%	Alexander's A N	2%	Alexander's A N	2%

As a measure of the robustness of the process, Alexander A's (AA) index is used to measure how sensitive the rankings are to changes in criteria weights (expressed as a percentage).

The index is described in Alexander (1989), and is the sum of the squared differences in ranks expressed as a fraction of the maximum possible sum of the squared differences in ranks (the maximum sum of the squared differences for 20 ranked lakes is 2,660):

$$A = \frac{\sum_{i=1}^{N} (x_{ik} - x_{ij})^2}{\max \sum_{i=1}^{N} (x_{ik} - x_{ij})^2} \qquad (2)$$

where:

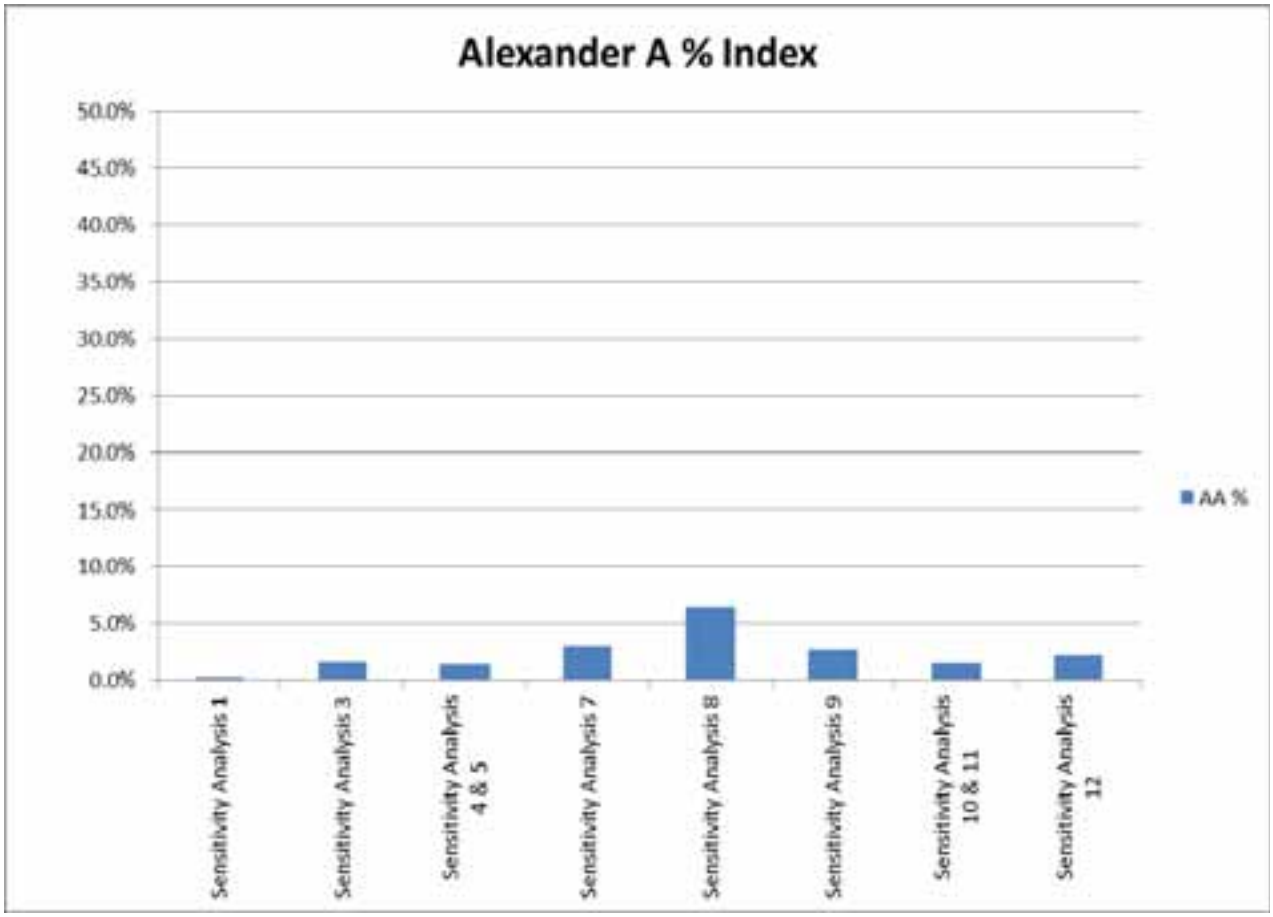
x_{ij} is the rank of alternative *i* with variable at (previous) value *j*

x_{ik} is the rank of alternative *i* with variable at (changed) value *k*

N = the number of alternatives

Results for each Sensitivity Analysis are presented at Figure 3.

Figure 7: Alexander A % Index



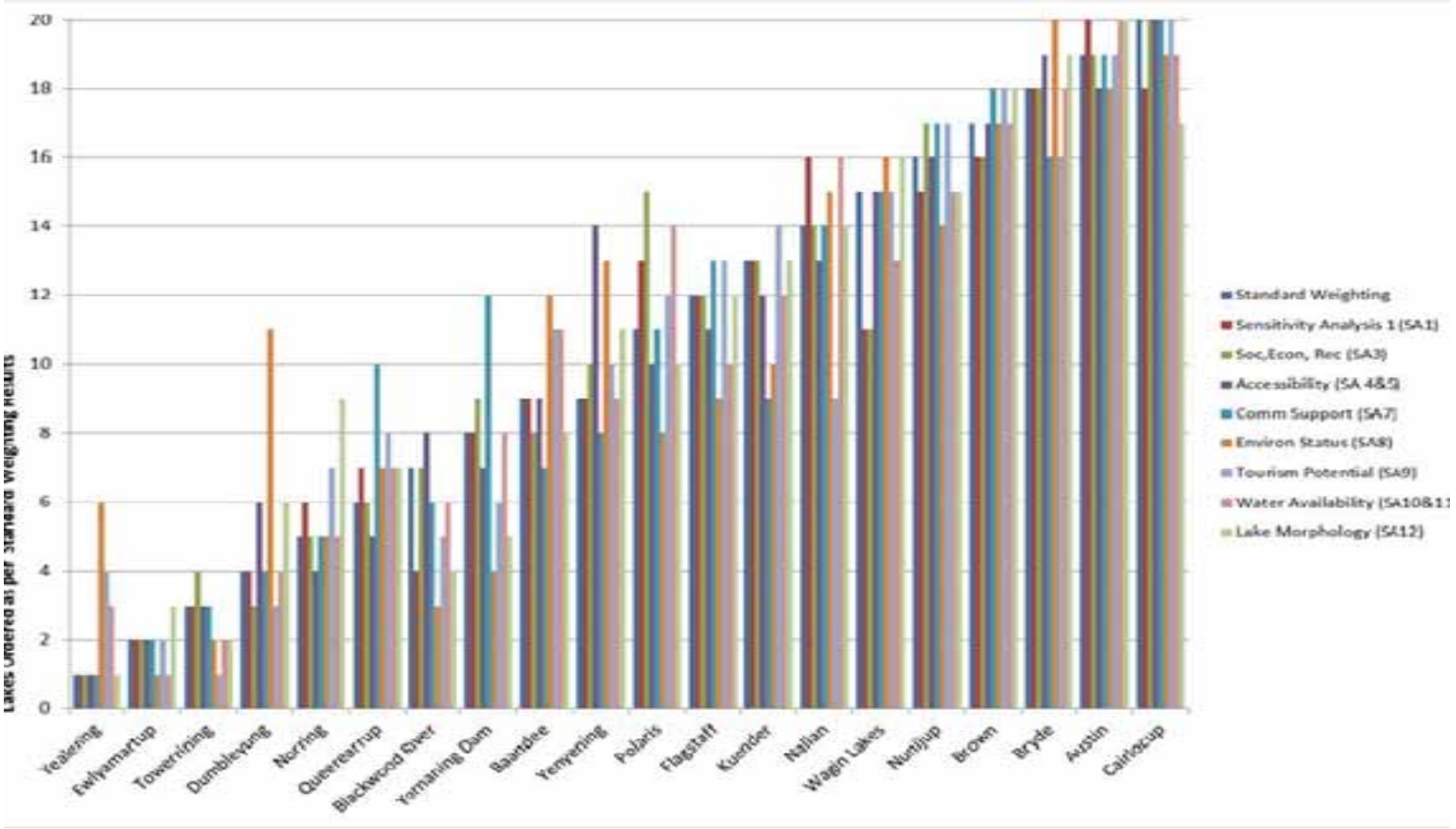
An AA percentage of 0% represents no change while a value of 100% indicates complete reversal in ranks, that is, the maximum possible sensitivity.

The AA index for Sensitivity Analysis 1 is 0%, for Sensitivity Analysis 3, 1.6%, and for Sensitivity Analysis 4&5, 1.4% indicating that the ranking has not significantly changed in either case. This indicates the lake ranking process is robust.

The graph at Figure 3 also shows that lake ranking is most susceptible to changes made in Sensitivity Analysis 8 (6.4%). Nevertheless, even a 6.4% AA score indicates low susceptibility of lake rankings to changes in criteria weighting. The rankings performed under this MCA process are sound.

Weighted results for all criteria are presented at Figure 4. This gives a more detailed representation of how each lake ranks (from 1 to 20) for the Standard Weighting (in blue) and each of the eight Sensitivity Analyses. Refer to the legend for colour coding. As an example, Lake Yealering ranks 1st in five of the eight Sensitivity Analyses. . It drops to 3rd when a heavy weight is assigned to water availability, 4th when a heavy weight is assigned to tourism potential and 6th when a heavy weight is assigned to environmental status.

Figure 8: All Results for All Weightings



8. CONCLUSIONS

- The Department of Regional Development and Lands (RDL) 'Living Lakes' Plan proposes to enhance one or more existing lake systems to create permanent and accessible water bodies in the Wheatbelt and adjoining regions. Twenty-five lakes were nominated by community members and other interested parties in response to an RDL expression of interest process. Five of these lakes were subsequently withdrawn. The aim of this report is to assess the remaining nominations against the Living Lakes Plan objective and established selection criteria, providing a justification for a short-list of two or three lakes to be considered further for lake enhancement.

  Results indicate that the three highest ranking lakes obtain very similar scores:
  - Yealering (1, Score = 313),
  - Ewlyamartup (2, Score = 311) and
  - Towerrinning (3, Score = 308).

  Lower ranking lakes receive lower scores. For example,
  - Dumbleyung (4, Score = 290) and
  - Norring (5, Score = 285).

- In general, the sensitivity analyses did not significantly affect the rankings (rankings of all 20 lakes changed by just 1% – 6% for each of the sensitivity analyses), especially the top ranked lakes. Yealering, Ewlyamartup and Towerrinning remain the first thee ranked lakes (although not in the same order) for five of the eight sensitivity analyses.

- Referring to Figure 4, Yealering is the top ranked lake in five of the eight Sensitivity Analyses. It drops to 3rd when a heavy weight is assigned to water availability (Yealering scored highly against criteria regarding potential groundwater and surplus rainfall availability, but poorly regarding nearby water courses for potential diversion), 4th when a heavy weight is assigned to tourism potential, and 6th when a heavy weight is assigned to environmental status (the lake is designated to be of regional environmental significance with the potential of excluding lake enhancement).

- Ewlyamartup retains its ranking of 2nd for five of the sensitivity analyses. It rises to 1st rank when a heavy weight is assigned to environmental status and water availability, and drops to 3rd rank when a heavy weight is assigned to suitable lake morphology (a clear outlet area to possibly assist water level enhancement through containment was not determined, but the lake does form part of a chain that connects during flood events).

- Towerrinning retains its 3rd ranking for three of the sensitivity analyses. It rises to 1st rank when a heavy weight is assigned to tourism potential and to 2nd rank when a heavy weight is assigned to environmental status, water availability and suitability of lake morphology. It falls to 4th rank when a heavy weight is assigned to social, economic and recreational importance (swapping its 3rd rank with Dumbleyung).

- In conclusion, this Multicriteria Analysis short-lists three lakes for further consideration in the Living Lakes Plan being undertaken by the Department of Regional Development and Lands: (1) Yealering, (2) Ewlyamartup, and (3) Towerrinning.

The ranking of all 20 nominated lakes provided in this report is shown to be robust, and can be used to decide on other lakes for consideration should the highest ranking lakes be disqualified for any reason during the consideration process.

9. REFERENCES

Alexander, E. R., 1989. Sensitivity analysis in complex decision models. Journal of the American Planning Association 55 (3), 323-333.

Avon Water Assets: 15-3-04 data file from Department of Water (part of background data collated for the then Avon Regional NRM Strategy.

Belton, V. and Vickers, S. (1990) Use of a simple multi attribute value function incorporating visual interactive sensitivity analysis for multiple criteria decision making, in C.A. Bana-e-Costa (Ed) Readings in Multiple Criteria Decision Aid, Springer-Verlag, London.

Cale D, Halse S, and Walker C (2004) *Wetland Monitoring in the Wheatbelt of south-west Western Australia: site descriptions, waterbird, aquatic invertebrate and groundwater data*. Conservation Science W Aust,. 5(1): 20-135

Department of Environment and Conservation (DEC) (2009). *WetlandBase* (an online State wetlands database). [www.dec.wa.gov.au/management-and-protection/wetlands/wetlandbase/view-wetlandbase-online].

Department of Environment and Conservation (2010) *Long term Monitoring of the Lake Bryde Threatened Ecological Community* DEC Nature Conservation Service Biodiversity Monitoring Protocol.

Department of Regional Development and Lands: List of Nominated lakes

Department of Regional Development and Lands: Key Contacts

Department of Regional Development and Lands: Confidential List of Contacts

Department of Regional Development and Lands: Nominated lake information

Department of Regional Development and Lands: Purpose for Living Lakes Feasibility Study RDL39610 (July 2011)

Department of Water (2006) *Upper Avon River Recovery Plan Section 20 – Yealering Lakes*

Environment Australia (2001). *A Directory of Important Wetlands in Australia, Third edition.* Environment Australia, Canberra. www.environment.gov.au/water/publications/environmental/wetlands/database.

Bureau of Mineral Resources, Geology and Geophysics (1970*) Geological Map Series,1:250 000 of the following areas:*
,SG50-15 - Cue
,SH50-15 - Kellerberrin
,SH50-16 - Southern Cross
,SI50-6 - Collie
,SI50-7 - Dumbleyung
,SI50-8 - Newdegate
,SI50-11 - Mt Barker

Green Skills (2003) *Wetlands Study for the Upper Kent Catchment*: a*n inventory, assessment and history of priority wetlands including recommendations for management* – report produced for the Natural Heritage Trust and the Water and Rivers Commission. April 2003.

Grein S B (1995) *Remnant Vegetation and Natural Resources of the Blackwood River Catchment –an Atlas* Agriculture Western Australia Miscellaneous Publication 9/95

Hajkowicz, S., Young, M., Wheeler, S., MacDonald, D.H. and Young, D. (2000). Supporting Decisions: Understanding Natural Resource Management Assessment Techniques. CSIRO Land and Water.

Halse S, Pearson G, and Patrick S (1993) *Vegetation of depth-gauged wetlands in nature reserves of south-west Western Australia*. Department of Conservation and Land Management, Technical Report No 30 June 1993.

Hewitt,James. Executive Director Infrastructure and Investment, Tourism WA (2011) RE: Living Lakes tourism potential criterion, request for a Tourism WA rating for each lake. Emailed to Sasha Naughton 10/10/2011

Hydrogeological Map Series,Digital (GIS) Data provided by the Department of Water (DoW)

JDA Consultant Hydrologists and Advanced Choice Economics: Living Lakes Feasibility Questionnaire (2011) at www.surveymonkey.com.

Katanning LCDC (2010) *Restoring Lake Ewlyamartup – Engineering Concept Plan* – a project directed by the Lake Ewlyamartup Working Group under the auspices of the Katanning Land Conservation District Committee.

Lane J, Clarke A, and Winchcombe Y.(2011) South West Wetlands Monitoring Program Report 1997-2010. Western Australian Department of Environment and Conservation

Nijkamp, P., Rietveld, P. and Voogd, H. (1990) Multicriteria evaluation in physical planning, North Holland, Amsterdam.

Pen L (1997) *A systematic overview of the environmental values of the wetlands, rivers and estuaries of the Busselton-Walpole region*. Water and Rivers Commission – Water Resource Allocation and Planning Report Series No WRAP 7.

Shire of West Arthur (2008) *Lake Towerrinning Strategic Management Plan*

South West Catchments Council (2001) *Waterways and Wetlands in the South West NRM Region* Technical Report No 1 South West Regional Strategy for Natural Resource Management - prepared for SWCC by Dr Bruce Hamilton. August 2001.

South West Catchments Council (2004) *Water Assets of the South West Region* Technical report prepared for the Water Technical Working Group South West Region NRM for the South West Catchments Council - June n2004

Water and Rivers Commission (2003) *Yenyening Lakes Management Strategy 2002-2012* Water Resource Management Series 32.

Additional References Specific to Lakes A to Y

A1,"Shire of Cue (2010) ""Interest in Lake Austin and Lake Nallan"" Letter to Tara Whitney"

B4,"Brad Thompson (2010) ""Baandee Lake Water Skiing Information"" including existence of artificial dam wall Emailed to Tara Whitney 22/9/2010"

B2,"Tobias Vudzijena (2010) ""Lake Baandee Memorandum"" Letter to Greg Powell (25/8/2010) "

B1,"Brad Thompson (2010)Expression of Interest for Lake Baandee, Letter to Tara Whitney 19/8/2010"

C1,"Alan Lamb (2010) Expression of Interest Blackwood River near Boyup Brook, Letter to Tara Whitney 25/8/2010"

E1,Peter Bentley (2010) Lake Bryde: Expression of Interest Email to Tara Whitney 23/8/2010

F1,Peter Bentley (2010) Lake Cairlocup: Expression of Interest Email to Tara Whitney 23/8/2010

H11,"White, X. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 18/8/2010"

H10,"Ball, G&T. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 16/8/2010"

H9,"Wilson, G&L. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 16/8/2010"

H8,"Thompson, S. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 16/8/2010"

H7,"Alderton, J.E. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 16/8/2010"

H6,"Bairstow, D&C. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 13/8/2010"

H5,"Ramm, A&S. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 13/8/2010"

H4,"Lloyd, D&T. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 13/8/2010"

H3,"Ramm, J. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 13/8/2010"

H2,"Gossage, D. (2010) Expression of Interest Lake Dumbleyung Email to Tara Whitney 13/8/2010"

H1,"Dare, L&J. (2010) Expression of interest Lake Dumbleyung Email to Tara Whitney 13/8/2010"

I5,"Lake Ewlyamartup Working Group ""Restoring Lake Ewlyamartup, Engineering Concept Plan"" (Sept 2010)"

I4,"Lake Ewlyamartup Working Group ""Restoring Lake Ewlyamartup"" for Katanning Landcare (n.d)"

I3,"Lake Ewlyamartup Working Group ""Lake Ewlyamartup Public Information Evening"" (23/9/2010) "

I2,"Van Der Waag, J. Expression of Interest Lake Ewlyamartup, Email to Tara Whitney (28/8/2010)"

I1,"Beck, C. (2010) Expression of Interest Lake Ewlyamartup, Email to Tara Whitney (18/8/2010)"

M1,"Marcus Owen ""Memo -Shire of Lake Grace"" (July 2010) to Tara Whitney"

N7,"Shire of Cue (2010) ""Interest in Lake Austin and Lake Nallan"" Letter to Tara Whitney (23/8/10)"

N6,"Shire of Cue - CEO Peter Money (Aug 2009) ""Works at Nallan"" Emailed to Stan Scott (14/8/10)"

N3,"""Management plans for Nallan Lake and Milly Soak"" (n.d) no author"

N2,"Shire of Cue (Stan Scott) ""Silt Removal at Lake Nallan"" (16/2/2005)"

N1,"From Peter Morrison ""Memorandum (Dec 2002) - Comments Relating To Lake Nallan Management Plan"" to Stan Scott (11/12/2002)"

O1,Webster. C (2010) Expression of Interest Lake Norring Email to Tara Whitney (19/8/2010)

P3,Stipanicev. C (2010) Expression of Interest Lake Nunijup Emailed to Tara Whitney 2/9/2010

P2,Keightley. S (2010) Lake Norring Late Application Accepted. Email to Tara Whitney 1/9/2010

P1,Whitney. T (2010) Application missed deadline. Email to Sasha Keightley 31/8/2010

Q1,"Shire of Yilgarn, Sowiack, J. (2010) ""Expression of Interest for Lake Polaris"" Letter to Paul Rosair 25/8/2010"

T7,"Naughton, S. (2010) Water Quality Information available for Lake Emailed to All Shire Councils 23/9/2010"

T6,"Johnston, K. (2010) Expression of Interest in Lake Email to Tara Whitney 26/8/2010"

T5,"""Water Examination Laboratory results of lake Towerrinning"" (Mar 2010)"

T4,"""Lake Towerrinning Strategic Management Plan - Reviewed August 2008"

T3,"Griffiths, G. (May 2003) ""Algal Bloom in Lake "" to Noel Mason"
T2,"""Bird Survey of Lake "" (July 2002)"

T1,"West Arthur Tourism Development Strategy ""Lake Towerrinning"" p.25-26 (March 2002) "

V1,"Logue, K. (2010) Expression of Interest Wicherina Dam Email to Tara Whitney 24/8/2010"

W11,Shire of Wickepin (2010) Confirming Interest In Lake Yealering Study. Email to Tara Whitney

W9,"Hills, I (2010) Expression of Interest in Lake Yealering. Emailed to Tara Whitney (n.d)"

W8,"Living Lakes, Lake Yealering Expression of interest (Sept 2010) letter from Shire of Wickepin to RDL"

W7,Lake Yealering Progress Association Inc (2010) Letter to Ian Hills 7/9/10

W6,Lake Yealering Golf Club (2010) Letter to Ian Hills 6/9/2010

W5,Facey Group (2010) Letter to Ian Hills 3/8/2010

W4,"Lake Yealering: Farmer,D. (2010) Email to Ian Hills subject: Yealering Lake 17/2/10"

W3,Lake Yealering: DoW (2010) Yealering Water Quality and Nutrient Monitoring 2008

W2,"""Yealering 1907-2007"""

W1,DOW (2006) Upper Avon River Recovery Plan Section - 20 - Yealering Lakes report No: RRP 12 Dec 2006

X7,"Whittington, C. Expression of Interest Yenyening Lakes Emailed to Bernard Kelly 10/9/2010"

X6,Yenyening Lakes: Shire of Brookton (2010) Expression of Interest. Letter to Tara Whitney 26/8/2010

X5,"Beverley IGA, Confirmation that Expression of Interest has been Received. Emailed to Tara Whitney (26/8/2010)"

X4,"Evans, J. (2010) Expression of Interest Yenyening Lakes. Emailed to Tara Whitney and Sasha Keightley 24/8/2010"

X3,"Yenyening Lakes Management Committee "A Vegetation Survey of Yenyening Lakes Nature Reserve and Adjoining Vegetation"" (March 2003)"

X2,Water and Rivers Commission (2003) Yenyening Lakes Management Strategy (2002-2012)

X1,Yenyening Lake System Sketches (1:2500) (April 2002)

Y2,"Shire of Cuballing (2010) Middleton, A. ""Aerial Photographs of Yornaning Siding"" Sent to Dept. Regional Development 25/8/2010"

Y1,Shire of Cuballing (2010) Expression of Interest Yornaning Siding Letter to Tara Whitney 2/8/2010

APPENDIX A: WITHDRAWN LAKES - INFORMATION SUMMARY

A.1 Cemetery Lake (G)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Lockhart)
- Shire - Lake Grace
- Nearest town, 3 km away, is Lake Grace with a population of 507 (2006).

Social, Recreational and Economic Importance

- Not established

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified
- Nomination of this lake was withdrawn by the proponent (M.Owen, 1 September 2011)

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 0km

Public Land – Vesting and Access

- Vesting - Within Unallocated Crown Land (UCL)
- Access –via unsealed road off Dumbleyung Lake Grace Road and through Reserve 22716, vested for ‘Common’ purpose.

Environmental Status

- Wetland of National Significance - part of the Lake Grace wetland system which is listed under Directory of Important Wetlands (Environment Australia 2001).
- Regional NRM Significance – Not specifically assessed, but part of Lake Grace system (Low overall; - with ranking 3 out of 5 for environmental values).
- Threatened Flora (within 1 km) - Priority Three - Poorly Known Taxa (1 record)

Landscape geomorphology and lake morphology

- Moderate sized seasonal lake.
- Soil landscape – Lagan 1 subsystem salt lake Phase – “Large seasonally dry saline playa lakes on saline playa deposits”.
- Bathymetry and Depth – No data.

Hydrogeology

- Not assessed

Surface Hydrology

- Not assessed

Refer to Figure 2G for an aerial view of Cemetery Lake, Figure 3G for a catchment plan and Figure 4G for access details.

A.2 Lake Grace North (L)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Lockhart)
- Shire - Lake Grace
- Nearest town, 21 km away, is Lake Grace with a population of 507 (2006).

Social, Recreational and Economic Importance

- Not established

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified
- Nomination of this lake was withdrawn by the proponent (M.Owen 1 September 2011)

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 3km

Public Land – Vesting and Access

- Vesting - Within Unallocated Crown Land (UCL)
- Access – northern portion traversed by Dumbleyung Lake Grace Road; other possible access from western side via unmade roads off Jarring Road South.

Environmental Status

- Wetland of National Significance - part of the Lake Grace wetland system which is listed under Directory of Important Wetlands (Environment Australia 2001).
- Regional NRM Significance - Not specifically assessed, but part of Lake Grace system (Low overall; but with ranking 3 out of 5 for environmental values)
- Threatened Flora (within 1 km) - Four Priority One (4 records) and Priority Three (1 records) - all Poorly Known Taxa
- Cultural Heritage Sites in vicinity - 5 records

Landscape geomorphology and lake morphology

- Very large (> 5,500 ha) seasonally dry saline playa lake
- Soil landscape – Lagan 1 subsystem salt lake Phase – “Seasonally dry saline playa lakes on saline playa deposits in the southern wheatbelt”.

- Bathymetry and Depth – No data.

Hydrogeology

- Not assessed

Surface Hydrology

- Not assessed

Refer to Figure 2L for an aerial view of Lake Grace (North), Figure 3L for a catchment plan and Figure 4L for access details.

A.3 Lake Grace South (M)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Avon (Lockhart)
- Shire - Lake Grace
- Nearest town, 41 km away, is Kukerin with a population of 190 (2006).

Social, Recreational and Economic Importance

- Not established

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified
- Nomination of this lake was withdrawn by the proponent (M.Owen 1 September 2011)

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 2km

Public Land – Vesting and Access

- Vesting - Within Reserve 28395 vested in WA Wildlife Authority for ‘Conservation; Fauna; Protection of Flora’.
- Access - via Wolseley Road (to the north) or via Beetacoo Road (central portion) both leading off the Pingrup – Lake Grace Road.

Environmental Status

- Wetland of National Significance - part of the Lake Grace wetland system which is listed under Directory of Important Wetlands (Environment Australia 2001).
- Regional NRM Significance - Not specifically assessed, but part of Lake Grace system (Low overall; but with ranking 3 out of 5 for environmental values)
- Threatened Flora (within 1 km) - One Priority - Poorly Known Taxa (1 record)
- Threatened Fauna (within 5 km) - Two records for birds (Schedule 1 - Fauna that is rare or is likely to become extinct).

Landscape geomorphology and lake morphology

- Very large (> 5,500 ha) seasonally dry saline playa lake
- Soil landscape – Lagan 1 subsystem salt lake Phase – “Seasonally dry saline playa lakes on saline playa deposits in the southern wheatbelt”,
- Bathymetry and Depth – No data.

Hydrogeology

- Not assessed

Surface Hydrology

- Not assessed

Refer to Figure 2M for an aerial view of Lake Grace (South), Figure 3M for a catchment plan and Figure 4M for access details.

A.4 Lake Stubbs (S)

Location

- Planning Region - Wheatbelt
- NRM Region – Wheatbelt (Avon)
- Catchment (sub-catchment) - Magenta Internal (Lake Stubbs)
- Shire - Lake Grace
- Nearest town, 5 km away, is Newdegate with a population of 441 (2006).

Social, Recreational and Economic Importance

- Some level of recreational use assumed

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- No formal studies identified
- Nomination of this lake was withdrawn by the proponent (M.Owen 1 September 2011)

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 3km

Public Land – Vesting and Access

- Vesting - Within Unallocated Crown Land (UCL).
- Access - via Watson Road (to the west) or via unmade roads or tracks off Newdegate Road North (to the east and south).

Environmental Status

- Regional NRM Significance - Low overall (ranking 2 out of 5 for environmental values)
- Cultural Heritage Sites in vicinity - 21 records

Landscape geomorphology and lake morphology

- Large (> 500 ha) seasonal lake.
- Soil landscape – Newdegate 2 Subsystem – wetland within “Lower to upper slopes and crests on laterite and colluvium over weathered granite in the south-eastern wheatbelt”.
- Bathymetry and Depth – No data.

Hydrogeology

- Not assessed

Surface Hydrology

- Not assessed

Refer to Figure 2S for an aerial view of Lake Stubbs, Figure 3S for a catchment plan and Figure 4S for access details.

A.5 Wicherina Dam (V)

Location

- Planning Region - Mid West
- NRM Region – Northern Agriculture
- Catchment (sub-catchment) - Greenough
- Shire - Geraldton-Greenough
- Nearest town, 46 km away, is Geraldton with a population of 27,420 (2006).

Social, Recreational and Economic Importance

- Wicherina Dam is vested in the Water Corporation. Historically used as a drinking water source for Geraldton and surrounding areas. Associated with a Wicherina wellfield.

Evidence of Community Support

- Living Lakes Initiative Stage 1 On-line Survey Questionnaire not completed
- Nomination withdrawn by the proponent (K. Logue - 2 September 2011)

Tourism Potential

- Distance from Route 107 “Oceans to Outback” – 123km

Public Land – Vesting and Access

- Vesting - Within Reserve 17711 vested in Minister for Water Resources for ‘Catchment’ - a use likely to be incompatible with active recreational use of waterbody
- Access - via unsealed road off Geraldton - Mt Magnet Road.

Environmental Status

- No information of relevance identified

Landscape geomorphology and lake morphology

- Small (< 10 ha) lake or reservoir formed by existing Water Corporation dam on Wicherina Brook
- Soil landscape – Mt Horner System North Munja Subystem – “Dissected margin of sandplain within Mid west”.
- Bathymetry and Depth – No data

Hydrogeology

- Not assessed

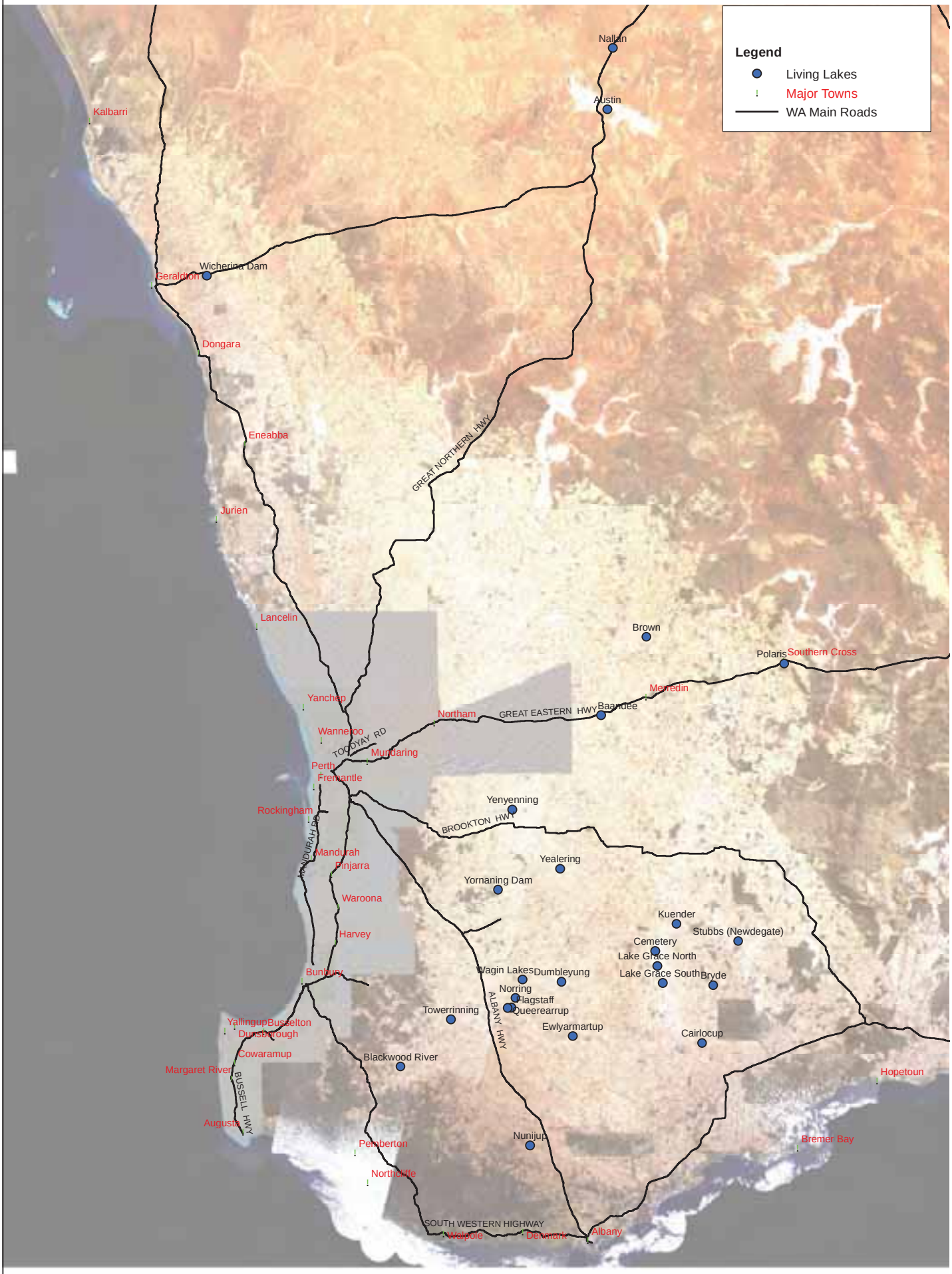
Surface Hydrology

- Not assessed

Refer to Figure 2V for an aerial view of Wicherina Dam, Figure 3V for a catchment plan and Figure 4V for access details.

FIGURE 1A

Map showing location of 25 nominated lakes



Data Source: NearMap.com - Hypertiles

Job No. J4905
Scale: 1:2,563,962

0 20,500 41,000 82,000 Meters

Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part1

Figure 1A: Location of Nominated Lakes

FIGURE 2A to 2Y

Aerial view of each nominated Lake

Data Source: Google Maps - accessed Sep 2011

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Living Lakes Feasibility Stage 1: Part 1

Figure 2A

Aerial View of Lake Austin - Shire of Cue

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1
Figure 2B
Aerial View of Lake Baandee - Shire of Kellerberrin

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2C

Aerial View of Blackwood River at Terry Road Crossing - Shire of Boyup Brook

Data Source: Google Maps - accessed Sep 2011

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Living Lakes Feasibility Stage 1: Part 1

Figure 2D

Aerial View of Lake Brown - Shire of Nungarin

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2E

Aerial View of Lake Bryde - Shire of Kent

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2F

Aerial View of Lake Cairlocup - Shire of Kent

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2G

Aerial View of Lake Cemetery - Shire of Lake Grace

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2H

Aerial View of Dumbleyung Lake - Shire of Dumbleyung

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2I

Aerial View of Ewlyamartup Lake - Shire of Katanning

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2J

Aerial View of Flagstaff Lake - Shire of Woodanilling

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1
Figure 2K
Aerial View of Lake Kuender - Shire of Lake Grace

Data Source: Google Maps - accessed Sep 2011

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Living Lakes Feasibility Stage 1: Part 1

Figure 2L

Aerial View of Lake Grace North - Shire of Lake Grace

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2M

Aerial View of Lake Grace South - Shire of Lake Grace

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2N

Aerial View of Nallan Lake - Shire of Cue

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

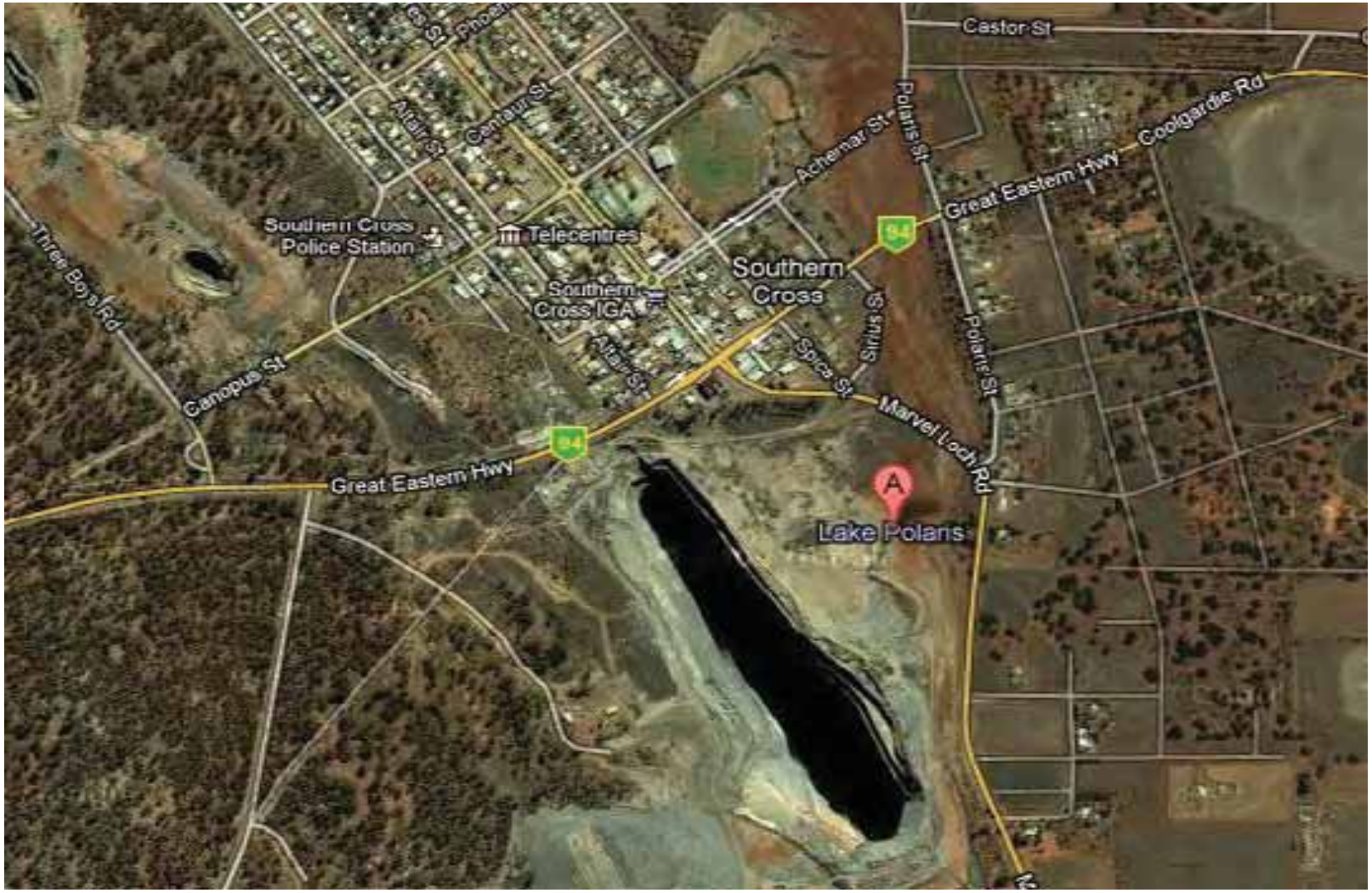
Figure 2O

Aerial View of Norring Lake - Shire of Wagin

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 2P
Aerial View of Nunijup Lake - Shire of Cranbrook



Data Source: Google Maps - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 2Q
Aerial View of Lake Polaris - Shire of Yilgarn

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 2R
Aerial View of Queerearrup Lake - Shire of Woodanilling

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1

Figure 2S

Aerial View of Lake Stubbs - Shire of Lake Grace

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1

Figure 2T

Aerial View of Towerrinning Lake - Shire of West Arthur

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1
Figure 2U
Aerial View of Wagin Lakes - Shire of Wagin

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2V

Aerial View of Wicherina Dam - Shire of Geraldton-Greenough

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 2W
Aerial View of Lake Yealering - Shire of Wickepin

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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Living Lakes Feasibility Stage 1: Part 1

Figure 2X

Aerial View of Yenyenning Lakes - Shire of Brookton

Data Source: Google Maps - accessed Sep 2011

Job No: J4905

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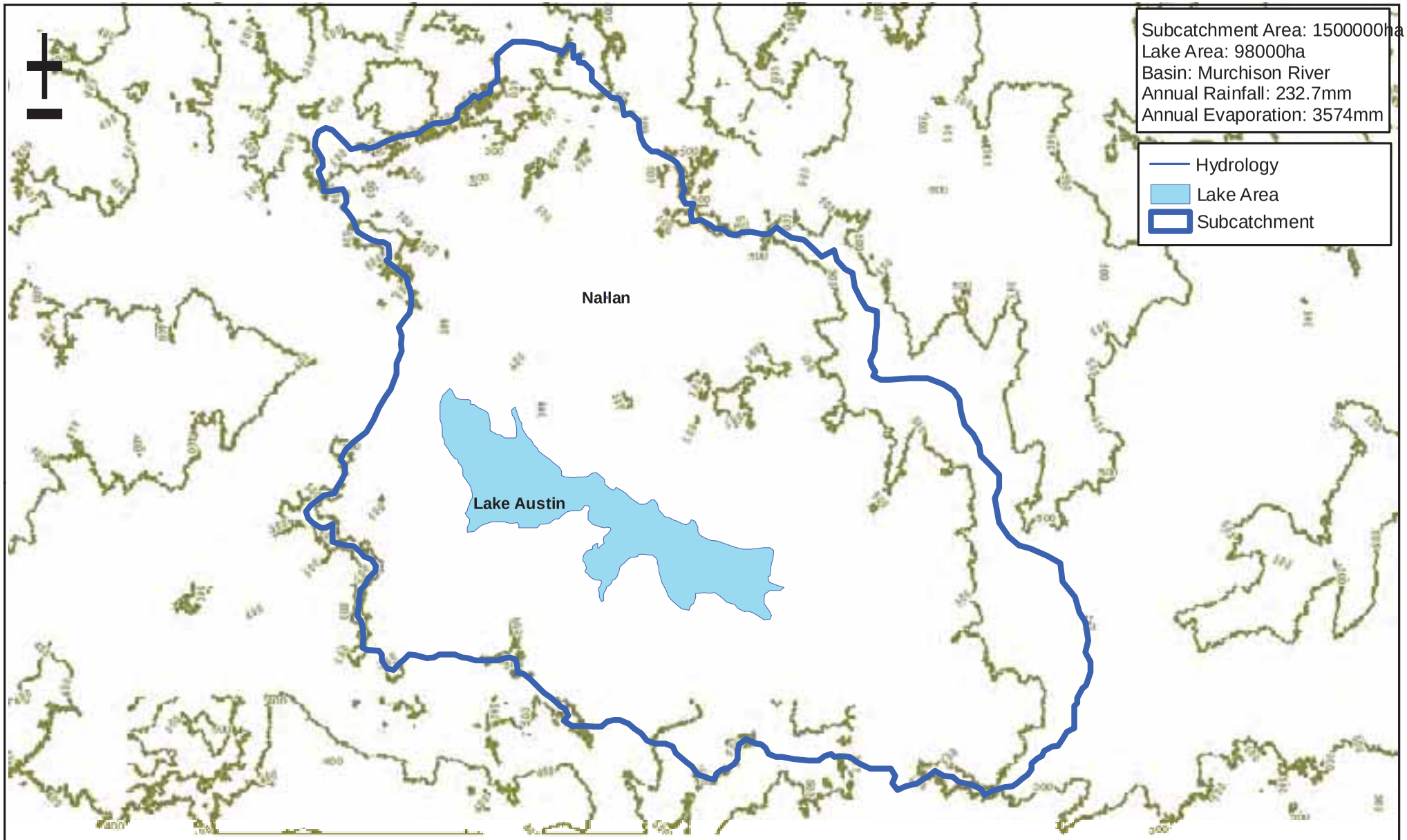
Living Lakes Feasibility Stage 1: Part 1
Figure 2Y
Aerial View of Yornaning Dam - Shire of Cuballing

FIGURE 3A to 3Y

Catchment map for each nominated Lake

Lake Austin



Data Source: Landgate (2011)

JDA

Job No. J4905
Scale:1:1,000,000

0 5 10 20 30 40 50
Kilometres

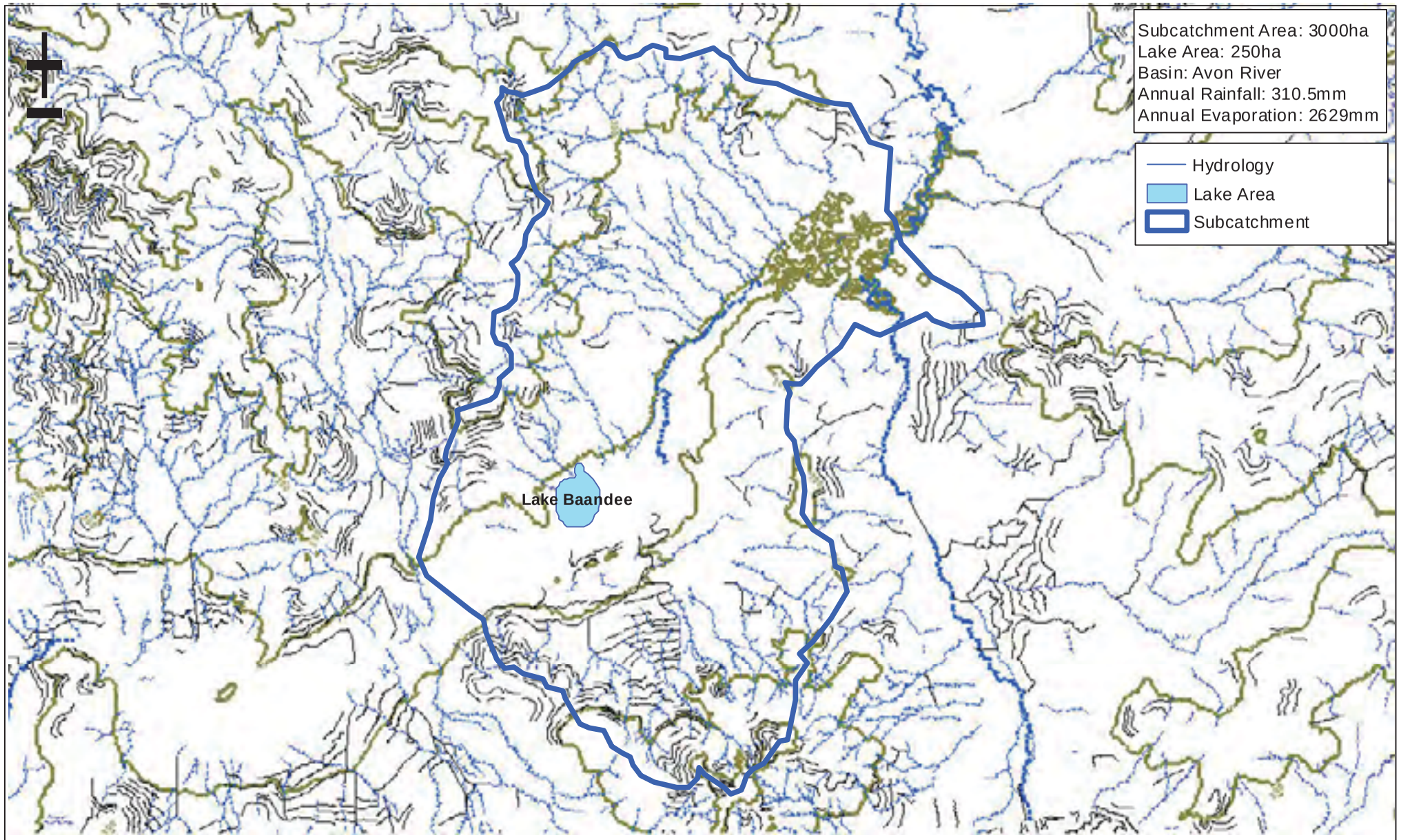
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3A

Lake Austin - Catchment

Lake Baandee



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:185,000

0 1 2 4 6 8 Kilometres

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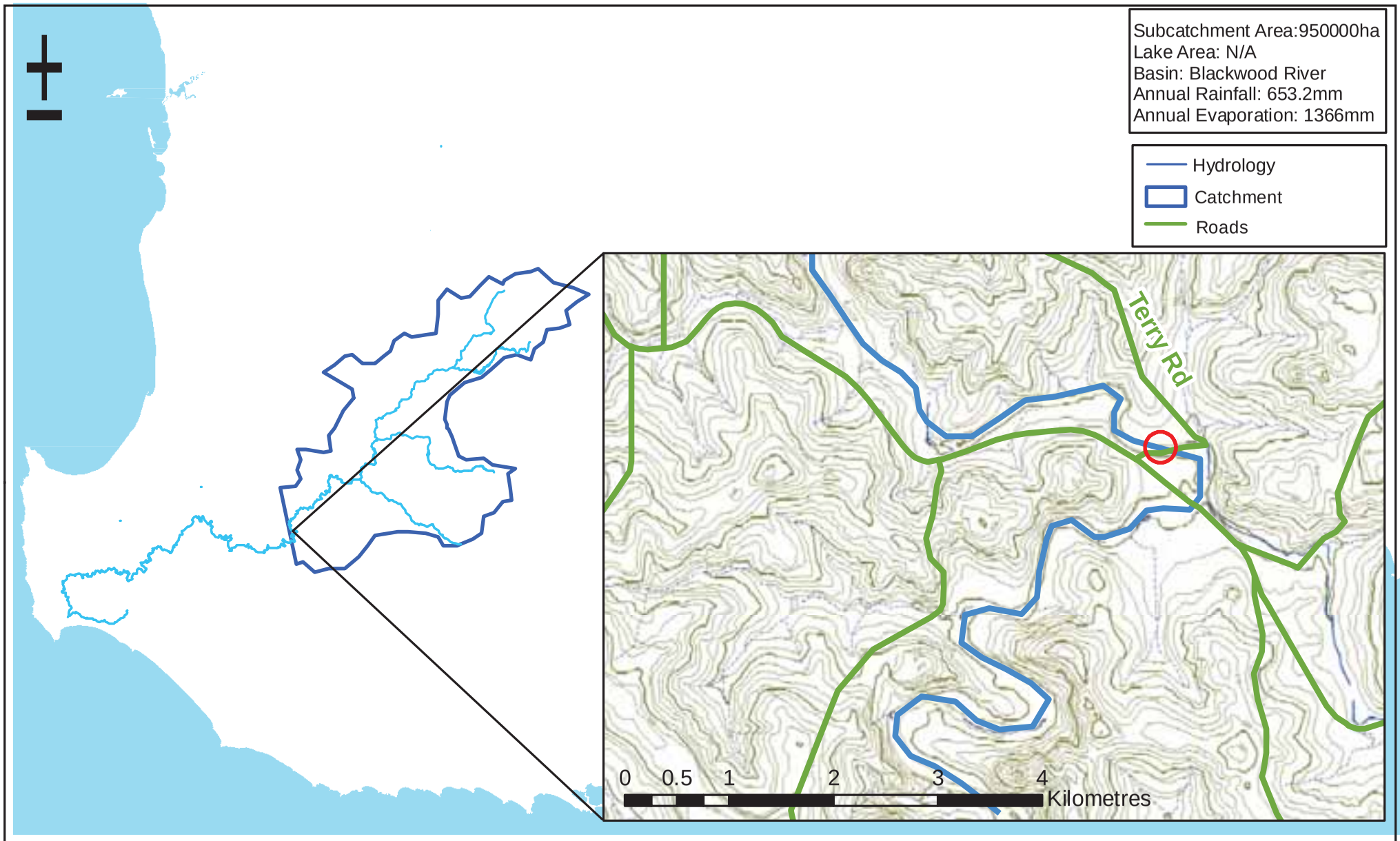
Living Lakes Feasibility Stage 1: Part 1

Figure 3B

Lake Baandee - Catchment

Blackwood River at Terry Rd Crossing



Data Source: Landgate (2011)

Job No. J4905
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0 7.5 15 30 45 60
Kilometres

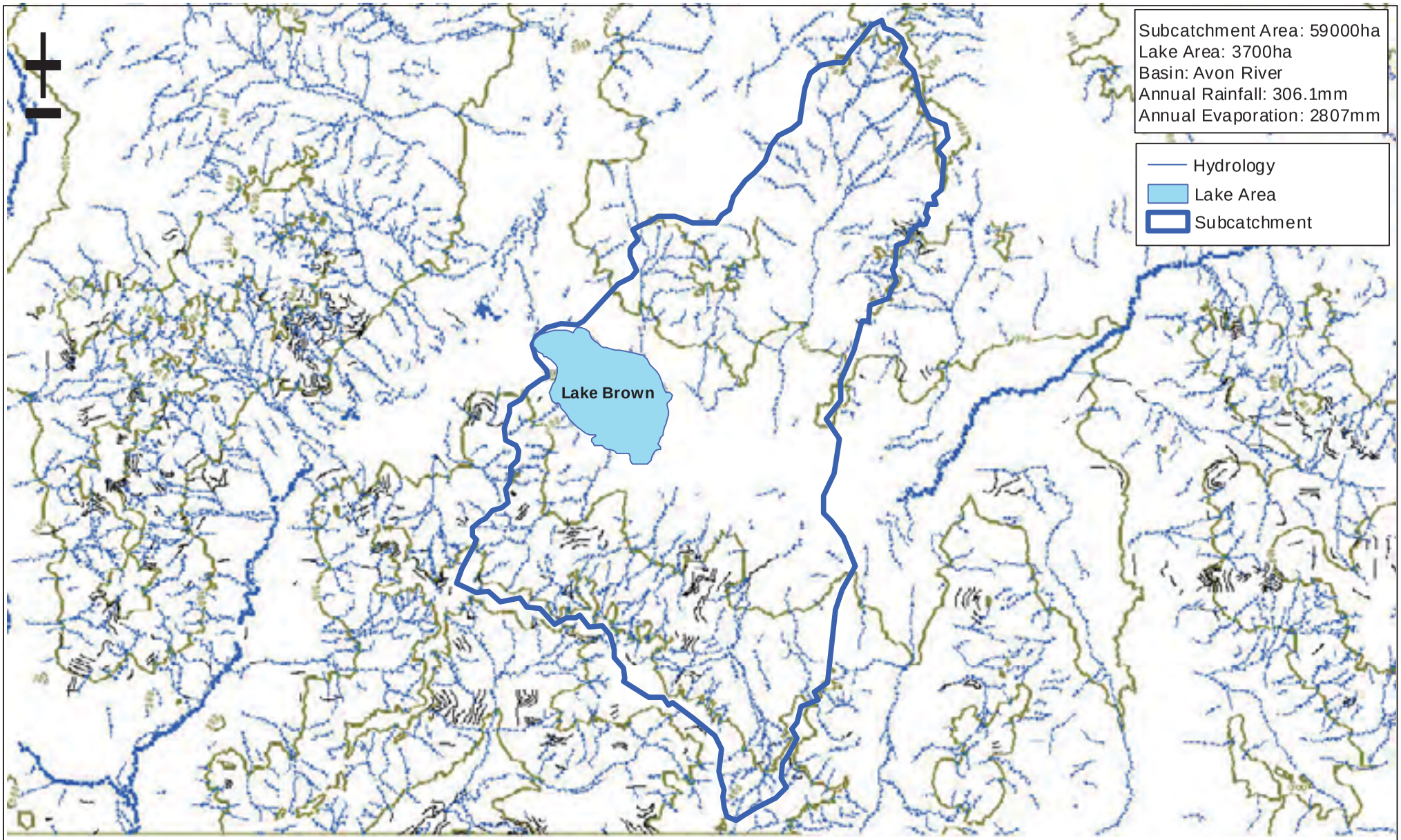
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3C

Blackwood River at Terry Rd Crossing - Catchment

Lake Brown



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:300,000

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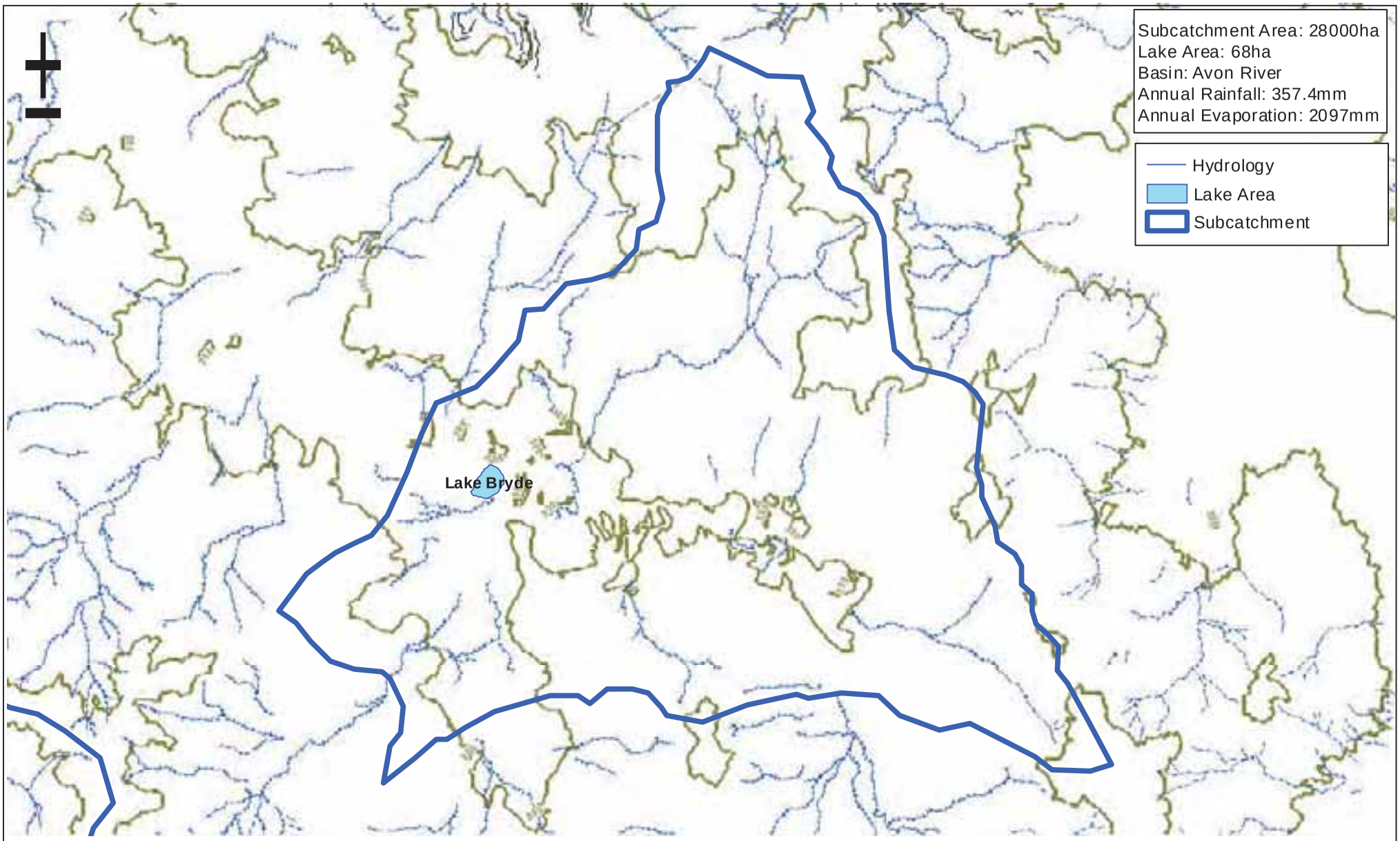
Living Lakes Feasibility Stage 1: Part 1

Figure 3D

Lake Brown - Catchment

Lake Bryde



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:161,000

0 1 2 4 6 8 Kilometres

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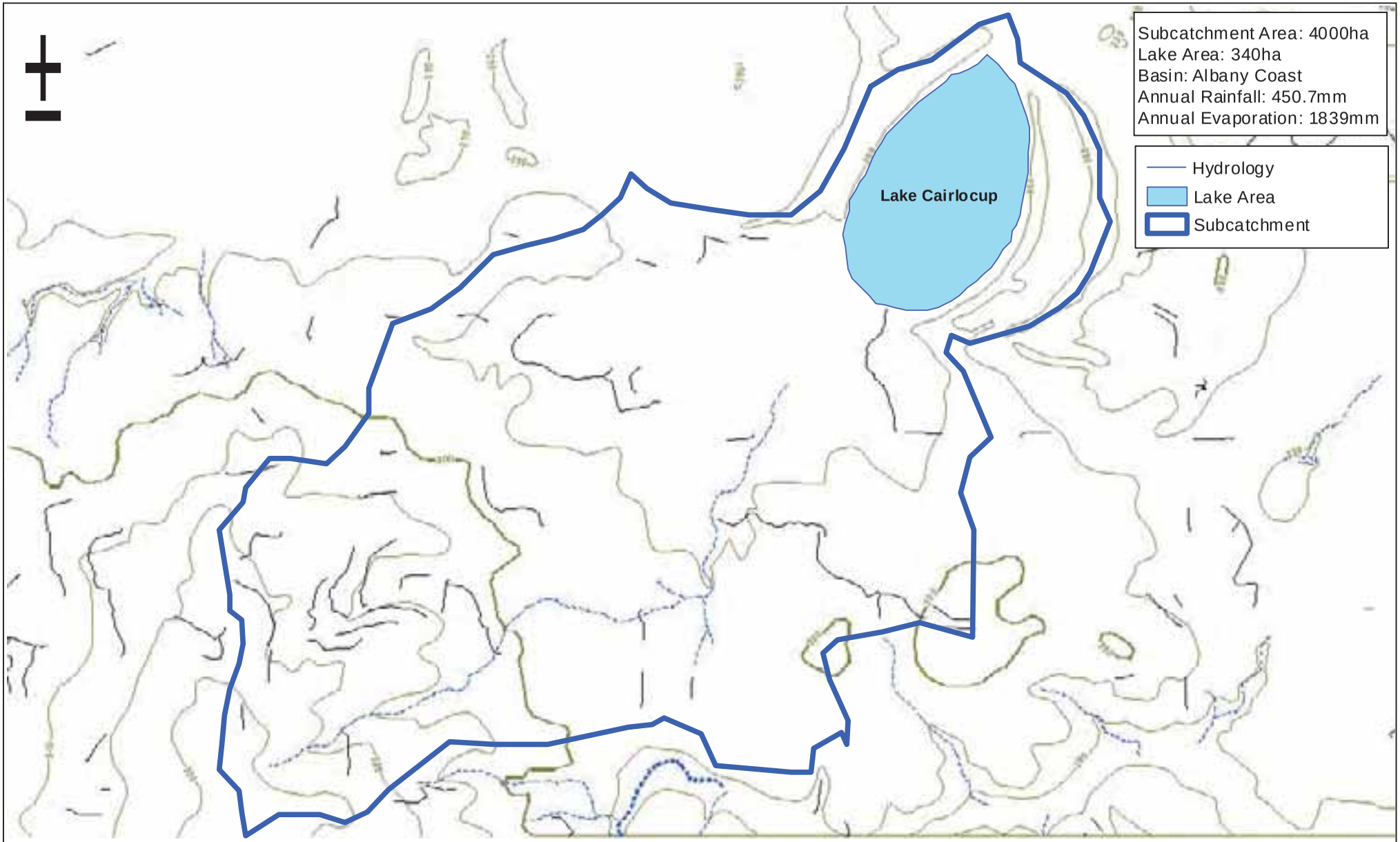
Living Lakes Feasibility Stage 1: Part 1

Figure 3E

Lake Bryde - Catchment

Lake Cairlocup



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:53,000

0 1 2 3 4 Kilometres

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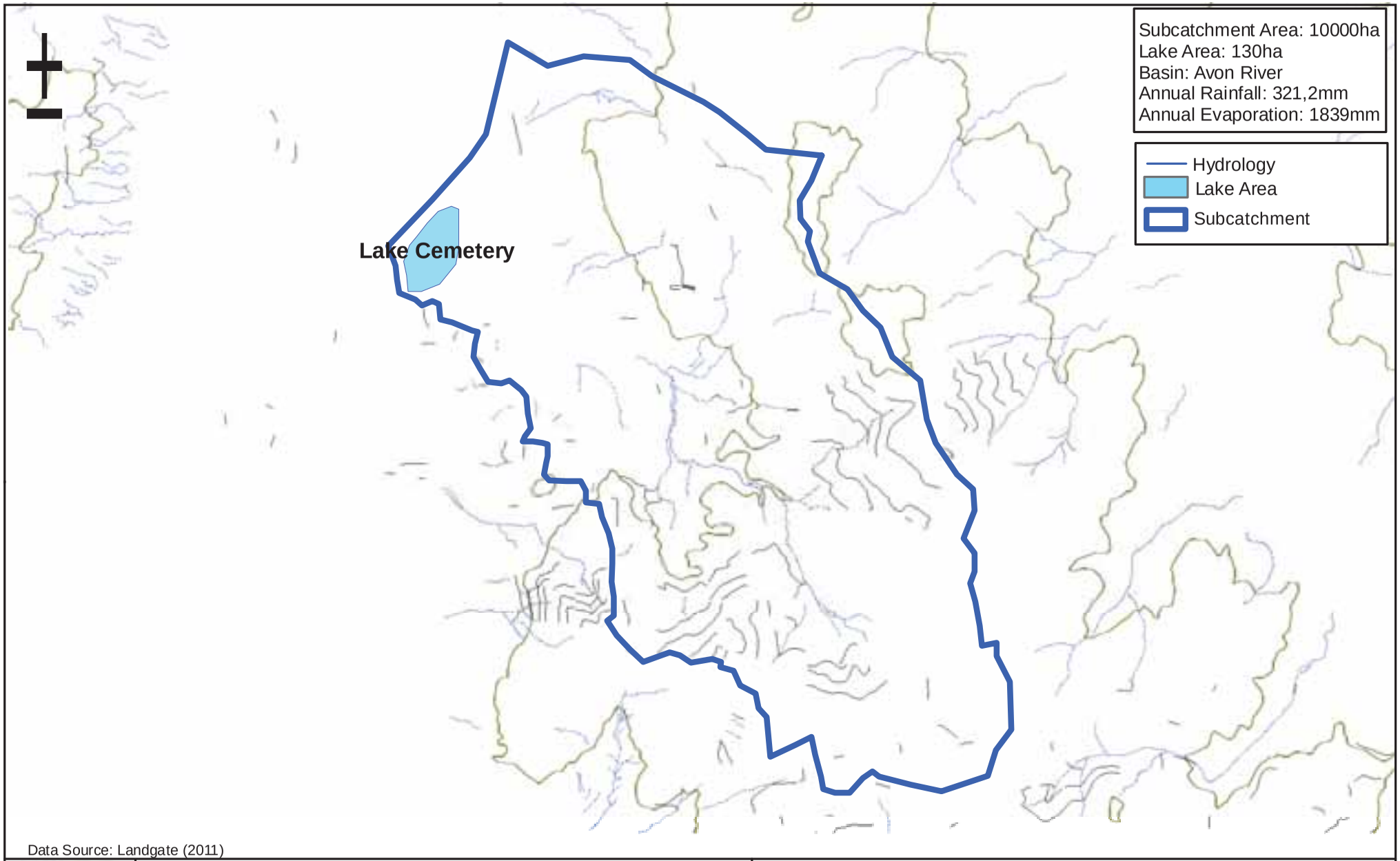
Living Lakes Feasibility Stage 1: Part 1

Figure 3F

Lake Cairlocup - Catchment

Lake Cemetery



Data Source: Landgate (2011)

Job No. J4905
Scale:1:105,000

0 0.5 1 2 3 4 Kilometres

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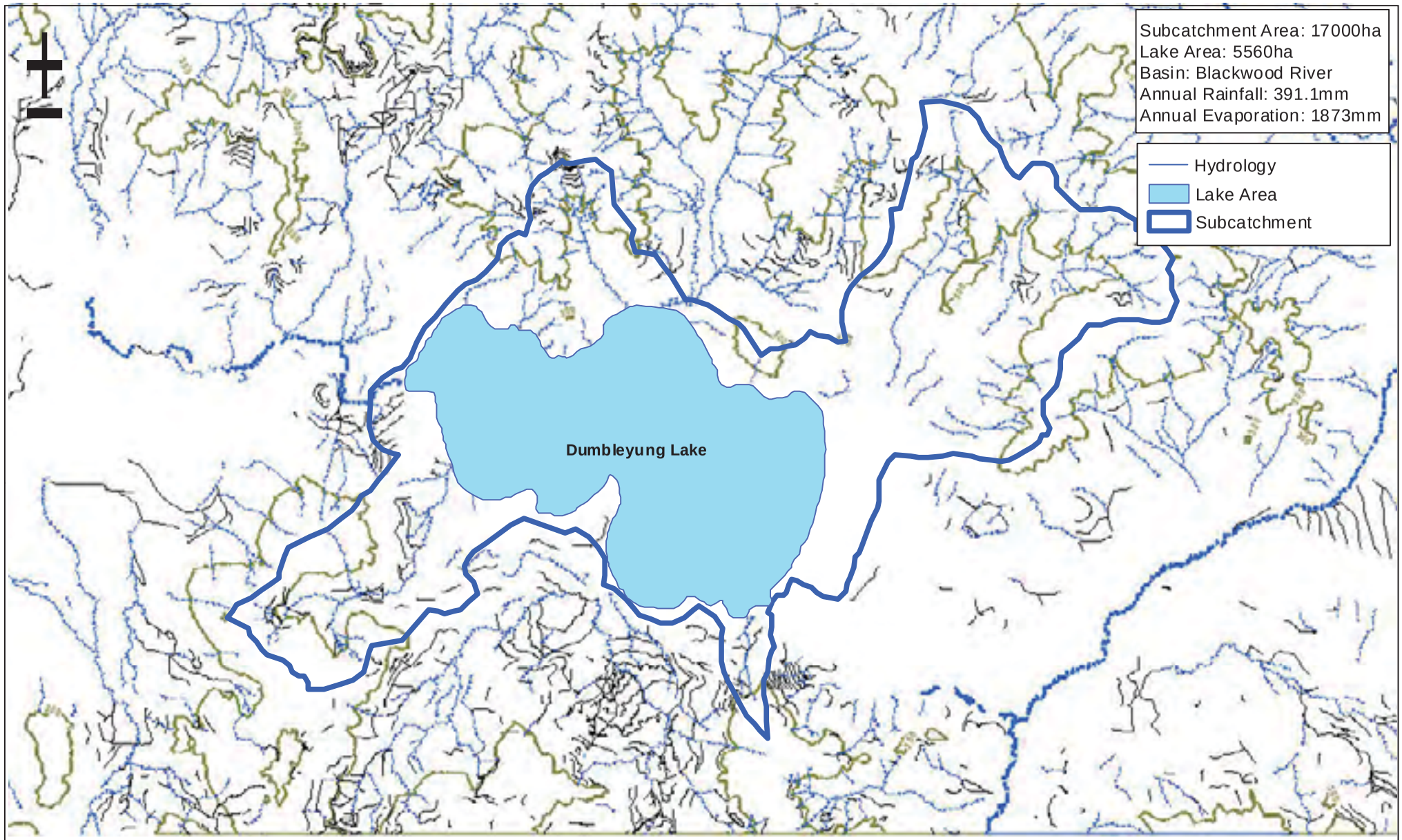
Living Lakes Feasibility Stage 1: Part 1

Figure 3G

Lake Cemetery - Catchment

Dumbleyung Lake



Data Source: Landgate (2011)

JDA

Job No. J4905
Scale: 1:140,000
0 0.5 1 2 3 4
Kilometres

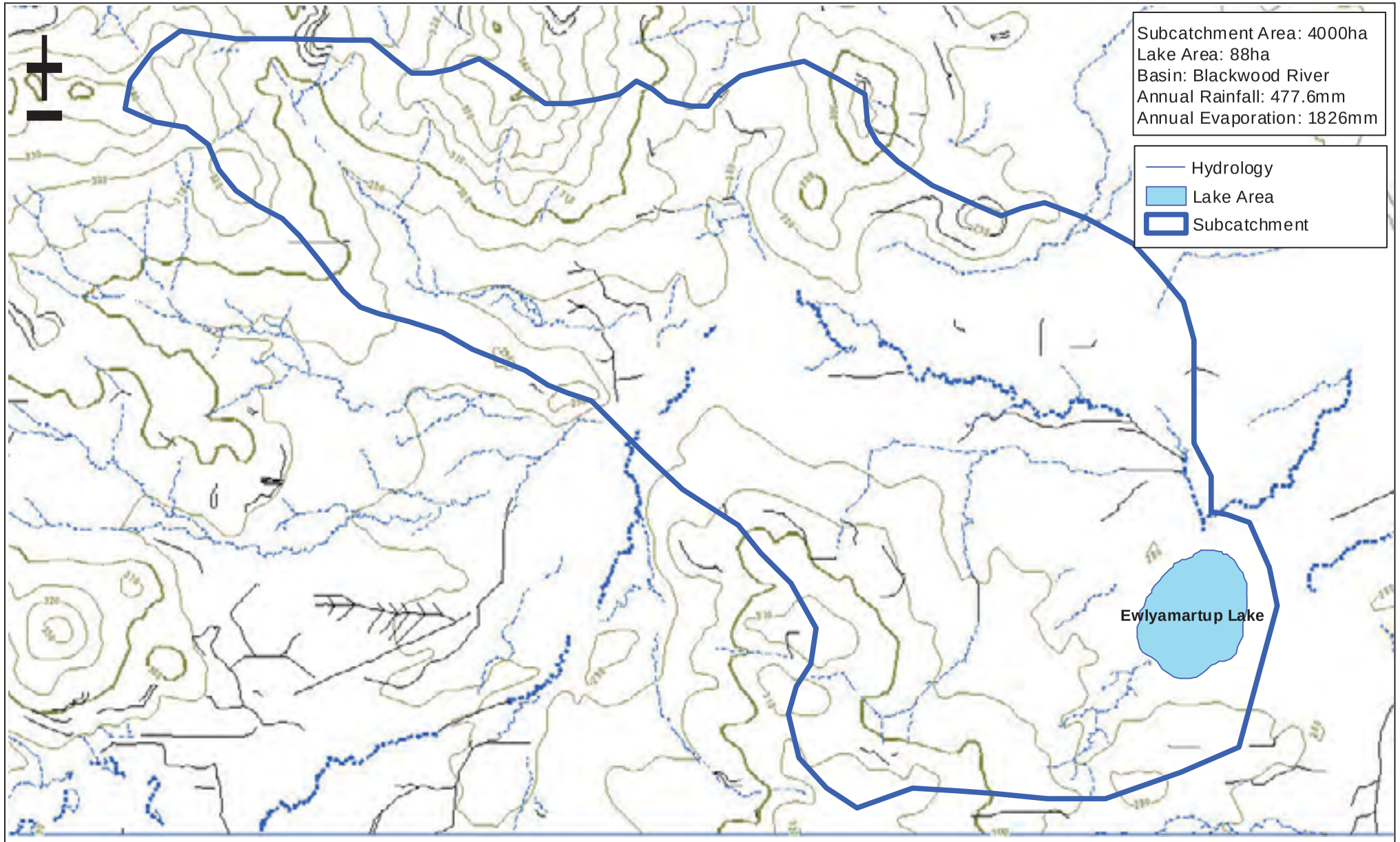
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3H

Dumbleyung Lake - Catchment

Ewlyamartup Lake



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:50,000

0 1 2 3 4 Kilometres

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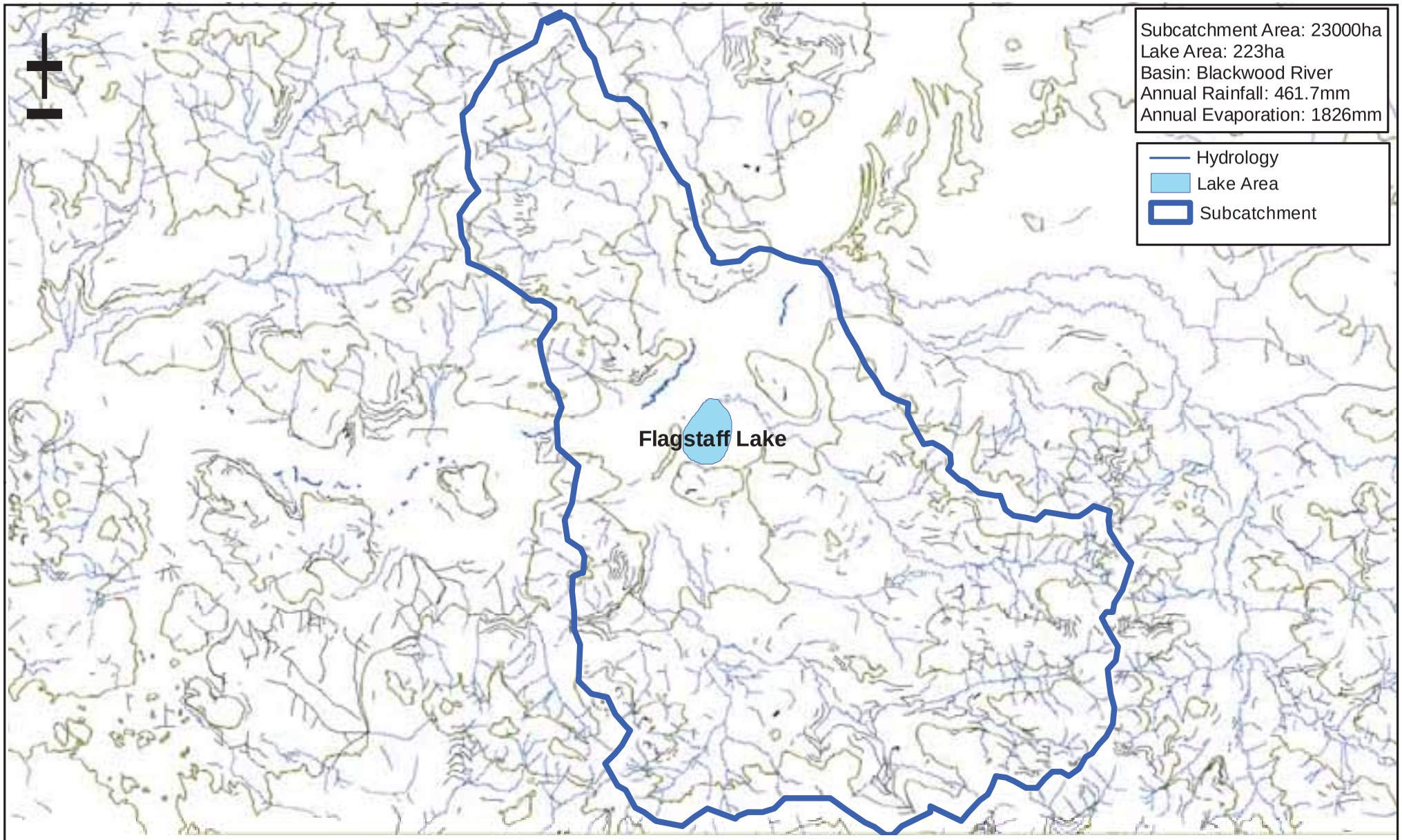
Living Lakes Feasibility Stage 1: Part 1

Figure 3I

Ewlyamartup Lake - Catchment

Flagstaff Lake



Data Source: Landgate (2011)

JDA

Job No. J4905
Scale:1:150,000

0 0.5 1 2 3 4
Kilometres

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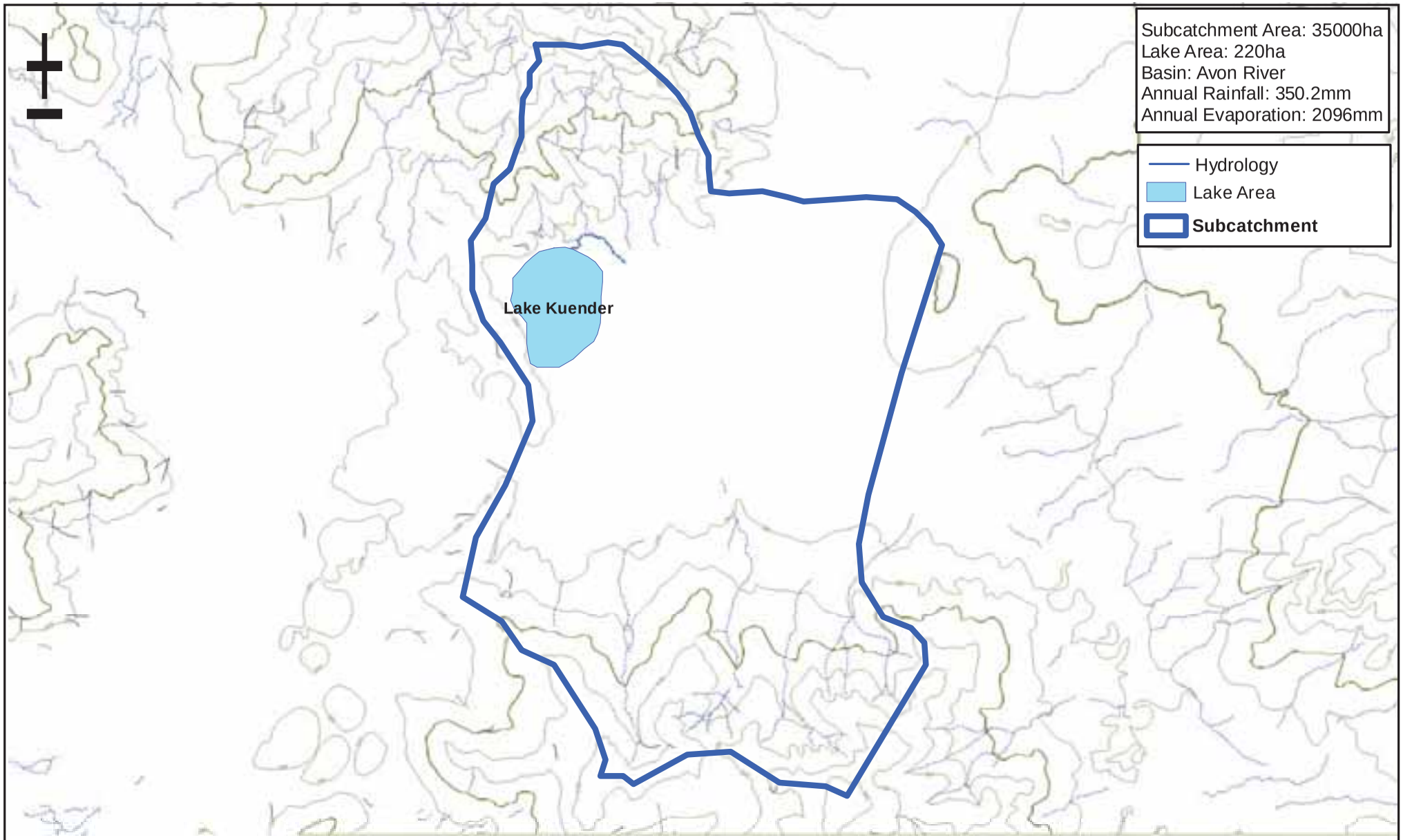
Living Lakes Feasibility Stage 1: Part 1

Figure 3J

Flagstaff Lake - Catchment

Lake Kuender



Data Source: Landgate (2011)

Job No. J4905
Scale:1:83,500

0 0.5 1 2 3 4 Kilometres

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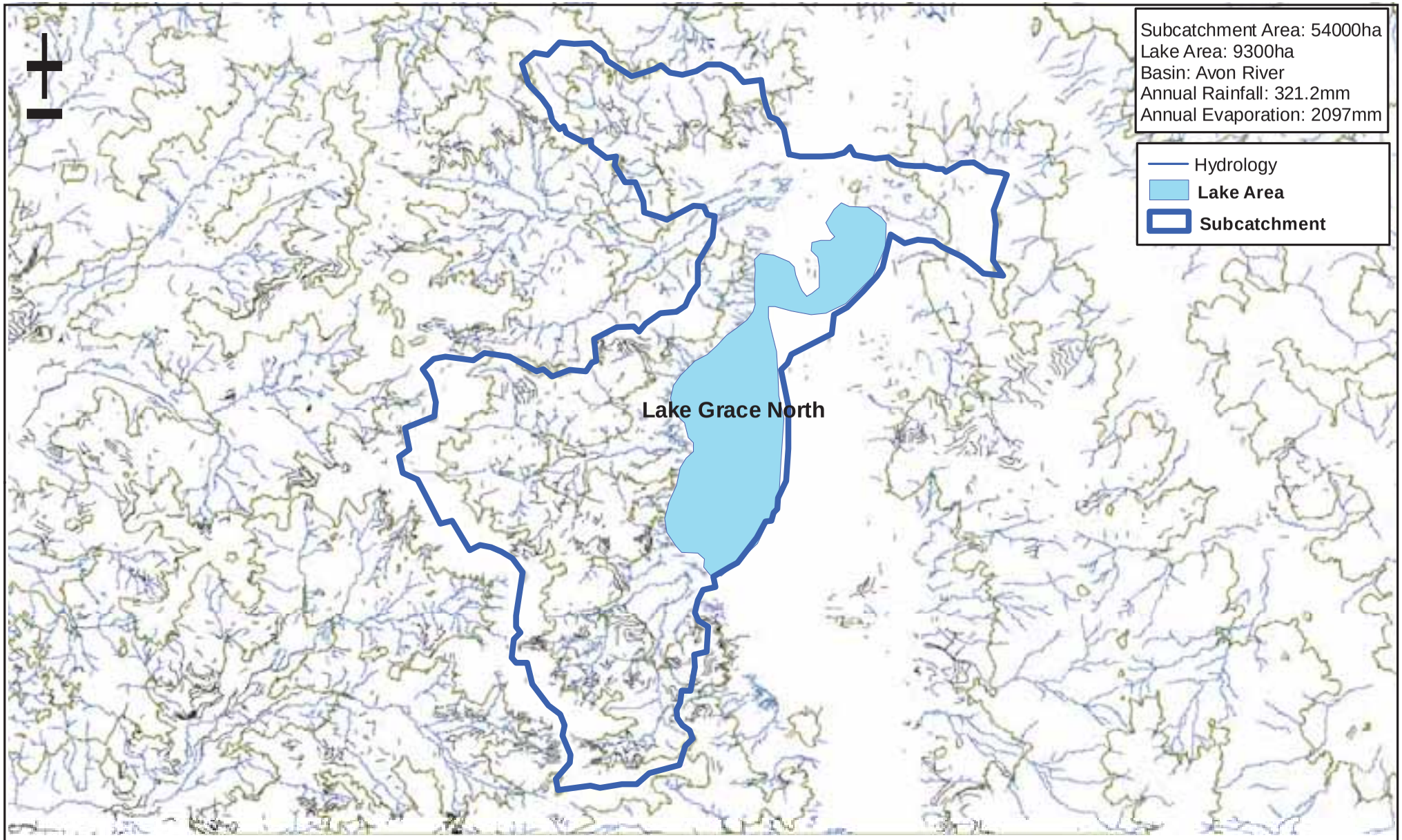
Living Lakes Feasibility Stage 1: Part 1

Figure 3K

Lake Kuender - Catchment

Lake Grace North



Data Source: Landgate (2011)

Job No. J4905
Scale:1:290,000

0 2 4 8 12 16 Kilometres

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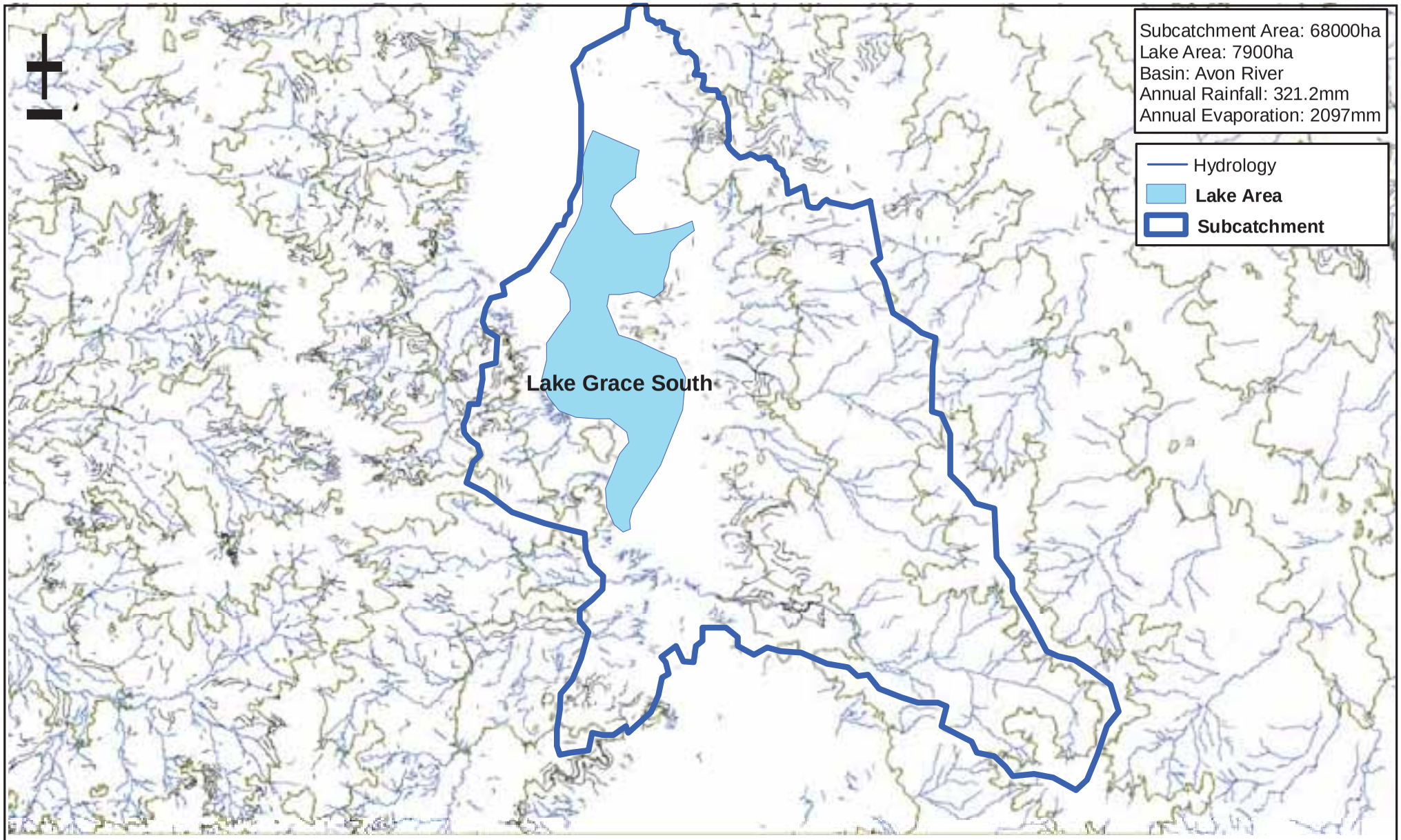
Living Lakes Feasibility Stage 1: Part 1

Figure 3L

Lake Grace North - Catchment

Lake Grace South



Data Source: Landgate (2011)

Job No. J4905
Scale:1:275,000

0 2 4 8 12 16 Kilometres

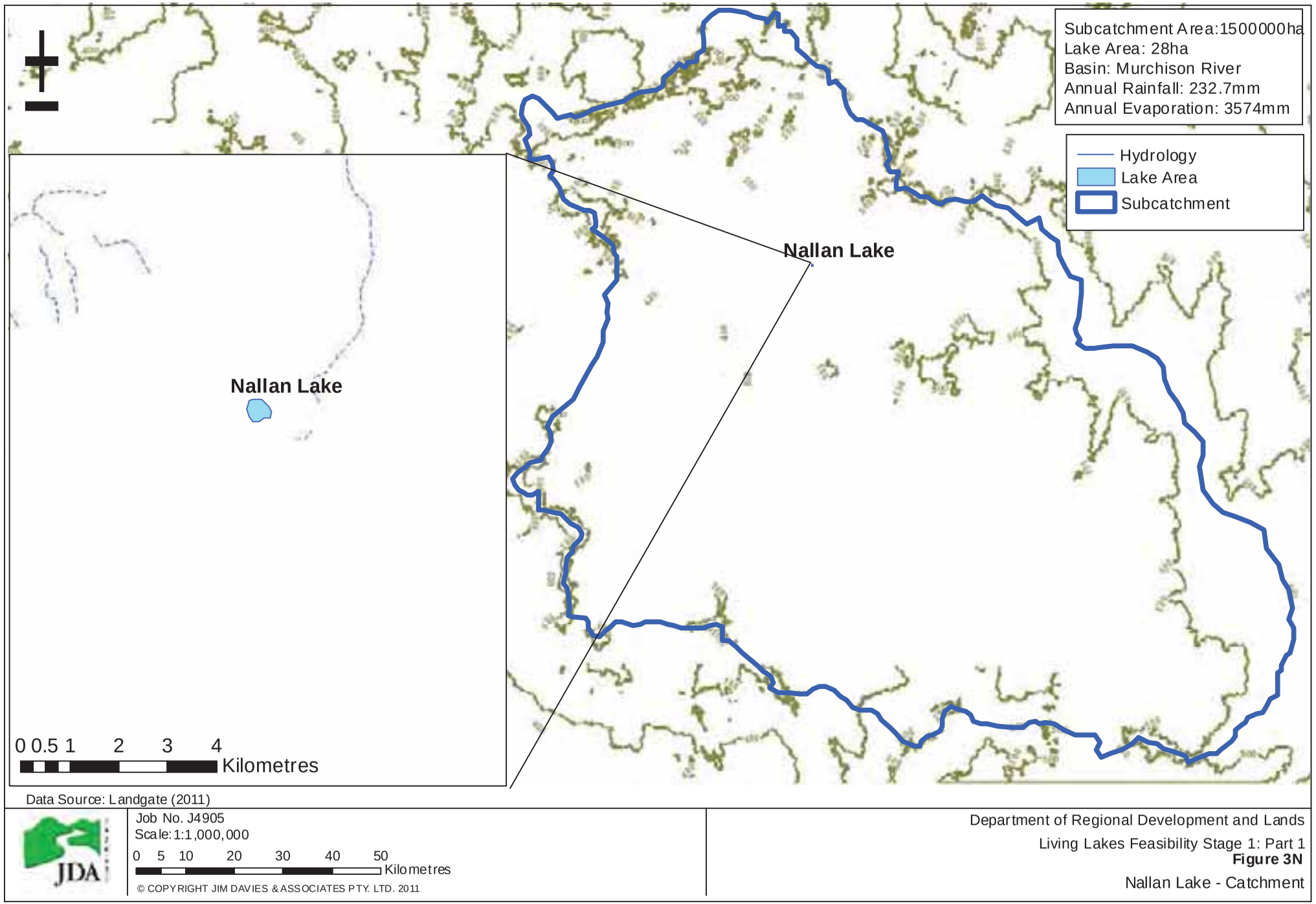
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

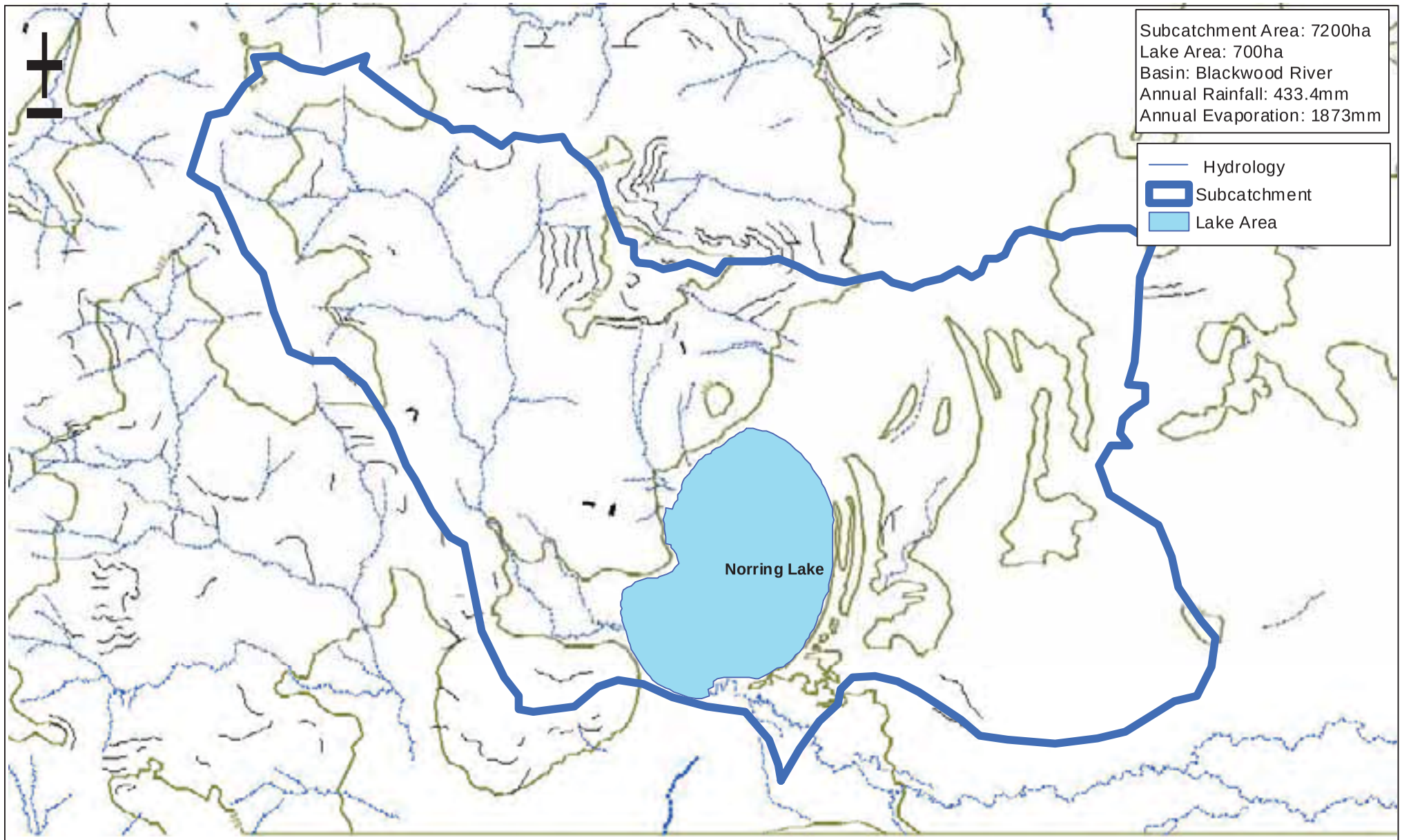
Figure 3M

Lake Grace South - Catchment

Nallan Lake


Subcatchment Area:1500000ha
Lake Area: 28ha
Basin: Murchison River
Annual Rainfall: 232.7mm
Annual Evaporation: 3574mm
Hydrology
Lake Area
Subcatchment
Nallan Lake
Nallan Lake
0 0.5 1 2 3 4
Kilometres
Data Source: Landgate (2011)
Job No. J4905
Scale: 1:1,000,000
0 5 10 20 30 40 50
Kilometres
© COPYRIGHT JIM DAVIES & ASSOCIATES PTY. LTD. 2011
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 3N
Nallan Lake - Catchment

Norring Lake



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:70,000

0 0.5 1 2 3 4 Kilometres

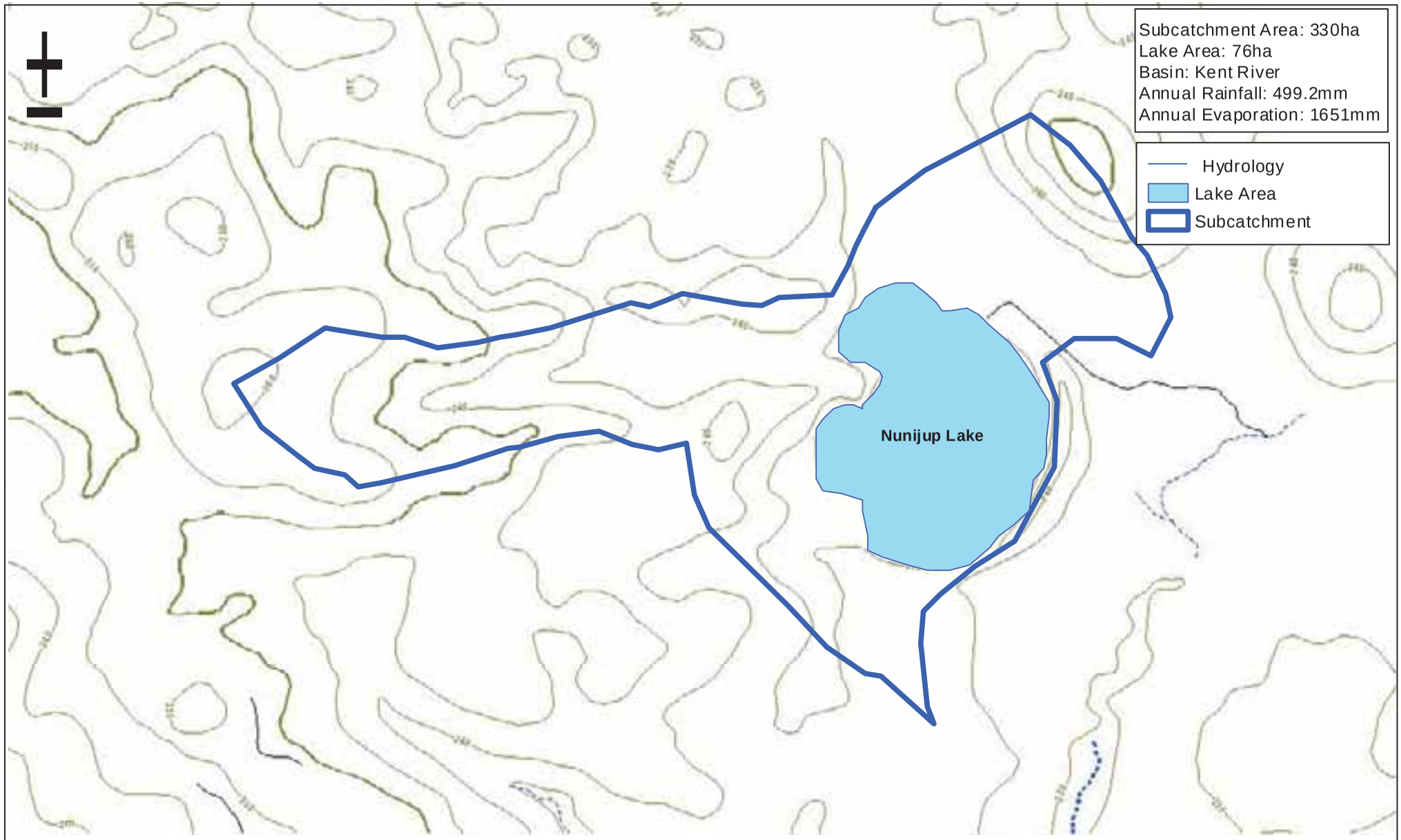
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3O

Norring Lake - Catchment

Nunijup Lake



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:21,000

0 0.2 0.4 0.8 1.2 1.6 Kilometres

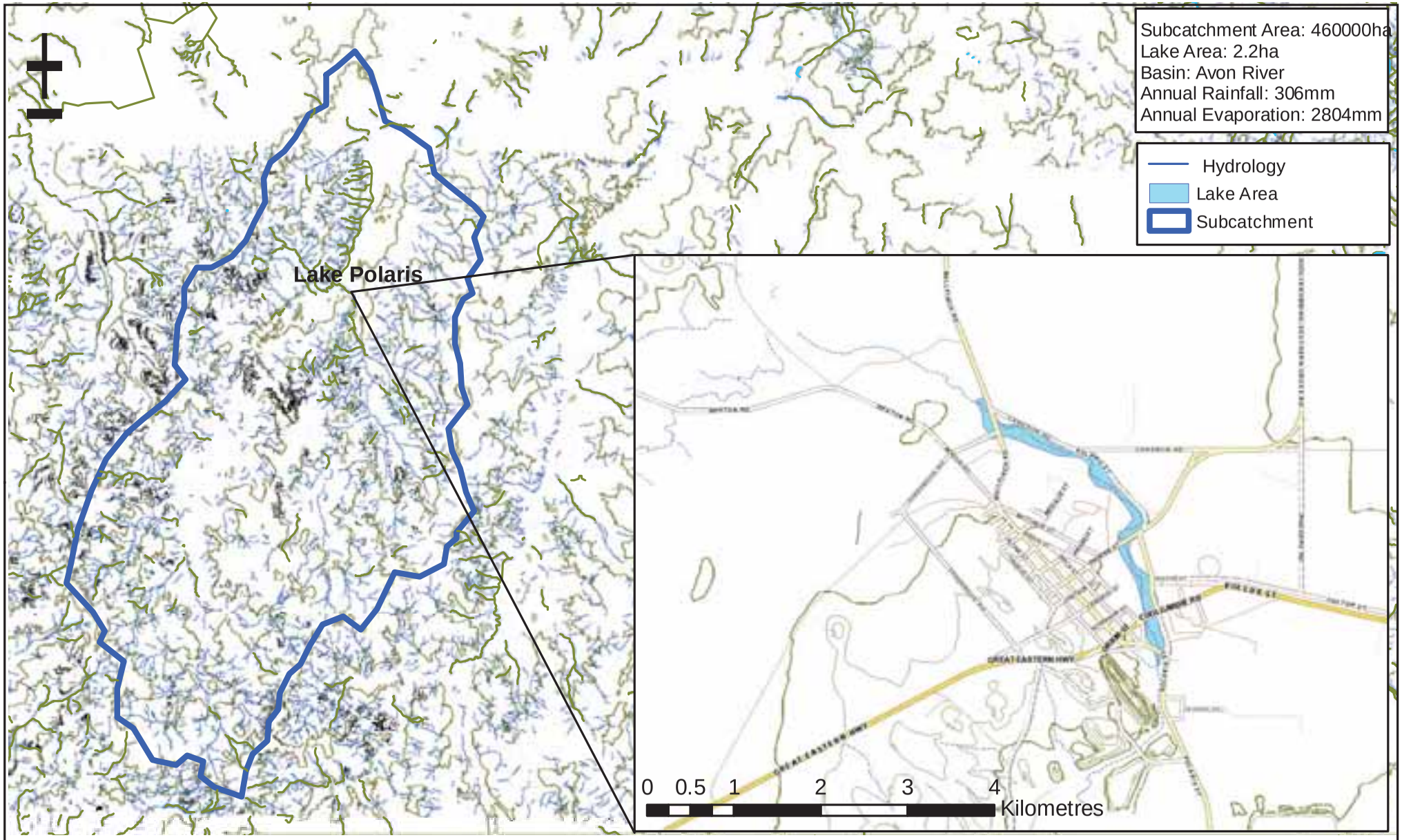
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3P

Nunijup Lake - Catchment

Lake Polaris



Data Source: Landgate (2011)

JDA

Job No. J4905
Scale:1:865,549
0 5 10 20 30 40
Kilometres

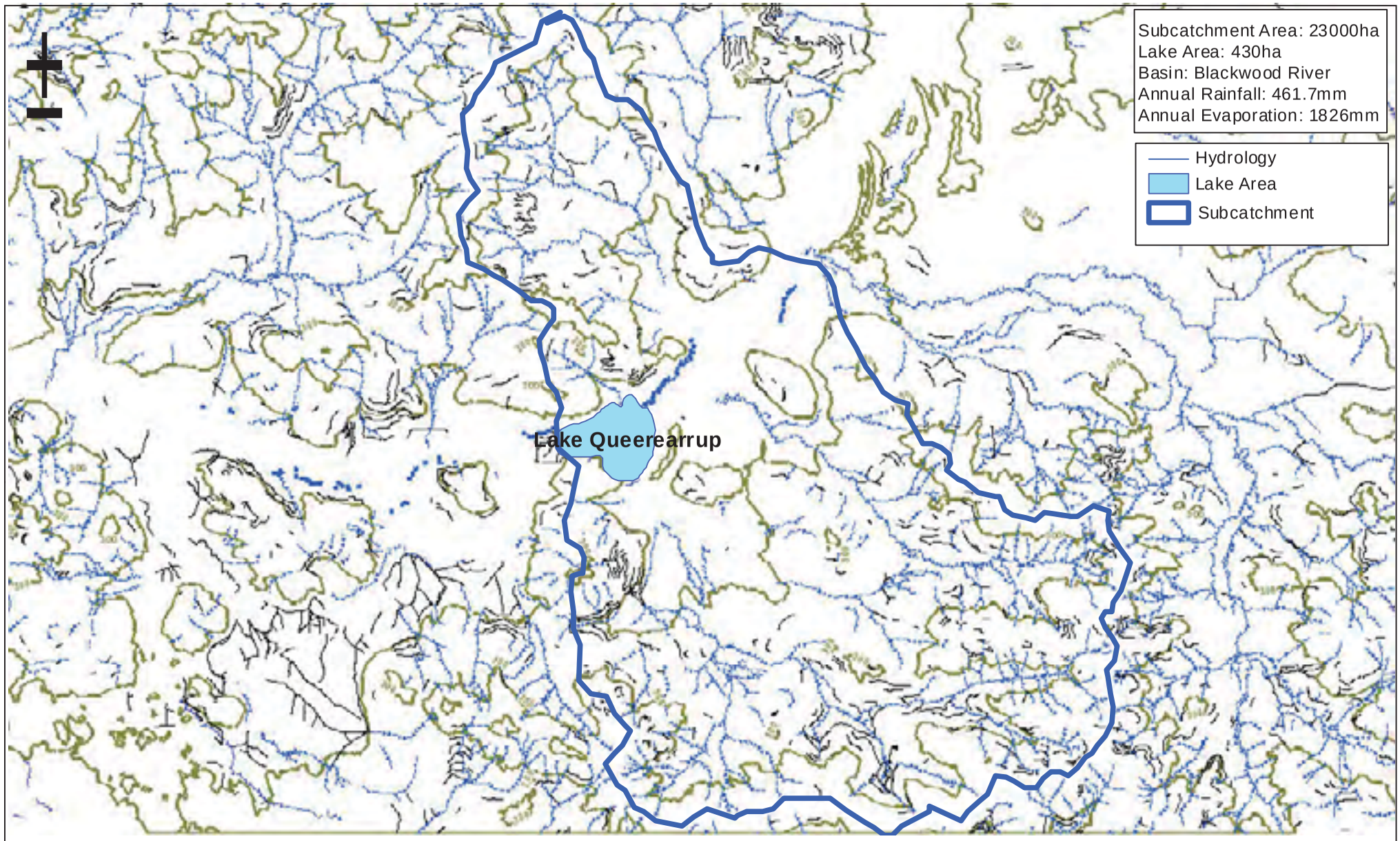
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3Q

Lake Polaris - Catchment

Queerearrup Lake



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:150,000

0 0.5 1 2 3 4 Kilometres

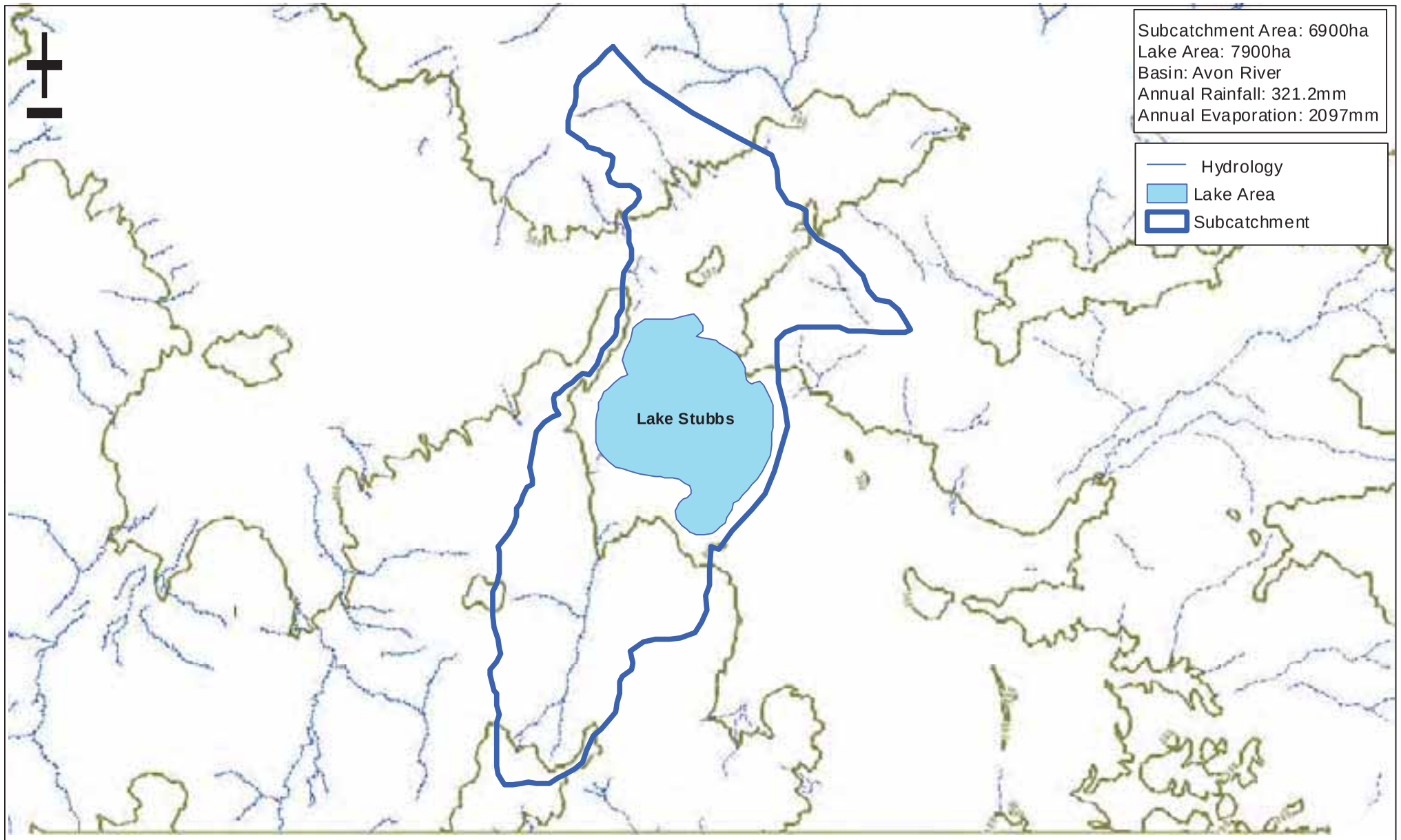
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3R

Queerearrup Lake - Catchment

Lake Stubbs



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:120,000
0 0.5 1 2 3 4
Kilometres

Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3S

Lake Stubbs - Catchment

Towerrining Lake

Data Source: Landgate (2011)

Job No. J4905
Scale: 1:85,000
0 0.5 1 2 3 4 Kilometres

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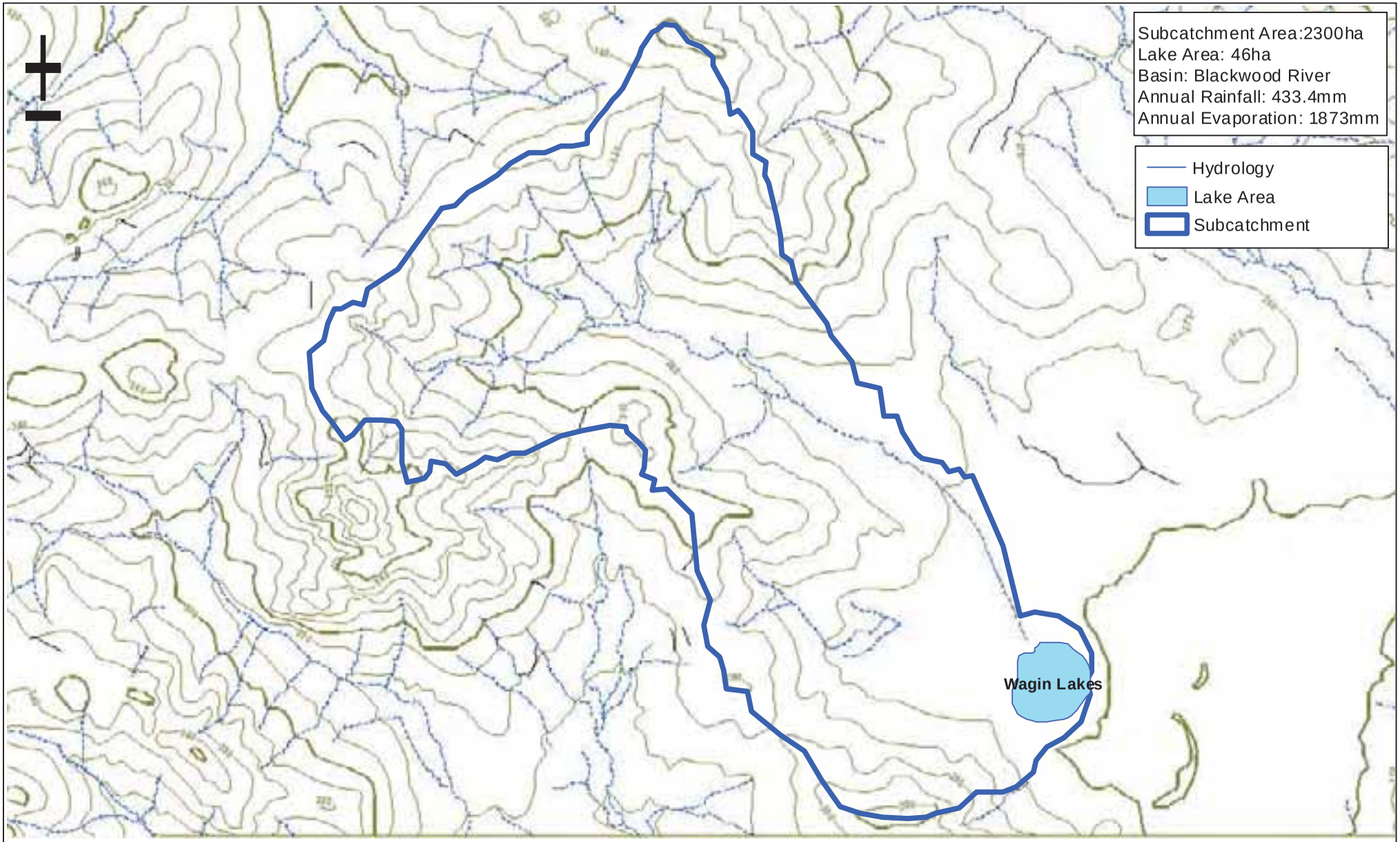
Living Lakes Feasibility Stage 1: Part 1

Figure 3T

Towerrining Lake - Catchment Map

Wagin Lakes



Data Source: Landgate (2011)

Job No. J4905

Scale: 1:50,000

0 0.5 1 2 3 4 Kilometres

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Living Lakes Feasibility Stage 1: Part 1

Figure 3U

Wagin Lakes - Catchment Map

Wicherina Dam

Data Source: Landgate (2011)

Job No. J4905
Scale:1:50,000
0 0.5 1 2 3 4 Kilometres

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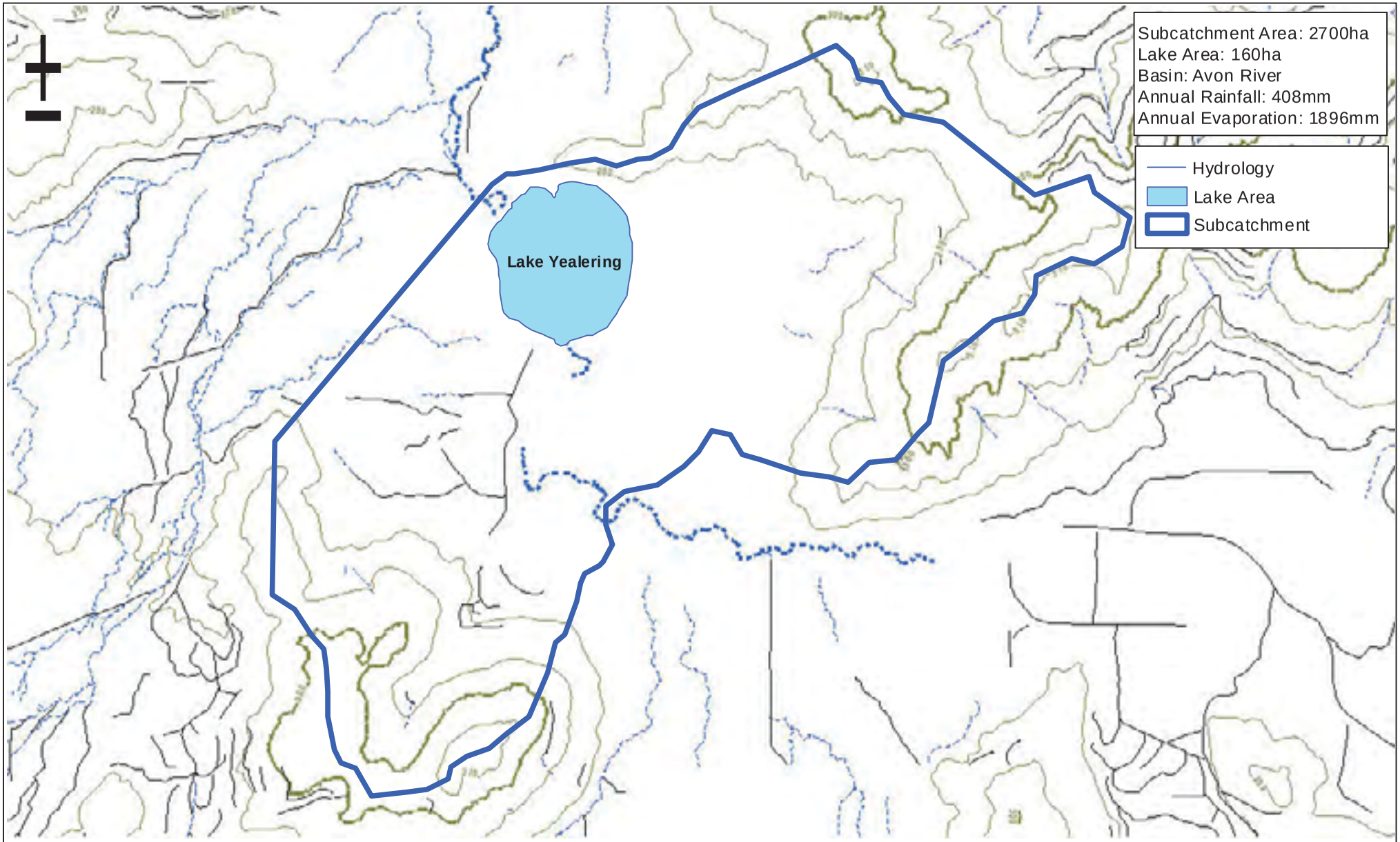
Living Lakes Feasibility Stage 1: Part 1

Figure 3V

Wicherina Dam - Catchment

Lake Yealering

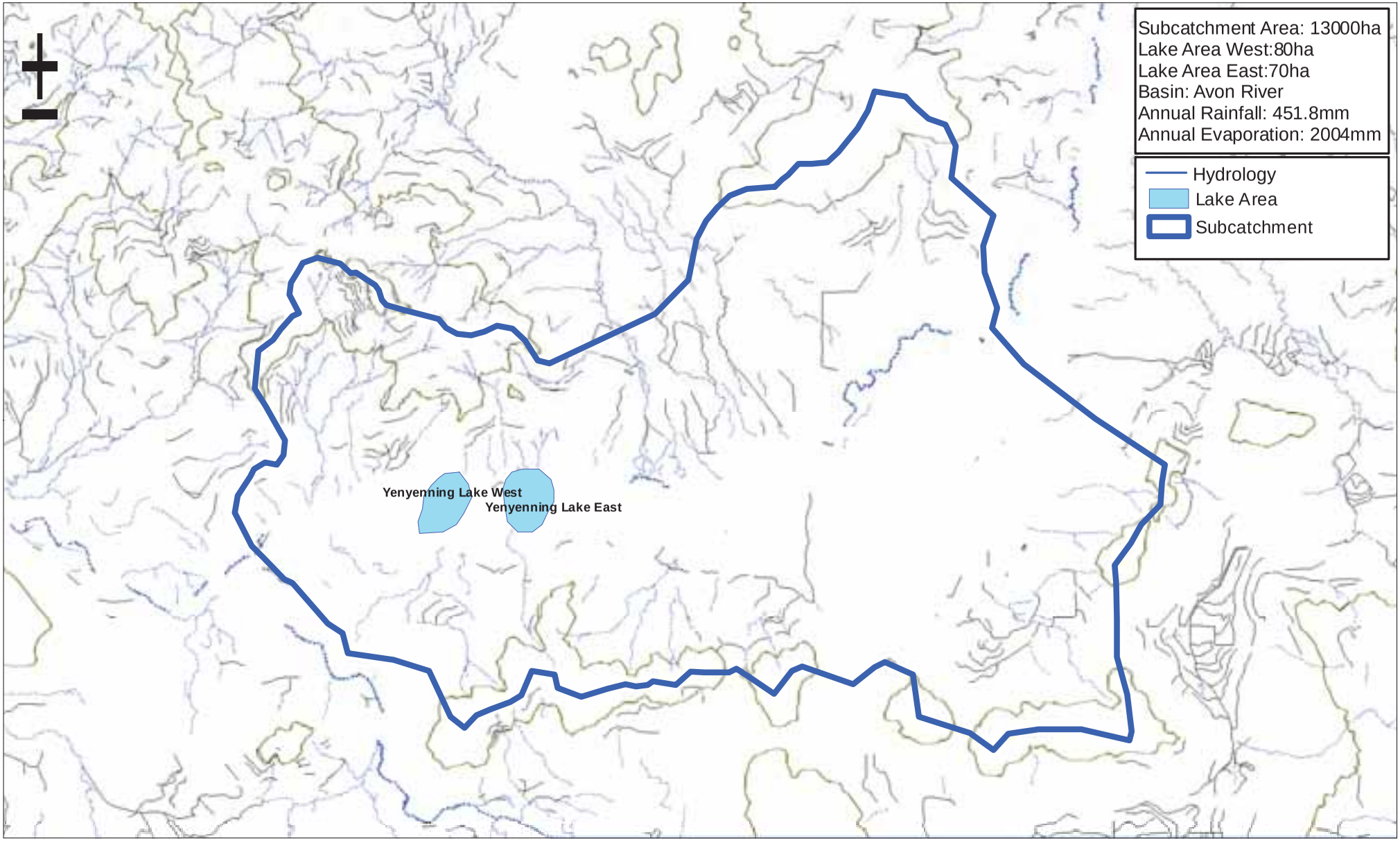


Data Source: Landgate (2011)

Job No. J4905
Scale: 1:50,000
0 0.5 1 2 3 4 Kilometres

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 3W
Lake Yealering - Catchment Map

Yenyenning Lakes



Data Source: Landgate (2011)

JDA

Job No. J4905
Scale:1:100,000
0 1 2 3 4 Kilometres

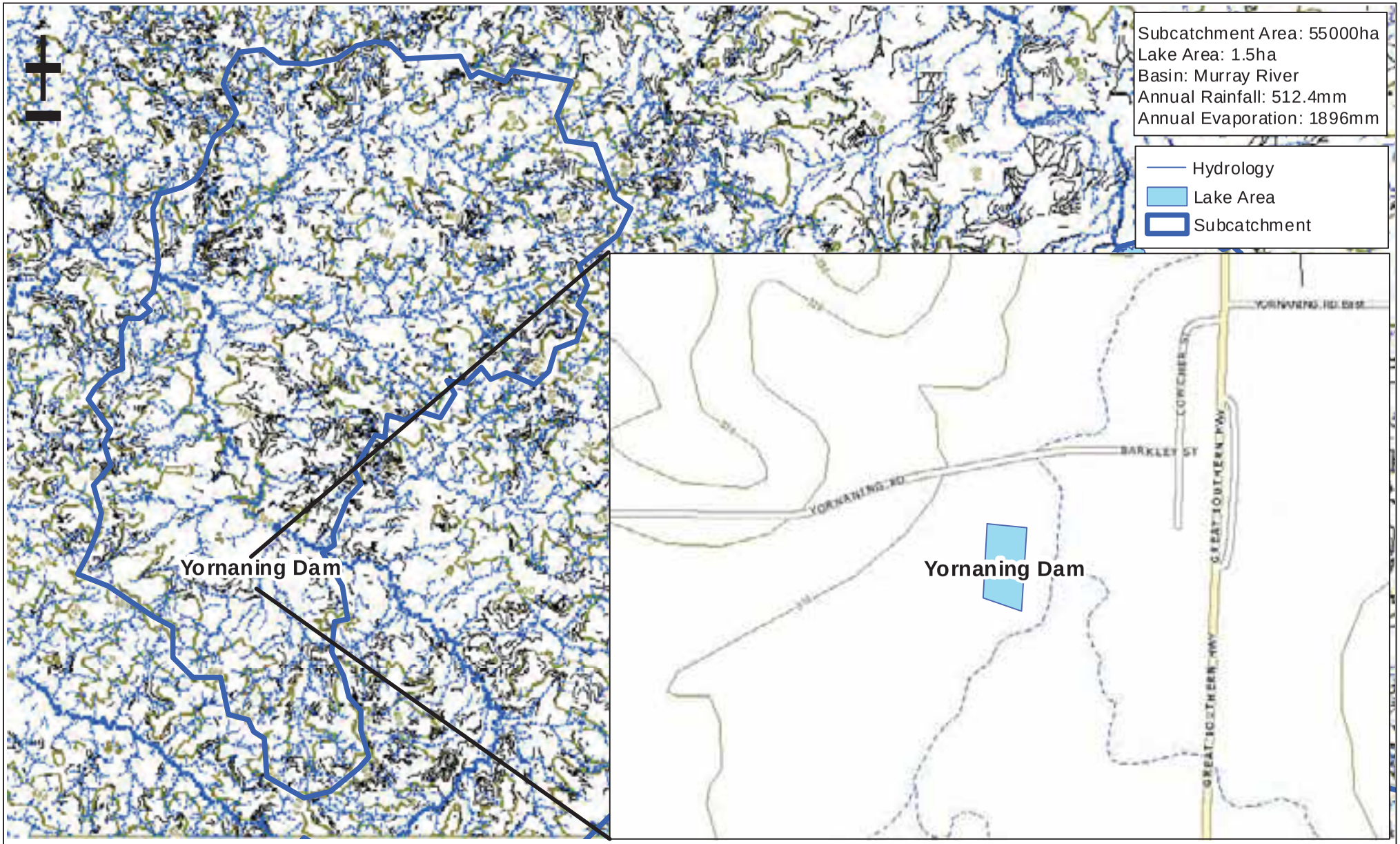
Department of Regional Development and Lands

Living Lakes Feasibility Stage 1: Part 1

Figure 3X

Yenyenning Lakes - Catchment

Yornaning Dam



Data Source: Landgate (2011)

Job No. J4905
Scale: 1:263,000

0 5 10 15 20 Kilometres

Department of Regional Development and Lands

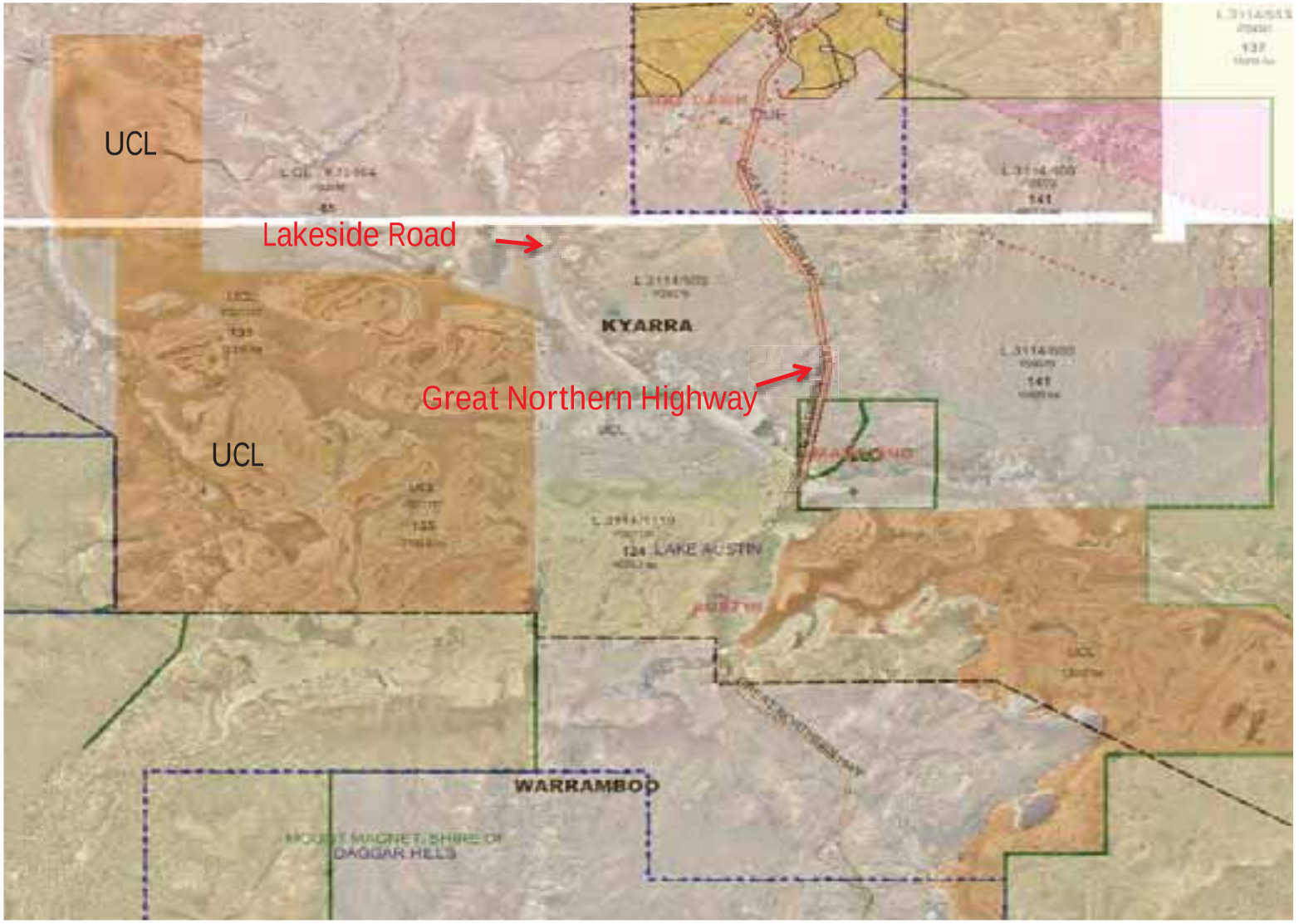
Living Lakes Feasibility Stage 1: Part 1

Figure 3Y

Yornaning Dam - Catchment

FIGURE 4A to 4Y

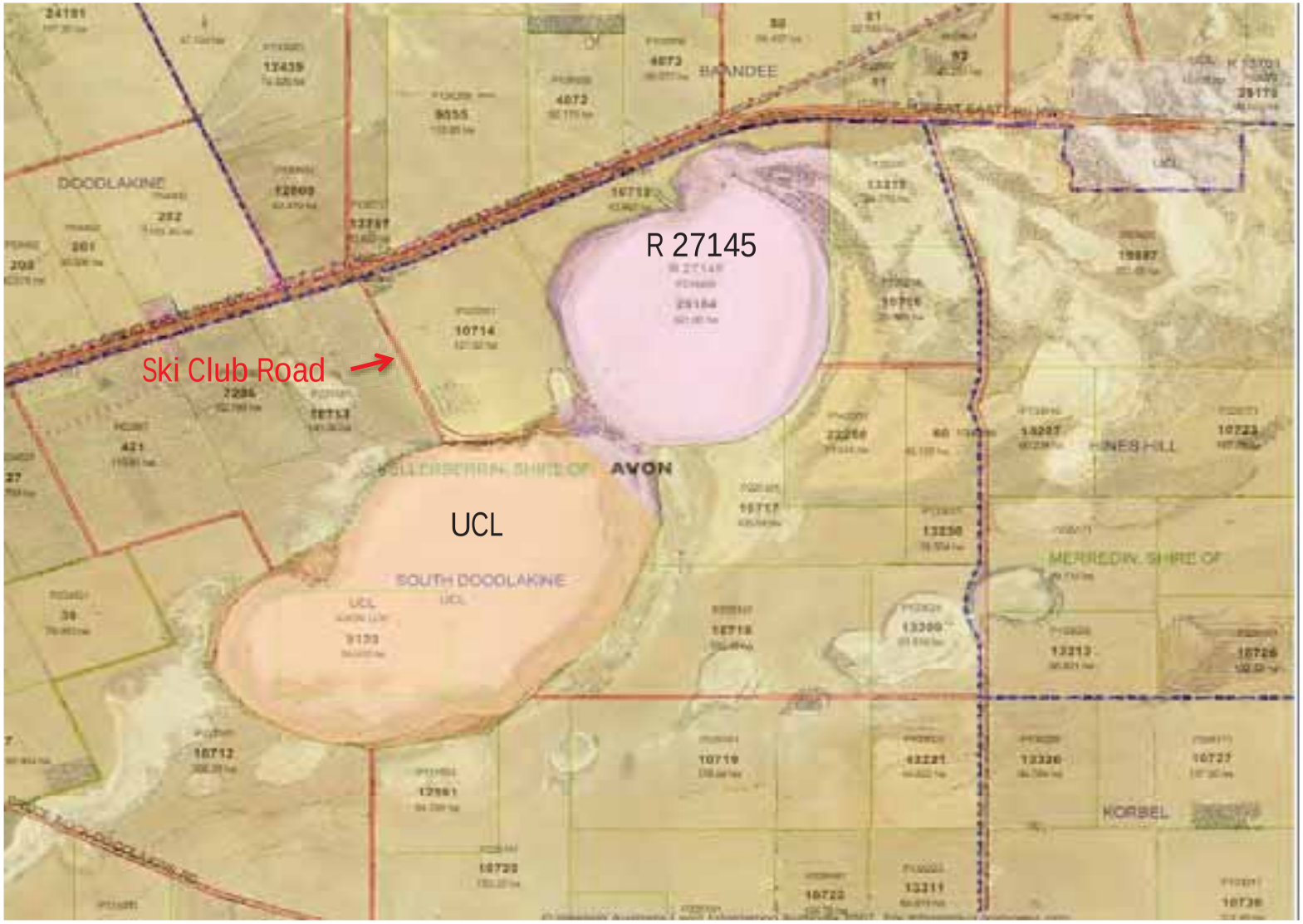
Land vesting and access for each nominated Lake



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

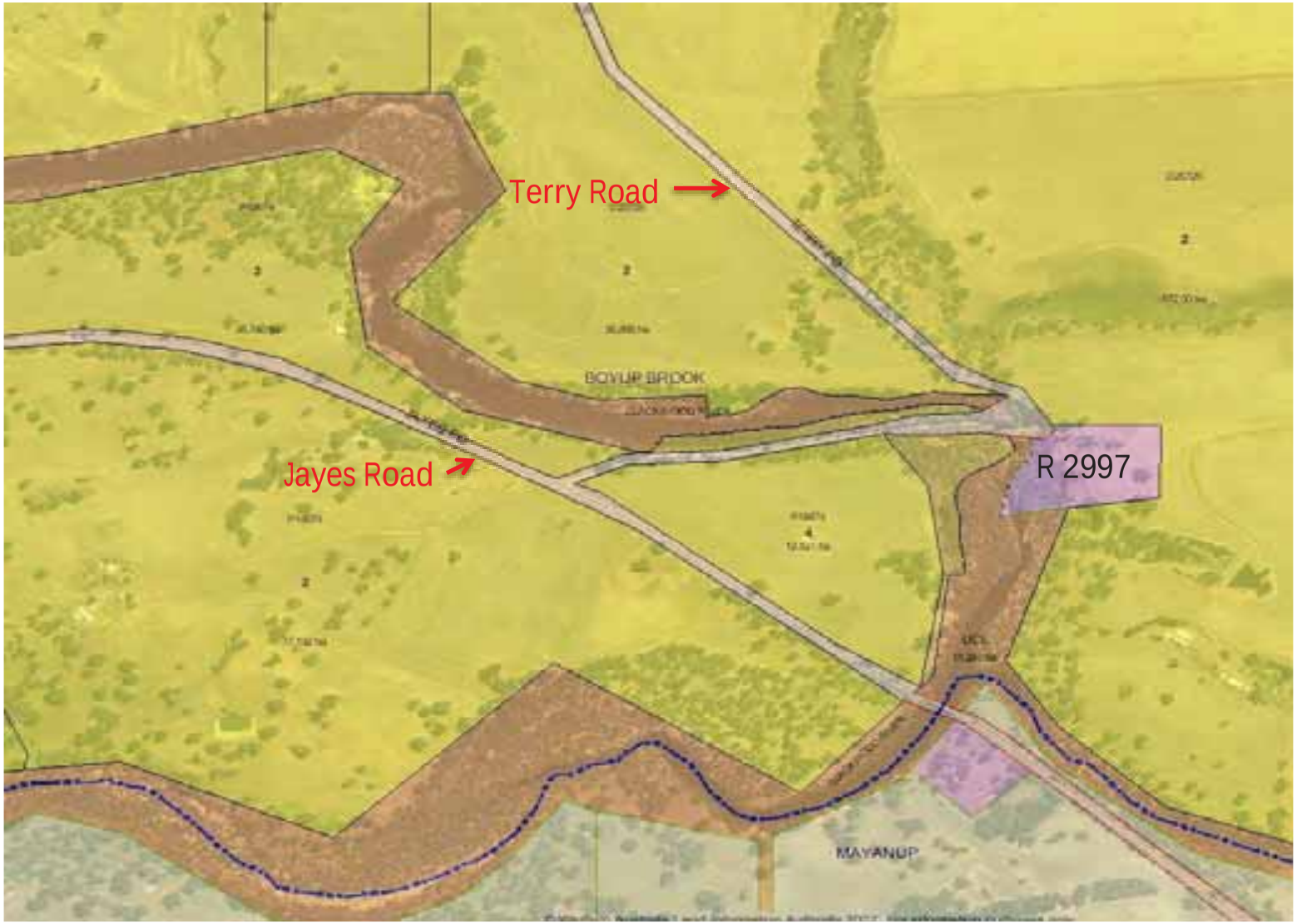
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4A
Lake Austin - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4B
Lake Baandee - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

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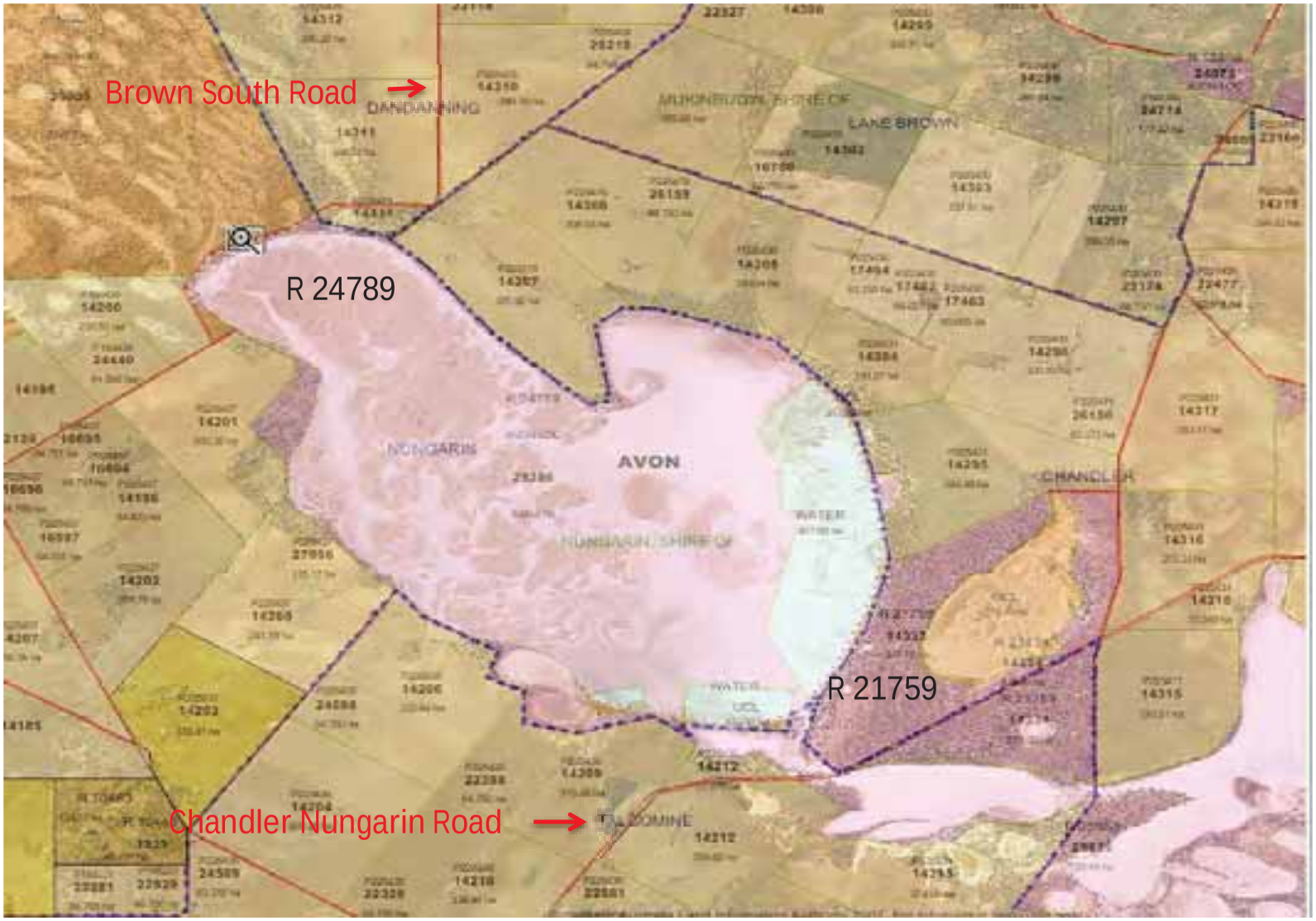
Living Lakes Feasibility Stage 1: Part 1

Figure 4C

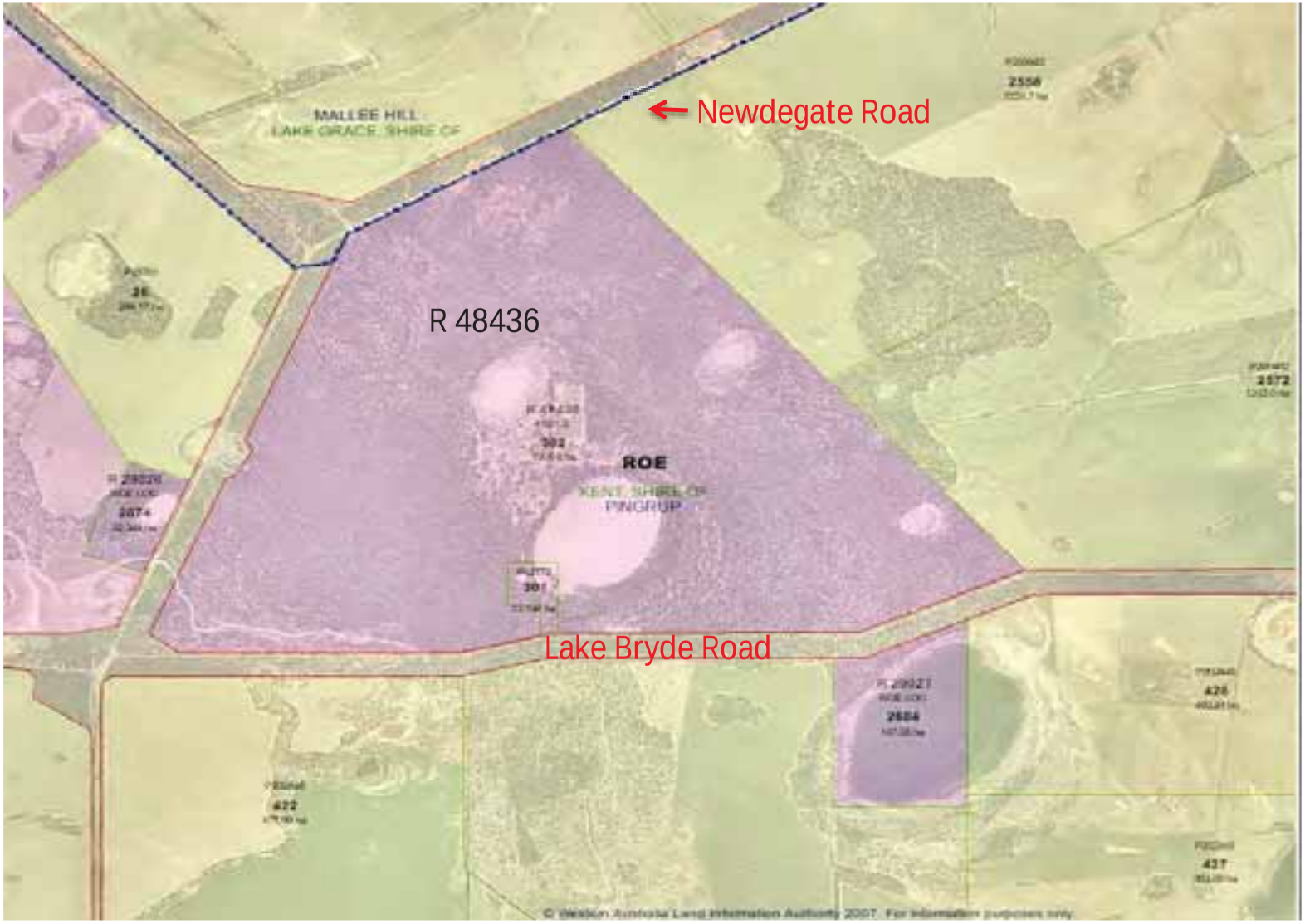
Blackwood River at Terry Road Crossing - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

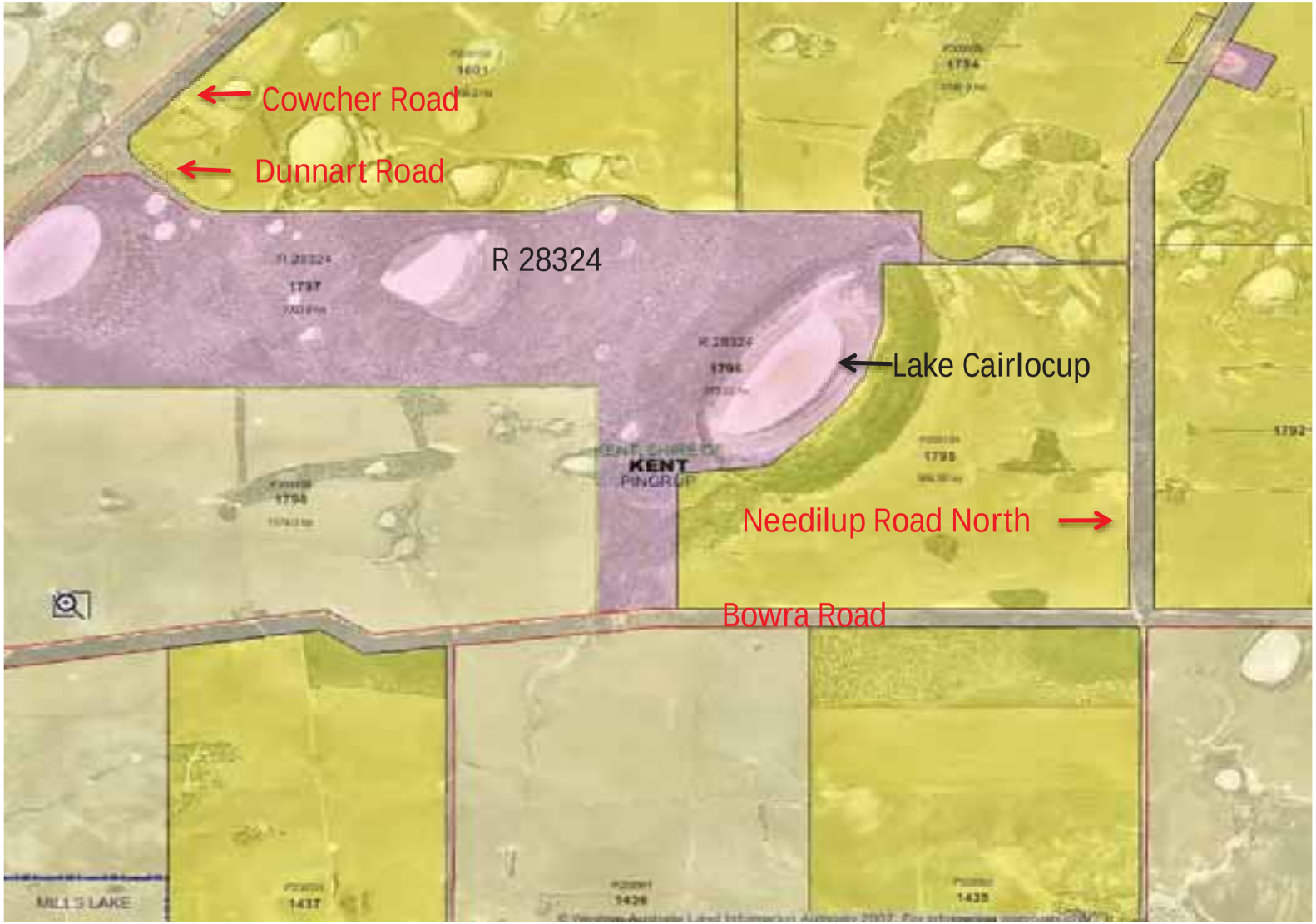
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4D
Lake Brown - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

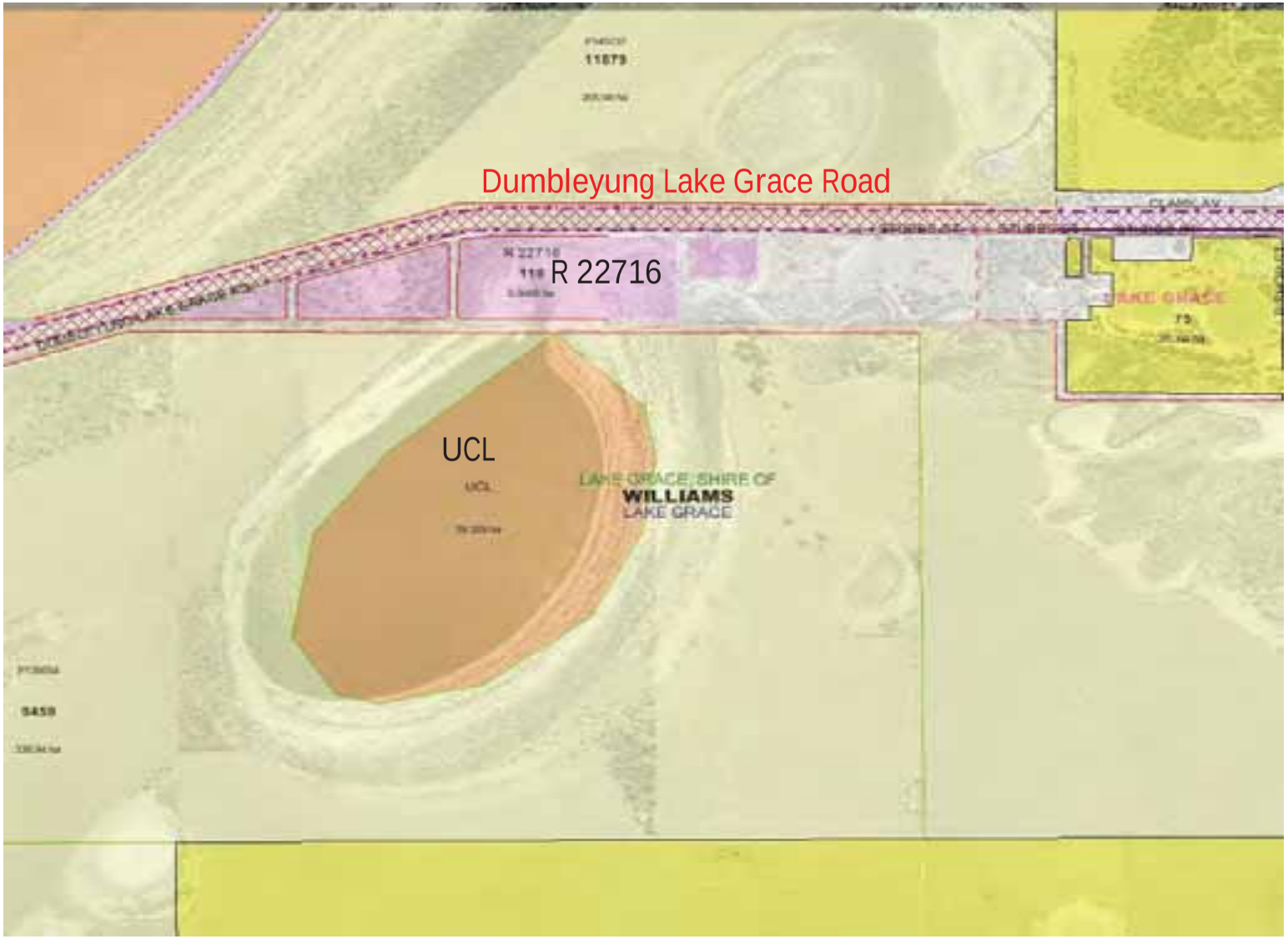
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4E
Lake Bryde - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4F
Lake Cairlocup - Public Land and Access Roads



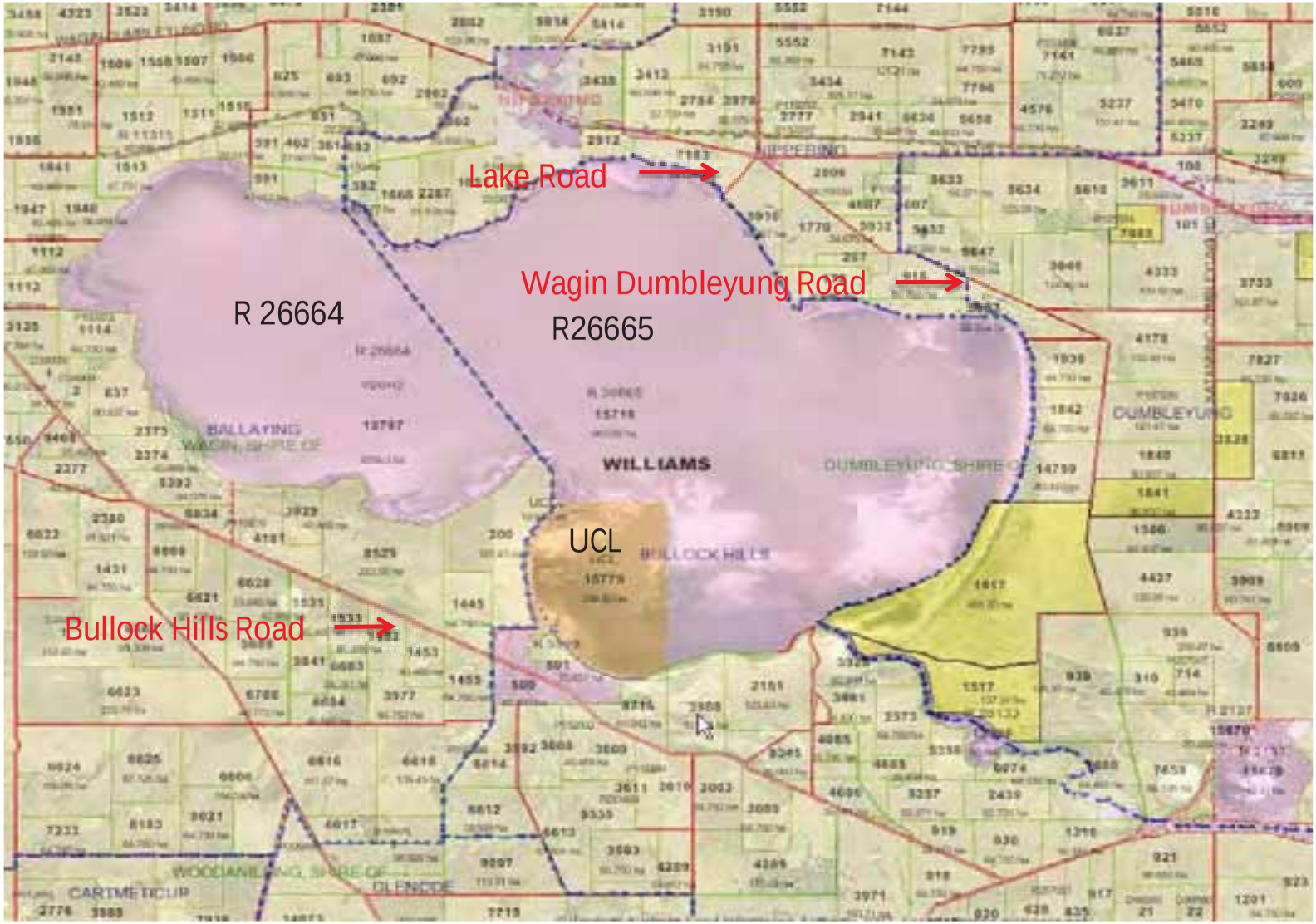
Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1

Figure 4G

Lake Cemetery - Public Land and Access Roads



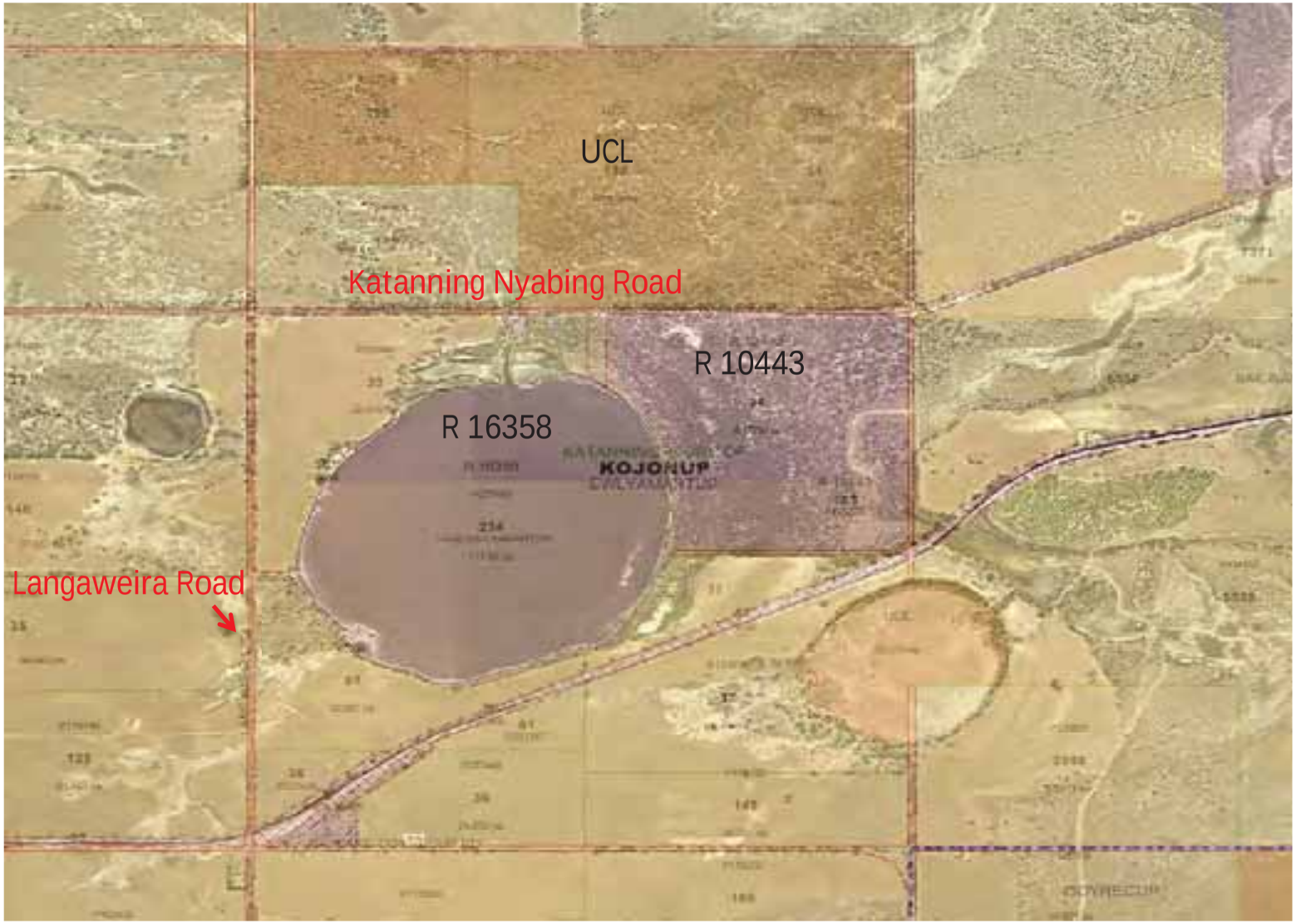
Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1

Figure 4H

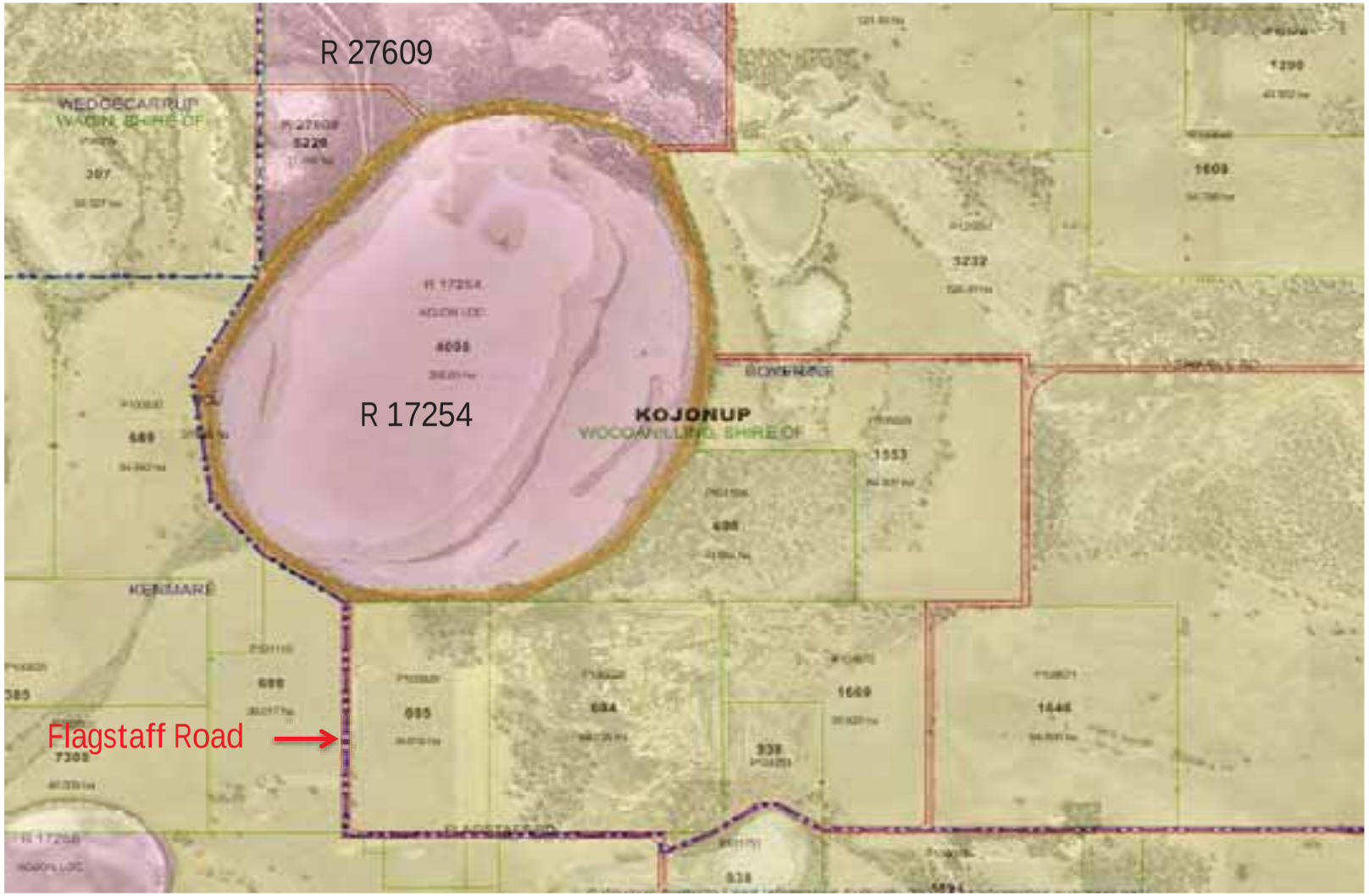
Dumbleyung Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

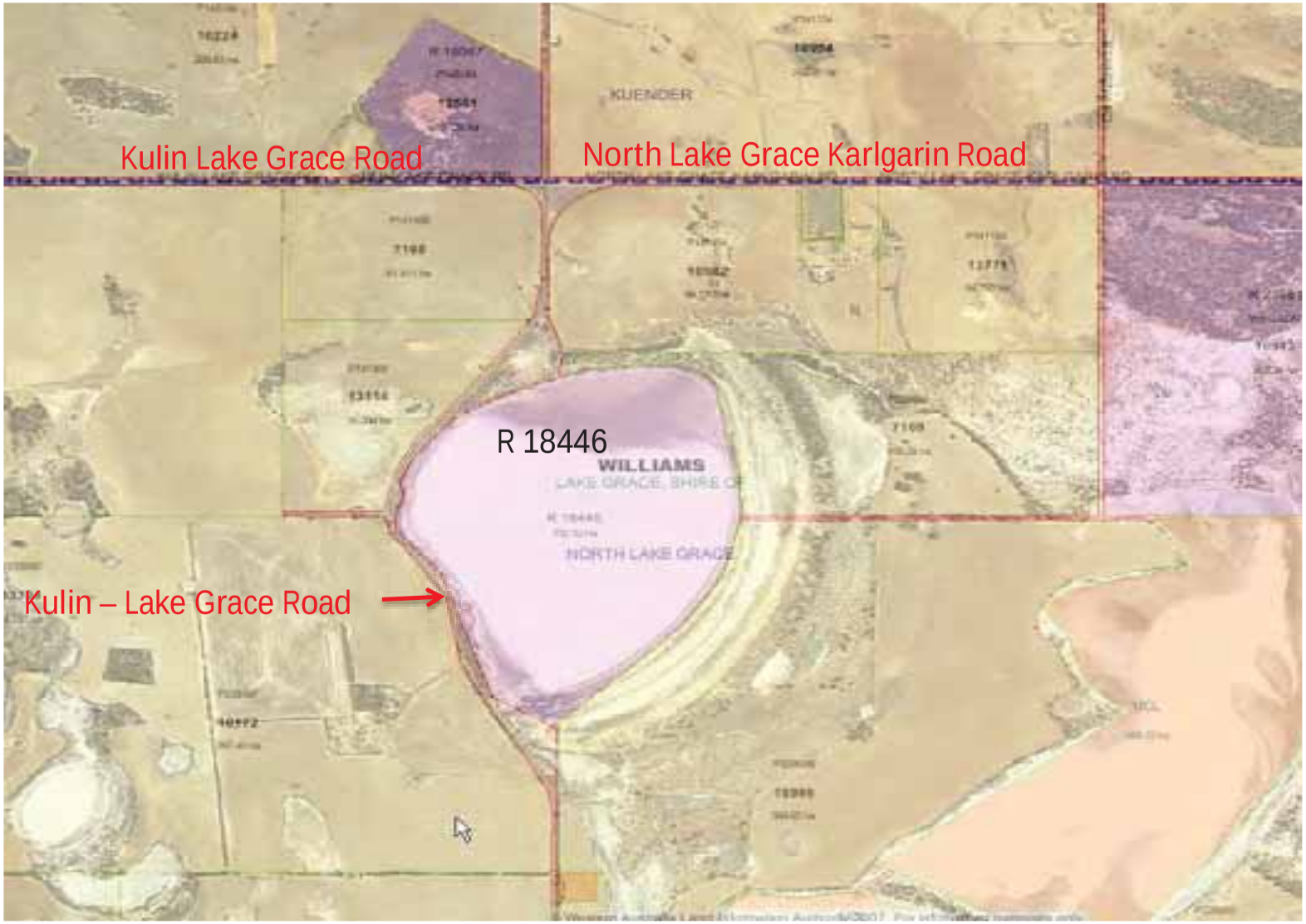
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4l
Ewlyamartup Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

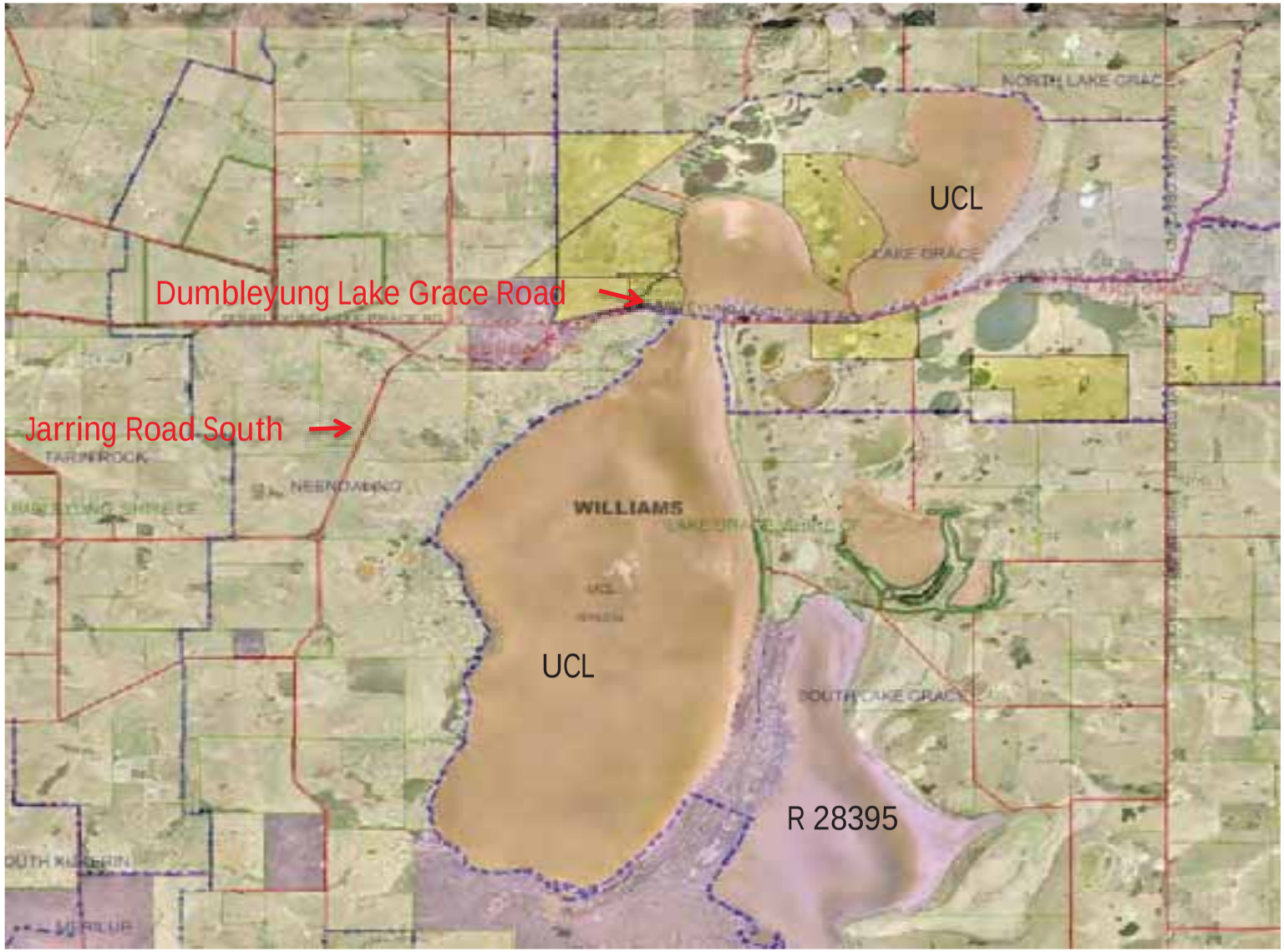
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4J
Flagstaff Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

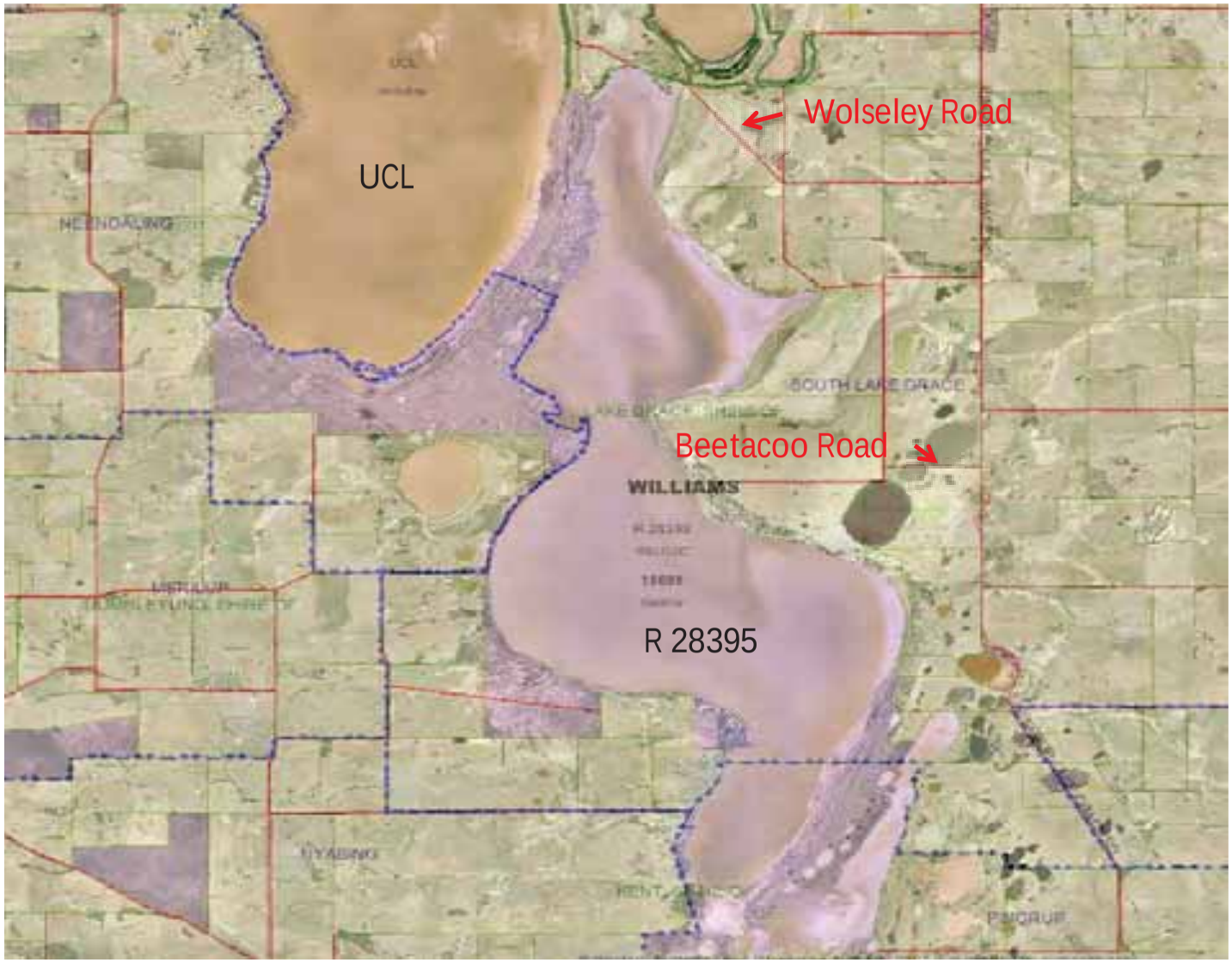
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4K
Lake Kuender - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

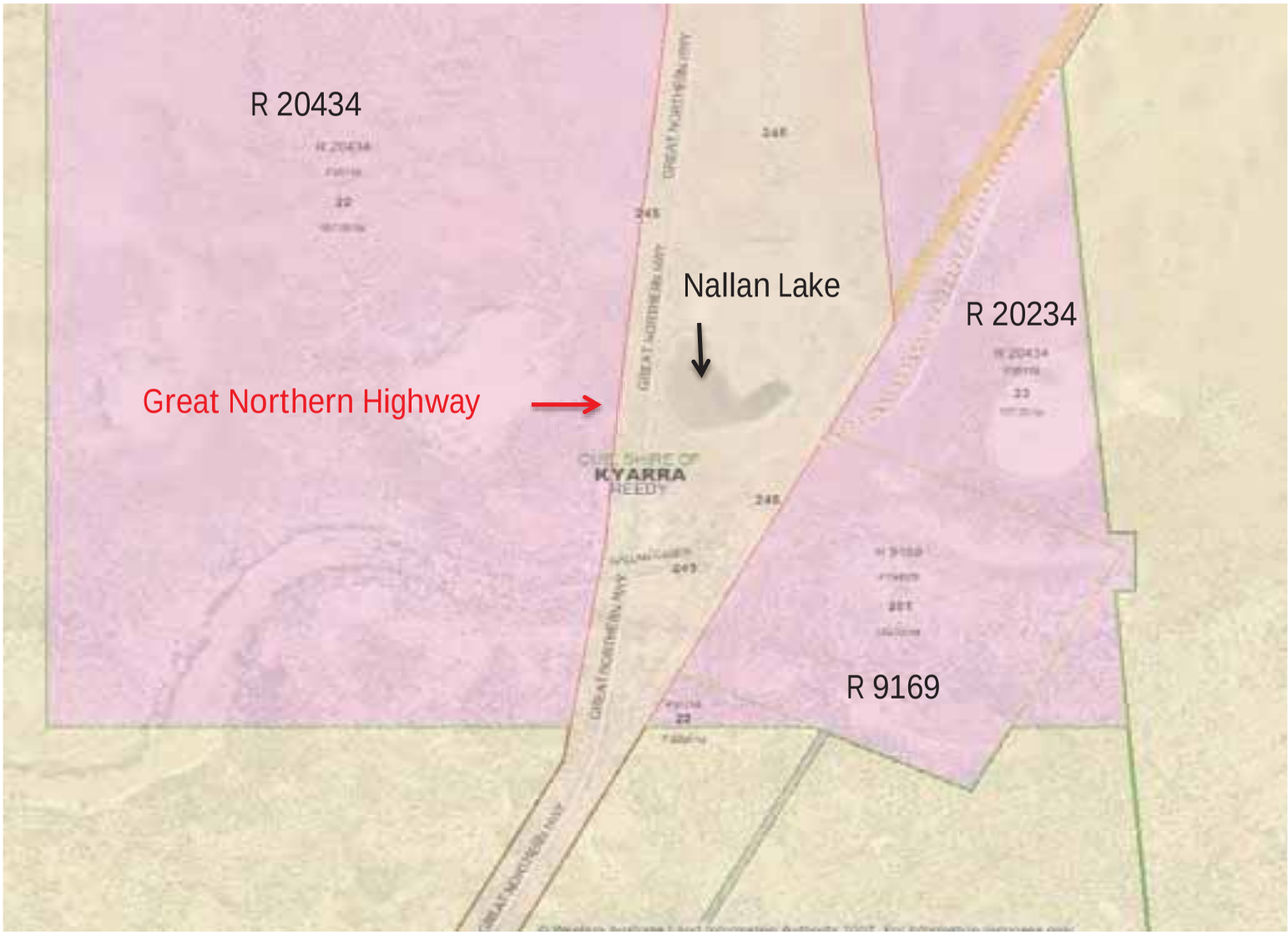
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4L
Lake Grace North - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

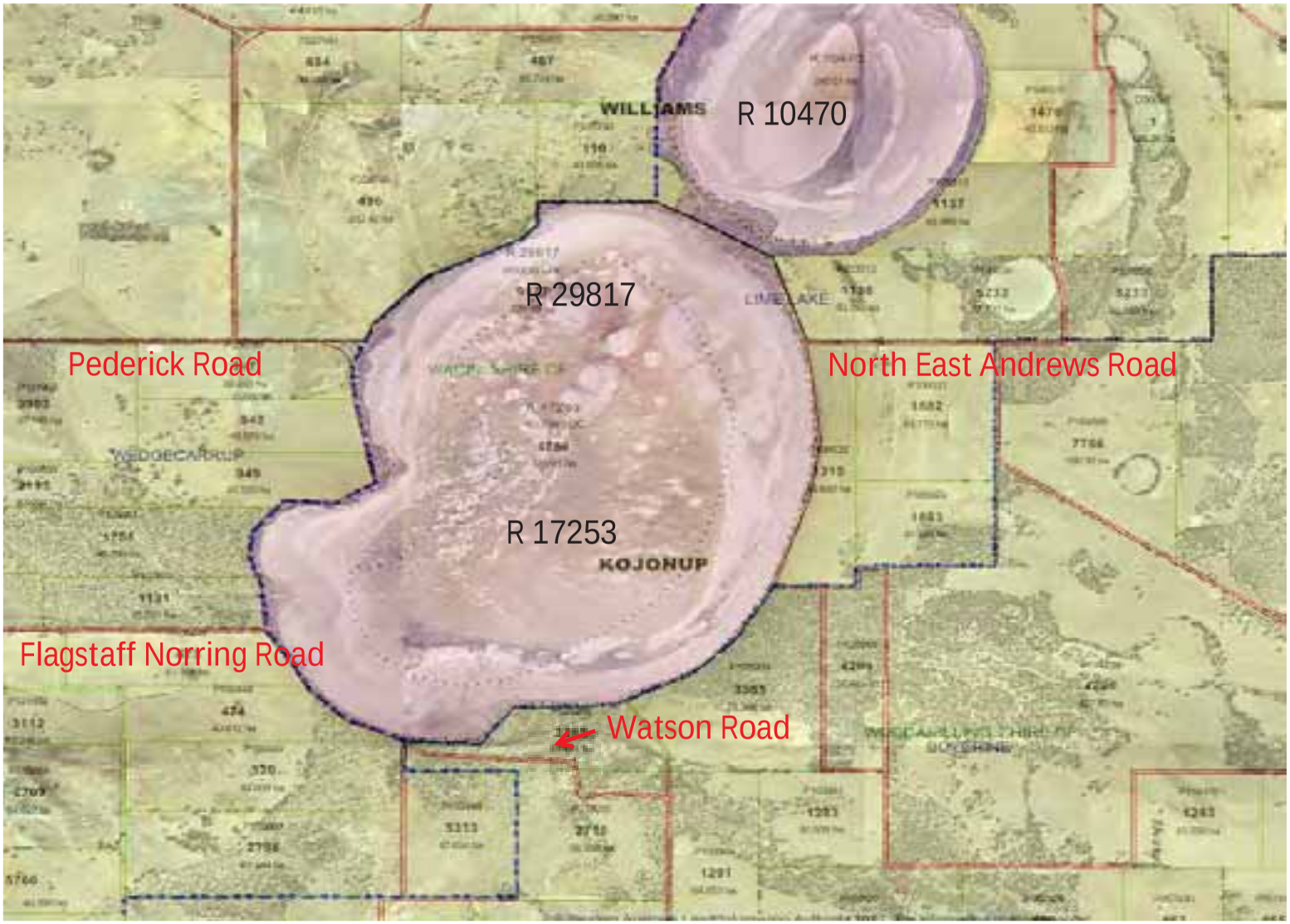
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4M
Lake Grace South - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

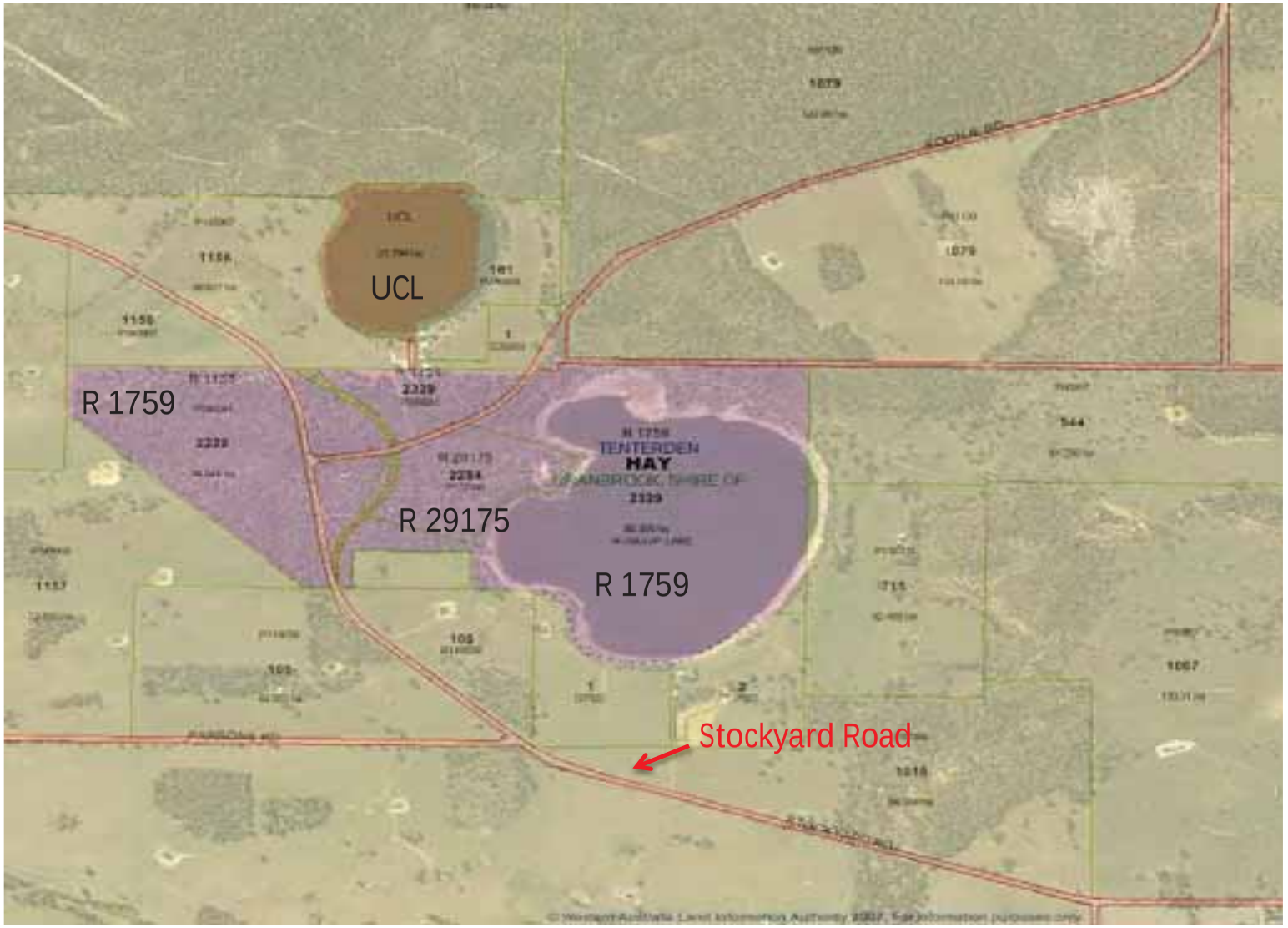
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4N
Nallan Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

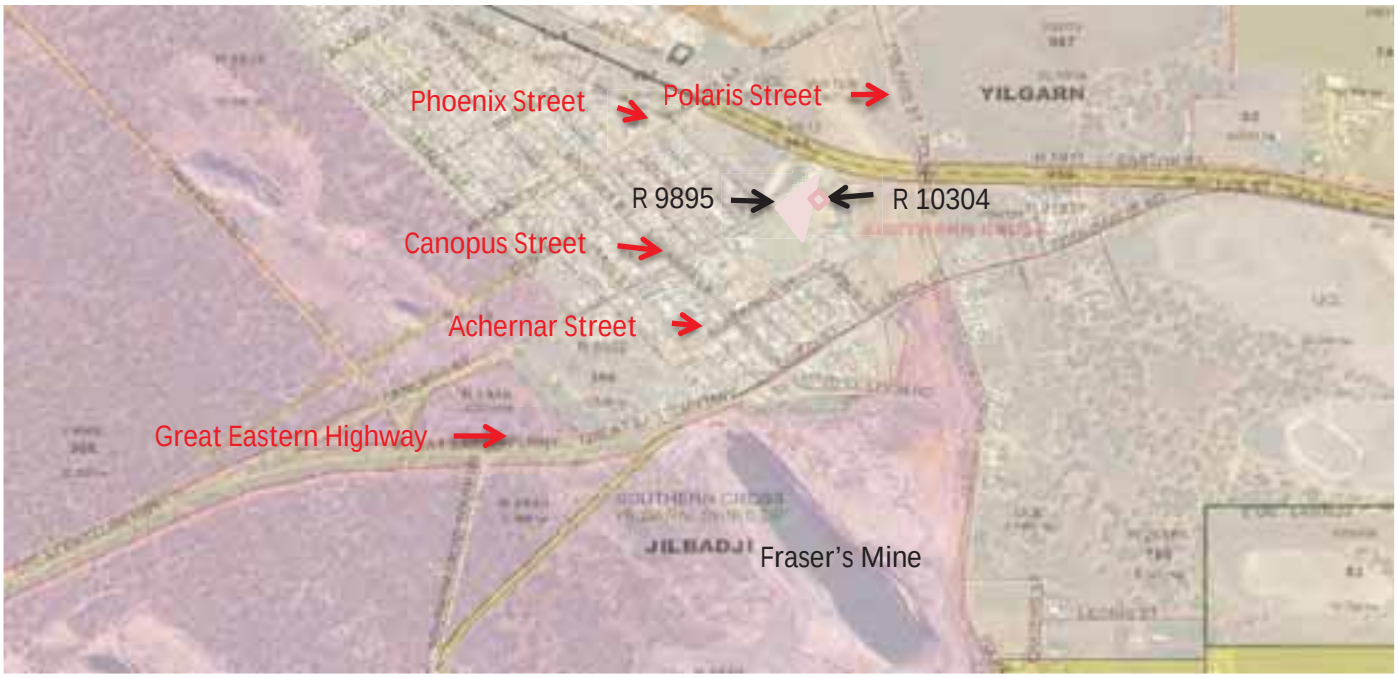
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4O
Norring Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

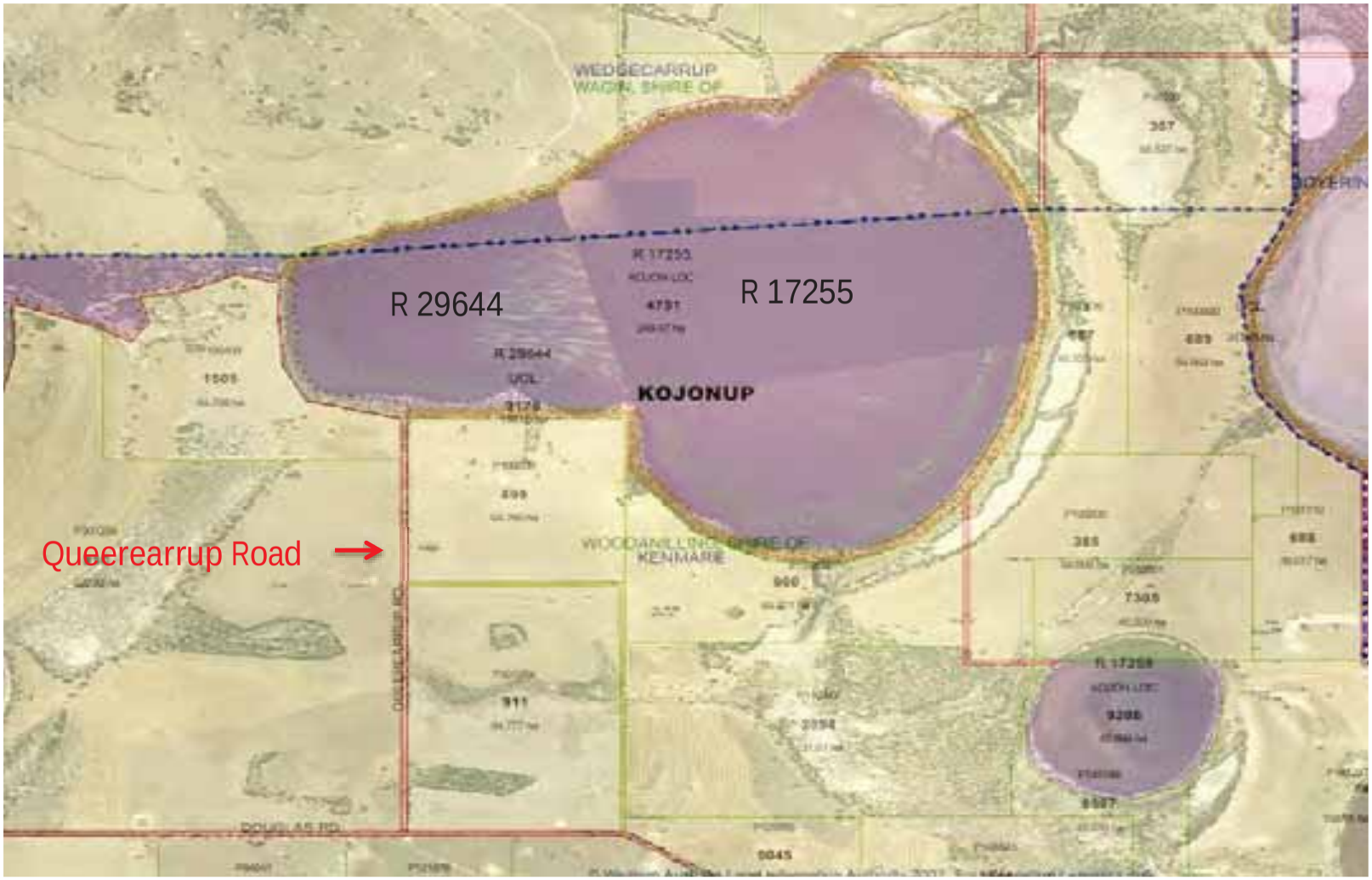
Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4P
Nunijup Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

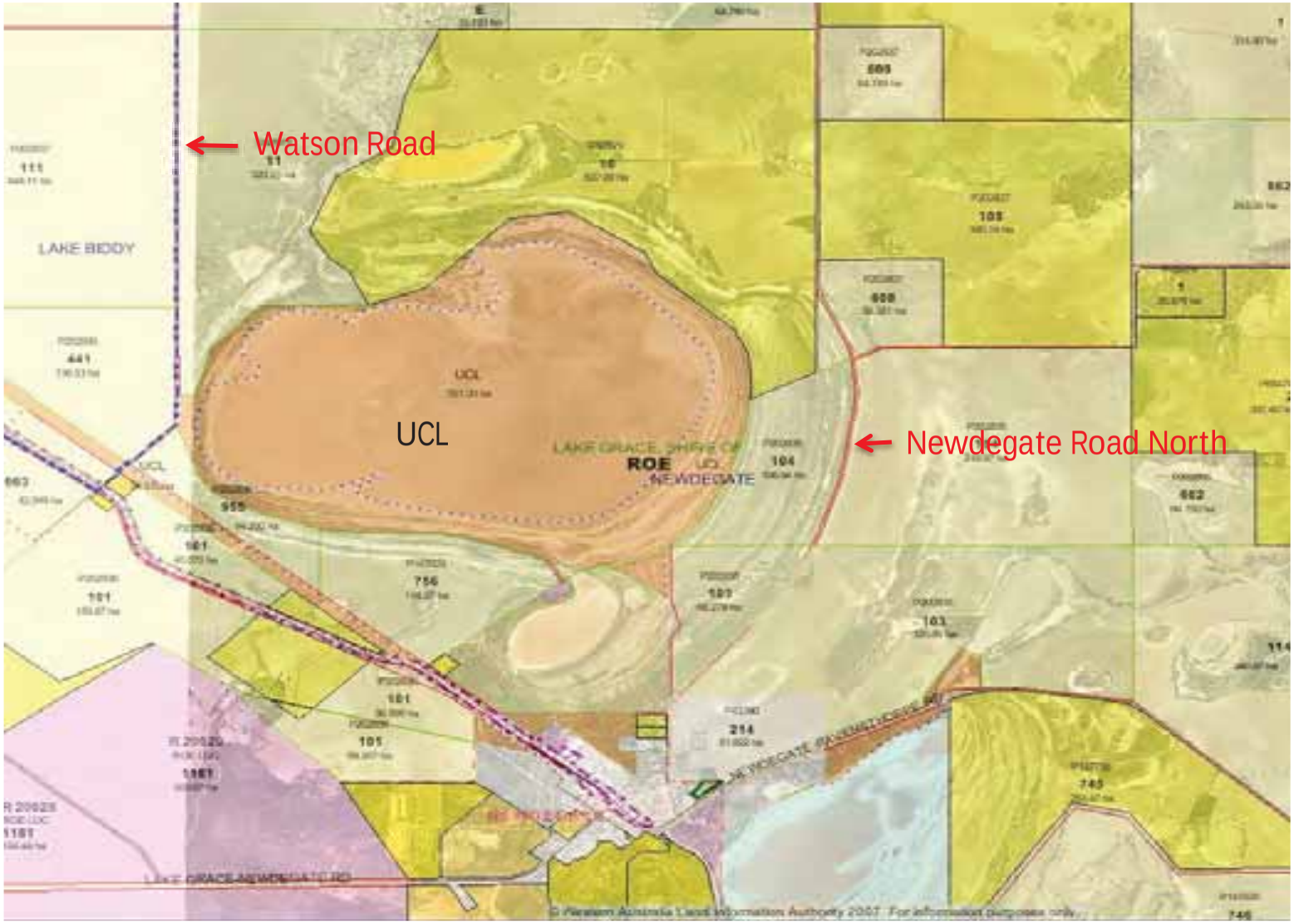
JDA	Job No. J4905	Department of Regional Development and Lands Living Lakes Feasibility Stage 1: Part 1 **Figure: 4Q** Lake Polaris - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

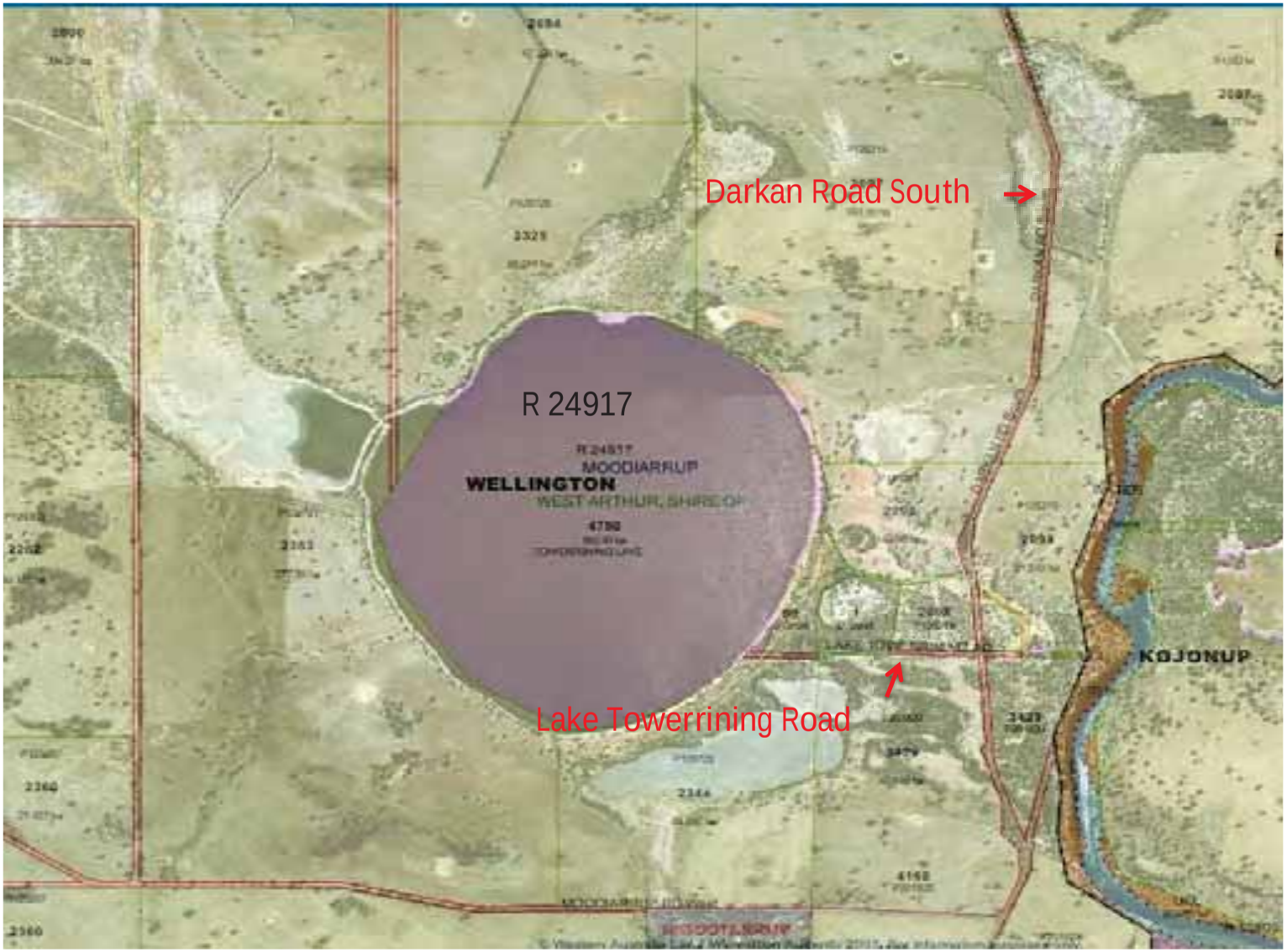
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4R
Queerearrup Lake - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4S
Lake Stubbs - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4T
Towerrining Lake - Public Land and Access Roads

Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4U
Wagin Lakes - Public Land and Access Roads

Data Source: Landgate Map Viewer - online image - accessed Sep 2011

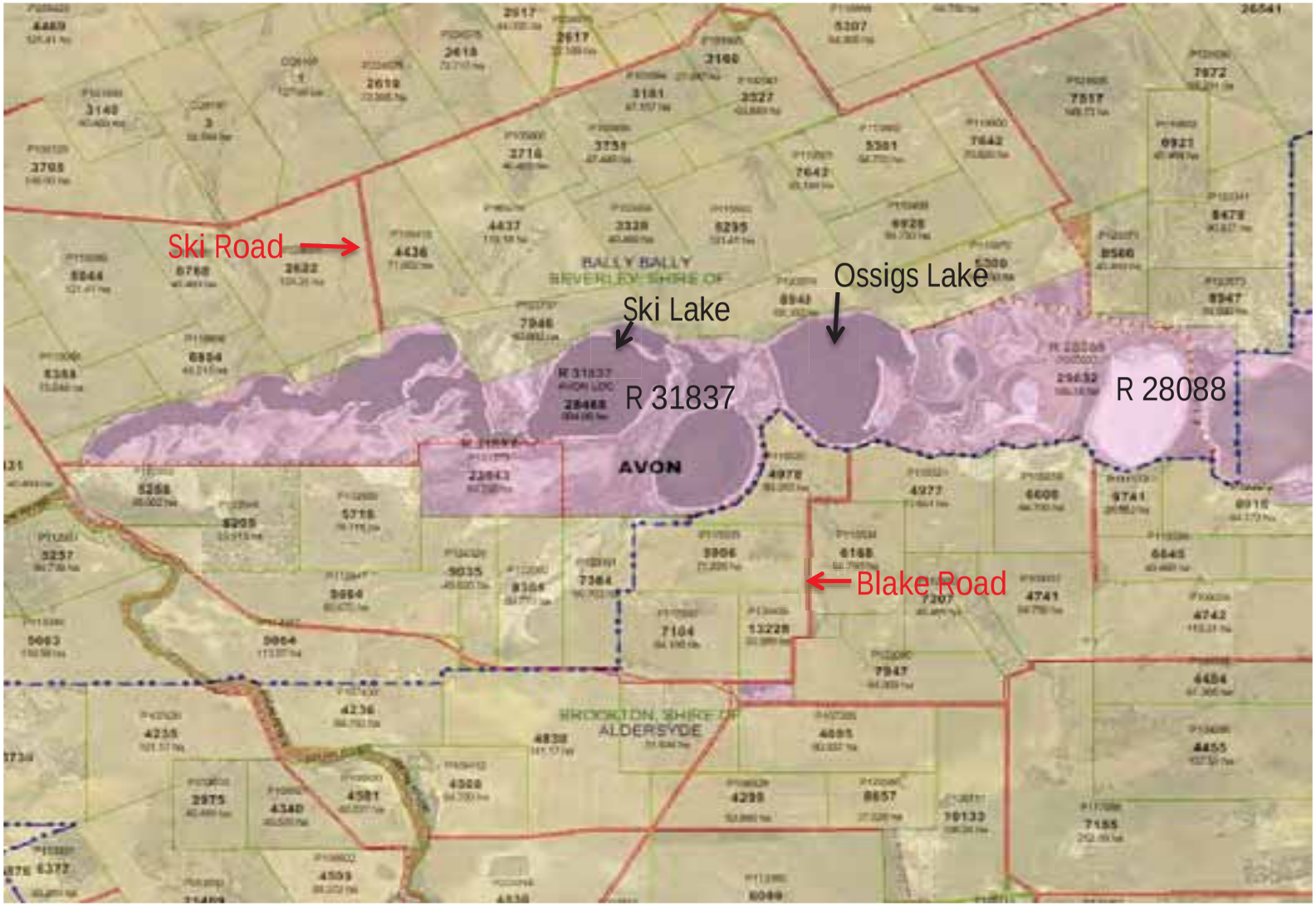
Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4V
Wicherina Dam - Public Land and Access Roads

Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

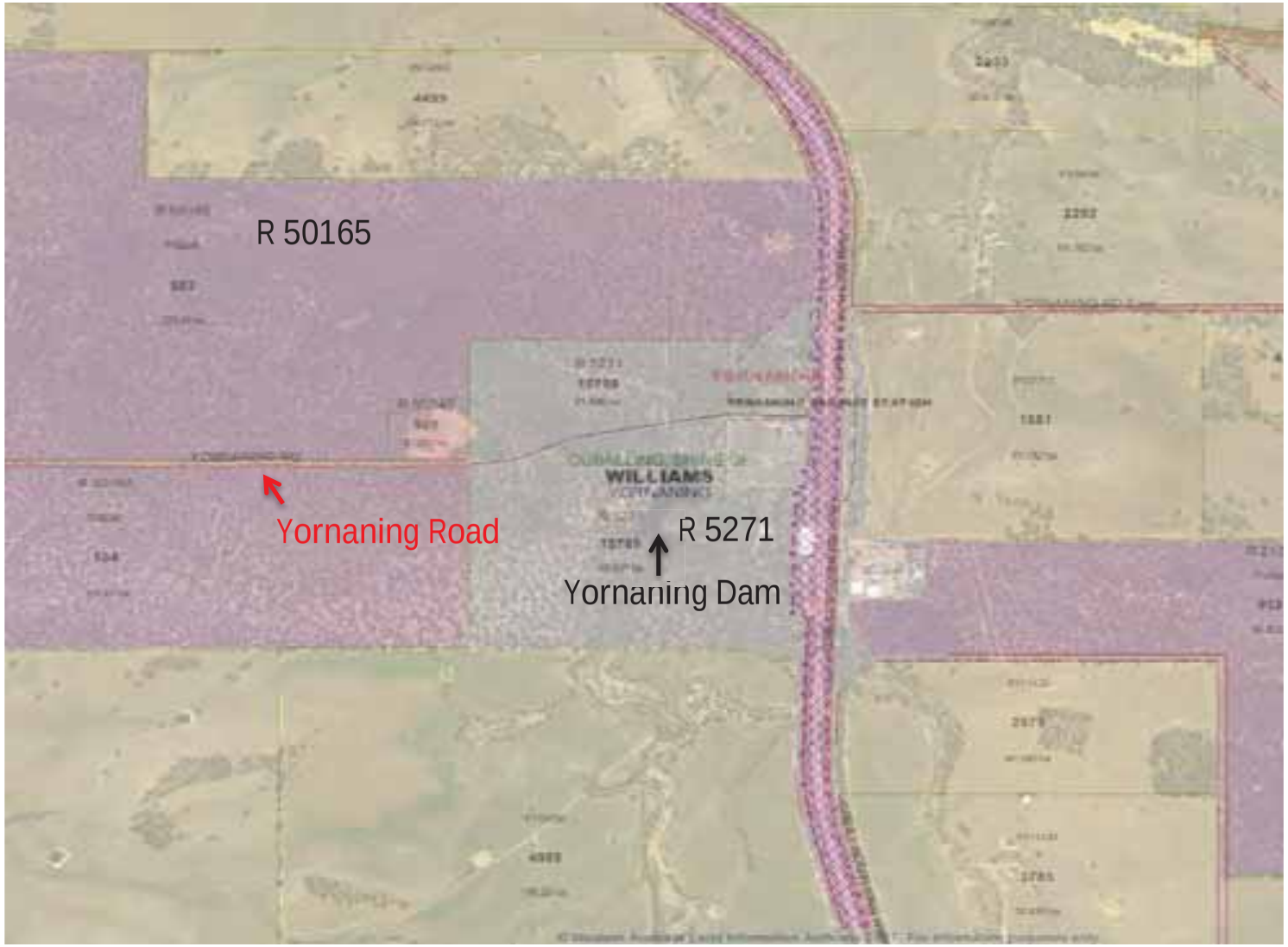
Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4W
Lake Yealering- Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4X
Yenyenning Lakes - Public Land and Access Roads



Data Source: Landgate Map Viewer - online image - accessed Sep 2011

Job No: J4905

Department of Regional Development and Lands
Living Lakes Feasibility Stage 1: Part 1
Figure 4Y
Yornaning Dam - Public Land and Access Roads

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Fx: +61 8 9381 9279

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