

Natural Resources
Adelaide and Mt Lofty Ranges



Water Allocation Plan

WESTERN MOUNT LOFTY RANGES



Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

Licensed under Creative Commons
Attribution 3.0 Australia License
www.creativecommons.org/licenses/by/3.0/au
Copyright Owner: Crown in right of the State of South Australia 2013
© Government of South Australia 2013

Produced by: Adelaide and Mount Lofty Ranges Natural Resources Management Board
Maps produced by: Department for Water (now Department of Environment, Water and Natural Resources)
Projection: Transverse Mercator
Datum: Geocentric Datum of Australia 1994
Source: Department for Water (now DEWNR)

Water Allocation Plan

WESTERN MOUNT LOFTY RANGES

Natural Resources Management Act 2004

Water Allocation Plan
for the
Western Mount Lofty Ranges Prescribed
Water Resources Area

I, Ian Hunter, Minister for Sustainability, Environment and Conservation,
hereby adopt this Water Allocation Plan pursuant to section 80(3)(a) of the
Natural Resources Management Act 2004

Ian Hunter



Date:

17/9/13

Minister for Sustainability, Environment and Conservation

Contents

1. Introduction	8	3.3. Northern Adelaide Plains PWA	63
1.1. The Prescribed Area	8	3.4. Barossa PWRA	65
1.1.1. Western Mount Lofty Ranges Prescribed Water Resources Area	8	3.5. Marne Saunders PWRA	65
1.1.2. Little Para Proclaimed Watercourse	8	3.6. Eastern Mount Lofty Ranges PWRA	65
1.2. McLaren Vale Prescribed Wells Area	8	3.7. River Murray Prescribed Watercourse	66
1.3. Water allocation planning	11	4. Assessment of demand on water resources	67
1.3.1. Water licences and allocations	11	4.1. Needs of water users	67
1.3.2. Existing users	11	4.2. Demand	67
1.3.3. New use	11	4.2.1. Historical demand	67
1.4. Water resources and catchments in the Prescribed Area	11	4.3. Present demand	69
1.4.1. Types of water resources	11	4.3.1. Water use for licensed purposes	69
1.4.2. Central Hills Catchments	12	4.3.2. Water use for non-licensed purposes	72
1.4.3. Willunga Basin and Fleurieu Peninsula Catchments	16	4.4. Climate change	73
1.4.4. Watercourses across the plains	20	4.5. Future demand	73
2. Needs of water-dependent ecosystems	23	5. Capacity of the water resources in the Prescribed Area	74
2.1. Introduction	23	5.1. Capacity of underground water	74
2.1.1. Environmental water requirements and provisions	23	5.2. Underground water extraction limit	74
2.1.2. Water-dependent ecosystems	23	5.3. Capacity of surface water and watercourse water	84
2.1.3. Flow regime	23	5.4. Surface water and watercourse water extraction limits	84
2.2. Environmental water requirements	25	5.5. Diversion limits	85
2.2.1. Underground water-dependent ecosystems	25	5.6. Capacity of watercourses across the plains	121
2.2.2. Determining environmental water requirements	25	5.7. Watercourses across the plains extraction limits	121
2.2.3. Measuring environmental water requirements	47	6. Water Allocation criteria	126
2.2.4. Capacity of the water resource to meet environmental water requirements	53	6.1. Objectives	126
2.2.5. Environmental water quality requirements	55	6.2. General allocation criteria	126
2.3. Environmental water provisions	56	6.3. Allocation of underground water	126
2.3.1. Acceptable level of risk	56	6.4. Allocation of surface water and watercourse water (not from a watercourse across the plains)	128
2.3.2. Determination of environmental water provisions	56	6.5. Allocation of water from watercourses across the plains	132
2.3.3. Environmentally sustainable extraction limit	57	6.6. Variation of water licences	134
2.3.4. Underground water-dependent ecosystems	57	7. Transfer criteria	135
2.4. Environmental water requirements and provisions for wetlands	58	7.1. Objectives	135
2.4.1. Fleurieu Wetlands	58	7.2. General transfer criteria	135
2.4.2. Central Hills wetlands	60	7.3. Transfer of underground water allocations	135
2.5. Environmental water requirements and provisions for watercourses across the plains	60	7.4. Transfer of surface water and watercourse water allocations	136
2.5.1. Environmental water provisions from SA Water reservoirs	62	8. Permits	137
3. Effects on other water resources	63	8.1. Objectives	137
3.1. McLaren Vale PWA	63	8.2. General permit criteria	137
3.2. Central Adelaide PWA	63	8.3. Well permits	138
		8.4. Draining and discharging water into a well	139
		8.5. Water storages and diversions	141
		8.6. Commercial forestry	144

9. Monitoring and evaluation	147	Figure 5.1	Underground water management zones of the South Para River catchment	75
10. Recommendations for other plans or legislation	153	Figure 5.2	Underground water management zones of the Little Para River catchment	76
10.1. Introduction	153	Figure 5.3	Underground water management zones of the River Torrens catchment	77
10.2. Development regulations	153	Figure 5.4a	Underground water management zones of the (Northern) Onkaparinga catchment	78
10.3. Better Development Plan Project	153	Figure 5.4b	Underground water management zones of the (Southern) Onkaparinga catchment	79
10.4. Council development plans	153	Figure 5.5	Underground water management zones of the Fleurieu Peninsula catchments	80
10.5. Land and Business (Sale and Conveyancing) Regulations 2010	154	Figure 5.6	Surface water management zones of the Little Para River catchment	86
11. Abbreviations	155	Figure 5.7	Main watercourses of the Little Para River catchment	87
12. References	156	Figure 5.8a	Surface water management zones of the (Northern) South Para River catchment	88
Appendix A – Glossary	157	Figure 5.8b	Surface water management zones of the (Eastern) South Para River catchment	89
Appendix B – Other figures	166	Figure 5.8c	Surface water management zones of the (Central) South Para River catchment	90
Appendix C – F- values for Fleurieu Peninsula catchments	168	Figure 5.9	Main watercourses of the South Para River catchment	91
Appendix D – Fleurieu Peninsula Catchments mean annual rainfall	169	Figure 5.10a	Surface water management zones of the (Eastern) River Torrens catchment	92
Appendix E – Unit threshold flow rates for Fleurieu Peninsula catchments	170	Figure 5.10b	Surface water management zones of the (Western) River Torrens catchment	93
FIGURES		Figure 5.11	Main watercourses of the River Torrens catchment	94
Figure 1.1 Western Mount Lofty Ranges PWRA	9	Figure 5.12a	Surface water management zones of the (Upper Northern) Onkaparinga River catchment	95
Figure 1.2 Catchments in the Western Mount Lofty Ranges PWRA	10	Figure 5.12b	Surface water management zones of the (Northern) Onkaparinga River catchment	96
Figure 1.3 South Para River catchment	12	Figure 5.12c	Surface water management zones of the (Central) Onkaparinga River catchment	97
Figure 1.4 Little Para River catchment	13	Figure 5.12d	Surface water management zones of the (Southern) Onkaparinga River catchment	98
Figure 1.5 River Torrens catchment	14	Figure 5.13	Main watercourses of the Onkaparinga River catchment	99
Figure 1.6 Onkaparinga River catchment	15	Figure 5.14a	Surface water management zones of the (Northern) Willunga Basin catchment	100
Figure 1.7 Willunga Basin catchment	16	Figure 5.14b	Surface water management zones of the (Western) Willunga Basin catchment	101
Figure 1.8 Myponga River catchment	17	Figure 5.14c	Surface water management zones of the (Central) Willunga Basin catchment	102
Figure 1.9 Hindmarsh and Inman Rivers catchment	18	Figure 5.14d	Surface water management zones of the (Southern) Willunga Basin catchment	103
Figure 1.10 Fleurieu Coastal catchment	19	Figure 5.15	Main watercourses of the Willunga Basin catchment	104
Figure 1.11 Gawler River Prescribed Watercourse	21			
Figure 1.12 Little Para Proclaimed Watercourse	21			
Figure 1.13 River Torrens/Karrawirra Parri Prescribed Watercourse	22			
Figure 1.14 Onkaparinga River Prescribed Watercourse	22			
Figure 2.1 Flow types	24			
Figure 2.2 Reach types	27			
Figure 2.3 Fleurieu wetlands	59			
Figure 2.4 Central Hills wetlands	61			
Figure 3.1 Neighbouring Prescribed Areas	64			
Figure 4.1 Estimated total irrigated land area by crop type	70			

Figure 5.16	Surface water management zones of the Fleurieu Peninsula catchment	105	Table 4.5b	Irrigation land use change in the Fleurieu Peninsula Region 1970-2004	71
Figure 5.17	Main watercourses of the Myponga River catchment	106	Table 5.1	Underground water extraction limits in the South Para River catchment	81
Figure 5.18	Main watercourses of the Hindmarsh and Inman Rivers catchment	107	Table 5.2	Underground water extraction limits in the Little Para River catchment	81
Figure 5.19	Main watercourses of the Fleurieu Coastal catchment	108	Table 5.3	Underground water extraction limits in the River Torrens catchment	82
Figure 5.20	Watercourse water management zones of the Gawler River Prescribed Watercourse	122	Table 5.4	Underground water extraction limits in the Onkaparinga River catchment	83
Figure 5.21	Watercourse water management zones of the Little Para Proclaimed Watercourse	123	Table 5.5	Underground water extraction limits in the Fleurieu Peninsula catchments	83
Figure 5.22	Watercourse water management zones of the River Torrens/Karrawirra Parri Prescribed Watercourse	124	Table 5.6	Extraction and diversion limits for the surface water management zones of the South Para River catchment	109
Figure 5.23	Watercourse water management zones of the Onkaparinga River Prescribed Watercourse	125	Table 5.7	Extraction and diversion limits for the surface water management zones of the Little Para River catchment	111
Figure B.1	Third order (and above) watercourses	166	Table 5.8	Extraction and diversion limits for the surface water management zones of the River Torrens catchment	112
Figure B.2	Third order (and above) watercourses underlain by Permian Sand Aquifers	167			
TABLES			Table 5.9	Extraction and diversion limits for the surface water management zones of the Onkaparinga River catchment	114
Table 2.1	Flow types	24			
Table 2.2	Reach types	26	Table 5.10	Extraction and diversion limits for the surface water management zones of the Willunga Basin catchment	117
Table 2.3	Native and exotic fish species in the Prescribed Area and their functional groupings	29	Table 5.11	Extraction and diversion limits for the surface water management zones of the Fleurieu Peninsula catchments	119
Table 2.4	Environmental water requirements for fish in the Mount Lofty Ranges	30	Table 5.12	Extraction limit for the watercourse water management zone of the Gawler River	121
Table 2.5	Environmental water requirements for macroinvertebrates in the Mount Lofty Ranges	36	Table 5.13	Extraction limits for the watercourse water management zones of the Little Para Proclaimed Watercourse	121
Table 2.6	Environmental water requirements for plants in the Mount Lofty Ranges: Two-part table: 1 Semi-aquatic functional groups; 2 Aquatic functional groups	41	Table 5.14	Extraction limits for the watercourse water management zones of the River Torrens/Karrawirra Parri	121
Table 2.7	Measurable indicators	48	Table 5.15	Extraction limits for the watercourse water management zones of the Onkaparinga River	121
Table 2.8	Measurable indicators passed	53	Table 8.1	Water affecting activities	137
Table 4.1	Irrigation land use change in the Central Hills region 1970–2000	68	Table 9.1	Regional NRM Plan 20 year targets	148
Table 4.2	Irrigation land use change in the Fleurieu Peninsula region 1970–2000	68	Table 9.2	Monitoring, evaluation and review framework	149
Table 4.3	Capacity of reservoirs in the Prescribed Area	69	Table 9.3	Underground water monitoring	151
Table 4.4	Irrigated area of crops – existing user applications by catchments in the Prescribed Area	70	Table 9.4	Surface water and watercourse monitoring	151
Table 4.5a	Irrigation land use change in the Central Hills region 1970–2004	71	Table 9.5	Schedule of reporting	152

1 Introduction

1.1. THE PRESCRIBED AREA

The Prescribed Area managed by this water allocation plan (this plan) covers the water resources of: Western Mount Lofty Ranges Prescribed Water Resources Area (PWRA) and the Little Para Proclaimed Watercourse.

The three types of water resources in the Prescribed Area managed by this plan are underground water, surface water and watercourses.

1.1.1. Western Mount Lofty Ranges Prescribed Water Resources Area

By regulation made pursuant to the *Natural Resources Management Act 2004* (NRM Act) on 20 October 2005, the wells, surface water and watercourses in the following areas were declared to be prescribed water resources:

- Western Mount Lofty Ranges Prescribed Wells Area (PWA)
- Western Mount Lofty Ranges Surface Water Area
- Western Mount Lofty Ranges Prescribed Watercourses.

These areas are collectively referred to as 'Western Mount Lofty Ranges PWRA' and cover a total area of approximately 2750 km² from Gawler in the north, to Middleton and across to Cape Jervis on the south coast (Figure 1.1).

Western Mount Lofty Ranges PWRA has been divided into eight catchments based on surface water catchment boundaries (Figure 1.2):

- South Para River catchment
- Little Para River catchment
- River Torrens catchment
- Onkaparinga River catchment
- Willunga Basin catchment
- Myponga River catchment
- Hindmarsh and Inman rivers catchment
- Fleurieu coastal catchment.

The Western Mount Lofty PWRA also includes three watercourses as they cross the Adelaide Plains to Gulf St Vincent:

- Gawler River – downstream of the junction of North Para River and South Para River
- River Torrens/Karrawirra Parri – downstream of Gorge Weir
- Onkaparinga River – downstream of Clarendon Weir.

These watercourses, together with the portion of Little Para Proclaimed Watercourse that is downstream of Little Para Reservoir, are referred to as 'watercourses across the plains'.

1.1.2. Little Para Proclaimed Watercourse

By proclamation made pursuant to the *Water Resources Act 1976* on 19 January 1978, Little Para River was declared to be a 'proclaimed watercourse'. Little Para Proclaimed Watercourse, which is a prescribed watercourse for the purposes of the NRM Act, extends from a point upstream of Little Para Reservoir to Port Wakefield Road (Figure 1.1).

A water allocation plan has never been adopted for Little Para Proclaimed Watercourse, and because it is directly hydrologically connected to water resources in the Western Mount Lofty Ranges PWRA, it is included in this plan.

The portion of Little Para Proclaimed Watercourse that is upstream of the Little Para Reservoir is located within Western Mount Lofty Ranges PWRA (Little Para River catchment – Figure 1.1) and is managed in the same way as the other watercourses in that area. The portion of Little Para Proclaimed Watercourse that is downstream of Little Para Reservoir is managed in the same way as the other watercourses across the Adelaide Plains.

1.2. MCLAREN VALE PRESCRIBED WELLS AREA

McLaren Vale PWA is located wholly within the boundaries of the Prescribed Area. By regulation made on 24 December 1998, all existing and future wells within McLaren Vale PWA (which included the former Willunga Basin PWA) were declared to be prescribed wells.

The first water allocation plan for McLaren Vale PWA (providing for the allocation of underground water) was adopted in 2000. Following a review of that plan in 2003, the Minister for Environment and Conservation adopted a new water allocation plan for the McLaren Vale PWA on 17 February 2007.

This plan does not replace or otherwise affect the water allocation plan for McLaren Vale PWA, or water licences to take underground water in that area. The allocation of underground water in McLaren Vale PWA, and transfers and other dealings with water allocations in that area, will continue to be assessed against the objectives and principles in the water allocation plan for McLaren Vale PWA. Surface water and watercourse water in Willunga Basin catchment will be allocated in accordance with the objectives and principles in this plan.



Figure 1.1 Western Mount Lofty Ranges PWRA

Legend

- Western Mount Lofty Ranges Prescribed Water Resources Area
- Prescribed watercourse

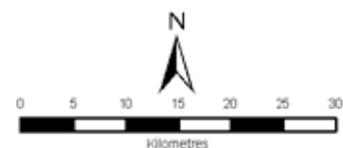
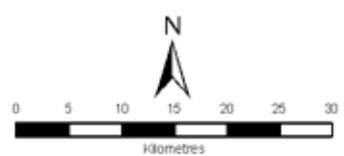




Figure 1.2 Catchments in Western Mount Lofty Ranges PWRA

Legend

- Catchments
- Western Mount Lofty Ranges Prescribed Water Resources Area
- Prescribed watercourses



1.3. WATER ALLOCATION PLANNING

Under the NRM Act, Adelaide and Mount Lofty Ranges Natural Resources Management Board (the board) must prepare a water allocation plan for each of the prescribed water resources in its region. A water allocation plan provides for the allocation and use of water, and for the transfer of and other dealings with water allocations. It is essential to protect the economic, social and environmental needs of the Prescribed Area for future generations and to provide secure and equitable access to water for all users.

In accordance with section 78 of the NRM Act, the board prepared the 'Concept Statement for the Western Mount Lofty Ranges Water Allocation Plan' in August 2006. The concept statement set out the proposed content of this plan and identified issues and topics for community discussion and consultation during its development. This plan is based on the concept statement and has taken into account community feedback on the concept statement.

1.3.1. Water licences and allocations

Water licences in the Prescribed Area will include a quantity of water determined under the provisions of this plan or the NRM Act (see Sections 1.3.2 and 1.3.3). The holder of a licence is entitled to obtain an annual water allocation equal to the relevant amount provided on the licence. A water allocation is an authorisation under the NRM Act to take water from a prescribed water resource.

1.3.2. Existing users

Water licences will be granted to existing users through an associated but independent process that has been undertaken in parallel to the development of this plan.

Existing users are entitled to a water licence with a quantity of water before water is allocated for new use. In the Prescribed Area, an existing user is a person who:

- took water at any time during the period 1 July 2001 to 13 October 2004 (inclusive); or
- needs water for a development, project or undertaking to which they were legally committed or in respect of which they had, in the opinion of the Minister for Sustainability, Environment and Conservation (the Minister), committed significant financial or other resources between 1 July 2001 and 13 October 2004; and
- applied for a water licence on or before 20 April 2006.

The entitlements of existing users are determined in accordance with section 164N of the NRM Act. An allocation to an existing user is therefore not assessed on the objectives and principles for the allocation of water in Section 6 of this plan.

However, the objectives and principles dealing with the transfer of water licences and water allocations, and the variation of water licences, apply to all future dealings with water licences and allocations.

1.3.3. New use

Any water that is available after the entitlements of existing users are met may be allocated in accordance with the objectives and principles in this plan.

1.4. WATER RESOURCES AND CATCHMENTS IN THE PRESCRIBED AREA

1.4.1. Types of water resources

The three types of water resources in the Prescribed Area managed by this plan are underground water, surface water and watercourse water.

Underground water

The NRM Act defines 'underground water' to mean:

- (a) 'water occurring naturally below ground level;
- (b) water pumped, diverted or released into a well for storage underground'.

Surface water

The NRM Act defines 'surface water' to mean:

- (a) 'water flowing over land (except in a watercourse) –
 - (i) after having fallen as rain or hail or having precipitated in any other manner; or
 - (ii) 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;
- (c) water of the kind referred to in paragraph (a) that is contained in any stormwater infrastructure'.

The NRM Act defines 'land' (referred to in paragraph (a) of the above definition) to include 'any building or structure fixed to land'. Runoff from roofs and other structures is therefore surface water for the purposes of the NRM Act.

Watercourse water

The NRM Act defines 'watercourse' to mean: 'a river, creek or other natural watercourse (whether modified or not) in which water is contained or flows whether permanently or from time to time and includes –

- (a) a dam or reservoir that collects water flowing in a watercourse;
- (b) a lake through which water flows;
- (c) a channel (but not a channel declared by regulation to be excluded from the ambit of this definition) into which the water of a watercourse has been diverted;
- (d) part of a watercourse;
- (e) an estuary through which water flows;
- (f) any other natural resource, or class of natural resource, designated as a watercourse for the purposes of this Act by an NRM plan.'

1.4.2. Central Hills catchments

South Para River catchment

South Para River catchment (Figure 1.3) covers 344 km². It is located approximately 40 km north-east of Adelaide, and includes the towns of Gawler and Williamstown, extending towards Springton and Kersbrook.

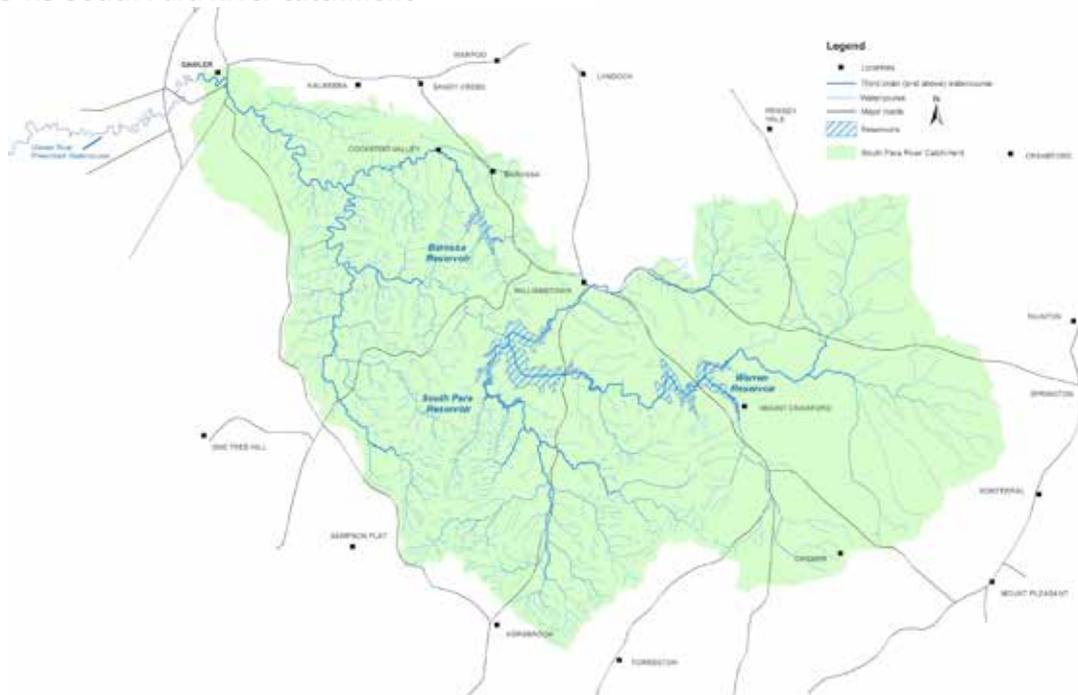
Underground water

South Para River catchment is underlain mostly by fractured rock aquifers comprising Adelaidean sediments and Barossa Complex, with small areas of Kanmantoo Group. Of these, the Adelaidean sedimentary rocks found in the centre and far north-western areas of the catchment are the most favourable for underground water recharge rates, salinity levels and yield. Barossa Complex rocks, found in the south-west and centre of the catchment, typically provide lower water quality and poorer yields and are less suited for irrigation. The Kanmantoo Group rocks found in the far north-east of the catchment typically provide low water quality and poor yields.

Surface water and watercourse water

Average annual rainfall in the catchment is 613 mm, varying between 450 mm at Gawler and 750 mm around the Mount Crawford Forest area. Parts of South Para River catchment supply water to Warren, South Para and Barossa reservoirs, which have a total combined capacity of 54,635 ML. South Para River headwaters are near Mount Crawford. The river flows north-west through the Para Fault Escarpment before meeting North Para River at Gawler where it becomes the Gawler River.

Figure 1.3 South Para River catchment



Little Para River catchment

Little Para River catchment (Figure 1.4), the smallest catchment in the Prescribed Area, covers 87 km². It is located approximately 25 km north-east of Adelaide, and includes the towns of Upper Hermitage and Inglewood, and extends to Mount Gawler and Paracombe.

Underground water

Little Para River catchment is underlain mostly by fractured rock aquifers comprising Adelaidean sedimentary rock. These favoured sedimentary rocks are found across most of the catchment, with some small sedimentary aquifers of alluvial deposits found in the valley floors.

Surface water and watercourse water

Average annual rainfall in the catchment is 650 mm, varying between 550 mm around the Little Para Reservoir and 750 mm near Mount Gawler and Inglewood. Little Para River catchment partially supplies water to Little Para Reservoir, which has a capacity of 20,800 ML and functions mainly as a storage facility for River Murray water. Little Para River headwaters are near Upper Hermitage from which the river flows north-west into Little Para Reservoir, then west to the Adelaide Plains.

Figure 1.4 Little Para River catchment



River Torrens catchment

The River Torrens catchment (Figure 1.5), covering 341 km², is located approximately 30 km east of Adelaide, and extends from Kersbrook in the north to Summertown in the south, and beyond Mount Pleasant to the east.

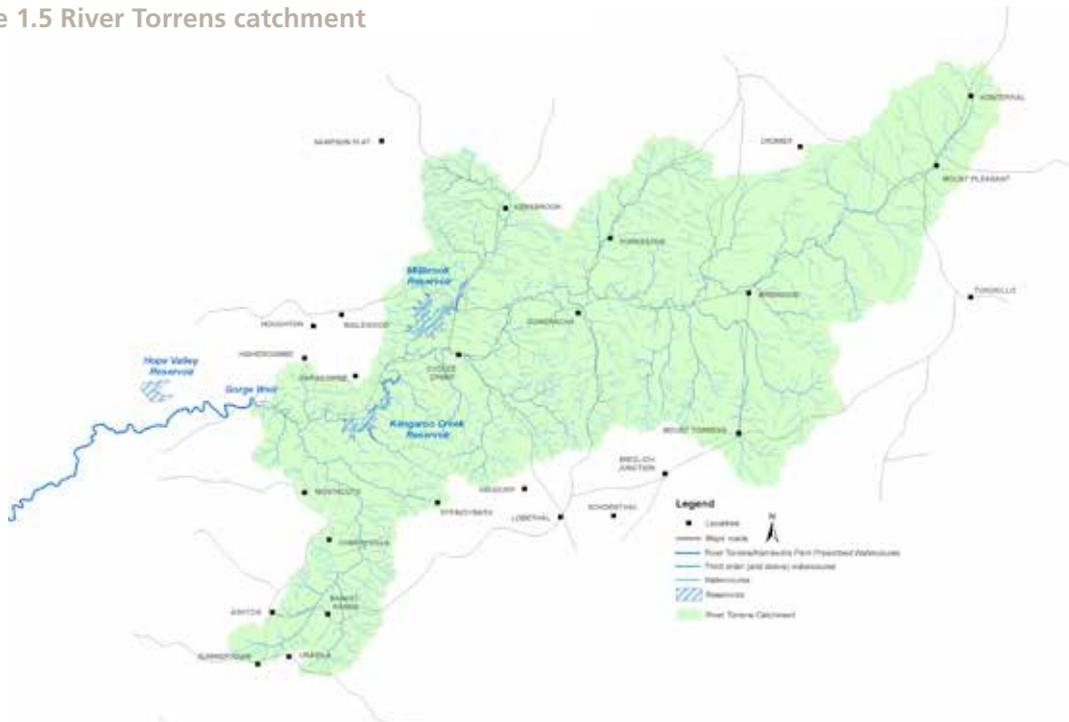
Underground water

The catchment is underlain mostly by fractured rock aquifers comprising Adelaidean sedimentary rock, with small areas of the Barossa Complex and Kanmantoo Group. The favoured Adelaidean sedimentary rocks are found across most of the catchment, with the lower performing Barossa Complex rocks found only in the north-west between Kangaroo Creek Reservoir and Kersbrook. The Kanmantoo Group rocks are found only east of Birdwood.

Surface water and watercourse water

Average annual rainfall in the catchment is 770 mm, varying between 700 mm east of Birdwood and 1000 mm near Summertown. Parts of River Torrens catchment supply Millbrook and Kangaroo Creek reservoirs, which have a total capacity of 16,500 ML and 19,160 ML respectively. Both reservoirs supply water to the Hope Valley Reservoir, which has a total capacity of 2840 ML. River Torrens/Karrawirra Parri headwaters are near Mount Pleasant. The river flows south-west past Gumeracha, down to the Gorge Weir, before entering the Adelaide Plains.

Figure 1.5 River Torrens catchment



Onkaparinga River catchment

Onkaparinga River catchment (Figure 1.6) covers 516 km² and is located approximately 25 km east and south-east of Adelaide. It includes the towns of Lobethal, Summertown, Hahndorf and Echunga, extending down beyond Kangarilla and to the coast near Port Noarlunga.

Underground water

Onkaparinga River catchment is underlain mostly by fractured rock aquifers comprising Adelaidean sedimentary rock, but some areas are composed of the Barossa Complex and Kanmantoo Group. The favoured Adelaidean sedimentary rocks are found across most of the catchment. The lower performing Barossa Complex rocks are found in the north-west of the catchment near Uraidla, as well as east of Oakbank. Kanmantoo Group rocks are found only east of Lobethal. Some small sedimentary aquifers of alluvial deposits are found in the valley floors. Part of McLaren Vale PWA (around the Kangarilla area) falls within the Onkaparinga River catchment boundary (see Section 1.2).

Surface water and watercourse water

Average annual rainfall in the catchment is 850 mm, varying between 800 mm at Oakbank and Kangarilla, and 1000 mm at Uraidla, with areas adjacent to Willunga Basin catchment decreasing to 500 mm at the coast. Onkaparinga River catchment supplies Mount Bold Reservoir, which has a capacity of 46,180 ML, making it the largest reservoir in the Prescribed Area. Water captured by the Mount Bold Reservoir is also diverted to Happy Valley Reservoir, which has a capacity of 11,600 ML. Onkaparinga River is the third largest watercourse in South Australia. Its headwaters are near Charleston and it flows south-west past Oakbank and Mylor down to Clarendon Weir and Onkaparinga Gorge, before entering Gulf St Vincent at Port Noarlunga South.

Figure 1.6 Onkaparinga River catchment



1.4.3. Willunga Basin and Fleurieu Peninsula catchments

Willunga Basin catchment

Willunga Basin catchment (Figure 1.7) covers 262 km². It is located approximately 40 km south of Adelaide, and includes the towns of Blewitt Springs and Willunga, extending south to Mount Terrible and beyond Sellicks Beach along the coast.

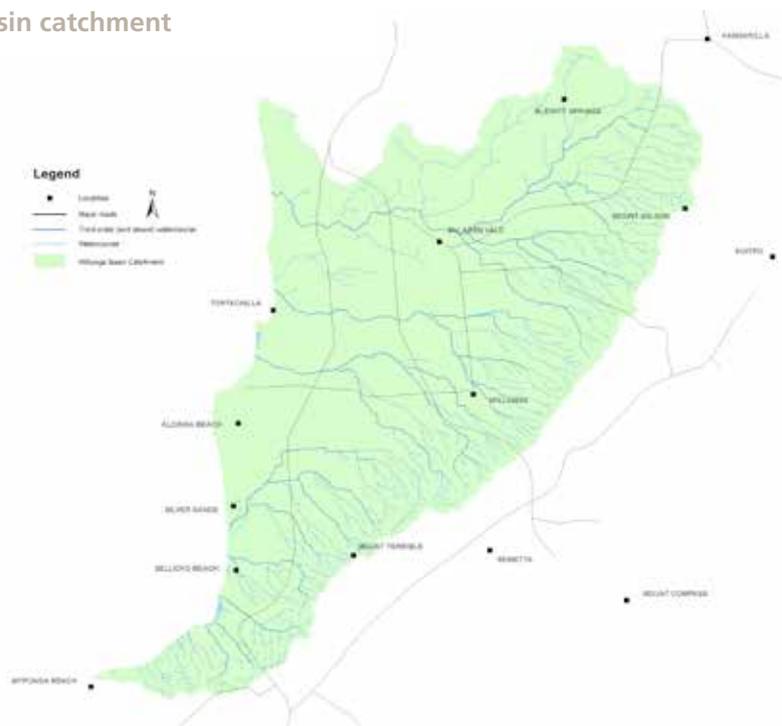
Underground water

Underground water resources in Willunga Basin catchment are managed by (and described in) the water allocation plan for the McLaren Vale PWA (see Section 1.2).

Surface water and watercourse water

Average annual rainfall in the catchment is 700 mm, varying between 850 mm at Mount Wilson and 550 mm at Silver Sands. Willunga Basin catchment is an elevated coastal plain and, unlike the other catchments, has no major rivers. The most significant watercourses in this catchment are Pedler, Ingleburn (Maslin), Port Willunga and Sellicks creeks, all of which flow westwards to the coast.

Figure 1.7 Willunga Basin catchment



Myponga River catchment

Myponga River catchment (Figure 1.8) covers 138 km² and is located approximately 50 km south of Adelaide, and includes the areas behind Sellicks Hill Range, out to Myponga Hill and Myponga Beach.

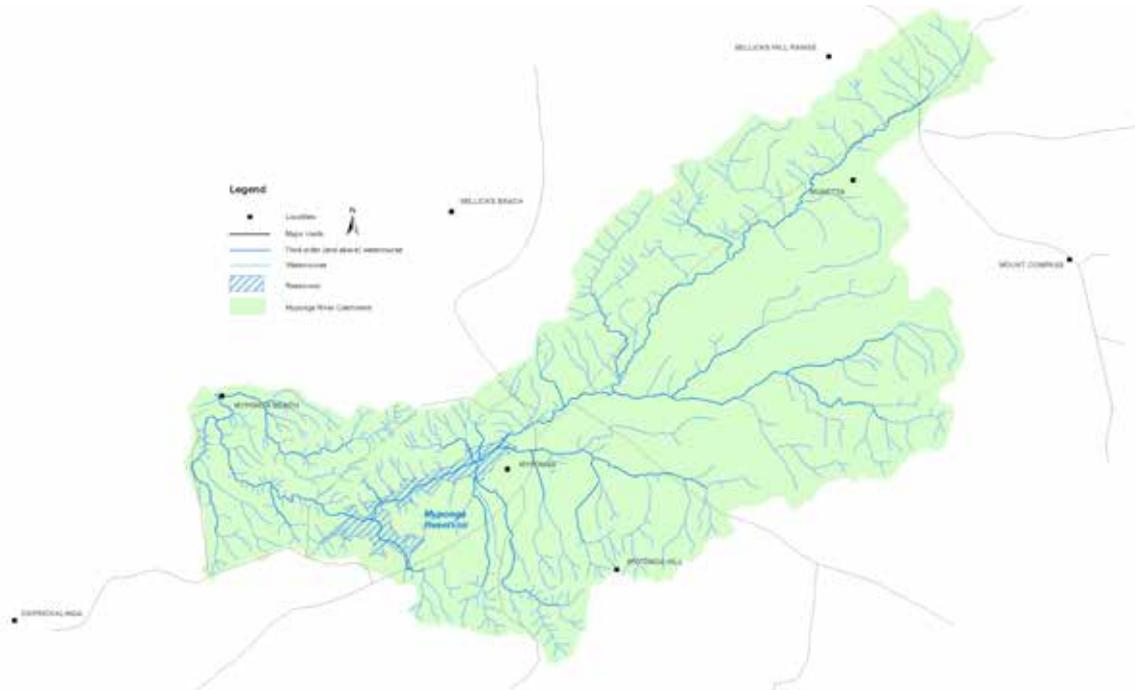
Underground water

Myponga River catchment is underlain by sedimentary aquifers comprising Permian Sand, Tertiary Limestone and Quaternary sediments, with some fractured rock aquifers around the catchment boundary. The Tertiary Limestone, in a limited area to the east of Myponga Reservoir, is by far the most productive aquifer with high yields and low salinity. Permian Sand aquifers, which also typically provide good yields and low salinity, are found in the higher areas north-east of the reservoir. Extensive areas of fractured rock, with the favoured Adelaidean sedimentary rocks, are found throughout Sellicks Hill Range. Small areas of lower quality water in fractured rocks of the Barossa Complex are found along the eastern boundary of the catchment, and in the Kanmantoo Group along the coastal boundary.

Surface water and watercourse water

Average annual rainfall in the catchment is 760 mm, varying between 750 mm at Myponga Beach and 850 mm around Myponga Hill. Part of Myponga River catchment supplies water to Myponga Reservoir, which has a capacity of 26,800 ML. Myponga River headwaters are near the intersection of Pages Flat Road and the Adelaide to Victor Harbor Road. The river flows south-west behind Sellicks Hill Range through Myponga, and then west to the coast at Myponga Beach.

Figure 1.8 Myponga River catchment



Hindmarsh and Inman rivers catchment

Hindmarsh and Inman rivers catchment (Figure 1.9) covers 373 km². It is located approximately 65 km south of Adelaide, and includes the area south of Spring Mount Road, extending down to Range Road and towards the coast to include the towns of Middleton and Victor Harbor.

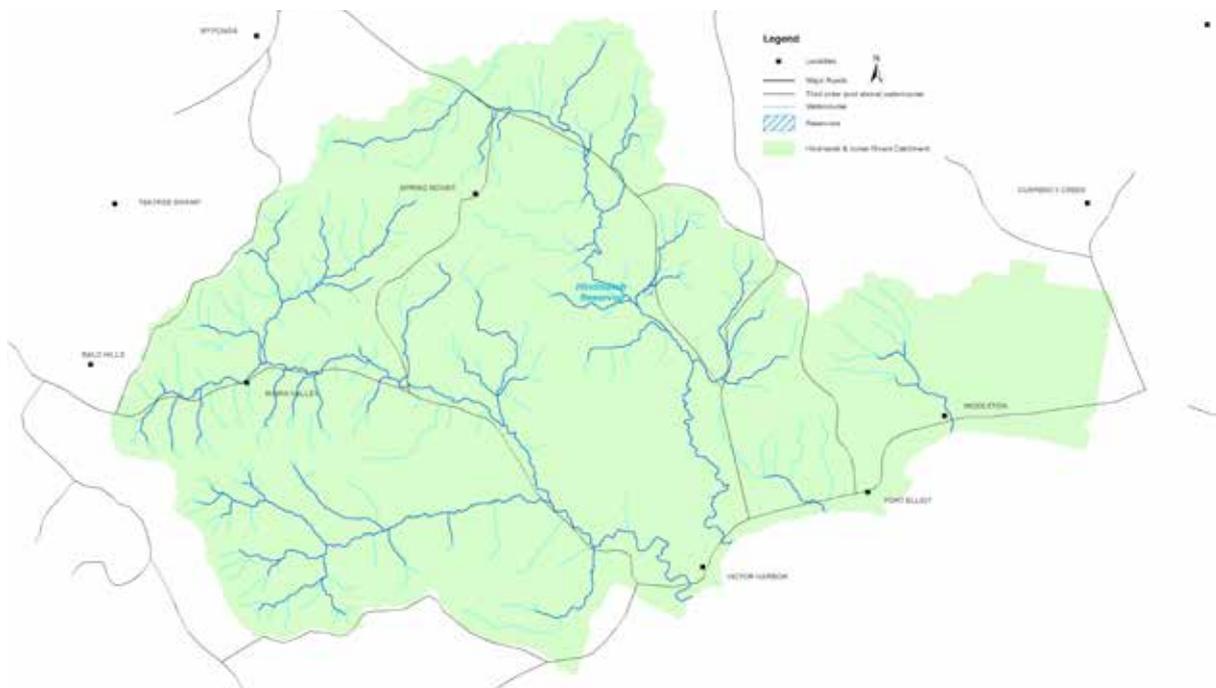
Underground water

Hindmarsh and Inman rivers catchment is underlain mostly by sedimentary aquifers comprising Permian Sand, Tertiary Limestone and, to a lesser extent, Quaternary sediments, with some fractured rock aquifers around the catchment boundary. The most well developed aquifers are in the Tertiary Limestone in central Hindmarsh Tiers area, which typically has high yields and low salinity. The Permian Sand aquifers are found mainly in the southern parts of the catchment. Some small areas of fractured rock aquifers lie within the favoured Adelaidean sedimentary rocks and poorer Barossa Complex along the north-western boundary of the catchment. Poorer Kanmantoo Group fractured rock aquifers are found mainly in the southern part of Hindmarsh Tiers catchment and in the eastern lower catchment of Hindmarsh River.

Surface water and watercourse water

Average annual rainfall in the catchment is 770 mm, which varies between 900 mm at Spring Mount and 550 mm at Victor Harbor. Hindmarsh River headwaters are near Hindmarsh Tiers, and the river flows south towards Hindmarsh Valley, reaching the coast north of Victor Harbor. Inman River headwaters are near Bald Hills, and the river flows south-east across the catchment reaching the coast south of Victor Harbor. The catchment also supports many wetlands that are listed as critically endangered ecological communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (see Section 2.4.1).

Figure 1.9 Hindmarsh and Inman rivers catchment



Fleurieu Coastal catchment

Fleurieu Coastal catchment (Figure 1.10) comprises a group of smaller catchments on Fleurieu Peninsula and is the largest catchment in the Prescribed Area, covering 682 km². It is located approximately 75 km south of Adelaide, and includes the towns of Carrickalinga, Cape Jervis and Waitpinga.

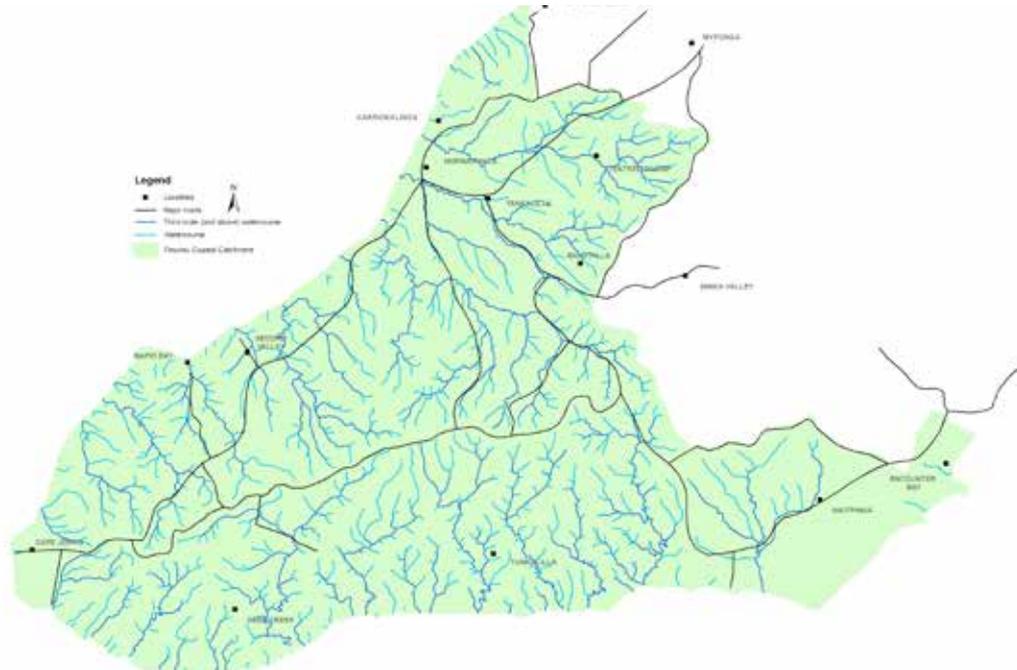
Underground water

Fleurieu Coastal catchment is underlain by fractured rock aquifers of the Kanmantoo Group, and sedimentary aquifers comprising Quaternary sediments and, to a lesser extent, Permian Sand. The Quaternary sediments and poorer Kanmantoo Group are found throughout the catchment, with the favoured Permian Sand aquifers mainly along the northern boundary. Some small areas of fractured rock aquifers, comprising Adelaidean sedimentary rocks in the area, lie to the north of Delamere and towards the coast.

Surface water

Average annual rainfall in the catchment is 750 mm, varying between 500 mm at Carrickalinga and 900 mm in the central subcatchments. Fleurieu Coastal catchment is comparable to Willunga Basin catchment in so far as it has no major rivers or reservoirs. The catchment disperses water from the central plateau to Gulf St Vincent to the north, and to Encounter Bay, Backstairs Passage and the Southern Ocean to the south. The catchment also supports many wetlands that are listed as critically endangered ecological communities under the EPBC Act (see Section 2.4.1).

Figure 1.10 Fleurieu Coastal catchment



1.4.4. Watercourses across the plains

The Prescribed Area includes four main watercourses as they cross the Adelaide Plains to Gulf St Vincent. These watercourses receive water from reservoir overflow and releases and surface water runoff, including stormwater from urban areas, from the surrounding non-prescribed areas.

Gawler River

Gawler River – downstream of the junction of the North Para River and the South Para River (Figure 1.11) – flows west through Gawler West, past Angle Vale, and out to the coast at Port Gawler. Across the Adelaide Plains, Gawler River traverses areas that are primarily rural in land use. The Gawler–Two Wells–Virginia floodplain has had major floods on average once in every ten years in the past 115 years. A flood mitigation dam on the North Para River was consequently constructed and opened in 2008.

Little Para River

Little Para River – downstream of Little Para Reservoir (Figure 1.12) – flows westerly across the Adelaide Plains through Salisbury into Barker Inlet, one of South Australia's largest estuaries. The estuary provides an important habitat for mangroves, seagrasses, birds and fish, and nursery area for various fish and crustacean species. The lower reaches of Little Para River have been extensively affected by urban stormwater runoff, as well as grazing land use, with fertilisers and animal waste washing into the river.

River Torrens–Karrawirra Parri

River Torrens–Karrawirra Parri – downstream of the Gorge Weir (Figure 1.13) – flows south-west out of Highbury, past Walkerville, into the City of Adelaide and Torrens Lake, past Thebarton, and out to the coast at West Beach. Across the Adelaide Plains the river has been highly modified for additional flood protection, and developed into a linear park. In its lower reaches this modification has been through a new breakout channel with high training banks. Along its course through urbanised areas, the river receives high and increasing volumes of surface water runoff.

Onkaparinga River

Onkaparinga River – downstream of the Clarendon Weir (Figure 1.14) – flows south-west out of Clarendon, into Onkaparinga Gorge, to Old Noarlunga, and then out to the coast at Port Noarlunga South. Across the Adelaide Plains, Onkaparinga River traverses both urban and rural land use areas. The catchments on its northern side that contribute to the flow in the river are not within the Prescribed Area (see Figure 5.23). Diversion from Clarendon Weir to Happy Valley Reservoir has made significant changes to natural flow conditions downstream of the weir, which thus overflows only during flood events.

Figure 1.11 Gawler River Prescribed Watercourse



Figure 1.12 Little Para Proclaimed Watercourse



Figure 1.13 River Torrens/Karrawirra Parri Prescribed Watercourse



Figure 1.14 Onkaparinga River Prescribed Watercourse



2 Needs of water - dependent ecosystems

2.1. INTRODUCTION

2.1.1. Environmental water requirements and provisions

Environmental water requirements

Section 76(4)(a)(i) of the *Natural Resources Management Act 2004* (NRM Act) provides that a water allocation plan must include an assessment of the quantity and quality of water needed by the ecosystems that depend on the water resource and the times at which, or the periods during which, those ecosystems will need that water.

Section 76(4)(aab) of the NRM Act also requires a water allocation plan to include:

- (i) an assessment of the capacity of the water resource to meet environmental water requirements;
- (ii) information about the water that is to be set aside for the environment including, insofar as is reasonably practicable, information about the quantity and quality, the time when that water is expected to be made available, and the type and extent of the ecosystems to which it is to be provided; and
- (iii) a statement of the environmental outcomes expected to be delivered on account of the provision of environmental water under the plan.

The NRM Act defines ‘environmental water requirements’ to mean “those water requirements that must be met in order to sustain the ecological values of ecosystems that depend on the water resource, including their processes and biodiversity, at a low level of risk”.

The environmental water requirements (EWRs) of water-dependent ecosystems in the Prescribed Area are assessed in Section 2.2, wetlands in Section 2.4 and watercourses across the Adelaide Plains in Section 2.5.

Environmental water provisions

Section 76(4)(b)(i) of the NRM Act provides that a water allocation plan must achieve an equitable balance between environmental, social and economic needs for water.

For the purposes of this plan ‘environmental water provisions’ mean “those parts of environmental water requirements that can be met at any given time”, with consideration of existing users’ rights and social and economic impacts.

Environmental water provisions for the Prescribed Area are described in Section 2.3, for wetlands in Section 2.4 and for watercourses across the plains in Section 2.5. The provisions for the Prescribed Area do not aim to return water-dependent ecosystems to a pristine condition, but to keep them at an acceptable level of risk. The surface water extraction limits in this plan have been set on the basis of the water regime needed to maintain water-dependent ecosystems in the Prescribed Area at an acceptable level of risk.

2.1.2. Water-dependent ecosystems

The Prescribed Area supports a diverse range of water-dependent ecosystems, which comprise an array of plant, animal and micro-organism communities and their non-living environment, whose functions depend on water. Water-dependent ecosystems include watercourses, riparian zones, wetlands, floodplains, estuaries and aquifer systems.

These ecosystems have a complex dependence on water availability and flow, and have evolved in response to the flow regime they have historically experienced. The total volume of water these systems receive is important for their survival; equally important is how and when that water is delivered.

2.1.3. Flow regime

The flow regime is the flow pattern seen in rivers, streams and wetlands, and has the basic components:

- magnitude – the depth of water delivered by a flow
- frequency – the number of times a flow occurs within a given period of time
- duration – the length of time of a flow
- timing – when flows occur within a given year.

Changes in the flow regime are likely to adversely affect the condition and composition of water-dependent ecosystems (Poff et al. 1997; Bunn and Arthington 2002; Lloyd et al. 2003).

To account for the timing component, flow regimes can be described for flow seasons. The flow seasons in the Prescribed Area, based on the natural flow distribution during the year, are:

- low flow season – generally constant low flows or no flow with shorter periods of high flow following significant rainfall events (typically December–April, and often May)
- high flow season – generally more frequent periods of higher flows, and higher baseflow (typically July–October)
- transitional seasons – the two seasons of transitional months between low and high flow seasons.

Each flow season has different flow types. Table 2.1 identifies the flow types used when describing EWRs.

TABLE 2.1 FLOW TYPES

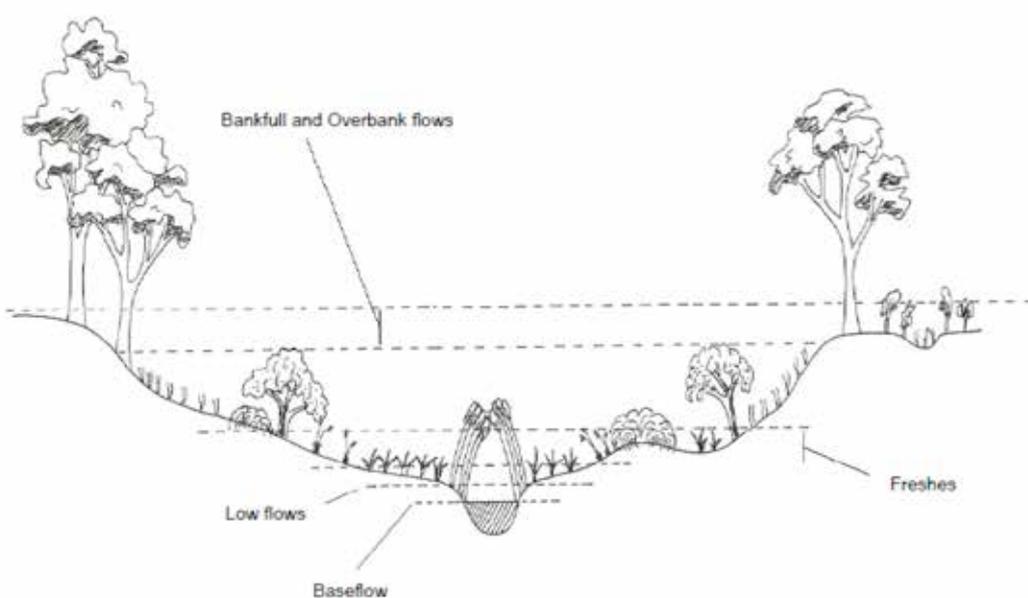
Flow type	Description
Zero flows	When no flows are recorded in the channel; during these periods, the stream may contract to a series of pools or ponds, or may dry out completely.
Low flows (low flow season)	Defined as the baseflow that maintains water flowing through the channel, keeping in-stream habitats wet and pools full; the permanence of flow in a stream is a product of the combination of low flows and zero flows.
Low flow freshes	Small and short duration high flow events that last for one to several days as a result of localised rainfall during the low flow season.
Low flows (high flow season)	The persistent increase in baseflow with the onset of the wet season (beginning in the transitional low to high flow season), lasting through to the end of the transitional high to low flow season (and start of the next low flow season).
High flow freshes	Long, sustained increases in flow during high flow season as a result of heavy rainfall events, which may last for a number of weeks, but are still contained within the channel.
Bankfull flows	Flows that fill the channel, but do not spill onto the floodplain (can occur any time but are more commonly associated with the high flow season).
Overbank flows	Higher flows than the bankfull flows that spill out of the channel onto the floodplain (can occur any time but are more commonly associated with the high flow season).

These flows induce and provide different ecological responses, for example:

- low flows and baseflow that keep refuge pools wet
- freshes that flush excess sediment from the watercourse
- flows that stimulate fish spawning
- bankfull and overbank flows that transport organic material into and along a watercourse.

Figure 2.1 shows where in a watercourse various flow types occur. Baseflow is discussed in detail in Section 2.2.1.

Figure 2.1 Flow types



2.2. ENVIRONMENTAL WATER REQUIREMENTS

The EWRs of water-dependent ecosystems in the Prescribed Area were determined through a project managed by the former Department of Water, Land and Biodiversity Conservation. The goal of these EWRs is to provide self-sustaining populations of aquatic and riparian flora and fauna, which are resilient to times of drought.

The EWRs were determined by an expert panel of state and national experts in ecology, hydrology, hydrogeology and geomorphology. They identified priority water-dependent biota and physical processes of the Mount Lofty Ranges, and determined their EWRs.

This section describes the EWRs in the Prescribed Area and assesses the capacity of the water resources to meet EWRs under current levels of water resources development. The information is based on the report by VanLaarhoven and van der Wielen (2009).

2.2.1. Underground water-dependent ecosystems

Surface water runoff, watercourse flows and underground water all contribute to the needs of water-dependent ecosystems in the Prescribed Area. Underground water may contribute to surface water runoff and watercourse flows by discharging to the surface as springs or baseflow, and some organisms (including stygofauna and phreatophytic vegetation) use the underground water while still below the surface.

The extent to which water-dependent ecosystems in the Prescribed Area rely on baseflow is largely unknown at a local scale, but many wetlands and pools are likely to be at least partially maintained by baseflow. Maintaining baseflow in watercourses is therefore a critical EWR in the Prescribed Area. The component of surface water runoff and watercourse flows derived from underground water has been taken into account when determining

environmental requirements (Teoh et al. In prep).

Limited information on the presence, distribution and water requirements of stygofauna and phreatophytic vegetation in the Prescribed Area mean it is currently not possible to assess their dependence on underground water and hence their EWRs. The focus of this section is therefore on EWRs supplied by surface water and watercourse water, which include contribution of baseflows from the underground water resources where identified.

2.2.2. Determining environmental water requirements

The aquatic species present in the Prescribed Area are well understood but information on their distribution is limited. To assess EWRs across the Prescribed Area, it was necessary to establish where the various water-dependent ecosystems were likely to occur, and then use known species information to determine the EWRs at these locations.

This process considered two key factors:

- reach types – lengths of watercourses that have similar geomorphology, hydrology and key habitats (such as permanent pools and baseflow) that are considered to support similar water-dependent biota, ecosystems and processes
- functional groups – species deemed to have similar EWRs.

Reach types

The particular characteristics of reach type enables them to be dissociated from one another. The physical form and behaviour of a watercourse provides the basis for the ecological processes that occur. Watercourse geomorphology, together with information on where pools occur, their position in the catchment and rainfall, have been used to define the six key reach types in the Prescribed Area (Table 2.2). Figure 2.2 shows the location and examples of reach types in the Prescribed Area.

Each reach type is expected to support a given suite of habitats, which are known to support particular functional groups.

TABLE 2.2 REACH TYPES

Reach type	Description
Headwaters	Drainage paths located at the top of the catchment in the rocky or alluvial upstream areas of first and second order watercourses; mostly terrestrial or damp, with flows following rainfall events; some pools may persist if spring-fed or in wet catchments; provide runoff to downstream reaches and may provide baseflow or throughflow to downstream reaches
Upper pool riffle channel	Located in the upper catchments, include small to large pools connected by short riffles (shallow stretch of a river or stream where the current is faster than average and where the water forms small rippled waves as a result) or long runs; have distinct seasonal pattern with higher baseflows in the high flow season; freshes and bankfull flows associated with rainfall extend the surface area and water depth; occasional overbank flows spill onto the floodplain; aquatic habitats are present, including permanent or semi-permanent pools and moderate to high energy riffle and run habitats
Mid-pool riffle channel	Larger trunk streams in the upper to mid-catchments with small to large pools connected by short riffles or long runs; flow patterns are similar to the upper pool riffle channel, but with larger volumes because of the larger catchment areas; habitats include permanent pools and high energy riffle and run habitats
Gorge	Steeper tributary streams in the upper to mid-catchment with more aggressive flows and coarser substrates (bedrock, cobble, gravel and sand); includes persistent to semi-persistent pools with fast flows across riffles and runs; distinct seasonal pattern with higher baseflows in the high flow season; freshes and bankfull flows associated with rainfall extend the surface area and water depth
Lowland channel	Large low gradient channel, breaking out of the hills; consist of large and long pools separated by short run segments and occasional riffles; a 'losing' reach (where water is 'lost' from the stream to underground water) may consist of a small channel with few in-stream features; distinct seasonal pattern with higher baseflows in the high flow season; freshes and bankfull flows associated with rainfall extend the surface area and water depth; occasional overbank flows spilling out into the floodplain
Fleurieu wetlands (including Swamps of the Fleurieu Peninsula) and other wetlands in the Mount Lofty Ranges region	Land that is permanently or periodically inundated with water where the water may be static or flowing (may range from freshwater to saline water) and where the inundation with water influences organisms or ecological processes; typical flow regimes are generally low energy flow, continuously wet, with a seasonal increase in baseflow; flow may be provided by rainfall and interflow (perched wetlands), stream flow or underground water (Permian Sand wetlands, fractured rock wetlands) or a combination of sources; habitat types include permanently damp-wet environments, with or without standing water

Functional groups

A functional group comprises species that have similar life cycles, habitat requirements and EWRs.

Functional groups have been allocated to three well-studied biotic groups, selected to represent the diverse range of fauna and flora in the Prescribed Area:

- aquatic macroinvertebrates
- fish
- vegetation.

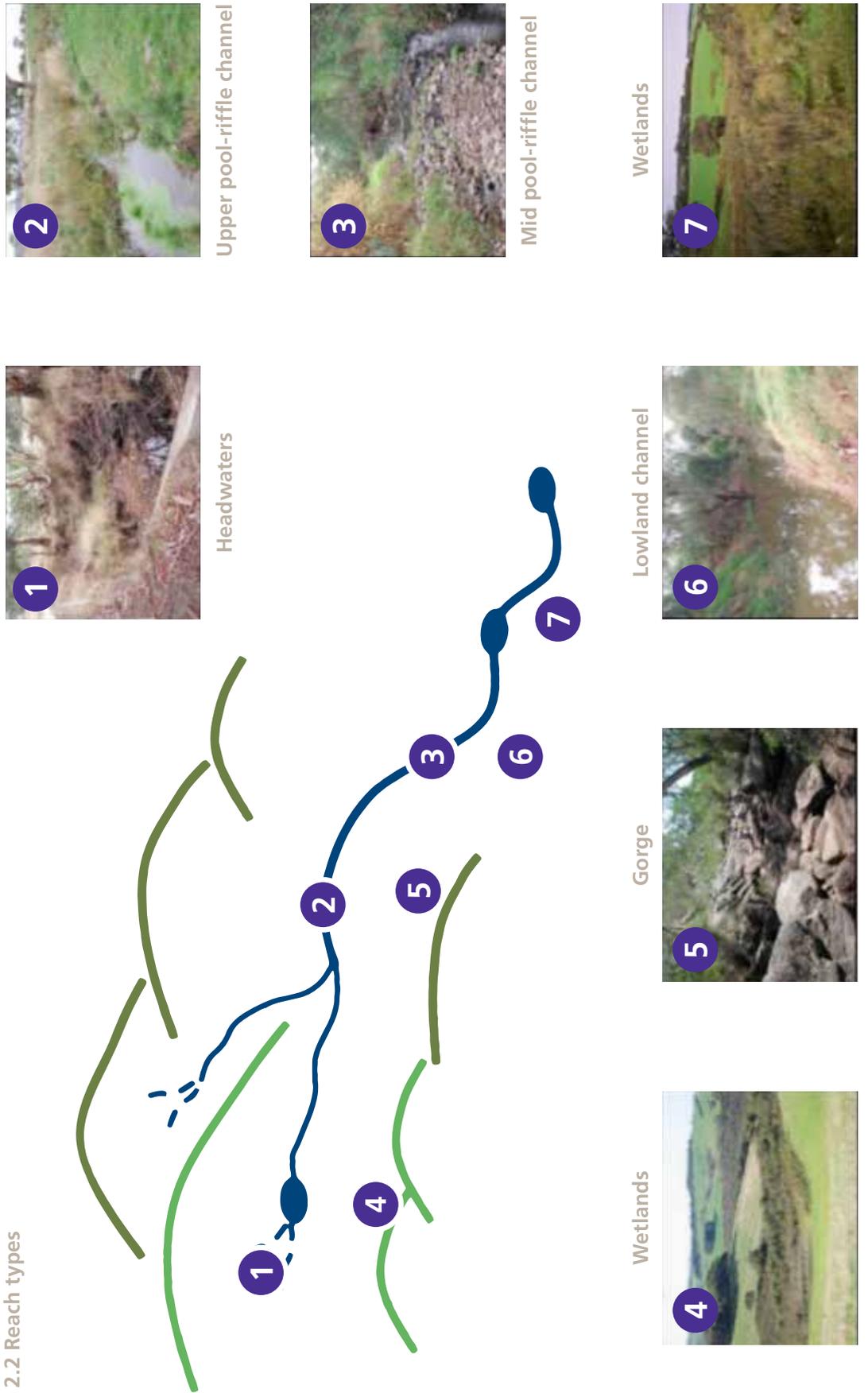
The functional groups in each of these three biotic groups, and their EWRs, are described below.

Fish

In the Mount Lofty Ranges, 30 native and 9 exotic freshwater fish species have been recorded. Three of the native species have conservation significance on a national scale, and 20 have conservation significance at the State scale. McNeil and Hammer (2007) have comprehensively reviewed fish of the Mount Lofty Ranges and their distribution.

Native freshwater fish of the Mount Lofty Ranges are of two broad types: resident freshwater species (remain in a small range in a catchment throughout their life); and migratory species (require extensive migration in a waterway, or from the waterway to the sea or estuary at some stage of their life cycle). Within these two

Figure 2.2 Reach types



broad types, five primary functional groups of native fish have been identified in the Mount Lofty Ranges (Hammer 2007; McNeil and Hammer 2007).

Resident freshwater species

Obligate freshwater, stream specialised: Species that have particular habitat or environmental requirements for survival, and are specialised to live in stream habitats; often found as the only species in a reach but are restricted to specific habitats; include Southern Pygmy Perch, Mountain Galaxias and River Blackfish.

Obligate freshwater, wetland specialised: Species that require particular habitats or environments for survival, and are specialised to live in wetland habitats; often found as rare species in diverse fish assemblages, being restricted to specific habitats in lowland or terminal stream reaches; include Yarra Pygmy Perch, Murray Hardyhead, Chanda Perch and Southern Purple-spotted Gudgeon.

Obligate freshwater, generalists: Mostly found in association with other species and occupy multiple habitats in a reach; the types of habitats present determine community composition and structure (and therefore water requirements); includes Gudgeon species, numerous species from terminal wetlands and euryhaline species like gobies.

Migratory freshwater species

Some fish species require migration to and from the sea or estuary as part of their life cycle such as Climbing Galaxias, Congolli, Common Galaxias and lampreys. Other species are known to move extensively but remain within freshwater systems for all life-cycle stages.

Fleurieu wetlands

A habitat-based group has also been described for the Fleurieu wetlands. Species in this group come from the different functional groups but the specific low energy nature of the habitat means that the water requirements are slightly different from the general functional group requirements. Species include Southern Pygmy Perch, River Blackfish and potentially Climbing Galaxias.

Table 2.3 lists the native and exotic fish species in the Prescribed Area.

Table 2.4 outlines the EWRs, grouped by flow season and flow component, required to support self-sustaining populations of these functional groups of fish, and the ecological processes the EWRs support (VanLaarhoven and van der Wielen 2009). Fish are reliant on other biotic groups and so the EWRs for these groups are also part of the requirements for fish. For example, many fish rely on macroinvertebrates as a food source (e.g. Lloyd 1987). Aquatic, in-stream, riparian and floodplain vegetation provide shade and habitat for fish survival, sources of terrestrial and aquatic macroinvertebrates (food), shelter during floods, and sites for spawning and recruitment (including indirectly through input of woody debris and leaf litter).

TABLE 2.3 NATIVE AND EXOTIC FISH SPECIES IN THE PRESCRIBED AREA AND THEIR FUNCTIONAL GROUPINGS

Functional group	Species	Scientific name	Cons status**		Record type#	
			Nat	State	SFP	WMLR
D	Pouched Lamprey	<i>Geotria australis</i>		EN	0	3
D	Shortheaded Lamprey	<i>Mordacia mordax</i>		EN	0	3
D	Shortfinned Eel	<i>Anguilla australis</i>		R	0	0
Fw	Freshwater Catfish	<i>Tandanus tandanus</i>		P, V		3*
Fg	Bony Herring	<i>Nematalosa erebi</i>				
Fg	Smelt	<i>Retropinna semoni</i>			0	
D	Climbing Galaxias	<i>Galaxias brevipinnis</i>		V	3	3
D	Common Galaxias	<i>Galaxias maculatus</i>			3	3
Fs	Mountain Galaxias 1	<i>Galaxias olidus</i>		R	0	3
Fs	Mountain Galaxias 2	<i>Galaxias</i> sp. 1		R	3	
Fg	Murray Rainbowfish	<i>Melanotaenia fluviatilis</i>		R		3*
Fg	Smallmouthed Hardyhead	<i>Atherinosoma microstoma</i>			3	3
Fw	Murray Hardyhead	<i>Craterocephalus fluviatilis</i>	VU	E		
Fg	Unspecked Hardyhead	<i>Craterocephalus stercusmuscarum fulvus</i>		R		
Fw	Chanda Perch	<i>Ambassis agassizii</i>		P, E		
Fs	River Blackfish	<i>Gadopsis marmoratus</i>		P, E	0	0
Fg	Murray Cod	<i>Maccullochella peelii peelii</i>	VU	R		1*
Fp	Murray–Darling Golden Perch	<i>Macquaria ambigua ambigua</i>				1*
Fs	Southern Pygmy Perch	<i>Nannoperca australis</i>	P, E	3		
Fw	Yarra Pygmy Perch	<i>Nannoperca obscura</i>	VU	P, E		
Fg	Silver Perch	<i>Bidyanus bidyanus</i>		P, V		1*
D	Congolli	<i>Pseudaphritis urvillii</i>		R	3	3
Fg	Midgley’s Carp Gudgeon	<i>Hypseleotris</i> sp. 1				3*
Fg	Murray–Darling Carp Gudgeon	<i>Hypseleotris</i> sp. 3		R	3	
Fg	Hybrid forms	<i>Hypseleotris</i> spp.			3	
Fw	Southern Purple-spotted Gudgeon	<i>Mogurnda adspersa</i>		P, E		2
Fg	Flathead Gudgeon	<i>Philypnodon grandiceps</i>			3	3
Fg	Dwarf Flathead Gudgeon	<i>Philypnodon</i> sp. 1		R	3	3?
Fg	Western Bluespot Goby	<i>Pseudogobius olorum</i>			3	3
Fg	Lagoon Goby	<i>Tasmanogobius lasti</i>				
Ex	Common Carp	<i>Cyprinus carpio</i>			1	3
Ex	Tench	<i>Tinca tinca</i>				3
Ex	Rainbow Trout	<i>Oncorhynchus mykiss</i>			3	3
Ex	Brown Trout	<i>Salmo trutta</i>			3	3
Ex	Brook Trout	<i>Salvelinus fontinalis</i>				1
Ex	Gambusia	<i>Gambusia holbrooki</i>			3	3
Ex	Redfin	<i>Perca fluviatilis</i>			3	3
Ex	Barramundi	<i>Lates calcarifer</i>				1

Notes

* MLR functional group: D = diadromous; Fs = obligate freshwater, specialists stream; Fw = obligate freshwater, specialists wetland; Fg = obligate freshwater, generalist; Fp = obligate freshwater, potamodromous generalist; Ex = exotic

** Conservation status: National (Nat.): VU=Vulnerable (*Environment Protection and Biodiversity Conservation Act 1999*); State: P = protected (*Fisheries Management Act 2007*), E = Endangered, V = Vulnerable, R = Rare (DEH 2003)

Record type: 1 = verified records, limited in number; 2 = species present but no recent records; 3 = recent records at a few or more locations; 0 = presumed to exist based on unverified records or nearby records plus suitable habitat; * = translocated; ? = unknown if native or translocated (or both); SFP = Southern Fleurieu Peninsula, Goolwa to Cape Jervis; WMLR = Western Mount Lofty Ranges north of Cape Jervis

TABLE 2.4 ENVIRONMENTAL WATER REQUIREMENTS FOR FISH IN THE MOUNT LOFTY RANGES

Some groups have species with specific requirements, identified in the table for River Blackfish (RB), Southern Pygmy Perch (SPP), Mountain Galaxias (MG) and Yarra Pygmy Perch (YPP); requirements for diadromous and potadromous fish grouped together in ‘diadromous/migratory’ column (VanLaarhoven and van der Wielen 2009)

Ecological process supported by EWR							
Flow season	Flow component	Freshwater obligate (stream specialist)	Freshwater obligate (wetland specialist)	Freshwater obligate (generalist)	Diadromous/migratory	Fleurieu wetland	
Low flow season	Zero flow	Maintain persistent aquatic conditions through combination of zero flows, low flows and channel shape					
		Discourage exotic fish		Discourage exotic fish		Discourage exotic fish	
	Low flow	Persistent water in pools throughout season (base flow ideal); cool and well oxygenated (RB), well vegetated (SPP) Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Maintain shallows (larval habitat) for spawning and recruitment (RB, SPP)	Persistent cool, well-oxygenated, tolerable salinity water in wetlands, channels, riffles, anabranches and refuges (pools, billabongs) throughout season (base flow ideal); tannin-reach, clearer water (YPP) Promote successful spawning events Continuously flowing cool water discourages exotic fish in these habitats	Persistent water in pools throughout season (base flow ideal) Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Promote successful spawning events	Persistent water in pools throughout season (base flow ideal) Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Sustained flow to allow upstream migration	Persistent water in wetlands throughout season (base flow ideal) Cool flowing conditions discourage exotic fish Access to shallows (larval habitat) for spawning and recruitment	
	Fresh	Refill pools, maintain water quality Prevent vegetation encroachment Clean substrates for egg deposition (MG, RB) and feeding (RB) Allow movement between pools Maintain submerged aquatic vegetation habitat (SPP) Variable flows discourage exotic fish	Refill pools, maintain water quality Prevent vegetation encroachment Maintain water in a range of habitats at different elevations to allow co-existence of species with different requirements Variable flows discourage exotic fish	Refill pools, maintain water quality Prevent vegetation encroachment Variable flows discourage exotic fish	Refill pools, maintain water quality (particularly pools and migration barriers) Prevent vegetation encroachment Variable flows discourage exotic fish	Low energy freshes that refill wetlands and maintain water quality Allow localised movement between wetlands Variable flows discourage exotic fish	

Ecological process supported by EWR

Flow season	Flow component	Freshwater obligate (stream specialist)	Freshwater obligate (wetland specialist)	Freshwater obligate (generalist)	Diadromous/migratory	Flourieu wetland	
Transitional flow season 1	Zero flow	Maintain persistent aquatic conditions through combination of zero flows, low flows and channel shape					
		Discourage exotic fish	Discourage exotic fish	Discourage exotic fish	Discourage exotic fish	Discourage exotic fish	
	Low flow	Persistent water in pools; cool and well oxygenated (RB), well vegetated (SPP) Trigger spawning, oxygenate riffles and allow access to new habitats (spawning sites) (MG) Localised movement between pools (RB, SPP) Maintain water quality Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Maintain shallows for juveniles and young fish (RB) Promote successful spawning	Persistent cool, well oxygenated, tolerable salinity water in wetlands, channels, riffles, anabranches and refuges (pools, billabongs); tannin-reach, clearer water (YPP) Continuously flowing cool water discourages exotic fish in these habitats	Discourage exotic fish Persistent water in pools Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur	Discourage exotic fish Persistent water in pools Maintenance of permanent water in slow flow areas (larval lampreys) Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Sustained flow to allow upstream and downstream migration	Persistent water in wetlands throughout the season (base flow ideal) Cool flowing conditions discourage exotic fish Allow localised movement between wetlands Access to shallows for juveniles and young fish	
Fresh	Trigger spawning, oxygenate riffles and allow access to new habitats (spawning sites) (MG) Allow movement between pools Variable flows discourage exotic fish	Allow fish movement to recolonise vacant habitats Variable flows discourage exotic fish	Allow fish movement to recolonise vacant habitats Variable flows discourage exotic fish	Promote spawning success (raise water levels to allow access to emergent vegetation (e.g. common galaxias spawning lower stream reaches), appropriate water quality, permanence and access where species congregate) Trigger spawning, oxygenate riffles (CG) and successive access to riparian spawning habitat Allow fish movement to recolonise vacant habitats	Variable flows discourage exotic fish Allow movement between wetlands		

TABLE 2.4 ENVIRONMENTAL WATER REQUIREMENTS FOR FISH IN THE MOUNT LOFTY RANGES CONTINUED

Ecological process supported by EWR

Flow season	Flow component	Freshwater obligate (stream specialist)	Freshwater obligate (wetland specialist)	Freshwater obligate (generalist)	Diadromous/migratory	Fleurieu wetland
High flow season	Zero flow	Maintain persistent aquatic conditions through combination of zero flows, low flows and channel shape				
	Low flow	Discourage exotic fish Persistent water in pools; cool and well oxygenated (RB), well vegetated (SPP) Allow movement between pools over local and relatively long distances Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Maintain water quality Maintain shallows, hollows and cavities (larval habitat) with low salinity water for spawning and recruitment (RB) Access to emergent and edge vegetation for spawning and recruitment (SPP)	Discourage exotic fish Persistent water in pools Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Allow fish movement to recolonise vacant habitats Sustain flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat Continuously flowing cool water discourages exotic fish in these habitats	Discourage exotic fish Persistent water in pools Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Allow fish movement to recolonise vacant habitats Sustain flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat in lowland/floodplain reaches	Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur Sustain flow to allow upstream and downstream migration Allow fish movement to recolonise vacant habitats	Discourage exotic fish Persistent water in wetlands throughout season (base flow ideal) Cool flowing conditions discourage exotic fish Increase seasonal flow to prevent vegetation encroachment of open water Allow movement between wetlands Sustained flow between wetlands to allow connectivity with stream reaches for colonisation by Climbing Galaxias Access to shallows for spawning and recruitment
	Fresh	Allow movement between pools over relatively long distances Maintain water quality Access to emergent and edge vegetation for spawning and recruitment (SPP) Variable flows discourage exotic fish	Flows to provide access to off-channel habitat for adult conditioning, spawning sites and larval habitat Variable flows discourage exotic fish	Allow fish movement to recolonise vacant habitats Flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat in lowland/floodplain reaches Variable flows discourage exotic fish	Promote spawning success (raise water levels to allow access to emergent vegetation (e.g. Common Galaxias spawning lower stream reaches), appropriate water quality, permanence and access where species congregate) Attractant flow to trigger upstream migration Trigger spawning, and successive access to riparian spawning habitat Variable flows discourage exotic fish	Increase seasonal flow to prevent vegetation encroachment of open water Allow movement between wetlands Sustain flow between wetlands to allow connectivity with stream reaches for colonisation by Climbing Galaxias Flow related disturbance to maintain a mosaic of habitats to allow species coexistence Access to shallows for spawning and recruitment Variable flows discourage exotic fish

Ecological process supported by EWR

Flow season	Flow component	Freshwater obligate (stream specialist)	Freshwater obligate (wetland specialist)	Freshwater obligate (generalist)	Diadromous/migratory	Fleurieu wetland
Transitional flow season 2	Zero flow	Discourage exotic fish	Maintain persistent aquatic conditions through combination of zero flows, low flows and channel shape	Discourage exotic fish		Discourage exotic fish
	Low flow	<p>Persistent water in pools; cool and well oxygenated (RB), well vegetated (SPP)</p> <p>Localised movement between pools (RB, SPP)</p> <p>Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur</p> <p>Maintain water quality</p> <p>Maintain shallows, hollows and cavities (larval habitat) with low salinity water for spawning and recruitment (RB)</p> <p>Access to emergent and edge vegetation for spawning and recruitment (SPP)</p>	<p>Persistent cool, well oxygenated, tolerable salinity water in wetlands, channels, riffles, anabranches and refuges (pools, billabongs); tannin-reach, clearer water (YPP)</p> <p>Sustain flows to provide access to off-channel habitat for adult conditioning, spawning sites and larval habitat</p> <p>Continuously flowing cool water discourages exotic fish in these habitats</p>	<p>Persistent water in pools</p> <p>Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur</p> <p>Allow fish movement to recolonise vacant habitats</p> <p>Sustain flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat in lowland / floodplain reaches</p>	<p>Persistent water in pools</p> <p>Maintain shallower sub-optimal habitats and pool margins when exotic predatory fishes occur</p> <p>Sustained flow to allow upstream and downstream migration</p> <p>Allow fish movement to recolonise vacant habitats</p>	<p>Persistent water in wetlands throughout the season (base flow ideal)</p> <p>Cool flowing conditions discourage exotic fish</p> <p>Seasonal flow increase to prevent vegetation encroachment of open water</p> <p>Sustain flow between wetlands to allow connectivity with stream reaches for colonisation by Climbing Galaxias</p> <p>Access to shallows for spawning and recruitment</p>
	Fresh	<p>Allow movement between pools</p> <p>Maintain water quality</p> <p>Variable flows discourage exotic fish</p>	<p>Flows to provide access to off-channel habitat for adult conditioning, spawning sites and larval habitat</p> <p>Variable flows discourage exotic fish</p>	<p>Flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat in lowland / floodplain reaches</p> <p>Variable flows discourage exotic fish</p>	<p>Promote spawning success (raises water levels to allow access to emergent vegetation (e.g. Common Galaxias spawning lower stream reaches), appropriate water quality, permanence and access where species congregate)</p> <p>Flow to allow upstream and downstream migration</p> <p>Variable flows discourage exotic fish</p>	<p>Seasonal flow increase to prevent vegetation encroachment of open water</p> <p>Allow movement between wetlands</p> <p>Sustained flow between wetlands to allow connectivity with stream reaches for colonisation by Climbing Galaxias</p> <p>Variable flows discourage exotic fish</p>

TABLE 2.4 ENVIRONMENTAL WATER REQUIREMENTS FOR FISH IN THE MOUNT LOFTY RANGES CONTINUED

Ecological process supported by EWR

Flow season	Flow component	Freshwater obligate (stream specialist)	Freshwater obligate (wetland specialist)	Freshwater obligate (generalist)	Diadromous/migratory	Fleurieu wetland
Transitional flow season 2	Zero flow	Discourage exotic fish	Maintain persistent aquatic conditions through combination of zero flows, low flows and channel shape	Discourage exotic fish		Discourage exotic fish
	Bankfull/overbank	Maintain shallows (larval habitat) for spawning and recruitment	Flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat	Flows to provide access to off-channel habitat for larger species (e.g. Murray Cod, Golden Perch) for adult conditioning, spawning sites and larval habitat in lowland/floodplain reaches		
Any season	Bankfull/overbank	Maintain deep pool structure (scour sediment, prevent vegetation encroachment) Channel forming flows to maintain habitat diversity Discourage exotic fish (flushing)	Channel forming flows to maintain wide range of habitat diversity (regional-scale mosaic), including physical habitat and vegetation Maintain deep pool structure (scour sediment, prevent vegetation encroachment) Discourage exotic fish (flushing)	Maintain deep pool structure (scour sediment, prevent vegetation encroachment) Channel forming flows to maintain habitat diversity Discourage exotic fish (flushing)	Maintain deep pool structure (scour sediment, prevent vegetation encroachment) Scour in channel cease-to-flow points to improve connectivity Channel forming flows to maintain habitat diversity Discourage exotic fish (flushing)	

Aquatic macroinvertebrates

A variety of programs have collected 338 aquatic macroinvertebrate taxa from the Mount Lofty Ranges. In the broadest sense, aquatic macroinvertebrates in the Mount Lofty Ranges belong to two functional groups – those that require flowing water (found in riffles, runs and cascades) and those with a distinct preference for still or very slow flowing water (found in pond or pool habitats, and slow flowing lowland streams) (VanLaarhoven and van der Wielen 2009). Within these two broad groups, six different community types can be identified, depending on the type of habitats and persistence of flow regime (wet or dry climate). The same species can be found in a number of different community types and it is difficult to identify specific indicator taxa that are restricted to just one community. Often, the difference between types is in degrees of species diversity and relative abundance of different species from each group, with fewer or more still water or flowing water taxa found in particular habitat types (MLR EWR Expert Panel in prep).

Flowing water (permanent or seasonal flow) species

Flowing water, cascade: Macroinvertebrates in these habitats tend to live on the surface of the bedrock, and have adapted to withstand high flows during floods by evolving secure attachment mechanisms. Overall diversity is relatively low, as the number of species that require access to subsurface habitats at various times during their life cycle (e.g. juveniles migrating into the stream bed, species that use the subsurface habitats as refuges during floods) is small. These species are not well adapted to dry periods, as refuges in these habitats are limited.

Flowing water, riffle: The cobble/boulder habitats of riffles or the gravel habitats that characterise runs provide a wide diversity of microhabitats, so that these areas are generally the most diverse communities in stream systems. Cascade species are still present in riffles, living on the upper surfaces of rocks but other taxa present can use other microhabitats. With significant subsurface refuge habitats, most species can survive short periods of no flow (although diversity is highest in permanently flowing streams).

Still water (permanent or seasonal water) species

Still water, persistent ponds and pools: The diversity of macroinvertebrates is highest among the still-water communities in ponds or pools where water is present throughout the year. The diversity and abundance of plants in permanent ponds and pools ensure a wide range of microhabitats.

Still water, lowland streams: In the main, lowland stream macroinvertebrate communities reflect the types of taxa present in persistent ponds and pools. However, available habitats tend to be different, including the surfaces of woody debris (where species that are not present in persistent ponds and pools can be found) and the root zone of trees present on the water's edge, as well as in-stream vegetation.

Still water (temporary water) species

Still water, temporary pools: Some of the species found in persistent ponds and pools can be found in temporary pools in the river channel. However, the drying period restricts the diversity of macroinvertebrates to those that are adapted to dry habitats – through characteristics like higher resistance to poor water quality, resistant egg stages, ability to survive in damp mud on the bottom of pools, or the ability to move out of the habitat and colonise other waterbodies nearby (returning when water is present again).

Still water, floodplain wetlands: In wetlands disconnected from the groundwater and relying on stream floods, the macroinvertebrate community is determined by the frequency of the filling of wetlands and the subsequent persistence of the water. In general, the same species are present in all cases. The main differences are the diversity of the community, with lower diversity related to less frequent filling and lower levels of persistence. The EWRs of this group are very similar to those of the still water, temporary pools group so EWRs for the two groups are described together.

Table 2.5 outlines the EWRs, grouped by flow season and flow component, of these functional groups of aquatic macroinvertebrates and the ecological processes the EWRs support.

TABLE 2.5 ENVIRONMENTAL WATER REQUIREMENTS FOR MACROINVERTEBRATES IN THE MOUNT LOFTY RANGES

Ecological process supported by EWR

Flow season	Flow component	Flowing water, riffle	Still water, persistent pools and ponds	Still water, lowland streams	Still water, temporary pools
Low flow season	Zero flow				Maintain habitat quality (determines conditions for temporary water specialists)
	Low flow	Maintain persistent aquatic habitat conditions	Maintain persistent aquatic habitat conditions (pool habitat)	Maintain persistent aquatic habitat conditions (pool habitat)	Maintain persistent aquatic habitat conditions (pool habitat)
	Fresh	Maintain habitat quality (clean surface habitats)	Refill pools, maintain water quality	Maintain habitat quality (flush pools – water quality)	Maintain habitat quality (flush pools – water quality)
Transitional flow season 1	Zero flow				Maintain habitat quality (determines conditions for temporary water specialists)
	Low flow	Maintain persistent aquatic habitat conditions Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats
	Fresh	Maintain habitat quality (flush pools – water quality)	Maintain habitat quality (flush pools – water quality)	Maintain habitat quality (flush pools – water quality)	Maintain habitat quality (flush pools – water quality)

Ecological process supported by EWR

Flow season	Flow component	Flowing water, cascade	Flowing water, riffle	Still water, persistent pools and ponds	Still water, lowland streams	Still water, temporary pools
High flow season	Zero flow					Maintain habitat quality (determines conditions for temporary water specialists)
	Low flow	Maintain persistent aquatic habitat conditions Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats
	Fresh	Maintain habitat quality (overturn cobbles and clean riffles) Entrain organic material from banks	Maintain habitat quality (overturn cobbles and clean riffles) Entrain organic material from banks	Entrain organic material from banks	Entrain organic material from banks	Entrain organic material from banks
Transitional flow season 2	Zero flow					
	Low flow	Maintain persistent aquatic habitat conditions Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats	Maintain persistent aquatic habitat conditions (pool habitat) Allow movement to recolonise vacant habitats
	Fresh	Maintain habitat quality (overturn cobbles and clean riffles)	Maintain habitat quality (overturn cobbles and clean riffles)			

TABLE 2.5 ENVIRONMENTAL WATER REQUIREMENTS FOR MACROINVERTEBRATES IN THE MOUNT LOFTY RANGES CONTINUED

Ecological process supported by EWR						
Flow season	Flow component	Flowing water, cascade	Flowing water, riffle	Still water, persistent pools and ponds	Still water, lowland streams	Still water, temporary pools
Any season	Bankfull	Maintain channel morphology – habitat resetting				
			Entrain organic material from banks	Maintain pool habitat – scour sediments	Maintain pool habitat – scour sediments	Maintain pool habitat – scour sediments
				Entrain organic material from banks	Entrain organic material from banks	
	Overbank					Maintain persistent aquatic habitat conditions (pool habitat for still water floodplain wetland species)

Vegetation

In the Mount Lofty Ranges, 510 plant species have been identified that require the presence of surface water at some stage of their life cycle. The South Australian Aquatic Biodiversity database was used to determine which of these plant species was considered to be water dependent. Databases used to find records of water-dependent plant species in the Mount Lofty Ranges included Casanova (2004), data collected during the Eastern Mount Lofty Ranges (EMLR) Fish Inventory (Hammer 2004), during the Wetland Inventory of the Fleurieu Peninsula (Harding 2005), and the Biological Database of South Australia held by the Department of Environment, Water and Natural Resources (which includes records from the South Australian Herbarium).

Functional groups for water-dependent vegetation were developed and refined from the work of Brock and Casanova (1997), Casanova and Brock (2000) and Leck and Brock (2000). Taxa were assigned to functional groups by plant ecologists on the expert panel, based on expertise and with reference to a range of botanical textbooks and databases.

Three broad groups of vegetation types can be identified in the Mount Lofty Ranges: terrestrial species associated with waterways and wetlands; amphibious species that require or tolerate the presence of surface water at some stage of their life cycle; and submerged species that require extended periods of free surface water. Within these three broad vegetation types, ten functional groups can be identified (Casanova 2011).

Terrestrial species

Many members of these groups are annual herbaceous species. The terrestrial group includes a large proportion of exotic species such as grasses and clovers that are often associated with watercourses. Soil disturbance associated with watercourses provides open habitat for these ruderal species to colonise.

Terrestrial dry (Tdr): Desiccation tolerant species that are intolerant of flooding but will persist in damper parts of the landscape and can invade or persist in riparian zones and the edges of wetlands. They do not have a flow requirement and are not considered further.

Terrestrial damp (Tda): These species germinate and establish on saturated or damp ground but cannot tolerate extended flooding in the vegetative state. They can persist in the environment in puddles as they dry or the table drains. To persist in riparian zones and wetlands they need high water events, where water spreads out over the landscape long enough to saturate the soil profile, and then retreats. The soil profile needs to remain damp for around three months. In this climatic zone (cool wet winters, hot dry summers) the timing should be brief spring flooding, allowing maturation in the late spring and early summer. Examples include some *Allocasuarina*, *Centipeda* and *Chenopodium* species, as well as a range of grasses.

Amphibious species

Amphibious fluctuation tolerator, low growing (Atl): This functional group can germinate on saturated soil or underwater, and grow totally submerged, as long as they are not inundated by the time they start to flower and set seed. They require shallow flooding for around three months in the spring. Shorter flooding times may eventually deplete the seed bank. Examples include *Ficinia*, *Elatine* and *Glossostigma* species.

Amphibious fluctuation tolerator, emergent (Ate): This functional group of emergent sedges and rushes has a wide tolerance to water presence. They survive in saturated soil or shallow water (unlike Tda) but also require their photosynthetic parts to remain above water (be emergent). The fluctuation toleration refers to the depth of water, as well as the presence of water. They prefer to keep their roots wet (damp soil to shallow surface water present), although the preferred duration varies widely between species (average of six months). They tolerate dry times as adults, preferably in the late summer to autumn. Examples include many *Eleocharis*, *Juncus* and *Cyperus* species.

Amphibious fluctuation tolerator, woody (Atw): This functional group of woody perennial species that hold their seeds on their branches, requires water to be present in the root zone but will germinate in shallow water or on a drying profile. Generally restricted to permanently saturated areas, that don't dry out over summer, or if so, for short periods of time or areas in which they can access groundwater most or all of the time. Examples include some *Eucalyptus*, *Leptospermum* and *Melaleuca* species.

Amphibious fluctuation responder, plastic (Arp): This functional group occupies a similar zone to the Atl group, except that they have a physical response to water level changes such as rapid shoot elongation or a change in leaf type. They can persist on damp and drying ground because of their morphological flexibility but can flower even if the site does not dry out. They occupy a slightly deeper/wetter for longer site than the Atl group. Examples include *Myriophyllum* and *Persicaria* species.

Amphibious fluctuation responder, floating (Arf): These species grow underwater or float on the top of the water, and require the year-round presence of free surface water of some depth. Many of them can survive and complete their life cycle stranded on the mud, but they reach maximum biomass growing in free water all year round. They require the presence of permanent pools of water. Examples include *Azolla*, *Lemna* and *Nymphoides* species.

Submerged species

Submerged r-selected (Sr): Species that colonise recently flooded areas. Many require drying to stimulate high germination percentages, and they can complete their life cycle quickly and die off naturally. They persist through a dormant, long-lived bank of seeds or spores in the soil. They prefer habitats that are flooded once a year or so, to a depth of more than 10 cm. If they do not receive flooding, they can persist in the seed bank and recover when water becomes available. Examples include annual *Chara* and *Nitella*, as well as *Lepilaena* species.

Submerged emergent (Se): Species that require permanent saturated soil or surface water, but they need to remain emergent. Many of the swamp cyperaceous and restionaceous species belong to this group. They require permanent shallow water or saturated root-zone for germination, growth and reproduction and freshes during the low flow season to maintain water presence and quality. Examples include *Typha*, *Phragmites* and *Bolboschoenus* species, and *Triglochin procerum*.

Submerged k-selected (Sk): Species require that a site be flooded to >10 cm for more than a year for them to either germinate or reach sufficient biomass to start reproducing. Completely water-dependent, true aquatic species. Essentially restricted to permanent pools and ponds. Examples include *Vallisneria* and some *Potamogeton*, *Chara* and *Nitella* species. Table 2.6 outlines the EWRs, grouped by flow season and flow component, of these functional groups of vegetation and the ecological processes the EWRs support. The flow component associated with a particular ecological process for a function group can vary depending on which habitat the plant is found in. For example, water for germination of river red gums on a floodplain would need to be an overbank flow, while the same process on an in-stream bench would require a fresh. Table 2.6 refers broadly to habitats as aquatic (wetted at zero flow to low flow in a season); in-stream (from edge of pools to top of bank, including riffles, runs, benches, bars and stream bank); riparian (top of bank); and floodplain.

The particular water requirements between species in a group are variable in preferred timing, depth, duration and frequency of wetting. Maintaining a naturally variable water regime helps promote a diversity of species over time and space, including at different heights from the stream bed up to the floodplain. Table 2.6 lists the EWRs for plants based on the most common seasonal patterns for plant groups in the Mount Lofty Ranges, although some species may germinate and reproduce at different times or opportunistically with the appropriate flow regime.

**TABLE 2.6 ENVIRONMENTAL WATER REQUIREMENTS FOR PLANTS IN THE MOUNT LOFTY RANGES:
TWO-PART TABLE: 1 SEMI-AQUATIC FUNCTIONAL GROUPS; 2 AQUATIC FUNCTIONAL GROUPS**

PART 1

		Tda = terrestrial damp; Atl = amphibious fluctuation tolerator, low growing; Ate = amphibious fluctuation tolerator, emergent; Atw = amphibious fluctuation tolerator, woody			
Season	Component	Tda	Atl	Ate	Atw
Low flow season	Zero flow		Reproduction – needs to be exposed – gradual seasonal decline in water level (in-stream)		
	Low flow		Establishment and growth (damp soil to shallow water – in-stream)	Establishment and growth (damp soil to shallow water – in-stream)	Establishment and growth (damp soil to shallow water – in-stream)
	Fresh	Establishment (damp soil – in-stream and riparian)	Establishment and growth (damp soil to shallow water – in-stream)	Establishment and growth (damp soil to shallow water – in-stream)	Establishment and growth (damp soil to shallow water – in-stream)
	Bankfull/ overbank	Preferred time for dispersal of newly produced propagules late in season	Preferred time for dispersal of newly produced propagules late in season	Preferred time for dispersal of newly produced propagules late in season	Preferred time for dispersal of newly produced propagules late in season
Transitional flow season 1	Zero flow	Establishment (dampen soil – floodplain)	Establishment and growth (dampen soil – riparian and floodplain)	Establishment and growth (dampen soil – riparian and floodplain)	Establishment and growth (dampen soil for pairs of years – riparian and floodplain)
	Low flow		Growth (damp soil to shallow water – in-stream)	Growth (damp soil to shallow water – aquatic and low in-stream)	Growth (damp soil to shallow water – aquatic and low in-stream)
	Fresh		Growth (damp soil to shallow water – in-stream)	Growth (damp soil to shallow water – in-stream)	Growth (damp soil to shallow water – in-stream)
	Bankfull/ overbank		Growth (damp soil – riparian and floodplain)	Growth (damp soil to shallow water – riparian and floodplain)	Growth (damp soil to shallow water – riparian and floodplain)

**TABLE 2.6 ENVIRONMENTAL WATER REQUIREMENTS FOR PLANTS IN THE MOUNT LOFTY RANGES:
TWO-PART TABLE: 1 SEMI-AQUATIC FUNCTIONAL GROUPS; 2 AQUATIC FUNCTIONAL GROUPS**

PART 1 CONTINUED

Season	Component	Tda	Atl	Ate	Atw
High flow season	Zero flow				
	Low flow	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)
	Fresh	Germination, establishment and growth (damp soil – in-stream and riparian) Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, shape in-channel features)	Germination, establishment and growth (saturated soil to shallow water – in-stream and riparian) Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance	Germination, establishment and growth (saturated soil to shallow water – in-stream and riparian) Regulates distribution of shorter species by inundating photosynthetic parts that need to remain emergent Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance	Germination, establishment and growth (saturated soil to shallow water – in-stream and riparian) Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, shape in-channel features)
	Bankfull/ overbank	Germination, establishment and growth (damp soil – riparian and floodplain) Reproduction – exposed on recession of overbank flows	Germination, establishment and growth (saturated soil to shallow water – riparian and floodplain)	Germination, establishment and growth (saturated soil to shallow water – riparian and floodplain)	Germination, establishment and growth (saturated soil to shallow water – riparian and floodplain)

Season	Component	Tda	Atl	Ate	Atw
Transitional flow season 2	Zero flow		Reproduction – needs to be exposed – gradual seasonal decline in water level (aquatic and in-stream)		
	Low flow		Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream) Reproduction – needs to be exposed – gradual seasonal decline in water level (aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)
	Fresh	Germination, establishment and growth (damp soil – in-stream and riparian)	Germination, establishment and growth (saturated soil to shallow water – in-stream and riparian) Reproduction – needs to be exposed – gradual seasonal decline in water level (aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – in-stream and riparian)	Germination, establishment and growth (saturated soil to shallow water – in-stream and riparian)
	Bankfull/ overbank	Germination, establishment and growth (damp soil – riparian and floodplain)	Germination, establishment and growth (saturated soil to shallow water – riparian and floodplain) Reproduction – exposed on recession of overbank flows	Germination, establishment and growth (saturated soil to shallow water – riparian and floodplain)	Germination, establishment and growth (saturated soil to shallow water – riparian and floodplain)
All		Promote community diversity over time by retaining flow variability to provide a variety of depth/duration/frequency over time and space to meet requirements of different species (within and between functional groups)			
Anytime	Low flow	Prevent terrestrial invasion of aquatic habitat (where appropriate)			
	Fresh	Dispersal of propagules			
	Bankfull/ overbank	Dispersal of propagules Promote community diversity over time by maintaining diversity of habitats (e.g. shape in-channel and floodplain features) and by removing competitive dominants and terrestrial (dry competitors through high flow disturbance)			

**TABLE 2.6 ENVIRONMENTAL WATER REQUIREMENTS FOR PLANTS IN THE MOUNT LOFTY RANGES:
TWO-PART TABLE: 1 SEMI-AQUATIC FUNCTIONAL GROUPS; 2 AQUATIC FUNCTIONAL GROUPS
PART 2**

Arp = amphibious fluctuation responder, plastic; Arf = amphibious fluctuation responder, floating; Sr = submerged r-selected; Se = submerged emergent; Sk = submerged K-selected

Season	Component	Arp	Arf	SR	Se	Sk
Low flow season	Zero flow	Maintain persistent aquatic conditions through combination of low flows, zero flows and channel morphology Commonly reproduce on gradually declining seasonal water level (aquatic and in-stream)	Maintain persistent aquatic conditions through combination of low flows, zero flows and channel morphology Drying stimulates germination for some species Commonly reproduce on gradually declining seasonal water level (aquatic and in-stream)	Maintain persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintain persistent aquatic conditions through combination of low flows, zero flows and channel morphology Commonly reproduce on gradually declining seasonal water level (aquatic and in-stream)	Maintain persistent aquatic conditions through combination of low flows, zero flows and channel morphology Commonly reproduce on gradually declining seasonal water level (aquatic and in-stream)
	Low flow	Establishment and growth (damp soil to shallow water – in-stream)	Establishment and growth (saturated soil to shallow water – aquatic) Commonly reproduce on gradually declining seasonal water level (aquatic)	Establishment and growth (surface water – aquatic) Drying by seasonal decline in water level stimulates germination in some species Commonly reproduce on gradually declining seasonal water level (surface water – aquatic)	Establishment and growth (saturated soil to shallow water – aquatic)	Establishment and growth (surface water – aquatic) Commonly reproduce on gradually declining seasonal water level (surface water – aquatic)
	Fresh	Establishment and growth (damp soil to shallow water – in-stream) Preferred time for dispersal of newly produced propagules late in season	Maintain water in aquatic habitats Preferred time for dispersal of newly produced propagules late in season Maintain water quality (aquatic habitats)	Maintain water in aquatic habitats Preferred time for dispersal of newly produced propagules late in season Maintain water quality (aquatic habitats)	Maintain water in aquatic habitats Preferred time for dispersal of newly produced propagules late in season Maintain water quality (aquatic habitats)	Maintain water in aquatic habitats Preferred time for dispersal of newly produced propagules late in season Maintain water quality (aquatic habitats)
	Bankfull/ overbank	Establishment and growth (dampen soil – floodplain wetlands)	Establishment and growth (saturated soil to shallow water – floodplain wetlands)	Establishment and growth (surface water – floodplain wetlands)	Establishment and growth (saturated soil to shallow water – floodplain wetlands)	Establishment and growth (surface water – permanent floodplain wetlands)

Season	Component	Arp	Arf	SR	Se	Sk
Transitional flow season 1	Zero flow	Maintenance of persistent aquatic conditions through combination of low and zero flows	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology
	Low flow	Growth (damp soil to shallow water – aquatic and low in-stream)	Growth (saturated soil to shallow water – aquatic)	Growth (saturated soil to shallow water – aquatic)	Growth (saturated soil to shallow water – aquatic)	Growth (surface water – permanent floodplain wetlands)
	Fresh	Growth (damp soil to shallow water – in-stream)				
	Bankfull/ overbank	Growth (damp soil to shallow water – floodplain wetlands)	Growth (saturated soil to shallow water – floodplain wetlands)	Maintenance of persistent aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent aquatic conditions through combination of low flows, zero flows and channel morphology
High flow season	Zero flow					
	Low flow	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic)	Germination, establishment and growth (surface water – aquatic)	Germination, establishment and growth (saturated soil to shallow water – aquatic)	Germination, establishment and growth (surface water – aquatic)
	Fresh	Germination, establishment and growth (saturated soil to shallow water – in-stream) Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Germination, establishment and growth (surface water – in-stream habitats that stay inundated for at least 4 months) Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)
	Bankfull/ overbank	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands)	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands)	Germination, establishment and growth (surface water – floodplain wetlands)	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands)	Germination, establishment and growth (surface water – permanent floodplain wetlands)

**TABLE 2.6 ENVIRONMENTAL WATER REQUIREMENTS FOR PLANTS IN THE MOUNT LOFTY RANGES:
TWO-PART TABLE: 1 SEMI-AQUATIC FUNCTIONAL GROUPS; 2 AQUATIC FUNCTIONAL GROUPS
PART 2 CONTINUED**

Season	Component	Arp	Arf	SR	Se	Sk
Transitional flow season 2	Zero flow	Maintenance of persistent aquatic conditions through combination of low flows, zero flows and channel morphology Commonly reproduce on gradually declining seasonal water level (aquatic)	Maintenance of persistent aquatic conditions through combination of low flows, zero flows and channel morphology Commonly reproduce on gradually declining seasonal water level (aquatic)	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent saturated or aquatic conditions through combination of low flows, zero flows and channel morphology	Maintenance of persistent aquatic conditions through combination of low flows, zero flows and channel morphology Commonly reproduce on gradually declining seasonal water level (aquatic)
	Low flow	Germination, establishment and growth (saturated soil to shallow water – aquatic and in-stream) Commonly reproduce on gradually declining seasonal water level (aquatic and in-stream)	Germination, establishment and growth (saturated soil to shallow water – aquatic) Commonly reproduce on gradually declining seasonal water level (aquatic)	Germination, establishment and growth (surface water – aquatic) Drying by seasonal decline in water level stimulates germination in some species Commonly reproduce on gradually declining seasonal water level (aquatic)	Germination, establishment and growth (saturated soil to shallow water – aquatic)	Germination, establishment and growth (surface water – aquatic) Commonly reproduce on gradually declining seasonal water level (aquatic)
	Fresh	Germination, establishment and growth (saturated soil to shallow water – in-stream) Commonly reproduce on gradually declining seasonal water level (in-stream)	Germination, establishment and growth (surface water – in-stream habitats that stay inundated for at least 4 months)	Germination, establishment and growth (surface water – floodplain wetlands) Commonly reproduce on gradually declining seasonal water level (aquatic)	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands)	Germination, establishment and growth (surface water – permanent floodplain wetlands) Commonly reproduce on gradually declining seasonal water level (flood recession in floodplain wetlands)
All	Bankfull/ overbank	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands) Commonly reproduce on gradually declining seasonal water level (flood recession in floodplain wetlands)	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands) Commonly reproduce on gradually declining seasonal water level (flood recession in floodplain wetlands)	Germination, establishment and growth (surface water – floodplain wetlands) Commonly reproduce on gradually declining seasonal water level (flood recession in floodplain wetlands)	Germination, establishment and growth (saturated soil to shallow water – floodplain wetlands)	Germination, establishment and growth (surface water – permanent floodplain wetlands) Commonly reproduce on gradually declining seasonal water level (flood recession in floodplain wetlands)
All	Low flow	Promote community diversity over time by retaining flow variability to provide a variety of depth/duration/frequency over time and space to meet requirements of different species (within and between functional groups)	Promote community diversity over time by retaining flow variability to provide a variety of depth/duration/frequency over time and space to meet requirements of different species (within and between functional groups)	Promote community diversity over time by retaining flow variability to provide a variety of depth/duration/frequency over time and space to meet requirements of different species (within and between functional groups)	Promote community diversity over time by retaining flow variability to provide a variety of depth/duration/frequency over time and space to meet requirements of different species (within and between functional groups)	Promote community diversity over time by retaining flow variability to provide a variety of depth/duration/frequency over time and space to meet requirements of different species (within and between functional groups)
Any time	Fresh	Dispersal of propagules	Dispersal of propagules	Dispersal of propagules	Dispersal of propagules	Dispersal of propagules
	Bankfull/ overbank	Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)	Promote community diversity over time by maintaining diversity of habitats (e.g. scour pools, create undercut banks, deposit bars and benches)
		Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance	Promote community diversity over time by removal of competitive dominants and terrestrial competitors through high flow disturbance

Relating reach types and functional groups

By using information known about the functional groups and their location, a conceptual model was created for each reach type showing the water-dependent ecosystems likely to be present. The functional groups likely to be found in each reach type are described in VanLaarhoven and van der Wielen (2009).

The EWRs for each reach type were then determined by aggregating the EWRs of all functional groups found at that location. Section 2.2.3 details how these EWRs were quantified.

2.2.3. Measuring environmental water requirements

Environmental water requirements were measured by describing them in quantifiable, hydrological terms called 'metrics' (referred to in this plan as measurable indicators) that represent important parts of the flow regime. The purpose of this process was to express EWRs in numerical terms to enable them to be quantitatively assessed against changes in the flow regime.

Standard hydrological measures (flow components) were first quantified to represent the flow types across the different reaches in the Prescribed Area. These measures were derived by examining the habitats found at a range of sites across the Mount Lofty Ranges and then identifying appropriate flow components to support relevant ecological processes. These flow levels are described as measurable indicators that best represent the EWRs of each functional group.

The measurable indicators, and the function or importance of each measurable indicator in meeting ecological objectives, are described in Table 2.7. An example of a measurable indicator is the number of years where one or more low flow freshes occur. This measurable indicator is important for all reach types to flush mountain galaxias spawning sites, to maintain damp conditions on the banks for plant establishment and to transport plant propagules (e.g. seeds).

The assessment of EWRs was based on the presumption that the risk to water-dependent ecosystems will increase with increasing deviation from the 'natural' flow regime. The 'natural' flow regime (assumed to be the flow regime with the impact of dams removed) was calculated using modelled runoff data and recognises that some irreversible changes to pre-European flows have occurred due to land clearance and water resources development. 'Current' flow is either actual gauged data or modelled flow using detailed information on rainfall, soils and land use in the Prescribed Area. The hydrological model used to calculate these flows (Alcorn 2008) accounts for the recharge of underground water aquifers and system losses as a result of evaporation and seepage.

For each of the measurable indicators, limits were set on an acceptable variance from the natural flow regime, while still maintaining the ecological processes they support at a low level of risk. A measurable indicator that remained within these limits was considered to 'pass'. A measurable indicator that exceeded these limits 'failed' to provide that particular EWR. It is considered that the EWRs will be met if all of the measurable indicators are within these limits.

Accordingly, the EWRs of water-dependent ecosystems in the Prescribed Area can be described as follows:

Passing all of the measurable indicators will ensure that water-dependent ecosystems in the Prescribed Area will get enough water, and at the times at which they need that water, to sustain the ecological values of those ecosystems, including their processes and biodiversity, at a low level of risk.

TABLE 2.7 MEASURABLE INDICATORS

Season	Flow component	Measurable indicator	Measurement unit	Reach type	Flow purpose
Low flow season	Low flows	Average daily low flow season (LFS) flow	ML/day	All	Correlated with macroinvertebrate health General measure of seasonal discharge – indicator of habitat persistence, recharge to groundwater where relevant
		80th percentile exceedence non-zero flow	ML/day	All	Maintenance of core aquatic habitat (refugia) Flows to prepare Climbing Galaxias breeding Promote flowering and seed set of some aquatic plant species (Arp)
	Zero flows	Number of years with LFS zero flow spells	# years	All	Correlated with the viability of core aquatic habitat (refugia) Promote flowering and seed set of some aquatic plant species (Atl) Discourage exotic fish species
		Average number of LFS zero flow spells per year	events/season	All	Can cause ‘false start’ breeding events for plants Determines habitat quality for temporary still-water macroinvertebrate species
		Average duration of LFS zero flow spells	days/spell	All	Correlated with the viability of core aquatic habitat (refugia) Promote flowering and seed set of some aquatic plant species (Atl) Discourage exotic fish species
	Low flow freshes	Number of years with one or more LFS freshes	# years	All	Flush Mountain Galaxias spawning sites Maintain damp conditions on banks for plant establishment Transport plant propagules
		Average number of LFS freshes per year	events/season	All	Maintenance of core aquatic habitat (refugia) Flush Mountain Galaxias spawning sites Allow localised fish movement Transport plant propagules Refresh pool water quality
		Average total duration of LFS freshes per year	days/season	All	Maintenance of core aquatic habitat (refugia) Flush Mountain Galaxias spawning sites Allow localised fish movement Transport plant propagules

Transitional flow season 1 (low-high, T1)

Season	Flow component	Measurable indicator	Measurement unit	Reach type	Flow purpose
Transitional flow season 1 (low-high, T1)	Low flows	Average daily T1 flow	ML/day	All	General measure of seasonal discharge – indicator of habitat persistence, recharge to groundwater where relevant
		80th percentile exceedence non-zero flow	ML/day	All	Maintain core aquatic habitat (refugia) Stimulate Mountain Galaxias breeding Prepare Climbing Galaxias breeding Open Common Galaxias migration to sea Allow localised fish movement Extend habitat to riffles for macroinvertebrates
		Current month reaching median flow of natural T1 median (delay in onset)	# years	Upper pool riffle only	Delayed onset of T1 means longer low flow stress for refuges and shorter flow period Important for fish survival Ensure sufficient duration of habitat availability for plants
	Zero flows	Number of years with T1 zero flow spells	# years	All	Correlated with the viability of core aquatic habitat (refugia) Discourage exotic fish species
		Average number of T1 zero flow spells per year	events/season	All	Determines habitat quality for temporary still-water macroinvertebrate species
		Average duration of T1 zero flow spells	days/spell	All	Correlated with the viability of core aquatic habitat (refugia) Discourage exotic fish species
	T1 freshes	Number of years with one or more T1 freshes	# years	All	Enhance movement of Common Galaxias to sea Transport plant propagules
		Average number of T1 freshes per year	events/season	All	Enhance movement of Common Galaxias to sea
		Average total duration of T1 freshes per year	days/season	All	Maintain core aquatic habitat (refugia) Enhance movement of Common Galaxias to sea Transport plant propagules
		Number of years with 2 or more T1 freshes	# years	n.a. for upper pool riffle dry	Promote successful Climbing Galaxias breeding
		Frequency of spells higher than LFS fresh level	events/season	Lowland only (not ephemeral)	Localised fish movement

TABLE 2.7 MEASURABLE INDICATORS CONTINUED

Season	Flow component	Measurable indicator	Measurement unit	Reach type	Flow purpose
High flow season	Low flows	Average daily high flow season (HFS) flow	ML/day	All	Correlated with macroinvertebrate health General measure of seasonal discharge – indicator of habitat persistence, recharge to groundwater where relevant
		80th percentile exceedence non-zero flow	ML/day	All	Maintenance of core aquatic habitat (refugia) Localised movement of macroinvertebrate and fish species (recolonise vacant habitats) Breeding and movement for diadromous fish Regulate terrestrial and amphibious plant distribution Extend habitat availability for plants, including amphibious
	Zero flows	Number of years with HFS zero flow spells	# years	All	Correlated with the viability of core aquatic habitat (refugia) Discourage exotic fish species
		Average number of HFS zero flow spells per year	events/season	All	Determines habitat quality for temporary still-water macroinvertebrate species
		Average duration of HFS zero flow spells	days/spell	All	Correlated with the viability of core aquatic habitat (refugia) Discourage exotic fish species
	HFS freshes	Number of years with one or more HFS freshes	# years	All	Promote fish spawning success Promote large-scale fish movement Trigger upstream fish migration Transport plant propagules Dampen bank soils for plant germination and establishment (Tda) Maintain habitat (overturn substrates and scour pools) Regulate terrestrial/amphibious plant distribution Entrain organic material from banks
					Average number of HFS freshes per year
		Average total duration of HFS freshes per year	days/season	All	Discourage exotic fish (Gambusia) Promote fish spawning success Promote large-scale fish movement Trigger upstream fish migration Transport plant propagules Dampen bank soils for plant germination and establishment (Tda) Maintain habitat (overturn substrates and scour pools) Regulate terrestrial/amphibious plant distribution Entrain organic material from banks Expand riffles for macroinvertebrates

Season	Flow component	Measurable indicator	Measurement unit	Reach type	Flow purpose
High flow season - continued	HFS freshes (continued)	Number of years with 1 or more spells greater than the annual 5th percentile exceedence flow in HFS	# years	Upper pool riffle wet only	Correlate with large-scale fish movement
		Number of years with 2 or more freshes early in the season (Jul, Aug)	# years	All but upper pool riffle and lowland ephemeral	Stimulate successful Climbing Galaxias breeding
Transitional flow season 2 (high–low, T2)	Low flows	Average daily T2 flow	ML/day	All	General measure of seasonal discharge – indicator of habitat persistence, recharge to groundwater where relevant
		Median non-zero daily T2 flow	ML/day	All but upper pool riffle dry	Promote resilience in fish populations leading into the subsequent LFS Access to spawning habitats for Southern Pygmy Perch Prime Gudgeon spawning
		80th percentile exceedence non-zero flow	ML/day	All	Maintenance of core aquatic habitat (refugia) Localised movement of macroinvertebrate and fish species (recolonise vacant habitats) Breeding and movement for diadromous fish Promote plant reproduction (Arf, Sk)
		Current month reaching median flow of natural T2 median (early onset)	# years	All	Early onset of low flow season means longer low flow stress for refuges and shorter flow period Promote survival of fish Support Gudgeon spawning Support reproduction of some amphibious plants (ATI)
	Zero flows	Number of years with T2 zero flow spells	# years	All	Correlate with the viability of core aquatic habitat (refugia) Discourage exotic fish species Promote germination of some amphibious plants (Sr)
		Average number of T2 zero flow spells per year	events/season	All	Determine habitat quality for temporary still-water macroinvertebrate species
		Average duration of T2 zero flow spells	days/spell	All	Correlate with viability of core aquatic habitat (refugia) Discourage exotic fish species Promote germination of some amphibious plants (Sr)
	T2 freshes	Number of years with one or more T2 freshes	# years	All	Maintain core aquatic habitat (refugia) Maintain habitat (overturn substrates, scour algae for macroinvertebrates) Provide fish edge habitat (especially Southern Pygmy Perch) Scour algae to provide macroinvertebrate habitat and food Transport plant propagules Promote establishment of in-stream vegetation

TABLE 2.7 MEASURABLE INDICATORS CONTINUED

Season	Flow component	Measurable indicator	Measurement unit	Reach type	Flow purpose
Transitional flow season 2 high-low, T2 - continued	T2 freshes (continued)	Average number of T2 freshes per year	events/season	All	Maintain core aquatic habitat (refugia) Amount of flow related edge habitat for Southern Pygmy Perch Attractant flow for migratory fish
		Average total duration of T2 freshes per year	days/season	All	Maintain core aquatic habitat (refugia) Maintain habitat (overturn substrates) Amount of flow related edge habitat for Southern Pygmy Perch Transport plant propagules Promote establishment of in-stream vegetation
		Frequency of spells higher than LFS fresh level	events/season	Lowland only (not ephemeral)	Enhance localised fish movement (pool to pool)
		Number of years with 1 or more spells greater than the annual 5th percentile exceedence flow	# years	Upper pool riffle only	Large scale fish movement
		Number of consecutive years with no T2 fresh	# years	Upper pool riffle dry only	Maintain core aquatic habitat (refugia)
Any time of year	Bankfull	Number of years with 1 or more bankfull flows	# years	All	Maintain floodplain vegetation (recruitment and survivorship – pairs of years) Fill floodplain wetlands Regulate distribution of terrestrial plant competitors Regulate plant distribution Maintain channel morphology
		Average duration of bankfull flow spells	days	All	Fill floodplain wetlands Promote fish recruitment (access to flood-runners) Correlate fish recruitment (dry upper pool riffle)
		Average total duration of bankfull flow per year	days/year	All	Fill floodplain wetlands Promote fish recruitment (access to flood-runners) Correlate to fish recruitment (dry upper pool riffle)

2.2.4. Capacity of the water resource to meet environmental water requirements

Using the measurable indicators, EWRs were tested at 66 sites throughout the Prescribed Area under the current level of water resources development. None of these sites met all of the measurable indicators and only half the sites met 75% or less of the measurable indicators (Table 2.8).

The results of these tests show that all aspects of the flow regime at the test sites have been impacted by water resources development in the Prescribed Area. Table 2.8 shows that measurable indicators in the low flow season were the most impacted, followed by the transitional seasons and larger flows in the high flow season. These impacts are largely due to dam development and watercourse extractions in the Prescribed Area.

These results suggest that water-dependent ecosystems in the Prescribed Area are at an elevated risk of degradation.

TABLE 2.8 MEASURABLE INDICATORS PASSED

Season	Measurable indicator	Number of sites tested	Sites passed	% sites passed
Annual: can occur at any time of the year	Number of years with 1 or more bankfull flows	66	60	90.9
	Average duration of bankfull flow spells	66	66	100.0
	Average total duration of bankfull flow per year	66	60	90.9
Low flow season	Average daily LFS flow	66	50	75.8
	80th percentile exceedence non-zero flow	66	15	22.7
	Number of years with LFS zero flow spells	66	57	86.4
	Average number of LFS zero flow spells per year	66	61	92.4
	Average duration of LFS zero flow spells	66	45	68.2
	Number of years with one or more LFS freshes	66	29	43.9
	Average number of LFS freshes per year	66	32	48.5
	Average total duration of LFS freshes per year	66	4	6.1
Transition 1: low to high flow season	Average daily T1 flow	66	46	69.7
	80th percentile exceedence non-zero flow	66	20	30.3
	Current month reaching median flow of natural T1 median (delay)	47	19	40.4
	Number of years with T1 zero flow spells	66	57	86.4
	Average number of T1 zero flow spells per year	66	65	98.5
	Average duration of T1 zero flow spells	66	51	77.3
	Number of years with one or more T1 freshes	66	46	69.7
	Average number of T1 freshes per year	66	35	53.0
	Average total duration of T1 freshes per year	66	27	40.9
	Number of years with 2 or more T1 freshes	60	37	61.7
	Frequency of spells higher than LFS fresh level	2	1	50.0

TABLE 2.8 MEASURABLE INDICATORS PASSED - CONTINUED

Season	Measurable indicator	Number of sites tested	Sites passed	% sites passed
High flow season	Average daily HFS flow	66	62	93.9
	80th percentile exceedence non-zero flow	66	30	45.5
	Number of years with HFS zero flow spells	66	51	77.3
	Average number of HFS zero flow spells per year	66	65	98.5
	Average duration of HFS zero flow spells	66	52	78.8
	Number of years with one or more HFS freshes	66	58	87.9
	Average number of HFS freshes per year	66	59	89.4
	Average total duration of HFS freshes per year	66	57	86.4
	Number of years with 1 or more spells greater than the annual 5th percentile exceedence flow in HFS	41	38	92.7
	Number of years with 2 or more freshes early in the season (Jul, Aug)	19	18	94.7
Transition 2: high to low flow season	Average daily T2 flow	66	60	90.9
	Median non-zero daily T2 flow	60	22	36.7
	80th percentile exceedence non-zero flow	66	13	19.7
	Current month reaching median flow of natural T2 median (early onset)	66	29	43.9
	Number of years with T2 zero flow spells	66	50	75.8
	Average number of T2 zero flow spells per year	66	66	100.0
	Average duration of T2 zero flow spells	66	50	75.8
	Number of years with one or more T2 freshes	66	45	68.2
	Average number of T2 freshes per year	66	52	78.8
	Average total duration of T2 freshes per year	66	33	50.0
	Frequency of spells higher than LFS fresh level	2	2	100.0
	Number of years with 1 or more spells greater than the annual 5th percentile exceedence flow	47	38	80.9
	Number of consecutive years with no T2 fresh	6	2	33.3

Impacts of dams on flows

Dams intercept water and, in doing so, impact on the movement of water through the landscape. Because dams generally do not allow water to pass downstream until they fill and spill, they change the flow regime by reducing the total volume of flow and delaying flow events. This delay can affect the presence of water in permanent or temporary pools – they may not fill to the same volume or they may dry more quickly. The water quality in these pools may also be affected by a lack of flushing. This, in turn, can impact on the species that use these areas as a refuge in drier times of the year.

The impacts of dams on the flow regime are proportionately higher in the low flow season when dams are not full and flows are generally smaller. In contrast, larger flows are less impacted as they will cause dams to fill and spill much quicker. These impacts are reflected in the performance of the measurable indicators described above.

The manner and timing of the collection or diversion of water by dams therefore has the potential to impact negatively on the health of water-dependent ecosystems. Using a threshold flow rate to minimise these impacts on the flow regime is discussed in Section 2.3.3.

Indicator species

Two species of fish (Southern Pygmy Perch and Mountain Galaxias) and aquatic macroinvertebrates (indicator species) were selected to assess the relationship between the measurable indicators and actual environmental health. Adequate monitoring data was only available for these species.

Monitoring data on the breeding and survivorship success of the two fish species, and aquatic macroinvertebrate population condition, was compared to the proportion of measurable indicators that passed at a number of the test sites. This analysis showed that worsening ecological conditions were generally associated with fewer measurable indicators being met at a site. Other processes, such as habitat quality, water quality and predation, can also affect ecological conditions, but this correlation is in part driven by changes to the flow regime.

2.2.5. Environmental water quality requirements

Water quality plays an important role in determining the nature and condition of water-dependent ecosystems, and is linked to the flow regime in many complex ways. For example, increased periods of zero flow, reduced flow rates and less frequent flushing fresh flows can allow pollutants to build up in pools and increase in concentration through evaporation. Water quality issues of particular local significance include dissolved oxygen, salinity, temperature, suspended solids, nutrients, and toxins such as pesticides, herbicides and heavy metals.

The Healthy Waters Project, being managed by the Environment Protection Authority in partnership with the board and Department of Environment, Water and Natural Resources (DEWNR), is in the process of identifying environmental values and water quality objectives for water resources in the Adelaide and Mount Lofty Ranges region. Pending the results of that project, and in the absence of knowledge of specific water quality tolerances and requirements of water-dependent ecosystems, targets for environmental water quality parameters have not been identified for the Prescribed Area, besides those inherent in the flow regime that has been provided for.

An appropriate flow regime helps to maintain water quality in the Prescribed Area. For example, cool baseflows may maintain water temperature and freshes flowing through riffles increase oxygen concentrations in pools and dilute salts. Several of the measurable indicators of EWRs in the Prescribed Area have water quality objectives.

The water quality objectives identified through the Healthy Waters Project will eventually be incorporated into the Environment Protection (Water Quality) Policy 2003 (made under the *Environment Protection Act 1993*) and help inform future water quality management decisions in the Prescribed Area.

2.3. ENVIRONMENTAL WATER PROVISIONS

This section includes information about the water that is to be set aside for the environment and a statement of the environmental outcomes expected to be delivered on account of the provision of environmental water under this plan.

Environmental water requirements are not currently being met at any of the test sites in the Prescribed Area (Section 2.2.4). In order to meet 100% of the measurable indicators identified in Section 2.2.3, an extraction limit of 1–2% of surface water capacity would be required for each surface water management zone (see Section 5.3) in the Prescribed Area. This would require significant reductions to existing levels of water extractions.

In order to set an extraction limit that will be environmentally, socially and economically sustainable, an acceptable level of risk for water-dependent ecosystems in the Prescribed Area must be determined. The goal in this plan is to maintain water-dependent ecosystems sites at an acceptable level of risk.

The process for defining an acceptable level of risk and setting an environmentally sustainable extraction limit is described in VanLaarhoven (2010) and this section is based on that report.

2.3.1. Acceptable level of risk

An acceptable target that is expected to allow indicator species' populations to be self-sustaining was identified using expert opinion. The correlations between ecological condition and the measurable indicators (see Section 2.2.4) were then used to determine the percentage of measurable indicators needed to be met at each site to achieve minimum acceptable ecological condition.

The acceptable target for each indicator species, as described in VanLaarhoven (2010), is given below.

Fish – acceptable target

Mountain Galaxias and Southern Pygmy Perch are relatively short-lived species (approximately three years). Suitable breeding conditions are therefore needed often enough to build population numbers and promote resilience to withstand poorer flow years and ensure the survival of these species.

Consecutive years of poor to marginal breeding events occur under natural conditions and native fish species have developed strategies to persist through these periods. Enough recruitment is expected in the marginal years to maintain sufficient population numbers for these species to recover in subsequent years once improved hydrological conditions prevail.

Expert opinion suggests that better than marginal recruitment events are needed in at least seven years out of every ten to maintain sufficient population numbers. Under stable climatic conditions, the probability of a run of three consecutive years of poor to marginal fish breeding is once in 37 years, potentially leading to population crashes for fish species with relatively short

life cycles. More conservative targets would reduce the probability of such crashes.

The ecological target of seven out of ten years having better than marginal recruitment equates to approximately 85% of measurable indicators being met.

Aquatic macroinvertebrates – acceptable target

Expert opinion recommends that a target of macroinvertebrate population condition between moderate and good is likely to promote resilience and allow populations to be sustainable in the long term.

As with fish, this ecological target equates to approximately 85% of measurable indicators being met.

2.3.2. Determination of environmental water provisions

Using the correlations between measurable indicators and ecological conditions described in Section 2.3.1, at least 85% of the measurable indicators need to be met at the surface water management zone scale to maintain self-sustaining water-dependent ecosystems.

Therefore, to maintain water-dependent ecosystems at an acceptable level of risk, while providing for social and economic needs in the Prescribed Area, the environmental water provisions have been determined to be:

Passing 85% of measurable indicators at the surface water management zone scale will meet the acceptable level of risk.

This applies in the Prescribed Area with the exception of Fleurieu wetlands (see Section 2.4.1), and watercourses across the plains (see Section 2.5).

2.3.3. Environmentally sustainable extraction limit

Ecological models tested a range of water extraction scenarios to quantify the percentage of surface water resource capacity that could be extracted while ensuring that measurable indicators would also be satisfied. The purpose of the modelling was to identify which management options would pass at least 85% of measurable indicators.

The modelling showed that to maintain a flow regime that meets the acceptable target of passing 85% of measurable indicators, a total of 5% of surface water resource capacity could be extracted. This is not considered to be socially or economically sustainable and would require significant reductions to existing levels of water extractions.

Threshold flows

An analysis of the impacts of current levels of water resources development in the Prescribed Area on EWRs showed that the largest impacts occur in the low flow season (Section 2.2.4). Dams generally capture runoff (or water in a watercourse) until they fill and overflow at the spillway. The key impact of dams on the environment is the interception of low flows and break-of-season flows, which delay the first flows for the season for downstream watercourses. Delaying the first flows of the season may have a dramatic impact on downstream flora and fauna that have been enduring a long dry summer. Permanent pools that normally provide dry-season refuges for these aquatic plants and animals may become too salty or dry up altogether. Break-of-season flows are also thought to trigger breeding in some native fish species.

Returning these lower flows to the system reduces impacts on the measurable indicators and therefore allows a larger percentage of the surface water resource capacity to be allocated, while maintaining an acceptable level of risk to water-dependent ecosystems.

The modelling showed that returning flows at or below a defined threshold flow rate from all dams greater than 5 ML significantly improved the success of many of the measurable indicators.

The threshold flow rate in the Prescribed Area is defined as the '20th percentile exceedence non zero flow'. This means that flows that occur for 20% of the flowing period can be taken. These are higher flows that generally account for 80–95% of the total annual flow volume.

Returning flows at or below the threshold flow rate from dams allows for a higher extraction limit of 25% of surface water capacity. This higher extraction limit will meet the acceptable target of passing 85% of measurable indicators. This target is met at over 75% of the test sites. This level of extraction at the surface water management zone scale is considered to be socially and economically sustainable.

Surface water extraction limit

On the basis of the above discussion, the following surface water extraction limit has been determined as maintaining water-dependent ecosystems in the Prescribed Area at an acceptable level of risk:

With provision of threshold flows, the environmentally sustainable surface water extraction limit is 25% of surface water resource capacity at the surface water management zone scale.

Scale of management

The extraction limits in this plan apply at the management zone scale. Surface water management zones have been developed on the basis of reach types: the confluence of reach types (with the exception of headwaters) has generally been used to define each surface water management zone (see Section 5.3). This helps to ensure that at a management zone scale, the water-dependent ecosystem will get enough water to maintain it at an acceptable level of risk without being compromised by water extractions from adjacent watercourses.

Statement of expected environmental outcomes

The provision of environmental water under this plan – by virtue of an environmentally sustainable surface water extraction limit of 25% of surface water capacity as the surface water management zone scale with the provision of threshold flows – is expected to maintain water-dependent ecosystems in the Prescribed Area at an acceptable level of risk (see Section 2.3.1).

2.3.4. Underground water-dependent ecosystems

Information on the presence, distribution and water requirements of organisms that use underground water while still below the surface is limited (Section 2.2.1). It is thus not possible to assess their EWRs at present.

This Plan protects the contribution of underground water to the environment by limiting underground water extraction volumes (see Section 5.2) and managing underground water extractions in the area of wetlands and third order (and above) watercourses (see principle 19 in Section 6.3, and principles 139 and 140.c in Section 8.3). Wetlands and third order (and above) watercourses are expected to rely significantly on underground water.

2.4. ENVIRONMENTAL WATER REQUIREMENTS AND PROVISIONS FOR WETLANDS

2.4.1. Fleurieu wetlands

The Fleurieu wetlands include the most significant wetlands within the Prescribed Area, namely the Swamps of the Fleurieu Peninsula, which are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as critically endangered ecological communities. The indicative location of Fleurieu wetlands is shown in Figure 2.3.

In addition to the functional groups supported by the various reach types throughout the Prescribed Area (Section 2.2.2), the wetlands of the Fleurieu Peninsula support many species of plants and animals of high conservation significance. These include 742 plant species, of which 139 have conservation status, including 73 species having status under the State *National Parks and Wildlife Act 1972* (NPW Act), and six species being listed as threatened species (three endangered and three vulnerable) under the EPBC Act. The wetlands of the Fleurieu Peninsula have also been recorded as supporting 183 vertebrate species. Of these, 22 species have conservation status under the NPW Act, and three species are protected under the EPBC Act. Considerable investment has already been made to protect and restore Fleurieu wetlands by fencing wetland areas from stock grazing, providing alternative water sources for stock and rehabilitating habitat.

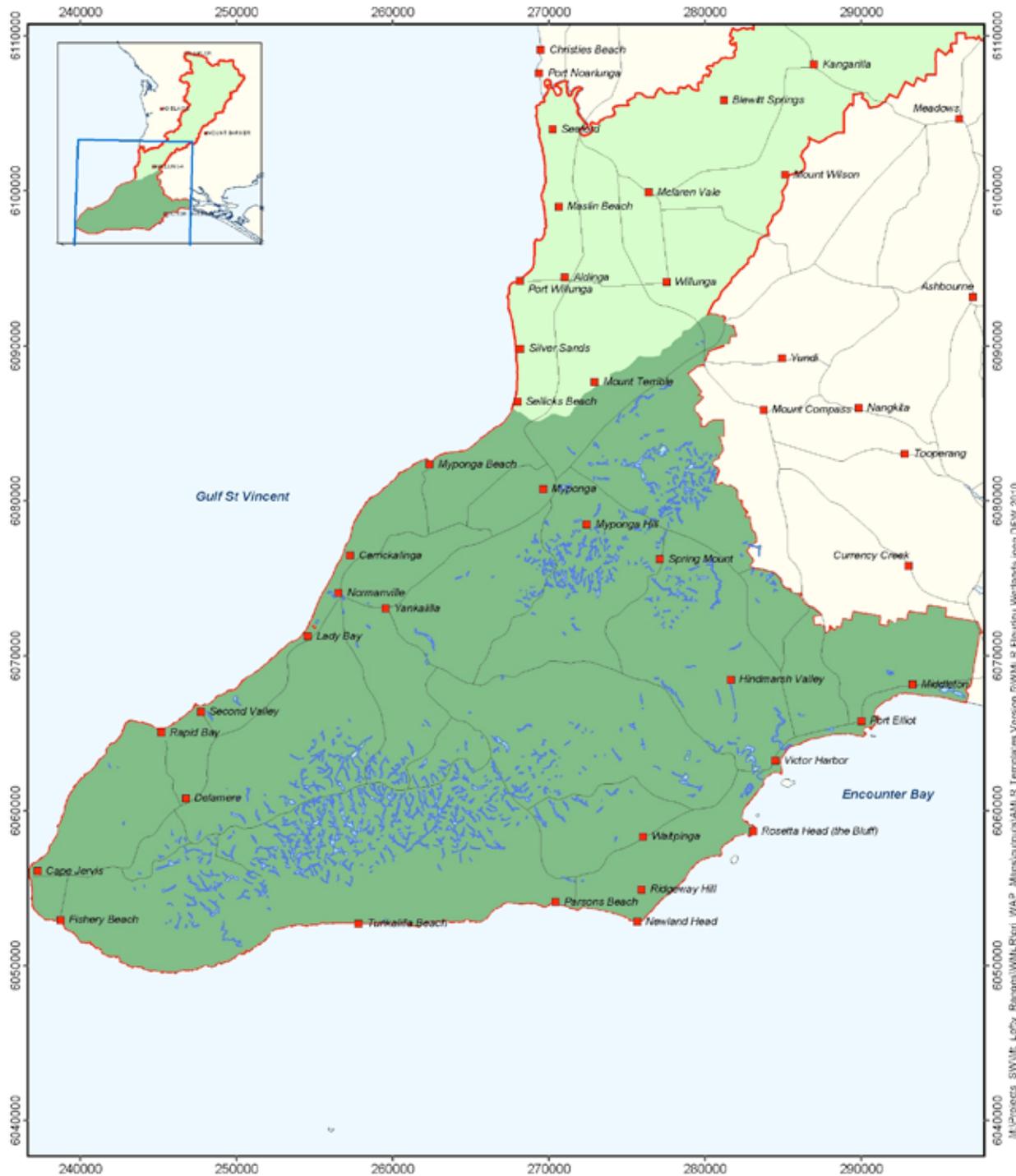
The Fleurieu wetlands have diverse sources of water (e.g. surface and subsurface flows, watertable interaction), species composition, and extent and condition. Many are underlain by highly organic or peaty soils. Peat substrates are very sensitive to water stress and may be permanently damaged if they dry completely. The consequences could be loss of species that depend on them, greatly increased erosion potential and higher risk of fire damage.

The 'natural' flow regime (e.g. timing, duration, flow patterns, sources of water) for Fleurieu wetlands, particularly perched wetlands, has changed significantly because of land clearance and water interception by dams and commercial forestry. In cleared areas, this can cause increased runoff during high rainfall events (except where there is commercial forestry), and conversely, less water reaching the wetlands from reduced subsurface flows during dry periods. Increased runoff over shorter periods can trigger erosion, further threatening the wetland. As a balance between water for social and economic purposes, and environmental water provisions, the recommended extraction limit for new dams above a Fleurieu wetland is 25% of the local adjusted runoff to enable water to be taken during high rainfall periods, and allow for low flows during drier periods.

The provision of water to Fleurieu wetlands – by virtue of a surface water extraction limit of 25% of the local adjusted runoff with the provision of threshold flows – is expected to maintain those wetlands at an acceptable level of risk.

A multi-disciplinary assessment approach for new dams (e.g. hydrology, hydrogeology, wetland ecology, geomorphology, land management and/or environmental engineering) will consider a range of factors for the provision of low flows to a Fleurieu wetland, for example, location and extent of wetland, type and significance of wetland, sources of water to the wetland, land use and management.

The overarching environmental water provisions for the Prescribed Area (an extraction limit of 25% of surface water resource capacity, subject to the provision of low flows) still apply at the surface water management zone scale.



Legend

- Roads
- Fleurieu Peninsula Catchments
- Western Mount Lofty Ranges Prescribed Water Resources Area
- ▨ Wetlands

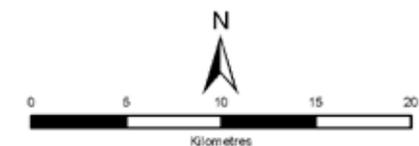


Figure 2.3 Fleurieu wetlands (this figure is for indicative purposes only)

2.4.2. Central Hills wetlands

Wetlands in the Central Hills catchments, other than the Fleurieu wetlands, are known as Central Hills wetlands. Their indicative location is shown in Figure 2.4.

These Central Hills wetlands should be protected, but they do not have the same level of conservation significance or risks as the EPBC listed Fleurieu Swamps. Furthermore, there is no net new use for surface water and watercourses in the catchments above the reservoirs where most of the Central Hills wetlands are situated, minimising the risk of water resources development to these wetlands.

The overarching environmental water provision for the Prescribed Area (an extraction limit of 25% of surface water resource capacity, subject to the provision of threshold flows) is considered reasonable to maintain Central Hills wetlands at an acceptable level of risk.

The provision of water to Central Hills wetlands – by virtue of a surface water extraction limit of 25% of surface water resource capacity with the provision of threshold flows – is expected to maintain those wetlands at an acceptable level of risk.

2.5. ENVIRONMENTAL WATER REQUIREMENTS AND PROVISIONS FOR WATERCOURSES ACROSS THE PLAINS

The watercourses across the plains are all downstream of reservoirs and their hydrological characteristics are vastly altered from their natural forms. Reservoirs capture most upstream flow and only a reduced flow reaches downstream environments.

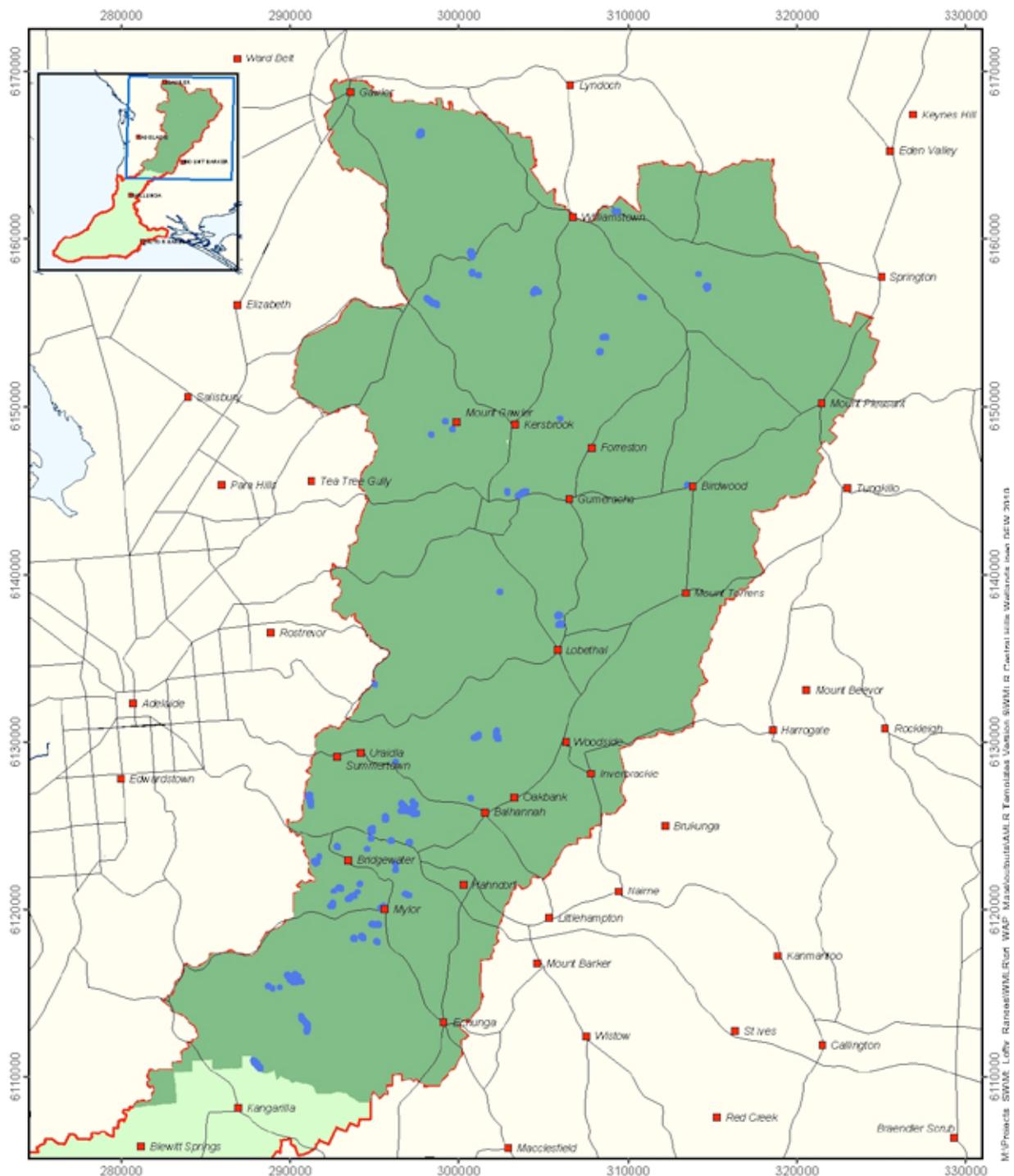
The significantly changed flow regime has altered the original values and physical characteristics of the watercourses across the plains. Given the heavy urbanisation and development in the riparian zones and on the floodplains of these watercourses, it is neither desirable nor realistic to restore the original flow regime. However, the watercourses, including features such as the Torrens Lake, have important environmental values as well as social, recreational, cultural and economic values.

The methodology used to determine environmental water provisions for catchments upstream of the reservoirs is not applicable to the watercourses across the plains. The aim for these watercourses is to maintain the remaining, reduced ecological values, while recognising the inherent limitations of high levels of development and urbanisation.

The water-dependent ecosystems remaining in these watercourses will be provided for in part by reservoir releases, which aim to maintain and protect the most hydrologically impacted zone of these watercourses – the area immediately downstream of the reservoirs (although the environmental benefit of these flows probably extends for many kilometres downstream). Managing the impacts of water extractions through the use of threshold flow rates, below which water cannot be taken, helps ensure that essential flows that support the retention of aquatic refuge habitats, such as permanent pools, are protected.

Further study on the River Torrens to maintain fish migration indicates seasonal flow variation, and the importance of flows during the autumn and spring (Hammer 2011). The flows can be supplied with a depth of at least 100 mm in all reaches of zone 4 during autumn and spring (threshold flow rates of at least 1000 litres/second (L/s)). There is also flexibility in winter to lower the minimum flow depth variation. While an absolute minimum end of system flow to support regular fishway operation at the outlet weir at Breakout Creek is in the order of 150 L/s, a minimum threshold flow rate of 200 L/s is recommended during winter. Stormwater events in summer are expected, subject to their intensity, to refill the pools throughout zone 4 (see Figure 5.22).

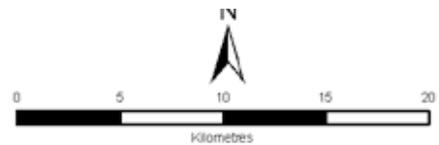
The highly modified characteristics of the lower parts of the River Torrens allow a significantly increased volume of water to reach the coastal and marine environment, negatively impacting the coastal ecological processes (i.e. reduced light penetration). Therefore it is beneficial to extract water from zone 4 (see Figure 5.22) in a way that allows minimum flows to maintain fish migration as described above. The recommended extractions from zone 4 are based on ensuring threshold flow rates that maintain fish migration and not constrained by a maximum extraction limit. This is also consistent with outcomes for stormwater recycling in Water for Good.



Legend

-  Major road
-  Central Hills catchments
-  Western Mount Lofty Ranges Prescribed Water Resource Area
-  Wetlands

Figure 2.4 Central Hills wetlands (this figure is for indicative purposes only)



2.5.1. Environmental water provisions from SA Water reservoirs

The environmental water provisions considered reasonable for the watercourses across the plains (downstream of SA Water reservoirs) are significantly different to the rest of the Prescribed Area. SA Water has an obligation to ensure public water supply, and is also required to provide reasonable environmental flows in these watercourses.

SA Water will supply up to 16.5 GL annually to be released from its reservoirs for environmental flow purposes, subject to the outcomes of trial investigations of the required flow regime.

Such releases for environmental purposes may need to be managed down the watercourse below the reservoir by restricting licensed water users from extracting water from the watercourse during the release. Once the releases have fulfilled environmental flow requirements, then water may be extracted.

Torrens Lake is not a natural characteristic of the River Torrens, but it is a very significant cultural feature in the watercourse. In summer, and particularly during hot periods, the lake can become stratified and cyanobacteria can grow to toxic levels, and be closed for recreational activities due to public health and safety concerns. This reduces the amenity of Torrens Lake as it impacts on the social and cultural values of the area.

Strategies to manipulate flows to achieve water quality and good mixing in Torrens Lake may effectively mitigate high levels of cyanobacteria. The supply of additional water during the low flow season (summer months) should have a positive impact on the local fish community. Potential benefits include: upstream movement of diadromous species to important habitat; permanence and quality of refuges; increase in the available habitat wetting shallow pools and preserving important shallow riffle habitat; and improvement in the water requirements for ecological assets.

Trials are proposed to test the modelling and assumptions, which will inform the timing, duration and conditions of water quality flow releases from Kangaroo Creek Reservoir to mitigate the raising of cyanobacteria to toxic levels in Torrens Lake. Those flows may ultimately be recovered from the river according to conditions approved by the Minister.

The provision of environmental water under this plan is expected to maintain watercourses across the plains in the Prescribed Area at an acceptable level of risk (see Section 2.3.1).

3 Effects on other water resources

The taking and use of water in the Prescribed Area can have an effect on other water resources.

Section 76(4)(a)(ii) of the *Natural Resources Management Act 2004* (NRM Act) provides that a water allocation plan must include an assessment of whether the taking or use of water from the prescribed water resource will have a detrimental impact on the quantity or quality of water available from any other water resource.

The neighbouring Prescribed Areas (Figure 3.1) are:

- McLaren Vale Prescribed Wells Areas (PWA)
- Central Adelaide PWA
- Northern Adelaide Plains PWA
- Barossa Prescribed Water Resources Area (PWRA)
- Marne Saunders PWRA
- Eastern Mount Lofty Ranges PWRA.

The taking of surface water and watercourse water from the Prescribed Area will not affect the quantity or quality of water from neighbouring Prescribed Areas – with the exception of McLaren Vale PWA – because these resources are hydrologically separate (as defined by their respective surface water catchment boundaries).

There may be some interaction with underground water resources in the neighbouring PWAs due to the level of interconnection between these resources.

The principles in Sections 6, 7 and 8 of this plan aim to reduce the impacts of the taking and use of water in the Prescribed Area on other water resources, water users and the environment.

3.1. MCLAREN VALE PRESCRIBED WELLS AREA

McLaren Vale PWA is located wholly within the boundaries of the Prescribed Area (Section 1.2).

Interconnection with the Prescribed Area

There is a degree of connectivity between the surface water resources of the Prescribed Area and McLaren Vale PWA. The surface water in Willunga Basin that recharges the aquifers becomes underground water. Underground water is managed by the water allocation plan for McLaren Vale PWA. For the Prescribed Area, an allowance has been made for surface water flows that recharge the aquifers. This plan will ensure that the taking and use of surface water within the Prescribed Area will not further reduce recharge in McLaren Vale PWA.

Furthermore, the taking and use of underground water elsewhere in the Prescribed Area is unlikely to have a significant impact on the quantity and quality of water in McLaren Vale PWA, as there is either no hydrogeological connectivity or an insignificant connectivity between the aquifers in the Prescribed Area and those in McLaren Vale PWA.

3.2. CENTRAL ADELAIDE PRESCRIBED WELLS AREA

Central Adelaide PWA was prescribed by regulation on 7 June 2007 to protect the underground water resources in that area and to manage increasing use.

Central Adelaide PWA contains Tertiary and Quaternary sedimentary aquifers overlying a fractured rock aquifer, and is divided into the Golden Grove Embayment to the east (adjacent to the Mount Lofty Ranges) and the Adelaide Plains Sub-Basin to the west. The Tertiary sedimentary aquifers constitute the largest and most important underground water resource in Central Adelaide PWA.

Depending on the nature of the bounding faults, both Tertiary aquifers (T1 and T2) can be hydraulically connected to fractured rock aquifers along the Hills Face Zone. The aquifer at greatest risk of over-extraction is the shallowest Tertiary (T1) aquifer. Fractured rock aquifers also occur beneath Golden Grove Embayment.

Interconnection with the Prescribed Area

Underground water in the fractured rock aquifers in the Prescribed Area flows in a north-westerly direction into the Tertiary and Quaternary fractured rock aquifers in Central Adelaide PWA.

The actual volume of this water is difficult to quantify. Continued monitoring of wells in Central Adelaide PWA will help determine whether the taking of water in the Prescribed Area is impacting on the taking of water from wells in Central Adelaide PWA.

3.3. NORTHERN ADELAIDE PLAINS PRESCRIBED WELLS AREA

Northern Adelaide Plains PWA was initially proclaimed in 1976 after intensive pumping during the 1960s formed a large cone of depression in the Tertiary aquifers. By regulation made under the *Water Resources Act 1997* on 22 July 2004, the boundaries of the PWA were varied to include the Kangaroo Flat Area. The fractured rock aquifers in the Mount Lofty Ranges are the main source of recharge to these aquifers. Recharge occurs by lateral flow down gradient towards the coast.

Between 1992 and 2001, SA Water undertook controlled releases of water from the Little Para Reservoir at an average rate of 380 ML per year in order to provide additional water for recharging aquifers in Northern Adelaide Plains PWA. A release of approximately 1200 ML per year would be required to maintain underground water-dependent ecosystems relying on the natural recharge of the shallow sandy Quaternary (Q1) aquifer.

Interconnection with the Prescribed Area

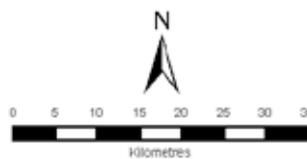
Underground water from the fractured rock aquifers in the Prescribed Area flows in a westerly direction towards the sedimentary aquifers in Northern Adelaide Plains PWA. Continued monitoring of wells and observation wells in the PWA will assist in determining whether the taking of water in the Prescribed Area is impacting on the taking of water from wells in Northern Adelaide Plains PWA.



Figure 3.1 Neighbouring prescribed areas

LEGEND

-  Prescribed Wells Areas (PWA)
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Prescribed Watercourses
-  Other Prescribed Water Resources Areas (PWRA)



3.4. BAROSSA PRESCRIBED WATER RESOURCES AREA

The underground water resources in the Barossa Valley were first prescribed on 1 July 1989. On 14 May 1992, North Para River and its tributaries within a defined area were declared to be 'proclaimed watercourses'. On 17 December 1998, the surface waters within that area were declared to be 'proclaimed water resources'. On 19 May 2005, all watercourses and surface water in the Greenock Creek catchment area were prescribed.

The underground water system in Barossa PWRA can be broadly grouped into three principal aquifer systems: the upper aquifer, lower aquifer (both sedimentary) and an underlying fractured rock aquifer. These aquifers are hydraulically connected and any one can be a source of recharge or a point of discharge to any of the other aquifers, depending on their location in the valley. Recharge of the aquifer systems is predominantly from winter rainfall. The water flows in a general westerly direction towards the sedimentary aquifers in the valley floor. Technical investigations have shown that lateral flow from the fractured rock aquifer is the main source of recharge for the lower aquifer, which provides for approximately 30% of total irrigation in the PWRA. Extraction from the fractured rock aquifer accounts for approximately 50% of total irrigation in the PWRA.

Interconnection with the Prescribed Area

The same boundaries that distinguish the surface water resources and watercourses in the Prescribed Area from those in Barossa PWRA also distinguish the underlying fractured rock aquifers. The adjacent aquifers in the Prescribed Area have limited permeability and to date there has been a low demand, mainly due to the unsuitability of the steeper terrain for irrigation and poor underground water yields. The taking and use of water in the Prescribed Area is therefore unlikely to have a significant impact on the quantity and quality of water in Barossa PWRA.

3.5. MARNE SAUNDERS PRESCRIBED WATER RESOURCES AREA

Fractured rock aquifers, present throughout the hills region of Marne Saunders PWRA, are an important source of water for irrigation, stock and/or domestic use, and the environment. Water yields are generally low. At a regional scale, the general movement of water is towards the east where the hills slope down to the Murray Plains.

Interconnection with the Prescribed Area

The same boundaries that distinguish the surface water resources and watercourses in the Prescribed Area from those in Marne Saunders PWRA also distinguish the underlying fractured rock aquifers. In the Prescribed Area, there is a low demand for water from aquifers, mainly because the steeper terrain is unsuitable for irrigation and underground water yields are poor. The taking and use of water in the Prescribed Area is therefore unlikely to have a significant impact on the quantity and quality of water in Marne Saunders PWRA.

3.6. EASTERN MOUNT LOFTY RANGES PRESCRIBED WATER RESOURCES AREA

Where their boundaries meet, the Prescribed Area and Eastern Mount Lofty Ranges PWRA share the following geology:

- Kanmantoo Group in the River Torrens catchment
- Adelaidean rocks in the Onkaparinga River catchment
- Permian Sand in the Fleurieu Peninsula catchments.

Interconnection with the Prescribed Area

In the Prescribed Area, extractions from the Kanmantoo Group are limited and accordingly little impact is likely on Eastern Mount Lofty Ranges PWRA in the vicinity of the shared boundary (at the top of the River Torrens catchment).

The Adelaidean rocks are considered to be a good aquifer, particularly to the north and south of Mount Barker. Extractions within 500 metres either side of the catchment boundary may have small drawdown impacts across the boundary, but not at a rate detrimental to the quantity and quality of water available in Eastern Mount Lofty Ranges PWRA.

Where the boundary between Southern Fleurieu Peninsula catchments and Eastern Mount Lofty Ranges PWRA is underlain by fractured rock aquifers, the number of existing underground water users (as evidenced by the low number of wells) is relatively low due to the poor quantity and quality of underground water. An exception is the boundary with the Tookayerta catchment to the west of Mount Compass township, which lies over the Permian Sand aquifer. Underground water flow is currently in a south-westerly direction (into the southern Fleurieu area). Any intensive extractions within 500 metres of the boundary could have drawdown impacts on the other side of the boundary, and could therefore impact on the quantity and quality of water in the Prescribed Area and in Eastern Mount Lofty Ranges PWRA. It is anticipated that any impacts will be prevented by the management regime (management zones and sustainable extraction limits – see Sections 5.1 and 5.2) being put in place in this plan.

The eastern boundary of the Prescribed Area near Currency Creek catchment in Eastern Mount Lofty Ranges PWRA also overlies the Permian Sand aquifer. However, because of the limited extent of the aquifer in the Prescribed Area, there appears to be little flow of underground water across the boundary into Eastern Mount Lofty Ranges PWRA. The taking of water from wells in the Prescribed Area is therefore unlikely to impact on the quantity and quality of water in Currency Creek catchment. Furthermore, as the direction of underground water flow in the Permian Sand aquifer in Currency Creek catchment is away from the Prescribed Area, the taking of water from wells in that catchment is unlikely to impact on the quantity and quality of water in this aquifer in the Prescribed Area.

3.7. RIVER MURRAY PRESCRIBED WATERCOURSE

There is no direct hydrological connection between water resources in the Prescribed Area and the River Murray Prescribed Watercourse, but water from the River Murray is used to supply reticulated water for metropolitan Adelaide.

The water allocation plan for the River Murray Prescribed Watercourse provides for an allocation of 650 GL over a rolling five-year period for metropolitan water supplies. During periods of extended drought, the quantity of water that can be taken for metropolitan water supplies may be progressively reduced and is reviewed depending on flows from upstream.

The proportion of Adelaide's water supply taken each year from the River Murray varies from 10% to 90% depending on storage levels in SA Water reservoirs in the Prescribed Area (see Section 4.3). Accordingly, any reduction of inflows to reservoirs in the Prescribed Area could increase reliance on the River Murray.

To address the potential reduction of inflows to these reservoirs, and to limit demand on the River Murray, no new surface water or watercourse water will be made available for allocation, dam development or commercial forestry upstream of the reservoirs (see principle 36 in Section 6, and principles 170 and 205 in Section 8 of this plan).

4 Assessment of demand on water resources

Section 76(4)(d) of the *Natural Resources Management Act 2004* (NRM Act) provides that a water allocation plan must assess the capacity of the resource to meet the demands for water on a continuing basis.

This section assesses the demand for water in the Prescribed Area. Section 5 assesses the capacity of water resources in the Prescribed Area to meet this demand.

4.1. NEEDS OF WATER USERS

The Prescribed Area is home to approximately 211,000 people¹. It has nearly 15,500 hectares of irrigated agriculture, which produces an estimated farm gate value of \$230 million annually, as well as significant flow-on regional economic benefits.

Approximately 75% of the State's population depends on the Prescribed Area, which supplies 60% of metropolitan Adelaide's water requirements in an average year. The water resources in the Prescribed Area are therefore vitally important socially, economically and ecologically to all South Australians.

The Prescribed Area contains approximately 11,500 wells, 13,000 dams and 250 watercourse water extraction points². Eight water supply reservoirs are distributed throughout the Little Para River, South Para River, River Torrens, Onkaparinga River and Myponga River catchments – the reservoir catchments.

There is a high demand for consumptive use of the water resources in the Prescribed Area, but their ecological importance has also been recognised. The watercourses, wetlands and swamps in the Prescribed Area, including the Swamps of the Fleurieu Peninsula, listed as critically endangered ecological communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, are of high conservation significance (see Section 2.4.1).

4.2. DEMAND

4.2.1. Historical demand

An analysis of irrigation use based on four Australian Bureau of Statistics (ABS) datasets between 1970 and 2000 shows that the extent and nature of irrigation fluctuated during this period. In 1970, the area of irrigated land in the Prescribed Area was approximately 11,000 hectares. This increased to 12,000 hectares in 1975, declined to approximately 8500 hectares in 1987, and increased again to slightly more than 13,000 hectares in 2000.

Subregional trends

Tables 4.1 and 4.2 show that the fluctuations in demand have not been uniform, and that the type and extent of land use change has varied across the Prescribed Area.

This data is suitable for broad comparisons only, as the defined catchment boundaries (see Figure 1.2) and ABS data sets are not fully aligned.

Some key subregional trends are:

- in the Central Hills region, a comparison of crop plantings in 1970 and 2000 (Table 4.1) shows that the increase in grapevine plantings correlated with a significant decrease in the area planted to potatoes, along with small declines in areas planted to irrigated pasture and orchards
- in the Fleurieu Peninsula region (Table 4.2), irrigated pasture has been, and continues to be, the most common type of irrigated agriculture; total irrigated area has increased substantially; and irrigated grapevines have emerged as a significant use of irrigated land.

¹ Australian Bureau of Statistics (ABS) (2006)

² DEWNR data

TABLE 4.1 IRRIGATION LAND USE CHANGE IN CENTRAL HILLS REGION 1970–2000
(SOURCE: ABS)

Year	Area of irrigated crops in the Central Hills region (hectares)					
	Vegetables (potatoes)	Orchards	Grapevines	Pasture	Lucerne and other	Total
1970	1584 (1143)	1595	25	2510	940	6654
1971	1415 (966)	1743	32	2760	918	6868
1972	1280	1522	53	3137	562	6554
1974	1184	1619	49	3353	582	6787
1975	1192	1694	54	3314	363	6617
1976	1114	1637	54	3260	356	6421
1979	1196	1349	60	2597	568	5770
	Potatoes	Apples and cherries	Grapevines	Pasture	Other	Total
1987	516	900	260	2141	683	4500
1988	639	900	417	1771	873	4600
1999	466	1282	1070	2166	958	5922
2000	500	1362	1800	2170	158	6890

TABLE 4.2. IRRIGATION LAND USE CHANGE IN FLEURIEU PENINSULA REGION 1970–2000
(SOURCE: ABS)

Year	Area of irrigated crops in the Fleurieu Peninsula region (hectares)					
	Vegetables (potatoes)	Orchards	Grapevines	Pasture	Lucerne and other	Total
1970	181 (67)	2	2	11228	380	11793
1971	211 (74)	2	6	1435	354	2008
1972	200	0	6	1271	434	1911
1974	191	41	33	1586	400	2251
1975	208	29	32	1617	447	2333
1976	177	41	36	1672	246	2172
1979	239	10	45	1507	178	1979
	Potatoes	Apples and cherries	Grapevines	Pasture	Other	Total
1987	93	24	30	1630	73	1850
1988	58	26	21	2207	88	2400
1989	116	19	107	2235	142	2619
2000	14	19	500	2240	155	2928

4.3. PRESENT DEMAND

Demand can be broadly divided into:

- environmental water requirements
- water use for licensed purposes (including public water supply and irrigation)
- water use for non-licensed purposes.

4.3.1. Water use for licensed purposes

Public water supply

Public water supply represents the major use of water in the Prescribed Area. In an average year, the reservoir catchments in the Prescribed Area supply 60% of metropolitan Adelaide’s mains water. In years of abundant rainfall, this can be as much as 90%, and as little as 10% in times of drought. The balance has historically been supplemented by water from the River Murray.

The capacity of each reservoir in the Prescribed Area is shown in Table 4.3.

TABLE 4.3 CAPACITY OF RESERVOIRS IN THE PRESCRIBED AREA

Catchment	Reservoir	Capacity ³
Little Para River	Little Para:	20,800 ML
	Warren:	4,790 ML
South Para River	South Para:	45,330 ML
	Barossa:	4,515 ML
River Torrens	Millbrook:	16,500 ML ⁴
	Kangaroo Creek:	19,160 ML ⁵
Onkaparinga River ⁶	Mount Bold:	46,180 ML
Myponga River	Myponga:	26,800 ML

These water supply reservoirs are under the control of SA Water. SA Water is an existing user (see Section 1.3.2) and is entitled to a water allocation that will meet its reasonable requirements to supply Adelaide and surrounding areas with mains water from these reservoirs.

The ongoing drought conditions across South Australia and the Murray–Darling Basin indicate that non-traditional sources for public water supply will need to be explored further. The State’s water plan, *Water for Good: A plan to ensure our water future to 2050*, was developed as an overarching plan to manage water resources in South Australia. The plan encourages diversification of water supplies to reduce reliance on the River Murray and other rain-dependent water sources.

To address the potential reduction of inflows to these reservoirs, no new surface water or watercourse water will be made available for allocation, dam development or commercial forestry upstream of the reservoirs (see principle 36 in Section 6, and principles 170 and 205 in Section 8 of this plan).

Water use for irrigation purposes

Irrigation water use requires a water allocation to take water. Other purposes that require a water allocation include intensive animal farming, mining, commercial, industrial and recreational use. These water uses are referred to as ‘licensed purposes’.

The demand for water for licensed purposes is estimated based on the water requirements of existing users as at 14 October 2004. Existing users have been identified from applications for existing user water licences and include current water users as well as eligible prospective users.

Table 4.4 shows the current existing user demand for irrigation (in hectares) in the eight catchments in the Prescribed Area.

Based on these applications, the current total area of existing irrigation is 15,491 hectares, an 18% increase on the level of use estimated in 2000 (13,156 hectares, ABS data). Table 4.4 and Figure 4.1 show that pasture is the predominant irrigated crop in the eight catchments in the Prescribed Area, at 39% of the total irrigated land area. Grapevines also make up a significant proportion (34%). The third largest proportion is fruit and nut trees (18%).

This data is only suitable for broad comparisons as the defined catchment boundaries in the Prescribed Area and ABS data sets are not fully aligned.

The total volumetric demand for existing user water requirements is in the process of being refined. Based on provisional water requirements of existing users, current demand for licensed purposes is estimated to be:

- 15.9 GL for surface water and watercourse water (with the exception of demand for public water supply by SA Water, detailed above)
- 51.8 GL for groundwater.

This demand is provisional and has been calculated based on theoretical enterprise water requirements, water availability limitations from dam storages and assumed split of this demand between resources.

³ Some reservoir capacities are greater than the annual runoff to the reservoir. This allows for the storage of runoff from multiple years and/or water from the River Murray.

⁴ Water captured by Millbrook Reservoir is also diverted into Kangaroo Creek Reservoir.

⁵ Water captured by Kangaroo Creek Reservoir is also diverted into Hope Valley Reservoir, which has a capacity of 2,840 ML.

⁶ Water captured by Mount Bold Reservoir is also diverted to Happy Valley Reservoir, which has a capacity of 11,600 ML.

TABLE. 4.4 IRRIGATED AREA OF CROPS – EXISTING USER APPLICATIONS BY CATCHMENTS IN THE PRESCRIBED AREA (SOURCE: DEWNR)

Catchment	Gardens, ovals and all turf	Trees, including all fruit and nut	Pasture, including lucerne	Grapevines	Other, including vegetables, flowers, berries, nurseries	Total
(hectares)						
South Para River	18	114	114	518	8	772
Little Para River	13	206	54	72	4	352
River Torrens	66	1,041	1,020	1,294	223	3,644
Onkaparinga River	334	1,116	1,932	2,473	520	6,375
Willunga Basin	7	35	62	679	9	792
Myponga River	5	84	1,166	74	68	1,397
Hindmarsh and Inman Rivers	34	53	1,030	87	9	1,213
Fleurieu Coastal	41	78	667	130	30	946
Totals	518	2,727	6,045	5,327	874	15,491

Little Para Proclaimed Watercourse

Currently, 13 licence holders take water from Little Para Proclaimed Watercourse. A total of 638,446 kilolitres (kL) is allocated, with three stock and domestic licensed users (2040 kL), nine licensed irrigators (635,046 kL) and one licensed recreational user (1360 kL).

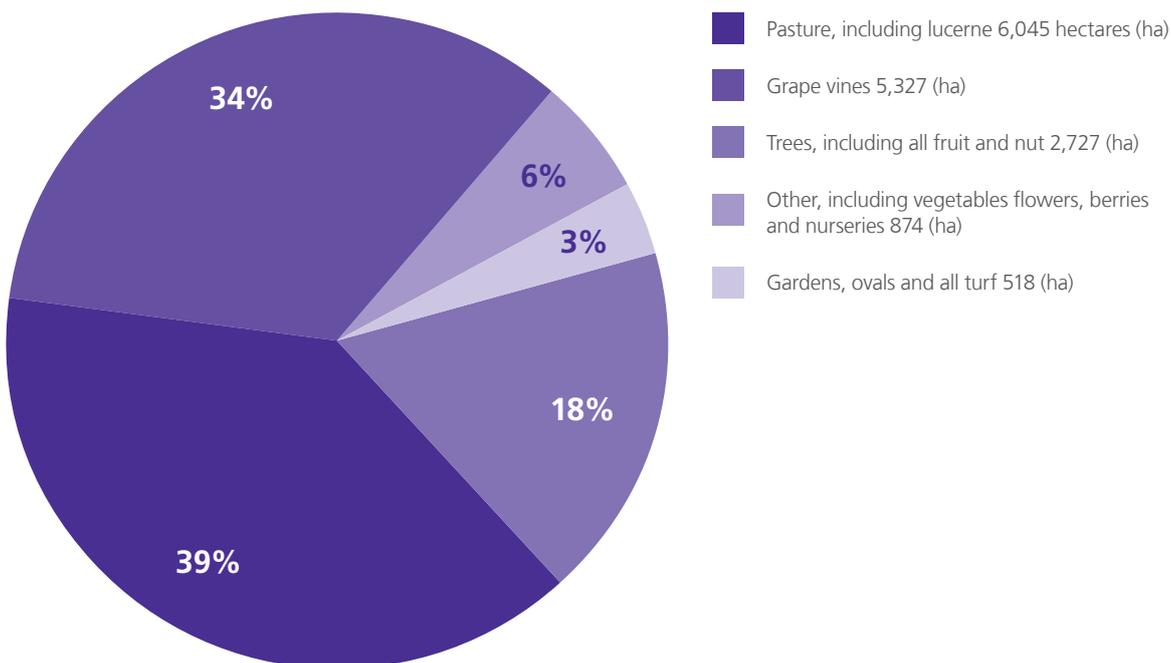


Figure 4.1 Estimated total irrigated land area by crop type in prescribed area (Source: DEWNR - Existing user applications)

Subregional trends

Tables 4.5a and 4.5b compare present and historical demand in Central Hills region and in Fleurieu Peninsula region.

Central Hills region has seen a significant increase in the total area of land irrigated for agricultural purposes. Irrigation of orchards, grapevines and pasture increased substantially in Central Hills region between 2000 and 2004, with an increase in demand of 818, 1640 and 1300 hectares, respectively. The identification of existing users through the water licence application process (whose

water use may not be represented in the earlier data) may account for the apparent increase in pasture irrigation. The substantial increases in orchards and grapevines are likely to represent significant investment and a relatively recent increase in demand for water.

In comparison, the extent and nature of land irrigated for agriculture in the southern Fleurieu Peninsula region has not changed significantly since 2000.

TABLE 4.5A IRRIGATION LAND USE CHANGE IN CENTRAL HILLS REGION 1970–2004
(SOURCE: ABS AND DEWNR)⁷

Year	Area of irrigated crops in the Fleurieu Peninsula region (hectares)					
	Potatoes	Orchards	Grapevines	Pasture	Other	Total
1970	1584	1595	25	2510	940	6654
2000	500	1362	1800	2170	1058	6890
2004	–	1180	3440	3470	920	9010

TABLE 4.5B IRRIGATION LAND USE CHANGE IN FLEURIEU PENINSULA REGION 1970–2004
(SOURCE: ABS AND DEWNR)⁸

Year	Area of irrigated crops in the Fleurieu Peninsula region (hectares)					
	Potatoes	Orchards	Grapevines	Pasture	Other	Total
1970	181	2	2	1228	380	1793
2000	14	19	500	2240	155	2928
2004	–	190	330	2400	220	3140

⁷1970–2000 data sourced from ABS, 2004 data sourced from the department.

⁸1970–2000 data sourced from ABS, 2004 data sourced from the department.

4.3.2. Water use for non-licensed purposes

Stock and/or domestic use

Stock and domestic water use makes up the majority of non-licensed use in the Prescribed Area.

In the Prescribed Area there are approximately 11,500 wells, 2860 of which are recorded as stock and domestic wells. It is estimated that the groundwater demand for stock and domestic use is approximately 1340 ML.

Of the approximately 13,000 dams in the Prescribed Area, 1700 are used for irrigation purposes. The remaining 11,300 dams are used for stock and domestic or other non-licensed purposes. The total capacity of unlicensed dams is 16,516 ML, and the estimated total surface water demand for stock and domestic use is approximately 4956 ML.

Commercial forestry

Forests are recognised as having a significant impact on the water resources in the Prescribed Area. Commercial plantation forests reduce runoff and can affect recharge to aquifers. They can also affect aquifers by direct extraction from shallow watertables. The approximately 12,400 ha of plantation forestry in the Prescribed Area comprises 8900 ha of softwood (pine), 1500 ha of hardwood (including Tasmanian blue gum), and 2000 ha of farm forestry (various species). Of the existing plantings, the extent of ForestrySA plantations may be considered to be static. Operations by private interests have stopped in the region, so little expansion of hardwood plantations is anticipated.

Aboriginal water needs

Governments across Australia are in the early stages of formally recognising Aboriginal relationships with water for spiritual, cultural and economic purposes (Rural Solutions 2008). The *Inter-governmental Agreement on a National Water Initiative* demonstrates a commitment by all states and territories to include indigenous representation in water planning, to incorporate indigenous social, spiritual and customary objectives and strategies, and to take into account any native title rights to water.

Access to, and use of, water from prescribed water resources by Aboriginal people for the purpose of social, cultural or spiritual use is exempt from licensing, provided they do not stop, impede or divert the flow of water.

In accordance with the Notice of Authorisation to Take Water for Stock and Domestic Purposes and for Native Title Purposes from Certain Prescribed Water Resources published in the South Australian Government Gazette on 20 October 2005 (pages 3736–3737) a water licence is not required to take water from any of the prescribed water resources in the Prescribed Area by a person who is a native title holder in relation to the land or water on or in which that water source is situated. The provision is that the taking is for the purpose of satisfying that person's personal, domestic, cultural, spiritual or non-commercial communal needs and the taking of that water is in the exercise or enjoyment of their native title rights and interests. The taking of water in these circumstances must not involve stopping, impeding or diverting the flow of water for the purpose of collecting the water or diverting the flow of water from a water resource.

4.4. CLIMATE CHANGE

It is widely accepted that changes in climatic conditions beyond historical variability are occurring worldwide. The likely future impacts of climate change include rising temperatures, a reduction in total rainfall, and an increase in extreme events such as drought and bushfire. Modelling by CSIRO shows temperatures in the coastal or southern regions of South Australia, including the Prescribed Area, increasing by 0.3–1.3°C by 2030, and by 0.6–3.8°C by 2070.

The extent of the impacts of climate change on water resources in the Prescribed Area is not known with any specificity. Any reduction in rainfall and/or increase in temperatures and drought events is likely to impact on the water available to be captured by dams and reservoirs, the flow of water in watercourses and the recharge of aquifers. This will, in turn, affect (among other things) agricultural production systems. Water for Good forecasts a 41% reduction over the next 40 years in inflows to the Mount Lofty Ranges reservoirs as a result of climate change. This will pose significant future challenges for the allocation of water resources in the Prescribed Area.

Another significant report on possible climate change impacts indicates that changing weather patterns translate to a potential reduction in annual rainfall of 13%, which may lead to a potential reduction in annual runoff from the major catchments in the Prescribed Area of more than 30% over the period to 2050. The greatest impact of climate change on monthly rainfall totals that is likely to be translated to runoff generation appears to be during the autumn and early winter period from April to June. Modelling showed rainfall to be reduced by as much as 25% over this period.

The policies in this plan are based on the most up-to-date meteorological, hydrological and hydrogeological information. They are also structured in such a way that any changes in the capacity of water resources in the Prescribed Area, including as a result of climate change, can be incorporated in the plan. Any changes to the understanding and/or the future impacts of climate change will be included in future reviews of this plan. Ongoing monitoring and evaluation during the life of this plan will also support this adaptive management framework (see monitoring and evaluation in Section 9).

4.5. FUTURE DEMAND

Without regulatory management the demand for water in the Prescribed Area could be expected to increase as a result of a variety of factors, including the following:

- The Prescribed Area incorporates areas of extensive urban and peri-urban expansion. While SA Water is expected to meet the increased demand generated by urban expansion, peri-urban expansion places new pressures on water resources through stock and/or domestic dams and wells.
- Increased demand for water for irrigation, mining and possibly forestry.

- Although difficult to quantify, a number of factors, including ongoing drought in the Murray–Darling Basin and fluctuations in national and international commodity markets, may lead to increases in demand for agricultural products that can be grown in the Prescribed Area. Any such increase in demand for these products will increase the demand for water.
- Irrespective of potential increases in demand on water resources through the future growth plans of industries and individuals, the unfolding challenge of climate change means growers looking to drought-proof their production systems may look to increase storages to ensure certainty of supply.

Large-scale assessments of the demand for, and availability of, water needs to be viewed in terms of the management systems being put in place by this plan. Limits on the extraction of water have been put in place at several scales. Ultimately, this plan establishes the limits for extraction of water by all industries and activities within the Prescribed Area. Market forces will determine any changes to the distribution and nature of water use.

Future capacity of the land

The capacity of the land to support further development is thought to be good, and it is likely to be access to water rather than land capacity that limits future development of water-using activities. The lack, or low volume, of water available for new allocation (depending on the resource) means that any such additional demand will generally need to be met through increases in efficiency, transfers or alternative water sources.

It is difficult to predict the likely effect of the provisions of this plan on land value in the Prescribed Area. The low or zero volume of water available for new allocation, and limits on construction of new dams and wells, may affect the value of land that does not currently have access to water. However, the improved security of water supply and granting of a valuable asset may improve the value of land with developed water resources.

5. Capacity of the water resources in the Prescribed Area

5.1. CAPACITY OF UNDERGROUND WATER

The eight catchments in the Prescribed Area are divided into underground water management zones for the purposes of managing the taking and use of underground water (Figures 5.1–5.5). The boundaries of underground water management zones are based on surface water subcatchment boundaries and hydrogeology.

The underground water resource capacity is the volume of annual recharge in an underground water management zone (column 2, Tables 5.1–5.5).

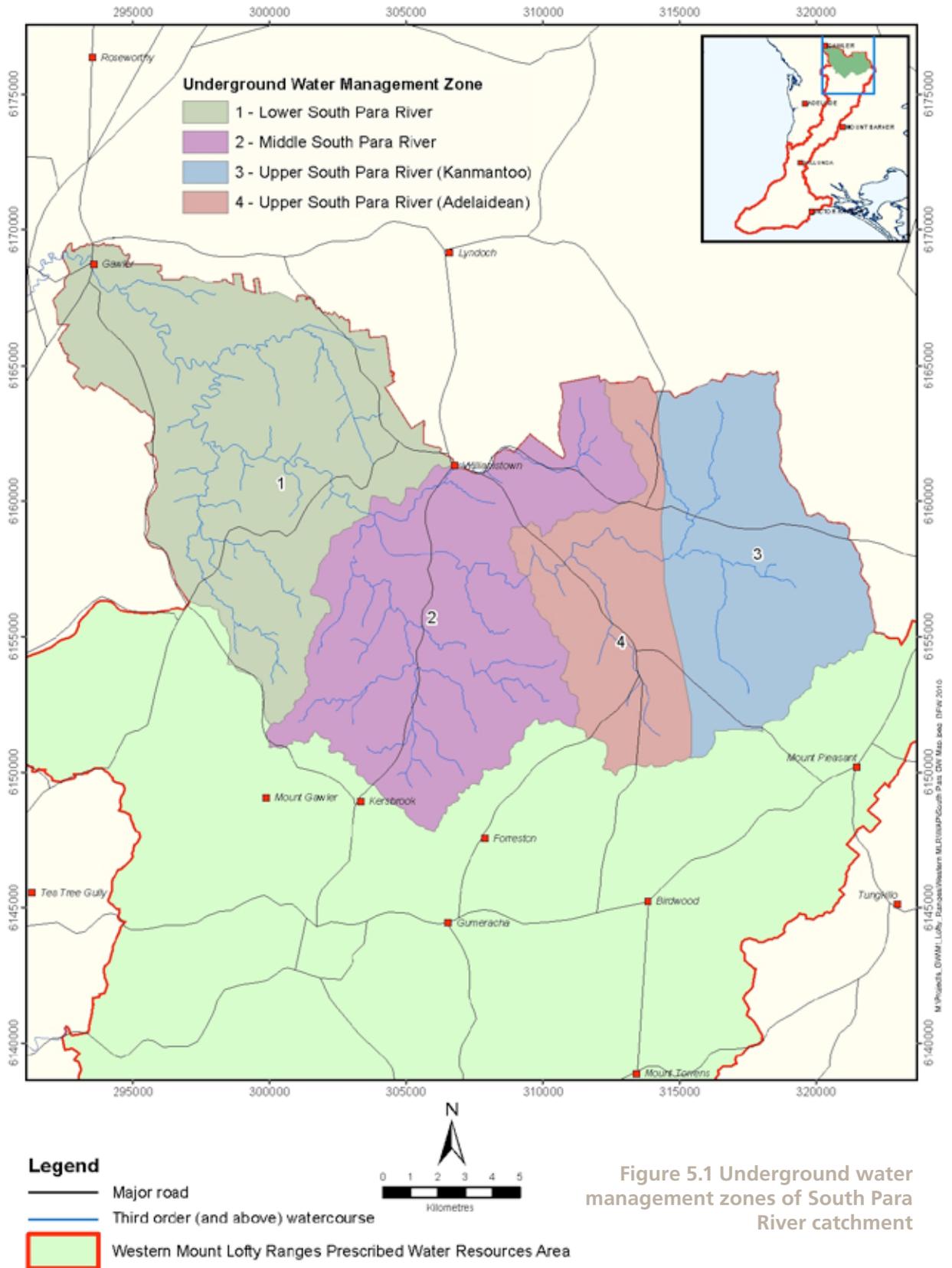
The capacity of the underground water resource has been determined by a combination of analyses of groundwater chemistry, water level trends, estimates of underground water use and calculations of baseflow in watercourses. Variations in rainfall, geology and land use (including commercial forestry) were taken into account. On this basis, the total underground water resource capacity is calculated to be approximately 143 GL.

5.2. UNDERGROUND WATER EXTRACTION LIMIT

Each underground water management zone has an underground water extraction limit – the total annual volume of underground water that can be taken by existing users and for new use in an underground water management zone.

The underground water extraction limit is the difference between the underground water resource capacity and the sum of baseflow, existing non-licensed underground water use (including deemed commercial forestry water use) in a given underground water management zone. The underground water extraction limit for each underground water management zone is given in Tables 5.1–5.5.

Ongoing monitoring of underground water levels and salinity will reveal further information and understanding of the resources and be used to inform reviews of the plan.



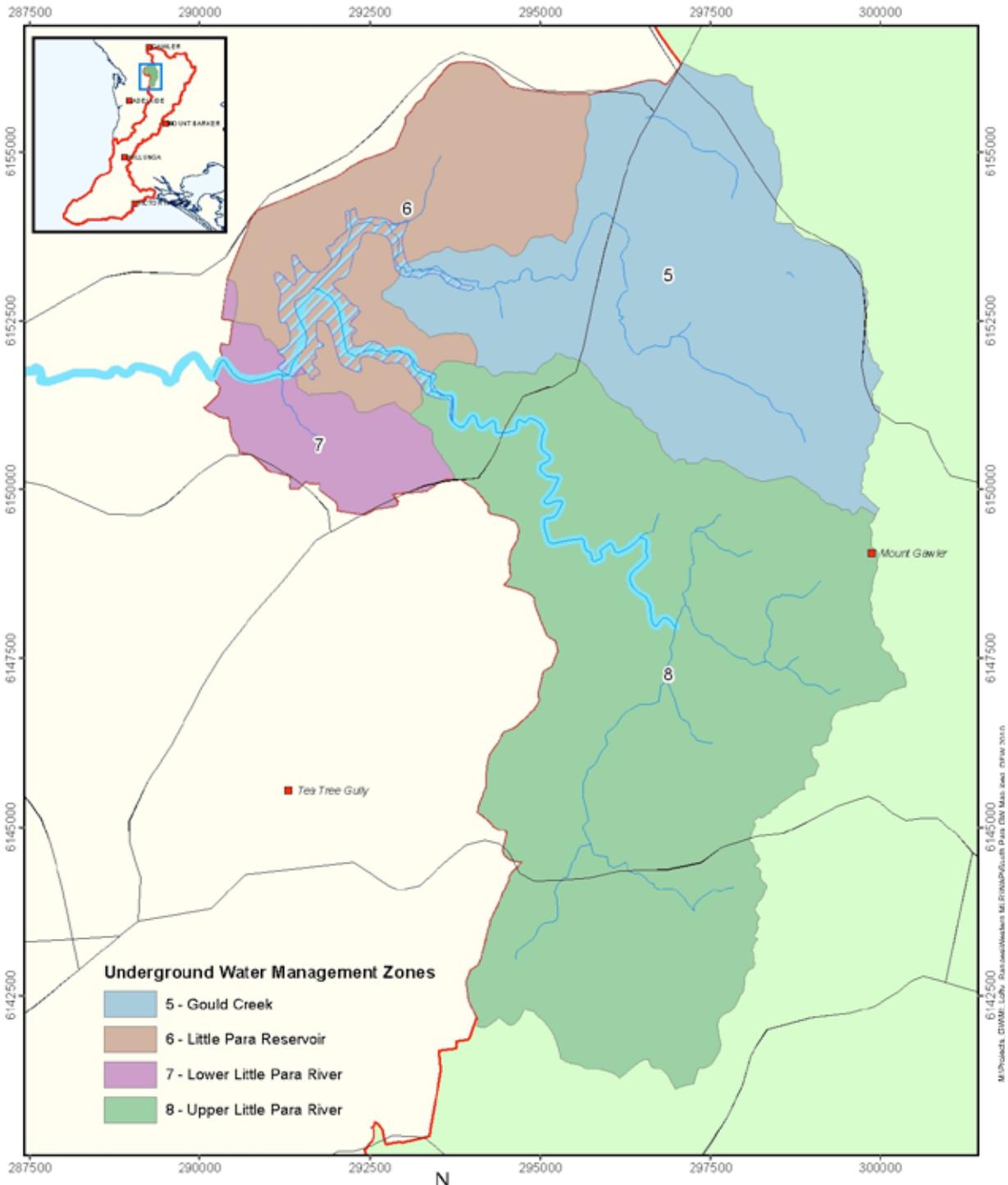
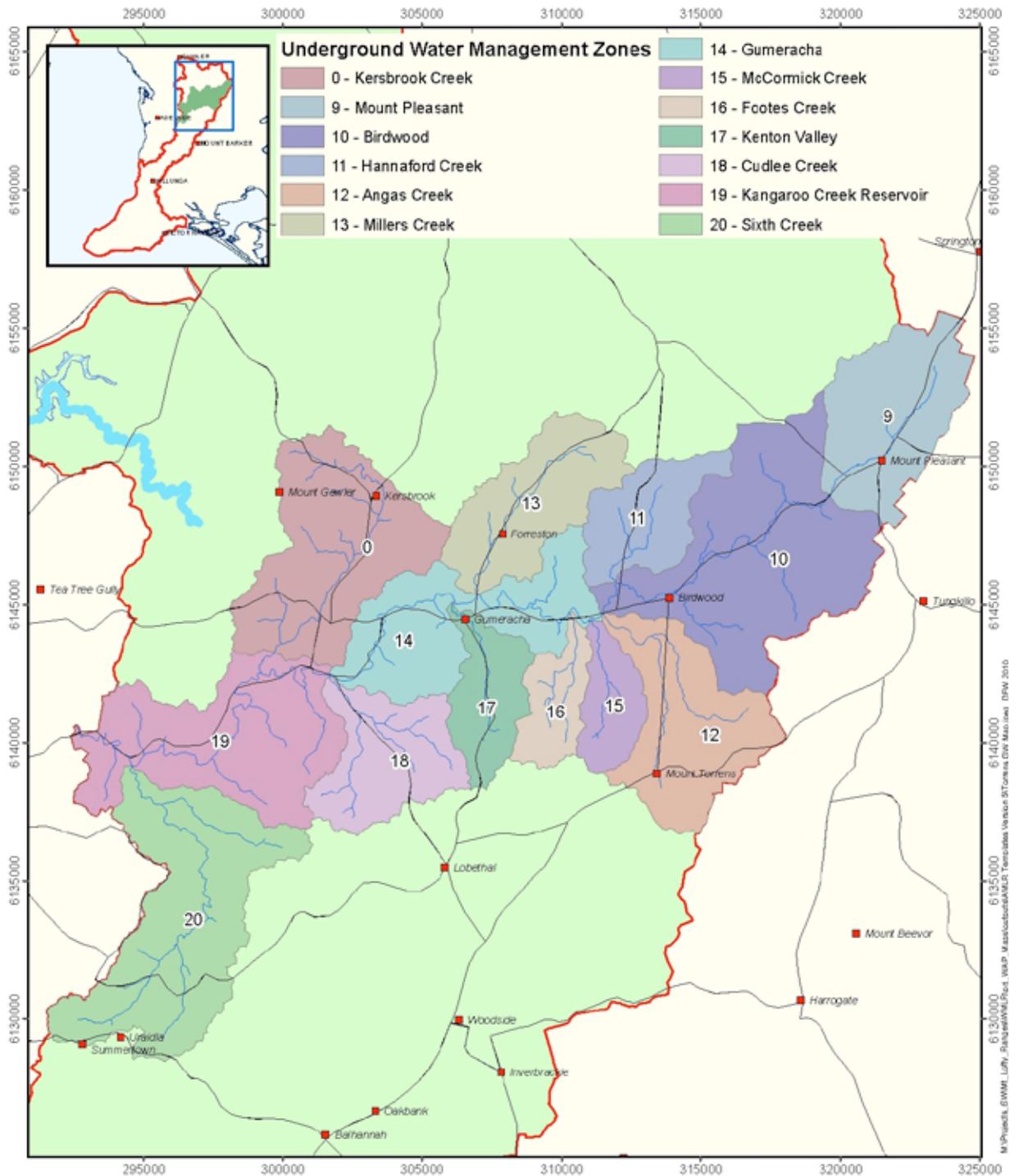


Figure 5.2 Underground water management zones of Little Para River catchment



Legend

- Major road
- Third order (and above) watercourses
- Little Para Proclaimed Watercourse
- Western Mount Lofty Ranges Prescribed Water Resources Area
- ▨ Reservoir

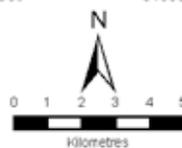


Figure 5.3 Underground water management zones of River Torrens catchment

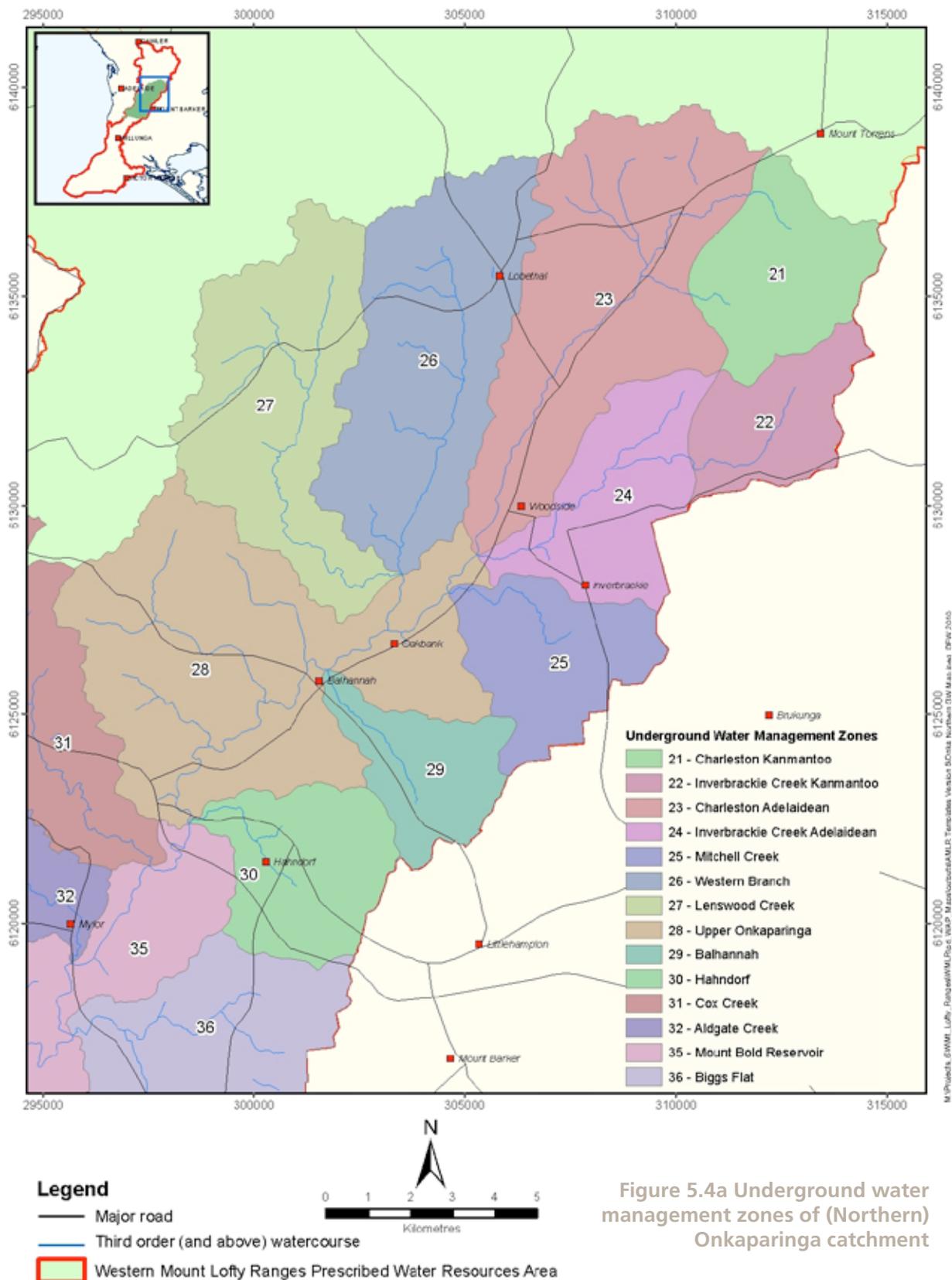
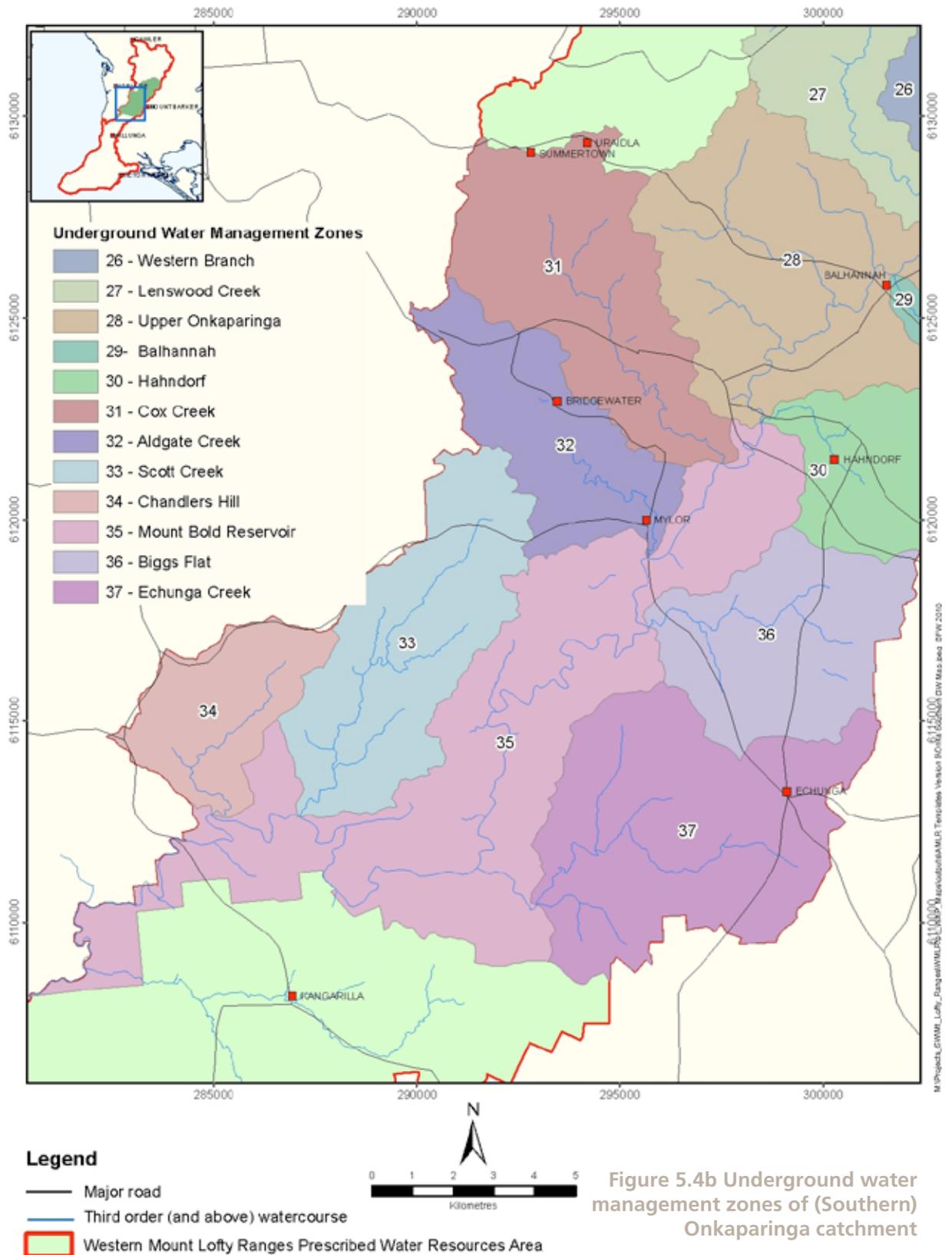


Figure 5.4a Underground water management zones of (Northern) Onkaparinga catchment



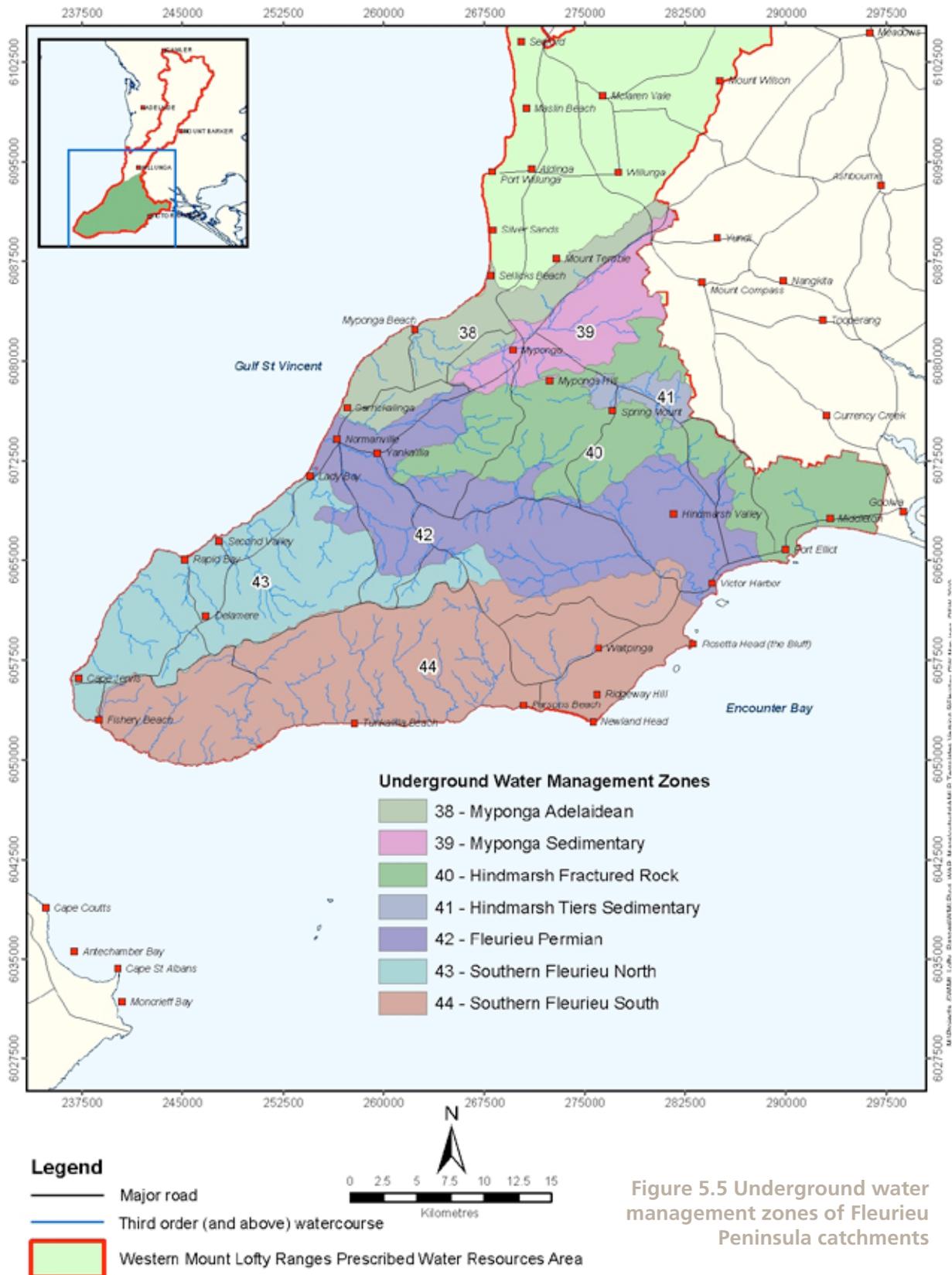


TABLE 5.1 UNDERGROUND WATER EXTRACTION LIMITS IN SOUTH PARA RIVER CATCHMENT

Underground water management zones	Underground water resource capacity (ML)	Baseflow (ML)	Existing non-licensed extractions (estimated ML)	Extraction limit (ML)
Lower South Para (inc Lower Gawler River)	6,714	1,351	70	5,293
Middle South Para River	6,969	3,784	44	3,142
Upper South Para River (Adelaidean)	2,058	1,538	34	486
Upper South Para River (Kamantoo)	1,263	660	8	596
TOTAL	17,004	7,333	156	9,517

TABLE 5.2 UNDERGROUND WATER EXTRACTION LIMITS IN LITTLE PARA RIVER CATCHMENT

Underground water management zones	Underground water resource capacity (ML)	Baseflow (ML)	Existing non-licensed extractions (estimated ML)	Extraction limit (ML)
Gould Creek	1,570	460	14	1,096
Little Para Reservoir	393	209	7	178
Lower Little Para River	376	87	3	286
Upper Little Para River	3,027	1,407	9	1,611
TOTAL	5,366	2,163	33	3,171

TABLE 5.3 UNDERGROUND WATER EXTRACTION LIMITS IN RIVER TORRENS CATCHMENT

Underground water management zones	Underground water resource capacity (ML)	Baseflow (ML)	Existing non-licensed extractions (estimated ML)	Extraction limit (ML)
Kerbrook Creek	2,032	1,428	3	601
Mount Pleasant	606	300	16	290
Birdwood	2,771	1,273	48	1,450
Hannaford Creek	1,326	416	10	900
Angas Creek	2,245	587	6	1,652
Millers Creek	3,026	604	32	2,390
Gumeracha	2,957	1,079	35	1,843
McCormick Creek	1,080	257	10	813
Footes Creek	1,301	283	2	1,016
Kenton Valley	2,040	420	17	1,603
Cudlee Creek	1,454	882	22	550
Kangaroo Creek Reservoir	2,325	1,330	37	957
Sixth Creek	5,377	2,809	33	2,535
TOTAL	28,540	11,668	271	16,600

TABLE 5.4 UNDERGROUND WATER EXTRACTION LIMITS IN THE ONKAPARINGA RIVER CATCHMENT

Underground water management zones	Underground water resource capacity (ML)	Baseflow (ML)	Existing non-licensed extractions (estimated ML)	Extraction limit (ML)
Charleston Kanmantoo	1,348	652	24	672
Inverbrackie Creek Kanmantoo	700	305	0	395
Charleston Adelaidean	3,569	979	40	2,550
Inverbrackie Creek Adelaidean	1,532	567	25	940
Mitchell Creek	928	155	19	754
Western Branch	2,990	998	42	1,950
Lenswood Creek	5,447	2,182	9	3,256
Upper Onkaparinga	3,980	1,906	40	2,034
Balhannah	1,003	220	13	770
Hahndorf	1,065	355	8	701
Cox Creek	3,445	2,029	66	1,350
Aldgate Creek	2,101	1,846	55	200
Scott Creek	2,479	1,487	15	977
Chandler's Hill	557	373	5	180
Mount Bold Reservoir	3,992	2,644	14	1,334
Biggs Flat	1,436	323	11	1,102
Echunga Creek	2,360	1,063	27	1,270
TOTAL	38,932	18,084	413	20,435

TABLE 5.5 UNDERGROUND WATER EXTRACTION LIMITS IN THE FLEURIEU PENINSULA CATCHMENTS

Underground water management zones	Underground water resource capacity (ML)	Baseflow (ML)	Existing non-licensed extractions (estimated ML)	Extraction limit (ML)
Myponga Adelaidean	3,404	1,781	4	1,619
Myponga Sedimentary	7,768	3,303	135	4,330
Hindmarsh Fractured Rock	8,697	6,484	174	2,039
Hindmarsh Tiers Sedimentary	3,372	1,372	12	1,988
Fleurieu Permian	14,482	6,781	87	7,614
Southern Fleurieu North	6,065	4,013	237	1,815
Southern Fleurieu South	9,172	7,673	302	1,197
TOTAL	52,960	31,407	951	20,602

5.3. CAPACITY OF SURFACE WATER AND WATERCOURSE WATER

The eight catchments in the Prescribed Area are divided into surface water management zones for the purposes of managing the taking and use of surface water and watercourse water (Figures 5.6–5.19). For Central Hills catchments, the boundaries of surface water management zones are based on the confluence of watercourses and likely presence of water-dependent ecosystems (such as a permanent pool), which support various aquatic habitats and have specific environmental water requirements (see Section 2).

For Fleurieu Peninsula catchments this approach would have resulted in the size of surface water management zones being relatively small, with some being almost at the property scale. Management of surface water resources is generally not done at the property scale due to the lack of detailed information that would be required at that scale. Furthermore:

- in comparison to the rest of the Prescribed Area, gauged streamflow data is limited, being collected in only five of the 50 catchments
- the five gauged catchments represent a large portion of the Fleurieu Peninsula catchments, but their hydrogeology is not entirely representative of the hydrogeology of the rest of the catchments
- there are limitations to extrapolating this limited catchment-scale runoff data to surface water management zones in the gauged catchments, and more importantly, to the ungauged catchments
- confidence is lower in the resource capacity data for the surface water management zones in the Fleurieu Peninsula catchments, particularly in the ungauged catchments, than in the resource capacity data for surface water management zones in the rest of the Prescribed Area.

Because of the limited data and, more critically, to ensure that water users across gauged and ungauged areas are treated equitably in the planning process, surface water resources in Fleurieu Peninsula catchments will be managed at a catchment scale. The five catchments with gauging stations each have two surface water management zones, one based upstream and one downstream of the gauging station. This approach effectively redistributes the water across the surface water management zone, but does not increase total water available for extraction in the zone.

The surface water resource capacity is the total volume of surface water runoff at the downstream end of a surface water management zone. This is the runoff that would flow over land in a surface water management zone if there were no dams or forests in that zone.

Surface water resource capacity was calculated by modelling flow data from gauging stations and rainfall in the Prescribed Area. The impact of dams and forests was removed and runoff apportioned

to each surface water management zone according to rainfall, resulting in a surface water resource capacity for each zone. On this basis, total surface water resource capacity (not including the watercourses across the plains) is calculated to be approximately 286 GL.

5.4. SURFACE WATER AND WATERCOURSE WATER EXTRACTION LIMITS

Each surface water management zone has a surface water extraction limit. Based on Section 2.3 of this plan, the surface water extraction limit for a surface water management zone is:

25% of surface water resource capacity, with provision of threshold flows.

This is the maximum annual volume of surface water and watercourse water (but not water from a main watercourse) that can be taken in a surface water management zone. The surface water extraction limit will ensure sufficient flows for environmental water provisions (water-dependent ecosystems, underground water recharge and system losses) in a surface water management zone as well as for downstream users. Managing water using smaller, localised surface water management zones helps to ensure the provision of water to all water users, including the environment.

The local extraction limit for new extractions in areas upstream of Fleurieu wetlands is 25% of the local adjusted runoff to these wetlands (Section 2.4.1). The extraction limit of 25% of surface water resource capacity will still apply at the surface water management zone scale.

25% local extraction limit for new extractions of water in areas upstream of Fleurieu wetlands

A watercourse fed by runoff from an upstream surface water management zone is called a main watercourse. The extraction limit that applies to it is called the main watercourse extraction limit. This is the maximum annual volume of water that can be taken from a main watercourse and any surface water management zones that contribute to the flow of water in any part of the main watercourse. The main watercourse extraction limit at the downstream end of a surface water management zone is therefore the sum of the surface water extraction limit for that zone and any upstream surface water management zones.

The surface water extraction limit and main watercourse extraction limit for each surface water management zone are listed in Tables 5.6–5.11.

Under this plan, there will be no net new surface water and watercourse water use upstream of reservoirs in South Para River, Little Para River, River Torrens, Onkaparinga River and Myponga River catchments, which have reached their extraction limits. However, subject to the transfer rules in Section 7 of this plan,

water licences and/or water allocations may be transferred within, and between, surface water management zones in these catchments.

5.5. DIVERSION LIMITS

Each surface water management zone has a diversion limit of two times the surface water extraction limit. It is the total volume of surface water and watercourse water that can be collected or diverted by all dams and/or intercepted by existing and new commercial forests. The diversion limit for each surface water management zone is listed in Tables 5.6–5.11.

There will be no net new surface water and watercourse water use upstream of reservoirs in South Para River, Little Para River, River Torrens, Onkaparinga River and Myponga River catchments means that new dams – including dams for stock and/or domestic purposes – can be constructed in these catchments only where there is a reduction in dam capacity that is equal to, or greater than, the capacity of the proposed new dam.

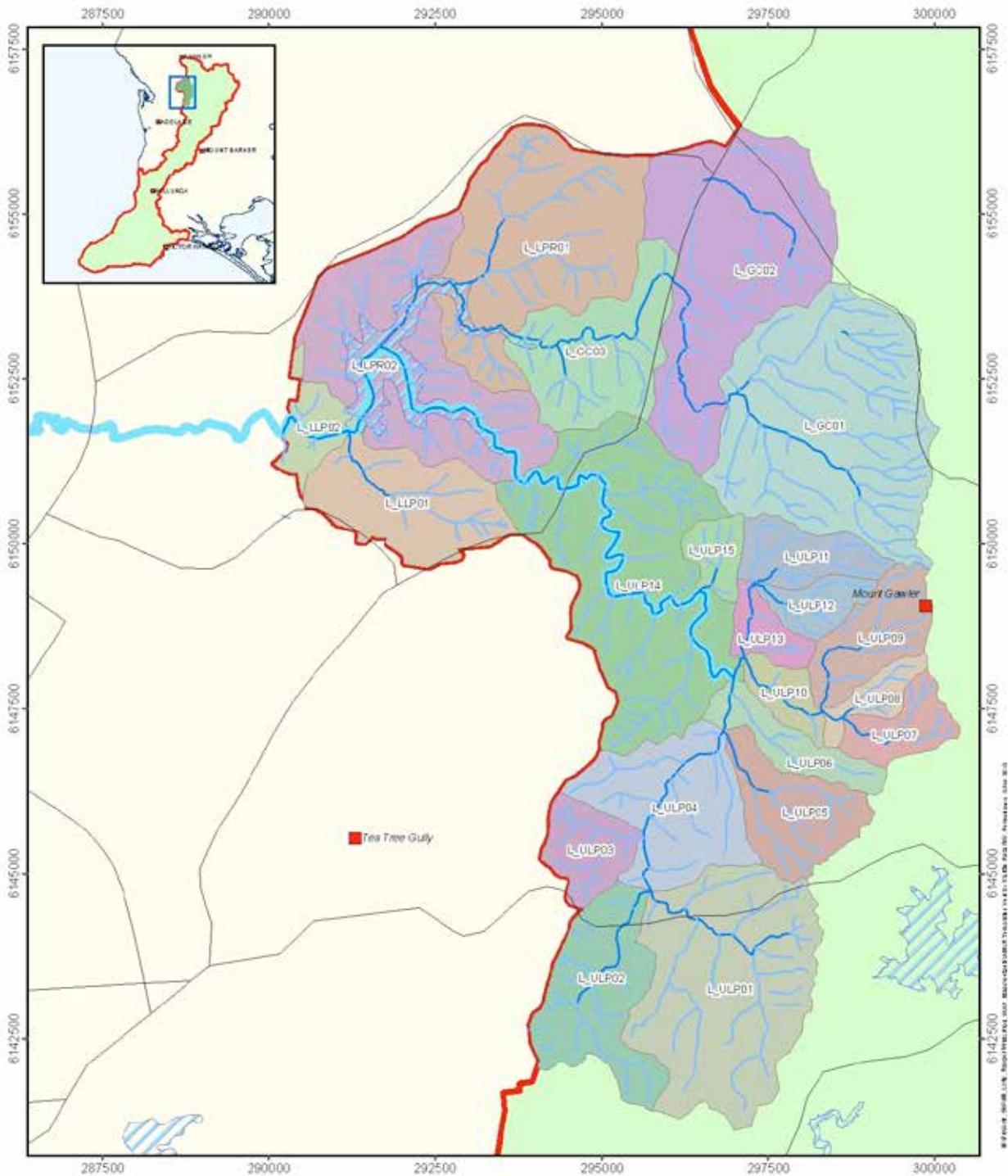
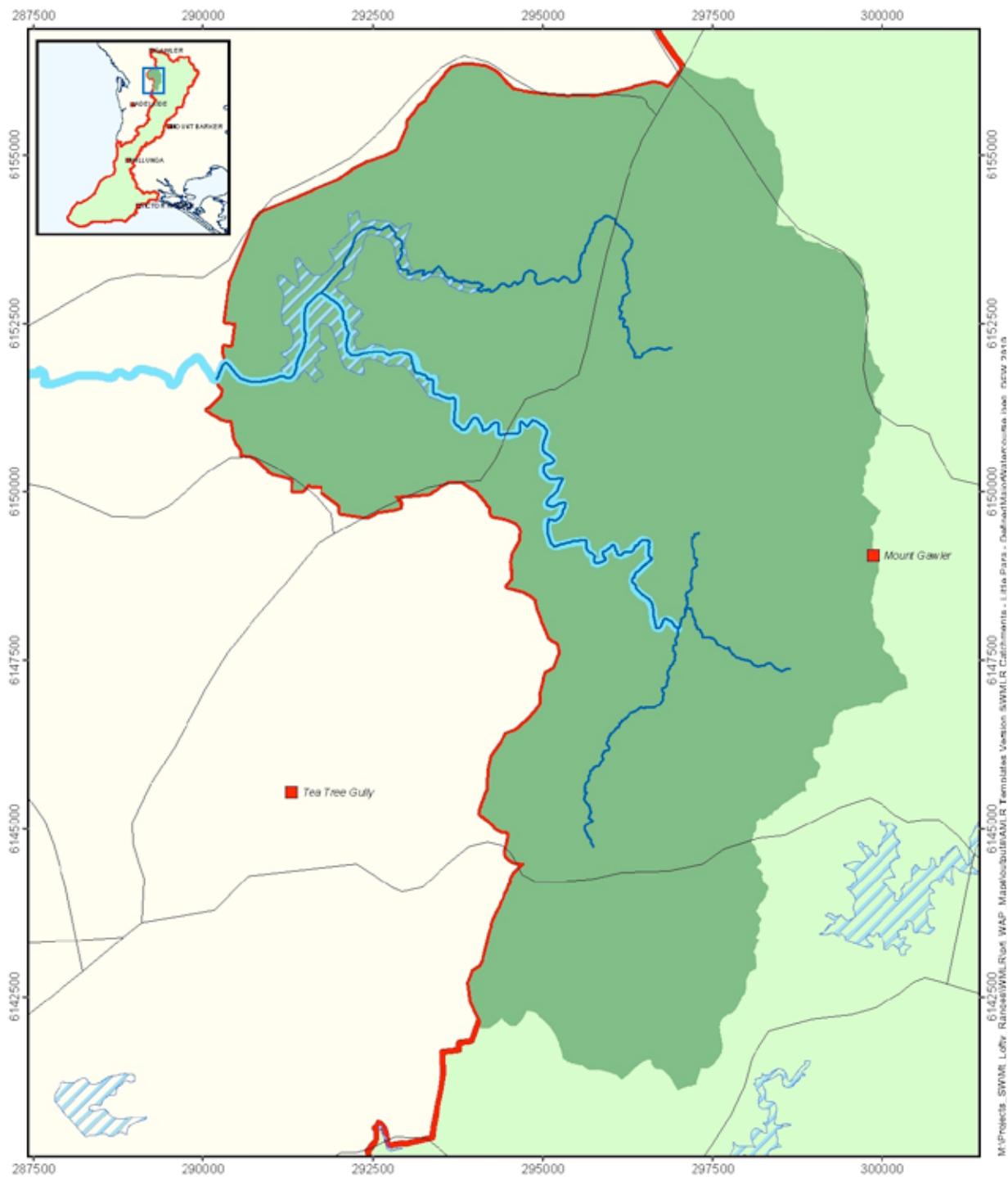


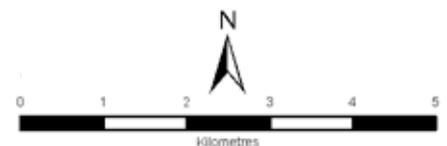
Figure 5.6 Surface water management zones of Little Para River catchment

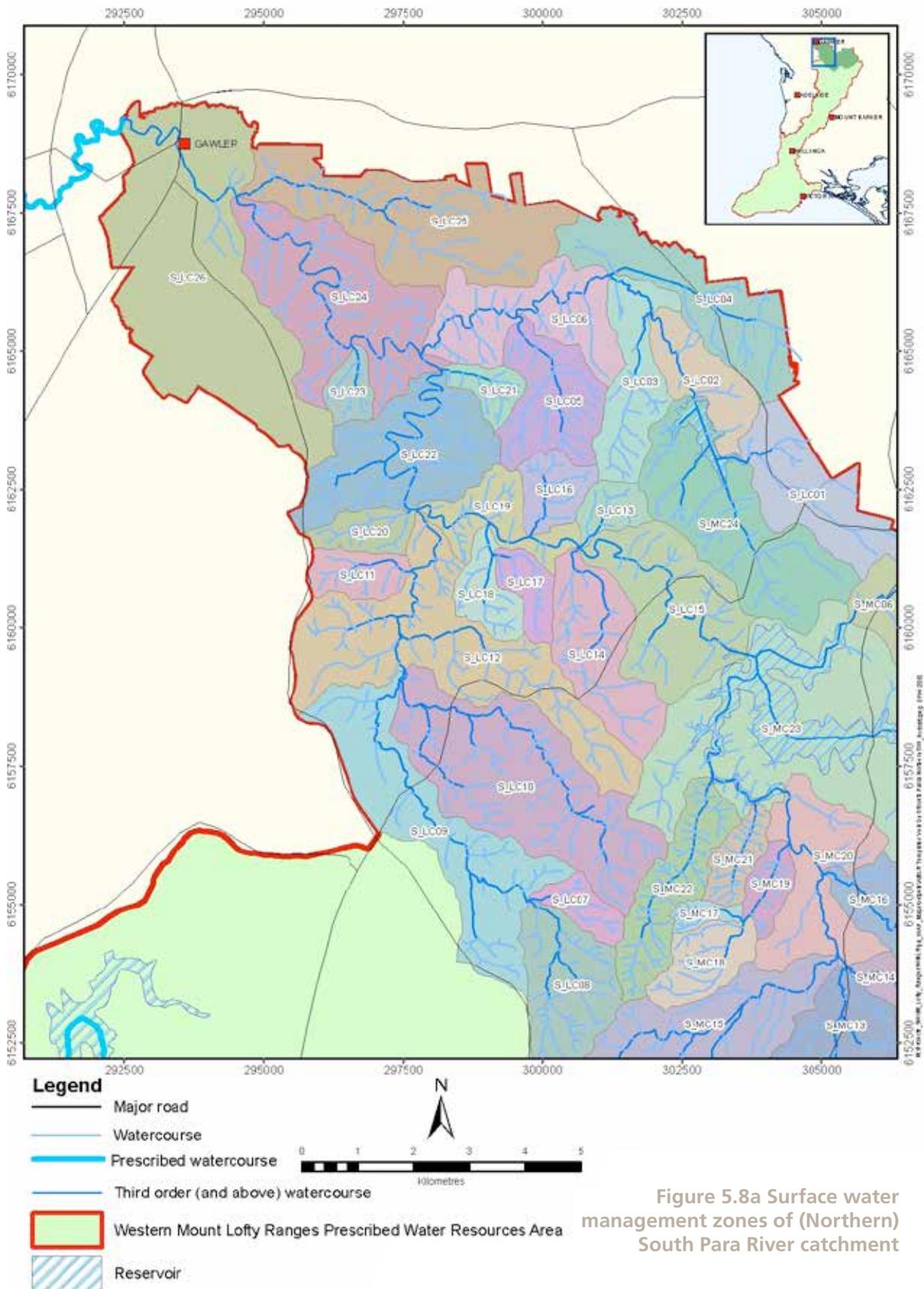


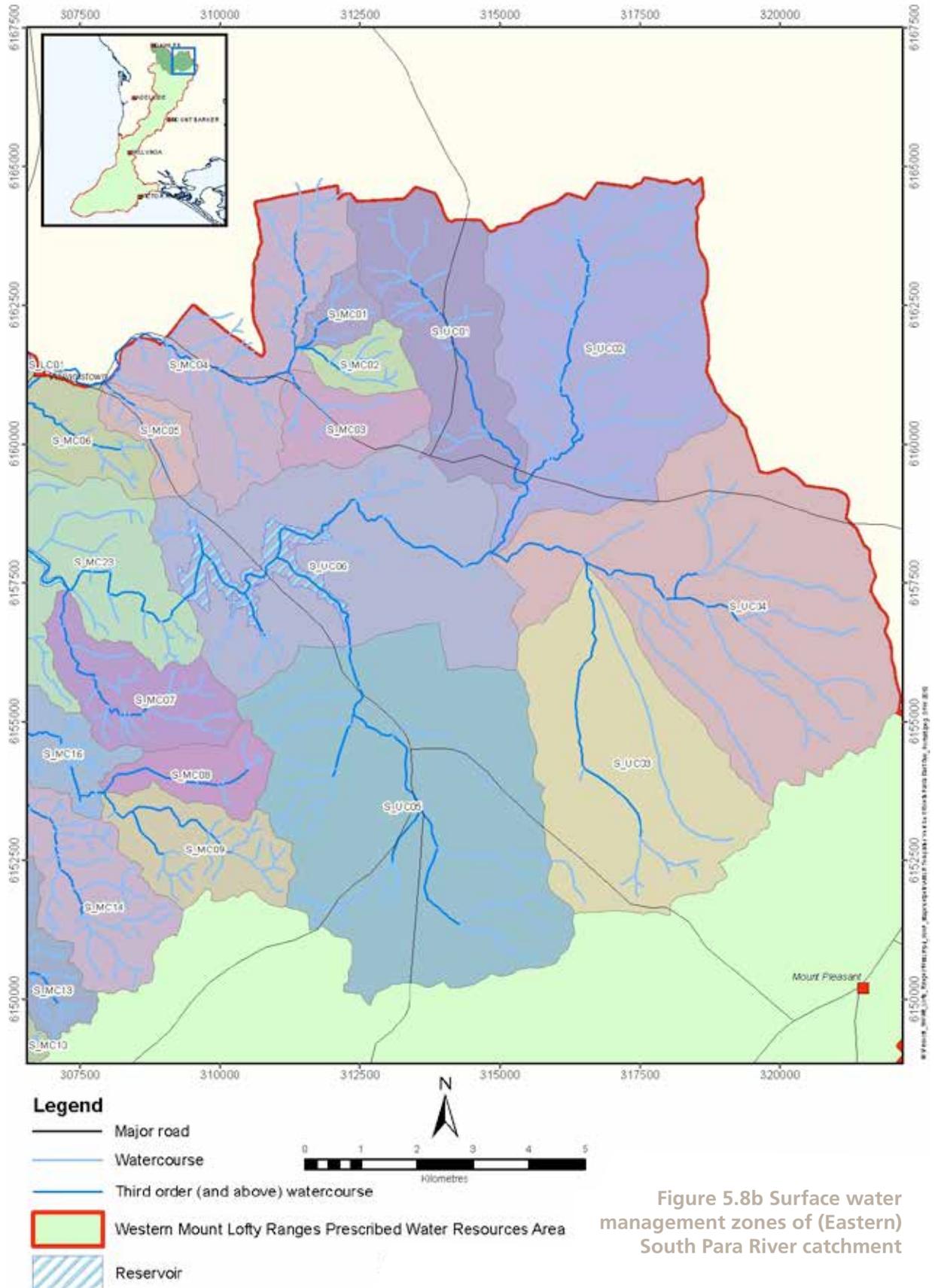
Legend

-  Major road
-  Little Para Proclaimed Watercourse
-  Main watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.7 Main watercourses of Little Para River catchment







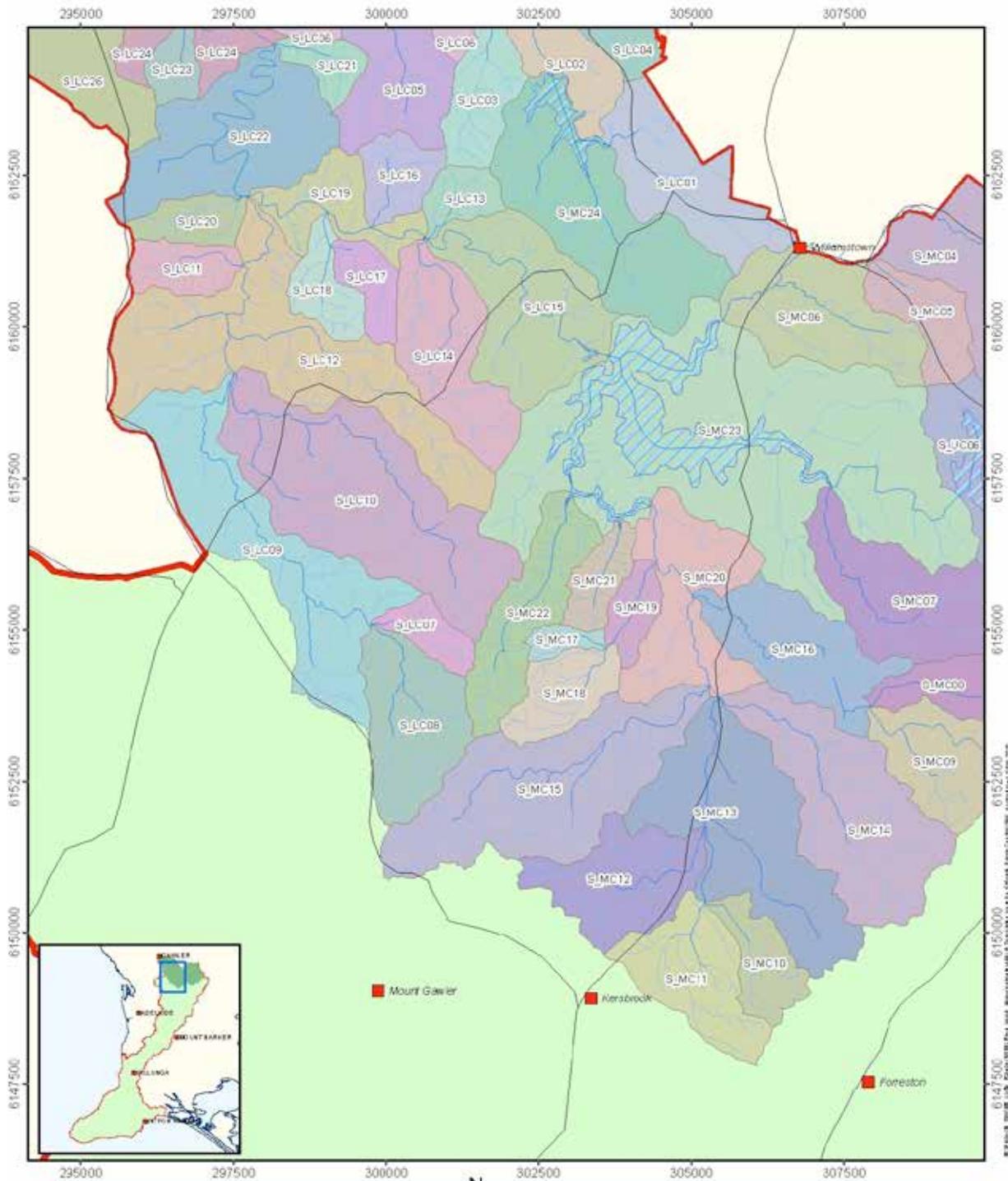
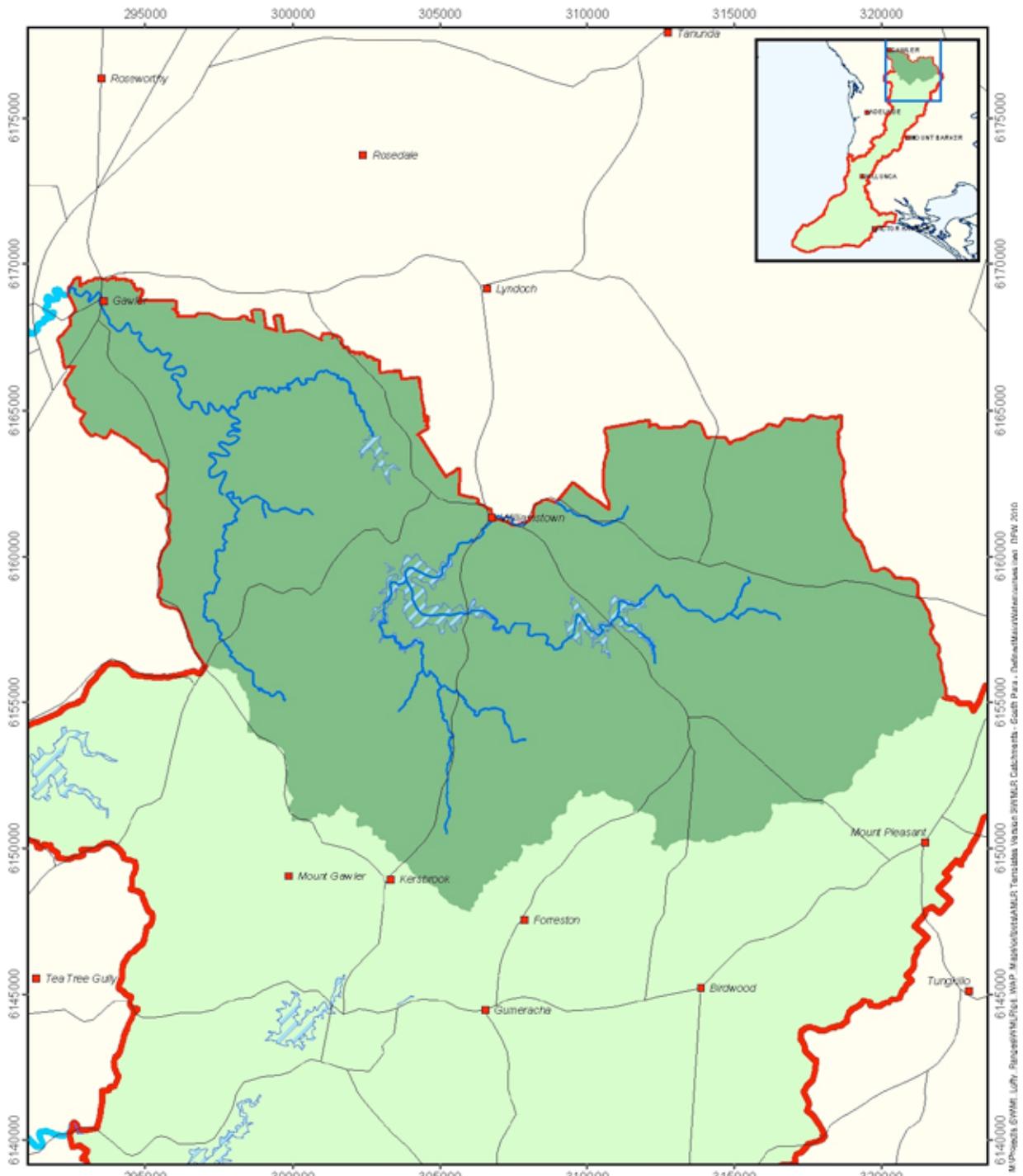


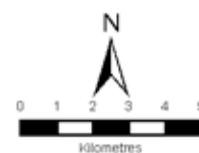
Figure 5.8c Surface water management zones of (Central) South Para River catchment

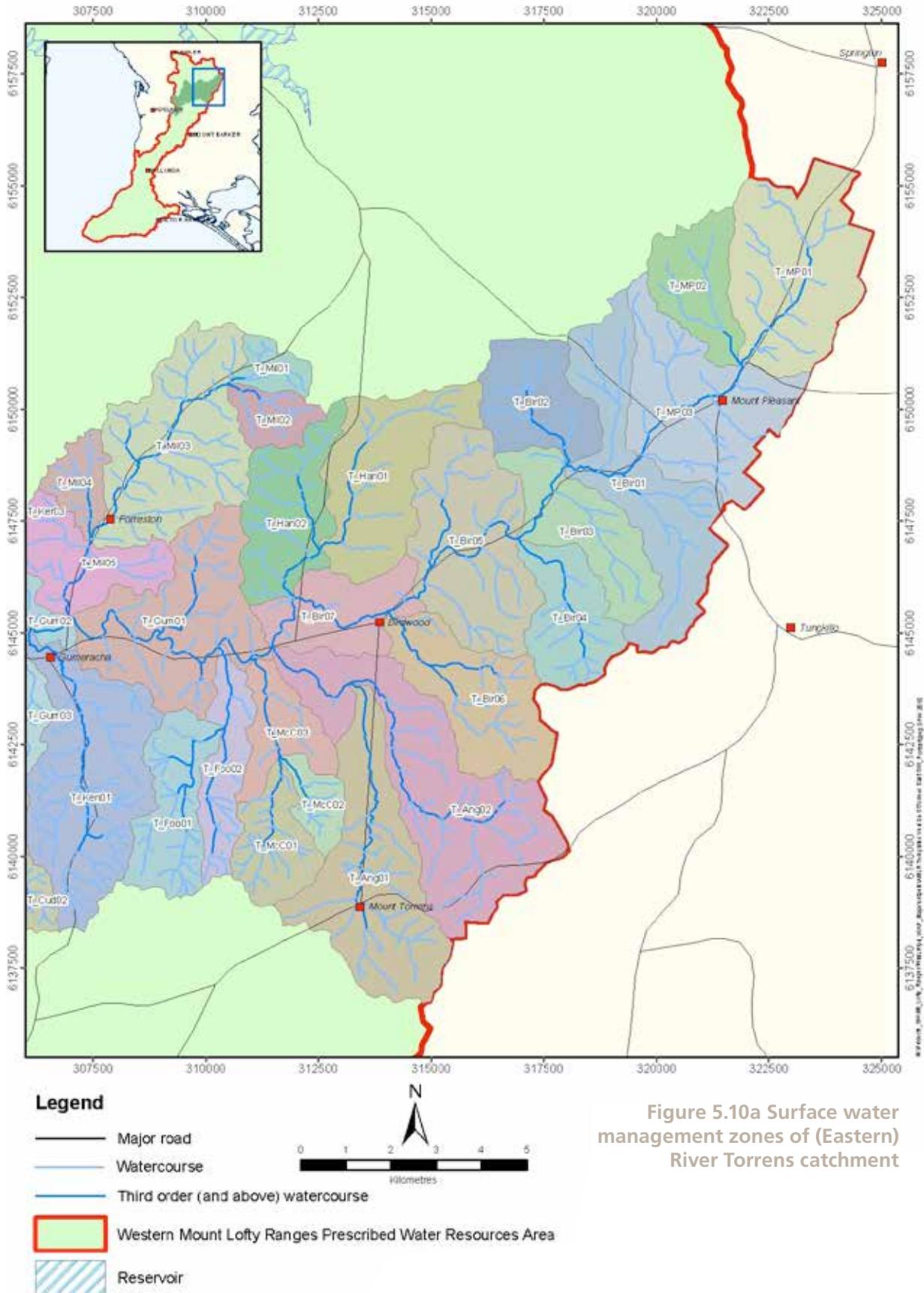


Legend

- Major road
- Prescribed watercourse
- Main watercourse
- Western Mount Lofty Ranges Prescribed Water Resources Area
- Reservoir

Figure 5.9 Main watercourses of South Para River catchment





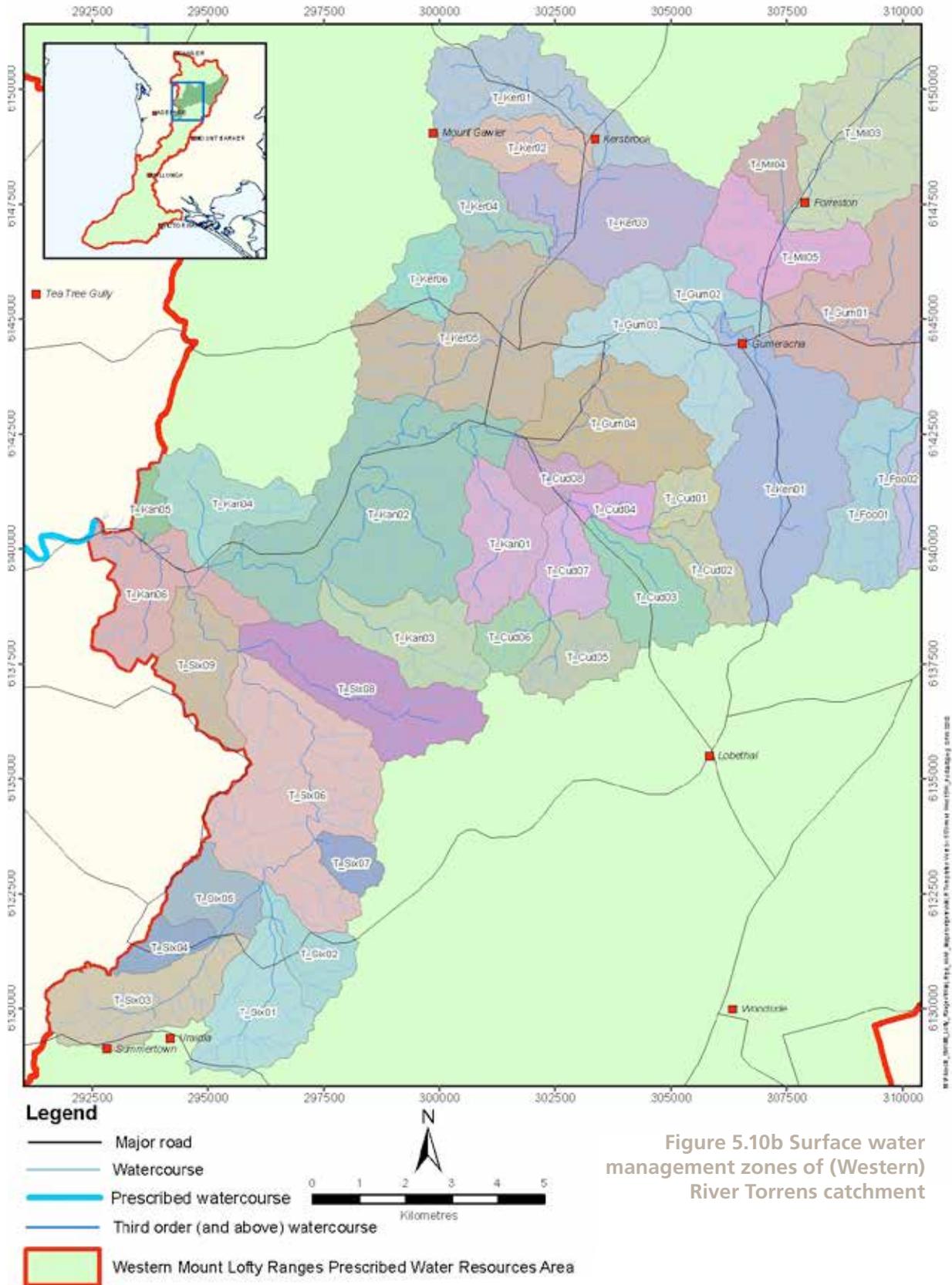
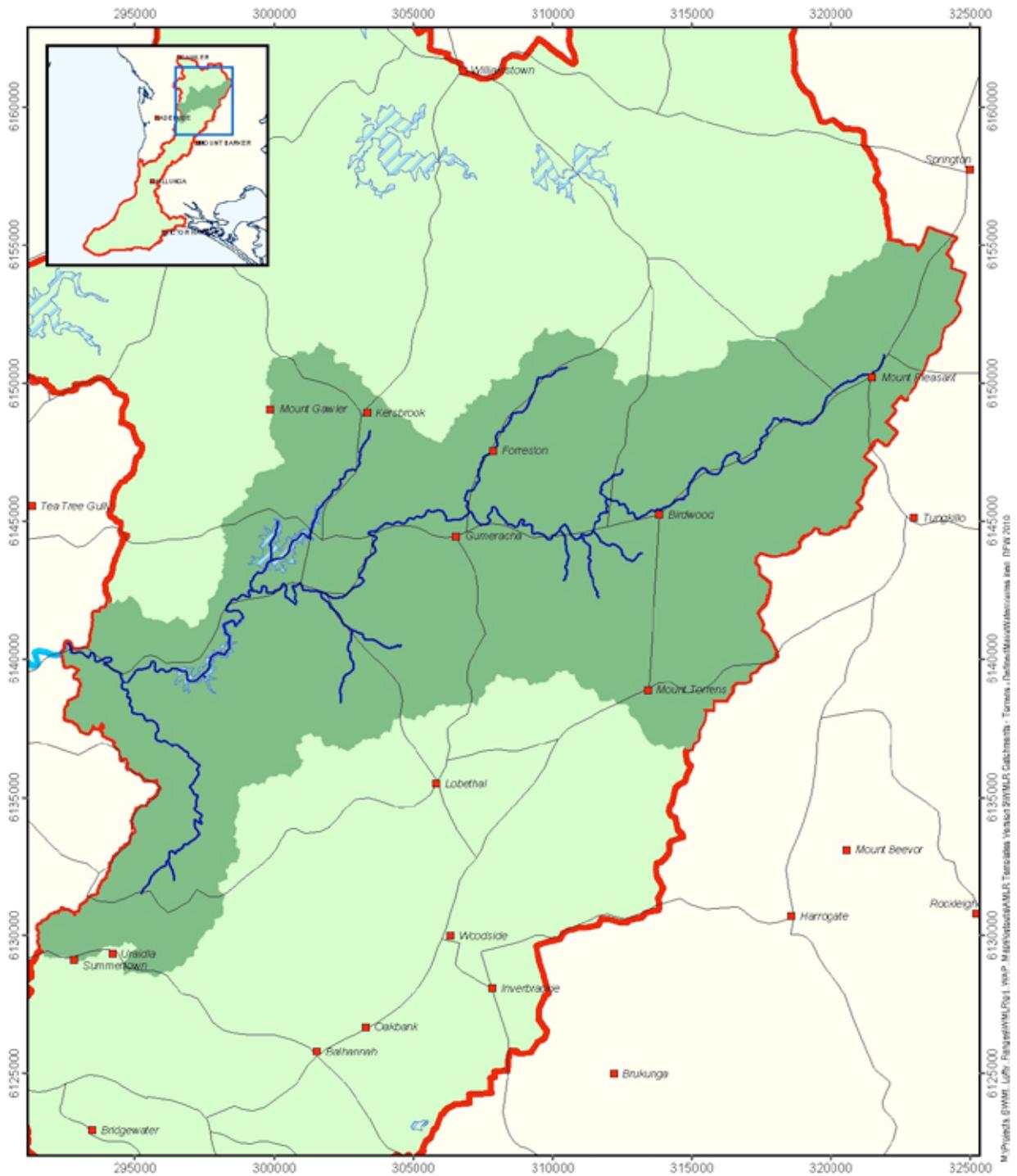


Figure 5.10b Surface water management zones of (Western) River Torrens catchment



Legend

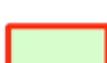
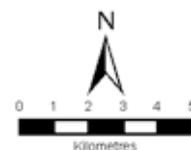
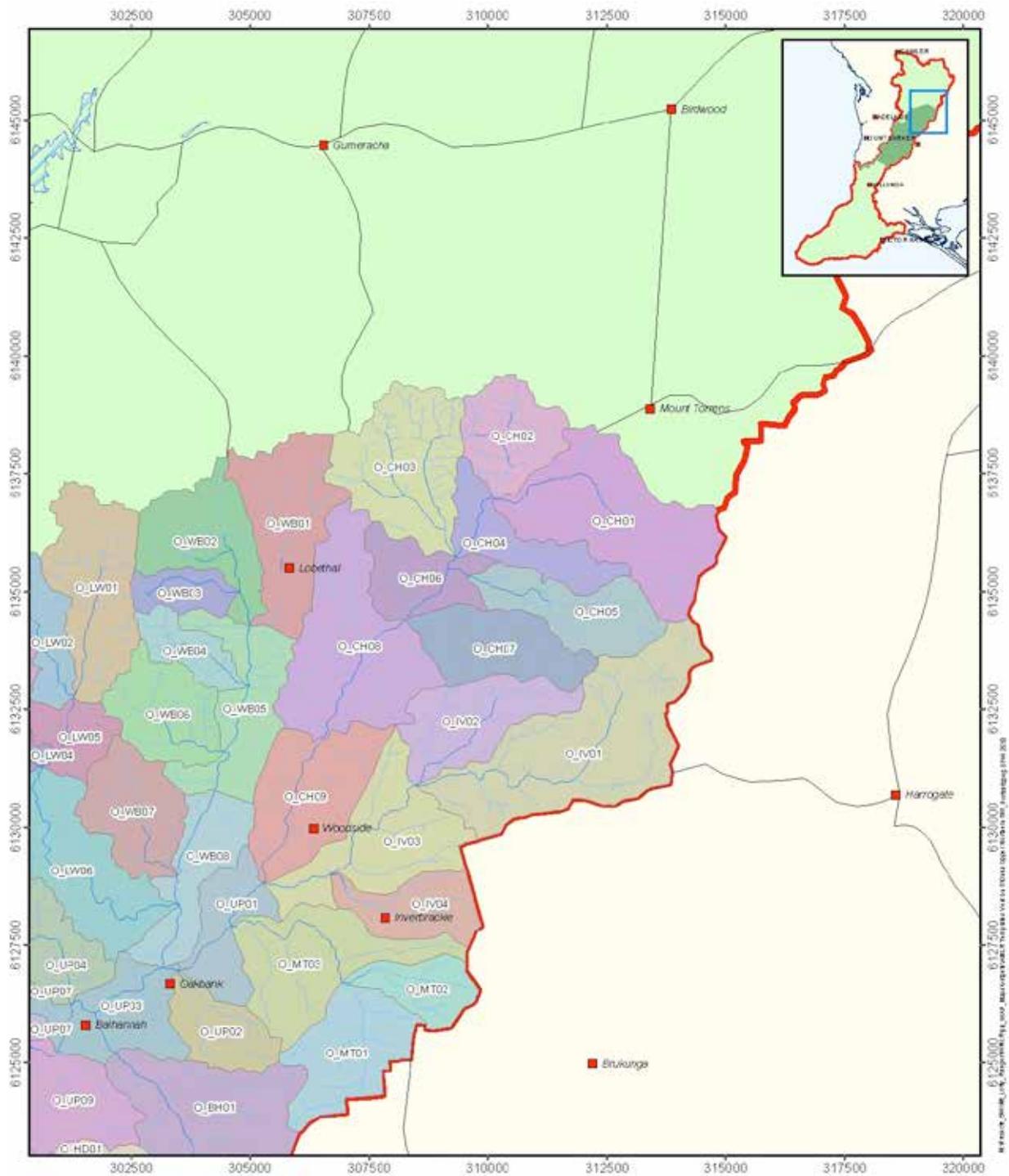
-  Major road
-  Prescribed watercourse
-  Main watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.11 Main watercourses of River Torrens catchment





Legend

-  Major road
-  Watercourse
-  Third order (and above) watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.12a Surface water management zones of (Upper Northern) Onkaparinga River catchment

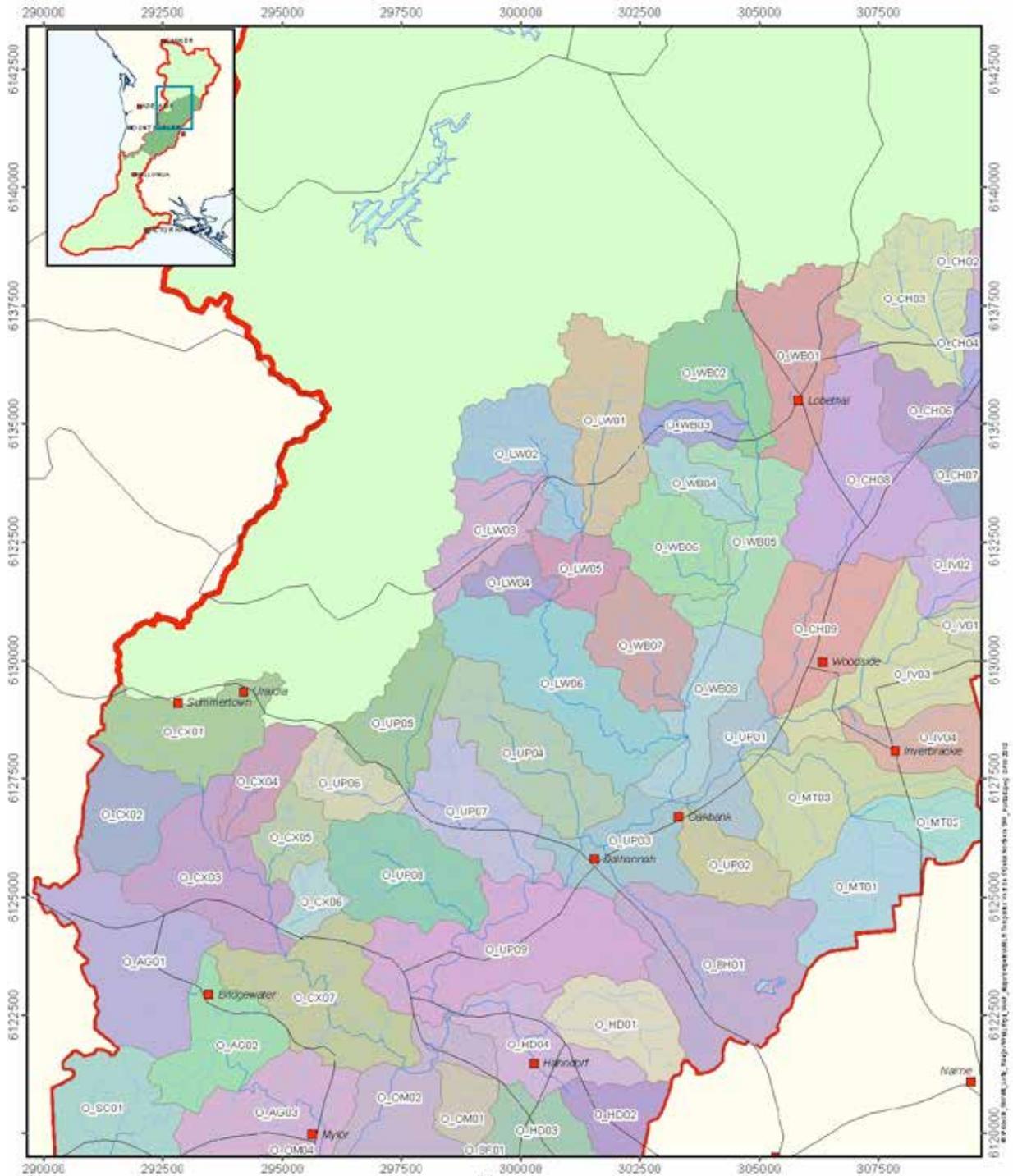
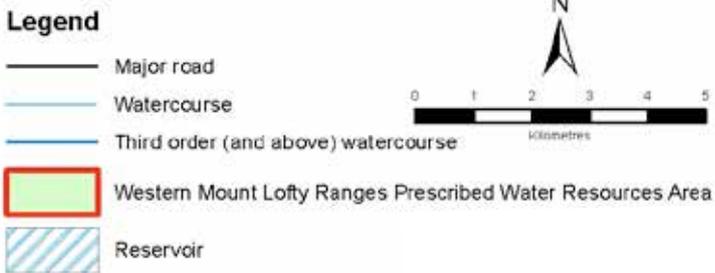


Figure 5.12b Surface water management zones of (Northern) Onkaparinga River catchment



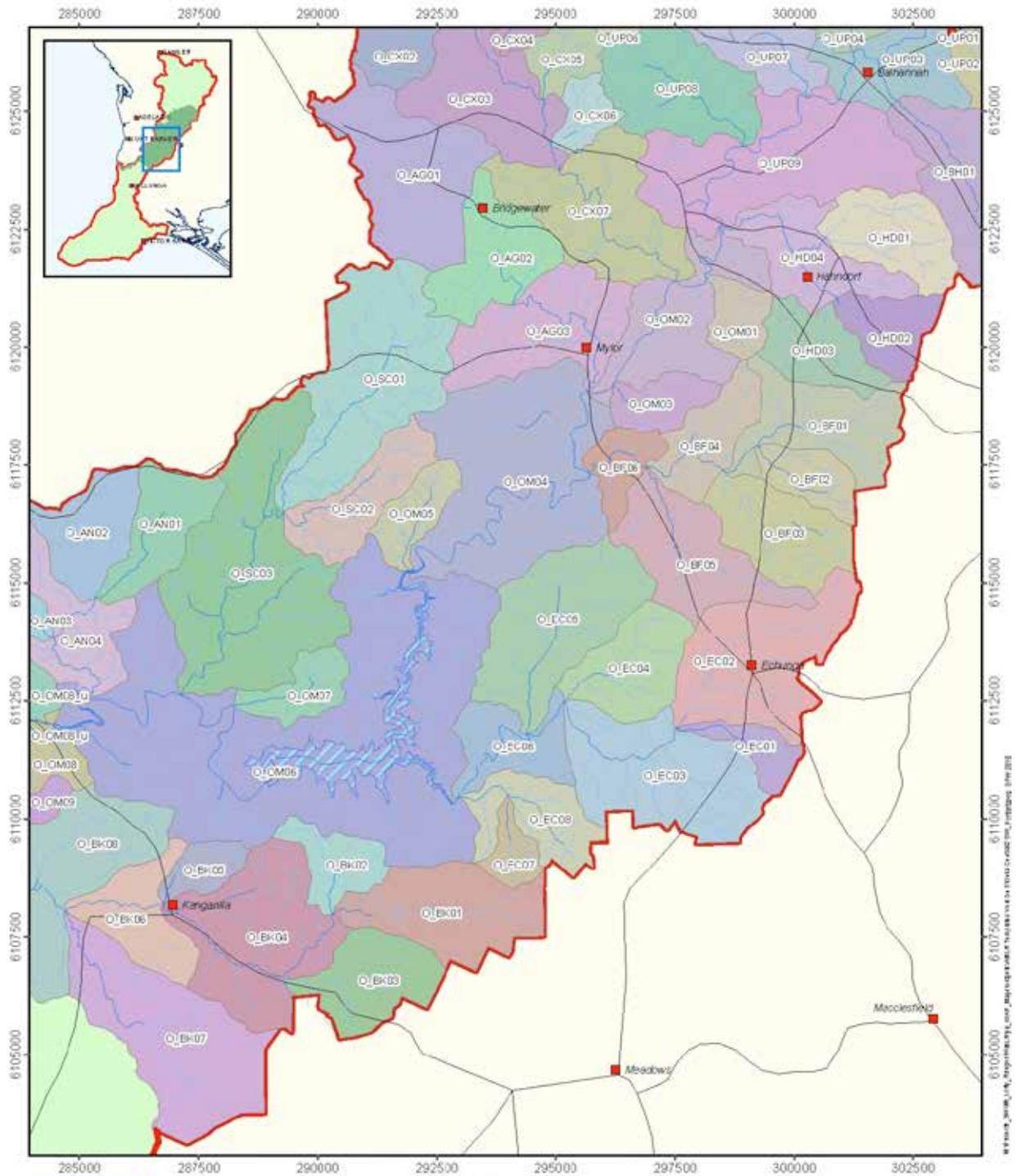


Figure 5.12c Surface water management zones of (Central) Onkaparinga River catchment

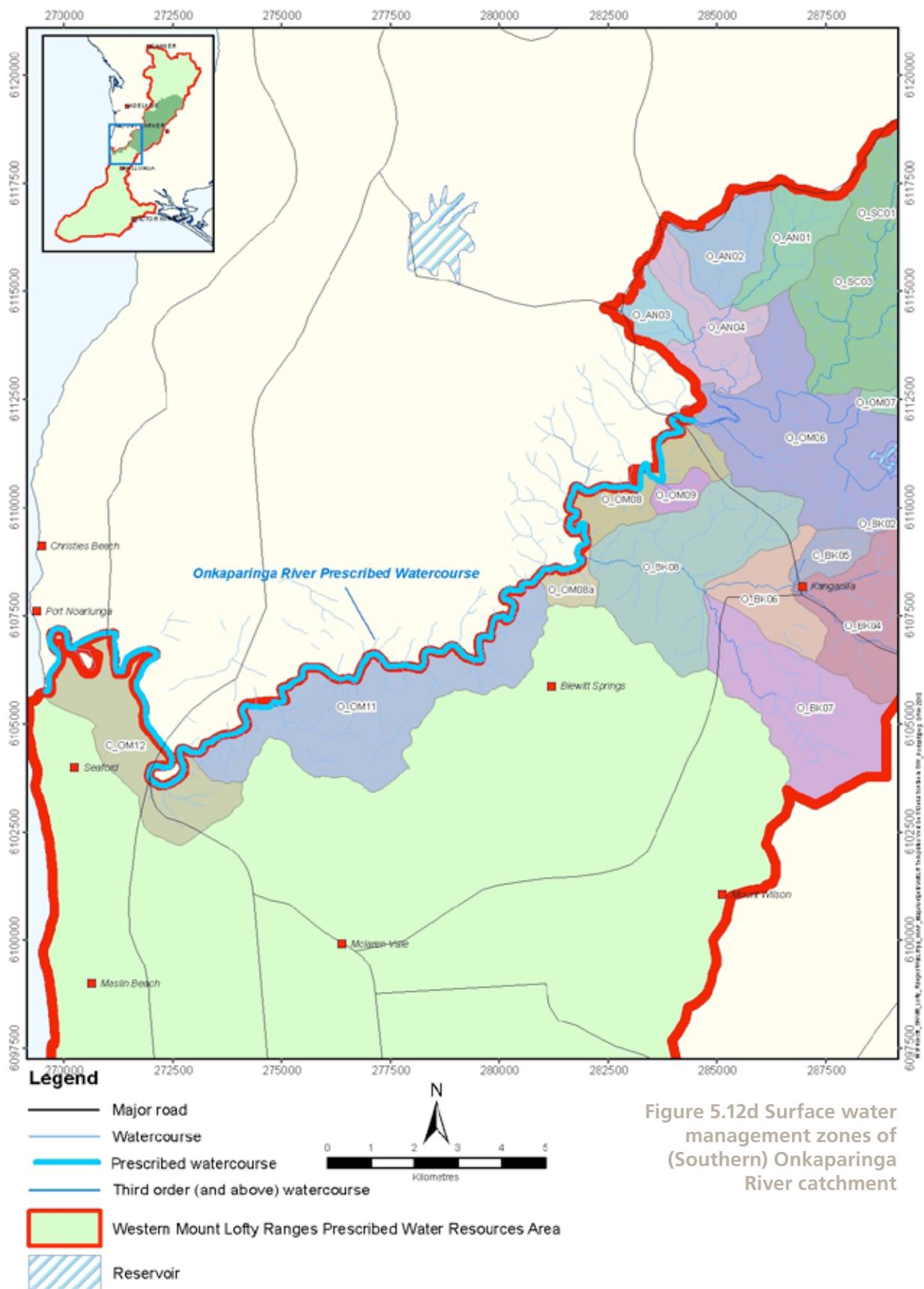
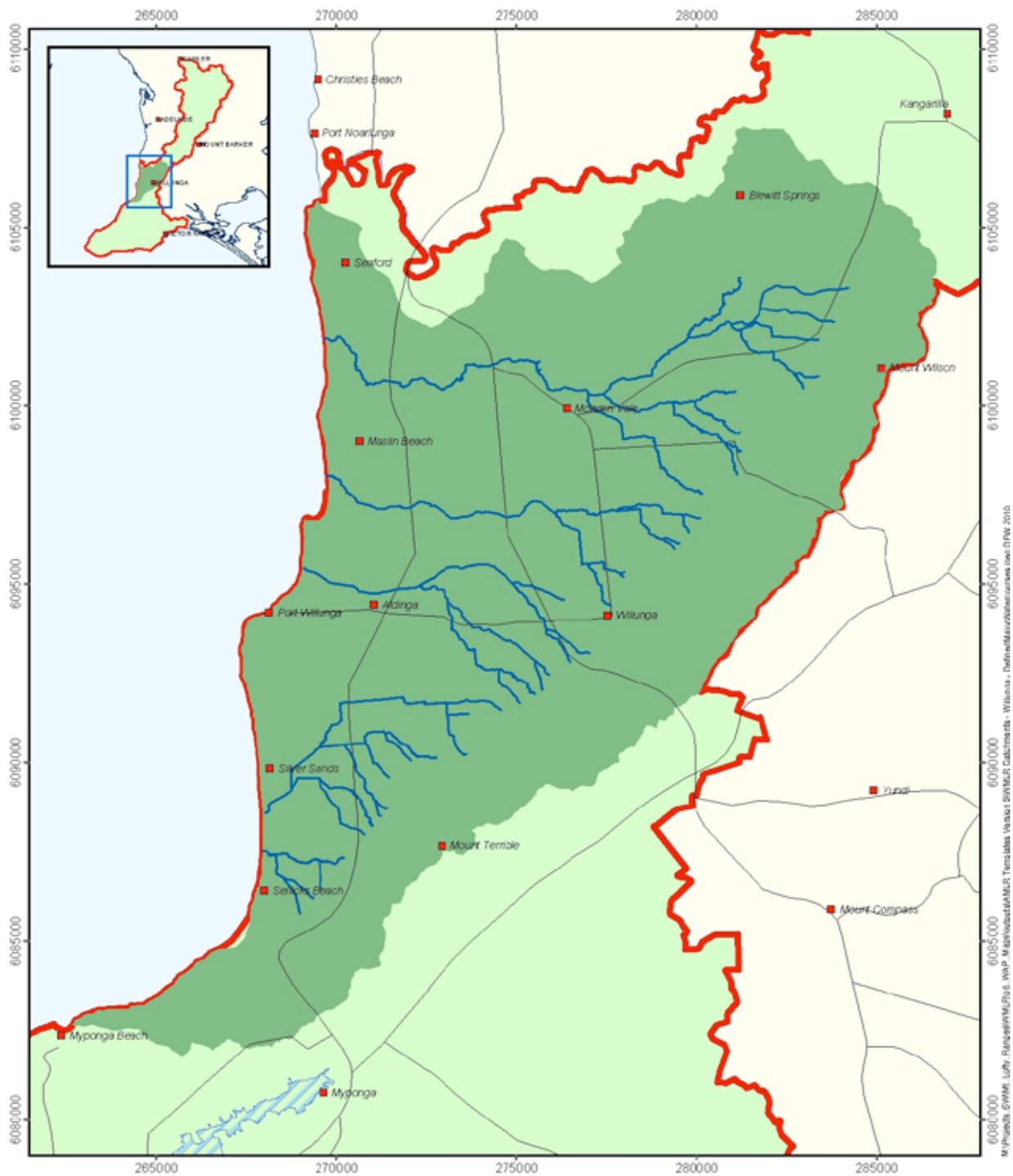


Figure 5.12d Surface water management zones of (Southern) Onkaparinga River catchment



Legend

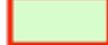
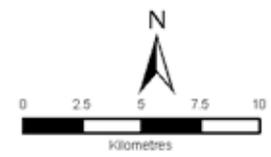
-  Major road
-  Main watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.13 Main watercourses of Onkaparinga River catchment



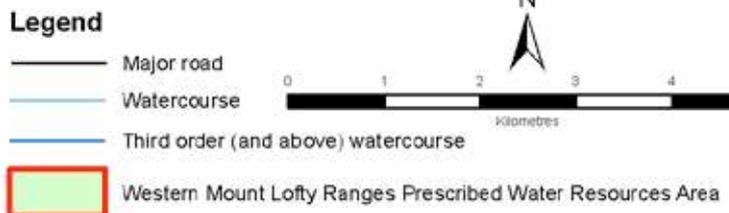
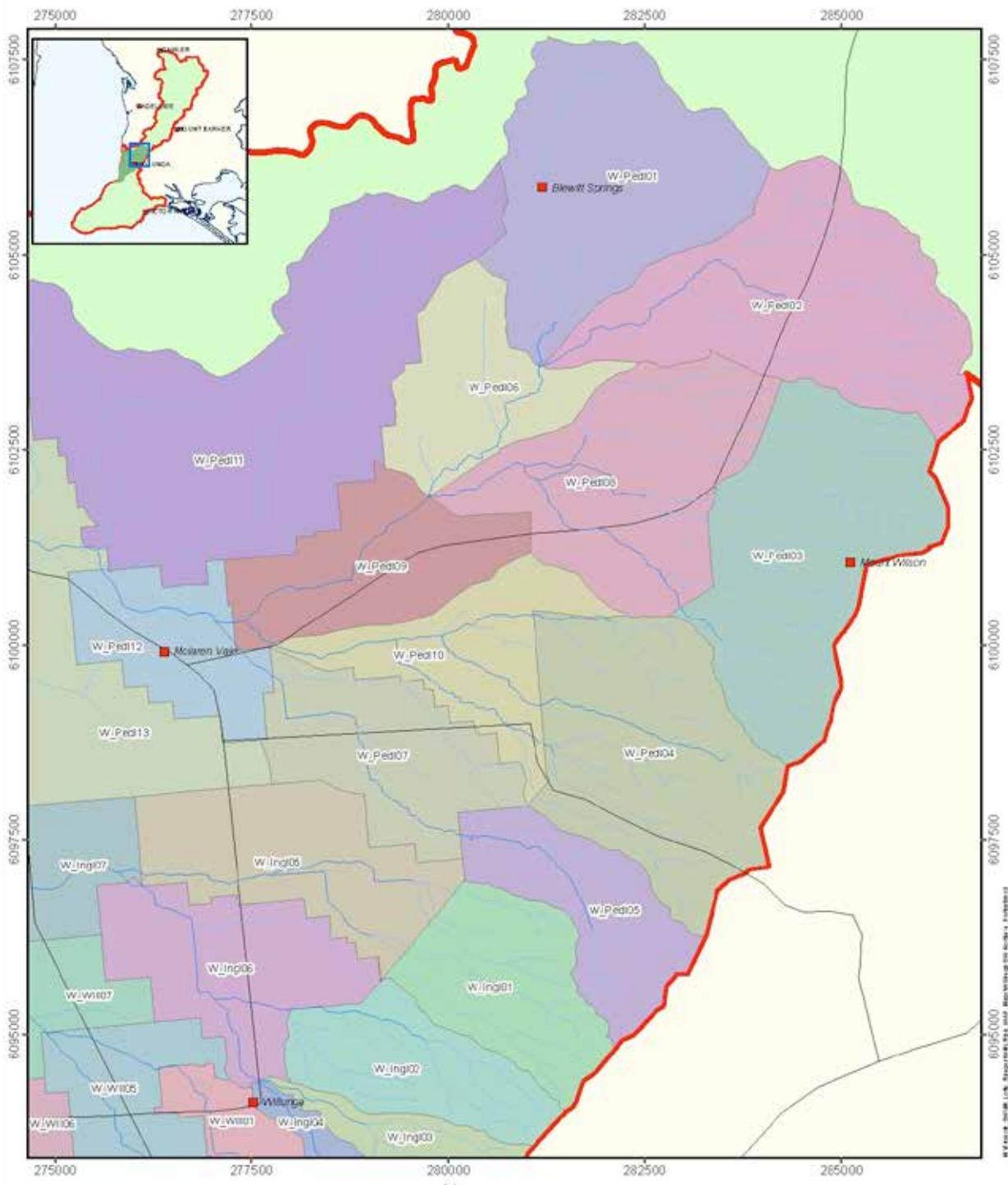


Figure 5.14a Surface water management zones of (Northern) Willunga Basin catchment

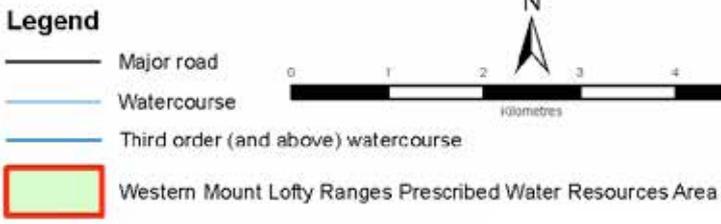
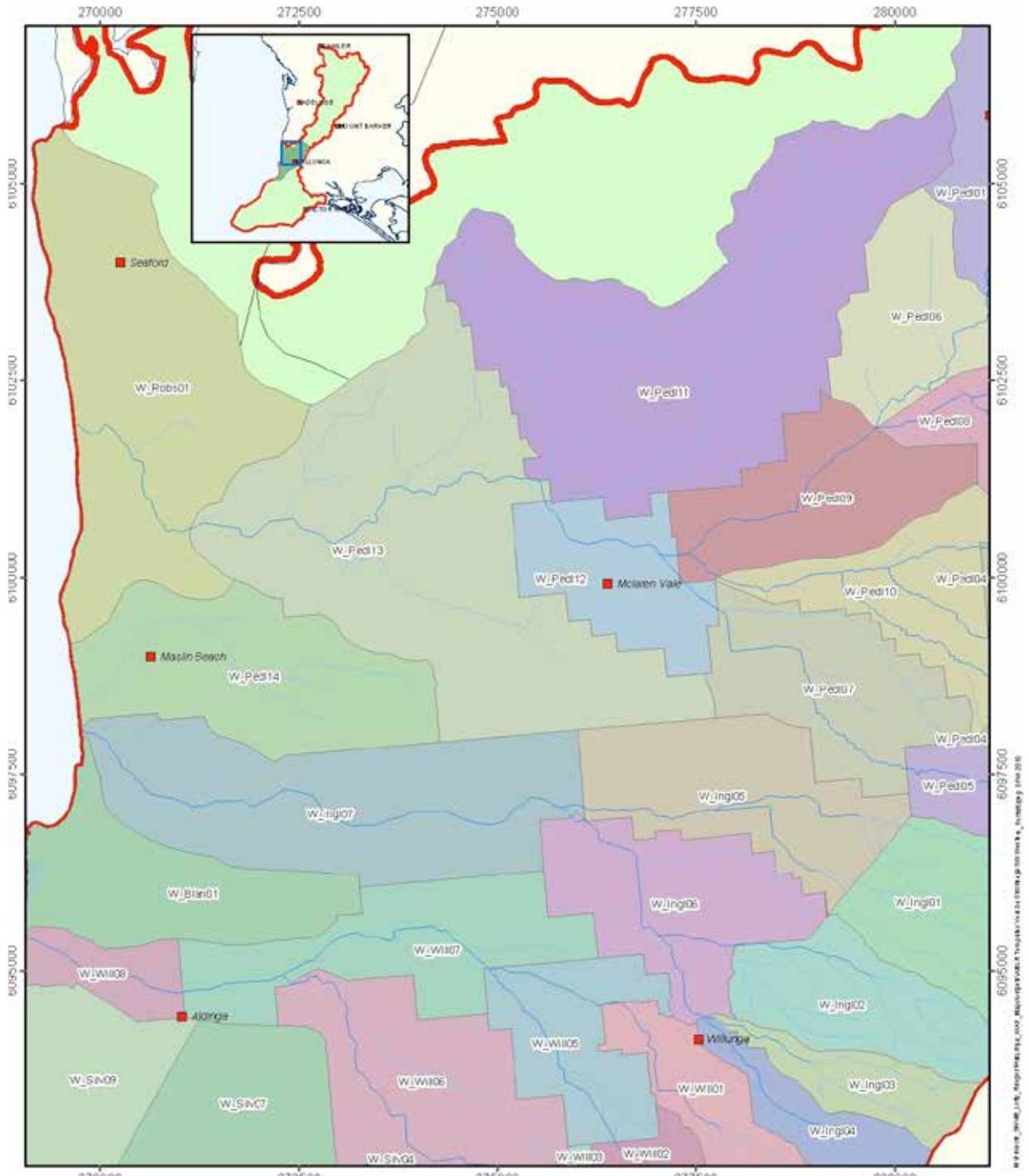


Figure 5.14b Surface water management zones of (Western) Willunga Basin catchment

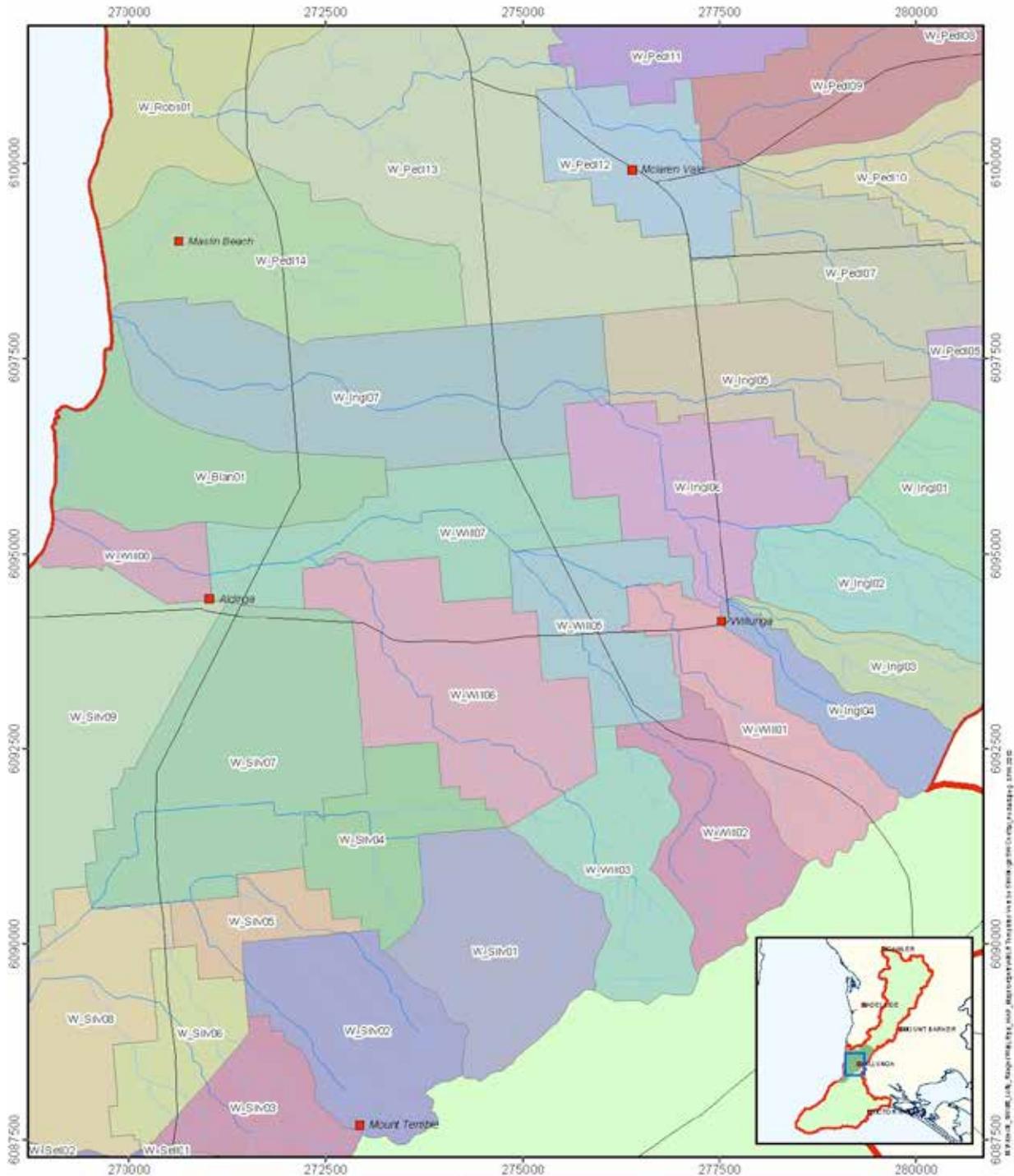
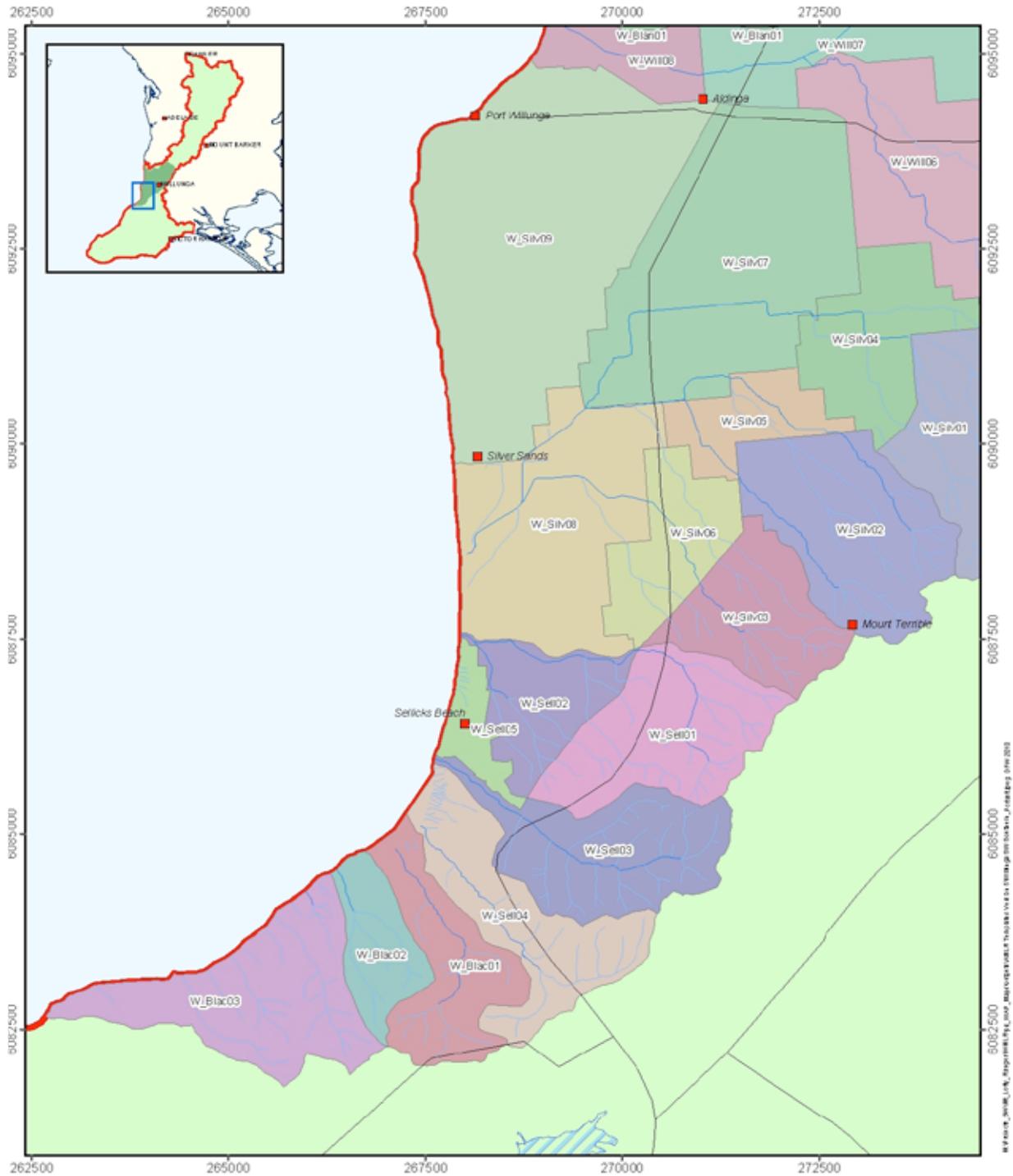


Figure 5.14c Surface water management zones of (Central) Willunga Basin catchment



Legend

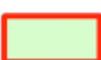
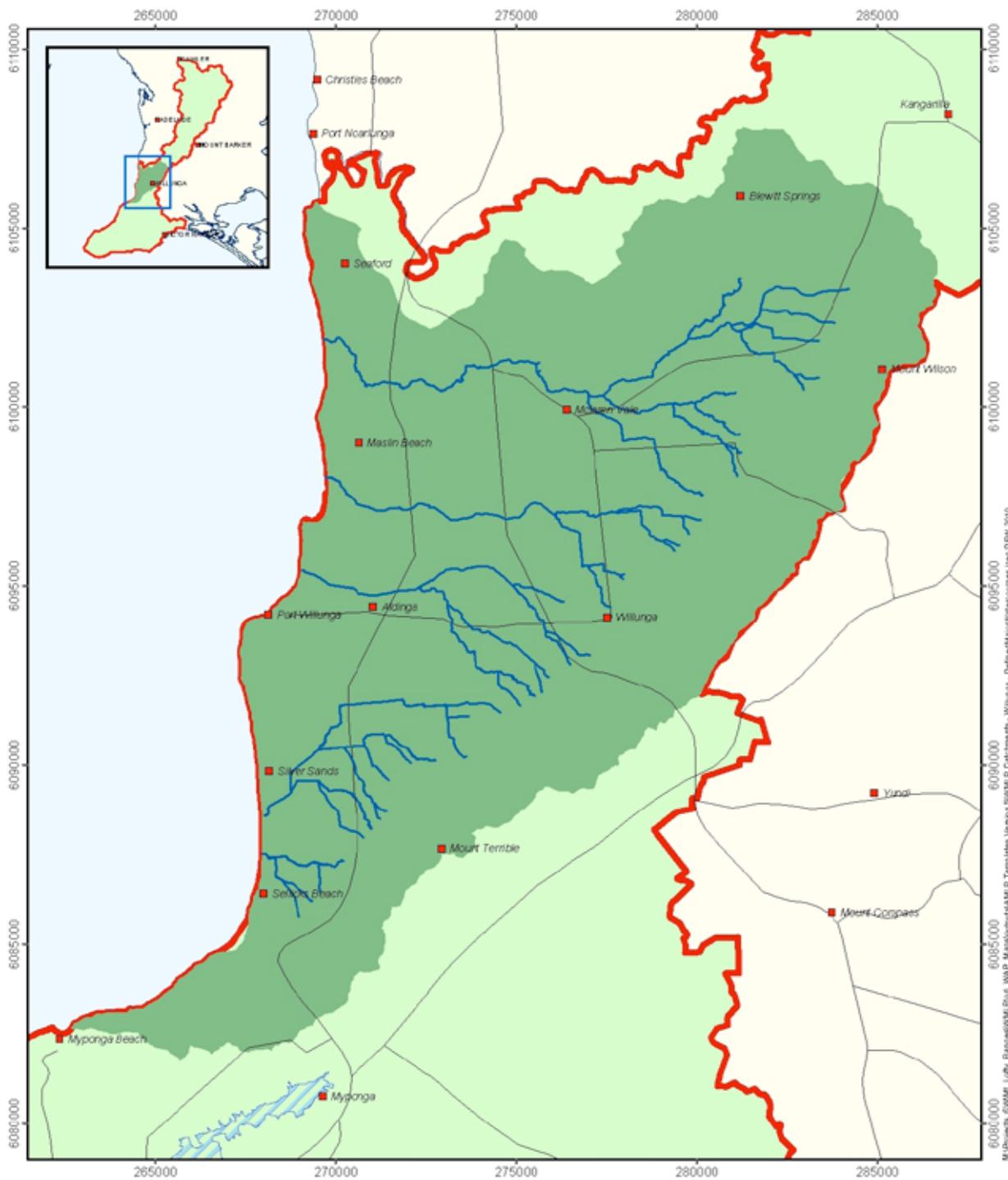
-  Major road
-  Watercourse
-  Third order (and above) watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.14d Surface water management zones of (Southern) Willunga Basin catchment



Legend

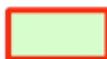
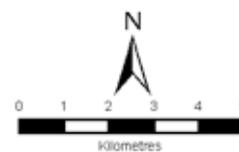
-  Major road
-  Main watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.15 Main watercourses of Willunga Basin catchment



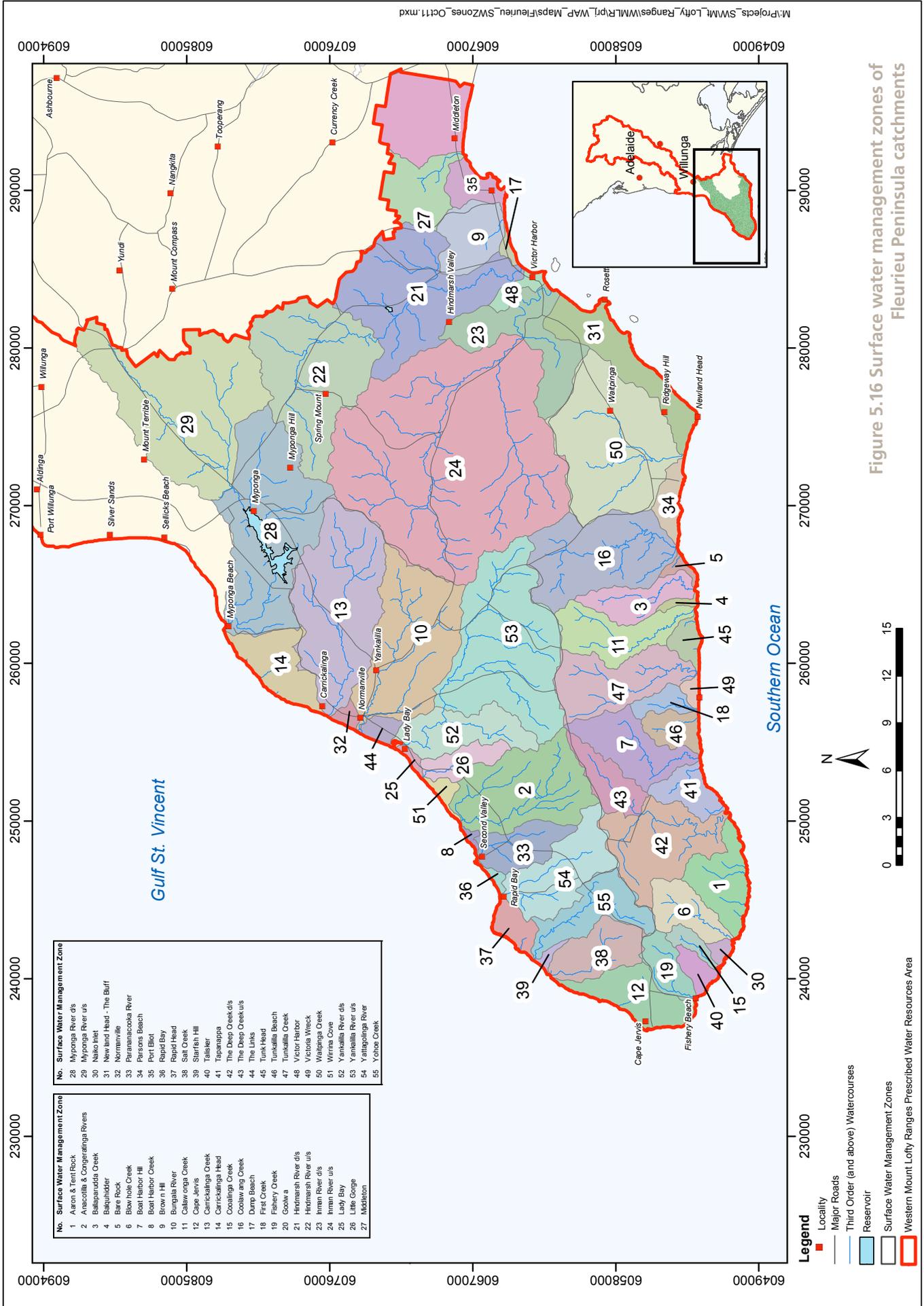
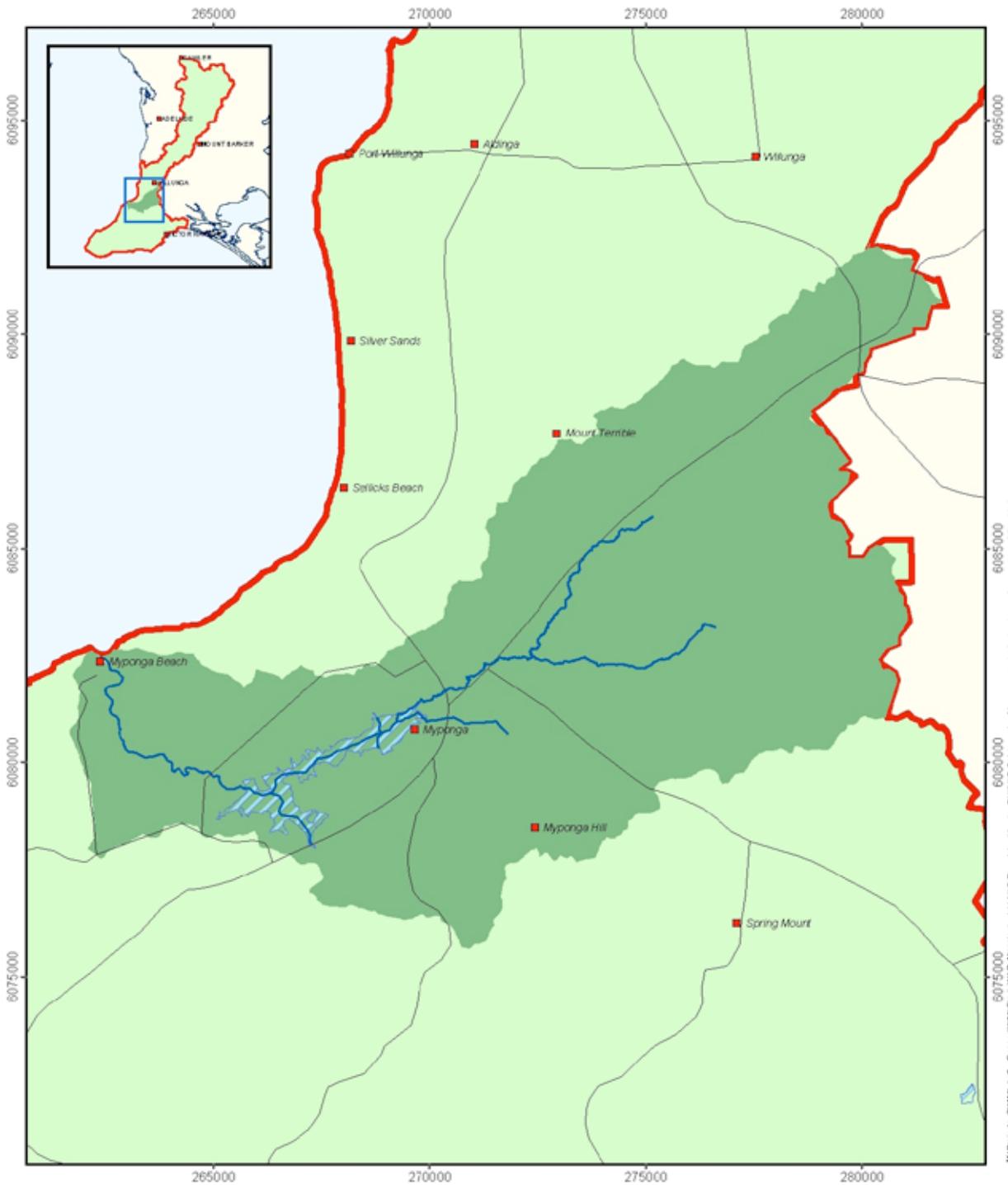


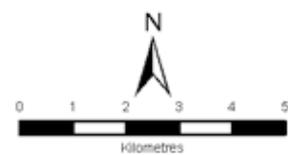
Figure 5.16 Surface water management zones of Fleurieu Peninsula catchments

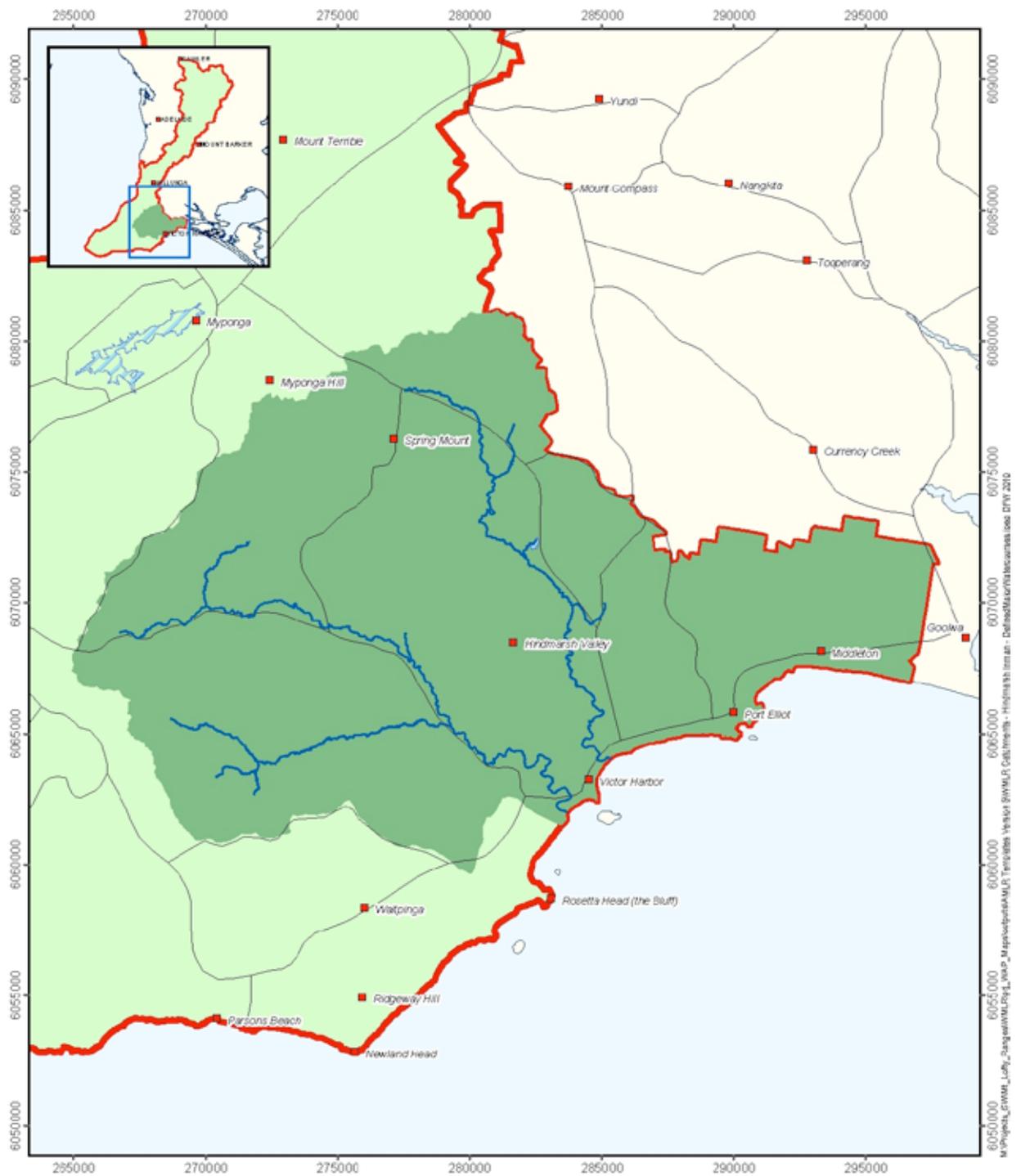


Legend

-  Major road
-  Main watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.17 Main watercourses of Myponga River catchment

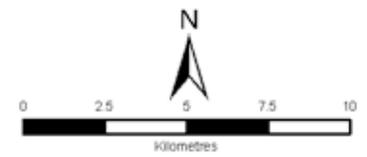




Legend

-  Major road
-  Main watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.18 Main watercourses of Hindmarsh and Inman rivers catchment



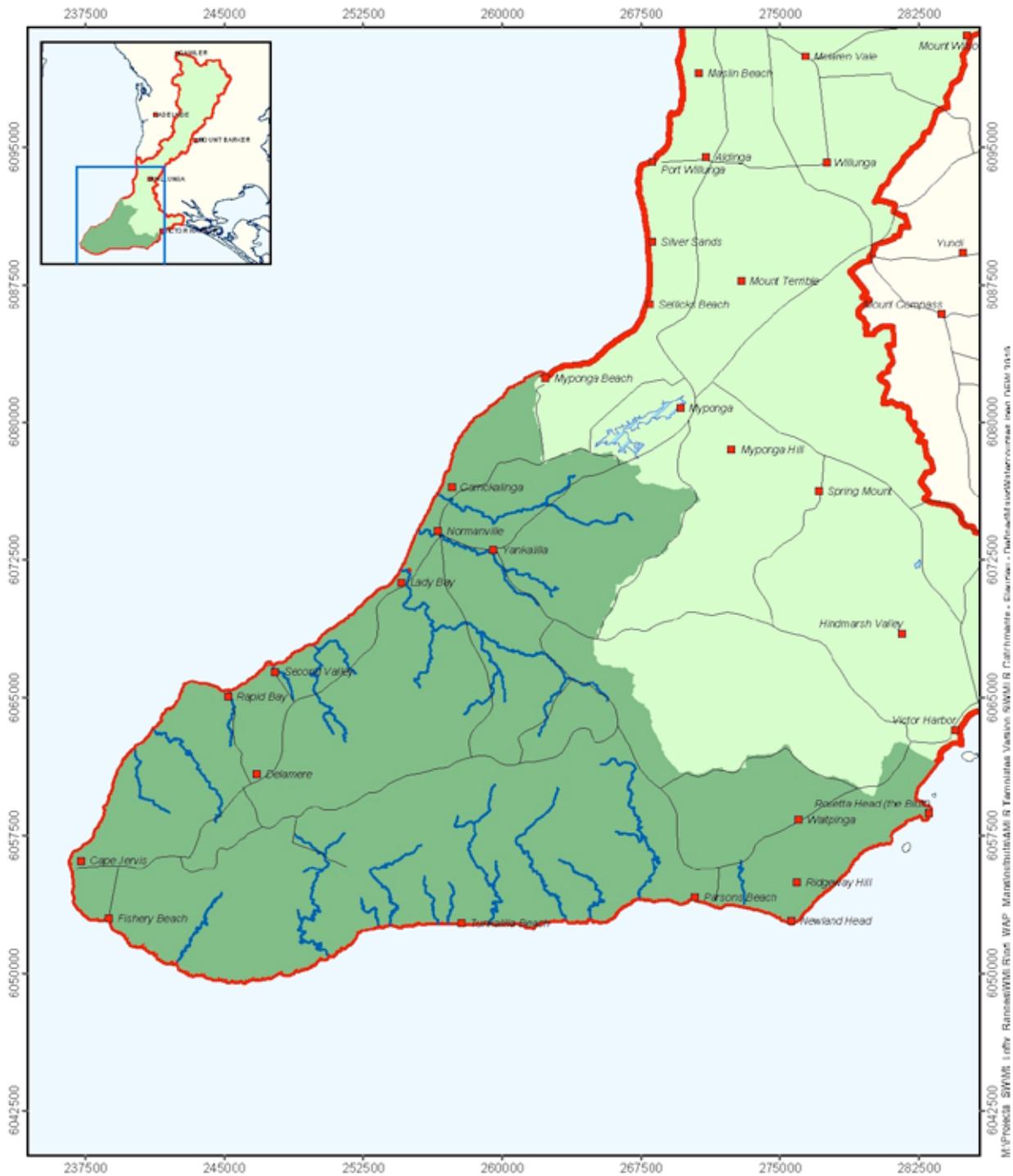


TABLE 5.6 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF SOUTH PARA RIVER CATCHMENT

SOUTH PARA RIVER CATCHMENT

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
S_LC01	4.13	250	61	62	-	125	1.02	-	-
S_LC02	2.43	120	50	30	93	60	0.64	0.87	1.02
S_LC03	3.28	145	44	36	129	73	0.49	0.73	0.87
S_LC04	4.92	220	45	55	-	110	0.50	-	-
S_LC05	3.56	145	41	36	-	73	0.40	-	-
S_LC06	4.53	170	38	43	263	85	0.32	0.40	0.73
S_LC07	1.05	81	78	20	-	41	1.74	-	-
S_LC08	4.09	340	83	85	-	170	1.98	-	-
S_LC09	7.66	470	61	117	223	235	1.05	1.36	1.98
S_LC10	9.79	618	63	154	-	309	1.12	-	-
S_LC11	1.39	62	44	16	-	31	0.50	-	-
S_LC12	9.49	479	50	120	512	239	0.67	0.50	1.36
S_LC13	1.04	48	46	12	-	24	0.54	-	-
S_LC14	4.26	239	56	60	-	120	0.86	-	-
S_LC15	5.73	319	56	80	-	159	0.84	-	-
S_LC16	1.50	64	43	16	-	32	0.45	-	-
S_LC17	1.16	55	47	14	-	27	0.57	-	-
S_LC18	1.46	66	45	17	-	33	0.52	-	-
S_LC19	2.32	97	42	24	222	49	0.43	0.45	0.86
S_LC20	1.23	52	43	13	-	26	0.45	-	-
S_LC21	0.96	35	36	9	-	17	0.30	-	-

SOUTH PARA RIVER CATCHMENT CONTINUED

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
S_LC22	6.04	229	38	57	805	115	0.33	0.45	1.03
S_LC23	0.90	33	36	8	-	16	0.29	-	-
S_LC24	7.79	241	31	60	1,145	121	0.19	0.29	0.81
S_LC25	8.18	267	33	67	-	133	0.22	-	-
S_LC26	13.88	381	27	95	1,307	191	0.13	0.22	0.65
S_MC01	1.31	195	149	49	-	98	2.50	-	-
S_MC02	1.69	249	147	62	-	124	2.43	-	-
S_MC03	3.29	469	142	117	-	234	2.28	-	-
S_MC04	9.87	1,369	139	342	570	684	2.16	2.24	2.50
S_MC05	1.99	262	132	65	-	131	1.94	-	-
S_MC06	4.62	534	116	133	769	267	1.47	1.94	2.24
S_MC07	5.23	727	139	182	-	364	2.17	-	-
S_MC08	2.80	425	152	106	-	213	2.61	-	-
S_MC09	4.95	754	153	189	-	377	2.63	-	-
S_MC10	1.75	266	152	66	-	133	2.62	-	-
S_MC11	3.53	521	147	130	-	261	2.45	-	-
S_MC12	3.78	526	139	132	-	263	2.17	-	-
S_MC13	7.59	1,061	140	265	593	530	2.20	2.17	2.62
S_MC14	6.86	990	144	248	-	495	2.35	-	-
S_MC15	8.30	1,137	137	284	-	568	2.10	-	-
S_MC16	4.18	540	129	135	430	270	1.86	2.33	2.63
S_MC17	0.51	65	127	16	-	32	1.80	-	-
S_MC18	1.98	256	129	64	-	128	1.86	-	-
S_MC19	1.05	126	120	32	112	63	1.59	1.77	1.86
S_MC20	4.56	545	120	136	1,803	273	1.58	1.77	2.35
S_MC21	1.24	147	119	37	-	74	1.55	-	-
S_MC22	3.55	442	125	110	-	221	1.72	-	-
S_MC23	21.38	2,470	116	617	8,833	1235	1.47	1.55	2.17
S_MC24	7.22	678	94	170	-	339	0.92	-	-
S_UC01	9.39	1,815	193	454	-	908	2.40	-	-
S_UC02	19.79	3,437	174	859	1,313	1,718	1.92	2.06	2.40
S_UC03	16.63	2,855	172	714	-	1,428	1.87	-	-
S_UC04	25.37	4,079	161	1,020	1,734	2,040	1.63	1.72	1.87
S_UC05	27.76	5,339	192	1,335	-	2,670	2.37	-	-
S_UC06	19.75	3,732	189	933	5,314	1,866	2.29	1.72	2.37
TOTAL	344.69	41,237		10,308		20,621			

TABLE 5.7 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF LITTLE PARA RIVER CATCHMENT

LITTLE PARA RIVER CATCHMENT

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
L_GC01	10.35	1,211	117	303	-	606	1.80	-	-
L_GC02	8.85	768	87	192	495	384	1.06	1.43	1.80
L_GC03	4.22	299	71	75	570	150	0.73	1.28	1.43
L_LLPO1	3.88	179	46	45	-	90	0.46	-	-
L_LLPO2	1.17	51	43	13	57	25	0.40	*	*
L_LPRO1	7.99	419	52	105	674	209	0.60	1.08	1.28
L_LPRO2	7.78	359	46	90	2,349	180	0.47	1.08	1.87
L_ULPO1	8.43	1,480	176	370	-	740	2.58	-	-
L_ULPO2	3.92	669	171	167	-	334	2.45	-	-
L_ULPO3	1.59	240	151	60	-	120	1.95	-	-
L_ULPO4	4.35	630	145	157	755	315	1.81	1.95	2.58
L_ULPO5	2.67	430	161	107	-	215	2.21	-	-
L_ULPO6	1.57	235	150	59	921	118	1.92	2.21	2.30
L_ULPO7	1.33	238	179	60	-	119	2.66	-	-
L_ULPO8	0.84	148	176	37	97	74	2.59	2.63	2.66
L_ULPO9	2.23	394	177	99	-	197	2.61	-	-
L_ULPO10	0.92	133	144	33	228	66	1.80	2.46	2.63
L_ULPO11	1.70	255	150	64	-	128	1.94	-	-
L_ULPO12	1.04	163	157	41	-	81	2.10	-	-
L_ULPO13	0.93	128	137	32	136	64	1.63	1.90	2.10
L_ULPO14	10.31	1,089	106	272	1,585	544	1.01	1.41	2.46
L_ULPO15	0.87	110	126	27	-	55	1.41	-	-
TOTAL	86.94	9,628		2,408		4,814			

* SWMZ L_LLPO2 does not have a main watercourse unit threshold flow rate range, but has a threshold flow rate of 55 L/s

TABLE 5.8 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF RIVER TORRENS CATCHMENT

RIVER TORRENS CATCHMENT

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
T_Ang01	11.99	1,460	122	365	-	730	2.66	-	-
T_Ang02	15.18	1,700	112	425	790	850	2.29	2.44	2.66
T_Bir01	10.40	1,348	130	337	990	674	1.53	1.50	1.51
T_Bir02	5.53	793	143	198	-	396	1.86	-	-
T_Bir03	6.13	808	132	202	1,390	404	1.58	1.51	1.86
T_Bir04	5.17	732	142	183	-	366	1.81	-	-
T_Bir05	10.82	1,556	144	389	1,962	778	1.87	1.55	1.81
T_Bir06	7.72	1,205	156	301	-	603	2.19	-	-
T_Bir07	5.22	764	146	191	2,983	382	1.94	1.62	2.30
T_Cud01	1.52	234	154	59	-	117	3.89	-	-
T_Cud02	2.54	423	166	106	-	211	4.41	-	-
T_Cud03	4.49	759	169	190	-	380	4.52	-	-
T_Cud04	1.57	234	149	58	223	117	3.65	3.89	4.41
T_Cud05	3.19	610	191	153	-	305	5.55	-	-
T_Cud06	1.91	387	202	97	-	193	6.11	-	-
T_Cud07	2.75	437	159	109	359	219	4.08	5.13	6.11
T_Cud08	2.10	287	136	72	843	143	3.14	4.05	5.13
T_Foo01	5.50	925	168	231	-	463	3.23	-	-
T_Foo02	4.00	601	150	150	382	301	2.63	2.97	3.23
T_Gum01	11.03	1,918	174	480	4,959	959	2.40	1.79	2.97
T_Gum02	2.29	429	187	107	6,393	214	2.76	2.05	3.36

RIVER TORRENS CATCHMENT CONTINUED

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
T_Gum03	7.55	1,460	193	365	6758	730	2.93	2.21	2.23
T_Gum04	7.45	1,504	202	376	7134	752	3.18	2.23	2.26
T_Han01	8.74	1,191	136	298	-	596	2.21	-	-
T_Han02	6.45	923	143	231	529	461	2.42	2.21	2.30
T_Kan01	4.63	813	176	203	-	407	4.35	-	-
T_Kan02	17.82	2,393	134	598	9018	1,197	2.71	2.26	5.01
T_Kan03	5.02	955	190	239	-	477	5.01	-	-
T_Kan04	4.50	554	123	138	-	277	2.32	-	-
T_Kan05	0.81	87	108	22	-	44	1.82	-	-
T_Kan06	5.54	606	109	151	2450	303	1.87	1.82	6.23
T_Ken01	12.84	2,091	163	523	-	1,046	3.36	-	-
T_Ker01	7.26	1,143	157	286	-	572	2.58	-	-
T_Ker02	2.94	471	160	118	-	235	2.66	-	-
T_Ker03	8.27	1,331	161	333	736	666	2.69	2.58	2.66
T_Ker04	3.13	519	166	130	-	260	2.85	-	-
T_Ker05	12.61	2,048	162	512	1478	1,024	2.73	2.63	2.85
T_Ker06	2.51	399	159	100	-	200	2.63	-	-
T_McC01	4.03	605	150	151	-	302	2.97	-	-
T_McC02	1.85	249	135	62	-	125	2.44	-	-
T_McC03	3.51	449	128	112	326	224	2.22	2.44	2.97
T_Mil01	1.56	222	142	55	-	111	2.70	-	-
T_Mil02	2.08	294	141	74	-	147	2.68	-	-
T_Mil03	11.81	1,654	140	413	543	827	2.63	2.64	2.70
T_Mil04	2.13	307	144	77	-	154	2.77	-	-
T_Mil05	5.24	739	141	185	804	369	2.66	2.64	2.77
T_MP01	10.99	1,081	98	270	-	540	1.45	-	-
T_MP02	4.75	513	108	128	-	257	1.73	-	-
T_MP03	10.39	1,018	98	254	653	509	1.44	1.45	1.73
T_Six01	5.25	1,261	240	315	-	630	9.21	-	-
T_Six02	2.56	566	221	142	457	283	7.98	8.79	9.21
T_Six03	5.83	1,547	265	387	-	774	10.89	-	-
T_Six04	1.50	369	246	92	-	184	9.57	-	-
T_Six05	2.74	609	222	152	631	305	8.06	9.57	10.89
T_Six06	13.77	2,271	165	568	1,721	1,135	4.87	6.49	9.87
T_Six07	1.33	260	195	65	-	130	6.49	-	-
T_Six08	7.50	1,210	161	303	-	605	4.69	-	-
T_Six09	3.84	461	120	115	2,139	231	2.82	4.69	7.16
TOTAL	341.78	51,783		12,946		25,894			

TABLE 5.9 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF ONKAPARINGA RIVER CATCHMENT

ONKAPARINGA RIVER CATCHMENT

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
O_AG01	8.19	2,776	339	694	-	1,388	11.33	-	-
O_AG02	4.73	1,370	289	342	1,037	685	8.31	10.15	11.33
O_AG03	6.60	1,626	246	406	1,443	813	6.04	8.61	10.15
O_AN01	3.71	543	146	136	-	271	4.70	-	-
O_AN02	3.91	531	136	133	-	266	4.10	-	-
O_AN03	1.96	247	126	62	-	124	3.55	-	-
O_AN04	4.57	564	123	141	471	282	3.41	3.55	4.70
O_BF01	5.36	533	100	133	186	267	4.22	4.11	4.19
O_BF02	2.16	212	98	53	-	106	4.11	-	-
O_BF03	4.83	467	97	117	-	233	3.98	-	-
O_BF04	3.35	324	97	81	384	162	4.01	3.98	4.19
O_BF05	5.93	560	95	140	-	280	3.84	-	-
O_BF06	1.91	178	93	44	568	89	3.71	3.84	4.08
O_BH01	9.85	1,121	114	280	-	560	3.79	-	-
O_BK01	6.27	733	117	183	-	366	4.49	-	-
O_BK02	2.48	282	114	71	-	141	4.28	-	-
O_BK03	4.30	494	115	123	-	247	4.36	-	-
O_BK04	8.88	997	112	249	626	499	4.19	4.28	4.49
O_BK05	1.53	160	105	40	-	80	3.67	-	-
O_BK06	3.81	362	95	90	757	181	3.07	3.67	4.32
O_BK07	9.86	1,056	107	264	-	528	3.84	-	-
O_BK08	11.21	959	86	240	1,261	479	2.52	3.63	4.09
O_CH01	9.23	1,089	118	272	-	545	3.25	-	-
O_CH02	3.91	465	119	116	-	233	3.31	-	-
O_CH03	7.12	909	128	227	-	455	3.77	-	-
O_CH04	3.55	405	114	101	490	202	3.03	3.21	3.31
O_CH05	4.43	543	122	136	-	271	3.48	-	-
O_CH06	3.37	383	114	96	949	192	3.03	3.21	3.77
O_CH07	4.63	535	116	134	-	267	3.12	-	-
O_CH08	9.23	1,087	118	272	1,354	544	3.23	3.12	3.35

ONKAPARINGA RIVER CATCHMENT CONTINUED

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
O_CH09	6.21	696	112	174	1,528	348	2.94	3.26	3.30
O_CX01	5.52	1,711	310	428	-	855	11.82	-	-
O_CX02	3.93	1,230	313	307	-	615	12.06	-	-
O_CX03	6.72	1,974	294	493	1,580	987	10.70	10.74	12.06
O_CX04	2.55	774	304	194	-	387	11.43	-	-
O_CX05	2.14	631	294	158	-	316	10.74	-	-
O_CX06	1.48	392	265	98	-	196	8.79	-	-
O_CX07	7.70	1,720	223	430	2,108	860	6.34	8.79	11.34
O_EC01	1.56	193	123	48	-	96	4.23	-	-
O_EC02	8.00	940	118	235	-	470	3.87	-	-
O_EC03	8.54	1,028	120	257	540	514	4.05	3.87	4.23
O_EC04	4.36	508	117	127	-	254	3.82	-	-
O_EC05	8.30	1,003	121	251	-	501	4.07	-	-
O_EC06	3.38	384	114	96	1,014	192	3.64	3.82	4.07
O_EC07	1.31	159	121	40	-	79	4.10	-	-
O_EC08	3.62	424	117	106	146	212	3.85	3.92	4.10
O_HD01	4.25	720	170	180	-	360	4.26	-	-
O_HD02	2.62	440	168	110	-	220	4.20	-	-
O_HD03	3.37	569	169	142	-	285	4.21	-	-
O_HD04	4.56	734	161	184	616	367	3.85	4.11	4.26
O_IV01	11.72	1,514	129	379	-	757	3.72	-	-
O_IV02	4.84	588	121	147	-	294	3.30	-	-
O_IV03	6.63	748	113	187	808	374	2.86	3.07	3.72
O_IV04	3.28	383	117	96	-	192	3.07	-	-
O_LW01	6.50	1,772	272	443	-	886	7.14	-	-
O_LW02	4.92	1,390	283	348	629	695	7.70	8.01	8.43
O_LW03	3.80	1,124	296	281	-	562	8.43	-	-
O_LW04	1.70	487	286	122	-	244	7.85	-	-
O_LW05	2.32	581	251	145	1,217	291	6.05	7.14	8.01
O_LW06	9.15	2,175	238	544	1,882	1,088	5.44	6.76	7.85
O_MT01	5.08	543	107	136	-	271	3.19	-	-
O_MT02	2.49	272	109	68	-	136	3.34	-	-
O_MT03	6.60	682	103	171	374	341	3.00	3.13	3.34
O_OM01	1.76	251	142	63	-	126	4.20	-	-
O_OM02	6.10	836	137	209	11,289	418	3.90	4.11	9.75
O_OM03	2.03	274	135	68	-	137	3.80	-	-
O_OM04	13.95	2,144	154	536	13,905	1,072	4.85	3.80	8.61
O_OM05	2.17	348	160	87	-	174	5.54	-	-

ONKAPARINGA RIVER CATCHMENT CONTINUED

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
O_OM06	33.76	4,348	129	1087	17,774	2,174	3.68	3.84	5.64
O_OM07	2.21	241	109	60	-	120	3.84	-	-
O_OM08	3.80	336	88	84	338	168	2.59	*	*
O_OM08a	1.09	88	81	22	1,716	44	2.17	*	*
O_OM09	0.89	79	89	20	-	40	2.61	-	-
O_OM11	13.31	725	55	181	1,981	363	0.96	*	*
O_OM12	7.79	250	32	63	2,205	125	0.26	*	*
O_SC01	10.68	1,716	161	429	-	858	7.33	-	-
O_SC02	4.11	584	142	146	-	292	5.89	-	-
O_SC03	14.02	1,715	122	429	1,004	858	4.48	5.64	7.33
O_UP01	3.36	441	131	110	2,821	221	2.94	3.13	3.34
O_UP02	3.00	422	141	105	-	211	3.38	-	-
O_UP03	4.56	631	139	158	6,572	316	3.28	3.25	6.76
O_UP04	6.63	1,193	180	298	-	597	5.43	-	-
O_UP05	4.22	1,041	247	260	-	521	9.75	-	-
O_UP06	2.77	709	256	177	-	355	10.45	-	-
O_UP07	5.53	1,008	182	252	689	504	5.57	7.84	10.45
O_UP08	6.18	1,250	202	312	-	625	6.76	-	-
O_UP09	10.96	1,687	154	422	8,294	844	4.03	3.98	7.84
O_WB01	6.10	998	164	249	-	499	4.68	-	-
O_WB02	5.02	885	176	221	-	443	5.41	-	-
O_WB03	1.74	318	182	79	-	159	5.73	-	-
O_WB04	2.04	352	173	88	-	176	5.21	-	-
O_WB05	5.17	758	147	190	828	379	3.80	4.68	5.73
O_WB06	4.27	730	171	183	-	365	5.09	-	-
O_WB07	4.49	699	156	175	-	350	4.27	-	-
O_WB08	4.16	558	134	140	1325	279	3.19	4.27	5.09
TOTAL	517.89	77,615		19,404		38,814			

* SWMZs O_OM08, O_OM08a, O_OM11 and O_OM12 do not have a main watercourse unit threshold flow rate range. The threshold flow rate for O_OM08 is 200 L/s and 215 L/s for the other SWMZs

TABLE 5.10 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF WILLUNGA BASIN CATCHMENT

WILLUNGA BASIN CATCHMENT

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
W_Blac01	2.93	170	58	43	-	85	2.22	-	-
W_Blac02	1.69	73	44	18	-	37	1.47	-	-
W_Blac03	4.57	169	37	42	-	85	1.12	-	-
W_Blan01	4.99	85	17	21	-	42	0.26	-	-
W_Ingl01	4.59	232	51	58	-	116	3.07	-	-
W_Ingl02	4.03	181	45	45	-	91	2.47	-	-
W_Ingl03	2.02	108	53	27	-	54	3.35	-	-
W_Ingl04	2.30	125	54	31	-	62	3.40	-	-
W_Ingl05	5.70	128	22	32	34	64	0.76	1.54	3.07
W_Ingl06	5.31	117	22	29	99	58	0.69	1.80	3.40
W_Ingl07	9.64	150	16	38	119	75	0.37	1.17	1.80
W_Pedl01	8.86	378	43	94	-	189	1.83	-	-
W_Pedl02	9.65	509	53	127	-	255	2.58	-	-
W_Pedl03	9.27	646	70	161	-	323	4.04	-	-
W_Pedl04	8.60	501	58	125	-	250	2.95	-	-
W_Pedl05	4.14	261	63	65	-	131	3.40	-	-
W_Pedl06	4.38	136	31	34	230	68	1.07	1.83	2.58
W_Pedl07	5.14	140	27	35	66	70	0.86	1.72	3.40
W_Pedl08	7.91	287	36	72	113	143	1.38	2.59	4.04
W_Pedl09	4.98	125	25	31	341	63	0.73	1.94	2.59
W_Pedl10	4.42	131	30	33	78	66	0.97	2.12	2.95
W_Pedl11	15.69	428	27	107	-	214	0.83	-	-

WILLUNGA BASIN CATCHMENT CONTINUED

Catchment summary				Extraction limits		Diversion limit	Unit threshold flow rate	Main watercourse unit threshold flow rate range	
SWMZ	Area (km ²)	Surface water resource capacity (ML)	Annual adjusted runoff (mm)	Surface water extraction limit (ML)	Main watercourse extraction limit (ML)	Diversion limit (ML)	SWMZ UTFR (L/s/km ²)	Minimum UTFR (L/s/km ²)	Maximum UTFR (L/s/km ²)
W_Pedl12	3.67	77	21	19	477	39	0.52	1.72	2.12
W_Pedl13	16.01	310	19	78	610	155	0.44	0.83	1.86
W_Pedl14	6.95	131	19	33	-	66	0.33	-	-
W_Robs01	11.25	169	15	42	631	85	0.22	1.20	1.38
W_Sell01	4.15	238	57	60	-	119	2.29	-	-
W_Sell02	2.27	67	29	17	51	33	0.72	1.60	2.29
W_Sell03	4.01	264	66	66	-	132	2.83	-	-
W_Sell04	3.81	217	57	54	-	109	2.16	-	-
W_Sell05	0.89	21	24	5	-	11	0.50	-	-
W_Silv01	5.56	256	46	64	-	128	2.40	-	-
W_Silv02	4.88	211	43	53	-	105	2.09	-	-
W_Silv03	2.99	127	42	32	-	63	2.03	-	-
W_Silv04	3.34	75	22	19	71	37	0.63	1.56	2.40
W_Silv05	1.78	35	19	9	51	17	0.47	1.50	2.09
W_Silv06	2.54	55	22	14	33	28	0.59	1.22	2.03
W_Silv07	9.11	142	16	35	142	71	0.29	0.92	1.56
W_Silv08	6.26	100	16	25	183	50	0.31	0.82	1.22
W_Silv09	11.55	162	14	40	-	81	0.23	-	-
W_Will01	4.21	254	60	64	-	127	2.53	-	-
W_Will02	3.87	270	70	68	-	135	3.33	-	-
W_Will03	4.19	256	61	64	-	128	2.62	-	-
W_Will05	3.65	104	28	26	138	52	0.68	1.98	3.33
W_Will06	7.20	172	24	43	71	86	0.50	1.02	2.62
W_Will07	5.49	116	21	29	224	58	0.37	1.02	1.98
W_Will08	1.63	28	17	7	224	14	0.24	1.09	1.17
TOTAL	262.07	8 937		2 234		4 470			

TABLE 5.11 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF FLEURIEU PENINSULA CATCHMENTS

No.	Surface water management zone	Area (km ²)	Surface water resource capacity (ML)	Surface water extraction limit (ML)	Diversion limit (ML)
1	Aaron & Tent Rock	16.5	754	188	377
2	Anacotilla & Congeratinga rivers	38.2	3,336	834	1,668
3	Ballaparudda Creek	12.6	1,833	458	917
4	Balquhidder	1.4	111	28	56
5	Bare Rock	1.9	133	33	67
6	Blowhole Creek	12.1	1,230	308	615
7	Boat Harbor Hill	0.9	41	10	20
8	Boat Harbor Creek	19.8	1,818	454	909
9	Brown Hill	15.2	884	221	442
10	Bungala River	49.3	2,656	664	1,328
11	Callawonga Creek	19.5	2,326	581	1,163
12	Cape Jervis	17.3	805	201	402
13	Carrickalinga Creek	55.9	3,811	953	1,906
14	Carrickalinga Head	16.6	974	243	487
15	Coalinga Creek	3.5	257	64	129
16	Coolawang Creek	40.8	4,094	1,023	2,047
17	Dump Beach	1.4	75	19	37
18	First Creek	4.8	403	101	201
19	Fishery Creek	8.5	584	146	292
20	Goolwa	26.7	1,003	251	501
21	Hindmarsh River d/s	56.4	3,880	970	1,940
22	Hindmarsh River u/s	55.7	7,289	1,822	3,644
23	Inman River d/s	27.5	1,778	445	889
24	Inman River u/s	164.3	11,741	2,935	5,870
25	Lady Bay	1.3	63	16	32
26	Little Gorge	7.8	624	156	312

TABLE 5.11 EXTRACTION AND DIVERSION LIMITS FOR SURFACE WATER MANAGEMENT ZONES OF FLEURIEU PENINSULA CATCHMENTS CONTINUED

No.	Surface water management zone	Area (km ²)	Surface water resource capacity (ML)	Surface water extraction limit (ML)	Diversion limit (ML)
27	Middleton	16.2	1,185	296	592
28	Myponga River d/s	63.4	6,256	1,564	3,128
29	Myponga River u/s	75.5	9,392	2,348	4,696
30	Naiko Inlet	1.8	115	29	58
31	Newland Head - The Bluff	19.0	1,296	324	648
32	Normanville	1.9	69	17	34
33	Parananacooka River	12.9	850	213	425
34	Parsons Beach	6.1	306	77	153
35	Port Elliot	7.5	314	79	157
36	Rapid Bay	1.2	67	17	34
37	Rapid Head	5.9	280	70	140
38	Salt Creek	15.8	1,080	270	540
39	Starfish Hill	1.3	69	17	34
40	Talisker	4.2	260	65	130
41	Tapanappa	9.3	452	113	226
42	The Deep Creek d/s	30.2	2,532	633	1,266
43	The Deep Creek u/s	11.1	1,139	285	570
44	The Links	2.9	136	34	68
45	Tunk Head	4.6	397	99	198
46	Tunkalilla Beach	7.5	675	169	338
47	Tunkalilla Creek	26.5	3,027	757	1,514
48	Victor Harbor	3.4	131	33	65
49	Victoria Wreck	1.7	128	32	64
50	Waitpinga Creek	61.1	4,630	1,158	2,315
51	Wirrina Cove	2.4	101	25	50
52	Yankalilla River d/s	19.4	1,253	313	627
53	Yankalilla River u/s	63.7	5,103	1,276	2,551
54	Yattagolinga River	24.7	1,804	451	902
55	Yohoe Creek	18.3	1,657	414	828
Total		1,195.2	97,202	24,301	48,601

The unit threshold flow rate (L/sec/km²) at the point of capture (by farm dams) or at the point of diversion or extraction from a watercourse for the Fleurieu Peninsula catchments is calculated according to information in Appendix E.

5.6. CAPACITY OF WATERCOURSES ACROSS THE PLAINS

The resource capacity for each of the watercourses across the plains is based on surface water runoff from the surrounding non-prescribed areas and baseflow from underground water in Northern Adelaide Plains PWA and Central Adelaide PWA.

The watercourses across the plains are divided into watercourse water management zones for the purposes of managing them (Figures 5.20–5.23).

The resource capacity for each of the watercourses across the plains (Tables 5.12–5.15) has been apportioned between the watercourse water management zones.

5.7. WATERCOURSES ACROSS THE PLAINS EXTRACTION LIMITS

The extraction limits for the watercourses across the plains are based on surface water runoff from the surrounding non-prescribed areas, baseflow from underground water in Northern Adelaide Plains PWA and Central Adelaide PWA and, in the case of the Gawler River, flows from reservoir spillage.

No watercourse water will be made available for allocation for new use from Onkaparinga River downstream of Clarendon Weir. This will help to maintain the current estuarine condition of lower Onkaparinga River.

TABLE 5.12 EXTRACTION LIMIT FOR WATERCOURSE WATER MANAGEMENT ZONE OF GAWLER RIVER

Management zone	Resource capacity (ML)	Watercourse across the plains extraction limit (ML)	Minimum threshold flow rate (L/s)	Maximum threshold flow rate (L/s)
Zone 1	16,000	10,000	500	690

TABLE 5.13 EXTRACTION LIMITS FOR WATERCOURSE WATER MANAGEMENT ZONES OF LITTLE PARA PROCLAIMED WATERCOURSE

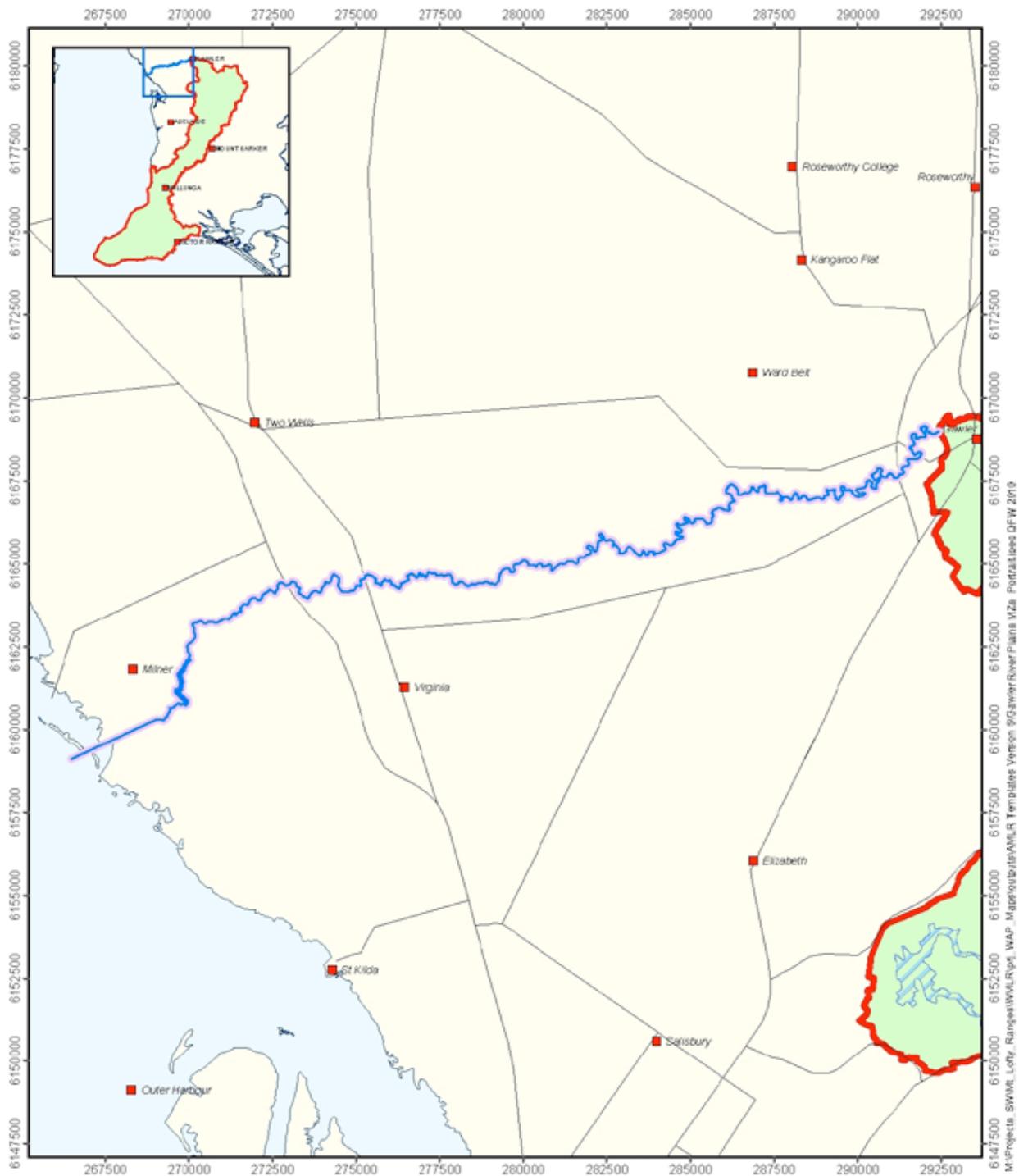
Management zone	Resource capacity (ML)	Watercourse across the plains extraction limit (ML)	Threshold flow rate (L/s)
Zone L_LLP02_u	1,916	97	55
Zone L_LLP03_u	2,015	121	55–200

TABLE 5.14 EXTRACTION LIMITS FOR WATERCOURSE WATER MANAGEMENT ZONES OF RIVER TORRENS/KARRAWIRRA PARRI

Management zone	Resource capacity (ML)	Watercourse across the plains extraction limit (ML)	Threshold flow rate (L/s)
Zone 1 (LTPWZ1)	12,482	2,362	650
Zone 2 (LTPWZ2)	19,128	10,669	850
Zone 3 (LTPWZ3)	23,111	15,014	1,000
Zone 4 (LTPWZ4)	25,307	see principle 81(c)	see principle 81(c)

TABLE 5.15 EXTRACTION LIMITS FOR WATERCOURSE WATER MANAGEMENT ZONES OF ONKAPARINGA RIVER

Management zone	Resource capacity (ML)	Watercourse across the plains extraction limit (ML)	Threshold flow rate (L/s)
Zone 1 (O_OM08)	1,352	338	200
Zone 2 (O_OM08a)	6,864	1,716	215
Zone 3 (O_OM11)	7,924	1,981	215
Zone 4 (O_OM12)	8,820	2,205	215



Legend

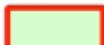
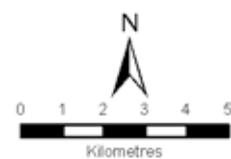
-  Major road
-  Gawler River management zone
-  Gawler River Prescribed Watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir

Figure 5.20 Watercourse water management zones of Gawler River Prescribed Watercourse



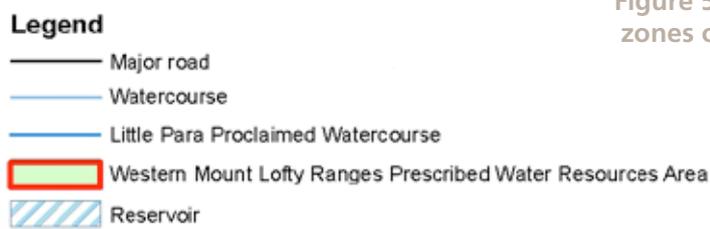
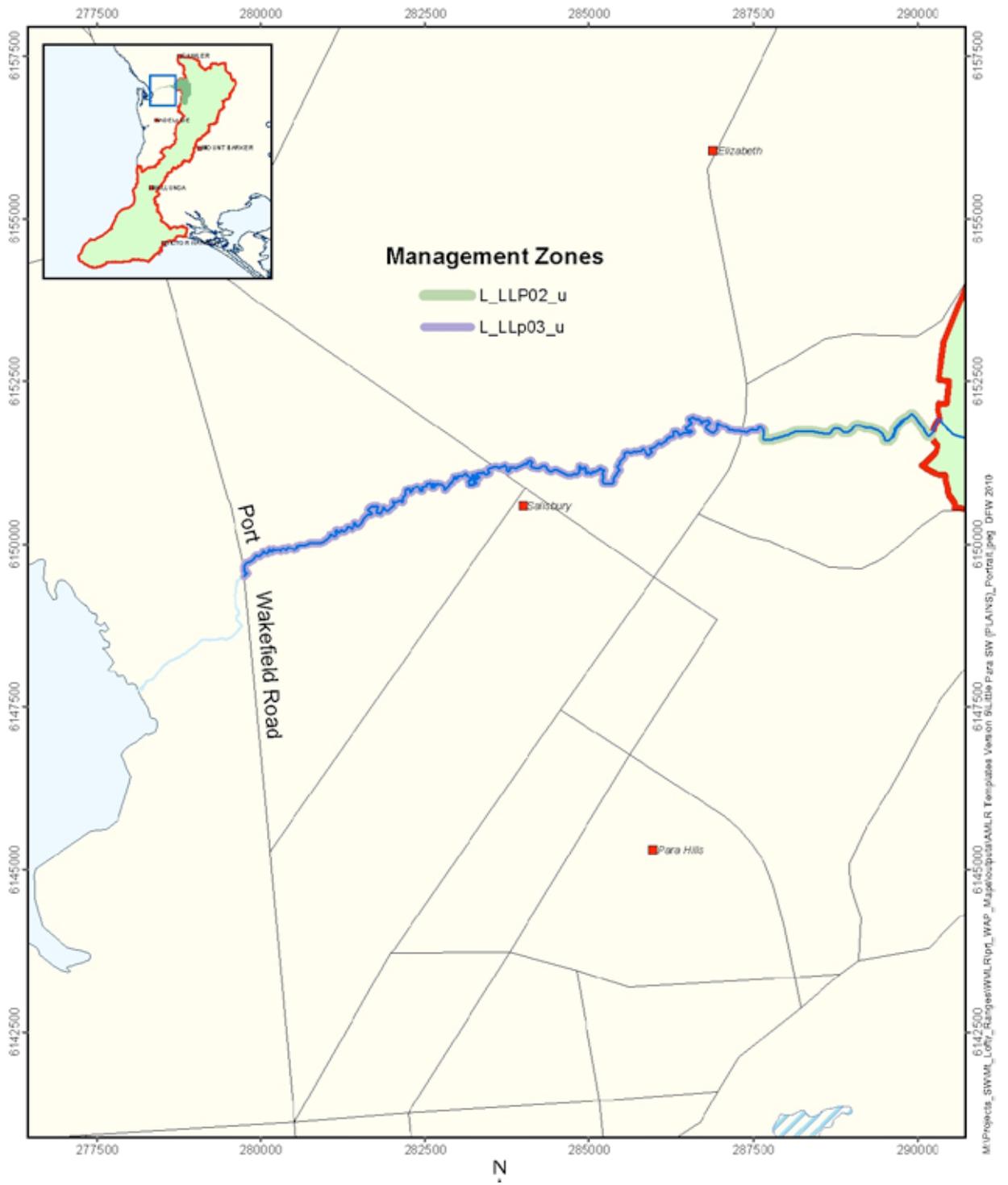
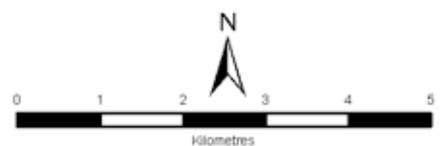


Figure 5.21 Watercourse water management zones of Little Para Proclaimed Watercourse



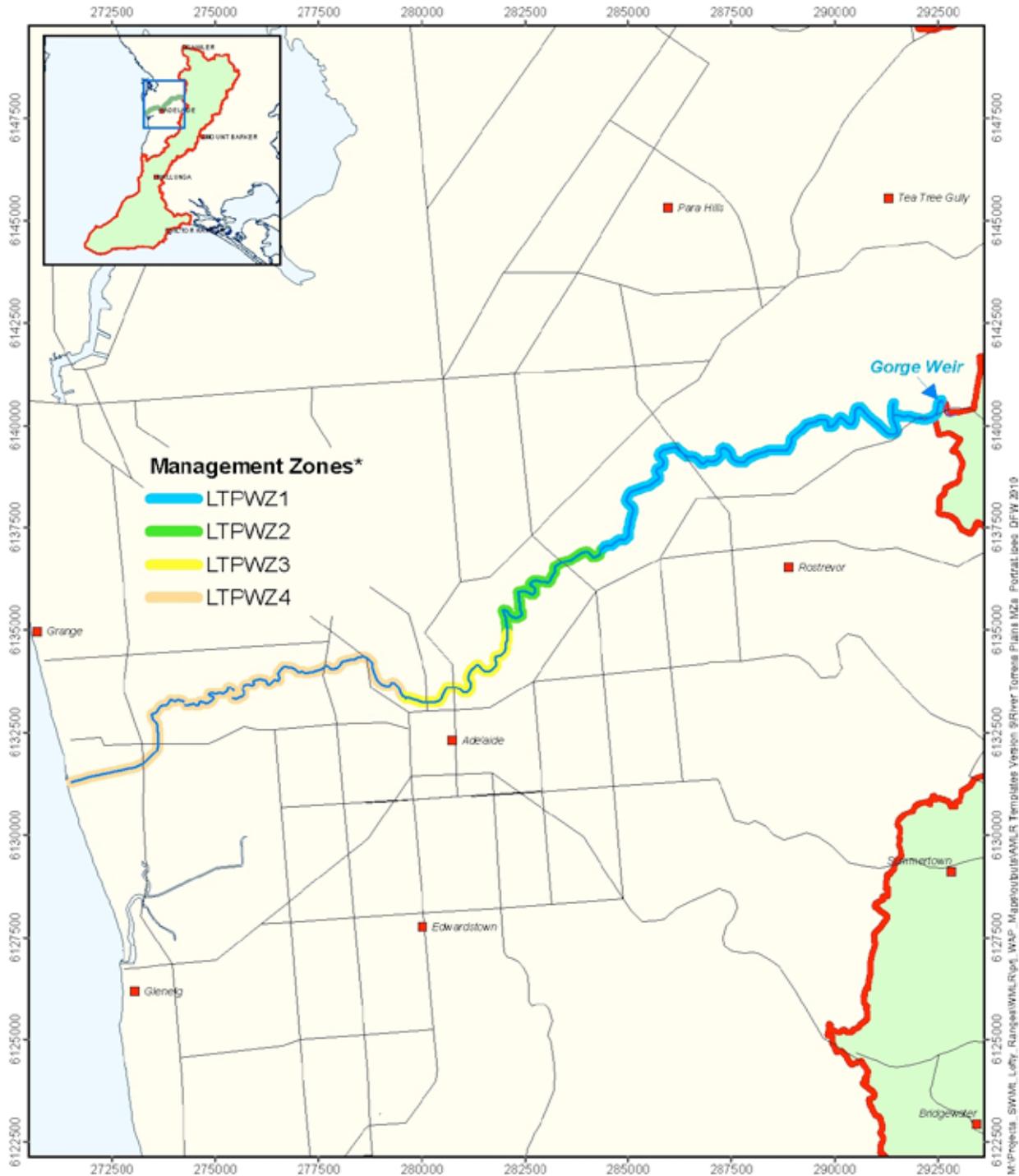
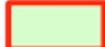
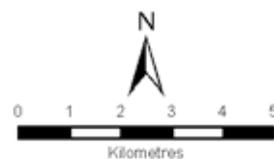


Figure 5.22 Watercourse water management zones of River Torrens/Karrawirra Parri Prescribed Watercourse

Legend

-  Major road
-  River Torrens/Karrawirra Parri Prescribed Watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area



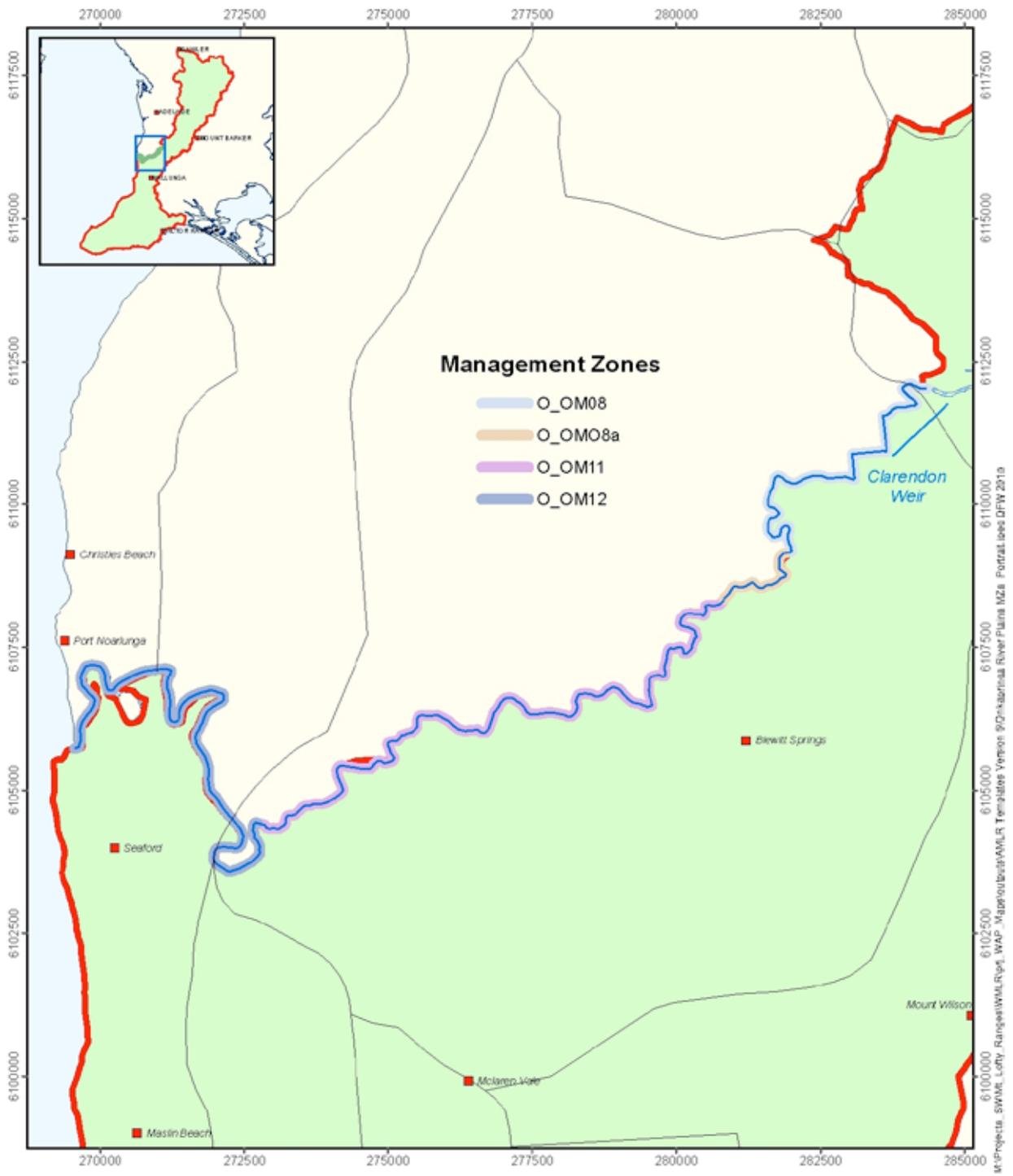


Figure 5.23 Watercourse water management zones of Onkaparinga River Prescribed Watercourse

Legend

-  Major roads
-  Onkaparinga River Prescribed Watercourse
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Reservoir



6. Water allocation criteria

This section sets out the objectives and principles that apply to the allocation of water in the Prescribed Area.

Note: Words in italics (except for references to legislation) have a specific meaning for the purposes of this plan (defined in Appendix A: Glossary). These words are italicised the first time they appear under each numbered heading. Subsequent references under that heading appear in standard font.

6.1. OBJECTIVES

The following objectives apply to the allocation of water in the Prescribed Area.

- a. Allocate and use water resources sustainably.
- b. Maintain *water-dependent ecosystems*.
- c. Minimise the impact of the taking and use of water on prescribed water resources, other *water resources*, other water users and the environment.

6.2. GENERAL ALLOCATION CRITERIA

The following general principles apply to the allocation of underground water, surface water and watercourse water in the Prescribed Area.

1. Water will be allocated as a volume that may be taken and used in a *water use year*.
2. A water licence will specify intervals of at least 12 months at which the Minister may vary the conditions of the licence.
3. Water allocations must be taken in the following order:
 - a. *recharge allocations*;
 - b. underground water, surface water or watercourse water allocations;
 - c. *rollover allocations*.
4. Water must not be allocated if the taking and/or use of water would, in the opinion of the Minister, have the potential to cause a significant adverse impact on any of the following:
 - a. underground water, surface water or watercourses;
 - b. water-dependent ecosystems;
 - c. other water users;
 - d. the productive capacity of the land, including (but not limited to) causing or exacerbating soil salinity or waterlogging.
5. For the purposes of principle 4.d, the Minister may require an applicant for a water allocation to provide an assessment from a suitably qualified professional to the satisfaction of the Minister, and the Minister may provide guidelines to the applicant outlining requirements for any assessment.
6. Despite the other principles in this plan, the Minister may grant a water licence for the taking of water for stock and/or domestic purposes by or from a dam with a capacity of 5 ML or more, provided that water was taken by or from that dam at any time during the period 1 July 2001 to 13 October 2004.

6.3. ALLOCATION OF UNDERGROUND WATER

The following principles apply to the allocation of underground water in the Prescribed Area in addition to the principles in Section 6.2 of this plan. These principles do not apply to the allocation of underground water in the McLaren Vale PWA.

Interpretation

7. For the purposes of principles 8 to 20 (inclusive), '*underground water*' and '*underground water allocation*' do not include water that has been drained or discharged into a well in accordance with a permit granted pursuant to section 135 of the *Natural Resources Management Act 2004* (NRM Act) or an environmental authorisation granted pursuant to the *Environment Protection Act 1993*.

Underground water extractions

8. For the purposes of this plan, '*underground water extractions*' means the aggregate of:

- a. underground water allocations (but not *recharge allocations* or *rollover allocations*); and
- b. the volume of underground water that is taken for non-licensed purposes (including water that is deemed to be taken by commercial forests as determined in accordance with principle 200) not including existing non-licensed extractions identified in Tables 5.1–5.5.

Underground water extraction limit

9. For the purposes of this plan, '*underground water extraction limit*' means the total volume of underground water extractions allowed in an *underground water management zone* (UWMZ).

10. Underground water must not be allocated if the allocation would cause underground water extractions in the UWMZ in which the water would be allocated to exceed (or further exceed) the underground water extraction limit for that UWMZ.

Well buffer zones

11. Subject to principle 14, underground water must not be allocated if the allocation would cause the *well buffer zone* of the well from which the whole or a part of the allocation would be taken to overlap (or further overlap) the well buffer zone of an *operational well*.

12. For the purposes of this plan, '*well buffer zone*' means a circular area centred on an operational well, the radius of which is determined in accordance with the following table:

Well category	Radius of well buffer zone (m)
Wells used only for non-licensed purposes	50
Wells in the Myponga and Hindmarsh Limestone UWMZs: underground water allocations less than or equal to 50 ML	125
Wells in the Myponga and Hindmarsh Limestone UWMZs: underground water allocations greater than 50 ML	250
Wells in all other UWMZs: underground water allocations less than 10 ML	50
Wells in all other UWMZs: underground water allocations between 10 ML and 50 ML (inclusive)	100
Wells in all other UWMZs: underground water allocations greater than 50 ML	200

13. The well buffer zone of a well will be based on the volume of water that could potentially be taken from that well under the terms of the relevant water licence.

14. Principle 11 does not apply if an aquifer test undertaken by the applicant in a manner and to a standard acceptable to the Minister, no earlier than five years before the date of the application, demonstrates to the Minister's satisfaction that:

- a. the well from which the allocation would be taken would not (or does not) target water from the same aquifer as the operational well; or
- b. taking the volume of water would not have the potential to cause a significant detrimental impact on water levels, yield or water quality in the operational well.

15. Before undertaking an aquifer test, the applicant must give written notification by registered post to each owner and/or occupier of land whose well buffer zone would be overlapped (or further overlapped) as a result of the proposed allocation, seeking:

- a. to verify the location of the operational well;
- b. to verify that the well is operational; and
- c. written permission to access the well to measure water levels in and collect water samples from the well.

16. If an owner and/or occupier of land given written notification under principle 15.c does not provide written permission to the applicant and Minister to access the well within 30 days of receiving the written notification, the potential of any impact of the allocation of water on those wells will not be considered.

Zones of high intensity underground water use

17. Underground water must not be allocated in a *zone of high intensity underground water use*.

Underground water-dependent ecosystems

18. For the purposes of this plan, *'buffer zone of an underground water-dependent ecosystem'* means an area that extends:

- a. 5 metres from the edge of a drainage path;
- b. 10 metres on each side of the centre line of a watercourse;
- c. 200 metres on each side of the centre line of a watercourse underlain by a Permian Sand aquifer;

- d. 50 metres from the edge of a wetland in fractured rock systems; or
- e. 200 metres from the edge of a wetland underlain by a Permian Sand aquifer.

19. Underground water must not be allocated if the allocation would cause the well buffer zone of the well from which the whole or a part of the allocation would be taken to overlap (or further overlap) the buffer zone of an underground water-dependent ecosystem.

Rollover allocations

20. Subject to principle 21, if the whole or a part of an underground water allocation is not taken in a *water use year* ('the credit year'), the unused allocation may be taken in the following two water use years (and is referred to in this plan as a 'rollover allocation'), subject to the following:

- a. no more than 15% of the underground water allocation at the end of the credit year may be taken in the two water use years after the credit year;
- b. a rollover allocation must not be taken until the full amount of the underground water allocation for the relevant water use year is taken;
- c. the volume of underground water that may be taken by the holder of a water licence in a water use year must not exceed 115% of their underground water allocation at the start of that water use year;
- d. if not taken beforehand, a rollover allocation expires at the end of the second full water use year after the credit year; and
- e. a rollover allocation may be taken only through a meter.

21. A rollover allocation may not be taken until the start of the second full water use year after the *adoption date*.

Water that has been drained or discharged into a well

22. For the purposes of principles 23 and 24:

- a. 'recharge period' means the period between 1 October and 30 September in the following calendar year; and
- b. 'recovery period' means the period between 1 October in the same calendar year that follows the recharge period and 30 September in the following calendar year.

23. Water that has been drained or discharged into a well in a *recharge period* in accordance with a permit granted pursuant to section 135 of the NRM Act or an environmental authorisation granted pursuant to the *Environment Protection Act 1993* may be allocated to be taken in the *recovery period* (and is referred to in this plan as a 'recharge allocation'), subject to the following conditions:

- a. the volume of water allocated must not exceed 80% of the volume of water that was drained or discharged into a well, as recorded by a water meter, in the recharge period; and
- b. the water must be taken from the same *allotment* and from the same aquifer that the water was drained or discharged into.

24. Unless taken beforehand, a recharge allocation expires within three years of the end of the recharge period.

6.4. ALLOCATION OF SURFACE WATER AND WATERCOURSE WATER (NOT FROM A WATERCOURSE ACROSS THE PLAINS)

The following principles apply to the allocation of surface water and watercourse water (not from a *watercourse across the plains*) in the *Prescribed Area*. These principles apply in addition to the principles in Section 6.2 of this plan.

General

25. Principles 26 to 56 (inclusive) do not apply to the allocation of *roof runoff*, water from a watercourse across the plains or, subject to principle 66, *stormwater management* or *water sensitive urban design*.

Location

26. Surface water and watercourse water must not be allocated if the whole or a part of the allocation would be taken directly from a *Fleurieu wetland* or a *Central Hills wetland*.

27. The locations of Fleurieu wetlands and Central Hills wetlands identified in Figures 2.3 and 2.4 are indicative only. An on-site assessment by the *relevant authority* will confirm the exact location and extent of a wetland.

28. Surface water and watercourse water may be allocated only if an assessment is undertaken by a suitably qualified expert or experts in one or more of the following: hydrology, hydrogeology, wetland ecology, geomorphology, land management and/or environmental engineering, and the Minister is satisfied that the taking of the whole or part of the allocation at the proposed location will not cause a significant impact on a Fleurieu wetland or a Central Hills wetland.

29. For the purpose of principle 28, the assessment may consider factors including, but not limited to, the location and the extent of wetland, the type and significance of wetland, sources of water to the wetland, water regime, land use, land management and existing extractions, and low flows required by the wetland.

Water extractions

30. For the purposes of this plan, '*water extractions*' means the aggregate of:

- a. surface water and watercourse water allocations (not including allocations for the purpose of taking *roof runoff* and for stormwater management and water sensitive urban design); and
- b. stock and/or domestic use from each dam, which is deemed to be:
 - i. where a volumetric water allocation is taken from a dam that was constructed before the *adoption date* and the allocation is less than 70% of the capacity of the dam – the difference between the allocation and 70% of the capacity of the dam (which must not exceed 30% of the capacity of the dam);
 - ii. where a water allocation is not required to take water from a dam – 30% of the capacity of the dam;
 - iii. in any other case – zero; and
- c. surface water that is deemed to be taken by *commercial forests* (as determined in accordance with principle 201).

Allowable volume to be taken from a dam

31. Except for a dam that is part of a watercourse, the total volume of water that can be allocated to be taken from a dam must not exceed the capacity of the dam.

Surface water extraction limit

32. For the purposes of this plan, '*surface water extraction limit*' means the maximum volume of water extractions (not including water extractions from a *main watercourse*) allowed in a *surface water management zone* (SWMZ).

33. Surface water, and watercourse water that would not be taken from a main watercourse, must not be allocated if the allocation would cause water extractions (not including water extractions from a main watercourse) in the SWMZ in which the water would be allocated to exceed (or further exceed) the surface water extraction limit for that SWMZ.

Main watercourse extraction limit

34. For the purposes of this plan, 'main watercourse extraction limit' means the maximum volume of water extractions allowed from:

- a. a main watercourse in the SWMZ in which the limit applies ('the relevant SWMZ'); and
- b. any SWMZs that contribute to the flow of water in any part of the main watercourse that is in the relevant SWMZ.

35. Surface water and watercourse water must not be allocated if it would cause water extractions in:

- a. the SWMZ in which the water would be allocated ('the relevant SWMZ'); and
- b. any SWMZs that contribute to the flow of water in any part of a main watercourse, to exceed (or further exceed) the main watercourse extraction limit for any of those SWMZs.

Water extractions in areas upstream of reservoirs

36. Surface water and watercourse water must not be allocated in the *catchment* of a *reservoir*, or in the catchment of a weir in the Prescribed Area that diverts water to the Happy Valley or Hope Valley reservoirs, unless:

- a. the water allocation is transferred from within the catchment of the reservoir or weir; or
- b. there has been a prior reduction in the total volume of water extractions in the catchment of the reservoir or weir in which the water would be allocated that is equal to, or greater than, the proposed allocation; and
- c. the allocation would not cause a net increase in the total volume of surface water and watercourse water use (as at the adoption date) in the catchment of the reservoir or weir in which the water would be allocated.

37. For the purposes of principle 36.c, 'the total volume of surface water and watercourse water use (as at the adoption date)' is the aggregate of:

- a. subject to any reduction pursuant to section 164N(3) of the NRM Act, the quantity of water to which existing users are entitled at the adoption date;
- b. stock and/or domestic use from each dam, which is deemed to be:
 - i. if the entitlement referred to in principle 37a above was taken from a dam and the entitlement is less than 70% of the capacity of the dam – the difference between the entitlement and 70% of the capacity of the dam (which must not exceed 30% of the capacity of the dam);
 - ii. where a water allocation is not required to take water from a dam – 30% of the capacity of the dam;
 - iii. in any other case – zero; and

- c. surface water that is deemed to be taken by *commercial forests* (as determined in accordance with principle 201) at the adoption date.

Local adjusted runoff

38. For the purposes of this plan, 'local adjusted runoff' means the volume of water that would flow over land (with the presence of dams and forests excluded) to an *extraction point* or a Fleurieu wetland, which is calculated by multiplying the catchment of the extraction point or Fleurieu wetland (km²) by the *annual adjusted runoff* (in mm).

Water extractions in areas upstream of Fleurieu wetlands

39. Surface water and watercourse water must not be allocated if the allocation would cause water extractions in the catchment of a Fleurieu wetland to exceed (or further exceed) 25% of the local adjusted runoff (in ML) to the wetland.

40. For the purposes of principle 39, the maximum volume of water that may be allocated in the catchment of a Fleurieu wetland (in addition to any existing allocations in the catchment of the Fleurieu wetland) is calculated as follows:

catchment of the Fleurieu wetland (km²) X annual adjusted runoff (mm) X 0.25

water extractions in the catchment of the Fleurieu wetland (in ML)

—

41. For the purposes of principles 39 and 40:

- a. 'catchment of the Fleurieu wetland' includes:
 - i. the area of land in the SWMZ in which the water would be allocated within which rainfall contributes to runoff to the wetland; and
 - ii. in relation to a main watercourse, the combined area of land in any *upstream SWMZs*; and
- b. 'annual adjusted runoff' includes:
 - i. the annual adjusted runoff (in mm) in the SWMZ in which the water would be allocated; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any *upstream SWMZs*.

Local runoff limit

42. Surface water and watercourse water must not be allocated if it would cause water extractions and *deemed dam losses* in the catchment of the extraction point from which the water allocation would be taken to exceed (or further exceed) the local adjusted runoff (in ML) to that point.

43. For the purposes of principle 42, the maximum volume of water that may be allocated to be taken from an extraction point (in addition to any existing allocation to take water from the extraction point) is calculated as follows:

$$\begin{array}{|c|} \hline \text{catchment of the} \\ \text{extraction point (km}^2\text{) X} \\ \text{annual adjusted runoff} \\ \text{(mm)} \\ \hline \end{array} \quad - \quad \begin{array}{|c|} \hline \text{water extractions and} \\ \text{deemed dam losses} \\ \text{in the catchment of} \\ \text{the extraction point} \\ \text{(including existing water} \\ \text{extractions (but not} \\ \text{deemed dam losses) from} \\ \text{the extraction point)} \\ \text{(in ML)} \\ \hline \end{array}$$

44. For the purposes of principles 42 and 43:

- a. 'catchment of the extraction point' includes:
 - i. the area of land in the SWMZ in which the water would be allocated within which rainfall contributes to runoff to the extraction point; and
 - ii. in relation to a main watercourse, the combined area of land in any upstream SWMZs; and
- b. if the water allocation is being transferred from within the catchment of the extraction point – 'water extractions and deemed dam losses in the catchment of the extraction point' does not include the proposed allocation; and
- c. 'annual adjusted runoff' includes:
 - i. the annual adjusted runoff (in mm) in the SWMZ in which the water would be allocated; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any upstream SWMZs.

Impacts on downstream users

45. Surface water and watercourse water must not be allocated if it would cause water extractions and deemed dam losses in the catchment of a *downstream extraction point* to exceed (or further exceed) the local adjusted runoff (in ML) to that point.

46. For the purposes of principle 45, the maximum volume of water that may be allocated to be taken from an extraction point (in addition to any existing allocation to take water from the extraction point) must not exceed, after making the following calculation for each downstream extraction point, the lesser of those calculations:

$$\begin{array}{|c|} \hline \text{catchment of the} \\ \text{downstream extraction} \\ \text{point (km}^2\text{) X annual} \\ \text{adjusted runoff (mm)} \\ \hline \end{array} \quad - \quad \begin{array}{|c|} \hline \text{water extractions and} \\ \text{deemed dam losses in} \\ \text{the catchment of the} \\ \text{downstream extraction} \\ \text{point (including existing} \\ \text{water extractions and} \\ \text{deemed dam losses} \\ \text{from the downstream} \\ \text{extraction point) (in ML)} \\ \hline \end{array}$$

47. For the purposes of principles 45 and 46:

- a. 'catchment of the downstream extraction point' includes:
 - i. the area of land in the SWMZ in which the downstream extraction point is located within which rainfall contributes to runoff to the downstream extraction point; and
 - ii. in relation to a main watercourse, the combined area of land in any upstream SWMZs; and
- b. if the water allocation is being transferred from within the catchment of the downstream extraction point – 'water extractions and deemed dam losses in the catchment of the downstream extraction point' does not include the proposed allocation; and
- c. 'annual adjusted runoff' includes:
 - i. the annual adjusted runoff (in mm) in the SWMZ in which the downstream extraction point is located; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any upstream SWMZs.

Threshold flow rate

48. For the purposes of this plan, except in the case of a main watercourse and a watercourse across the plains, the threshold flow rate (in litres/second) is calculated as follows:

$$\begin{array}{|c|} \hline \text{unit threshold flow rate} \\ \text{(litres/second/km}^2\text{)} \\ \hline \end{array} \quad \times \quad \begin{array}{|c|} \hline \text{catchment of the dam,} \\ \text{wall or other structure} \\ \text{(km}^2\text{)} \\ \hline \end{array}$$

49. For the purposes of this plan, the threshold flow rate (in litres/second) for a main watercourse is calculated as follows:

$$\begin{array}{|c|} \hline \text{main watercourse unit} \\ \text{threshold flow rate (litres/} \\ \text{second/km}^2\text{)} \\ \hline \end{array} \quad \times \quad \begin{array}{|c|} \hline \text{catchment of the dam,} \\ \text{wall or other structure} \\ \text{(km}^2\text{)} \\ \hline \end{array}$$

50. Subject to principle 52, water flowing at or below the threshold flow rate must:

- a. remain in the watercourse or *drainage path*; or
- b. re-enter the original watercourse or drainage path as soon as it is reasonably practicable to do so and not be of a poorer quality than the water that was diverted.

51. Subject to principle 52, if the whole or a part of a water allocation will be taken from or by a dam, or from a watercourse, the relevant water licence will be granted subject to a condition that requires:

- a. the dam or infrastructure from or by which the water will be taken to be fitted with a device that prevents, and is maintained to prevent, the dam or infrastructure from taking water flowing at or below the threshold flow rate; and
- b. the device referred to in principle 51a to be designed, constructed and maintained in accordance with principle 191.

52. Principles 50 and 51 do not apply if the Minister is satisfied that:

- a. the construction, installation or use of a device referred to in principle 51a is not reasonably practicable in the circumstances; and
- b. the water flowing at or below the threshold flow rate that will be taken by the dam or infrastructure will be returned to the same watercourse or drainage path immediately downstream of the dam or infrastructure as soon as it is reasonably practicable to do so after the water has been taken; and
- c. the water flowing at or below the threshold flow rate that will be returned in accordance with principle 52.b will not be of a poorer quality than the water that was taken by the dam or infrastructure.

53. Water must not be allocated unless the applicant can demonstrate to the satisfaction of the Minister how compliance with principles 50 and 52 will be achieved.

Maximum diversion rate

54. Water must not be taken from a *third order (and above) watercourse* at a rate that exceeds the *maximum diversion rate*.

55. For the purposes of this plan, the maximum diversion rate (in litres/second) is calculated as follows:

$$\frac{\text{volume of water to be collected or diverted (ML)}}{\text{number of days in an average year that flows are above the threshold flow rate}} \div 0.0864 \text{ (to convert ML/day into litres/second)}$$

56. For the purposes of principle 55, the 'number of days in an average year that flows are above the threshold flow rate' in each SWMZ will be determined at the time of assessment.

Rollover allocations – surface water allocations

57. Subject to principle 59, if the whole or a part of a surface water allocation is not taken in a *water use year* ('the credit year'), the unused allocation may be taken in the following water use year (and is referred to in this plan as a '*rollover allocation*'), subject to:

- a. no more than 10% of the surface water allocation at the end of the credit year may be taken in the water use year after the credit year;
- b. a rollover allocation must not be taken until the full amount of the surface water allocation for the relevant water use year is taken;
- c. the volume of surface water that may be taken by the holder of a water licence in a water use year must not exceed 110% of their surface water allocation at the start of that water use year; and
- d. if not taken beforehand, a rollover allocation expires at the end of the full water use year after the credit year.

58. A rollover allocation cannot be taken until the start of the second full water use year after the adoption date and unless a meter has been installed.

59. Principle 57 does not apply to a watercourse water allocation.

Roof runoff

60. Principles 61 to 64 (inclusive) apply only to the allocation of roof runoff in excess of the volume that is authorised to be taken in accordance with the Notice of Authorisation to Take Water published in the South Australian Government Gazette on 30 August 2012 (pp. 3921-3928) (as may be varied or replaced from time to time).

61. An allocation as roof runoff of 1,500 kL/yr or greater may be granted only where the pre-existing local adjusted runoff is returned to the environment:

- a. by as close as practicable to the natural path;
- b. as soon as reasonably practicable following precipitation; and
- c. in a manner that does not cause significant detrimental impacts to the environment, including (but not limited to) erosion.

62. The maximum volume (in ML) that may be allocated as roof runoff is calculated as follows:

$$\frac{\text{(connected roof area (m}^2\text{))} \times \text{rainfall (mm)}}{1,000,000} - \text{pre-existing local adjusted runoff}$$

63. For the purposes of principle 62, 'rainfall' is the average annual rainfall for the relevant location (in mm) determined in accordance with the Notice of Authorisation to Take Water published in the South Australian Government Gazette on 30 August 2012 (pp. 3921-3928) (as may be varied or replaced from time to time).

64. All water taken in accordance with a *roof runoff allocation* must be directed to water storage facilities with no seepage losses and that are designed to minimise evaporation losses.

Stormwater management and water sensitive urban design

The following principles apply to the allocation of surface water, or watercourse water, as runoff from urban areas in the Prescribed Area for the purpose of stormwater management and water sensitive urban design. These principles apply in addition to the principles in Section 6.2 of this plan.

65. For the purposes of principles 66 and 67:

- a. *new urban land use development* means development that is (or was) authorised by a development approval under the *Development Act 1993* and that is (or was) commenced after 14 October 2004;
- b. *runoff from a new urban land use development* is the volume of water (as determined by a suitably qualified and experienced engineer to the satisfaction of the Minister) that runs off a new urban land use development and is calculated by multiplying the rainfall (in mm) by the area of the new urban land use development (taking into account the area of impervious surfaces and the reduced runoff due to the implementation of water sensitive urban design and open space); and
- c. *pre-development runoff* is the volume of water that had run off land before the new urban land use development on that land.

66. If the extraction point from which surface water, as runoff from a new urban land use development, would be taken is not in the catchment of a reservoir or a weir that diverts water to the Happy Valley or Hope Valley reservoirs the pre-development runoff may be allocated subject to principles 26 to 64 (inclusive).

67. Surface water or watercourse water as runoff from a new urban land use development may only be allocated where:

- a. the allocation would not exceed the difference between the runoff from a new urban land use development and the pre-development runoff;
- b. if the extraction point is in the catchment of a reservoir, or in the catchment of a weir in the Prescribed Area that diverts water to the Happy Valley or Hope Valley reservoirs – the pre-development runoff is returned to the environment:
 - i. as close as reasonably practicable to the natural flow path;
 - ii. as soon as reasonably practicable following precipitation, including where the water is held for water quality remediation; and

- iii. in a manner that does not cause significant detrimental impacts to the environment, including (but not limited to) erosion, and water users at a downstream extraction point; and

- c. the Minister is satisfied that the allocation would not significantly affect recharge to underground water.

68. Despite principles 66 and 67, surface water and watercourse water may be allocated for the purpose of stormwater management and water sensitive urban design:

- a. for urban development in those areas described as *Planned Urban Areas to 2038* as shown on Maps E5 (except for McLaren Flat, McLaren Vale and Willunga) except from the Onkaparinga River and E8 in *The 30-year plan for Greater Adelaide – A Volume of the South Australian Planning Strategy*; or
- b. from the River Torrens/Karrawirra Parri downstream of Torrens Lake (zone 4 in Figure 5.22), subject to an assessment being undertaken by an independent expert that demonstrates to the Minister's satisfaction that water is provided to meet the requirements of the environment and licensed water users downstream from where the water is to be taken.

69. For the purposes of principle 68, the volume of watercourse water or surface water that may be allocated is calculated as the volume of water (as determined by a suitably qualified and experienced engineer to the satisfaction of the Minister) that runs off an urban land use development and is calculated by multiplying the rainfall (in mm) by the area of the urban land use development (taking into account the area of impervious surfaces and the reduced runoff due to the implementation of water sensitive urban design and open space).

6.5. ALLOCATION OF WATER FROM WATERCOURSES ACROSS THE PLAINS

The following principles apply to the allocation of water from *watercourses across the plains* in the Prescribed Area. These principles apply in addition to the principles in Section 6.2 of this plan.

Watercourse across the plains extraction limit

70. For the purposes of this plan, '*watercourse across the plains extraction limit*' means the maximum volume of water extractions allowed from:

- a. a watercourse across the plains; and
- b. any of the *catchments* that contribute to the flow of water in any part of the watercourse.

71. Water to be taken from a watercourse across the plains must not be allocated if it would cause *water extractions* in the catchment of the watercourse to exceed the watercourse across the plains extraction limit.

72. Water must not be allocated from the Onkaparinga River, unless:

- a. the water is transferred from the Onkaparinga River; and
- b. the allocation would not cause a net increase in the total volume of watercourse water use (as at the *adoption date*) from the Onkaparinga River.

Restrictions on water extractions to protect environmental water releases

73. Where, as a condition on a water licence, SA Water is required to release water from a *reservoir* for environmental or water quality purposes, the Minister may require, before the release of that water, notification to all licensees who extract water from a watercourse across the plains within a designated distance downstream of the reservoir, of the timing of the release.

74. If the whole or a part of a water allocation will be taken from a watercourse across the plains, the relevant water licence may be granted subject to a condition that:

- a. prohibits the taking of water from the watercourse; or
- b. restricts the volume of water that may be taken and/or the timing of the taking of water,

for the period of any release of water from a reservoir by SA Water for environmental or water quality purposes.

Local runoff limit

75. Water to be taken from a watercourse across the plains must not be allocated if it would cause water extractions and *deemed dam losses* in the catchment of the *extraction point* from which the allocation would be taken, to exceed (or further exceed) the *local adjusted runoff* to that point.

76. For the purposes of principle 75, the maximum volume of water that may be allocated to be taken from an extraction point (in addition to any existing water allocation to take water from the extraction point) is calculated as follows:

$$\begin{array}{|c|} \hline \text{catchment of the} \\ \text{extraction point (km}^2\text{)} \\ \text{X annual adjusted} \\ \text{runoff (mm)} \\ \hline \end{array} \quad - \quad \begin{array}{|c|} \hline \text{water extractions and} \\ \text{deemed dam losses} \\ \text{in the catchment of} \\ \text{the extraction point} \\ \text{(including any existing} \\ \text{water allocation (but not} \\ \text{deemed dam losses) from} \\ \text{the extraction point)} \\ \text{(in ML)} \\ \hline \end{array}$$

77. For the purposes of principles 75 and 76, if the water allocation is being transferred from within the catchment of the extraction point ‘water extractions and deemed dam losses in the catchment of the extraction point’ does not include the proposed allocation.

Impacts on downstream users

78. Water to be taken from a watercourse across the plains must not be allocated if it would cause water extractions and deemed dam losses in the catchment of a *downstream extraction point* to exceed (or further exceed) the local adjusted runoff (in ML) to that point.

79. For the purposes of principle 78, the maximum volume of water that may be allocated to be taken from an extraction point (in addition to any existing allocation to take water from the extraction point) must not exceed (after making the following calculation for each downstream extraction point) the lesser of those calculations:

$$\begin{array}{|c|} \hline \text{catchment of the} \\ \text{extraction point (km}^2\text{)} \text{ X} \\ \text{annual adjusted runoff} \\ \text{(mm)} \\ \hline \end{array} \quad - \quad \begin{array}{|c|} \hline \text{water extractions and} \\ \text{deemed dam losses in} \\ \text{the catchment of the} \\ \text{downstream extraction} \\ \text{point (including existing} \\ \text{water extractions and} \\ \text{deemed dam losses} \\ \text{from the downstream} \\ \text{extraction point) (in ML)} \\ \hline \end{array}$$

80. For the purpose of principles 78 and 79, if the water allocation is being transferred from within the catchment of the extraction point ‘water extractions and deemed dam losses in the catchment of the extraction point’ does not include the proposed allocation.

Threshold flow rate

81. For the purposes of this plan, the threshold flow rate for a watercourse across the plains is:

- a. for the *watercourse water management zone* of the Gawler River – a minimum of 500 L/s and a maximum of 690 L/s (see Table 5.12), which will be determined at the time of assessment;
- b. for the watercourse water management zones of the Little Para Proclaimed Watercourse, listed in Table 5.13;
- c. for the watercourse water management zones of the River Torrens/Karrawirra Parri, listed in Table 5.14, except for Zone 4, where during:
 - i. all months except for October to November (inclusive) and April to May (inclusive), a minimum threshold flow rate of 200 L/s is required at the point of extraction to maintain operation of the fishway at the outlet weir at Breakout Creek; or
 - ii. the months of October to November (inclusive) and April to May (inclusive), a minimum threshold flow rate of 1000 L/s, or a flow depth of at least 100 mm, is required at the point of extraction in all natural reaches in Zone 4 (upstream of Breakout Creek); and

iii. where, as a condition on a water licence, SA Water is required to release water from a reservoir for environmental or water quality purposes, and there is agreement with the Minister and/or a *relevant authority* to recapture the released water, there is no minimum threshold flow rate for the period when the water is released from Zone 3 to Zone 4, through the Torrens Weir;

d. for the watercourse water management zones of the Onkaparinga River, listed in Table 5.15.

82. Subject to principle 84, water flowing at or below the threshold flow rate must:

- a. remain in the watercourse; or
- b. re-enter the watercourse as soon as it is reasonably practicable to do so and not be of a poorer quality than the water that was diverted.

83. Subject to principle 84, if the whole or a part of a water allocation will be taken from or by a dam, or from a watercourse, the relevant water licence will be granted subject to a condition that requires:

- a. the dam or infrastructure from or by which the water allocation will be taken to be fitted with a device that prevents, and is maintained to prevent, the dam or infrastructure from taking water flowing at or below the threshold flow rate; and
- b. the device referred to in principle 83.a to be designed, constructed and maintained in accordance with principle 191.

84. Principles 82 and 83 do not apply if:

- a. the Minister is satisfied that the construction, installation or use of a device referred to in principle 83.a is not reasonably practicable in the circumstances; and
- b. the water flowing at or below the threshold flow rate that will be taken by the dam or infrastructure will be returned to the same watercourse immediately downstream of the dam or infrastructure as soon as it is reasonably practicable to do so after the water has been taken; and
- c. the water flowing at or below the threshold rate that will be returned in accordance with principle 82.b will not be of a poorer quality than the water that was taken by the dam or infrastructure.

85. Water must not be allocated unless the applicant can demonstrate to the satisfaction of the Minister how compliance with principles 83 and 84 will be achieved.

6.6. VARIATION OF WATER LICENCES

The following principles apply to the variation of all water licences in the *Prescribed Area*.

General assessment

86. The Minister may refuse to grant an application to vary a water licence and/or a water allocation in circumstances where the

Minister has, pursuant to section 166 of the NRM Act, reserved from allocation excess water that is available for allocation from the relevant underground water management zone or surface water management zone (as the case may be) from which the water would be taken following the variation.

87. A variation of the quantity of water specified on a water licence, the location of the point of taking, or the conditions endorsed on a water licence must be consistent with the objectives, and the principles in Sections 6.2 to 6.5 (inclusive) and Section 7 of this plan.

88. A water licence must not be varied to allow:

- a. underground water to be taken from surface water or watercourses;
- b. surface water or watercourse water to be taken from underground water; or
- c. *roof runoff* to be taken from underground water, surface water that is not roof runoff or watercourses.

Threshold flow rate

89. If the whole or a part of a water allocation is taken from or by a dam, or from a watercourse, the Minister may vary the relevant water licence by imposing a condition on the water licence that requires:

- a. the dam or infrastructure from or by which the water allocation is taken to be fitted with a device that:
 - i. prevents, and is maintained to prevent, the dam or infrastructure from taking water flowing at or below the *threshold flow rate*; and
 - ii. is designed, constructed and maintained in accordance with principle 191; or
- b. if the Minister is satisfied that the construction, installation or use of a device referred to in principle 89.a is not reasonably practicable in the circumstances, the water flowing at or below the threshold flow rate that is:
 - i. taken by the dam or infrastructure to be returned to the same watercourse or *drainage path* immediately downstream of the dam or infrastructure as soon as it is reasonably practicable to do so after the water has been taken; and
 - ii. returned in accordance with principle 89.b.i to not be of a poorer quality than the quality of the water that was taken.

90. For the purposes of principle 89, 'threshold flow rate' means the rate of flow determined in accordance with principles 48, 49 or 81.

Maximum diversion rate

91. If the whole or a part of a water allocation is taken from a *third order (and above) watercourse*, the Minister may vary the relevant water licence, by imposing a condition on the water licence that provides that water may not be taken from the third order (and above) watercourse at a rate that exceeds the *maximum diversion rate* determined in accordance with principles 55 and 56.

7. Transfer criteria

This section sets out the objectives and principles that apply to the transfer (permanent or temporary trade to new owners) of water licences and water allocations in the Prescribed Area.

Note: words in italics (except for references to legislation) have a specific meaning for the purposes of this plan and are defined in Appendix A: Glossary. These words are italicised the first time they appear under each numbered heading. Subsequent references under that heading appear in standard font.

7.1. OBJECTIVES

The following objectives apply to the transfer (permanent or temporary trade) of water licences and water allocations in the Prescribed Area.

- A. Allocate and use water resources sustainably.
- B. Maintain *water-dependent ecosystems*.
- C. Minimise the impact of water use on prescribed water resources, other water users and the environment.

7.2 GENERAL TRANSFER CRITERIA

The following principles apply to the transfer (trade) of water licences and water allocations in the Prescribed Area.

92. The Minister may refuse to grant an application to transfer a water licence and/or a water allocation between underground water management zones or surface water management zones (as the case may be) in circumstances where the Minister has, pursuant to section 166 of the NRM Act, reserved from allocation excess water that is available for allocation from the relevant underground water management zone or surface water management zone from which the water would be taken following the transfer.
93. The whole or part of a water allocation may be transferred without the assessment required by principles 95 or 110 where there is no increase in the volume of water to be allocated, and there is no change to the location of the point of taking and to the conditions relating to the allocation.

7.3 TRANSFER OF UNDERGROUND WATER ALLOCATIONS

The following principles apply to the transfer of water licences and water allocations to take *underground water* in the Prescribed Area. These principles are in addition to the principle in Section 7.2 of this plan. They do not apply to the transfer of water licences and water allocations to take underground water in the McLaren Vale PWA.

Interpretation

94. For the purposes of principles 95 to 107 (inclusive), '*underground water*' and 'underground water allocation' does not include water that has been drained or discharged into a well in accordance with a permit granted pursuant to section 135 of the *Natural Resources Management Act 2004* (NRM Act) or an environmental authorisation granted pursuant to the *Environment Protection Act 1993*.

General assessment

95. Subject to principles 93 and 101 (inclusive), the transfer of an underground water allocation must be assessed against and comply with the criteria for the allocation of underground water in Sections 6.2 and 6.3 of this plan.
96. An underground water allocation may be transferred between *underground water management zones* (UWMZs; including UWMZs in different *catchments* delineated in Figure 1.2) or within an UWMZ.
97. An underground water allocation must not be transferred to be taken as a surface water or watercourse water allocation.
98. An underground water allocation must not be transferred if the Minister is satisfied that the transfer may have the potential to cause a significant adverse effect on an aquifer, including (but not limited to) changes in:
- a. local water levels; and
 - b. salinity.

Permanent transfers

99. If a part of an underground water allocation is transferred permanently, the *well buffer zone* around the well (or wells) from which the allocation could be taken immediately before the transfer will be adjusted (where necessary) in accordance with the table in principle 12.
100. If the whole of an underground water allocation is transferred permanently, the *well buffer zone* around the well (or wells) from which the allocation could be taken immediately before the transfer will be adjusted (where necessary) so that it has a radius of 50 metres.

Temporary transfers

101. A maximum volume of 500 kL of underground water may be temporarily transferred for a period within any one *water use year* without assessment against the criteria for the transfer of underground water allocations in this plan, provided that:
- a. the transfer would not cause the total volume of *underground water extractions* in the UWMZ in which the water would be allocated to exceed (or further exceed) the *underground water extraction limit* for that UWMZ;
 - b. the transfer would not result in an increase to the total volume of underground water allocated in a *zone of high intensity underground water use*; and
 - c. the transfer would not cause the well buffer zone of the well from which the whole or a part of the transferred allocation would be taken to overlap (or further overlap) the *buffer zone of an underground water-dependent ecosystem*.

102. An underground water allocation that is transferred under principle 101 must not be taken as a *rollover allocation* in any following water use year.

103. Except where an underground water allocation is transferred in accordance with principle 101, if the whole or a part of an underground water allocation is transferred temporarily:

- a. the well buffer zone around the well (or wells) from which the allocation can be taken after the transfer will be determined in accordance with the table in principle 12; and
- b. the well buffer zone around the well (or wells) from which the allocation could be taken immediately before the transfer will remain unchanged; and
- c. the allocation is to be accounted for in both the originating and receiving management zones for the duration of the temporary transfer.

Transfers between other prescribed areas

104. Subject to principle 105, an allocation from any other prescribed area shall not be transferred to be taken from the Prescribed Area.

105. An underground water allocation may only be transferred temporarily between the Prescribed Area and any other prescribed area if:

- a. the allocation will only be transferred within the boundaries of a single *property* that lies within both the Prescribed Area and any other prescribed area; and
- b. the water allocation plan for any other prescribed area allows for transfers between that prescribed area and the Prescribed Area; and
- c. the proposed transfer complies with the relevant allocation and transfer principles in the water allocation plan for that prescribed area that the water allocation would be transferred to or from.

106. An allocation transferred in accordance with principle 105 shall not be subsequently transferred, except if:

- a. there are no changes to the location of taking, the volume of water allocated and any conditions associated with the allocation; or
- b. the allocation is transferred back to the source or sources on the same property that allocation originally came from (pursuant to principle 105), provided that the proposed transfer complies with the relevant allocation and transfer principles in the water allocation plan for the prescribed area to which the water allocation would be transferred or from.

Zones of high intensity underground water use

107. An underground water allocation may be transferred within a *zone of high intensity underground water use*.

Rollover allocations

108. A rollover allocation may only be transferred if there is no change to the location of the point of taking.

Recharge allocations

109. A recharge allocation may be transferred only if the allocation will be taken from the same allotment, and from the same aquifer and under the same conditions from which it was taken before the transfer.

7.4. TRANSFER OF SURFACE WATER AND WATERCOURSE WATER ALLOCATIONS

The following principles apply to the transfer of water licences and water allocations to take surface water and watercourse water in the *Prescribed Area*. These principles apply in addition to the principles in Section 7.2 of this plan.

General assessment

110. Subject to principle 93, the transfer of a surface water or watercourse water allocation must be assessed against and comply with the relevant criteria for the allocation of surface water and watercourse water in Sections 6.2, 6.4 and 6.5 of this plan.

111. A surface water or watercourse water allocation (not from a *watercourse across the plains*) may only be transferred between *surface water management zones* (SWMZs) in the same catchment delineated in Figure 1.2 or within an SWMZ.

112. An allocation to take water from a watercourse across the plains may only be transferred between *watercourse water management zones* on the same watercourse or within a watercourse water management zone.

113. A surface water or watercourse water allocation must not be transferred to be taken as an underground water allocation.

114. A surface water or watercourse water allocation must not be transferred temporarily.

115. A surface water or watercourse water allocation for the purposes of stormwater management or water sensitive urban design may be transferred only if there is no increase in the volume of water allocated, and there is no change to the location of the *extraction point* and to the conditions relating to the allocation.

Stock and/or domestic purposes

116. A *stock and/or domestic allocation* may be transferred only where there is no change to the location of the extraction point.

Roof runoff allocations

117. A *roof runoff allocation* must not be transferred to be taken as an underground water allocation or a watercourse water allocation, or as a surface water allocation that is not a roof runoff allocation.

118. A roof runoff allocation may be transferred only where there is no increase in the volume of water allocated, and there is no change to the location of the *extraction point* and to the conditions relating to the allocation.

8. Permits

This section sets out the objectives and principles used to assess an application for a permit to undertake certain water affecting activities in the *Prescribed Area*.

Pursuant to section 127(3) of the *Natural Resources Management Act 2004* (NRM Act) a person can undertake the activities identified in Table 8.1 in the *Prescribed Area* only in accordance with a permit granted by the *relevant authority*.

TABLE 8.1 WATER AFFECTING ACTIVITIES

Water affecting activity	Relevant authority
Drilling, plugging, backfilling or sealing of a well	Minister
Repairing, replacing or altering the casing, lining or screen of a well	Minister
Draining or discharging water directly or indirectly into a well	Minister
The erection, construction, modification, enlargement or removal of a dam, wall or other structure that will collect or divert, or collects or diverts: - water flowing in a prescribed watercourse or - surface water flowing over land in a surface water prescribed area.	Board
Establishing or expanding a <i>commercial forest</i> ⁹	Minister

The rules in the Natural Resources Management Plan for the Adelaide and Mount Lofty Ranges Natural Resources Management region (regional NRM plan) do not apply to these activities in the *Prescribed Area*.

The regional NRM plan identifies additional water affecting activities for which a permit is required. Although those activities are not identified in this plan, a permit will still be needed to undertake any such activities in the *Prescribed Area*. The regional NRM plan sets out the matters that will be taken into account when determining whether to grant or refuse an application for a permit for those activities.

Note: words in italics (except for references to legislation) have a specific meaning for the purposes of this plan and are defined in Appendix A: Glossary. These words are italicised the first time they appear under each numbered heading. Subsequent references under that heading appear in standard font.

8.1. OBJECTIVES

The following objectives apply to all water affecting activities in the *Prescribed Area*.

- A. Protect the quantity and quality of water resources.
- B. Maintain natural hydrological systems and environmental flows.
- C. Protect watercourse, lake and floodplain geomorphology.
- D. Minimise the impact of the taking and use of water on prescribed water resources, other water users and the environment.

8.2. GENERAL PERMIT CRITERIA

The following principles apply to all water affecting activities identified in this plan in the *Prescribed Area*.

- 119. Activities should not compromise the use or quality of water resources, or the capacity for natural systems to restore or maintain water quality.
- 120. Activities should not take place where they are likely to adversely impact on the migration of biota.
- 121. Natural creek and watercourse systems should be retained.
- 122. The design, construction and management of structures and activities must not result in watercourse erosion.
- 123. Activities should be designed and located so as not to alter the geomorphology of a watercourse.
- 124. Activities should not contribute to dryland salinity or rising watertables.
- 125. Activities should not compromise the integrity of authorised scientific data collection and monitoring facilities related to the assessment and management of water resources.
- 126. Activities should not:
 - a. be located in ecologically sensitive areas;
 - b. cause or exacerbate unnatural waterlogging, or increase underground water induced salinity;
 - c. affect water-dependent ecosystems; or
 - d. impact on ecological diversity and habitats.

⁹ At the adoption date, section 127(5)(ja) of the NRM Act had not come into operation. The principles in Section 8.6 will only apply when the *Natural Resources Management (Commercial Forests) Amendment Act 2011* comes into operation.

8.3. WELL PERMITS

The following objectives and principles apply to:

- drilling, plugging, backfilling or sealing of a well; and
- repairing, replacing or altering the casing, lining or screen of a well.

For the purposes of this section, these activities are collectively referred to as '*well construction*'.

These objectives and principles apply in addition to the objectives in Section 8.1 and the principles in Section 8.2 of this plan. These objectives and principles do not apply to well construction in the McLaren Vale PWA.

Objectives

- A. Ensure that wells are drilled, plugged, backfilled or sealed in a manner that will protect the quality of underground water resources.
- B. Minimise the impact of repairing, replacing or altering the casing, lining or screens of wells on underground water resources.
- C. Protect underground water resources from pollution, deterioration and undue depletion.
- D. Ensure the integrity of *headworks* is maintained.
- E. Ensure that wells are constructed in the target aquifer system.
- F. Protect underground water-dependent ecosystems.

Principles

Well construction

127. Well construction must be in accordance with the General Specification (as may be varied or replaced from time to time) for Well Construction, Modification and Abandonment in South Australia ('*General Specification*') as provided by the *relevant authority*.

128. The equipment, materials and methods used in well construction must not adversely affect the quality of underground water.

129. The headworks of a well must be constructed so that water taken for *licensed purposes* can be metered without interference.

130. A well must access water only from the target aquifer.

131. Aquifers must be protected during well construction to prevent adverse impacts on the integrity of the aquifer.

132. Where a well passes or will pass through more than one aquifer, or into a confined aquifer, the casing must be pressure cemented in accordance with the General Specification.

Well location

New wells

133. Subject to principle 134, wells for the purpose of taking underground water must not be drilled where the *well buffer zone* around the proposed well would overlap the well buffer zone of an *operational well*.

134. Notwithstanding principle 133, the relevant authority may grant a permit to drill a well from which water will be taken only for *non-licensed purposes* if:

- a. the relevant authority is satisfied that the aquifer into which the proposed well will be drilled is not directly hydraulically connected to the aquifer that is targeted by the operational well; or
- b. the relevant authority is satisfied that:
 - i. it is not reasonably practicable to maintain the specified buffer distance at any point on the *allotment* on which the proposed well will be drilled; and
 - ii. the well buffer zones of the proposed well and the operational well overlap by no more than 10 metres.

135. Subject to principle 137, wells for the purpose of taking underground water must not be drilled where the proposed well would be within 300 metres of an operational well into which a person is authorised to drain or discharge water as part of a *managed aquifer recharge operation*.

136. For the purposes of principle 135, a person will be 'authorised to drain or discharge water as part of a managed aquifer recharge operation' if they have been granted a permit pursuant to section 135 of the NRM Act or an environmental authorisation pursuant to the *Environment Protection Act 1993*.

137. Principle 135 does not apply where:

- a. the applicant is authorised to drain or discharge water into the operational well;
- b. the proposed well is part of a managed aquifer recharge operation that includes the operational well;
- c. the aquifer into which the proposed well will be drilled is not directly hydraulically connected to the aquifer that is targeted by the operational well;
- d. the proposed well is a replacement well that complies with principles 140 and 141 (inclusive); or
- e. water from the proposed well will be taken only for *non-licensed purposes* and:
 - i. the relevant authority is satisfied that it is not reasonably practicable to maintain the specified distance at any point on the allotment on which the proposed well will be drilled; or
 - ii. the proposed well will be drilled no closer than 290 metres from the well into which a person is authorised to drain or discharge water as part of a managed aquifer recharge operation.

138. For the purposes of principles 134.a and 137.c, the applicant must provide to the relevant authority a technical report undertaken by a qualified hydrogeologist.

139. A permit to drill a well for the purpose of taking underground water must not be granted if the well buffer zone around the proposed well would overlap the *buffer zone of an underground water-dependent ecosystem*.

Replacement wells

140. Subject to principle 141, if a well ('the original well') needs to be replaced, the relevant authority may grant a permit to drill a replacement well, provided that the original well is backfilled in accordance with the General Specification and:

- a. the replacement well is located no farther than 20 metres from the original well; or
- b. if the original well is located within the well buffer zone of an *operational well* or the well buffer zone of the original well overlaps the well buffer zone of an operational well:
 - i. the replacement well is not located closer to the operational well than the original well; and
 - ii. the replacement well targets the same aquifer as the original well; or
- c. if the original well is located within the buffer zone of an underground water-dependent ecosystem or the well buffer zone of the original well overlaps the buffer zone of an underground water-dependent ecosystem:
 - i. the replacement well is not located closer to a drainage path, watercourse, watercourse underlain by a Permian Sand aquifer, wetland in fractured rock systems or wetland underlain by a Permian Sand aquifer, than the original well; and
 - ii. the replacement well targets water from the same aquifer as the original well.

141. Principle 140 does not apply to a well from which water would be taken only for non-licensed purposes if:

- a. the relevant authority is satisfied that it is not reasonably practicable to maintain the specified buffer distance at any point on the allotment on which the proposed well would be drilled; and
- b. the well buffer zone of the proposed well and the operational well overlap by no more than 10 metres.

Wells for draining and discharging water

142. The headworks of a well into which water will be drained or discharged must be constructed so that draining or discharging operations, and the taking of water from the well, can be metered without interference.

143. The headworks of a well into which water will be drained or discharged must be constructed so that water cannot leak if the well becomes clogged.

144. Wells constructed for the draining or discharge of water at pressures greater than gravity must be pressure cemented along the full length of the casing.

8.4. DRAINING AND DISCHARGING WATER INTO A WELL

The following objectives and principles apply to the draining and discharging of water into a well in the *Prescribed Area*. These objectives and principles apply in addition to the objectives in Section 8.1 and the principles in Section 8.2 of this plan. These objectives and principles do not apply to the draining and discharging of water into wells in the McLaren Vale PWA.

Objectives

- A. Ensure that *managed aquifer recharge operations* are operated and managed sustainably.
- B. Ensure that reasonable and practicable measures are taken to avoid contaminating underground water.
- C. Prevent environmental harm from the draining and discharging of water into a well.
- D. Ensure that draining and discharging water directly or indirectly into a well does not have the potential to adversely affect:
 - a. the quality of underground water;
 - b. the integrity of the aquifer, including (but not limited to) the confining layer of the aquifer and the ability of the aquifer to transmit water;
 - c. watertables, including (but not limited to) waterlogging, land salinisation and damage to infrastructure (e.g. roads, buildings and foundations);
 - d. underground water-dependent ecosystems;
 - e. the ability of other underground water users to lawfully take underground water; or
 - f. the longevity of operations.

Principles

145. Water may be drained or discharged into a well for the purpose of a managed aquifer recharge operation where the hydrogeological risk assessment undertaken by the applicant in accordance with principles 146 to 152 (inclusive) shows that:

- a. the source water:
 - i. will not contravene the water quality criteria in Schedule 2 of the Environment Protection (Water Quality) Policy 2003 or any subsequent or related policy; or
 - ii. is of equal or better quality than the *ambient underground water*; and
- b. a lowering of salinity levels in the ambient underground water will not have the potential to adversely impact on *water-dependent ecosystems*.

Assessment of proposed drainage and discharge operation

146. A permit to drain and discharge water into a well must not be granted unless a hydrogeological risk assessment is undertaken to the satisfaction of the *relevant authority* by a qualified hydrogeologist with experience in managed aquifer recharge operations.

147. For the purposes of principle 146, and subject to principle 148, a hydrogeological risk assessment must be consistent with the National Water Quality Management Strategy Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) and other related documents current at the time, and include:

- a. an investigation into the suitability of the draining or discharging site, including (but not limited to) tests for transmissivity and storage coefficient, method of injection and maximum injection pressures, calculated likely impacts on the integrity of the well and confining layers, and impacts of potentiometric head changes to other underground water users;
- b. the infrastructure locations, pump levels, standing water levels and depths of all wells located within 1 kilometre of the well into which it is proposed to drain or discharge water;
- c. the thickness of the aquifer and its capacity to accept further water;
- d. the local underground water gradients within 1 kilometre of the well into which it is proposed to drain or discharge water;
- e. the location of water-dependent ecosystems within 1 kilometre of the well into which it is proposed to drain or discharge water;
- f. the potential impacts and consequences of injection on:
 - i. the water quality characteristics of the ambient underground water;
 - ii. the land, including waterlogging or salinisation of soils, and infrastructure;
 - iii. underground water-dependent ecosystems;
 - iv. permanent pools in watercourses;
- g. an appropriate operation or management plan demonstrating that operational procedures are in place to protect the integrity of the aquifer on an ongoing basis; and
- h. a water quality assessment that identifies hazards in the *source water*.

148. Principles 147.a, 147.f.i. and 147.h do not apply to *roof runoff* that is drained or discharged into a well through a closed system of capture and transport, provided that the system is equipped with a mechanism to divert first flush water.

149. For the purposes of principle 147, the relevant water quality characteristics shall be measured using sufficient representative samples of:

- a. the source water; and
- b. ambient underground water collected from the proposed point of injection or as near as possible to the proposed point of injection and from the same aquifer into which it is proposed to drain or discharge water.

150. For the purposes of principle 149, 'sufficient representative samples' means suitable samples, collected with equipment appropriate for the substance, material or characteristic to be measured and taken at suitable locations and times to accurately represent the quality of the relevant water.

151. A permit to drain or discharge water into a well must not be granted if the draining or discharging of water would have the potential to degrade underground water-dependent ecosystems or to reduce the suitability of the underground water for other purposes for which it might reasonably be used.

152. If the source water is the ambient underground water, and the infrastructure used to both take and drain and discharge that water into a well is closed to any substance, material or characteristics that may alter the water before or during the draining and discharging of that water into a well, the hydrogeological risk assessment required under principle 147 may be modified with the agreement of the relevant authority.

Drainage and discharge operations

153. Draining and discharging water directly or indirectly into a well must be carried out in a manner that does not adversely affect the aquifer or the ability of other underground water users to lawfully take underground water.

154. Draining and discharging water directly or indirectly into a well must:

- a. be undertaken by gravity drainage only, unless the relevant authority is satisfied that the hydrogeological risk assessment conducted in accordance with principles 146 to 152 (inclusive) demonstrates that there is no potential for an adverse impact on underground water users if some other method of draining and discharging water is used; and
- b. not have the potential to cause *artesian conditions* in the aquifer.

155. Where water is to be drained or discharged under pressure, the operational pressures must not have the potential to cause the overlying confining beds to hydraulically fail.

8.5. WATER STORAGES AND DIVERSIONS

The following objectives and principles apply to the erection, construction, modification, enlargement or removal of a dam, wall or other structure that will collect or divert, or collects or diverts:

- water flowing in a *prescribed watercourse*; or
- surface water flowing over land in a *surface water prescribed area*.

These objectives and principles apply in addition to the objectives in Section 8.1 and the principles in Section 8.2 of this plan. These objectives and principles do not apply to *turkey nest dams*.

Except for principles 164 and 191, a reference to ‘constructed’ in this section means ‘erected, constructed, modified or enlarged’.

Objectives

- A. Maintain and improve the quantity and quality of surface water and watercourse water in the *Prescribed Area*.
- B. Ensure that new dams, walls or other structures are constructed and managed in a manner that:
 - a. protects the needs of downstream users;
 - b. protects *water-dependent ecosystems*; and
 - c. protects water quantity and quality.

Principles

Reservation of excess water

156. A dam should not be constructed if the Minister has, pursuant to section 166 of the NRM Act, reserved from allocation excess water that is available for allocation from surface water and/or watercourses:

- a. in the surface water management zone in which the dam would be constructed; or
- b. if the SWMZ in which the dam would be constructed contributes to the flow of water in any downstream SWMZ – in any of those downstream SWMZs.

Location

157. Dams, walls or other structures must not be constructed within a *Fleurieu wetland* or a *Central Hills wetland*.

158. The locations of Fleurieu wetlands and Central Hills wetlands identified in Figures 2.3 and 2.4 are indicative only. An on-site assessment undertaken by the *relevant authority* will confirm the exact location and extent of a wetland.

159. Dams, walls or other structures may be constructed only if an assessment is undertaken by suitably qualified expert or experts in one or more of the following: hydrology, hydrogeology, wetland ecology, geomorphology, land management and/or environmental engineering, and the Relevant Authority is satisfied that the location of the proposed dam, wall or other structure will not cause a significant impact on a Fleurieu wetland, or Central Hills wetland.

160. For the purpose of principle 159 the assessment may consider factors including, but not limited to, the location and extent of wetland, the type and significance of wetland, sources of water to the wetland, water regime, land use, land management and existing extractions, and low flows required by the wetland.

161. Dams must not be constructed on a *third order (and above) watercourse* or a *watercourse across the plains*.

Dams for licensed purposes

162. Dams, walls or other structures that collect or divert water for *licensed purposes* must not be constructed unless the applicant is authorised by a water allocation to take water for those purposes.

163. A dam with a capacity of 5 ML or more must not be constructed if the capacity of the dam will exceed two times the water allocation to be taken from the dam at the date of assessment.

Dams for non-licensed purposes

164. Dams, walls or other structures that collect or divert a volume of water of less than 5 ML and are used only for *non-licensed purposes* may only be erected or constructed if the relevant authority is satisfied that:

- a. there is no capacity to connect to SA Water supply and the flow rate of water that could be taken from a well on the *allotment* on which the proposed dam would be constructed is less than 0.1 L/s; or
- b. the salinity of the water that could be taken from a well on the allotment on which the proposed dam would be constructed is greater than:
 - i. 1500 mg/L for general domestic purposes;
 - ii. 1000 mg/L if the water is used for drinking purposes; or
 - iii. 3000 mg/L for watering stock (other than stock subject to intensive farming); or
- c. the applicant is unable to take underground water for any other reason.

165. Principle 164 does not apply to the construction of dams that collect or divert water for non-licensed purposes in the Willunga Basin catchment (as delineated in Figure 1.2).

Diversion limit

166. For the purposes of this plan, ‘*diversion limit*’ means the total allowable:

- a. capacity of dams; and
- b. volume of surface water that can be taken by *commercial forests* (as determined in accordance with principle 201)

in a *surface water management zone* (SWMZ).

167. A dam must not be *constructed* if the capacity of the dam would cause the diversion limit for the SWMZ in which the dam would be constructed to be exceeded (or further exceeded).

Surface water extraction limit

168. A dam must not be constructed if *dam use* from the proposed dam and *water extractions* (not including water extractions from a *main watercourse*) in the *SWMZ* in which the dam would be constructed would exceed (or further exceed) the *surface water extraction limit* for that *SWMZ*.

Main watercourse extraction limit

169. A dam must not be constructed if dam use from the proposed dam and *water extractions* in:

- a. the *SWMZ* in which the dam would be constructed ('the relevant *SWMZ*'); and
- b. any *SWMZs* that contribute to the flow of water in any part of a main watercourse,

would exceed (or further exceed) the *main watercourse extraction limit* for any of those *SWMZs*.

Dams in areas upstream of reservoirs

170. Subject to principle 172, dams must not be constructed in the *catchment* of a *reservoir*, or in the *catchment* of a weir in the *Prescribed Area* that diverts water to the Happy Valley or Hope Valley reservoirs, unless the relevant authority is satisfied:

- a. there has been a prior reduction in the total volume of water extractions and *deemed dam losses* in the *catchment* of the reservoir or weir in which the dam would be constructed that is equal to, or greater than, dam use and deemed dam losses from the proposed dam; and
- b. that dam use and deemed dam losses from the proposed dam would not cause a net increase in the total volume of surface water and watercourse water use (as at the *adoption date*) in the *catchment* of the reservoir or weir in which the dam would be constructed.

171. For the purposes of principle 170.b, 'the total volume of surface water and watercourse water use (as at the adoption date)' is the aggregate of:

- a. subject to any reduction pursuant to section 164N(3) of the NRM Act, the quantity of water to which existing users are entitled at the adoption date;
- b. stock and/or domestic use from each dam, which is deemed to be:
 - i. if the entitlement referred to in principle 171a was taken from a dam and the entitlement is less than 70% of the capacity of the dam – the difference between the entitlement and 70% of the capacity of the dam (which must not exceed 30% of the capacity of the dam);
 - ii. where a water allocation is not required to take water from a dam – 30% of the capacity of the dam;
 - iii. in any other case – zero; and
- c. surface water that is deemed to be taken by *commercial forests* (as determined in accordance with principle 201) at the adoption date.

172. Principle 170 does not apply to the construction of detention basins for water quality remediation in accordance with principle 67.b.ii.

Dams in areas upstream of Fleurieu wetlands

173. A dam must not be *constructed* in the *catchment* of a Fleurieu wetland if dam use from the proposed dam and *water extractions* in the *catchment* of the wetland would exceed (or further exceed) 25% of the *local adjusted runoff* (in ML) to the wetland.

174. For the purposes of principle 173, the total allowable dam use from a dam is calculated as:

$\text{catchment of the Fleurieu wetland (km}^2\text{)} \times \text{annual adjusted runoff (mm)} \times 0.25$	-	$\text{water extractions in the catchment of the Fleurieu wetland (not including dam use from the proposed new dam or the existing dam that is proposed to be enlarged) (in ML)}$
--	---	---

175. For the purposes of principles 173 and 174:

- a. 'catchment of the Fleurieu wetland' includes:
 - i. the area of land in the *SWMZ* in which the dam would be constructed within which rainfall contributes to runoff to the wetland; and
 - ii. in relation to a main watercourse, the combined area of land in any *upstream SWMZs*; and
- b. 'annual adjusted runoff' includes:
 - i. the annual adjusted runoff (in mm) in the *SWMZ* in which the dam would be constructed; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any *upstream SWMZs*.

Local runoff limit

176. A dam must not be constructed if dam use and deemed dam losses from the proposed dam, and *water extractions* and deemed dam losses in the *catchment* of the proposed dam, would exceed (or further exceed) the *local adjusted runoff* (in ML) to the dam.

177. For the purposes of principle 176, the total allowable dam use and deemed dam losses from a dam is calculated as:

$\text{catchment of the dam (km}^2\text{)} \times \text{annual adjusted runoff (mm)}$	-	$\text{water extractions and deemed dam losses in the catchment of the dam (not including dam use and deemed dam losses from the proposed new dam or the existing dam that is proposed to be enlarged) (in ML)}$
---	---	--

178. For the purposes of principles 176 and 177:

- a. 'catchment of the dam' includes the area of land in the SWMZ in which the dam would be constructed within which rainfall contributes to runoff in the dam; and
- b. 'annual adjusted runoff' includes the annual adjusted runoff (in mm) in the SWMZ in which the dam would be constructed.

Impacts on downstream users

179. A dam must not be constructed if dam use and deemed dam losses from the proposed dam, and water extractions and deemed dam losses in the catchment of a *downstream extraction point*, would exceed (or further exceed) the local adjusted runoff (in ML) to the downstream extraction point.

180. For the purposes of principle 179, the total dam use and deemed dam losses from a dam must not exceed the lesser of the following calculations for each downstream extraction point:

$\text{catchment of the downstream extraction point (km}^2\text{) X annual adjusted runoff (mm)}$	-	$\text{water extractions and deemed dam losses in the catchment of the downstream extraction point (including existing dam use and deemed dam losses from the downstream extraction point, but not including dam use and deemed dam losses from the proposed new dam or the existing dam that is proposed to be enlarged) (in ML)}$
---	---	---

181. For the purposes of principles 179 and 180:

- a. 'catchment of the downstream extraction point' includes:
 - i. the area of land in the SWMZ in which the downstream extraction point is located within which rainfall contributes to runoff to the downstream extraction point; and
 - ii. in relation to a main watercourse, the combined area of land in any upstream SWMZs;
- b. 'annual adjusted runoff' includes:
 - i. the annual adjusted runoff (in mm) in the SWMZ in which the downstream extraction point is located; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any upstream SWMZs.

Threshold flow rate

182. Subject to principle 184, water flowing at or below the threshold flow rate must:

- a. remain in the watercourse or *drainage path*; or
- b. re-enter the original watercourse or drainage path as soon as it is reasonably practicable to do so and not be of a poorer quality than the water that was diverted.

183. Subject to principle 184, a new dam, wall or other structure must be fitted with a device that prevents the dam, wall or other structure from collecting or diverting water flowing at or below the threshold flow rate.

184. Principles 182 and 183 do not apply:

- a. to a dam that has a capacity of no more than 2 ML and that collects or diverts water only for non-licensed purposes; or
- b. if the relevant authority is satisfied that:
 - i. the construction, installation or use of a device referred to in principle 183 is not reasonably practicable in the circumstances; and
 - ii. the water flowing at or below the threshold flow rate that will be collected or diverted by the dam, wall or other structure will be returned to the same watercourse or drainage path immediately downstream of that dam, wall or other structure as soon as it is reasonably practicable to do so after the water has been collected or diverted; and
 - iii. the water flowing at or below the threshold flow rate that will be returned in accordance with principle 180.b.ii will not be of a poorer quality than the quality of the water that was collected or diverted.

185. A dam, wall or other structure must not be constructed unless the applicant can demonstrate to the satisfaction of the Minister how compliance with principles 182 to 184 will be achieved.

186. For the purposes of this plan, '*threshold flow rate*' means the rate of flow determined in accordance with principles 48,49 or 81.

Maximum diversion rate

187. A wall or other structure that collects or diverts water flowing in a third order (and above) watercourse must not collect or divert water at a rate that exceeds the *maximum diversion rate* determined in accordance with principles 55 and 56.

Construction, modification and enlargement

188. Dams, walls and other structures must be designed and constructed in accordance with best practice standards.

189. Dams, walls and other structures must be constructed in such a way that they minimise:

- a. seepage, evaporation, loss of soil through erosion and the accumulation of silts behind the dam, wall or other structure; and
- b. the removal or destruction of native, in-stream or riparian vegetation.

190. Dams, walls and other structures that collect or divert water should not:

- a. adversely affect the migration of aquatic biota in a watercourse;
- b. alter the hydrology of a watercourse in such a way as to adversely impact on the ecology;
- c. result in flooding, either upstream or downstream of the dam; or
- d. result in any of the following:
 - i. increased erosion;
 - ii. bed and bank instability;
 - iii. downstream sedimentation; or
 - iv. decline in water quality.

191. A device referred to in principles 51, 83, 89 and 183 that prevents the collection or diversion of water flowing at or below the threshold flow rate must:

- a. if, in the opinion of the relevant authority, it is appropriate in the circumstances – be designed and constructed to ensure operation is automated and cannot be manually overridden;
- b. be maintained to prevent erosion of the bed or banks of the watercourse downstream of the dam, wall or other structure;
- c. where practicable, allow the passage of native fish and other aquatic fauna along the watercourse both upstream and downstream of the dam, wall or other structure;
- d. be maintained in such a condition that the device continues to be effective in complying with principles 51, 83, 89 or 183; and
- e. not be obstructed or tampered with in any way.

Removal of a dam, wall or other structure

192. The removal of a dam, wall or other structure must not result in:

- a. increased erosion;
- b. increased flooding that is likely to adversely impact infrastructure;

- c. bed and bank instability;
- d. downstream sedimentation;
- e. loss of riparian vegetation; or
- f. decline in water quality.

193. The site of the removed dam, wall or other structure should be remediated and revegetated so that there are no ongoing impacts on the downstream environment.

8.6. COMMERCIAL FORESTRY

A permit is required to establish a new *commercial forest* or to expand an existing commercial forest, pursuant to section 127(5)(ja) of the NRM Act¹⁰.

The following objectives and principles apply in addition to the objectives in Section 8.1 and the principles in Section 8.2 of this plan.

Note: If commercial land use approval is required for a proposal to establish or expand a commercial forest, under the Development Act, the development approval process will involve referral of the development application for assessment against the principles for managing the impacts of commercial forestry in this plan. That is, a separate NRM permit application under the NRM Act will not be required.

Objectives

- A. Allow for the expansion of *commercial forests* within sustainable limits.
- B. Minimise the adverse impacts of the water use of commercial forests on other water users and *water-dependent ecosystems*.

Principles

Felling and replanting

194. For the purposes of this plan, the principles in this section do not apply to commercial forests where the initial and any subsequent, planting densities are less than 250 trees per hectare.

195. For the purposes of this plan, a permit is not required to either fell or replant a *commercial forest*, provided there is no increase in the area, or a change in the location of the commercial forest.

Reservation of excess water

196. A commercial forest should not be planted in the Minister has, pursuant to section 166 of the NRM Act, reserved from allocation excess water that is available for allocation from underground water in the underground water management zone in which the commercial forest would be planted.

¹⁰At the adoption date, section 127(5)(ja) of the NRM Act had not come into operation. The principles in Section 8.6 will only apply when section 10 of the *Natural Resources Management (Commercial Forests) Amendment Act 2011* comes into operation.

197. A commercial forest should not be planted if the Minister has, pursuant to section 166 of the NRM Act, reserved from allocation excess water that is available for allocation from surface water and/or watercourses:

- a. in the surface water management zone in which the commercial forest would be planted; or
- b. if the SWMZ in which the commercial forest would be planted contributes to the flow of water in any downstream SWMZ – in any of those downstream SWMZs

Location

198. A commercial forest must not be planted within:

- a. 5 metres of the edge of a drainage path;
- b. 10 metres of each side of the centre line of a watercourse;
- c. 200 metres of each side of the centre line of a watercourse underlain by a Permian Sand aquifer;
- d. 50 metres of the edge of a wetland in fractured rock systems; or
- e. 200 metres of the edge of a wetland underlain by a Permian Sand aquifer.

Underground water

Underground water extraction limit

199. A commercial forest must not be planted if it would cause underground water extractions in the underground water management zone (UWMZ) in which the commercial forest would be planted to exceed (or further exceed) the underground water extraction limit for that UWMZ.

200. For the purposes of this plan, the volume (in ML) of underground water taken by a commercial forest is the sum of:

- a. the recharge impacts of a commercial forest that was planted after the adoption date, calculated as:

$$\left[\text{new commercial forest area (km}^2\text{)} \times \text{UWMZ area/recharge rate (mm)} \times 0.85 \right] - \left[\text{new commercial forest area (km}^2\text{)} \times \text{annual adjusted runoff (mm)} \times 0.85 \times \text{baseflow coefficient} \right]$$

- b. where the watertable is no more than 6 metres below ground level, or the relevant authority is satisfied that the commercial forest would extract underground water:
 - i. 1.82 ML/ha/year for a hardwood commercial plantation forest; and
 - ii. 1.66 ML/ha/year for a softwood commercial plantation forest.

Surface water and watercourse water

201. For the purposes of this plan, the volume (in ML) of surface water deemed to be taken by a commercial forest is calculated as:

$$\left[\text{area of commercial forest (km}^2\text{)} \times \text{annual adjusted runoff (mm)} \right] \times 0.85$$

Diversion limit

202. A commercial forest must not be planted if the volume of surface water deemed to be taken by the forest (as determined in accordance with principle 201) would cause the diversion limit for the surface water management zone (SWMZ) in which the commercial forest would be planted to be exceeded (or further exceeded).

Surface water extraction limit

203. A commercial forest must not be planted if it would cause water extractions (not including water extractions from a main watercourse) in the SWMZ in which it would be planted to exceed (or further exceed) the surface water extraction limit for that SWMZ.

Main watercourse extraction limit

204. A commercial forest must not be planted if it would cause water extractions in:

- a. the SWMZ in which the commercial forest would be planted ('the relevant SWMZ'); and
- b. any SWMZs that contribute to the flow of water in any part of a main watercourse,

to exceed (or further exceed) the main watercourse extraction limit for any of those SWMZs.

Water extractions in areas upstream of reservoirs

205. A commercial forest must not be planted in the catchment of a reservoir, or in the catchment of a weir in the Prescribed Area that diverts water to the Happy Valley or Hope Valley reservoirs, unless:

- a. the relevant authority is satisfied there has been a prior reduction in the total volume of water extractions in the catchment of the reservoir or weir in which the commercial forest would be planted that is equal to, or greater than, the volume of surface water deemed to be taken by the proposed commercial forest; and
- b. the volume of water deemed to be taken by the commercial forest would not cause a net increase in the total volume of surface water and watercourse water use (as at the adoption date) in the catchment of the reservoir or weir in which the commercial forest would be planted.

206. For the purposes of principle 205.b, ‘the total volume of surface water and watercourse water use (as at the adoption date)’ is the aggregate of:

- a. subject to any reduction pursuant to section 164(N) of the NRM Act, the quantity of water to which existing users are entitled at the adoption date;
- b. stock and/or domestic use from each dam, which is deemed to be:
 - i. if the entitlement referred to in principle 37.a above was taken from a dam and the entitlement is less than 70% of the capacity of the dam – the difference between the entitlement and 70% of the capacity of the dam (which must not exceed 30% of the capacity of the dam);
 - ii. where a water allocation is not required to take water from a dam – 30% of the capacity of the dam;
 - iii. in any other case – zero; and
- c. surface water that is deemed to be taken by commercial forests (as determined in accordance with principle 201) at the adoption date.

Water extractions in areas upstream of Fleurieu wetlands

207. A commercial forest must not be planted if it would cause water extractions in the catchment of a *Fleurieu wetland* to exceed (or further exceed) 25% of the *local adjusted runoff* to that wetland.

208. The total volume of surface water that may be taken by a commercial forest is calculated as:

$$\text{catchment of the Fleurieu wetland (km}^2\text{) X annual adjusted runoff (mm) X 0.25} - \text{water extractions in the catchment of the Fleurieu wetland (in ML)}$$

209. For the purposes of principles 207 and 208:

- a. ‘catchment of the Fleurieu wetland’ includes:
 - i. the area of land in the SWMZ in which the commercial forest would be planted within which rainfall contributes to runoff to the wetland; and
 - ii. in relation to a main watercourse, the combined area of land in any *upstream SWMZ*; and
- b. ‘annual adjusted runoff’ includes:
 - i. the annual adjusted runoff (in mm) in the SWMZ in which the commercial forest would be planted; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any upstream SWMZ.

Impacts on downstream users

210. A commercial forest must not be planted if it would cause water extractions and *deemed dam losses* in the *catchment of a downstream extraction point* to exceed (or further exceed) the local adjusted runoff (in ML) to that point.

211. The total volume of water that may be taken by a commercial forest must not exceed, after making the following calculation for each downstream extraction point, the lesser of those calculations:

$$\text{catchment of the downstream extraction point (km}^2\text{) X annual adjusted runoff (mm)} - \text{water extractions and deemed dam losses in the catchment of the downstream extraction point (including water extractions and deemed dam losses from the downstream extraction point, but not including water extractions from the proposed new commercial forest or the existing commercial forest that is proposed to be expanded) (in ML)}$$

212. For the purposes of principles 210 and 211:

- a. ‘catchment of the downstream extraction point’ includes:
 - i. the area of land in the SWMZ in which the downstream extraction point is located within which rainfall contributes to runoff to the downstream extraction point; and
 - ii. in relation to a main watercourse, the combined area of land in any upstream SWMZ; and
- b. ‘annual adjusted runoff’ includes:
 - i. the annual adjusted runoff (in mm) in the SWMZ in which the downstream extraction point is located; and
 - ii. in relation to a main watercourse, the combined annual adjusted runoff (in mm) in any upstream SWMZ.

9. Monitoring and evaluation

Section 76(4)(d) of the *Natural Resources Management Act 2004* (NRM Act) provides that a water allocation plan must provide for regular monitoring of the capacity of the resource to meet the demands for water. Section 81(4) requires that a water allocation plan must be reviewed at least once in every 10 years after adoption.

This section provides for both these statutory requirements by outlining:

- provisions for monitoring the capacity and condition of the resource in order to sustain both the environment and the demands for water, and
- monitoring and evaluation provisions for the statutory review of the plan.

With respect to resource capacity monitoring, this section provides guidance on what, when and how to monitor the resource to obtain the best available information for making informed and up-to-date decisions on the management of the resource.

With respect to the statutory review, this section outlines:

- five-year management and resource condition outcomes anticipated from adoption of the plan
- provisions for monitoring and evaluating achievement of these outcomes including assessment of the validity of any underpinning assumptions
- description of how the outcomes of the plan could contribute to achieving the Adelaide and Mount Lofty Ranges Regional NRM Plan 20-year targets (Table 9.1)
- a set of key evaluation questions on the plan's effectiveness, impact and appropriateness to drive the review process and highlight any areas of improvement in the next iteration of the plan (Table 9.2).

This section provides a schedule for monitoring and reporting and who will take the lead on each, providing transparency and accountability to the process, and has been structured to be consistent with existing state and national NRM monitoring and evaluation frameworks and guidelines.

OBJECTIVES

- A. Monitor, evaluate and report on the state of the water resources.
- B. Ensure there is sufficient data available to:
 - i. assess the capacity and condition of the water resources;
 - ii. identify the causes of changes in quality and quantity of available water;
 - iii. assess the extent to which environmental water provisions are being met, and using the Verification of Water Allocation Science Program (VWASP) determine if the environmental water provisions meet the intended objectives;
 - iv. assess the sustainable limits of the resource and whether water use is within sustainable extraction limits; and
 - v. undertake a water resource risk assessment for the Prescribed Area.
- C. Assess the effectiveness of the plan's implementation.
- D. Evaluate the extent to which the plan contributes to the regional NRM plan 20-year targets.
- E. Assess the impacts of the plan.

TABLE 9.1 REGIONAL NRM PLAN 20-YEAR TARGETS		
Relevant regional NRM plan targets	Plan outcome	Timeframe
Water resources management within sustainable limits (T3)	Water resource is being used sustainably	5 years
	Groundwater quantity and quality are stabilised	5 years
	Environmental water provisions are being delivered	
	Water is taken and used in accordance with the conditions set out in the plan	
Maintain productive capacity of agriculture at current levels (T5)	Economic benefits of water use are maximised	5 years
	Existing users are protected from the potential impacts of new users	5 years
	Barriers to water trade and changing crop type reduced	
	Water entitlement becomes a tradeable asset	
Condition and function of ecosystems recover from current levels (T7)	Water-dependent ecosystem condition is stable or improving	20 years
	Environmental water provisions are being delivered	5 years
	Water is taken and used in accordance with the conditions set out in the plan	
Improve the capacity of people in the community, institutions and regional organisations to sustainably manage our natural resources (T13)	Barriers to water trades and changing crop type are reduced	5 years

TABLE 9.2 MONITORING, EVALUATION AND REVIEW FRAMEWORK¹¹

Evaluation purpose	Evaluation questions	Evaluation methods	What will be measured/tested and when
<p>1. Assess the capacity and condition of the resource</p>	<p>Did water quality and quantity change dramatically over time and why? Were these changes due to circumstances inside or outside of the plan?</p> <p>Are the environmental water provisions sufficient to manage the water-dependent ecosystems at an acceptable level of risk?</p> <p>What is the current and future demand for water?</p>	<p>Annual report card (the board)</p> <p>Plan review (the board)</p> <p>Analysis of water allocation and use data</p>	<p>Underground water (see Section 9.1)</p> <p>Underground water levels in the fractured rock aquifer (at least 6 monthly)</p> <p>Underground water salinity in the fractured rock aquifer (at least annually)</p> <p>Underground water levels in the sedimentary aquifers (at least 6 monthly)</p> <p>Underground water salinity in the sedimentary aquifers (at least annually).</p> <p>Data collected from the existing resource monitoring network</p> <p>Surface water (see Section 9.2)</p> <p>Surface water flow monitoring (continuous)</p> <p>Surface water quality monitoring (continuous)</p> <p>Surface water level monitoring (continuous)</p> <p>Data collected from the existing resource monitoring network</p> <p>Water use</p> <p>The volume of water taken for licensed purposes will be monitored by DEWNR on an annual basis through meter reading and other means</p> <p>Water-dependent ecosystems</p> <p>Monitoring through VVWASP (see Section 9.3)</p>
<p>2. Assess water resource risks for the Prescribed Area</p>	<p>What are the key water resource risks for the Prescribed Area?</p> <p>Over what timeframes are these risks relevant?</p> <p>What is the likelihood and consequence of environmental, social and economic consequences of water resource risks?</p> <p>To what extent are effective controls in place to mitigate water resource risks?</p> <p>What level of confidence is supported by data underpinning assessments of water resource risks?</p>	<p>Risk assessment as per Water Planning and Management Risk Assessment Framework (DEWNR)</p> <p>Plan review (the board)</p>	<p>The risk assessment will be based on multiple lines of evidence including the existing resource monitoring network</p>

¹¹To the best of the board’s and DEWNR’s endeavour

TABLE 9.2 MONITORING, EVALUATION AND REVIEW FRAMEWORK CONTINUED

Evaluation purpose	Evaluation questions	Evaluation methods	What will be measured/tested and when
<p>3. Evaluation of plan effectiveness</p>	<p>To what extent has the plan and issuing of licences been implemented?</p> <p>Was water use within the sustainable extraction limits set?</p> <p>To what extent has the plan contributed to intermediate and long term regional NRM plan outcomes and goals?</p>	<p>Plan review (the board)</p>	<p>Number of licences issued and conditions that have been implemented (i.e. meters, low flows)</p> <p>Water use through reading of meters and other means</p> <p>State and condition of water resources</p> <p>Delivery of environmental water provisions</p> <p>State and condition of water dependent ecosystems</p> <p>Installation of low flow bypasses</p> <p>Delivery of low flows</p> <p>Other indicators as required to test assumptions</p>
<p>4. Evaluation of plan impact</p>	<p>What were the unintended and intended positive/negative outcomes from the plan?</p>	<p>Plan review (the board)</p> <p>An independent assessment will be used to inform the plan review</p>	<p>Feedback from the community and Water Allocation Plan Advisory Committees (WAPACs)</p>
<p>5. Evaluation of plan appropriateness</p>	<p>To what extent is the plan consistent with current policy frameworks and guidelines for water planning and NRM?</p>	<p>Plan review (the board)</p> <p>State of the region report (the board)</p> <p>An independent assessment will be used to inform the plan review</p>	<p>Assessments of environmental water requirements</p> <p>Assessments of impact of plan provisions on community</p> <p>Assessment of resource condition</p> <p>VWASP (see Section 9.3)</p> <p>Feedback from WAPACs</p>

9.1. REGIONAL UNDERGROUND WATER MONITORING

- Underground water monitoring will be undertaken to assess the capacity of the resource to meet the demands for water on a continuing basis.
- The responsibility for existing regional underground water monitoring currently lies with DEWNR.
- Data from the full underground water monitoring network will be hosted by DEWNR in the State groundwater data repository (SA Geodata), and accessible online via the Obswell application

(<https://obswell.pir.sa.gov.au/new/obsWell/MainMenu/menu>). The board will also host data from all of the telemetered groundwater monitoring sites on its website.

- Monitoring is to be undertaken in a manner consistent with best practice and with sufficient documentation to demonstrate representative samples are collected, and sufficient quality assurance is achieved.
- The board and DEWNR will, to the best of their endeavours, undertake underground water monitoring as set out in Table 9.3.

TABLE 9.3 UNDERGROUND WATER MONITORING

What	Where	When
Underground water levels in the fractured rock aquifer	Fractured rock aquifer water level monitoring network locations in the PWRA	At least 6 monthly
Underground water salinity in the fractured rock aquifer	Fractured rock aquifer salinity level monitoring network in the PWRA	At least annually
Underground water levels in the sedimentary aquifers	Sedimentary aquifer water level monitoring network locations in the PWRA	At least 6 monthly
Underground water salinity in the sedimentary aquifers	Sedimentary aquifer water level monitoring network locations in the PWRA	At least annually

9.2. REGIONAL SURFACE WATER AND WATERCOURSE MONITORING

- Regional monitoring of the surface water and watercourse water resources will be undertaken to assess the capacity of the resource to meet the demands for water on a continuing basis.
- The responsibility for regional ongoing surface water and watercourse monitoring will be shared by the board and DEWNR.

- Monitoring is to be undertaken in a manner that is consistent with best practice and with sufficient documentation to demonstrate representative samples are collected, and sufficient quality assurance is achieved.
- The board and DEWNR will, to the best of their endeavours, undertake regional monitoring of the surface water and watercourse water resources as set out in Table 9.4.

TABLE 9.4 SURFACE WATER AND WATERCOURSE MONITORING

What	Where	When
Surface water flow monitoring	Surface water flow monitoring network in the PWRA	Continuous
Surface water quality monitoring	Surface water quality monitoring network in the PWRA	Continuous
Surface water level monitoring	Surface water level monitoring network in the PWRA	Continuous

9.3. REGIONAL ENVIRONMENTAL MONITORING

The board (in collaboration with DEWNR) will undertake a monitoring program (VWASP) which aims to collect comprehensive data at a number of sites and provide a basis for the validation of the ecological and hydrological hypothesis and assumptions used to determine the sustainable diversion limits and environmental water requirements.

The specific objectives of the VWASP are to:

- I. ensure that stated environmental outcomes are linked to quantitative predictions of ecological and resource condition
- II. test if the hypothesised environmental outcomes of providing the recommended environmental water provisions of the plan are being achieved
- III. test the hydro-ecological relationships used to inform allocation policies
- IV. test the accuracy of modelled hydrological conditions predicted to occur as a result of the implementation of the plan
- V. test if groundwater allocation policies for protecting groundwater contributions to the environment are appropriate.

A number of sites representative of the prescribed area will be chosen to monitor as part of the VWASP. The parameters to be measured are (but not limited to):

- flow
- volume
- macroinvertebrates
- water quality
- fish.

The board will continue long-term monitoring of native fish in the region, to the best of their endeavour.

Monitoring is to be undertaken in a manner that is consistent with best practice and with sufficient documentation to demonstrate representative samples are collected, chain of custody maintained and sufficient quality assurance is achieved.

9.4. SCHEDULE OF REPORTING

Table 9.5 outlines the timeframe, scale and responsibility of the reporting (see Table 9.2), which will be undertaken to the best of the board’s endeavour.

Report	Scale	Responsibility	Timeline
Annual report card	AMLRNRM region	The board	Every year (based on calendar year, delivered before June 30 the following year)
State of the region report	AMLRNRM region	The board	Every 5 years
Plan review	Prescribed Area	The board	Every 10 years

9.5. REVIEW

The plan will be reviewed when there is evidence from the monitoring program, or from other investigations, that:

- there is new knowledge and/or understanding of the water resources or the water-dependent ecosystems
- there are significant changes in water availability (which may be due to climate change, water use, seasonal variability or other unknown reasons)

- the implementation of low flow mechanisms has not begun within five years of the adoption of the plan
- low flows are not adequately provided once mechanisms to provide for low flows have been implemented.

Notwithstanding the above criteria, the plan will be reviewed within ten years of adoption in accordance with the requirements of the NRM Act.

10. Recommendations for other plans or legislation

10.1. INTRODUCTION

Development can have a detrimental effect on the sustainability of water resources in both quantity and quality.

Section 76(4)(h) of the *Natural Resources Management Act 2004* (NRM Act) provides that a water allocation plan must, to the extent that the regional NRM plan does not:

- identify any policies reflected in a Development Plan under the *Development Act 1993* that applies within its region that should, in the opinion of the board, be reviewed under that Act in order to improve the relationship in the policies in the Development Plan and the policies reflected in the water allocation plan; and
- identify the changes (if any) considered by the board to be necessary or desirable to any other statutory instrument, plan or policy (including subordinate legislation).

A review by the board identified a range of issues and made recommendations on:

- Development Regulations 2008 (Development Regulations)
- Better Development Plans Project
- Council Development Plans and water allocation policies.

10.2. DEVELOPMENT REGULATIONS

In conjunction with the Development Act, the Development Regulations provide the legislative framework that underpins the South Australian planning system. The Development Regulations contain a number of schedules that regulate the assessment of development applications.

Recommendations

- a Update Schedule 1 of the Development Regulations to incorporate separate definitions for irrigated and non-irrigated agriculture. Furthermore, additional investigations are required into the merits of reviewing the definition of forestry in the context of increased carbon trading and carbon offsets.
- b Consider amending Schedule 5 of the Development Regulations to enable planning authorities to obtain information from applicants regarding the proposed source of water for irrigated horticulture or other developments that will use water.
- c Consider the incorporation of maps (preferably GIS based) that identify prescribed areas already referred to in the Development Regulations.

10.3. BETTER DEVELOPMENT PLAN PROJECT

Planning SA's Better Development Plan Project seeks to promote greater consistency within Development Plans based on updated planning policy and the introduction of user-friendly mapping.

Recommendations

- a Provide greater policy focus on the implications of climate change as it relates to sustainable management of water and land use issues.
- b Provide greater guidance on the relationship between water allocation plan and Development Plan policies, including reference to water allocation plans and permit policies.
- c Provide a more robust policy base to address the management of watercourses and broader ecosystems in a development context. For instance, the existing 20 metre watercourse buffer may be too wide and restrictive in many circumstances.
- d Seek to prioritise policies in desired character statements to assist applicants and planning authorities to better understand what weight should be allocated to potentially competing policies.
- e Consider incorporating specific policies for prescribed areas. For instance, review the merits of listing certain water related land uses as non-complying, except if they have a water allocation, or introduce restrictive objectives and principles of development control supported by commentary in the zone's desired character statements that clearly discourage certain water related land uses from being approved if the proponent has not already obtained a water allocation.
- f The structure of the Planning Policy Library requires refinement to better align it with the NRM Act. For instance many of the headings and policies that sit under 'Coastal Areas' could be incorporated under the existing 'Natural Resources' heading and thereby promote a more integrated approach.

10.4. COUNCIL DEVELOPMENT PLANS

The Development Act requires each council to have a development plan, which contains a wide range of policies including natural resources management policies. Planning authorities (e.g. Councils and the Development Assessment Commission) use the plans as the core document to assess development applications. Development applications can only be approved or refused based on the policies contained within a development plan.

Pursuant to the requirements of the NRM Act, water allocation plans are required to provide for the sustainable use of water including the provision of water to the environment.

The policies in this plan limit opportunities for dam and commercial forestry development in reservoir catchments. Accordingly, it is

necessary that development plans within reservoir catchments have clear linkages, and refer, to the policies in this plan. As sustainable extraction and diversion limits also apply in other non-reservoir catchments, development plans should have clear linkages, and refer, to the policies in this plan.

In addition to water allocation plans containing policies to manage and regulate the sustainable use of water, they also contain policies and assessment provisions relating to water affecting activities pursuant to sections 127(3) and (5) of the NRM Act. Because these activities (dams) can be development in some circumstances pursuant to the Development Act, there is therefore a need for a consistent policy approach.

The following commentary identifies proposed water allocation plan policies and the recommended Development Plan responses.

This plan provides (principle 36) that there must not be an allocation of water made if this would cause a net increase in the total volume of surface water and watercourse water use (as at the adoption date) in the catchment of a reservoir or the catchment of a weir that diverts water to the Happy Valley or Hope Valley reservoirs. This means that land uses or activities in these areas that require new or additional water cannot be undertaken unless a sufficient water supply can be secured through the acquisition of a water allocation. This could be either through a transfer, and/or through a new allocation which is made consequent to a prior reduction in dam capacity and/or area of commercial forest plantations. This may also apply to transfers of a water allocation within a management zone that has already reached its sustainable extraction or diversion limit.

Recommendations

It is recommended that the Development Plans of the Alexandrina Council, Adelaide Hills Council, Barossa Council, Town of Gawler, City of Onkaparinga, City of Playford, City of Tea Tree Gully, City of Victor Harbor, and District Councils of Mount Barker and Yankalilla be amended as follows (where appropriate) to:

- a provide an overlay map identifying prescribed water resources areas (PWRAs); and
- b remove from the complying development list any land uses within a PWRA that require a water allocation or a water affecting activity permit; and
- c include a new principle of development control, whereby land uses that require the taking and/or using of a prescribed water resource should only be approved where the applicant can demonstrate how they will obtain a sufficient water allocation under the NRM Act; and
- d include the objectives and principles referred to in sections 8.5 and 8.6 of this plan.

10.5. LAND AND BUSINESS (SALE AND CONVEYANCING) REGULATIONS 2010

Schedule 1 of the Land and Business (Sale and Conveyancing) Regulations 2010 outlines the items where a prescribed encumbrance relating to other legislation must be included in the contract for the sale of land or business. There is currently no requirement to include section 125 of the NRM Act, which is the declaration of prescribed water resources. The inclusion of such a provision would alert prospective buyers as to whether the land or business is within a PWRA. However, as a water entitlement (licence or authorisation) is a personal property right rather than a property right associated with the land, this may not be considered as a prescribed encumbrance. If this is the case, then alternative options to notify prospective purchasers of land or businesses should be considered in consultation with the Real Estate Institute of South Australia.

Recommendations

An investigation is recommended into whether Schedule 1 of the Land and Business (Sale and Conveyancing) Regulations 2010 can include section 125 of the NRM Act – Declaration of prescribed water resources as a prescribed encumbrance. If it is determined that this cannot be considered as a prescribed encumbrance, then alternative options to notify prospective purchasers of land or businesses should be considered in consultation with the Real Estate Institute of South Australia.

11. Abbreviations

ABS	Australian Bureau of Statistics
ARf	Amphibious fluctuation responder, floating
ARp	Amphibious fluctuation responder, plastic
ATe	Amphibious fluctuation tolerator, emergent
ATI	Amphibious fluctuation tolerator, low growing
ATw	Amphibious fluctuation tolerator, woody
Board	Adelaide and Mount Lofty Ranges Natural Resources Management Board
DEWNR	Department of Environment, Water and Natural Resources
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)
EWR	environmental water requirement
GL	Gigalitre
ha	Hectare
HFS	high flow season
km	Kilometre
L	litre
LFS	low flow season
Minister	the Minister administering the NRM Act (Minister for Sustainability, Environment and Conservation)
ML	Megalitre
MLR	Mount Lofty Ranges
NRM Act	Natural Resources Management Act 2004
Plan	Western Mount Lofty Ranges Water Allocation Plan
PWA	prescribed wells area
PWRA	prescribed water resources area
s	second
SA Water	South Australian Water Corporation
Se	Submerged emergent
Sk	Submerged K-selected
SFP	Southern Fleurieu Peninsula
Sr	Submerged r-selected
SWMZ	surface water management zone
T1 flow	Transition 1 flow: low to high flow season
T2 flow	Transition 2: high to low flow season
T1 aquifer	Tertiary aquifer 1
T2 aquifer	Tertiary aquifer 2
Tda	Terrestrial damp
UWMZ	underground water management zone
VWASP	Verification of Water Allocation Science Program
WAP	water allocation plan
WAPAC	Water Allocation Plan Advisory Committee
WMLR	Western Mount Lofty Ranges

12. References

- Alcorn M. 2008. Restoring low flows in the Mount Lofty Ranges: Description of hydrological modelling to support the business case. DWLBC Technical Note 2008/26, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Adelaide.
- Australian Bureau of Statistics (ABS). 2006. Census data.
- Brock MA and Casanova MT. 1997. Plant life at the edges of wetlands: Ecological responses to wetting and drying patterns. In N Klomp and I Hunt (eds), *Frontiers in ecology: Building the links*. Elsevier Science, Oxford, pp. 181–192.
- Bunn S and Arthington A. 2002. Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. *Environmental Management*, 30, 492–507.
- Casanova MT. 2004. A census of submerged plants of the Angas River and Tookayerta Creek catchments. Unpublished report for the River Murray Catchment Water Management Board.
- Casanova MT. 2011. Using water plant functional groups to investigate environment water requirements. *Freshwater Biology*, 56/12; 2637-2652.
- Casanova MT. In preparation. Using plant functional groups to investigate environmental water requirements of a catchment.
- Casanova MT and Brock MA. 2000. How do depth, duration and frequency of flooding influence the establishment of wetland plant communities? *Plant Ecology*, 147, 237–250.
- Department for Environment and Heritage. 2003. 2003 Review of the Status of Threatened Species in South Australia. Proposed Schedules under the South Australian *National Parks and Wildlife Act 1972*: Discussion Paper. National Parks and Wildlife Council in partnership with the Department for Environment and Heritage, Adelaide.
- EconSearch. 2005. Western Mount Lofty Ranges Regulatory Impact Report. Department of Water, Land and Biodiversity Conservation, Adelaide.
- Government of South Australia. 2006. State Natural Resources Management Plan. Department of Water, Land and Biodiversity Conservation, Adelaide.
- Government of South Australia. 2009. Water for Good: A plan to ensure our water future to 2050. Office for Water Security, Adelaide.
- Hammer M. 2004. The Eastern Mount Lofty Ranges fish inventory: Distribution and conservation of freshwater fishes of tributaries in the Lower River Murray, South Australia. Native Fish Australia (SA) Inc, Adelaide.
- Hammer M. 2007. Freshwater fish monitoring for threatened species and environmental water requirements in the Eastern Mount Lofty Ranges. Aquasave Consultants report to the SA Murray Darling Basin Natural Resources Management Board, Murray Bridge.
- Hammer M. 2011. Ecological implications for freshwater fishes arising from specific hydrological changes to the lower River Torrens, Adelaide. Technical note to the Adelaide and Mount Lofty Ranges Natural Resources Management Board.
- Harding CL. 2005. Wetland inventory for the Fleurieu Peninsula, South Australia. Department for Environment and Heritage, Adelaide.
- Heneker T M and Cresswell D. 2010. Potential impact on water resource availability in the Mount Lofty Ranges due to climate change. DFW Technical Report 2010/03, Government of South Australia, through Department for Water, Adelaide.
- Leck MA and Brock MA. 2000. Ecological and evolutionary trends in wetlands: evidence from seeds and seed banks in New South Wales, Australia and New Jersey, USA. *Plant Species Biology*. 15: 97-112
- Lloyd N. 1987. Ecology and distribution of the small native fish of the lower River Murray, South Australia and their interactions with the exotic mosquitofish, *Gambusia affinis holbrooki*. MSc thesis, University of Adelaide.
- Lloyd N, Quinn G, Thoms M, Arthington A, Gawne B, Humphries P and Walker K. 2003. Does flow modification cause geomorphological and ecological responses in rivers? A literature review from an Australian perspective. Technical report 1/2004, CRCFE, Canberra.
- McNeil DG and Hammer M. 2007. Biological review of the freshwater fishes of the Mount Lofty Ranges. SARDI publication: F2006/00035. South Australian Research and Development Institute (Aquatic Sciences), Adelaide.
- Mount Lofty Ranges Environmental Water Requirements Expert Panel. In preparation. Environmental water requirements for the Mount Lofty Ranges prescribed water resources areas: Technical background report.
- Poff NL, Allan JD, Bain MB, Karr JR, Prestegard KL, Richter BD, Sparks RE and Stromberg J (Mount Lofty Ranges Environmental Water Requirements Expert Panel). 1997. The natural flow regime: A paradigm for river conservation and restoration. *Bioscience*, 47, 769–784.
- Rural Solutions. 2008. Aboriginal Access to Water Across Australia. Government of South Australia through Department of Water, Land and Biodiversity Conservation, Adelaide.
- Teoh K, Penney D and Alcorn M. In preparation. Capacity of surface water resources in the Western Mount Lofty Ranges – Methodology and results. Government of South Australia, through Department for Water, Adelaide.
- VanLaarhoven J and van der Wielen M. 2009. Environmental water requirements for the Mount Lofty Ranges Prescribed Water Resources Areas. DWLBC Report 2009/29, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Adelaide.
- VanLaarhoven J. In preparation. Environmentally sustainable extraction limits for the Western Mount Lofty Ranges Prescribed Water Resources Area. Technical Report 2009/30, Government of South Australia, through Department for Water, Adelaide.

Appendix A - Glossary

In this glossary, words in the singular include the plural and words in the plural include the singular.

Adoption date

The date this plan is adopted by the Minister administering the NRM Act.

Allocation

Depending on the context, has the same meaning as 'water allocation'.

Allotment

An allotment delineated on a certificate of title under the Real Property Act 1886 and includes two or more contiguous allotments owned or occupied by the same person. Allotments will be taken to be contiguous if they abut one another at any point or if they are separated only by:

- a street, road, lane, footway, court, railway, thoroughfare or travelling stock route; or
- a reserve or other similar open space dedicated for public purposes.

Allotments will be taken to be separated by intervening land if a line projected at right angles from any point on the boundary of one of them with the intervening land would intersect a boundary of the other with the intervening land.

Ambient underground water

The underground water present in an aquifer before draining and discharging water into a well. Ambient underground water may be native underground water or mixed underground water.

Annual adjusted runoff

The calculated mean annual amount of water (expressed in mm) flowing over any given area of land. This is the runoff that would flow over the land if there were no dams or forests. For South Para River, Little Para River, River Torrens, Onkaparinga and Willunga Basin catchments, the annual adjusted runoff for each surface water management zone is listed in Tables 5.6–5.11. The annual adjusted runoff for each watercourse across the plains is listed in Tables 5.12–5.15.

For surface water management zones in Fleurieu Peninsula catchments, the annual adjusted runoff is calculated as:

$$\text{Qno-dams} = (\text{Rain}) - F * \text{Tanh}(\text{Rain} / F)$$

where **Qno-dams** is the mean annual runoff adjusted for farm dams (mm).

Rain is the mean annual rainfall for the catchment area draining to the point of capture or extraction or diversion (mm) in Appendix D.

F value for each surface water management zone is provided in Appendix C.

If the catchment area draining to the point of capture extraction or diversion has plantation forestry, the Qno-dams needs to be further adjusted for the impacts of plantation forestry.

Aquatic macroinvertebrates

Animals without backbones that spend all or part of their life cycle in water. They are large enough to be seen with the naked eye and include insects, crustaceans, snails, worms, mites and sponges. Insects include the larvae of flying insects (e.g. midges, two-winged flies, dragonflies, mayflies, stoneflies and caddis flies) as well as the adults of some groups (e.g. waterbugs, beetles, springtails). Crustaceans include yabbies and freshwater shrimps, and prawns.

Aquifer

A permeable zone of rock or sediment in which underground water is stored and moves.

Areal recharge rate

The spatially averaged amount of water (in mm) that infiltrates to the underground water resource in an average year. The recharge volume for an underground water management zone is calculated by multiplying the areal recharge rate by the area of the underground water management zone.

Artesian conditions

Occur when underground water pressures cause the underground water level in a well to rise above the surface of the ground.

Baseflow

The component of flow in a watercourse from the discharge of underground water. Baseflow may sustain watercourse flow during periods of no rainfall.

Baseflow coefficient

The volumetric flow rate of the baseflow component of watercourse flow (ML/year) divided by the total volumetric watercourse flow rate (ML/year).

Buffer zone of an underground water-dependent ecosystem

An area that extends:

- 5 metres from the edge of a drainage path
- 10 metres on each side of the centre line of a watercourse
- 200 metres on each side of the centre line of a watercourse underlain by a Permian Sand aquifer
- 50 metres from the edge of a wetland in fractured rock systems; or
- 200 metres from the edge of a wetland underlain by a Permian Sand aquifer.

Catchment

Depending on the context:

- South Para River, Little Para River, River Torrens, Onkaparinga, Willunga Basin, Myponga River, Hindmarsh and Inman rivers or Fleurieu Coastal catchments, which are delineated in Figure 1.2; or
- the area of land determined by topographic features within which rainfall contributes to runoff at a particular point.

For the purpose of Section 6.5 of this plan, the catchment of an extraction point and the catchment of a downstream extraction point do not include the area of land upstream of Gorge Weir, Clarendon Weir or Gawler Junction (as the case may be).

Central Hills catchments

River Torrens, Onkaparinga River, South Para River and Little Para River catchments, delineated in Figure 1.2.

Central Hills wetlands

Wetlands of which the indicative location is delineated in Figure 2.4.

Commercial forest

A forest plantation where the forest vegetation is grown or maintained so that it can be harvested or used for commercial purposes (including through the commercial exploitation of the carbon absorption capacity of the forest vegetation).

Confined aquifer

An aquifer that is bound above and below by a confining layer of low permeability. Water in a confined aquifer is usually under pressure, causing the water level in a well completed in the confined aquifer to rise above the top of the aquifer.

Constructed

For the purposes of:

- principle 30,
- Section 8.5 (except for principles 164 and 191) and
- the definition of ‘water extractions’,

means ‘erected, constructed, modified or enlarged’.

Dam use

- The volume of water allocated to be taken from a dam; or
- Where a water allocation is not required to take water from a dam – 30% of the capacity of the dam.

Deemed dam losses

Water that is lost by evaporation and seepage from dams. For the purposes of this plan, dam losses are deemed to be 30% of the capacity of a dam.

Diversion limit

The total allowable:

- capacity of dams
- volume of surface water that can be taken by commercial forests (as determined in accordance with principle 201)

in a surface water management zone. The diversion limit for each surface water management zone is listed in Tables 5.6–5.11.

Domestic purpose

Has the same meaning as in section 3(1) of the NRM Act. In relation to the taking of water, ‘domestic purpose’ does not include:

- taking water for the purpose of watering or irrigating land, other than land used solely in connection with a dwelling; or
- without limiting the above – taking water for the purpose of watering or irrigating more than 0.4 of a hectare of land; or
- taking water to be used in carrying on a business (except for the personal use of persons employed in the business).

Downstream extraction point

An extraction point that is located downstream or down gradient of a proposed extraction point. A downstream extraction point includes:

- all extraction points that are downstream of, and in the same surface water management zone as, a proposed extraction point
- all extraction points on a main watercourse or a watercourse across the plains that are downstream of the proposed extraction point.

Drainage path

A fold, depression or contour in land or a path along which surface water flows.

Drawdown

A reduction in underground water level and/or pressure level in an aquifer as a result of taking water from the aquifer.

Ecosystem

Has the same meaning as in section 3(1) of the NRM Act: a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Environmental water provisions

Those parts of environmental water requirement that can be met at any given time, with consideration of existing users' rights and social and economic impacts. The environmental water provisions for the Prescribed Area do not aim to return water-dependent ecosystems to a pristine condition, but to keep them at an acceptable level of risk.

Environmental water requirement (EWR)

Those water requirements that must be met in order to sustain the ecological values of ecosystems that depend on the water resource, including their processes and biodiversity, at a low level of risk.

Existing user

A person who:

- took water at any time during the period 1 July 2001 to 13 October 2004 (inclusive); or
- needs water for a development, project or undertaking to which they were legally committed or in respect of which they had, in the opinion of the Minister, committed significant financial or other resources between 1 July 2001 and 13 October 2004; and
- applied for a water licence on or before 20 April 2006; or
- acquires the land (or the interest in land), or any successor to that person, from a person who was an existing user as above.

Extraction limit

See 'main watercourse extraction limit', 'surface water extraction limit', 'underground water extraction limit' and 'watercourse across the plains extraction limit'.

Extraction point

A dam that collects or diverts surface water flowing over land or water in a watercourse (including for non-licensed purposes), or a point at which surface water or watercourse water (including stormwater) is taken for licensed purposes.

First order watercourse

Based on the Strahler system of ordering watercourses, which is an international standard used to define stream size based on a hydrological algorithm. Starting at the top of a catchment, any watercourse that has no watercourses flowing into it is a first order watercourse.

Fleurieu Peninsula catchments

The Myponga River, Hindmarsh and Inman rivers, and Fleurieu Coastal catchments, delineated in Figure 1.2.

Fleurieu wetlands

Wetlands of which the indicative location is delineated in Figure 2.3. Fleurieu wetlands include Swamps of the Fleurieu Peninsula as listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Floodplain

Has the same meaning as in section 3(1) of the NRM Act and means any area of land adjacent to a watercourse, lake or estuary that is periodically inundated with water and includes any other area designated as a floodplain:

- by an NRM plan; or
- by a Development Plan under the *Development Act 1993*.

Flow regime

The flow pattern seen in rivers, streams and wetlands; made up of the following basic components:

- magnitude – the volume of water delivered by a flow
- frequency – the number of times a flow occurs within a given period of time
- duration – the period of time over which a flow occurs
- timing – when flows occur within a given year.

Flow seasons

Periods of flow characterised by different flow types.

Forest vegetation

Trees and other forms of forest vegetation including:

- roots or other parts of the trees or other forest vegetation that lie beneath the soil
- leaves, branches or other parts or products of trees or other forest vegetation.

Fractured rock aquifer

An aquifer in which underground water is stored and moves through fractures, joints and fissures in the rock.

Freshes

Short-term small increases in water flow that remain in the channel.

Functional group

Species that have similar life cycles, habitat requirements and environmental water requirements.

General Specification

The General Specification for Well Construction, Modification and Abandonment in South Australia, which is available from DEWNR.

General Registry Office Plan (GRO Plan)

A plan or map registered and held at the Lands Titles Office.

Headwaters

The upper tributaries of a watercourse.

Headworks

Any assembly on top of a well that is located between the well casing and the water delivery system.

Indicator species

The animal species (Southern Pygmy Perch, Mountain Galaxias and macroinvertebrate species) selected to help determine environmental water provisions in the Prescribed Area.

Intensive farming

Has the same meaning as in section 3(1) of the NRM Act: a method of keeping animals in the course of carrying on the business of primary production in which the animals are usually confined to a small space or area and usually fed by hand or by a mechanical means.

K-selected species

Species whose populations fluctuate at or near the carry capacity of the environment in which they reside.

Land

Has the same meaning as in section 3(1) of the NRM Act: according to the context:

- land as a physical entity, including land under water; or
- any legal estate or interest in, or right in respect of land

and includes any building or structure fixed to land.

Licensed purposes

The purposes for which a water allocation is required to take water under the NRM Act, including the taking of water for stock and/or domestic purposes from a dam that has a capacity of 5 ML or more.

Local adjusted runoff

The volume of water that would flow over land (with the presence of dams and forests excluded) to an extraction point or a Fleurieu wetland, which is calculated by multiplying the catchment of the extraction point or Fleurieu wetland (km²) by the annual adjusted runoff (in mm).

Main watercourse

A watercourse that receives flows from a watercourse in a different surface water management zone; delineated in Figures 5.7, 5.9, 5.11, 5.13, 5.15, 5.17, 5.18 and 5.19.

Main watercourse extraction limit

The maximum volume of water extractions allowed from:

- a main watercourse in the surface water management zone in which the limit applies ('the relevant surface water management zone')
- any surface water management zones that contribute to the flow of water in any part of the main watercourse that is in the relevant surface water management zone.

The main watercourse extraction limit for each surface water management zone is listed in Tables 5.6–5.11.

Main watercourse unit threshold flow rate

Each surface water management zone has a minimum and maximum main watercourse unit threshold flow rate, which reflect the ranges (minimum and maximum) upstream of the relevant surface water management zone. The unit threshold flow rate for an extraction point on a main watercourse will be determined at the time of assessment. The main watercourse unit threshold flow rate range for each surface water management zone is listed in Tables 5.6–5.13.

Managed aquifer recharge operation

A practice where water is artificially recharged (by draining or discharging water into a well) to an aquifer for subsequent recovery.

Maximum diversion rate

The maximum rate (in L/s) at which water may be taken from a third order (and above) watercourse.

Measurable indicators

Hydrological terms used to quantify the environmental water requirement. Examples of measurable indicators include average daily flows in the low flow season (generally summer to mid-autumn) and the average total duration of bankfull flows per year.

Native underground water

The underground water that exists in the relevant aquifer without any water that has been drained or discharged to that aquifer by artificial means.

New urban land use development

Development that is (or was) authorised by a development approval under the *Development Act 1993* and started after 14 October 2004.

Non-licensed purposes

The purposes for which a water allocation is not required to take water under the NRM Act.

Operational well

A well used to take water that has not been abandoned or backfilled, but does not include a monitoring well.

Pre-development runoff

The volume of water that had run off land before the new urban land use development on that land.

Prescribed Area

The areas:

- Western Mount Lofty Ranges PWA (the area bounded by the bold red line in GRO Plan No 242/2004)
- Western Mount Lofty Ranges Surface Water Area (the area bounded by the bold red line in GRO Plan No 241/2004)
- Western Mount Lofty Ranges Prescribed Watercourses (all watercourses within the areas bounded by the bold red line in GRO Plans No 241/2004 and 243/2004)
- Little Para Proclaimed Watercourse (as described in the Government Gazette published on 19 January 1978 (p. 294) pursuant to the Water Resources Act 1976).

Prescribed watercourse

A watercourse declared to be a prescribed watercourse under section 125 of the NRM Act or that is a prescribed watercourse for the purposes of the NRM Act pursuant to clause 54(2) of Schedule 4 of the NRM Act.

Property

An allotment or contiguous allotments owned or occupied by the same person, persons, or body and operated as a single unit. Allotments will be considered to be contiguous if they abut any point, or are separated only by a road, street, lane, footway, court, alley, railway, thoroughfare, easement, right-of-way, watercourse, channel or a reserve or similar open space.

Rain

For the purpose of calculating annual adjusted runoff and unit threshold flow rate in the Fleurieu Peninsula catchments, the mean annual rainfall for the catchment area draining to the point of capture or extraction or diversion (mm) as illustrated in Appendix D.

Reach

Length of watercourses that have particular characteristics that enable them to be dissociated from another.

Recharge

The infiltration of water into an aquifer from the land surface.

Recharge allocation

A water allocation to take water that has been drained or discharged into a well in accordance with a permit granted pursuant to section 135 of the NRM Act or an environmental authorisation granted pursuant to the *Environment Protection Act 1993*.

Recharge period

The period between 1 October and 30 September in the following calendar year.

Recovery period

The period between 1 October in the same calendar year that follows the recharge period and 30 September in the following calendar year.

Relevant authority

The authority to which an application for a permit to undertake a water affecting activity identified in Section 8 is made. The relevant authority for each water affecting activity is:

Water affecting activity	Relevant authority
Drilling, plugging, backfilling or sealing of a well	Minister
Repairing, replacing or altering the casing, lining or screen of a well	Minister
Draining or discharging water directly or indirectly into a well	Minister
The erection, construction, modification, enlargement or removal of a dam, wall or other structure that will collect or divert, or collects or diverts: <ul style="list-style-type: none">• water flowing in a prescribed watercourse• surface water flowing over land in a surface water prescribed area	Board
Establishing or expanding a commercial forest	Minister

Reservoir

For the purposes of principles 36, 66, 67, 73, 74, 81, 170, and 205, any of the following reservoirs:

- Little Para Reservoir
- Warren Reservoir
- South Para Reservoir
- Barossa Reservoir
- Millbrook Reservoir
- Kangaroo Creek Reservoir
- Mount Bold Reservoir
- Myponga Reservoir.

Reservoir catchments

Catchments in which water supply reservoirs are located: Little Para River, South Para River, River Torrens, Onkaparinga River and Myponga River catchments.

Rollover allocation

The portion of a water allocation that is not taken in a water use year that may be taken in a subsequent water use year in accordance with principles 20 or 57 of this plan.

Roof runoff

Water that runs off of any building or structure fixed to land after having fallen as rain or hail or having precipitated in any other manner.

Roof runoff allocation

A water allocation to take roof runoff.

r-selected species

Species whose populations are governed by their maximum reproductive capacity

Second order watercourse

Based on the Strahler system of ordering watercourses, which is an international standard used to define stream size based on a hydrological algorithm. Starting at the top of a catchment, any watercourse that has no watercourses flowing into it is a first order watercourse. Where two first order watercourses join, the watercourse becomes a second order watercourse.

Sedimentary aquifer

An aquifer consisting of layers of sediments, such as sand, clay, gravel and limestone, in which water is stored and moves through the pore spaces between the sediments.

Source water

The water that is drained or discharged into a well in accordance with a permit granted pursuant to section 135 of the NRM Act or an environmental authorisation granted pursuant to the *Environment Protection Act 1993*.

Stock and/or domestic allocation

A water allocation to take water for stock and/or domestic purposes from a dam that has a capacity of 5 ML or more.

Stock and/or domestic purposes

Watering stock (other than stock subject to intensive farming) or domestic purposes.

Stormwater

Water that runs off an urban land use development.

Stormwater management

The management of water that flows off roofs, properties and roads in urban areas during rain events.

Surface water

As in section 3(1) of the NRM Act:

- water flowing over land (except in a watercourse) –
 - after having fallen as rain or hail or having precipitated in any other manner; or
 - after rising to the surface naturally from underground;
- water of the kind referred to above that has been collected in a dam or reservoir;
- water of the kind referred to in the first dot point above that is contained in any stormwater infrastructure;
- water in a watercourse if the watercourse, or particular part of a watercourse, is declared by proclamation to constitute surface water for the purposes of the Act.

Surface water extraction limit

The maximum volume of water extractions (not including water extractions from a main watercourse) allowed in a surface water management zone (listed in Tables 5.6–5.11).

Surface water prescribed area

As in section 3(1) of the NRM Act, a part of the State declared to be a surface water prescribed area under section 125 of the NRM Act.

Surface water resource capacity

The total volume of water (expressed in ML) that flows over land into a watercourse at the downstream end of a surface water management zone (listed in Tables 5.6–5.11). This is the volume of water that would flow over the land if there were no dams or forests in the surface water management zone.

Note: The impacts of in-stream losses to the aquifer have been accounted for in the resource capacity of the main watercourses in the Willunga basin.

Swamps of the Fleurieu Peninsula

Wetlands that are listed as critically endangered ecological communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*¹².

Surface water management zone (SWMZ)

As delineated in Figures 5.6–5.16.

System losses

Water that is lost by evaporation and seepage (from surface water runoff and watercourse water).

Third order (and above) watercourse

A third or higher order (e.g. fourth or fifth order) watercourse (Figure B.1, Appendix B).

Based on the Strahler system of ordering watercourses (see First order watercourse). Where two first order watercourses (from the top of a catchment) join, the watercourse becomes a second order watercourse. When two or more second order watercourses join, they form a third order watercourse. When two or more third order watercourses join, they form a fourth order watercourse.

Threshold flow rate

The rate of flow (in L/s) at or below which water may not be diverted or collected by a dam, wall or other structure at a specific location, as determined in accordance with principles 48, 49 or 81.

Turkey nest dam

A dam that, apart from rainfall falling directly into it, does not have its own upstream catchment directly supplying water to it.

Unconfined aquifer

An aquifer with the watertable as its upper boundary.

Underground water

As in section 3(1) of the NRM Act:

- water occurring naturally below ground level;
- water pumped, diverted or released into a well for storage underground.

Underground water extraction limit

The total volume of underground water extractions allowed in an underground water management zone. The underground water extraction limit for each underground water management zone is listed in Tables 5.1–5.5.

Underground water extractions

The aggregate of:

- underground water allocations (but not recharge allocations or rollover allocations); and
- the volume of underground water that is taken for non-licensed purposes (including water that is deemed to be taken by commercial forests as determined in accordance with principle 200) not including existing non-licensed extractions identified in Tables 5.1–5.5.

Underground water resource capacity

The annual recharge volume in an underground water management zone. This has been derived from a combination of hydraulic and hydrochemical modeling, which has taken into account existing land use (including existing commercial forestry), variations in rainfall and geology types across the Prescribed Area, together with analyses of underground water in observation wells, underground water use and baseflow in watercourses.

Unit threshold flow rate

The proportion of flows (in L/s/km²) that may not be diverted or collected by a dam, wall or other structure in a given surface water management zone. This is derived from the volume of average daily flow events that are greater than or equal to 20% of all flows during a flowing period in an average flow year. For South Para River, Little Para River, River Torrens, Onkaparinga and Willunga Basin catchments, the unit threshold flow rate for each surface water management zone is listed in Tables 5.6–5.11. For the Fleurieu Peninsula catchments, the unit threshold flow rate (L/s/km²) at the point of capture (by farm dams) or at the point of diversion or extraction from a watercourse (L/s/km²) is calculated using information and the equation indicated in Appendix E.

Upstream SWMZ

Any surface water management zone that contributes to the volume of water flowing in a main watercourse.

Urban runoff

The volume of water (as determined to the satisfaction of the Minister by a suitably qualified engineer) that runs off a new urban land use development, and is calculated by multiplying rainfall (in mm) by the area of the new urban land use development (taking into account the area of impervious surfaces and reduced runoff due to open space).

Underground water management zone (UWMZ)

As delineated in Figures 5.1–5.5.

¹²Listing is on EPBC Act website in the Protected Matters Search Tool.

Water allocation

In respect of a water licence, as in section 3(1) of the NRM Act: an allocation under the terms of the licence in accordance with Chapter 7 Part 3 Division 2 of the NRM Act.

Water extractions

The aggregate of:

- surface water and watercourse water allocations (not including roof runoff allocations and stormwater allocations); and
- stock and/or domestic use from each dams, which is deemed to be:
 - where a water allocation is taken from a dam that was constructed before the adoption date and the allocation is less than 70% of the capacity of the dam – the difference between the allocation and 70% of the capacity of the dam (which must not exceed 30% of the capacity of the dam);
 - where a water allocation is not required to take water from a dam – 30% of the capacity of the dam;
 - in any other case – zero; and
- surface water that is deemed to be taken by commercial forests (as determined in accordance with principle 201).

Water licence

As in section 3(1) of the NRM Act: a licence granted by the Minister under section 146 of the NRM Act.

Water resource

As in section 3(1) of the NRM Act: a watercourse or lake, surface water, underground water, stormwater (to the extent that it is not within a preceding item) and effluent.

Water sensitive urban design

An approach to urban planning that integrates management of the total water cycle with the design of new developments to improve water use efficiency without adversely affecting lifestyle.

Water use year

The period between 1 July and 30 June in the following calendar year.

Watercourse

As in section 3(1) of the NRM Act: a river, creek or other natural watercourse (whether modified or not) in which water is contained or flows whether permanently or from time to time 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 ambit of this definition) into which the water of a watercourse has been diverted;
- part of a watercourse;
- an estuary through which water flows; and
- any other natural resource, or class of natural resource, designated as a watercourse for the purposes of the NRM Act by an NRM plan.

Watercourse across the plains

The watercourses that flow across the Adelaide Plains to Gulf St Vincent:

- Gawler River; downstream of the junction of the North Para River and the South Para River;
- River Torrens/Karrawirra Parri; downstream of Gorge Weir;
- Onkaparinga River; downstream of Clarendon Weir; and
- Little Para Proclaimed Watercourse; between the spillway of Little Para Reservoir and the point where the eastern boundary of Port Wakefield Road intersects Little Para River.

Watercourse across the plains extraction limit

The maximum volume of water extractions allowed from:

- a watercourse across the plains; and
- any of the catchments that contribute to the flow of water in any part of the watercourse.

The watercourse across the plains extraction limit for each watercourse water management zone is listed in Tables 5.12–5.15.

Watercourse across the plains resource capacity

The total volume of water that flows in a watercourse across the plains, apportioned between watercourse water management zones, which is based on surface water runoff from the surrounding non-prescribed areas and baseflow from underground water in Northern Adelaide Plains PWA and Central Adelaide PWA. The resource capacity for each watercourse water management zone is listed in Tables 5.12–5.15.

Watercourse water

Water in a watercourse.

Watercourse water management zone

A management zone for a watercourse across the plains, as delineated in Figures 5.20–5.23.

Water-dependent ecosystem

An array of plant, animal and micro-organism communities and their non-living environment, whose functions are dependent upon water. These ecosystems have a complex dependence on water availability and flow. Not only is the total volume of water these systems receive important for their survival, but also how and when that water is delivered.

Watertable

The upper surface of underground water. Soil is fully saturated below the watertable and unsaturated above it.

Well

As in section 3(1) of the NRM Act:

- an opening in the ground excavated for the purpose of obtaining access to underground water;
- an opening in the ground excavated for some other purpose but that gives access to underground water; or
- a natural opening in the ground that gives access to underground water.

Well buffer zone

A circular area centred on an operational well, the radius of which is determined in accordance with the following table:

Well category	Radius of well buffer zone (m)
Wells used only for non-licensed purposes	50
Wells in the Myponga and Hindmarsh Limestone UWMZs: underground water allocations less than or equal to 50 ML	125
Wells in the Myponga and Hindmarsh Limestone UWMZs: underground water allocations greater than 50 ML	250
Wells in all other UWMZs: underground water allocations less than 10 ML	50
Wells in all other UWMZs: underground water allocations between 10 ML and 50 ML (inclusive)	100
Wells in all other UWMZs: underground water allocations greater than 50 ML	200

Well construction

Drilling, plugging or sealing of a well, or repairing, replacing or altering the casing, lining or screen of a well.

Zone of high intensity underground water use

An area in an underground water management zone where, in the opinion of the Minister, the sustainability of the underground water resource is threatened by a high spatial density of underground water allocations in comparison to the underground water recharge in that underground water management zone. These areas will be identified on a map maintained and updated by DEWNR.

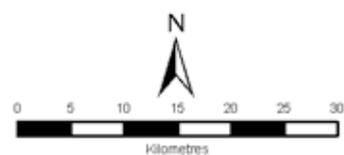
Appendix B - Other figures



Figure B.1 Third order (and above) watercourses

Legend

-  Third order (and above) watercourse
-  Catchment
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  River Murray Prescribed Watercourse



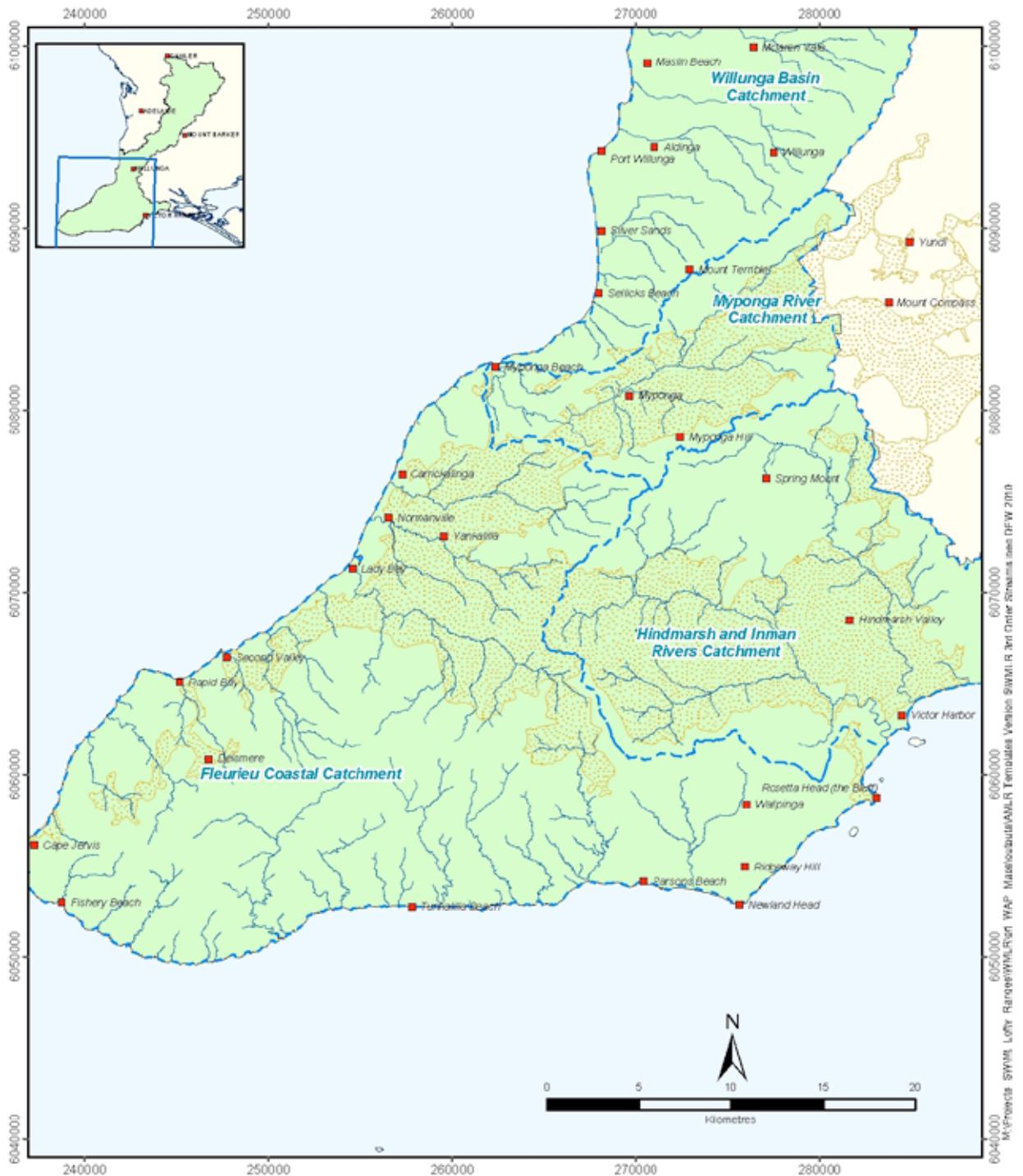
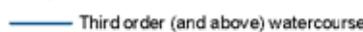
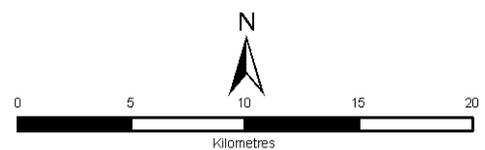


Figure B.2 Third order (and above) watercourses underlain by Permian Sand aquifers

Legend

-  Third order (and above) watercourse
-  Catchment
-  Western Mount Lofty Ranges Prescribed Water Resources Area
-  Permian Sand Aquifer

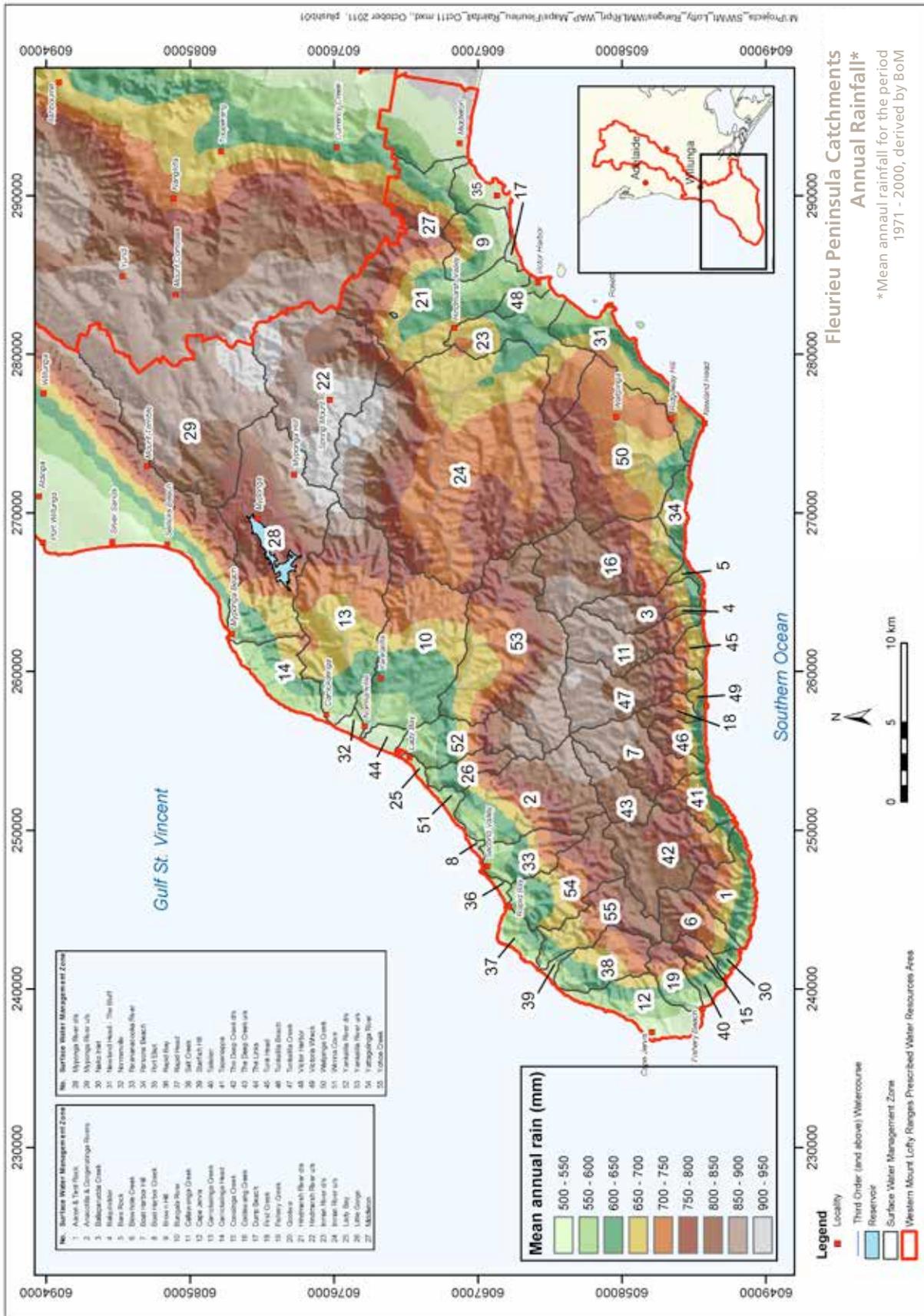


Appendix C – F-values for Fleurieu Peninsula catchments

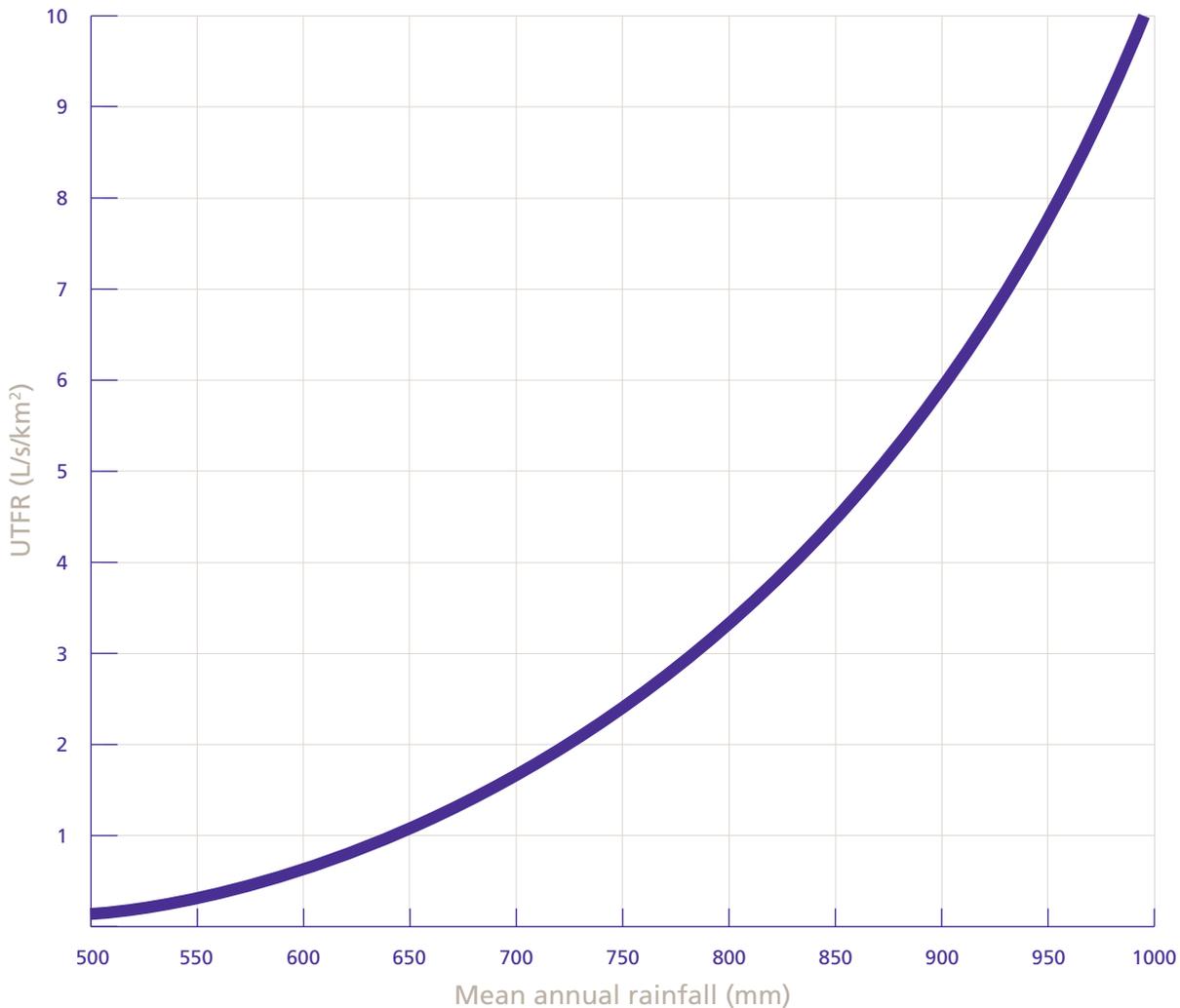
No.	SURFACE WATER MANAGEMENT ZONES	F-VALUES
1.	Aaron & Tent Rock	1460
2.	Anacotilla & Congeratinga rivers	1397
3.	Ballaparudda Creek	1102
4.	Balquhidder	1035
5.	Bare Rock	1052
6.	Blowhole Creek	1108
7.	Boat Harbor Hill	1031
8.	Boat Harbor Creek	1326
9.	Brown Hill	1103
10.	Bungala River	1277
11.	Callawonga Creek	1206
12.	Cape Jervis	1120
13.	Carrickalinga Creek	1271
14.	Carrickalinga Head	1055
15.	Coalinga Creek	1233
16.	Coolawang Creek	1201
17.	Dump Beach	904
18.	First Creek	1244
19.	Fishery Creek	1142
20.	Goolwa	1100
21.	Hindmarsh River	1188
22.	Hindmarsh River d/s	1252
23.	Inman River	1369
24.	Inman River d/s	1181
25.	Lady Bay	1031
26.	Little Gorge	1107
27.	Middleton	1086
28.	Myponga River	1232

No.	SURFACE WATER MANAGEMENT ZONES	F-VALUES
29.	Myponga River d/s	1236
30.	Naiko Inlet	1024
31.	Newland Head – The Bluff	1211
32.	Normanville	1145
33.	Parananacooka River	1190
34.	Parsons Beach	1264
35.	Port Elliot	1117
36.	Rapid Bay	981
37.	Rapid Head	1103
38.	Salt Creek	1166
39.	Starfish Hill	1019
40.	Talisker	1068
41.	Tapanappa	1495
42.	The Deep Creek	1503
43.	The Deep Creek d/s	1352
44.	The Links	1077
45.	Tunk Head	1020
46.	Tunkalilla Beach	1106
47.	Tunkalilla Creek	1228
48.	Victor Harbor	1263
49.	Victoria Wreck	1039
50.	Waitpinga Creek	1175
51.	Wirrina Cove	1200
52.	Yankalilla River	1379
53.	Yankalilla River d/s	1333
54.	Yattagolinga River	1403
55.	Yohoe Creek	1162

Appendix D – Fleurieu Peninsula catchments mean annual rainfall



Appendix E – Unit threshold flow rates for Fleurieu Peninsula catchments



Data provided in Appendix E were derived using the following equation:

$$UTFR = (Rain - 325) - 3150 * \tanh((Rain - 325) / 3150)$$

where

- UTFR is the unit threshold flow rate at the point of capture (by farm dams) or at the point of diversion or extraction from a watercourse (L/s/km²).
- Rain is the mean annual rainfall (Appendix D) for the catchment area draining to the point of capture or extraction or diversion (mm).
- 325 and 3150 are constants that define the relationship.

Mean annual rainfall (mm)	UTFR (L/s/km²)
500-550	0.27
550-600	0.52
600-650	0.9
650-700	1.43
700-750	2.14
750-800	3.04
800-850	4.16
850-900	5.52
900-950	7.15



Natural Resources
Adelaide and Mt Lofty Ranges



Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

