Government of South Australia

South Australian Arid Lands Natural Resources Management Board

May 2010

South Australian Arid Lands Natural Resources Management Board

Monitoring requirements for water resources in the Arid Lands

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DISCLAIMER

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EXECUTIVE SUMMARY

A review of past water resources monitoring programs in the SAAL NRM area indicates a mismatch between plans and performance. It is concluded that the main reasons for the poor performance has been the overly ambitious nature of many past plans coupled with the low level of dedicated, appropriate, qualified resources located within the area and applied to the monitoring tasks.

The highest recommended priorities for building on this foundation in relation to the establishment and operation of an appropriate water monitoring program are:

1. The development of Board policies to ensure that any persons or organisations involved in water related activities collect appropriate data and forward it to the Board for collation, cataloguing and analysis.

2. The continuation of present arrangements in monitoring while funds are set aside for the establishment of the improved arrangements as described below and detailed in the body of this report.

3. The appointment of a trained hydrologist to take charge of and operate the upgraded monitoring program as described in this report.

4. The hydrologist to oversee the establishment and operation of an ‘integrated’ water data base covering water related activities, surface water, groundwater, springs, water related environments, water quality, etc. This may be in cooperation with other agencies (Eg Bureau of Meteorology (BoM), the Department of Water Land and Biodiversity Conservation (DWLBC), Environmental Protection Agency, (EPA)), but the design and operation of the data bases must cover all the requirements of the Board in its primary objective of understanding and protecting the hydrology and related environments within its area. The data base should store data in a manner that maximises the usefulness of the data for later analysis. The data base should contain data on:

- The quantification of surface and groundwater related activities carried out within the area and the impacts that the activities have on the surface and groundwater related environments and/or other potential activities.

- The nature and location of environments that are dependent on the continuation of stream flows, spring discharges or near surface aquifers.

- The key hydrological parameters related to the ongoing health of a selection of high priority or representative examples of these water dependant environments, as described in this report.

- The historical records of past hydrological occurrences that can add value to an understanding of the hydrology of the water systems within the area.

5. The trial and operational development of new technologies for remote sensing of soil moisture, evaporation, surface flows, groundwater recharge, vegetation cover, etc., that can provide an improved ‘holistic’ understanding of the processes involved in local, catchment scale and regional water balances at a lower cost.

6. The establishment of a Monitoring Coordinating Committee to coordinate monitoring activities, ensure efficient use of limited resources and coordinate any needs for additional funding.

7. The Committee should develop programs and communication paths that seek to involve other public and private collectors of data within the NRM area in order to broaden the extent of data and the community’s appreciation of the role of data collection. Some examples are provided in the report.

8.By 2030, the average annual rainfall over the NRM Board’s area is expected to decrease by 2 to 5%. However, the variability will also increase so that while droughts will be deeper and longer, and major events may occur less frequently, when they do occur they may be more severe. Due to expected higher temperatures, evapotranspiration rates will also increase by about 2 to4%, thus causing greater stress on water held in storages and on any biota dependent on this water.

BACKGROUND

The Board's role in water management must be based on a good understanding of the hydrology within its areas of responsibility. The level of understanding must be in proportion to the level of risk that activities can impact on, or be impacted by aspects of the local and regional hydrology and hydrogeology.

Under the NRM Act the Board must produce a water management plan and carry out functions in data collection to facilitate the plan. The plan must include information on:

The water resources within the region;

The state and condition of the water resources and related trends; and

Environmental, social, economic and practical considerations relating to the use, management, conservation, protection, improvement and, if relevant, rehabilitation, of the water resources within the region.

The Australian water Resources Council (1988) listed the following uses for water data:

Water resource planning and management – e.g. water allocation planning; climatic studies; surface and groundwater interaction studies.

Land resource planning and management – e.g. salinity – land-use interaction studies; eutrophication investigations.

Environmental management – e.g. environmental impact assessments; estimating ecosystem water requirements; conservation of biodiversity.

Primary Industry – e.g. agriculture; mining; soil conservation studies.

Water and power supply – e.g. town supplies; irrigation.

Transport – e.g. design of drainage works for new roads, railways.

Flood mitigation – e.g. flood forecasting

The type and intensity of these activities will dictate the needs for monitoring data.

Since the area is arid, the population sparse and the level of past water related activities generally low, impacts to the hydrology of the region have also been low. However, as tourism extends, mining ventures increase, climates change and land uses intensify, the risks are also increasing with a corresponding need for the Board to raise its level of data collection in order to make adequate management decisions.

The main objectives of this review are to:

- Review and report on all monitoring, including historical and current monitoring activities.
- Identify partnerships and major stakeholders currently involved in monitoring activities.
- Establish a monitoring committee to coordinate and optimise monitoring activities, including data storage.
- Recommend appropriate monitoring program(s) to assess surface and groundwater in the region.

DESCRIPTION OF WATER RESOURCES

A map of the region detailing the extent of the SAAL NRM board's area of jurisdiction, as well as localities of importance in relation to the use and potential use of surface and groundwater is provided as Figure 1 (Page 9).

The Board's area can be broadly divided into two parts.

The northern region is dominated by relatively large surface drainage networks which terminate on Lake Eyre and is mostly underlain by the aquifers of the Great Artesian basin.

The Southern region receives virtually no flows from inter-state, the rainfall is low and the catchments are generally small. Surface water flows are generated on hilly/rocky headwaters and the majority is rapidly lost as the flows leave the hills and pass onto the plains or into shallow terminal lakes where it is soon evaporated.

Groundwater occurs in a variety of different aquifer types ranging in age from 800 million years to present and comprising a number of groundwater provinces. In the Northern part, the West part of the region is underlain by the Musgrave Block and Stuart Range province, located to the west of the Peak and Denison Inlier, while the Eastern part is underlain by the Warburton and Arrowie Basin, the Curnamona Craton as well as the Mt Painter, Mt Babbage and Willyama Inliers. In the Southern part are the Gawler Craton, Adelaide Geosyncline and the Pirie-Torrens basin provinces (Drexel et al 1993).

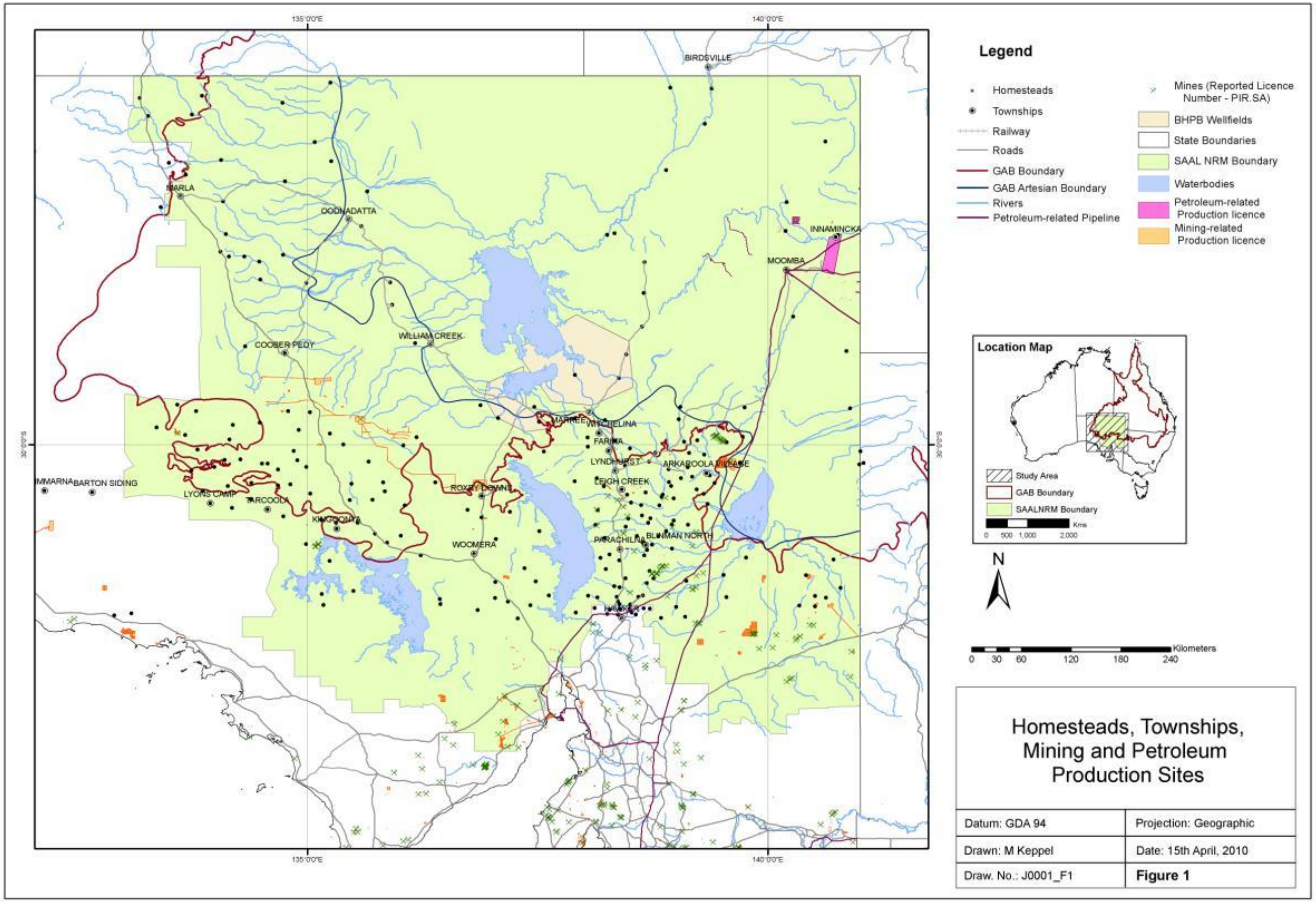
Northern Region

This region includes the Eromanga and Lake Eyre Basin and Peake and Dennison geological providences as defined in Figure 2 (Page 10). Surface water catchments for the area are displayed in Figure 3 (Page 11).

Surface Water

The Northern part receives relatively large and regular surface inflows from the North and East from distant high rainfall areas in Queensland via the Diamantina River, Eyre Creek and Cooper Creek and, to a lesser extent, from the Northern Territory from the N and NW via the Macumba and Hamilton Creek. The larger and more regular flows from Queensland are relatively well gauged as they move downstream and into South Australia. Shorter creeks such as the Arckaringa and Warriner rise on the margins of the Stuart Ranges within South Australia and flow east into Lake Eyre.

The Northern region within SA has the lowest rainfall in the continent with a large area centred in the vicinity of Lake Eyre receiving an average of only 150 mm/a. The highest rainfalls over the northern region occur over the elevated areas of the Stuart Shelf, located to the west of Lake Torrens, where the average rises to about 250 mm/a.



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BIRDSVILLE
MARLA
OODNADATTA
INNAMINCKA
MOOMBA
WILLIAM CREEK
COOBER PEDY
MARREE
MITCHELINA
FARINA
LYNDHURST
ARKAROOLA VILLAGE
LEIGH CREEK
MMARNA
BARTON SIDING
LYONS CAMP
TARCOOLA
ROXBY DOWNS
KINGOONYA
WOOMERA
PARACHILNA
BLINMAN NORTH
HAWKER
Legend
Homesteads
Townships
Railway
Roads
GAB Boundary
GAB Artesian Boundary
Rivers
Petroleum-related Pipeline
Mines (Reported Licence Number - PIR.SA)
BHPB Wellfields
State Boundaries
SAAL NRM Boundary
Waterbodies
Petroleum-related Production licence
Mining-related Production licence
Location Map
Study Area
GAB Boundary
SAALNRM Boundary
Kms
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N
Kilometers
0 30 60 120 180 240
Homesteads, Townships, Mining and Petroleum Production Sites
Datum: GDA 94
Projection: Geographic
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Date: 15th April, 2010
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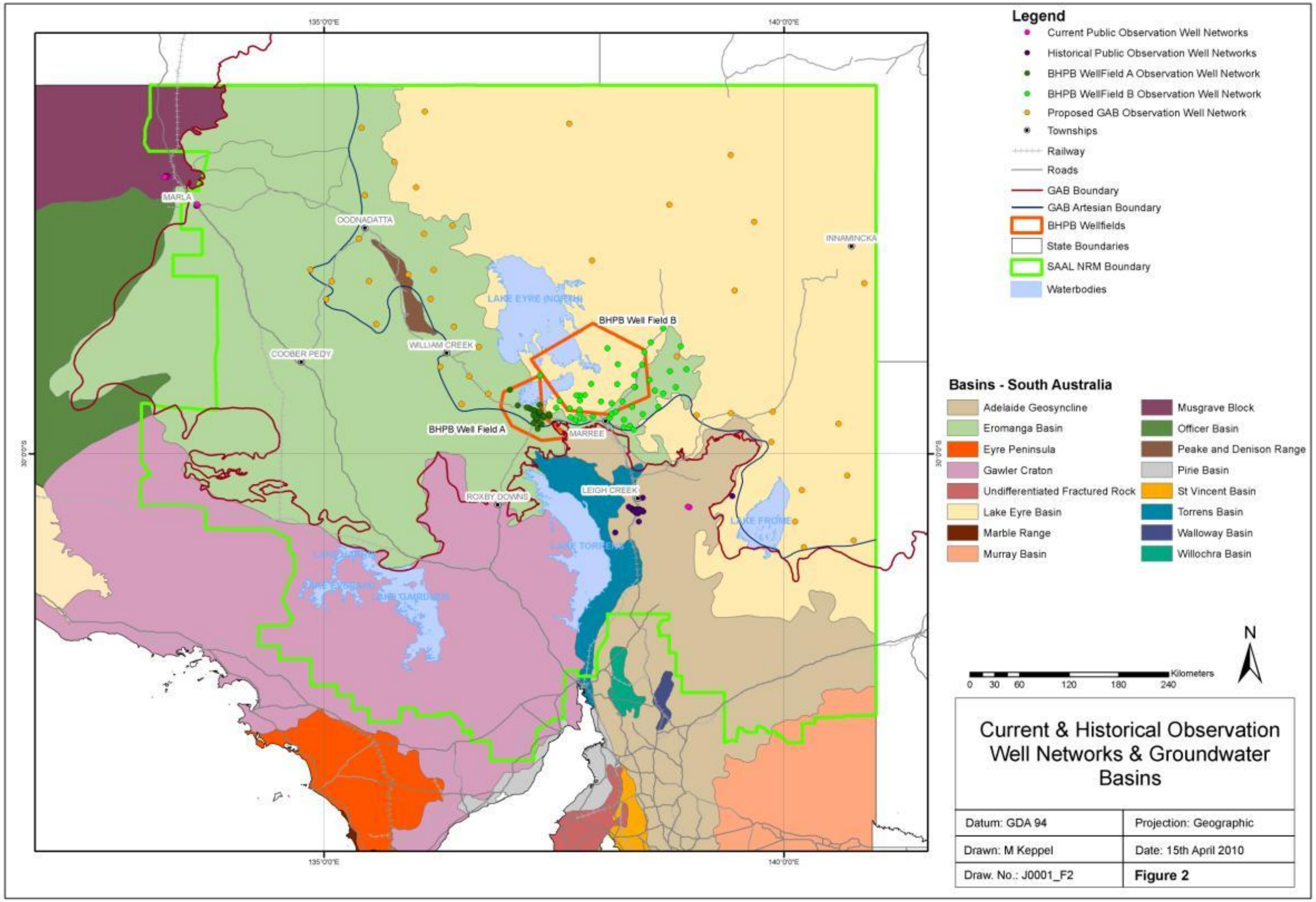
Figure 1


Legend
Current Public Observation Well Networks
Historical Public Observation Well Networks
BHPB WellField A Observation Well Network
BHPB WellField B Observation Well Network
Proposed GAB Observation Well Network
Townships
Railway
Roads
GAB Boundary
GAB Artesian Boundary
BHPB Wellfields
State Boundaries
SAAL NRM Boundary
Waterbodies
Basins - South Australia
Adelaide Geosyncline
Eromanga Basin
Eyre Peninsula
Gawler Craton
Undifferentiated Fractured Rock
Lake Eyre Basin
Marble Range
Murray Basin
Musgrave Block
Officer Basin
Peake and Denison Range
Pirie Basin
St Vincent Basin
Torrens Basin
Walloway Basin
Willochra Basin
MARLA
OODNADATTA
INNAMINCKA
LAKE EYRE (NORTH)
BHPB Well Field B
WILLIAM CREEK
COOBER PEDY
BHPB Well Field A
MARREE
ROXBY DOWNS
LEIGH CREEK
LAKE FROME
LAKE TORRENS
LAKE GAIRDNER
135°0'0"E
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Current & Historical Observation Well Networks & Groundwater Basins
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Date: 15th April 2010
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Figure 2

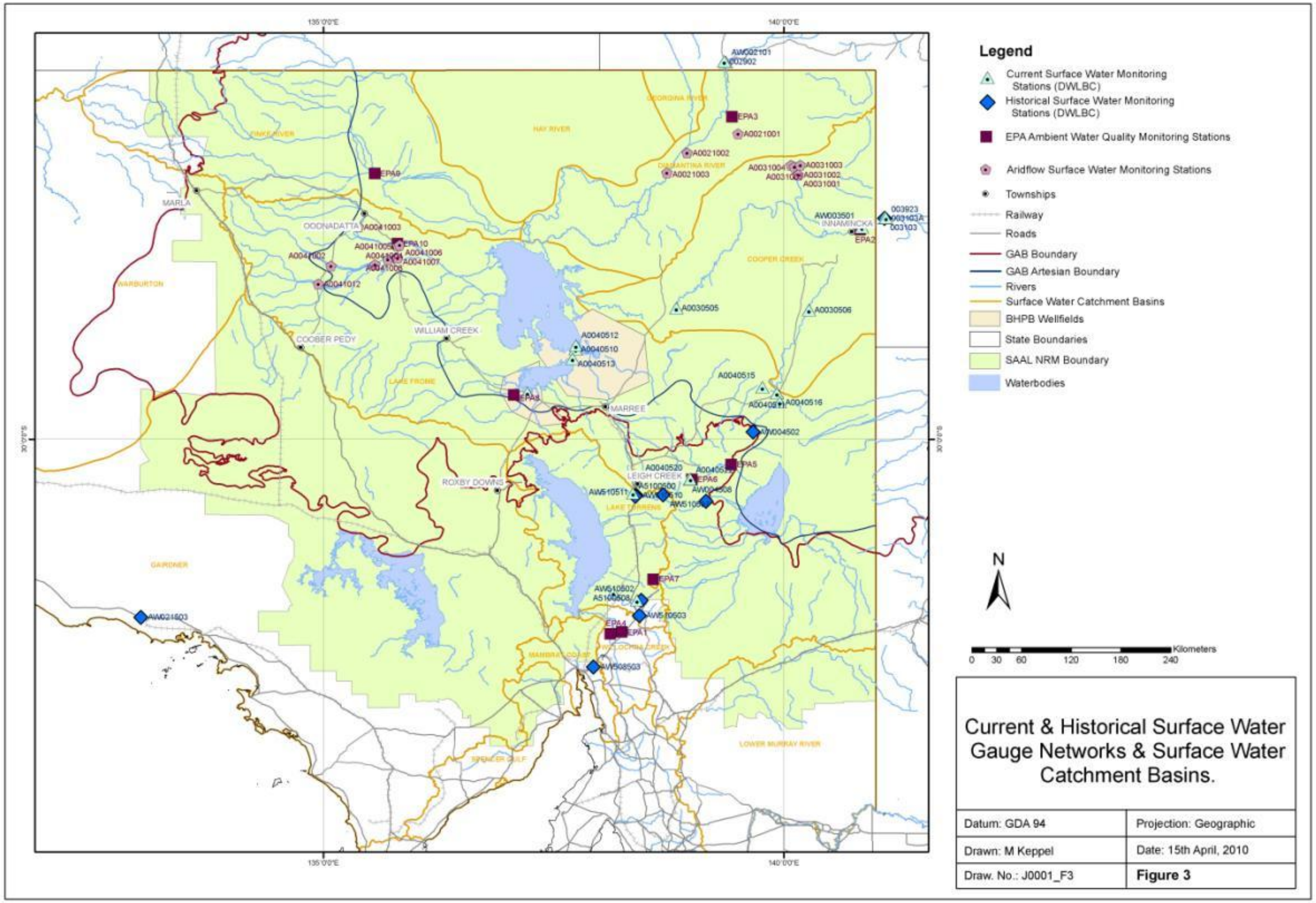
Legend
Current Surface Water Monitoring Stations (DWLBC)
Historical Surface Water Monitoring Stations (DWLBC)
EPA Ambient Water Quality Monitoring Stations
Aridflow Surface Water Monitoring Stations
Townships
Railway
Roads
GAB Boundary
GAB Artesian Boundary
Rivers
Surface Water Catchment Basins
BHPB Wellfields
State Boundaries
SAAL NRM Boundary
Waterbodies
N
0 30 60 120 180 240
Kilometers
Current & Historical Surface Water Gauge Networks & Surface Water Catchment Basins.
Datum: GDA 94
Projection: Geographic
Drawn: M Keppel
Date: 15th April, 2010
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Figure 3
MARLA
OODNADATTA
COOBER PEDY
WILLIAM CREEK
MARREE
ROXBY DOWNS
LEIGH CREEK
INNAMINCKA

There is a paucity of permanent surface water-bodies given the size of the area. Most have a tiny surface area and can be classified as wither a waterhole, lake, rock-hole or spring. A recent survey indicated that 532 permanent water-bodies could be identified in the area, with the majority of these being located within the Cooper Catchment. Springs and rock-holes fed by artesian water from the GAB are located in discrete areas (Silcock, 2009).

In general, the rivers and catchments of the Lake Eyre Basin are considered to be in relatively good condition, with this state being put down to a minimal level of hydrological modification being undertaken to date. However, knowledge considered important in relation to management of the catchments within the basin is still considered low when compared to catchments located in coastal regions. (LEBIA, 2009)

Groundwater

Underlying most of this Eastern area is the Great Artesian groundwater basin. This basin is a groundwater system which covers 22 % of the Australian continent (310,000 km^2). The groundwater in the Great Artesian Basin occurs in multi-layered sandstone aquifers separated by less-pervious rock layers up to 3,000 m deep. The Cadna-Owie Formation and Algebuckina Sandstone are the major water bearing aquifers, the overlying aquifers the Winton and Mackunda Formation and the Coorikiana Sandstone have poor yields with high salinity.

Along the Western margin of the GAB, and forming one of the most prominent water features of the region are the natural groundwater spring discharges. These springs often are associated with a mound composed of limestone and detrital material and therefore the springs that occur in the GAB are commonly referred to as “mound springs”.

The GAB springs that occur within South Australia occur in a roughly acuate pattern that extends from Dalhousie Springs in the northern region, located approximately 40kms south of the South Australian Border with the Northern Territory, to an area in the vicinity of the Northern Flinders Ranges near the South Australian Border with New South Wales. All regions where these springs occur are located within the SAAL NRM area of jurisdiction.

Lake Eyre basin sediments occupy a large area in the North-East corner of South Australia and the South-East corner of the Northern Territory. As such they are better known as providing a confining unit to underlying upper Cretaceous aquifer units of the Winton and Makunda Formations. However, a number of discrete unconfined and confined aquifers can be found through-out the Tertiary units of the Lake Eyre Basin. Exploitation for stock and domestic supplies is known. Salinities vary from 1,000 milligrams per litre (mg/L) to >100,000 mg/L and transmissivities are inferred to be approximately <100 m^3/day. Recharge is interpreted to be from local rainfall (Shepherd, 1978).

The Peake and Denison Ranges consist of granitic intrusives and metasediments interpreted to be associated with the Adelaide Geosyncline. As a consequence,

groundwater within the Peake and Denison Ranges is interpreted to be largely contained within fractured rock aquifers. It is also interpreted that the flanks of the Peake and Denison ranges may also be an important local recharge point for the GAB, given the aquifer units of the Algebuckina Sandstone and the Cadna-Owie formation are known to outcrop in this region.

Southern Provinces

This region includes the Gawler Craton, Torrens Basin and the northern portion of the Adelaide Geosyncline as defined in Figure 2 (Page 10). Surface water catchments for the area are displayed in Figure 3 (Page 11).

Surface water

Unlike the northern region, the southern region is dominated by three main surface terminal lakes for surface drainage, Lakes Frome, Torrens and Gairdner. The Flinders Ranges separate the first two. Lower lying land with little surface drainage separates the latter two.

The Flinders Ranges receive 250 – 350 mm/a rainfall and being steep and rocky are the source of many creeks which flow irregularly outwards to Lakes Frome and Torrens.

Lake Gairdner lies within the Gawler Craton which is an area of low hills and outcrops with short drainage paths which disappear on the surrounding plains or in the extensive system of terminal lakes.

Groundwater

The Northern Flinders Ranges are generally interpreted to be the northern extension of the Adelaide Geosyncline groundwater province. The water mostly occurs in rock fractures with the highest yields occurring near faults; however a minor component of groundwater is present in cavities in the limestone aquifers. Recharge to the groundwater occurs by direct infiltration of rainfall or by infiltration of surface water in streams. The groundwater yields are highly variable depending on the aquifer and the extent of fracturing. The groundwater quantity and quality for the province is estimated to be 400,000 GL of freshwater, 925,000 GL of brackish water and 1,300,000 GL of saline waters (AACWMB 2006).

The groundwater in the Gawler Craton Province mostly occurs in the Tertiary sediments, weathered basement highs and palaeochannels. The freshest groundwater is yielded by the weathered basement highs, though highly saline groundwater is contained in deep fractured rock aquifers. The groundwater yields are generally very low with the normal well yield being below 1 litre a second (Ls^{-1}) (AACWMB 2006).

The Pirie-Torrens Basin is made up of two interconnected basins and underlies the area at the head of the Spencer Gulf and continues under the Southern part of Lake Torrens. The groundwater in the basin mostly occurs in Tertiary sand aquifers,

though it also occurs in Quaternary shallow sand or gravel beds. Groundwater yields from both the Tertiary and Quaternary aquifers are both highly variable, however the Tertiary aquifer yields are typically between 0.5-2 Ls^{-1} and the Quaternary aquifer yields are 0.6-2 Ls^{-1}. The Tertiary aquifer groundwater is relatively fresh due to its proximity of the recharge area (the Flinders Ranges), whereas the Quaternary aquifers groundwater quality ranges from 1,000-40,000 mgL^{-1}. The groundwater quantity and quality for the Pirie-Torrens Basin is estimated to be 6,850 GL of freshwater (AACWMB 2006).

The groundwater in the Stuart Shelf Region mostly occurs in a fractured rock aquifer within the Arcoona Quartzite and a sandy dolomite karstic aquifer within the Andamooka Limestone. Groundwater yields from the Arcoona Quartzite aquifer are variable (structurally controlled), but they are mostly less than 1 Ls^{-1}. Groundwater yields from the Arcoona Limestone can be high but is mostly unpredictable and low yielding.

Water-Dependent Ecosystems

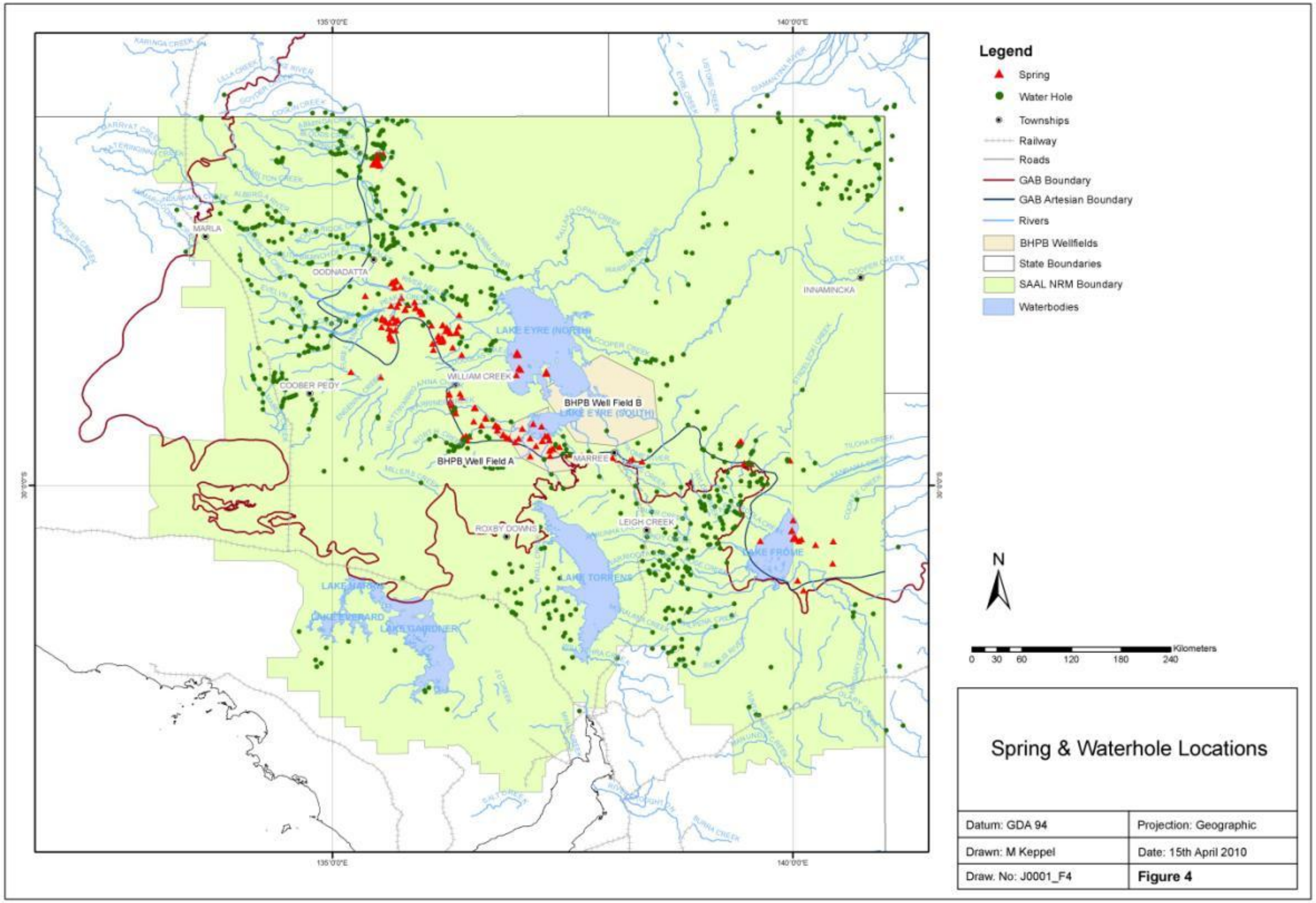
The springs of the South Australian GAB are rare wetland environments found within largely arid and semi-arid regions of the state. They are home to a number of endemic flora and fauna species that are found no-where else. In addition they have significant cultural and historical significance to the local indigenous and non-indigenous populations of the region. As a consequence, their ongoing preservation and protection is considered a high priority.

There is a clear mandate for Boards to take a lead role in ensuring the water-dependent ecosystems found within their catchment areas are identified and their environmental water requirements protected.

Other important water-dependent ecosystems in the region include the GAB Spring communities (also EPBC listed), Goyders Lagoon, Lake Eyre and Strzelecki Creek wetland systems and Coongie Lakes, located within Coongie Lakes National Park, near Innamincka.

Table 14 in Appendix A and Figure 4 (Page 15) show the location of water holes and springs identified to date.

Other smaller scale significant sites are likely to be located during current investigations to determine the location and extent of spring systems in the Flinders Ranges and Aboriginal Lands.



Legend
Spring
Water Hole
Townships
Railway
Roads
GAB Boundary
GAB Artesian Boundary
Rivers
BHPB Wellfields
State Boundaries
SAAL NRM Boundary
Waterbodies
N
Kilometers
0 30 60 120 180 240
Spring & Waterhole Locations
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Projection: Geographic
Drawn: M Keppel
Date: 15th April 2010
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Figure 4
LAKE EYRE (NORTH)
LAKE EYRE (SOUTH)
BHPB Well Field A
BHPB Well Field B
LAKE TORRENS
LAKE FROME
LAKE GAIRDNER
LAKE EVERARD
MARLA
OODNADATTA
COOBER PEDY
WILLIAM CREEK
MARREE
ROXBY DOWNS
LEIGH CREEK
INNAMINCKA
135°0'0"E
140°0'0"E

Competing Uses of Water.

A significant user of water is the natural environment. With the exception of the mound springs, the sustainability of natural environments is mainly dependent on rainfall and the redistribution of that part of the excess rainfall that runs off via the network of watercourses, with temporary storage in waterholes and terminal lakes.

Within an arid area, any diversion of surface water is likely to diminish the amount of water available to a natural environment. Similarly, the extraction of groundwater that feeds springs or maintains water levels in waterholes can have the same result.

Moreover, since dams sites are generally limited to small headwater locations and supplies from surface dams are very unreliable due to high evaporation and increased salinity, the ability to capture large amounts of surface water for surface storage and use is intrinsically low. The only major dam in the area is the Aroona dam near Leigh creek which is used on an opportunistic basis. Hence all supplies, other than opportunistic farming supplies and those that can be catered for by a roof and tank systems, must generally come from groundwater or via a pipeline from some distant location.

Therefore, the inter-relationship between surface water and groundwater is considered to be the most important problem to resolve in relation to understanding the hydrology of the region, as this will aid determining management solutions concerning the above described supply of water for human usage, as well as solutions concerning the maintenance of water sources supporting natural environments.

The highest priority in relation to developing a better understanding the hydrology of the region

Mining is the highest water user in the area. An indication of the current and future volume of water used by the mining and other sectors is outlined below. In addition, Figure 1 (Page 9) details the location of all past and present licensed mining operations.

Table 1.1: Indicative water demand in the Far North Prescribed Wells Area (SAAL NRM 2009)

Purpose	**Present Artesian**	**Non-Artesian**	**Future**	**Long Term**
Stock and Domestic	50	10	33.5	33.5
Mining	33.3		120*	120*
Petroleum	17		60	60
Power Generation	1	-	20*	150*
Wetlands	12	-	7	7
Town Water Supplies	2.49	1.34	4	5
Road Maintenance	0.8		0.5	0.8
Industrial and Tourism	2?		5	10
Commercial	-		1	20?
Springs	~66		~68	~68
Total	**~185**	**~11**	**~319**	**~474**

Flooding

Because of the unsealed roads, paucity of bridges, occasional heavy and widespread rainfall, and wide floodplains, flooding can often cause considerable damage and inconvenience. The prediction, tracking and warning of heavy rainfall and ensuing flood peaks can reduce the risks associated with flooding. Data on the relationships between heavy rainfall, flood flows and the depth and extent of flooding on different catchments provides information for the design of road culverts/floodways.

HISTORICAL SURFACE WATER DATA COLLECTION

Rainfall Networks

Since rain is by far the greatest contributor to the water wealth of the area and the initiator of the terrestrial part of the hydrological cycle, its observation and recording must remain the backbone of the water data collection programme. Other climate data is of equal concern in relation to the cause or fate of rainfall. Pan evaporation data is a particularly useful measurement in relation to the estimation of water losses from lakes and other open water storages. Information concerning current and historical surface rain gauging stations is provided in Tables 1 and 2 respectively (Appendix A). A map of current and historical rain gauging stations are provided as Figure 5 (Page 19) and Figure 6 (Page 20) respectively.

Historical Surface Flow Networks

Information concerning historical surface water gauging stations and evaporation gauging stations is provided in Tables 3 and 4 respectively and are located in Appendix A. A map of historical and current surface water gauging stations and evaporation gauging stations is provided as Figure 3.

Flow measurements relying on field flow measurements

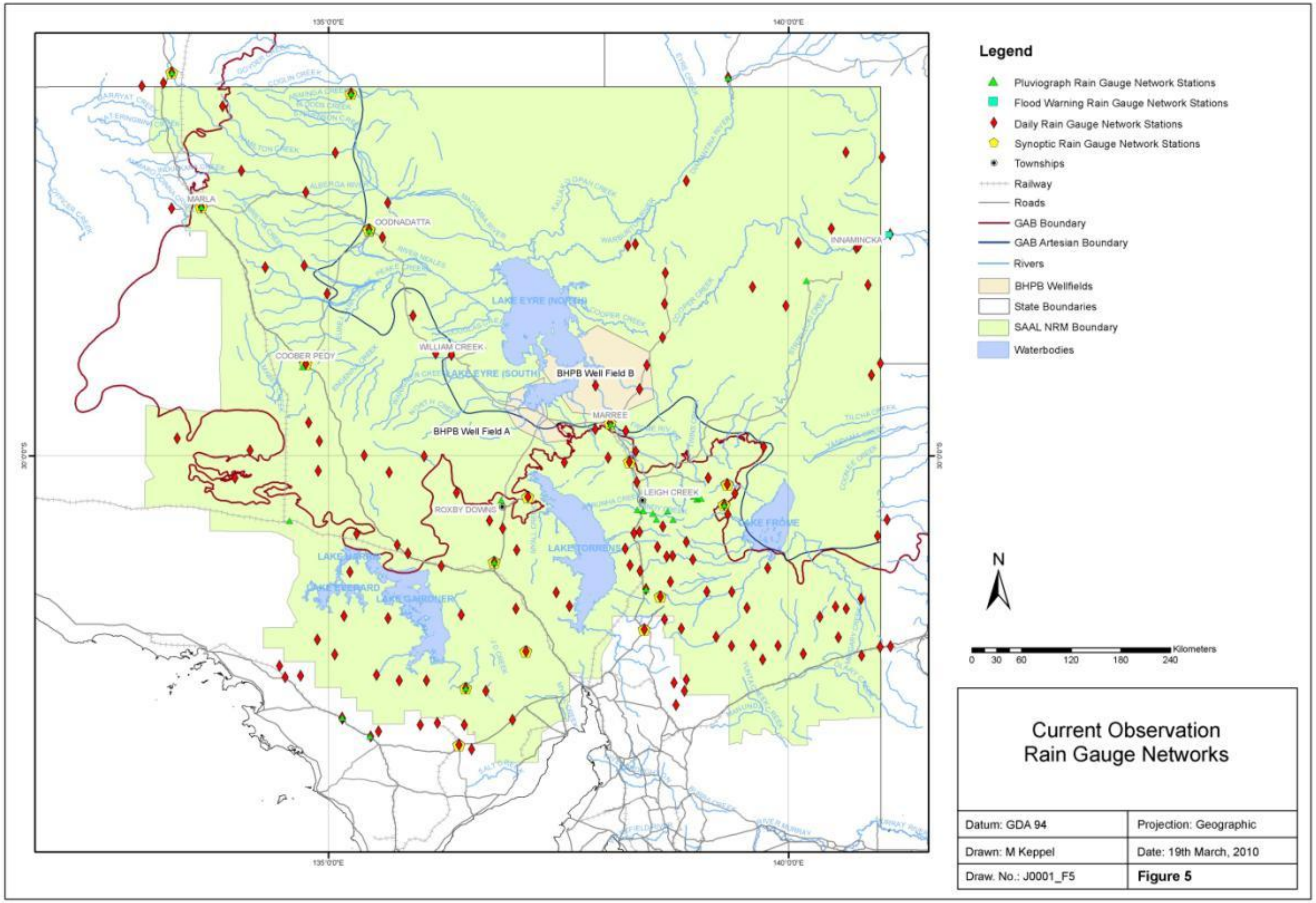
The first generation of surface water data collection focussed on the estimation of flow quantity at sites of specific interest or at sites selected to be representative of certain types of landscape. The method required the continuous measurement of water level via a long term level recorder and the establishment of a relation between the water level and the flow at that level across a range of levels from the lowest to the highest recorded. The flows were generally measured by a team of persons in a boat using a current meter and weight to determine the product of the cross section area and mean flow velocity at the measurement site.

Using this method, quantification of flow rates and volumes has been relatively successful where the flow rates were not too great and access could be gained, often by air, to the site ahead of the arrival of a flood. These conditions applied at sites on the Diamantina River and Cooper Creek at Birdsville and Innamincka respectively, but sites proved almost impossible to access during floods in most other parts, such

as in the Flinders Ranges. Flow measurements in the Flinders Ranges have been generally unsuccessful due to poor reliability of water level recorders (due to heat and damage from fast flowing sediment/debris laden flows) and access difficulties. For most of the Flinders sites records exist of flow levels, but not of flow quantities.

Additional rainfall data to assist in establishment of rainfall to runoff relations

With the unsolved, ongoing problem of establishing the relationship between water levels and flow rate (often referred to as the site ‘rating’) at all the remote sites without ready access during floods (ie most of the sites), an alternative strategy was



Legend
Pluviograph Rain Gauge Network Stations
Flood Warning Rain Gauge Network Stations
Daily Rain Gauge Network Stations
Synoptic Rain Gauge Network Stations
Townships
Railway
Roads
GAB Boundary
GAB Artesian Boundary
Rivers
BHPB Wellfields
State Boundaries
SAAL NRM Boundary
Waterbodies
N
Kilometers
0 30 60 120 180 240
MARLA
OODNADATTA
COOBER PEDY
WILLIAM CREEK
LAKE EYRE (NORTH)
LAKE EYRE (SOUTH)
BHPB Well Field B
BHPB Well Field A
MARREE
INNAMINCKA
LEIGH CREEK
ROXBY DOWNS
LAKE TORRENS
LAKE FROME
LAKE GAIRDNER
135°0'0"E
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Current Observation
Rain Gauge Networks
Datum: GDA 94
Projection: Geographic
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Date: 19th March, 2010
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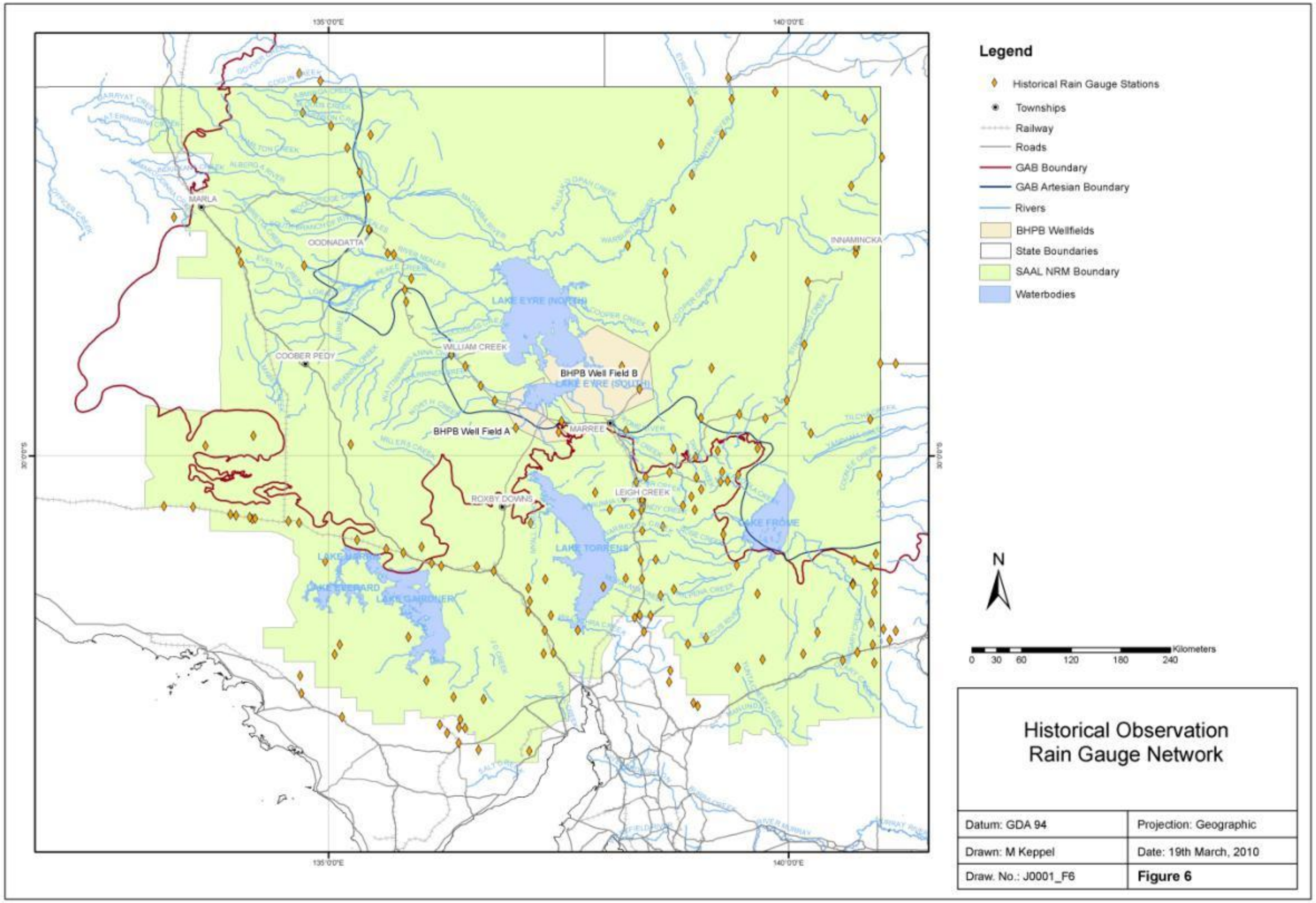
Figure 5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Legend
Historical Rain Gauge Stations
Townships
Railway
Roads
GAB Boundary
GAB Artesian Boundary
Rivers
BHPB Wellfields
State Boundaries
SAAL NRM Boundary
Waterbodies
N
Kilometers
0 30 60 120 180 240
MARLA
OODNADATTA
INNAMINCKA
LAKE EYRE (NORTH)
LAKE EYRE (SOUTH)
WILLIAM CREEK
COOBER PEDY
BHPB Well Field B
BHPB Well Field A
MARREE
LEIGH CREEK
ROXBY DOWNS
LAKE TORRENS
LAKE FROME
LAKE GAIRDNER
Historical Observation
Rain Gauge Network
Datum: GDA 94
Projection: Geographic
Drawn: M Keppel
Date: 19th March, 2010
Draw. No.: J0001_F6
Figure 6

called for. The most promising strategy has been to abandon attempts to establish an accurate site rating (ie to abandon the aim of accurately quantifying flow volumes and rates) and to focus instead on gaining a better understanding of the amounts and intensity of rainfall required to initiate different relative levels of runoff. This can be done using recorded rainfalls and water levels only. Advantages of this approach are that rainfall recording is inherently more reliable and less costly than water level recording and that more information on the hydrology of the catchments can be gathered this way.

During the 1980s and 1990s many recording rain-gauges (pluviometers) were placed in the catchments upstream of the sites where water levels were being measured.

The AridFlo Program

The next advance came with the availability of a low cost robust water level recorder which could be left on site and was sufficiently reliable to only require downloading every 6 months, or could be downloaded via satellite communication. The AridFlo programme was a low cost Federal Government initiative focussed on the Lake Eyre basin. The focus of the deployment of the recorders was on the better understanding of the:

- Initiation of runoff;
- Frequency of flows and the losses via evaporation and transmission as the flows move downstream; and
- Relationships between the flow statistics and the river health.

Subsequent analysis of the data collected has shown the success of this strategy (Costelloe J, 2008). Table 6 within Appendix A is an inventory of the water level recorders used as part of the initial AridFlo programme. The locations of these are indicated in Figure 3 (Page 11). According to the N-RIMS online data base as maintained by the South Australian Department of Environment and Heritage (DEH), the last of the Aridflo monitoring stations was closed in 2007.

Water Quality Surface Flow Networks

The Environment Protection Authority has monitoring sites for monitoring of ambient water quality. This program (Ambient Water Quality Program) commenced in 2003 Site details are shown in Table 7 (Appendix A) and their location are shown in Figure 3 (Page 11).

Currently there are 10 sites across the region; the period of record for most of these sites is only of the order of two to three years.

The region does not have the diverse threats to water quality found in urban and industrial settings. Hence the key objective for the water quality monitoring program is to characterise the patterns of natural water quality variation and the ecosystems that depend upon them. Such an understanding should enable the impact of future threats to water quality to be assessed based on a sound understanding of the character and variability of the systems present. The aims of the water quality monitoring program are:

- To obtain a clear understanding of the range of variations in measured water quality parameters under existing natural conditions
- To develop an understanding of the influence of geology, topography and land use on expected water quality and ecosystem patterns and processes observed.

Major regional threats to water quality mostly relate to interactions with animals, including stock and feral species, although there is the potential for localised industrial and tourist impacts (AWE 2004). Water quality impacts of animals include increased turbidity or habitat damage through trampling, increased nutrient levels and possibly microbial contamination. Other issues of concern relate to mining or petroleum operations, and potentially to upstream activities including pesticide residues from agriculture or horticulture, particularly in the case of cross-border watercourses.

HISTORICAL GROUNDWATER MONITORING NETWORKS

There are three groundwater observation networks located within the SAAL NRM area of jurisdiction that can be considered historical in record. These were used to monitor groundwater resources within localised areas. These networks are currently still in operation, however different wells from the ones discussed below are currently employed. Locations of historical, current and proposed groundwater monitoring networks are provided in Figure 2 (Page 10). Specific details concerning each historical monitoring well can be found in Table 9 located in Appendix A. The historical monitoring networks are discussed below:

Marla Monitoring Network

Monitoring wells used to monitor yield, flow, accumulated flow and water level with data loggers are located in the vicinity of Marla, near the north-western boundary of the SAAL NRM area of jurisdiction. Information pertaining to this monitoring network is publically available through the Obswell online data base. As opposed to the current day network, there are ten monitoring wells that are historically part of the Marla groundwater monitoring network. All historical monitoring wells are located within the sub-artesian part of the GAB. No information as to why these wells are no longer used was found. Information pertaining to the current day network can be found in the section entitled “Current Groundwater Monitoring Networks”.

Leigh Creek Monitoring Network

An historical groundwater monitoring network used to monitor groundwater resources in the vicinity of the town and mining operations of Leigh Creek consists of 77 wells and is located within the south-central part of the SAAL NRM area of jurisdiction. The majority of these wells are located approximately 14 kilometres south of the township of Leigh Creek and are located within the fractured rock aquifer to the south of the GAB; one well located approximately 100kms east of Leigh Creek is located within the non-artesian part of the GAB. Information pertaining to this monitoring network is publically available through the Obswell online data base. No information as to why this monitoring network is no longer used was found.

However, a reduced network at the Emu Creek and Windy Creek wellfields are still being monitored by the current operators of the Leigh Creek Coalfield Operations

Great Artesian Basin Network

Monitoring of artesian wells in the Great Artesian Basin (GAB) in South Australia commenced in the 1970s with the work being conducted by the Department of Water, Land and Biodiversity Conservation (DWLBC) and its predecessors. Wells are monitored for shut in pressure and electrical conductivity from existing pastoral wells. Because of the high cost of drilling and monitoring wells in this remote area, wells have been monitored on a piecemeal or opportunistic manner whenever sufficient resources are available. In 2004, over 200 artesian wells were monitored providing the most comprehensive snap shot of artesian pressures in the region to date. Results from this survey will be used to produce a potentiometric surface in the SA portion of the GAB.

A specific dedicated monitoring network is however being established, as part the Commonwealth funded upgrade of the GAB wide network (refer section "Current Groundwater Monitoring Networks").

Other Groundwater Monitoring

Monitoring Wells

In addition to the information described above, information concerning other groundwater monitoring activity in the vicinity of the SAAL NRM area of jurisdiction can be found in Deane, 2004 and is summarised below:

- SA Water undertakes water quality monitoring for remote townships, however this information is not available through Obswell;

- Transport SA utilises groundwater for road maintenance. It is understood that some monitoring of usage is undertaken, but details are not readily available.

- SANTOS provides volume of water produced as part of petroleum production (co-produced water) to the DWLBC for water balance calculation purposes

GAB Springs - Dalhousie

Currently DWLBC monitor four springs within the Dalhousie complex approximately every six months. The springs are monitored for flow rates using boxed weirs, with flow rate varying from ~ 5Ls^{-1} to 180 Ls^{-1}. Field measurements of temperature, electrical conductivity, pH and Dissolved Oxygen are also recorded. The monitoring network was inherited from Bureau of Rural Sciences (BRS - formerly AGSO). The full size of the pre existing BRS network is unknown also no historical data was transferred from the Commonwealth to the SA government.

The monitored springs are located towards the northern end of the spring complex and springs monitored include Main Spring and Witjirrie Mound Spring. It is understood monitoring of these spring is undertaken on an opportunistic basis, with no official funding for support. It is also understood that this current monitoring programme commenced mid 1997.

GAB Springs - BHP Billiton

A number of different spring groups are monitored in the vicinity of Well Field A and along the southern extent of Well Field B. Historically GAB Springs were monitored on a monthly basis for flow and water quality. At present approximately 40 springs are monitored every six months by Land Use Consultants for BHP Billiton for flow and water quality (pH, electrical conductivity and temperature). Monitoring data is provided to the state government in the form of an annual report. Past copies of monitoring reports from the Olympic Dam Operation mound spring monitoring program are available from the South Australian Department of Primary Industries and Resources (PIR SA).

CURRENT SURFACE WATER MONITORING NETWORKS

Information concerning current surface water gauging and evaporation stations is provided in Tables 5 and 6, respectively, and is also located in Appendix A. A map of historical gauging stations is provided as Figure 3 (Page 11).

The review of surface water data needs is based on the draft, unpublished, but largely completed report "Surface Water Monitoring in the Arid North of South Australia" prepared and provided by the SA Dept of Land Water and Biodiversity Conservation (DWLBC) (Deane, unpub.). The report is an excellent reference source and the recommendations are reported to have only been made after extensive discussions with stakeholders. The costs at 2004 prices were $A1 million for initial establishment of the network and $75,000 for ongoing operation and maintenance. A summary of the report, along with its prioritised recommendations are provided in Appendix B.

The following information has been distilled from this report. Further relevant details from this report are included in Appendix B.

Creeks Discharging Westwards into Lake Eyre

Diamantina River

Cross-border flows from the Diamantina River are measured near Birdsville under a joint venture agreement with the Queensland government. Three Aridflo water level and salinity logging sites have been sited at Goyders lagoon, Koonchera waterhole and Warburton Creek. The EPA also maintains an ambient water quality monitor at Goyders lagoon.

The main objective for surface water monitoring is to gain an appreciation of the long term trend and variability of cross border flows and the frequency, timing and losses from flows as they progress through the waterholes of the channel country down through Goyders lagoon to Warburton Creek and Lake Eyre. Deane Unpub. recommends the continuation of the present programmes with a modest increase in the placement of Aridflo loggers to gain further information on the relationship between the health of waterhole refugia and the frequency, relative size and salinity of inflows.

Cooper Creek

This is similar to the Diamantina catchment, in that the cross-border flows are measured near Innamincka under a joint venture agreement with the Queensland government. Five Aridflo water level and salinity logging sites have been sited within the Coongie lakes complex.

The recommendations in Deane Unpub was to maintain the existing collection programmes, but to review the Aridflo data sites after analysis of the presently collected data and a parallel review of further ecosystems (refugia) where flow data would assist in making management decisions.

Data collected from the Aridflo programme appeared sufficient for the quantification of flows across the border, flood warnings, prediction of the movement of water downstream for natural irrigation of floodplains and replenishment of waterholes.

Creeks Discharging Eastwards into Lake Eyre

Several flow measurement sites have been established by the NT Government on the headwaters of the Finke River, which is the only watercourse to enter SA from the North West headwaters of the Lake Eyre basin. However no measurement sites exist near the border and the watercourse is only mapped for a short distance inside SA indicating that very little flow enters via this path.

A series of continuously mapped watercourses flowing eastwards towards Lake Eyre North have their headwaters along the path of the Stuart Highway within SA and converge to enter the lake i) at its northern end via the Macumba River and ii) on its western side via the Neales River. A series of smaller watercourses terminate in Lake Cadibarrawirracanna half way between Coober Pedy and William Creek to the South, several shorter watercourses converge to Lake Eyre South

Only nine Aridflo gauges were located within this area, which are sited along the Neales River. The data has been analysed and shown to be very useful in determining the frequency and relative sizes of flows and the order of magnitude of losses taking place between the gauging locations.

Despite frequent recommendations for the establishment of an index flow measurement station on one of the main creeks flowing to Lake Eyre from the North East and East none have materialised. This area is more highly populated and presently appears to have higher development potential than the North West area. Flood warning via radar could be considered.

Western Flinders Ranges, Lake Torrens and Lake Eyre South

The Willochra Creek provides inflows to the Board's area from the south and a flow gauge exists in the gorge near the point where the Creek discharges from the hills across the plain towards Lake Torrens. Flow measurements have also been obtained at Mernmerna, Aroona and Arcoona Creeks. None of the shorter, but steeper catchments discharging into Lake Torrens from the hills on its western side have been gauged.

River flow gauging stations were re-established at Emu and Windy Creeks in 2009 by the NRM Board.

Eastern Flinders Ranges and Lake Frome

Lake Frome receives surface flows from the Strezlecki overflow arm of the Cooper Creek and from the arc of catchments comprising the Eastern Flinders Ranges and the Northern Olary Ranges.

Two flow gauging stations operated in the northern Flinders Ranges for more than 15 years on Hamilton Creek and Mt McKinley Creek. Water quality samples have been

taken at several other sites. No flow measurements have been taken on the creeks flowing north from the Olary Ranges within SA, although records of flow have been obtained from the Umberumberka and Stevens Creek reservoirs providing water supplies to Broken Hill over many years. Much data is believed to exist from records kept in relation to the operation of steam trains.

In addition, attempts have been made to record flows from the eastern Flinders tributaries and it is suggested that sufficient data could be collated to enable rainfall to runoff modelling to be undertaken for these creeks.

Lake Torrens and the North Spencer Gulf

The situation in relation to flows into Torrens Lake from western flowing tributaries from the Flinders ranges is similar to that above for the eastern tributaries. Data for previously established gauging stations exists and with data from Aroona dam might be sufficient to enable rainfall to runoff models to be established.

Gawler Craton complex

This is the area that has the least data and knowledge on hydrology. In view of the high interest in mining, it is suggested that this area should receive the highest priority for the next 10 years.

CURRENT GROUNDWATER MONITORING NETWORKS

Currently, there are five operational groundwater monitoring networks within the SAAL NRM board jurisdictional area. Locations of current and proposed groundwater monitoring networks are provided in Figure 2 (Page 10). Specific details concerning each monitoring well can be found in Tables 8, 10, 11 and 12 and are located in Appendix A. The monitoring networks are discussed below:

Marla Monitoring Network

Monitoring wells used to monitor yield, flow, accumulated flow and water level with data loggers are located in the vicinity of Marla, near the north-western boundary of the SAAL NRM area of jurisdiction. Information pertaining to this monitoring network is publically available through the Obswell online data base. The current Marla groundwater monitoring network consists of six wells. All current monitoring wells are located within the sub-artesian part of the GAB.

Anangu-Pitjantjatjara Land Monitoring Network

Monitoring wells used to monitor yield, flow, accumulated flow and water level with data loggers within the Aboriginal Lands are located , near the north-western boundary of the SAAL NRM area of jurisdiction, as well as to the east of Leigh Creek (Nepabunna), located within the south-central part of the SAAL NRM area. Information pertaining to this monitoring network is publically available through the Obswell online data base.

The Aboriginal Lands Monitoring Network consists of 46 wells in total.. All wells are located outside the GAB.

BHP Billiton Well-field A and Well-field B monitoring networks

As part of their mining and resultant water extraction operations from the GAB, BHP-Billiton are required under the Roxby Downs Indenture to monitor impact to groundwater resources in the vicinity of extraction bores in their Well-field A and Well-field B areas. These well-fields are located near the centre of the SAAL NRM area of jurisdiction in the vicinity of Lake Eyre South. The monitoring bore networks consisted of a specified series of bores and springs in which a number of required parameters are monitored set intervals of time. Parameters can include a flow rate, pressure, salinity or chemistry. Although groundwater from the main J-K GAB aquifer is the primary target of monitoring, bores have been installed to monitor the perched water table in the overlying Tertiary/Quaternary units, as well as the basement units below.

Details concerning the monitoring programs are reported annually to the DWLBC. A subset of springs is monitored monthly by BHP Billiton, while consultancy groups undertake wider spring monitoring every six months.

Proposed Great Artesian Basin Regional Groundwater Monitoring Network

A dedicated groundwater monitoring network for the artesian part of the GAB is currently being established as part of a basin wide national network. Funding for the new monitoring network has been obtained from the Commonwealth Government.

This network is largely based around the monitoring network established in the 1970's and maintained by the DWLBC.

The head-works of the 58 existing wells selected for the network will be modified to facilitate monitoring. Of these, some 17 connected to water-tight distribution systems will be equipped with data loggers to monitor pressure and possibly flow, subject to agreement from pastoralists.

The recently drilled replacement well for the Oodnadatta Town Water Supply will also be included in the network.

The network will be monitored annually.

A separate network for the non artesian part of the GAB will be established in 2009/2010, again with funding from the Commonwealth. This will include sites drilled as part of the National Water Commission funded GAB project "Allocating Water and Maintaining Springs in the Great Artesian Basin".

KEY STAKEHOLDERS

South Australian Arid Lands Natural Resource Management Board (SAAL NRM)

The Board has statutory responsibilities for water information collection and management.

Department of Water, Land and Biodiversity Conservation (DWLBC)

The Department has on-going surface water and groundwater monitoring programs in the region.

Bureau of Meteorology (BoM)

Responsible for water data generally and rainfall in particular

Department of Transport, Energy and Infrastructure (DTEI)

Associated with the design of drainage works for new roads and railways, the Department undertakes modelling of stormwater events based on pluviometric data and flood frequency analysis based on historical data. Accordingly, there is a preference for reliable, long term data from a few catchments than poor/short term data from many catchments. There is also a preference to focus on monitoring of small catchments (easier to model and important for the design of culverts, whereas the bigger catchments generally have flood ways, for which the design parameters are not as critical).

Department of Environment and Heritage (DEH)

The DEH is responsible for the monitoring and management of springs and wetlands. Essentially responsible for monitoring biodiversity, risk assessment of ecological assets, not landscape processes/flows. Most DEH monitoring activity is based around the region's Parks and Reserves.

Environment Protection Agency (EPA)

The EPA has responsibility in the region for surface water quality and groundwater quality (excluding salinity). These parameters are monitored under the Ambient Groundwater Quality Monitoring program. The agency also has responsibility for surface water habitat monitoring at the State level, and for State of the Environment Reporting.

SANTOS

SANTOS has water reporting obligations under its licence and has its own interests for flood monitoring in relation to access to production wells. To that end, the company has a significant amount of information on the effects of flows on the Cooper Creek. SANTOS have been tracking floods using NOAA satellite images, complemented by information on rain and water levels provided by 13 BoM stations. The company is considering establishing a new monitoring station downstream of Durham Downs. There is also a need for gauging on the North West Branch of the Cooper Creek near Coongie.

Mining Industry

Water use reporting and groundwater level monitoring as part of licensing conditions

Community Based Monitoring

The Scientific Expedition Group (SEG) contributes scientific expertise both to dedicated expeditions run by the Group and also to collaborative expeditions with Universities, Government or other research or community organisations. The SEG has maintained a study area in the Gammon Ranges since 1988. The project involves hydrological, ecological and water balance monitoring within the Arcoona Creek catchment. Monitoring of rain gauges, water quality parameters, vegetation monitoring with photo-points and human impact monitoring with photo-points are generally undertaken quarterly.

MONITORING GAPS & DISCUSSION

General Water Resources Management

Recognise Past Experience

Upon reflection of the South Australian experience, the overwhelming conclusion has been that the mismatch between objectives, feasibility and the provision of operational resources to the data collection programmes as originally envisaged and periodically reviewed, has resulted in only a low level of programme efficiency until recently.

Better Prioritisation

The ability to capture large amounts of surface water for surface storage and use is low since dam sites are generally limited to small headwater locations and supplies are very unreliable due to high evaporation and increased salinity. All supplies larger than what can be catered for by a roof and tank system must generally come from groundwater or via a pipeline from some distant location. For this reason the highest priority for an understanding of surface water is to understand its relation to the maintenance of eco-systems and the recharge of groundwater, which is by far the more feasible source of water for activities requiring large water supplies, such as mining.

Rationalise Data Sources and Formats

Because of the remote nature of the area, its long occupation by a sparse population highly dependent on water and the sporadic and fragmented nature of past government data programs, the accumulated data and information on water is unusually broadly spread between three sources:

Collated data banks of specific direct and indirect aspects of hydrology;

Information contained in historical accounts; and

Local knowledge of persons living within or visiting the area.

In respect of the above, and in view of the considerable expense in collecting data on infrequent, ephemeral surface flows in the area as well as the very high hydrologic, temporal and spatial variability and uncertainty in objectives for data collection programmes, there appears to be a higher than normal role for a team of specialist archivists or researchers to trawl through historic accounts and to interview local persons to gain their knowledge on hydrologic causes and effects. This approach has been successfully undertaken by the BoM in respect to historical accounts of flooding across the whole of SA.

Foster Coordination and Integration.

A changed situation has arisen in which the State government no longer has the resources or incentive to undertake large scale surface water data collection in remote areas of the State. The Bureau of Meteorology is in the process of assuming greater responsibility for coordination and integration of water related data bases.

Responsibility for water data collection is being devolved to regional Boards. This responsibility includes:

The development application of appropriate advances in technology,

The management of data in relation to regulatory compliance by mining or other private developments or for usage in solving local water management problems.

In light of these recent developments, it is strongly recommended that the Board appoint an experienced hydrologist to ensure all present and past data collection programmes being undertaken within their area related to surface and groundwater hydrology is adequately archived for future analysis. The hydrologist would also be responsible for the periodic analysis of the data on a project basis to provide information on a particular aspect of benefit to improved water resource management. Priority should be given to:

Groundwater and surface water interactions involved in groundwater recharge

The relations between surface flows and health/productivity of river environments

Local storm and flood warnings

Surface Water Monitoring

Use Rainfall to Runoff Models to assist in Past Flow Data Interpretation

Past formal flow measurement, with an aim to determine flow quantities at specific locations, has been restricted to the Diamantina River, Cooper Creek and Flinders Ranges streams. Sporadic observations and estimations may have been made on other streams, but these have not been collated or analysed. In general the best sites for quantification of flow rates and volumes for the Diamantina River and Cooper Creek lie in Queensland.

Quantification of flow rates and volumes in the Flinders Ranges have been generally unsuccessful due to poor reliability of water level recorders (due to heat and damage from fast flowing sediment/debris laden flows) and access difficulties to obtain water level to flow relations during flood events. Volumetric flow estimation via water level and salinity measurements has been carried out with potentially greater success at Aroona dam, but this data needs to be sorted in respect to concurrent evaporation, off-take and spill influences.

More recently, greater success has been had by limiting data acquisition to the occurrence and relative sizes of water fluxes (gains and losses) at water holes, using

lower cost, simple but robust water level recorders. This information will assist with the development of rainfall to runoff models.

Use Radar Enhanced Rainfall Measurement Methods

Inspection of the locations of historical and current rainfall gauges (Figure 5 & Figure 6, Pages 19 & 20) shows that both the number and the distribution of gauges are now generally better than they have been in the past. However, several areas, including the central northern areas comprising the Simpson Desert and Lake Eyre Parks and Regional Reserves and several areas comprising the headwaters of the river courses flowing eastwards from the Stuart shelf escarpment into Lake Eyre, never had, and still do not have any rainfall measurements.

One of the largest of the Stuart shelf drainage areas lies between Andamooka, Coober Pedy and William Creek and covers the headwaters of all creeks draining into Lake Cadibarrawirricanna and Lake Eyre South. Continuing north, another area lies between Oodnadatta, Mt Dare and Mt Cavanagh. This area covers the headwaters of creeks draining into the Macumba River.

The area between the Barrier Highway and the SAALNRMB boundary with the River Murray Board area also appears to have never had any rainfall recording stations.

Areas that historically had a better rainfall coverage than at present include the lower reaches of the creeks draining from northern NSW towards Lake Frome (Tilcha, Yandama and Coonee Creeks) and from the northern Flinders Ranges to the arc of terminal lakes between Lake Eyre South and Lake Callabonna (Frome River to Hamilton Creek).

All of these areas have very low population density, poor access and harsh conditions. Areas outside the parks and reserves are used for opportunistic grazing with stock levels dictated by the availability of feed, which itself forms a crude measure of rainfall.

Despite these gaps the Bureau of Meteorology now publish maps of 24 hour rainfall totals for all areas of Australia. These are compiled using composite radar rainfall measurements, with each radar having a nominal maximum range of about 500 kms and the measurements adjusted according to the daily measurements from the synoptic gauges within that range. At the maximum range, the whole of the SAALNRMB area is covered by the radars at Woomera and Alice Springs, however, the accuracies of these radars decrease significantly with distance beyond about 200 kms and the spatial density (and accuracy) of the 'ground-truthing' daily gauged measurements. Thus the accuracy over the areas of no gauges (the Simpson desert/Lake Eyre regions and the arc between the Strezlecki Track and Lake Frome/NSW border) and the distant areas with few gauges only (the north-west corner area between Birdsville and Innamincka), will have a lower measurement confidence.

Use New Concepts and Technologies – Modelling and Remote Imaging

The area is characterised by wide plains with occasional rocky outcrops or ranges with shallow soils. The surface hydrology is dominated by rainfall and evaporation. The surface water flows within the area are infrequent and generally involve runoff generated on the rocky outcrops or steeper shallower soil areas. The flows may only exist over a relatively short distance to a playa lake, where the water is evaporated. Larger flows may travel a greater distance than smaller ones before they lose their momentum through infiltration and filling of local playa type storages. En-route, infiltration from the infrequent flows may be the major recharge mechanism for local groundwater. The salinity of the flows may be initially low, but when evaporation reduces the flow, or the flow passes over areas where salts have previously accumulated, the salinity may be high. Groundwater salinity and level variation are the main indicators of the long term trends.

The source and sink for surface flows are readily discernable by remote sensing and mapping. It is recommended that surface water monitoring should recognise this pattern and be based to a greater extent on spatial mapping than on temporal recording at only a few locations.

The estimation of surface flows resulting from rainfall over rocky outcrops (as for urban roofs and paved areas) is relatively straightforward, even in arid areas, when the rainfall and the area of outcrop are known. The passage of a recent flow can also be identified by the presence of water in playa lakes.

The above approach suggests that remote sensing of soil moisture and the presence of flows in playa lakes, in conjunction with rainfall measurement should be the main method of understanding the surface water flows within the area. Since the areas are large and rainfall is very variable, even over relatively small areas, until recently the estimation of flow could only be undertaken with any accuracy close to existing rain-gauges. However, the Bureau of Meteorology has recently developed daily mapping of rainfall based on radar images with ground-truthing from a network of daily reporting rain-gauges.

The aridity of the area leads to the raised feasibility of satellite imaging to trace and record the passage of floods as they move downstream, the rise and recession of soil moisture during and after rainfall events and the general greening of the vegetation as a result of the rainfall and transmission of flows.

These are technologies which offer large potential benefits to surface water data collection within the arid areas and are currently available. However, investigation and development into practical tools suitable for the purposes of the Board is required.

Climate Change

Inspection of the maps provided on the Bureau of Meteorology's website shows that by 2030 the average annual rainfall over the NRM Board's area is expected to decrease by 2 to 5%. However, the variability will also increase so that while droughts will be deeper and longer, and major rain events may occur less frequently, when they do occur they may be more severe. Due to the expected higher temperatures, evapotranspiration rates will also increase by about 2 to 4%, thus causing greater stress on water held in storages and on any biota dependant on this water.

Under these circumstances, land and water management will obviously become more difficult with the need for progressive changes in management methods.

Under a regime of greater climate variability, the duration of monitoring programs must be lengthened due to the increased frequency of 'zero' events in most records. The added duration of monitoring programs will add cost and also delay the date when the analysis of that part of the data that has already been collected can reveal accurate statistics (eg. on averages and the risks of extreme events, such as floods and droughts). The higher temperatures and added variability of all climate measures will also place greater stresses on the reliability of measuring equipment and staff comfort. The need for more robust measuring equipment will also add costs.

The different techniques used for water data collection in arid and temperate areas have been described. Climate change will accentuate the differences, but the rate of change will be gradual and new techniques suitable for more arid environments can be developed progressively, as required.

Groundwater Monitoring

There are many gaps in groundwater monitoring networks throughout the SAAL NRM jurisdiction. This is not surprising considering the very large region and low population density and the resultant patchy distribution of water usage.

The basic principal for groundwater monitoring in the SAAL NRM region is to monitor for existing and potential new impacts as a result of alterations to the hydrogeological system. These changes may be a consequence of groundwater extraction or changes in land use that has an impact on groundwater recharge or discharge. In general terms any changes in groundwater usage should result in increased monitoring.

In time, specific monitoring protocols will need to be developed for the different geological regions. This would include, but not been limited to the construction of the well, the frequency of sampling and degree of purging prior to water quality sampling. Also the size and impact of the alteration to the hydrogeological system needs to be considered in the design of any groundwater monitoring network. In essence any new developments need to be assessed on a site by site basis.

Ultimately the most useful monitoring wells are those that are specifically designed rather than using wells that were drilled for other purposes.

Groundwater Dependent Ecosystems

Outside of the GAB Springs monitoring programs at Dalhousie and BHP Billiton there is very little historical or present day monitoring of groundwater dependent ecosystems.

Water Quality

From the ecological perspective, the key characteristic of interest in ephemeral systems is surface water persistence. The presence of drought refuges is critical for aquatic biodiversity conservation across scales of space and time (Costelloe et al 2004). Refuges were defined in the Aridflo project as being capable of persisting without inflows for at least 18 - 24 months. Many of these refugia waterholes apparently persist without significant contributions from groundwater (Costello et al 2003, 2004).

The *Environment Protection and Biodiversity Conservation Act 1999* is Commonwealth legislation that provides for the protection of 'Matters of National Environmental Significance' including wetlands listed under the RAMSAR convention. Coongie Lakes is one such wetland. Threatened ecological communities are also subject to protection and GAB Spring communities are listed in this regard. The Act requires referral to the Minister for Environment of any action that potentially affects the listed Matter for assessment. Specific guidance can be obtained with respect to the Coongie Lakes RAMSAR site

Understanding salinity processes in the region is a significant knowledge gap. A research project, funded by the Australian Research Council and supported by the Board, is currently investigating this topic. There is little or no existing continuous salinity monitoring in surface waters, with the only site being the Arcoona Creek gauging station operated by the Scientific Expedition Group. DWLBC do not monitor continuous salinity in surface waters at the existing gauging stations, however current policy is to install conductivity meters wherever data loggers are deployed to measure flow or water level. Any future stations installed will include conductivity meters, and there are plans to instrument existing stations with salinity probes.

Issues for the design of a water quality monitoring program relate mainly to the unpredictable nature of flows in the region and the influence of flows on water quality conditions. Water quality can be expected to vary as a function of time since the last flow event and this must be considered in interpretation of the results from any sampling programs. Hence it is not a simple case of planning to visit a site on a given day for samples as the site may be inaccessible or even completely dry given extended drought conditions.

Telemetered water-level monitoring sites would provide accurate indications of the time elapsed since cease to flow levels were achieved. This would provide some flexibility in planning water quality sampling visits.

Broad patterns in water quality are yet to be linked to specific physical conditions present, such as geology, to enable a degree of predictive ability in assessment. The level of natural diversity in water quality parameters including biological communities needs further characterisation.

Salinity processes are also still to be understood. Costelloe et al (2004) recommend developing an improved understanding of catchment salinity transportation processes as salinity fluctuations play an important role in structuring biological communities. An improved knowledge of surface water to groundwater interactions will assist in this regard.

An additional recommendation from Costelloe et al (2004) was for the assessment of the performance of AusRivAS protocols in Lake Eyre Basin rivers, especially relating to the level of taxonomic resolution. Comparison of AusRivAS data with Aridflo data (which is of a higher taxonomic resolution) may help to evaluate this.

Perhaps the most significant knowledge gap for the management of water resources and dependent ecosystems in the region is spatial data relating to the precise location and ecological value of water-dependent ecosystems. These sites will require investigations to determine their ecological value and significance within the landscape. Work is currently being undertaken to address this gap.

Coordination

A strong motivating factor in undertaking the state-wide review of water monitoring is to look for opportunities for integration of monitoring effort. This includes integration between and within a range of stakeholder groups. The role of the catchment authority must be central in coordinating this due to their on-ground presence in the region. A position based in the relevant NRM authority and responsible for coordinating monitoring needs to be established to provide continuity and support this in an on-going fashion.

RECOMMENDATIONS

Board's Objectives and Programs in Water Monitoring

Summary of Recommended Actions and General Programmes for Water Monitoring.

1. Employ a hydrologist. It is strongly recommended that the Board appoint an experienced hydrologist to identify all past data collection programmes undertaken within their area related to surface and groundwater hydrology, to develop these in line with the following recommendations and to ensure that this data is adequately collected, archived and periodically analysed to meet identified water resource management objectives. Required experience for the hydrologist would include:

Familiarity with methods for hydrological surfaces and groundwater data collection, processing, storage and analysis;

good understanding of both surface water and groundwater hydrology, their inter-relations and their influences on water-dependent ecologies;

familiarity with outback conditions;

20 years minimum experience; and

very good communication and inter-personal skills.

2. Establish a Monitoring Committee involving key stakeholders identified above. There is a need for all groups/ agencies with interests and obligations in water information to work together to optimise the capacity provided through the community, industry and statutory bodies, ensure efficient use of limited resources and to co-ordinate funding applications. Establish monitoring objectives, collection and analyses programs and stakeholder participation. Secure funds. Deploy measurement equipment and arrange for data collection, processing and analysis.

3. Establish data storage and/or access to other existing data networks. Create a temporal data base and/or establish access protocols for all time based surface and groundwater data relating to activities and processes taking place or planned within the Boards area. Establish a similar GIS data base and/or access protocol for the receipt and analysis of spatial data and information

4. The Monitoring Committee/hydrologist to identify communication links to other persons/agencies collecting data and/or interested in providing information relevant to improved understanding of the water systems.

5. Collect data on all water diversions. It is suggested that avoidance of overuse and/or over-allocation of surface and groundwater via water diversions is the single most pressing management responsibility of the Board. Knowledge of where water is being diverted and used is therefore the first requirement of a data collection programme.

6. Identify water flow dependant environments. Any use or diversion of water for one purpose may, in the long term, diminish that available for downstream water dependant environments. The use of surface water, in particular, will have a more

immediate impact on the downstream environment. The second most pressing requirement is therefore to identify the environments that are most at risk through present or likely future use. Moreover, since it may be assumed that environments in arid areas that are reliant on local rainfall and flows are at their limit in respect to sustainability, any change of climate that reduces rainfall will further stress environments and reinforce these as 'no-use/or allocation' zones.

7. Measure rainfall. Of all the hydrologic parameters, both incentives and feasibility for measuring rainfall are greatest. Rainfall data has the greatest impact on the livelihood of all activities within the area and is the main driver of all the hydrologic processes. It is suggested that securing a real-time, accurate spatial coverage of rainfall data and a secure, accessible rainfall data bank should be the highest priority for the Board. It is recommended that the board investigate and utilise the latest radar and satellite enhanced estimates of rainfall being developed by the Bureau of Meteorology (BoM). The knowledge and quantification of rainfall (particularly over higher, rocky topography) will enable hypotheses to be formed on the occurrence of surface water run-off generation, transfer downstream, and eventual fate, either by transpiration, evaporation or groundwater recharge.

8. Data on run-off generation/transfer can be gained from a combination of formal flow data collection, local observations, remote sensing and/or modelling. Data on the fate of the rain generated water can be gained by different means:

Transpiration can be gained via remote sensing of vegetation;

evaporation via remote sensing of vestige storages in lakes and playas and by data on water levels in water holes; and

recharge via data from formal or informal groundwater observation bores.

9. Use models incorporating rainfall data and other data/information (as above) to calibrate against other data sequences in order to extend understanding on relations involving soil moisture, runoff, recharge, etc. Once good rainfall records are available the main aim of data collection should be to collect sufficient data for the establishment of rainfall to runoff models showing flow generation and subsequent transfer downstream with losses to the three pathways identified above. The WaterCress model is a suitable model for most purposes. Using existing data on rainfall and runoff (or water levels), set up WaterCress models, with channel losses incorporated, to attempt to calibrate against known flow occurrences and filling of, and evaporation from terminal lakes. Greater detail is given in the next sections on surface and groundwater data collection. Wherever appropriate, attention should be provided to the collection of the interactions between surface and groundwater data and their relations with water related environments.

10. Collect salinity data. Much water in arid areas is saline. High salinity, particularly of groundwater or small quantities of ephemeral water in terminal lakes, is generally not beneficial to natural environments. Desalination of high salinity ground water for mining ventures with limited asset lives may thus be a suitable use for water that does not seriously diminish environments in the long term. Similarly the diversion of excess surface water from terminal lakes (ie before it evaporates) for recharge of groundwater also appears to be unlikely to diminish natural environments. Thus the collection of salinity data is a powerful means for identifying catchment processes and water supply options.

11. Make data and information collection an interest and responsibility of all persons and organisations involved in the SAAL NRMB area. Local groups with an interest in water data and information within their local area should be brought into the data collection process and asked to contribute to it. The form of data collected will reflect the interest and resources available. The data bank will act as the collation and analysis source for disseminating water management information and developing policies.

12. Research remote sensing as a monitoring and flood prediction tool. The aridity, scale, difficult of access, limited resources for data collection and slow flow velocities over much of the area leads to the raised feasibility and desirability of utilising radar to enhance rainfall measurements and satellite imaging to trace and record and predict the passage of floods as they move downstream, the rise and recession of soil moisture during and after rainfall and flow events, and the general greening of the vegetation as a result of the rainfall and transmission of flows. These are technologies which offer large potential benefits to surface and integrated water resource data collection within the arid areas, but require to be investigated and developed into practical tools, suitable for the purposes of the Board.

Surface Water Management Recommendations

The highest priorities for surface water data collection include the real-time monitoring of flood generation and downstream transmission of flows for flood warning, the maintenance of cross border flows, the relations between flow frequencies, pool storages, groundwater exchanges and the health of water related environments and the improved understanding of local hydrology in project areas.

Specific sites for surface water monitoring, which conform to the recommendations provided in this report, have been identified and reported (with estimated costs) in an unpublished report by the SA Department of Water, Land and Biodiversity. (Deane, Unpub.). The recommendations are for 4 new, high-priority fully rated flow gauging stations additional to the 3 existing stations. The new Gawler Ranges station has been raised to high priority in this report, from the low priority given by DWLBC. The summary table below details these stations along with an additional 8 stations linked in reduced priority. These could be established if resources could be located for their establishment and operation.

In addition, the renewal of the AridFlo program is recommended as high priority. This program will focus on monitoring of water levels in selected (generally deep) refugia waterholes, in conjunction with ecological monitoring (particularly of the fish assemblage). A list of priority locations for monitoring throughout the Lake Eyre basin is provided in Costelloe, 2008 Sections 5.1.1 to 5.1.5. with about one half of these located in SA.

There would appear to be high priority to extend (and rationalise) the AridFlo program to cover the whole of the SAALNRMB area. Thus, as a first step, the Monitoring Committee should review the past AridFlo programme with a view to recommencing it, but also extending it to cover the whole SAAL area. As part of this, advantage should be taken of the Santos monitoring locations, interests and activities.

Table A: Hydrological sites and Costing Recommendations (Deane Unpub.)

Station name	Station type	Status	Cost to Initiate[1] $,000's	Ongoing annual cost to maintain[1] $,000's	Priority	Comments[1]
Cooper Creek @ Cullyamurra Waterhole	Base	Existing	NA	4	High	Cross-border monitoring requirement. Operated as a joint venture with the Queensland Government. Historically operated on a share basis with each jurisdiction being responsible for periods of around 10 years Ongoing cost includes downloading data from local Aridflo loggers, data verification and entry to Hydstra for all data
Diamantina River @ Birdsville	Base	Existing	NA	4	High	Cross-border monitoring requirement. Operated as a joint venture with the Queensland Government. Historically operated on a share basis with each jurisdiction being responsible for periods of around 10 years Ongoing cost includes downloading data from local Aridflo loggers, data verification and entry to Hydstra for all data
Aroona Creek @ Aroona Dam	Base	Existing	NA	4	High	Dam level monitoring for mining operations at Leigh Creek water supply. Gives an indication of overall catchment yield and rainfall to runoff understanding
Eastern Flinders stream	Base	Recommended	130[2]	4	High	Includes data review of existing, preliminary runoff model, (if possible based on data); site evaluations for all eastern Flinders proposed sites; installation and initiation of the base station. (This costing is based on an improved rock bar at a suitable site. If a gauging weir structure is found to be necessary to achieve required accuracy, significant additional cost will be incurred.
NW Branch Cooper Creek upstream of Coongie Lakes	Project	Recommended	100	8	High	Install cost includes a review of the Aridflo network, summaries and review of data; locate suitable site; instrument and commission site. Ongoing cost includes downloading data from local Aridflo loggers, data verification and entry to Hydstra for all data
Gawler Ranges	Project	Recommended	100	4	High[4]	Recommend initial investigation of farm dam density and ecological assets to identify major catchment threats. This would cost around $250, 000, subject to availability of imagery. Installation of project gauging station will require considerable investigations to determine suitable sites.
Wilpena Creek	Project	Recommended	60[2]	4	High	Required to assess the impact of tourism based development on water resources

Table A: Hydrological sites and Costing Recommendations (Deane Unpub.) (continued)

Station name	Station type	Status	Cost to Initiate[1] $,000's	Ongoing annual cost to maintain[1] $,000's	Priority	Comments[1]
Eastern Flinders stream upper catchment	Project	Recommended	60[2]	4	Med-High	Station required to investigate loss processes (in association with the high priority station identified above). Station siting would be determined during investigations for the base station.
Western River draining to Lake Eyre	Base	Recommended	100[3]	8	Med-High	Installation includes site evaluation and review of the local Aridflo network and data collected to date. A site for the additional western rivers project station would also be determined Ongoing cost includes downloading data from 6 local Aridflo loggers, data verification and entry to Hydstra for all data
Warburton Creek @ downstream of Goyders Lagoon	Project	Recommended	60	6	Med	Install cost includes a review of the local Aridflo network and a review of data; locate suitable site; instrument and commission site. Ongoing cost includes downloading data from local Aridflo loggers, data verification and entry to Hydstra for all data
Cooper Creek @ downstream of Etadunna Swamp	Project	Recommended	60	4	Med	
Additional Western River site	Project	Recommended	60[3]	4	Med	Priority depends on whether the Neales at Algebuckina is the site for the Base station. If this is the case the second station on the western rivers becomes a low priority.
Musgrave Ranges stream	Project	Recommended	100	4	Med	Includes two site visits to identify suitable sites and to install the instruments; little likelihood of surface water development
Western Flinders Ranges (Brachina area)	Project	Recommended	60	4	Med	Knowledge level is generally good in this region but the middle western Flinders Ranges hydrology is a knowledge gap
Northerly flowing stream draining the Olary Spur	Project	Recommended	60	4	Low	Some initial information on these flows could be obtained from gaugings undertaken on Broken Hill water supply reservoirs.
TOTAL			**$1,010**	**$74**		

Notes:
1 Costings based on cost recovery where work is undertaken by DWLBC at September 2004 pay scales. Indicative guide only, more accurate costings would require the development of detailed proposals. Ongoing costs factor in instrument depreciation over a three-year period. Cost per site is based on the recommended minimum network of 5 base stations and 11 project stations. This value would change subject to any alteration to this network. No cost sharing arrangement is implied by the designation of station categories.

2 Costings assume technical investigation to site stations will be undertaken under the Base station. This cost will be required irrespective of whether one site or more is implemented.

3.Costings for western rivers stations will require one technical investigation to locate the ideal site. This cost will be required irrespective of whether one site or more is implemented.

4. Was given low priority by DWLBC

Groundwater Management Recommendations

The SAAL NRM jurisdiction covers an enormous part of SA as well as a vast array of different climatic zones and variability. The large temporal variability of rainfall has significant impacts on both the hydrology and hydrogeology of the region.

Hydrogeological, hydrology and ecological investigations over the past few decades have identified a number of data and knowledge gaps. These include

Surface/groundwater interaction
Recharge/discharge rates and processes
Interaction between springs and production bores

The purpose of monitoring should be to detect trends as well obtain a greater understanding of the above processes. In order to move towards this direction it is recommended that:

1. Current monitoring arrangements of both monitoring bore and spring networks are continued and expand where possible as discussed in this report.

2. The development of super monitoring sites should be established to obtain not only a greater understanding of long term trends but just as important the processes that are responsible for these trends. This will ultimately result in a pro active rather than re-active management system.

Monitoring Bore Networks

Monitoring of artesian wells is complex particularly in the harsh arid environment in the north of SA. There are many uncertainties associated with the monitoring artesian wells such as consistent access to the well head, potential corrosion and leakage down-hole, well usage prior to arriving on site. This results in an inherent uncertainty in the recorded values of shut-in pressures. Under an ideal scenario a specifically designed and dedicated monitoring network should be established. Unfortunately the high cost of drilling or rehabilitating wells to establish such a network is prohibitive.

Recently funding has become available for converting existing well heads to a specification that will allow a more consistent approach to obtaining shut in pressures. The funding will allow approximately 40 wells to be included into a

network with some wells having logging capabilities. It is strongly recommended that this new network be monitored at a minimum of every year.

Confined portion of the GAB

A proposed network of 41 monitoring wells intended to provide information concerning the artesian part of the GAB at a regional level has been put forward by the DWLBC. These wells also formed part of a national GAB-wide monitoring network originally designed by the Bureau of rural Science (BRS). Wells are evenly spread throughout the artesian part of the GAB in South Australia, although the density of wells increases slightly near the artesian water boundary. Funding for the commencement of monitoring has been approved (Sibenaler pers comms, 2009), although the authors are unaware as to whether monitoring has commenced.

Unconfined portion of the GAB

The proposed regional observation well network for the GAB is restricted to the confined portion of the GAB. However, not only is the unconfined portion of the GAB part of the same hydrogeological system, water within the unconfined portion is also potentially under the same exploitation pressures. It is therefore considered prudent to treat both the unconfined and confined portions of the GAB with the same level of management concern.

It is recommended that an observation well network of similar-well density to that planned for the confined portion of the GAB be established. On planning of this network, allowance should be made for existing users of groundwater, including current pastoral, township and commercial operations. In addition, provision for potential future usage, both in relation to volume or spatial extent should be attempted.

It is understood that funding has been made available for DWLBC to establish such a network.

Existing Observation Well Networks

For the existing network it is recommended that detailed monitoring occur at a bi-annual basis at a minimum throughout the GAB in SA. In particular areas to focus on should include areas east of Lake Frome, Well Field B and the Central North region. Furthermore a number of irregularities in the monitoring records should be investigated; in particular well completion records and matching well pressures with maximum temperatures.

New Observation Well Networks

In addition, it is recommended that a new regional groundwater monitoring network be established for all different geological regions. It is recommended that at least two wells are established for monitoring purposes in the following geological regions: a) the Gawler Craton, b) the Adelaide Geosyncline (Northern Finders Ranges) and c) the Torrens Basin.

Additional to these regional networks, more localized networks should be established at groundwater reliant communities/townships such as Coober Pedy and Glendambo.

The main objective of these networks is to establish baseline information such as water level and salinity. This information can then be used in the development of any new site specific monitoring program that may arises due to increased groundwater extraction or changes in land use.

GAB Springs

In relation to springs that occur within the GAB, it is recommended that a dedicated GAB springs network, should be established as a priority. Currently, only springs associated with BHBP and 4 springs within the Dalhousie Springs complex are monitored on a regular basis. This existing spring monitoring network should be used as the basis of an expanded monitoring network.

Subject to permitting requirements, it is also recommended that a number of springs within the expanded spring monitoring network have weirs, as well as pressure, conductivity and temperature transducers installed to improve the quality and frequency of data obtained. If budgetary constraints allow, it is also recommended that these transducers be connected via satellite telemetry to make monitoring real-time and to save money in relation to travel costs. In relation to site selection for weir emplacements, it is recommended that only springs with a defined, single outflow channel be chosen to simplify weir construction and data collection.

Alternatively, spring flow monitoring may be conducted using a salt dilution methodology. However, as with the use of weirs, only spring sites with a defined single outflow channel should be selected for application of this methodology.

Water quality monitoring should involve flow, electrical conductivity, pH, Temperature and Dissolved Oxygen (DO). In addition, it is recommended that a water sample be collected each month for at least one to two years and analysed for major cations and anions.

It is also suggested that multiple monitoring stations be placed at one or a number of study sites, including at least one large spring within the south western portion of the GAB, with one monitoring station placed in close proximity to the vent of the spring and one other placed within the portion of the tail at which point calcium carbonate has begun to precipitate. . The purposes of monitoring can be summarised as follows:

- Determine natural variance in spring-flow and hydrochemistry over time. This will help with the interpretation of what a drop in pressure due to groundwater exploitation may have on the environment. In relation to the hydrochemistry, monitoring will also help determine if there are hydrochemical or water quality parameters useful in relation to determining the health of a spring-supported environment and whether this can be used to assess how at risk an environment may be from changes in flow. For example, pH is particularly pertinent for carbonate-precipitating springs, as it is a good indicator of when

conditions for the precipitation of calcium carbonate are reached. Understanding the development of such conditions is considered useful in relation to spring management because the precipitation of carbonate material within the pool and conduit of a spring is an effective means of slowing and eventually ceasing spring water flow.

Monitoring will help determine the presence of any seasonal pattern to hydrochemical and water quality within the spring supported aquatic environment. This will not only provide valuable information in relation to any seasonality with spring environments but may also possibly contribute to local climatology studies.

Suggested spring locations for multiple monitoring station points include the larger flow springs of Warburton Spring within the Beresford Hill Spring System, Jersey Spring located within Wabna Kadarbu National Park or the Francis Springs area near the Peak and Denison Inlier. The risk with lower flowing springs for the installation of multiple monitoring points is the likelihood of a change in tail direction emanating from a point close to the vent is increased and the paucity of water makes accurate sampling within the tail environment more difficult over extended periods of time.

In addition, it is recommended that the SAAL NRM seek to obtain all historical data from BRS regarding Dalhousie Spring monitoring. Once this data is obtained, a review concerning spring flow and water conditions can be undertaken, with an eye to interpreting natural variation in spring waters over time and potentially recognising patterns associated with groundwater usage impacts.

Super Monitoring Sites

As alluded to earlier, the SAAL NRM jurisdiction covers an enormous part of SA and includes a vast array of different climatic zones and variability. The large temporal variability of rainfall has significant impacts on both the hydrology and hydrogeology of the region.

As a consequence, the development of a highly effective monitoring strategy that covers the entire region would require a very large investment in infrastructure well beyond the financial capability of the SAAL Board.

Therefore, the development of a number of monitoring super sites is proposed. These super sites would help managers and their supporting researchers obtain a greater understanding of long term trends as well as an understanding of the processes that are responsible for these trends. This will ultimately result in a pro-active rather than re-active management system.

It is recognised that the concept of these super monitoring sites will take time as well as additional resources. However much planning work can commence now so that when future opportunities arise the SAAL NRM is well placed to maximise these opportunities.

The following is a list of potential super monitoring sites with proposed actions for their establishment as such.

Northern Flinders Ranges

Select suitable catchment.
Undertake well survey.
Select appropriate wells for monitoring of water level and salinity.
Install a suite of monitoring wells perpendicular to drainage line.
Establish weather station (solar, rainfall)
Install a weir with logger to measure outflow and salinity.
Evaluate surface/groundwater interaction and processes.

Beresford Hill Spring Complex

There are one or two existing bores within 1km of this site. These should be complimented with the installation of an additional 2-3 bores.
Monitoring stations at Warburton and Little Beresford springs to be installed.
Establish seismic recorder.

Frome Embayment

It would appear that there a great number of privately drilled monitoring wells within this region already. Establishment of a super site here would require the SAAL NRM to acquire the data from an appropriate number of these bores on an ongoing basis.

Dalhousie

The Bureau of Rural Sciences (BRS) has been collecting monitoring data here for some time. Establishment of a super site here would entail acquiring this data and expanding upon it. Once these data are obtained, a review concerning spring flow and water conditions can be undertaken, with the aim to interpreting natural variation in spring water over time and potentially recognising patterns associated with groundwater usage impacts.

PROPOSED HYDROLOGY PROJECT

One of the key recommendations from this review is the appointment of a hydrologist dedicated to the region. Should this recommendation be accepted, it is assumed that the hydrologist would in time develop the appropriate programs of work that have been broadly outlined in this report. Taking into account the lead time required to develop work programs and the opportunity to access potentially available funding in the short term, the following project is suggested for implementation in the first instance, with the understanding that such a project would encompasses any new methodologies that were demonstrated to be more applicable to the area.

Previous Hydrological Assessments of the Windy and Emu Creek Catchments

It is recommended that the catchments be adopted as a case study for trialling a new approach to water data collection and analysis, as proposed in this report and that funds be sought to investigate, document and assess the approach for adoption in other catchments.

Table B below shows the surface water data collected in the Windy and Emu creek catchments draining westward from the Northern Flinders Ranges towards Lake Torrens. Aroona dam is situated just downstream of the confluence of the creeks as they emerge from the Ranges. The town of Leigh Creek, situated just north of the dam, draws its water from a combination of surface water from the dam and desalinated groundwater from borefields situated 10 kms upstream of the dam.

Table 1: Rain Water Gauging Stations located with the Windy and Emu Creek Catchment area

Station Code	Station Name	Obs. Interval	Opened	Owner
AW510507	WINDY CREEK @ Maynards Well	Level, flow, ad hoc WQ	1972 - 1989	DWLBC (SA)
AW510510	WINDY CREEK @ Leigh Creek	Level, flow, ad hoc WQ	1986 – 2003	DWLBC (SA)
AW510511	EMU CREEK @ Leigh Creek	Level, flow	1986 – 2003	DWLBC (SA)
A5100500	AROONA CREEK @ Aroona Dam	Level, ad hoc WQ	1960 - current	DWLBC (SA)
AW510512	WINDY CREEK CATCHMENT PLUVIO @ North Moolooloo	Continuous	1986	DWLBC (SA)
AW510513	WINDY CREEK CATCHMENT PLUVIO @ North Mocatoona	Continuous	1986	DWLBC (SA)
AW510514	WINDY CREEK CATCHMENT PLUVIO @ Maynards Well	Continuous	1986	DWLBC (SA)
AW510515	EMU CREEK CATCHMENT PLUVIO @ Pfitzners Well	Continuous	1986	DWLBC (SA)
AW510516	AROONA DAM PLUVIO @ Aroona Dam	Continuous	1986	DWLBC (SA)

Coal was first discovered at Leigh Creek in 1888 and water has been of critical importance to mining operations since that time, particularly after major operations commenced during and after World War II. In addition, Leigh Creek is also on the railway line between Adelaide and Alice Spring. As a consequence, the procurement of water for mining, railway operations and tourism has been a matter of continuous importance. More recently, the areas around Aroona dam and in the Ranges

generally have become a focus for successful land regeneration, which potentially alters the hydrological and groundwater-recharge characteristics of the area.

A groundwater monitoring network of approximately 77 bores was once used to monitor groundwater in the vicinity of the town and mining operations (refer Page 23). The majority of the wells are located approximately 14 kms south of the township, adjacent to Windy and Emu Creeks. Although no publicly available record was found to date, it is expected that monitoring of many of these bores would have continued in some capacity. The following conclusions were drawn from an analysis of available monitoring data:

Recharge conditions in the Windy Creek well field area vary greatly.

It is likely that natural discharge in the Emu Creek catchment areas occurs more often than might be expected from examination of water level records, but is missed because monitoring events are too widely spaced to show recharge pulses.

Outcomes from a desktop assessment of surface and groundwater characteristics and resources for the same catchment undertaken in 2008 (AGT, 2008/36) included the following:

The level of available groundwater monitoring data across the catchment is limited and enabled only general observations to be made; and

estimates of the quantity of recharge have been possible using a chloride mass balance approach.

Proposed Methodology

The proposed approach requires a team lead by an experienced surface water hydrologist, Since the hydrologist has yet to be employed, the role must be undertaken in the interim by a consultant or similar. The other members of the team will be an historian/archivist, an ecologist and a hydrogeologist.

The team members will be performing different activities, but will be communicating and exchanging information during the project in order to identify and pursue priority leads identified by the different members. The aim of the project will be to obtain quantitative information about the hydrology of the catchment and the associated water-dependent environments

Assessment of data by the team will be undertaken in three phases:

<u>The pre-measurement phase (1850-1940).</u>
During this period, it is likely that only daily rainfall records will be available to researcher, however, any other water-related measures will be sought, including the identification and recording of information related to other disciplines outside of hydrology. Such records include station diaries, train water filling records, stock number records, records of vegetation, bore drilling and related water data, descriptions of flood heights and the like.

The early measurement phase (1940 to 1980).

During this period, record-keeping may have commenced, but records may have been "lost" or may not have been collated in such a way that their multi-disciplinary value is revealed. Records collected during this time include vegetation surveys, listing of waterholes, water levels in Aroona dam, bore data climate data from Leigh Creek Airport and the like.

The late measurement phase (1980 to present).

During this period, data will have been collected on creek flows and groundwater levels. Modelling of data should be able to be undertaken linking rainfall to river flow, flow salinity, location of flow generation and river losses by infiltration or transpiration, aquifer recharge and withdrawal, vegetation growth and decline, erosion and sedimentation etc.

The late measurement phase should also:

- Investigate the uses of remote sensing to identify spatial variation of hydrologic parameters such as radar measurement of spatial rainfall variation, surface wetness, vegetation growth and decline, the filling of Lake Torrens and the like; and

- use any models constructed and calibrated using the later data to fill in possible outcomes for earlier phases and checking for compatibility with earlier non-quantitative records.

The starting points for work in each phase will be the collation of the rainfall data and the identification of the occurrence of significant floods and droughts. The historian will seek all sources of information related to these events in the data sources identified. The other team members will follow up on leads identified by the historian and will attempt to infer likely qualitative outcomes of these in their areas of expertise.

Previous desktop reviews of the catchment have attempted to assess the groundwater resources via a chloride mass balance approach. Further investigation of this methodology in this environment is warranted to complement or indeed replace traditional, more expensive assessments of recharge. This would require a one-off sampling program of existing well.

Associated with this sampling program is the undertaking of a well survey to identify existing wells that would be suitable as observation wells, Drilling of additional wells may be required, particularly a suite of wells perpendicular to either creek where previous work has indicated recharge may be occurring. Selected bores would be monitored continuously at key locations.

Timing and funding

Although this project is a trial, the time allocated for its completion must be sufficient to gauge its practicality and success. A minimum time of 9 months will be required, with the historian/ archivist expected to have the greatest work load, particularly during the initial phases. No additional data will be collected, but the team will incur travel and accommodation expenses. A breakdown of estimated expenses is provided in the table below:

Table C: Breakdown of Project expenses:

Resource	**Responsibilities**	**Cost**
Historian/ Archivist	Information sources, documentation, full time for 9 months	$65,000
Surface hydrologist	Team leader, documentation, data analysis, modeller	$25,000
Ecologist	Documentation, communication, modeller	$15,000
Hydrogeologist	Documentation, remote sensing, modeller	$20,000
	Well survey and sampling, installation of water level recorders	$15,000
Total		**$140,000**

End Product

The final product of the project will be a report that will provide the following:

The rainfall statistics for the catchment in terms of means, temporal and spatial variability and trends.

An identification of the surface and groundwater basins for which inter-linked models can be defined

A model showing the water balance for each basin within the total catchment in terms of areas and amounts of runoff generation; recharge, storage, withdrawal for use, evapotranspiration, spring discharge, salinity and the like.

Long term trends in rainfall and climate dependent ecosystems

Conclusions on the success of the project

Recommendations for ongoing monitoring for water resource assessment and planning for similar catchments within the SAALNRM region.

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APPENDIX A: TABLES

Table 1: Current Rain Water Gauging Stations

Station Code	Station Name	Obs. Interval	Opened	Owner
17007	Allandale	Daily	1909	BOM (AUS)
17097	Angorichina	Daily	1969	BOM (AUS)
17004	Anna Ck	Daily	1883	BOM (AUS)
16093	Arckaringa Stn	Daily	28/01/2002	BOM (AUS)
17049	Arcoona Bluff	Continuous	23/04/2003	BOM (AUS)
17134	Arcoona South	Continuous	21/08/2005	BOM (AUS)
17099	Arkaroola	Daily	1938	BOM (AUS)
17099	Arkaroola	Synop	1938	BOM (AUS)
45028	Arrabury Stn	Daily	29/01/2002	BOM (AUS)
17010	Balcanoona	Daily	29/04/1945	BOM (AUS)
17010	Balcanoona	Synop	29/04/1945	BOM (AUS)
17010	Balcanoona	Continuous	17/06/2001	BOM (AUS)
20000	Bimbowrie	Daily	29/09/1999	BOM (AUS)
38026	Birdsville Airport	Continuous	25/06/2000	BOM (AUS)
38026	Birdsville Airport	Daily	4/05/2001	BOM (AUS)
17125	Bookabourdie	Daily	29/06/1997	BOM (AUS)
20001	Boolcoomatta	Daily	30/05/1982	BOM (AUS)
46050	Broken Hill (Pine View)	Daily	21/07/1999	BOM (AUS)
47049	Broken Hill (Thackaringa)	Daily	1/05/2001	BOM (AUS)
17130	Callanna	Daily	3/05/1998	BOM (AUS)
45063	Cameron Corner	Daily	29/04/2005	BOM (AUS)
17076	Clayton	Daily	30/07/1996	BOM (AUS)
17016	Clifton Hills	Daily	1894	BOM (AUS)
20002	Cockburn	Daily	29/06/1988	BOM (AUS)
16007	Coober Pedy	Daily	1921	BOM (AUS)
16007	Coober Pedy	Synop	1921	BOM (AUS)
16094	Copper Hills Stn	Daily	30/08/1994	BOM (AUS)
17019	Cordillo Downs	Daily	1883	BOM (AUS)
17020	Cowarie	Daily	30/08/1981	BOM (AUS)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
20004	Curnamona	Daily	1881	BOM (AUS)
17026	Daralingie	Daily	2002	BOM (AUS)
17058	Dulkaninna	Daily	29/11/1950	BOM (AUS)
17111	Dullingari	Daily	1984	BOM (AUS)
20005	Erudina	Daily	29/04/2011	BOM (AUS)
17132	Etadunna	Daily	4/05/1998	BOM (AUS)
17135	Exclosure	Continuous	21/08/2005	BOM (AUS)
17024	Farina	Daily	1879	BOM (AUS)
17024	Farina	Synop	1879	BOM (AUS)
20015	Four Brothers	Daily	6/08/1985	BOM (AUS)
20006	Frome Downs	Daily	1889	BOM (AUS)
16083	Hamilton Stn	Daily	1931	BOM (AUS)
19018	Holowilena	Daily	1868	BOM (AUS)
17121	Innamincka Hotel	Daily	30/08/1993	BOM (AUS)
17028	Innamincka Stn	Daily	30/10/1982	BOM (AUS)
17089	Kalamurina	Daily	27/02/1998	BOM (AUS)
20010	Koonamore	Daily	29/06/1988	BOM (AUS)
15603	Kulgera	Daily	29/09/1968	BOM (AUS)
15603	Kulgera	Synop	29/09/1968	BOM (AUS)
15603	Kulgera	Continuous	30/06/1996	BOM (AUS)
19012	Kylmorn	Daily	30/10/2001	BOM (AUS)
16100	Lambina	Daily	2006	BOM (AUS)
17110	Leigh Ck Airport	Continuous	13/07/1992	BOM (AUS)
17115	Lindon	Daily	29/09/1987	BOM (AUS)
17139	Lyndhurst	Daily	2006	BOM (AUS)
17030	Macumba	Daily	1891	BOM (AUS)
17126	Marree Aero	Continuous	30/06/1998	BOM (AUS)
17031	Marree Comparison	Daily	30/07/1985	BOM (AUS)
17031	Marree Comparison	Synop	30/07/1985	BOM (AUS)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
19111	Martins Well	Daily	1958	BOM (AUS)
19114	Minburra	Daily	17/11/1997	BOM (AUS)
17131	Moolawatana	Daily	9/05/1998	BOM (AUS)
20049	Mooleulooloo	Daily	30/01/1932	BOM (AUS)
17123	Moomba Airport	Continuous	8/04/1995	BOM (AUS)
16082	Mount Barry	Daily	29/11/1980	BOM (AUS)
15510	Mount Cavenagh	Daily	27/02/1939	BOM (AUS)
17070	Mount Dare	Daily	1950	BOM (AUS)
17070	Mount Dare	Synop	1950	BOM (AUS)
17070	Mount Dare	Continuous	19/09/2000	BOM (AUS)
20052	Mt Victor	Daily	1971	BOM (AUS)
17036	Mulka	Daily	30/05/2017	BOM (AUS)
17037	Muloorina Homestead	Daily	30/10/1981	BOM (AUS)
20016	Mulyungarie	Daily	1901	BOM (AUS)
17038	Mundowdna	Daily	3/05/1998	BOM (AUS)
17067	Mungeranie	Daily	16/06/1997	BOM (AUS)
45012	Nappa Merrie	Daily	1908	BOM (AUS)
17041	Narrina	Daily	30/08/1949	BOM (AUS)
17106	New Quinyambie	Daily	1973	BOM (AUS)
17127	Nilpinna	Daily	30/03/1998	BOM (AUS)
19095	Oakburne	Daily	30/01/1967	BOM (AUS)
17043	Oodnadatta Airport	Continuous	31/10/1994	BOM (AUS)
17043	Oodnadatta Airport	Synop	31/10/1994	BOM (AUS)
17114	Oodnadatta Police Stn	Daily	30/07/1985	BOM (AUS)
17114	Oodnadatta Police Stn	Synop	30/07/1985	BOM (AUS)
20050	Plumbago	Daily	29/11/1970	BOM (AUS)
17133	Sambot Waterhole	Continuous	21/08/2005	BOM (AUS)
19110	Siccus	Daily	1989	BOM (AUS)
20055	Strathearn	Daily	30/08/1989	BOM (AUS)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
17022	Tantanna	Daily	2002	BOM (AUS)
20053	Tepco	Daily	1928	BOM (AUS)
17103	The Plateau	Continuous	8/08/2005	BOM (AUS)
16095	Tieyon	Daily	11/05/1995	BOM (AUS)
17112	Tirrawarra	Daily	1984	BOM (AUS)
16047	Todmorden	Daily	29/04/1949	BOM (AUS)
17048	Umberatana	Daily	1886	BOM (AUS)
15624	Victory Downs	Daily	1945	BOM (AUS)
17052	Wertaloona	Daily	30/05/2006	BOM (AUS)
17053	William Ck	Daily	30/05/1996	BOM (AUS)
19070	Wilpena Pound	Daily	27/02/1962	BOM (AUS)
19070	Wilpena Pound	Synop	27/02/1962	BOM (AUS)
17129	Wilpoorinna	Daily	3/05/1998	BOM (AUS)
17054	Wirrealpa	Daily	30/07/1975	BOM (AUS)
17055	Witchelina	Daily	1898	BOM (AUS)
17056	Wooltana	Daily	1877	BOM (AUS)
19057	Yalpara	Daily	29/06/2007	BOM (AUS)
20059	Yarramba	Daily	30/07/1994	BOM (AUS)
16000	Arcoona	Daily	1882	BOM (AUS)
18214	Botenella Hills	Daily	8/01/2006	BOM (AUS)
16003	Bulgunnia	Daily	30/07/1930	BOM (AUS)
16006	Commonwealth Hill	Daily	30/07/1941	BOM (AUS)
16090	Coober Pedy Airport	Continuous	21/06/1994	BOM (AUS)
16009	Coondambo	Daily	30/08/1985	BOM (AUS)
18037	Curtinye	Daily	29/06/2018	BOM (AUS)
18197	Gawler View	Daily	2/03/1997	BOM (AUS)
18031	Gilles Downs	Daily	1925	BOM (AUS)
16084	Glendambo	Daily	30/08/1982	BOM (AUS)
16034	Hiltaba	Daily	1948	BOM (AUS)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
18172	Hi-View	Daily	30/03/1969	BOM (AUS)
16087	Ingomar	Daily	30/03/1956	BOM (AUS)
18190	Karinya	Daily	30/07/1987	BOM (AUS)
18040	Kimba	Daily	30/10/2020	BOM (AUS)
18040	Kimba	Synop	30/10/2020	BOM (AUS)
16021	Kokatha	Daily	30/01/1931	BOM (AUS)
16022	Kondoolka	Daily	29/06/2005	BOM (AUS)
16024	Lake Everard	Daily	1933	BOM (AUS)
16025	Mahanewo	Daily	29/04/2010	BOM (AUS)
16085	Marla Police Stn	Daily	30/07/1985	BOM (AUS)
16085	Marla Police Stn	Synop	30/07/1985	BOM (AUS)
16085	Marla Police Stn	Continuous	7/08/1985	BOM (AUS)
16027	McDouall Peak	Daily	29/04/2009	BOM (AUS)
16028	Millers Ck	Daily	30/07/2029	BOM (AUS)
18053	Minnipa	Daily	30/08/2014	BOM (AUS)
18195	Minnipa DPI	Continuous	9/06/1996	BOM (AUS)
18195	Minnipa DPI	Daily	9/06/1996	BOM (AUS)
16088	Mintabie	Daily	11/02/1992	BOM (AUS)
16059	Mobella	Daily	30/07/1953	BOM (AUS)
16086	Moonaree	Daily	19/02/1986	BOM (AUS)
16030	Mount Eba	Daily	1878	BOM (AUS)
16067	Mount Ive	Daily	29/04/1981	BOM (AUS)
18057	Mount Wudinna	Daily	1907	BOM (AUS)
16031	Mulgathing	Daily	1934	BOM (AUS)
16032	Nonning	Daily	1903	BOM (AUS)
16032	Nonning	Synop	1903	BOM (AUS)
16032	Nonning	Continuous	30/09/1973	BOM (AUS)
16016	North Well	Daily	29/06/1998	BOM (AUS)
16033	Oakden Hills	Daily	30/10/1979	BOM (AUS)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
16096	Olympic Dam Aerodrome	Continuous	12/11/1997	BOM (AUS)
16035	Parakylia Stn	Daily	29/11/1936	BOM (AUS)
16036	Pernatty Stn	Daily	1928	BOM (AUS)
18166	Pimbena	Daily	1969	BOM (AUS)
16039	Purple Downs	Daily	1903	BOM (AUS)
16040	Roxby Downs Stn	Daily	29/11/1933	BOM (AUS)
18186	Siam	Daily	29/04/2007	BOM (AUS)
16098	Tarcoola Aero	Continuous	28/09/1997	BOM (AUS)
16048	The Twins Stn	Daily	1930	BOM (AUS)
16046	Thurlga	Daily	30/07/1998	BOM (AUS)
16062	Wirraminna Homestead	Daily	14/09/2004	BOM (AUS)
18094	Wirrulla	Daily	30/05/2022	BOM (AUS)
16001	Woomera Aerodrome	Daily	1949	BOM (AUS)
16001	Woomera Aerodrome	Synop	1949	BOM (AUS)
16001	Woomera Aerodrome	Continuous	1955	BOM (AUS)
18095	Wudinna	Daily	1927	BOM (AUS)
18083	Wudinna Aero	Continuous	18/04/1999	BOM (AUS)
16055	Yardea	Daily	1877	BOM (AUS)
16056	Yudnapinna	Daily	30/07/1984	BOM (AUS)
16056	Yudnapinna	Synop	30/07/1984	BOM (AUS)
16065	Andamooka	Daily	29/06/1965	BOM (AUS)
16065	Andamooka	Synop	29/06/1965	BOM (AUS)
17119	Beltana Roadhouse	Daily	1986	BOM (AUS)
17012	Beltana Stn	Daily	1872	BOM (AUS)
17014	Blinman	Daily	1874	BOM (AUS)
17017	Commodore	Daily	30/07/2010	BOM (AUS)
19113	Edeowie	Daily	12/11/1984	BOM (AUS)
19113	Edeowie	Continuous	30/03/2004	BOM (AUS)
19017	Hawker	Daily	1882	BOM (AUS)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
19017	Hawker	Synop	1882	BOM (AUS)
17136	Maynards Well	Continuous	5/12/2005	BOM (AUS)
17032	Moolooloo	Daily	1947	BOM (AUS)
17098	Motpena	Daily	27/02/1969	BOM (AUS)
17128	Mulgaria	Daily	3/05/1998	BOM (AUS)
17113	Nilpena	Daily	30/03/1985	BOM (AUS)
17137	North Moolooloo	Continuous	20/04/2006	BOM (AUS)
19107	Oraparinna	Daily	1985	BOM (AUS)
17138	Pfitzners Well	Continuous	20/04/2006	BOM (AUS)
16043	South Gap Stn	Daily	1882	BOM (AUS)
19046	Warcowie	Daily	1872	BOM (AUS)
17051	Warraweena	Daily	10/08/2004	BOM (AUS)
545002	Nappa Merrie TM	Operational	4/03/2002	BOMQ (Qld)
AW004521	ARCOONA CREEK CATCHMENT PLUVIO @ 4kms along South Branch	Continuous	1997	DWLBC (SA)
AW004518	ARCOONA CREEK CATCHMENT PLUVIO @ Exclusion Zone	Continuous	1990	DWLBC (SA)
AW004517	MT MCKINLAY CREEK CATCHMENT PLUVIO @ Gammon Plateau	Continuous	1988	DWLBC (SA)
AW004519	ARCOONA CREEK CATCHMENT PLUVIO near Sambot Waterhole	Continuous	1991	DWLBC (SA)
AW510516	AROONA DAM PLUVIO @ Aroona Dam	Continuous	1986	DWLBC (SA)
AW510514	WINDY CREEK CATCHMENT PLUVIO @ Maynards Well	Continuous	1986	DWLBC (SA)
AW510513	WINDY CREEK CATCHMENT PLUVIO @ North Mocatoona	Continuous	1986	DWLBC (SA)
AW510512	WINDY CREEK CATCHMENT PLUVIO @ North Moolooloo	Continuous	1986	DWLBC (SA)
AW510515	EMU CREEK CATCHMENT PLUVIO @ Pfitzners Well	Continuous	1986	DWLBC (SA)
AW509505	KANYAKA CREEK CATCHMENT PLUVIO @ The Oaks	Continuous	1983	DWLBC (SA)
A0041013	NEPABUNNA ABORIGINAL COMMUNITY RAIN GAUGE		?	DWLBC (SA)

Table 1: Current Rain Water Gauging Stations (continued)

Station Code	Station Name	Obs. Interval	Opened	Owner
AW510516	AROONA DAM PLUVIO @ Aroona Dam	Continuous	19/02/1986	PRIV (AUS)
A0051001	INYARINI HOMELAND (KENMORE PARK) RAIN GAUGE		?	DWLBC (SA)

Table 2: Historical Rain Gauging Stations

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
17000	Abminga Railway Siding	Daily	1939	1980	BOM (AUS)
17001	Alberga	Daily	1930	1979	BOM (AUS)
17002	Alberrie Ck	Daily	30/01/1930	29/12/1977	BOM (AUS)
17095	Alton Downs	Daily	1886	1939	BOM (AUS)
17073	Andrewilla Police Camp	Daily	30/03/1994	29/12/2002	BOM (AUS)
17006	Apollinaris Well	Daily	1925	1953	BOM (AUS)
16093	Arckaringa Stn	Daily	19/10/1994	7/08/1999	BOM (AUS)
45028	Arrabury Stn	Daily	1914	27/02/2001	BOM (AUS)
17008	Arrowie	Daily	29/11/1976	29/12/1949	BOM (AUS)
17009	Avondale	Daily	1898	1953	BOM (AUS)
17013	Beresford	Daily	1930	1978	BOM (AUS)
20000	Bimbowrie	Daily	1882	1949	BOM (AUS)
38002	Birdsville Police Stn	Daily	1892	3/05/2001	BOM (AUS)
38002	Birdsville Police Stn	Synop	1892	3/05/2001	BOM (AUS)
17100	Blanchewater Stn	Daily	1879	1938	BOM (AUS)
17062	Cadelga	Daily	1886	1962	BOM (AUS)
16091	Cadney Park	Daily	5/11/1993	16/12/2003	BOM (AUS)
17074	Callabonna	Daily	1902	1909	BOM (AUS)
45063	Cameron Corner	Daily	27/02/1991	8/12/1996	BOM (AUS)
17072	Car 732 Mile	Daily	1947	1978	BOM (AUS)
19087	Cavenagh	Daily	29/06/1982	29/12/2010	BOM (AUS)
19074	Cavenagh West	Daily	1885	1925	BOM (AUS)
15597	Charlotte Waters	Daily	1874	1938	BOM (AUS)
20027	Childs	Daily	1925	1943	BOM (AUS)
20033	Choclate	Daily	1930	1935	BOM (AUS)
17076	Clayton	Daily	29/04/2014	28/06/2028	BOM (AUS)
20003	Coondappie	Daily	1917	1945	BOM (AUS)
17018	Copley	Daily	1883	1963	BOM (AUS)
20034	Corona	Daily	29/04/1930	29/12/1944	BOM (AUS)

Table 2: Historical Rain Gauging Stations (continued)

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
17116	Coulthard	Daily	1990	29/08/2002	BOM (AUS)
17021	Coward Springs	Daily	30/08/1997	29/12/1977	BOM (AUS)
17075	Dalhousie Springs	Daily	1880	1890	BOM (AUS)
15539	Duffield	Daily	27/02/1946	29/12/1976	BOM (AUS)
17023	Edwards Ck	Daily	29/11/2029	29/12/1980	BOM (AUS)
16012	Eringa	Daily	1931	1975	BOM (AUS)
17025	Finniss Springs	Daily	29/09/2020	29/12/1971	BOM (AUS)
46005	Fortville	Daily	30/03/1936	29/12/1945	BOM (AUS)
20015	Four Brothers	Daily	29/11/2024	24/06/1971	BOM (AUS)
17080	Freelingwell	Daily	30/07/1987	29/12/1939	BOM (AUS)
19097	Glenroy	Daily	1906	1908	BOM (AUS)
17078	Goyders Lagoon	Daily	1901	1919	BOM (AUS)
17117	Greenwood Hill	Daily	1990	29/08/2002	BOM (AUS)
17087	Haddon	Daily	29/06/1984	29/12/1936	BOM (AUS)
17069	Ilbunga	Daily	29/04/1930	29/12/1979	BOM (AUS)
17027	Innamincka Police Camp	Daily	29/09/1983	29/12/1952	BOM (AUS)
17118	Innamincka Town Site	Daily	1/12/1976	20/08/2002	BOM (AUS)
17071	Irrapatanna	Daily	1954	1965	BOM (AUS)
19021	Johnburgh Post Office	Daily	29/06/1982	29/12/1966	BOM (AUS)
20007	Kalabity	Daily	30/08/2020	29/12/1979	BOM (AUS)
17089	Kalamurina	Daily	29/09/1984	29/12/1998	BOM (AUS)
17063	Kanowana	Daily	1888	1939	BOM (AUS)
17124	Keleary	Daily	30/03/1996	29/12/1998	BOM (AUS)
17066	Killalpaninna	Daily	1885	1924	BOM (AUS)
20037	Lake Charles	Daily	29/04/1930	29/12/1944	BOM (AUS)
20011	Lake Dismal	Daily	1921	1982	BOM (AUS)
17005	Leigh Ck Aero	Daily	29/06/1951	29/12/1982	BOM (AUS)
17101	Leigh Ck E.T.S.A	Continuous	30/08/1972	11/08/1975	BOM (AUS)
17101	Leigh Ck E.T.S.A	Daily	29/09/1972	29/12/1975	BOM (AUS)

Table 2: Historical Rain Gauging Stations (continued)

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
17108	Leigh Ck Northern Coalfield	Daily	30/07/1975	29/12/1977	BOM (AUS)
17108	Leigh Ck Northern Coalfield	Continuous	11/08/1975	29/10/1977	BOM (AUS)
20038	Lockhart Bore	Daily	1937	1944	BOM (AUS)
17029	Lyndhurst Post Office	Daily	29/11/2002	29/12/1989	BOM (AUS)
19101	Matt Whim	Daily	1954	1965	BOM (AUS)
20014	Mingary	Daily	30/07/2021	29/12/1973	BOM (AUS)
17079	Minnie Downs	Daily	1915	1940	BOM (AUS)
17090	Montacollina	Daily	29/11/1985	29/12/2003	BOM (AUS)
17096	Moomba	Continuous	30/10/1972	30/05/2000	BOM (AUS)
17096	Moomba	Daily	30/10/1972	15/03/2005	BOM (AUS)
17096	Moomba	Synop	30/10/1972	15/03/2005	BOM (AUS)
17033	Mount Dutton	Daily	29/11/2029	29/12/1980	BOM (AUS)
17081	Mount Gason	Daily	30/08/2010	29/12/2027	BOM (AUS)
17064	Mount Hopeless	Daily	1918	1936	BOM (AUS)
17034	Mount Lyndhurst	Daily	1878	1953	BOM (AUS)
17034	Mount Lyndhurst	Daily	22/10/1999	30/05/2002	BOM (AUS)
17120	Mount Painter	Daily	29/04/1990	29/01/2002	BOM (AUS)
17035	Mount Serle	Daily	29/06/2017	29/01/1991	BOM (AUS)
46023	Mundi Mundi	Daily	1894	1960	BOM (AUS)
17038	Mundowdna	Daily	1944	1958	BOM (AUS)
17067	Mungeranie	Daily	1887	29/07/1938	BOM (AUS)
17039	Murnpeowie	Daily	1893	6/07/1999	BOM (AUS)
20046	Mutooroo Mine	Daily	29/04/1991	29/12/1999	BOM (AUS)
17042	Nepabunna Mission	Daily	30/07/1939	29/12/1975	BOM (AUS)
19003	Old Baratta Homestead	Daily	1882	10/04/1989	BOM (AUS)
17043	Oodnadatta Airport	Continuous	1961	30/07/1985	BOM (AUS)
17044	Oodnadatta Post Office	Daily	30/05/1991	29/12/1941	BOM (AUS)
17122	Owieandana	Daily	30/08/1993	19/07/2003	BOM (AUS)
17045	Pandie Pandie	Daily	29/04/1949	29/12/1964	BOM (AUS)

Table 2: Historical Rain Gauging Stations (continued)

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
17094	Parallana	Daily	1881	1907	BOM (AUS)
17047	Pedirka	Daily	27/02/1930	29/12/1980	BOM (AUS)
17088	Peechywarrina	Daily	30/03/1982	29/12/2003	BOM (AUS)
17083	Puttaburra	Daily	30/08/2027	29/12/1933	BOM (AUS)
17105	Quinyambie	Daily	30/05/1987	29/12/1973	BOM (AUS)
47090	Rat Hole Tank	Daily	1891	1917	BOM (AUS)
20040	Security	Daily	1926	1943	BOM (AUS)
16079	Spare Tyre Hill	Continuous	26/06/1975	29/12/1975	BOM (AUS)
17061	Stuarts Ck	Daily	1877	1930	BOM (AUS)
47035	Thackaringa	Daily	1891	1949	BOM (AUS)
47088	Thackaringa Town	Daily	30/07/1990	29/12/2018	BOM (AUS)
47073	Tharinga Tank	Daily	1891	1923	BOM (AUS)
17059	The Knob	Daily	1925	1953	BOM (AUS)
17109	The Peake	Daily	29/11/1973	29/12/1991	BOM (AUS)
20060	Tickalina	Daily	30/07/1994	29/05/2001	BOM (AUS)
17060	Tilcha	Daily	1884	1942	BOM (AUS)
17093	Tinga Tingana	Daily	29/11/1991	29/12/2000	BOM (AUS)
17068	Troudaninna	Daily	1893	1936	BOM (AUS)
20041	Wallaces	Daily	1925	1944	BOM (AUS)
17050	Warrina	Daily	1891	1930	BOM (AUS)
20042	Watsons Well	Daily	1925	1944	BOM (AUS)
20023	Waukaringa	Daily	30/07/1989	29/12/1963	BOM (AUS)
17053	William Ck	Daily	1874	1968	BOM (AUS)
19063	Willow Springs	Daily	1951	1954	BOM (AUS)
19049	Wilpena Head Stn	Daily	30/03/2003	29/12/1985	BOM (AUS)
17091	Wondillina	Daily	30/10/1997	29/12/2007	BOM (AUS)
17057	Wyambana	Daily	30/05/1938	29/12/1949	BOM (AUS)
17102	Yankaninna	Daily	29/04/2020	14/09/1993	BOM (AUS)
17086	Yudnamultana	Daily	30/05/2009	29/12/1931	BOM (AUS)

Table 2: Historical Rain Gauging Stations (continued)

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
18000	Arkaringa	Daily	1938	1955	BOM (AUS)
16070	Arlcoodaby	Daily	1894	1903	BOM (AUS)
18121	Barna	Daily	1925	1940	BOM (AUS)
16002	Bookaloo	Daily	30/10/1997	29/12/1984	BOM (AUS)
18008	Buclkeboo Post Office	Daily	1933	1987	BOM (AUS)
16004	Burando	Daily	30/05/2015	29/12/1967	BOM (AUS)
18187	Churinga	Daily	1940	28/09/2004	BOM (AUS)
16058	Comet	Daily	1954	1965	BOM (AUS)
16010	Coondambo Railway Stn	Daily	29/06/1940	29/12/1971	BOM (AUS)
16018	Coralbignie	Daily	1877	1891	BOM (AUS)
18018	Cortlinye Rocks Stn	Daily	29/06/2016	28/09/1991	BOM (AUS)
18125	Cungena	Daily	29/11/2018	28/11/1993	BOM (AUS)
16011	East Well	Daily	1936	1977	BOM (AUS)
18157	Gawler Ranges	Daily	29/06/1981	29/12/1991	BOM (AUS)
16015	Hesso	Daily	30/07/2015	29/12/1979	BOM (AUS)
16034	Hiltaba	Daily	1918	1939	BOM (AUS)
16060	Jumbuck	Daily	30/07/1953	29/12/1965	BOM (AUS)
18169	Kankappie	Daily	27/02/1969	29/12/1978	BOM (AUS)
18041	Kimba (The Pines)	Daily	30/03/2015	29/12/1966	BOM (AUS)
16020	Kingoonya	Daily	30/07/2015	27/06/1998	BOM (AUS)
16023	Kultanaby Tar	Daily	1934	1969	BOM (AUS)
16026	Malboona	Daily	30/05/1940	29/12/1953	BOM (AUS)
18052	Minnipa Agricultural Centre	Daily	1915	3/12/2001	BOM (AUS)
18052	Minnipa Agricultural Centre	Synop	1915	3/12/2001	BOM (AUS)
18052	Minnipa Agricultural Centre	Continuous	7/08/1973	1/03/1997	BOM (AUS)
16066	Mirikata	Daily	29/09/1960	29/12/1980	BOM (AUS)
16029	Moonaree	Daily	30/10/1977	29/12/1986	BOM (AUS)
16075	Mount Gunson	Daily	30/08/1970	29/12/1987	BOM (AUS)
16075	Mount Gunson	Daily	6/09/1999	29/11/2003	BOM (AUS)

Table 2: Historical Rain Gauging Stations (continued)

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
16067	Mount Ive	Daily	1881	30/03/1994	BOM (AUS)
16053	Number One Tank	Daily	1908	1927	BOM (AUS)
16089	Olympic Dam	Daily	25/06/1992	29/06/1997	BOM (AUS)
16089	Olympic Dam	Synop	25/06/1992	29/06/1997	BOM (AUS)
18135	Pile Pudla	Daily	30/08/1933	29/12/1944	BOM (AUS)
16037	Pimba	Daily	30/03/2015	19/02/1990	BOM (AUS)
17084	Ryansville	Daily	1919	1924	BOM (AUS)
16068	Tar 336 Mile	Daily	30/03/2018	29/12/2021	BOM (AUS)
16072	Tar 340 Mile	Daily	30/01/2026	29/12/1938	BOM (AUS)
16069	Tar 348 Mile	Daily	1922	1926	BOM (AUS)
16078	Tar 354 Mile	Daily	30/05/1940	29/12/1982	BOM (AUS)
16054	Tar 377 Mile	Daily	1916	1983	BOM (AUS)
16045	Tar 397 Mile	Daily	30/10/2016	29/12/1983	BOM (AUS)
16044 16044	Tarcoola Tarcoola	Daily Synop	1903 1903	8/08/1999 8/08/1999	BOM (AUS) BOM (AUS)
16076	Wallatinna Homestead	Daily	30/03/1943	29/12/1956	BOM (AUS)
16063	Wilgena Dams	Daily	27/02/1987	29/12/1978	BOM (AUS)
16062	Wirraminna Homestead	Daily	28/02/2000	29/12/2021	BOM (AUS)
16050	Wirraminna Railway Stn	Daily	30/07/2015	29/12/1979	BOM (AUS)
16052	Woocalla	Daily	30/03/2015	29/12/1968	BOM (AUS)
16074	Yarna	Daily	1969	25/02/1990	BOM (AUS)
16057	Yeltacowie	Daily	30/08/2024	29/12/1975	BOM (AUS)
18100	Yeltana	Daily	1929	30/08/2003	BOM (AUS)
16071	Andamooka Homestead	Daily	1880	1907	BOM (AUS)
17003	Angorichina Hostel	Daily	1866	1977	BOM (AUS)
19092	Arkaba	Daily	1867	1920	BOM (AUS)
17011	Beltana	Daily	1874	1985	BOM (AUS)
17077	Beltana Depot Well	Daily	1926	1936	BOM (AUS)
17015	Brachina Siding	Daily	29/04/1950	29/12/1980	BOM (AUS)

Table 2: Historical Rain Gauging Stations (continued)

Station Code	Station Name	Obs Interval	Opened	Closed	Owner
17065	Ediacara	Daily	1881	1938	BOM (AUS)
19019	Hookina	Daily	29/09/2006	29/12/1956	BOM (AUS)
16081	Lake Torrens	Daily	30/05/1973	29/12/1980	BOM (AUS)
16081	Lake Torrens	Synop	30/05/1973	29/12/1980	BOM (AUS)
17107	Leigh Ck South	Continuous	29/09/1977	27/09/1993	BOM (AUS)
17107	Leigh Ck South	Daily	29/09/1977	27/09/1993	BOM (AUS)
19064	Mount Little	Daily	30/10/1956	29/12/1981	BOM (AUS)
17040	Myrtle Springs	Daily	1897	25/11/2000	BOM (AUS)
17046	Parachilna	Daily	30/03/1930	29/12/1980	BOM (AUS)
17085	St Ronans	Daily	29/04/2026	29/12/1936	BOM (AUS)
17051	Warraweena	Daily	1930	1963	BOM (AUS)
16061	Whittata	Daily	29/09/1982	29/12/2029	BOM (AUS)
17092	Wintabatingana	Daily	1879	1889	BOM (AUS)
16051	Wirrappa	Daily	30/07/2015	29/12/1978	BOM (AUS)
AW004502	HAMILTON CREEK @ Terrapinna Springs	Continuous	1972	1991	DWLBC (SA)
AW510503	WARRUWARLDUNHA HILL CHANNEL @ Hawker	Continuous	1997	2003	DWLBC (SA)
AW021504	KOONIBBA CATCHMENT PLUVIO @ Koonibba Tanks	Continuous	1990	1991	DWLBC (SA)

Table 3: Historical Ad Hoc Surface Water Gauging Stations

Site Code	Site Name	Parameters	Period	Owner
AW004502	HAMILTON CREEK @ Terrapinna Springs	Level, flow, ad hoc WQ	1972 - 1991	DWLBC (SA)
AW004508	MT MCKINLAY CREEK @ Wertaloona	Level, flow, ad hoc WQ	1973 - 1989	DWLBC (SA)
AW021503	PENONG ROAD CATCHMENT PLUVIO @ Penong	Rainfall, level	1990 - 1991	DWLBC (SA)
AW508503	SALTIA CREEK @ Saltia		1979 - 1991	DWLBC (SA)
?	SALTIA CREEK CATCHMENT PLUVIO @ Saltia		1979 - 1995	DWLBC (SA)
AW510502	MERNMERNA CREEK @ Sugarloaf Hill	Level, flow, ad hoc WQ	1973 - 1991	DWLBC (SA)
AW510503	WARRUWARLDUNHA HILL CHANNEL @ Hawker	Rainfall, level, flow	1997 - 2003	DWLBC (SA)
AW510507	WINDY CREEK @ Maynards Well	Level, flow, ad hoc WQ	1972 - 1989	DWLBC (SA)
AW510510	WINDY CREEK @ Leigh Creek	Level, flow, ad hoc WQ	1986 – 2003	DWLBC (SA)
AW510511	EMU CREEK @ Leigh Creek	Level, flow	1986 – 2003	DWLBC (SA)
003103A	COOPER CREEK @ Nappa Merrie		1949 - 1989	NRW (QLD)
001101A	EYRE CREEK @ Glengyle H.S.	No Data	1969 - 1988	NRW (QLD)

Table 4: Current and Historical Evaporation Gauging Stations

Station Code	Station Name	Obs. Interval	Opened	Closed	Owner
38026	Birdsville Airport	Daily	4-May-01		BOM (AUS)
38002	Birdsville Police Stn	Daily	1969	3-May-01	BOM (AUS)
17096	Moomba	Daily	16-Nov-72	15-Mar-05	BOM (AUS)
17043	Oodnadatta Airport	Daily	30-Jan-57	30-Jul-85	BOM (AUS)
47039	Umberumberka Reservoir	Daily	1922		BOM (AUS)
16081	Lake Torrens	Daily	30-May-73	28-Feb-80	BOM (AUS)
17107	Leigh Ck South	Daily	1979	27-Sep-93	BOM (AUS)
18012	Ceduna Amo	Daily	24-Feb-68		BOM (AUS)
18139	Gum View	Daily	1967	10-Sep-05	BOM (AUS)
18044	Kyancutta	Daily	1931	1958	BOM (AUS)
18052	Minnipa Agricultural Centre	Daily	1964	28-Jun-01	BOM (AUS)
16089	Olympic Dam	Daily	25-Jun-92	29-Jun-97	BOM (AUS)
16001	Woomera Aerodrome	Daily	1967		BOM (AUS)
16056	Yudnapinna	Daily	1938	1947	BOM (AUS)

Table 5: Current Ad Hoc Surface Water Gauging Stations

Station Code	Site Name	Parameters	Period	Owner
A0030505	COOPER CREEK @ Kopperamanna Ferry Crossing	Ad hoc WQ	1974 - current	DWLBC (SA)
AW003501	COOPER CREEK @ Callamurra Water Hole	Level, flow, ad hoc WQ	1973 - current	DWLBC (SA)
AW002101	DIAMANTINA RIVER @ Birdsville	Level, flow, ad hoc WQ	1949 - current	DWLBC (SA)
A0030506	STREZLECKI CREEK @ Merti Merti	Ad hoc WQ	1976 - current	DWLBC (SA)
A0040510	GOYDER CHANNEL @ Lake Eyre			DWLBC (SA)
A0040511	MOPPACOLLINA CHANNEL @ Strezlecki Track			DWLBC (SA)
A0040512	LAKE EYRE NORTH @ Level Post Bay	Ad hoc WQ	1974 - current	DWLBC (SA)
A0040513	LAKE EYRE SOUTH @ Muloorina Track			DWLBC (SA)
A0040514	LAKE EYRE SOUTH @ Curdimurka			DWLBC (SA)
A0040515	LAKE BLANCHE @ Waterhole Hut			DWLBC (SA)
A0040516	LAKE CALLABONNA @ Mt Hopeless Creek			DWLBC (SA)
A0040520	ARCOONA CREEK @ Gammon Ranges National Park	Level, EC	1993 - current	SEG
A0040522	ARCOONA CREEK CATCHMENT PLUVIO @ Arcoona Saddle			DWLBC (SA)
A5100500	AROONA CREEK @ Aroona Dam	Level, ad hoc WQ	1960 - current	DWLBC (SA)
A5100505	HOOKINA CREEK @ Mernmerna Springs			DWLBC (SA)
A5100508	HOOKINA CREEK @ Cotabena			DWLBC (SA)

Table 5: Current Ad Hoc Surface Water Gauging Stations (continued)

Station Code	Site Name	Parameters	Period	Owner
AW510510	WINDY CREEK @ Leigh Creek	Level, flow, ad hoc WQ	2010 - current	DWLBC (SA)
W510511	EMU CREEK @ Leigh Creek	Level, flow, ad hoc WQ	2010 - current	DWLBC (SA)
001902	EYRE CREEK @ Glengyle		1970 - current	BOMQ (Qld)
003103	COOPER CREEK @ Nappa Merrie TM			BOMQ (Qld)
002902	DIAMANTINA RIVER @ Birdsville Police Stn			BOMQ (Qld)
003923	River @ Nappa Merrie			BOMQ (Qld)

Table 6: Aridflo Water Level Recorders

Station Code	Site Name	Parameters	Opened	Closed	Value Add/ Comments
A0041012	Lora Creek near Mount Barry	Water Level	10/08/2000	26/04/2006	The Aridflo data-loggers are now being used as part of a research program to investigate salinity processes in the Lake Eyre Basin. This will continue to provide a continuous flow record for the sites due to the extra funding provided by the Board to maintain the loggers during the period between the cessation of Aridflo and the commencement of the current project. A likely approach is to reduce the number of loggers in a rationalised network of priority sites, possibly including the use of telemetry.
A0041002	Arckaringa Creek near Mount Barry	Water Level	10/08/2000	26/04/2006	
A0041003	Neales River at South Stewart Water Hole	Water Level	6/08/2000	26/04/2006	
A0041011	Peake Creek uptream Nilpinna Creek	Water Level	31/10/2004	27/04/2006	
A0041010	Nilpinna Creek upstream of Peake Creek	Water Level	30/11/2000	27/04/2006	
A0041009	PEAKE CREEK @ upstream Peake Waterhole	Water Level	2/04/2000	29/11/2000	
A0041008	PEAKE CREEK @ Peake Waterhole	Water Level	2/04/2000	31/10/2004	
A0041005	NEALES RIVER at upstream Algebuckina Bridge	Water Level	2/04/2000	29/10/2004	
A0041004	Neales River at Algebuckina Bridge	Water Level	2/04/2000	28/04/2006	
A0041007	Peake Creek at Railway Bridge	Water Level	2/04/2000	27/04/2006	
A0041006	Neales River at Algebuckina Water Hole	Water Level	2/04/2000	7/04/2007	
A0021003	Warburton Creek upstream Ultoomurra Water Hole	Water Level	9/04/2000	10/04/2007	
A0021002	Goyder Lagoon at Goyder Lagoon Water Hole	Water Level	15/08/2000	11/04/2007	
A0021001	Goyder Lagoon at Kunchera Water Hole	Water Level	17/08/2000	12/04/2007	
A0031004	Apanburra Channel at Lake Apanburra	Water Level	17/04/2000	11/07/2007	

Table 6: Aridflo Water Level Recorders

Station Code	Site Name	Parameters	Opened	Closed	Value Add/ Comments
A0031005	HAMILTON CREEK at downstream Coongie Lakes	Water Level	26/08/2000	13/11/2004	The Aridflo data-loggers are now being used as part of a research program to investigate salinity processes in the Lake Eyre Basin. This will continue to provide a continuous flow record for the sites due to the extra funding provided by the Board to maintain the loggers during the period between the cessation of Aridflo and the commencement of the current project. A likely approach is to reduce the number of loggers in a rationalised network of priority sites, possibly including the use of telemetry.
A0031001	Cooper Creek Northwest Branch at Coongie Lake	Water Level	25/08/2000	5/02/2003	
A0031002	Browne Creek at Lake Toontoowaranie	Water Level	23/08/2000	26/04/2005	
A0031003	Ellar Creek at Lake Goolangirie	Water Level	16/04/2000	11/07/2007	

Table 7: EPA Ambient Water Quality Program

Map Reference	Site Code	Site Name	Parameters	Originally Opened	EPA Period
EPA_1	AW509503	Kanyaka Creek: old Kanyaka ruins	Bugs 4/yr chem monthly	1970	Since 2003
EPA_2	AW003501	Cooper creek: Cullamurra waterhole	Bugs 4/yr chem monthly	1973	Since 2003
EPA_3		Diamantina - Clifton Hill	Bugs 4/yr chem monthly		Since 2003
EPA_4		Willochra - South of Partacoona	Bugs 4/yr chem monthly		Since 2003
EPA_5		Arkaroola Creek - Arkaroola Waterhole	Bugs 4/yr chem monthly		Since 2003
EPA_6		Aroona Creek - Sambot waterhole	Bugs 4/yr chem monthly		Since 2003
EPA_7		Nunyeroo Creek - Wilcolo Fire Track	Bugs 4/yr chem monthly		Since 2003
EPA_8		Margaret Creek - South Oodnadatta Track	Bugs 4/yr chem monthly		Since 2003
EPA_9		Yardaparinna Creek - Macumba Homestead	Bugs 4/yr chem monthly		Since 2003
EPA_10		Neales - Algebuckina Waterhole	Bugs 4/yr chem monthly		Since 2003

Table 8: Current Public Groundwater Observation Well Networks

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
5643-00035	WNT019	MARLA	364135.9	6979309.05	53	-27.302532	133.626995	14.42	1/11/2008	7/11/1980	40
5643-00055	WNT016	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	12.12	1/11/2008	21/07/1981	40
5643-00059	WNT014	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	13.04	1/11/2008	29/07/1981	42
5643-00060	WNT012	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	12.75	1/11/2008	30/03/1982	42
5643-00057	WNT010	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	11.78	1/11/2008	27/07/1981	40
5643-00058	WNT013	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	12.91	1/11/2008	28/07/1981	42
5544-00101		PITLANDS	330843	7014151	53	-26.984397	133.295434	14.59	4/05/2008	8/11/1977	68
5544-00132		PITLANDS	331326	7013953	53	-26.986242	133.300272	24.26	6/05/2008	23/07/1982	79
5544-00157		PITLANDS	331372	7013148	53	-26.993513	133.300626	7.54	4/05/2008	13/04/1987	30
5544-00158		PITLANDS	330387	7013876	53	-26.986823	133.290803	0.13	31/10/2007	14/04/1987	48
5544-00159		PITLANDS	329662	7014345	53	-26.982502	133.283564	12.01	4/05/2008	15/04/1987	40
5544-00172		PITLANDS	329548	7013916	53	-26.986359	133.282357	42.93	4/05/2008	7/04/1998	72
5544-00169		PITLANDS	329057	7013734	53	-26.987941	133.277386	59.25	4/05/2008	14/06/1998	90.7
5544-00170		PITLANDS	328746	7013410	53	-26.990827	133.274208	53.61	4/05/2008	15/06/1998	103.3
6636-00101		PITLANDS	305958.26	6614738.3	54	-30.584159	138.97636	53.14	30/04/2008	8/08/1980	64

Table 8: Current Public Groundwater Observation Well Networks (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
6636-00149		PITLANDS	304272	6615383	54	-30.57807	138.958906	53.98	30/04/2008	13/05/1983	120
5544-00171		PITLANDS	328148	7012826	53	-26.996023	133.268104	55.5	4/05/2008	16/06/1998	78

Table 9: Historical Public Groundwater Observation Well Networks

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
6536-00189	COP010	LEIGHCK	250511.35	6608723.44	54	-30.628108	138.397107	14.32	9/04/1991	12/04/1978	80
6536-00195	COP015	LEIGHCK	249807.41	6609391.46	54	-30.621939	138.38993	18.85	9/04/1991	31/07/1978	152
6536-00196	COP014	LEIGHCK	250150.43	6609110.59	54	-30.624543	138.393438	37.1	30/04/1983	26/07/1978	128
6536-00231	COP016	LEIGHCK	250291.43	6610914.51	54	-30.608311	138.395343	10	9/04/1991	13/03/1981	62
6536-00232	COP017	LEIGHCK	250588.35	6610680.55	54	-30.610482	138.398381	15.51	9/04/1991	14/03/1981	68
6536-00235	COP019	LEIGHCK	249940.42	6610654.55	54	-30.610581	138.391622	12.49	9/04/1991	29/03/1981	62
6536-00237	COP018	LEIGHCK	250631.34	6610800.46	54	-30.60941	138.398858	4.76	9/04/1991	28/03/1981	92
6536-00255	COP024	LEIGHCK	245728.43	6612381.45	54	-30.594127	138.348151	5.13	21/12/1988	2/07/1982	84
6536-00260	COP025	LEIGHCK	252384.41	6607992.5	54	-30.635087	138.416456	11	9/04/1991	28/07/1982	162
6536-00262	COP023	LEIGHCK	250150.43	6609110.59	54	-30.624543	138.393438	37.17	9/04/1991	29/06/1982	120
6536-00268	COP078	LEIGHCK	254230.36	6610991.53	54	-30.608433	138.436413	8.54	9/04/1991	16/05/1983	200
6536-00279	COP026	LEIGHCK	249520.37	6609630.51	54	-30.619724	138.386997	12.87	9/04/1991	26/10/1982	104
6536-00280	COP027	LEIGHCK	249517.37	6609627.45	54	-30.619751	138.386965	16.03	9/08/1985	26/10/1982	56
6536-00281	COP028	LEIGHCK	251290.39	6608666.47	54	-30.628784	138.405213	23.19	9/04/1991	27/10/1982	142
6536-00286	COP033	LEIGHCK	251198.33	6608382.47	54	-30.631325	138.404186	43.82	9/04/1991	4/11/1982	86
6536-00287	COP034	LEIGHCK	251373.4	6608212.46	54	-30.632894	138.40597	44.52	9/04/1991	5/11/1982	86

Table 9: Historical Public Groundwater Observation Well Networks (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
6536-00293	COP038	LEIGHCK	250547.35	6608639.52	54	-30.628872	138.397461	22.07	9/08/1985	13/11/1982	76
6536-00298	COP072	LEIGHCK	250272.39	6608032.55	54	-30.634286	138.394449	50.06	9/08/1985	12/04/1983	176
6536-00299	COP080	LEIGHCK	257860.42	6608855.57	54	-30.628429	138.473746	39.87	9/04/1991	19/05/1983	64
6536-00310	COP082	LEIGHCK	254827.37	6610147.53	54	-30.616164	138.442435	20.74	9/04/1991	28/06/1983	96
6536-00313	COP084	LEIGHCK	253724.34	6610453.49	54	-30.613179	138.431011	15.02	9/08/1985	6/07/1983	100
6536-00314	COP039	LEIGHCK	252053.34	6607741.48	54	-30.637281	138.412945	49	9/04/1991	16/11/1982	140
6536-00401	COP043	LEIGHCK	253473.37	6596750.51	54	-30.736653	138.425119	24.22	9/04/1991	28/11/1982	120
6536-00404	COP046	LEIGHCK	250990.41	6611069.46	54	-30.60706	138.402665	7.53	9/04/1991	6/12/1982	132
6536-00406	COP047	LEIGHCK	252463.4	6606578.47	54	-30.64785	138.416941	71.05	9/04/1991	8/12/1982	104
6536-00412	COP053	LEIGHCK	252397.43	6610853.5	54	-30.609299	138.417277	12.59	9/04/1991	14/01/1983	142
6536-00413	COP054	LEIGHCK	245601.42	6611720.48	54	-30.600058	138.346665	44.51	9/04/1991	17/01/1983	130
6536-00414	COP055	LEIGHCK	246800.34	6610648.55	54	-30.609975	138.358896	41.42	9/04/1991	19/01/1983	200
6536-00428	COP056	LEIGHCK	243986.4	6612804.51	54	-30.589942	138.330104	59.92	9/04/1991	25/01/1983	176
6536-00431	COP065	LEIGHCK	251033.37	6611278.45	54	-30.605185	138.403163	27	9/08/1985	28/01/1983	168
6536-00434	COP067	LEIGHCK	251912.37	6608268.49	54	-30.632501	138.411601	15.54	9/04/1991	5/02/1983	176
6737-00029	COP008	LEIGHCK	350469.35	6629037.34	54	-30.461564	139.442454	25.25	23/06/1988		90.53

Table 9: Historical Public Groundwater Observation Well Networks (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
6536-00438	COP070	LEIGHCK	250190.4	6608746.51	54	-30.627833	138.393767	16.46	9/08/1985	10/03/1983	200
6536-00442	COP062	LEIGHCK	252510.42	6610984.45	54	-30.608142	138.418486	10.62	9/04/1991	2/03/1983	78
6536-00446	COP075	LEIGHCK	253031.39	6611095.46	54	-30.607249	138.423942	9.34	9/04/1991	23/04/1983	120
6536-00449	COP058	LEIGHCK	247954.37	6609442.55	54	-30.62109	138.370629	66.35	9/04/1991	29/01/1983	184
6536-00451	COP059	LEIGHCK	252318.34	6610741.53	54	-30.610292	138.416426	12.15	9/04/1991	1/02/1983	102
6537-02341	COP004	LEIGHCK	257028.37	6625245.49	54	-30.480505	138.468912	16.52	1/07/1985		10.97
6536-00292	COP037	LEIGHCK	250929.33	6607566.54	54	-30.638624	138.401185	46.92	20/03/1987	12/11/1982	157
6536-00429	COP057	LEIGHCK	242387.41	6614163.5	54	-30.577349	138.313782	25.19	12/12/1986	27/01/1983	192
6536-00236	COP020	LEIGHCK	250152.4	6611158.44	54	-30.606083	138.393953	14.2	5/04/1989	30/03/1981	62
6536-00282	COP029	LEIGHCK	251205.34	6608581.53	54	-30.629532	138.404306	19.2	9/04/1991	29/10/1982	102
6536-00317	COP041	LEIGHCK	253227.34	6607753.48	54	-30.637416	138.425186	9.43	9/04/1991	18/11/1982	60
6536-00416	COP012	LEIGHCK	250689.4	6610696.53	54	-30.610359	138.399438	18.47	9/08/1985	22/01/1983	176
6536-00444	COP074	LEIGHCK	253093.39	6611157.45	54	-30.606703	138.424603	7	9/04/1991	21/04/1983	186
6536-00450	COP064	LEIGHCK	252684.43	6611007.52	54	-30.60797	138.420305	13.65	9/04/1991	5/03/1983	94
6536-00047	COP001	LEIGHCK	229364.3	6582719.56	54	-30.857868	138.16985	-999			6.7
6536-00233	COP021	LEIGHCK	250674.38	6610756.53	54	-30.609815	138.399296	19.88	26/07/1985	6/05/1981	123

Table 9: Historical Public Groundwater Observation Well Networks (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
6536-00284	COP031	LEIGHCK	250716.42	6608998.54	54	-30.625671	138.399311	20.23	9/04/1991	30/10/1982	142
6536-00318	COP042	LEIGHCK	250809.42	6608540.54	54	-30.629819	138.40017	12.56	9/04/1991	18/11/1982	144
6536-00410	COP051	LEIGHCK	250605.38	6606847.5	54	-30.645038	138.397634	63.95	9/04/1991	15/12/1982	136
6536-00433	COP066	LEIGHCK	249605.35	6609635.48	54	-30.619697	138.387883	13.57	30/04/1983	3/02/1983	152
6536-00197	COP011	LEIGHCK	250916.38	6610988.54	54	-30.607774	138.401874	4.03	25/07/1990	29/07/1978	88
6536-00283	COP030	LEIGHCK	250670.4	6608922.48	54	-30.626347	138.398812	34.16	9/04/1991	29/10/1982	54
6536-00291	COP036	LEIGHCK	250899.35	6607701.52	54	-30.637401	138.400905	45.8	9/04/1991	9/11/1982	80
6536-00430	COP060	LEIGHCK	250905.38	6610999.49	54	-30.607673	138.401762	7.67	9/04/1991	2/02/1983	103
6536-00448	COP077	LEIGHCK	253290.34	6610769.49	54	-30.610241	138.426563	12.05	9/04/1991	25/04/1983	32
6536-00407	COP048	LEIGHCK	252657.35	6607011.46	54	-30.643987	138.419067	51.78	9/04/1991	9/12/1982	142
6536-00443	COP063	LEIGHCK	252267.41	6610678.46	54	-30.61085	138.41588	12.51	9/04/1991	4/03/1983	110
6536-00453	COP068	LEIGHCK	250939.4	6607475.47	54	-30.639447	138.401268	46.03	9/08/1985	3/03/1983	164
6536-00437	COP069	LEIGHCK	252337.38	6610802.54	54	-30.609746	138.416639	13.71	9/08/1985	4/03/1983	176
6536-00294	COP071	LEIGHCK	252561.38	6607076.48	54	-30.643381	138.418082	62.7	30/08/1983	30/03/1983	185
6536-00447	COP076	LEIGHCK	252346.42	6611085.51	54	-30.607197	138.416801	8.36	25/07/1990	25/04/1983	24
6536-00269	COP079	LEIGHCK	256858.33	6609845.47	54	-30.619302	138.463533	17.24	9/04/1991	18/05/1983	200

Table 9: Historical Public Groundwater Observation Well Networks (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
6536-00311	COP083	LEIGHCK	256423.35	6609455.49	54	-30.622729	138.458907	24.14	9/04/1991	30/06/1983	144
6536-00452	COP073	LEIGHCK	252500.36	6610900.46	54	-30.608897	138.418361	8.32	9/08/1985	16/03/1983	160
6536-00198	COP013	LEIGHCK	249975.37	6610868.46	54	-30.60866	138.392038	15.67	21/05/1983	27/07/1978	152
6536-00238	COP022	LEIGHCK	251051.39	6610668.51	54	-30.610687	138.403204	11.59	9/04/1991	8/05/1981	121
6536-00285	COP032	LEIGHCK	251746.4	6608514.48	54	-30.630249	138.40993	24.9	9/04/1991	30/10/1982	186
6536-00290	COP035	LEIGHCK	251599.38	6607602.55	54	-30.638439	138.408178	50.18	9/04/1991	9/11/1982	148
6536-00316	COP040	LEIGHCK	253004.4	6607039.51	54	-30.643806	138.422691	69.07	9/04/1991	17/11/1982	116
6536-00403	COP045	LEIGHCK	251069.4	6611230.47	54	-30.605625	138.403527	9.1	9/04/1991	1/12/1982	86
6536-00408	COP049	LEIGHCK	251555.36	6606920.51	54	-30.644578	138.407556	55.88	9/04/1991	11/12/1982	97
6536-00409	COP050	LEIGHCK	250178.43	6607877.5	54	-30.635664	138.393432	52.56	9/04/1991	13/12/1982	116
6536-00411	COP052	LEIGHCK	249158.39	6608612.47	54	-30.628825	138.382977	55.1	9/04/1991	16/12/1982	144
6536-00440	COP061	LEIGHCK	252318.34	6610741.53	54	-30.610292	138.416426	12.88	9/04/1991	1/03/1983	126
6536-00309	COP081	LEIGHCK	253724.36	6610452.5	54	-30.613188	138.431011	15.03	9/04/1991	27/06/1983	96
5643-00039	WNT007	MARLA	364135.9	6979309.05	53	-27.302532	133.626995	14.6	5/12/1986	12/11/1980	40
5643-00042	WNT017	MARLA	364135.9	6979309.05	53	-27.302532	133.626995	10.31	7/12/1990	26/11/1980	40
5643-00052	WNT005	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	12.98	11/11/1994	23/07/1981	41

Table 9: Historical Public Groundwater Observation Well Networks (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latitude	Longitude	Latest SWL	SWL Date	Drill Date	Max Depth
5643-00056	WNT004	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	12.8	14/07/1997	25/07/1981	40
5643-00023	WNT006	MARLA	363660.83	6979307.25	53	-27.302501	133.622195	12.28	20/11/1999	1/01/1950	40
5643-00051	WNT009	MARLA	363537.75	6980262.07	53	-27.293871	133.621058	12.64	4/10/1990	22/07/1981	41
5643-00045	WNT008	MARLA	364135.9	6979309.05	53	-27.302532	133.626995	13	10/09/1989	13/12/1978	40
5643-00040	WNT018	MARLA	364135.9	6979309.05	53	-27.302532	133.626995	10.41	16/09/1997	21/11/1980	40
5643-00018	WNT011	MARLA	362883.78	6978887.09	53	-27.306216	133.614297	10.18	23/10/2004	15/10/1976	27
5643-00041	WNT015	MARLA	364135.9	6979309.05	53	-27.302532	133.626995	9.26	10/09/1989	23/11/1980	40
6636-101			305958	6614738	54	-30.584159	138.97636	53.14	30/04/2008	08/08/1980	64
6636-149			304272	6615383	54	- 30.578070	138.9589063	53.98	40/04/2008	13/05/1983	120

Table 10: Current BHPB Groundwater Observation Well Network

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6338-33	VENABLES 1A	WELLA_OBS	729123	6714451	53	0.37	25/11/2004	20
6338-06	HBO013 - BOOPEECHEE SPRING BORE	WELLA_OBS	730903.2	6722468.72	53	0	19/10/1997	-999
6338-44	GAB 8	WELLA_OBS	729232.79	6725509.07	53	-4.98	25/11/2004	101.15
6338-46	GAB 10	WELLA_OBS	723388	6729817	53	-12.61	26/11/2004	106
6338-47	GAB 11	WELLA_OBS	722293	6730670	53	-17.12	26/11/2004	71
6338-49	MB 2	WELLA_OBS	724903.07	6709020.94	53	15.04	25/11/2004	62
6338-50	GAB 12A	WELLA_OBS	723044	6724765	53	-4.09	26/11/2004	133
6338-51	GAB 13A	WELLA_OBS	721916	6727070	53	7.38	26/11/2004	160
6338-52	GAB 14A	WELLA_OBS	721066	6726275	53	12.63	26/11/2004	171
6338-53	GAB 15A	WELLA_OBS	725419	6721820	53	-7.19	25/11/2004	126
6338-54	GAB 16A	WELLA_OBS	723609	6722133	53	-7.14	25/11/2004	120
6338-55	GAB 17A	WELLA_OBS	722090	6726170	53	5.26	24/10/2002	145
6338-56	GAB 18A	WELLA_OBS	721198	6724946	53	17.57	24/10/2002	156
6338-63	GAB 19	WELLA_OBS	725830	6727151	53	-10.49	26/11/2004	97
6338-64	GAB 23	WELLA_OBS	722392	6725191	53	-1.22	18/10/1997	124
6338-65	GAB 22	WELLA_OBS	723495	6724032	53	-5.99	26/11/2004	101

Table 10: Current BHPB Groundwater Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6338-66	GAB 21	WELLA_OBS	724464	6722174	53	-7.6	25/11/2004	92.5
6338-67	GAB 21S	WELLA_OBS	724467	6722162	53	4.36	19/10/1997	10
6338-68	GAB 22S	WELLA_OBS	723490	6724020	53	6	19/10/1997	10
6338-69	GAB 23S	WELLA_OBS	722385	6725185	53	5.29	18/10/1997	18
6338-36	GAB 5A	WELLA_OBS	720985	6731153	53	-20.94	26/11/2004	113
6338-38	HERMIT HILL 1	WELLA_OBS	737602.85	6724030.96	53	-5.82	25/11/2004	42
6338-39	HERMIT HILL 2	WELLA_OBS	731555.89	6724259.99	53	-2.31	25/11/2004	69
6338-40	HERMIT HILL 3	WELLA_OBS	737699.9	6723642.85	53	0.66	25/11/2004	31.5
6338-42	HERMIT HILL 4	WELLA_OBS	736945.88	6726228.1	53	-10.15	25/11/2004	39.5
6338-70	GAB 6S	WELLA_OBS	724412	6723489	53	2	19/10/1997	15.4
6338-02	NEW YEARS GIFT	WELLA_OBS	722778	6718663	53	-2.25	25/11/2004	72.24
6338-23	GAB 6A	WELLA_OBS	724431	6723478	53	-7.11	25/11/2004	116
6338-24	GAB 7	WELLA_OBS	727633	6729444	53	-12.56	26/11/2004	105
6338-27	GAB 1	WELLA_OBS	720655.93	6715850.81	53	-2.83	22/10/2002	99.75
6338-31	GAB 2	WELLA_OBS	726643.03	6716386.79	53	0.14	23/10/2002	87.5
6338-35	GAB 5	WELLA_OBS	720926	6731055	53	-22.24	26/11/2004	139.5

Table 10: Current BHPB Groundwater Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6338-71	GAB 30A	WELLA_OBS	717036	6733552	53	-35.5	26/11/2004	168
6338-72	GAB 31A	WELLA_OBS	715730	6734485	53	-39.98	27/11/2004	181
6339-09	GOSSE SPRING BORE (MB1)	WELLA_OBS	727615	6737430	53	-61.26	26/11/2004	88
6339-10	MB 4	WELLA_OBS	696445	6756392	53	-7.04	27/11/2004	226
6339-12	GAB 24 (LAKE EYRE SOUTH)	WELLA_OBS	713927	6734778	53	-30.29	20/10/1997	180
6339-15	GAB 33A	WELLA_OBS	704475	6737201	53	-28.15	27/11/2004	126
6338-76	GAB 12S	WELLA_OBS	723056	6724751	53	5.55	19/10/1997	12
6338-77	GAB 14S	WELLA_OBS	721105	6726258	53	14.65	18/10/1997	18
6338-78	GAB 15S	WELLA_OBS	725428	6721806	53	5.49	9/09/1996	12
6338-79	GAB 16S	WELLA_OBS	723596	6722132	53	4.14	19/10/1997	12
6338-80	GAB 18S	WELLA_OBS	721185	6724954	53	10.2	18/10/1997	21
664-020	BOOCALTANINNA BORE	WELLB_OBS	293298	6808507	54	-78.95	9/09/2004	807
6438-92	BROLGA BORE	WELLB_OBS	766523	6717627	53	-6.13	5/11/2004	125
6438-95	CALLANNA BORE 2	WELLB_OBS	783259	6722214	53	-3.9	5/11/2004	120
664-004	CANNAWAUKANINNA	WELLB_OBS	261285	6812751	54	-86.53	8/09/2004	867.77
6639-07	CHAPALANNA BORE	WELLB_OBS	288897	6759161	54	-33.94	5/09/2004	416.66

Table 10: Current BHPB Groundwater Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6438-01	CHARLES ANGAS BORE	WELLB_OBS	744860.9	6733734	53	-49.03	6/11/2004	-999
6539-02	CLAYTON BORE	WELLB_OBS	245668	6758679	54	-32.62	7/09/2004	523
6539-09	CLAYTON BORE 2	WELLB_OBS	245022	6758997	54	-24.43	4/09/2004	570
6639-09	CLAYTON DAM BORE	WELLB_OBS	270910	6735087	54	-14.72	5/09/2004	347.17
6639-16	COORYANINNA 2	WELLB_OBS	282442	6778142	54	-63.05	6/09/2004	517
6539-14	DULKANINNA 2	WELLB_OBS	252846	6785700	54	-60.02	17/05/2007	706.5
6538-04	FROME CREEK BORE	WELLB_OBS	219639	6720536	54	0.06	3/11/2004	174
654-014	GEORGIA BORE	WELLB_OBS	215451	6804617	54	-87.19	9/09/2005	999
6339-06	JACKBOOT BORE	WELLB_OBS	728448.86	6773019.05	53	-60.74	28/09/2006	503.22
6538-67	LAKE BILLY 2	WELLB_OBS	254516	6726174	54	-9.18	2/11/2004	378
6539-05	LAKE HARRY BORE	WELLB_OBS	232915	6740771	54	-36.83	4/09/2004	414.6
6539-04	MARION BORE	WELLB_OBS	221697.25	6738437.02	54	-19.2	4/11/2004	300
6438-79	MAYNARDS BORE	WELLB_OBS	760116.76	6721866.04	53	-5.43	5/11/2004	61
6438-87	MORPHETTS BORE	WELLB_OBS	765065.79	6718620.06	53	-6.68	5/11/2004	139
6439-09	MORRIS CK. BORE	WELLB_OBS	748989	6741945	53	-65.03	7/11/2004	-999
6439-20	MULOORINA 1	WELLB_OBS	782462	6761846	53	-70.58	4/11/2004	618

Table 10: Current BHPB Groundwater Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
664-001	NEW KOPPERAMANNA 1	WELLB_OBS	274131	6829740	54	-49.47	9/09/2004	992.58
6539-01	PEACHAWARINNA BORE	WELLB_OBS	226972	6785521	54	-70.64	8/09/2004	757.12
6539-08	PETERS BORE	WELLB_OBS	210219	6740125	54	-32.79	4/09/2006	396.24
6639-02	SINCLAIR BORE	WELLB_OBS	260813	6767497	54	-23.21	6/09/2004	551.08
6639-18	TARKANINNA 2 ("BULL ANT")	WELLB_OBS	266799	6754652	54	-23.13	5/09/2004	476.5
6.54E+08	TENT HILL 2	WELLB_OBS	241519	6711965	54	-8.6	2/11/2004	197
6.54E+08	TWO MILE BORE 2	WELLB_OBS	234903	6709842	54	1.4	11/08/2003	125.5
6.54E+08	WELL CREEK BORE 2	WELLB_OBS	235153	6719012	54	-2.22	3/11/2004	260
6639-08	YARRA HILL BORE	WELLB_OBS	275740	6751479	54	-26.8	5/09/2004	314
6538-33	WIRRINGINA SPRING 1	WELLB_OBS	245248	6707171	54	0.06	19/12/2006	-999
6.54E+08	WIRRINGINA SPRING 2	WELLB_OBS	245247	6707210	54	0.7	2/11/2004	-999
6438-80	WCB 1	WELLB_OBS	769422.79	6725931.04	53	-21.09	5/11/2004	192.9
6439-18	WCB 2	WELLB_OBS	770256.77	6742041.99	53	-57.25	5/11/2004	329.5
6439-24	OB 6	WELLB_OBS	775492	6748437	53	-68.91	6/11/2004	416
6439-26	OB 3	WELLB_OBS	770087.62	6748152.99	53	-76.92	6/11/2004	343
6439-27	OB 1	WELLB_OBS	766606.72	6748110.91	53	-75.32	6/11/2004	485

Table 10: Current BHPB Groundwater Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6539-15	S5	WELLB_OBS	226841	6761505	54	-67.38	7/09/2004	656
6539-16	S4	WELLB_OBS	243300.15	6734558.04	54	-35.21	3/11/2004	349
6539-17	D3	WELLB_OBS	244816	6773270	54	-50.37	7/09/2004	690
6538-70	S3	WELLB_OBS	221893.25	6725756.03	54	-37.2	3/11/2004	286
6538-71	S3A	WELLB_OBS	226193.28	6728445.97	54	-39.3	3/11/2004	322
6438-96	S2	WELLB_OBS	773487.79	6719538	53	-7.15	5/11/2004	104
6438-97	S1	WELLB_OBS	758908	6732780	53	-33.63	6/11/2004	321
654-015	D2	WELLB_OBS	254717	6800638	54	-77.72	29/07/2005	843
6639-17	JEWELLERY CREEK 2	WELLB_OBS	299652	6780837	54	-72.84	6/09/2004	544.5
6438-04	COORANNA BORE	WELLB_OBS	769373	6730885	53	-24.75	5/11/2004	218

Table 11: Current BHPB Groundwater Production Bores

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6338-57	GAB 12	WELLA_PROD	723092.03	6724616.94	53	9.75	1/12/1995	133
6338-58	GAB 14	WELLA_PROD	720836.99	6726259.84	53	28.27	30/11/1995	168
6338-59	GAB 15	WELLA_PROD	725216.86	6722086.07	53	-4.08	23/10/2002	121
6338-60	GAB 16	WELLA_PROD	723188.04	6722292.85	53	3.09	30/11/1995	115
6338-61	GAB 18	WELLA_PROD	720903	6724792.02	53	23.61	1/12/1995	150
6338-74	GAB 30-B	WELLA_PROD	717065	6733597	53	0	15/08/1991	164
6338-75	GAB 31	WELLA_PROD	715703	6734495	53	0	4/07/1991	175
6339-13	GAB 32	WELLA_PROD	714046	6735007	53	-6.12	30/11/1995	169
6338-22	GAB 6	WELLA_PROD	724404.98	6723711.98	53	5.55	30/11/1995	116
6539-18	GAB 53	WELLB_PROD	221344.98	6777738.98	54	-999		797
6539-20	GAB 52	WELLB_PROD	217322.96	6775678.38	54	-95.47	29/06/1996	789
6539-19	GAB 51	WELLB_PROD	212997.34	6773285.21	54	-90.37	4/05/1996	770

Table 12: Proposed GAB Observation Well Network

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
6239-45	TRIG BORE 2	GAB_MON	673271	6751798	53	-35.98	30/09/2008	111
6442-02	POONARUNNA 1	GAB_MON	787003.58	6910284.81	53	-53.19	10/09/2004	1699.26
5941-46	WIRE YARD BORE	GAB_MON	502342.8	6867214.88	53	-4.29	7/09/1996	66
6838-29	WOOLATCHIE BORE	GAB_MON	390574.97	6694911.99	54	-34.07	4/05/2005	596
5945-75	3 O'CLOCK CREEK BORE	GAB_MON	540782.73	7073159.9	53	-17.24	2/07/2008	275
5943-01	ALBERGA BORE	GAB_MON	543957	6992377	53	-17.14	5/12/2004	365.76
624-004	ARMISTICE BORE 2	GAB_MON	664364	6808510	53	-51	29/08/1996	496
6640-023	BHPB - C1	GAB_MON	289517.6	6796236.8	54	-999		843
6738-189	BHPB - C4	GAB_MON	347735	6729162	54	-999		537
6935-08	BLACK OAK BORE 1	GAB_MON	425352.17	6568454.04	54	-9.35	13/11/2000	138.38
7037-03	COONEE CREEK BORE	GAB_MON	470338.97	6654850.97	54	-27.74	10/05/2005	403.86
6937-09	COOTABARLOW 3	GAB_MON	423056.64	6636803.7	54	-34.17	6/05/2005	419.18
6044-09	APPERINNA BORE 2	GAB_MON	575942	7032101	53	-46.2	30/04/2006	489.5
6142-04	DUCKHOLE 2	GAB_MON	607438.87	6945405.92	53	-44.88	2/09/1996	250.78
7041-100	DULLINGARI 6	GAB_MON	487944.43	6886226.81	54	-49.16	15/09/2004	1609.34
6139-25	FERGIES 1A	GAB_MON	623213	6785280	53	0	15/06/1985	9

Table 12: Proposed GAB Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
5941-06	FERGYS BORE	GAB_MON	548062	6888932	53	-22.95	6/12/2004	77
654-014	GEORGIA BORE	GAB_MON	215451	6804617	54	-87.19	9/09/2005	999
6741-01	JENNET 1	GAB_MON	349468.71	6876627.94	54	-112.89	17/10/1995	1687.07
6141-47	KEMPES	GAB_MON	613712	6866741	53	-22.13	28/11/2004	42
6838-06	LAKE CROSSING BORE NO.4	GAB_MON	391596	6731330	54	-26.64	17/11/2000	519.1
6936-13	LAKESIDE BORE 2	GAB_MON	416299.03	6599030.96	54	-6.15	13/11/2000	323
6041-37	LHDH 15 (NEW PEAKE)	GAB_MON	590120.8	6896530.06	53	-28.25	29/11/2004	86.87
6139-22	MARGARET CREEK (NEW) 2	GAB_MON	644974	6740092	53	-11.01	1/10/2008	28.5
6643-10	MT GASON 2	GAB_MON	277966	6978990	54	-87.82	28/05/2007	1500
5841-47	MUGGERS BORE	GAB_MON	485781	6902442	53	-0.13	6/12/2004	96
6738-02	MURNPEOWIE HS	GAB_MON	311227	6725853	54	-9.34	18/09/2004	397
6744-01	PANDIEBURRA 1	GAB_MON	343278.11	7039689.33	54	-111.46	12/09/2004	2210.71
6843-06	PARACHIRRINNA BORE	GAB_MON	369733.58	6959580.87	54	-96	16/09/2004	1556
6142-07	PEACHAMURANNA NO.2	GAB_MON	638168	6955157	53	-65.79	30/11/2004	713
6445-04	POOLOWANNA 3	GAB_MON	766221.62	7075513.43	53	-113.48	18/08/1994	2691.69
6145-01	PURNI 1	GAB_MON	609611.54	7092272.73	53	-69.77	29/04/2006	1880.01

Table 12: Proposed GAB Observation Well Network (continued)

Unit No.	Obs. No	Network	Easting	Northing	Zone	Latest SWL	SWL Date	Max Depth
5941-01	RASPBERRY CREEK	GAB_MON	508371	6888740	53	-15.89	9/09/2002	126.8
6141-76	WOOD DUCK 2	GAB_MON	617426	6901943	53	-53.86	29/11/2004	249
6143-02	SNAKE CREEK NO.2	GAB_MON	599485	7001423	53	-55.9	8/09/2006	676
6239-41	STRANGWAYS 2	GAB_MON	653765	6773211	53	-27.23	30/09/2008	120
614-039	SUNNY CREEK BORE 2	GAB_MON	638139	6833250	53	-12.95	27/11/2004	220
7038-02	TILCHA 2	GAB_MON	461014.72	6717324.96	54	-33.97	10/05/2005	717.19
604-021	TREVORS BORE	GAB_MON	555636	6836912	53	-3.06	7/12/2004	-999
7036-07	KIDMANS BORE NO2	GAB_MON	477238.01	6576699.05	54	-1	9/05/2005	177.3
5942-47	STUARTS BORE (HWY DEPT)	GAB_MON	537685	6940075	53	-17.24	5/12/2004	365

Table 13: Spring Locations

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
604100171	GABWELLS6	569157.71	6896174.97	53	-28.1	135.704
604100176	GABWELLS6	595295.75	6889613.02	53	-28.1	135.970
604100177	GABWELLS6	595673.76	6886892.01	53	-28.1	135.974
634000018	GABWELLS6	696657.75	6838969.95	53	-28.6	137.010
634000032	GABWELLS6	696207.74	6836649.02	53	-28.6	137.006
693600091	GABWELLS6	446591	6613991	54	-30.6	140.443
594000001	GABWELLS6	519873.76	6817583.84	53	-28.8	135.204
594500007	GABWELLS6	546849.74	7070494.95	53	-26.5	135.470
613900043	GABWELLS6	640634.82	6739534.85	53	-29.5	136.450
614100052	GABWELLS6	618190.77	6854905.83	53	-28.4	136.207
643800075	GABWELLS6	773540.94	6714491.92	53	-29.7	137.826
604100170	GABWELLS6	562744.74	6897132.95	53	-28	135.638
594500019	GABWELLS6	549165.77	7077088.95	53	-26.4	135.493
614100003	GABWELLS6	605620.8	6873068.07	53	-28.3	136.077
614100005	GABWELLS6	617460.84	6873195.13	53	-28.3	136.198
614100051	GABWELLS6	617004.7	6855284.87	53	-28.4	136.195
604100165	GABWELLS6	566634.72	6876358.94	53	-28.2	135.679
634000017	GABWELLS6	696734.78	6839198.01	53	-28.6	137.011
613900019	GABWELLS5	625146.86	6781428.88	53	-29.1	136.286
594500050	GABWELLS6	547478.69	7073262.95	53	-26.5	135.476
604100008	GABWELLS6	588877.86	6894034.92	53	-28.1	135.905
604100018	GABWELLS6	564797.81	6882287.95	53	-28.2	135.660
613900006	GABWELLS6	644316.69	6739510.93	53	-29.5	136.488
613900012	GABWELLS6	636978.76	6786459.73	53	-29	136.407
613900033	GABWELLS6	640772.83	6738281.02	53	-29.5	136.452
613900044	GABWELLS6	641392.82	6738993.93	53	-29.5	136.458
614000002	GABWELLS6	607546.69	6843931.94	53	-28.5	136.099
614100025	GABWELLS6	612739.94	6859737.96	53	-28.4	136.151
623900017	GABWELLS6	674006.85	6746260.88	53	-29.4	136.793

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
643800006	GABWELLS6	773347.94	6714844.86	53	-29.7	137.824
604100168	GABWELLS6	560078.76	6869829.97	53	-28.3	135.613
634000020	GABWELLS6	696122.8	6838935.01	53	-28.6	137.005
594500028	GABWELLS6	549192.75	7076528.98	53	-26.4	135.493
594500038	GABWELLS6	549514.73	7075884.93	53	-26.4	135.497
594500039	GABWELLS6	548833.73	7075859.95	53	-26.4	135.490
594500045	GABWELLS6	548995.74	7074311.98	53	-26.5	135.491
613900024	GABWELLS6	626897.83	6777392.9	53	-29.1	136.304
614100015	GABWELLS6	624880.67	6865972.9	53	-28.3	136.274
633900001	GABWELLS6	700352.94	6747740.83	53	-29.4	137.064
604100173	GABWELLS6	577906.8	6892991.02	53	-28.1	135.793
604100175	GABWELLS6	593747.8	6890623.94	53	-28.1	135.954
634000010	GABWELLS6	727252.78	6814011.02	53	-28.8	137.328
594500037	GABWELLS6	548806.76	7076082.89	53	-26.4	135.490
604100074	GABWELLS6	561216.8	6862136.95	53	-28.4	135.625
673800008	GABWELLS6	352473.53	6706632.4	54	-29.8	139.474
643800073	GABWELLS6	773387.91	6714838.9	53	-29.7	137.825
634000004	GABWELLS6	726857.71	6815315.03	53	-28.8	137.324
634000013	GABWELLS6	726678.74	6813677.95	53	-28.8	137.322
634000019	GABWELLS6	696917.79	6838778.02	53	-28.6	137.013
634000036	GABWELLS6	697143.74	6836700.04	53	-28.6	137.016
594400018	GABWELLS6	543536.7	7067064.9	53	-26.5	135.437
594500030	GABWELLS6	547993.75	7076220.96	53	-26.4	135.481
604500005	GABWELLS6	551861.71	7078964.97	53	-26.4	135.520
623900014	GABWELLS6	680866.88	6740397.91	53	-29.5	136.865
623900022	GABWELLS6	680306.8	6740405.86	53	-29.5	136.859
634000003	GABWELLS6	726992.76	6815516.97	53	-28.8	137.325
614100023	GABWELLS5	612837.76	6860295.03	53	-28.4	136.152
594500042	GABWELLS6	548164.77	7074946.98	53	-26.4	135.483

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
604500011	GABWELLS6	550015.73	7077568.9	53	-26.4	135.502
613900023	GABWELLS6	626857.88	6777836.08	53	-29.1	136.304
614100026	GABWELLS6	616003.66	6856946.09	53	-28.4	136.184
623800001	GABWELLS6	692641.93	6731495	53	-29.5	136.988
623900046	GABWELLS6	657644.78	6752305.86	53	-29.3	136.624
633800020	GABWELLS6	721067.83	6732478.96	53	-29.5	137.281
633900004	GABWELLS6	726849.95	6738372.02	53	-29.5	137.339
653800017	GABWELLS6	235050.55	6709885.54	54	-29.7	138.261
604100166	GABWELLS6	556496.74	6879950.94	53	-28.2	135.576
693600088	GABWELLS6	407299.02	6618023.05	54	-30.6	140.033
594500013	GABWELLS6	548466.73	7077399.95	53	-26.4	135.486
594500065	GABWELLS6	549782.77	7077630.98	53	-26.4	135.499
594500066	GABWELLS6	549782.77	7077630.98	53	-26.4	135.499
613900026	GABWELLS6	628269.65	6769710.82	53	-29.2	136.319
614100027	GABWELLS6	616701.79	6857065.09	53	-28.4	136.191
614100032	GABWELLS6	606592.75	6851244.03	53	-28.5	136.089
623900020	GABWELLS6	662327.8	6760385.94	53	-29.3	136.671
633800009	GABWELLS6	730963.79	6722346.87	53	-29.6	137.385
634000012	GABWELLS6	727046.78	6813492.02	53	-28.8	137.326
634000033	GABWELLS6	696282.73	6836394.02	53	-28.6	137.007
604200007	GABWELLS6	568699.79	6927022.98	53	-27.8	135.697
604200010	GABWELLS6	566301.76	6918679.95	53	-27.9	135.673
623900025	GABWELLS6	650232.8	6773487.9	53	-29.2	136.545
633800001	GABWELLS6	721685	6732283.87	53	-29.5	137.287
633800006	GABWELLS5	730902	6722455	53	-29.6	137.384
673800025	GABWELLS6	349006.59	6733098.25	54	-29.5	139.442
634000030	GABWELLS6	695982.73	6837406.03	53	-28.6	137.004
634000037	GABWELLS6	697773.75	6836912.01	53	-28.6	137.022
633800003	GABWELLS5	728948.76	6733419.82	53	-29.5	137.362

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
594500014	GABWELLS6	548575.76	7077304.95	53	-26.4	135.487
623900016	GABWELLS6	686306.88	6736198.9	53	-29.5	136.922
623900024	GABWELLS6	683745.85	6737264.91	53	-29.5	136.895
653800037	GABWELLS6	214227.61	6710669.41	54	-29.7	138.047
604100179	GABWELLS6	561209.74	6876400.92	53	-28.2	135.624
693600085	GABWELLS6	405219.28	6616391.3	54	-30.6	140.011
594400016	GABWELLS6	546743.75	7067555	53	-26.5	135.469
594400026	GABWELLS6	549631.72	7066840.95	53	-26.5	135.498
594500029	GABWELLS6	547815.7	7076281.99	53	-26.4	135.480
594500059	GABWELLS6	548723.7	7070034.98	53	-26.5	135.489
604200005	GABWELLS6	563115	6924145	53	-27.8	135.641
614100012	GABWELLS6	621020.62	6866218.85	53	-28.3	136.235
613800053	GABWELLS6	641734	6734292	53	-29.5	136.462
634000026	GABWELLS6	696609.81	6838195	53	-28.6	137.010
693600084	GABWELLS6	405858.36	6616639.29	54	-30.6	140.018
693600087	GABWELLS6	428397.97	6609413.01	54	-30.6	140.253
693600090	GABWELLS6	446292.05	6587157.95	54	-30.8	140.438
633800007	GABWELLS5	728603.94	6720673.82	53	-29.6	137.361
633900003	GABWELLS5	708592.82	6736076.12	53	-29.5	137.152
594500012	GABWELLS6	549585.74	7077596.92	53	-26.4	135.497
594500026	GABWELLS6	549497.74	7077427.92	53	-26.4	135.496
594500027	GABWELLS6	549620.71	7077328.98	53	-26.4	135.498
614100014	GABWELLS6	623084.87	6867874.87	53	-28.3	136.255
604100167	GABWELLS6	557211.79	6877580.95	53	-28.2	135.583
634000040	GABWELLS6	698239.76	6820396.93	53	-28.7	137.030
594500025	GABWELLS6	548880.69	7076908.96	53	-26.4	135.490
604200004	GABWELLS6	566001.71	6925775.96	53	-27.8	135.670
604500017	GABWELLS6	555299.76	7079726.95	53	-26.4	135.554
614100029	GABWELLS6	617125.89	6857163.05	53	-28.4	136.196

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
623900031	GABWELLS6	650872	6773199	53	-29.2	136.551
633800082	GABWELLS6	729060.79	6714534.87	53	-29.7	137.367
604100169	GABWELLS6	562988.72	6867336.91	53	-28.3	135.643
683800001	GABWELLS6	358153.35	6707285.27	54	-29.8	139.533
693600083	GABWELLS6	405977.36	6617079.35	54	-30.6	140.019
594500032	GABWELLS6	548431.74	7076052.97	53	-26.4	135.486
594500034	GABWELLS6	547790.75	7075926.89	53	-26.4	135.479
594500049	GABWELLS6	548053.75	7073625.98	53	-26.5	135.482
604200006	GABWELLS6	567641.73	6926799.95	53	-27.8	135.687
614100016	GABWELLS6	625749.81	6863493.89	53	-28.3	136.283
673800064	GABWELLS6	347847.56	6731292.21	54	-29.5	139.430
634000016	GABWELLS6	726927.71	6813867.02	53	-28.8	137.325
634000042	GABWELLS6	700227.78	6818506.03	53	-28.7	137.050
604100030	GABWELLS5	564338.79	6855188.09	53	-28.4	135.657
594500006	GABWELLS6	547808.73	7075159.96	53	-26.4	135.480
594500040	GABWELLS6	548109.75	7075271.92	53	-26.4	135.483
613900008	GABWELLS6	623754.85	6791150.81	53	-29	136.271
614000001	GABWELLS6	628034.87	6846282.88	53	-28.5	136.308
623900023	GABWELLS6	680235.86	6741116.93	53	-29.4	136.858
643800023	GABWELLS6	750514.84	6715422.84	53	-29.7	137.588
653800033	GABWELLS6	245248	6707171	54	-29.7	138.366
634000014	GABWELLS6	726578.72	6814033.94	53	-28.8	137.321
693700056	GABWELLS6	404763.32	6638904.29	54	-30.4	140.009
594500057	GABWELLS6	548590.72	7070553.93	53	-26.5	135.488
604100002	GABWELLS6	571141.65	6900409.09	53	-28	135.724
604400005	GABWELLS6	550831.76	7065662.9	53	-26.5	135.510
623900005	GABWELLS6	661911.86	6761869.96	53	-29.3	136.666
683700068	GABWELLS6	402921.35	6625861.32	54	-30.5	139.988
653800189	GABWELLS6	245247	6707210	54	-29.7	138.366

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
693600081	GABWELLS6	405648.27	6617283.29	54	-30.6	140.016
604100023	GABWELLS5	552505.81	6871366.89	53	-28.3	135.535
594500017	GABWELLS6	547885.72	7077092.89	53	-26.4	135.480
594500060	GABWELLS6	548514.78	7070000	53	-26.5	135.487
614100010	GABWELLS6	621022.87	6866218.82	53	-28.3	136.235
633900018	GABWELLS6	720966.77	6750007.97	53	-29.4	137.276
604100174	GABWELLS6	580989.74	6897959.02	53	-28	135.824
634000025	GABWELLS6	696839.75	6838537	53	-28.6	137.012
634000028	GABWELLS6	696436.76	6838006.01	53	-28.6	137.008
613900042	GABWELLS6	630460.8	6767206.96	53	-29.2	136.342
614100007	GABWELLS6	617627.65	6873199.02	53	-28.3	136.199
614100013	GABWELLS6	622126.92	6870363.08	53	-28.3	136.245
634000034	GABWELLS6	696763.81	6837102.95	53	-28.6	137.012
634000039	GABWELLS6	698405.77	6820636.99	53	-28.7	137.031
634000043	GABWELLS6	695681.76	6838328.03	53	-28.6	137.001
693600086	GABWELLS6	410903.97	6613904.03	54	-30.6	140.071
693600089	GABWELLS6	413707.99	6616229.02	54	-30.6	140.100
693500241	GABWELLS6	416277.25	6554771.38	54	-31.1	140.122
604200012	GABWELLS5	573930	6907017	53	-28	135.752
594500051	GABWELLS6	547876.71	7072984.92	53	-26.5	135.480
594500054	GABWELLS6	548728.72	7071567.93	53	-26.5	135.489
604000008	GABWELLS6	551290.83	6811576.83	53	-28.8	135.526
604500006	GABWELLS6	551932.78	7078856.92	53	-26.4	135.521
614100002	GABWELLS6	635515.81	6885482.98	53	-28.1	136.380
614100024	GABWELLS6	612850.81	6860317.95	53	-28.4	136.152
614100028	GABWELLS6	617348.84	6858016.82	53	-28.4	136.198
643800074	GABWELLS6	773541.92	6714519.96	53	-29.7	137.826
634000002	GABWELLS6	727076.77	6815801.95	53	-28.8	137.326
634000015	GABWELLS6	726827.79	6814292.97	53	-28.8	137.324

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
634000027	GABWELLS6	696850.78	6838091.96	53	-28.6	137.013
693600082	GABWELLS6	405963.3	6617460.27	54	-30.6	140.019
594500044	GABWELLS6	548652.75	7074563.92	53	-26.4	135.488
594500056	GABWELLS6	546887.69	7070789.97	53	-26.5	135.470
604100034	GABWELLS6	553402.58	6880297.99	53	-28.2	135.544
604200009	GABWELLS6	567203.75	6919264.99	53	-27.8	135.683
604400006	GABWELLS6	551668.78	7066609.95	53	-26.5	135.519
643800076	GABWELLS6	750535.94	6715343.84	53	-29.7	137.589
673800063	GABWELLS6	347694.35	6732127.33	54	-29.5	139.428
594500047	GABWELLS6	547210.79	7077650.93	53	-26.4	135.473
594500048	GABWELLS6	547390.71	7075951.96	53	-26.4	135.475
604100029	GABWELLS6	561855.66	6859687.97	53	-28.4	135.631
604500007	GABWELLS6	551887.79	7078779.91	53	-26.4	135.520
604500014	GABWELLS6	550633.72	7076255.92	53	-26.4	135.508
613900013	GABWELLS6	635377.78	6790946.82	53	-29	136.390
634000021	GABWELLS6	696084.74	6838794.97	53	-28.6	137.005
634000022	GABWELLS6	696299.81	6838634.96	53	-28.6	137.007
634000041	GABWELLS6	699886.82	6818939.03	53	-28.7	137.047
693600080	GABWELLS6	405490.32	6617502.36	54	-30.6	140.014
594500011	GABWELLS6	548540.77	7077650.97	53	-26.4	135.487
594500015	GABWELLS6	548266.76	7077231.91	53	-26.4	135.484
613900028	GABWELLS6	628780.67	6773642.12	53	-29.2	136.324
623900021	GABWELLS6	673233.86	6751641.95	53	-29.4	136.785
623900029	GABWELLS6	671713.88	6751541.89	53	-29.4	136.769
623900037	GABWELLS6	672083.84	6752596.91	53	-29.3	136.773
634000029	GABWELLS6	696683.78	6837832.93	53	-28.6	137.011
604100006	GABWELLS5	587888.78	6901285.1	53	-28	135.894
604200011	GABWELLS5	573055	6920031	53	-27.8	135.742
594500031	GABWELLS6	548308.72	7076110.91	53	-26.4	135.485

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
604500004	GABWELLS6	551772.69	7079150.96	53	-26.4	135.519
614100009	GABWELLS6	621022.74	6866205.97	53	-28.3	136.235
614100011	GABWELLS6	621020.62	6866218.85	53	-28.3	136.235
633900007	GABWELLS6	724579.91	6738383.78	53	-29.5	137.316
604100178	GABWELLS6	595950.71	6887148.94	53	-28.1	135.977
653800018	GABWELLS5	232397	6707876	54	-29.7	138.233
634000005	GABWELLS6	727060.73	6815160.94	53	-28.8	137.326
634000006	GABWELLS6	727269.78	6815020.02	53	-28.8	137.328
604100007	GABWELLS5	588921.82	6894450.95	53	-28.1	135.905
604100020	GABWELLS5	569816.73	6879759.83	53	-28.2	135.711
614100008	GABWELLS6	622078.7	6870366.01	53	-28.3	136.245
614100022	GABWELLS6	613131.87	6860278.04	53	-28.4	136.155
633800014	GABWELLS6	732292.03	6722412.86	53	-29.6	137.399
633800021	GABWELLS6	714636	6726504.98	53	-29.6	137.216
634000009	GABWELLS6	727450.75	6814193.97	53	-28.8	137.330
594500052	GABWELLS6	547663.79	7075030.91	53	-26.4	135.478
594500053	GABWELLS6	548910.76	7071577.98	53	-26.5	135.491
614100030	GABWELLS6	613062.67	6855302.02	53	-28.4	136.154
623900030	GABWELLS6	651039	6773614	53	-29.2	136.553
623900034	GABWELLS6	649373.86	6757358.92	53	-29.3	136.538
633900005	GABWELLS6	696494.94	6736028.01	53	-29.5	137.027
683800002	GABWELLS6	360058.55	6706086.44	54	-29.8	139.552
604100172	GABWELLS6	577578.79	6891892.91	53	-28.1	135.790
623900050	GABWELLS6	650896	6773055	53	-29.2	136.552
634000011	GABWELLS6	727181.77	6813662.02	53	-28.8	137.327
634000044	GABWELLS6	695690.75	6837553.02	53	-28.6	137.001
693600079	GABWELLS6	405052.3	6617385.35	54	-30.6	140.010
604200015	GABWELLS5	563776	6925164	53	-27.8	135.647
594500016	GABWELLS6	548331.73	7077138.96	53	-26.4	135.485

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
594500036	GABWELLS6	549669.74	7076080.92	53	-26.4	135.498
594500043	GABWELLS6	548590.79	7074841.93	53	-26.4	135.487
604100022	GABWELLS6	567833.74	6879182.89	53	-28.2	135.691
633900008	GABWELLS6	727367.89	6737948.86	53	-29.5	137.345
604100180	GABWELLS6	561753.7	6857556.93	53	-28.4	135.630
613900045	GABWELLS5	637837	6738167	53	-29.5	136.422
634000024	GABWELLS6	695992.74	6838179.95	53	-28.6	137.004
614100017	GABWELLS5	634570.83	6871621.05	53	-28.3	136.372
594500003	GABWELLS6	547932.76	7072779.93	53	-26.5	135.481
594500041	GABWELLS6	547780.7	7075154.97	53	-26.4	135.479
613900029	GABWELLS6	627362.96	6776753.94	53	-29.1	136.309
614100019	GABWELLS6	632998.73	6863652.9	53	-28.3	136.357
614100020	GABWELLS6	632924.83	6865174.07	53	-28.3	136.356
614100049	GABWELLS6	617876.91	6873403.98	53	-28.3	136.202
623900028	GABWELLS6	680504.88	6740834.94	53	-29.4	136.861
633800005	GABWELLS6	739343	6724989.96	53	-29.6	137.471
633900017	GABWELLS6	712108.82	6753266.89	53	-29.3	137.184
634000035	GABWELLS6	696889.74	6836904.95	53	-28.6	137.013
634000045	GABWELLS6	695296.81	6812421.92	53	-28.8	137.001
604100024	GABWELLS5	567334.69	6867606.85	53	-28.3	135.687
604500015	GABWELLS6	551218.78	7077371.9	53	-26.4	135.514
613900003	GABWELLS6	624413.92	6780811.93	53	-29.1	136.278
613900027	GABWELLS6	629063.94	6772401.02	53	-29.2	136.327
673800005	GABWELLS6	345997.46	6729711.23	54	-29.6	139.410
634000008	GABWELLS6	727381.7	6814473.97	53	-28.8	137.329
683600015	GABWELLS6	370644.18	6613809.51	54	-30.6	139.651
594200003	GABWELLS5	535419.76	6909152.04	53	-27.9	135.360
594500035	GABWELLS6	549203.73	7076296.91	53	-26.4	135.493
594500068	GABWELLS6	549779.7	7077390.95	53	-26.4	135.499

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
614000004	GABWELLS6	637490.82	6837320.89	53	-28.6	136.406
614100018	GABWELLS6	631796.65	6864426.96	53	-28.3	136.345
623900036	GABWELLS6	675347.85	6750296.88	53	-29.4	136.807
634000031	GABWELLS6	695821.79	6837120.95	53	-28.6	137.002
614100004	GABWELLS5	605676.78	6873141.04	53	-28.3	136.077
594500010	GABWELLS6	548746.78	7077777.89	53	-26.4	135.489
594500018	GABWELLS6	548082.72	7076894.9	53	-26.4	135.482
594500058	GABWELLS6	548529.7	7070098.96	53	-26.5	135.487
604500008	GABWELLS6	550509.72	7077994.93	53	-26.4	135.507
604500012	GABWELLS6	550121.72	7077461.94	53	-26.4	135.503
604500016	GABWELLS6	551068.71	7077223.97	53	-26.4	135.512
613900031	GABWELLS6	623703.8	6789572.84	53	-29	136.270
693500001	GABWELLS6	410018.29	6566348.4	54	-31	140.057
634000023	GABWELLS6	695955.81	6838446.94	53	-28.6	137.003
634000038	GABWELLS6	698190.76	6820841.96	53	-28.7	137.029
633800004	GABWELLS5	735072.85	6726608.95	53	-29.6	137.426
594500033	GABWELLS6	548271.77	7075987.89	53	-26.4	135.484
604100076	GABWELLS6	589406.83	6895064.11	53	-28.1	135.910
604500009	GABWELLS6	550325.75	7077719.98	53	-26.4	135.505
614100006	GABWELLS6	617627.68	6873202.01	53	-28.3	136.199
614100050	GABWELLS6	615736.67	6853397.93	53	-28.4	136.182
673800009	GABWELLS6	353023.44	6706734.22	54	-29.8	139.480
683700067	GABWELLS6	403645.24	6626700.27	54	-30.5	139.996
683800016	GABWELLS6	400756.45	6710852.36	54	-29.7	139.974
634000007	GABWELLS6	727160.79	6814767.02	53	-28.8	137.327
633800011	GABWELLS5	707958.98	6714345.74	53	-29.7	137.149
594400017	GABWELLS6	544254.74	7067656.97	53	-26.5	135.444
594500055	GABWELLS6	547173.7	7071212.89	53	-26.5	135.473
604100017	GABWELLS6	553089.71	6882504.87	53	-28.2	135.541

Table 13: Spring Locations (continued)

Unit No.	Group Code	Easting	Northing	Zone	Latitude	Longitude
614100031	GABWELLS6	616623.61	6853348.86	53	-28.4	136.191
643800007	GABWELLS6	762266.89	6714169.04	53	-29.7	137.710

Table 14: Waterhole Locations

Name	Type	Latitude	Longitude
	Perennial	-28.858719	134.43053
WATTLE WATERHOLE	Perennial	-27.86344	136.725159
SECRET BANK	Perennial	-28.233189	134.351059
DEEP WATERHOLE	Perennial	-29.8046	136.825049
TEMPLE BAR SOAK	Perennial	-30.927059	138.43994
	Perennial	-29.408199	137.981289
WATTLE WATERHOLE	Perennial	-28.02781	136.457349
WAMOOTA SPRING	Perennial	-30.875349	138.62828
	Perennial	-31.944299	138.73636
	Perennial	-27.899189	136.01826
RAIN CAMP WATERHOLE	Perennial	-27.261259	134.555279
	Perennial	-31.972969	139.76597
DETCHARINGA WATERHOLE	Perennial	-26.00976	140.910739
	Perennial	-30.989679	138.809509
	Perennial	-26.44309	135.562689
HOLIDAY WATERHOLE	Perennial	-29.58268	136.332939
	Perennial	-29.57309	136.400849
	Perennial	-30.068369	138.52873
ANDAMOOKA WATERHOLE	Perennial	-30.678149	137.307609
	Perennial	-27.405049	135.633369
CADBURY SPRING	Perennial	-31.44838	138.62544
FIFTEEN MILE WELL	Perennial	-31.33897	138.890239
BOGGY WATERHOLE	Perennial	-27.47722	139.83802
	Perennial	-25.88415	139.646039
BRADY WATERHOLE	Perennial	-26.88206	140.62089
LAURIE BANK	Perennial	-31.67687	137.587909
	Perennial	-31.77175	138.47877
LONGHOLE WATERHOLE	Perennial	-29.56119	136.291409
	Perennial	-29.75732	139.530749

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-29.57052	139.429699
HARDIES BASIN WELL	Perennial	-31.979939	137.51015
	Perennial	-28.51696	134.844689
	Perennial	-26.186159	135.132849
ST A'BECKET POND (YAMELPOONA)	Perennial	-30.19751	138.30626
	Perennial	-30.821059	138.370919
	Perennial	-27.09666	134.341419
GOAT WATERHOLE	Perennial	-28.96541	134.4863
	Perennial	-26.40933	135.522509
	Perennial	-28.208569	135.0834
	Perennial	-31.932069	134.88186
TRIG WATERHOLE	Perennial	-29.972499	135.964639
WIRRAWANDRA WATERHOLE	Perennial	-26.3633	140.804929
ARCKARINGA WATERHOLE	Perennial	-28.147579	135.283299
MOORILPERINA WATERHOLE	Perennial	-26.04739	135.75442
JACKY WATERHOLE	Perennial	-27.06873	135.49207
	Perennial	-25.954209	134.92733
AMBUTCHERA WATERHOLE	Perennial	-26.441379	135.642839
	Perennial	-29.65964	139.55058
YADMALPIPOORINA WATERHOLE	Perennial	-28.48232	134.735179
USOPIPPE WATERHOLE	Perennial	-27.556399	138.42092
CHRYSLER CREEK WATERHOLE	Perennial	-29.81862	135.32636
DURRABINNIE WELL	Perennial	-26.760039	140.79246
COOMBARRANA WATERHOLE	Perennial	-28.19612	134.935579
	Perennial	-26.308089	135.507489
YAWAKOORRILLINA WATERHOLE	Perennial	-28.01173	138.516689
HAWKS NEST WATERHOLE	Perennial	-28.850299	134.438149
	Perennial	-30.92318	138.861409
	Perennial	-30.297989	139.390089

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
THIRD SPRING	Perennial	-31.02846	138.591109
NILDOTTIE SPRING	Perennial	-31.045999	138.793539
	Perennial	-27.39449	135.670209
JACKY WATERHOLE	Perennial	-28.776779	134.3775
KOORAKARINA WATERHOLE	Perennial	-27.865279	136.736889
	Perennial	-26.268119	135.089479
	Perennial	-27.14333	134.45654
APPACULDRIE WATERHOLE	Perennial	-26.78835	140.589489
	Perennial	-27.54502	135.562539
WHIMBERINA WATERHOLE	Perennial	-29.88018	137.38089
	Perennial	-30.13209	139.09925
TEETA WATERHOLE	Perennial	-25.963149	139.850609
	Perennial	-30.125689	138.15043
	Perennial	-26.34307	135.25937
	Perennial	-29.924839	139.66775
	Perennial	-27.605169	135.605499
DEAD HORSE WATERHOLE	Perennial	-29.565509	136.30315
YANDANDARRE WATERHOLE	Perennial	-30.95493	136.757849
LAGOON WATERHOLE	Perennial	-29.17597	134.2463
DIRRIECOLANNIE WATERHOLE	Perennial	-26.103839	140.37649
SIXTEEN MILE WATERHOLE	Perennial	-29.24011	134.792239
THE DOROTHY WATERHOLE	Perennial	-29.90503	137.901729
ONE TREE SPRING	Perennial	-30.81902	138.560249
	Perennial	-27.010909	133.31215
DAMPOUNEENA WATERHOLE	Perennial	-29.06103	138.33127
ONE BOX WATERHOLE	Perennial	-29.3108	136.943389
WILKINDINNA SPRING	Perennial	-30.27433	139.05529
	Perennial	-29.52673	136.42097
NAPPAMILKIE WATERHOLE	Perennial	-26.17548	140.63987

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
RUM HOLE	Perennial	-28.375739	134.98815
CADLAREENA WATERHOLE	Perennial	-28.4921	136.462669
BOTTOM BOX WATERHOLE	Perennial	-29.04226	134.54606
	Perennial	-31.379639	136.95261
	Perennial	-26.72026	135.767279
	Perennial	-31.95554	138.83614
BULBUN SOAKAGE	Perennial	-26.533639	133.941519
BENNETT WATERHOLE	Perennial	-28.08986	134.57296
WANGEERARANGENA WATERHOLE	Perennial	-28.45365	136.73958
	Perennial	-29.16134	136.331539
RAIL WATERHOLE	Perennial	-26.850819	135.78957
	Perennial	-31.13753	136.89906
TOOKANINNA WATERHOLE	Perennial	-27.15751	135.28788
	Perennial	-31.29314	140.68567
	Perennial	-29.615709	136.317469
WILDAWILDANA SPRING	Perennial	-30.935779	138.863659
MARQUALPIE WATERHOLE	Perennial	-26.89997	140.816539
CHIMNEY SPRINGS	Perennial	-29.76898	139.55295
JUNCTION WATERHOLE	Perennial	-27.17177	134.577069
TINDOG WATERHOLE	Perennial	-27.46739	136.149869
MORILLA WATERHOLE	Perennial	-26.3234	135.53135
BITTER SPRING	Perennial	-30.681069	138.764339
	Perennial	-30.898999	138.8389
PARKE CAMP WATERHOLE	Perennial	-27.324309	134.453509
HORSESHOE SPRING	Perennial	-30.87768	138.59237
MOSQUITO WATERHOLE	Perennial	-27.21306	136.1067
ALIENA WATERHOLE	Perennial	-31.892579	138.769589
MIRRABUCKINNA WATERHOLE	Perennial	-30.03504	137.51327
	Perennial	-28.235569	134.81995

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
WEIRACADANA WATERHOLE	Perennial	-27.02247	135.789239
	Perennial	-27.923579	135.50178
ULIBAN SPRING	Perennial	-30.229599	139.04784
YARDAPARINNA WATERHOLE	Perennial	-27.20831	135.69873
	Perennial	-28.81064	134.36533
	Perennial	-26.62909	135.14493
PINDA SPRING	Perennial	-30.77124	138.872969
WALLATINNA WATERHOLE	Perennial	-27.463269	133.40887
LENNON WATERHOLE	Perennial	-27.580919	134.779599
KADIOWLA WATERHOLE	Perennial	-26.042149	135.809629
	Perennial	-26.4892	134.450379
HORSE CAMP WATERHOLE	Perennial	-29.06239	134.478549
MICKRAPYRA WATERHOLE	Perennial	-25.750869	138.731379
HOPE VALLEY WELL	Perennial	-31.005579	135.768089
	Perennial	-29.75688	139.52294
EIGHT MILE WATRHOLE	Perennial	-29.12584	134.818769
PERRY PONDS	Perennial	-25.978559	135.00248
PUROONA WATERHOLE	Perennial	-27.990489	136.408219
BURT CAMP WATERHOLE	Perennial	-29.688569	139.13843
WOPPALANCHA WATERHOLE	Perennial	-27.82235	138.86835
	Perennial	-26.979449	134.078659
	Perennial	-31.380719	136.96476
DINNER TIME WATERHOLE	Perennial	-27.927299	136.210669
POINT HOLES	Perennial	-30.97137	138.891389
UNDOOCOOLINA ROCKHOLES	Perennial	-26.337699	134.413619
	Perennial	-27.34954	135.665469
DISPUTED WATERHOLE	Perennial	-31.308579	136.78789
	Perennial	-26.44649	134.46206
	Perennial	-27.21877	134.07505

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
BALD HILL SPRING	Perennial	-30.988649	138.650749
MOONLIGHT WATERHOLE	Perennial	-28.30809	134.702039
TIRRITAPOORINA WATERHOLE	Perennial	-28.286349	134.80608
	Perennial	-30.016249	139.264249
YORKEYS WATERHOLE	Perennial	-32.449199	137.685859
FOUR MILE WATERHOLE	Perennial	-27.501639	133.996419
YACKIE WATERHOLE	Perennial	-30.418159	139.08213
WEETOOTLA SPRING	Perennial	-30.47348	139.246819
WADMATAGUNNIEUDINGA WATERHOLE	Perennial	-28.47711	136.720609
	Perennial	-26.346209	135.065649
	Perennial	-30.96443	138.64116
	Perennial	-29.76043	139.50793
EVYLIN WATERHOLE	Perennial	-28.83944	134.45108
PULPAREE WATERHOLE	Perennial	-26.859909	140.85037
SORDONA WATERHOLE	Perennial	-26.32908	135.27298
FOUNTAIN SPRING	Perennial	-31.1228	138.86647
BARNEY WATERHOLE	Perennial	-27.5757	134.60273
OUILARINNA SOAKAGE	Perennial	-27.09783	134.463399
NORTH CADELGA WATERHOLE	Perennial	-26.011719	140.56176
GAP WATERHOLE	Perennial	-27.26652	135.6471
WEEDNA SPRING	Perennial	-30.358059	138.807379
	Perennial	-29.806209	136.797189
YERELINA WATER	Perennial	-30.15634	139.21716
ROCKY WATERHOLE	Perennial	-30.88391	137.061919
JUMP UP SPRING	Perennial	-30.1714	139.20243
	Perennial	-31.69372	135.17725
DONGA WATERHOLE	Perennial	-27.17087	139.08922
	Perennial	-31.750819	138.797689
JINBRO WATERHOLE	Perennial	-26.07976	140.51802

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
WATHADERRADURKIE WATERHOLE	Perennial	-26.73194	140.122729
MURNPEOWIE WATERHOLE	Perennial	-29.61777	139.038989
TUB HOLE	Perennial	-28.54528	134.739109
	Perennial	-27.321369	135.66692
	Perennial	-29.580799	136.35129
	Perennial	-29.631619	136.2679
MOONGOOMURDIE WATERHOLE	Perennial	-26.252729	140.181439
	Perennial	-31.37902	136.9563
ERABENA WATERHOLE	Perennial	-27.18052	136.090719
	Perennial	-26.491059	134.39981
	Perennial	-31.285729	137.0498
INNINIGINNA WATERHOLE	Perennial	-26.342529	135.55371
CHARLIE POOLS	Perennial	-30.9392	136.95211
KORRAWILYA SPRING	Perennial	-30.1189	139.044669
	Perennial	-29.15933	136.33243
FOURTEEN MILE WATERHOLE	Perennial	-29.202409	134.808859
	Perennial	-32.24311	136.012109
FOUNTAIN SPRING	Perennial	-30.722709	138.56154
BOX HOLE WATERHOLE	Perennial	-28.697639	134.215679
TOP BOX WATERHOLE	Perennial	-29.028069	134.585869
	Perennial	-31.420459	137.501239
EULPA WATERHOLE	Perennial	-26.03048	140.9335
	Perennial	-26.983059	133.52073
	Perennial	-27.379659	135.683689
	Perennial	-28.222259	135.152509
	Perennial	-27.28227	135.55318
	Perennial	-31.7639	138.596779
HARRY HARRY WATERHOLE	Perennial	-32.607029	141.20224
FOURTH SPRING	Perennial	-31.02741	138.604299

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
SMUTS WATERHOLE	Perennial	-26.442489	140.215879
MAGPIE WATERHOLE	Perennial	-27.217339	134.03081
	Perennial	-27.32868	135.11784
	Perennial	-29.50773	136.430489
	Perennial	-27.59118	134.74553
	Perennial	-27.31059	135.493349
HILSON WELL	Perennial	-31.255529	137.404599
TEAL WATERHOLE	Perennial	-29.72167	135.14528
	Perennial	-28.68094	138.598769
NARRINA SPRING	Perennial	-30.89377	138.752659
AITKEN WELL	Perennial	-31.008599	137.47218
PERAWILLIA SPRINGS	Perennial	-31.668509	138.798029
KODAK HOLE	Perennial	-28.58919	134.63948
EUCOLO WATERHOLE	Perennial	-31.209979	136.63918
ALCOORANCARINNA WATERHOLE	Perennial	-26.402369	135.059289
MAGPIE WATER	Perennial	-30.8928	138.65334
	Perennial	-27.52499	135.08064
EMU HOLE	Perennial	-28.012049	134.655469
	Perennial	-27.057659	134.30297
CHERRIKANA WATERHOLE	Perennial	-26.66303	135.302429
MUD SPRING	Perennial	-30.71461	138.91974
	Perennial	-27.181249	136.09768
FIRE CAMP WATERHOLE	Perennial	-27.83878	134.70067
	Perennial	-32.48963	139.60431
	Perennial	-29.57518	139.41822
	Perennial	-29.661979	137.58198
JEREMIAH SPRING	Perennial	-30.45951	138.594949
	Perennial	-26.610689	140.22456
	Perennial	-27.19093	136.09322

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-32.659659	141.019369
KALKAMUNNA WATERHOLE	Perennial	-28.010279	136.00705
	Perennial	-27.22181	134.053739
POUND SPRING	Perennial	-30.634209	139.180879
AMBEROONA SPRING	Perennial	-30.22263	139.04114
BLANCHEWARRA WATERHOLE	Perennial	-28.017549	139.308609
	Perennial	-31.96352	141.16477
RYAN SOAK	Perennial	-27.025969	134.385839
OOLTIPAWOOLAMA WATERHOLE	Perennial	-26.384399	134.983159
ELBA WELL	Perennial	-26.55593	140.93789
KOORATHINNA WATERHOLE	Perennial	-27.954129	136.31069
TWELVE MILE WATERHOLE	Perennial	-29.17256	134.81989
	Perennial	-27.39948	135.64253
THE JOHN WATERHOLES	Perennial	-30.00748	139.534719
TOP WATERHOLE	Perennial	-29.063139	138.56277
DICKA DICKANA WATERHOLE	Perennial	-29.13021	138.14037
	Perennial	-30.17536	138.9975
MOUND YAROL SPRINGS	Perennial	-29.73829	139.94807
	Perennial	-26.64033	135.15014
	Perennial	-31.13878	136.89735
Buffalo Dam	Perennial	-31.763089	134.9351
Purdy Dam	Perennial	-31.895579	134.820009
MADARY WATERHOLE	Perennial	-27.000959	141.18355
TWO MILE WATERHOLE	Perennial	-26.01771	139.847709
GREENFIELD BLUFF DAM	Perennial	-31.398689	137.35192
MAGPIE WATERHOLE	Perennial	-28.86371	134.502509
MUCKAJIMPA WATERHOLE	Perennial	-26.154569	139.574129
STUBBS WATERHOLE	Perennial	-30.30406	139.40116
APPEALINNA SPRING	Perennial	-31.44648	138.62314

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
CROSSING WATERHOLE	Perennial	-27.19979	133.99463
CADELGA WATERHOLE	Perennial	-26.08824	140.410719
BETAWAPPAMUNNINNA WATERHOLE	Perennial	-28.440429	136.749379
UNKUMILKA WATERHOLE	Perennial	-28.67378	138.299369
COORAMBALAPINNA WATERHOLE	Perennial	-26.886529	140.538219
CALYARA ARAPAKA WATERHOLE	Perennial	-26.1447	135.5441
	Perennial	-27.360819	135.6824
BROKEN LEG WATERHOLE	Perennial	-27.154439	133.95461
	Perennial	-26.157139	135.53035
POOROKOOMURCHIE WATERHOLE	Perennial	-26.087899	140.51078
BULLS SPRING	Perennial	-30.205259	139.04176
	Perennial	-26.587839	135.07417
FRANCIS CAMP WATERHOLE	Perennial	-27.728389	134.54517
	Perennial	-26.49666	134.41455
CLARK WATERHOLE	Perennial	-29.345949	138.864979
MIDDLE BOX WATERHOLE	Perennial	-29.03652	134.56208
MARAKATINNA WATERHOLE	Perennial	-26.40006	135.004629
TODMORGEN WATERHOLE	Perennial	-27.362499	134.370059
NURKANURKANA WATERHOLE	Perennial	-27.10009	135.533619
	Perennial	-27.520279	135.083989
ROVER ROCKHOLE	Perennial	-30.45891	139.10886
TOORAPALANNA WATERHOLE	Perennial	-28.661509	138.45734
TOORAMURCHIE WATERHOLE	Perennial	-26.007169	140.513569
	Perennial	-27.049369	134.29741
SWIMMING WATERHOLE	Perennial	-28.83859	134.36669
WARRANCURRAYUNA WATER	Perennial	-30.186999	139.00236
TILLAWITINNA WATERHOLE	Perennial	-27.492479	138.2151
	Perennial	-27.191369	136.085649
TEE JUNCTION WATERHOLE	Perennial	-30.11186	139.434339

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-26.08718	140.451859
OONGUNDINNA WATERHOLE	Perennial	-27.55617	134.00234
	Perennial	-26.16886	135.147559
SWAMP WATERHOLE	Perennial	-27.980639	136.442109
	Perennial	-27.37671	135.16566
	Perennial	-31.043169	137.164709
NERRINGNERINGA WELL	Perennial	-26.027539	135.592709
WIMBRA WATERHOLE	Perennial	-29.717359	137.29919
ROCKY SPRING	Perennial	-30.22672	139.15812
FREW WELL	Perennial	-26.045579	140.09935
KULPAKUNA WATERHOLE	Perennial	-27.69651	136.87826
LIGNUM WATERHOLE	Perennial	-28.50459	134.76329
LITTLE CHRISTMAS WATERHOLE	Perennial	-27.614869	136.77179
MUNDY WATER	Perennial	-30.42367	138.50513
PACKSADDLE WATERHOLE	Perennial	-29.097109	134.24757
ROBERT WATERHOLE	Perennial	-28.855609	134.36682
	Perennial	-30.23131	139.30878
SPRING WELL	Perennial	-31.887069	138.816809
	Perennial	-27.584179	135.633879
LONGS CREEK WATERHOLE	Perennial	-29.13146	134.45792
	Perennial	-27.43478	135.59474
JACKS CAMP HOLE	Perennial	-27.62936	135.99362
MARSHES WATERHOLE	Perennial	-27.29305	135.4705
WALL HOLE	Perennial	-25.958649	134.78513
KOORTANYANINNA WATERHOLE	Perennial	-29.60491	139.21884
	Perennial	-31.380109	136.967399
	Perennial	-29.561629	137.525379
FINK SPRINGS	Perennial	-30.528729	138.732179
LITTLE TWO SPRINGS	Perennial	-30.57277	138.71884

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
OULCALKINNADINNA SPRING	Perennial	-30.56322	139.066389
ANACOWRA WATERHOLE	Perennial	-26.8017	135.45494
BOBBIEMOONGA WATERHOLE	Perennial	-26.59959	139.55419
COOLINA WATERHOLE	Perennial	-27.280939	136.52789
	Perennial	-31.37863	136.961479
	Perennial	-29.996129	139.679019
	Perennial	-29.46997	136.681019
	Perennial	-27.20296	135.992729
CHINCARDINA WATERHOLE	Perennial	-28.078949	136.72491
MIRRAMIRRINNA WATERHOLE	Perennial	-29.607539	139.02183
ALKOTHINGA WATERHOLE	Perennial	-26.144439	135.38207
	Perennial	-26.87163	133.736549
	Perennial	-28.501569	134.940589
PARENTIE WATERHOLE	Perennial	-27.968999	134.60655
POLLATURKARA WATERHOLE	Perennial	-26.702359	140.62813
COOLPITCHARINNA WATERHOLE	Perennial	-27.173289	134.211129
ERINA WATERS	Perennial	-31.06662	138.800209
	Perennial	-28.012839	136.765609
	Perennial	-27.28339	134.155289
	Perennial	-26.47846	134.394009
DEBNEY HOLE	Perennial	-30.020709	138.789049
TOM LAGOON	Perennial	-27.246809	134.82476
JIMMY WATERHOLE	Perennial	-28.161769	134.633829
	Perennial	-26.78352	135.415889
	Perennial	-26.29273	135.443089
BOOLKA SOAKAGE	Perennial	-30.154299	140.70306
	Perennial	-31.96791	134.830959
WEEDY SPRING	Perennial	-30.642009	139.10514
CLIFF WATERHOLE	Perennial	-27.84989	136.29485

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-30.9582	136.77141
	Perennial	-26.587029	135.07
MONGULINA WELL	Perennial	-25.761629	133.826769
TEDDY LOOKOUT WATERHOLE	Perennial	-28.274829	134.7092
	Perennial	-27.373	135.682629
	Perennial	-26.62034	135.128909
	Perennial	-26.484559	134.45163
OPOSSUM WATERHOLE	Perennial	-26.393839	135.302429
TWELVE MILE WATERHOLE	Perennial	-30.668519	141.14909
FRESHWATER SPRING	Perennial	-30.24549	139.014039
	Perennial	-25.900559	141.020639
	Perennial	-26.44472	135.368299
	Perennial	-32.227589	136.00597
	Perennial	-27.36872	135.541149
	Perennial	-28.867589	134.99325
ST MARY POOL	Perennial	-29.578039	139.41648
	Perennial	-29.385869	139.034999
TINKARNOORAKOO WATERHOLE	Perennial	-28.640709	138.51362
ROCKY GORGE WATERHOLE	Perennial	-31.16536	136.986989
	Perennial	-30.731629	138.488509
UNDUPATALLINA WATERHOLE	Perennial	-27.200139	135.66679
YANKEE GUNYA WATERHOLE	Perennial	-29.417919	136.610209
GLEESON SPRING	Perennial	-30.38621	139.232069
	Perennial	-26.304789	135.4813
	Perennial	-27.584539	134.778939
CARRURANNA WATERHOLE	Perennial	-28.629589	138.316189
	Perennial	-26.78353	140.316169
	Perennial	-27.5493	134.23053
SALT CREEK SPRINGS	Perennial	-31.530309	139.167929

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-26.006559	140.450689
	Perennial	-25.89057	141.10369
	Perennial	-26.471939	134.39531
LOWER SALT WATER	Perennial	-30.731359	138.587099
JUNCTION WATERHOLE	Perennial	-27.624809	136.0822
	Perennial	-26.97566	134.08404
PIDLEEOMINA WATERHOLE	Perennial	-30.0281	137.38323
	Perennial	-29.503919	136.43689
	Perennial	-31.789509	135.681049
BRINDLE CAMP WATERHOLE	Perennial	-26.922239	135.48422
	Perennial	-29.84596	134.90947
	Perennial	-29.521309	136.40876
JUNCTION WATERHOLE	Perennial	-29.089559	134.466919
THE WATERFALL	Perennial	-30.86513	138.62048
	Perennial	-26.302289	135.49597
	Perennial	-31.58697	134.64096
KARDECOODNANA WATERHOLE	Perennial	-27.977109	136.365099
WATCHIEBILLNA WATERHOLE	Perennial	-26.773769	140.37727
TRUNTHA WATERHOLE	Perennial	-26.080159	140.47137
CANTEEN WATERHOLE	Perennial	-27.951449	136.19719
	Perennial	-31.424949	140.65847
MIDDLE WATERHOLE	Perennial	-27.634399	136.084769
AGUNTA WATERHOLE	Perennial	-26.303489	134.777599
	Perennial	-27.365439	135.711289
GILLAN GILLAN WATERHOLE	Perennial	-27.19514	139.02865
KULLUKULLANA WATERHOLES	Perennial	-27.94227	136.76382
MIDWERTA SPRING	Perennial	-30.88158	138.844929
	Perennial	-26.154819	135.1048
BARLOW WATERHOLES	Perennial	-28.01044	136.7688

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
ABMINGA WATERHOLE	Perennial	-26.13416	134.84606
LIAR WATERHOLE	Perennial	-27.9082	134.191519
TRIG WATERHOLE	Perennial	-28.44672	136.39455
MUDLA MIRACKA WATERHOLE	Perennial	-27.666199	136.80926
	Perennial	-29.63497	139.5637
	Perennial	-27.416189	135.617869
	Perennial	-28.61451	138.689939
WIRRIARRINA WATERHOLE	Perennial	-27.967509	136.085839
WILLOWS WATERHOLE	Perennial	-29.596999	136.470129
TOOPAWARRINA WATERHOLE	Perennial	-27.160099	135.903729
MOOLABULLANA WATERHOLE	Perennial	-27.947249	136.45116
	Perennial	-29.56495	136.37845
	Perennial	-25.769609	139.72772
	Perennial	-30.666159	138.369409
	Perennial	-27.353369	135.550379
	Perennial	-27.32791	135.55667
	Perennial	-26.46517	134.4534
	Perennial	-27.227629	136.107189
PUTTWADINA WATERHOLE	Perennial	-27.62619	136.51651
ELATINA WATER	Perennial	-31.36131	138.621379
YERELINA SPRING	Perennial	-30.11766	139.09564
YANINGURIE WATERHOLE	Perennial	-28.962339	140.10911
ARKAROOLA SPRINGS	Perennial	-30.31833	139.4475
GILES WATERHOLE	Perennial	-31.54582	137.306959
TRIAL HOLE	Perennial	-26.764579	135.496019
	Perennial	-26.158189	135.11152
	Perennial	-27.562289	134.238719
KANGAOOLA WATERHOLE	Perennial	-28.630609	138.48262
PARALANA HOT SPRINGS	Perennial	-30.17477	139.44196

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-29.75955	140.24605
	Perennial	-29.813239	136.71783
	Perennial	-29.99036	139.67346
	Perennial	-27.488379	134.42958
	Perennial	-29.81559	136.74089
	Perennial	-29.269859	135.49743
	Perennial	-31.40194	136.99431
	Perennial	-26.155379	135.09187
MAINWATER SPRING	Perennial	-30.354259	139.21296
SYDNEY SPRING	Perennial	-30.69849	138.78654
KENNEBERY WATERHOLE	Perennial	-29.63388	137.78757
	Perennial	-29.940469	139.23445
SEBASTAPOL SPRING	Perennial	-30.848099	138.70293
	Perennial	-27.16869	136.282919
	Perennial	-28.26251	135.98582
	Perennial	-29.553369	137.428589
	Perennial	-29.784029	136.44363
CHETONGA SOAKAGE	Perennial	-26.027939	133.57714
LAMMYS WATERHOLE	Perennial	-31.216259	137.41542
MINNITINNI SPRING	Perennial	-31.37769	138.865659
	Perennial	-29.723139	137.301629
	Perennial	-31.37909	140.66161
FAULKNESS WATERHOLE	Perennial	-29.81282	135.32076
	Perennial	-29.759879	139.53686
CAMEL YARD SPRING	Perennial	-30.645359	139.08873
KOODNANIE WATERHOLE	Perennial	-27.472219	138.84557
NANTOWARPUNNA WATERHOLE	Perennial	-29.543679	138.321169
MURDARINNA WATERHOLE	Perennial	-27.30304	135.047989
	Perennial	-27.09957	134.347949

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-32.407	139.530409
GUM WATERHOLE	Perennial	-26.83186	135.769579
	Perennial	-26.45456	135.421429
TOOPARCOOLONA WATERHOLE	Perennial	-28.2447	134.989629
SOUTH GAP WELL	Perennial	-31.60304	137.531469
	Perennial	-27.27239	135.8631
MIRRA WATERHOLE	Perennial	-26.22056	140.174469
	Perennial	-31.12613	137.052199
PETERMORRA SOAK	Perennial	-29.51355	139.602469
	Perennial	-26.2657	135.085639
UPPER TWO SPRINGS	Perennial	-30.585629	138.729759
MUSSEL WATERHOLE	Perennial	-28.460699	136.381269
	Perennial	-32.431	136.248679
	Perennial	-29.573739	139.42119
	Perennial	-28.50753	134.920889
	Perennial	-27.680089	136.85194
MONTOCOLLARA WATERHOLE	Perennial	-26.39891	140.202619
GARDINER WATERHOLE	Perennial	-27.786719	138.18708
TYWANDRA WATERHOLE	Perennial	-26.555219	140.16846
WURLEY HOLE	Perennial	-27.682649	134.84187
CLAY WATERHOLE	Perennial	-28.288629	134.551279
	Perennial	-31.35479	138.7032
WATKINS WELL	Perennial	-31.20031	139.1049
MORIANNA SPRING	Perennial	-30.416859	138.89327
	Perennial	-28.210399	135.088279
WINDOWIDNA SPRINGS	Perennial	-30.11162	139.1911
	Perennial	-31.40496	136.996019
WADLAWILWEN WATERHOLE	Perennial	-28.265839	135.248899
	Perennial	-29.985839	139.727839

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
CHARLIE POOLS	Perennial	-30.9411	136.951189
	Perennial	-26.29678	135.465089
SALT WATER SPRINGS	Perennial	-30.513289	138.618579
ALBAMGUNDEEDNA WATERHOLE	Perennial	-26.84917	135.476379
OOLGAWA WATERHOLE	Perennial	-26.78244	135.895429
	Perennial	-29.632699	139.56707
	Perennial	-26.459069	139.33715
	Perennial	-26.18869	135.512699
TOP WATERHOLE	Perennial	-29.070419	134.78201
	Perennial	-31.286529	139.36738
ULOONANERA WATERHOLE	Perennial	-26.078269	140.417829
	Perennial	-26.147199	135.55246
BRINDANA SPRING	Perennial	-29.964039	139.61776
	Perennial	-27.3976	135.53999
MUNDAWERTINA WATERHOLE	Perennial	-29.952329	139.44037
	Perennial	-26.688489	135.73256
LAMBINA SOAKAGE	Perennial	-26.96752	134.295299
DERRARA WATERHOLE	Perennial	-26.144529	140.183049
	Perennial	-29.4993	136.05797
PINGLA SOAKAGE	Perennial	-27.73478	137.053119
NICHOLLS SPRINGS	Perennial	-30.2075	139.41593
	Perennial	-26.68451	135.722769
BRUCE WATERHOLE	Perennial	-29.288389	136.742369
	Perennial	-27.138049	134.449489
	Perennial	-26.30426	135.46752
WELCOME WATERHOLE	Perennial	-27.591159	134.944849
APPREETINNA WATERHOLES	Perennial	-27.823809	134.118569
THE MATT WATERS	Perennial	-31.958169	138.830049
MUCKERINNA WATERHOLE	Perennial	-26.05235	135.49549

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
ALGEBULLCULLIA WATERHOLE	Perennial	-28.49031	134.95274
	Perennial	-29.520289	136.425359
TARRAWEELIEBULLINA WATERHOLE	Perennial	-27.633399	136.55854
KIERA WATERHOLE	Perennial	-27.347809	134.312199
	Perennial	-26.38206	135.653679
DUM DUM WATERHOLE	Perennial	-27.13106	134.391589
MINDILINNA WATERHOLE	Perennial	-29.727419	136.297869
	Perennial	-30.168609	139.331089
	Perennial	-26.21014	141.087499
	Perennial	-27.535479	135.22261
YEDLACHANNA SPRING	Perennial	-30.544929	139.028129
TOWALUNGINNA WATERHOLE	Perennial	-27.05149	133.7844
	Perennial	-25.8953	141.023009
INNOINNA SOAKAGE	Perennial	-26.002559	133.58191
PANTAPINNA WELL	Perennial	-31.336809	138.79368
BULL HOLE WATERHOLE	Perennial	-26.643489	140.469219
MICKS WATERHOLE	Perennial	-27.161189	139.28084
THE BLOWER WATERHOLE	Perennial	-29.80566	136.854039
	Perennial	-32.4934	139.636689
	Perennial	-30.95493	138.505929
INDINNATHURRA (NINETY NINE) WATERHOLE	Perennial	-27.171029	134.26935
JUNCTION WATERHOLE	Perennial	-29.007419	134.247679
DOOLCOOMARELVIE WATERHOLE	Perennial	-27.479839	138.91243
	Perennial	-30.8639	138.49199
DUCK PONDS	Perennial	-29.85917	139.29554
ATAMUTANA WATERHOLE	Perennial	-26.390889	135.135799
QUONGDONG WATERHOLE	Perennial	-28.87581	134.359989
	Perennial	-29.53335	136.41775
KARRAWARANINNA WATERHOLE	Perennial	-28.912709	138.63605

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-26.697939	135.74298
	Perennial	-29.54708	136.415329
GOLDEN LINK DAM	Perennial	-31.639869	137.513229
EMU SPRINGS WATERHOLE	Perennial	-30.94715	136.756809
STUART WATERHOLE	Perennial	-30.57698	138.83445
BALLUNANE WATERHOLE	Perennial	-28.53088	136.670649
GOVERNMENT HOLE	Perennial	-28.840069	134.27445
THE SEVEN WATERHOLES	Perennial	-26.98143	134.07608
PETER WATERHOLE	Perennial	-27.0508	139.037239
	Perennial	-30.959209	136.773849
DAMPOONA WATERHOLE	Perennial	-26.946189	140.29136
	Perennial	-27.1672	136.35509
	Perennial	-26.97448	134.08773
PIERADUTTA WATERHOLE	Perennial	-27.758529	136.910949
MARIANNA WATERHOLE	Perennial	-26.744109	140.86717
	Perennial	-26.98898	134.072489
REEDY CREEK SPRING	Perennial	-31.470129	138.77512
BOWDEN WATERHOLE	Perennial	-26.078769	135.71707
ITALOWIE SPRING	Perennial	-30.564119	139.16282
MINNNE POND	Perennial	-27.824239	134.669279
WONGYARRA WATERHOLE	Perennial	-26.41747	140.39804
ARTILLINA WATERHOLE	Perennial	-27.164539	135.92166
	Perennial	-25.858439	134.53909
TWINS WATERHOLE	Perennial	-28.860869	134.42625
SMITHY HOLE	Perennial	-28.84932	134.15077
	Perennial	-31.87719	138.09988
	Perennial	-26.480169	134.453039
	Perennial	-27.468639	136.356989
	Perennial	-26.68898	135.72692

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
TOOLIMBIE WATERHOLE	Perennial	-26.522079	140.936489
	Perennial	-27.329519	134.45266
	Perennial	-27.697969	135.861779
EDIDINA WATERHOLE	Perennial	-27.433189	135.7826
BURT WATERHOLE	Perennial	-30.004639	138.296209
	Perennial	-26.292059	135.55718
	Perennial	-31.26094	137.338439
	Perennial	-29.58185	136.34631
BULLETIN WATERHOLE	Perennial	-27.59308	134.76135
WOOLDOONOOLDOONA WATERHOLE	Perennial	-30.27373	139.287459
MUNDOO OOPINNA WATERHOLE	Perennial	-30.28291	139.370889
YONGOONA WATER	Perennial	-31.330269	138.65562
MARSH WATERHOLE	Perennial	-27.58252	134.24676
	Perennial	-27.74718	134.432139
ANCHOR WATERHOLE	Perennial	-27.935369	136.729569
NECKEENA WATERHOLE	Perennial	-27.49096	136.43979
	Perennial	-27.208099	136.105949
GATE WATERHOLE	Perennial	-28.20322	135.4764
ELBOW WATERHOLE	Perennial	-29.60901	136.328969
	Perennial	-29.62594	136.318929
	Perennial	-29.949139	139.653569
MISSIONARY WATERHOLE	Perennial	-28.829449	134.45496
	Perennial	-27.267589	136.016609
GUM WATERHOLE	Perennial	-31.456309	137.499969
UNDOOLDINA WATERHOLE	Perennial	-27.073309	135.512809
	Perennial	-29.50737	136.44359
OOTCHUCUTIDINNA WATERHOLE	Perennial	-26.520859	140.90264
TIDNAMURKUNA WATERHOLE	Perennial	-28.038819	135.815709
COTTONBUSH WATERHOLE	Perennial	-28.948969	134.50834

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
WALGIDYA WATERHOLE	Perennial	-27.28303	135.1206
	Perennial	-27.481519	136.30644
ADMUDREEDMANA WATERHOLE	Perennial	-26.584269	135.304429
	Perennial	-26.54532	140.214179
	Perennial	-29.3797	139.04955
	Perennial	-32.19661	136.05153
MORALLIE WATERHOLE	Perennial	-27.019259	134.05348
YELLOW BULLOCK WATERHOLE	Perennial	-28.783849	134.45526
	Perennial	-30.856919	136.92813
WUNTUNTOOPININNA WATERHOLE	Perennial	-27.942069	136.297459
SANDHILL WATERHOLE	Perennial	-28.391319	136.409419
TUNKALANA WATERHOLE	Perennial	-27.579089	136.39643
BOLLA BOLLANA SPRING	Perennial	-30.287459	139.28148
	Perennial	-27.23236	134.7119
WIRRINGINA WATERHOLE	Perennial	-29.79672	138.43462
NEPOUIE SPRING	Perennial	-30.469839	139.357349
	Perennial	-26.289389	135.555879
	Perennial	-25.90967	135.13618
	Perennial	-29.56788	137.42886
	Perennial	-27.020219	135.579019
TRIG WATERHOLE	Perennial	-30.454279	137.259189
WEEINEA WATER	Perennial	-30.13943	139.21272
	Perennial	-27.266389	135.8549
FINGER POST WATERHOLE	Perennial	-29.04924	134.52409
	Perennial	-29.19992	136.3134
	Perennial	-30.55928	138.419989
	Perennial	-26.908649	135.47878
BORA SPRING	Perennial	-30.90515	138.881819
	Perennial	-27.466279	137.52699

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-26.463949	141.075459
BLACK SWAN WATERHOLE	Perennial	-29.488999	136.705809
MARABY WATER	Perennial	-31.81948	138.65002
CLIFF HOLE	Perennial	-28.55777	134.699119
	Perennial	-26.72875	140.623269
OOCOONDINNA SOAKAGES	Perennial	-26.92975	133.81361
CAPTAINS HOLE SPRING	Perennial	-30.97269	138.515169
	Perennial	-29.03309	134.571139
PULARINNA WATERHOLE	Perennial	-27.186439	134.19226
TROUDANINNA WATERHOLE	Perennial	-29.200739	138.96721
WOOLROONA SPRING	Perennial	-30.79086	138.873579
MIDDLE SANDY SPRING	Perennial	-30.760339	138.710119
ALERTANA WATERHOLE	Perennial	-26.398189	135.088729
WILLY HOLE	Perennial	-28.811679	134.13841
PIGEON SPRING AND WATERHOLE	Perennial	-29.87723	139.583249
	Perennial	-27.22108	134.03462
	Perennial	-29.388739	134.744959
TEDDY WATERHOLE	Perennial	-28.87585	134.40445
CONRAD WATERHOLE	Perennial	-28.37754	134.844369
	Perennial	-31.76862	138.712729
SANDHILL WATERHOLE	Perennial	-27.19143	135.640219
	Perennial	-27.1987	134.160269
TRIG WATERHOLE	Perennial	-30.904019	137.405629
THREE FORGES WATERHOLE	Perennial	-26.77224	135.492469
WEETOWIE WATERHOLE	Perennial	-30.840249	139.28926
TOP WATERHOLE	Perennial	-27.655259	136.070919
BOTTLE HILL DAM	Perennial	-31.28434	137.296929
SWALLOW WATERHOLE	Perennial	-27.40744	135.412009
	Perennial	-26.431339	135.448849

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
GUM HOLE	Perennial	-27.771339	134.08593
YELTACOWIE WATERHOLE	Perennial	-31.355489	137.430769
WILLIEYANNA WATERHOLE	Perennial	-26.16795	140.20579
	Perennial	-26.471599	140.194279
WIMBERTON WATER	Perennial	-31.802739	138.6886
OOLOOLARINA WATERHOLE	Perennial	-26.40893	135.03504
KEMP BORE	Perennial	-31.40885	139.33943
MARAKATINNA WATERHOLE	Perennial	-26.39448	134.995639
	Perennial	-31.40344	137.58947
	Perennial	-29.539669	136.24329
REEDY HOLE SPRINGS	Perennial	-30.253579	138.84189
BLUEY WATERHOLE	Perennial	-26.73028	140.334639
YEKAMUNGA WATERHOLE	Perennial	-26.387789	135.14408
	Perennial	-31.27553	137.00843
WUNTANOORINNA WATERHOLE	Perennial	-27.89971	136.614659
	Perennial	-29.609489	137.544179
WOODCUTTERS WATERHOLE	Perennial	-29.57842	136.377209
	Perennial	-27.015889	136.23475
TUNDADINNA WATERHOLE	Perennial	-27.982959	136.21478
	Perennial	-27.609729	134.94056
	Perennial	-30.289869	138.471249
OPPATHAKANA WATERHOLE	Perennial	-28.429899	136.776209
	Perennial	-27.556459	134.23558
	Perennial	-26.11213	134.93853
	Perennial	-26.97301	134.093019
MOUNT FITTON SPRING	Perennial	-29.969249	139.537059
BALTA BALTONA WATERHOLE	Perennial	-29.25684	135.49667
	Perennial	-31.132	136.9092
	Perennial	-28.03835	136.457479

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
TEA TREE SPRING	Perennial	-30.951869	138.451489
NULLA NERINGEE WATERHOLE	Perennial	-25.850499	138.730699
WORTURPA SPRING	Perennial	-30.42265	139.2462
	Perennial	-29.80094	136.661579
	Perennial	-29.46523	136.11966
OLD WOOLSHED BORE	Perennial	-31.91872	139.187249
	Perennial	-29.561229	136.411759
	Perennial	-30.064489	138.05509
	Perennial	-27.38394	135.680629
ANZAC DAM	Perennial	-31.25946	137.559599
MICKERIE WATERHOLE	Perennial	-26.189809	140.19459
UPALINNA WATER	Perennial	-31.49653	138.709349
PANNIKAN WATERHOLE	Perennial	-28.43516	134.50763
WAUKAWOODNA SPRINGS	Perennial	-30.779409	138.914329
LIGNUM WATERHOLE	Perennial	-27.6459	136.071679
	Perennial	-28.38502	134.653
MUNDARINNA WATERHOLE	Perennial	-27.285219	134.98048
WOOLSHED WATERHOLE	Perennial	-27.894239	136.240649
ANDAWARADAMA WATERHOLE	Perennial	-26.54106	135.2927
ROCKY WATERHOLE	Perennial	-29.554109	139.216909
	Perennial	-31.39355	140.8793
MODAWILPANNA WELLS	Perennial	-28.580519	138.816709
DUCK WATERHOLE	Perennial	-27.63964	136.07297
CENTIPEDE CREEK WATERHOLE	Perennial	-29.017349	134.60715
	Perennial	-25.872079	141.111399
HORSESHOE WATERHOLE	Perennial	-26.85093	140.81854
	Perennial	-29.659359	137.507139
YIJULKA WATERHOLE	Perennial	-28.07323	135.355519
RASPBERRY WATERHOLE	Perennial	-26.31074	135.10511

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
MUNYALLINA SPRINGS	Perennial	-30.445919	139.381129
ANGLE POLE WATERHOLE	Perennial	-27.49982	135.401429
PANDITOUPNA NO 2	Perennial	-31.762609	138.720849
EMMERONA WATER	Perennial	-30.212099	139.01934
TWENTY MILE WATERHOLE	Perennial	-29.15091	134.44986
NILPIE WATERHOLE	Perennial	-26.66935	140.94506
	Perennial	-29.71877	139.943419
	Perennial	-29.575989	136.381919
	Perennial	-25.90986	141.014689
WORNA-POORINA WATERHOLE	Perennial	-28.510879	134.78947
PAT WELL	Perennial	-31.772409	138.969009
BEDA WATERHOLE	Perennial	-31.866449	137.60877
	Perennial	-26.802619	140.712729
DEPOT SPRING	Perennial	-30.4491	138.73593
	Perennial	-26.44937	135.431209
PERNUNA SPRING	Perennial	-30.70911	138.91845
BLANCHEWATER WATERHOLE	Perennial	-29.56873	139.43369
	Perennial	-27.299039	135.49262
	Perennial	-30.68841	137.27
	Perennial	-27.17473	135.88703
GAP WATERHOLE	Perennial	-27.015459	135.77475
	Perennial	-27.204819	134.133899
PEECHERRIBIRRINA WATERHOLE	Perennial	-28.22961	136.047439
	Perennial	-30.304089	138.135229
STACEY BANK	Perennial	-28.204839	135.07625
NARRATELLA WATERHOLE	Perennial	-26.298319	140.911529
	Perennial	-32.411849	139.92156
WOOLATCHI SOAK	Perennial	-29.835419	140.1198
PUTHERA WATERHOLE	Perennial	-26.349869	140.836459

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-27.44076	135.588749
	Perennial	-26.199279	135.50693
	Perennial	-26.333069	135.27126
THE FISH PONDS	Perennial	-29.74639	139.26452
EURICHELA PERMANENT SPRINGS	Perennial	-31.92464	138.92407
	Perennial	-31.330099	138.647839
	Perennial	-26.724039	135.77107
PUBLIC HOUSE SPRINGS	Perennial	-29.760359	139.51474
	Perennial	-27.28269	135.86396
SAWPITS WATERHOLE	Perennial	-26.483579	140.72048
	Perennial	-29.62628	139.571419
WEANER WATERHOLE	Perennial	-27.61735	136.48613
MORALANA SPRING	Perennial	-31.59673	138.481849
	Perennial	-29.76829	136.871329
MURLOOCOPPIE ROCKHOLE	Perennial	-28.509799	134.19685
	Perennial	-27.400459	135.53978
WARRACUNNA WATERHOLE	Perennial	-27.47894	138.250699
	Perennial	-29.4618	136.4926
STOCKYARD SPRING	Perennial	-30.711109	138.926579
	Perennial	-29.93392	139.65686
	Perennial	-27.171809	133.342179
THE JOHN WATERHOLES	Perennial	-30.62744	139.198299
	Perennial	-29.511679	136.439429
	Perennial	-29.88232	139.55851
MORO SPRING	Perennial	-30.685119	139.216869
ALLEUMBA WATERHOLE	Perennial	-27.131589	134.43605
TOONDOOLOO WATERHOLE	Perennial	-26.056519	139.866449
	Perennial	-26.595929	135.08705
	Perennial	-27.842789	135.19083

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
	Perennial	-26.303089	135.57034
	Perennial	-31.345789	137.64704
KACHUMBA WATERHOLE	Perennial	-26.1519	140.85406
MASON WATERHOLE	Perennial	-31.3727	136.953919
JONES SPRING	Perennial	-30.051879	139.18087
	Perennial	-26.426219	135.363289
	Perennial	-27.43444	135.32987
DOONGOONARRA WATERHOLE	Perennial	-26.2793	140.47406
	Perennial	-26.97774	134.081349
INDENEBRINNA WATERHOLE	Perennial	-27.127869	135.41023
ARINA WATERHOLE	Perennial	-26.04304	135.65643
LAKE MOOLCARPE	Perennial	-28.6323	138.475619
SANDY CAMP SPRINGS	Perennial	-30.745969	138.740729
	Perennial	-30.322629	139.437889
NANTIBURRY SPRING	Perennial	-30.808699	138.65858
BOSWORTH WELLS	Perennial	-31.116319	137.33848
	Perennial	-28.517969	134.834119
MIRRANIE WATERHOLE	Perennial	-26.50533	140.16952
COOKERWILPINNA WATERHOLE	Perennial	-27.655729	138.272929
	Perennial	-27.58972	134.744449
WYALTA WATERHOLE	Perennial	-28.656969	138.40882
WOORONG WATERHOLE	Perennial	-28.95297	134.209609
SAMBOT WATERHOLE	Perennial	-30.442199	139.040209
ONE TREE WATERHOLE	Perennial	-29.62114	138.450379
JUNCTION WATERHOLE	Perennial	-31.443869	137.36352
	Perennial	-29.468799	137.50879
NEW KOPPERAMANNA BORE	Perennial	-28.64054	138.68764
WALPUCUNNIA WATERHOLE	Perennial	-28.534579	136.71262
MUDCARNIE WATERHOLE	Perennial	-26.856489	140.532669

Table 14: Waterhole Locations (continued)

Name	Type	Latitude	Longitude
CHARLIE POOLS	Perennial	-30.93763	136.95236
ELINGBARRINA WATERHOLE	Perennial	-26.072709	135.18478
POWICHINA WATERHOLE	Perennial	-28.000259	139.30648
TERRIETCHA WATERHOLE	Perennial	-26.2896	140.94438
	Perennial	-27.9214	135.49833
	Perennial	-26.4595	135.55034

APPENDIX B: SUMMARY OF DWLBC REPORT "SURFACE WATER MONITORING IN THE ARID NORTH OF SOUTH AUSTRALIA" (DEANE UNPUB.)

The review of surface water data needs is based on the unpublished draft report "Surface Water Monitoring in the Arid North of South Australia" prepared and provided by the SA Dept of Land Water and Biodiversity Conservation (DWLBC) (Deane, Unpub.). This report:

- Describes the range of normal objectives for surface water data collection and methods for maximising the information that can be obtained from the collection networks;
- Describes the general nature and occurrence of surface water within the different sub-regions of the NRM Board's area of responsibility;
- Reviews previous recommendations for surface water data collection and describes the actual data collected. The large discrepancy between the past recommendations and the actual data collected is noted;
- Reviews means by which the discrepancy might be reduced by employing different technologies and operations;
- Provides a listing, with costs, for a 'recommended' and an 'ideal' network of sites for surface water quantity and quality data collection. The report is not clear on which of these is preferred.

The report identifies the legislative responsibilities of the (then) Catchment Water Management Boards under the (then) Water Resources Act 1997 to produce a Catchment Water Management Plan and to carry out functions in resource assessment to facilitate the Plan. These responsibilities have now been transferred, inter alia, to the NRM Boards, which under the Natural Resources Management Act 2004 are required to prepare and maintain a Regional NRM Plan which must include similar information on:

- The water resources within the region;
- The state and condition of the water resources and related trends; and
- Environmental, social, economic and practical considerations relating to the use, management, conservation, protection, improvement and, if relevant, rehabilitation, of the water resources within the region.

The report is an excellent reference source and the recommendations are reported to have only been made after extensive discussions with stakeholders. The costs at 2004 prices were $A1 million for initial establishment of the network and $75,000 for ongoing operation and maintenance. Priorities and recommendations from this report are summarised in the table presented on page 43

Further Recommendations (Deane, Unpublished)

The recommended hydrological monitoring strategy is to instrument selected refugia waterholes, which will be the focus of ecological monitoring (particularly of the fish assemblage), with water level loggers.

As a first step, the robust and targeted refugia monitoring strategy requires an inventory of refugia waterholes across the LEB, particularly in catchments with little published data on water body morphologies (e.g., Georgina River, Finke River, other NT catchments).

Updating and analysis of ARIDFLO water level logger data 37
High priority candidate waterholes for monitoring are summarized in Sections 5.1.1 to 5.1.5.

It is recommended that the LEB monitoring program take advantage of the planned Santos flood monitoring network on Cooper Creek by identifying refugia monitoring site near the Santos sites (e.g. Tabbareah Waterhole near Durham Downs) and by the establishment of a water level logger on the Northwest Branch, with Santos providing the servicing and maintenance of the site. The latter recommendation would probably require forming a partnership with Santos and jointly seeking funding assistance for the installation costs.

The monitoring of ungauged catchments approach has a lower priority than the refugia monitoring approach and is not recommended. However, consideration should be given to encouraging partner organizations (e.g. mining or pastoral companies, research projects) to contribute to a monitoring program in ungauged catchments where the organizations operate.

The monitoring of high value wetlands has a lower priority than the refugia monitoring approach and is not recommended. This approach would be justified by specific threats to a group of wetlands from a particular development. However, the onus for the installation and maintenance costs of any monitoring could be placed on the developing organization.

It is recommended that the discharge data from high quality gauging stations with long records in the areas with significant changes in land-use and catchment storage be analysed on an on-going basis for any evidence of statistically significant flow regime change.

The ARIDFLO network requires a data collection trip by approximately September-October 2009. Unless partner organizations (e.g. research projects) volunteer to continue the maintenance and downloading of the network, the network should be disbanded and replaced by new instrumentation installed in high priority refugia waterhole sites.