TECHNICAL REPORT

NON-PRESCRIBED GROUNDWATER RESOURCES ASSESSMENT – NORTHERN AND YORKE NATURAL RESOURCES MANAGEMENT REGION

PHASE 1 – LITERATURE AND DATA REVIEW

2011/17

Government of South Australia
Department for Water

NON-PRESCRIBED GROUNDWATER RESOURCES ASSESSMENT — NORTHERN AND YORKE 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 – Northern and Yorke 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 Australia (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 Northern and Yorke Natural Resources Management (NYNRM) 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 the NYNRM 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. NORTHERN AND YORKE NATURAL RESOURCES MANAGEMENT REGION

The NYNRM Region (Fig. 1) spans an area of over three million hectares and sustains a population of around 89 000 people (NYNRMB 2009a). It is bounded to the west by Spencer Gulf and extends from Arkaroola in the north to Hamley Bridge in the south. The region encompasses Yorke Peninsula, the Northern Mount Lofty Ranges and Southern Flinders Ranges.

2.1. CLIMATE

The climate of the NYNRM Region varies with latitude and altitude. According to the Köppen-Geiger climate classification system (Peel, Finlayson & McMahon 2007), regional-scale climate can be divided into two broad categories divided by a line between Wallaroo and Clare (Fig. 2):

(1) south of this line, the climate can be described as temperate with distinctly dry and warm summers

(2) to the north, the climate can be described as semi-arid to arid with hot dry summers and cold winters.

Coastal areas generally experience a milder and wetter climate, while rainfall decreases and conditions tend toward extremes in temperature with increasing distance inland. Toward the northern half of the NYNRM Region, areas of higher relief receive higher rainfall. Clare receives mean annual rainfall of 631 mm/y, while the Southern Flinders Ranges township of Georgetown receives mean annual rainfall of 472 mm/y (BoM 2010). Across the entire NYNRM Region, evaporation rates increase from south to north. Class A Pan evaporation rates vary between around 1 400 mm/y at the southern tip of Yorke Peninsula up to around 2 600 mm/y toward the northern extent of the study area.

2.2. TOPOGRAPHY

The topography across Yorke Peninsula is undulating and gently rolling, with elevations generally less than 100 m Australian Height Datum (AHD). Arthurton, located around central Yorke Peninsula (Fig. 1), reaches an elevation of approximately 250 m AHD. To the east of Gulf St Vincent, the northern Mount Lofty Ranges extend from Kapunda in the south to beyond Peterborough in the north east. In contrast to Yorke Peninsula, relief across the ranges is commonly around 300 m AHD and reaches a maximum of around 940 m AHD at Mount Bryan. The Southern Flinders Ranges is located to the east and north-east of Port Pirie. Relief in this region varies from low lying coastal plains around Baroota, through to gorges and ranges which show contrasting elevations of between around 300–800 m AHD.

2.3. LAND USE

The predominant land uses across the NYNRM Region are agriculture and grazing (Table 1; Fig. 3). Barley, wheat and oats are the principal focus of primary production. Cropping and grazing contribute around 25% of the State's agricultural income (NYNRMB 2010). The NYNRM Region includes the internationally recognised viticulture and winemaking area of Clare Valley. Mining, mineral processing, forestry, fishing, aquaculture and tourism are important industries for the region's current and future economic prospects.

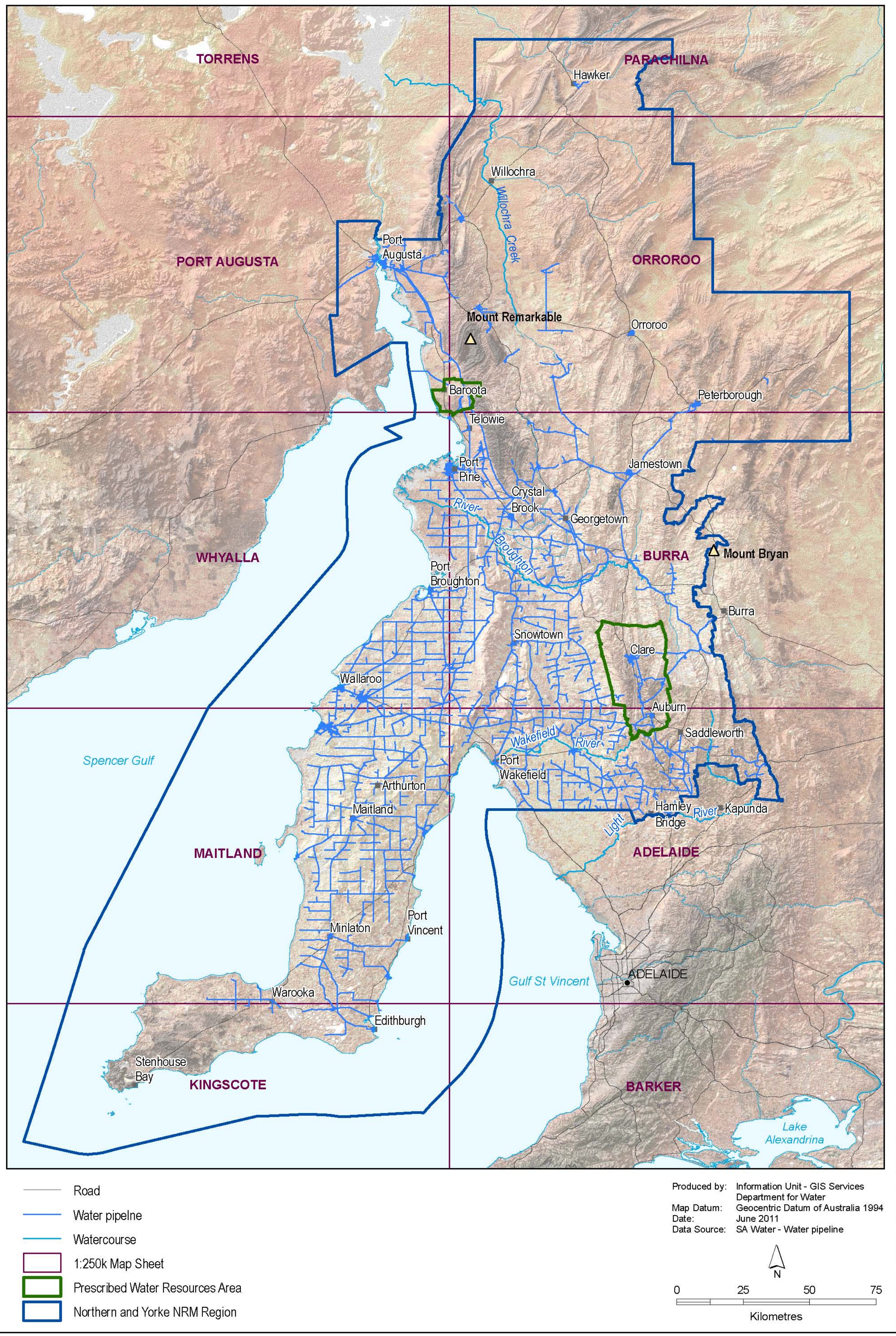

Figure 1. Location map and SA Water reticulation infrastructure

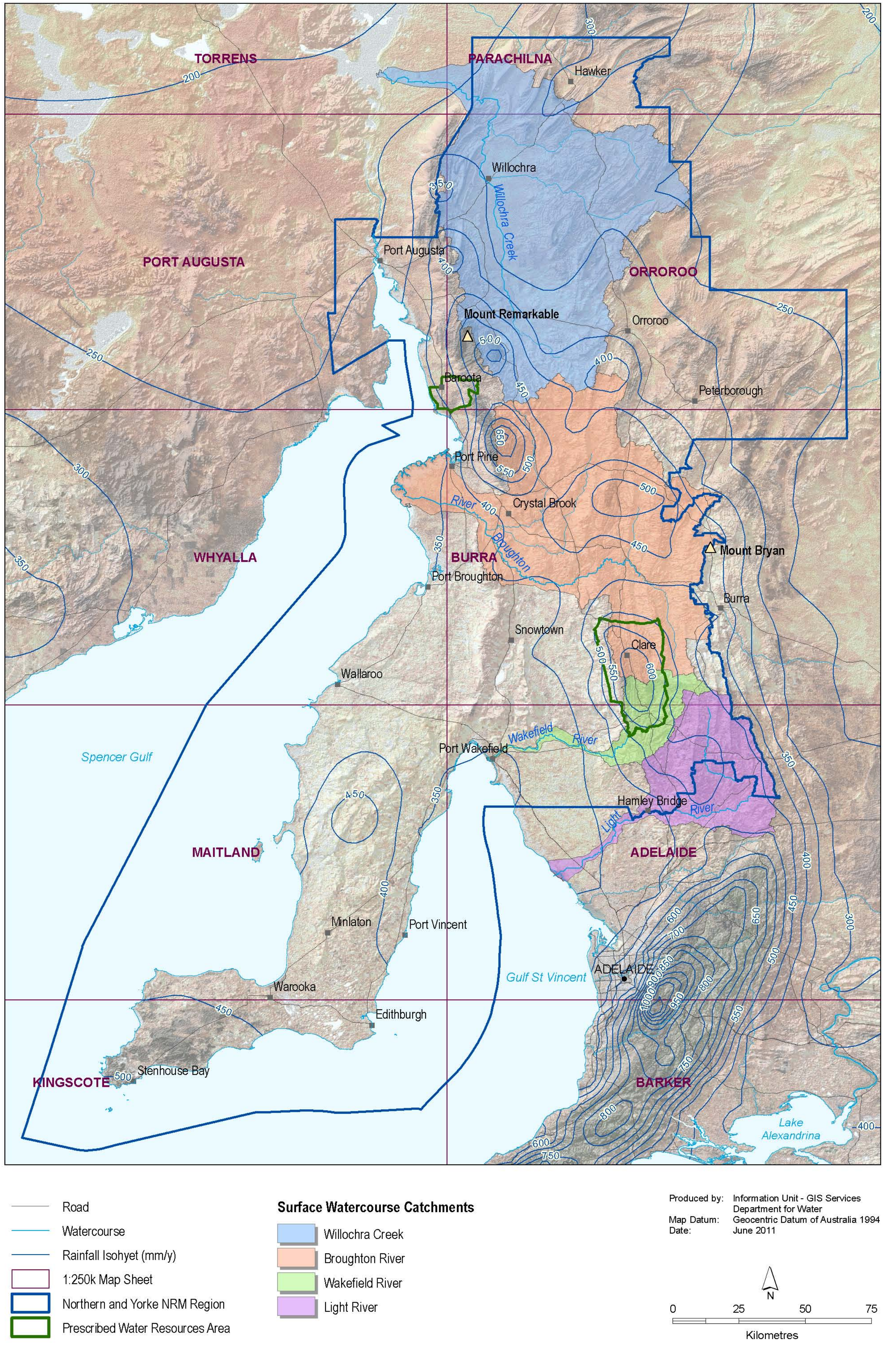

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Figure 2. Surface water catchments, main watercourses and rainfall isohyets

Although fragments of native vegetation which support significant biodiversity have been retained in places across the region, nearly two-thirds of the region's remnant native vegetation has been cleared. Declining soil health, pests and diseases are recognised as processes which limit primary production across the region. Diversions of surface water and groundwater have altered natural water regimes and Magarey and Deane (2005) have reported that some smaller groundwater resources are "…at or already above a sustainable level of use". Across the NYNRM Region, it is estimated that around 30 000 hectares (300 km^2) of land is affected by secondary salinity (i.e. salinity arising from human induced changes) (NYNRMB 2009a). The NYNRM Board cite sustainable crop management and grazing practices as becoming a major focus, with increasing awareness of the role of native vegetation in stabilising soils and reducing impacts of shallow-groundwater induced salinity (NYADINRMC 2003).

Table 1. Land use classified by number of land parcels and total area of land parcels

Land use	Count	%	Area (ha)	%
Grazing (modified pasture)	16 437	41.1	1 686 373	47.7
Cropping	15 536	38.8	1 542 210	43.7
Grazing (native vegetation)	1 663	4.2	198 095	5.6
National parks/reserves/recreation	781	2.0	62 583	1.8
Vineyards	383	1.0	9 321	0.3
Forestry	31	0.1	7 661	0.2
Residential (rural)	1 240	3.1	6 179	0.2
Water body	146	0.4	5 787	0.2
Residential (urban)	3 165	7.9	5 588	0.2
Quarries	36	0.1	2 897	0.1
Horticulture (annual)	81	0.2	1 551	0.0
Public service	231	0.6	1 454	0.0
Horticulture (perennial)	92	0.2	1 060	0.0
Mining/manufacturing/industrial	81	0.2	809	0.0
Airports	18	0.0	740	0.0
Piggery	65	0.2	401	0.0
Waste disposal site	40	0.1	252	0.0
Total	**40 026**	**100**	**3 532 961**	**100**

2.4. WATER RESOURCES

Early expansion of the agricultural sector across the NYNRM region resulted in increasing demand for water, primarily for stock and domestic uses. Water supply problems associated with increases in demand were temporarily mitigated by the construction of a reservoir at Baroota in 1921. To ensure water supplies to the regional centres of Whyalla, Port Augusta and Port Pirie, the Morgan-Whyalla pipeline was constructed between 1940 and 1944 (DWR 2000). Water resources are scarce, especially in the north.

Surface water and groundwater resources are essential in maintaining the social fabric and economic viability of the NYNRM Region. Many townships and homesteads rely heavily on captured rainwater and groundwater for stock and domestic water supplies. Surface water resources play a crucial role in the conservation of the natural biodiversity of the area and management plans have been completed across the three main surface watercourses of the region—namely, the Wakefield, Light and Broughton Rivers (Fig. 2) (NYNRMB 2009a).

The NYNRM Region comprises two groundwater resources which have been prescribed under the *Natural Resources Management Act, 2004*: the Clare Valley Prescribed Water Resources Area (PWRA) and the Baroota PWRA. The Clare Valley is well known for viticulture and wine production, relying on irrigation from dams, groundwater and imported River Murray water. Large increases in irrigation occurred in the Baroota area in the late-1990s. Other groundwater resources of significance across the NYNRM Region include those found within the Walloway, Willochra, Carribie and Para-Wurlie Basins and Booborowie Valley (Fig. 4). The status of groundwater resources in the prescribed areas and in Willochra Basin, Booborowie Valley and Baroota, are described in *Groundwater Status Reports* prepared for each of these areas (available online: http://www.waterconnect.sa.gov.au/GSR) and consequently, only a limited analysis and discussion of these groundwater resources is presented herein.

Across the NYNRM Region, water supplies are sourced from the River Murray, desalination and local groundwater resources. Most townships across the NYNRM Region are serviced by SA Water reticulation schemes. Water from the River Murray is distributed via the Morgan-Whyalla and Swan Reach pipelines, supplying Port Pirie, Clare, Jamestown and parts of Yorke Peninsula. Reticulated potable water for Yorke Peninsula comprises three water supply systems: (1) The Upper Paskeville system which supplies River Murray water to most of the region south of Paskeville down to the southern townships of Yorketown and Edithburgh (2) the Lower Paskeville system which supplies River Murray water to the copper coast area – a region of South Australia situated in northern Yorke Peninsula – including the townships of Moonta, Wallaroo and Kadina and (3) the stand-alone Warooka system which supplies the southern townships of Warooka and Point Turton.

From the mid-1950s, Warooka and Point Turton and surrounding farmlands have been supplied by groundwater. Town supply wells are completed within the Para-Wurlie groundwater basin. The Para-Wurlie Basin is not a prescribed resource; however, the Northern and Yorke Regional Natural Resources Management Plan (NYNRMB 2009a) lists the basin as a priority area for protection. The capacity of the Warooka water supply system is dictated by the sustainable yield of the Para-Wurlie Basin.

Previous work undertaken by SA Water (2010) determined that future demand may exceed sustainable yield of the Para-Wurlie basin. As such, it has been suggested that the Carribie Basin could be used as a supplementary future source of water for the Warooka system; however, further work is required to determine the sustainable yield of Carribie Basin to ensure all groundwater resources are utilised sustainably. Furthermore, the impacts of seawater intrusion due to extraction from near-coastal groundwater wells need to be considered to avoid potentially irreversible deterioration in water quality.

Meeting increasing demand for water by Yorke Peninsula's coastal settlements is constrained by the central location of the Upper Paskeville trunk main (Fig. 1). Many coastal landowners still rely on rainwater for potable supply. There are 22 identified existing settlements across Yorke Peninsula which lie outside SA Water's potable, reticulated supply system (SA Water 2010). Marion Bay Council recently commissioned a small-scale desalination plant for town water supply in response to increasing community concern over water security.

Toward the northern extent of the NYNRM Region, many townships (e.g. Orroroo, Hawker, Quorn, Wilmington and Melrose) rely on local groundwater resources for their town water supply. In the Mid-North region, DFW on the behalf of SA Water, is overseeing a 2010-11 drilling program to upgrade and expand the town water supplies at Hawker and Parachilna. The program will augment single-well systems with a second town water supply well. These works will address risks associated with water supply failure and provide an adequate supply for desalination at Hawker.

2.4.1. SURFACE WATER

The study site encompasses four surface watercourse catchments—namely, the Broughton, Light, Wakefield and Willochra catchments (Fig. 2). All watercourses in the Mid North region—from Hamley Bridge to Port Augusta—exhibit ephemeral or intermittent flow regimes. However, Yorke Peninsula shows far less drainage expression, with most of the rainfall runoff collected in landlocked, saline lagoonal systems (NYNRMB 2009a).

2.4.1.1. The Willochra Catchment

The Willochra catchment is drained by the Willochra Creek and its tributaries – namely, Booleroo Creek, Yanyarrie Creek, Boolcunda Creek, Kanyaka Creek and Wirreanda Creek. The Willochra Creek and a number of other drainage lines associated with the Southern Flinders Ranges, flow in a northerly direction towards Lake Torrens. Another series of Southern Flinders Ranges drainage lines flow in a north-westerly direction towards Lake Frome (NYNRMB 2009a).

2.4.1.2. The Broughton Catchment

In the Broughton catchment, Freshwater Creek, Yackamoorundie Creek and Rocky River are tributaries of the Broughton River. The upper reaches of the Broughton River can be traced to just east of Clare; this brackish to saline stream traverses around 20 km of the Broughton catchment before discharging into Spencer Gulf near between Port Pirie and Port Broughton.

2.4.1.3. The Wakefield Catchment

The Wakefield catchment is drained only by the Wakefield River. The Wakefield River, which lacks any significant tributaries, rises in ranges located between Auburn and Saddleworth, just south of Clare. The Wakefield River discharges to Gulf St Vincent via a mangrove-estuarine system that fringes the coastline around the township of Port Wakefield.

2.4.1.4. The Light Catchment

The Upper Light River, Gilbert River, Julia Creek and Pine Creek sub-catchments of the Light catchment drain the south-eastern extent of the study area. The Light River merges with the Gilbert River just downstream of Hamley Bridge, before discharging to Gulf St Vincent around 5 km north of Middle Beach (around 25 km south of the study site's southern-most extent).

2.5. *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) (available online: http://www.waterforgood.sa.gov.au/). These 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 Demand and Supply Statements provide demand and supply projections for the scenarios of high and low population growth and high and low greenhouse gas emission. 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) for the NYNRM Region are likely to be for stock, irrigation, residential and non-residential purposes (e.g. industrial, commercial and institutional). There is considerable evidence that there will be significant growth in the mining industry in South Australia 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.

2.5.1. MINING

Across the NYNRM Region, for the 2003-04 financial year, the total value of mineral production and processing was $57 million (DTEI 2005). Major mineral based industries are located at Port Augusta and Port Pirie (smelting mainly silver, lead and zinc).

Mineral exploration activity is increasing across Yorke Peninsula. Numerous mineral production tenements and mineral production tenement applications, as well as many exploration licenses and exploration license applications, exist across the NYNRM Region. Notable development projects include the Hillside Prospect (copper-gold) and the Clinton Project (Coal-Biomass-to-Liquid project). In the Mid-Some diamond exploration activity is occurring east of Peterborough and a significant copper-gold resource has been discovered near Olary.

There are numerous small-scale mining developments across the region. These are mostly pits and quarries for non-mineral commodities (e.g. sand, sandstone, slate, granite, gypsum and salt). Related water-use activities could potentially impact on the region's potable and/or non-potable groundwater resources.

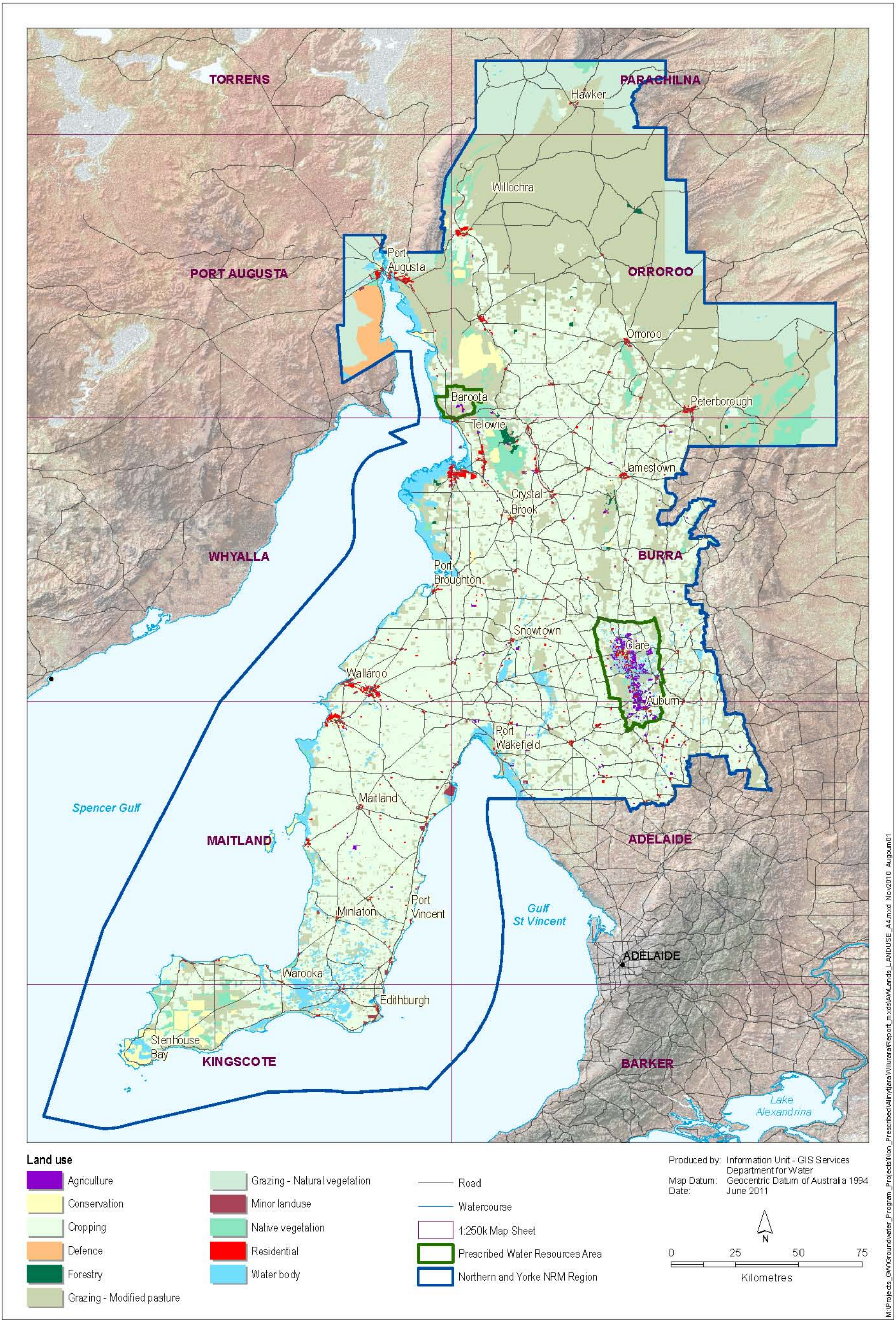

Figure 3. Aggregated land use categories

3. HYDROGEOLOGY

3.1. GEOLOGICAL SETTING

The NYNRM Region comprises three distinct groundwater provinces: (1) the Adelaide Geosyncline; (2) Pire-Torrens Basin; and (3) St Vincent Basin. The Adelaide Geosyncline comprises Neoproterozoic and Early Cambrian consolidated sedimentary sequences up to 15 km in thickness which have been folded and metamorphosed (Preiss 1987). The Geosyncline extends the length of the Mount Lofty and Flinders Ranges through to Kangaroo Island in the south. The area to the north of Mount Remarkable comprises Neoproterozoic Adelaidean metasediments, Cambrian limestones and dolomites (Martin, Sereda & Clarke 1998). The western margin of the Geosyncline is demarcated by the Torrens Hinge Zone (Fig. 4) (Thomson 1970) – a 40 km wide deep crustal fracture zone – which also forms the transition zone between the Adelaide Geosyncline and Pirie-Torrens and St Vincent Basins.

Unconsolidated sedimentary sequences west of the Torrens Hinge Zone are underlain by the flatter Stuart Shelf and are much thinner than their Adelaide Geosyncline counterparts. Sediments of the Pirie Basin range in age from Late Eocene (Kanaka Beds) to Plio-Pleistocene (Gibbon Beds). St Vincent Basin sediments range from mid-Eocene (North Maslin Sand) to Holocene (Saint Kilda Formation). Sediments within Torrens Basin range from Early Eocene to around Pliocene (Neuroodla Formation) (Drexel, Preiss & Parker 1993). The Pirie Basin comprises Tertiary marine facies whereas Torrens Basin sediments are non-marine, but the two basins are connected by a narrow corridor of Cainozoic sediments north of Port Augusta and as such are often considered a single groundwater basin (Martin, Sereda & Clarke 1998). The greatest accumulation of sedimentary deposits has occurred along the flanks of the Flinders and Willouran Ranges.

The main stratigraphic units of the NYNRM Region have been summarised in Table 31, with particular emphasis given to stratigraphic units of hydrogeologic significance. An expanded description of these units has been detailed in Appendix A.

3.2. REGIONAL HYDROGEOLOGY

Groundwater systems of the NYNRM Region can be classified according to groundwater provinces. These are typically based on the type of groundwater flow system and geologic substrate (Dooley, Ciganovic & Henschke 2003). Across the NYNRM Region, intermediate flow systems, including local systems, occur within fractured rock aquifers (e.g. the Clare Valley) and sedimentary valley infills (e.g. Willochra and Walloway Basins). Regional and intermediate flow systems occur within sand/clay aquifers of the Pirie-Torrens and St Vincent Basins. Low-salinity groundwater is common in the Baroota and Clare Valley PWRAs and within the Walloway, Willochra, Carribie and Para-Wurlie Basins and Booborowie Valley. Beyond these areas, groundwater salinities are variable and well yields are low.

3.2.1. Pirie-Torrens Basin

The Pirie-Torrens Basin is a structural depression which is coincident with the north-south trending Torrens Hinge Zone (Fig. 4) (Martin, Sereda & Clarke 1998). Across the coastal plains north of Yorke Peninsula, the Pirie-Torrens Basin comprises (approximately) Pleistocene mottled clay, sand and gravel, Miocene–Oligocene limestone, Eocene carbonaceous sand, shale, lignite and Cambrian limestone and basal clastics (Parker & Fanning 1998).

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Figure 4. Groundwater basins and surface geology

3.2.2. Yorke Peninsula

Moderate rainfall (around 300–700 mm/y), hot summers and strong winds result in relatively high evaporation rates across Yorke Peninsula. Almost all groundwater shows high salinity and is non-potable. Groundwater residing in Tertiary, Permian and Cambrian sediments is brackish (around 2 000–7 000 mg/L) (Shepherd 1978) and is suitable only for stock watering. Yorke Peninsula relies on River Murray water for the majority of its potable needs.

Parker and Fanning (1998) note that northern Yorke Peninsula is not known for large storages of low-salinity groundwater. Across the northern half of Yorke Peninsula, few groundwater salinity or well yield data have been recorded (Figs. 5 and 7).

3.2.3. Adelaide Geosyncline

Groundwater within the Adelaide Geosyncline area is sourced mainly from fractured rock aquifers. Commonly cited factors that influence the quantity and quality of groundwater residing within fractured rock aquifers include:

- Extent of joints and fractures and the degree of their interconnectedness
- Lithology
- Extent of weathering
- Recharge, which is governed by the frequency and intensity of rainfall and by runoff processes.

Groundwater recharge to fractured rock aquifers is variable. The dynamics of fractured rock aquifer hydrology is more uncertain than sedimentary systems. The volume of rainfall recharge is generally considered to be governed by the nature of soils and land cover, while groundwater quality is determined largely by the location of the bore or well with respect to local recharge zones.

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 land cover and soils. Across the NYNRM area, rainfall recharge is governed mainly by climatic processes (NYNRMB 2009a). The winter–spring period is dominated by frontal systems originating from the Southern Ocean, where regular rainfall events are correlated with orographic uplift of air masses. Rain shadow effects are observed inland past major topographic highs (e.g. Flinders and Mount Lofty Ranges). During autumn and spring, more widespread rainfall often occurs as a result of tropical air flows originating from the northwest.

Due to the range of climatic processes observed across the study area, a large degree of spatial and temporal variability in rainfall is observed. Furthermore, in arid areas, annual rainfall in most years may be very low, but may be in the order of around 800 mm/y or more during occasional wet years. Due to this temporal variability, estimates of annual average recharge are somewhat unreliable relative to those areas which receive more consistent rainfall from year to year. However, estimates of annual recharge rates in the NYNRM area may assist in calculating first-order approximations of long-term sustainable yield. It should be noted that the evaluation of sustainable yield via recharge rate estimation does not take into account explicitly those issues linked to groundwater discharge (e.g. water–dependent ecosystems; springs and soaks; seawater intrusion).

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 recharge zones. Recharge to fractured rock systems across the NYNRM Region is 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.

Estimates of recharge rates for groundwater basins across the NYNRM Region have been calculated by a number of authors (Table 2). Recharge ranges between 5–75 mm/y depending on the location of the basin (Section 2.1) and on the method by which the flux was estimated.

Table 2. Estimated rainfall recharge rates

Basin (Region)	Recharge (mm/y)	Method	Author
Pirie-Torrens (Baroota)	5–7	Water table fluctuation	Martin, Sereda and Clarke (1998)
Adelaide Geosyncline (Clare Valley)	50–75	Aquifer properties and environmental tracers	DWR (2001)
Yorke Peninsula (Carribie lens)	47	Water table fluctuation	Wischusen (1987)
	35	Chloride mass balance	Mathews (1988)

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 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 on publicly available state and national geoservers – namely, PIRSA's South Australian Resources Information Geoserver (*SARIG*) and Geoscience Australia's geoserver.

Recent water level and salinity data is available for current active groundwater observation networks. This 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 3 highlights the low availability of recent (2000–2010) groundwater data, which represents only 8% and 14% of the 'latest' salinity and water level observations, respectively. A large proportion of the data for both parameters pre-dates 1980. Most wells have only a single water salinity and/or level observation collected at the time of drilling.

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.

Table 3. Summary of latest groundwater data age for the non-prescribed NYNRM Region.

Period	Salinity (mg/L)		Standing water level (m below ground surface)		Well yield (L/s)	
	Drillholes	%	Drillholes	%	Drillholes	%
No date recorded	53	1	177	2	155	3
Pre-1960	2 462	28	1 646	19	923	19
1960-1969	725	8	3 201	37	244	5
1970-1979	2 587	30	2	0	1 364	27
1980-1989	1 234	14	1 314	15	1 053	21
1990-1999	988	11	1 176	14	619	12
2000-2010	697	8	1 186	14	636	13
Total	**8 746**		**8 702**		**4 994**	

4.1.1. GROUNDWATER SALINITY

Across the NYNRM Region, records exist for 21 181 drillholes. Of these, 8 746 water well records are available which detail observations of groundwater salinity (Table 3). Only 697 of 8 746 water wells (8%) have salinity observations recorded within the past 10 years. 2 462 wells (28%) have salinity observations recorded prior to 1960 and a total of 5 827 wells (67%) have salinity observations recorded prior to 1980.

Salinity data density appears greatest toward the southern extent of Yorke Peninsula and across fractured rock aquifers of the Mid-North (Fig. 5) where groundwater is of usable quality. Elsewhere, a paucity of salinity data is likely due to high salinity of groundwater within the aquifers. Groundwater salinity around southern Yorke Peninsula is variable, with the exception of Para-Wurlie and Carribie Basins which typically show groundwater salinity less than 1 000 mg/L. The highest groundwater salinities on Yorke Peninsula (greater than 20 000 mg/L) are most commonly observed in near-coastal wells and may be a result of evaporative concentration in shallow aquifers in groundwater discharge areas. This may also be the cause of a cluster of inland occurrences of high salinity immediately to the north of Maitland.

Across the Mid-North, groundwater showing lower salinity appears limited to fractured rock environments. Two north-south trending bands of lower salinity can be observed (1) between Crystal Brook and Quorn and (2) between Clare and just north of Orroroo. These bands of lower–salinity groundwater appear to correlate with topographic highs and are likely to reflect orographic lift of air masses and associated higher rates of rainfall (Fig. 2). Higher groundwater salinities to the east of these bands are likely due to rain shadow effects and reduced recharge. Groundwater showing the highest salinity (greater than 20 000 mg/L) has been sampled from near-coastal wells. Higher salinities here may be due to evapotranspiration effects.

4.1.2. STANDING WATER LEVEL

Of the 21 181 drillholes within the NYNRM Region for which records exist, 8 702 water wells have records detailing depth to groundwater. While 1 186 of 8 702 water wells (14%) have standing water level recorded within the past 10 years, 5 026 wells (58%) have standing water level observations recorded prior to 1970.

The spatial density and areal distribution of standing water level data (Fig. 6) closely matches that of salinity data (because observations of a number of groundwater parameters are likely to be recorded for any given drillhole). Across southern Yorke Peninsula, groundwater is typically encountered less than 5 m below ground surface. The exceptions are wells completed within Para-Wurlie and Carribie Basins which show standing water levels at greater depth (up to around 12 m). Wells showing the greatest depth to groundwater (greater than 50 m) appear clustered immediately north of Minlaton. Digital elevation models show this to be an area of higher relief.

Across the Mid-North, wells completed within fractured rock aquifers show variable standing water levels. Variation in water levels are correlated with variations in topographic relief. Contrastingly, groundwater is encountered at a more uniform, shallower depth within palaeovalley aquifers of the Walloway and Willochra Basins and within alluvial aquifers of Booborowie Valley.

4.1.3. WELL YIELD

Records for well yield are available for 4 994 wells. Typically, well yield is recorded at the time of drilling. Consequently, well yield data from 2 686 of 4 994 water wells (54%) have been recorded prior to 1980, while only 636 wells (13%) have well yield recorded within the past ten years.

Across the region, well yields are predominantly less than 1 L/s (Fig. 7). Across the NYNRM Region, the reported purpose relating to groundwater use is variable. Groundwater is the principal source of town water supply for townships located around southern Yorke Peninsula and also for numerous townships located north of Quorn. Groundwater supplies sufficient for irrigation are predominantly located within the Booborowie Valley and Willochra and Walloway Basins. Higher yielding wells are also reported widely across the Clare Valley PWRA and Baroota PWRA. Beyond these areas, groundwater is used mainly for watering livestock via windmill operated wells and the full supply potential of the aquifers has not been tested.

4.2. MONITORING NETWORKS

Since the 1970s, DFW has been responsible for groundwater monitoring across the NYNRM Region. Currently, DFW monitors a number of observation networks which monitor water level and salinity. Current networks are focussed on monitoring high–value water resources which have been identified as being vulnerable to significant degradation and to enable reporting on the condition and status of the resource. However, considerable uncertainty exists regarding groundwater resource status due to irregular intervals between which monitoring data have been evaluated (NYNRMB 2009a).

Commissioned by DFW, environmental consultants Australian Groundwater Technologies (AGT) recently completed a detailed statewide review of groundwater, surface water and soil condition monitoring sites. The scope of works for the statewide review included a review of monitoring networks across the NYNRM Region (AGT 2010). The NYNRM monitoring review has focused mainly on:

- Drivers and objectives of monitoring
- A summary of current monitoring infrastructure, period of record and frequency of monitoring (Table 4)
- Recommendations for the establishment and maintenance of a robust water resources monitoring network across the NYNRM Region, such that DFW can reliably report on the state and condition of groundwater and surface water resources.

Magarey and Deane (2004) have collated well and yield data for the most significant small groundwater resources across the NYNRM Region and monitoring recommendations for these resources have been reported (Section 6.2).

4.3. DATA SUMMARIES BY MAP SHEET

This report has compiled groundwater data available from within the SAGeodata database for the Northern and Yorke 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 are included. Non-prescribed data are the focus of discussions presented herein; however, groundwater data from within the Prescribed Water Resources Areas are included on map products and within the 1:250 000 tables for contextual purposes. 1:100 000 map sheet tables contain data only from the non-prescribed regions.

For consistency, the reference to map sheet areas will follow a uniform naming convention. For example, the ORROROO 1:250 000 Map Sheet area will be referred to in this reports as ORROROO and the Orroroo 1:100 000 Map Sheet will be referred to in this report as *Orroroo*.

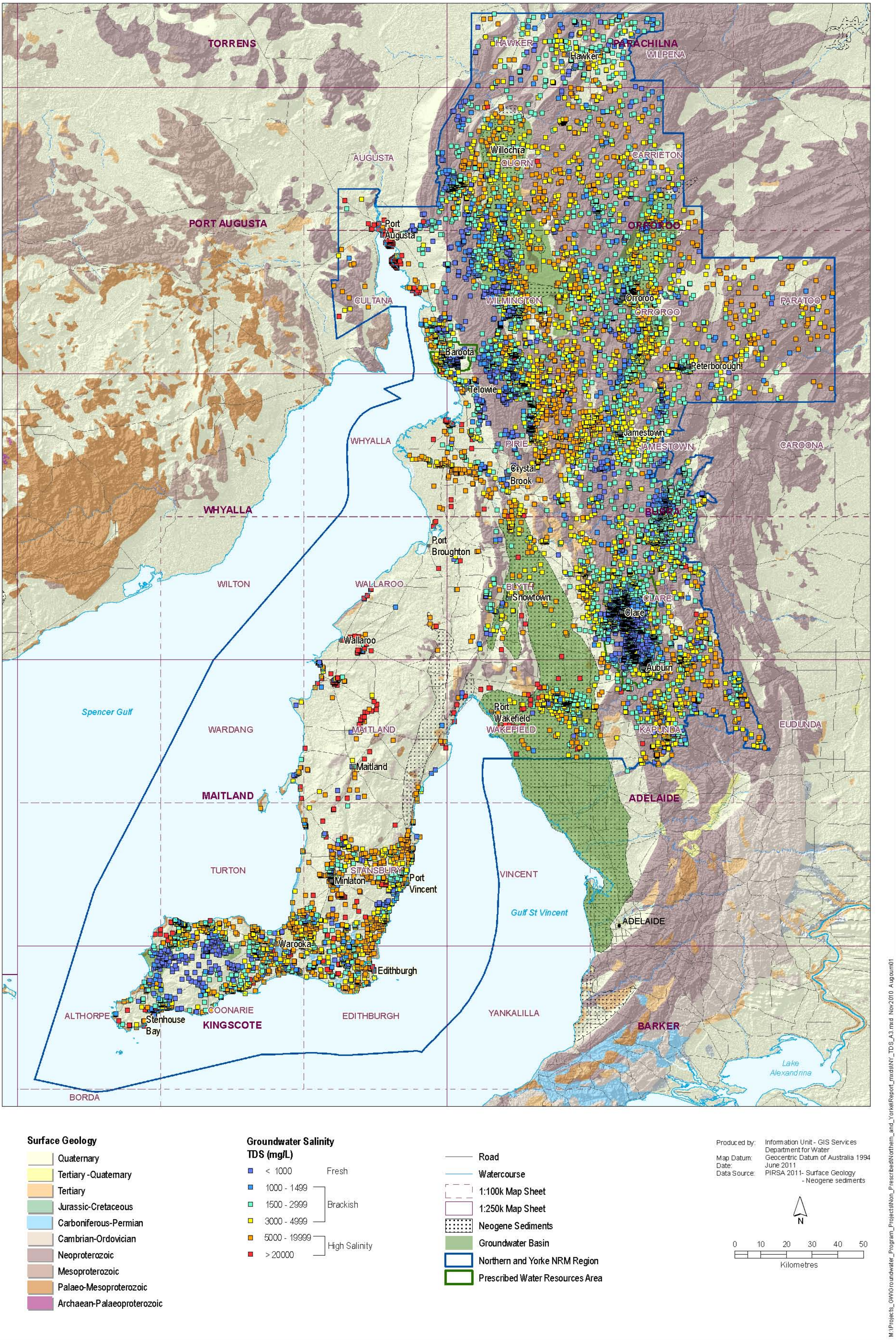


Figure 5. Spatial distribution of salinity observations. Salinity measured by total dissolved solids (mg/L)

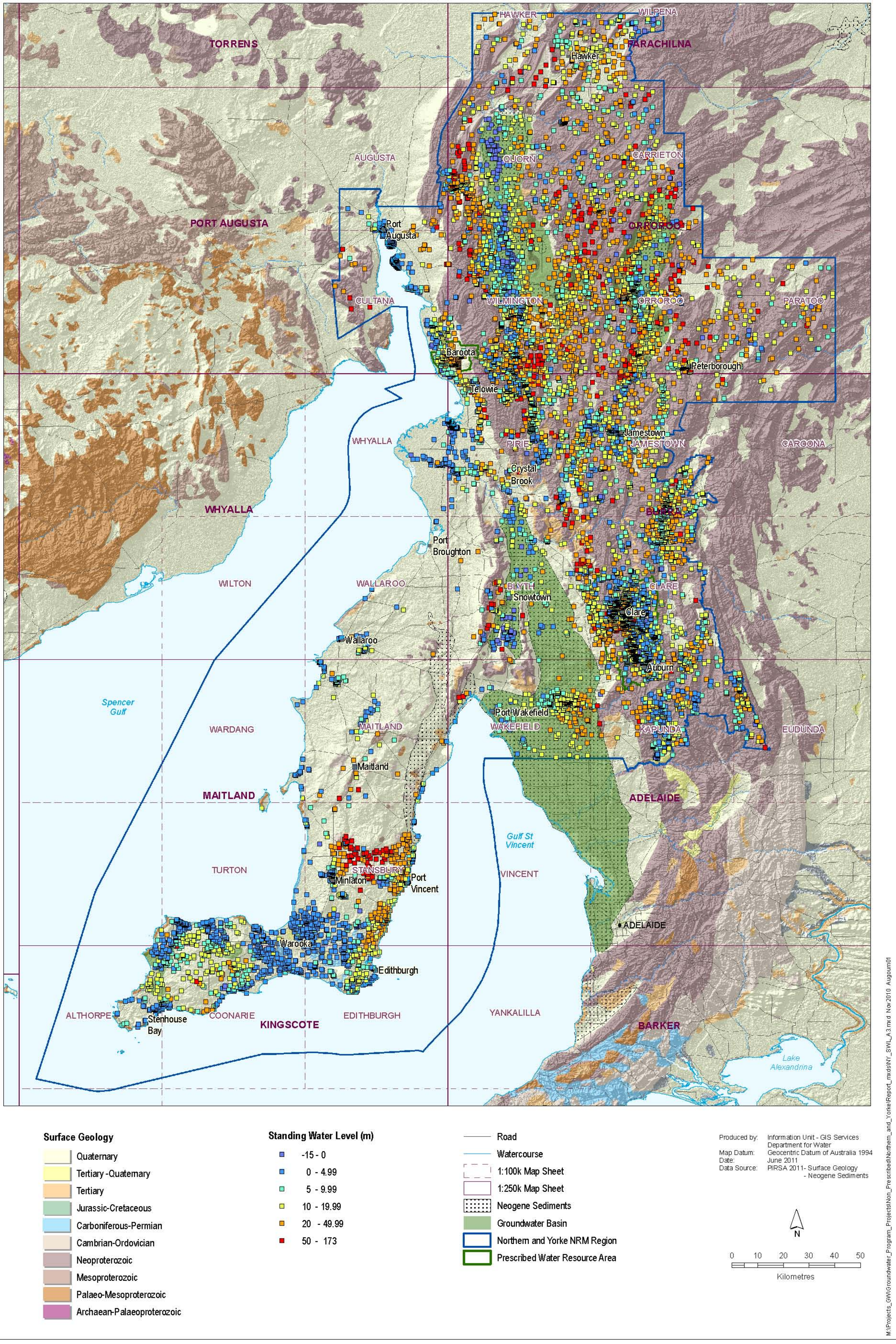


Figure 6. Spatial distribution of standing water level (SWL) observations. SWL measured as metres below ground surface

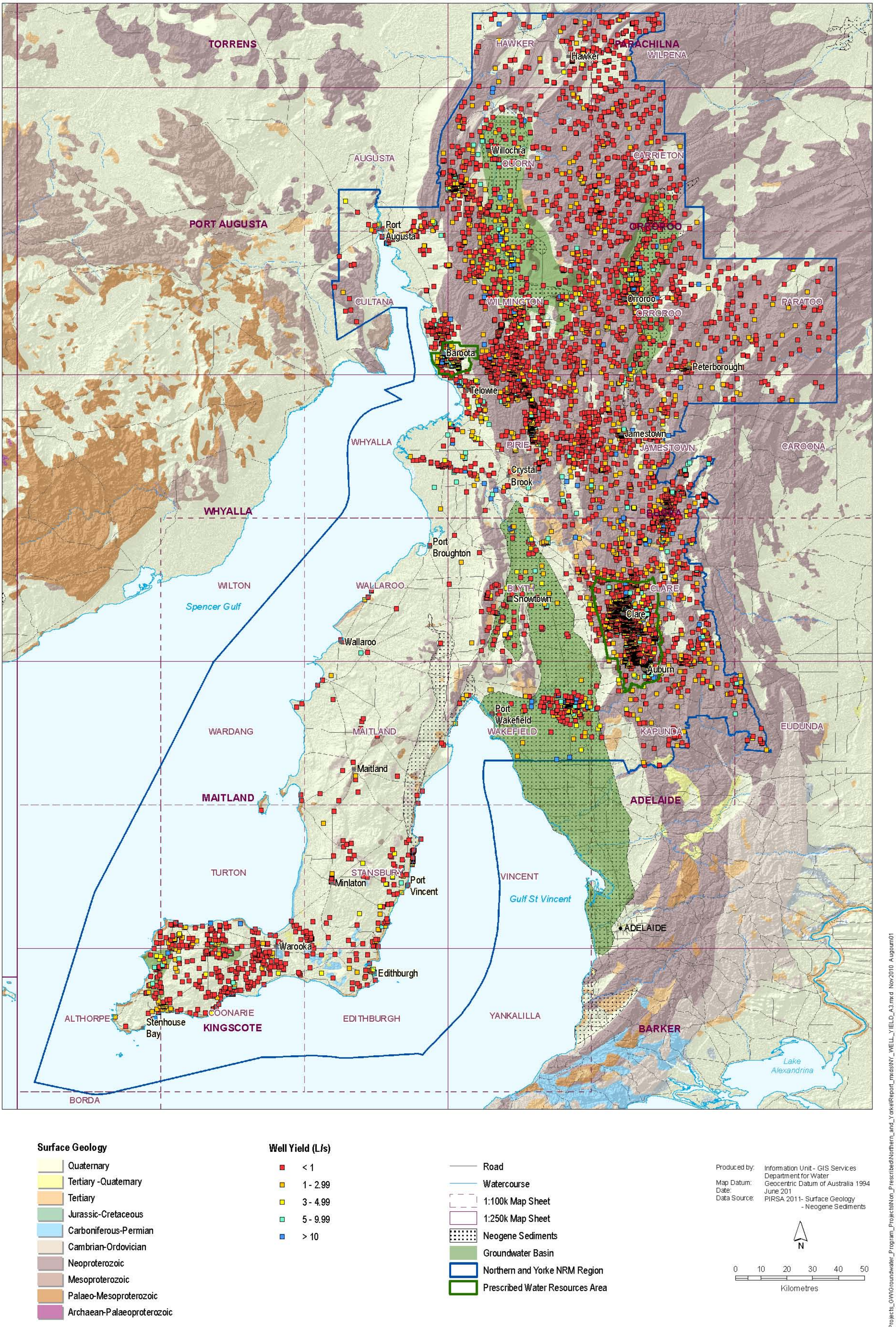
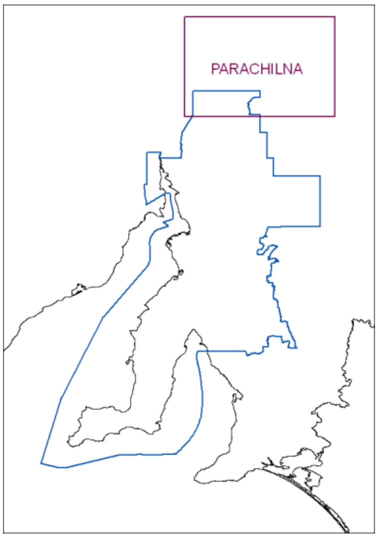


Figure 7. Spatial distribution of well yield observations. Yield measured as litres per second (L/s)

Table 4. Groundwater monitoring networks, showing the number of current and historical sites, monitoring frequency and the main formations monitored

Groundwater Networks	Total Sites	Historical Sites		Current Sites		Monitoring Frequency		Comment
		SWL	Salinity	SWL	Salinity	SWL	Salinity	Formations Monitored
Balaklava	31	2	16	23	0	Six-monthly	N/A	Tertiary limestone
Booborowie	68	19	37	33	19	Six-monthly	Variable	Saddleworth Formation; Woolshed Flat Shale; un-named Quaternary sediments
Carribie (and Para-Wurlie)	20	2	4	14	3	Three-monthly	Six-monthly	Bridgewater Formation
Clare Auburn	267	110	226	155	37	Three-monthly	Six-monthly	Tapley Hill Formation; Woolshed Flat Shale; Saddleworth Formation; Mintaro Shale; Rhynie Sandstone; Skillogalee Dolomite
Georgetown	9	1	0	8	1	Three-monthly	Six-monthly	Undefined
Gilbert	5	0	0	5	0	Variable	N/A	Undefined
Kybunga	9	2	2	7	2	Three-monthly	Six-monthly	Skillogalee Dolomite; Marola Sandstone Member
Lochiel	44	24	0	20	0	Six-monthly	N/A	Undefined
Para-Wurlie	**See Carribie**							
Pirie	51	13	9	27	21	Three-monthly	Six-monthly	Gibbon Beds; Hindmarsh Clay
Walloway	19	5	8	8	2	Three-monthly	Six-monthly	Undifferentiated Quaternary and Tertiary sediments
Willochra	65	28	35	20	2	Three-monthly	Six-monthly	Belair Subgroup; Emeroo Subgroup; Tapley Hill Formation; Gilbert Range Quartzite; Undifferentiated Quaternary and Tertiary sediments

4.3.1. 1:250 000 MAP SHEET – PARACHILNA



Most wells across PARACHILNA have been drilled for the purpose of livestock watering and most wells are windmill operated. A total of 184 of 267 wells (69%) show salinities in the range of 1 500–5 000 mg/L (Table 5). Well yields are typically low, with 142 of 177 wells (80%) yielding less than 1 L/s. Piedmont slope deposits of Tertiary–Holocene age flank the Flinders Ranges and wells completed within these deposits often show lower salinities and higher well yields.

The exception to small-scale livestock wells has been the town water supply wells for the township of Hawker. SA Water currently supplies groundwater to Hawker which shows salinities of around 2 300 mg/L (SA Water 2008). Rainwater is still used for Hawker's potable supply (Preiss 1999). Groundwater salinities of less than 3 000 mg/L are common north of Hawker, but increase to around 7 000 mg/L further south (Shepherd 1978).

Table 5. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for PARACHILNA

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(267)	8.2 (22)	13.9 (37)	48.7 (130)	20.2 (54)	7.5 (20)	1.5 (4)	0 (0)
Max well depth (m)	(235)	40 (21)	41.3 (32)	40.9 (113)	29.9 (48)	30.3 (18)	13.9 (3)	0 (0)
Yield (L/s)	(154)	0.46 (14)	0.35 (21)	0.35 (83)	0.31 (23)	0.51 (12)	1.8 (1)	0 (0)
SWL (m)	(238)	15.3 (21)	15 (35)	18.4 (117)	16.4 (46)	18 (17)	10.7 (2)	0 (0)
Water cut (m)	(24)	28 (1)	31 (5)	31.5 (14)	30.5 (2)	35 (1)	28 (1)	0 (0)
Observation year		1979	1979	1979	1979	1980	1978	0

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
%	(274)	9.5 (26)	13.9 (38)	36.9 (101)	20.4 (56)	15.3 (42)	4 (11)	0 (0)
Max well depth (m)	(256)	11.4 (20)	18 (35)	27.3 (98)	46.9 (51)	64.1 (42)	87 (10)	0 (0)
Water cut (m)	(24)	0 (0)	17 (3)	31 (13)	30 (3)	36.5 (4)	82 (1)	0 (0)
Observation year		1979	1979	1980	1980	1978	1979	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(177)	80.2 (142)	13 (23)	2.8 (5)	2.8 (5)	1.1 (2)
Max well depth (m)	(166)	40.5 (133)	33.5 (21)	87 (5)	86.9 (5)	43.7 (2)
Water cut (m)	(25)	32 (14)	28 (7)	61.8 (2)	18.7 (2)	0 (0)
Observation year		1980	1989	1978	1982	1951

4.3.1.1. Hawker (6534) 1:100 000 Map Sheet

Across *Hawker*, the surface geology comprises predominantly the Wilpena (ABC Range Quartzite) and Umberatana Groups which are widespread across the area. Undifferentiated alluvial and fluvial sequences of Pleistocene–Holocene age infill the broad valleys. These sequences comprise gravel, silt and clayey sands, often interlayered with off white to grey silty clays. The thickness of sediments is variable, ranging from 100 m in the northwest, to around 20 m in the southeast.

Low-salinity groundwater is widespread across *Hawker*, with 67 of 160 wells (42%) showing salinities in the range of 1 500–3 000 mg/L and a further 40 wells (25%) with salinities less than 1 500 mg/L (Table 6). Production zone details are available only for wells located toward the eastern boundary of the map sheet, which are likely to be intersecting the Hawker and Wilpena Groups, Sandison Subgroup and Moralana Supergroup. The salinities of this group of wells ranges between 800 and 9 600 mg/L (median 2 085mg/L).

The depth to watertable is generally shallow. Standing water levels are available for 161 wells, of which 93 wells (58%) show depths to water of less than 20 m. Depth to water cut is generally greater than standing water level, indicating groundwater may be under pressure. Across *Hawker*, well yields are generally low, with 63 of 89 wells (71%) showing yields of less than 1 L/s. Most groundwater observations (salinity, water level and yield) were recorded around 1980.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(160)	11.3 (18)	13.8 (22)	41.9 (67)	23.1 (37)	7.5 (12)	2.5 (4)	0 (0)
Max well depth (m)	(139)	40 (17)	44 (19)	44.5 (59)	24 (31)	46.8 (10)	13.9 (3)	0 (0)
Yield (L/s)	(76)	0.56 (10)	0.5 (10)	0.63 (37)	0.61 (12)	1.05 (6)	1.8 (1)	0 (0)
SWL (m)	(138)	15 (17)	17.4 (21)	19.2 (59)	17 (29)	23.4 (10)	10.7 (2)	0 (0)
Water cut (m)	(16)	28 (1)	31 (5)	37.5 (8)	36 (1)	0 (0)	28 (1)	0 (0)
Observation year		1979	1979	1979	1979	1979	1978	0
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**
%	(161)	6.2 (10)	18 (29)	33.5 (54)	22.4 (36)	13.7 (22)	6.2 (10)	0 (0)
Max well depth (m)	(153)	21.1 (10)	15 (27)	26.9 (51)	52.1 (34)	65.6 (22)	86 (9)	0 (0)
Water cut (m)	(15)	0 (0)	26.4 (2)	31 (5)	30 (3)	36.5 (4)	82 (1)	0 (0)
Observation year		1979	1979	1979	1979	1973	1979	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(89)	70.8 (63)	15.7 (14)	5.6 (5)	5.6 (5)	2.2 (2)
Max well depth (m)	(86)	50 (61)	31 (13)	87 (5)	86.9 (5)	43.7 (2)
Water cut (m)	(16)	34.5 (10)	24 (2)	61.8 (2)	18.7 (2)	0 (0)
Observation year		1979	1983	1978	1982	1951

4.3.1.2. Wilpena (6634) 1:100 000 Map Sheet

Neoproterozoic basement outcrop is common where *Wilpena* intersects the boundary of the NYNRM region. Outcrop comprises mainly sandstone, siltstone and silty limestone of the Umberatana and Wilpena Groups. Toward the south-west, valley infills comprise undifferentiated Pleistocene alluvial and fluvial sediments. Quaternary gravel and clayey gravel thicknesses are commonly between around 4–30 m, which are underlain by undifferentiated Tertiary-Pleistocene sediments to a total depth of 70 m below ground level (below ground surface). Tertiary clay is common with an average thickness of 10 m. Below this, basement has been indentified as possibly the Burra Group or Saddleworth Formation.

Across *Wilpena*, groundwater salinities are low, as 82 of 107 wells (77%) show salinity less than 3 000 mg/L (Table 7). In general, wells showing a salinity greater than 5 000 mg/L occur towards the western boundary of the map sheet and their locations coincide with mapped sedimentary surface geology. Production zone details are not available, however around 30 of the 45 wells completed in valley sediments have been drilled to depths of less than 80 m, suggesting most of these wells are likely to be completed within the sediments.

Across *Wilpena*, the depth to groundwater is shallow, as 73 of 113 wells (65%) show standing water levels less than 20 m. Typically, the depth to water cut is greater than standing water level, suggesting groundwater may be under pressure. Across the map sheet, well yields are generally low, with 79 of 88 wells (90%) showing yields of less than 1 L/s.

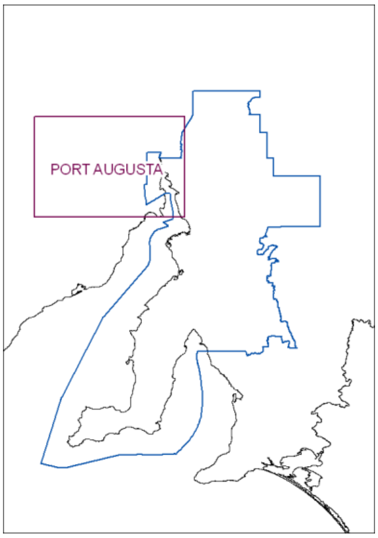
Table 7. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Wilpena*

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(107)	3.7 (4)	14 (15)	58.9 (63)	15.9 (17)	7.5 (8)	0 (0)	0 (0)
Max well depth (m)	(96)	42.2 (4)	37 (13)	39.8 (54)	33.3 (17)	28.7 (8)	0 (0)	0 (0)
Yield (L/s)	(78)	0.23 (4)	0.23 (11)	0.32 (46)	0.23 (11)	0.29 (6)	0 (0)	0 (0)
SWL (m)	(100)	19.4 (4)	6 (14)	18.1 (58)	15.8 (17)	16.4 (7)	0 (0)	0 (0)
Water cut (m)	(8)	0 (0)	0 (0)	27 (6)	25 (1)	35 (1)	0 (0)	0 (0)
Observation year		1980	1979	1980	1980	1980	0	0

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
%	(113)	14.2 (16)	11.5 (13)	38.9 (44)	24.8 (28)	9.7 (11)	0.9 (1)	0 (0)
Max well depth (m)	(103)	7.6 (10)	18.1 (12)	29.6 (44)	46 (25)	70 (11)	88 (1)	0 (0)
Water cut (m)	(9)	0 (0)	17 (3)	32.5 (6)	0 (0)	0 (0)	0 (0)	0 (0)
Observation year		1979	1980	1980	1980	1980	1980	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(88)	89.8 (79)	10.2 (9)	0 (0)	0 (0)	0 (0)
Max well depth (m)	(80)	36.5 (72)	37.8 (8)	0 (0)	0 (0)	0 (0)
Water cut (m)	(9)	24.5 (4)	30 (5)	0 (0)	0 (0)	0 (0)
Observation year		1980	1993	0	0	0

4.3.2. 1:250 000 MAP SHEET – PORT AUGUSTA



PORT AUGUSTA has limited extent within the NYNRM Region, with only *Cultana* and *Augusta* (Section 4.3.3.1) containing reportable data.

4.3.2.1. Cultana (6432) 1:100 000 Map Sheet

The surface geology of *Cultana* comprises two distinct regions that are bisected by Gulf St Vincent. To the east of the gulf and within a few kilometres of the coastline, surficial geology comprises mainly the Holocene St Kilda Formation with minor outcrop of the Neoproterozoic Wilpena Group (ABC Range Quartzite). Further inland, undifferentiated aeolian sediments are common, grading to undifferentiated Pleistocene fluvial and alluvial deposits. The eastern boundary of *Cultana* coincides with the foot of the western slopes of the Mount Lofty Ranges, comprising outcrops of the Wilpena (ABC Range Quartzite) and Umberatana Groups. The eastern extent of Baroota PWRA occupies part of the south-eastern quadrant of *Cultana*. Across the sheet, few drillhole data describe hydrostratigraphic unit thicknesses. However, a cluster of wells within Baroota PWRA and some wells just to the north, show that Quaternary sediment (predominantly Hindmarsh Clay) thicknesses range between 58 and 98 m (mean ≈ 77 m; from 15 drillholes). In this area, logs from two drillholes indicate: (1) the Gibbon Beds are around 36 m in thickness (2) the Uley Formation is around 41 m in thickness and (3) the depth to Neoproterozoic basement (ABC Range Quartzite) ranges between 120–130 m below ground surface.

To the west of Gulf St Vincent, outcrop of the Wilpena Group is common, with minor occurrences of the Palaeoproterozoic Lower Gawler Ranges Volcanics and the Neoproterozoic Hiltaba Suite and Callanna Group. Undifferentiated Pleistocene alluvial and fluvial sediments are widespread between the basement outcrop and the coastline. Data from two wells suggest Quaternary sediments range in thickness between 10–20 m. Undifferentiated Tertiary to Pleistocene sediments have thicknesses ranging between 8–78 m (mean ≈ 35 m; from nine drillholes). The depth to basement (mostly Beda Volcanics) varies between 8–78 m below ground surface (mean ≈ 35 m; from 11 drillholes).

Across *Cultana*, the groundwater salinity is variable. Near-coastal wells show high salinity, with 86 of 232 wells (37%) showing salinities greater than 20 000 mg/L (Table 8). Wells showing low salinity are clustered immediately north of the Baroota PWRA and around the foothills of the Mount Lofty Ranges. Wells located north of the Baroota PWRA are completed mainly within Hindmarsh Clay and show salinities ranging between 800 and 11 400 mg/L (mean 4 632 mg/L; from 15 drillholes). Salinity within the Tertiary sequences (mainly the Melton Limestone and Kanaka and Gibbon Beds) ranges between 1 690–6 500 mg/L (mean 3 869 mg/L; from 11 drillholes). Few salinity data are available to the west of Gulf St Vincent. The median period salinity data was recorded is 1974.

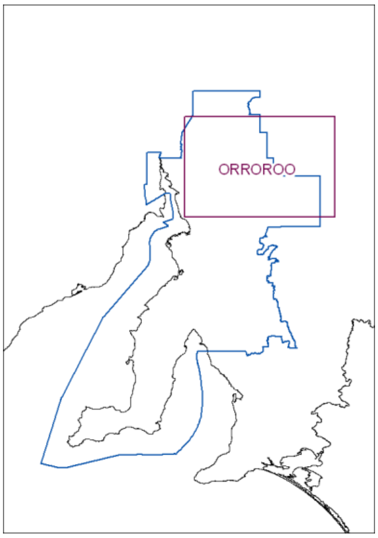
Most *Cultana* wells have shallow standing water levels, with 157 of 250 wells (63%) having standing water levels of less than 5 m. In general, depth to water cut is similar to standing water level – evidence that groundwater conditions are likely to be unconfined. The median period water level data was collected was 1974. Well yields are low, as 106 of 133 wells (80%) yield less than 1 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(232)	9.9 (23)	5.2 (12)	14.2 (33)	12.5 (29)	11.2 (26)	9.9 (23)	37.1 (86)
Max well depth (m)	(227)	42 (23)	33.8 (12)	30.8 (33)	29.3 (29)	22.4 (24)	24.3 (22)	6.4 (84)
Yield (L/s)	(102)	0.33 (15)	0.13 (9)	0.75 (25)	0.25 (26)	0.38 (13)	0.48 (14)	0 (0)
SWL (m)	(185)	16 (20)	13.4 (8)	10.4 (29)	12.3 (18)	7 (15)	23 (15)	0.8 (80)
Water cut (m)	(70)	37.5 (10)	38.5 (4)	22.9 (19)	24 (14)	17.1 (10)	42 (11)	20.3 (2)
Observation year		1974	1975	1974	1974	1958	1975	1973
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**
%	(250)	62.8 (157)	9.6 (24)	12.4 (31)	8.4 (21)	4.8 (12)	2 (5)	0 (0)
Max well depth (m)	(248)	7 (157)	15.4 (24)	30.1 (31)	41 (20)	62.4 (12)	110.9 (4)	0 (0)
Water cut (m)	(66)	2.6 (30)	18.9 (5)	21 (12)	33 (10)	51.2 (6)	93.9 (3)	0 (0)
Observation year		1974	1973	1974	1974	1974	1967	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(133)	79.7 (106)	15.8 (21)	2.3 (3)	2.3 (3)	0 (0)
Max well depth (m)	(133)	30.2 (106)	39 (21)	39.3 (3)	109 (3)	0 (0)
Water cut (m)	(83)	24 (64)	32 (15)	7 (1)	24.4 (3)	0 (0)
Observation year		1974	1974	1974	1956	0

4.3.3. 1:250 000 MAP SHEET – ORROROO



ORROROO encompasses both the Flinders Ranges and the Mount Lofty-Olary geological provinces. It lies within the central part of the Adelaide Geosyncline and comprises rocks of the Neoproterozoic Adelaidean sequences (Binks 1970). Rainfall across the ORROROO is low and therefore groundwater is an important source of water supplies for livestock. Groundwater salinities are variable and generally increase to the north and east with decreasing rainfall (Fig 2). A total of 1 692 of 2 861 wells (59%) have salinities in the range of 1 500–5 000 mg/L (Table 9). Well yields are low, with 1 461 of 1 993 wells (73%) yielding less than 1 L/s. About 50% of ORROROO comprises basement outcrop and about 25% represented by the Willochra and Walloway Basins.

The north-south trending Willochra Basin is around 80 km in length and around 16 km wide and contains up to 180 m of Cainozoic sediments. Salinity increases from south to north and varies between around 1 000–7 000 mg/L (Binks 1970). The best quality groundwater occurs in Tertiary aquifers near the township of Orroroo with salinity of less than 3 000 mg/L (Shepherd 1978). The north-south trending, inter-montane Walloway Basin is around 65 km in length and around 13 km wide. Maximum sediment thickness is around 140 m. Salinity is reported to be around 1 400 mg/L near Mount Remarkable (Fig. 1), increasing to around 7 000 mg/L toward the north (Shepherd 1978).

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	>20 000
%	(2861)	9.1 (260)	11 (316)	33.1 (948)	26 (744)	17.7 (506)	2.9 (83)	0.1 (4)
Max well depth (m)	(2560)	45.7 (232)	42.1 (288)	41.1 (851)	36.6 (657)	36.9 (457)	43 (73)	54.9 (2)
Yield (L/s)	(1660)	0.63 (144)	0.51 (213)	0.5 (591)	0.38 (407)	0.38 (268)	0.48 (36)	0.5 (1)
SWL (m)	(2314)	10.3 (219)	18.4 (264)	16 (768)	16.8 (599)	15.2 (402)	21.3 (61)	15.2 (1)
Water cut (m)	(375)	48.5 (32)	44.5 (50)	44 (133)	34 (86)	44 (69)	48 (5)	0 (0)
Observation year		1975	1977	1977	1976	1974	1959	1956
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**
%	(2934)	13 (381)	16.2 (474)	29.2 (858)	18.8 (552)	16.1 (471)	6.3 (186)	0.4 (12)
Max well depth (m)	(2793)	40.2 (365)	19.6 (445)	27.7 (812)	38.1 (523)	57 (456)	82.6 (180)	201 (12)
Water cut (m)	(340)	81 (32)	18 (40)	28 (102)	36 (70)	58.5 (62)	77 (30)	134 (4)
Observation year		1975	1976	1979	1979	1979	1979	2010

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(1993)	73.3 (1461)	18.7 (372)	3.8 (76)	1.9 (38)	2.3 (46)
Max well depth (m)	(1916)	44.2 (1389)	42 (368)	71.9 (75)	84.3 (38)	91.4 (46)
Water cut (m)	(408)	42 (215)	36.8 (144)	38 (25)	45 (9)	81 (15)
Observation year		1979	1985	1983	1975	1983

4.3.3.1. Augusta (6433) and Quorn (6533) 1:100 000 Map Sheets

The northern part of the Willochra Basin is the dominant physiographic feature of *Quorn*. Hydrostratigraphic logs from two drillholes indicate that the basin comprises sequences of undifferentiated Pleistocene alluvial and fluvial sediments up to 30 m in thickness, underlain by Eocene sediments up to 140 m thickness. Basement has been identified as the Neoproterozoic Tapley Hill Formation. Across *Quorn* and beyond the boundary of the Willochra Basin, basement outcrop is ubiquitous. Surface geology maps show the Umberatana Group to be dominant; the Wilpena Group and Pound Subgroup are common. A lack of geological logs makes it difficult to characterise these fractured rock groundwater systems further.

Along the eastern boundary of *Augusta*, outcrop of the Neoproterozoic Wilpena (ABC Range Quartzite), Burra and Umberatana Groups and Heysen Supergroup form a prominent north-south trending ridge. West of this ridge, the surface geology comprises undifferentiated alluvial and fluvial sediments of Holocene-Pleistocene age which are typically sandy clays, up to a depth of 5–10 m below ground surface. Salinities are variable across *Augusta* and *Quorn*, with the exception of the Willochra Basin where salinities are mostly less than 5 000 mg/L (Table 10). For the 717 wells that have salinity observations available, 561 wells (78%) show salinities in the range of 1 500–10 000 mg/L. The median period of data collection is around the mid-1970s. Due to an absence of production zone details, it is not possible to report salinity with respect to specific hydrostratigraphic units.

Across the map sheet, groundwater levels are generally near-surface, with 396 of 833 wells (48%) having standing water levels of less than 10 m. In general, the depth to water cut is greater than standing water level (by as much as around 50 m within Willochra Basin) indicating groundwater may be under pressure. Moderate well yields can be observed in places across the map sheet, with 108 of 468 wells (23%) showing yields ranging between 1 and 3 L/s. However, most wells (316 wells, or 68%) are low yielding (less than 1 L/s). Trends in the spatial distribution of higher yielding wells across the map sheet are not apparent.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	>20 000
%	(717)	6.3 (45)	9.5 (68)	29.1 (209)	26.6 (191)	22.5 (161)	3.9 (28)	2.1 (15)
Max well depth (m)	(666)	46.7 (42)	60 (65)	54 (195)	54.7 (172)	51.5 (150)	31.4 (27)	48 (15)
Yield (L/s)	(404)	0.45 (21)	0.61 (45)	0.63 (127)	0.5 (105)	0.5 (87)	0.63 (9)	1.75 (10)
SWL (m)	(567)	14.9 (34)	18.9 (48)	18.9 (167)	15 (158)	12.2 (129)	14.1 (20)	4.5 (11)
Water cut (m)	(161)	45 (11)	60 (15)	46.8 (56)	47 (38)	82 (28)	33.5 (2)	25 (11)
Observation year		1974	1975	1976	1974	1974	1974	1998
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**
%	(833)	33.7 (281)	13.8 (115)	21.8 (182)	13.3 (111)	11.3 (94)	5.9 (49)	0.1 (1)
Max well depth (m)	(804)	6 (277)	22.1 (113)	30.1 (169)	48.4 (106)	67 (89)	81.2 (49)	148 (1)
Water cut (m)	(146)	28.2 (30)	17.5 (12)	26.5 (30)	43.5 (28)	59.4 (25)	75 (20)	140 (1)
Observation year		1996	1974	1977	1980	1980	1980	2005

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	>10
%	(468)	67.5 (316)	23.1 (108)	4.5 (21)	3.4 (16)	1.5 (7)
Max well depth (m)	(456)	59.4 (306)	56 (107)	71.9 (21)	56.1 (15)	49.5 (7)
Water cut (m)	(165)	50 (93)	47.5 (52)	42 (12)	50 (6)	41.8 (2)
Observation year		1980	1985	1986	1969	1953

4.3.3.2. Wilmington (6532) 1:100 000 Map Sheet

Wilmington covers the southern part of the Willochra Basin and most of the areal extent of Baroota PWRA (because the scope of this assessment extends only to non-prescribed groundwater areas, well data from the Baroota PWRA is excluded from data analyses presented here. The status of groundwater resources in the Baroota PWRA is described in the *Groundwater Status Report* prepared for this area (available online: http://www.waterconnect.sa.gov.au/GSR). The Neoproterozoic Burra and Umberatana Groups dominate the surface geology with some occurrences of the Wilpena Group and Yudnamutana Subgroup also identified. Geological logs of drillholes completed in fractured rock aquifers are few in number, however around 20 drillhole logs suggest the main lithologies to be siltstone and shale of the Umberatana Group. Sedimentary sequences within the Willochra Basin are consistent with the northern part of the Basin (Section 4.3.3.1), although geological logs suggest Quaternary and Tertiary sedimentary sequences are only around 30 m in thickness. Thicker Eocene sequences are observed toward the north, but are absent toward the south.

More than half of the wells on the map sheet (582 of 1 000 wells, or 58%) show salinities of less than 3 000 mg/L (Table 11). A further 224 wells (22%) show salinities in the range of 3 000–5 000 mg/L. Many of the wells showing low salinity are completed in fractured rock aquifers, which are located near the north-eastern boundary of the map sheet. To the south, variability in the areal distribution of salinity increases. This variability in salinity distribution is widespread across the Willochra Basin and toward the map sheet's south-eastern boundary. Production zone details are not available for any wells and therefore, evaluation of salinity as it relates to particular hydrostratigraphic units has not been possible.

The depth to groundwater is variable across the map sheet; however, along the western margin of Willochra Basin, standing water levels are mostly less than 10 m. Almost all wells located within the basin show a greater depth to water cut than depth to groundwater, indicating groundwater may be under pressure. Wells completed in fractured rock aquifers more commonly show depth to water cut which is similar to standing water level, suggesting unconfined conditions. Most wells are low yielding – 483 of 690 wells (70%) show yields of less than 1 L/s. Higher yielding wells are clustered around the western margin of Willochra Basin, where 13 wells (2%) show yields greater than 10 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	>20 000
%	(1000)	16.3 (163)	13.8 (138)	28.1 (281)	22.4 (224)	15.6 (156)	3.6 (36)	0.2 (2)
Max well depth (m)	(878)	46.9 (148)	41.8 (124)	36.6 (243)	33.5 (193)	36.6 (138)	45.1 (32)	0 (0)
Yield (L/s)	(558)	0.76 (101)	0.65 (91)	0.63 (170)	0.51 (107)	0.38 (70)	0.48 (18)	0.5 (1)
SWL (m)	(823)	8.5 (142)	13.3 (118)	10.7 (232)	16.5 (178)	18.8 (125)	26.8 (28)	0 (0)
Water cut (m)	(115)	53 (25)	48 (23)	71 (29)	24 (18)	33.3 (18)	28 (2)	0 (0)
Observation year		1975	1977	1976	1975	1973	1953	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**
%	(1082)	17.4 (188)	20.7 (224)	23.2 (251)	17.7 (191)	16.1 (174)	4.7 (51)	0.3 (3)
Max well depth (m)	(1026)	18.1 (178)	21.3 (209)	33 (239)	40.3 (182)	56.1 (167)	83.7 (48)	144 (3)
Water cut (m)	(115)	81 (15)	20 (24)	30 (31)	43 (22)	63 (17)	82 (3)	128 (3)
Observation year		1975	1976	1976	1976	1976	1976	2006

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	>10
%	(690)	70 (483)	19.3 (133)	5.4 (37)	2.2 (15)	3.2 (22)
Max well depth (m)	(672)	45.7 (468)	45 (131)	78.6 (36)	87 (15)	97.3 (22)
Water cut (m)	(135)	42 (64)	43 (46)	25 (10)	28 (3)	86.5 (12)
Observation year		1976	1979	1983	1977	2006

4.3.3.3. Orroroo (6632) 1:100 000 Map Sheet

Orroroo shows basement outcrop and surficial sedimentary geology spanning approximately equal areas. Outcrop comprises near-equal proportions of the Neoproterozoic Burra and Umberatana Groups, with minor occurrences of the Emeroo Subgroup and Wilpena Group. Undifferentiated Pleistocene alluvial and fluvial sediments infill the broad valleys. The Walloway Basin occupies around one-third of *Orroroo*. Hydrostratigraphic logs are available for 19 wells completed in Walloway Basin sediments which span the northern half of *Orroroo*. Hydrostratigraphic logs indicate (1) undifferentiated Quaternary sediments are mostly around 30 m thick, but may be up to 85 m in thickness (2) undifferentiated Tertiary sediments underlie Quaternary sediments to depths ranging between 86–254 m below ground surface and (3) Neoproterozoic basement has been intercepted in five of the 19 drillholes, which comprises dark siltstone and shale of the Tapley Hill Formation. Few geological log data are available beyond the boundary of Walloway Basin.

Salinity observations recorded from wells spanning *Orroroo* indicate that groundwater salinities are low. Only 11 of 796 wells (1%) show salinities greater than 10 000 mg/L (Table 12). 337 wells (42%) show salinity in the range 1 500–3000mg/L and a further 213 wells (27%) show salinity in the range 3 000–5 000 mg/L. Fractured rock aquifers show some spatial variability in groundwater salinity. However, the Walloway Basin shows a trend of fresher groundwater toward the north of *Orroroo*. In this area, 13 wells monitor undifferentiated Pliocene–Pleistocene sediments or undifferentiated Quaternary alluvial and fluvial sediments. Groundwater salinities for these wells ranges between 1 700–5 000 mg/L (median 1 931 mg/L).

The depth to groundwater across the Walloway Basin is shallow; variability in depth to groundwater is greater for those wells completed in fractured rock aquifers. Across the map sheet, 827 wells have standing water level records available, with 449 wells (54%) having levels less than 20 m. In general, depth to water cut is greater than standing water level, suggesting that in most areas groundwater may be under pressure. Across the map sheet, well yields are extremely low – 377 of 519 wells (73%) yield less than 1 L/s. Most salinity, yield and standing water level data were collected prior to 1980.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(796)	6.9 (55)	9.4 (75)	42.3 (337)	26.8 (213)	13.2 (105)	1.4 (11)	0 (0)
Max well depth (m)	(711)	41.8 (46)	38 (67)	39.6 (305)	30.9 (190)	25.3 (95)	25 (8)	0 (0)
Yield (L/s)	(422)	0.5 (22)	0.5 (45)	0.5 (196)	0.34 (108)	0.28 (48)	0.76 (3)	0 (0)
SWL (m)	(626)	18 (39)	22.7 (62)	18.3 (269)	19.8 (168)	14.4 (81)	13.5 (7)	0 (0)
Water cut (m)	(87)	32 (3)	30 (11)	31.5 (44)	33 (17)	36 (11)	50 (1)	0 (0)
Observation year		1964	1979	1979	1965	1965	1961	0
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**
%	(827)	6.4 (53)	13.3 (110)	34.6 (286)	23 (190)	15.4 (127)	6.5 (54)	0.8 (7)
Max well depth (m)	(791)	83.8 (53)	15.2 (100)	23.2 (272)	34.1 (180)	55 (125)	80.7 (54)	230 (7)
Water cut (m)	(75)	0 (0)	15 (10)	24.5 (26)	33 (24)	47 (9)	74.5 (6)	0 (0)
Observation year		1979	1979	1979	1979	1979	1979	2010

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(519)	72.6 (377)	19.1 (99)	3.3 (17)	1.7 (9)	3.3 (17)
Max well depth (m)	(500)	42.7 (358)	34 (99)	61 (17)	83.8 (9)	64.9 (17)
Water cut (m)	(97)	35 (50)	30 (39)	38 (5)	164 (1)	17.7 (2)
Observation year		1979	1990	1985	1965	1979

4.3.3.4. Carrieton (6633) 1:100 000 Map Sheet

The surface geology of *Carrieton* is dominated by Neoproterozoic basement outcrop and comprises mainly the Wilpena and Umberatana Groups; occurrences of the Emeroo, Yudnamutana and Yerilina Subgroups and the Burra Group have also been mapped in this area. The Walloway Basin is found in the southern part of *Carrieton*. Geological logs are not available for drillholes that are completed within sedimentary units and consequently discussion regarding sedimentary stratigraphy has been omitted.

Across *Carrieton*, 308 wells have salinity records available and 214 (69%) of these wells show salinities in the range 1 500–5 000 mg/L (Table 13). Wells located within the Walloway Basin generally have low salinities; however wells which appear to be completed in fractured rock aquifers show greater spatial variability in salinity distribution. Production zone information has not been recorded for any Carrieton wells and therefore groundwater salinity within particular hydrostratigraphic units is uncertain.

Typically, depths to groundwater are shallow, as 78% of wells (238 from 307 wells) have standing water levels of less than 30 m (median period of data collection is 1980). In general, the depth to water cut is greater than standing water level, indicating that groundwater may be under pressure. Well yields in this region are low, with 264 wells of 299 (88%) showing yields of less than 1 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(308)	2.9 (9)	12.3 (38)	39 (120)	30.5 (94)	14.3 (44)	1 (3)	0 (0)
Max well depth (m)	(272)	42.7 (7)	43.3 (35)	36.7 (106)	33.5 (85)	34.7 (36)	36 (3)	0 (0)
Yield (L/s)	(250)	0.29 (7)	0.38 (34)	0.29 (96)	0.29 (74)	0.29 (36)	0.4 (3)	0 (0)
SWL (m)	(252)	35.1 (8)	26.6 (34)	17.4 (94)	15.5 (79)	17.1 (34)	16.5 (3)	0 (0)
Water cut (m)	(25)	0 (0)	34.5 (4)	42 (9)	32.5 (8)	21 (3)	83 (1)	0 (0)
Observation year		1980	1980	1980	1980	1980	1981	0

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
%	(307)	8.5 (26)	11.7 (36)	37.1 (114)	20.2 (62)	13 (40)	9.4 (29)	0 (0)
Max well depth (m)	(288)	12.6 (24)	21 (33)	27.1 (110)	36.6 (55)	52.2 (40)	88.7 (26)	0 (0)
Water cut (m)	(19)	21 (1)	18 (4)	23 (8)	51 (1)	70 (3)	76.5 (2)	0 (0)
Observation year		1980	1980	1980	1980	1980	1979	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(299)	88.3 (264)	10 (30)	1 (3)	0.3 (1)	0.3 (1)
Max well depth (m)	(270)	36 (236)	38 (29)	59.4 (3)	35.1 (1)	4.8 (1)
Water cut (m)	(27)	30.5 (16)	32 (10)	51 (1)	0 (0)	0 (0)
Observation year		1980	1980	1980	1980	0

4.3.3.5. Caroona (6731) and Paratoo (6732) 1:100 000 Map Sheets

Neoproterozoic basement outcrop spans around half the area of *Caroona* and *Paratoo*. The Umberatana and Wilpena Groups predominate, with the Burra Group and an unnamed breccia also identified in this area. Valley infills have been identified as Pleistocene–Holocene alluvial and fluvial sediments. Quaternary sediments range in thickness between 0.2–24 m (mean ≈ 4 m).

Across the map sheets, groundwater salinities are moderately high. Of 116 wells, 55 (47%) show salinities greater than 5 000 mg/L and a further 30 wells (26%) show salinities in the range 3 000–5 000 mg/L (Table 14). No trends are apparent in the areal distribution of high salinity wells, irrespective of well location with respect to surface geology. Wells in this area lack information regarding their production zone and the aquifer being monitoring. Most salinity observations were recorded prior to 1985.

Groundwater is found at variable depths and 100 wells have records of standing water levels. Across the map sheets, 32 wells (32%) show standing water levels in the range 10–20 m, while 39 wells (39%) show standing water levels ranging between 20 and 50 m. Some wells show water cut at a similar depth to standing water level, suggesting unconfined conditions are likely. However, other wells show a depth to water cut that is greater than standing water level indicating that groundwater may be under pressure. The spatial distribution of wells with data indicating groundwater under pressure appears random in nature. The majority of standing water level data were collected prior to 1988.

Well yields in the Paratoo and Caroona area are low. Of the 83 wells that have records of well yields, 64 wells (77%) show well yields of less than 1 L/s, while a further 17 wells (21%) yield in the range of 1–3 L/s. Most yield data were reported prior to 1990.

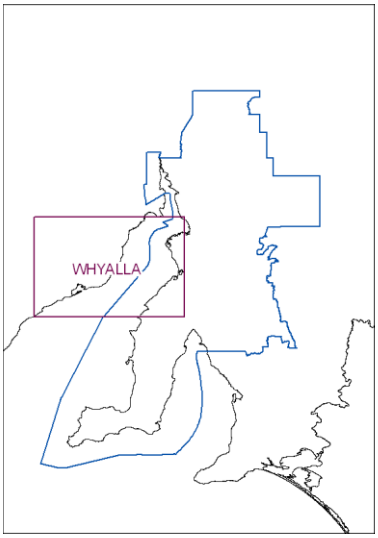
Table 14. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for *Paratoo* and *Wardang*

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(116)	0.9 (1)	7.8 (9)	18.1 (21)	25.9 (30)	37.9 (44)	8.6 (10)	0.9 (1)
Max well depth (m)	(104)	30 (1)	30 (9)	42.1 (21)	42.7 (23)	42.6 (42)	61 (7)	45.7 (1)
Yield (L/s)	(73)	2.27 (1)	0.46 (6)	0.48 (14)	0.48 (18)	0.37 (30)	0.25 (4)	0 (0)
SWL (m)	(84)	8.5 (1)	11.9 (9)	15.2 (17)	15.2 (17)	21.2 (34)	24.4 (5)	15.2 (1)
Water cut (m)	(27)	0 (0)	54 (1)	53.4 (4)	34 (10)	37.5 (12)	0 (0)	0 (0)
Observation year		1982	1976	1979	1981	1985	1956	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
%	(100)	12 (12)	14 (14)	32 (32)	20 (20)	19 (19)	3 (3)	0 (0)
Max well depth (m)	(98)	19.5 (11)	28 (14)	33.5 (31)	46.7 (20)	45.7 (19)	79.3 (3)	0 (0)
Water cut (m)	(16)	18 (2)	0 (0)	29.5 (8)	39 (3)	54 (3)	0 (0)	0 (0)
Observation year		1980	1978	1983	1988	1980	1964	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(83)	77.1 (64)	20.5 (17)	2.4 (2)	0 (0)	0 (0)
Max well depth (m)	(83)	42.6 (64)	41.1 (17)	33.2 (2)	0 (0)	0 (0)
Water cut (m)	(30)	39.5 (20)	37.4 (10)	0 (0)	0 (0)	0 (0)
Observation year		1982	1990	1974	0	0

4.3.4. 1:250 000 MAP SHEET – WHYALLA



WHYALLA has limited extent within the NYNRM Region, with only *Whyalla* (Section 4.3.5.1) and *Wallaroo* containing reportable data.

4.3.4.1. Wallaroo (6430) 1:100 000 Map Sheet

Across *Wallaroo*, undifferentiated Quaternary aeolian sediments and Pleistocene fluvial and alluvial sediments are widespread. The northern reach of Melton Palaeovalley aligns with the eastern boundary of the map sheet. The Holocene St Kilda Formation and Semaphore Sand are common along the map sheet's coastline, where minor occurrences of Eocene–Miocene marine limestone have also been described. Coastal Mesoproterozoic basement outcrop comprising the Hiltaba Suite has been identified over a lateral distance of around 16 km; this outcrop is located around half way between the northeast and south-west extent of the map sheet. Palaeoproterozoic–Cambrian basement outcrop comprising the Wallaroo and Hawker Groups and the Emeroo Subgroup has also been identified toward the south-eastern quadrant of the map sheet. The thicknesses of the Quaternary and Tertiary sequences are variable.

Toward the south-western quadrant, undifferentiated Pleistocene fluvial and alluvial sediments show thicknesses in the range of 0.3–18 m (mean ≈ 4 m; from 39 drillholes). Here, the Melton Limestone thickness is around 14–17 m (from three drillholes) and undifferentiated Palaeocene–Pleistocene rocks have been logged up to 26 m in thickness (mean ≈ 10 m; from 65 drillholes). 246 drillholes have intercepted basement, at depths ranging up to 272 m (mean ≈ 10 m).

Drillholes located in and near the Melton Palaeovalley show undifferentiated Quaternary sediment thickness ranging up to 27 m (mean ≈ 6 m; from 38 drillholes). Undifferentiated Tertiary sediment thicknesses range up to 42 m (mean ≈ 22 m; from 24 drillholes). The depth to basement varies up to 69 m below ground surface (mean ≈ 16 m; from 55 drillholes).

Although few salinity data have been recorded across *Wallaroo*, evidence suggests that groundwater salinity is high, as 26 of 41 wells (63%) show salinities greater than 20 000 mg/L (Table 15). Most high-salinity wells are located near the coast. Five salinity observations are located in the vicinity of Melton Palaeovalley and show salinity in the range of 15 000–24 000 mg/L. Production zone details are not available for any wells with salinity records across *Wallaroo*. The median period salinity data was recorded is 1988.

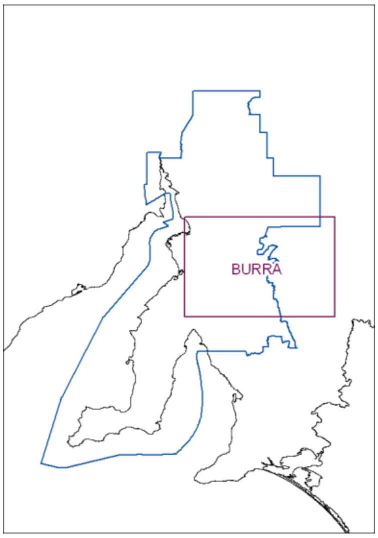
The depth to groundwater appears to be shallow, however it should be noted that most observations describe near-coastal water levels, with 43 of 66 wells (65%) show standing water levels of less than 5 m. Few wells have the depth to water cut recorded, so it is difficult to predict whether unconfined conditions can be expected here. In general, well yield appears to be low, with 11 of 15 wells (73%) showing yields less than 1 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	>20 000
%	(40)	2.5 (1)	5 (2)	5 (2)	2.5 (1)	2.5 (1)	17.5 (7)	65 (26)
Max well depth (m)	(34)	10.8 (1)	4.6 (2)	6.3 (2)	6.1 (1)	11.5 (1)	35 (7)	14.4 (20)
Yield (L/s)	(8)	0 (0)	0.08 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0.8 (7)
SWL (m)	(29)	1.8 (1)	1.7 (2)	3.5 (2)	1.6 (1)	2.5 (1)	3 (3)	5.1 (19)
Water cut (m)	(10)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	12.9 (10)
Observation year		1978	1992	2006	2006	2006	1992	1989
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**
%	(66)	65.2 (43)	15.2 (10)	13.6 (9)	4.5 (3)	1.5 (1)	0 (0)	0 (0)
Max well depth (m)	(60)	6.2 (43)	16 (8)	17.5 (7)	75.8 (2)	0 (0)	0 (0)	0 (0)
Water cut (m)	(8)	6.3 (6)	12 (1)	32.3 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Observation year		2002	1994	2002	1978	1957	0	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	>10
%	(15)	73.3 (11)	13.3 (2)	6.7 (1)	6.7 (1)	0 (0)
Max well depth (m)	(15)	13.7 (11)	24.3 (2)	21 (1)	67.1 (1)	0 (0)
Water cut (m)	(12)	9.8 (9)	20 (2)	15 (1)	0 (0)	0 (0)
Observation year		1995	1996	2001	1974	0

4.3.5. 1:250 000 MAP SHEET – BURRA



BURRA encompasses the transition between the southern Flinders Ranges and northern Mount Lofty Ranges which occurs in the vicinity of the Burra township. The main purpose of wells located around the southern Flinders Ranges is for stock watering, although groundwater is of suitable quality for limited irrigation in places. A total of 1 227 of 2 600 wells (47%) show groundwater salinity in the range 1 500–5 000 mg/L (Table 16) and 1 061 of 1 695 wells (63%) show low yields of less than 1 L/s. However, 419 wells (25%) show moderate yields of 1–3 L/s. As far north as Crystal Brook, groundwater salinities within the Adelaidean basement rocks are often less than 3 000 mg/L; however salinity increases to around 7 000 mg/L further to the north (Shepherd 1978).

Considerable volumes of low salinity groundwater are located within the Clare Valley PWRA and smaller volumes of variable salinity groundwater occur within (the non-prescribed) Booborowie Valley (Fig. 4). Booborowie Valley is a typical example of alluvial aquifers situated in inter-montane valleys within the Mount Lofty and Flinders Ranges. The Booborowie Valley is infilled with poorly sorted piedmont gravels, silts and clays to around 30 m thickness (Shepherd 1978). Groundwater salinities vary between around 900–6 000 mg/L. Although there is no metering of groundwater extraction volumes, estimated extractions have shown a significant decline from about 1 200 ML/y in 1990 to around 300 ML/y in 2010 (see *Groundwater Status Report,* available online: http://www.waterconnect.sa.gov.au/GSR).

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(2600)	8.7 (227)	10.1 (262)	37.1 (965)	28.3 (737)	12.7 (331)	1.8 (47)	1.2 (31)
Max well depth (m)	(2342)	30.5 (202)	28.8 (248)	31 (878)	27.4 (656)	24.4 (290)	25.5 (40)	12.5 (28)
Yield (L/s)	(1480)	0.9 (128)	0.78 (175)	0.6 (560)	0.5 (422)	0.3 (176)	0.25 (12)	0.25 (7)
SWL (m)	(1863)	11.9 (151)	12 (195)	10.9 (692)	10.5 (534)	10 (238)	4.1 (28)	3.7 (25)
Water cut (m)	(684)	23.5 (56)	22.9 (81)	22.4 (264)	25 (193)	24.4 (69)	29.9 (9)	11.1 (12)
Observation year		1973	1977	1975	1977	1977	1966	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**
%	(2530)	29.1 (737)	23.6 (596)	26.5 (670)	11.4 (289)	6.6 (167)	2.8 (70)	0 (1)
Max well depth (m)	(2414)	7.7 (710)	17.1 (569)	28.2 (635)	37.2 (280)	52 (156)	82.6 (63)	154.5 (1)
Water cut (m)	(498)	7.6 (85)	15 (144)	26 (154)	36 (58)	46 (44)	74 (12)	143.3 (1)
Observation year		1986	1977	1977	1977	1977	1977	1983

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(1695)	62.6 (1061)	24.7 (419)	4.3 (73)	5.5 (94)	2.8 (48)
Max well depth (m)	(1649)	31.1 (1023)	34 (415)	39.8 (72)	37.7 (92)	45 (47)
Water cut (m)	(750)	28 (371)	24 (262)	20 (47)	21 (40)	15 (30)
Observation year		1977	1984	1986	1977	1983

4.3.5.1. Whyalla (6431) and Pirie (6531) 1:100 000 Map Sheets

Neoproterozoic basement outcrop is limited to the eastern half of *Pirie* and comprises mainly the Emeroo Subgroup with minor occurrences of the Wilpena Group (ABC Range Quartzite) located further to the west. Drillhole data density is greater across the plains of *Whyalla* and toward the west of *Pirie*.

Across the plains, stratigraphic logs suggest Quaternary sediments can reach thicknesses of up to 115 m (from 558 observations). The Pooraka Formation is widespread across the map sheets with a mean thickness of 3 m (from 108 drillholes). The Hindmarsh Clay has been found to be around 60 m in thickness (mean ≈ 12 m; calculated from 98 drillholes). Tertiary sediments are widespread across the map sheets and have been logged with a thickness of up to 125 m (mean ≈ 18 m; calculated from 83 drillholes). The Neoproterozoic basement is described predominantly as the Emeroo subgroup, logged at a mean depth of around 220 m below ground surface (calculated from 81 drillholes).

Groundwater salinity appears lowest (less than 1 000 mg/L) along north-south trending topographic highs, commencing from the northern boundary of *Pirie*. Groundwater also appears to be low in salinity at what appears to be piedmont slopes between the western fringe of this ridge and the coastal plains of *Whyalla*. Many near-coastal wells show high salinities (some greater than 20 000 mg/L). There is a large degree of variability in salinity, with a near-even number of observations spread across salinity classes less than 10 000 mg/L (Table 17). Most groundwater salinity data have been recorded prior to 1977.

In general, depth to groundwater is shallow in wells located close to the coast. Toward the east, the standing water level increases with increasing relief. Standing water level of less than 10 m have been recorded in 720 of 1 115 wells (65%). The median period that groundwater water level data was collected is 1990. However, observations of deeper standing water levels were recorded around 1977. Wells located on the coastal plains have standing water levels which approximate depth to water cut, suggesting unconfined conditions. Some wells in areas of higher relief show depth to water cut that is greater than standing water level, indicating groundwater may be under pressure. Well yields are variable, but generally appear to be greater in sedimentary environments. For 575 of 663 wells (87%), yields are less than 3 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 *Pirie* and *Whyalla*

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	>20 000
%	(1007)	10.7 (108)	10.8 (109)	25.9 (261)	24.6 (248)	20.6 (207)	4.1 (41)	3.3 (33)
Max well depth (m)	(918)	30.5 (95)	22.5 (104)	27.7 (246)	24.4 (235)	18.3 (173)	8.5 (34)	8.9 (31)
Yield (L/s)	(594)	0.9 (64)	1 (71)	0.63 (166)	0.38 (159)	0.25 (118)	0.13 (14)	0.43 (2)
SWL (m)	(783)	11 (78)	9 (89)	8.5 (212)	10 (201)	8.7 (150)	3.4 (27)	2.7 (26)
Water cut (m)	(128)	29 (7)	22 (25)	18 (30)	22 (27)	16.3 (24)	3.7 (8)	4 (7)
Observation year		1964	1977	1977	1977	1977	1957	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
%	(1115)	43.3 (483)	21.3 (237)	19.6 (219)	7.9 (88)	5.7 (63)	2.2 (25)	0 (0)
Max well depth (m)	(1088)	6.1 (479)	16.4 (230)	29 (211)	36.6 (85)	49.7 (61)	75.6 (22)	0 (0)
Water cut (m)	(145)	4 (51)	15.5 (46)	26 (25)	36 (7)	48 (11)	79 (5)	0 (0)
Observation year		1990	1977	1977	1977	1977	1977	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	>10
%	(663)	65.9 (437)	20.8 (138)	4.5 (30)	6.5 (43)	2.3 (15)
Max well depth (m)	(637)	24.4 (417)	30.3 (135)	33.3 (30)	36 (41)	39.6 (14)
Water cut (m)	(141)	18 (65)	24 (47)	18 (13)	17.5 (12)	52.5 (4)
Observation year		1977	1977	1985	1976	1977

4.3.5.2. Blyth (6530) 1:100 000 Map Sheet

A north-south trending ridge comprising the Neoproterozoic Wilpena Group (ABC Range Quartzite) outcrops along the western half of *Blyth*. Minor outcrops of Burra Group and Emeroo Subgroup are located around the north-eastern boundary, but there are little data that describes the vertical extent of these units.

Quaternary and Tertiary sediments are the main surficial geological features of *Blyth*. Quaternary sediments are mostly described as undifferentiated Pleistocene alluvial and fluvial deposits, although a wide band of aeolian deposits have been mapped along the western boundary of the map sheet. Occurrences of undifferentiated lacustrine and playa sediments have been identified near the centre of the map sheet and toward the southern boundary. The Pooraka Formation and Hindmarsh Clay are widespread across coastal plains, commonly infilling valleys. The Pooraka Formation has been logged up to 51 m in thickness (mean ≈ 10 m; from 79 drillholes) and Hindmarsh Clay reaches up to 70 m in thickness (mean ≈ 23 m; from 98 drillholes). Tertiary deposits are identified as mainly the Clinton Formation. This formation occurs only to the east of the north-south trending ABC Range Quartzite ridge, reaching up to 140 m in thickness (mean ≈ 56 m; from 72 drillholes) and is commonly overlain by Hindmarsh Clay.

To the east of the outcropping ABC Range Quartzite, basement has been described as undifferentiated Neoproterozoic rock at depths of up to 164 m below ground surface (mean ≈ 79 m; from 70 drillholes). South-west of the ABC Range Quartzite ridge, the Palaeoproterozoic–Cambrian basement comprises the Moralana Supergroup and Wallaroo Groups; to the north-west, the Neoproterozoic basement comprises the Umberatana Group and Emeroo Subgroups. The Moralana and Wallaroo Groups have been logged at maximum depths of 127 m below ground surface (mean ≈ 29 m; from 72 drillholes) and 729 m below ground surface (mean ≈ 210 m; from 36 drillholes), respectively. The Umberatana Group and Warinna Supergroup have been observed at maximum depths of 497 m below ground surface (mean ≈ 94 m; from 121 drillholes) and 286 m below ground surface (mean ≈ 132 m; from 14 drillholes), respectively.

Across *Blyth*, groundwater salinities are moderately high, with 201 of 219 wells (92%) showing salinities in the range 3 000–10 000 mg/L (Table 18). Trends in the areal distribution of groundwater salinity are not apparent. Only four wells toward the southern third of the map sheet have construction details and associated groundwater salinity records ranging between 17 000 and 25 000 mg/L. Three of these wells are completed in the ABC Range Quartzite at around 50–100 m depth and the fourth well is completed in the Umberatana Group at between 60–80 m depth. Observations associated with these four wells were recorded in the mid-1980s.

The vast majority of standing water level observations have been taken from wells located to the east of the ABC Range Quartzite ridge. The water table is very shallow for most wells completed within valley alluvium. Across *Blyth*, 122 of 301 wells (41%) show standing water levels of less than 5 m. Depth to water cut is often far greater than depth to groundwater – evidence that groundwater is likely to be under pressure in most instances. In general, well yield is low. A total of 124 of 148 wells (84%) show well yields less than 3 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(219)	3.2 (7)	2.7 (6)	21.5 (47)	47 (103)	17.8 (39)	5.5 (12)	2.3 (5)
Max well depth (m)	(197)	56 (5)	29.7 (6)	42.7 (43)	27 (89)	26.4 (37)	62 (12)	73 (5)
Yield (L/s)	(103)	19 (3)	1.02 (2)	0.61 (22)	1 (47)	1.25 (19)	0.31 (6)	0.55 (4)
SWL (m)	(166)	47.9 (4)	12.7 (5)	17 (38)	9.2 (75)	9 (31)	11.6 (8)	25.5 (5)
Water cut (m)	(52)	34 (3)	0 (0)	44.5 (8)	35 (21)	24.4 (11)	56 (5)	53.8 (4)
Observation year		1983	1968	1983	1983	1975	1984	1984
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**
%	(301)	40.5 (122)	16.9 (51)	17.3 (52)	10.6 (32)	6.3 (19)	8 (24)	0.3 (1)
Max well depth (m)	(279)	29 (115)	18.2 (46)	21 (49)	36.5 (30)	58 (18)	85.2 (20)	154.5 (1)
Water cut (m)	(46)	43 (15)	26 (9)	18 (11)	35.5 (3)	45 (2)	72 (5)	143.3 (1)
Observation year		1986	1985	1985	1985	1985	1985	1983

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(148)	51.4 (76)	32.4 (48)	5.4 (8)	9.5 (14)	1.4 (2)
Max well depth (m)	(147)	54.9 (75)	49.3 (48)	52.1 (8)	33.6 (14)	58.7 (2)
Water cut (m)	(74)	31.1 (33)	38.3 (26)	28.5 (6)	23.9 (7)	24.4 (2)
Observation year		1983	1984	1986	1985	1976

4.3.5.3. Clare (6630) 1:100 000 Map Sheet

The Clare Valley PWRA occupies around one quarter of the area of the Clare Map Sheet. The southern reach of Booborowie Valley overlies the map sheet's northern extent. Groundwater availability and quality across the Clare Valley PWRA and Booborowie Valley have been described in detail (e.g. Stewart 2005; Magarey and Deane 2005) and both areas are the subject of a *Groundwater Status Report* (available online: http://www.waterconnect.sa.gov.au/GSR).

In general, Quaternary deposits are logged as undifferentiated Holocene alluvial and fluvial sediments, reaching depths of up to 14 m below ground surface (mean ≈ 6 m; from 20 drillholes). The Pooraka Formation has been identified in two drillholes located toward the northern boundary of the map sheet, with a thickness of 10 m. Tertiary deposits are described in only six drillholes – these sediments are water-bearing Miocene–Pliocene clayey sands and gravels with thicknesses ranging between 3 and 34 m (mean ≈ 10 m). Outcrop across the Clare Map Sheet comprises the Neoproterozoic Umberatana and Burra Groups and the Emeroo Subgroup. Logs describing the stratigraphy of fractured rock aquifers are limited to an area to the north of the Clare Valley PWRA. Undifferentiated Neoproterozoic units are found at up to 42 m depth below ground surface (mean ≈ 17 m; from 11 drillholes). The top of the Callanna Group is intersected at a mean depth of 61.5 m below ground surface (from four drillholes). In general, only single observations are available for other lithologies, making it difficult to evaluate their vertical extents.

Although groundwater within the Booborowie Valley appears low in salinity, groundwater beyond Booborowie Valley is generally brackish. Salinities from 473 of 606 wells (78%) are in the range 1 500–5000 mg/L (Table 19). Trends in the spatial distribution of these higher-salinity wells are not evident. Most wells, 324 of 442 (73%), show a depth to groundwater of less than 20 m. In general, the depth to water cut is greater than standing water level, indicating groundwater may be under pressure. The median period that groundwater salinity and water level data was collected is the mid-1970s.

With the exception of the higher yielding wells within Booborowie Valley, wells across non-prescribed areas of the Clare Map Sheet are low yielding. Of 358 wells, 315 (88%) show yields of less than 3 L/s (including wells completed within Booborowie Valley aquifers).

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(606)	5.9 (36)	5.9 (36)	47.7 (289)	30.4 (184)	9.2 (56)	0.5 (3)	0.3 (2)
Max well depth (m)	(560)	24.5 (33)	25.3 (33)	30.6 (269)	30.5 (167)	30.5 (54)	41.2 (3)	18.9 (1)
Yield (L/s)	(317)	0.63 (9)	0.88 (19)	0.63 (148)	0.61 (108)	0.62 (32)	0 (0)	0.13 (1)
SWL (m)	(383)	14.8 (25)	9.7 (22)	14.2 (185)	12.2 (115)	12.2 (35)	8.5 (1)	0 (0)
Water cut (m)	(244)	16.5 (8)	21 (16)	22 (111)	24 (81)	27.5 (26)	29.9 (1)	18.3 (1)
Observation year		1973	1973	1973	1973	1973	1960	1956
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**
%	(442)	15.6 (69)	22.2 (98)	35.5 (157)	18.8 (83)	6.8 (30)	1.1 (5)	0 (0)
Max well depth (m)	(425)	10.6 (67)	17 (96)	27.9 (148)	36.6 (80)	48.8 (29)	71.3 (5)	0 (0)
Water cut (m)	(127)	9 (23)	15 (22)	25 (49)	33 (21)	42.6 (10)	64.7 (2)	0 (0)
Observation year		1973	1972	1973	1973	1973	1973	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(358)	60.9 (218)	27.1 (97)	3.1 (11)	5 (18)	3.9 (14)
Max well depth (m)	(357)	33 (217)	39.6 (97)	43 (11)	50.4 (18)	46.4 (14)
Water cut (m)	(241)	27.2 (117)	22.6 (85)	22 (11)	18 (15)	10 (13)
Observation year		1972	1983	1989	1986	1982

4.3.5.4. Jamestown (6631) 1:100 000 Map Sheet

The area encompassed by *Jamestown* shows sequences of folded, north-south trending synclines and anticlines. Neoproterozoic basement exposures have been identified as mainly the Burra, Callanna and Umberatana Groups, with some occurrences of the Emeroo and Wilpena Groups. An indication of the likely thicknesses of Quaternary and Tertiary sediments can be inferred from drillhole data. Across the Jamestown map sheet, logged drillholes are clustered in two distinct groups: (1) a group adjacent to the northern boundary and (2) another group located toward the south-western boundary.

In the northern region, Quaternary sediments are likely to range up to 10 m in thickness (mean ≈ 3 m; from 28 drillholes). The thickness of Tertiary sequences is uncertain, but two drillhole logs suggest they may be around 2–3 m. Logs from drillholes located toward the south indicate that the Quaternary sediment thickness may be 4 m (from two drillholes).

In general, groundwater across the map sheet is found at moderately shallow depth, with 334 of 714 (47%) of wells showing standing water levels of less than 10 m and a further 236 wells (33%) ranging between 10 and 20 m. Depth to water cut is often greater than standing water level, indicating groundwater may be under pressure. Although some higher yielding wells are observed in Booborowie Valley, the vast majority of wells, 473 of 539 wells (88%), show yields of less than 3 L/s.

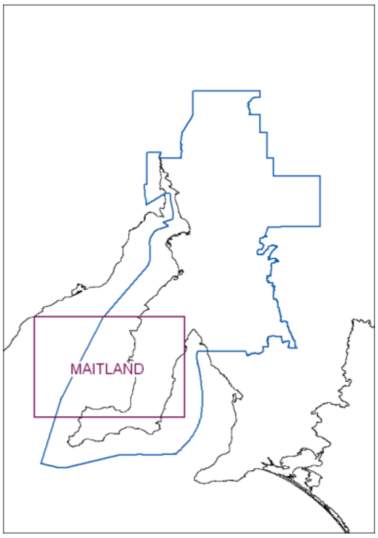
Across *Jamestown*, the groundwater salinity is variable, with good quality groundwater occurring in the Booborowie Valley and in alluvial sediments towards the north-western quadrant of the map sheet. Within the Booborowie Valley, 35 wells monitoring both Quaternary sediments and fractured rock aquifers show salinities of less than 3 000 mg/L. More generally, of the 799 wells with recorded salinity data, 369 (46%) show salinities ranging between 1 500 and 3 000 mg/L. In total, 762 wells (95 %) show salinities less than 5 000 mg/L (Table 20). Lower-salinity observations (less than 3 000 mg/L) appear to be recorded prior to 1980, whereas higher-salinity observations (greater than 3 000 mg/L) have been recorded mostly prior to 1995.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(799)	9.6 (77)	13.8 (110)	46.2 (369)	25.8 (206)	4.6 (37)	0 (0)	0 (0)
Max well depth (m)	(700)	31.6 (70)	37.7 (104)	32 (321)	27.4 (171)	26.7 (34)	0 (0)	0 (0)
Yield (L/s)	(481)	0.94 (53)	0.61 (82)	0.6 (223)	0.53 (108)	0.3 (15)	0 (0)	0 (0)
SWL (m)	(563)	12 (45)	14.5 (78)	10.9 (261)	10.2 (150)	10.8 (29)	0 (0)	0 (0)
Water cut (m)	(265)	22 (38)	25 (39)	22.4 (114)	26 (63)	21 (11)	0 (0)	0 (0)
Observation year		1972	1975	1977	1995	1990	0	0
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**
%	(714)	17.5 (125)	29.3 (209)	33.1 (236)	11.1 (79)	7 (50)	2.1 (15)	0 (0)
Max well depth (m)	(664)	11.5 (111)	18.3 (196)	30.5 (221)	39 (77)	54.9 (44)	85.3 (15)	0 (0)
Water cut (m)	(185)	15 (17)	15 (63)	30 (68)	36.5 (20)	50 (17)	0 (0)	0 (0)
Observation year		1993	1996	1995	1990	1997	1965	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(539)	63.3 (341)	25 (135)	4.6 (25)	3.7 (20)	3.3 (18)
Max well depth (m)	(520)	33.4 (324)	33.5 (134)	39.8 (24)	41 (20)	46.2 (18)
Water cut (m)	(294)	29 (155)	22 (103)	9.8 (17)	25 (7)	13.6 (12)
Observation year		1979	1991	1991	1973	1985

4.3.6. 1:250 000 MAP SHEET – MAITLAND



MAITLAND encompasses central Yorke Peninsula where groundwater data are sparse. Topography in this region is mainly low-lying coastal plains. Across MAITLAND, groundwater salinity is high (Table 21). Only 171 of 1 140 wells (15%) show salinity less than 1 500 mg/L. Most of the wells, 263 of 286 (92%), are low yielding (less than 3 L/s). Most salinity data were collected around the mid-1950s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(1140)	8.9 (101)	6.1 (70)	17.8 (203)	20.1 (229)	30.9 (352)	9.3 (106)	6.9 (79)
Max well depth (m)	(1004)	7.2 (82)	4.9 (63)	7.6 (179)	9.1 (196)	13.6 (318)	13.4 (95)	18 (71)
Yield (L/s)	(254)	1.89 (23)	0.39 (16)	0.38 (37)	0.25 (53)	0.45 (73)	0.25 (26)	0.9 (26)
SWL (m)	(911)	3.5 (80)	3.2 (61)	4.3 (160)	4.4 (175)	7.6 (285)	6 (86)	4 (64)
Water cut (m)	(194)	6.2 (16)	17.5 (10)	10.7 (32)	24.2 (36)	23 (49)	12.1 (20)	18.3 (31)
Observation year		1956	1972	1957	1956	1956	1957	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
%	(1037)	51 (529)	15.1 (157)	10.7 (111)	9.3 (96)	8.6 (89)	5 (52)	0.3 (3)
Max well depth (m)	(1009)	3.7 (518)	10.9 (142)	22.8 (110)	30.5 (95)	45 (89)	86.1 (52)	115.8 (3)
Water cut (m)	(190)	3 (49)	9.1 (39)	21.7 (40)	29.8 (28)	39.8 (22)	79.8 (12)	0 (0)
Observation year		1977	1977	1982	1957	1956	1956	1956

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(286)	67.8 (194)	24.1 (69)	3.8 (11)	3.1 (9)	1 (3)
Max well depth (m)	(285)	15.4 (194)	24 (68)	16.8 (11)	39 (9)	39 (3)
Water cut (m)	(168)	23 (102)	18 (50)	22 (7)	23.5 (8)	12 (1)
Observation year		1978	1984	1981	1985	1985

4.3.6.1. Turton (6328) 1:100 000 Map Sheet

Turton is predominately covered by the ocean. Toward the southern boundary of the map sheet, the surface geology has been identified as mainly the Quaternary Bridgewater Formation which forms the northern half of the Para-Wurlie Basin. Along the coastline of western Yorke Peninsula, geological logs indicate occurrences of the Holocene St Kilda Formation, Semaphore Sand and undifferentiated Quaternary aeolian, fluvial and alluvial sediments. Coastal outcrop of Palaeoproterozoic basement rocks comprise the Wallaroo Group, Donington Suite and Hutchinson Formation.

Near the Para-Wurlie Basin, Tertiary deposits have been recorded up to 42 m in thickness (mean ≈ 16 m from six drillholes). These drillholes show the depth to basement to be in the range of 6 to 42 m below ground surface.

The groundwater salinity is moderately high across *Turton*, with 234 of 333 wells (70%) showing salinities in the range 1 500–10 000 mg/L (median period of data collection is 1977) (Table 22). However, a paucity of production zone detail prevents assigning salinity levels to specific hydrostratigraphic units.

The depth to groundwater is shallow, with 220 of 300 wells (73%) showing a standing water level less than 5 m. Most wells show a depth to water cut greater than the standing water level, indicating groundwater may be under pressure at some locations. Well yields are low, with 87 of 120 wells (73%) showing a yield of less than 1 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(333)	11.7 (39)	7.5 (25)	23.4 (78)	21.9 (73)	24.9 (83)	7.5 (25)	3 (10)
Max well depth (m)	(297)	8.5 (33)	3.5 (24)	4 (72)	3.6 (60)	4.9 (77)	4.3 (21)	24.9 (10)
Yield (L/s)	(113)	1.89 (18)	0.25 (9)	0.37 (21)	0.25 (21)	0.35 (26)	0.16 (10)	0.75 (8)
SWL (m)	(269)	4 (35)	2.5 (21)	2.6 (61)	2.4 (54)	3.2 (72)	3 (18)	3.5 (8)
Water cut (m)	(59)	4 (11)	6.4 (3)	7.3 (16)	3.1 (11)	13.1 (10)	9 (2)	27.5 (6)
Observation year		1977	1975	1977	1977	1977	1962	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**
%	(300)	73.3 (220)	17.3 (52)	8.7 (26)	0.3 (1)	0.3 (1)	0 (0)	0 (0)
Max well depth (m)	(290)	3.3 (212)	12.2 (50)	25.6 (26)	345 (1)	113 (1)	0 (0)	0 (0)
Water cut (m)	(42)	4.8 (22)	7.2 (12)	33.5 (7)	0 (0)	111 (1)	0 (0)	0 (0)
Observation year		1977	1978	1978	1978	1997	0	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(120)	72.5 (87)	18.3 (22)	5 (6)	2.5 (3)	1.7 (2)
Max well depth (m)	(119)	7.8 (87)	15.9 (21)	11.5 (6)	17 (3)	33 (2)
Water cut (m)	(45)	10 (35)	7.7 (6)	4.3 (2)	5.3 (2)	0 (0)
Observation year		1978	1983	1971	1985	1984

4.3.6.2. Wardang (6329) and Maitland (6429) 1:100 000 Map Sheets

Basement outcrop is sparse across *Maitland* and *Wardang*. The main outcropping Mesoproterozoic unit is Hiltaba Suite granite, which occurs toward the centre of the map sheet. To the south, minor Palaeoproterozoic–Cambrian outcrops of the Kulpara Formation (up to 190 m thick), Parara Limestone and Wallaroo Group have been identified. Near the northern boundary of the Maitland Map Sheet, geological logs show minor outcrops of the Neoproterozoic Emeroo Subgroup. The Quaternary geology of *Wardang* is restricted to coastal-fringe formations – namely, the St Kilda Formation and Semaphore Sand.

The north-western quadrant of the Maitland Map Sheet hosts undifferentiated Quaternary aeolian sediments with a mean thickness of 11 m (from 8 drillholes). In this area, Tertiary sediments and calcrete are logged with a mean thickness of 10 m (from 116 drillholes). Typically, the Tertiary sequences overlie the Burra Group and have a mean thickness of 20 m (from 23 drillholes). The Melton Palaeovalley is located along the eastern boundary of the map sheet and contains a thin veneer of Quaternary sediments (mean thickness of 4 m from 31 drillholes) which overlie Tertiary sediments of up to 67 m thickness (mean ≈ 19 m from 105 drillholes). In general, the basement comprises the Wallaroo Group which lies at a maximum depth of 162 m below ground surface (mean depth ≈ 23 m; from 179 drillholes).

Across *Maitland* and *Wardang*, groundwater salinities are high, with 60 of 118 wells (51%) showing salinities greater than 10 000 mg/L, while only 23 wells (19%) have salinities less than 1 500 mg/L (Table 23). Trends in the spatial distribution of groundwater salinity across the map sheets are not evident. Only three wells have information identifying which aquifer may be monitored – it is likely these wells are completed in Hiltaba Suite granite and show salinities in the range of 25 000 to 31 000 mg/L. Depth to groundwater is generally shallow, as 82 of 111 wells (74%) show standing water levels of less than 10 m. The depths to water cut approximates the standing water levels, suggesting unconfined conditions. The date of salinity and water level data collection is mostly pre-1960.

Few wells have well yield records available; however 20 of 26 wells (77%) show yields of less than 1 L/s. Groundwater level and water quality data are not available for any of the wells completed within the Melton Palaeovalley.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	>20 000
%	(118)	13.6 (16)	5.9 (7)	4.2 (5)	10.2 (12)	15.3 (18)	20.3 (24)	30.5 (36)
Max well depth (m)	(93)	2.4 (11)	3.1 (5)	68.9 (2)	2.4 (10)	8 (15)	13.4 (21)	10.2 (29)
Yield (L/s)	(23)	0.1 (1)	0 (0)	0.03 (1)	0.16 (3)	0.44 (4)	0.63 (5)	0.5 (9)
SWL (m)	(98)	2 (13)	3.1 (6)	4.6 (5)	2.1 (10)	8.5 (15)	7.2 (21)	3.4 (28)
Water cut (m)	(33)	0 (0)	0 (0)	2.6 (1)	39 (1)	59.1 (4)	12 (10)	5.2 (17)
Observation year		1957	1957	1957	1961	1957	1958	1993
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**
%	(111)	54.1 (60)	19.8 (22)	13.5 (15)	6.3 (7)	4.5 (5)	1.8 (2)	0 (0)
Max well depth (m)	(95)	2.6 (58)	13.4 (9)	23.4 (14)	84 (7)	81.1 (5)	80.8 (2)	0 (0)
Water cut (m)	(32)	1.4 (13)	6.9 (2)	12.2 (8)	50 (5)	55.8 (2)	78.3 (2)	0 (0)
Observation year		1961	1957	1993	1993	1956	1980	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	>10
%	(26)	76.9 (20)	23.1 (6)	0 (0)	0 (0)	0 (0)
Max well depth (m)	(26)	54.3 (20)	58.4 (6)	0 (0)	0 (0)	0 (0)
Water cut (m)	(15)	51.2 (11)	45 (4)	0 (0)	0 (0)	0 (0)
Observation year		1962	1994	0	0	0

4.3.6.3. Stansbury (6428) 1:100 000 Map Sheet

In general, the surface geology of *Stansbury* can be described as comprising undifferentiated Pleistocene–Holocene fluvial and alluvial sediments at the coastal fringes of the map sheet, grading to aeolian sediments toward the centre. Stratigraphic sequences have been logged in detail only in the northern third of the map sheet. Logs show Quaternary sediments reaching 2–5 m in thickness on average and up to 10 m in places. Undifferentiated Tertiary to Pleistocene rocks obtain a mean thickness of 13 m (from 324 drillholes) and show a maximum thickness of 44 m. Toward the northwest, the Clinton Formation has been logged in one drillhole with a thickness of 20 m. Toward the northeast, the Rogue Formation has been logged in three drillholes with a mean thickness of 32 m. Palaeoproterozoic–Mesoproterozoic basement sequences comprise the Hiltaba Suite and Wallaroo Group. The mean depth to the Hiltaba Suite basement is 11 m below ground surface (from 125 drillholes) and 14 m below ground surface (from 217 drillholes) for the Wallaroo Group.

Across *Stansbury*, groundwater salinities are moderately high, with 395 of 689 wells (57%) showing salinities in the range 3 000–9 000 mg/L (Table 24). Trends in the spatial distribution of salinity are not evident. Production zone details are not available for any wells on this sheet and consequently, an evaluation of the groundwater salinity of specific hydrostratigraphic units is not possible. The median period that salinity data was collected is the mid-1950s.

Many wells show a shallow depth to watertable, with 257 of 626 wells (41%) having a standing water level of less than 5 m (median period of data collection is 1978). The shallowest depth to water table is recorded toward the south-western quadrant of the map sheet, with the greatest depths recorded around topographic highs located near the centre of the map sheet. Within 5 km of the eastern coastline, standing water levels of between 20–50 m are common. Most wells show a depth to water cut which approximate the standing water level, suggesting unconfined conditions are likely.

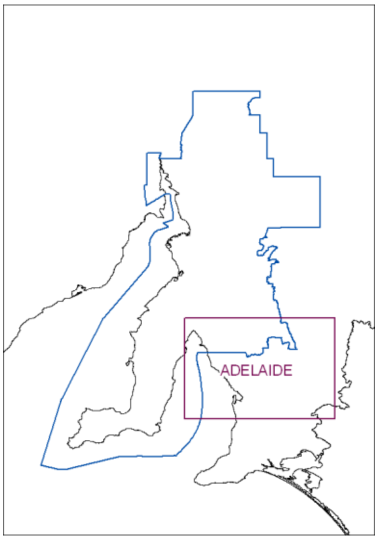
Although most wells, 87 of 140 (62%), show well yields of less than 1 L/s, 41 wells (29%) show well yields up to 3 L/s. Higher yielding wells (up to 10 L/s) appear mainly along the peninsula's east coast and within 6 km of the coastline. Most yield data were recorded around the early-1980s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(689)	6.7 (46)	5.5 (38)	17.4 (120)	20.9 (144)	36.4 (251)	8.3 (57)	4.8 (33)
Max well depth (m)	(614)	17.7 (38)	7.5 (34)	12.2 (105)	27.3 (126)	24.2 (226)	21 (53)	21.9 (32)
Yield (L/s)	(118)	3.25 (4)	1 (7)	0.4 (15)	0.3 (29)	0.5 (43)	0.1 (11)	1 (9)
SWL (m)	(544)	4.7 (32)	5.2 (34)	8.2 (94)	18.3 (111)	17.9 (198)	7.5 (47)	4.2 (28)
Water cut (m)	(102)	31 (5)	22 (7)	25.9 (15)	31.8 (24)	24 (35)	17.8 (8)	23.7 (8)
Observation year		1956	1957	1956	1956	1956	1956	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**
%	(626)	41.1 (257)	13.4 (84)	10.5 (66)	14.1 (88)	12.5 (78)	8 (50)	0.5 (3)
Max well depth (m)	(624)	4.1 (256)	10.7 (84)	21.3 (66)	30.5 (87)	44.2 (78)	87.3 (50)	115.8 (3)
Water cut (m)	(116)	4 (20)	15 (27)	23 (21)	29.5 (24)	39.8 (14)	81.7 (10)	0 (0)
Observation year		1978	1957	1994	1956	1956	1956	1956

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(140)	62.1 (87)	29.3 (41)	3.6 (5)	4.3 (6)	0.7 (1)
Max well depth (m)	(140)	26 (87)	24 (41)	30 (5)	42 (6)	39 (1)
Water cut (m)	(108)	24.5 (56)	18 (40)	24 (5)	25.5 (6)	12 (1)
Observation year		1982	1984	1995	1986	2007

4.3.7. 1:250 000 MAP SHEET - ADELAIDE



ADELAIDE encompasses contrasting terrain: high, undulating relief of the northern Mount Lofty Ranges occurs to the east and flat coastal plains to the west. Across ADELAIDE, few wells show low groundwater salinity (Table 25). Only 67 of 793 wells (8%) show salinity less than 1 500 mg/L. Most wells (490 wells, or 62%) show salinity in the range 1 500–5 000 mg/L. Half the wells (165 of 324 wells, or 51%) are low yielding (less than 1 L/s), although 91 wells (28%) show moderate yields of 1–3 L/s, while 28 wells (9%) yield greater than 10 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(793)	4 (32)	4.4 (35)	29.3 (232)	32.5 (258)	21.4 (170)	2.5 (20)	5.8 (46)
Max well depth (m)	(739)	9.8 (29)	30.5 (33)	33.5 (214)	19.6 (237)	23.8 (163)	42.1 (18)	82 (45)
Yield (L/s)	(294)	0.28 (5)	1.06 (16)	1.16 (125)	0.63 (78)	0.5 (43)	0.5 (10)	1.89 (17)
SWL (m)	(626)	6.1 (27)	13.1 (26)	15 (180)	9.8 (202)	9.6 (144)	9.1 (13)	6.5 (34)
Water cut (m)	(125)	21.1 (2)	36 (5)	33 (49)	17.8 (32)	29 (23)	42 (5)	32.9 (9)
Observation year		1977	1973	1980	1979	1977	1970	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
%	(725)	23.4 (170)	21.9 (159)	34.8 (252)	13 (94)	5.9 (43)	1 (7)	0 (0)
Max well depth (m)	(698)	6.3 (162)	15.6 (153)	27.2 (245)	37 (89)	57.9 (42)	85 (7)	0 (0)
Water cut (m)	(99)	8.5 (14)	16 (19)	30 (38)	40 (17)	49.4 (8)	75 (3)	0 (0)
Observation year		1977	1977	1980	1984	1979	1974	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(324)	50.9 (165)	28.1 (91)	7.7 (25)	4.6 (15)	8.6 (28)
Max well depth (m)	(322)	30.5 (164)	37 (91)	44.8 (25)	71 (15)	72 (27)
Water cut (m)	(136)	23.8 (63)	28 (45)	38 (16)	62 (3)	61.5 (9)
Observation year		1963	1984	1996	1984	1986

4.3.7.1. Wakefield (6529) 1:100 000 Map Sheet

Undifferentiated Quaternary aeolian and coastal marine sediments dominate *Wakefield*. Logs from 259 drillholes indicate these deposits have a mean thickness of 1.5 m. The Semaphore Sand Member is ubiquitous along the eastern coastline of Gulf St Vincent; logs from 40 drillholes show a mean thickness of 1 m. The Tertiary Carisbrook Sand and Clinton Formation and Quaternary Hindmarsh Clay are widespread across the map sheet showing mean thicknesses of 10 m (from 89 drillholes), 41 m (from 220 drillholes) and 17 m (from 223 drillholes), respectively. Tertiary deposits are also identified across the map sheet as sequences of the Port Willunga Formation overlying the Rogue Formation, which in turn, overlies the Clinton Formation. The Port Willunga, Rogue and Clinton Formations have mean thicknesses of 13 m (from 53 drillholes), 20 m (from 192 drillholes) and 41 m (from 220 drillholes), respectively. Toward the northern boundary of the map sheet, minor outcrops of the Neoproterozoic Wilpena Group (ABC Range Quartzite) and Emeroo Subgroup are evident.

Groundwater salinity is variable across the map sheet. In general, higher salinities are observed in near-coastal wells, while fresher groundwater occurs closer to the eastern boundary of the map sheet. Out of a total of 302 wells, 183 (61%) show salinities in the range 1 500–5 000 mg/L (Table 26). One near-coastal well located at the northern extent of Gulf St Vincent has a production zone at a depth of 95–158 m, suggesting it to be completed in the Kulpara Formation and ABC Range Quartzite; the salinity of this well is 30 573 mg/L. Toward the eastern boundary, two wells completed in the Clinton Formation (at 81–85 m below ground surface) and undifferentiated Neoproterozoic rocks (at 122–247 m below ground surface) show salinities of 2 472 mg/L and 3 213 mg/L, respectively. Most salinity observations were recorded around 1980.

Depth to groundwater is shallow near the coast and increases with increasing distance inland. A total of 206 of 300 wells (69%) show standing water levels in the range of 5 to 20 m. Typically, depth to water cut is greater than standing water level, indicating confined conditions and that groundwater is likely to be under pressure. Most water level data were recorded around the late-1980s.

Wells with observations of high yield appear to be randomly distributed across the map sheet. A total of 85 of 185 wells (46%) show yields of less than 1 L/s; however, 27 wells (15%) show yields greater than 10 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(302)	2 (6)	4.3 (13)	35.8 (108)	24.8 (75)	14.9 (45)	4 (12)	14.2 (43)
Max well depth (m)	(294)	27.6 (6)	48.7 (13)	36 (105)	24.6 (73)	25.8 (44)	54 (11)	82.9 (42)
Yield (L/s)	(173)	0.08 (1)	1.26 (9)	1.26 (79)	0.6 (44)	0.32 (18)	0.28 (6)	2.21 (16)
SWL (m)	(255)	9 (5)	18.3 (11)	17 (92)	12.5 (66)	13 (40)	7.4 (9)	5.9 (32)
Water cut (m)	(38)	0 (0)	37.8 (2)	56.3 (21)	27.5 (4)	25 (1)	48 (2)	33 (8)
Observation year		1979	1957	1983	1980	1980	1959	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
%	(300)	12.7 (38)	20.7 (62)	48 (144)	14.7 (44)	3.3 (10)	0.7 (2)	0 (0)
Max well depth (m)	(294)	26.5 (38)	19.1 (60)	30.2 (142)	33.2 (42)	48.2 (10)	74.8 (2)	0 (0)
Water cut (m)	(39)	21 (7)	24.8 (4)	40 (18)	40.8 (8)	51.2 (2)	0 (0)	0 (0)
Observation year		1990	1984	1985	1994	1980	1965	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(185)	45.9 (85)	24.3 (45)	8.6 (16)	6.5 (12)	14.6 (27)
Max well depth (m)	(184)	25.9 (85)	38.2 (45)	41.5 (16)	76.6 (12)	71.8 (26)
Water cut (m)	(43)	47.5 (8)	29.2 (16)	35.5 (8)	62 (3)	62.3 (8)
Observation year		1949	1985	1993	1989	1986

4.3.7.2. Kapunda (6629) and Eudunda (6729) 1:100 000 Map Sheets

Kapunda and *Eudunda* cover the northern extent of the Mount Lofty Ranges and the southern part of the Clare Valley PWRA. Neoproterozoic basement outcrop predominates in the south-eastern margin of the study area and comprises mainly the Burra Group with minor occurrences of the Emeroo Subgroup and Umberatana Group. The Burra Group is widespread across *Kapunda* and has been encountered in 16 drillholes, with a maximum depth to basement of 13.7 m below ground surface (mean ≈ 4 m). The Emeroo Subgroup is common toward the western boundary of the map sheet; logs from 37 drillholes show a mean depth to basement of 13.2 m below ground surface, but can be found up to 25 m depth. Although the Umberatana Group is featured on surficial geological mapping, supporting geological log data are not available.

A thin veneer of Quaternary sediments is evident from logs of 136 drillholes, showing a mean thickness of 4 m. Toward the west of *Kapunda*, the Pooraka Formation has been logged in four drillholes, showing a mean thickness of 14 m. The Hindmarsh Clay is common in this area, with a mean thickness of 7 m. Undifferentiated Tertiary sediments are described mostly as fine sands grading to clayey sands, with a mean thickness of 11 m (from 63 drillholes).

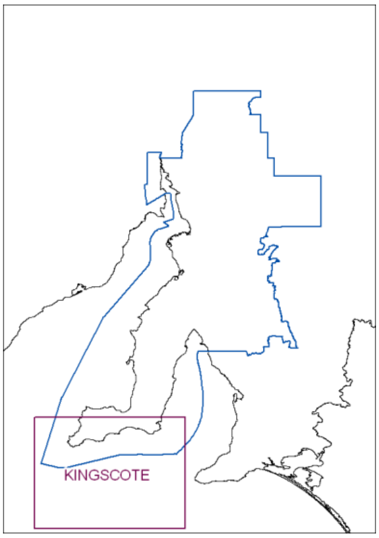
Across *Kapunda* and *Eudunda*, groundwater salinities are variable, ranging between 95 and 71 400 mg/L, although 317 of the 490 wells (65%) show salinities in the range of 1 500–5 000 mg/L (Table 27). Within basin infill sediments, the depth to groundwater is generally less than 10 m (233 of 424 wells, or 55%), but has been recorded up to 70 m for wells at higher relief. In places, depth to water cut is greater than standing water level, possibly indicating groundwater under pressure. The median period that salinity and water level data was recorded is the late-1970s. Typically, well yields are low, with 126 of 139 wells (91%) showing yields of less than 3 L/s. The median period that well yield data was recorded is the mid-1980s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(490)	5.3 (26)	4.5 (22)	25.3 (124)	37.3 (183)	25.3 (124)	1.6 (8)	0.6 (3)
Max well depth (m)	(444)	9.1 (23)	18.1 (20)	29 (109)	16 (164)	18.5 (118)	35.1 (7)	52.1 (3)
Yield (L/s)	(121)	0.62 (4)	1.01 (7)	1.05 (46)	0.75 (34)	0.75 (25)	0.73 (4)	0.25 (1)
SWL (m)	(370)	4.7 (22)	10.3 (15)	10.8 (88)	7.4 (136)	8 (103)	13.7 (4)	19.8 (2)
Water cut (m)	(87)	21.1 (2)	36 (3)	28 (28)	16.4 (28)	30.5 (22)	42 (3)	32.9 (1)
Observation year		1977	1977	1979	1977	1977	1978	1960
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**
%	(424)	33 (140)	21.9 (93)	25 (106)	11.3 (48)	7.5 (32)	1.2 (5)	0 (0)
Max well depth (m)	(403)	6.1 (132)	14.5 (89)	25.9 (101)	42.7 (45)	57.9 (31)	85 (5)	0 (0)
Water cut (m)	(60)	13.2 (12)	12.2 (13)	27.4 (17)	40 (10)	54 (5)	75 (3)	0 (0)
Observation year		1977	1977	1978	1981	1979	1989	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(139)	57.6 (80)	33.1 (46)	6.5 (9)	2.2 (3)	0.7 (1)
Max well depth (m)	(138)	40 (79)	33.8 (46)	63 (9)	15.2 (3)	77.4 (1)
Water cut (m)	(93)	21.3 (55)	28 (29)	39 (8)	0 (0)	8.2 (1)
Observation year		1983	1984	1999	1984	1959

4.3.8. 1:250 000 MAP SHEET – KINGSCOTE



KINGSCOTE encompasses the southern extent of Yorke Peninsula. Quaternary aeolian deposits of the Bridgewater Formation are common to the west. Groundwater is commonly found within the Bridgewater Formation, but significant storages of potable water (less than 1 000 mg/L) are limited to the Carribie and Para-Wurlie Basins (Fig. 4) (Zang 2006). Groundwater from Para-Wurlie Basin provides the town water supplies for Warooka and Point Turton. Salinity across the map sheet is relatively low, with 410 of 706 (58%) wells showing salinities less than 3 000 mg/L (Table 28). However, wells yields are poor, as 210 of 292 (72%) wells yield less than 1 L/s.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(706)	22.4 (158)	10.2 (72)	23.9 (169)	15 (106)	18.6 (131)	7.2 (51)	2.7 (19)
Max well depth (m)	(632)	15.9 (145)	5.1 (68)	7.6 (154)	4.6 (91)	5.6 (113)	10 (45)	12.5 (16)
Yield (L/s)	(264)	0.23 (76)	0.57 (20)	0.36 (72)	0.23 (27)	0.25 (36)	0.25 (22)	3 (11)
SWL (m)	(539)	8.2 (140)	3.2 (59)	4.1 (133)	2.8 (79)	3.4 (96)	3.4 (27)	8 (5)
Water cut (m)	(210)	12.8 (49)	13.9 (20)	10.2 (58)	6.7 (15)	6.3 (30)	8 (25)	8 (13)
Observation year		1978	1976	1978	1976	1958	1959	1958

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
%	(627)	52.6 (330)	18.8 (118)	24.2 (152)	3.2 (20)	0.8 (5)	0.3 (2)	0 (0)
Max well depth (m)	(603)	3.4 (322)	11.1 (112)	19.8 (143)	31.2 (19)	60 (5)	61.5 (2)	0 (0)
Water cut (m)	(152)	3.4 (56)	10 (35)	19.9 (50)	25 (4)	53 (5)	36.1 (2)	0 (0)
Observation year		1978	1978	1978	1977	1985	1970	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(292)	71.9 (210)	17.5 (51)	5.1 (15)	3.8 (11)	1.7 (5)
Max well depth (m)	(291)	13.4 (209)	16.8 (51)	17.1 (15)	26.2 (11)	24 (5)
Water cut (m)	(196)	12 (123)	10 (43)	8 (14)	12.8 (11)	14 (5)
Observation year		1978	1978	1981	1983	2001

4.3.8.1. Althorpe (6227) and Coonarie (6327) 1:100 000 Map Sheets

The Quaternary Bridgewater Formation dominates the mapped surface geology of *Coonarie* and *Althorpe*. The Carribie and Para-Wurlie Basins are covered by these two map sheets. The coastline comprises mainly Semaphore Sand with intrusions of Palaeoproterozoic quartz gabbronorite (identified as Donington Suite). Minor occurrences of St Kilda Formation and undifferentiated lacustrine sediments have been mapped at the southern tip of Yorke Peninsula and also near the eastern boundary of *Coonarie*. Undifferentiated fluvial and alluvial glaciogenic sediments and undifferentiated Pleistocene sediments have been identified toward the north-eastern boundary of *Coonarie*.

Across these map sheets, the thickness of the Quaternary sediment is uncertain. Geological logs from five drillholes located within Para-Wurlie Basin show that undifferentiated Tertiary–Pleistocene rocks have thickness ranging between 16 and 39 m (mean ≈ 23 m) and depth to Palaeoproterozoic basement (Donington Suite) ranges between 31 and 48 m below ground surface (mean ≈ 38 m). A further five drillholes located to the east of Para-Wurlie Basin indicate that undifferentiated Tertiary–Pleistocene rock thicknesses range up to 80 m (mean ≈ 24.0 m) and depth to basement ranges between 18 and 83 m below ground surface (mean ≈ 38 m).

Groundwater showing very low salinity (less than 1 000 mg/L) is evident within the Carribie and Para-Wurlie Basins and also in the region between these two basins. Near-coastal wells show far greater variability in salinity. However, across the two map sheets, 151 of 503 wells (30%) show salinities less than 1 000 mg/L and a further 185 wells (37 %) show salinities in the range 1 000–3 000 mg/L (Table 29). Most salinity records were collected around the late-1970s.

The depth to groundwater is shallow, with more than half the wells for which there are water level records (233 of 440 wells (53%)) show standing water level of less than 5 m. In general, the depth to water cut is similar to standing water level, suggesting unconfined conditions. However, Magarey and Deane (2005) cite the Para-Wurlie and Carribie Basins to comprise unconfined to semi-confined aquifers.

Typically, well yields are low – 190 of 258 wells (74%) show well yield of less than 1 L/s. However, higher yielding wells appear to be more common within the Carribie and Para-Wurlie Basins and in the region between the Carribie Basin and the southern coastline.

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

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(503)	30 (151)	11.1 (56)	25.6 (129)	11.1 (56)	12.7 (64)	7.6 (38)	1.8 (9)
Max well depth (m)	(474)	15.9 (143)	10.6 (53)	9.1 (123)	5 (53)	3.7 (60)	11.5 (34)	10.7 (8)
Yield (L/s)	(232)	0.23 (76)	0.57 (20)	0.38 (67)	0.23 (21)	0.23 (27)	0.19 (17)	0.15 (4)
SWL (m)	(397)	8.4 (138)	3.7 (44)	4.1 (104)	2.3 (44)	2.4 (47)	3.1 (18)	7.3 (2)
Water cut (m)	(193)	12.8 (49)	13.9 (20)	10.4 (57)	6.7 (15)	3.7 (25)	7 (21)	7.9 (6)
Observation year		1978	1976	1979	1979	1977	1959	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
%	(439)	53.1 (233)	19.6 (86)	22.8 (100)	3.6 (16)	0.5 (2)	0.5 (2)	0 (0)
Max well depth (m)	(419)	3.3 (228)	13.4 (81)	22 (91)	39 (15)	58.2 (2)	61.5 (2)	0 (0)
Water cut (m)	(139)	3.4 (54)	11.6 (35)	19.7 (42)	44.5 (4)	55 (2)	36.1 (2)	0 (0)
Observation year		1978	1978	1978	1979	2003	1970	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(258)	73.6 (190)	17.4 (45)	3.9 (10)	3.1 (8)	1.9 (5)
Max well depth (m)	(257)	15.2 (189)	17.1 (45)	18.4 (10)	35.8 (8)	24 (5)
Water cut (m)	(177)	12.8 (115)	9.1 (39)	4.1 (10)	32.5 (8)	14 (5)
Observation year		1978	1978	1964	1982	2001

4.3.8.2. Edithburgh (6427) 1:100 000 Map Sheet

Undifferentiated Pleistocene–Holocene alluvial and fluvial sediments are widespread across *Edithburgh*. Undifferentiated lacustrine and playa sediments are common toward the centre of the map sheet and glaciogenic sediments outcrop extends from the centre to the northern boundary of the map sheet. An absence of geological logs prevent any further characterisation of *Edithburgh* stratigraphy.

Across the map sheet, groundwater salinity is moderately high, with 157 of 203 wells (77%) showing salinities ranging between 1 500 and 10 000 mg/L (Table 30). Most of the lower-salinity wells appear to be clustered around a topographic high located toward the centre of the map sheet, while wells showing higher salinity appear to be located closer to the coast. Most salinity data have been collected around the mid-1950s.

Standing water levels are mostly shallow—138 of 188 wells (73%) show depths to groundwater of less than 10 m. Deeper standing water levels appear restricted to a zone 7 km in width, just inland of the eastern coastline. Typically, the depth to water cut approximates standing water level, suggesting that unconfined conditions prevail here. Water level data were collected mainly around the 1950s.

Across *Edithburgh*, well yields are variable. Inland wells appear to be low yielding, whereas some near-coastal wells show higher yields. However, 26 of 34 wells (76%) show well yields less than 3 L/s.

Table 30. Summary of salinity, standing water level and yield data and associated median values (with number of data points in brackets) for Edithburgh

Associated median well data	Total number of wells	Salinity (mg/L)						
		<1 000	1 000–1 499	1 500–2 999	3 000–4 999	5 000–9 999	10 000–19 999	≥20 000
%	(203)	3.4 (7)	7.9 (16)	19.7 (40)	24.6 (50)	33 (67)	6.4 (13)	4.9 (10)
Max well depth (m)	(158)	2.5 (2)	3.6 (15)	4.6 (31)	4.4 (38)	9.4 (53)	6.1 (11)	17 (8)
Yield (L/s)	(32)	0 (0)	0 (0)	0.25 (5)	0.21 (6)	0.63 (9)	0.63 (5)	4 (7)
SWL (m)	(142)	1.3 (2)	2.7 (15)	3.1 (29)	3.1 (35)	7.9 (49)	3.4 (9)	8 (3)
Water cut (m)	(17)	0 (0)	0 (0)	10 (1)	0 (0)	9.1 (5)	8.5 (4)	8 (7)
Observation year		1945	1955	1955	1955	1955	1956	1996
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**
%	(188)	51.6 (97)	21.8 (41)	23.9 (45)	2.7 (5)	0 (0)	0 (0)	0 (0)
Max well depth (m)	(184)	3.4 (94)	9.4 (40)	13.9 (45)	27.4 (5)	0 (0)	0 (0)	0 (0)
Water cut (m)	(13)	3.8 (2)	9.1 (7)	25 (3)	24 (1)	0 (0)	0 (0)	0 (0)
Observation year		1958	1995	1977	1956	0	0	0

Associated median well data	Total number of wells	Yield (L/s)				
		<1	1–2.99	3–4.99	5–9.99	≥10
%	(34)	58.8 (20)	17.6 (6)	14.7 (5)	8.8 (3)	0 (0)
Max well depth (m)	(34)	10.1 (20)	14.8 (6)	10 (5)	18 (3)	0 (0)
Water cut (m)	(19)	8.5 (8)	15.3 (4)	9 (4)	7.5 (3)	0 (0)
Observation year		1979	1997	1986	1996	0

5. GROUNDWATER RESOURCES

Groundwater resources of the NYNRM Region are found in Quaternary and Tertiary sediments and within fractured rock aquifers of mainly Proterozoic age, but also of Cambrian–Permian age. The density of groundwater data is greatest toward the southern ‘foot’ of Yorke Peninsula and throughout the fractured rock aquifers of northern Mount Lofty Ranges and southern Flinders Ranges. This corresponds to areas of higher demand for groundwater. Elsewhere, there is a paucity of groundwater data although high-salinity groundwater has typically been reported in these areas.

Where groundwater data does exist, water level and water quality data relating to specific aquifers are often uncertain due to a lack of production zone information.

Occurrences of groundwater salinity less than 3 000 mg/L are mostly found within PWRAs. Outside the PWRAs, groundwater resources in the Booborowie Valley and the Willochra, Walloway, Para-Wurlie and Carribie Basins have low salinities. Salinities are variable within fractured rock aquifers of the northern Mount Lofty Ranges and southern Flinders Ranges.

Regional standing water levels indicate that groundwater can be intersected at shallow depth throughout much of the low-lying areas, however the depth to groundwater within fractured rock aquifers of the northern Mount Lofty Ranges and southern Flinders Ranges is variable. In areas where good quality groundwater is encountered at shallow depth, the drilling to and subsequent investigation of deeper aquifers has largely been unnecessary. Consequently, in these areas limited information exists with respect to groundwater residing at greater depths.

Wells throughout the study region show yields that are predominately less than 1 L/s, which is not likely to accommodate the needs of high-volume groundwater users. However, considerable uncertainty surrounds the estimates of well yields and improved well construction and further aquifer testing would assist in increasing the accuracy of these estimates.

5.1. QUATERNARY

The main aquifers that have been developed in the southern Pirie-Torrens Basin comprise Quaternary sediments (Telford Gravel). Quaternary aquifers also occur within outwash alluvium associated with old drainage lines, resulting in their limited areal extent and variable groundwater quality. These systems are typically unconfined, but semi-confined conditions are known to exist. In general, low salinity groundwater (less than 3 000 mg/L) is restricted to a narrow zone at the foot of the Flinders Ranges and minor occurrences near drainage lines.

Undifferentiated Quaternary alluvial and fluvial sediments are common across Yorke Peninsula. Alluvial aquifers show groundwater of generally high salinity and poor water quality. Aeolian sediments of the Bridgewater Formation are the most commonly developed aquifers on Yorke Peninsula. Their distribution is mainly across western parts of southern Yorke Peninsula. Groundwater salinity within aeolian sediments is highly variable, with the exception of Carribie and Para-Wurlie Basins which show salinities mostly less than 1 000 mg/L (Martin, Sereda & Clarke 1998).

There is potential for further groundwater development from Quaternary sequences (not limited to the Bridgewater Formation); however, the discovery of significant volumes of potable quality are unlikely. Existing groundwater data may suggest low salinity at a number of discrete locations, but the areal extent of these resources would need to be validated using recent groundwater observations. Should high-salinity groundwater be deemed fit for a given purpose, then opportunities for groundwater development of the Bridgewater Formation or other Quaternary sequences may be possible.

5.2. TERTIARY

Across the southern Pirie-Torrens Basin, fine grained Tertiary sands commonly overlie Palaeoproterozoic–Neoproterozoic basement. Between Port Augusta and northern Yorke Peninsula, the early Tertiary Kanaka Beds represent the greatest opportunity for further groundwater development (Martin, Sereda & Clarke 1998). Furthermore, evidence suggests low-salinity groundwater may be found in Tertiary aquifers adjacent to faults along the foot of the Flinders Ranges, resulting from preferential flow along fault zones.

Tertiary sandstones, limestones and marls of the St Vincent Basin are common across the east coast of Yorke Peninsula. Sedimentary strata reach a maximum thickness of around 40 m (Shepherd 1978) and are underlain by Permian sands, Cambrian or Adelaidean rocks. Groundwater salinities are relatively high in Tertiary sediments and these resources are used mostly for stock watering. A deeper palaeovalley (Melton Palaeovalley) is located southeast of Wallaroo; however, little is known about groundwater resources here.

5.3. BASEMENT

Fractured rock (basement) aquifers are utilised mainly in areas of outcropping and shallow basement. Across the NYNRM Region, wells completed in fractured rock aquifers are located in the northern Mount Lofty Ranges and southern Flinders Ranges.

Where groundwater resources that are suitable for development have been encountered in shallow sedimentary sequences, little information is available for groundwater residing in fractured rock aquifers at greater depth. 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 for sedimentary aquifers. This is particularly true for the NYNRM Region 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 the region’s fractured rock aquifers.

Low-salinity groundwater (less than 1 000 mg/L) is common within the ABC Range Quartzite occurring south of Crystal Brook (Martin, Sereda & Clarke 1998). Although groundwater less than 3 000 mg/L is common across the Adelaide Geosyncline, the heterogeneous nature of fractured rock aquifers results in an unpredictable spatial distribution of salinity, with many wells showing salinities greater than 7 000 mg/L. Similarly, yields from well completed within Adelaide Geosyncline fractured rock aquifers are extremely variable. Typically, well yield is less than around 2 L/s, but some wells may show yields up to 20 L/s (Shepherd 1978).

Across Yorke Peninsula, fractured rock aquifers typically show groundwater of variable salinity and low well yields. Evidence suggests that around northern Yorke Peninsula, the ABC Range Quartzite hosts groundwater with salinity in the range of 500 to 1 500 mg/L, although yields are only around 0.5 to 2 L/s (Martin, Sereda & Clarke 1998). Groundwater in other fractured rock aquifers is generally non-potable due to high salinity (Zang 2006).

Table 31. Summary of main geological units and their hydrogeological significance (Shepherd 1978; Alley & Lindsay 1995; Callen *et al.* 1995; Martin, Sereda & Clarke 1998)

Age			Unit	Lithology	Occurrence and Hydrogeology
Quaternary	Holocene		Molineux Sand	Pale yellow; forms south-easterly trending dune systems	Not a recognised hydrostratigraphic unit; occurs mainly around Balaklava (around 25 km east of Port Wakefield)
Quaternary	Holocene		Undifferentiated aeolian sand	Fine grained, white/beige; may be an equivalent to Molineux Sand	Not a recognised hydrostratigraphic unit; widespread across Yorke Peninsula;
Quaternary	Holocene		Saint Kilda Formation	Shallow marine deposits; includes shell beds, sands and clays	Unconfined aquifer; salinity generally at or greater than sea water; occurs commonly between Minlaton and Edithburgh, Yorke Peninsula
Quaternary	Pleistocene	Late	Glanville Formation	Soft, white to cream-fawn richly fossiliferous shelly sand and clay and calcreted shell beds.	In general, groundwater is highly saline; occurs around Warooka and Fishermans Bay (Yorke Peninsula) and near Port Wakefield
Quaternary	Pleistocene	Late	Pooraka Formation	Alluvial, red-brown clayey sand and gravel, capped in general by soft powdery carbonate and/or calcrete; laterally discontinuous	Not generally recognised as a hydrostratigraphic unit; however, unit may contain groundwater adjacent to watercourse drainage channels; occurs mainly along eastern margin of Pirie Basin
Quaternary	Pleistocene	Middle	Bridgewater Formation	Calcareous sands; broken, rounded shell fragments and limestone; calcrete capping is common	Unconfined aquifer; occurs predominantly along the west coast of lower Yorke Peninsula, viz. between Corny Point and Cape Spencer; also unconfined aquifers of Carribie and Para-Wurlie Basins
Quaternary	Pleistocene	Middle	Telford Gravel	Alluvial fan and piedmont slope unit; coarse grained sand and gravel with boulders; laterally discontinuous	Semi-confined aquifer; occurs across most of Pirie Basin; the most heavily exploited hydrostratigraphic unit of the region
Quaternary	Pleistocene	Early	Hindmarsh Clay	Consolidated, mottled clay and sandy clay with gravel lenses and sand; rests on Pliocene sediments in places	Confining layer to Tertiary aquifers; occurs between Port Augusta and Port Pirie; in places, gravel lenses may provide small amounts of water suitable for stock purposes
Quaternary	Pleistocene	Early	Carisbrooke Sand	Fluviatile, alluvial, yellow, fine sands, silts and clays; thin gravel beds occur in outwash areas	Confined aquifer; low yields are common; occurs widely across St Vincent Basin, but not within 4–5 km of the coastline
Tertiary	Pliocene		Gibbon Beds	Mottled clayey sand, sandy clay and conglomerate	Unconfined and semi-confined aquifer; can be confining layer to Tertiary aquifer; salinity around 3 000–15 000 mg/L; well yield 0.5–2 L/s; occurs mainly along western margin of Pirie Basin
Tertiary	Pliocene		Hallett Cove Sandstone	Dense, sandy limestones and calcareous sandstones of marine deposition; fossils are common	Not recognised as a hydrostratigraphic unit across the study area, although extensively developed for irrigation around the Northern Adelaide Plains; occurs south of Wool Bay, Yorke Peninsula (between Stansbury and Edithburgh)

Age			Unit	Lithology	Occurrence and Hydrogeology
Tertiary	Miocene	Middle	Melton Limestone	Succession of five transgressive intervals: Upper intervals are fine-grained, quartzosed calcarenetic limestone; middle intervals often comprise quartzose, bryzoal, coarse calcarenite and calcirudite; lower intervals consist of gravelly quartzose, bryzoal, calcarenite, calcirudite and calcareous sandstone	Confined aquifer; crystalline in nature (low effective porosity); salinity around 1 000–15 000 mg/; well yield 0.5–2 L/s; occurs over eastern- and western-margins of Pirie Basin
			Port Willunga Formation	Soft bryzoal limestones and sandy limestones	Unconfined aquifer; water is generally suitable for stock purposes (2 000–7 000 mg/L; well yield 2 L/s; occurs around Stansbury to Edithburgh and in (east coast) cliffs south of Port Julia, Yoke Peninsula; also occurs as a confined aquifer south of Two Wells, St Vincent Basin
		Early	Munno Para Clay	Blue-grey, sandy, shelly clays	Confining layer; absent in some coastal areas and absent north of around Two Wells
	Oligocene	Early	Kanaka Beds	Succession of carbonaceous siltstone, shale and sand; some lignite present	Confined aquifer; generally high salinity (>15 000 mg/L); well yield ~0.6 L/s; occurs eastern Pirie Basin from around Port Augusta to northern York Peninsula
	Eocene	Late	Blanche Point Formation	Shelly clays showing discontinuous bands of dense, fine grained, fossiliferous sandstone	Confining bed. Occurs between Pine Point and Price, east coast of Yorke Peninsula
		Middle	Muloowurtie Clay	Ochreous sandy clays with lenses of fossiliferous sands	Confining bed (clays); hydrostratigraphic unit (sands) are likely to contain saline groundwater and have been recorded up to 120 m thickness near Price, north-eastern coast of Yorke Peninsula
Phanerozoic	Palaeozoic	Permian	Permian clay	Boulder till and fluvio-glacial sand	Confining bed; sediments commonly infill depressions of Precambrian basement; some sandy variants may have small storages of saline groundwater; commonly found beneath salt lakes and beneath Quaternary and Tertiary sediments; occurs mostly around Yorketown, Yorke Peninsula
			Cape Jervis Formation	Tills, sandstones and fossiliferous shales; both marine and non-marine deposition	Confined aquifer; common between Minlaton and Edithburgh, southern Yorke Peninsula

Age			Unit	Lithology	Occurrence and Hydrogeology
Phanerozoic	Palaeozoic	Cambrian - middle	Ramsay Limestone	Blue-grey crystalline nodular limestone	May contain small storages of groundwater, water quality unknown; known to occur across central and northern Yorke Peninsula
			Un-named unit	Undifferentiated clastics, evaporites and shales	Unconfined aquifer; salinity 2 000–3 000 mg/L; well yield 1–3 L/s; occurs in the Minlaton–Curramulka area, central Yorke Peninsula
		Cambrian - early	Parara Limestone	Blue-grey crystalline nodular limestone	Unconfined aquifer; salinity 2 000–3 000 mg/L; well yield 1–3 L/s; occurs in the Minlaton-Curramulka area, central Yorke Peninsula
			Kulpara Formation	Blue-grey limestone with Archeocyatha	
Proterozoic	Neoproterozoic		Adelaidean (Hiltaba Suite; Tapley Hill Formation; Umberatana, Wilpena, Callanna & Burra Groups)	Sequence of quartzites, sandstones, limestones, siltstones and shales	(1) Basement of Pirie Basin; salinity and yield is variable (typical of fractured rock aquifers); groundwater from wells at the foothills of the Flinders Ranges is suitable for stock purposes (2) Basement of Yorke Peninsula; not a recognised hydrostratigraphic unit in this region (3) Basement of St Vincent Basin; likely to contain only saline water
	Palaeoproterozoic		Mostly un-named, but includes: Lower Gawler Ranges Volcanics; Wallaroo Group; and Donington Suite	Sequence of gneisses, schists, granite and pegmatite	Basement of Yorke Peninsula; not a recognised hydrostratigraphic unit in this region

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 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 NYNRM Region (Table 32), 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 over-estimate 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 and Tertiary sequences, can be calculated for a defined region (e.g. 1:100K map sheet), or geological provinces (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 at which water-bearing fractures extend.

Table 32. Summary of total groundwater resources and estimated use (after Martin, Sereda & Clarke 1998)

Groundwater province	Total groundwater resource* (GL)	Estimated groundwater use (GL/y)	Comments and additional information
Pirie-Torrens Basin			Considers Tertiary and Quaternary sequences only. Estimates of storages within the underlying Proterozoic material are not considered. Potential aquifer sequences include the Tertiary Kanaka Beds, Melton Limestone, Gibbon Beds, Neuroolda Formation, Cotabena Formation and Quaternary Hindmarsh Clay, Telford Gravel, Pooraka Formation.
Fresh (0–1 500 mg/L)	3.4	1.4	
Brackish (1 500–7 000 mg/L)	9.5	0.3	
Saline (>7 000 mg/L)	45.3	-	
Walloway/Willochra Basin			Willochra - Formations include the basal Tertiary Langwarren Formation and unnamed Tertiary and Quaternary aquifers. The latest status report for the Willochra Basin(see *Groundwater Status Report,* available online: http://www.waterconnect.sa.gov.au/GSR). estimates groundwater use to be 410 ML/y. Walloway – Artesian and non-artesian groundwater is available from various undifferentiated Quaternary and Tertiary aquifers within the basin. The hydrogeology of these basins has not been well assessed. Magarey and Deane (2004) estimated use of 160 ML/y to be primarily for stock and domestic purposes.
Fresh (0–1 500 mg/L)	2.7	4.3	
Brackish (1 500–7 000 mg/L)	2.0		
Saline (>7 000 mg/L)	1.8		
Adelaide Geosyncline			Aquifers consist of Adelaidean metasediments, Cambrian limestones and dolomites. Due to the variable nature of fractured rock aquifers, resource volumes may be grossly overestimated. Prescribed water resource within this province is the Clare Valley PWRA.
Fresh (0–1 500 mg/L)	200.0	20.0	
Brackish (1 500–7 000 mg/L)	462.5		
Saline (>7 000 mg/L)	650.0		
Yorke Peninsula			It is unclear whether estimates include both groundwater resources that occur within both sedimentary sequences and Archean/Proterozoic basement. The most significant aquifer for potable supplies is the Quaternary Bridgewater Formation but higher salinity groundwater is available from underlying fractured rock aquifers. Limited volumes of low-salinity resources have been found in the Carribie and Para-Wurlie lenses within the Bridgewater Formation. Magarey and Deane (2004) reported Warooka town water supply from the Para-Wurlie lens to be 200 ML/y; groundwater storages have not been assessed but sustainable yield estimates are presented.
Fresh (0–1 500 mg/L)	1.3	0.2	
Brackish (1 500–7 000 mg/L)	3.5		
Saline (>7 000 mg/L)	3.3		

* Based on a matrix porosity of 0.1

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.

5.5. POTENTIAL CLIMATE CHANGE IMPACTS

Regional climate change scenarios for the NYNRM Region have been developed, based on statewide climate modelling conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in 2003. A report on the impact of different emission scenarios for the NYNRM Region (NYNRMB 2009a) concluded:

- By 2030, annual temperature will likely increase between 0.4–1.2°C
- By 2070, annual temperature will likely increase between 1.0–3.8°C
- Annual rainfall will likely decrease by 0–9% by 2030 and by 1–30% by 2070
- If CO_2 emissions stabilise, reduced warming and smaller rainfall changes would likely result

Forecasts of impacts to the hydrology of the NYNRM Region due to climate change include a considerable 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. Climate modelling results suggest rainfall events will increase in intensity but decrease in frequency, which would likely result in increased pressure on water resources, necessitating increasing groundwater well depths and increasing dam storages. Changes in the dynamics of surface water-groundwater interaction have been predicted and risks due to a lack of capacity for adaptation need to be considered.

Using CSIRO's assessments of temperature, evaporation and rainfall projections under different CO_2 emission scenarios, SA Water conducted an analysis of potential changes in demand for water across the Yorke Peninsula region (SA Water 2010). The analysis considered population, tourism and climatic variables against demands between 1998–99 and 2007–08. Results show a forecast of increased demand for water of around 13% by 2030 and an increase of around 30% by 2070.

The Northern and Yorke Natural Resources Management Board (2010) acknowledge that risk management is the greatest challenge that the Board will face when addressing impacts of climate change. The broad strategies identified by the Board in mitigating the impacts of climate change are reducing greenhouse gas emissions, adaptation to a changing climate and innovations in markets, technologies, institutions and in the way people live.

DFW 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. Groundwater resources which are located within the NYNRM Region and have been assessed are the Clare Valley PWRA and Baroota PWRA (Green, Gibbs & Wood 2011) (available online: http://www.waterconnect.sa.gov.au). Non-prescribed groundwater resources which may be evaluated in future climate change impact modelling include: Balaklava unconfined aquifer, Booborowie Valley, Carribie Basin, Para-Wurlie Basin, Walloway Basin and Willochra Basin.

6. RECOMMENDED FURTHER INVESTIGATIONS

This initial investigation has collated groundwater information for the NYNRM 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 NYNRM 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 networks that are recognised in the State's observation well database (*Obswell*) and recommended:

- Some wells be removed from selected networks due to duplication
- Frequency of data collection is to remain unchanged for three years, followed by a review of the data to determine whether frequency can be reduced without compromising the quality of the data
- Some wells could have groundwater level telemetry systems installed
- A number of historical wells in the Booborowie Valley could be reactivated to increase the spatial density of this network.

Magarey and Deane (2004) in their risk assessment study of small groundwater basins of the NYNRM region reported that timely evaluation of monitoring data is paramount in instances where groundwater systems are poorly understood. With the exception of the Clare Valley and Baroota PWRAs, expeditious data evaluation was recommended for all of the small groundwater basins studied. Three areas – the Para-Wurlie Basin, Marion Bay and Rocky River – have been identified as requiring further work to mitigate the risk of resource degradation. A detailed analysis of the Para-Wurlie Basin monitoring data was recommended to better define the level of risk.

There may be private groups across the region that 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. Known custodians of privately monitored groundwater networks and data should also be approached to share groundwater data for inclusion into the State database.

Outside of the established monitoring networks, 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 manage potable resources. However, the emergence of non-potable groundwater use highlights the importance of understanding and monitoring these resources so that they can be 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 resources. 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 6.8.1). Furthermore, refining the hydrogeological significance of various geological units could be achieved via interpretation of stratigraphic logs from existing lithological logs. However, large areas can be devoid of drillhole information (e.g. central Yorke Peninsula) and drilling programs would best define the likely areal extent of groundwater resources. 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.

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 NYNRM 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. FRACTURED ROCK AQUIFERS

Fractured rock (basement) aquifers are utilised in a number of areas across the NYNRM Region. 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 are available for fractured rock aquifers, which is often due the existence of shallower available resources that limits the need to drill deeper water wells.

An investigation targeting fractured rock 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.

6.6.1. BASEMENT INTERPRETATION

A regional definition of depth to basement is a valuable product in the estimation of sedimentary sequence thicknesses and groundwater storage volumes. A basement map based on geophysical data including shallow seismic, regional gravity and magnetic data is recommended for the development of 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.

6.7. 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 Murray-Darling Basin modelling projects (e.g. Crosbie *et al.* 2008) should be investigated. Estimating rates of rainfall recharge within fractured rock environments (e.g. the Adelaide Geosyncline) 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 NYNRM Region, in addition to facilitating the evaluation of climate change impacts on recharge into the future. Ideally, climate change modelling conducted in future studies would encompass groundwater systems of the Booborowie Valley, Carribie Basin, Para-Wurlie Basin, Walloway Basin, Willochra Basin and unconfined aquifers around Balaklava.

6.8. 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.

6.8.1. 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.

6.8.1.1. 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 are 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.

6.8.2. 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) map 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 subsequent iterations of data map production.

7. CONCLUSION

Surface water and groundwater resources are essential in maintaining the social fabric and economic viability of the NYNRM Region. Many townships and homesteads rely heavily on groundwater for stock and domestic water supplies. In response, it has become necessary to improve the knowledge of groundwater resources to improve resource management. The assessments in this report have collated data on hydrogeological formations and groundwater resources to consolidate current knowledge, identify key knowledge gaps, explore the need for further investigations and improve the ability to advise on groundwater development opportunities.

Groundwater within the Adelaide Geosyncline area is sourced mainly from fractured rock aquifers. Commonly cited factors that influence the quality and quality of groundwater residing within fractured rock aquifers include: (1) the extent of joints and fractures and the degree of their interconnectedness (2) lithology (3) the extent of weathering and (4) recharge (which is governed by the frequency and intensity of rainfall and runoff processes). Low-salinity groundwater (less than 1 000 mg/L) is common across the Clare Valley and Baroota Prescribed Water Resources Areas and from wells completed within the ABC Range Quartzite which occurs south of Crystal Brook. In arid areas, annual rainfall in most years may be near-nil, but may be in the order of around 800 mm/y or more during very occasional wet years. Due to this temporal variability, estimates of annual average recharge are somewhat unreliable relative to those areas which receive more consistent rainfall from year to year.

Undifferentiated Quaternary alluvial and fluvial sediments are common across Yorke Peninsula. Alluvial aquifers contain groundwater of generally high salinity. Aeolian sediments of the Bridgewater Formation are the most commonly developed aquifers on Yorke Peninsula. Their distribution is mainly across western parts of lower Yorke Peninsula. Groundwater salinities within these sediments are highly variable, with the exception of the Carribie and Para-Wurlie Basins which have salinities mostly less than 1 000 mg/L.

Between Port Augusta and northern Yorke Peninsula, the early Tertiary Kanaka Beds represent the greatest opportunity for further groundwater development. Furthermore, evidence suggests low-salinity groundwater may be found in Tertiary aquifers adjacent to faults along the foot of the Flinders Ranges, resulting from preferential flow along fault zones.

At the regional scale, the NYNRM Board predict drivers of increasing demand for groundwater will be population growth, livestock numbers, mining activity and tourism. Changes in the supply of groundwater are likely to be influenced by climate change. Based on modelling conducted by CSIRO, impacts of climate change are likely to include increasing temperature (leading to increasing rates of evaporation) and decreasing rates of rainfall.

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.

APPENDIX

A. *NORTHERN AND YORKE GEOLOGICAL FORMATIONS*

This section aims to provide a more detailed description of the most commonly occurring geological formation across the study area. However, the following descriptions of stratigraphic units are not exhaustive. Geological summaries presented here are based on Lindsay and Shepherd (1966), Binks (1970), Shepherd (1978), Drexel, Preiss and Parker (1983), Drexel and Preiss (1995) and Geoscience Australia (2010); the reader is referred to these references for a more detailed discussion on geological formations.

BASEMENT

For the purpose of the discussion presented here, weathered basement and crystalline basement have not been differentiated. Groundwater can occur within weathered crystalline basement and within fractured rock aquifers. Within fractured rock aquifers, salinities are often high and yields are typically low. However, salinity and yield can be variable – the quality and quantity between wells in the same aquifer and sometimes only hundreds of metres apart can differ substantially.

Moonta Porphyry (Lxm)

Palaeoproterozoic rocks that host rich copper-gold ore bodies which, between around 1860–1923, were mined around the Yorke Peninsula townships of Moonta and Kadina. This unit occurs exclusively on northern Yorke Peninsula. It is massive, fine grained to porphyritic rhyolite, rhyodacite to dacite. The formation is more gneissic where metamorphism and deformation has been more intense (e.g. Wardang Island).

Adelaidean

The Adelaidean is a (local) South Australian chronostratigraphic scale which refers to the period during which Proterozoic sedimentation occurred in the Adelaide Geosyncline. Subdivisions of the Adelaidean – viz. Willouran, Torrensian, Sturtian and Marinoan – are based on type sections of strata. The Flinders Ranges and Mount Lofty Ranges host a record of Adelaidean sedimentation which is internationally recognised for its high level of completeness. Formations of Adelaidean-age comprise sequences of quartzites, sandstones, limestones, siltstones and shales. Examples of supergroups include River Wakefield, Burra, Belair, Umberatana and Wilpena Groups.

Adelaidean rocks comprise the basement of three main basins within the study area: (1) Pirie Basin—fractured rock aquifers where salinity and well yields are variable, although groundwater occurring at the foothills of the Flinders Ranges is often suitable for stock purposes (2) Yorke Peninsula—in general, formations in this region are rarely water bearing and (3) St Vincent Basin—fractured rock aquifers which commonly contain only saline groundwater.

TERTIARY

Tertiary sediments across Yorke Peninsula bear groundwater of relatively high salinity which is suitable only for stock. Across most of the southern Pirie-Torrens Basin, Tertiary sands overlie basement rocks. Yields are highly variable, although typically yield falls within the range 0.5–2 L/s (Martin, Sereda &

Clarke 1998). Tertiary sediments are thickest at the base of the Flinders Ranges, coincident with a mountain-front recharge zone. In this area, salinity ranges between 1 500–3 000 mg/L.

Kulpara Formation (Eok)

Marine shelf to basinal carbonates with Archeocyatha. Dolomite massive to thick-bedded and can be locally stromatolitic. Blue-grey limestone is generally thick bedded, locally oolitic with intraclasts and is commonly found to be fossiliferous. Occurs within Stansbury Basin, Yorke Peninsula.

Parara Limestone (Eop)

Blue-grey nodular limestone; can be interbedded dark grey to black. Minor mottled argillaceous limestone and thin calcareous shale. Occurs within Stansbury Basin, Yorke Peninsula, overlying the Kulpara Formation. South of the central Yorke Peninsula hinge line, the Parara Limestone has been recorded up to 270 m thickness (Drexel and Preiss 1995), consisting of stylonodular and massive glauconitic skeletal limestone.

Un-named Formation

Undifferentiated clastics, evaporites and shales are common in the Minlaton–Curramulka area, central Yorke Peninsula. This un-named formation is an unconfined aquifer; groundwater is generally of reasonable quality (around 2 000–3 000 mg/L) and moderate well yields (around 1–3 L/s) have been reported.

Ramsay Limestone (Eor)

Blue-grey crystalline, flaggy to nodular, thin to medium-bedded limestone with basal sandy oolitic clastics and bioclastic limestone. The formation is known to occur across the Stansbury Basin , Yorke Peninsula, outcropping around western Stansbury Basin. This aquifer may contain small storages of groundwater; however, due to paucity of data, water quality is uncertain. Ramsay Limestone overlies Parara Limestone.

Cape Jervis Formation (CP-j)

Uppermost part comprises glacio-marine siltstone with foraminifers. Poorly sorted, unconsolidated yellow-green siltstone, sandstone, sandy limestone, tills, fossiliferous shales and grit with rounded pebbles and boulders. Large granite erratics and a high concentration of coarser clasts are a feature of this formation. Pollen and spores are abundant. Mostly a confined aquifer that occurs commonly between the southern Yorke Peninsula townships of Minlaton and Edithburgh, this formation also forms the base of coastal cliffs and the floor of salt lakes. The Cape Jervis Formation is around 50 m thickness at outcrop, but has been recorded up to 236 m thickness near Stansbury.

Permian clay

A confining bed that occurs mainly around Yorketown, Yorke Peninsula. It is commonly found beneath salt lakes and beneath Quaternary and Tertiary sediments. This formation comprises boulder till and fluvio-glacial sand – these sediments commonly infill depressions found within Precambrian basement. Some of the more-sandy variants of the Permian clay may have small storages of saline groundwater.

Muloowurtie Clay

Muloowurtie Clay has been described only briefly within geological literature. This formation comprises ochreous sandy clays with lenses of fossiliferous sands. This unit has been recorded up to 120 m thickness near Price, north-eastern coast of Yorke Peninsula. Sandy clays exhibit hydraulic properties of a confining bed, while sandy lenses are likely to contain saline groundwater.

Blanche-Point Formation (Teb)

A confining bed comprising shelly clays, showing discontinuous bands of dense, fine grained, fossiliferous sandstone with distinctive silicified horizons. The lowest succession of the formation comprises very glauconitic, green and grey and fossiliferous calcareous mudstone with occasional thin limestone lenses. The Blanche Point Formation occurs along the east coast of Yorke Peninsula, between Pine Point and Price.

Kanaka Beds (Teoa)

The Kanaka Beds are generally described as a confined aquifer, often showing high salinity (>15 000 mg/L) and poor well yields (around 0.6 L/s). However, Martin, Sereda and Clarke (1998) cite this formation as containing the most prospective confined aquifers with regard to further development of groundwater. The Kanaka Beds exhibit as a succession of carbonaceous siltstone, shale and sand; some minor lignite is often present. The Kanaka Beds occur discontinuously from around Port Augusta to northern Yorke Peninsula (i.e. the eastern margin of Pirie Basin). This formation generally overlies highly weathered Adelaidean strata.

Munno Para Clay (Towm)

Confining layer mainly occurring south of the Gawler River. It is reportedly absent in some coastal areas and also absent north of around Two Wells. Lindsay and Shepherd (1966) describe the formation as comprising sticky, dark blue-grey clay with limestone bands. The clay is described as silty, sandy, calcareous, pyritic and carbonaceous.

Port Willunga Formation (Tow)

The Port Willunga Formation is an unconfined aquifer hosting water that is generally suitable for stock purposes (around 2 000–7 000 mg/L) with well yields of approximately 2 L/s. This formation comprises soft bryzoal marly limestones and sandy limestones up to around 30 m thickness. It is found between Stansbury to Edithburgh and also along the east coast of Yoke Peninsula in cliffs south of Port Julia. The Port Willunga Formation also occurs as a confined aquifer at places within St Vincent Basin, south of Two Wells.

Melton Limestone (Tomm)

Melton Limestone occurs largely as a confined aquifer that is crystalline in nature with low effective porosity. Well yields range between 0.5–2 L/s. Salinity is cited to be around 1 000–15 000 mg/L. This formation occurs over the eastern and western-margins of the Pirie Basin and is generally sand/gritty bryozoal limestone with Lepidocyclina. More specifically, Melton Limestone exhibits a succession of five transgressive intervals: Upper intervals are fine-grained, quartzosed calcarenetic limestone; middle intervals often comprise quartzose, bryzoal, coarse calcarenite and calcirudite; lower intervals consist of gravelly quartzose, bryzoal, calcarenite, calcirudite and calcareous sandstone.

Hallett Cove Sandstone (Tph)

Hallett Cove Sandstone is not recognised as a hydrostratigraphic unit across the study area, although the unit has been extensively developed for irrigation around the Northern Adelaide Plains. This formation occurs between Stansbury and Edithburgh, south of Wool Bay, Yorke Peninsula, where thin remnant outcropping can be observed. It is a red-brown, dense calcareous sandstone and siltstone and sandy limestone of shallow marginal marine deposition. Oyster-rich beds, gastropods and bivalves are common.

Gibbon Beds (TpQag)

The Gibbon Beds are limited to the western margin of the Pirie Basin and are a sequence of mottled, cross-bedded gravel, conglomerate, sandstone and shale or clay. The dominant rock type is coarse gravel with well-rounded cobbles up to 0.3 m diameter in a clay and silt matrix and interbeds of fine silt and well sorted sand. This formation can occur as an unconfined or semi-confined aquifer and also as a confining layer to deeper Tertiary aquifers.

QUATERNARY

On lower Yorke Peninsula, shallow groundwater is abstracted from coastal aeolian sediments (Bridgewater Formation). Along the flanks of the Flinders Ranges, groundwater is common within sand and gravel beds of modern and ancient watercourses and alluvial fans. Small groundwater basins such as Willochra and Walloway Basins have significant storages of groundwater within Quaternary sediments (Drexel & Preiss 1995).

Carisbrooke Sand (Qpac)

The non-marine sediments of the Carisbrooke Sands occurs widely across the Pirie and St Vincent Basins, but because this formation is associated with alluvial and continental sedimentation and aeolian redistribution between sea-level highstands, it is not found within 4–5 km of the coast. Carisbrooke Sand comprises fluviatile, alluvial, yellow, fine sands, silts and clays and thin gravel beds commonly occur in outwash areas. This formation is commonly cited as a confined aquifer with low well yields. It partly overlies and interfingers the Hallett Cove Sandstones.

Hindmarsh Clay (Qpah)

The Hindmarsh Clay was formed within the same depositional environment as the Carisbrooke Sand. Drilling investigations have identified that this formation is widespread beneath Gulf St Vincent and Spencer Gulf. The Hindmarsh Clay comprises consolidated, mottled red-brown to orange clay and sandy clay, with upper fluvial and alluvial red-brown silty sandstone and basal gravel lenses and sand. This formation rests on Pliocene sediments in places. It is often a confining layer to Tertiary aquifers. The Hindmarsh Clay commonly occurs between Port Augusta and Port Pirie where, in places, basal gravel lenses may provide small amounts of water suitable for stock purposes.

Telford Gravel (Qpat)

The Pleistocene alluvial fan and piedmont slope unit, Telford Gravel, comprises coarse-grained sand and polymict gravel with boulders. This formation is a laterally discontinuous, semi-confined aquifer which occurs across most of the Pirie Basin. This formation represents the most heavily exploited hydrostratigraphic unit of the NYNRM Region.

Bridgewater Formation (Qpcb)

Across Yorke Peninsula the Quaternary limestone aquifer contains lithology of the Bridgewater Formation, consisting of calcareous sands, broken shell fragments and limestone. The sequence often has calcrete at the surface and can be indurated to unconsolidated throughout. It forms a thin veneer, widespread along the west coast of lower Yorke Peninsula, most notably between Corny Point and Cape Spencer. This formation manifests as unconfined to semi-confined aquifers (e.g. Carribie and Para Wurlie Basins).

Pooraka Formation (Qpap)

Alluvial, red-brown clayey sand and gravel of the Pooraka Formation is capped in general by soft powdery carbonate and/or calcrete. This formation occurs mainly along eastern margin of the Pirie Basin. They form an apron of variable thickness unconformably overlying Gibbon Beds. Not generally recognised as a hydrostratigraphic unit; however, this formation is laterally discontinuous and may contain groundwater adjacent to watercourse drainage channels.

Glanville Formation (Qpcg)

Intertonguing with and laterally equivalent to the Bridgewater Formation is the Glanville Formation. This formation comprises soft, white to cream-fawn richly fossiliferous shelly sand and clay and calcreted shell beds. It occurs around Warooka and Fishermans Bay (Yorke Peninsula) and near Port Wakefield. In general, groundwater found within this formation is highly saline.

Saint Kilda Formation

The Saint Kilda Formation comprises various sedimentary facies, deposited by various marine processes. In general, sediments are calcareous, fossiliferous, shallow marine deposits, including shell beds, sands and clays. This formation commonly occurs as an unconfined aquifer between Minlaton and Edithburgh, Yorke Peninsula and shows salinity generally at or greater than sea water.

Undifferentiated aeolian sand

Fine grained, white/beige sands that may be an equivalent to the Molineux Sand. Although widespread across Yorke Peninsula, this formation is not a recognised hydrostratigraphic unit.

Molineux Sand (Qem)

The Molineux Sand occurs mainly around Balaklava (around 25 km east of Port Wakefield). This formation comprises pale yellow sands which form south-easterly trending dune systems. This formation is not a recognised hydrostratigraphic unit.

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

3-D – Three dimensional

Adaptive management — A management approach often used in natural resource management where there is little information and/or a lot of complexity and there is a need to implement some management changes sooner rather than later. The approach is to use the best available information for the first actions, implement the changes, monitor the outcomes, investigate the assumptions and regularly evaluate and review the actions required. Consideration must be given to the temporal and spatial scale of monitoring and the evaluation processes appropriate to the ecosystem being managed.

Aquatic macrophytes — Any non-microscopic plant that requires the presence of water to grow and reproduce

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

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

AGT – (environmental consultants) Australian Groundwater Technologies

AHD – see m AHD

AWRIS – The Australian Water Resources Information System

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

Biodiversity — (1) The number and variety of organisms found within a specified geographic region. (2) The variability among living organisms on the earth, including the variability within and between species and within and between ecosystems

Biological diversity — See 'biodiversity'

Biomonitoring — The measurement of biological parameters in repetition to assess the current status and changes in time of the parameters measured

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

CMB — Chloride mass balance

CSIRO — Commonwealth Scientific and Industrial Research Organisation

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.

DTEI – Department for Transport, Energy and Infrastructure

DWLBC — Former Department of Water, Land and Biodiversity Conservation (Government of South Australia)

DWR – Department for Water Resources

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

Ecological indicators — Plant or animal species, communities, or special habitats with a narrow range of ecological tolerance; for example, in forest areas, such indicators may be selected for emphasis and monitored during forest plan implementation because their presence and abundance serve as a barometer of ecological conditions within a management unit

Ecology — The study of the relationships between living organisms and their environment

Ecosystem — Any system in which there is an interdependence upon and interaction between, living organisms and their immediate physical, chemical and biological environment

Environmental water requirements — The water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

Estuarine habitat — Tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean and in which ocean water is at least occasionally diluted by freshwater run-off from the land

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

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’

Habitat — The natural place or type of site in which an animal or plant, or communities of plants and animals, live

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 project (DFW)

Impact — A change in the chemical, physical, or biological quality or condition of a water body caused by external sources

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

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

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

NRM — Natural Resources Management; all activities that involve the use or development of natural resources and/or that impact on the state and condition of natural resources, whether positively or negatively

NYADINRMC – Northern and Yorke Agricultural District Integrated Natural Resources Management Committee

NYNRM — Northern and Yorke Natural Resources Management

NYNRMB — Northern and Yorke Natural Resources Management Board

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 (PIRSA)

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

Pasture — Grassland used for the production of grazing animals such as sheep and cattle

PDF – Portable Document Format

Penetrating well — See 'fully-penetrating well'

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

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

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

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

PWRA — Prescribed Water Resources Area

QA – Quality Assurance

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

RESIC – Resources & Energy Sector Infrastructure Council

Reticulated water — Water supplied through a piped distribution system

Riparian — Of, pertaining to, or situated or dwelling on the bank of a river or other water body

Riparian areas — Geographically delineable areas with distinctive resource values and characteristics that comprise the aquatic and riparian ecosystems

Riparian habitat — The transition zone between aquatic and upland habitat. These habitats are related to and influenced by surface or subsurface waters, especially the margins of streams, lakes, ponds, wetlands, seeps and ditches

Riverine habitat — All wetlands and deep-water habitats within a channel, with two exceptions — wetlands dominated by trees, shrubs, persistent emergent mosses or lichens and habitats with water that contains ocean-derived salt in excess of 0.5 parts per thousand

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 (PIRSA)

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

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

Standing Water Level — Depth to groundwater below natural ground surface

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

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

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

SWL — Standing Water Level. Depth to groundwater below 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

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

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 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

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

Wetlands — Defined by the Act as a swamp or marsh and includes any land that is seasonally inundated with water. This definition encompasses a number of concepts that are more specifically described in the definition used in the Ramsar Convention on Wetlands of International Importance. This describes wetlands as areas of permanent or periodic to intermittent inundation, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tides does not exceed six metres.

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