The Department of
Water, Land and
Biodiversity
Conservation

Saunders Creek Catchment Groundwater Assessment

Report DWLBC 2002/01

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Department of Water, Land and Biodiversity Conservation

July 2002

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Zulfic, D., and Barnett, S., 2002. Saunders Creek Catchment Groundwater Assessment. *South Australia. Department of Water, Land and Biodiversity Conservation. Report,* DWLBC 2002/01.

Covering Photographs
Saunders Creek Catchment area dams and broad acre crops.

Foreword

South Australia’s water resources are fundamental to the economic and social wellbeing of the State. Water resources are an integral part of our natural resources. In pristine or undeveloped situations, the condition of water resources reflects the equilibrium between rainfall, vegetation and other physical parameters. Development of surface and groundwater resources changes the natural balance and causes degradation. If degradation is small, and the resource retains its utility, the community may assess these changes as being acceptable. However, significant stress will impact on the ability of a resource to continue to meet the needs of users and the environment. Degradation may also be very gradual and take some years to become apparent, imparting a false sense of security.

Management of water resources requires a sound understanding of key factors such as physical extent (quantity), quality, availability, and constraints to development. The role of the Resource Assessment Division of the Department of Water, Land and Biodiversity Conservation is to maintain an effective knowledge base on the State’s water resources, including environmental and other factors likely to influence sustainable use and development, and to provide timely and relevant management advice.

Bryan Harris
Director, Resource Assessment Division
Department of Water, Land and Biodiversity Conservation

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ABSTRACT

The Saunders Creek is a tributary catchment for the River Murray which generates ephemeral flows in very wet years. Concerns have been expressed at the construction of large dams in the headwaters of the catchment, and their impacts on streamflow, and consequently recharge to aquifers.

The catchment can be divided into two distinct groundwater regions: the Hills Zone and the Plains Zone. The Hills Zone comprises the consolidated basement rocks of the Mount Lofty Ranges, which form fractured rock aquifers. Borehole yields are generally low and salinities vary, apart from the western portion of the catchment where better quality water is drawn.

The Plains Zone is underlain by unconsolidated sediments of the Murray Basin. The main aquifer is the Murray Group Limestone, which is utilised for domestic and stock purposes and is recharged mainly by infiltration of streamflow.

INTRODUCTION

The Saunders Creek Catchment covers an area of 230 km^2 and is located on the western margin of the Murray Basin, approximately 80 km north-east of Adelaide (Fig. 1). Two major creeks provide the majority of streamflow, originating from the eastern Mount Lofty Ranges. The confluence of these creeks is before a downstream gorge, and from there Saunders Creek flows eastwards onto the Murray Plains before eventually reaching the River Murray at Pellaring Flat. The creek intermittently flows to the Murray in very wet years, recharging the aquifer beneath the plains.

The catchment adjoins the southern boundary of the Marne catchment and has over the recent years, experienced considerable dam development for the irrigation of vineyards in the headwaters of the upstream catchment. As a result, there have been strong concerns expressed about the impacts that may occur by reducing streamflow and consequently, reducing recharge to the downstream aquifer. This has caused falling groundwater levels in some areas.

The Department of Water, Land and Biodiversity Conservation (DWLBC) was required to assess the sustainability of the groundwater resources and their state of development, to assist in the decision making process regarding the possible proclamation of the resource. The investigation was based on existing information and the findings derived from the adjacent Marne catchment study (Barnett and Zulfic, 2001).

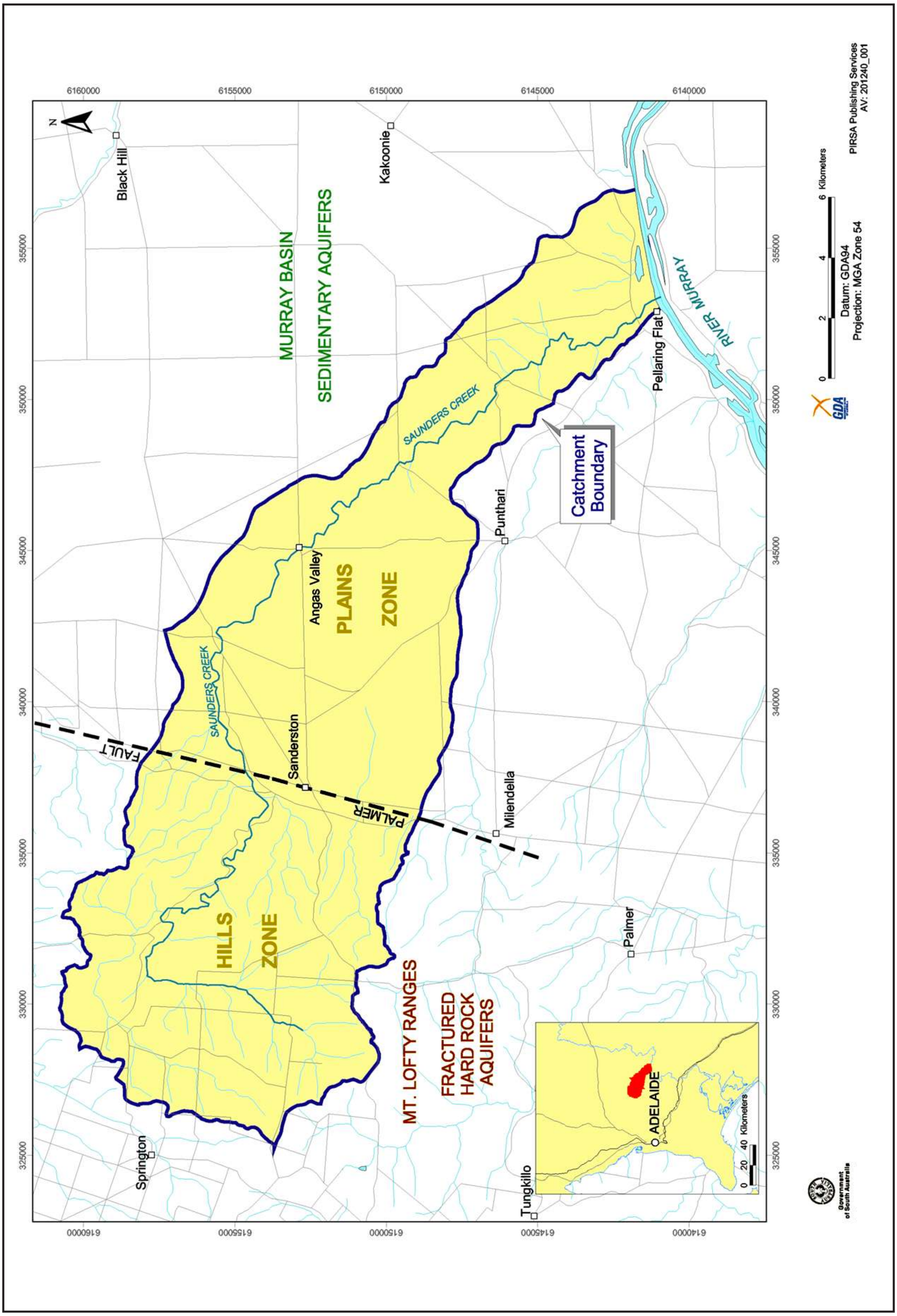

Figure 1. Saunders Creek Catchment Locality Plan

HYDROGEOLOGY

The Saunders Creek catchment area can be divided into two distinct regions with different geology and consequently, different groundwater systems: the Hills Zone and Plains Zone, separated by the Palmer Fault scarp (Fig. 1).

Hills Zone

This zone comprises the consolidated basement rocks of the Mt Lofty Ranges. Groundwater is stored and moves through joints and fractures which form fractured rock aquifers. Recharge to the fractured rock aquifer occurs directly from the portion of the rainfall which percolates through the soil profile, but the most of the rainfall runs off to the streams or is used by plants.

Groundwater moves from the higher points in the landscape to the lowest where it discharges to the streams. Generally, the streams act as drains for the fractured rock aquifer systems (Fig. 2). This discharge constitutes the baseflow of the streams which can dominate flow for the most of the year, particularly over the summer and between rainfall events.

In the Saunders Creek catchment, the basement rocks consists of grey micaceous and feldspatic sandstones and siltstones of the Kanmantoo Group. These rocks are of Cambrian age and have been metamorphosed by heat and pressure. They are generally tight and impermeable, with few open system of fractures and joints in which groundwater can be stored and transmitted. Clayey weathering products from the metamorphosed rocks tend to infill any joints and fractures that may be present which can reduce recharge. Soluble products can be dissolved leading to an increase in salinity of the groundwater. Borehole yields are low, generally below 2 L/s, except for the western portion of the catchment where yields can be over 10 L/s (Fig. 3).

Annual rainfall ranges from 620 mm in the higher western parts of the catchment, to only 340 mm on the eastern margins. This decrease in rainfall across the catchment from west to east reflects a strong rain-shadow effect.

Groundwater salinity is dependent on the rock type and rainfall recharge, and varies from 500 to 8000 mg/L (Fig. 4). Groundwater is mainly used as a source of stock and domestic supplies. In the western portion of the catchment, groundwater is used for irrigation mainly because of better quality and more reliable supplies. The main landuse is grazing and dairy farming. Recently, there has been an increase in vine growing in the western part of the hills zone (headwaters).

Plains Zone

After flowing out of the hills onto the plains, the Saunders Creek loses water as it recharges the underlying aquifers which are used for stock, domestic and in rare instances, irrigation purposes (Fig. 2).

From the western boundary of the Plains Zone at the Palmer Fault scarp, the Saunders Creek falls about 100 m to the level of the River Murray, over a distance of 25 km. The landscape is undulating to flat with elevations from 40–50 m AHD near the River Murray to about 160 m AHD at the western boundary.

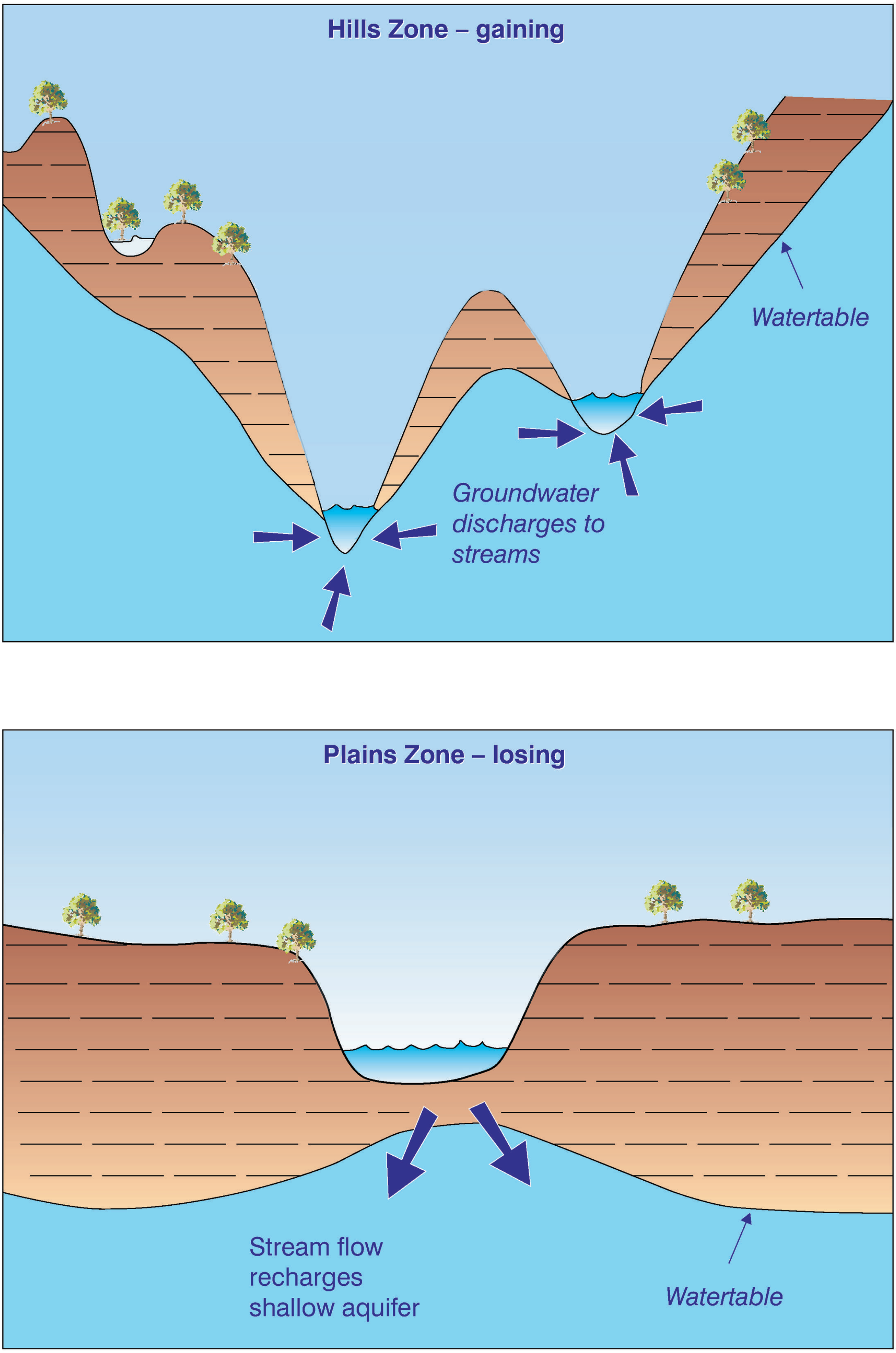

Figure 2. Groundwater - surface water interaction

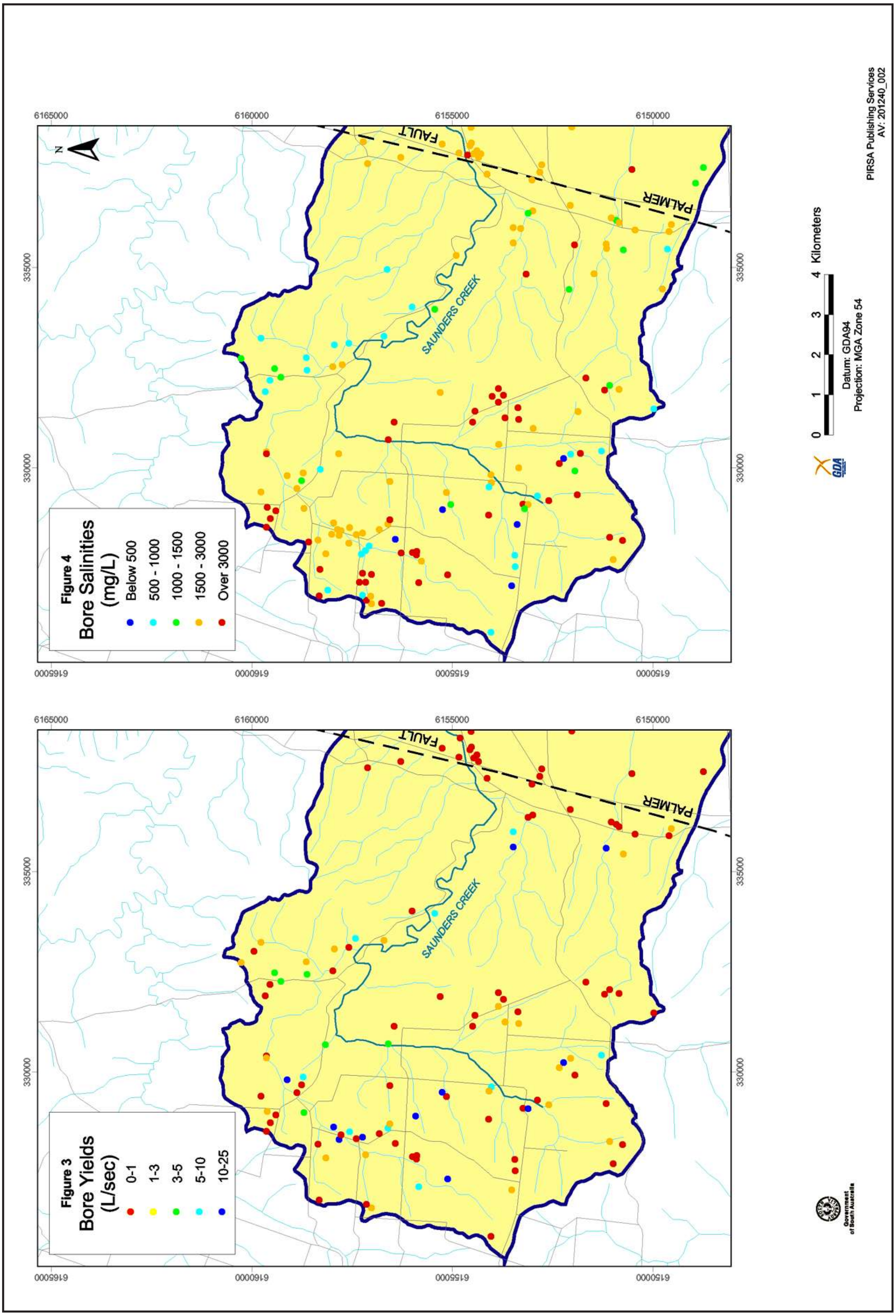

Figure 3. and 4. Saunders Creek Catchment Hills Zone

Unconsolidated sediments of the Murray Basin underlie the Plains Zone. They consist of layers of limestones, and sands and clays, which overlie basement rocks that are exposed in the Hills Zone to the west. Groundwater flows through pore spaces in the sand and limestone beds towards the River Murray, where it eventually discharges.

There are four main layers of Murray Basin sediments in the Saunders Creek Catchment as shown in the geological section (Fig. 5). The groundwater characteristics of each will be discussed in order of increasing depth below ground level, namely:

- Quaternary Sediments
- Murray Group Limestone
- Ettrick Formation
- Renmark Group.

Quaternary Sediments

There are a variety of these younger sediments which were deposited in different environments, ranging from the pale-yellow wind-blown sands found on the higher ground, to the alluvial silts, sands, clays and gravels of the modern drainage channels.

The alluvial sediments average about 10 m in thickness and consist mainly of interbedded clay, sands and gravels which increase in thickness toward the hills. Small supplies of up to 0.5 L/s may be obtained from shallow bores completed in alluvium, with salinities mostly in the range 2000–3000 mg/L.

The colluvial outwash of the Pooraka Formation forms a wedge-shaped deposit of red-brown clays and minor gravels up to 60 m thick adjacent to the Palmer Fault scarp, which decreases in thickness to only a few metres toward the east away from the hills (Fig. 5). The Saunders Creek floodplain has been eroded down into these clays.

Murray Group Limestone

This limestone is yellow-brown to grey, highly fossiliferous and sandy, with solution cavities present in some areas. The groundwater from this aquifer is the main source of stock, domestic and irrigation supplies for the Saunders Creek catchment.

The limestone aquifer is unconfined over most of the Saunders Creek area but in the western part of the area, upstream of Angas Valley, the aquifer is locally confined, being overlain by the thick sequence of clays and clayey sands of the Pooraka Formation (Fig. 5).

The thickness of the Murray Group Limestone is not well defined due to very few bore records for this area. It varies from 10 to 30 m according to these records. However, previous analysis of numerous bore logs for the Marne catchment suggests that the thickness may vary from only a few metres in the western portion of the study area, where the sediments are thinning out towards the contact with the basement rocks, to about 50 m on the eastern margins of the area. The average thickness of the aquifer is believed to be 20-25 m.

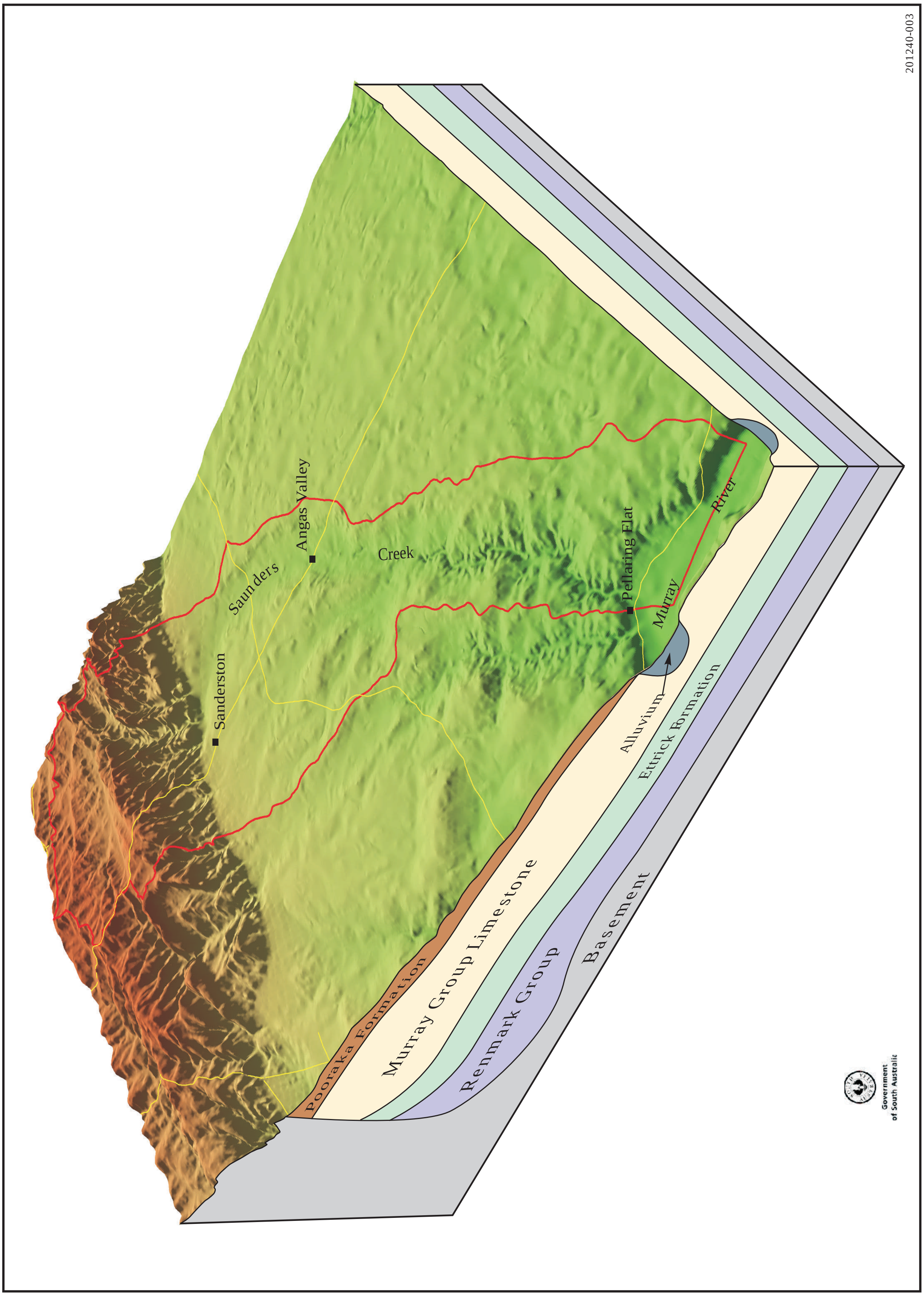

Figure 5. Geological cross-section (E–W) of the plains zone showing topography, Saunders Creek Catchment

The groundwater flow direction is generally from the ranges in the west toward the east, where the aquifer discharges in the River Murray valley which is the lowest point in the area. The watertable gradient is very steep and falls about 35 m over the 20 km distance.

In the western part of the zone, salinities range from 1500 to 3000 mg/L (Fig. 7), and yields are occasionally greater than 5 L/s (Fig. 6). Most commonly recorded yields are between 1 to 3 L/s.

However, a very sharp increase in the salinity is recorded downstream, in the vicinity of Angas Valley, varying from 3000 to 7000 mg/L, as well as a decrease in supply, with the majority of bores yielding less than 1 L/s. Therefore, the salinity is mostly too high and the yields too low, for groundwater to be utilised for irrigation purposes.

Ettrick Formation

This is a low permeability unit consisting of grey-green sandy marls of variable thickness (10 m in the western part to 20 m near the River Murray), which help confine the underlying Renmark Group aquifer. Its existence is poorly defined due to scarce bore log records. The comparison to the Marne catchment suggests that it is likely to be absent over the northern part of the study area.

Renmark Group

This confined aquifer consists of dark-brown, fine to medium-grained sands and interbedded carbonaceous clays and lignites. These sediments are discontinuous because their distribution is restricted by the undulating nature of the basement topography. It is confined by carbonaceous clays and lignites and the overlying marls, where they occur.

Very few bores on the western margin of the Murray Basin penetrate and develop this aquifer. According to the scarce lithological data, the Renmark Group sediments have been encountered at depths varying from about 20 m to over 70 m. Several bores that fully penetrate these sediments show that the thickness varies from 10 m to over 50 m.

An area of very low salinities (1000 - 1500 mg/L) occurs near the western margins, south from Sanderston (Fig. 7). The salinity increases to 3000 mg/L, and further downstream, is similar to the limestone aquifer at 7000 mg/L. The supply capabilities are in the range of 0.5-5 L/s (Fig. 6). This is suggesting that recharge most likely occurs from the basement rocks of the Mount Lofty Ranges, along the western margins of the basin, with the regional groundwater flow similar to the overlying limestone aquifer (ie., from the basin margins eastward towards the River Murray).

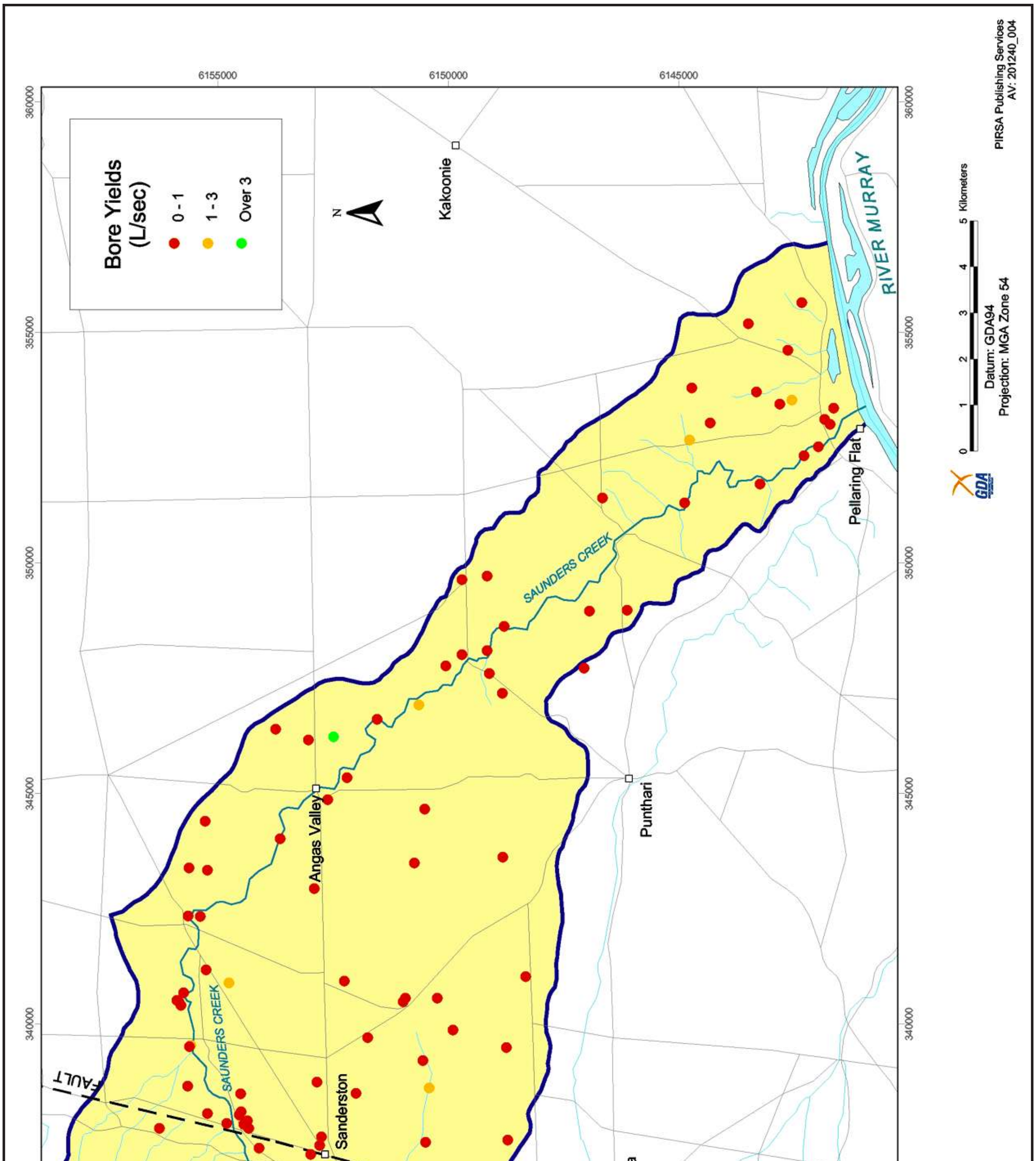

Figure 6. Saunders Creek Catchment Plains Zone

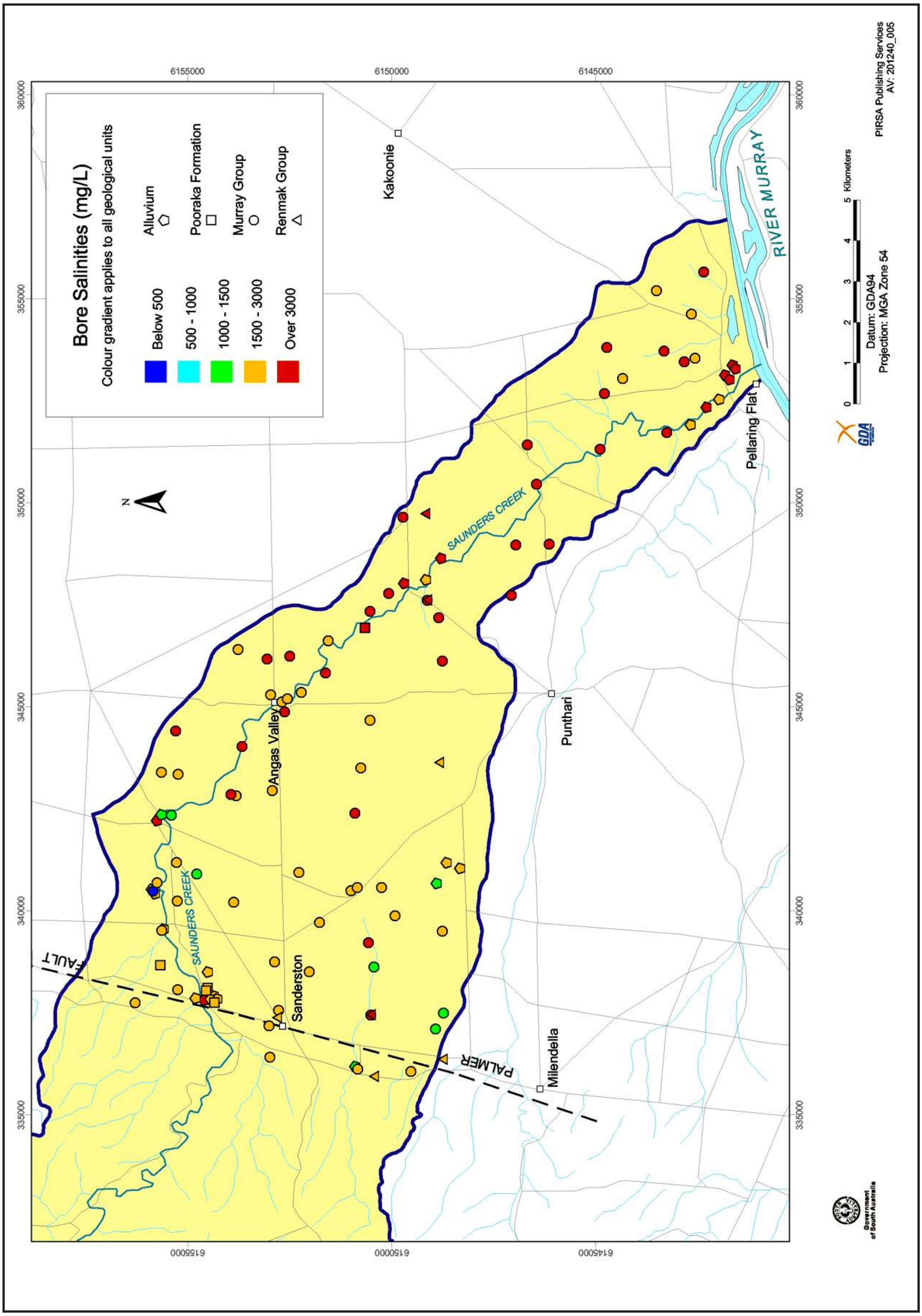

Figure 7. Saunders Creek Catchment Plains Zone

RECHARGE

Recharge to the limestone aquifer can occur by three processes (Fig.8):

1 from surface water flowing in Saunders Creek down through underlying permeable alluvial sediments (where the aquifer is unconfined)

2 by groundwater subflow from the Hills Zone fractured rock aquifers across the Palmer Fault zone (where the aquifer is confined)

3 by vertical recharge from rainfall.

Recharge from rainfall is relatively low outside the Saunders Creek valley due to the thickness of the clayey Pooraka Formation and the low rainfall, which decreases from only 340 mm/y near the ranges, to 275 mm/y at the River Murray. Because of limited information no assessment has been made concerning rainfall recharge rates. Assuming that they are similar to the Marne River catchment and based on the results of the groundwater modelling of that area, recharge rates outside Saunders Valley are about 1 mm/year.

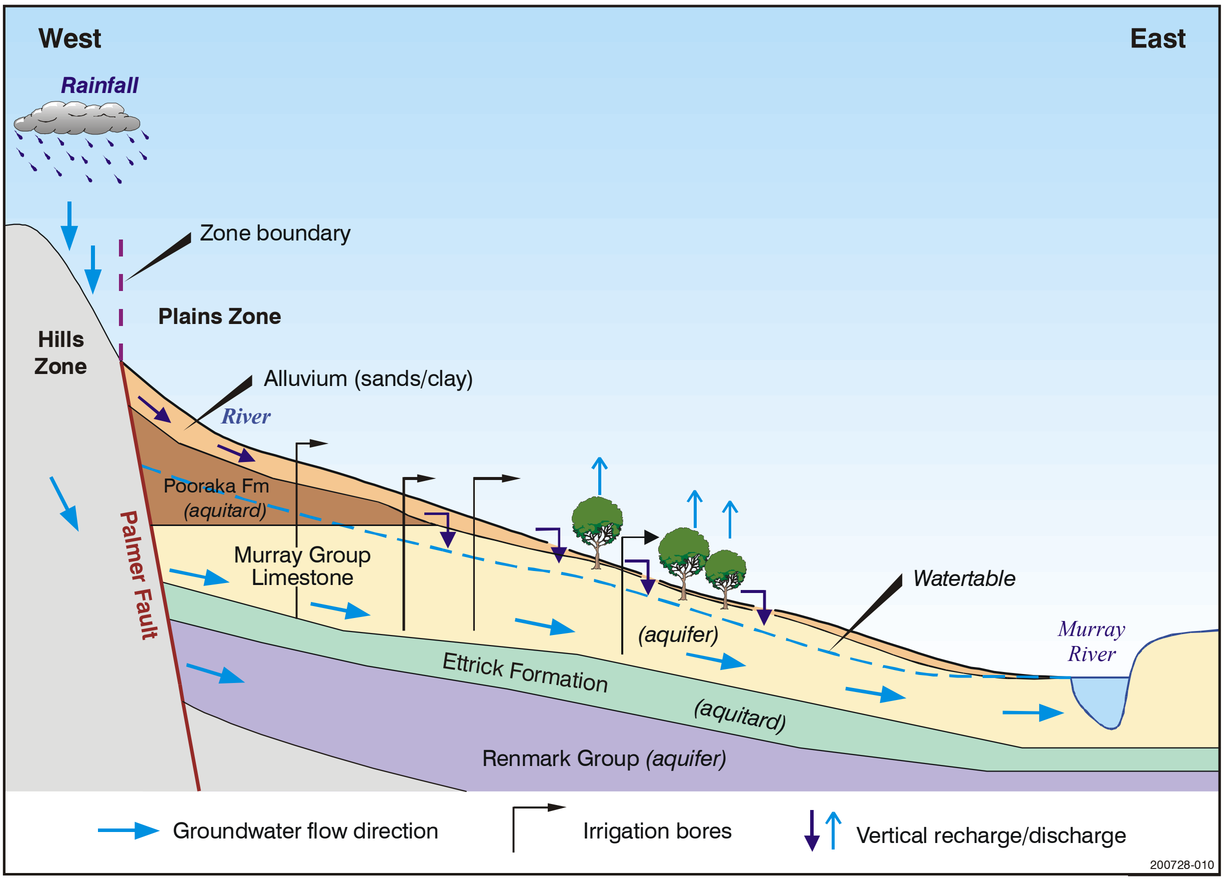

Figure 8. Recharge and discharge mechanisms for the limestone aquifer

DRILLING HISTORY

An analysis of the State drillhole database SA_GEODATA for this catchment has provided data on the history of well drilling. In 1976, the passing of the Water Resources Act required a permit to be obtained for each new well drilled, and the submission of well construction details to the appropriate agency. However, in order to obtain information on wells drilled before 1976, a well location survey was carried out in the Hundred of Angas in 1980.

The oldest bore was drilled in 1914 for a stock water supply near Sanderston. Until 1976, about 163 bores were established in the area, 66 in the hills and 97 in the plains (Table 1). Since 1976, another 118 bores have been drilled. However, during this period more bores were drilled in the hills (74) than on the plains (44). It must be remembered that the stated purpose for which any well was drilled does not necessarily reflect its current use. For example, a bore drilled for the purpose of irrigation (as described on the well permit), may have encountered poor yields or salinities, and is not now used for that purpose.

Table 1. History of groundwater development

Purpose	Number of wells drilled			
	Before 1976		After 1976	
	Hills	Plains	Hills	Plains
Irrigation	7	9	26	8
Domestic/stock	7	6	3	14
Stock	13	36	18	11
No data available	39	46	27	11
Total	**66**	**97**	**74**	**44**

Because of the lack of groundwater development, there has been no long term monitoring of groundwater levels or salinities.

AQUIFER TEST

An aquifer test on the limestone aquifer was conducted in May 1999. A 45.5 hour continuous discharge test provided an estimate of the permeability of the aquifer.

The bore (unit No 6728-3266) was very low yielding, pumping at only 0.625 L/s. According to the driller's log for this bore, the thickness of the limestone aquifer is 35 m. The water level steadily dropped from 31.35 m below ground at the start of pumping, to 39.27 m at the end, a drawdown of 7.92 m. Two observation bores were used, windmills 250 m to the east and 3 km to the south-east, near the Saunders Creek bridge. The results show that the radius of influence of the pumping bore is less than 250 m. The values obtained for the transmissivity (T) were very low, 19-21 m^2/d and for the hydraulic conductivity (k) around 0.6 m/d.

These results show why there is very little development of the limestone aquifer for irrigation.

SUMMARY AND CONCLUSIONS

The Saunders Creek catchment is divided into two distinct groundwater regions: the Hills Zone and the Plains Zone. The Hills Zone comprises the consolidated basement rocks of the Mount Lofty Ranges which form fractured rock aquifers. Borehole yields are generally low and salinities variable.

The Plains Zone is underlain by unconsolidated sediments of the Murray Basin. The main aquifer is the Murray Group Limestone which is mainly developed for stock and domestic purposes, with groundwater extraction for irrigation purposes almost non existent, mainly because of low yields.

The drilling activity as illustrated in Table 1 shows that there has been no significant increase in the construction of wells and therefore the groundwater consumption. Consequently, future groundwater development is not likely, due to high salinity levels and low yields, from aquifers in both the Hills and Plains Zones of the catchment. Falling groundwater levels are the result of lack of recharge, not overpumping. The contribution of large dams in reducing runoff and recharge is not known.

SI Units Commonly Used Within Text

Name of unit	Symbol	Definition in terms of other metric units	
Millimetre	mm	10^{-3} m	length
Metre	m		length
Kilometre	km	10^{3} m	length
Hectare	ha	10^{4} m^{2}	area
Microlitre	µL	10^{-9} m^{3}	volume
Millilitre	mL	10^{-6} m^{3}	volume
Litre	L	10^{-3} m^{3}	volume
Kilolitre	kL	1 m^{3}	volume
Megalitre	ML	10^{3} m^{3}	volume
Gigalitres	GL	10^{6} m^{3}	volume
Microgram	µg	10^{-6} g	mass
Milligram	mg	10^{-3} g	mass
Gram	g		mass
Kilogram	kg	10^{3} g	Mass

REFERENCES

Barnett, S., Yan, W. and Zulfic, D., 2001. Marne River Catchment Groundwater Assessment. South Australia. Department for Water Resources, Report DWR 2001/009.