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Department of Water, Land and Biodiversity Conservation

SUMMARY OF GROUNDWATER RECHARGE ESTIMATES FOR THE CATCHMENTS OF THE WESTERN MOUNT LOFTY RANGES PRESCRIBED WATER RESOURCES AREA

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INTRODUCTION

Estimates of annual groundwater recharge are provided in this technical note to inform the water allocation planning process for the Western Mount Lofty Ranges (WMLR) Prescribed Water Resources Area (PWRA). The annual catchment recharge volume is one of the catchment water balance components required to determine suitable allocation volumes for licensed groundwater extraction and use.

Groundwater recharge investigations were conducted between 2005 and 2007 to determine annual recharge rates at a number of investigation sites in the Eastern and Western Mount Lofty Ranges (EMLR and WMLR). Sites were selected to be representative of a range of the geology and climate zones typical of the Mount Lofty Ranges (MLR). Recharge rates were derived from detailed hydraulic and hydrochemical analyses of groundwater in observation wells installed at these investigation sites. Full reports of the EMLR investigations (Banks et al., 2007) and WMLR investigations (Green et al., 2007) have been published and are available on the DWLBC website.

GROUNDWATER RECHARGE ESTIMATES

As there is a large number of sub-catchments in the WMLR PWRA, and a small number of recharge investigation sites, it has been necessary to firstly determine an annual recharge rate at the location of each investigation site, and then to extrapolate these recharge rate estimates to whole sub-catchments, including those that do not have a recharge investigation site. Recharge volumes listed in Tables 1 and 2 have been derived from an aggregate of annual recharge fluxes for each area of different geology type within a sub-catchment, weighted by the average annual rainfall for the catchment. This has been carried out according to the following procedure:

1. Annual recharge rates for each major geology type have been calculated by applying hydrochemical models to the groundwater hydrochemistry at investigation sites in the Mount Lofty Ranges, including three in the WMLR and two in the EMLR. These are considered to be reference recharge fluxes for the principal geology types in the MLR.

2. When applying these reference recharge rates to the equivalent geology in sub-catchments that do not have an investigation site, the annual rainfall difference between the sub-catchment and the respective investigation site is used to scale the reference recharge rate to provide a local recharge rate estimate for that geology in that sub-catchment.

3. This derivation is applied to each geology type within a sub-catchment. The areal recharge rate for each geology type within a sub-catchment is then multiplied by the percentage of the catchment with that geology type. These proportioned recharge fluxes are then summed to provide an aggregate areal recharge rate for the whole sub-catchment.

4. Recharge volumes are derived by multiplying aggregate areal recharge rate (mm) by the sub-catchment area (km^2) to arrive at a sub-catchment recharge volume in megalitres (ML).

Recharge estimates based on this method are provided in Table 1 for the sub-catchments of the Onkaparinga, Torrens, South Para and Little Para rivers. Table 2 provides estimates for the catchments of the Southern Fleurieu Peninsula, which have been derived by the same method. Figures 1 and 2 show the location of the sub-catchments.

Table 1. Recharge estimates for sub-catchments of the Western Mount Lofty Ranges

Catchment/Sub-catchment	**Sub-catchment area** (km^2)	**Aggregate areal recharge** (mm)	**Annual recharge volume** (ML)
Onkaparinga River sub-catchments			
Aldgate Creek	19.452635	108	2 101
Baker Gully	47.935243	63	3 020
Balhannah	10.242403	68	696
Biggs Flat	23.583535	61	1 439
Chandlers Hill	14.078180	40	563
Charleston	51.509297	32	1 648
Clarendon Weir	15.145610	61	924
Cox Creek	28.886256	111	3 206
Echunga Creek	39.165764	64	2 507
Hahndorf	14.682221	54	793
Inverbrackie Creek	26.741153	26	695
Lenswood Creek/Cock Creek	28.397496	66	1 874
Mitchell Creek	14.507269	44	638
Mount Bold Reservoir	46.829735	91	4 262
Scott Creek	28.497521	87	2 479
Upper Onkaparinga	47.107691	85	4 004
Western Branch	32.967548	91	3 000
River Torrens sub-catchments			
Angas Creek	27.121831	26	705
Birdwood	50.893112	24	1 221
Cudlee Creek	20.109153	46	925
Footes Creek	9.454558	87	823
Gumeracha	28.352623	54	1 531
Hannaford Creek	15.049536	60	903
Kangaroo Creek Reservoir	38.598745	63	2 432
Kenton Valley	12.833297	65	834
Kersbrook Creek	36.755888	61	2 242
McCormick Creek	9.312787	32	298
Millers Creek	22.832041	61	1 393
Mount Pleasant	25.857318	24	621
Sixth Creek	44.220015	77	3 405
South Para River sub-catchments			
Upper	118.668827	60	7 120
Middle	108.156655	73	7 895
Lower (incl. Lower Gawler River)	120.106229	56	6 726
Little Para River sub-catchments			
Gould Creek	24.532368	64	1 570
Little Para Reservoir	14.121306	28	395
Lower Little Para River	12.525094	30	376
Upper Little Para River	43.419120	70	3 039

Table 2. Recharge estimates for sub-catchments of the Southern Fleurieu Peninsula

Catchment/Sub-catchment	Sub-catchment area (km^2)	Aggregate areal recharge (mm)	Annual recharge volume (ML)
Southern Fleurieu Peninsula sedimentary catchments			
Myponga River (incl. Black Hill catchment)	156.351259	67	10 476
Hindmarsh Tiers	55.751348	60	3 345
Innman River (incl. Victor Harbour)	195.252578	53	10 348
Lower Hindmarsh River (incl. Dump Beach)	56.592357	45	2 547
Carrickalinga Creek	55.891851	62	3 465
Bungala River (incl. Normanville & The Links)	49.319693	59	2 910
Yankalilla River	83.092874	46	3 822
Southern Fleurieu Peninsula fractured rock catchments			
Carrickalinga Head	16.607362	46	764
Lady Bay	1.267779	66	84
Little Gorge	7.810116	37	289
Wirrina Cove	2.446993	59	144
Anacotilla and Congeratinga Rivers	38.205433	31	1 184
Boat Harbour Hill	0.879314	16	14
Parananacooka River	12.933420	33	427
Rapid Bay	1.181153	45	53
Rapid Head	5.864737	29	170
Yattegolinga River	24.736692	37	915
Yohoe Creek	18.262077	34	621
Starfish Hill	1.273360	21	27
Coolawang Creek	40.768002	38	1 549
Salt Creek	15.834327	37	586
Cape Jervis	17.297351	23	398
Waitpinga Creek	61.150244	24	1 468
Newland Head – The Bluff	19.088860	28	534
Tunkalilla Creek	26.477797	29	768
Callawonga Creek	19.506481	30	585
Boat Harbour Creek	19.806653	29	574
The Deep Creek	41.289583	29	1 197
Ballaparudda Creek	12.587645	28	352
First Creek	4.814415	27	130
Fishery Creek	8.503916	24	204
Tunkalilla Beach	7.488708	26	195
Tapanappa	9.301437	24	223
Blowhole Creek	12.094661	26	314
Parsons Beach	6.076998	28	170
Balquhidder	1.366555	24	33
Cooalinga Creek	3.529314	25	88
Bare Rock	1.857804	23	43
Tunk Head	4.622378	24	111
Talisker	4.248961	22	93
Aaron and Tent Rock	16.552138	24	397
Victoria Wreck	1.703255	23	39
Naiko Inlet	1.822524	21	38

Catchment/Sub-catchment	**Sub-catchment area** (km^2)	**Aggregate areal recharge** (mm)	**Annual recharge volume** (ML)
Brown Hill	15.246664	34	518
Middleton	15.895912	37	588
Goolwa	26.548248	18	478
Port Elliot	7.482165	19	142

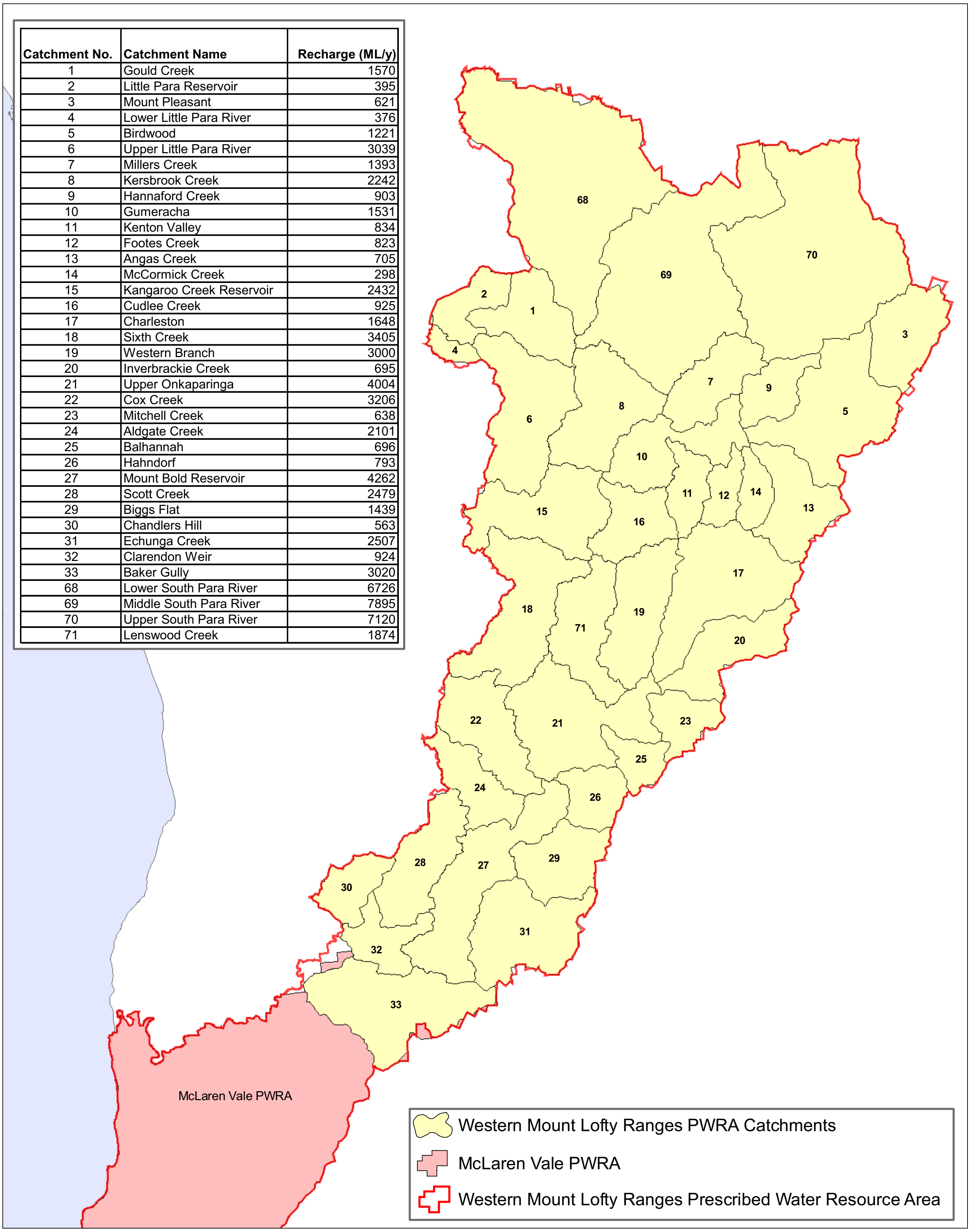
The calculation of recharge using hydrochemical models was more successful at some investigation sites than at others. In some cases, a number of different hydrogeological and hydrochemical indicators were used to support a recharge estimate based on the chloride mass balance (CMB) method of recharge estimation. This method assumes that chloride concentrations in rainwater are conserved when the water recharges the groundwater system. That is, chloride is not added or lost through exchange processes with soil or rock either before or after the water has added to groundwater. Under this assumption, the chloride concentration of groundwater is a product of the rainfall chloride concentration and the evaporative concentration that occurs to the water between its falling as rain and its addition to groundwater. The CMB method typically results in an under-estimate of the true recharge amount.

The CMB recharge estimates that are based on data from the investigation sites can be considered more reliable than CMB estimates that are based on pre-existing production wells for several reasons:

- the completion of piezometers with screen depths at several depths allows the direction of groundwater flow to be determined, allowing determination of whether direct recharge is occurring at that location
- the piezometer screen depth and water table depth are known, allowing samples to be taken from close to the water table – the preferred location for CMB samples
- the full hydrochemical analyses of samples from these location allows a confirmation of the degree of water-rock interaction that has occurred, and whether chloride concentrations are likely to have been affected by this
- the investigation sites are not in agricultural plots, where groundwater chloride concentrations may have been affected by recirculation of irrigation water and/or the addition of fertilisers
- other hydrochemical analyses indicate the age of the groundwater, allowing confirmation of whether or not the CMB recharge estimate reflects contemporary recharge rates, which may be higher than recharge that occurred prior to land clearing in these areas.

There does however remain a significant potential for error in these recharge estimates. The reference recharge estimates are subject to error in their derivation by hydrochemical models, and the process of extrapolation to other sub-catchments is likely to compound these errors. The method of extrapolation described above takes no account of differences in vegetation coverage, soil coverage or slope, which may differ markedly between the location of a recharge investigation site and a sub-catchment in which the recharge rate derived at that site is applied. However, as the CMB method has been very influential in deriving these estimates, they are likely to err more towards being too low than too high.

Catchment No.	Catchment Name	Recharge (ML/y)
1	Gould Creek	1570
2	Little Para Reservoir	395
3	Mount Pleasant	621
4	Lower Little Para River	376
5	Birdwood	1221
6	Upper Little Para River	3039
7	Millers Creek	1393
8	Kersbrook Creek	2242
9	Hannaford Creek	903
10	Gumeracha	1531
11	Kenton Valley	834
12	Footes Creek	823
13	Angas Creek	705
14	McCormick Creek	298
15	Kangaroo Creek Reservoir	2432
16	Cudlee Creek	925
17	Charleston	1648
18	Sixth Creek	3405
19	Western Branch	3000
20	Inverbrackie Creek	695
21	Upper Onkaparinga	4004
22	Cox Creek	3206
23	Mitchell Creek	638
24	Aldgate Creek	2101
25	Balhannah	696
26	Hahndorf	793
27	Mount Bold Reservoir	4262
28	Scott Creek	2479
29	Biggs Flat	1439
30	Chandlers Hill	563
31	Echunga Creek	2507
32	Clarendon Weir	924
33	Baker Gully	3020
68	Lower South Para River	6726
69	Middle South Para River	7895
70	Upper South Para River	7120
71	Lenswood Creek	1874



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Groundwater Recharge in Subcatchments of the Western Mount Lofty Ranges

Produced By: Mount Lofty Ranges Group
Knowledge and Information Division
Department of Water, Land and Biodiversity Conservation
Datum: Geocentric Datum of Australia 1994 (GDA 94).
Date: 13th April 2007

N

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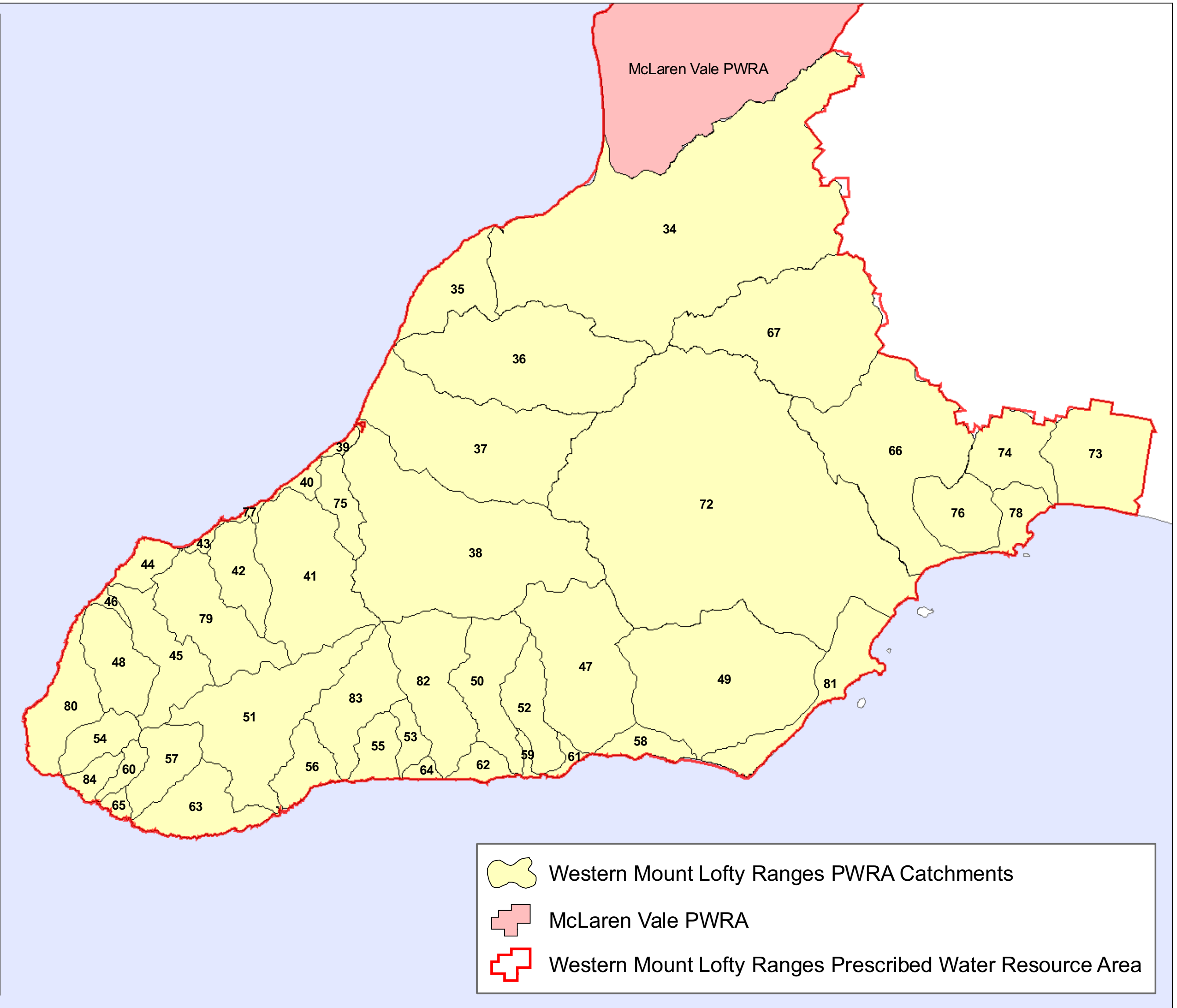
Figure 1

Catchment No.	Catchment Name	Recharge (ML/y)
34	Myponga River	10476
35	Carrickalinga Head	764
36	Carrickalinga Creek	3465
37	Bungala River	2910
38	Yankalilla River	3822
39	Lady Bay	84
40	Wirrina Cove	144
41	Anacotilla & Congeratinga Rivers	1184
42	Parananacooka River	427
43	Rapid Bay	53
44	Rapid Head	170
45	Yohoe Creek	621
46	Starfish Hill	27
47	Coolawang Creek	1549
48	Salt Creek	570
49	Waitpinga Creek	1468
50	Callawonga Creek	585
51	The Deep Creek	1197
52	Ballaparudda Creek	352
53	First Creek	130
54	Fishery Creek	204
55	Tunkalilla Beach	195
56	Tapanappa	223
57	Blowhole Creek	314
58	Parsons Beach	170
59	Balquhidder	33
60	Cooalinga Creek	88
61	Bare Rock	43
62	Tunk Head	111
63	Aaron & Tent Rock	397
64	Victoria Wreck	39
65	Naiko Inlet	38
66	Lower Hindmarsh River	2547
67	Hindmarsh Tiers	3345
72	Inman River	10348
73	Goolwa	478
74	Middleton	588
75	Little Gorge	289
76	Brown Hill	518
77	Boat Harbour Hill	14
78	Port Elliot	142
79	Yattagolinga River	915
80	Cape Jervis	398
81	Newland Head - The Bluff	533
82	Tunkalilla Creek	768
83	Boat Harbor Creek	574
84	Talisker	93



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Datum: Geocentric Datum of Australia 1994 (GDA 94).

Date: 13th April 2007

Groundwater Recharge in Subcatchments of the Southern Fleurieu Peninsula

N

0 5 10 15 km

Figure 2

CONCLUSIONS

The method of groundwater recharge estimation applied to the sub-catchments of the WMLR PWRA may result in recharge estimates with potentially large margins of error. However, the preliminary estimates provided here, based on available data, are useful for initial management decisions. Estimates should be refined subsequently through the future monitoring and analysis of the response of aquifers to licensed groundwater extraction.

For nearly all sub-catchments, the estimate of groundwater recharge derived by the methods described in this document provides a lower catchment recharge volume than estimates previously derived from catchment water balance methods (Barnett & Zulfic, 2000; Zulfic et al., 2003; Zulfic, 2006; Barnett & Rix, 2006).

It is recommended that in the water allocation planning process, estimates derived from only one estimation method are used, rather than a compromise between the values derived from different methods.

In view of the high degree of uncertainty associated with all recharge estimates derived for the WMLR, it is recommended that a precautionary approach be taken and that the estimates of recharge volume derived from the MLR groundwater recharge investigations, as listed in Tables 1 and 2, should be used for water allocation planning purposes.

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