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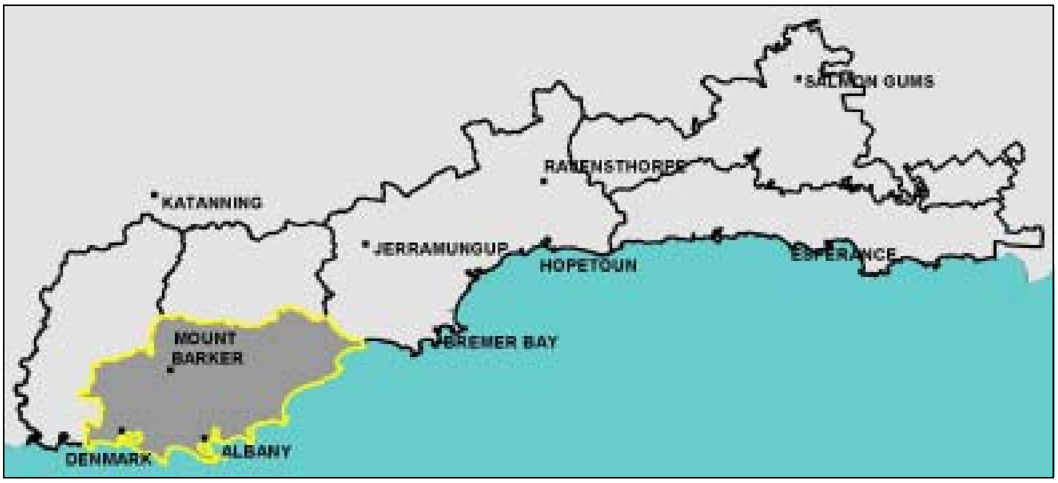

Department of Agriculture
Government of Western Australia

Groundwater trends in the Albany Hinterland sub-region

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The South Coast Regional Initiative Planning Team (SCRIPT) has divided the South Coast region of Western Australia into six sub-regions The Albany Hinterland is in the western portion (see Figure 1). It is bounded by the Pallinup River in the east, Stirling Ranges to the north and the Kent River catchment boundary in the west. Two-thirds (580,000 ha) of the sub-region has been cleared for agriculture. This publication describes the groundwater trends, risk of shallow watertables, and technical feasibility of salinity management within the agricultural land.

Soil-landscape zones are spatial units based on geology and geomorphology. Since most groundwater processes in WA are controlled by the geologic and regolith properties, these zones can be used for allocating hydrological attributes such as groundwater characteristics and trends. The hydrological attributes are then used to assess the risk of shallow watertables and technical feasibility of salinity management.

Refer to *Further Information* for a description of groundwater flow systems, risk analysis and technical feasibility of salinity management.

Climate

The sub-region has a temperate, moderately dry winter and warm summers. Cold fronts from the south-west bring most of the winter rainfall. Annual rainfall distribution reflects this. Average annual rainfall is 1,100 mm in the coastal areas near Denmark, decreasing to 400 mm at the Stirling Ranges in the north and Wellstead to the east. Rainfall reliability also decreases inland, although evaporation increases.

Albany Sandplain Zone (242)

Albany Sandplain Zone contains areas with differing hydrological properties and has been divided into Albany Sandplain Zone Central and Albany Sandplain Zone West.

- **Albany Sandplain Zone West**

This portion of the Albany Sandplain Zone covers 40% of the Albany Hinterland. It is roughly bounded by the catchments of the Kalgan, King and Napier Rivers. It consists of a moderately dissected sandplain with hills, on a deeply weathered mantle overlying sedimentary and granitic rocks. The area is reasonably well-drained, with all rivers flowing into the Southern Ocean.

Groundwater flow systems

Groundwater systems are local and intermediate, discharging into nearby creeks and rivers.

Groundwater depth, quality and trends

Depth to groundwater ranges from 3 to 17 m. Groundwater salinities range from 125 mS/m (marginal) to 2,500 mS/m (saline). In general, groundwater salinity increases away from the coast. Groundwater pH ranges from 5 (slightly acid) to 6.3 (neutral).

Groundwater levels between the Stirling and Porongurup Ranges are rising by 0.15 to 0.40 m/yr (Figure 1: bore JK3i00). Over the last five years, levels south of the Porongurup Ranges have fallen by 0.05 to 0.10 m/yr (Figure 1: bore GW11i91). Monitoring in areas planted with blue gums has shown levels to be falling by up to 0.40 m/yr (Figure 1: bore DM3d90).

Risk of shallow watertables

Areas south of the Porongurup Ranges have a low risk of shallow watertables (Table 1) because the aquifers are only slightly saline and large areas are planted with blue gums. Areas north of the ranges have a moderate risk of shallow watertables.

Technical feasibility of salinity management

The potential for recovery of saline areas is low. Prospects for containment and adaptation are good to moderate because most of the area is reasonably well drained. Effects of salinity can be minimised by management such as planting trees and other perennials, and surface drainage.

- **Albany Sandplain Zone Central**

This covers one-third of the sub-region. It is bounded by the Stirling Ranges to the north, the Pallinup River to the east, the Kalgan River catchment divide to the west and the Southern Ocean in the south. It contains broad plains with numerous lakes and seasonally inundated depressions. The sandplain has poor internal drainage. Linear sand dunes and lunettes adjacent to swamps are common. Some of the deeper lakes are saline. Closer to the coast, small rivers improve drainage.

Groundwater flow systems

Groundwater beneath the sandplain is an intermediate to regional saline system with very low gradients (<0.5%) resulting in very little lateral flow. Groundwater discharge does occur in some places along the Pallinup River and in areas where lakes intercept groundwater; however the effect of this discharge is minimal. The smaller rivers close to the coast have local to intermediate groundwater systems and discharge into the Southern Ocean.

Groundwater depth, quality and trends

Depth to groundwater in the sandplain area ranges from 7 m to more than 20 m, while areas that drain into creeks have water within 5 m of the surface. Groundwater salinity ranges from 300 mS/m (brackish) to 3,300 mS/m (saline). Groundwater pH is 6 to 7 (neutral). Levels are currently rising at a steady rate of 0.10–0.15 m/yr (Figure 1: bores Koj1d88 and SH1d90).

Risk of shallow watertables

The sandplain has a medium risk of shallow watertables due to current depth and rate of rise. At the current rate, it will be more than 50 years before groundwater is close to the surface.

Low-lying areas where groundwater has risen and intercepted the surface will create discharge areas (usually lakes). The number of these areas will increase and more low-lying areas will become affected by salinity as groundwater levels rise.

Technical feasibility of salinity management

The recovery of salt-affected land has a low technical feasibility because it would require a significant reduction in recharge over a large area to impact on the regional aquifer. However with current management practices it is possible to adapt to salinity. Additionally, with the relatively deep groundwater, there is time to plan and implement containment strategies.

Warren–Denmark Zone (254)

The Warren–Denmark Zone covers one-quarter of the Albany Hinterland. The main landforms are lateritic plains, hills, dissected terrain and coastal dunes. They are based on sediments and colluvium over granitic rocks. The Denmark and Hay catchments contain large rivers.

Groundwater flow systems

The groundwater flow systems are local with boundaries similar to the topographic catchment divides.

Groundwater depth, quality and trends

Depth to groundwater is variable depending on landscape position. In the hilly areas it is 9 to 14 m below ground while in the lower areas closer to creeklines groundwater can be 1 m below ground.

Groundwater salinities vary with annual rainfall. In areas that receive less than 500 mm annual rainfall, salinities are greater than 2,500 mS/m (saline), while areas that receive more than 500 mm annual rainfall, groundwater salinities reach 1,300 mS/m. Groundwater pH is 6 to 6.8 (neutral).

Groundwater levels show strong seasonal trends that will continue until discharge areas are formed. Trends are mixed and range from a falling trend of 0.10 m/yr (Figure 1: bore GCR5d88), to a rising trend of 0.15 m/yr (Figure 1: bore NH11d88). This range occurs because of differences in aquifer responsiveness to rainfall, depth to groundwater and the various land uses applied to the landscape.

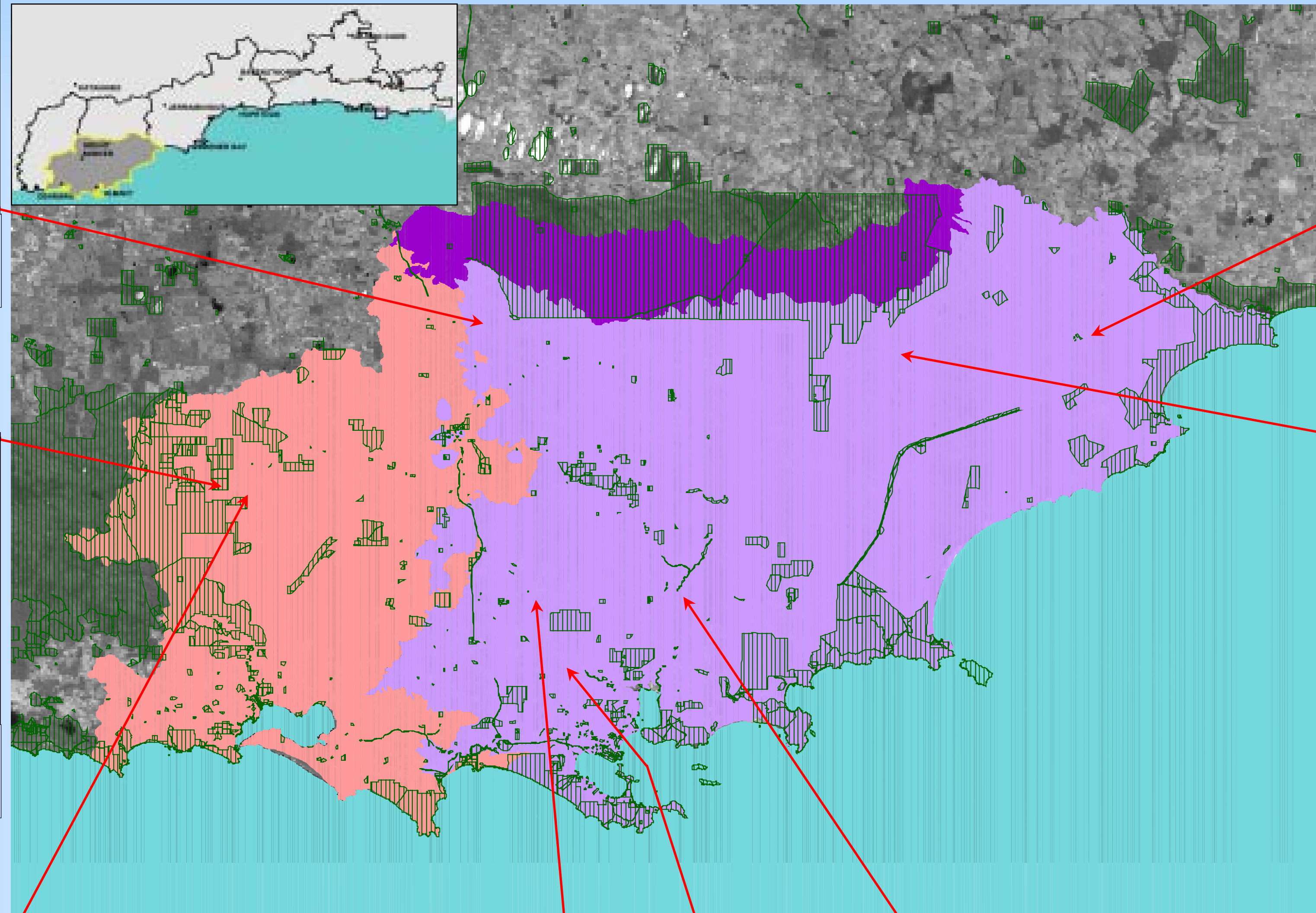
Risk of shallow watertables

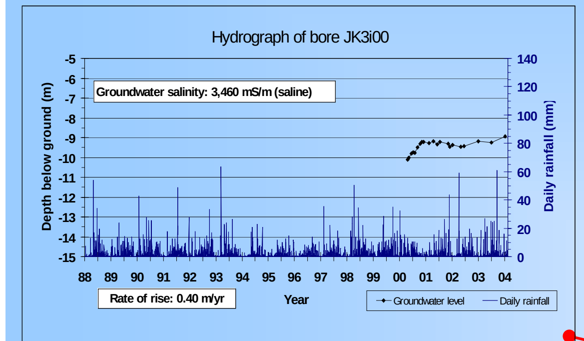
The zone has a moderate risk of shallow watertables (Table 1) which are predominantly expressed in valley floors and as hillside seeps. In some areas the presence of geological structures such as dolerite dykes and shear zones has caused shallow watertables to develop.

Technical feasibility of salinity management

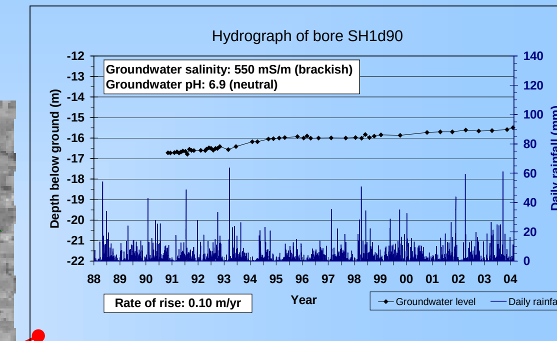
With current management practices, the technical feasibility of recovering salt-affected areas is good and the feasibility of containing salinity is excellent.

SCRIPT sub-region	Soil-landscape zone	Proportion of sub-region's agricultural land (%)	Time until potential salinity fully develops[SIF]	Salinity management technical feasibility[SIF]		
				Recovery	Containment	Adaptation
Albany Hinterland	Albany Sandplain (242)	73	Medium-term (30–75 yrs)	Low	Good	Moderate
	Warren–Denmark (254)	25	Imminent (<10 yrs)	Good	Excellent	Excellent

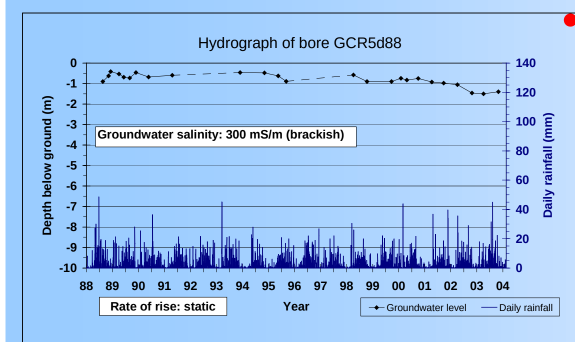




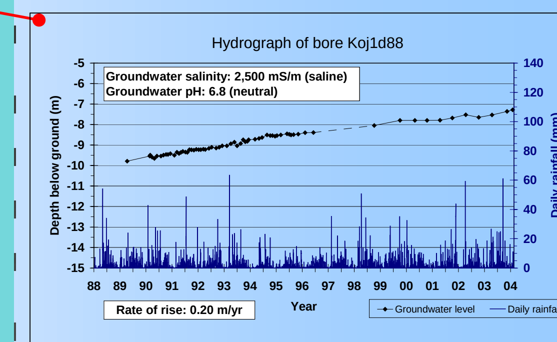
Location: East of Kendenup; Kalgan River Catchment
Soil-landscape system: Upper Kalgan (242Uk)
Soil: Deep grey sandy duplex
Land use: Cropping
Landform: Lower flats
Average annual rainfall: 525 mm



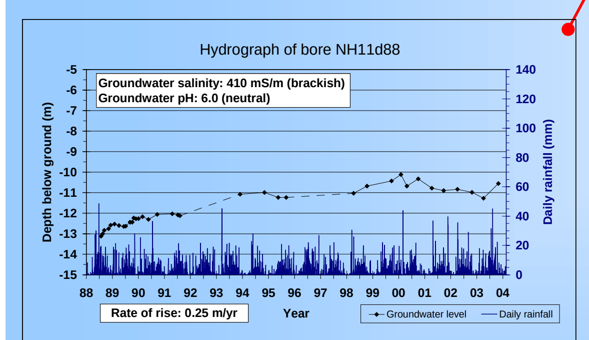
Location: North of Green Range; South Stirling Sandplain
Soil-landscape system: Chillinup (242Ch)
Soil: Pale deep sand
Land use: Annual pasture
Landform: Sandplain
Average annual rainfall: 500 mm



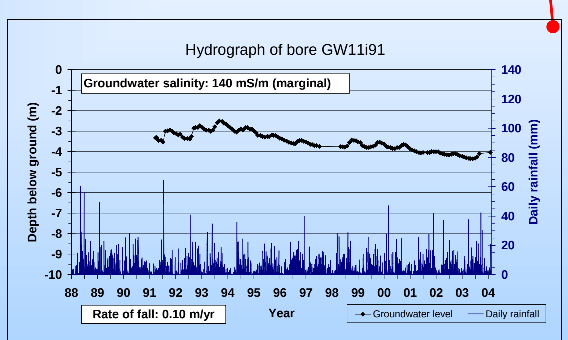
Location: West of Mt Barker; Denmark River Catchment
Soil-landscape system: Roe Hills (254Rh)
Soil: Duplex sandy gravel
Land use: Annual pasture
Landform: Valley
Average annual rainfall: 800 mm



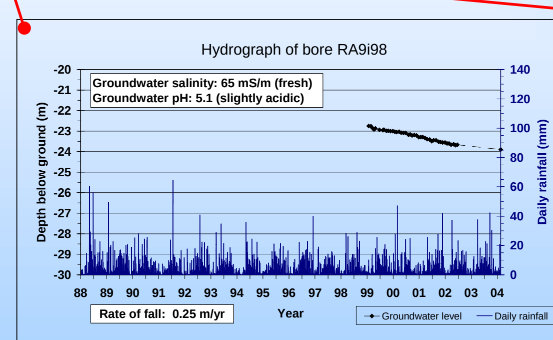
Location: East of Wellstead; South Stirling Sandplain
Soil-landscape system: Chillinup (242Ch)
Soil: Grey shallow duplex
Land use: Annual pasture
Landform: Open depression
Average annual rainfall: 500 mm



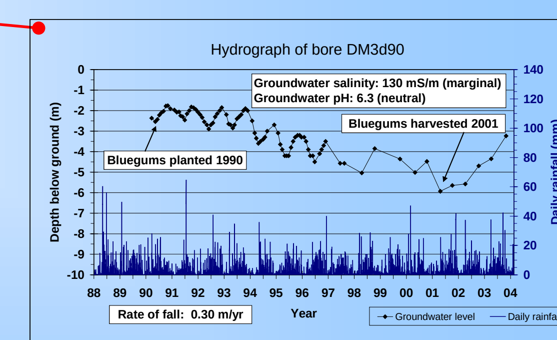
Location: West of Mt Barker; Denmark River Catchment
Soil-landscape system: Kent (254Ke)
Soil: Duplex sandy gravel
Land use: Annual pasture
Landform: Catchment divide
Average annual rainfall: 775 mm



Location: South-east of Narrikup; King River Catchment
Soil-landscape system: Redmond (242Re)
Soil: Deep grey sandy duplex
Land use: Annual pasture
Landform: Valley
Average annual rainfall: 775 mm



Location: North of Albany; King River Catchment
Soil-landscape system: King (242Kg)
Soil: Duplex sandy gravel
Land use: Perennial pasture
Landform: Upland flat
Average annual rainfall: 825 mm



Location: North-east of Albany; Kalgan River Catchment
Soil-landscape system: Redmond (242Re)
Soil: Duplex sandy gravel
Land use: Bluegums
Landform: Mid-slope
Average annual rainfall: 775 mm

Figure 1: Groundwater trends in the Albany Hinterland sub-region

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Table 1: Risk of shallow watertables for systems in Albany Hinterland sub-region

Soil-landscape zone	Soil-landscape system	% of sub-region's agricultural land in system	Risk of shallow watertables[NLWRA]			Proportion of system with low-lying areas (0–0.5 m)[LMP]
			2000	2020	2050	
Albany Sandplain (242)	Chillinup (242Ch)	28	M	M	M	20
	Redmond (242Re)	14	M	M	H	20
	King (242Kg)	12	L	L	L	10
	Upper Kalgan (242Uk)	8	M	M	H	20
	Porongurup Range (242Pr)	5	M	M	M	10
	Lower Pallinup (242Lp)	3	NA	NA	NA	10
	Mount Manypeaks (242Mm)	1	NA	NA	NA	<5
	Torbay (242Tb)	1	NA	NA	NA	-
Warren–Denmark (254)	Kent (254Ke)	15	M	M	H	10
	Kentdale (254Kd)	3	M	M	H	10
	Broke (254Br)	3	H	H	H	35
	Walpole Hills (254Wh)	2	L	L	M	5
	Nullakai Dunes (254Nk)	1	NA	NA	NA	-
	Wilgarup Valleys (254Wv)	1	NA	NA	NA	5
Stirling Range (248)	Jaffa (248Jf)	1	NA	NA	NA	10
	Stirling Range (248St)	1	L	L	L	15

Source: Short and McConnell (2001)

NLWRA and LMP: Refer to *Further Information* for definitions and risk categories

Further information

Soil-landscape zones and systems

Soil-landscape mapping in south-western Australia is based on a hierarchical system that enables correlation between surveys at different scales and maintains a consistent approach for dealing with areas of varying complexity in both landscape and soil patterns.

The first two levels of the hierarchy, *regions* and *provinces,* are based on the descriptions and framework introduced by the CSIRO Division of Soils in 1983 for the whole of Australia. The remaining four levels of the hierarchy - *zones, systems, subsystems* and *phases* are based on mapping conducted by the Department of Agriculture, Western Australia. At higher levels in the hierarchy the mapping units are based on regional geomorphological differences and at lower levels the individual soil and landscape components become more important.

The level of mapping unit is implicit in its label and as the scale of mapping increases, the label (in brackets) becomes more detailed. For example, the South Coast region falls into the Western Region (2) and predominantly within the Stirling Province (24) with some overlap into the Avon Province (25). Zones within these provinces are defined using geomorphological and geological criteria, and areas in these zones with recurring patterns of landforms, soils and vegetation, are grouped into systems. For example, the Albany Hinterland sub-region contains predominantly the Albany Sandplain Zone (242), which contains a number of systems, including the King (242Kg) and the Chillinup System (242Ch). The information in this publication pertains to the soil-landscape zone and system levels.

Groundwater flow systems

Groundwater processes causing salinity can be categorised according to their flow systems because the scale (local, intermediate or regional) reflects the ease with which salinisation can be managed.

Local groundwater flow systems are those where recharge and discharge of groundwater are in close proximity to each other — usually within 1–3 km. These systems are very responsive to land use changes.

Intermediate groundwater flow systems have a horizontal extent of 5–10 km and generally occur across several properties.

Regional groundwater flow systems have groundwater recharge and discharge areas separated by distances of 50 km or more and consequently are very slow to respond to land use changes. Regional groundwater flow systems can be overlain by local and intermediate groundwater flow systems.

National Land and Water Resources Audit (NLWRA)

The NLWRA was established in 1997 under the *Natural Heritage Trust Act*, to collect and collate primary data and information related to natural resource management. The extent and impacts of dryland salinity were identified as part of the NLWRA.

Risk of shallow watertables

Risk of shallow watertables was assessed using groundwater level trend data from the Department of Agriculture's AgBores database. Risk of shallow watertables (Table 2) was applied to entire systems based on assessment of the most frequently occurring groundwater depth and trend data for each unit.

Table 2: Definition of risk categories

Risk	Groundwater level and trend
High (H)	<2 m 2–5 m and rising
Moderate (M)	<2 m and falling 2–5 m and static or falling 5–10 m and rising >10 m and rising
Low (L)	5–10 m and static or falling >10 m and static
No risk	>10 m and falling
Not assessed (NA)	Insufficient groundwater data to make an assessment

Land Monitor Project (LMP)

The LMP was a satellite- and terrain-based assessment combined with mapping of salinity, topography, vegetation extent and change.

Low-lying areas

A digital elevation model was used to determine 'height above flowpath' in order to map low-lying areas. Height above flowpath measures the vertical elevation from flowpaths, which are areas where water flow accumulation is high (not just creeklines). Once the flowpath is defined, the low-lying areas within a discrete (0.0–0.5 m) height class above the flowpath can be identified. Low-lying areas may be at risk of flooding, inundation and waterlogging, and where groundwater levels are rising, indicate areas with a potential to develop shallow watertables.

Salinity Investment Framework (SIF)

The SIF was undertaken to guide public investment in salinity management initiatives. As part of the process, the range of salinity management options was assessed for each soil-landscape zone. The options included existing engineering and plant-based practices or systems that will deliver the maximum impact on the extent and severity of salinity.

Timing of salinity

Hydrological equilibrium occurs when the groundwater in an area of risk ceases to rise and the area of groundwater discharge ceases to expand. The average time required for a soil-landscape zone to reach hydrological equilibrium (Table 3) was assessed on the basis of available groundwater trend data and analyses prepared for the National Land and Water Resources Audit.

Table 3: Timing scales of salinity

Term	Time until potential salinity fully develops
Imminent	<10 years
Short-term	10–20 years
Short-medium term	20–30 years
Medium-term	30–75 years
Long-term	>75 years

Technical feasibility of salinity management

Technical feasibility is a measure of the availability and capacity of salinity management options to recover, contain or adapt to salt-affected land. The technical feasibility factors are largely qualitative and were based on published data and assessments by hydrologists from the Department of Agriculture. Technical feasibility is based on the average hydrological responsiveness of the entire soil-landscape zone.

Definitions of technical feasibility are:

- recovery – reverse the salinisation process and recover degraded land and water resources
- containment – manage salinity so that further impacts are minimised
- adaptation – live with and adapt to the consequences of salinity and minimise the losses.

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Acknowledgments

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