# TECHNICAL REPORT

## NON-PRESCRIBED GROUNDWATER RESOURCES ASSESSMENT – EYRE PENINSULA NATURAL RESOURCES MANAGEMENT REGION

## PHASE 1 – LITERATURE AND DATA REVIEW

## 2011/16



Government of South Australia
Department for Water

# NON-PRESCRIBED GROUNDWATER RESOURCES ASSESSMENT — EYRE PENINSULA NATURAL RESOURCES MANAGEMENT REGION

# PHASE 1 – LITERATURE AND DATA REVIEW

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# FOREWORD

South Australia’s Department for Water leads the management of our most valuable resource—water.

Water is fundamental to our health, our way of life and our environment. It underpins growth in population and our economy—and these are critical to South Australia’s future prosperity.

High quality science and monitoring of our State’s natural water resources is central to the work that we do. This will ensure we have a better understanding of our surface and groundwater resources so that there is sustainable allocation of water between communities, industry and the environment.

Department for Water scientific and technical staff continue to expand their knowledge of our water resources through undertaking investigations, technical reviews and resource modelling.

**Scott Ashby**
**CHIEF EXECUTIVE**
**DEPARTMENT FOR WATER**

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# 1. INTRODUCTION

In its *Water for Good* plan, the Government of South Australia (2009) states that resource assessment, monitoring and management of non-prescribed groundwater resources are crucial and necessary elements which will assist in achieving sustainable use of the resource. The Department for Water has lead agency responsibility for ensuring the sustainable management of groundwater resources of the state of South Australia (the State) and has developed the *Groundwater Program* to fulfil responsibilities under the *Natural Resources Management Act 2004* and in response to water security issues facing the State. This report presents findings of the sub-program *Non-prescribed groundwater resource assessments – Eyre Peninsula Natural Resources Management Region*.

In an environment where water resources are increasingly scarce, a better understanding of both potable and non-potable water resources capacity and a more proactive approach to management is required. The Government of South Australian (2009) in its *Water for Good* plan, identified that the State's non-prescribed water resources require monitoring and management to enhance sustainable development opportunities and avoid them being over exploited. *Water for Good* supports this through an action to expand monitoring networks and increase the regularity of assessments and reporting.

There is only limited understanding of groundwater resources in most non-prescribed regions across the State. Current knowledge gaps regarding the occurrence, storage and quality of groundwater resources present significant barriers to the management and future development of many groundwater systems. Addressing these gaps is especially important due to anticipated increases in demand for water, changes in land use and potential impacts associated with a changing climate.

The pressure to access new water resources will also increase. The impacts of land use change such as mining and energy operations may go undetected unless suitable monitoring and assessment is in place (Government of South Australia 2009). New pressures are likely to be realised for non-potable resources that traditionally have not been utilised or managed. Baseline information is important to allow appropriate planning to avoid unsustainable extraction and detrimental resource decline.

Through the Department for Water's *Groundwater Program*, an opportunity exists to deliver an improved understanding of the State's groundwater resources and to better understand the potential for further groundwater development. Benefits to stakeholders include a better understanding of the potential for groundwater to support South Australia's social and economic development and the identification of resources that require a strong focus on detailed scientific investigation and effective monitoring.

## 1.1. OBJECTIVES

The objective of this project is to improve the understanding of non-prescribed groundwater resources in the Eyre Peninsula Natural Resources Management (EPNRM) Region. Water resources are important for sustaining agriculture, industry, mining and rural townships, but non-prescribed regions have traditionally been poorly understood due to limited monitoring and investigation programs. A better understanding of the potential for groundwater development will benefit a broad range of stakeholders and assist to identify regions that require further investigation and effective monitoring.

The aim of this report is to integrate and describe the existing data and knowledge about the non-prescribed groundwater resources of EPNRM Region. This assessment aims to compile geological and hydrogeological data giving particular attention to the identification of major hydrogeological units and related groundwater information. Based on the available information, discussions on groundwater salinity, level and yield are supported by a selection of map products. The report identifies further steps required to identify priority areas for further assessment and to address the knowledge gaps that may exist.

# 2. EYRE PENINSULA

The study area is defined by the Eyre Peninsula Natural Resources Management (EPNRM) Region (Fig. 1). The EPNRM Region is approximately 81 000 km$^2$, roughly triangular in shape and bounded to the east and west by the Spencer Gulf and the Great Southern Ocean, respectively. The Gawler Ranges and the Great Victoria Desert (north of Ceduna and Fowlers Bay) delineate the EPNRM Region's northern extent.

The EPNRM Region encompasses 13 major towns and numerous smaller communities in 11 district councils. Local government areas that span the study area include the City of Port Lincoln and District Councils of Ceduna, Cleve, Elliston, Franklin Harbour, Kimba, Le Hunte, Lower Eyre Peninsula, Streaky Bay and Tumby Bay.

## 2.1. CLIMATE

The EPNRM Region experiences a temperate climate with hot, dry summers and cool, wet winters. The coastal areas experience a milder and wetter climate, while inland conditions are hot and dry (Flint & Rankin 1991). Average summer temperatures range between 14°C and 31°C; average winter temperatures vary between 5°C and 18°C (Table 1). Rainfall is variable, falling mainly during May through September. Local storms during summer often make considerable contributions to total annual rainfall (Parker & Fanning 1998). The Eyre Mallee sub-region, centrally located on the peninsula, is more arid than the coastal and southerly regions. Mean annual rainfall (Fig. 2) varies from less than 300 mm/y in the north-west to around 600 mm/y in the south. Rainfall is greatest along the south-west coast and decreases steadily in quantity and frequency with increasing distance from the coast (Rankin & Flint 1991). Mean annual Class A evaporation rates ranges between 1800 mm/y in the south to 2200 mm/y in the north of the region.

**Table 1. Climatic averages for a selection of Eyre Peninsula localities (Bureau of Meteorology, 2010)**

| Locality | Annual Mean Max Temp. °C | Annual Mean Min Temp. °C | Summer Mean Max Temp. °C | Summer Mean Min Temp. °C | Winter Mean Max Temp. °C | Winter Mean Min Temp. °C | Temp Period of Record | Annual Mean Rainfall | Rainfall Period of Record |
|---|---|---|---|---|---|---|---|---|---|
| **Whyalla** | 23.3 | 13 | 28.5 | 18.0 | 17.7 | 7.8 | 1955 - 2001 | 278 mm | 1906 - 2001 |
| **Pt Lincoln** | 20.7 | 11.6 | 24.9 | 14.8 | 16.3 | 8.5 | 1892 - 2002 | 491 mm | 1866 - 2002 |
| **Streaky Bay** | 23 | 12.2 | 28.5 | 15.7 | 17.1 | 8.7 | 1926 - 2010 | 379 mm | 1865 - 2010 |
| **Kimba** | 23.5 | 10.3 | 30.6 | 15.2 | 16.2 | 5.5 | 1967 - 2010 | 346 mm | 1920 - 2010 |
| **Folwers Bay** | 21.5 | 12.3 | 24.4 | 16.6 | 17.7 | 7.5 | 1927 - 1967 | 300 mm | 1878 - 2010 |

## 2.2. TOPOGRAPHY

The topography of southern EP is dominated by the Lincoln Uplands along the east coast and the Marble Range along the west coast (Schwarz 2003). A broad alluvial plain separates the two with a coastal plain separating the uplands from the eastern coastline; the coastal areas are dominated by undulating dunes with an average height of around 7 m (Schwarz 2003).

Central EP is dominated by sand dune-covered plains with several areas of hilly uplands and granite plains (Flint & Rankin 1991). On the central west coast, the landscape comprises extensive plains, undulating rises and broad hilly areas up to 160 m AHD (Flint 1992). Most granite exposures are subdued, forming only small outcrops (Flint 1992).

North-eastern EP has a gently undulating topography, with the exception of areas of higher elevation west and north-west of Cowell (Parker & Fanning 1998). A wide coastal plain extends from Whyalla to Cowell, rising gently inland by as much as 50 m (Parker & Fanning 1998).

The north-west coast comprises narrow sandy beaches and coastal dunes with low cliffs incised into the Bridgewater Formation. Inland, calcrete sands show low relief and no surface drainage and grade towards the north-east into slightly elevated seif dunes (Rankin & Flint 1991). The majority of the far north-west region is less than 200 m AHD, with a rise inland from the coastal margin towards highly undulating aeolian dunes. Karst sinkholes are buried below younger dunes in most places but provide vertical connection with underlying groundwater systems when exposed at ground surface (Firman 1978).

## 2.3. SURFACE WATER

The EP region is one of the driest in Australia, where surface water resources are scarce due to low rainfall, high evaporation and relatively flat topography (Eyre Peninsula Catchment Water Management Board 2005). Only small amounts of mean annual rainfall occurs as runoff, to collect in rivers located towards the east and south of the EPNRM Region. Where present, stream flow (Fig. 2) is intermittent and often highly saline, originating from saline groundwater baseflow (Taylor 2003). High intensity rainfall events can temporarily improve water quality in local springs.

Streams draining the western flanks of the Lincoln Uplands and eastern flanks of the Marble Range combine into a large central drainage system following the Wanilla Palaeochannel, although highly permeable ground limits surface runoff (Schwarz 2003). The flat terrain of the central and western regions contributes little or no surface drainage; rainfall either evaporates or recharges aquifers due to highly porous surface material (Eyre Peninsula Catchment Water Management Board 2005).

In north-eastern EP, drainage from the Cleve Hills occurs either to the south, from short ephemeral creeks with steep gradients, or to the north into Salt Creek; after crossing the Charleston Fault, Salt Creek’s highly saline waters discharge to Tertiary aquifers (Parker & Fanning 1998). The semi-arid coastal plain south-west of Whyalla exhibits little or no drainage (Parker & Fanning 1998).

Southern EP drainage consists of small ephemeral streams, the majority of which are saline or brackish except after very heavy rain (Schwarz 2003). EP’s largest surface watercourse, the Tod River, discharges to Spencer Gulf just north of Port Lincoln and is the only surface water resource that produces a permanent, reliable flow (Eyre Peninsula Catchment Water Management Board 2005). The Tod Reservoir, located around 23 km upstream of the Tod River mouth, has a capacity of around 11 300 ML. The Tod Reservoir previously contributed to water supply but its original intent was for stock supplies only. Salinity of the reservoir has increased by around 13 mg/L per year since 1930 (Eyre Peninsula Catchment Water Management Board 2005) and as such, usage ceased in 2002, although it remains an important part of SA Water’s contingency planning as an emergency water source (SA Water 2008).

## 2.4. LAND USE

Across EP land is used for primary production, dense urban centres, commercial and industrial activities and significant areas of remnant native vegetation amongst a large number of land use classes. There are many wetlands across EP and the region also contains nearly 100 parks, from large national parks such as Coffin Bay National Park, to smaller conservation parks and reserves (Eyre Peninsula Natural Resources Management Board 2009). Many areas that are important for biodiversity conservation are also important for water resources management (Eyre Peninsula Catchment Water Management Board 2005).

In order to simplify the numerous land use categories that exist on EP, similar land uses have been grouped into a number of key land use types (Fig. 2, Tab. 2). Dryland agriculture represents the largest land use group (56%) and includes numerous subclasses related to production from dryland agriculture.

Making up a significant proportion of the landscape are residual native cover (18%) and nature conservation (20%), which incorporate a number subclasses including national parks, wilderness and habit or species protection/conservation areas. Remnant native vegetation includes regions often unsuitable for agriculture, such as deep sands or sheet limestone (Eyre Peninsula Catchment Water Management Board 2005).

Rates of development and land use change are highest in urban and semi-urban areas and areas associated with emerging mining developments and defence activities (Eyre Peninsula Natural Resources Management Board 2009). Services and utilities (<2%) incorporates numerous intensive use subclasses including defence, commercial, manufacturing, industrial, transport and other utilities.

Water bodies include reservoirs, lakes and marshes as well as estuaries and costal waters, which may be used for production or conservation. Irrigated agriculture includes irrigated crops as well as a number of intensive uses such as aquaculture and intensive animal production.

**Table 2. Categorised land use for the EPNRM Region**

| Land Use | Area ($km^2$) | % Total Area |
|---|---|---|
| Dryland Agriculture | 29 777 | 56.40 |
| Nature Conservation | 10 326 | 20.03 |
| Residual Native Cover | 9308 | 18.06 |
| Water Body | 870 | 1.69 |
| Grazing Natural Vegetation | 842 | 1.63 |
| Service & Utilities | 254 | 1.86 |
| Residential | 76 | 0.15 |
| Mining | 69 | 0.13 |
| Forestry | 18 | 0.04 |
| Irrigated Agriculture | 6 | 0.01 |

## *2.5. WATER RESOURCES*

Social and economic development is closely correlated to the availability of potable water. Limited supply of fresh water restricted early settlement across EP. Attempts to secure supplies under *The Water Conservation Act (1936)* were via a system of wells, tanks and small reservoirs (State Water Plan 2000). This system was insufficient to meet demand and as such, alternative sources were required. These included increasing groundwater usage, importing of River Murray water and the use of the Tod River Reservoir, which has now ceased.

Groundwater and River Murray water are the two key water resources with recycled water, dams and private rainwater tanks important minor sources. The majority of imported River Murray water is utilised by the city of Whyalla, leaving the rest of the region greatly dependant upon groundwater or.

Groundwater provides the vast majority of EP's reticulated water supply, servicing residential, industrial and stock demand for many of Eyre Peninsula's communities (Fig. 1).

Good quality groundwater supplies on Eyre Peninsula (EP) are considered to be a vulnerable resource and are not consistently available across the region, with some areas reliant on alternative water supply sources. An estimated 30% of the rural population relies solely on rainwater, private surface water collection and/or groundwater for their stock and domestic supplies.

Spatially, occurrences of fresh groundwater are highly variable and the location of good quality groundwater (sufficient for stock and domestic purposes) is generally controlled by local rainfall patterns, land cover and geology. The majority of potable groundwater resources occur in lenses along the western and southern coastal margins of EP (Fig. 1) and are typically defined by the 1000 mg/L isohaline.

The EPNRM Region comprises two groundwater resource areas which have been prescribed under the *Natural Resources Management Act, 2004:* The Musgrave and Southern Basins Prescribed Wells Areas (PWA), where most of the larger fresh groundwater lenses occur. Water extracted from lenses within the Southern Basins PWA supply the majority of water delivered through the extensive reticulation system.

Outside of the PWAs, other discrete groundwater resources of potable quality have been identified and supply small coastal townships such as Port Kenny and Fowlers Bay, which are located along EP's west coast. The recognised urban and regional water resources of potable significance are bounded by a Water Protection Area (WPA) (Fig. 1), which are initiated to afford the highest level of protection possible. By recommendation of the appropriate authority, any part of the State may be declared to be a WPA and the Minister may exercise such powers considered necessary for the protection of the quality of surface or groundwater within a WPA.

Low salinity groundwater resources may be at risk of degradation as a result of increasing demand, particularly during peak demand periods. Increasing groundwater salinity coupled with an increasing demand for water has been noted as a risk to the region's water supply security, development and economic growth (Taylor 2003).

## 2.6. DEMAND AND SUPPLY

A key commitment in *Water for Good* is the development of Regional Demand and Supply Statements, the first of which has been released for the Eyre Peninsula region (DFW, 2011). These Statements ensure that long-term water security solutions for each region are based on a thorough understanding of the state of all local water resources, the demand for these resources and likely future pressures.

The Eyre Peninsula Demand and Supply Statement (DFW 2011) provides demand and supply projections for the scenarios of high and low population growth and high and low greenhouse gas emissions. Two projection sets address the demand and supply for (1) drinking quality water only; and (2) for all water sources and human demands.

The main sectors of water source usage (both potable and non potable) are likely to be for stock use, residential use and non-residential purposes (e.g. industrial, commercial and institutional). Minor use sectors include mining and irrigation. However, the potential for major expansion in the mining sector on Eyre Peninsula has been recognised with considerable evidence that there will be significant growth in the mining industry over the next 40 years (e.g. Government of South Australia 2007; RESIC 2010). Mining operations require significant volumes of water, but can typically be of a lower quality than is required for stock or irrigation. The Resources and Energy Infrastructure Council (2010) reported that the water demand across the State's resource sector will increase from approximately 43 GL/y in 2010 to 130 GL/y in 2019.). It is important that associated water resource demands are considered, planned for and managed, while balancing this against environmental and social requirements.

### 2.6.1. MINING

Within the EPNRM Region there is already significant exploration activity occurring at various levels of investigation and production. One Steel is producing iron ore south of Whyalla and is the largest producer in Australia outside of the Pilbara. Mineral development projects on EP include Mulaquana uranium, Wilcherry Hill iron ore, Bramfield iron ore, Warramboo iron ore and Poochera Kaolin. Centrex Minerals Wilgerup iron ore prospect has an approved mining lease approximately 20 km south-east of Lock, a project that is actively utilising non-prescribed groundwater. There are also numerous other minor active mines across the non-prescribed region. These are mostly pits and quarries for non mineral commodities (e.g. sand, sandstone, granite, gypsum and salt)

Numerous mineral production tenements and mineral production tenement applications, as well as many exploration licenses and exploration license applications exist over the EPNRM Region. Additionally, both geothermal and petroleum exploration or exploration license applications exist for the region. Such activity has the potential to expand into water dependant development opportunities

The consequence is that mining operations often require large volumes of water, which can typically be of a lower quality than is required for stock or irrigation purposes. Related water-use activities, if unmanaged, could adversely impact on the regions potable and/or non-potable groundwater resources and their existing users.

RESIC (2010) identified and surveyed infrastructure needs of available operational or advance stage mineral development projects, a number of which are within the EPNRM Region (Table 3). The work included estimates of project water requirements for the periods 2010–11, 2012–14, 2015–19 and >2020. The data suggest that the demand for water, from the currently identified ventures, will more than double over the next decade. DFW (2011) reports that mining activity projections will increase water demand in 2050 by approximately 14.7 GL, a level currently not available without private augmentation. DFW (2011) reports that mining activity projections will increase water demand in 2050 by approximately 14.7 GL, a level currently not available without private augmentation.

**Table 3. Predictive water resource demands for mining operations within the EPNRM Region.**

| Company Name | Project Title | Mine Location | Water Consumption over the four time periods (ML/annum) | | | | Source of water | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1–2 Years | 3–5 Years | 6–10 Years | >10 Years | 1–2 Years | 3–5 Years | 6– 10 Years | >10 Years |
| Minotaur Exploration Ltd | Poochera Kaolin Project | 10 km south-west from Poochera | 25 | 150 | 150 | 150 | Mains 100% | Desal 100% | Desal 100% | Desal 100% |
| OneSteel | Capacity expansion | Whyalla | 6000 | 5000 | 4000 | 5000 | Mains 100% | Mains 80%<br>Desal 20% | Mains 60%<br>Desal 40% | Mains 60%<br>Desal 40% |
| Centrex Metals Limited | Carrow Magnetite Deposit | Carrow | 0 | 0 | 4000 | 4000 | - | - | Desal 100% | Desal 100% |
| Centrex Metals Limited | Bungalow Magnetite | North-east EP. 9 km north-north-west & 16 km north of Cowell | 0 | 0 | 4000 | 4000 | - | - | Desal 100% | Desal 100% |
| Centrex Metals Limited | Charleton Gully Magnetite Deposit | Charleton Gully | 0 | 0 | 4000 | 4000 | - | - | Desal 100% | Desal 100% |
| Lincoln Minerals Limited | Gum Flat | 20 km west of Port Lincoln | 1000 | 1000 | 2000 | 2500 | Groundwater 100% | | | |
| Centrex Metals Limited | Wilgerup | 30 km south-east of Lock | 1100 | 1100 | 1100 | 0 | No Source Provided | Groundwater 100% | Groundwater 100% | - |

Data Source - RESIC Infrastructure Demand Study (2010)

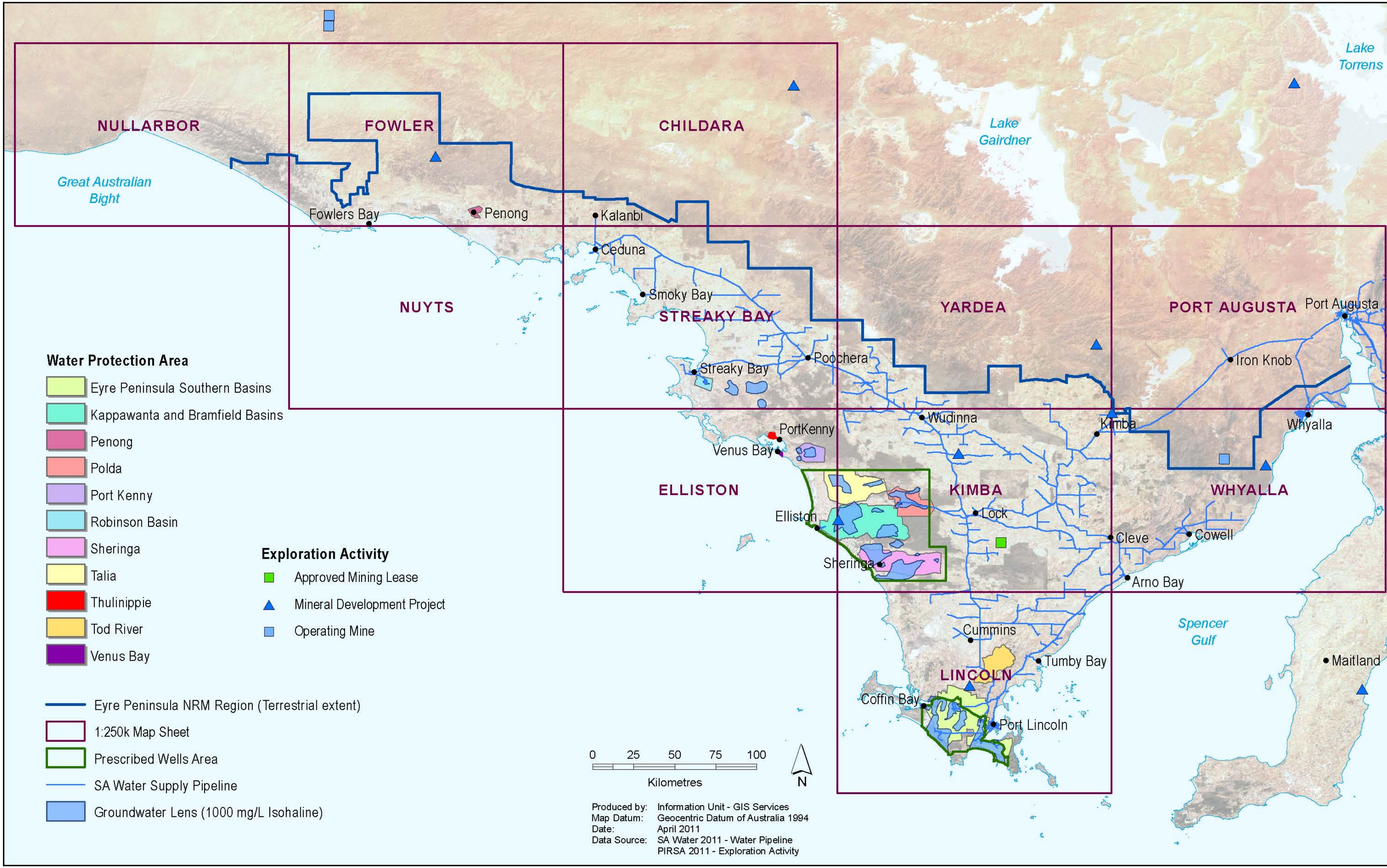


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**Figure 1: Eyre Peninsula Natural Resources Management Region**

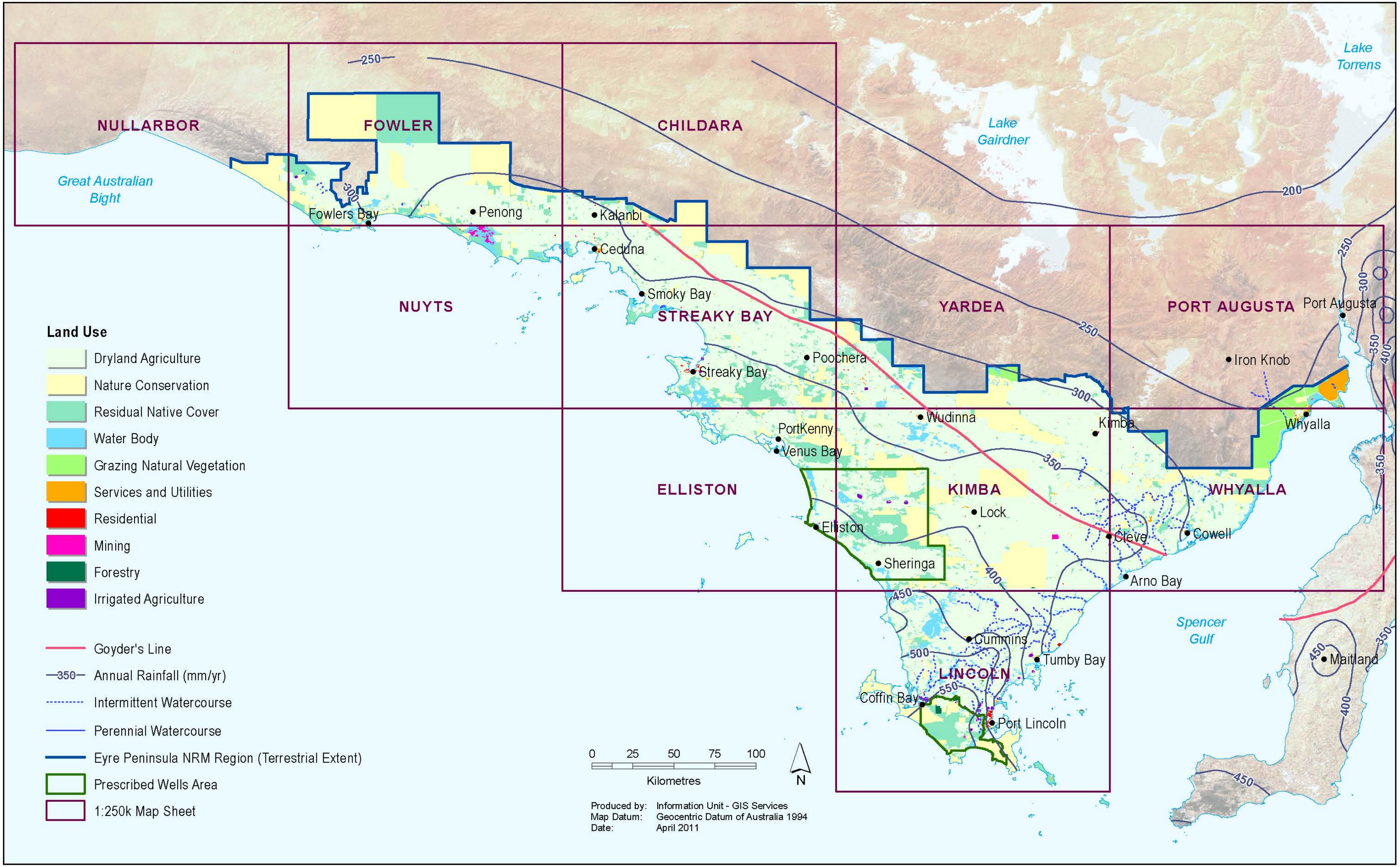



**Figure 2: Land use and climate**

# 3. HYDROGEOLOGY

## 3.1. GEOLOGICAL SETTING

Regionally the Eyre Peninsula is underlain by the Gawler Craton (Fig. 4), a basement province that has been tectonically stable for the past 1450 million years (Parker 1995). Basement rocks of the Gawler Craton outcrop as the Gawler Ranges along the EPNRM Region's northern boundary, inland of the east coast and as small isolated outcrops throughout the region. A significant geological feature incised within basement meta-sediments is the Polda Trough, a narrow east-west trending intra-cratonic graben, which has been infilled by Permian, Jurassic and Tertiary sediments during periods of marine transgressions and recessions (Flint 1992). Elsewhere across Eyre Peninsula, a cover of Tertiary and Quaternary sediments is ubiquitous.

The Eucla Basin, found on the western border of the State, overlies weathered and crystalline basement of the Gawler Craton and is host to marine and terrestrial Tertiary sediments that represent significant water bearing units. The south-eastern extent of the Eucla Basin extends roughly over the western-half of EP (Fig. 4). This delineation of the Eucla Basin is more widespread than previous estimates of the basin's limits and includes Tertiary sediments of the onshore Polda Trough, Uley Basin and Wanilla Basin, which were probably contiguous (Benbow, Lindsay & Alley 1995). Smaller provinces within the regions are the Marble Ranges and the Cowell Sub-basin of the larger Pirie-Torrens Basin (Fig. 4). Figure 5 displays the region's surface geology, presented by geological age.

## 3.2. REGIONAL HYDROGEOLOGY

Although groundwater is the main source of EP's potable water, the resource is of variable quality and quantity. Regionally, most groundwater occurs in saline or brackish aquifers with generally low yields. Groundwater occurs within Quaternary, Tertiary and Jurassic sediments and within weathered and fractured Pre-Cambrian basement rocks. Limited hydrogeological information is available and since the mid-1970's, only a small number of water wells have been drilled and few groundwater investigations conducted (SKM 2008).

A greater density of drillholes classed as water wells may be correlated with areas of better quality groundwater, as more wells are drilled where lower salinity and higher yields are encountered. Potable quality groundwater is mostly observed along the south and west coasts where the majority of supply is from Quaternary Limestone (QL) and Tertiary Sands (TS) aquifers.

A simplified distribution of stratigraphic units across EP is presented Figure 3. Localised occurrences of Quaternary and Tertiary sediments occur around the east coast and across central EP. Also, outcropping bedrock occurs between groundwater basins of the west and south coasts. Deeper sedimentary formations are coincident with the Polda Trough, Cummins Basin and Cowell Basin groundwater provinces and within palaeovalleys.

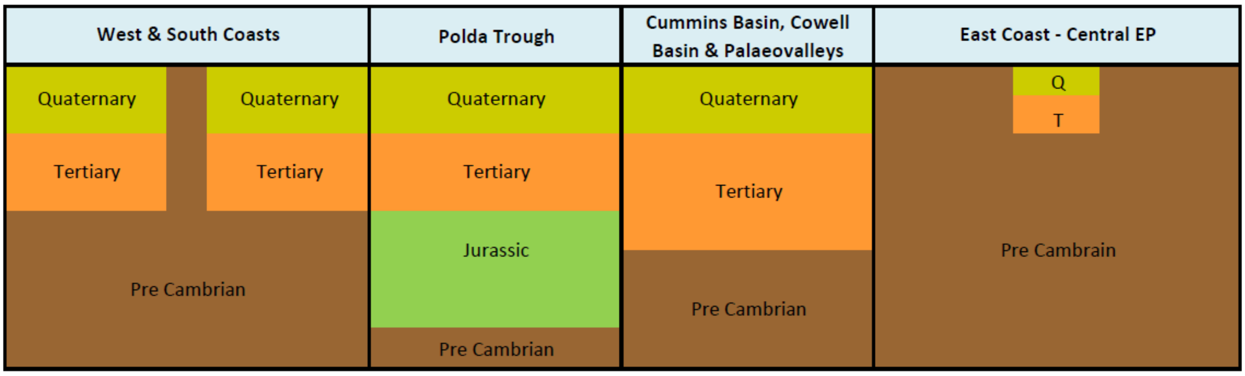



**Figure 3. Simplified conceptual occurrence of stratigraphic ages across Eyre Peninsula (based on Taylor 2003)**

## 3.2.1. QUATERNARY AQUIFERS

Throughout the EP region, the largest potable groundwater storages are found within the Bridgewater Formation (Barnett 1982; Martin, Sereda & Clarke 1998). Most fresh groundwater lens extents are delineated by groundwater isohalines of less than 1 000 mg/L (Fig. 1). QL aquifers typically have hydraulic properties of an unconfined or semi-confined aquifer (Love *et al.* 1994) and the yield of the limestone can vary greatly. The majority of potable water is encountered in the Southern Basins and County Musgrave PWA (Fig. 6). The Southern Basins PWA is the major source of groundwater delivered through the Eyre Peninsula Water Supply Network (EPWSN). Elsewhere along the west coast, beyond the EPWSN extent, Independent Eyre Peninsula Water Supply Schemes (IEPWSS) supply a number of the larger communities (Coffin Bay, Elliston and formally Streaky Bay). Several smaller west coast communities (Venus Bay, Port Kenny, Penong and Fowlers Bay) also source groundwater from local freshwater lenses. These small isolated resources are managed locally by councils and are potentially at risk of over-extraction and consequent degradation (State Water Plan 2000). Observed salinity increases indicate current extraction may already exceed safe yields (Taylor 2003).

## 3.2.2. TERTIARY AQUIFERS

Tertiary sands are distributed throughout EP and contain aquifers that are either semi-confined or confined and generally overlain by Quaternary sediments and aquifers. Salinity in the Tertiary sediments can vary considerably but is generally more saline (>5000 mg/L) than the overlying Quaternary sediments (Martin, Sereda & Clarke 1998). Groundwater wells are often difficult to construct in the unconsolidated and fine-grained Tertiary sands and yields are generally poorer in comparison to the Quaternary aquifers.

Where extensive drilling and targeted investigations into groundwater resources have occurred, the presence of a Tertiary clay aquitard has been identified separating the Quaternary aquifers from the less-transmissive Tertiary sands (Love *et al.* 1994). Where these Tertiary clays are thin or absent, downward vertical leakage may form lenses of potable water within the Tertiary aquifers. These occurrences are likely to be very localised and difficult to sustain (Taylor 2003).

### 3.2.2.1. Palaeovalley Aquifers

An extensive network of palaeodrainage exists within the Gawler Craton and palaeovalley sediments are prominent across much of the study area (Fig. 4). Neogene and Palaeogene sedimentary deposits of gravels, sands, silts and clays fill ancient drainage networks incised into the crystalline basement. They no longer function as active surface water systems but often form good aquifers which are capable of storing significant quantities of groundwater (Magee 2009). There are limited groundwater data available, but within the study area these resources are likely to be saline as a result of ancient marine depositional environments (Martin, Sereda & Clarke 1998). Salt lakes often form present-day surface expressions of the palaeodrainage network and are also sites of evaporative discharge from the palaeovalley aquifers (Martin, Sereda & Clarke 1998).

Palaeovalleys within the study region occur to the south-west of Tarcoola and south of the Gawler Range Volcanics and include the Narlaby, Thurlga, Yaninee and a number of unnamed palaeovalleys. Exploratory drillhole data exists but no estimates of storage have been made. Groundwater salinities range from about 5 000 mg/L to over 50 000 mg/L and although yields are not well known, anecdotal reports have indicated that some of the aquifers may be artesian (Martin, Sereda & Clarke 1998). Due to the potential importance of palaeovalleys as a groundwater resource, an extended discussion is provided in Appendix B.

### 3.2.3. JURASSIC AQUIFERS

The Polda Trough (Fig. 4) is a narrow east-west intra-cratonic graben incised into the crystalline basement. It extends from about 200 km off shore from Elliston, to past Lock in the east. The trough contains Permian and Jurassic sediments consisting of sand, clay and lignite, with the generally fine grained, low yielding sequences having salinities greater than 30 000 mg/L (Martin, Sereda & Clarke 1998). The Polda Trough holds considerable potential for the extraction of saline groundwater from the deeper sedimentary sequences (Martin, Sereda & Clarke 1998).

### 3.2.4. FRACTURED ROCK AQUIFERS

Basement lithology includes gneisses, volcanics and granites of the Gawler Craton. Basement rocks crop out in places and may be weathered to a depth of as much as 50 m (Martin, Sereda & Clarke 1998). The understanding of fractured rock aquifers is limited and they are often irregular in occurrence, salinity and yield. The heterogeneous nature of fractured rock aquifers accounts for the observed unsystematic distributions of groundwater salinity. Basement outcrops and the shallowest occurrences are found inland of the east coast and along the northern boundary of the EPNRM Region, south of the Gawler Ranges. Isolated occurrences of surface basement outcrop occur throughout the region.

## *3.3. RECHARGE*

In determining the water balance, rainfall recharge is the most difficult parameter to estimate as it is dependent on variables including rainfall intensity and duration and the nature of the geological substrate. Groundwater recharge across EP occurs predominantly via infiltration of “recent” rainfall (SKM 2008). The most heavily developed Quaternary groundwater systems of EP are unique in comparison to other semi-arid regions across the State due to their higher recharge rates (Martin & Evans 2002).

There is a strong correlation between groundwater level trends and rainfall; intense rainfall events are typically associated with high levels of recharge. The occurrence of surface calcrete and limestone surface cover coupled with seasonal rainfall events promotes large volumes of localised runoff and rapid infiltration to the underlying Quaternary limestone aquifer through dissolution features. In some areas, this process has resulted in extensive potable groundwater lenses that are now developed to supply water across the region.

Recharge to TS aquifers is not well understood and is thought to be low relative to QL aquifers. Where Tertiary clays are absent, there is potential for downward leakage from the overlying Quaternary sediments.

Groundwater recharge to fractured rock aquifers is considered to be localised and irregular. Although the dynamics of fractured rock aquifer hydrology is more uncertain than sedimentary systems, the volume of recharge is generally considered to be governed by the underlying fracturing (permeability) of the rock, while groundwater quality is determined largely by the location of the well with respect to local freshwater intake. Recharge to fractured rock systems on Eyre Peninsula are not well understood but recharge may occur where basement material outcrops and sub-crops, as well as via vertical and lateral leakage from adjacent aquifers.

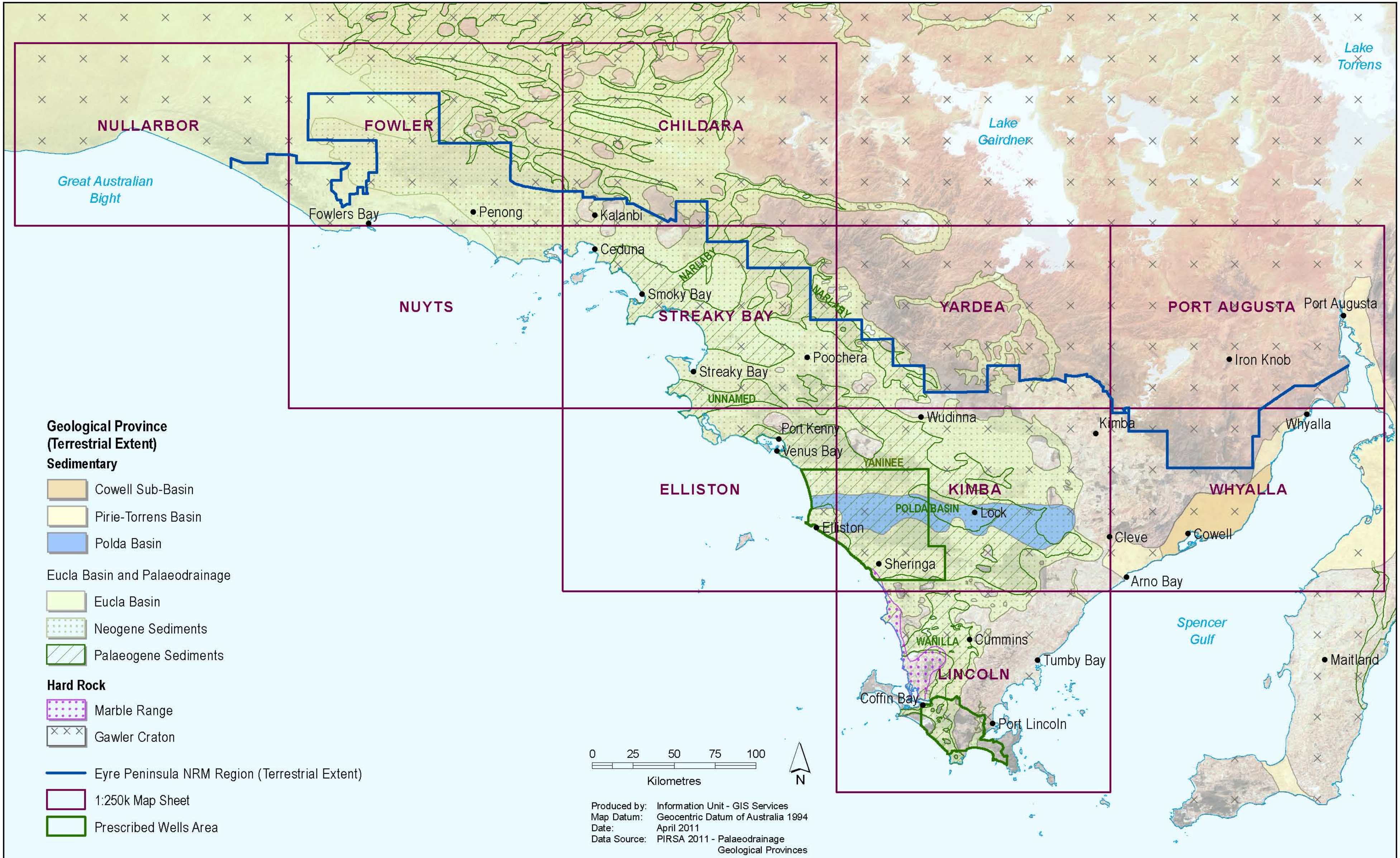



**Figure 4: Major geological provinces**

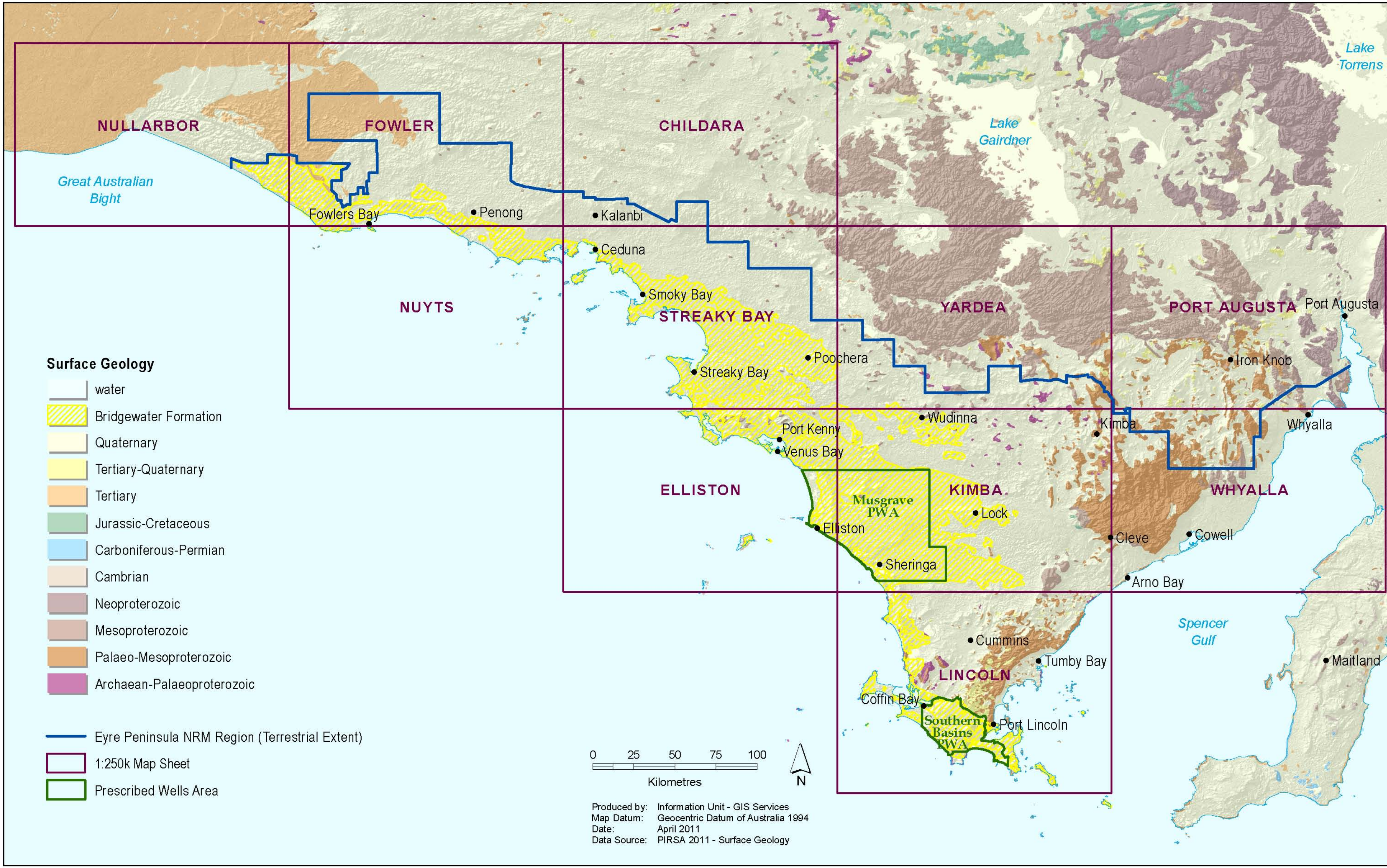



**Figure 5: Surface geology**

# 4. GROUNDWATER DATA

## 4.1. DATA

Data used in the production of this report have been sourced principally from South Australia's hydrogeological database (SA Geodata) which is administered by the Department for Water (DFW) and Primary Industries and Resources, South Australia (PIRSA). Whilst every effort is made to present information from the database as accurately as possible, there will be limitations on data accuracy in relation to data being up-to-date, validated or complete. Other sources of information accessed in support of these assessments include available literature and publicly available state and national geoservers – namely, PIRSA's South Australian Resource Information Geoserver (*SARIG*) and Geoscience Australia's (GA) geoserver.

Recent water level and salinity data are available for current active groundwater observation networks. These data can be accessed via the groundwater information database (*Obswell*) on the South Australian Government's *WaterConnect* website. In areas that are not currently monitored, it is common to find that only a few groundwater parameters (e.g. salinity and water level) have been sporadically recorded since 1999. Table 4 highlights the low availability of recent (2000–2010) groundwater data, which represents only 8% and 16% of the 'latest' salinity and water level observations respectively. A large proportion of the data for both parameters predates 1980. Most wells have only a single water salinity and/or level observation collected at the time of drilling.

**Table 4. Summary of latest groundwater data age for the non-prescribed EPNRM Region.**

| Period of Record | Total Dissolved Solids | | Standing Water Level | |
|---|---|---|---|---|
| | Drillholes | % | Drillholes | % |
| No date recorded | 96 | 2 | 115 | 3 |
| Pre-1960s | 1182 | 29 | 887 | 23 |
| 1960–1979 | 1299 | 32 | 1214 | 31 |
| 1980–1999 | 1178 | 29 | 1075 | 27 |
| 2000–2010 | 345 | 8 | 618 | 16 |
| **Total** | **4100** | | **3909** | |

Exploration for new groundwater resources which are suitable for domestic and stock purposes is focused in regions where salinity is known to be low. For this reason, drillhole data is likely to be clustered around these areas. Information regarding relatively saline groundwater is likely to be sparse, as demand for this resource has traditionally been low.

Although there are a great number of wells for which water quality data exists, a common constraint is the lack of associated well construction and production zone details. This limits the ability to assign groundwater observations to a specific hydrogeological formation.

For consistency throughout this report, the reference to map sheet areas will follow a uniform naming convention. For example, the STREAKY BAY 1:250 000 map sheet area will be referred to in this report as STREAKY BAY and the Streaky Bay 1:100 000 map sheet will be referred to in this report as *Streaky Bay*.

## 4.1.1. GROUNDWATER SALINITY

The regional non-prescribed groundwater assessment has utilised all of the most recent salinity data available, presented both as data points and an interpolated data grid using an inverse distance weight algorithm (Fig. 6). Although the number of drillholes within the non-prescribed region exceeds 16 000, only 5 936 are classed as water wells, of which 75% have an observed groundwater salinity record.

The majority of groundwater salinity data is available over EP's southern coast and along the western coastline from Coffin Bay to Streaky Bay and is coincident with most of the fresher groundwater occurrences (Fig. 6). There is a lack of groundwater salinity data between Streaky Bay and Ceduna. North of Ceduna, data density increases but is typically of higher salinity. A large amount of data, predominantly indicating high groundwater salinity, exists along the eastern coastline and inland of Cleve and Cowell towards Kimba. The interior of the EPNRM Region, coincident with the reticulated water pipeline, generally has very sparse groundwater salinity data, most of which indicate high salinity.

The groundwater salinity data, inclusive of PWA data, are summarised for each of the 1:250 000 map sheets within the study area (Tables 6, 12, 18, 21, 25, 31 & 37). KIMBA and LINCOLN, which host the Musgrave and Southern Basins PWAs, have the greatest number of wells with salinity observations. Salinity <1 000 mg/L has the greatest occurrence within these map sheets (44% and 32% of records respectively) and the percentage of data with salinity <3 000 mg/L is also high (76% for KIMBA and 60% for LINCOLN).

ELLISTON has a large number of salinity records <5 000 mg/L (71%), with 24% of observations <1 000 mg/L. STREAKY BAY has the next highest observed occurrence of salinity <1 000 mg/L but occurrences of high salinity groundwater are also frequent for the map sheet.

Groundwater salinity in excess of 10 000 mg/L is most common for FOWLER (63%), WHYALLA (66%), NUYTS (88%) and YARDEA (88%). Lower salinity groundwater is observed in a small number of wells on FOWLER and WHYALLA, but NUYTS and YARDEA have very few observations of fresher groundwater.

The associated median of maximum well depth and median yield are provided for each salinity range. FOWLER, KIMBA and WHYALLA suggest a pattern of increasing salinity with depth but similar trends are not apparent for the other maps sheets. Associated median yields reveal low regional well yields, with almost all median records below 1 L/s; the one exception a median of >10 L/s for salinities <1 000 mg/L on STREAKY BAY.

## 4.1.2. STANDING WATER LEVEL

All the most recent standing water level (SWL) data available is considered for this groundwater assessment (Fig. 7). That is, if multiple groundwater level data exists for a well, only the most recent data value is considered. Similar to the salinity data, less than a quarter of the 16 000 plus drillholes have an observed SWL value.

The distribution of data is similar to that of the salinity data, as wells observed for one parameter are likely to be observed for the other. Consequently, most SWL data occurs along the southern coast and along the west coast to Streaky Bay. Smaller numbers of data points exist along the far west coast, east coast and over the inland area between Cleve, Cowell and Kimba. There is a distinct lack of data in the central and northern sections of the study area which closely aligns with the main Tod to Ceduna water supply pipeline.

The majority of water levels for ELLISTON, KIMBA, LINCOLN and WHYALLA are within 10 m of ground surface (Tables 21, 25, 31 & 37). Water levels STREAKY BAY and FOWLER are variable with data more evenly spread over the intervals <30 m. NUYTS has a high balance of water levels less than five metres deep, which are mostly coincident with the location of the Lake MacDonnell Gypsum mine south of Penong. YARDEA water levels are the deepest, predominantly greater than 20 m, a likely reflection of the elevated topography and limited local recharge.

### 4.1.3. WELL YIELD

Throughout the region, a number of wells have been developed to provide adequate stock-quality groundwater to support grazing. Well yields are typically low and many have been unsuccessful (Martin, Sereda & Clarke 1998).

A summary of the well yield records within the study area reveals the overwhelming majority yield less than one litre per second (Fig. 8). The median of all yields across the study area is 0.25 L/s with an associated median salinity of around 4000 mg/L.

Only a very small number of wells have an observed yield of 5 L/s or greater. These are mostly restricted to the Quaternary limestone aquifer within the Prescribed Wells Areas. Elsewhere, a small number of high-yielding wells (>5 L/s) are observed, predominantly in the east and south of EP, in the highlands between Cleve and Cowell, Tumby Bay and Cummins, with limited observations in the far north-west near Penong, Streaky Bay and Venus Bay.

## *4.2. MONITORING*

Currently a number of observation networks that monitor groundwater level and salinity are established across the EPNRM Region (Table 5). Many of the existing networks are focussed on monitoring high value water resources which have been identified as being highly dependent on rainfall patterns. Uncertainty regarding groundwater resource status exists in other areas due to a lack of dedicated monitoring or irregular intervals between which monitoring data have been collected and evaluated.

Australian Groundwater Technologies (AGT) has currently compiled a series of detailed reviews of groundwater, surface water and dryland salinity monitoring sites across the non-prescribed EPNRM Region (AGT 2010) as part of a statewide program initiated by DFW. The AGT monitoring review focuses on: (1) drivers and objectives of monitoring; (2) a summary of current monitoring infrastructure, period of record and frequency of monitoring; and (3) recommendations for the establishment and maintenance of a robust water resources monitoring network across the EPNRM Region, such that DFW can assess and report on the state and condition of groundwater and surface water resources.

**Table 5. Summary of monitoring networks in the non-prescribed regions of the EPNRM Region**

| Groundwater Networks | Total Sites | Historical Sites | | Current Sites | | Monitoring Frequency | | Comment | |
|---|---|---|---|---|---|---|---|---|---|
| | | SWL | Salinity | SWL | Salinity | SWL | Salinity | Purpose | Formations Monitored |
| Penong | 16 | 0 | 16 | 15 | 0 | Monthly | - | Stock & domestic supply | Largely undefined, inc. Pidinga Formation. |
| Streaky | 90 | 25 | 26 | 55 | 61 | Monthly | Monthly | Town water supply (Robinson Lens) | Many undifferentiated, inc. Bridgewater, Pidinga & Garford Formations. |
| Venus Bay | 22 | 1 | 1 | 20 | 13 | Monthly | Random | Town water supply | Many undefined or unnamed, inc. Bridgewater & Garford Formations. |
| Cummins | 73 | 20 | 64 | 50 | 0 | Six monthly | - | Dryland salinity | Many undefined or unnamed, inc. Bridgewater & Uley Formations. |
| Wanilla | 55 | 26 | 25 | 29 | 0 | Six monthly | - | Dryland salinity | Undefined |
| Cowell | 65 | 12 | 50 | 35 | 0 | Six monthly | - | Dryland salinity | Many undefined or unnamed, inc. Gibbon Beds, Melton Limestone, Pooraka Formation, Donington Suite & Hutchison Group. |
| Tod River | 14 | 12 | 13 | 1 | 0 | Random | - | Dryland salinity | Mostly unnamed, inc. Hutchison Group. |
| Darke Peak | 19 | 7 | 0 | 12 | 0 | Six monthly | - | Dryland salinity | Undefined |
| Murdinga | 15 | 0 | 0 | 15 | 0 | Random | - | Dryland salinity | Undefined |
| EPA (EPNRM) | 11 | 0 | 0 | 0 | 11 | - | Random | EPA Statewide monitoring | Mostly Bridgewater Formation within Prescribed Wells Areas |

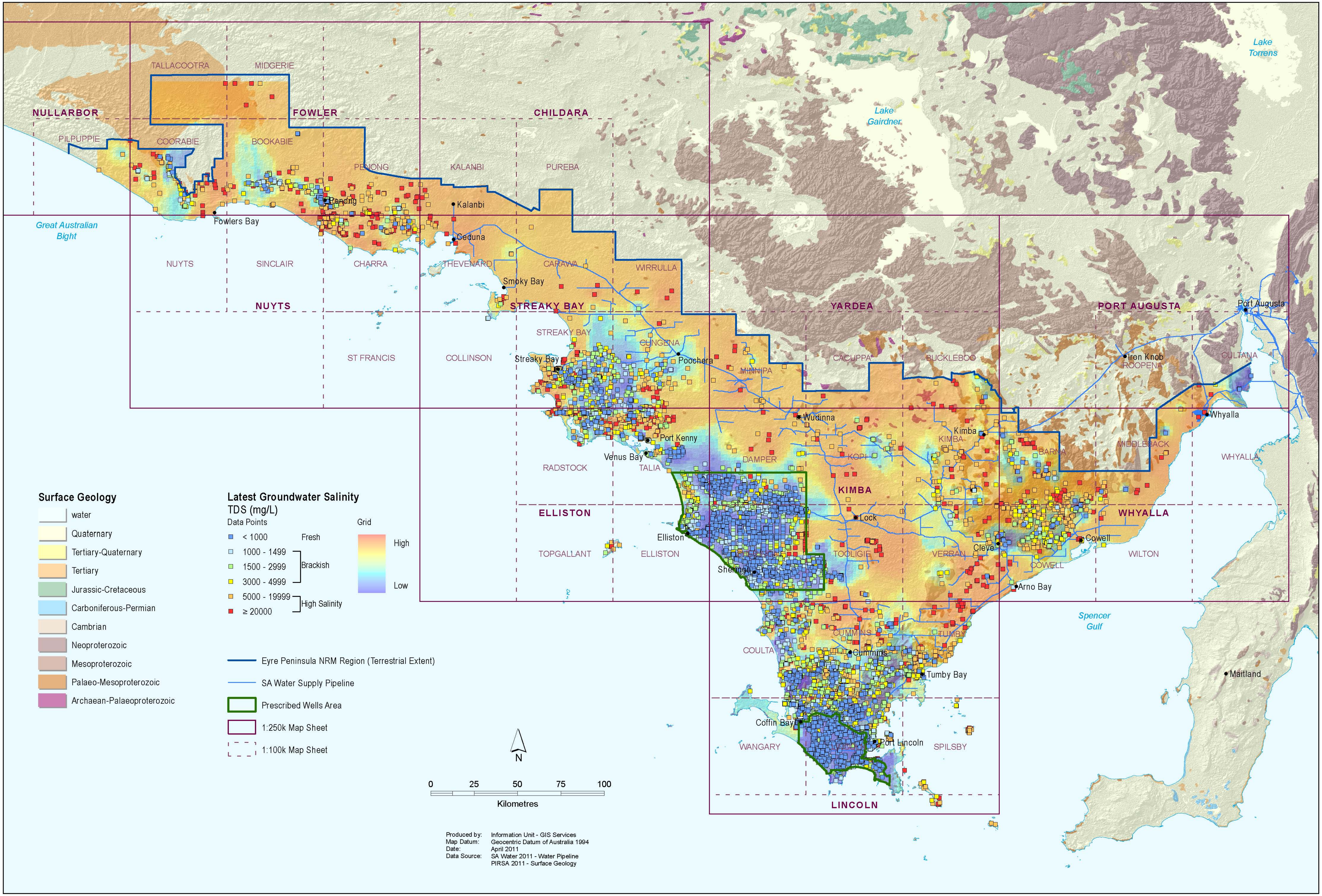



Figure 6: Groundwater salinity data

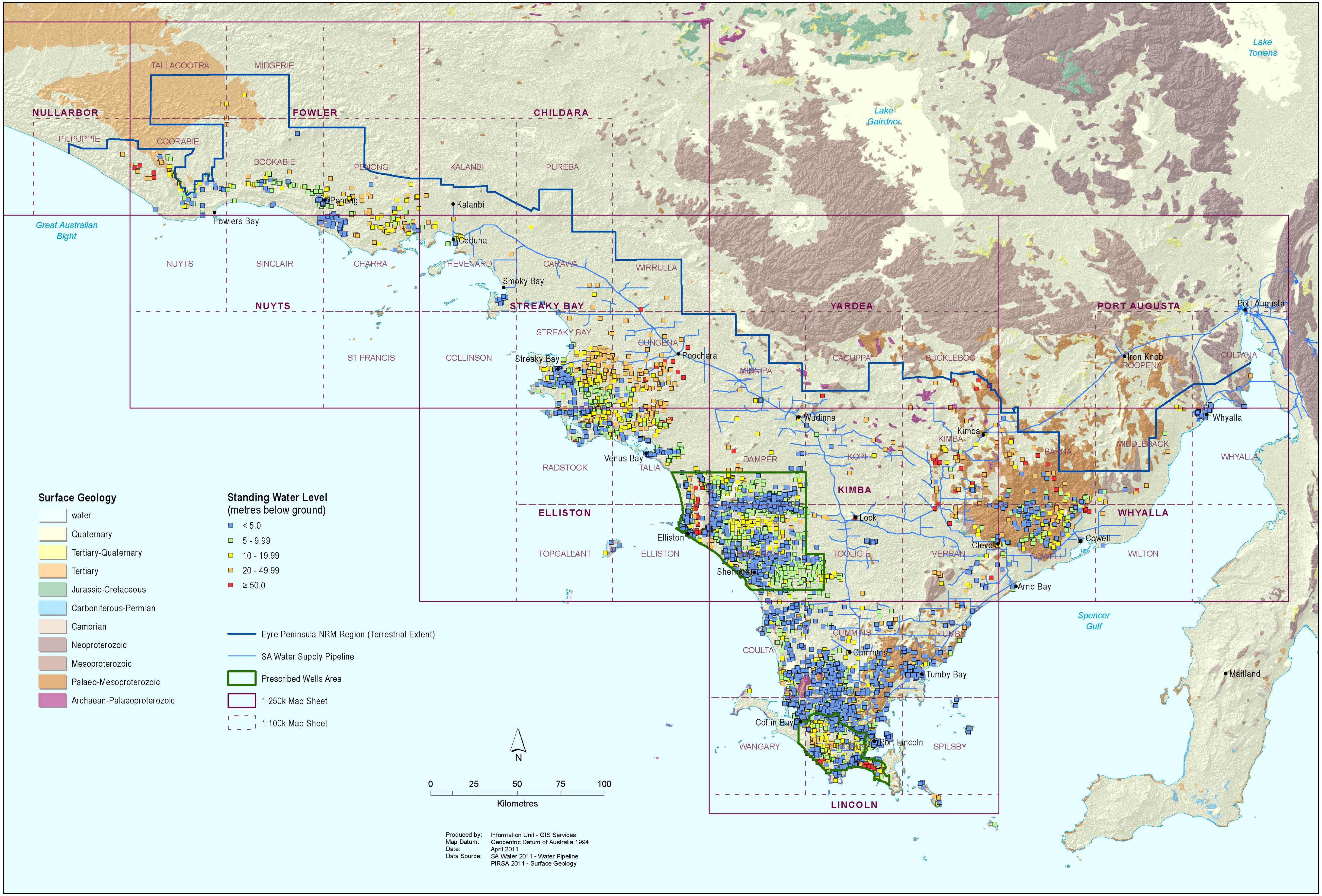



**Figure 7: Groundwater standing water level data**

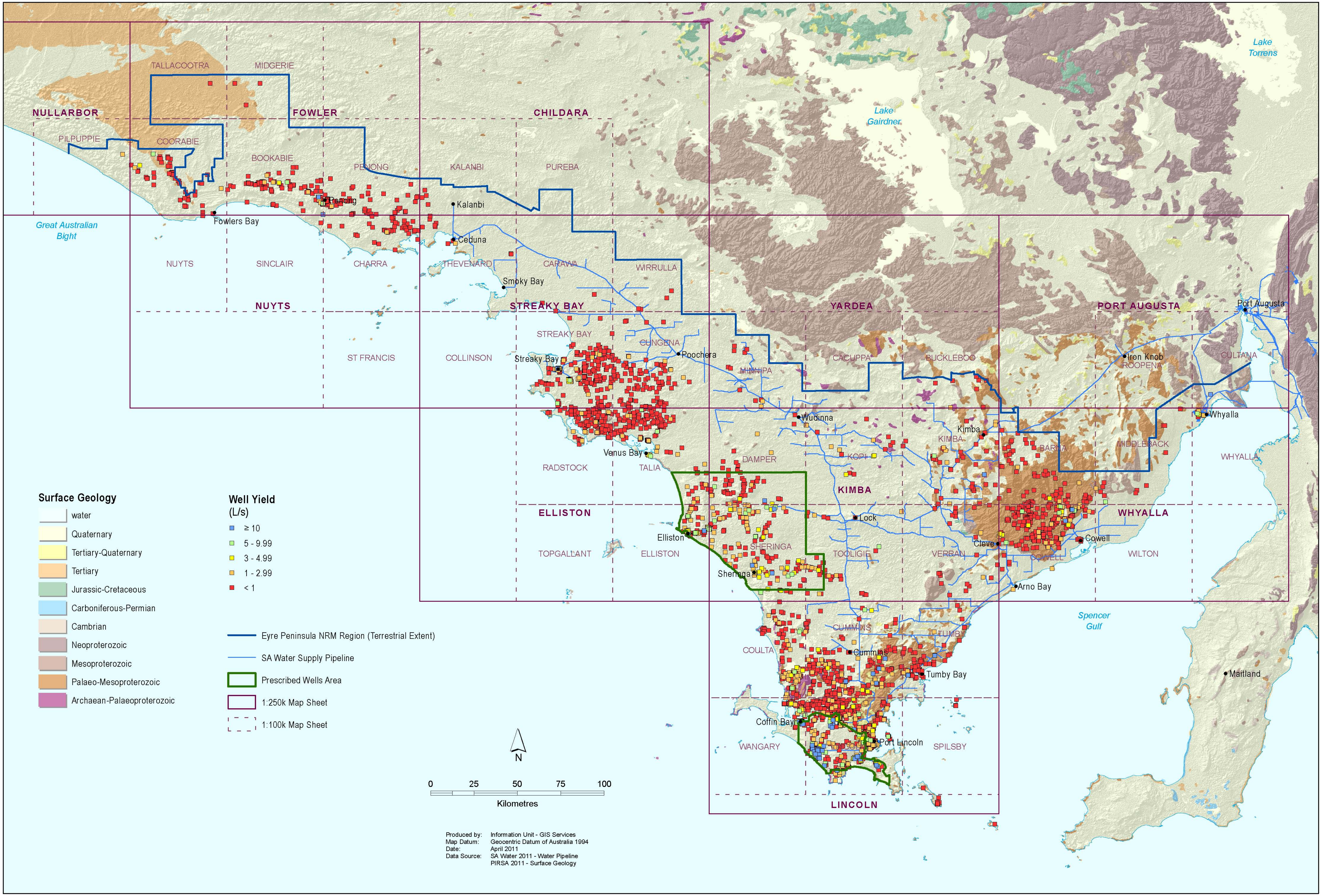



Figure 8: Groundwater well yield data

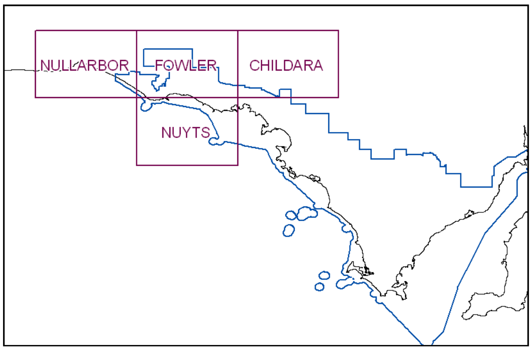
## 4.3. MAP SHEET DATA

This report has compiled groundwater data available from within the SA Geodata database for the Eyre Peninsula Natural Resources Management Region. Information on groundwater salinity, standing water level, yields and data age are tabulated by 1:250 000 and 1:100 000 map sheets and where applicable, information on associated water cuts and maximum well depth is included. Non-prescribed data are the focus of discussions presented herein; however, groundwater data from within the Prescribed Wells Areas are included on map products and within the 1:250 000 tables for contextual purposes. 1:100 000 map sheet tables contain only data from the non-prescribed regions.

Stratigraphic information sourced from SA Geodata is also included in the data summaries to give a general representation of the location and thickness of potential aquifer units. The median thickness of a stratigraphic unit is calculated using only fully-penetrating samples, that is, when the entire thickness of a unit is intercepted.

For consistency, the reference to map sheet areas will follow a uniform naming convention. For example, the STREAKY BAY 1:250 000 map sheet area will be referred to in this report as STREAKY BAY and the Streaky Bay 1:100 000 map sheet will be referred to in this report as *Streaky Bay*.

### 4.3.1. FOWLER 1:250 000 MAP SHEET (INCLUDES NULLARBOR, NUYTS AND CHILDARA)




The north-west of the study area falls largely within FOWLER but it also extends onto NULLARBOR, NUYTS and CHILDARA. Available groundwater data indicates salinity is mostly above 5000 mg/L and standing water level is typically less than 20 m (Table 6).

The entire Fowler map sheet is less than 200 m above sea level; there is a rise in topography inland from the coast towards undulating aeolian dunes, which gives way further inland to the gently undulating surface of the Nullarbor Plain. Karst sinkholes have developed in the Quaternary limestone (Bridgewater Formation) and through the Ripon Calcrete in places. Where they are not buried beneath younger dunes, they provide vertical connection with the groundwater surface (Firman 1978).

The SA Water reticulation network does not service communities on these map sheets, with the exception of Kalanbi on CHILDARA. Small communities in the north-west, including Penong and Fowlers Bay, rely on alternative sources of water including rainwater, reclaimed water and groundwater that underlie the local dunal systems. Potable supplies of water (<500 mg/L) are obtained from the dunes, but the current level of extraction and the consequent impact of resource usage is uncertain; no water quality and water level information is available to ascertain the aquifer response to current use.

**Table 6. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for FOWLER, NULLARBOR, NUYTS and CHILDARA.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (556) | 9.7 (54) | 4.3 (24) | 7.4 (41) | 9.5 (53) | 21.2 (118) | 18.9 (105) | 29 (161) |
| Max Well depth (m) | (539) | 11.5 (51) | 9.9 (24) | 13.4 (38) | 13.8 (50) | 14 (113) | 16.5 (103) | 19.7 (160) |
| Yield (L/s) | (288) | 0.14 (34) | 0.27 (12) | 0.13 (19) | 0.19 (31) | 0.25 (73) | 0.1 (52) | 0.08 (67) |
| SWL (m) | (392) | 8.2 (46) | 7.1 (20) | 8.8 (31) | 8 (42) | 10.1 (88) | 10.1 (60) | 4.6 (105) |
| Water cut (m) | (242) | 9 (23) | 10.1 (10) | 9 (21) | 13.6 (19) | 10.3 (44) | 16.3 (50) | 23.6 (75) |
| Observation year | | 1979 | 1974 | 1979 | 1967 | 1977 | 1958 | 1951 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (427) | 29.7 (127) | 28.3 (121) | 24.8 (106) | 10.5 (45) | 5.6 (24) | 0.7 (3) | 0.2 (1) |
| Max well depth (m) | (420) | 4.9 (126) | 10.7 (118) | 18.6 (103) | 27.4 (45) | 44.7 (24) | 75 (3) | 108.8 (1) |
| Water cut (m) | (169) | 3.4 (29) | 8.8 (59) | 17 (39) | 25.5 (18) | 40.3 (20) | 68 (3) | 107.3 (1) |
| Observation year | | 1957 | 1979 | 1958 | 1957 | 1958 | 2002 | 1957 |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (317) | 93.7 (297) | 4.4 (14) | 0.6 (2) | 0.9 (3) | 0.3 (1) |
| Max well depth (m) | (310) | 16.8 (291) | 13 (13) | 53.5 (2) | 42.3 (3) | 9 (1) |
| Water cut (m) | (200) | 13.6 (186) | 5.8 (9) | 39 (2) | 9.2 (3) | - |
| Observation year | | 1957 | 1977 | 1999 | 1973 | 1978 |

#### 4.3.1.1. Midgerie (5435) and Tallacootra (5335) 1:100 000 Map Sheets

Small southerly sections of *Tallacootra* and *Midgerie* fall within the study area. The surface geology is dominated by Nullarbor Limestone which, along with other Tertiary sequences including the Ooldea Sand, Pidinga Formation and Hampton Sandstone, has a median thickness of 25 m with units up to 96 m found in the east. Here Tertiary units are overlain by undifferentiated Quaternary aeolian sediments with a median thickness of 5 m. Undifferentiated Archaean to Palaeo-Mesoproterozoic basement rocks have been found within a few metres from the surface in some areas and as deep as 100 m in others.

Groundwater quality data is sparse with only six wells having salinity measurements (Table 7). Salinity is mostly high ranging between 20 000–30 000 mg/L; one well is comparatively fresher (<10 000 mg/L). Standing water level ranges between 13.5–33.5 m and yields are very low with a median of just 0.2 L/s. No production zone details are available for the wells but based on water levels and stratigraphic data, wells are presumed to be screened within Tertiary sediments.

**Table 7. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Midgerie* and *Tallacootra*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (6) | - | - | - | - | 16.7 (1) | - | 83.3 (5) |
| Max Well depth (m) | (6) | - | - | - | - | 41 (1) | - | 37.5 (5) |
| Yield (L/s) | (3) | - | - | - | - | 0.14 (1) | - | 0.28 (2) |
| SWL (m) | - | - | - | - | - | - | - | - |
| Water cut (m) | (5) | - | - | - | - | 32 (1) | - | 34.2 (4) |
| Observation year | | - | - | - | - | 1976 | - | 1976 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (4) | - | - | 75 (3) | - | 25 (1) | - | - |
| Max well depth (m) | (4) | - | - | 66 (3) | - | 75.5 (1) | - | - |
| Water cut (m) | (4) | - | - | 19 (3) | - | 43.8 (1) | - | - |
| Observation year | | - | - | 1981 | - | 1981 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (4) | 100 (4) | - | - | - | - |
| Max well depth (m) | (4) | 49.5 (4) | - | - | - | - |
| Water cut (m) | (4) | 36.5 (4) | - | - | - | - |
| Observation year | | 1976 | - | - | - | - |

#### 4.3.1.2. Coorabie (5334), Pilpuppie (5234) and Nuyts (5333) 1:100 000 Map Sheets

The Bridgewater Formation is the dominant Quaternary sediment identified on *Coorabie* and *Pilpuppie* with an average thickness of 9 m. The Le Hunte Member and the Glanville Formation have also been identified in a small number of wells located in the south-east of *Coorabie*. Tertiary sediments are dominated by the Nullarbor Limestone but also include the Wilson Bluff Limestone, Hampton Sandstone and the Pidinga Formation and have been found as deep as 155 m. Basement rock, identified as the Mulgathing Complex, has a median depth of 56 m.

Salinity data has been observed from 96 wells and is highly variable but mostly saline (Table 8), ranging from 500–116 000 mg/L with a median of 8200 mg/L. There is a general trend of increasing salinity with increasing depth in the north-west, while in the south-east the shallow wells are highly saline. The four wells located within a few kilometres of the coast are saline at 11 000–40 000 mg/L. Less than 20% of groundwater salinity data is post-1999, with most recorded in the 1970s to 1990s. Production zone details are available for 24 wells; those open to the Bridgewater Formation have salinity between 1400–40 000 mg/L and those within the Tertiary (predominantly the Nullarbor Limestone), are between 600–30 000 mg/L. Yields are predominantly less than 1 L/s (90%), except for two records of 3 and 6.5 L/s, with the latter screened in the Pidinga Formation. Standing water levels cover a large range (4–107 m) and have a median of 16 m.

**Table 8. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Coorabie, Pilpuppie* and *Nuyts*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (96) | 7.3 (7) | 6.3 (6) | 8.3 (8) | 13.5 (13) | 22.9 (22) | 17.7 (17) | 24 (23) |
| Max Well depth (m) | (94) | 15.4 (6) | 17.2 (6) | 20.3 (8) | 18.6 (13) | 22 (21) | 22.9 (17) | 15.5 (23) |
| Yield (L/s) | (57) | 0.14 (6) | 0.45 (5) | 0.4 (4) | 0.25 (5) | 0.5 (13) | 0.13 (8) | 0.13 (16) |
| SWL (m) | (74) | 7.2 (7) | 16.5 (5) | 16.5 (7) | 15.5 (11) | 18.6 (17) | 16.8 (9) | 10.4 (18) |
| Water cut (m) | (60) | 18 (3) | 16.8 (5) | 17.1 (3) | 18 (5) | 12.2 (13) | 16.8 (12) | 14.9 (19) |
| Observation year | | 1964 | 1968 | 1964 | 1951 | 1973 | 1959 | 1957 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (78) | 19.2 (15) | 16.7 (13) | 37.2 (29) | 10.3 (8) | 11.5 (9) | 3.8 (3) | 1.3 (1) |
| Max well depth (m) | (77) | 4 (15) | 7.6 (13) | 19.4 (28) | 29.3 (8) | 44.6 (9) | 75 (3) | 108.8 (1) |
| Water cut (m) | (52) | 3.4 (10) | 7.2 (9) | 17 (16) | 28.3 (6) | 42.1 (7) | 68 (3) | 107.3 (1) |
| Observation year | | 1957 | 1957 | 1956 | 1978 | 1957 | 2002 | 1957 |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (62) | 90.3 (56) | 6.5 (4) | 1.6 (1) | 1.6 (1) | - |
| Max well depth (m) | (61) | 20.3 (55) | 60.3 (4) | 75 (1) | 81 (1) | - |
| Water cut (m) | (51) | 16.9 (46) | 53.6 (3) | 68 (1) | 43 (1) | - |
| Observation year | | 1963 | 1965 | 2002 | 1973 | - |

#### 4.3.1.3. Bookabie (5434) 1:100 000 Map Sheet

Quaternary sediments, including an unnamed calcrete and the Wiabuna and Bridgewater Formations, dominate the surface geology of *Bookabie* with a median thickness of 6 m. Tertiary sequences, predominantly the Pidinga Formation, have a median thickness of 18 m. Sedimentary sequences are underlain by Mesoproterozoic to Palaeoproterozoic rocks including Hiltaba Suite and St Peter Suite. Depth to basement ranges from 2–88 m.

Salinity data is available from 159 drillholes (Table 9) but are almost entirely confined to the southern half of the map sheet. Associated well production zone information is available for only a small subset of these. Salinity is highly variable, ranging from 157–70 500 mg/L with a median of 6250 mg/L, but several occurrences of good quality groundwater are apparent. While there appears to be a general trend of increasing salinity with increasing depth, the areal distribution of salinity appears to be random, except within ten kilometres of the coast where salinity is generally high (10 000–50 000 mg/L). Nearly half of the salinity data pre-dates 1960 with only 3% post-1999. Standing water levels vary greatly ranging between 0.5–57 m with a median of 7 m. Yields are between 0.01–18 L/s, although the majority are less than 1 L/s and the median just 0.15 L/s.

Only 14 wells have construction details, 11 of which are open to the Bridgewater Formation at depths ranging 1.5–17 m. Salinity is between 966–11 000 mg/L with a median of 2000 mg/L; yields are low, ranging from 0.04–2 L/s with a median of 0.32 L/s. Three wells are screened within the Tertiary sediments of the Pidinga Formation between 7–42 m; one bore has salinity of 2500 mg/L, while the others are greater than 20 000 mg/L with yields of 3 and 6.3 L/s.

**Table 9. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Bookabie*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (159) | 10.1 (16) | 6.3 (10) | 11.3 (18) | 14.5 (23) | 24.5 (39) | 21.4 (34) | 11.9 (19) |
| Max Well depth (m) | (154) | 8.1 (16) | 8.9 (10) | 7.6 (17) | 12.3 (20) | 9.9 (39) | 12 (33) | 29 (19) |
| Yield (L/s) | (98) | 0.1 (12) | 0.1 (6) | 0.19 (9) | 0.19 (16) | 0.22 (27) | 0.1 (18) | 0.07 (10) |
| SWL (m) | (106) | 6.9 (13) | 6.2 (8) | 6.9 (12) | 7.4 (18) | 6.3 (30) | 8.5 (20) | 21 (5) |
| Water cut (m) | (73) | 5.8 (7) | 5.5 (3) | 6.1 (8) | 6.6 (6) | 7 (16) | 11.9 (19) | 25.3 (14) |
| Observation year | | 1957 | 1970 | 1962 | 1979 | 1979 | 1959 | 1951 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (116) | 29.3 (34) | 45.7 (53) | 19 (22) | 5.2 (6) | 0.9 (1) | - | - |
| Max well depth (m) | (114) | 4.8 (33) | 9.9 (53) | 13.7 (21) | 25.3 (6) | 97 (1) | - | - |
| Water cut (m) | (38) | 3.1 (12) | 7 (20) | 10.7 (3) | 25 (2) | 31 (1) | - | - |
| Observation year | | 1979 | 1979 | 1969 | 1960 | 1981 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (111) | 89.2 (99) | 7.2 (8) | 0.9 (1) | 1.8 (2) | 0.9 (1) |
| Max well depth (m) | (106) | 11 (95) | 9 (7) | 32 (1) | 23.6 (2) | 9 (1) |
| Water cut (m) | (66) | 7.8 (57) | 5.8 (6) | 10 (1) | 6.1 (2) | - |
| Observation year | | 1957 | 1980 | 1996 | 1966 | 1978 |

### 4.3.1.4. Penong (5534) and Kalanbi (5634) 1:100 000 Map Sheets

Basement rocks of the Palaeoproterozoic St Peter Suite and the Mesoproterozoic Hiltaba Suite underlie *Penong* and *Kalanbi* at a median depth of 14 m. Overlying Tertiary sequences include the Pidinga Formation, Hampton Sandstone, Nullarbor Limestone and Wilson Bluff Limestone. The surface geology is dominated by Quaternary sequences, mainly the Wiabuna Formation but also the Bridgewater Formation, which have a median thickness of 6 m.

The town of Penong is located in the south-west corner of *Penong* and is surrounded by the Penong Water Protection Area (WPA). Water supply for Penong is sourced from lenses of low salinity groundwater within the generally saline regional groundwater. A network of 16 wells previously monitored salinity (last measured in 1996, ranging between 430–10 000 mg/L) and currently monitor water levels monthly (which vary from 3–12 m below ground). A number of other wells within the WPA have salinities less than 1000 mg/L and are found predominantly within one kilometre south-east of Penong. The wells have water levels less than 10 m below ground with both the Bridgewater and Pidinga Formations identified at this depth in this area. Apart from a few lenses of water with salinities between 1000–5000 mg/L to the south and south-east, the rest of *Penong* generally has salinities greater than 10 000 mg/L (Table 10). Wells showing high salinity appear to be screened within either Tertiary or fractured rock aquifers, suggesting that there is no trend in salinity with increasing depth.

**Table 10. Summary of salinity, standing water levels and yield data and associated median values (with number of data points in brackets) for *Penong* and *Kalanbi*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (151) | 16.6 (25) | 4 (6) | 7.9 (12) | 7.3 (11) | 19.2 (29) | 17.9 (27) | 27.2 (41) |
| Max Well depth (m) | (143) | 11.9 (23) | 12.3 (6) | 15.5 (10) | 18 (11) | 17.7 (26) | 22.9 (27) | 25 (40) |
| Yield (L/s) | (88) | 0.18 (14) | 0.16 (1) | 0.06 (6) | 0.13 (9) | 0.13 (19) | 0.06 (15) | 0.06 (24) |
| SWL (m) | (101) | 8.5 (21) | 7.8 (5) | 8.9 (10) | 13.7 (9) | 10.7 (22) | 15.2 (13) | 19.2 (21) |
| Water cut (m) | (100) | 9.1 (13) | 6.5 (2) | 9.5 (10) | 14.5 (8) | 15.2 (13) | 17.7 (19) | 23.8 (35) |
| Observation year | | 1979 | 1979 | 1980 | 1970 | 1979 | 1958 | 1951 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (106) | 5.7 (6) | 47.2 (50) | 29.2 (31) | 8.5 (9) | 9.4 (10) | - | - |
| Max well depth (m) | (103) | 9.1 (6) | 12 (47) | 18.3 (31) | 28 (9) | 45 (10) | - | - |
| Water cut (m) | (70) | 9.3 (4) | 9 (31) | 18.3 (17) | 26.8 (9) | 39.6 (9) | - | - |
| Observation year | | 1961 | 1979 | 1961 | 1957 | 1951 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (94) | 98.9 (93) | 1.1 (1) | - | - | - |
| Max well depth (m) | (94) | 18.6 (93) | 13.7 (1) | - | - | - |
| Water cut (m) | (78) | 17.8 (78) | - | - | - | - |
| Observation year | | 1958 | 1946 | - | - | - |

#### 4.3.1.5. Charra (5533) and Sinclair (5433) 1:100 000 Map Sheets

Limited stratigraphic data exists for *Charra* and *Sinclair and* as such, some geological units may not be included in the description and consequently thicknesses and depths are not provided. The Quaternary Bridgewater Formation blankets the area with the Wiabuna Formation to the north-east, Yamba Formation primarily to the north-east and the Semaphore Sand Member found along the coast. The underlying Tertiary sediments have been identified as the Pidinga Formation overlying Hiltaba Suite basement rocks.

Salinities are highly variable, ranging between 385–52 000 mg/L, although most wells are over 10 000 mg/L (Table 11). SWL is between 3–32 m with a median of 19 m and yields are low, between 0.01–1 L/s, with a median 0.1 L/s. Data is quite dated, with over two thirds from the 1940s and 1950s. Construction details are available for only two wells. They are both identified as screened in the Pidinga Formation between 18–24 m and have salinities just over 7000 mg/L. A natural topographic depression occurs near the coast in the north-west of *Charra*/north-east of *Sinclair* which acts as a groundwater discharge area and is the site of a gypsum quarry. The low relief and evaporative discharge results in groundwater which is often hyper saline.

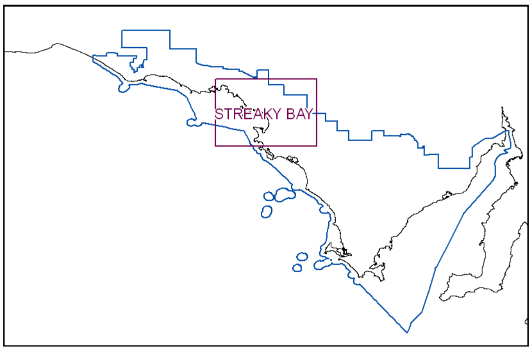
**Table 11. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Charra* and *Sinclair*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (144) | 4.2 (6) | 1.4 (2) | 2.1 (3) | 4.2 (6) | 18.8 (27) | 18.8 (27) | 50.7 (73) |
| Max Well depth (m) | (142) | 22.5 (6) | 2.1 (2) | 2.8 (3) | 2.4 (6) | 22 (26) | 12 (26) | 7.2 (73) |
| Yield (L/s) | (42) | 0.12 (2) | - | - | 0.25 (1) | 0.25 (13) | 0.05 (11) | 0.06 (15) |
| SWL (m) | (111) | 6.7 (5) | 1.6 (2) | 2 (2) | 1.8 (4) | 17.3 (19) | 13.4 (18) | 1.2 (61) |
| Water cut (m) | (4) | - | - | - | - | 22 (1) | - | 2.5 (3) |
| Observation year | | 1949 | 1970 | 1979 | 1959 | 1957 | 1958 | 1948 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (123) | 59.3 (73) | 4.1 (5) | 17.1 (21) | 18.7 (23) | 0.8 (1) | - | - |
| Max well depth (m) | (122) | 5.2 (73) | 10.4 (5) | 19.7 (20) | 26.5 (23) | 35.7 (1) | - | - |
| Water cut (m) | (5) | 2.5 (3) | - | - | 24.4 (2) | - | - | - |
| Observation year | | 1948 | 1950 | 1957 | 1951 | 1958 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (46) | 97.8 (45) | 2.2 (1) | - | - | - |
| Max well depth (m) | (45) | 23.6 (44) | 27 (1) | - | - | - |
| Water cut (m) | (1) | 22 (1) | - | - | - | - |
| Observation year | | 1951 | 1989 | - | - | - |

## 4.3.2. STREAKY BAY 1:250 000 MAP SHEET




The townships of Ceduna, Smoky Bay, Streaky Bay and Poochera are located within the extent of STREAKY BAY. Pastoral properties rely on drains, boreholes and windmill-equipped wells to augment the low annual rainfall. Groundwater is obtained from aquifers within the Bridgewater Formation and underlying Tertiary sediments, which receive limited recharge from local winter rainfall. Palaeodrainage systems are ubiquitous over most of STREAKY BAY with the Narlaby Palaeovalley identified over the northern extent.

Available groundwater data are summarised in Table 12, indicating highly variable observations of both groundwater salinity and standing water level. Many wells to the east and south of Streaky Bay have intersected groundwater of salinity less than 5000 mg/L. The Robinson freshwater lens, located nine kilometres south-east of Streaky Bay, contains potable water below 1000 mg/L and is bounded by the Robinson Lens Water Protection Area. Elsewhere, minor occurrences of fresh water have been noted on or near the flanks of buried granite inselbergs, with the fresh groundwater ‘floating’ on top of the regional saline watertable due to density effects (Rankin & Flint 1991).

**Table 12. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for STREAKY BAY.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (589) | 14.6 (86) | 10 (59) | 15.6 (92) | 10.5 (62) | 12.6 (74) | 14.8 (87) | 21.9 (129) |
| Max Well depth (m) | (571) | 12.1 (82) | 23.5 (57) | 26.2 (89) | 24.2 (60) | 30 (69) | 15.4 (86) | 14 (128) |
| Yield (L/s) | (328) | 0.38 (36) | 0.5 (37) | 0.38 (52) | 0.38 (33) | 0.29 (40) | 0.25 (55) | 0.63 (75) |
| SWL (m) | (503) | 7.2 (76) | 13.1 (50) | 16.5 (81) | 19.6 (53) | 22.2 (58) | 11.5 (78) | 8.5 (107) |
| Water cut (m) | (336) | 8.6 (40) | 24 (30) | 17.3 (53) | 17.7 (29) | 24.7 (24) | 10 (60) | 8.7 (100) |
| Observation year | | 1978 | 1978 | 1978 | 1978 | 1964 | 1959 | 1976 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (632) | 21 (133) | 22.8 (144) | 23.1 (146) | 19.1 (121) | 12.2 (77) | 1.7 (11) | - |
| Max well depth (m) | (629) | 5.8 (131) | 10 (144) | 18.3 (145) | 31.1 (121) | 44.2 (77) | 56.4 (11) | - |
| Water cut (m) | (394) | 4.1 (73) | 7 (106) | 14.8 (116) | 25.3 (76) | 33.5 (23) | - | - |
| Observation year | | 1985 | 1978 | 1977 | 1963 | 1954 | 1940 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (376) | 77.7 (292) | 19.9 (75) | 1.1 (4) | 0.5 (2) | 0.8 (3) |
| Max well depth (m) | (375) | 31.4 (291) | 12 (75) | 8.3 (4) | 30.6 (2) | 9 (3) |
| Water cut (m) | (271) | 22.9 (193) | 7.8 (70) | 4.3 (4) | 1 (1) | 4.2 (3) |
| Observation year | | 1956 | 1981 | 1977 | 1962 | 1973 |

### 4.3.2.1. Thevenard (5633) 1:100 000 Map Sheet

The SA Water reticulation network is well distributed across *Thevenard* and services the townships of Smoky Bay and Ceduna. Due to relatively low reliance on groundwater, groundwater salinity data is sparse (Table 13). Stratigraphic information is also scarce for *Thevenard* and is limited primarily to the areas north and west of Ceduna. The basement has been identified as predominantly St Peter Suite with a median depth of 13 m. Tertiary sequences, dominated by the Garford Formation, have a median thickness of 9 m. A thin veneer of Quaternary sequences consists of Bridgewater and Wiabuna Formations. The Narlaby Palaeovalley extends onto this map sheet in the vicinity of Smoky Bay.

In the north-west corner of *Thevenard*, salinity is high but variable (8000–56 000 mg/L, median 24 000 mg/L) and yields are low (median 0.1 L/s). In the south-eastern corner of the map sheet, shallow wells (1–5 m) display variable salinities ranging from 2500 to 46 000 mg/L with a median of 18 000 mg/L.

**Table 13. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Thevenard*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (25) | - | - | 4 (1) | 4 (1) | 20 (5) | 32 (8) | 40 (10) |
| Max Well depth (m) | (24) | - | - | 1.5 (1) | 2.4 (1) | 23.9 (4) | 10.8 (8) | 25.9 (10) |
| Yield (L/s) | (10) | - | - | - | - | 0.06 (4) | 0.13 (2) | 0.06 (4) |
| SWL (m) | (17) | - | - | 0.9 (1) | - | 14 (3) | 4.4 (6) | 3.1 (7) |
| Water cut (m) | (7) | - | - | - | - | - | 10.7 (3) | 25.2 (4) |
| Observation year | | - | - | 1965 | - | 1958 | 1961 | 1954 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (31) | 29 (9) | 25.8 (8) | 32.3 (10) | 6.5 (2) | 6.5 (2) | - | - |
| Max well depth (m) | (31) | 1.5 (9) | 8.8 (8) | 20.5 (10) | 46.4 (2) | 35.7 (2) | - | - |
| Water cut (m) | (18) | - | 7.5 (8) | 14.9 (9) | 50 (1) | - | - | - |
| Observation year | | 1965 | 2004 | 1982 | 1948 | 1920 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (11) | 90.9 (10) | 9.1 (1) | - | - | - |
| Max well depth (m) | (10) | 22 (9) | 60 (1) | - | - | - |
| Water cut (m) | (6) | 16 (6) | - | - | - | - |
| Observation year | | 1956 | 2004 | - | - | - |

### 4.3.2.2. Carawa (5733) 1:100 000 Map Sheet

A thin veneer of Quaternary Bridgewater Formation, Wiabuna Formation and Moornaba Sand is widespread over *Carawa*. Underlying Tertiary sequences of the Garford Formation typically overlie the Pidinga Formation. Depth to basement ranges between 8–154 m with a median of 51 m and consists of Archean to Palaeoproterozoic rocks including the St Peter and Hiltaba suites. The Narlaby Palaeovalley bisects *Carawa* and contains undifferentiated Quaternary sediments and the Garford and Pidinga Formations.

The SA Water reticulation network dissects *Carawa* and explains the paucity of groundwater wells within the area. Seven wells have pre-1977 water quality data (Table 14), but construction details exist for just one; this well is screened in the Bridgewater Formation at a depth of 10 m and has a salinity of 27 000 mg/L. The remaining wells have salinities between 8000–40 000 mg/L at depths of 20–40 m, which are likely to correlate with Tertiary sequences. Yields for three wells are all less than 1 L/s.

**Table 14. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Carawa*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (7) | - | - | - | - | - | 28.6 (2) | 71.4 (5) |
| Max Well depth (m) | (6) | - | - | - | - | - | 21.3 (2) | 28.7 (4) |
| Yield (L/s) | (2) | - | - | - | - | - | - | 0.13 (2) |
| SWL (m) | (4) | - | - | - | - | - | 18.9 (1) | 24.4 (3) |
| Water cut (m) | (1) | - | - | - | - | - | - | 8.5 (1) |
| Observation year | | - | - | - | - | - | 1940 | 1953 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (7) | 14.3 (1) | - | 28.6 (2) | 42.9 (3) | 14.3 (1) | - | - |
| Max well depth (m) | (7) | 6 (1) | - | 26.2 (2) | 34.1 (3) | 39.6 (1) | - | - |
| Water cut (m) | (1) | 3.5 (1) | - | - | - | - | - | - |
| Observation year | | 1987 | - | 1968 | 1912 | 2010 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (3) | 100 (3) | - | - | - | - |
| Max well depth (m) | (3) | 10.3 (3) | - | - | - | - |
| Water cut (m) | (2) | 6 (2) | - | - | - | - |
| Observation year | | 1982 | - | - | - | - |

### 4.3.2.3. Wirrulla (5833) 1:100 000 Map Sheet

The south/south-east section of *Wirrulla* falls within the study area. Quaternary sediments, dominated by aeolian sediments with some Bridgewater Formation found in the south-west, have a median thickness of 3 m. The Tertiary sequences are represented by the Garford and Pidinga formations with an average thickness of 22 m. Basement, including the weathered Hiltaba Suite, has been identified at depths of 8–124m.

Water quality data exists for only four wells (Table 15); three have production zone details and are screened across multiple formations including Quaternary, Tertiary and basement sequences. Low salinity water (2340 mg/L) is observed in the one shallow (10 m) well, whereas the three deeper wells (>40 m) have salinities in excess of 20 000 mg/L.

**Table 15. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Wirrulla*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (4) | - | - | 25 (1) | - | - | - | 75 (3) |
| Max Well depth (m) | (4) | - | - | 10 (1) | - | - | - | 47.2 (3) |
| Yield (L/s) | (3) | - | - | 0.1 (1) | - | - | - | 0.33 (2) |
| SWL (m) | (1) | - | - | - | - | - | - | 16.3 (1) |
| Water cut (m) | (4) | - | - | 6 (1) | - | - | - | 38.7 (3) |
| Observation year | | - | - | 1978 | - | - | - | 1949 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (2) | - | - | 50 (1) | - | - | 50 (1) | - |
| Max well depth (m) | (2) | - | - | 57 (1) | - | - | 53.3 (1) | - |
| Water cut (m) | (1) | - | - | 53 (1) | - | - | - | - |
| Observation year | | - | - | 2010 | - | - | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (4) | 100 (4) | - | - | - | - |
| Max well depth (m) | (4) | 50.3 (4) | - | - | - | - |
| Water cut (m) | (3) | 18.3 (3) | - | - | - | - |
| Observation year | | 1978 | - | - | - | - |

### 4.3.2.4. Streaky Bay (5732) 1:100 000 Map Sheet

*Streaky Bay* is typically dominated by approximately ten metre thick Quaternary sediments. The Bridgewater Formation is ubiquitous with the Semaphore Sand Member found along the coast. Underlying Tertiary sequences include the Garford, Pidinga and Pantoulbie Formations which have a median thickness of 14 m. Basement material has been identified as either Hiltaba Suite or St Peter Suite.

Limited groundwater data are available in the northern third of *Streaky Bay*, with most data available in the lower two thirds. The majority of data is from the 1950s to 1980s (Table 16), with only 20% collected in the last ten years. Salinity is between 60–108 200 mg/L with a median of 4570 mg/L. Wells with salinity in excess of 20 000 mg/L are generally found near the coast. From the 56 wells with production zone information, the Bridgewater Formation has salinity between 700–45 000 mg/L, median 5 000 mg/L and a median yield of 0.3 L/s. Tertiary Garford Formation salinities are between 350–55 000 mg/L, median 1700mg/L and have a median yield of 0.4 L/s. SWL is between 0.6–44 m, median 9 m with a general trend of deeper levels in the east. Yield is between 0.006–12 L/s, median of 0.5 L/s, with the rare high yields found near the coast.

Due to the generally highly saline groundwater found at Streaky Bay, the town water supply was historically obtained from the Robinson Lens, located about nine kilometres south-east of the town. The resource comprises a near-surface freshwater lens in the Bridgewater Formation separated from underlying high salinity groundwater in Tertiary sediments by a clay aquitard (Dodds, 1995). In 2003, the Streaky Bay water supply system was connected to the SA Water reticulation network. Since then, the amount of water extracted from the lens has reduced significantly with no extraction since 2007–08.

The Robinson Lens is monitored monthly for standing water level and salinity by a network of 61 wells. Salinity readings from May 2010 range between 160–38 000 mg/L, median 1800 mg/L, with the high salinities found in southern wells. The standing water level ranges between 1–15 m, but are typically around four metres below ground. Production zones within the Bridgewater Formation range between 3–12 m.

Elsewhere near the township of Streaky Bay, a number of wells completed in the Bridgewater Formation have historical salinity data typically in excess of 15 000 mg/L. Wells south and west of the Robinson Lens also generally observed higher salinities. However, to the north-east, a number of wells open to the deeper Garford or Pantoulbie formations have yielded low salinity groundwater, many less than 2000 mg/L.

A groundwater lens of salinity less than 1000 mg/L is identified and mapped in the south-east corner of *Streaky Bay.* The current extent and condition of the freshwater resource is uncertain, as most data is many decades old. Limited production zone information indicates the Bridgewater and Garford Formations are the main aquifers in the area. Relatively low salinity (mostly <5000 mg/L) groundwater may occur within palaeovalley sediments identified in the area.

**Table 16. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Streaky Bay*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (420) | 16.9 (71) | 10 (42) | 15.5 (65) | 11.2 (47) | 9.5 (40) | 14 (59) | 22.9 (96) |
| Max Well depth (m) | (413) | 9.4 (68) | 12.4 (41) | 24 (64) | 14 (46) | 21.5 (40) | 12.3 (58) | 12 (96) |
| Yield (L/s) | (221) | 0.38 (28) | 0.5 (23) | 0.38 (36) | 0.38 (22) | 0.38 (17) | 0.5 (39) | 1 (56) |
| SWL (m) | (380) | 6.4 (63) | 9.6 (40) | 13.9 (61) | 8.2 (41) | 13.1 (35) | 9.5 (55) | 7 (85) |
| Water cut (m) | (301) | 8.6 (40) | 24 (27) | 17.7 (45) | 16.4 (26) | 21.5 (20) | 9.5 (54) | 7 (89) |
| Observation year | | 1986 | 1985 | 1978 | 1978 | 1978 | 1975 | 1978 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (469) | 25.6 (120) | 28.1 (132) | 25.6 (120) | 16 (75) | 4.7 (22) | - | - |
| Max well depth (m) | (466) | 6.1 (118) | 10 (132) | 18.3 (119) | 31 (75) | 37 (22) | - | - |
| Water cut (m) | (358) | 4.2 (73) | 7 (98) | 15 (106) | 25.3 (66) | 33.5 (15) | - | - |
| Observation year | | 1987 | 1978 | 1977 | 1970 | 1967 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (248) | 68.1 (169) | 28.2 (70) | 1.6 (4) | 0.8 (2) | 1.2 (3) |
| Max well depth (m) | (248) | 28 (169) | 12 (70) | 8.3 (4) | 30.6 (2) | 9 (3) |
| Water cut (m) | (234) | 20 (157) | 7.6 (69) | 4.3 (4) | 1 (1) | 4.2 (3) |
| Observation year | | 1958 | 1981 | 1977 | 1962 | 1973 |

### 4.3.2.5. Cungena (5832) 1:100 000 Map Sheet

The Bridgewater Formation is the dominant surface geology of *Cungena* and has a median thickness of 5 m with the Wiabuna Formation also identified. Tertiary sequences, dominated by the Garford Formation but also including the Pidinga and the Pantoulbie Formations, have an average thickness of 14 m. Basement rock is predominantly the Hiltaba Suite but the Sleaford and St Peter Suite have also been identified. Depth to basement is anywhere between 5–117 m (median depth of 18 m) with shallow basement found in the south.

The northern half of *Cungena*, which includes the township of Poochera, is serviced by the reticulated water pipeline and as such, wells are concentrated in the lower half of the map sheet. The salinity in most wells ranges between 370–10 000 mg/L (Table 17), with a median of 4300 mg/L. High salinity wells (10 000–40 000 mg/L), which are deeper than 20 m, are found mostly in the south but include the few wells scattered in the north of *Cungena*. Groundwater salinity observations below 1000 mg/L are primarily coincident with the two unnamed fresh groundwater lenses located in the south-west corner of the map sheet, but this data is many decades old.

Overall, less that 5% of data was observed in the last ten years, with most pre-1950. Construction details are available for eleven wells, nine of which are screened in the Garford Formation (1000–7000 mg/L; SWL 22–40 m; yield 0.25–1.4 L/s). The other two wells are screened in basement rock, with salinity 1700 and 9500 mg/L and a yield of 0.2 L/s.

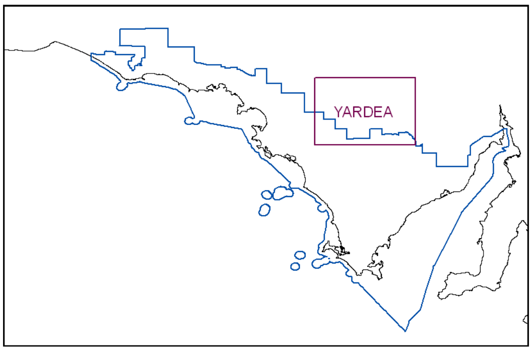
**Table 17. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Cungena*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (133) | 12 (16) | 12.8 (17) | 18 (24) | 11.3 (15) | 21.8 (29) | 14.3 (19) | 9.8 (13) |
| Max Well depth (m) | (124) | 18.3 (15) | 26.5 (15) | 35.4 (23) | 41 (14) | 42.7 (25) | 46.9 (19) | 41.2 (13) |
| Yield (L/s) | (92) | 0.35 (8) | 0.38 (13) | 0.29 (16) | 0.32 (11) | 0.25 (19) | 0.04 (14) | 0.08 (11) |
| SWL (m) | (101) | 16.1 (14) | 21.4 (10) | 25.5 (18) | 30 (13) | 34.3 (20) | 33.5 (17) | 29.6 (9) |
| Water cut (m) | (23) | - | 24 (4) | 25.7 (5) | 30.5 (3) | 30 (5) | 51.2 (3) | 39.3 (3) |
| Observation year | | 1957 | 1960 | 1978 | 1956 | 1951 | 1951 | 1952 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (123) | 4.1 (5) | 4.1 (5) | 11.4 (14) | 30.9 (38) | 41.5 (51) | 8.1 (10) | - |
| Max well depth (m) | (123) | 9.4 (5) | 15.5 (5) | 19.2 (14) | 31.9 (38) | 46.9 (51) | 56.8 (10) | - |
| Water cut (m) | (16) | 22.4 (1) | 6 (1) | 24.1 (1) | 28.1 (6) | 38.2 (7) | - | - |
| Observation year | | 1978 | 1978 | 1978 | 1955 | 1953 | 1940 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (110) | 96.4 (106) | 3.6 (4) | - | - | - |
| Max well depth (m) | (110) | 40.3 (106) | 54.9 (4) | - | - | - |
| Water cut (m) | (26) | 31.7 (25) | 30 (1) | - | - | - |
| Observation year | | 1953 | 1955 | - | - | - |

## 4.3.3. YARDEA 1:250 000 MAP SHEET




YARDEA is found on the northern boundary of the EPNRM Region and overlaps the southern extent of the Gawler Ranges; the Narlaby Palaeovalley extends onto the south-eastern portion. Excluding the palaeovalley, Quaternary and Tertiary sediments are typically thin, with basement material generally occurring at shallow depths and frequently outcropping.

The main groundwater resources are expected to be in fractured basement material or Tertiary sediments within the Palaeovalley. Only a small number of groundwater data exist for this map sheet and is generally characterised by high salinity (>3000 mg/L), relatively deep occurrence (SWL greater than 30 m) and of yields below 1 L/s (Table 18).

**Table 18. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for YARDEA.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (32) | 3.1 (1) | - | - | 9.4 (3) | 6.3 (2) | 40.6 (13) | 40.6 (13) |
| Max Well depth (m) | (28) | - | - | - | 50.8 (2) | 52.4 (2) | 29.9 (11) | 63.4 (13) |
| Yield (L/s) | (19) | - | - | - | 0.2 (2) | 0.13 (1) | 0.25 (10) | 0.69 (6) |
| SWL (m) | (12) | - | - | - | 9.1 (1) | 66.5 (1) | 11 (4) | 41.2 (6) |
| Water cut (m) | (18) | - | - | - | 53.3 (2) | 75.3 (1) | 10.7 (7) | 46.9 (8) |
| Observation year | | 1937 | - | - | 1962 | 1967 | 1961 | 1959 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (14) | 7.1 (1) | 7.1 (1) | 14.3 (2) | 7.1 (1) | 28.6 (4) | 35.7 (5) | - |
| Max well depth (m) | (14) | 6.1 (1) | 18.3 (1) | 15.4 (2) | 67.5 (1) | 57.2 (4) | 85 (5) | - |
| Water cut (m) | (8) | 2.7 (1) | - | 11.1 (2) | 65 (1) | 40.6 (2) | 66.6 (2) | - |
| Observation year | | 1961 | 1962 | 1961 | 2007 | 1980 | 1985 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (20) | 85 (17) | 15 (3) | - | - | - |
| Max well depth (m) | (19) | 64.2 (16) | 30.5 (3) | - | - | - |
| Water cut (m) | (14) | 42.7 (11) | 7.3 (3) | - | - | - |
| Observation year | | 1960 | 1961 | - | - | - |

### 4.3.3.1. Buckleboo (6132) 1:100 000 Map Sheet

Only the southern half of *Buckleboo* is within the study area. The surface geology is predominantly Cainozoic sand plains; Quaternary and Tertiary sequences consist almost entirely of undifferentiated formations and have a combined median thickness of 12 m. Basement primarily consists of the

Hutchison Group. Across the map sheet, there are 15 wells with salinity records and values range between 330–46 000 mg/L with a median of 14 000 mg/L (Table 19). Nearly all yields are less than 1 L/s and the limited observations of SWL are all greater than 20 m. The reticulated water system extends to the southern boundary of *Buckleboo*.

**Table 19. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Buckleboo*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (15) | 6.7 (1) | - | - | 13.3 (2) | 13.3 (2) | 20 (3) | 46.7 (7) |
| Max Well depth (m) | (13) | - | - | - | 83.2 (1) | 52.4 (2) | 93.3 (3) | 52.7 (7) |
| Yield (L/s) | (8) | - | - | - | 0.2 (2) | 0.13 (1) | 0.19 (3) | 1.29 (2) |
| SWL (m) | (6) | - | - | - | - | 66.5 (1) | 30 (1) | 40.9 (4) |
| Water cut (m) | (9) | - | - | - | 53.3 (2) | 75.3 (1) | 30 (1) | 51.2 (5) |
| Observation year | | 1937 | - | - | 1960 | 1967 | 1960 | 1979 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (8) | - | - | 12.5 (1) | 12.5 (1) | 25 (2) | 50 (4) | - |
| Max well depth (m) | (8) | - | - | 67.5 (1) | 33 (1) | 71.2 (2) | 108.2 (4) | - |
| Water cut (m) | (5) | - | - | 65 (1) | 30 (1) | 51.2 (1) | 66.6 (2) | - |
| Observation year | | - | - | 2007 | 2006 | 1976 | 1976 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (9) | 88.9 (8) | 11.1 (1) | - | - | - |
| Max well depth (m) | (8) | 83.2 (7) | 67.5 (1) | - | - | - |
| Water cut (m) | (6) | 56.1 (5) | 65 (1) | - | - | - |
| Observation year | | 1957 | 2007 | - | - | - |

#### 4.3.3.2. Minnipa (5932) and Cacuppa (6032) 1:100 000 Map Sheet

*Minnipa* is dominated by Quaternary sediments, particularly aeolian sands. Underlying Quaternary sequences include Moornaba Sand and the Pooraka, Bridgewater and Wiabuna Formations and have a median thickness of three metres. Tertiary sediments consist primarily of the Garford Formation and have a median thickness of 32 m. Basement is predominantly the Hiltaba Suite which is observed in outcrop throughout *Minnipa*, particularly the north-east corner.

The reticulated water system is present across much of this map sheet. Groundwater quality data is available for only 16 wells and this data was recorded predominantly before 1970 (Table 20). Salinity is high, between 4000–51 000 mg/L with a median of 17 000 mg/L and the median yield is 0.4 L/s. Production zone details exist for 6 wells, the deepest open to the Hiltaba Suite with a salinity of 40 000 mg/L. Four are screened in the Garford Formation and have salinity between 15 000–18 000 mg/L and yields of 0.25–1.4 L/s. The one remaining well is screened in the underlying Pidinga Formation and has salinity of 51 000 mg/L and an extremely low yield of 0.0001 L/s. Indentified palaeovalleys include the Narlaby (north-west to south-east *Minnipa*), Yaninee (south-west corner of *Minnipa*) and Thurlga (eastern *Cacuppa)*.

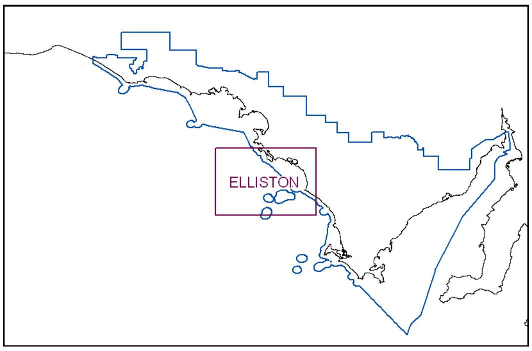
**Table 20. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Minnipa* and *Cacuppa*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (16) | - | - | - | 6.3 (1) | - | 56.3 (9) | 37.5 (6) |
| Max Well depth (m) | (15) | - | - | - | 18.3 (1) | - | 27.4 (8) | 64.2 (6) |
| Yield (L/s) | (11) | - | - | - | - | - | 0.25 (7) | 0.69 (4) |
| SWL (m) | (6) | - | - | - | 9.1 (1) | - | 10.4 (3) | 48.3 (2) |
| Water cut (m) | (9) | - | - | - | - | - | 9 (6) | 42.7 (3) |
| Observation year | | - | - | - | 1962 | - | 1961 | 1955 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (6) | 16.7 (1) | 16.7 (1) | 33.3 (2) | - | 16.7 (1) | 16.7 (1) | - |
| Max well depth (m) | (6) | 6.1 (1) | 18.3 (1) | 15.4 (2) | - | 63.4 (1) | 85 (1) | - |
| Water cut (m) | (3) | 2.7 (1) | - | 11.1 (2) | - | - | - | - |
| Observation year | | 1961 | 1962 | 1961 | - | 1960 | 1999 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (11) | 81.8 (9) | 18.2 (2) | - | - | - |
| Max well depth (m) | (11) | 42.7 (9) | 30.2 (2) | - | - | - |
| Water cut (m) | (8) | 30.8 (6) | 7.2 (2) | - | - | - |
| Observation year | | 1961 | 1961 | - | - | - |

### 4.3.4. ELLISTON 1:250 000 MAP SHEET




A number of fresh groundwater lenses are defined within ELLISTON, including the Kappawanta-Bramfield and Talia lenses within the Musgrave PWA and the Port Kenny and Venus Bay lenses in the non-prescribed region. The host sediments are a combination of Bridgwater Formation (Pleistocene aeolianite) and undifferentiated Tertiary sands. Available groundwater data indicates a significant occurrence of salinity less than 5000 mg/L and standing water levels typically less than 20 m (Table 21).

The townships of Venus Bay and Port Kenny are not currently supplied by reticulated water. Rainwater provides the main source of water for the permanent residents and some private carting of water from the District Council of Elliston storage facility is also used. Near the townships of Venus Bay and Port Kenny, the small low salinity lenses are used to supplement town water supplies and a rise in demand is predicted over the next 10-15 years. A conservative management policy for active water reserves has been implemented by DC Elliston, placing limits on new applicants wishing to use the resource (Rob Gregor [DC Elliston] 2011, pers. comm.)

**Table 21. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for ELLISTON. Includes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (695) | 23.9 (166) | 8.9 (62) | 21.2 (147) | 16.8 (117) | 10.1 (70) | 9.2 (64) | 9.9 (69) |
| Max Well depth (m) | (660) | 10.3 (163) | 16.2 (58) | 12.2 (142) | 7.9 (108) | 16.2 (65) | 15.5 (59) | 27.1 (65) |
| Yield (L/s) | (356) | 0.63 (69) | 0.25 (27) | 0.4 (73) | 0.38 (55) | 0.25 (43) | 0.13 (42) | 0.25 (47) |
| SWL (m) | (593) | 5.1 (150) | 9.1 (54) | 6.7 (131) | 4.3 (97) | 9.5 (59) | 10.5 (52) | 12 (50) |
| Water cut (m) | (368) | 10.1 (86) | 15.7 (28) | 10 (71) | 9.1 (44) | 15 (38) | 16.3 (42) | 16.2 (59) |
| Observation year | | 1978 | 1969 | 1977 | 1977 | 1968 | 1960 | 1955 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (638) | 39.3 (251) | 22.9 (146) | 19.9 (127) | 8.6 (55) | 5.5 (35) | 3.8 (24) | - |
| Max well depth (m) | (635) | 4.4 (249) | 11.3 (146) | 19.5 (127) | 30 (55) | 42.2 (34) | 73.2 (24) | - |
| Water cut (m) | (350) | 4.3 (86) | 8.5 (99) | 16.5 (88) | 27 (38) | 36.6 (25) | 66.6 (14) | - |
| Observation year | | 1977 | 1977 | 1974 | 1964 | 1955 | 1977 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (388) | 78.1 (303) | 15.5 (60) | 4.1 (16) | 1.8 (7) | 0.5 (2) |
| Max well depth (m) | (385) | 21 (301) | 13.5 (60) | 9.3 (16) | 22.6 (6) | 19.9 (2) |
| Water cut (m) | (329) | 15 (257) | 7 (50) | 5.2 (16) | 18.8 (4) | 16.1 (2) |
| Observation year | | 1956 | 1988 | 1999 | 1977 | 1978 |

#### 4.3.4.1. Radstock (5731) 1:100 000 Map Sheet

Basement comprising the Hiltaba Suite, is found at a median depth of 11 m, with small outcrops of Calca Granite found to the east. The Garford Formation is the commonly identified Tertiary sequence and has a median thickness of 7 m. Quaternary sediments are predominately the Bridgewater Formation but include the Glanville and Wiabuna Formations and have a median thickness of 6 m.

On *Radstock*, less than 5% of data is post 1999, with more than half of the observations from the 1950s. In and around the small coastal town of Bairds Bay, there is no recent groundwater data and very limited historical data. From the available information, groundwater salinities in wells located within the township range between 3000–20 000 mg/L.

In general, salinity on *Radstock* is highly variable (370–60 000 mg/L, median 3400 mg/L) and no vertical or spatial trend is apparent (Table 22). Well yields are low with a median of 0.3 L/s. Seven wells are open to the Hiltaba Suite and range in salinity between 850–26 000 mg/L over a range of depths from 8–62 m. The production zones of 36 wells are within the Garford Formation at depths of 3–37 m with salinity 400–68 000 mg/L and median of 5200 mg/L. The Bridgewater Formation is screened in 27 wells up to a maximum depth of 57 m and has salinities of 800–45 000 mg/L with a median of 7200 mg/L.

**Table 22. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Radstock*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (165) | 17 (28) | 10.3 (17) | 18.8 (31) | 13.3 (22) | 13.3 (22) | 11.5 (19) | 15.8 (26) |
| Max Well depth (m) | (162) | 13.9 (28) | 21.3 (17) | 20.1 (31) | 15.9 (21) | 13.1 (21) | 14.6 (18) | 17 (26) |
| Yield (L/s) | (120) | 0.38 (15) | 0.3 (17) | 0.38 (26) | 0.32 (12) | 0.12 (17) | 0.1 (16) | 0.25 (17) |
| SWL (m) | (144) | 8.6 (25) | 14.6 (16) | 10.3 (29) | 9.6 (19) | 8.5 (19) | 8.7 (16) | 7.8 (20) |
| Water cut (m) | (119) | 17.7 (13) | 18 (15) | 11.4 (24) | 15.5 (10) | 12.1 (16) | 12.8 (16) | 9.1 (25) |
| Observation year | | 1953 | 1953 | 1977 | 1974 | 1958 | 1954 | 1955 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (157) | 31.2 (49) | 26.1 (41) | 28 (44) | 8.9 (14) | 5.1 (8) | 0.6 (1) | - |
| Max well depth (m) | (157) | 4.5 (49) | 12.2 (41) | 23 (44) | 31.5 (14) | 47.4 (8) | 63.1 (1) | - |
| Water cut (m) | (114) | 4 (24) | 9.1 (33) | 16.6 (36) | 25.6 (12) | 37.5 (8) | 62.5 (1) | - |
| Observation year | | 1969 | 1955 | 1953 | 1954 | 1953 | 1963 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (129) | 92.2 (119) | 7.8 (10) | - | - | - |
| Max well depth (m) | (129) | 20.1 (119) | 8.5 (10) | - | - | - |
| Water cut (m) | (117) | 13.9 (108) | 4 (9) | - | - | - |
| Observation year | | 1953 | 1977 | - | - | - |

### 4.3.4.2. Talia (5831) 1:100 000 Map Sheet

The Musgrave PWA occupies the south-east corner of *Talia* and the Port Kenny Water Protection Area is located in the east of the map sheet and contains the Port Kenny Lens. The Yaninee Palaeovalley occurs over much of *Talia's* southern half and the Polda Trough occurs in the south-east corner.

Basement material (predominantly identified as the Hiltaba Suite) outcrops in the north and is surrounded by Quaternary Pooraka Formation, which transitions to the widespread Bridgewater Formation. The Quaternary sequences have a median thickness of 6.5 m. Tertiary sediments have a median thickness of 20 m and are dominated by the Garford Formation, but the Poelpena and Pidinga Formations have also been identified.

In the north/north-west of the map sheet, salinity is between 29–112 880 mg/L with a median of 5500 mg/L, SWL is between 1–70m with a median of 12 m and yield is between 0.006–6 L/s with a median of 0.25 L/s. Thirteen wells are screened in the Hiltaba Suite with salinity of 1100–37 000 mg/L and a median of 16 000 mg/L, SWL is between 12–65 m and yields are between 0.013–0.5 L/s. Twenty-two wells screened in the Garford Formation have salinity between 240–40 000 mg/L and a median of 4320 mg/L, SWL between 2–30 m and yields between 0.006–1 L/s. Four wells identified to be open to the Bridgewater Formation, with just the one having a salinity reading which is 1720 mg/L. SWL is between 4–11 m and yield is between 0.25–0.6 L/s.

Wells located in the southern half of *Talia* have salinity between 350–87 000 mg/L with a median of 2100 mg/L. Standing water levels are between 0.6–15 m with a median of 4.5 m. Yields range from 0.04–6.3 L/s and have a median of 1.3 L/s. Eight wells are positively identified as screened in the Bridgewater Formation, with salinities between 600–33 000 mg/L, median 2100 mg/L. SWL is between 2–7 m and yields range from 0.08–3.5 L/s. Nine wells are identified to be open to the Garford Formation with all bar one observing salinity below 1000 mg/L. Standing water levels are between 4–12 m and yield data for one well is 1.4 L/s.

**Table 23. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Talia*. Excludes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (221) | 18.1 (40) | 7.2 (16) | 19.5 (43) | 11.8 (26) | 12.2 (27) | 14.5 (32) | 16.7 (37) |
| Max Well depth (m) | (207) | 13.7 (37) | 20.4 (14) | 15.6 (40) | 11.7 (22) | 21 (27) | 19.2 (31) | 30.8 (36) |
| Yield (L/s) | (135) | 0.38 (15) | 0.08 (7) | 0.3 (23) | 0.32 (17) | 0.25 (22) | 0.12 (22) | 0.13 (29) |
| SWL (m) | (181) | 6.8 (32) | 6 (13) | 4.3 (38) | 7 (19) | 13.7 (25) | 14 (27) | 20.7 (27) |
| Water cut (m) | (155) | 9.1 (28) | 8 (10) | 6 (27) | 9.1 (15) | 18.6 (19) | 17.7 (23) | 26.8 (33) |
| Observation year | | 1970 | 1968 | 1981 | 1959 | 1963 | 1959 | 1954 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (198) | 29.8 (59) | 26.8 (53) | 22.7 (45) | 11.1 (22) | 8.1 (16) | 1.5 (3) | - |
| Max well depth (m) | (196) | 6.5 (58) | 13.7 (53) | 21 (45) | 34.1 (22) | 39.6 (15) | 85.3 (3) | - |
| Water cut (m) | (145) | 4.5 (33) | 9.1 (44) | 17.7 (33) | 28.2 (20) | 37.8 (12) | 76 (3) | - |
| Observation year | | 1981 | 1970 | 1961 | 1955 | 1955 | 1988 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (150) | 86.7 (130) | 10.7 (16) | 0.7 (1) | 2 (3) | - |
| Max well depth (m) | (147) | 23.1 (128) | 15.4 (16) | 8 (1) | 50.5 (2) | - |
| Water cut (m) | (128) | 17.7 (112) | 6.5 (14) | 3 (1) | 31.5 (1) | - |
| Observation year | | 1956 | 1983 | 1982 | 1975 | - |

### *Port Kenny*

Historical (1944–1988) groundwater data taken from wells located in the town of Port Kenny indicate typically highly saline groundwater (1300–113 000 mg/L, median 6200 mg/L). As a result, Port Kenny derives its water supply from private rainwater tanks and the Thulinippie Well located 4 km north-west of the town. The well is reportedly within a Pleistocene aeolianite aquifer that is easily depleted during periods of low rainfall (Flint 1992); and a safe yield is unknown. Approximately six megalitres of unfiltered water is pumped per day from the well (DC Elliston 2007). This resource may be highly sensitive to over-pumping due to higher salinities observed in a number of nearby observation wells. In high demand periods, groundwater salinities in excess of 4000 mg/L have been recorded (DC Elliston 2007).

Investigations during 1967–1970 and the drilling of at least 17 wells outlined the Port Kenny Lens approximately 13 km south-east of the town (Flint 1992). The lens has observed low salinity groundwater but recent data is not available. The sedimentary basin housing the lens contains Quaternary Bridgewater Formation and Tertiary Poelpena Formation sediments up to 24 m deep (Taylor 2003); the Garford Formation has also been identified nearby. The lens is thought to cover an area of at least 35 $km^2$, although the full extent of the lens is not well defined (Flint 1992).

Previous estimates of annual recharge to the lens and extractable yield have been made. However, Taylor (2003) agrees the figures cannot be verified as the true extent of the lens is unknown and insufficient historical and modern groundwater data exists to determine the response of the lens to rainfall variations or to accurately estimate recharge.

### *Venus Bay*

Venus Bay does not receive water via the SA Water pipeline but relies on groundwater from the Quaternary Bridgewater Formation and rainwater collected by domestic tanks (EPCWMB 2005). SA Water (2003) estimates the existing potential consumption of Venus Bay at 29 ML/a. Groundwater is sourced from a small local lens immediately east of Venus Bay. The resource is generally of poor quality, with the pumped salinity ranging up to 4000 mg/L. Though the safe yield was estimated at approximately 20 ML/year, the apparent limited recharge and storage capacity suggest that future production should be carefully monitored (Flint 1992).

### *Monitoring Network*

The Venus Bay–Port Kenny observation network incorporates 21 wells. Water levels are monitored monthly, whilst the observation of salinity is sporadic. The majority of wells are located within the Thulinippie and Venus Bay Water Protection Areas to monitor the groundwater resources surrounding the town water supply wells.

There are ten observation wells located within the Thulinippie WPA. Salinity is monitored on a random basis. At the time of writing the most recent observations (2009) recorded salinities of 600–13 500 mg/L with a median of 1500 mg/L. SWL is monitored monthly and is recently (August 2010) between 1.3–10.4 m below ground with a median of 5 m.

Nine wells are located within the Venus Bay WPA and are within the historically mapped extent of the Yaninee Palaeovalley. Well depths are shallow (4–11m) with five of the wells screened in the Bridgewater Formation. Recent (2009) data indicates salinities between 2800–11 000 mg/L with a median of 3500 mg/L. SWL is monitored monthly and is between 1–7 m.

Two observation wells are located in the distant north-west corner of the Talia map sheet and are currently monitored monthly for SWL. Historical (1985) salinity measurements of these wells indicate the occurrence of fresh groundwater (800 and 1000 mg/L).

#### 4.3.4.3. Elliston (5830) 1:100 000 Map Sheet

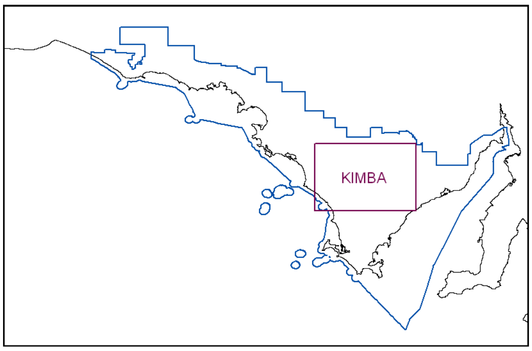
The terrestrial component of *Elliston* is entirely within the Musgrave PWA and as such, no detailed discussion is provided. For a brief summary of groundwater quality, please refer to Table 24.

**Table 24. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Elliston*. Includes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (224) | 33.5 (75) | 8 (18) | 28.1 (63) | 23.2 (52) | 3.6 (8) | 2.7 (6) | 0.9 (2) |
| Max Well depth (m) | (217) | 9.5 (75) | 9.2 (17) | 8.5 (62) | 3.8 (48) | 4.3 (7) | 4 (6) | 9.5 (2) |
| Yield (L/s) | (84) | 2 (33) | 0 (0) | 0.7 (24) | 1 (22) | 1.3 (2) | 0.4 (2) | 1.1 (1) |
| SWL (m) | (204) | 4.1 (70) | 7.7 (16) | 5.4 (57) | 3 (46) | 2.7 (8) | 0.8 (5) | 4.8 (2) |
| Water cut (m) | (74) | 7 (35) | 0 (0) | 12.2 (18) | 5.2 (16) | 50 (2) | 13.7 (2) | 16 (1) |
| Observation year | | 1979 | 1977 | 1977 | 1977 | 1965 | 1977 | 1977 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (217) | 57.1 (124) | 18 (39) | 10.6 (23) | 6.5 (14) | 1.4 (3) | 6.5 (14) | - |
| Max well depth (m) | (216) | 3.6 (123) | 10 (39) | 16.5 (23) | 29.1 (14) | 48.5 (3) | 83.6 (14) | - |
| Water cut (m) | (71) | 4.5 (29) | 7.8 (16) | 14 (10) | 28.5 (7) | 42.5 (1) | 66.6 (8) | - |
| Observation year | | 1978 | 1978 | 1978 | 1978 | 1977 | 1977 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (91) | 44 (40) | 33 (30) | 16.5 (15) | 4.4 (4) | 2.2 (2) |
| Max well depth (m) | (91) | 15.1 (40) | 13 (30) | 9.5 (15) | 10.5 (4) | 19.9 (2) |
| Water cut (m) | (74) | 12 (31) | 8 (23) | 5.4 (15) | 6 (3) | 16.1 (2) |
| Observation year | | 1985 | 1994 | 1999 | 1983 | 1978 |

### 4.3.5. KIMBA 1:250 000 MAP SHEET




The townships of Kimba, Lock and Wudinna are supplied by the SA Water reticulation network. Pastoral properties on KIMBA augment their water supply with stock dams and wells equipped with windmills. Frequent water shortages occurred until 1975, when the Lock–Kimba pipeline from the Tod Trunk Main was connected to the Kimba reticulation system (Flint & Rankin 1991).

Groundwater is obtained from Precambrian basement, Tertiary sediments and Quaternary sediments (Shepherd 1978). The most important source of groundwater on KIMBA is the Polda (freshwater) Basin, which is located within the Musgrave PWA. Available groundwater data suggests mostly low salinity observations and standing water levels less than 10 m (Table 25).

**Table 25. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for KIMBA. Includes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (1605) | 44.5 (715) | 16.6 (266) | 14.6 (234) | 5.2 (84) | 4.9 (78) | 6.9 (110) | 7.4 (118) |
| Max Well depth (m) | (1550) | 12.5 (702) | 12.8 (261) | 11.9 (224) | 15.5 (78) | 14.9 (70) | 25.9 (101) | 22.6 (114) |
| Yield (L/s) | (292) | 0.64 (110) | 1.26 (39) | 0.55 (42) | 0.38 (16) | 0.4 (16) | 0.32 (37) | 0.25 (32) |
| SWL (m) | (1318) | 5.9 (632) | 5.7 (232) | 5.6 (196) | 5.9 (65) | 4.6 (51) | 9.5 (69) | 5 (73) |
| Water cut (m) | (897) | 7.6 (443) | 7.6 (161) | 9 (113) | 9.9 (36) | 8.5 (37) | 13.6 (60) | 21.3 (47) |
| Observation year | | 1968 | 1967 | 1977 | 1967 | 1967 | 1962 | 1990 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (1462) | 39.3 (575) | 35.1 (513) | 17.9 (262) | 4.5 (66) | 1.9 (28) | 1.2 (18) | - |
| Max well depth (m) | (1454) | 6 (572) | 12.2 (509) | 19.9 (262) | 30.5 (65) | 47.1 (28) | 81.5 (18) | - |
| Water cut (m) | (806) | 4.3 (224) | 7.6 (340) | 15 (179) | 26.5 (43) | 41.2 (13) | 63.4 (7) | - |
| Observation year | | 1979 | 1995 | 1995 | 1985 | 1962 | 1962 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (344) | 63.7 (219) | 25 (86) | 6.1 (21) | 3.8 (13) | 1.5 (5) |
| Max well depth (m) | (342) | 22.8 (218) | 18.3 (85) | 12.8 (21) | 25.9 (13) | 12.5 (5) |
| Water cut (m) | (277) | 14 (161) | 8.9 (82) | 7 (21) | 9.1 (9) | 7 (4) |
| Observation year | | 1973 | 1970 | 1997 | 1969 | 1969 |

#### 4.3.5.1. Damper (5931) 1:100 000 Map Sheet

The Musgrave PWA covers the southern third of *Damper*. The SA Water pipeline extends over the northern extent and the Yaninee Palaeovalley occurs over much of the map sheet. Basement rocks have been identified as undifferentiated Archaean to Palaeoproterozoic basement, including Sleaford

Complex and Hiltaba Suite, at a median depth of 42 m. The Yaninee Palaeovalley extends onto Damper and Tertiary sediments of the Garford and Poelpena Formations have been identified and are found from shallow depths to up to 100 m. Quaternary sediments include Moornaba Sand, Pooraka Formation and Bridgewater Formation with a median thickness of 4 m.

Groundwater data and construction details are generally limited, with most data collected over 50 years ago. The majority of *Damper* groundwater data is observed within the PWA, where salinities are predominantly less than 1000 mg/L. Outside the PWA data is scarce, with only a few wells having observed salinity values, typically in excess of 5000 mg/L (Table 26).

Outside of the PWA, 27 wells have salinity between 794–36 000 mg/L (median 15 700 mg/L). Standing water level are between 1.5–50.6 m, median 16.7 m and yields are mostly less than 1 L/s with a median of 0.3 L/s. Limited production zone and stratigraphic interval data are available for correlation with groundwater data, but indicates Quaternary, Tertiary and Basement formations are being accessed.

**Table 26. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Damper*. Excludes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (27) | 3.7 (1) | 3.7 (1) | 18.5 (5) | 7.4 (2) | - | 40.7 (11) | 25.9 (7) |
| Max Well depth (m) | (26) | 31 (1) | 29.6 (1) | 16.8 (5) | 2.4 (1) | - | 27.4 (11) | 33.5 (7) |
| Yield (L/s) | (10) | 0.31 (1) | 0.5 (1) | 0.3 (3) | - | - | 0.51 (3) | 1.05 (2) |
| SWL (m) | (18) | 21 (1) | 25.9 (1) | 4.6 (3) | 1.5 (2) | - | 20.9 (10) | 12 (1) |
| Water cut (m) | (12) | 30 (1) | - | 17.9 (4) | - | - | 25.6 (5) | 26.2 (2) |
| Observation year | | 1973 | 1973 | 1984 | - | - | 1961 | 1983 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (26) | 30.8 (8) | 3.8 (1) | 23.1 (6) | 34.6 (9) | 3.8 (1) | 3.8 (1) | - |
| Max well depth (m) | (25) | 5.5 (7) | 13.7 (1) | 19.5 (6) | 29.6 (9) | 44.5 (1) | 52.4 (1) | - |
| Water cut (m) | (12) | 5.5 (2) | - | 15.5 (4) | 25.5 (4) | 44.5 (1) | 50.3 (1) | - |
| Observation year | | 1965 | 1961 | 2005 | 1973 | 1949 | 1967 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (14) | 85.7 (12) | 14.3 (2) | - | - | - |
| Max well depth (m) | (14) | 28.5 (12) | 48.2 (2) | - | - | - |
| Water cut (m) | (10) | 25 (9) | 17.4 (1) | - | - | - |
| Observation year | | 1984 | 1980 | - | - | - |

### 4.3.5.2. Kopi (6031) 1:100 000 Map Sheet

The surface geology of *Kopi* is dominated by Quaternary sand plains, dune systems and inter-dunal clay pans. Minor outcropping of basement sequences (mainly Sleaford Complex) is also apparent. Quaternary sequences have a median thickness of 6 m. Yaninee palaeovalley sediments extend over the south-western region of *Kopi,* Tertiary sediments have a median thickness of 20 m. The region is well serviced by the SA Water reticulation system. Across the map sheet, wells have been completed in

Quaternary, Tertiary and basement sequences, but no clear pattern in the areal distribution of groundwater salinity is evident. Groundwater quality data for *Kopi* is sparse – only 32 wells have salinity measurements, mostly recorded pre-1990 (Table 27). Salinity in this inland region is mostly high with salinities ranging between 1600–65 920 mg/L (median 18 070 mg/L).

**Table 27. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Kopi*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (32) | - | - | 21.9 (7) | - | 6.3 (2) | 34.4 (11) | 37.5 (12) |
| Max Well depth (m) | (27) | - | - | 15.5 (2) | - | 73 (2) | 36.9 (11) | 54.3 (12) |
| Yield (L/s) | (16) | - | - | 3.6 (2) | - | 0.76 (2) | 0.48 (7) | 0.4 (5) |
| SWL (m) | (12) | - | - | 13.6 (2) | - | 27 (1) | 8.5 (5) | 38 (4) |
| Water cut (m) | (19) | - | - | 13.7 (2) | - | 44 (2) | 8.2 (10) | 23 (5) |
| Observation year | | - | - | 1972 | - | 1994 | 1961 | 1982 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (13) | 15.4 (2) | 15.4 (2) | 15.4 (2) | 23.1 (3) | 30.8 (4) | - | - |
| Max well depth (m) | (13) | 14.3 (2) | 19.5 (2) | 15.5 (2) | 42.4 (3) | 50.8 (4) | - | - |
| Water cut (m) | (11) | 3.1 (2) | 8.2 (2) | 13.7 (2) | 29 (3) | 43.9 (2) | - | - |
| Observation year | | 1961 | 1962 | 1987 | 1975 | 1994 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (17) | 52.9 (9) | 29.4 (5) | 17.6 (3) | - | - |
| Max well depth (m) | (17) | 43.6 (9) | 14 (5) | 15.9 (3) | - | - |
| Water cut (m) | (16) | 28.2 (8) | 5.2 (5) | 13.9 (3) | - | - |
| Observation year | | 1962 | 1961 | 1987 | - | - |

### 4.3.5.3. Kimba (6131) 1:100 000 Map Sheet

*Kimba* is dominated by Cainozoic sand plains, with Quaternary dune systems more common towards the north-east. Some basement outcropping is evident across the entire map sheet. The area encompassed by *Kimba* is underlain predominately by the Hutchison Group, with the Sleaford Formation, Hiltaba Suite and Moody Suite also present. The median depth to basement is just 7 m, although it is sometimes not encountered until a depth of 80 m. Overlying Tertiary sequences are largely undifferentiated and range in thickness between 1–122 m with a median of 14 m, typically decreasing in thickness towards the east. A thin veneer of Quaternary sediments is widespread across *Kimba*; Pooraka Formation has been identified in places, however most Quaternary deposits are undifferentiated.

The SA Water reticulation network is well distributed across *Kimba* and due to relatively low reliance on groundwater, salinity data is sparse. Data has been recorded from a total of 68 wells (Table 28), ranging between 243–38 850 mg/L (median 15 708 mg/L). Only eight low salinity (<3000 mg/L) observations have been recorded and these are widely distributed across *Kimba*. Similarly, the spatial distribution of higher salinity wells follows no distinct pattern. Of the nine wells for which construction details are available, wells showing high salinity appear to be screened within either Quaternary, Tertiary or fractured rock aquifers, suggesting that there is no trend in salinity level with increasing depth. Yields are predominately less than 1 L/s; two occurrences of higher yield (>5 L/s) occur in deeper drillholes (>50 m), with one identified as open to the Hutchison Group. Water cut information is sparse and highly variable.

**Table 28. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Kimba*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (68) | 1.5 (1) | 1.5 (1) | 5.9 (4) | 10.3 (7) | 10.3 (7) | 45.6 (31) | 25 (17) |
| Max Well depth (m) | (68) | 12 (1) | 8 (1) | 75.3 (4) | 28.4 (7) | 37.1 (7) | 50 (31) | 36.4 (17) |
| Yield (L/s) | (36) | - | - | 0.05 (3) | 0.3 (4) | 0.16 (2) | 0.38 (16) | 0.25 (11) |
| SWL (m) | (45) | - | 2.6 (1) | 53.3 (3) | 66.1 (3) | 14.5 (4) | 19.8 (21) | 29 (13) |
| Water cut (m) | (29) | - | - | - | 15 (1) | 88.2 (2) | 32 (16) | 30.4 (10) |
| Observation year | | 1941 | 1990 | 1959 | 1962 | 1956 | 1962 | 1955 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (67) | 14.9 (10) | 9 (6) | 22.4 (15) | 22.4 (15) | 14.9 (10) | 16.4 (11) | - |
| Max well depth (m) | (66) | 7 (10) | 15.6 (6) | 34 (15) | 31.5 (14) | 56.4 (10) | 80.8 (11) | - |
| Water cut (m) | (15) | - | 27.1 (1) | 22.6 (4) | 29.9 (5) | 41.9 (4) | 63.4 (1) | - |
| Observation year | | 1997 | 2001 | 2004 | 1961 | 1959 | 1962 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (43) | 81.4 (35) | 14 (6) | - | 2.3 (1) | 2.3 (1) |
| Max well depth (m) | (43) | 45.1 (35) | 51.5 (6) | - | 70.7 (1) | 84 (1) |
| Water cut (m) | (21) | 30.8 (15) | 25.6 (5) | - | - | 38 (1) |
| Observation year | | 1962 | 1961 | - | - | 1999 |

### 4.3.5.4. Sheringa (5930) 1:100 000 Map Sheet

SHERINGA is almost entirely coincident with the Musgrave PWA and as such, a detailed discussion of groundwater data is not provided. For a brief summary of groundwater quality, please refer to Table 29.

**Table 29. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Sheringa*. Includes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (994) | 52.2 (519) | 21.5 (214) | 15.4 (153) | 3.8 (38) | 3.3 (33) | 2.3 (23) | 1.4 (14) |
| Max Well depth (m) | (980) | 12.2 (515) | 12.2 (212) | 12.2 (151) | 13.7 (37) | 14.9 (32) | 13 (20) | 11.6 (13) |
| Yield (L/s) | (127) | 0.75 (74) | 1.26 (25) | 0.71 (18) | 0.38 (3) | 1 (5) | 1.43 (2) | - |
| SWL (m) | (868) | 5.9 (461) | 5.7 (188) | 5.5 (132) | 5 (33) | 3.1 (27) | 6.9 (14) | 5.9 (13) |
| Water cut (m) | (644) | 7.3 (356) | 7 (133) | 8.7 (84) | 11 (21) | 6 (23) | 7.8 (16) | 7.9 (11) |
| Observation year | | 1968 | 1967 | 1967 | 1967 | 1979 | 1967 | 1966 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (931) | 40.7 (379) | 38.9 (362) | 16.8 (156) | 2.9 (27) | 0.6 (6) | 0.1 (1) | - |
| Max well depth (m) | (926) | 6.4 (376) | 12.2 (360) | 20.3 (156) | 29.6 (27) | 44.2 (6) | 85 (1) | - |
| Water cut (m) | (586) | 4 (166) | 7.3 (264) | 15 (128) | 24 (24) | 31.1 (3) | 78 (1) | - |
| Observation year | | 1979 | 1995 | 1995 | 1995 | 1987 | 1984 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (152) | 46.7 (71) | 35.5 (54) | 9.9 (15) | 5.9 (9) | 2 (3) |
| Max well depth (m) | (152) | 14 (71) | 15.5 (54) | 9.6 (15) | 22.9 (9) | 12.5 (3) |
| Water cut (m) | (141) | 9 (63) | 7 (53) | 6.6 (15) | 7.9 (8) | 7 (2) |
| Observation year | | 1979 | 1988 | 2001 | 1963 | 1969 |

#### 4.3.5.5. Tooligie (6030) and Verran (6130) 1:100 000 Map Sheets

Across *Tooligie* and *Verran*, the scarcity of data makes it difficult to correlate groundwater salinity with specific hydrogeologic units. The boundary of the Polda Trough dissects both *Tooligie* and *Verran* in their northern half and contains Tertiary sediments with a median thickness of 24 m. Jurassic sediments of the Polda Formation are identified to depths over 500 m, a maximum thickness of 280 m and a median thickness of 52 m. In this area, there is little information regarding Polda Trough groundwater resources. The SA Water reticulation system is well distributed across *Tooligie*, which may explain the paucity of groundwater data.

A group of wells located in the centre of *Tooligie*, fringing the southern boundary of the Polda Trough, observe high salinity (10 000–20 000 mg/L). These wells are screened at shallow depths, less than 7 m; the substrate has been indentified as comprising undifferentiated Tertiary to Pleistocene rocks. No yield information is available.

Fresher groundwater is encountered immediately outside of the south-eastern extent of the Musgrave PWA. The freshest wells (30–1000 mg/L) appear to be screened from near-surface up to around 21 m depth in the Bridgewater Formation. Wells with salinities of 1000–5000 mg/L are generally screened between around 12–23 m depth, but can be as deep as 40 m and are likely to intercept Bridgewater and/or Poelpena Formations. Yields are low, generally less than 1 L/s.

Across *Verran*, the areal distribution of salinity appears to be random, except in the south-eastern corner near the coast where values appears to be consistently high (20 000–50 000 mg/L). These high salinities are generally observed in shallower wells, where geological logs indicate sandy clays are dominant, however some deeper wells (>30 m) also show high salinities. Further inland, to the north-west, several wells of depth 30–90 m have obtained lower salinities (<5000 mg/L), but a lack of stratigraphic and construction information makes it difficult to identify which aquifer has been intercepted.

Several wells in the northern extent of *Verran* show low salinities (1000–5000 mg/L). Two wells with low salinity (<1500 mg/L) are located within the extent of the Polda Trough – one of 79 m depth, which is mainly open hole within the 64 m thick Poelpena Formation, with the second well screened from 82 to 88 m depth in the Polda Formation. However across the map sheet, yields are generally poor (<1 L/s). Groundwater of lower salinity also occurs at the boundary of *Verran* and *Cowell*.

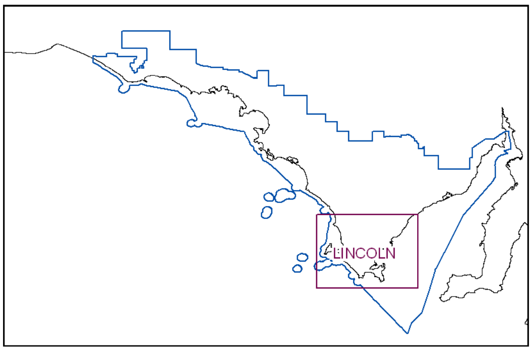
**Table 30. Summary of salinity, standing water level and yield data and the associated median values (with number of data points in brackets) for *Tooligie* and *Verran*. Excludes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (125) | 13.6 (17) | 5.6 (7) | 7.2 (9) | 6.4 (8) | 9.6 (12) | 11.2 (14) | 46.4 (58) |
| Max Well depth (m) | (120) | 13.8 (16) | 38.9 (6) | 14.6 (8) | 26.8 (8) | 19.3 (10) | 40.1 (14) | 6.7 (58) |
| Yield (L/s) | (41) | 0.38 (7) | 0.38 (4) | 0.44 (4) | 0.25 (3) | 0.4 (3) | 0.14 (6) | 0.22 (14) |
| SWL (m) | (81) | 10.5 (14) | 13.9 (4) | 8.5 (7) | 17 (6) | 16.5 (5) | 19.8 (6) | 1.5 (39) |
| Water cut (m) | (35) | 11.9 (6) | 14 (5) | 10.8 (4) | 63.1 (1) | 38.4 (1) | 37.5 (5) | 36.6 (13) |
| Observation year | | 1967 | 1967 | 1967 | 1949 | 1960 | 1959 | 1995 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (112) | 39.3 (44) | 13.4 (15) | 28.6 (32) | 8 (9) | 6.3 (7) | 4.5 (5) | - |
| Max well depth (m) | (111) | 4 (44) | 9.9 (14) | 20.2 (32) | 36 (9) | 42.7 (7) | 84.4 (5) | - |
| Water cut (m) | (33) | 5.8 (2) | 8.2 (5) | 14 (14) | 30.5 (5) | 42.7 (3) | 72.7 (4) | - |
| Observation year | | 1995 | 1967 | 1987 | 1969 | 1939 | 1963 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (50) | 86 (43) | 12 (6) | - | 2 (1) | - |
| Max well depth (m) | (49) | 36.3 (42) | 29.1 (6) | - | 49 (1) | - |
| Water cut (m) | (36) | 28.4 (29) | 23.2 (6) | - | 37 (1) | - |
| Observation year | | 1960 | 1973 | - | 1990 | - |

### 4.3.6. LINCOLN 1:250 000 MAP SHEET




Groundwater occurrences across LINCOLN are found within a variety of geological environments, including fractured Precambrian basement and both Tertiary and Quaternary sediments. The most heavily developed groundwater resources occur within the Bridgewater Formation, where salinities are generally below 3000 mg/L. Within the Southern Basins PWA, a number of discrete freshwater lenses (<1000 mg/L) are utilised to supply around 90% of the potable water to the broader EP region.

The Cummins Basin (Wanilla Palaeovalley) spans an area of around 1033 km$^2$ (Schwarz 2003) and trends north-east to south-west from Cummins to Kellidie. In places, the combined thickness of Quaternary and Tertiary sediments exceeds 130 m (Schwarz 2003). The main groundwater resources of this region are contained within sand and gravel aquifers of the Tertiary Wanilla and Uley Formations. Groundwater is of variable salinity, generally increasing with depth and ranges between approximately 500 and 20 000 mg/L (Table 31).

Little use is made of groundwater from the Cummins Basin due to its generally high salinity and low yield. Most towns and farms in the area are connected to mains water supply. Low salinity groundwater has been reported in fractured rock and weathered basement aquifers, but storages are generally low (Schwarz 2003).

**Table 31. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for LINCOLN. Includes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (2810) | 32.2 (905) | 10.7 (302) | 17.8 (501) | 14 (392) | 12.2 (343) | 8 (225) | 5.1 (142) |
| Max Well depth (m) | (2477) | 18.1 (826) | 14 (266) | 12.2 (437) | 11.5 (350) | 10.6 (296) | 14.1 (184) | 12.2 (118) |
| Yield (L/s) | (1197) | 0.63 (362) | 0.51 (153) | 0.5 (248) | 0.3 (192) | 0.25 (142) | 0.25 (68) | 0.33 (32) |
| SWL (m) | (2098) | 7.3 (742) | 5 (236) | 4.3 (382) | 3.7 (292) | 3.1 (233) | 5.2 (135) | 2.8 (78) |
| Water cut (m) | (1156) | 10.3 (470) | 10 (135) | 8.8 (182) | 10.6 (119) | 11 (96) | 10 (80) | 6 (74) |
| Observation year | | 1963 | 1976 | 1978 | 1977 | 1977 | 1969 | 1990 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (2662) | 48.1 (1281) | 28.4 (756) | 16.4 (437) | 3.9 (105) | 1.6 (42) | 1.3 (34) | 0.3 (7) |
| Max well depth (m) | (2585) | 6.5 (1237) | 12.3 (730) | 22.3 (430) | 47 (105) | 67.5 (42) | 99.8 (34) | 160 (7) |
| Water cut (m) | (1145) | 4 (424) | 8 (322) | 14.9 (256) | 27 (80) | 40.5 (31) | 67.1 (25) | 130 (7) |
| Observation year | | 1983 | 1977 | 1980 | 1996 | 1990 | 1996 | 2004 |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (1318) | 74.2 (978) | 16.1 (212) | 3 (39) | 2.7 (35) | 4.1 (54) |
| Max well depth (m) | (1270) | 13 (944) | 17.8 (206) | 31.5 (35) | 41.3 (34) | 19 (51) |
| Water cut (m) | (702) | 9.4 (484) | 9.9 (132) | 8.4 (26) | 10.5 (25) | 6 (35) |
| Observation year | | 1977 | 1983 | 1976 | 1975 | 1975 |

#### 4.3.6.1. Coulta (5929) 1:100 000 Map Sheet

The Bridgewater Formation is ubiquitous across *Coulta* with the Wiabuna Formation also present in places at shallow depths. These aeolian formations unconformably overlie Tertiary sediments that range in thickness from around one metre, up to around 30 m in areas closer to Coffin Bay, where outcrops of Achaean basement (Dutton Suite) also occur. Tertiary sediments across *Coulta* are widespread, varying in depth from around 1 m, to over 67 m toward the northern boundary of the map sheet. Tertiary sediments have been identified as mainly the Uley and Wanilla Formations and have an average thickness of 8 m. The Cummins Basin extends across part of this map sheet, but mainly occurs in the adjacent Cummins map sheet.

Salinity data are available from 258 drillholes across *Coulta* (Table 32). Associated well production zone information is available for only a small subset of these. Groundwater salinities are variable but mostly below 5000 mg/L, with several occurrences of good quality groundwater apparent. Towards the northern boundary, a cluster of near-coastal, low-salinity wells (<3000 mg/L) are present. Evidence suggests that wells here are screened mostly at shallow depth (<15 m) within the Bridgewater Formation, with the exception of one well which intercepts an undifferentiated Tertiary aquifer.

Towards the southern extent of *Coulta*, ten wells show low salinities (median 1044 mg/L). Seven of these wells are screened within Quaternary formations, two within Tertiary sediments and one uncased well that intercepts a fractured rock aquifer.

In the centre of *Coulta*, a large number of wells show low salinity. These wells are typically less then 20 m deep, however well construction details are not available. The few wells that show high salinities are randomly distributed across the map sheet, although rarely located close to the coast. Yields are predominately less than 1L/s. Water level data, most of which were recorded prior to 1990, show standing water levels to be predominantly greater than 10 m.

**Table 32. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Coulta*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (258) | 22.9 (59) | 16.7 (43) | 24 (62) | 18.2 (47) | 8.9 (23) | 4.3 (11) | 5 (13) |
| Max Well depth (m) | (251) | 11.2 (58) | 10.3 (42) | 8.2 (61) | 7.3 (45) | 5.8 (23) | 10.7 (11) | 13.4 (11) |
| Yield (L/s) | (130) | 0.75 (39) | 0.25 (24) | 0.45 (31) | 0.38 (22) | 0.13 (7) | 0.76 (4) | 0.82 (3) |
| SWL (m) | (203) | 4.5 (51) | 4.9 (36) | 4.6 (50) | 5.1 (35) | 2.4 (18) | 2.8 (8) | 2.5 (5) |
| Water cut (m) | (103) | 7.5 (30) | 8.2 (17) | 7.3 (22) | 9.4 (16) | 6.4 (7) | 5.2 (6) | 2.7 (5) |
| Observation year | | 1963 | 1963 | 1963 | 1963 | 1963 | 1978 | 1979 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (234) | 55.1 (129) | 28.2 (66) | 15.4 (36) | 1.3 (3) | - | - | - |
| Max well depth (m) | (234) | 4.9 (129) | 11.8 (66) | 18.1 (36) | 27.6 (3) | - | - | - |
| Water cut (m) | (98) | 3.2 (43) | 8.5 (33) | 13.1 (20) | 10.5 (2) | - | - | - |
| Observation year | | 1963 | 1966 | 1963 | 1979 | - | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (151) | 70.9 (107) | 23.8 (36) | 3.3 (5) | 2 (3) | - |
| Max well depth (m) | (151) | 12.6 (107) | 15.2 (36) | 18.3 (5) | 4.3 (3) | - |
| Water cut (m) | (101) | 7.6 (71) | 4.8 (24) | 7 (3) | 3.7 (3) | - |
| Observation year | | 1979 | 1973 | 1962 | 1970 | - |

### 4.3.6.2. Cummins (6029) 1:100 000 Map Sheet

The township of Cummins sits centrally on *Cummins*. The Cummins Basin is the dominant geological feature in the south-western quadrant of *Cummins* and comprises the Hutchison Formation as basement, overlain by the Tertiary Wanilla, Uley and Pidinga Formations. The Tertiary sediments in turn are unconformably overlain by the Quaternary Pooraka or Bridgewater Formations. In this area, salinities range from 1150–21 000 mg/L. Well construction details are available for 11 wells, the two highest salinities recorded (21 000 and 6500 mg/L) are from wells open to the fractured Sleaford Complex. Better quality groundwater is evident in the remaining nine wells (1150–3500 mg/L), which are completed in Quaternary and/or Tertiary sequences. Observed yields are generally low – predominately less than 1 L/s.

Observation wells in the Cummins monitoring network wells are located predominantly within the bounds of *Cummins*, but also extend onto *Lincoln* and *Wangary*. Currently, the Cummins network comprises 50 water level monitoring wells with levels monitored at roughly six-monthly intervals. The aquifers that are currently being monitored are largely undefined, but include undifferentiated Pleistocene sediments and either the Bridgewater or Uley formations.

The south-eastern quadrant of *Cummins* encompasses the Tod River (Reservoir) Water Protection Area and the Tod River Catchment monitoring network, which originally comprised 14 observation wells, but now only one well is currently monitored for water level data. The area comprises exposures of Archaean to Palaeoproterozoic basement (mainly Hutchison Group, interspersed with Donington Suite and sparsely distributed Sleaford Complex), with Quaternary colluvial and undifferentiated clay infills. In this area, salinity data from around 200 wells is variable, ranging between 200–30 950 mg/L (median 3456 mg/L). Well construction details are recorded for 18 wells, with most completed in fractured rock (Hutchison Group). Salinities range between 900–11 400 mg/L (median 3264 mg/L) and yields are generally less than 1 L/s.

Cainozoic dunes systems and sand plains cover the northern extent of *Cummins*. Basement has been identified as Sleaford Complex or (occasionally outcropping) Hutchison Group and has a median depth of 14 m. Tertiary sequences are almost ubiquitously Uley Formation overlying Wanilla Formation, although the presence of the Poelpena Formation has been noted. Quaternary deposits are often undifferentiated, although calcrete, sands, sandy clays and Bridgewater Formation are more common towards the north-west. Tertiary and Quaternary sequences are rarely observed to be greater than 10 m in thickness. Salinity observations are available from 66 wells and are high relative to those in the south, ranging between 275–110 755 mg/L (median 7568 mg/L). Six wells have construction details available, showing they are screened within Quaternary sediments with salinities between 2404–15 908 mg/L.

**Table 33. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Cummins*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (540) | 11.3 (61) | 6.7 (36) | 18.3 (99) | 18.5 (100) | 20.7 (112) | 15.6 (84) | 8.9 (48) |
| Max Well depth (m) | (493) | 5.7 (58) | 16.1 (31) | 10.8 (87) | 12 (91) | 11.6 (107) | 14.1 (78) | 13.9 (41) |
| Yield (L/s) | (198) | 0.4 (17) | 0.43 (16) | 0.32 (41) | 0.25 (45) | 0.25 (41) | 0.18 (29) | 0.08 (9) |
| SWL (m) | (377) | 1.2 (42) | 3.1 (24) | 2.9 (78) | 3 (77) | 3.1 (77) | 5.2 (57) | 3.1 (22) |
| Water cut (m) | (156) | 8.3 (14) | 11.5 (10) | 10 (24) | 11.3 (28) | 11 (31) | 9 (29) | 10 (20) |
| Observation year | | 1991 | 1991 | 1980 | 1990 | 1981 | 1981 | 1991 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (472) | 66.5 (314) | 20.8 (98) | 10.2 (48) | 1.9 (9) | 0.6 (3) | - | - |
| Max well depth (m) | (454) | 6 (301) | 13.2 (94) | 19.9 (47) | 38 (9) | 72 (3) | - | - |
| Water cut (m) | (114) | 6 (58) | 11 (33) | 17.8 (16) | 30 (5) | 46 (2) | - | - |
| Observation year | | 1991 | 1991 | 1977 | 1978 | 1965 | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (218) | 83.5 (182) | 11.9 (26) | 2.3 (5) | 0.5 (1) | 1.8 (4) |
| Max well depth (m) | (200) | 12.8 (169) | 15.8 (22) | 43 (5) | - | 13.5 (4) |
| Water cut (m) | (84) | 9.1 (67) | 9 (9) | 4 (5) | - | 11 (3) |
| Observation year | | 1977 | 1985 | 1991 | 1991 | 1990 |

### 4.3.6.3. Tumby (6129) 1:100 000 Map Sheet

The surface geology of *Tumby* shows extensions of the north-east to south-west trending basement exposures that are mapped on the adjacent *Cummins* sheet. Towards the northern extent, continuation of the Cainozoic sand plain and dune systems is evident.

Around topographic highs where basement exposures are dominant, salinity records are available for approximately 77 wells, with values between 214–34 015 mg/L (median 7026 mg/L). Most values were recorded before 1978 and an absence of well construction details makes correlations between groundwater quality and corresponding hydrostratigraphic units difficult. This problem is compounded by the fact that only 15 of the 77 wells have a total depth greater than 10 m.

Across the northern extent of *Tumby*, only 17 wells have salinity records, with the majority sampled in the 1990s and range between 7383–48 090 mg/L (median 36 451 mg/L). Three wells intercept the Donington Suite fractured rock aquifer, but the remaining wells do not have well construction records.

In the area between exposed basement and the south-eastern coastline, groundwater is used for a variety of purposes. Geological logs from more than 70 drillholes indicate that undifferentiated sands, heavy clays and weathered basement are dominant at depths up to 5–10 m. Groundwater is relatively fresh here, with salinities often measuring less than 5000 mg/L. Five wells are screened within undifferentiated Quaternary formations, however salinity data is not available for these wells making assessment of water quality relating to specific hydrogeological units difficult.

Evidence suggests that yields are predominately less than 1 L/s and water levels are typically less than 5 m. The SA Water reticulation system is well distributed across *Tumby* and supplies the townships of Ungarra, Tumby Bay and Port Neill.

**Table 34. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Tumby*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (127) | 3.9 (5) | - | 14.2 (18) | 25.2 (32) | 23.6 (30) | 13.4 (17) | 19.7 (25) |
| Max Well depth (m) | (118) | 2.7 (5) | - | 3.5 (16) | 4.5 (29) | 5.8 (29) | 5 (15) | 5.1 (24) |
| Yield (L/s) | (54) | 0.13 (1) | - | 0.95 (7) | 0.13 (17) | 0.13 (18) | 0.13 (7) | 0.35 (4) |
| SWL (m) | (103) | 2 (5) | - | 2.1 (14) | 2.4 (27) | 2.7 (25) | 2.7 (12) | 1.6 (20) |
| Water cut (m) | (34) | 8 (1) | - | 16.5 (2) | 45 (3) | 32.6 (5) | 5 (5) | 3 (18) |
| Observation year | | 1948 | - | 1988 | 1948 | 1948 | 1948 | 1992 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (115) | 79.1 (91) | 7.8 (9) | 3.5 (4) | 5.2 (6) | 3.5 (4) | 0.9 (1) | - |
| Max well depth (m) | (115) | 4 (91) | 9.1 (9) | 19.2 (4) | 45.1 (6) | 69.5 (4) | 61 (1) | - |
| Water cut (m) | (39) | 3 (28) | 10.5 (2) | 46 (1) | 37.5 (4) | 48.5 (4) | - | - |
| Observation year | | 1965 | 1960 | 1949 | 1977 | 2003 | 1976 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (58) | 91.4 (53) | 6.9 (4) | - | - | 1.7 (1) |
| Max well depth (m) | (57) | 5.6 (52) | 33 (4) | - | - | 4.5 (1) |
| Water cut (m) | (14) | 25.6 (12) | 37.5 (2) | - | - | - |
| Observation year | | 1948 | 1972 | - | - | 1965 |

### 4.3.6.4. Lincoln (6028) 1:100 000 Map Sheet

Much of *Lincoln* is included within the Southern Basins PWA. However, the regional centre of Port Lincoln and pastoral country towards the northern third of *Lincoln* are outside the PWA. The SA Water reticulation network services customers along *Lincoln's* east coast and those in the Port Lincoln township.

The non-prescribed area comprises several physiographic attributes. The north–south trending basement outcrop (Donington Suite) follows the eastern coastline. Some outcropping of the Hutchison Group continues further westwards, where valley infill of a colluvial nature is common. The north-western extent of *Lincoln* contains Cainozoic sand plains and the mid-reaches of the Cummins Basin. Quaternary sequences are generally up to 10 m in thickness, except towards the south-eastern coastline where they are often up to 30 m thick. Tertiary sequences are commonly less than 10 m in thickness, although palaeovalley infill sediments are mostly 30–40 m thick.

Across the non-prescribed area of *Lincoln*, 577 wells have salinity data available (Table 35). Most salinity measurements were recorded between 1933 and 2009, however very few measurements have been recorded post-2005. Salinity is generally low, with a median of 2778 mg/L, but range between 86–52 200 mg/L.

Salinity values appear to be low irrespective of whether wells are completed in Quaternary, Tertiary or basement sequences, with the exception of wells very close (less than around 500 m) to the coastline. Near-coastal wells often have salinities in excess of 10 000 mg/L.

Within the Quaternary and Tertiary sediments of the Cummins Basin, the groundwater salinity is generally low, except for wells located near the northern boundary of *Lincoln*.

**Table 35. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Lincoln*. Excludes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (577) | 19.8 (114) | 10.7 (62) | 24.3 (140) | 19.1 (110) | 15.1 (87) | 8 (46) | 3.1 (18) |
| Max Well depth (m) | (540) | 13.5 (101) | 12.2 (58) | 14 (127) | 14.5 (106) | 15.2 (85) | 24 (45) | 22 (18) |
| Yield (L/s) | (292) | 0.39 (52) | 0.32 (39) | 0.3 (72) | 0.25 (58) | 0.32 (50) | 0.44 (17) | 0.3 (4) |
| SWL (m) | (426) | 3.7 (90) | 4 (47) | 3.2 (103) | 3.7 (81) | 3.9 (64) | 5.2 (32) | 3.8 (9) |
| Water cut (m) | (210) | 8 (34) | 10.5 (23) | 9.5 (46) | 12.5 (33) | 15 (33) | 12 (27) | 6 (14) |
| Observation year | | 1961 | 1978 | 1990 | 1982 | 1986 | 1992 | 1990 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (584) | 64.7 (378) | 21.9 (128) | 9.9 (58) | 2.4 (14) | 0.9 (5) | 0.2 (1) | - |
| Max well depth (m) | (572) | 7 (366) | 12.1 (128) | 28.4 (58) | 55.4 (14) | 52 (5) | 61 (1) | - |
| Water cut (m) | (212) | 4.3 (132) | 9 (50) | 18 (24) | 44.5 (4) | 20.7 (2) | - | - |
| Observation year | | 1993 | 1992 | 1980 | 1984 | 1949 | 1949 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (318) | 79.2 (252) | 17.3 (55) | 1.6 (5) | 1.3 (4) | 0.6 (2) |
| Max well depth (m) | (316) | 15.2 (251) | 13.4 (54) | 48 (5) | 74 (4) | 27.1 (2) |
| Water cut (m) | (136) | 12.8 (102) | 6 (28) | 64.5 (2) | 66 (3) | 4 (1) |
| Observation year | | 1965 | 1993 | 1991 | 1996 | 1988 |

### 4.3.6.5. Wangary (5928) 1:100 000 Map Sheet

*Wangary* largely comprises the Coffin Bay National Park and consequently, few drillholes exist. Beyond Coffin Bay National Park, only the small north-eastern section of *Wangary* has groundwater data available. The spatial density of the wells from which data is obtained is high and their locations are coincident with the towns of Coffin Bay, Wangary and Mt Dutton Bay.

Overall, salinity data is available from 298 wells and ranges between 300–33 514 mg/L (median 1596 mg/L). Salinity measurements have been recorded between 1949 and 2010 (predominately pre-1990). Three wells are currently utilised for town water supply and 204 (76%) wells were drilled for domestic purposes.

Coffin Bay receives potable groundwater via a stand-alone reticulated supply, which extracts groundwater from the Coffin Bay Lens within the Southern Basin PWA. Observations from wells around Coffin Bay often show groundwater salinities less than 3000 mg/L (median 1672 mg/L from 166 records), however little data has been collected since 1999. Wells located towards the eastern and southern extents of the Coffin Bay township generally observe lower salinity measurements. Well construction records suggest that these wells are completed within Quaternary sediments.

In the township of Wangary, historical and recent (post-1999) information from 42 wells suggests groundwater of salinity less than 1000 mg/L (median 824 mg/L) is available from wells open to Quaternary, Tertiary and basement sequences (Hutchison Group). Basement is relatively shallow at this location and nearby outcrops occurs. At Mt Dutton Bay, recent data (post-1999) from shallow (Quaternary) wells show higher salinity values (median 2131 mg/L), relative to salinities recorded in the nearby townships.

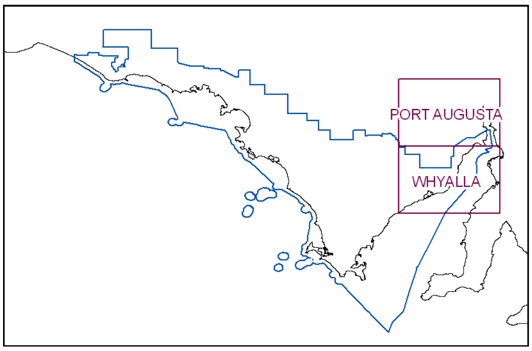
**Table 36. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Wangary*. Excludes PWA data.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (298) | 31.9 (95) | 15.4 (46) | 27.9 (83) | 14.8 (44) | 5 (15) | 2 (6) | 3 (9) |
| Max Well depth (m) | (285) | 13.3 (92) | 11.9 (45) | 12.2 (80) | 11 (39) | 8 (15) | 8.3 (6) | 9.2 (8) |
| Yield (L/s) | (234) | 0.63 (81) | 0.51 (37) | 0.65 (64) | 0.63 (33) | 0.51 (11) | 0.47 (2) | 0.75 (6) |
| SWL (m) | (275) | 7.7 (92) | 6.7 (43) | 8.2 (79) | 6.5 (40) | 5.7 (13) | 7.3 (1) | 6.3 (7) |
| Water cut (m) | (171) | 8.8 (57) | 6 (26) | 8.5 (46) | 7.1 (20) | 4.5 (9) | 7.6 (5) | 5.7 (8) |
| Observation year | | 1980 | 1979 | 1977 | 1976 | 1990 | 1993 | 1988 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (322) | 27 (87) | 50.9 (164) | 21.1 (68) | 0.9 (3) | - | - | - |
| Max well depth (m) | (306) | 7.3 (87) | 11.4 (151) | 17.3 (65) | 23.7 (3) | - | - | - |
| Water cut (m) | (185) | 3.5 (58) | 7.9 (92) | 14.2 (32) | 21 (3) | - | - | - |
| Observation year | | 1986 | 1977 | 1978 | 1981 | - | - | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (259) | 83.4 (216) | 12.4 (32) | 1.5 (4) | 1.9 (5) | 0.8 (2) |
| Max well depth (m) | (256) | 11.8 (213) | 15.2 (32) | 19.8 (4) | 38.1 (5) | 11.7 (2) |
| Water cut (m) | (173) | 7.6 (144) | 7.9 (24) | 2.5 (3) | 16.1 (1) | 3.6 (1) |
| Observation year | | 1980 | 1981 | 1978 | 1972 | 1976 |

## 4.3.7. WHYALLA AND PORT AUGUSTA 1:250 000 MAP SHEETS




The townships of Cowell, Arno Bay and Whyalla are found on WHYALLA, which covers contrasting groundwater regions of the western Pirie Basin (and the Cowell Sub Basin) and a large province of outcropping Gawler Craton sequence in the Cleve Hills. Groundwater in the Cleve Hills is typically from fractured rock aquifers, of variable salinity and typically of low yield. Where favourable these resources are used for stock watering. A number of springs also discharge following rainfall on the adjacent quartzite and granite ranges (Parker and Fanning 1998).

Salt Creek is semi-permanent due to the contribution of groundwater discharge to base flow; towards the plains of the Pirie and Cowell Basins, streams contribute to groundwater recharge before discharging into a coastal estuary north of Cowell (Parker & Fanning 1998).

Across the coastal plains between Whyalla and Arno Bay, Tertiary to Holocene sediments of the Pirie & Cowell Basin sediments reach a thickness in excess of 100 m. The little groundwater data that is available is mostly of high salinity (Table 37) and deeper than the fractured rock groundwater of the Cleve Hills.

**Table 37. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for WHYALLA and PORT AUGUSTA.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (477) | 6.9 (33) | 2.5 (12) | 8.8 (42) | 16.1 (77) | 30 (143) | 20.8 (99) | 14.9 (71) |
| Max Well depth (m) | (402) | 9.6 (21) | 14.9 (8) | 18.3 (36) | 18.3 (67) | 19.1 (128) | 24 (83) | 24 (59) |
| Yield (L/s) | (288) | 0.12 (6) | 0.38 (5) | 0.12 (19) | 0.16 (47) | 0.11 (102) | 0.12 (66) | 0.25 (43) |
| SWL (m) | (268) | 5.3 (15) | 4.7 (9) | 11.3 (29) | 11.1 (42) | 10.7 (96) | 9.8 (51) | 4.8 (26) |
| Water cut (m) | (187) | 26.5 (3) | 25.6 (3) | 21 (17) | 31 (28) | 18.3 (59) | 27.7 (43) | 28.3 (34) |
| Observation year | | 1975 | 1979 | 1979 | 1979 | 1979 | 1979 | 1985 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (480) | 37.7 (181) | 28.8 (138) | 19.2 (92) | 5.2 (25) | 6.9 (33) | 2.3 (11) | - |
| Max well depth (m) | (469) | 6 (175) | 11 (137) | 20 (90) | 37.2 (25) | 59.3 (32) | 84.7 (10) | - |
| Water cut (m) | (143) | 3.3 (41) | 8 (31) | 18.7 (32) | 31.1 (16) | 45.7 (19) | 82.2 (4) | - |
| Observation year | | 1996 | 1998 | 1979 | 1979 | 1988 | 1979 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (348) | 83.6 (291) | 10.9 (38) | 2.6 (9) | 2 (7) | 0.9 (3) |
| Max well depth (m) | (323) | 22.7 (274) | 32.7 (34) | 72 (7) | 41 (5) | 27 (3) |
| Water cut (m) | (186) | 25.9 (155) | 20.6 (20) | 49 (7) | 22 (3) | 10 (1) |
| Observation year | | 1979 | 1988 | 1988 | 1989 | 1975 |

#### 4.3.7.1. Barna (6231) 1:100 000 Map Sheet

Cainozoic sand plains and Quaternary dune systems are widespread across the northern extent of *Barna*. Basement outcrop, comprising the Hutchison Group quartzite and Miltalie Suite gneisses, dominate the surface geology in the southern half of *Barna* with a shallow median depth to basement of 14 m for the remainder.

Groundwater salinity records are available from 128 wells (Table 38), with salinities ranging between 202–41 720 mg/L, but are generally high with a median of 12 217 mg/L. Good quality groundwater (<2000 mg/L) has been observed in a number of wells but no clear pattern in spatial distribution is evident. Well construction and stratigraphic information suggests that most wells are open to the Quaternary Pooraka Formation or Hutchison Group fractured rock aquifers. Observed yields are mainly less than 1 L/s.

**Table 38. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Barna*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (105) | 2.9 (3) | 1 (1) | 7.6 (8) | 8.6 (9) | 21.9 (23) | 30.5 (32) | 27.6 (29) |
| Max Well depth (m) | (100) | 2.5 (3) | 119 (1) | 26.4 (8) | 54.4 (8) | 47.7 (22) | 28.4 (31) | 40 (27) |
| Yield (L/s) | (67) | 1.52 (1) | 0 (0) | 0.12 (4) | 0.07 (6) | 0.17 (16) | 0.11 (25) | 0.1 (15) |
| SWL (m) | (60) | 4.3 (2) | 94.6 (1) | 14.3 (6) | 24.4 (5) | 11.9 (12) | 9.3 (25) | 7.6 (9) |
| Water cut (m) | (60) | 1.2 (1) | 110 (1) | 22.3 (7) | 61 (5) | 36.6 (11) | 26.2 (19) | 34.2 (16) |
| Observation year | | 1961 | 1984 | 1961 | 1979 | 1979 | 1978 | 1986 |
| **Associated median well data** | **Total number of wells** | **Standing Water Level (metres below ground)** | | | | | | |
| | | **<5** | **5–9.99** | **10–19.99** | **20–29.99** | **30–49.99** | **50–99.99** | **≥100** |
| % | (72) | 26.4 (19) | 19.4 (14) | 16.7 (12) | 11.1 (8) | 16.7 (12) | 9.7 (7) | 0 (0) |
| Max well depth (m) | (68) | 4.6 (17) | 13.1 (14) | 21 (12) | 36.9 (8) | 55.2 (11) | 84 (6) | 0 (0) |
| Water cut (m) | (30) | 13 (2) | 12.8 (5) | 17.7 (6) | 29 (7) | 45.7 (7) | 79 (3) | 0 (0) |
| Observation year | | 1986 | 1979 | 1978 | 1978 | 1979 | 1990 | 0 |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (77) | 96.1 (74) | 2.6 (2) | 1.3 (1) | - | - |
| Max well depth (m) | (74) | 40.2 (71) | 47.5 (2) | 72 (1) | - | - |
| Water cut (m) | (53) | 31 (51) | 63 (1) | 69 (1) | - | - |
| Observation year | | 1979 | 1975 | 1991 | - | - |

#### 4.3.7.2. Cowell (6230) 1:100 000 Map Sheet

*Cowell* includes the townships of Arno Bay and Cowell, which are both connected to the SA Water reticulation system. *Cowell* is dominated by Palaeoproterozoic basement outcrop of the Hutchison Group, with minor intrusions of Moody Suite and Kimban Orogeny granitoids. Valleys between basement outcrops have been infilled with mainly Quaternary dune systems. These dune systems, along with Cainozoic sand plains, span from the southern and eastern fringes of basement outcrop to the south-eastern coastline and overlie older sediments of the Pirie-Torrens Basin and Cowell Sub-Basin.

Groundwater sampled from the region of basement outcrop shows variable salinities, ranging between 165–34 360 mg/L (median 6466 mg/L). Production zone details of 61 wells indicate that almost all wells are either partly or entirely completed within fractured rock aquifers. The occurrence of springs has been observed throughout this region and discharge from them is controlled by local rainfall-recharge events.

On the coastal plains, a paucity of salinity data (28 wells) makes assessment of groundwater quality difficult. Salinities are mostly high, ranging between 417 and 45 010 mg/L (median 9721 mg/L). Construction details exist for six wells, showing them to be completed in undifferentiated Quaternary sequences, with the exception of one well which is open to the Donington Suite.

**Table 39. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Cowell*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (284) | 4.2 (12) | 2.5 (7) | 10.2 (29) | 21.1 (60) | 37.3 (106) | 16.9 (48) | 7.7 (22) |
| Max Well depth (m) | (275) | 7.9 (11) | 11.6 (7) | 18.3 (28) | 16.1 (56) | 18.1 (104) | 22.1 (47) | 15.5 (22) |
| Yield (L/s) | (192) | 0.07 (4) | 0.31 (4) | 0.12 (15) | 0.18 (40) | 0.11 (79) | 0.13 (35) | 0.25 (15) |
| SWL (m) | (188) | 3.4 (6) | 4.7 (7) | 11.3 (21) | 10.6 (35) | 10.7 (83) | 7.6 (23) | 3.3 (13) |
| Water cut (m) | (111) | 31.4 (2) | 20 (2) | 19 (10) | 30.5 (21) | 16.1 (46) | 28 (19) | 18 (11) |
| Observation year | | 1979 | 1979 | 1979 | 1984 | 1979 | 1979 | 1995 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (245) | 33.1 (81) | 24.9 (61) | 28.6 (70) | 5.7 (14) | 6.5 (16) | 1.2 (3) | - |
| Max well depth (m) | (241) | 6 (80) | 13.2 (60) | 20 (68) | 36.7 (14) | 46.3 (16) | 118.3 (3) | - |
| Water cut (m) | (64) | 8.3 (12) | 10 (13) | 21 (23) | 38.1 (7) | 39 (9) | - | - |
| Observation year | | 1979 | 1979 | 1979 | 1988 | 1988 | 1958 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (224) | 85.3 (191) | 9.8 (22) | 2.7 (6) | 1.3 (3) | 0.9 (2) |
| Max well depth (m) | (221) | 19.2 (189) | 35.7 (22) | 74 (5) | 41 (3) | 20.2 (2) |
| Water cut (m) | (110) | 21 (91) | 20.6 (12) | 49 (5) | 34.6 (2) | - |
| Observation year | | 1979 | 1982 | 1988 | 1983 | 1969 |

#### 4.3.7.3. Middleback (6331), Whyalla (6431), Wilton (6330) and Cultana (6432) 1:100 000 Map Sheets

*Middleback*, *Whyalla* and *Wilton* contain insufficient amounts of groundwater data to facilitate a meaningful assessment. Similarly, PORT AUGUSTA's *Cultana* sheet has insufficient data, with only five salinity records available. For a brief summary of groundwater quality, please refer to Table 40.

**Table 40. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Middleback*, *Whyalla*, *Wilton* and *Cultana*.**

| Associated median well data | Total number of wells | Salinity (mg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <1000 | 1000–1499 | 1500–2999 | 3000–4999 | 5000–9999 | 10 000–19 999 | ≥20 000 |
| % | (29) | 24.1 (7) | - | - | 10.3 (3) | 6.9 (2) | 20.7 (6) | 37.9 (11) |
| Max Well depth (m) | (27) | 11.4 (7) | - | - | 13.1 (3) | 56 (2) | 89.9 (5) | 49.6 (10) |
| Yield (L/s) | (11) | 0.13 (1) | - | - | - | 0.27 (2) | 3.5 (2) | 0.63 (6) |
| SWL (m) | (17) | 5.3 (7) | - | - | 6.7 (2) | 14 (1) | 23.2 (3) | 30.7 (4) |
| Water cut (m) | (16) | - | - | - | 34.8 (2) | 12 (2) | 15.9 (5) | 43.3 (7) |
| Observation year | | 1975 | - | - | 1964 | 1992 | 1980 | 1975 |

| Associated median well data | Total number of wells | Standing Water Level (metres below ground) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | <5 | 5–9.99 | 10–19.99 | 20–29.99 | 30–49.99 | 50–99.99 | ≥100 |
| % | (160) | 50 (80) | 40.6 (65) | 5 (8) | 1.9 (3) | 1.9 (3) | 0.6 (1) | - |
| Max well depth (m) | (160) | 6 (80) | 10.4 (65) | 16.5 (8) | 54.3 (3) | 83.8 (3) | 85.3 (1) | - |
| Water cut (m) | (49) | 3.3 (29) | 6.3 (12) | 13.5 (4) | 45.3 (2) | 73.2 (1) | 85.3 (1) | - |
| Observation year | | 1999 | 2003 | 1997 | 1979 | 1980 | 1954 | - |

| Associated median well data | Total number of wells | Yield (L/s) | | | | |
|---|---|---|---|---|---|---|
| | | <1 | 1–2.99 | 3–4.99 | 5–9.99 | ≥10 |
| % | (28) | 50 (14) | 35.7 (10) | 3.6 (1) | 7.1 (2) | 3.6 (1) |
| Max well depth (m) | (28) | 49.6 (14) | 26.9 (10) | 53 (1) | 87.3 (2) | 68 (1) |
| Water cut (m) | (23) | 12 (13) | 15 (7) | 6.6 (1) | 5.1 (1) | 10 (1) |
| Observation year | | 1984 | 1999 | 1999 | 1996 | 1975 |

# 5. GROUNDWATER RESOURCES

Groundwater resources of Eyre Peninsula are found in Quaternary, Tertiary and Jurassic sedimentary sequences, as well as fractured rock (basement) aquifers of Pre-Cambrian age. The regions major stratigraphic units have been summarised in Table 41. Geological descriptions are largely referenced from the PIRSA Explanatory Notes series (PIRSA 2009). Particular attention is paid to stratigraphic units of hydrogeological significance; more detailed descriptions are presented in Appendix B.

Although the spatial occurrence of potential aquifers can be derived from stratigraphic logs, which are quite densely distributed throughout the study region, occurrence of non-prescribed groundwater data can be sparse. Where groundwater data does exist, correlation with a specific aquifer formation may be difficult due to lack of adequate well construction information.

Influenced by the related factors of water quality and population density, groundwater and well data is greatest along the coast, whereas the inland regions of the study area are largely devoid of groundwater data, often precluding commentary on the resource potential.

Occurrences of groundwater salinity less than 3000 mg/L are mostly found within the Prescribed Wells Areas. Outside of the PWA, the region around and between Venus Bay, Streaky Bay and Poochera have notable occurrences of lower salinity groundwater. Trends of lower salinity are difficult to map as high salinity observations are also common in this area, suggesting that the sustainability of lower salinity groundwater is likely to be limited. Elsewhere across the study region, observations of low salinity groundwater are infrequent with high salinity groundwater more common.

Regional standing water levels indicate that groundwater can be intersected at shallow depth throughout much of the region. It can be expected where favourable water resources are encountered at shallow depth, limited groundwater information and knowledge exists for the deeper aquifer formations.

Well yields throughout the study region are predominately less then 1 L/s, which would not favour the needs of high volume users, however data may only be indicative and improved well construction and aquifer testing could provide higher well yields in target areas.

## *5.1. QUATERNARY*

Quaternary aquifers of the EPNRM Region's west coast are largely identified as the Bridgewater Formation; a formation known to contain freshwater resources due to often favourable recharge conditions. Many of the region's identified fresh water resources are within the Prescribed Wells Areas, however several fresh groundwater lenses have been identified in the non-prescribed region. Most of these near coastal lenses are utilised for town water supply and qualitative assessments of resource capacity have generally not been made.

Communities along the far west coast utilise groundwater from perched aquifers within the Quaternary coastal dune systems. These perched aquifers are highly dependent on rainfall and as such, are likely to be very fragile systems (Martin, Sereda & Clarke 1998). While there is only a limited number of permanent residents, holiday populations can significantly increase the demand for water resources and there is concern for the capacity of groundwater to continue to support demand. It is uncertain how the water quality varies during the year, over the holiday season and after extended periods of low rainfall.

Across the study region there is potential for further groundwater extraction from Quaternary sequences (not limited to the Bridgewater Formation), however new sustainable resources of potable quality are unlikely. Existing groundwater data may suggest favourable salinity at a number of discrete locations, but the spatial extent would need to be investigated utilising recent groundwater observations. Should a groundwater resource of higher salinity be suitable for use, then numerous opportunities for groundwater extraction from the Bridgewater Formation or other Quaternary Formations are likely.

## *5.2. TERTIARY*

There is potential for groundwater development from Tertiary Aquifers. The most recognised formations are those that fill palaeovalleys (Fig. 4) such as the Pidinga, Garford, Poelpena, Uley and Wanilla Formations. Additional data validation is recommended in collaboration with PIRSA, utilising well construction details, water levels and regional geophysical data to confirm groundwater resource potential associated with these sedimentary features.

In the far north-west region (west of Ceduna and Penong), a small number of wells are known to be screened in the potentially significant Tertiary sediments of the Nullarbor Limestone, Wilson Bluff Limestone and Hampton Sandstone. These formation are suspected to store large volumes of water but salinities are unlikely to be of a potable quality.

The salinity of the Tertiary formations is highly variable but commonly of a lesser quality than overlying Quaternary aquifers. Low salinity Tertiary groundwater has been encountered in the smaller palaeovalley features located east of Streaky Bay and Penong where good quality water has also been reported in the Quaternary formations. Further inland, groundwater data for palaeovalley aquifers is limited with the available data indicating generally high salinity. However, further exploration is warranted given the potential volumetric capacity of these resources.

## *5.3. BASEMENT*

Fractured rock (basement) aquifers are utilised mainly in regions of outcropping and shallow basement; on Eyre Peninsula these are along the east coast in the Lincoln Uplands and in the ranges between Cleve, Cowell and Kimba. Basement groundwater resources are also known to be utilised along the region’s northern boundary, south of the Gawler Ranges.

Where groundwater resources that are suitable for development have been encountered in sedimentary sequences, often little information is available for groundwater within the deeper fractured rock aquifers. Additionally, many wells are not discretely open to basement rock material making it difficult to evaluate the properties of these fractured rock aquifers. Furthermore, the assessment of groundwater resource potential is far more difficult for fractured rock aquifers than it is for sedimentary formations. This is particularly relevant for Eyre Peninsula where only limited information is available.

Closer inspection and additional validation of well construction information may assist in developing a better understanding of fractured rock aquifers. Groundwater sampling from targeted existing wells, as well as new wells, will be required to accurately assess the potential of fractured rock aquifers.

**Table 41. Summary of major geological units and their hydrogeological significance.**

| Age | | | Unit | Lithology | Occurrence and Hydrogeology |
|---|---|---|---|---|---|
| Quaternary | Holocene | | Yamba Formation | Halite, gypsite, gypsarenite, selenite and minor carbonate and gypsiferous mud | Kyancutta-Warramboo and Lake Yaninee; gypsum mine south-east of Penong |
| | | | Moornaba Sand | Dunes of white, pale grey and orange quartz sand and interdunal valleys of red-brown sandy clay which grade laterally into quartz sand | Southern, central and eastern EP. One well salinity of 18 000 mg/L and 0.5L/s. |
| | Pleistocene | Late | Glanville Formation | Soft, white to cream-fawn richly fossiliferous shelly sand and clay and calcreted shell beds | Small pockets occur in far north-western EP and south of Streaky Bay. Open aquifer intervals identified in but no salinity or yield data available |
| | | | Wiabuna Formation | Distinctive yellow to orange siliceous sand and clayey sand, seif dunes and thin veneers of calcareous silt | North-western and west-central EP. Small number of open aquifer intervals identified, two with water quality data; salinity 36 500 & 51 000 mg/L TDS. Yield 0.0001 & 0.1 L/s |
| | | | Pooraka Formation | Alluvial, red-brown clayey sand and gravel, capped in general by soft powdery carbonate and/or calcrete | Eastern EP (Cleve Hills), between Kimba and Venus Bay and around Wanilla Palaeovalley. Limited water quality data available; Salinity between 7500–22 500 mg/L TDS (median 10 000 mg/L TDS). Yield between 0.08–2.7 L/s (median 0.8 L/s) |
| | | Middle | Bridgewater Formation | Calcareous sands, broken shell fragments and limestone, often with calcrete at the surface, karstic | Along the most of the west coast, absent only around Smoky Bay. Extends inland as far as Lock, Wudinna and Poochera. Is the most utilised aquifer on EP with much available historical well data. Salinity between 400–52 000 mg/L TDS (median 1100 mg/L TDS). Yield between 0.03–63L/s (median 0.6L/s) |
| Tertiary | Pliocene | | Uley Formation | Sandstone, clayey to orange-brown quartz, well sorted and rounded, minor lateritic and non-lateritic gravel | Southern Eyre Peninsula, particularly the Wanilla Palaeovalley. A number of wells screened in this formation; salinity between 500–26 500 mg/L TDS (median 1400 mg/L TDS. Yield between 0.3–1.3 L/s (median 0.5 L/s) |
| | | | Pantoulbie Formation | Sand, orange-brown, clayey; interbedded with quartz sand, sandy clay and minor lateritic gravel | Occurrence east of Streak Bay and west of Poochera. Only two wells screened in this formation. Salinity 1200 & 1800 mg/L TDS. Yield 1.3 L/s |
| | Miocene | Middle | Hampton Sandstone | Marine, estuarine and fluvial sandstone. Partly clayey at the base and glauconitic and fossiliferous at the top | Far north-western EP. Handful of wells screened in this area, three with water quality data. Salinity 8400, 26 000 & 31 000 mg/L TDS. Yield 0.06 & 0.5 L/s |
| | | | Garford Formation | Mudstone and minor sandstone horizons of silt sand. Palaeovalley sediments are both lacustrine clays and fluviatile sand | North-western and west-central EP inc. the Narlaby Palaeovalley. Wells screened in the area between Streaky Bay, Elliston, Wudinna and Poochera. Salinity between 240–55 000 mg/L TDS (median 2350 mg/L TDS). Yield between 0.0001–1.4 L/s (median 0.3 L/s) |
| | | | Pidinga Formation | Fine-grained to gravelly fluviatile sands and silt with interbeds of carbonaceous clay | Far north-west and within the Narlaby, Wanilla palaeovalley. Open aquifer intervals identified in far north-west; salinity between 2200–51 000 mg/L TDS (median 14 000 mg/L TDS). Yield between 0.0001–6.5 L/s (median 0.25 L/s) |
| | | Early | Nullarbor Limestone | Fossiliferous, bioclastic and micritic limestone with instances of quartz and quartz sand | Far north-western EP. Some open aquifer intervals identified with limited groundwater data; salinity 600–26 000 mg/L TDS (median 6200 mg/L TDS). Yield between 0.3–0.6 L/s (median 0.5 L/s) |

| Age | | | Unit | Lithology | Occurrence and Hydrogeology |
|---|---|---|---|---|---|
| | Eocene | Middle | Ooldea Sand | Aeolian dunes of medium-grained, quartz sand with well sorted, well rounded frosted grains and trace quantities of heavy minerals | Far north-western EP. No groundwater data available |
| | Eocene | Middle | Wilson Bluff Limestone | Mostly a white to grey wackestone with minor packstone and the basal part of the formation can be locally sandy | Far north-western EP. Open aquifer intervals identified, only two with water quality data. Salinity 1300 & 13 000 mg/L TDS. Yield 0.5 L/s |
| | Eocene | Middle | Wanilla Formation | Fine-grained to gravelly fluvial sand interbedded with variable thicknesses of carbonaceous clay | Cummins, Uley–Wanilla and Lincoln Basins in south-western EP. Open aquifer intervals identified in this area. Salinity between 500–7500 mg/L TDS (median 1700 mg/L TDS). Yield 0.13–0.9 L/s (median 0.5 L/s) |
| | Eocene | Middle | Poelpena Formation | Poorly sorted, fine to coarse grained quartz sand, silt and clay which are carbonaceous, micaceous and pyritic. Correlative of the Pidinga Formation | A sequence of, but not limited to, the Polda Trough; found extensively in central EP, especially between Lock and the West Coast. Majority of wells identified to be open to the Poelpena Formation are within the Musgrave PWA. Salinity between 240–35 000 mg/L TDS (median 950 mg/L TDS). Yield 0.01–63 L/s (median 1.3 L/s) |
| Jurassic | | | Polda Formation | Sands, silts, carbonaceous clays and lignite | Primarily constrained to the Polda Trough but has been identified in the adjacent Yaninee Palaeovalley. Open aquifer intervals identified in five wells (three within the Musgrave PWA). Salinity between 680-2060 mg/L TDS (median 1080 mg/L TDS). Yield between 0.04–0.25 L/s (median 0.16 L/s) |
| Precambrian | Proterozoic | Meso- | Hiltaba Suite | Massive anorogenic granitoids forming large batholiths and smaller plutons. Includes the Calca Granite | West central, north-east and north-west EP, especially between Kyancutta and Kalanbi. Numerous open aquifer intervals identified north of Bairds Bay, Venus Bay and across to Buckleboo; salinity between 870–48 000 mg/L TDS (median 12 500 mg/L). Yield between 0.01-1 L/s (median 0.1 L/s) |
| Precambrian | Proterozoic | Palaeoproterozoic | St Peter Suite | Complex comagmatic intrusive sequence, comprising fine to coarse, even-grained granite | North-western EP. Small number of open aquifer intervals identified, mainly near Penong; salinity between 700–47 250 mg/L TDS (median 30 000 mg/L). Yield between 0.03–0.3 L/s (median 0.2 L/s) |
| Precambrian | Proterozoic | Palaeoproterozoic | Donington Suite | Gneissic granite, granodiorite and adamellite with veins of pegmatite and aplite | Found along the eastern coast of EP and extends inland from Cowell towards the Gawler Ranges. A small number of open aquifer intervals identified in theses areas. Salinity between 500–27 000 mg/L (median 6600 mg/L). Yield between 0.01-5 L/s (median 0.4 L/s) |
| Precambrian | Proterozoic | Palaeoproterozoic | Hutchison Group | A basal massive to flaggy quartzite sequence (Warrow Quartzite, Lhw), overlain by carbonates, iron formation, amphibolite and pelitic to semi-pelitic schist. Includes Cook Gap Schist | Occurrence predominantly southern to eastern EP. Open aquifer intervals identified in the south and east; salinity between 500–35 000 mg/L TDS (median 5000 mg/L TDS). Yield between 0.001–10 L/s (median 0.3 L/s) |
| Precambrian | Archaean | | Mulgathing Complex | Granite; tonalite; gneiss; gabbro; basalt; pyroxenite; peridotite; komatiite | Limited occurrence identified in north-western EP. Some open aquifer intervals identified but no available groundwater data |
| Precambrian | Archaean | | Sleaford Complex | Metasediments, granites and gniesses. Includes the Dutton Suite | Central and south-western Eyre Peninsula; believed to extend to north-eastern Eyre Peninsula but has not been confidently identified. Open aquifer intervals identified in these areas; salinity between 250–29 500 mg/L TDS (median 1000 mg/L TDS). Yield between 0.05–7.6 L/s (median 0.6 L/s) |

# 5.4. GROUNDWATER POTENTIAL

Across South Australia few assessments have addressed regional groundwater storages. The Spencer Region Strategic Water Management Study (Martin, Sereda & Clarke 1998) provided first order assessments of groundwater storage for a number of geological and groundwater provinces. Available knowledge of shallow groundwater salinity was also considered to group groundwater storages by salinity class.

The provinces assessed, which included parts of the EPNRM Region (Table 42), do not cover all areas of South Australia and large regions remain devoid of the information suitable to conduct a meaningful assessment.

To determine the total storage estimates, data were interpreted from limited drillhole information within each of the individual provinces. Where suitable data were available, saturated aquifer thickness was evaluated, providing a representative value to extrapolate for each province area. An effective porosity of 10% is used to provide a total resource volume. It is important to recognise that the estimates are only first order approximations and that more detailed and targeted assessments will be required to refine the estimates of the total resource (Martin, Sereda & Clarke 1998).

These preliminary estimates of total groundwater storages within each province could potentially be an overestimate and it is likely that they are based on data that lacks a high degree of validation. Additionally, the ability to actually attain such resource volumes is dependent upon local scale issues including land access, drillhole specification and well and aquifer efficiency. Any estimates should be treated with caution until a more detailed and reliable assessment of groundwater resources can be addressed in subsequent investigations. Should future demand occur within these regions, it is recommended that groundwater resources be evaluated for their supply potential.

## 5.4.1. FUTURE ASSESSMENTS

Groundwater is available in most locations but is highly variable in quality and quantity. Improved estimates of resource potential should be made based on revised and more detailed knowledge of aquifer formations, their hydrogeological properties and associated water levels.

### 5.4.1.1. Sedimentary Aquifers

Sedimentary sequence information (e.g. mean thickness and range of occurrence) within Quaternary, Tertiary and Jurassic sequences, can be calculated for a defined region (e.g. 1:100K map sheet), or geological feature (e.g. palaeochannels). As a preliminary assumption, locations of greater sedimentary thickness may have a potential for larger volumes of groundwater storage. However, it is important that this assumption is coupled with the knowledge of groundwater levels to determine saturated thicknesses before estimates of saturated sedimentary thickness and groundwater volume can be derived.

### 5.4.1.2. Fractured Rock Aquifers

Fractured rock aquifers are far more complex than sedimentary sequences and hence, groundwater resource estimates require more simplifying assumptions about porosity and the degree of and depth to which water-bearing fractures extend.

### 5.4.1.3. Groundwater Use

The use of groundwater in non-prescribed regions can be difficult to quantify beyond the knowledge of town water supply volumes. Landowner surveys, land use maps and satellite imagery can be used to investigate land use practise and estimate the levels of groundwater-dependent irrigation.

**Table 42. Summary of total groundwater resources and estimated use (after Martin, Sereda & Clarke 1998)**

| Groundwater province | Total GW resource* (GL) | Estimated GW use (GL/y) | Comments and additional information |
|---|---|---|---|
| **Pirie-Torrens Basin** | | | EP, NY and SAAL NRM Regions. Considers Tertiary and Quaternary sequences only. Estimates of storages within the underlying Proterozoic material are not considered. Potential aquifer sequences include Tertiary Kanaka Beds, Melton Limestone, Gibbon Beds, Neuroolda Formation, Cotabena Formation and Quaternary Hindmarsh Clay, Telford Gravel, Pooraka Formation. |
| Fresh (0–1500 mg/L) | 3 425 | 1.4 | |
| Brackish (1500–7 000 mg/L) | 9 500 | 0.3 | |
| Saline (>7 000 mg/L) | 45 250 | - | |
| **Eyre Peninsula** | | | EPNRM Region only, but does not encompass all of Eyre Peninsula. It largely represents the extent of Bridgewater Formation and the generally thicker occurrences of Jurassic, Tertiary and Quaternary sediments. Excludes groundwater resources of the far west and fractured rocks aquifer assessments where basement outcropping is prominent. The most significant aquifer for potable supply is the Quaternary Bridgewater Formation. Deeper formations have a large volumetric potential but are generally of higher salinity. The Musgrave PWA and part of the Southern Basins PWA fall within this province. |
| Fresh (0–1500 mg/L) | 13 000 | 7.8 | |
| Brackish (1500–7 000 mg/L) | 39 000 | - | |
| Saline (>7 000 mg/L) | 50 000 | - | |
| **Palaeochannels** | | | EP, AW, NY and SAAL NRM Regions. An extensive region of palaeodrainage that drained the Musgrave Block, Stuart and Gawler Ranges exist within the Gawler Craton, far west and mid north of the state. They have the potential to contain large quantities of water (albeit of high salinity) and can be of vital importance to the mining industry. |
| Fresh (0–1500 mg/L) | - | - | |
| Brackish (1500–7 000 mg/L) | - | - | |
| Saline (>7 000 mg/L) | 6 000 | - | |
| **Coastal Dunes** | | | These potential resources are estimated for the Eyre Peninsula coastal margin from Streaky Bay to Fowlers Bay. Future development of this resource would require detailed sustainability estimates as the fragile resource may be highly sensitive to over pumping and deleterious impacts of sea water intrusion. |
| Fresh (0–1500 mg/L) | 85 | 6.3 | |
| Brackish (1500–7 000 mg/L) | - | - | |
| Saline (>7 000 mg/L) | - | - | |

* Based on a matrix porosity of 0.1

## 5.5. POTENTIAL CLIMATE CHANGE IMPACTS

Water resources are climate dependent and climate changes may pose future limitations on groundwater resources on Eyre Peninsula. Climate change impacts and the understanding of their implications will vary across the State; regional water Demand and Supply Statements will undertake regional scale assessments of the impact of climate change where this has not already occurred (Government of South Australia 2009).

Regional climate change scenarios for the EPNRM Region have been developed, based on statewide climate modelling conducted by the CSIRO Marine and Atmospheric Research Group (Suppiah *et al.* 2006). Projected impacts on annual temperature, rainfall and evaporation rates for the Eyre Region are summarised in SA Water's Long Term Plan for Eyre Region (2008), concluding:

- By 2030, annual temperature will likely increase between 0.4-1.2°C

- By 2070, annual temperature will likely increase between 0.9-3.5°C
- Annual rainfall will likely decrease by 1-10% by 2030 and by 2-30% by 2070
- Annual evaporation predicted to increase by 1-5% by 2030 and by 4-14% by 2070
- If $CO_2$ emissions stabilise, reduced warming and smaller rainfall changes would likely result.

Impacts to the hydrology due to climate change include a reduction in the volume of surface water run-off and groundwater recharge. This problem is likely to be compounded by an enhanced unpredictability in temporal and spatial distribution of rainfall. Predictions of decreased rainfall and increased evapotranspiration due to rising temperatures are expected to impact the groundwater resources by an increase in demand and a reduction in supply source. Using the maximum change 2030 prediction, the climate change impact on demand for water will potentially increase by 8-9% (SA Water 2008).

The Department for Water is undertaking assessments of groundwater resources which are vulnerable to the impacts of climate change through the *Impacts of Climate Change on Water Resources* (ICCWR) project. Detailed modelling of groundwater resources under various $CO_2$ emission scenarios is currently being conducted and forecasts made of potential climate change impacts on the rate of rainfall recharge. The scope of the ICCWR project is currently limited to Prescribed Wells Areas and Prescribed Water Resource Areas.

# 6. RECOMMENDED FURTHER INVESTIGATIONS

This initial investigation has collated groundwater information for the EPNRM Region and presents a regional description of the non-prescribed groundwater resources. Geological and hydrogeological data have been compiled with particular attention given to the identification of major hydrogeological units and related groundwater information.

Additional assessment of non-prescribed groundwater resources will be addressed in a prioritised manner and structured to allow stakeholders an opportunity to provide feedback on their priority needs for groundwater resources. The 'Phase 2' assessments will be developed to advance the understanding of groundwater resources for areas within the EPNRM Region deemed to have a greater short term need for improved knowledge. Areas for further and more detailed assessments in Phase 2 will be defined based on criteria including importance of and proximity to, proposed and projected development activities (e.g. mining or other industrial economic developments), as well as population development needs. It is anticipated that Phase 2 assessments will involve more detailed desktop analysis of the available information but may need to be supported by targeted field activities to fill information gaps.

The following recommendations are made with a view to guide project planning for future non-prescribed groundwater assessments. Identified key knowledge gaps include groundwater storage, sustainable yield, rates and volumes of groundwater abstraction and processes of groundwater recharge. Better knowledge of these parameters is fundamental to formulating strategies for sustainable water use.

## *6.1. DATA CAPTURE AND DATA VALIDATION – SA GEODATA*

It is recommended that greater attention be focused on groundwater data capture and validation and ensuring that all available historical groundwater data (e.g. microfiche and exploration files) are available via the State geodatabase, SA Geodata. Salinity or water level data, which is many decades old may be valuable for analyses of trends in the condition of the groundwater resource. Also, lengthy time series are useful in calibrating and validating numerical groundwater models. Importantly, archived data not yet entered into SA Geodata may include well construction details, which is invaluable as it enables a more robust assessment of groundwater resources through identifying the specific aquifer(s) from which groundwater samples have been taken.

PIRSA's Plan for Accelerated Exploration (PACE 2020) aims to improve the knowledge of groundwater occurrence and water quality by supporting exploration companies through co-funding drilling grants. It is expected that where suitable exploration methods are used, well yield, water cuts and standing water level are recorded and groundwater samples are collected. Following the relinquishment of Mineral Exploration Licenses, PIRSA captures stratigraphic information for inclusion into SA Geodata. A process needs to be implemented to ensure that all drillhole data from mineral exploration activities are captured, which could include groundwater levels, salinity chemistry, well yields and lithological logs.

## *6.2. GROUNDWATER MONITORING*

A number of groundwater monitoring networks are established across the study region. A detailed report covering all prescribed and non-prescribed monitoring networks was prepared for the Department for Water (AGT 2010). This report provides dialogue on groundwater observation network that are recognised in the State's online observation well database (*Obswell*). Other private groups across the region (e.g. mining ventures) may manage networks or groups of wells that actively observe groundwater, but are not under a formal arrangement to have data included into the State database.

Salinity monitoring of the town water supply lenses for Pt Kenny (Thulinippie Lens), Venus Bay and Streaky Bay is currently active, but the active monitoring network may be insufficient for the assessment of the spatial extent of the lenses. The Penong observation network has not been monitored and reported on for salinity since 1996. Similarly, the lenses within the Pt Kenny WPA have not been actively monitored since 1981. Due to the reliance of communities on these fragile potable resources, it is recommended that these resources are investigated in order to determine their sustainable use limits. Known custodians of privately monitored groundwater networks and data should also be approached to share groundwater data for inclusion into the State database.

In addition to the limited groundwater monitoring outside of the PWAs, the most recent available regional water well data for most areas (i.e. water level, salinity and yield) are several decades old. The lack of recent groundwater information does not allow an accurate appraisal of the current groundwater condition and hampers the assessment of the resource potential. Historically the establishment of groundwater monitoring networks has been to monitor potable water resources. However, the emergence of non-potable groundwater use highlights the importance to understand and monitor these resources so that they can be equitably managed for all potential users.

It is recommended that a regional monitoring program be developed, particularly for non-prescribed areas with a high probability of future development, to enable review of the status of both potable and non-potable groundwater resource. A suitable approach may target a broad network of operational wells for which stratigraphic and production zone information exists.

Recommendations and activities that relate to groundwater monitoring and associated infrastructure requirements will be closely linked with the *Groundwater Program's* Statewide Groundwater and Water Monitoring System project. This is a project that aims to deliver a reliable 'fit for purpose' State groundwater monitoring network that is under regular review with respect to current suitability and future needs.

### 6.2.1. MONITORED AQUIFERS

As part of this project, the occurrence of individual stratigraphic units of hydrogeological significance were examined and used to develop a hydrogeological discussion around the available groundwater data. For a limited number of suitable wells, available well production zone information was correlated with the associated stratigraphic intervals to indicate the geological interval(s) to which the well is open.

Knowledge of the open aquifer interval would allow for a more robust analysis of the available groundwater data. Further interpretation of lithological logs to hydrostratigraphic intervals coupled with validation of well production zones would allow an aquifer monitored description to be linked to a greater amount of groundwater observations.

## *6.3. AQUIFER EXTENT*

To determine volumetric estimates of groundwater storages, better definition of the vertical and areal extents of hydrostratigraphic units is required. Refined estimates of aquifer extent would aid in 3-D mapping of groundwater systems (Section 6.10.1). Furthermore, refining the hydrogeological significance of various geological units could be achieved via the generation of stratigraphic logs from existing lithological logs. However, large areas can be devoid of drillhole information (e.g. central Eyre Peninsula) and drilling programs would best define the likely areal extent of groundwater resources.

However, drilling programs are extremely resource intensive and geophysical methods may be favoured where budgetary constraints restrict drilling programs.

## 6.4. GEOPHYSICAL DATA

Geophysical datasets often provide valuable interpretation that could not otherwise be obtained without expensive conventional groundwater investigations. Where paucity of data presents barriers to defining aquifer extent, geophysical methods (e.g. gravity; electromagnetic; shallow seismic) may be the most cost-effective option for filling data gaps. Airborne geophysical techniques can acquire vast amounts of data within a short time frame over complex terrain.

Eyre Peninsula has numerous existing geophysical datasets collected for mineral exploration and there is a potential to revisit these data and reinterpret from a groundwater perspective. High priority areas for groundwater development may benefit from the use of geophysical surveying to provide an improved knowledge of aquifer formations extents and groundwater salinity distribution.

Magnetic Resonance Sounding provides a qualitative evaluation of sub-surface water content and, although in the early stages of application in Australia, this approach promises to be a valuable geophysical tool to aid in groundwater status assessments.

## 6.5. AQUIFER HYDRAULIC PROPERTIES

Hydraulic properties of an aquifer such as transmissivity and storage (specific yield or specific storage) can be determined by conducting aquifer tests. Tests targeted at specific hydrostratigraphic units would result in a more robust understanding of groundwater conditions across the EPNRM Region. Aquifer testing could be focused on areas where demand for groundwater is likely to be greatest. However, it should be noted that good quality data from aquifer tests are contingent on meeting numerous assumptions, two of which are: (1) The aquifer of interest is the only aquifer that is pumped/observed; and (2) the well(s) from which data are collected are screened across the entire thickness of the aquifer. Appropriately constructed wells can indicate the capacity of a groundwater system to supply water in the long term and in a sustainable manner.

## 6.6. PALAEOVALLEYS

Palaeovalleys are considered to be important sources of groundwater. Such resources already provide supplies to the Challenger gold mine in the State's north. The lateral extents of palaeovalleys on Eyre Peninsula have been progressively updated, but very limited groundwater information has been reported. Geoscience Australia's *Palaeovalley Groundwater* Project has applied and researched new methodologies to best investigate these resources, providing an improved basis for evaluating capacity. Techniques applied to date include aerial and ground geophysical datasets, targeted groundwater sampling and aquifer testing, digital elevation model manipulations and remote sensing imagery to differentiate thermal mass, soil moisture and vegetation indexes. The use of ESRI ArcHydro® groundwater tools have also been adopted, particularly for three dimensional representations of areas with a high density of data.

The use of these investigation methods should be considered for the Eyre Peninsula Palaeovalleys to reduce the knowledge gap of these potential high volume groundwater resources. Initially, additional assessments of existing available data could be completed for the Palaeovalleys and first order groundwater resource potential estimates calculated. Well yield information for these resources are largely unavailable, with any existing record generally of low yield (<1 L/s). On ground works, including water sampling, hydrochemical analysis and the pump testing of suitable wells would facilitate a more accurate appraisal.

## *6.7. FRESH GROUNDWATER LENSES*

Throughout the study area a number of fresh groundwater lenses based on a 1000 mg/L isohaline have been mapped. A number of these lenses are utilised for town water supplies, either to supplement SA Water reticulated supplies (e.g. previously Streaky Bay) or as the major water supply for towns not connected to the SA Water network (e.g. Penong, Port Kenny and Venus Bay). Other lenses, such as those found east of the Robinson Lens and Venus Bay (Port Kenny WPA), are of larger areal extent but are not utilised for town water supply.

Each small lens is important to the overall water planning for the region and as such, their sustainability is vital. In order to define a volumetric capacity and manage the resources potential, the vertical and horizontal extents of these lenses need to be accurately defined. It is unclear if extractions from these resources are metered and by what mechanism extraction information is captured and reported.

The defined lateral extents of many of the identified fresh groundwater lenses are based on dated salinity observations. A detailed review of each of these small, low salinity groundwater resources is highly recommended and those currently utilised or with a potential for development should have a monitoring networks reviewed or established.

## *6.8. FRACTURED ROCK AQUIFERS*

Basement or fractured rock aquifers are utilised in a number of regions across Eyre Peninsula. They are important to the overall groundwater resource capacity of the region but a large knowledge gap exists with regard to their development potential. Limited reliable data is available for fractured rock aquifers on Eyre Peninsula, which is often due the existence of shallower available resources that limits the need to drill deeper water wells.

An investigation targeting bedrock aquifers that includes a field sampling component, would allow greater certainty in the potential of these groundwater resources. The use of hydrochemical data would be important in defining the origin of water and connectivity with other aquifers.

### 6.8.1. BASEMENT INTERPRETATION

A regional definition of depth to basement is a valuable product in the estimation of sedimentary thickness and groundwater storage volumes. The subtraction of the basement layer from a land surface layer yields a sediment thickness and when linked to groundwater levels, indicates a saturated thickness and allows better estimates of resource potential. An initial product based on drillhole depth to basement has been developed, however, an improved basement map utilising geophysical data including shallow seismic, regional gravity and magnetic data is recommended for the development of more accurate resource assessments.

A valuable related product would be a map of saturated sedimentary thickness. Such a spatial product could be coupled with a distribution map of salinity and a well capacity rating, based on the knowledge of the formation type and well yields. Such a product would require detailed well and groundwater data validation and a program of aquifer testing.

## 6.9. GROUNDWATER RECHARGE

Recharge to the groundwater system is an important component to the water budget and estimates of recharge are essential to define a resource's capacity to sustain supply over a given time period. Further investigation is required to better understand the magnitude and processes of natural groundwater recharge in non-prescribed areas.

In order to better estimate recharge to unconfined aquifers, the feasibility of regional modelling of recharge using such packages as the WAVES model as used in the Murray Darling Basin (Crosbie *et al.* 2008) should be investigated. Estimating rates of rainfall recharge within fractured rock environments is especially challenging. Numerical modelling and/or water balance studies may aid in constraining estimated ranges of recharge to fractured rock aquifers.

Extending the scope of the Department for Water's *Impacts of Climate Change on Water Resources* project may aid in estimating future recharge rates of the non-prescribed groundwater resources across the EPNRM Region, in addition to facilitating the evaluation of climate change impacts on recharge into the future.

## 6.10. PRODUCTS

To enable easier interpretation of groundwater data, a number of map products have been generated during this study. These map products have been designed to improve accessibility to groundwater information for key stakeholders and the public. Additional map products have been identified which would complement the products developed here. Optimal technologies by which they might be delivered have been explored.

### 6.10.1. 3-D MAPPING

The petroleum and mining industries are well advanced in using 3-D mapping and visualisation techniques to aid in the assessment of potential reserves of oil or ore. Hydrogeologists in Australia are beginning to take advantage of these technologies to aid in the development of conceptual hydrogeologic models within a virtual 3-D environment. Manipulating and evaluating data within a 3-D environment enables volumetric assessment (e.g. groundwater storage) of the resource in addition to state-of-the-art static visualisation and animation.

#### 6.10.1.1. ArcHydro ®

ArcHydro® is a geodatabase design and incorporates a suite of accompanying tools tailored for support of water resource assessment applications within ESRI's ArcGIS® (Geographic Information System, or GIS) environment. ArcHydro® is compatible with Microsoft Access® and ArcGIS® thereby providing an interface between the State's stratigraphic database and GIS software. It is expected that the main benefits will be improvements in the way that groundwater data is queried, superior reporting products, 3-D visualisation and capabilities including the calculation of stratigraphic Geo-volumes, which can be used to develop estimates of groundwater storage.

### 6.10.2. ONLINE PDF MAPS

The most recent available datasets of groundwater and aquifer formations could be arranged and presented (for download) as high quality Portable Document Format (PDF) mapping products. These would deliver the functional advantages of spatial software through a layered information structure. Users (such as industry and community) would be able to toggle layers and annotations on and off, zoom in and out and query groundwater related layers and labels. Such a product could be delivered to the wider audience via the internet and current freeware (Adobe Reader). Any new data or knowledge generated and incorporated into the database can be updated to the PDF products in later iterations of the data maps.

# 7. CONCLUSION

The Eyre Peninsula is a significant contributor to the South Australian economy, predominately through primary industries such as grains, fishing and aquaculture. As well, mining development on Eyre Peninsula is emerging as a new major water consuming industry. In response, it has become necessary to improve the knowledge of groundwater resources to support industry demand and improve resource management. To consolidate current knowledge, this assessment report has collated data on hydrogeological formations and their groundwater with the intent is to identify key knowledge gaps, define the need for further investigations and improve the ability to advice on groundwater development opportunities.

Groundwater of highly variable quality exists throughout the region and resources of both potable and non-potable quality can be extracted. A good understanding of the impacts of any new groundwater resource development is required to ensure that existing groundwater resources and their users are not adversely affected. The supply potential of groundwater resources in the non-prescribed regions will be assisted by estimates of resource volumes, which will be the focus of subsequent non-prescribed investigations of the Groundwater Program. This will be addressed for both the small fragile potable resources of the far west coast and potential industry supporting non-potable supplies across the entire region.

The utilisation of a number of previously identified small good quality resources is limited to local stock and domestic purposes and may have the potential to be managed to support communities and other temporary developments. The managed use of such resources may help to reduce the burden on the current reticulated system. Effective management of these resources would require a current resource investigation, as well as guidelines to ensure their sustainability. Resources deemed fragile or identified to be in a high risk category should be closely monitored as rapid deterioration is likely to result from unmanaged extraction. One action, as identified in the *Water for Good* plan may include the bringing of additional water resources into formal management through prescription and water allocation planning.

Although a discussion of the available groundwater data is presented herein, this body of work does not explicitly identify any new viable resources without further assessment being actioned. The occurrence of individual stratigraphic units of hydrogeological significance are examined and used to develop a hydrogeological discussion around the available groundwater data. However, much of the groundwater data, due to a lack of supporting well construction information, is unable to be confidently allocated to an aquifer formation. An additional limitation which often precludes confident assessment is data age, which is often numerous decades old. The scarcity of available recent information limits the ability to make reliable estimates.

Identified key knowledge gaps include groundwater storage, sustainable yield, rates and volumes of groundwater abstraction and processes of groundwater recharge. Better knowledge of these parameters is fundamental to formulating strategies for sustainable water use. Additional assessments of non-prescribed groundwater resources will be addressed in 'Phase 2' of this program. Consideration of stakeholders needs for groundwater resources and criteria including importance of and proximity to, proposed and projected development activities will prioritise areas for further assessment. It is anticipated that 'Phase 2' assessments will involve more detailed desktop analysis of the available information but may need to be supported by targeted field activities to fill information gaps.

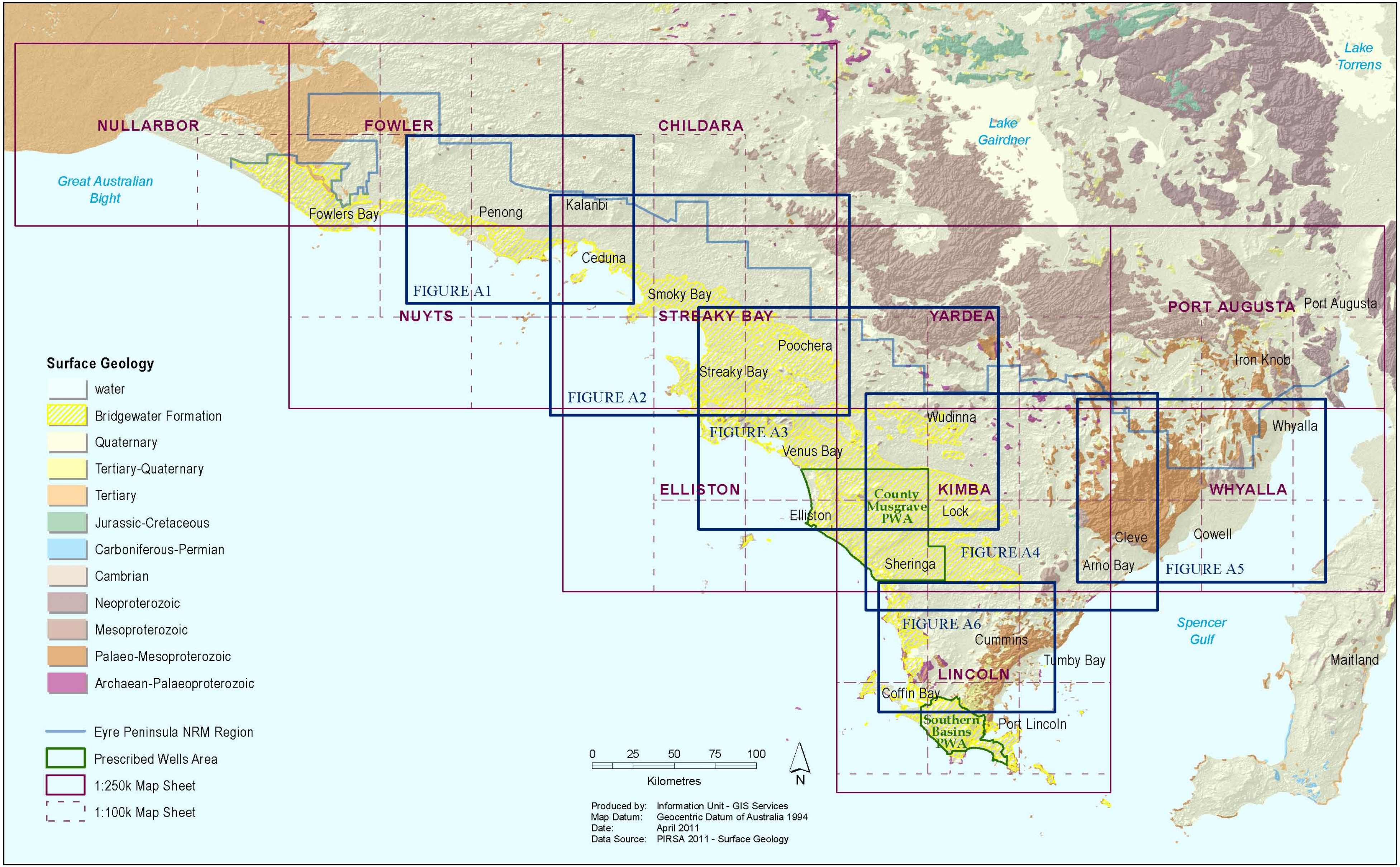
# APPENDICES

## A. GIS SUMMARY OF EXPLORATION DRILLHOLES AND GEOLOGICAL TRANSECTS

The region of Eyre Peninsula has been subject to numerous exploration programs that have identified the major stratigraphy.

As milestone of the *Palaeovalley Groundwater* Project, Geoscience Australia commissioned a literature review of palaeovalley groundwater resources in arid and semi-arid Australia (Magee 2009). Following this review, a suite of recommendations for the palaeovalley groundwater project was proposed. Recommendation 4 suggests that the Gawler Craton region is well suited to testing the potential of remote sensing or geophysical techniques in the elucidation of subsurface palaeovalley structure and composition, but emphasised the importance of addressing the overall lack of groundwater information pertaining to Gawler Craton palaeovalleys. Magee (2009) suggested that this will "…require detailed examination of unpublished information (most probably in South Australian Government records) and additional drilling transects combined with water bore pumping tests and groundwater chemical analyses". A first-order, GIS-based analysis is presented here which aims to address the unpublished literature review component of Recommendation 4. However, the scope of this analysis has been extended to include not only areas containing palaeovalley systems, but all non-prescribed areas of the EPNRM Region. It is anticipated that the products resulting from this analysis may also prove to be useful references for those investigating the feasibility of projects or development which will be dependent on groundwater resources.

The GIS-based analysis was approached on a scale of 1:100 000 map sheets. All mineral drillholes were evaluated visually and by drillhole name, in order to identify likely mineral exploration transects. These drillholes have been mapped as points and, where applicable, as transects. Where mineral exploration transects were evident, the drillhole information database SA Geodata was queried to identify any reports which may elucidate information that could assist defining the potential for groundwater resources. PIRSA's Resource Information Geoserver SARIG was used to locate and download the relevant reports. These reports were reviewed and any pertinent information contained within them reported in a summary table.




**Reference extents**

M:\Projects_GW\Eyre_Pen\Prj_GW Assessments\mxds\Report_Maps\ReferenceExtents_Landscape_A4.mxd Tan.J01

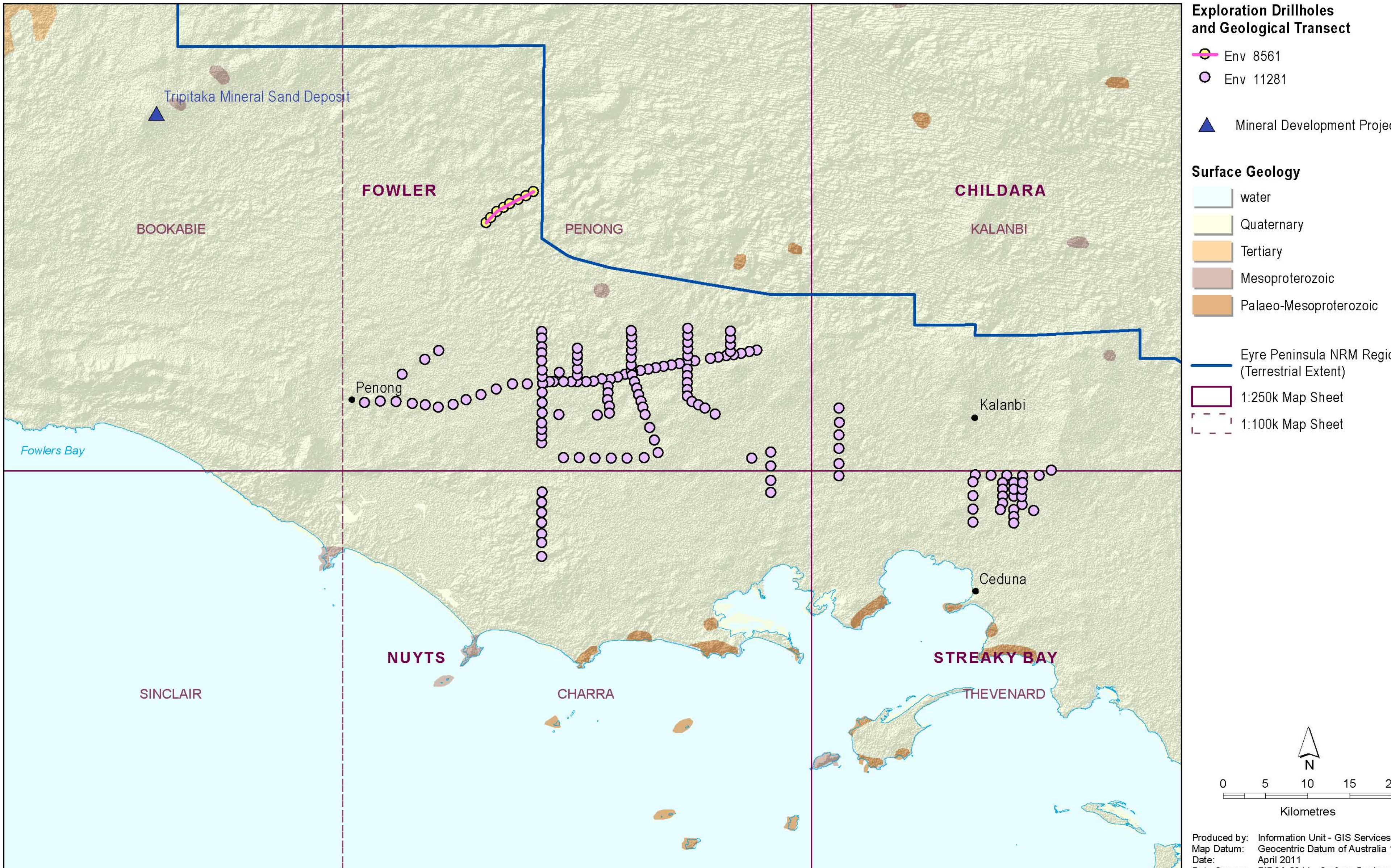



Figure A1: Exploration drillholes and geological transects

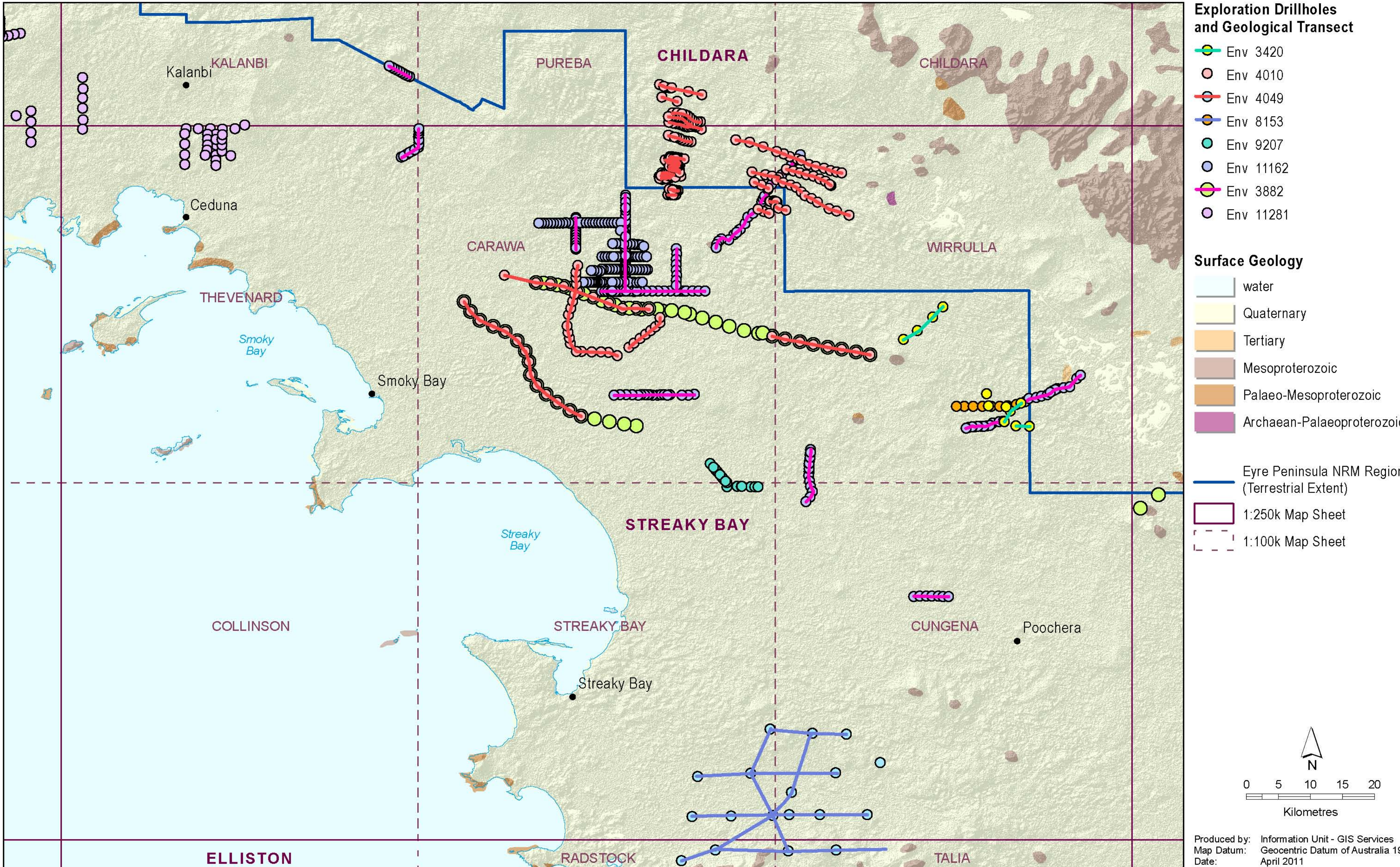
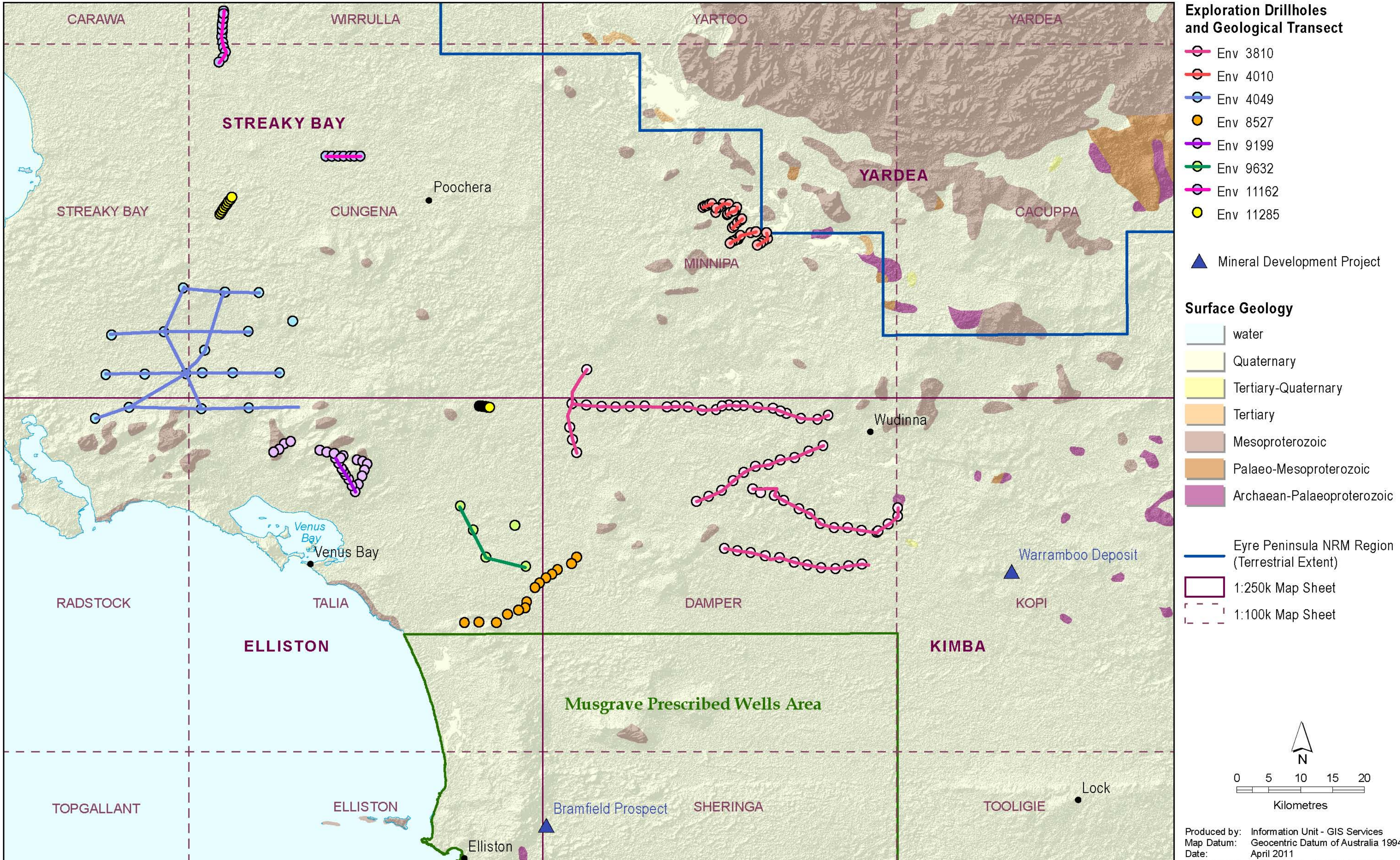



**Figure A2: Exploration drillholes and geological transects**

M:\Projects_GW\Eyre_Pen\Pri_GW Assessments\mxds\Report_Maps\FigureA2_ExplorationAndGeologicalTransects_Landscape_A4.mxd TanJ01




M:\Projects_GW\Eyre_Pen\Prj_GW Assessments\mxds\Report_Maps\FigureA3_ExplorationAndGeologicalTransects_Landscape_A4.mxd TanJ01

**Figure A3: Exploration drillholes and geological transects**

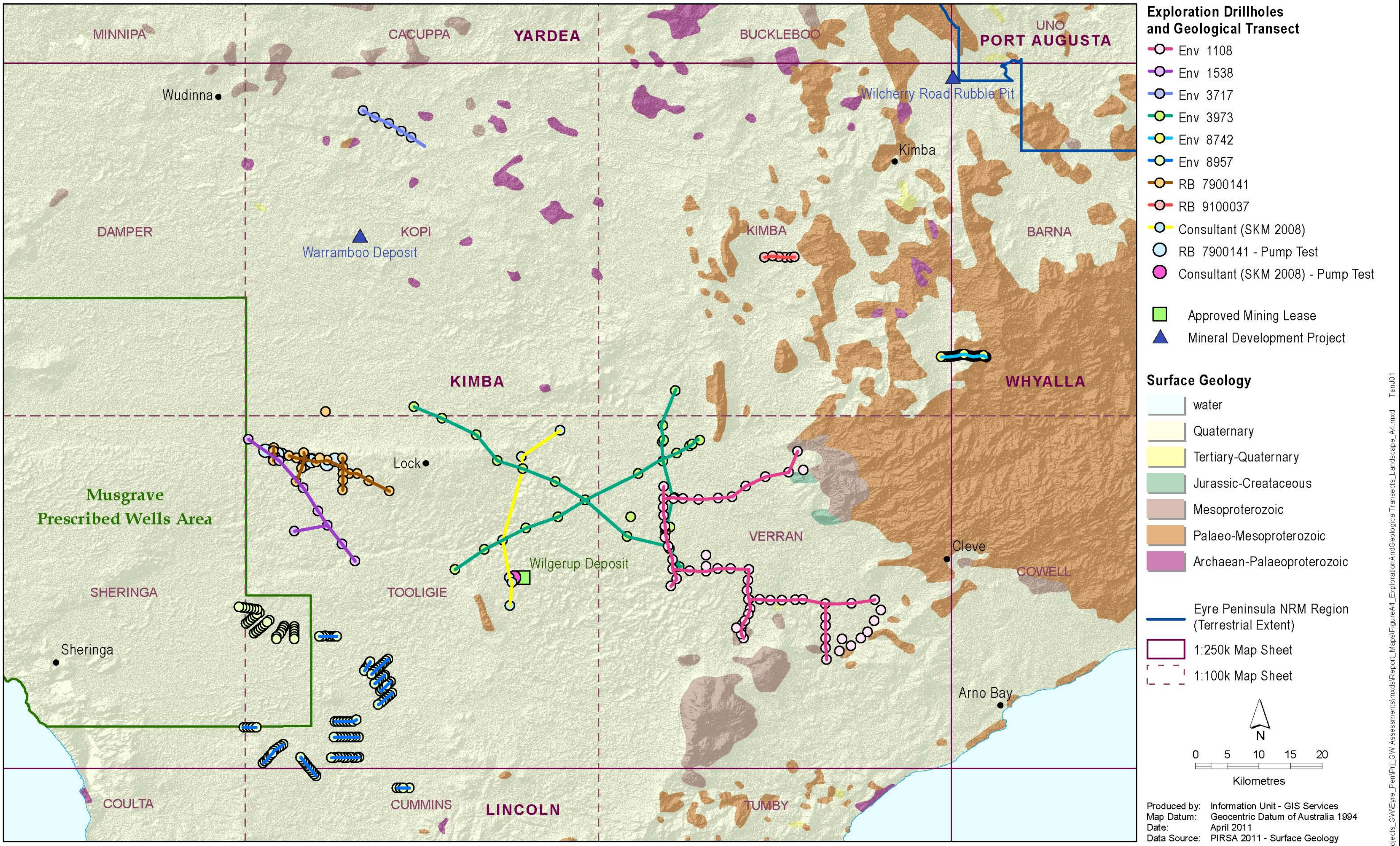



**Figure A4: Exploration drillholes and geological transects**

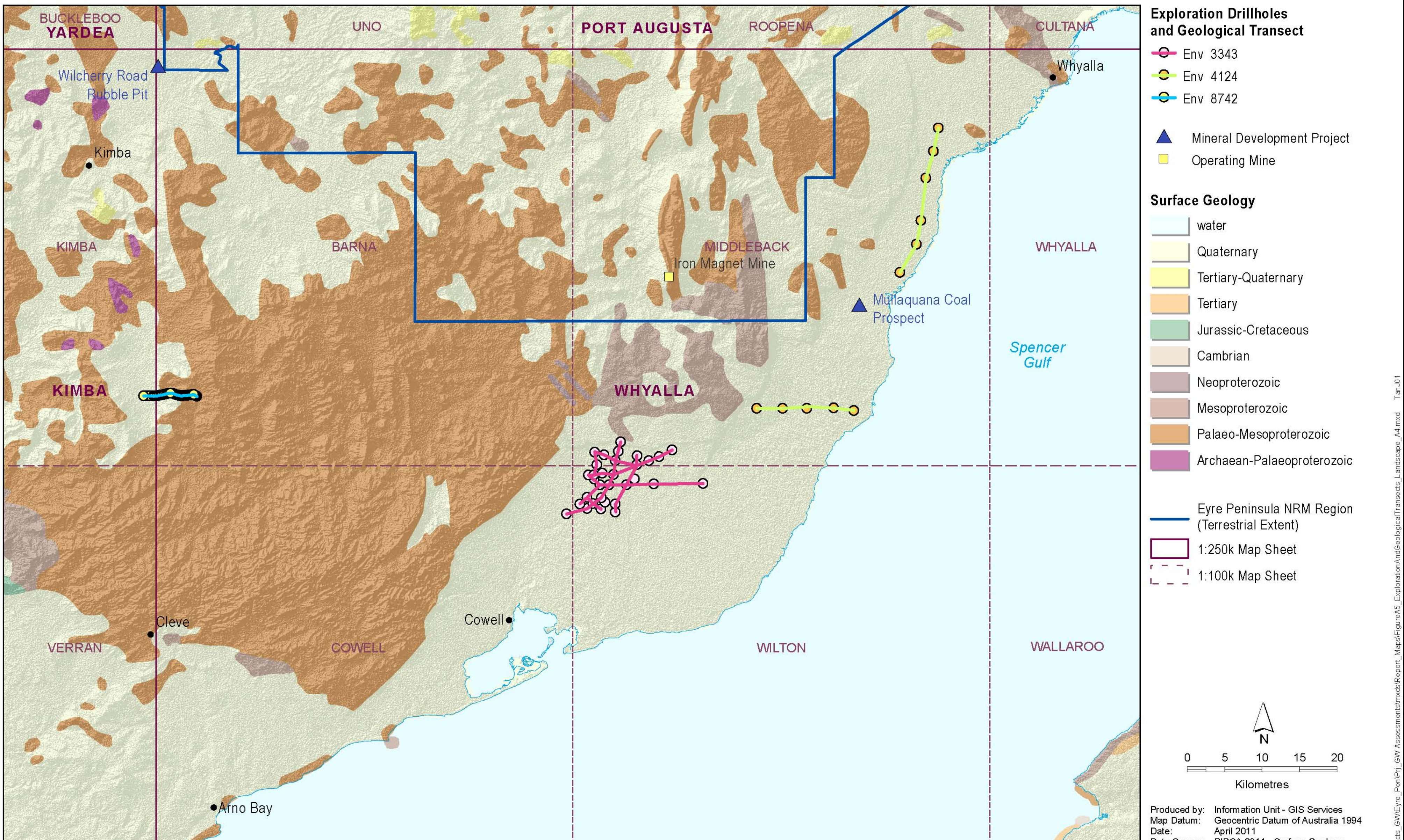



**Figure A5: Exploration drillholes and geological transects**

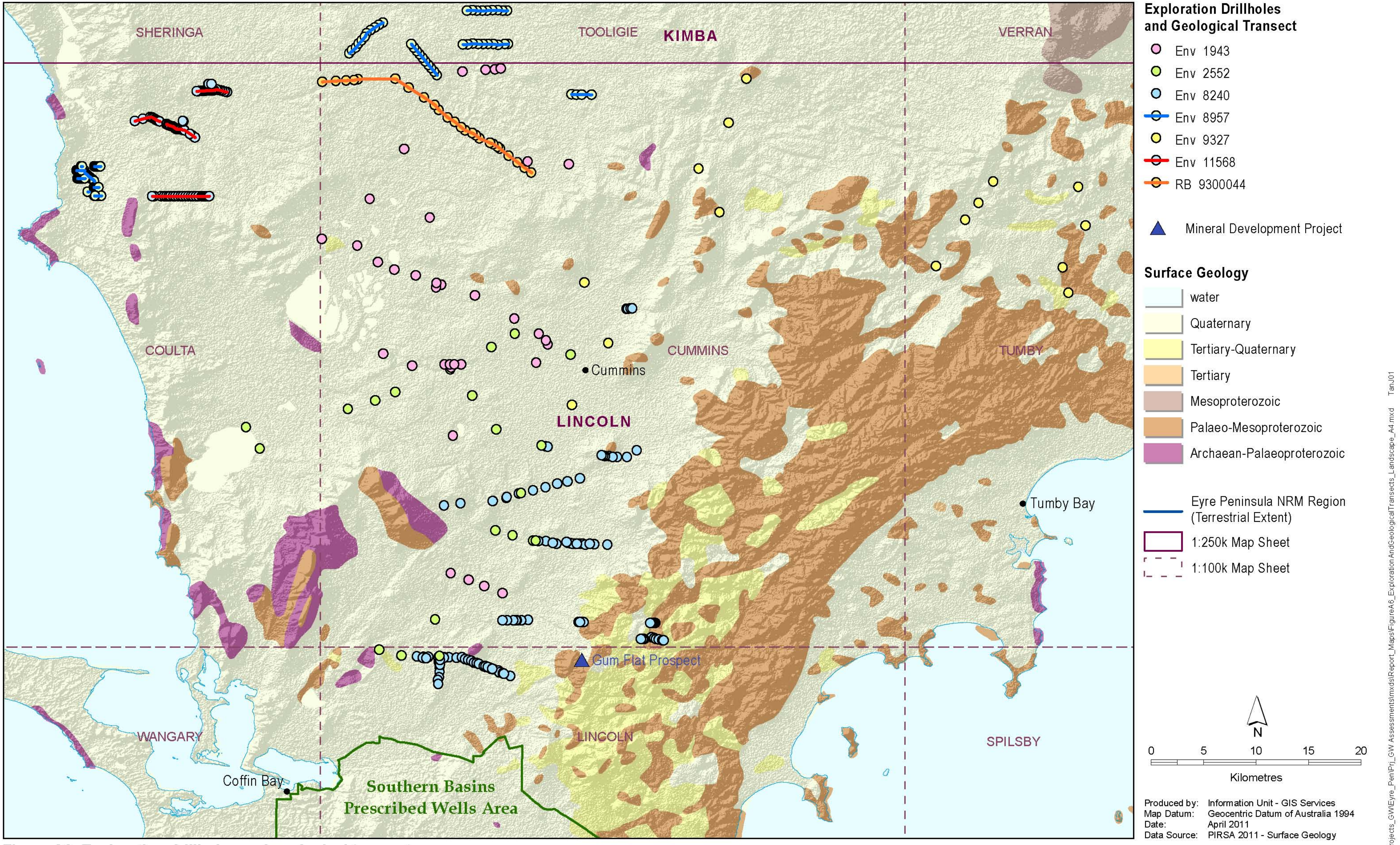



**Figure A6: Exploration drillholes and geological transects**

| Publication | Year | Licensee OR Commissioned by / Author | Survey type | Target minerals | Geo log (Analogue) | Strat/Lith log (Database) |
|---|---|---|---|---|---|---|
| *Open Envelope* | | | | | | |
| 1108 | 1968-69 | Kerr McGee Australia | Gp, GX, Rm | U | Y | Y/N |
| 1538 | 1970 | Mines Administration | Gp, GX, Rm | U | N | N/N |
| 1940 | 1972-73 | Blaker Motors & Exploration Drilling | Dh only | Kao | Y | N/N |
| 1943 | 1972 | Le Nickel (Aust.) Exploration | Sm | U | ?* | ? |
| 2256 | 1973-74 | Chevron Exploration Group | Gp, GX | U | Y | Y/N |
| 2552 | 1975-76 | Uranerz | Sm, Gp | U | Y | Y/N |
| 3343 | 1978-80 | CRA Exploration | Gp, GX | U, BM, Lig | Y | Y/N |
| 3420 | 1981 | Carpentaria Exploration Company | Gp | U | Y | Y/N |
| 3541 | 1979-85 | CRA Exploration & Shell Company of Australia | Gp, Gc | BM, Au, U | Y | Y/N |
| 3551 | 1979-82 | Pancontinental Mining; Power Reactor & Nuclear Fuel Development Corp.; PNC Exploration (Aust.) & Afmeco | Gp, Rm, Gc | U | Y | Y/N |
| 3575 | 1979-82 | Pancontinental Mining; Power Reactor and Nuclear Fuel Development Corp. & Afmeco | Gp,GX, Rm | U | Y | Y/N |
| 3717 | 1979-81 | Carpentaria Exploration Company | Gp, GX | U | Y | Y/N |
| 3773 | 1980-82 | Esso Exploration and Production Australia | Gp, (nil Dh) | BM, U | N/A | N/A |
| 3776 | 1980-82 | Afmeco | Gc, Gp, GX, Rm | U | Y | Y/N |
| 3810 | 1980 | Carpentaria Exploration Company | Gp, GX, Rm | U | Y | Y/N |
| 3882 | 1980 | Carpentaria Exploration Company | Gp | U | Y | Y/N |
| 3973 | 1980-85 | CRA Exploration | Gp, Sm | Lig | Y | Y/N |
| 4010 | 1981-83 | Carpentaria Exploration Company | Gp, GX, Rm, GW | BM, TE, U | Y | Y/N |
| 4049 | 1980-82 | CRA Exploration | Gp, GW, Rm | Au, BM, Kao, Lig, Sn, Ta, U, W | Y | Y/N |
| 4124 | 1980-82 | Dampier Mining Company & BHP Minerals | Gp, GX | Lig | Y | Y/N |
| 5247 | 1983-84 | CRA Exploration | Gc, Gp, GW | BM | Y | Y/N |
| 6459 | 1985-90 | CRA Exploration | Gc, Gp, GX, Rm | Dia, BM, Ag, U, W | Y | Y/N |
| 6695 | 1986-2002 | D.A. Wilson; I.P. Youles; Petroleum Engineering Services (Aust.); C. Youles; English China Clays International; Commercial Minerals; Normandy Industrial Minerals & Unimin Australia | GX | Au, BM, Dia, Kao | Y | Y/N |

| Publication | Year | Licensee OR Commissioned by / Author | Survey type | Target minerals | Geo log (Analogue) | Strat/Lith log (Database) |
|---|---|---|---|---|---|---|
| 8031 | 1988-94 | Stockdale Prospecting; Western Mining Corporation | Gp, GW | BM, Dia, Pb, Zn | Y | Y/N |
| 8076 | 1988-92 | Stockdale Prospecting | Gc, Gp | Dia | Y | Y/N |
| 8153 | 1989 | CRA Exploration | Gp | HM, U | Y | N/N |
| 8240 | 1989-94 | Southern Ventures NL & Dominion Metals | Gc, Gp | HM | Y | Y/N |
| 8471 | 1990-91 | National Mineral Sands (SA) NL; Swan Reach NL & Geopeko | Dh only | HM | Y | Y/N |
| 8478 | 1991-96 | Pasminco Australia | Gc, Gp, GX, Rm | BM | Y | Y/N |
| 8561 | 1989-92 | National Mineral Sands (SA) NL; Swan Reach NL & Geopeko | GX | HM | Y | Y/N |
| 8742 | 1992-94 | Pasminco Australia | Gp | BM | N | Y/N |
| 8957 | 1994-2002 | Lynch Mining; Alphadale & BHP Minerals | Gc, Gp, GX | Au, BM, Dia, HM | Y | Y/N |
| 9156 | 1995-2005 | Platsearch NL; Acacia Resources & Anglogold Australasia | Gp, Gc, | BM, Au | N | N/N |
| 9189 | 1996-98 | Equinox Resources NL & Phelps Dodge Australasia Inc | Gc, Gp | Au, BM, Cu | N | N/N |
| 9199 | 1993-97 | Commercial Minerals | Gc | Au, BM, Kao | N | N/N |
| 9207 | 1997-98 | Newcrest Mining | Gc, Gp, GX | Au, Cu, BM, | Y | Y/N |
| 9323 | 1197-99 | Goldstream Mining | Gc, Gp, | Au, Cu, BM | Y | Y/N |
| 9362 | 1994-98 | Diamond Ventures Exploration | Gc, Gp, GX | Au, Dia, HM | Y | Y/N |
| 9327 | 1997-2002 | Paladin Brightstar Joint Venture | Gp | U, BM | Y | Y/Y |
| 9372 | 1997-98 | Goldstream Mining | Gc, Gp | Au, BM | Y | Y/N |
| 11162 | 2006 | Iluka Resources | Gp, GX, | HM | Y | N/N |
| 11281 | 2006 | Red Metal | Dh/Gc | HM | Y | N/N |
| 11285 | 2006 | Minotaur Exploration; Toro Energy & Mithril Resources | Gc, Gp, Rm | Au, Cu, BM, U | N | N/N |
| 11377 | 2007 | Centrex Metals | Dh only | Fe | N | Y/Y |
| 11470 | 2007 | Murninnie Mining and Exploration (private syndicate) & Australasia Gold | Gc, Gp | Au, BM, U | Y | N/N |
| 11568 | 2008 | Monax Mining | Gc, Gp, GX, | Ag, Au, BM, | Y | Y/Y |

*Report Book*

| Publication | Year | Licensee OR Commissioned by / Author | Survey type | Target minerals | Geo log (Analogue) | Strat/Lith log (Database) |
|---|---|---|---|---|---|---|
| 79/00141 | 1979 | SADME / C.G. Gatehouse | AT, Gp, GW, HgX, Sm, | Lig | Y | N/N |
| 91/00037 | 1991 | DMS / W.M. Cowley | Gp, GX | BM | Y | Y/N |
| 93/00044 | 1993 | DME / L.R. Rankin | Gc, Gp | Ag, Au, Cu, BM | Y | Y/Y |
| *Mining Lease Applications* | | | | | | |
| MC 3947-3950 (Vol 1) | 2008 | Centrex Metals / Sinclair Knight Merz | GX, HgX | Fe | N | N/N |
| MC 3947-3950 (Vol 2) | 2008 | Centrex Metals / Sinclair Knight Merz | AT, GX, HgX, Gc, GW | Fe | Y | N/N |

***?**: Only available in hard copy – unsure of report content details.

**AT** Aquifer Tests

**Dh** Drillhole

**Gc** Geochemical

**Gp** Geophysics

**GW** Ground Water sampling

**GX** Geological cross section

**HgX** Hydrogeological cross section

**Rm** Radiometric

**Sm** Seismic

**Ag** Silver

**Au** Gold

**BM** Base Metals

**Cu** Copper

**Dia** Diamonds

**Fe** Iron oxides

**HM** Heavy Minerals

**Kao** Kaolinit

**Lig** Lignite

**Pb** Lead

**Sn** Tin

**Ta** Tantalum

**TE** Trace Elements

**U** Uranium

**Zn** Zinc

**W** Tungsten

# B. EYRE PENINSULA GEOLOGICAL FORMATION SUMMARY

More detailed descriptions of the geological formations summarised in Table 41 are presented in this appendix. Much of the material is derived from the Explanatory Notes for 1:250 000 Geological Maps series, which is distributed by PIRSA and Volumes 1 and 2 of The Geology of South Australia (Drexel, Preiss & Parker 1993; Drexel & Preiss 1995), which contain more detailed descriptions.

## BASEMENT

For the purposes of this report, weathered basement and hard crystalline basement have not been differentiated. Groundwater can occur within weathered crystalline basement and other fractured rock formations, however the salinity is often very high and yields unpredictable, but typically low. The crystalline basement is considered to act as hydraulic basement (Love *et al.* 1994).

### Sleaford Complex (ALs)

Late Archaean to Palaeoproterozoic rocks of the Sleaford Complex consist of metasediments, granites and gneisses (Flint & Rankin 1991),and are found extensively in central Eyre Peninsula and on the western half of southern Eyre Peninsula (EP). It is believed to extend to north-eastern Eyre Peninsula but has not been confidently identified.

Basement material of similar age (Archean to Mesoproterozoic) have been encountered west of central EP, but have not been positively identified as a specific formation. The Mulgathing Complex (ALm) has been positively identified on the Coorabie 1:100K Map Sheet.

### Hutchison Group (Lh)

The Hutchison Group consists of a basal quartzite sequence (such as the Warrow Quartzite), which is overlain by carbonates, banded iron formations, amphibolite and pelitic to semi-pelitic schists (Parker & Fanning 1998). Its occurrence has been positively identified in central and northern EP and westwards of Ceduna.

### Donington Suite (Ld)

Gneissic granite, granodiorite and adamellite with veins of pegmatite and aplite of the Donington Suite occur in a belt extending from Pt Lincoln, northward along the eastern coast which thickens as it extends inland at Cowell and reaches up to the Gawler Ranges.

### St Peter Suite (Lp)

The Lower Proterozoic units of the St Peter Suite represent a complex comagmatic intrusive sequence, comprising fine to coarse, even-grained granite (Rankin & Flint 1991). The St Peter Suite is found on the west coast south of Streaky Bay and north of Ceduna and Fowlers Bay. Other undifferentiated Lower Proterozoic basement rocks have been identified in stratigraphy logs in far north-western EP.

### Blue Range Beds (Mcb)

Mesoproterozoic fluvial sediments deposited unconformably on basement rocks, consisting predominantly of un-metamorphosed sandstone and conglomerate are known as the Blue Range Beds (Flint & Rankin 1991). The Blue Range Beds have minor surface exposure but are considered to be more extensive below the Polda Trough (Flint & Rankin 1991).

## POLDA TROUGH

The Polda Trough extends for more than 350 km from near Cleve in the east, westwards beyond Elliston offshore on to the continental margin in the Great Australian Bight. The Tertiary sands of the Polda Trough are a thick interbedded sequence of unconsolidated sands, silts and clays containing a series of confining beds and aquifers (Flint & Rankin 1991). Overlying the Polda Trough is a thin veneer of Tertiary and Pleistocene sediments that form the major low salinity aquifers of the area (Love *et al.* 1994)

### Kilroo Formation (N-k)

The Neoproterozoic Kilroo Formation is confined to the Polda Trough. Nearly 800 m of flat-lying sediments of mixed clastics, playa lake evaporites and volcanics of the Kilroo Formation has been intersected in the eastern Polda Trough (Preiss 1995). The formation has not been found in outcrop, but is considered to be widespread throughout the deeper sections of the Trough and is generally overlain by the Coolardie Formation (Preiss 1995).

### Coolardie Formation (CP-o)

The late Palaeozoic Coolardie Formation is characterised as mudstone, sandstone and siltstone beds of glacial derivation (Flint & Rankin 1991). The sequence unconformably overlies basement rocks in the shallow sections and the Kilroo Formation in the eastern section of the Polda Trough and is unconformably overlain by the Polda Formation (Rankin 1995).

### Polda Formation (J-o)

Representing the main aquifer unit of the Polda Trough, the Jurassic sediments of the Polda Formation extends the full length of and is constrained to, the Polda Trough. The formation unconformably overlies the Coolardie Formation and consists of sands, silts, carbonaceous clays and lignite (Martin, Sereda & Clarke 1998) and is disconformably overlain by the Tertiary Poelpena Formation (Harris 1966). The formation varies greatly in thickness, from 11 m to 282 m (Flint & Rankin 1991). Low transmissivity of between 0.6–45 $m^3$/day and a storage coefficient in the range of $1x10^{-4}$–$1x10^{-6}$ indicates the aquifer is confined (Love *et al.* 1994). The groundwater is highly saline, ranging between 30 000–50 000 mg/L. Due to its low permeability and highly saline water, the aquifer is not considered to have any potential for development for potable water supplies but may have considerable scope for industrial use (Martin, Sereda & Clarke 1998).

## TERTIARY

Tertiary sediments of the Eucla Basin lie unconformably on weathered and crystalline basement, occurring across most of Eyre Peninsula and represent aquifers that can be semi-confined or confined, often being clayey at the top, grading to sands at the base (Martin, Sereda & Clarke 1998). Outside of the prescribed wells areas, information on confining strata is rarely logged or stratigraphically identified as a low permeability sequence. The maximum thickness of Tertiary sediments coincides with the western Polda Trough, where intersected thicknesses range from 158 m to approximately 210 m. Eastwards, Tertiary sequences are much thinner to absent (where basement outcrops), with the maximum known thickness being 57m (Flint 1992). The following is a summary of the major water-bearing Tertiary stratigraphical units.

### Pidinga Formation (Tbp) and equivalents

The Pidinga Formation is a terrigenous clastic and consists of fine-grained to gravelly fluviatile sands and silt with interbeds of carbonaceous clay (Rankin & Flint 1991). The lower formation hosts coarse to gravelly sand grading to fine while the upper section consists of medium sand, silt and clays in (Rankin & Flint 1991). The formation is mostly confined to palaeovalleys (Benbow, Lindsay & Alley 1995); however, occurrences have been interpreted outside of palaeovalley extents and extensively in the north-western extent of EP, north and east of Fowlers Bay.

Up to 80 m of sediments of the Pidinga Formation have been found in the Narlaby Palaeovalley (Rankin & Flint 1991). The sequence is thinner in the unnamed palaeovalley to the south, with a maximum thickness of 55 m (Rankin & Flint 1991). There appears to be considerable lithological variation within the formation (Firman 1978) and the basal Pidinga Formation may not be easily distinguished from the underlying weathered rocks, due to reworking and/or weathering (Benbow, Lindsay & Alley 1995). Correlatives of the Pidinga Formation in the Polda Trough and Cummins-Uley-Wanilla groundwater basins are named the Poelpena and Wanilla formations, respectively (Benbow, Lindsay & Alley 1995).

### Hampton Sandstone (Tbh)

The middle Miocene marine, estuarine and fluvial Hampton Sandstone overlies the Pidinga Formation (Benbow, Lindsay & Alley 1995). The formation is partly clayey at the base and glauconitic and fossiliferous at the top, grading into limestone where it is overlain by Wilson Bluff Limestone (Benbow, Lindsay & Alley 1995). It has only been positively identified in a small number of drillholes in the north-western part of the study area.

### Garford Formation (Tig)

The middle Miocene Garford Formation comprises mudstone and minor horizons of silt and fine to coarse grained sand (Benbow, Lindsay & Alley 1995). Palaeovalley deposits of the Garford Formation comprise both lacustrine clays and fluviatile sand within channels incised into the underlying Pidinga Formation (Rankin & Flint 1991). Although thickest within the palaeovalleys, the Garford Formation extends as a widespread veneer of colluvial and alluvial sand, gravel and lacustrine clay over the crystalline basement on central west EP (Rankin & Flint 1991). The formation is found extensively between Venus Bay, Streaky Bay and Pildappa. Occurrences have also been identified to a lesser extent north of Ceduna and Fowlers Bay.

### Poelpena Formation (Tbe)

A sequence of the Polda Trough, the Poelpena Formation is a correlative of the Pidinga Formation and consists of poorly sorted, fine to coarse grained quartz sand, silt and clay which can be carbonaceous, micaceous and pyritic (Flint 1992). It is found extensively in central EP, especially between Lock and the west coast. The formation has a highly variable thickness, though it commonly exceeds 100 m in the eastern part of the Polda Trough (Alley & Lindsay 1995).

### Wilson Bluff Limestone (Tuw)

The Wilson Bluff Limestone unconformably overlies the Pidinga Formation and Hampton Sandstone and is mostly a white to grey wackestone, mudstone and rudstone with minor packstone (Benbow, Lindsay & Alley 1995). The formation has an average thickness of less than 150 m in South Australia, but increases to approximately 300 m in Western Australia (Benbow, Lindsay & Alley 1995). On the Eyre Peninsula, the formation has been identified to the east of Ceduna.

### Nullarbor Limestone (Tun)

The mostly bioclastic and micritic Nullarbor Limestone (Benbow, Lindsay & Alley 1995), overlies the Wilson Bluff Limestone and has been positively identified in far north-western EP. Within the Eucla Basin, the Nullarbor Limestone is generally about 30 m thick, but over much of north-western EP, it commonly has a thickness of only a few metres (Firman 1978).

### Wanilla Formation (Tbw)

The Wanilla Formation is restricted to the Cummins, Uley–Wanilla and Lincoln Basins and consists of fine-grained to gravelly fluvial sand interbedded with variable thicknesses of carbonaceous clay (Schwarz 2003). It rests unconformably on basement rock, attaining a maximum thickness of around 80 m and is in turn unconformably overlain by the Uley Formation (Schwarz 2003). It has been identified in drillholes up to 30 km north of Cummins.

### Uley Formation (TpQau)

The late Tertiary Uley Formation consists of a series of clayey sands and quartz sands which are generally well sorted with the top of the unit is defined by orange-brown mottled sandy clay (Schwarz 2003). It has not been observed in outcrop but is known from drillholes to be restricted to the Cummins, Uley–Wanilla and Lincoln basins (Schwarz 2003).

### Gibbon Beds (TpQag)

The Gibbon Beds are limited to the Pirie Basin on the north-east coast of EP and consists of a sequence of mottled, cross-bedded gravel, conglomerate, sandstone and shale or clay (Parker & Fanning 1998). The dominant lithology is coarse gravel with well-rounded cobbles in a clay and silt matrix and interbeds of fine silt and well sorted sand (Parker & Fanning 1998). In the western Pirie Basin, the Gibbon Beds attain a thickness of up to 80–90 m immediately south of the Charleston Fault (Parker & Fanning 1998).

## PALAEOVALLEYS

The following summary of Eyre Peninsula palaeovalley morphology and hydrology is based on a number of previous studies. Magee (2009) compiled a comprehensive review of existing literature that describes palaeovalley groundwater resources in arid and semi-arid Australia. Benbow, Lindsay and Alley (1995) have detailed palaeodrainage of the Eucla Basin. Binks and Hooper (1983), Frakes and White (1997) and Hou, Frakes and Alley (2003) report on the Narlaby and Yaninee palaeovalleys of the Gawler Craton and Polda Trough.

The most extensive region of palaeodrainage in South Australia fringes the Eucla Basin to the north, which has preserved alluvial, colluvial and paralic sediments. Palaeovalleys of the Gawler Craton and Polda Trough were incised during an early Eocene erosion event. In Eocene to Miocene times, networks of palaeorivers drained South Australia's Musgrave Block, Stuart Range and Gawler Ranges. Major sediment-infilling episodes occurred through the late Oligocene–Miocene and Pliocene–Pleistocene (Frakes & White 1997). During the early Pliocene (possibly also late Miocene), extensive fluvial and lacustrine sediments infilled palaeovalleys around the Eucla Basin.

Tertiary palaeovalleys draining the mineralised Gawler Craton principally flow in a south-west direction, although there is considerable variation, partly due to low gradients (the Narlaby channel falls approximately one metre per kilometre (Binks & Hooper 1983)). Evidence suggests that a distinct sea level rise during middle to late Eocene and middle Miocene, with associated marine transgressions, resulted in carbonate and silt deposition in palaeovalleys. These deposits comprise the Pidinga and

Garford formations (Frakes and White 1997). Channel fills have been exposed to varying degrees of weathering, with the depth of weathering ranging from only a few metres to more than 100 metres in bedrock-dominant regions (Hou, Frakes & Alley 2003).

Hou *et al.* (2007) mapped palaeodrainage channels of South Australia in response to high levels of exploration activity for uranium and heavy mineral sands, which are associated with palaeovalley sediments. Their areal extent was delineated through the integration of drillhole data, interpretation of geophysical and remotely sensed data and sedimentary history records (Rogers & Zang 2006).

While most channels are greater than 100 km in length and some up to around 500 km (Frakes & White 1997), their dimensions are greatly variable. The widths of the river valleys range from tens of metres to around 30 km and can reach depths of 120 m (Hou, Frakes & Alley 2003).

## QUATERNARY

The dunes and aeolianites along the coastal margin extend from Streaky Bay to Fowlers Bay covering an area of approximately 420 $km^2$ (Martin, Sereda & Clarke 1998). The mobile dunes reach heights of more than 30 m in places but are not continuous across the whole area (Martin, Sereda & Clarke 1998). It is assumed that almost all of the available rainfall percolates through the dunes to form a perched aquifer which may have a saturated thickness of up to five metres beneath some of the larger dunes, but typically is between one and two metres (Martin, Sereda & Clarke 1998).

### Bridgewater Formation (Qpcb)

Across EP, the Bridgewater Formation consists of calcareous sands, broken shell fragments and limestone, often with calcrete at the surface and can be indurated to unconsolidated throughout (Martin, Sereda & Clarke 1998). It forms a thin veneer widespread throughout western EP, extending well inland between Streaky Bay and Cummins, but only becomes saturated within the fresh water lenses towards the coast (Martin, Sereda & Clarke 1998). The unit unconformably overlies and blankets both Tertiary sediments and basement over most of central EP and is in turn overlain by south-east trending longitudinal sand dunes (Flint & Rankin 1991). Cliff exposures on the mainland attain a maximum thickness of around 150 m (Flint & Rankin 1991).

### Glanville Formation (Qpcg)

Intertonguing with and laterally equivalent to, the Bridgewater Formation is the Glanville Formation, which consists of soft, white to cream-fawn richly fossiliferous shelly sand and clay (Flint & Rankin 1991). The formation underlies much of the coastal zone (Parker & Fanning 1998). Calcreted shell beds crop out rarely on north-eastern EP and only occur along the coast near Cowell (Parker & Fanning 1998). Small outcrops are found between Fowlers Bay and Coorabie and are overlain by the St Kilda Formation (Firman 1978). The formation occurs on central EP in subsurface only (Flint & Rankin 1991).

### Pooraka Formation (Qpap)

Alluvial, red-brown clayey sand and gravels of the Pooraka Formation, capped in general by soft powdery carbonate and/or calcrete, is widespread on alluvial plains between Coffin Bay and Cummins and is scattered throughout central EP (Parker & Fanning 1998). They form an apron of variable thickness unconformably overlying Gibbon Beds and older units (Parker & Fanning 1998).

### Yamba Formation (Qly)

The Yamba Formation comprises halite, gypsite, gypsarenite, selenite and minor carbonate and gypsiferous mud of inland lakes occupying depressions in the Bridgewater Formation (Flint & Rankin 1991). The best development of Yamba Formation is around Kyancutta-Warramboo and Lake Yaninee (Flint & Rankin 1991).

### Wiabuna Formation (Qpew)

The distinctive yellow to orange siliceous sand and clayey sand of the Wiabuna Formation takes the form of inland calcareous seif dunes, minor siliceous seif dunes and thin veneers of calcareous silt (Rankin & Flint 1991). Found on the western side of EP, the unit overlies the Bridgewater Formation, onlaps crystalline basement and is disconformably overlain by thin veneers of Moornaba Sand (Rankin & Flint 1991). The Wiabuna Formation may be, at least in part, an inland equivalent of the upper member of the Bridgewater Formation (Rankin & Flint 1991).

### Moornaba Sand (Qhem)

Moornaba Sand consists of white, pale grey and orange quartz sand which forms spreads of modem dunes and veneers (Flint & Rankin 1991) that covers large tracts of EP (Parker & Fanning 1998), particularly in central EP north of Lock. Interdunal valleys generally consist of red-brown sandy clay which grade laterally into quartz sand and which in part may represent local Wiabuna Formation, Pooraka Formation and/or Hindmarsh Clay (Parker & Fanning 1998). Thicknesses vary from less than one metre in interdunal corridors to 10 m at the crest of dunes (Schwarz 2003). The sand forms veneers over seif dunes of the Wiabuna Formation, from which it was principally derived (Flint 1992).

### Semaphore Sand (Qhe)

A lateral equivalent of Moornaba Sand is the Semaphore Sand, a more extensive unit, though confined to near-coastal areas and consists of white to pale grey, chiefly calcareous sands (Flint 1992). The Semaphore Sand on central EP occurs only as a narrow dune ridge along the east coast near Arno Bay and on the west coast at Sheringa Beach where it disconformably overlies the Bridgewater and Glanville formations (Flint & Rankin 1991). Where the Semaphore Sand overlies the Bridgewater Formation, the unit is relatively thin (Flint 1992). The Semaphore Sand also forms prominent dunes along the less-protected sections of coastline on the west coast of EP, commonly capping the Bridgewater Formation coastal cliffs and occasionally the crystalline basement outcrop (Rankin & Flint 1991).

### St Kilda Formation (Qhk)

The St Kilda Formation, containing shallow marine sands, estuarine muds and shelly beach ridge deposits, is found in restricted outcrop between Fowlers Bay and Coorabie and fringing Baird Bay and Venus Bay (Flint 1992). Within Venus Bay up to at least 4 m of sediment has accumulated (Flint 1992). The St Kilda Formation is a facies equivalent of Semaphore Sand and Yamba Formation (Flint & Rankin 1991).

# UNITS OF MEASUREMENT

## Units of measurement commonly used (SI and non-SI Australian legal)

| Name of unit | Symbol | Definition in terms of other metric units | Quantity |
|---|---|---|---|
| day | d | 24 h | time interval |
| gigalitre | GL | $10^6$ $m^3$ | volume |
| gram | g | $10^{-3}$ kg | mass |
| hectare | ha | $10^4$ $m^2$ | area |
| hour | h | 60 min | time interval |
| kilogram | kg | base unit | mass |
| kilolitre | kL | 1 $m^3$ | volume |
| kilometre | km | $10^3$ m | length |
| litre | L | $10^{-3}$ $m^3$ | volume |
| megalitre | ML | $10^3$ $m^3$ | volume |
| metre | m | base unit | length |
| microgram | µg | $10^{-6}$ g | mass |
| microlitre | µL | $10^{-9}$ $m^3$ | volume |
| milligram | mg | $10^{-3}$ g | mass |
| millilitre | mL | $10^{-6}$ $m^3$ | volume |
| millimetre | mm | $10^{-3}$ m | length |
| minute | min | 60 s | time interval |
| second | s | base unit | time interval |
| tonne | t | 1000 kg | mass |
| year | y | 365 or 366 days | time interval |

# GLOSSARY

**Act (the)** — In this document, refers to the *Natural Resources Management (SA) Act 2004,* which supercedes the *Water Resources (SA) Act 1997*

**Aquiclude** — In hydrologic terms, a formation that contains water but cannot transmit it rapidly enough to furnish a significant supply to a well or spring

**Aquifer** — An underground layer of rock or sediment that holds water and allows water to percolate through

**Aquifer, confined** — Aquifer in which the upper surface is impervious (see 'confining layer') and the water is held at greater than atmospheric pressure; water in a penetrating well will rise above the surface of the aquifer

**Aquifer test** — A hydrological test performed on a well, aimed to increase the understanding of the aquifer properties, including any interference between wells and to more accurately estimate the sustainable use of the water resources available for development from the well

**Aquifer, unconfined** — Aquifer in which the upper surface has free connection to the ground surface and the water surface is at atmospheric pressure

**Aquitard** — A layer in the geological profile that separates two aquifers and restricts the flow between them

**Artesian** — An aquifer in which the water surface is bounded by an impervious rock formation; the water surface is at greater than atmospheric pressure and hence rises in any well which penetrates the overlying confining aquifer

**Baseflow** — The water in a stream that results from groundwater discharge to the stream; often maintains flows during seasonal dry periods and has important ecological functions

**Basin** — The area drained by a major river and its tributaries

**BoM** — Bureau of Meteorology, Australia

**Bore** — See 'well'

**Catchment** — That area of land determined by topographic features within which rainfall will contribute to run-off at a particular point

**Catchment Water Management Board** — A statutory body established under the Act whose prime function is to implement a catchment water management plan for its area

**Catchment water management plan** — The plan prepared by a CWMB and adopted by the Minister in accordance with the Act

**Confining layer** — A rock unit impervious to water, which forms the upper bound of a confined aquifer; a body of impermeable material adjacent to an aquifer; see also 'aquifer, confined'

**DES** — Drillhole Enquiry System; a database of groundwater wells in South Australia, compiled by the South Australian Department for Water (DFW)

**DFW** — Department for Water (Government of South Australia)

**Domestic purpose** — The taking of water for ordinary household purposes; includes the watering of land in conjunction with a dwelling not exceeding 0.4 hectares

**Drillhole —** See 'well'. A hole or passage made by a drill; usually made for exploratory purposes, typically used in the mining industry.

**Dryland salinity** — The process whereby salts stored below the surface of the ground are brought close to the surface by the rising watertable. The accumulation of salt degrades the upper soil profile, with impacts on agriculture, infrastructure and the environment.

**EC** — Electrical conductivity; 1 EC unit = 1 micro-Siemen per centimetre (µS/cm) measured at 25°C; commonly used as a measure of water salinity as it is quicker and easier than measurement by TDS

**EP** — Eyre Peninsula

**EPA** — Environment Protection Authority (Government of South Australia)

**Ephemeral streams or wetlands** — Those streams or wetlands that usually contain water only on an occasional basis after rainfall events. Many arid zone streams and wetlands are ephemeral.

**EPNRMB** — Eyre Peninsula Natural Resources Management Board

**Fully-penetrating well** — In theory this is a wellhole that is screened throughout the full thickness of the target aquifer; in practice, any screen that is open to at least the mid 80% of a confined aquifer is regarded as fully-penetrating

**Geological features** — Include geological monuments, landscape amenity and the substrate of land systems and ecosystems

**Geomorphic** — Related to the physical properties of the rock, soil and water in and around a stream

**Geomorphology** — The scientific study of the landforms on the Earth's surface and of the processes that have fashioned them

**GIS** — Geographic Information System; computer software linking geographic data (for example land parcels) to textual data (soil type, land value, ownership). It allows for a range of features, from simple map production to complex data analysis

**Groundwater** — Water occurring naturally below ground level or water pumped, diverted and released into a well for storage underground; see also 'underground water'

**Hydraulic conductivity (K)** — A measure of the ease of flow through aquifer material: high K indicates low resistance, or high flow conditions; measured in metres per day

**Hydrogeology** — The study of groundwater, which includes its occurrence, recharge and discharge processes and the properties of aquifers; see also 'hydrology'

**ICCWR —** Impacts of Climate Change on Water Resources Projects (DFW)

**Infrastructure** — Artificial lakes; dams or reservoirs; embankments, walls, channels or other works; buildings or structures; or pipes, machinery or other equipment

**Integrated catchment management** — Natural resources management that considers in an integrated manner the total long-term effect of land and water management practices on a catchment basis, from production and environmental viewpoints

**Intensive farming** — A method of keeping animals in the course of carrying on the business of primary production in which the animals are confined to a small space or area and are usually fed by hand or mechanical means

**Irrigation** — Watering land by any means for the purpose of growing plants

**Lake** — A natural lake, pond, lagoon, wetland or spring (whether modified or not) that includes part of a lake and a body of water declared by regulation to be a lake. A reference to a lake is a reference to either the bed, banks and shores of the lake or the water for the time being held by the bed, banks and shores of the lake, or both, depending on the context.

**Land** — Whether under water or not and includes an interest in land and any building or structure fixed to the land

**m AHD** — Defines elevation in metres (m) according to the Australian Height Datum (AHD)

**Model** — A conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating storm run-off, assessing the impacts of dams or predicting ecological response to environmental change

**Monitoring** — (1) The repeated measurement of parameters to assess the current status and changes over time of the parameters measured (2) Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, animals and other living things

**Natural recharge** — The infiltration of water into an aquifer from the surface (rainfall, streamflow, irrigation etc). See also recharge area, artificial recharge

**Natural resources** — Soil, water resources, geological features and landscapes, native vegetation, native animals and other native organisms, ecosystems

**Observation well** — A narrow well or piezometer whose sole function is to permit water level measurements

**Obswell** — Observation Well Network

**PACE 2020 —** Plan for Accelerated Exploration

**Palaeovalleys** — Ancient buried river channels in arid areas of the state. Aquifers in palaeovalleys can yield useful quantities of groundwater or be suitable for ASR

**Penetrating well** — See 'fully-penetrating well'

**Perennial streams** — Permanently inundated surface stream courses. Surface water flows throughout the year except in years of infrequent drought.

**Permeability** — A measure of the ease with which water flows through an aquifer or aquitard, measured in $m^2$/d

**Piezometer** — A narrow tube, pipe or well; used for measuring moisture in soil, water levels in an aquifer, or pressure head in a tank, pipeline, etc

**PIRSA** — Primary Industries and Resources South Australia (Government of South Australia)

**Pluviometer** — An automated rain gauge consisting of an instrument to measure the quantity of precipitation over a set period of time

**Population** — (1) For the purposes of natural resources planning, the set of individuals of the same species that occurs within the natural resource of interest. (2) An aggregate of interbreeding individuals of a biological species within a specified location

**Potable water** — Water suitable for human consumption such as drinking or cooking water

**Potentiometric head** — The potentiometric head or surface is the level to which water rises in a well due to water pressure in the aquifer, measured in metres (m); also known as piezometric surface

**Prescribed area, surface water** — Part of the state declared to be a surface water prescribed area under the Act

**Prescribed lake** — A lake declared to be a prescribed lake under the Act

**Prescribed watercourse** — A watercourse declared to be a prescribed watercourse under the Act

**Prescribed water resource** — A water resource declared by the Governor to be prescribed under the Act and includes underground water to which access is obtained by prescribed wells. Prescription of a water resource requires that future management of the resource be regulated via a licensing system.

**Prescribed well** — A well declared to be a prescribed well under the Act

**Production well** — The pumped well in an aquifer test, as opposed to observation wells; a wide-hole well, fully developed and screened for water supply, drilled on the basis of previous exploration wells

**PWA** — Prescribed Wells Area

**PWCA** — Prescribed Watercourse Area

**PWRA** — Prescribed Water Resources Area

**Recharge area** — The area of land from which water from the surface (rainfall, streamflow, irrigation, etc.) infiltrates into an aquifer. See also artificial recharge, natural recharge

**SA Geodata** — A collection of linked databases storing geological and hydrogeological data, which the public can access through the offices of PIRSA. Custodianship of data related to minerals and petroleum and groundwater, is vested in PIRSA and DWLBC, respectively. DWLBC should be contacted for database extracts related to groundwater

**SARIG —** South Australian Resources Information Geoserver

**SA Water** — South Australian Water Corporation (Government of South Australia)

**Seasonal watercourses or wetlands** — Those watercourses or wetlands that contain water on a seasonal basis, usually over the winter–spring period, although there may be some flow or standing water at other times

**Specific storage ($S_s$)** — Specific storativity; the amount of stored water realised from a unit volume of aquifer per unit decline in head; it is dimensionless

**Specific yield ($S_y$)** — The volume ratio of water that drains by gravity, to that of total volume of the porous medium. It is dimensionless

**State Water Plan** — Policy document prepared by the Minister that sets the strategic direction for water resource management in the State and policies for achieving the objects of the *Natural Resources Management (SA) Act 2004*

**Stock use** — The taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act)

**(S)** — Storativity; storage coefficient; the volume of groundwater released or taken into storage per unit plan area of aquifer per unit change of head; it is dimensionless

**Stormwater** — Run-off in an urban area

**Sub-catchment** — The area of land determined by topographical features within which rainfall will contribute to run-off at a particular point

**Surface water** — (a) water flowing over land (except in a watercourse), (i) after having fallen as rain or hail or having precipitated in any another manner, (ii) or after rising to the surface naturally from underground; (b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir

**Surface Water Archive** — An internet-based database linked to Hydstra and operated by DWLBC. It contains rainfall, water level, streamflow and salinity data collected from a network of surface water monitoring sites located throughout South Australia

**Sustainability** — The ability of an ecosystem to maintain ecological processes and functions, biological diversity and productivity over time

**SWL —** Depth to groundwater below the natural ground surface

**T** — Transmissivity; a parameter indicating the ease of groundwater flow through a metre width of aquifer section (taken perpendicular to the direction of flow), measured in $m^2/d$

**TDS** — Total dissolved solids, measured in milligrams per litre (mg/L); a measure of water salinity

**Tertiary aquifer** — A term used to describe a water-bearing rock formation deposited in the Tertiary geological period (1–70 million years ago)

**Transmissivity (T)** — A parameter indicating the ease of groundwater flow through a metre width of aquifer section

**Tributary** — A river or creek that flows into a larger river

**Underground water (groundwater)** — Water occurring naturally below ground level or water pumped, diverted or released into a well for storage underground

**Volumetric allocation** — An allocation of water expressed on a water licence as a volume (eg. kilolitres) to be used over a specified period of time, usually per water use year (as distinct from any other sort of allocation)

**Water affecting activities** — Activities referred to in Part 4, Division 1, s. 9 of the Act

**Water allocation** — (1) In respect of a water licence means the quantity of water that the licensee is entitled to take and use pursuant to the licence. (2) In respect of water taken pursuant to an authorisation under s.11 means the maximum quantity of water that can be taken and used pursuant to the authorisation

**Water allocation, area based** — An allocation of water that entitles the licensee to irrigate a specified area of land for a specified period of time usually per water–use year

**WAP** — Water Allocation Plan; a plan prepared by a CWMB or water resources planning committee and adopted by the Minister in accordance with the Act

**Water body** — Includes watercourses, riparian zones, floodplains, wetlands, estuaries, lakes and groundwater aquifers

**Watercourse** — A river, creek or other natural watercourse (whether modified or not) and includes: a dam or reservoir that collects water flowing in a watercourse; a lake through which water flows; a channel (but not a channel declared by regulation to be excluded from the this definition) into which the water of a watercourse has been diverted; and part of a watercourse

**Water cut —** The depth at which a water bearing unit is intersected during the process of drilling a well.

**Water-dependent ecosystems** — Those parts of the environment, the species composition and natural ecological processes, that are determined by the permanent or temporary presence of flowing or standing water, above or below ground; the in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

**Water licence** — A licence granted under the Act entitling the holder to take water from a prescribed watercourse, lake or well or to take surface water from a surface water prescribed area; this grants the licensee a right to take an allocation of water specified on the licence, which may also include conditions on the taking and use of that water; a water licence confers a property right on the holder of the licence and this right is separate from land title

**Water plans** — The State Water Plan, catchment water management plans, water allocation plans and local water management plans prepared under Part 7 of the Act

**Water quality criteria** — comprised of both numerical criteria and narrative criteria. Numerical criteria are scientifically derived ambient concentrations developed by the EPA (Commonwealth Government of Australia) or the states for various pollutants of concern, so that human health and aquatic life can be protected. Narrative criteria are statements that describe the desired water quality goal.

**Water quality data** — Chemical, biological and physical measurements or observations of the characteristics of surface and groundwaters, atmospheric deposition, potable water, treated effluents and wastewater and of the immediate environment in which the water exists

**Water quality information** — Derived through analysis, interpretation and presentation of water quality and ancillary data

**Water quality monitoring** — An integrated activity for evaluating the physical, chemical and biological character of water in relation to human health, ecological conditions and designated water uses

**Water quality standard** — A law or regulation that consists of the beneficial designated use or uses of a water body, the numerical and narrative water quality criteria that are necessary to protect the use or uses of that particular water body and an anti-degradation statement

**Water resource monitoring** — An integrated activity for evaluating the physical, chemical and biological character of water resources, including (1) surface waters, groundwaters, estuaries and near-coastal waters; and (2) associated aquatic communities and physical habitats, which include wetlands

**Water resource quality** — (1) The condition of water or some water-related resource as measured by biological surveys, habitat-quality assessments, chemical-specific analyses of pollutants in water bodies and toxicity tests. (2) The condition of water or some water-related resource as measured by habitat quality, energy dynamics, chemical quality, hydrological regime and biotic factors

**WDE** — Water dependent ecosystem

**Well** — (1) An opening in the ground excavated for the purpose of obtaining access to underground water. (2) An opening in the ground excavated for some other purpose but that gives access to underground water. (3) A natural opening in the ground that gives access to underground water

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