Appendix D: Management options description

Salinity can be addressed by a number of different management options and often a combination of options is required to not only remediate current salinity but also to prevent the future salinisation of land and water.

Management options for reducing the effects of salinity fall into five main categories: recharge reduction, discharge enhancement, engineering structures to prevent ocean inflows, ensuring appropriate leaching fractions and living with salt. Doing nothing may also be a valid response to salinity issues where low value assets are affected or where the cost of action is greater than the expected benefit.

D1 Recharge reduction

Recharge reduction treats the cause of salinity resulting from a high watertable. There are four main types of recharge control options:

- Agronomic: sowing higher water using pastures or crops;
- Tree establishment: planting high water using trees;
- Engineering: surface or sub-surface drains may be constructed to intercept and redirect water to drains or streams before it has the opportunity to leak to the watertable; and
- Irrigation management: ensuring more efficient irrigation.

A further management option that prevents future salinity is the protection of remnant vegetation.

D1.1 Agronomic options

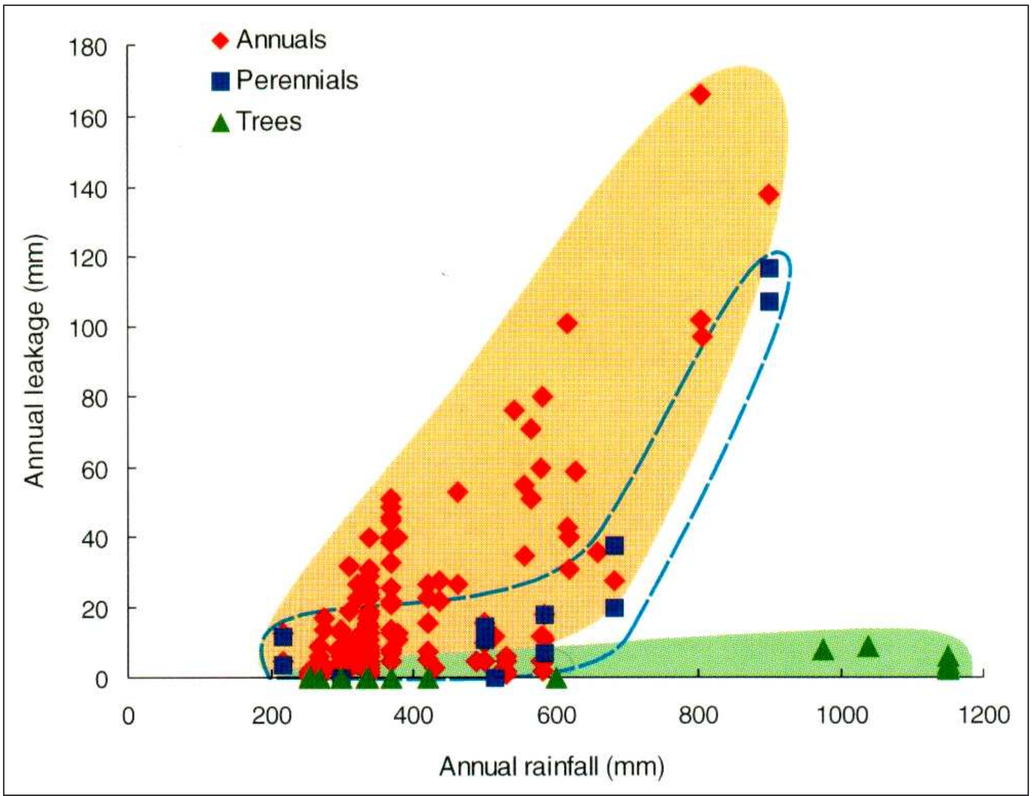
Agronomic options can be used to increase plant water use and decrease the amount of water passing through the root zone and adding to the groundwater store. As such, agronomic options address the cause of salinity resulting from a high watertable. The key agronomic option used for salinity control is the replacement of annual pastures with perennial species, which have deeper roots and a longer growing season. In some parts of South Gippsland where annual rainfall is above 750mm perennial rye grass grows almost year round (Gavan Lamb, DPI, *pers. comm.*, 2004). Perennial pastures can dry the soils to a greater extent than annual pastures, allowing more of the infiltrated rainfall to be stored in the soil profile during the higher rainfall autumn and winter periods. The result is less recharge to the watertable. Differences in water use between annual and perennial pastures are most pronounced in inland areas receiving less than about 600mm annual rainfall.

Pastures across much of the West Gippsland region are already based on perennial species (especially perennial ryegrass). Given this and the relatively high rainfall in the region, there is only limited scope to increase water use and decrease groundwater recharge by agronomic means.

Some of the key perennial pasture species suitable for reducing groundwater recharge include Lucerne, Phalaris, Cocksfoot and some of the native grasses such as Kangaroo Grass.

Figure 18 shows the relationship between annual rainfall and recharge for annual and perennial pastures and trees. It shows that in areas where rainfall is less than 600mm per year, replacing annual pastures with perennial pastures can significantly reduce the amount of recharge. In areas where the rainfall is greater than 600mm per year, perennial pasture is less effective, though it still results in a recharge reduction. Replacement of annual pasture with trees reduces the recharge much more significantly than perennial pasture under all rainfall volumes, but particularly in areas where rainfall is greater than 600mm per year.

- **Figure 18: Relationship between annual rainfall and recharge for different vegetation types (Walker *et al*, 1999)**



D1.2 Tree establishment options

As Figure 18 shows, recharge under trees is significantly less than under annual or perennial pastures under all rainfall volumes but particularly under rainfall of greater than 600mm per year. In high rainfall regions (>600mm/year) replacing annual pastures with perennial pastures is unlikely to result in a significant reduction in recharge. In these areas trees are the management option most likely to result in a significant recharge reduction and siting these trees in recharge zones will be an important management issue.

To ensure a multi-benefit outcome, trees are best planted in conjunction with either biodiversity or forestry programs. Tree planting for salinity control alone is not likely to be cost effective without the added benefit of increased biodiversity of increased economic output associated with forestry activities. In the West Gippsland region, there are significant opportunities to combine salinity control with both biodiversity and forestry outcomes.

The water use by trees can vary as a result of the species, the age of the stand and the density of planting. Species selection is an important consideration from both a recharge reduction and a biodiversity perspective. The most effective plantings will be in recharge zones or at break of slope. There may be an opportunity for incentives such as greenhouse credits as forests are known to sequester carbon.

The South Gippsland Salinity Management Strategy recommended extension of private forestry as a way of reducing recharge. The minimum rainfall in the South Gippsland area (covered by the Foster and Port Albert Salinity Management Areas) is 600mm increasing to as much is 1200mm in parts of the region. The land is relatively flat, still tractable in winter and there are several mills catering to the extensive private hardwood and softwood plantations in the area. Few farmers have invested in private forestry in the area, despite the suitability, mostly due to the long lead time before a profit can be realised. The South Gippsland Salinity Management Strategy identified the Giffard Plain as an area particularly well placed for plantations, particularly given the current and recent low returns to sheep farmers.

The planting of indigenous trees and shrubs can have significant biodiversity benefits. Plantings can enhance the population of threatened species, increase habitat for native fauna and increase the overall biodiversity of the area. Therefore, there is a strong need to ensure that planting trees for salinity control is coordinated with activities associated with the various native vegetation action plans (eg West Gippsland Native Vegetation Plan).

In addition to reducing groundwater recharge to the watertable aquifer, planting trees and woody indigenous shrubs may also affect the recharge to deeper aquifers where they outcrop and decrease runoff to stream and rivers. Although these effects are not likely to be significant enough to result in trees not being suitable for salinity control, natural resource managers need to be aware of these secondary effects when planning tree planting activities.

D1.3 Surface drainage

Improving surface drainage prevents water from ponding and causing excessive recharge. It also reduces the opportunity for waterlogging, which often coincides with land salinity. In areas with a high watertable, deeper drains can intercept groundwater throughflow and enhance discharge, helping to remove salt from the landscape and reduce the area of salt affected land.

D1.4 Improved irrigation management

Irrigation management as a salinity control option is mainly applicable to the Macalister Irrigation District but is also relevant to the irrigation areas in the Port Albert and Bengworden Salinity Management Areas and any new "greenfield" irrigation developments. Increasing irrigation efficiency reduces the volume of groundwater recharge and decreases the risk of salinity. The key activities that potentially have a recharge benefit include:

- *More efficient flood irrigation.* Most of the irrigation in the Macalister Irrigation District is flood irrigation especially on the lower permeability soils. Flood irrigation can become more efficient through:
- *Laser grading of irrigation bays* to ensure an even topographic grade (many irrigation layouts in the MID are already laser graded but the proportion and distribution are unknown);
- *Ensuring appropriate 'cut off' points for irrigation events* (ie not allowing the flood irrigation front to progress too far down the bay before cutting off the water flow)
- *Increasing flow rates to the tops of bays.* Recent work on the IBIS flood irrigation trial near Newry has shown that increased flood irrigation flow rates can decrease overall water use and groundwater recharge. Preliminary figures suggest that on the high permeability soils, the volume of recharge can be reduced by 46mm/irrigation or approximately 322mm/year (G. Lamb, DPI, *pers. comm.*, 2004).
- *Conversion of flood to spray irrigation* – Significant reductions in recharge, runoff and water consumption can be achieved through conversion from flood to spray irrigation especially on the higher permeability soils. A Sinclair Knight Merz (2001c) study calculated the approximate recharge reduction achieved by converting from flood to spray irrigation on various soil permeabilities based on survey results of farmer irrigation practices. The distribution of the soil permeabilities referred to in Table 83 are shown in Appendix I. Table 83 shows that conversion from flood to spray irrigation can result in a recharge reduction of between 57% and 82%.

Table 83: Estimates of average recharge reduction achieved in the Macalister Irrigation District by converting from flood to spray irrigation (from SKM, 2001c)

Soil permeability*	Average recharge rates for flood irrigation (mm/year)	Average recharge rates for spray irrigation (mm/yr)	Reduction in recharge rate by flood to spray conversion	% Reduction in recharge rate by flood to spray conversion
High to very high	795	144	651	82%
Moderate to high	307	114	193	63%
Low to very low	63	27	36	57%

* See Appendix G for distribution of soil types.

D2 Discharge enhancement

Discharge enhancement treats the symptoms of a high watertable and/or influx of saline water from the ocean by increasing the volume of groundwater being discharged resulting in a reduction in the watertable level. There are two main types of discharge enhancement options:

- Sub-surface drainage (engineering options such as groundwater pumping and tile drains)
- Tree establishment (eg trees used at break of slope to intercept groundwater prior to discharging further down-gradient)

D2.1 Sub-surface drainage

The most obvious engineering option to engender discharge enhancement is groundwater pumping. Groundwater pumping is used extensively in the Macalister Irrigation District and surrounds for salinity control. The main advantage of groundwater pumping is the very rapid effects on watertable levels and land salinity, which are not achieved through recharge control measures.

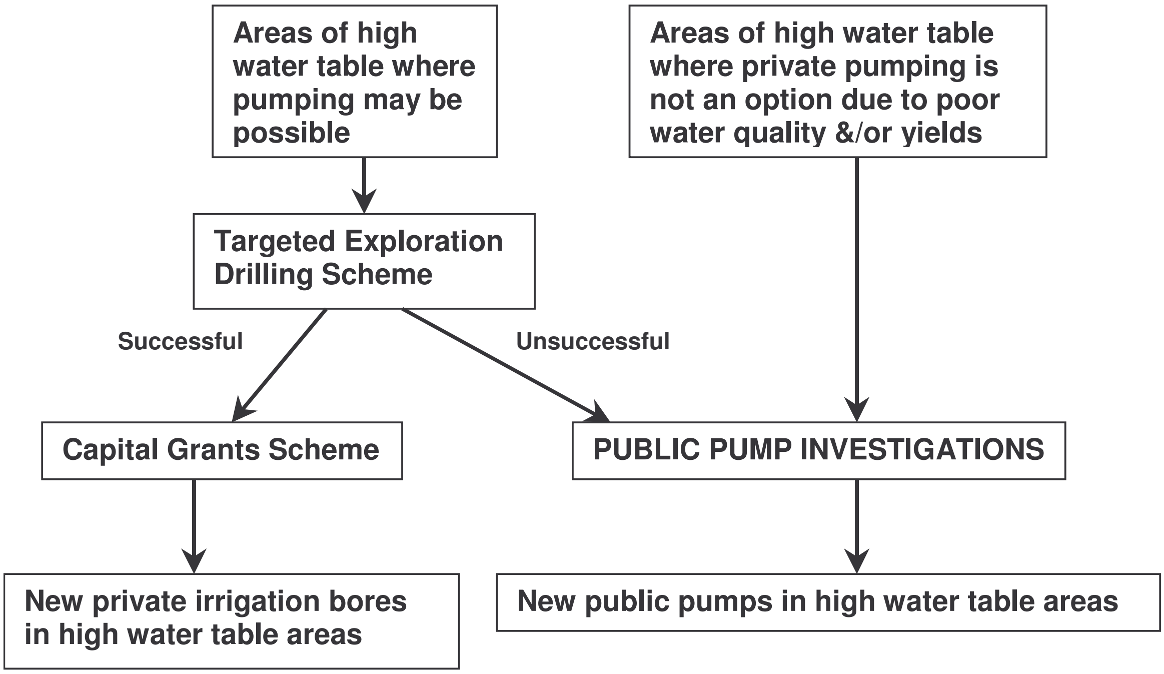
There are two types of groundwater pumps that reduce the watertable levels in the Macalister Irrigation District:

- Private irrigation bores pumping from the shallow aquifer; and,
- Public Groundwater Control Pumps, which are Government owned bores specifically designed to reduce watertable levels for salinity control purposes. Groundwater from these bores is discharged to drains, rivers, or channels.

Both public and private groundwater pumps tap a shallow aquifer occurring at a depth of between 5 and 20 metres. This aquifer occurs over much of the region but can be variable in thickness, yield and water quality.

The key decision making process in the "MID salinity mitigation procedure" relating to choice of private or public groundwater control pumps is illustrated in Figure 19. The "Targeted Exploration Drilling Scheme" and the "Capital Grants Scheme" referred to in Figure 19 are described below.

▪ **Figure 19: Decision process in choice of public or private groundwater pumping investigations (modified from the MID Salinity Mitigation Procedure)**



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Private irrigation bores

Reducing watertable levels by encouraging private pumping is preferable to the installation of new Public Groundwater Control Pumps for the following reasons:

- Private use of groundwater enables the groundwater resource to be used for productive purposes;
- On-going operating costs of Groundwater Control Pumps have to be borne by the local community;
- Pumping to drains, rivers and channels has adverse effects on water quality with environmental and diversion implications.

The recent increase in the number of private irrigation bores across the region has significantly reduced the watertable level in some areas (especially in the Nambrok/Denison area).

A landowner incentives program was recently trialed in the area to encourage the installation of new shallow irrigation bores in high watertable areas through two linked schemes:

- The Targeted Exploration Drilling Scheme (TEDS); and
- The Capital Grants Scheme.

The Targeted Exploration Drilling Scheme provides subsidised shallow groundwater investigations to locate suitable sites for new irrigation bores. The Capital Grants Scheme provides financial assistance to landowners for the installation of groundwater pumps. Both schemes are based on appropriate cost sharing arrangements between the landowner and the Government. The schemes are only available to landowners in high watertable areas that have been specifically targeted by the implementation program.

Groundwater Control Pumps

Groundwater Control Pumps are installed to reduce the effects of a high watertable only if private pumping is not a viable option either due to high groundwater salinity and/or low aquifer yield. There are currently 17 Groundwater Control Pumps operating in and around the Macalister Irrigation District (see Table 84 and Figure 20. There is also one privately owned bore which the landowner is paid to pump for salinity control (Barrett's Bore). 11 Public Groundwater Control Pumps and Barretts Pump were commissioned under the Lake Wellington SMP. The groundwater pumping program has been highly successful in lowering the watertable in the MID and contributing to salinity management.

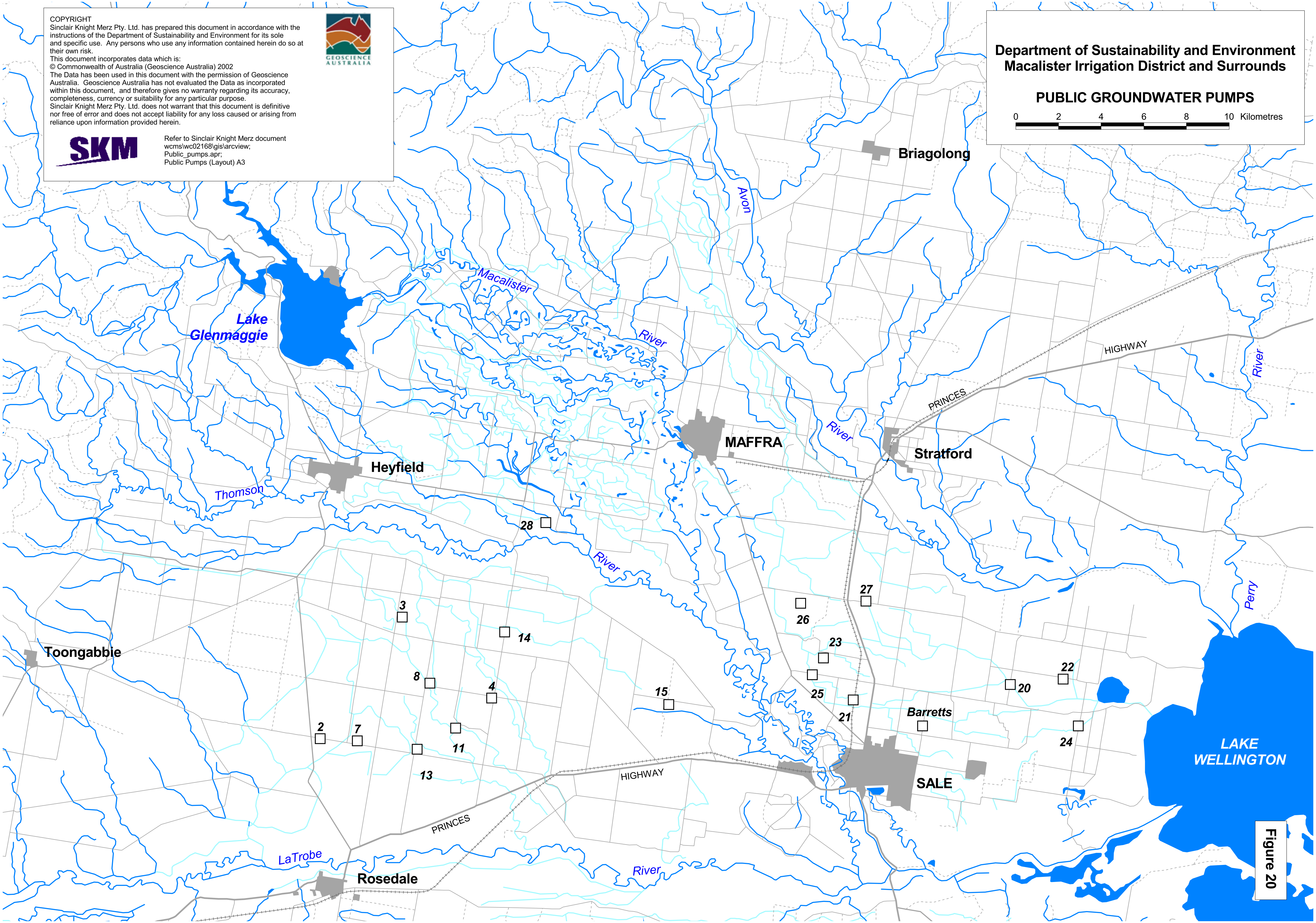
- **Table 84: Characteristics of Groundwater Control Pumps operating in and around the Macalister Irrigation District**

Pump ID	Location	Area of influence (ha)	Pumping rate (ML/d)	Annual volume pumped (ML)	Water salinity (EC)	Year installed	Receiving waters
2	Sale - Toongabbie Rd Winnindoo	1520	3.7	1300	5400	1960	CG No2A/1 Dr
3	Grattan's Denison	2830	4.5	840	700	1960	CG No2 Dr
4	Maffra - Rosedale Rd Nambrok	1520	5.0	1000	2100	1960	CG No 4/1/3 Dr
7	Sale - Toongabbie Rd Winnindoo	350	0.7	250	7000	1960	CG No 4/1 Dr
8	Fire Station Nambrok	530	1.2	100	100	1960	CG No 2 Dr
11	Killeens Road Nambrok	1130	1.3	500	1500	1960	CG No 3/2 Dr
13	Warren's Nambrok	800	2.4	800	1700	1994	CG No 2/2 Dr
14	Barnett's Denison	420	0.5	180	3000	1997	CG No 6/2/3 Dr
15	Langshaw's Fulham	900	1.6	580	5000	1997	CG No 4 Dr
20	Bengworden Rd Clydebank	560	1.4	510	9200	1994	Lake Wellington Main Drain
21	Napper's Bundalaguah/Sale	370	1.0	360	3000	1995	Lake Wellington No 2/3 Dr
22	Hughes Rd Clydebank	3850	2.2	800	11000	1996	Private drain to L Kakydra
23	Yuill Rd Bundalaguah	380	0.5	150	3000	1996	Lake Wellington No 4/3 Dr
24	Hearthall Rd The Heart	370	1.0	360	20000	1996	Lake Wellington No 1 Dr
25	Mrytlebank Rd Bundalaguah	200	1.0	360	600	2000	Main Sale Channel
26	Montgomery Rd Bundalaguah	160	0.6	180	3500	1999	Lake Wellington Drain 10a
27	Clydebank Rd Montgomery	550	1.0	200	7000	2000	Lake Wellington Drain
Barretts	Somerton Park Road, Sale	150	0.3	110	6000	1995	Lake Wellington No 1 Drain
TOTAL		**9840**		**5090**			

Department of Sustainability and Environment Macalister Irrigation District and Surrounds

PUBLIC GROUNDWATER PUMPS

Figure 20



Refer to Sinclair Knight Merz document
wcms\wc02168\gis\arcview;
Public_pumps.apr;
Public Pumps (Layout) A3

In addition to the Groundwater Control Pumps listed in Figure 20 there are a number of pumps in various stages of investigation and implementation (see Section 6.4.5).

The decision to install a Public Groundwater Control Pump is made after extensive investigations including:

- Compilation of depth to watertable maps;
- Mapping of land salinity;
- Use of computer models to determine the likely future depth to watertable and the impact of new groundwater pumps;
- Investigation into the possibility of encouraging more private groundwater pumping to lower the watertable;
- Consultation with landowners to determine trends in land salinity and the need for remedial action;
- Use of a computer model to determine the impact of discharging saline groundwater to drains or rivers;
- Consultation with drain and river diverters downstream of discharge point; and
- Evaluation of the social, environmental and economic costs and benefits of new Groundwater Control Pumps.

A Public Groundwater Control Pump is only installed if the economic and/or social benefits outweigh the costs and if the discharge of water to drains and rivers does not have environmental consequences nor have significant adverse effects on downstream water users.

Groundwater Control Pumps are operated when watertable control is needed. During unusually dry periods, many of the pumps are turned off due to lower groundwater recharge rates and the increase in private pumping. Conversely, during wet periods more pumps are turned on. The operation and maintenance of the Public Groundwater Control Pumps is managed by Southern Rural Water.

The investigation and installation costs associated with Public Groundwater Control Pumps are funded by the State Government. The operation and maintenance of the pumps is jointly funded by irrigators and the Wellington Shire. The irrigators' contribution is through the 'Salinity Mitigation Levy' of $0.40 per megalitre of water used.

Groundwater pumping from the shallow aquifer in the area has been highly successful in reducing the watertable level and the effects of salinity, especially in the Nambrok, Denison and Clydebank areas. For example, in 1991, there were approximately 7,000 hectares of land in the Nambrok/Denison region with a watertable depth of two metres or less which has now been reduced to approximately 4,900 hectares. A dramatic improvement in the soil salinity levels and pasture quality has been measured around Public Groundwater Control Pumps. This is confirmed by landowner comments about the improved productivity around these pumps.

Free flowing bores
The free flowing bore network in the MID was established in the 1960s and consists of 84 free flowing bores in the Nambrok-Denison area and 18 in the Cobains area. The bores provide a discharge point for the high watertable in the area and discharge into drains. The only costs after installation are for maintenance, as they do not require electricity.

Tile/Mole Drains
Tile/mole drains buried underground intercept groundwater and flow into a discharge pond/drain. They help to relieve groundwater pressure but may conflict with drain management as salt or nutrient levels may be increased in downstream drains.

D2.2 Tree establishment options

Planting trees at the break of slope can intercept relatively fresh groundwater and use it before it discharges further down-gradient where it often becomes too saline for trees. The advantage of this option for salinity benefits is that surface water run-off and groundwater flows slow and accumulate at topographic breaks of slope resulting in these locations being wetter and more likely to leak than other locations. Trees planted here can store and use this water rather than allowing it to leak to the watertable or discharge to the surface. Additionally, planting trees can provide shelter for stock, increase the value of land, improve the landscape and have biodiversity benefits. Although, planting tree belts may be difficult and expensive to fence and will occupy land suited to pasture, the benefits may offset some of the costs.

D3 Engineering structures to prevent saline inflows from lakes or ocean

The opening of the permanent entrance to the Gippsland Lakes has steadily increased the salinity of the entire Lakes system. Many surrounding wetlands have become saline. Engineering options to prevent saline water flowing into parts of the Lakes system or from the lakes into surrounding wetlands may help to retain them as freshwater lakes and wetlands.

D4 Ensuring appropriate leaching fractions for irrigated land

It is possible to irrigate with saline water without resulting in a pasture yield decline provided the volume of water applied is sufficient to flush the salts through the soil profile. Irrigation management extension can highlight the importance of ensuring appropriate leaching fractions for irrigated land to prevent salinity caused by under-irrigation with saline water.

D5 Living with salt

Living with salt treats the symptoms of salinity caused by a high watertable and/or influx of salinity from the ocean and makes use of the ‘opportunity’ that salinity represents. Agronomic options include salt tolerant pastures, crops and shrubs. Saline aquaculture or salt harvesting operations are also available options although the proximity to the coast and temperature variations make saline aquaculture unlikely to be viable. Salt harvesting operations require extremely saline water and sufficient supplies making it better suited to other regions.