4. Yarram Setting

Located to the south of the town of Yarram in the vicinity of Alberton, the largest of the mapped salinity discharge sites in the area occurs in the floodplain of the Albert River, just inland from its coastal estuary. Several smaller areas are mapped in the vicinity of Alberton West on farming land between some low hills to the south and the Alberton River to the north.

Figure 25 below shows a view of the discharge area mapped on the Albert River flats south of Yarram.

Figure 25. View north across the Jack River flats from the Old Alberton West Road.

4.1. Yarram Climate

As for Rosedale and Inverloch, 56 years of data drill climate data (1950 to July 2006) that includes daily rainfall and evaporation data was obtained from the SILO website for coordinates 38° 40' S and 146° 45' E. Mean annual average rainfall is mapped as being between 700 to 900 mm and mean annual potential evaporation is between 900 to 925 mm.

The data was processed the same as for the Rosedale and Inverloch data, with a resultant plot of daily potential recharge illustrating the variability in rainfall and evaporation over the years (see Appendix A). Of note (compared to the other two areas) is that the Yarram area displays a similar pattern to Rosedale. Given that Yarram and Rosedale are only about 50 km apart and in similar rainfall contour zones, the similarity in both pattern and magnitude of potential recharge events is not unexpected.

The 'estimated total annual recharge' plot (**figure 26**) shows that in all but 3 years (1982, 1994 and 1999), recharge conditions are likely to have occurred. However, the conditions at Yarram are relatively less conducive to recharge than the other two areas. The trend towards drying conditions is more pronounced than at Inverloch (despite both being on the coast) and similar to Rosedale. The decade to 1960 had an average of 93 mm/year recharge, but has declined to 78, 59, 52 then 37 mm/year over the next 4 decades. The 5 year rolling average line also clearly shows this declining recharge trend.

While the absolute recharge values and the method of their calculation could be debated, the method treats the raw daily rainfall and FAO evaporation data consistently across the three areas and throughout the period of record, so there is no doubt that the climatic conditions at the three sites are different. At Yarram, the climate data suggests groundwater levels should be showing a decline commensurate with less frequency and duration of recharge events. Such a decline is indicated by bores 14133 and 14134. (See **Figure 29**). How quickly a GFS responds to rainfall depends upon the scale of the GFS, and in this case, the local and intermediate scale of these two GFS allows relatively quick response to rainfall trend.

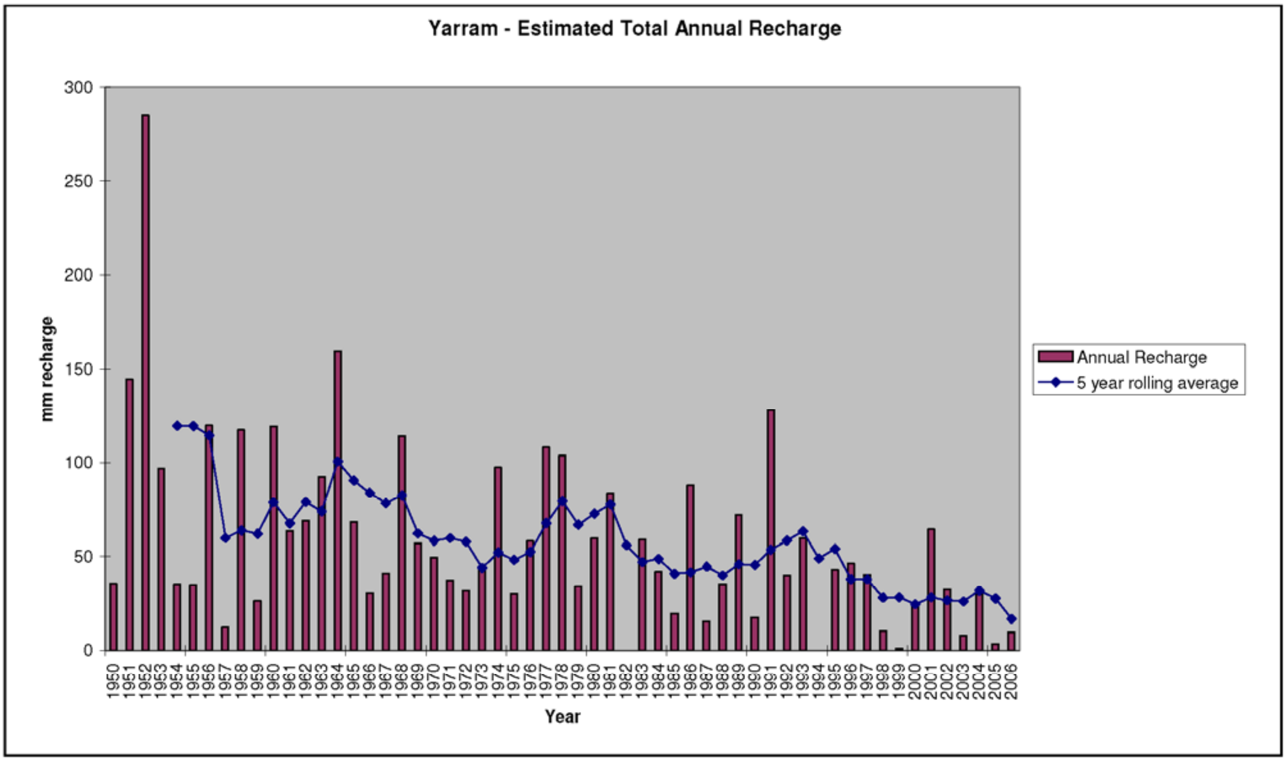

Figure 26. Estimated annual recharge for the Rosedale area

4.2. Yarram Groundwater Flow System

SKM (2005) defined both Tertiary and Quaternary Sediment based groundwater flow systems in the Yarram area. Parts of GFS 5, 10 and 11 are found in the vicinity. Both GFS 10 and 11 are very similar in geology and salinity status, with GFS 11 being the slightly higher areas inland and GFS10 being closer to the coastal areas and lakes. GFS 5 is mostly found upslope and beneath the quaternary GFS and forms the low hill to the west of Yarram.

For the full characterisation of GFS 11, see SKM 2005. The key characteristics of most importance in this Flowtube modelling exercise for the Yarram to Alberton salinity occurrence and upslope section (taken from the GFS report) are as follows:

Salinity Process – Influx of ocean water (on coastal fringe areas?) and discharge of intermediate groundwater flow system.

Groundwater Level Trend – Listed as 'rising', but hydrographs show discharge conditions have prevailed since monitoring began in 1992(ie. consistently near surface levels in bores in discharge areas) and the last few years have seen a decline in levels in some bores.

Groundwater salinity - 500 to 1000 mg/L TDS

Topography - less than 0.3^{o} slope

Soil Permeability – In the vicinity of Yarram – Alberton, low to high permeability is found.

Geology - Sands, gravels and clays.

Aquifer type - unconsolidated sediments

Aquifer properties (hydraulic conductivity, gradient, transmissivity, storage coefficient) - all unknown

Temporal recharge distribution - unknown

Spatial recharge distribution – unknown

Current landuse – Predominantly mixed farming.

4.2.1 Yarram conceptual model

The conceptual model developed for GFS 10 & 11 (see **figure 27** below) is that recharge occurs on the topographic highs, with local scale flow paths that follow ground surface gradient, leading to discharge at lower landscape locations. The mapped salinity sites in the vicinity of Alberton are primarily located on the lower floodplain – tidal zone, where it is unlikely that reduced recharge in the Yarram vicinity would have any benefit. Areas of high watertables in the Yarram – Alberton area are the product of low gradients, poor surface drainage and restricted lateral and vertical groundwater flow rates. This is partly due to the low gradients at or just above sea level in the shallow groundwater systems.

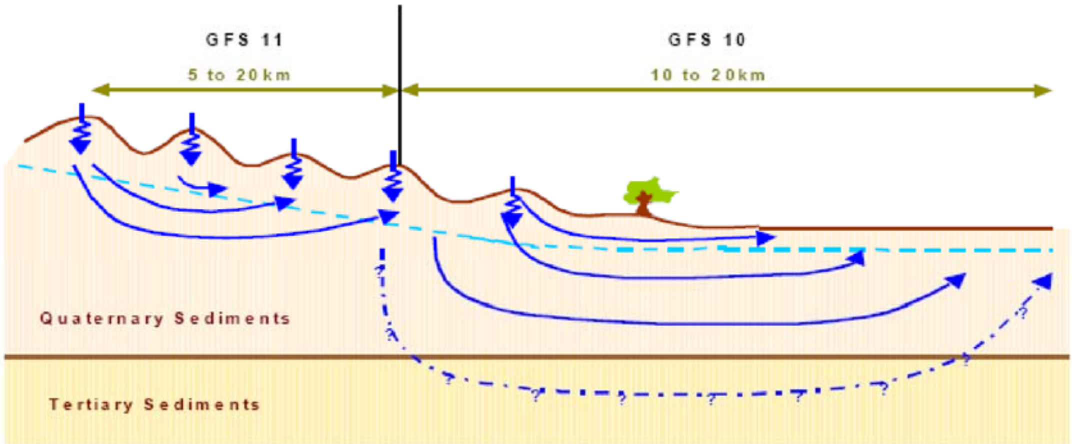

Figure 27. GFS 11 and 10 conceptual model (taken from SKM, 2005)

4.2.2 Yarram groundwater behaviour

Depth to groundwater data has been collected in the vicinity of the study site since December 1999**. Figure 28** provides a selection of depth to groundwater from natural surface in the form of a time series hydrograph. The monitoring bores are positioned adjacent to discharge zones on a river floodplain. Bores 14135 and 14136 are located at the Alberton West discharge site and show elevated groundwater levels within 1 metre of the natural surface. Groundwater behaviour with some seasonal response is seen in bores 14133 and 14134. Of note with these bores is the decline in levels sine 2003, which accords with the climatic data.

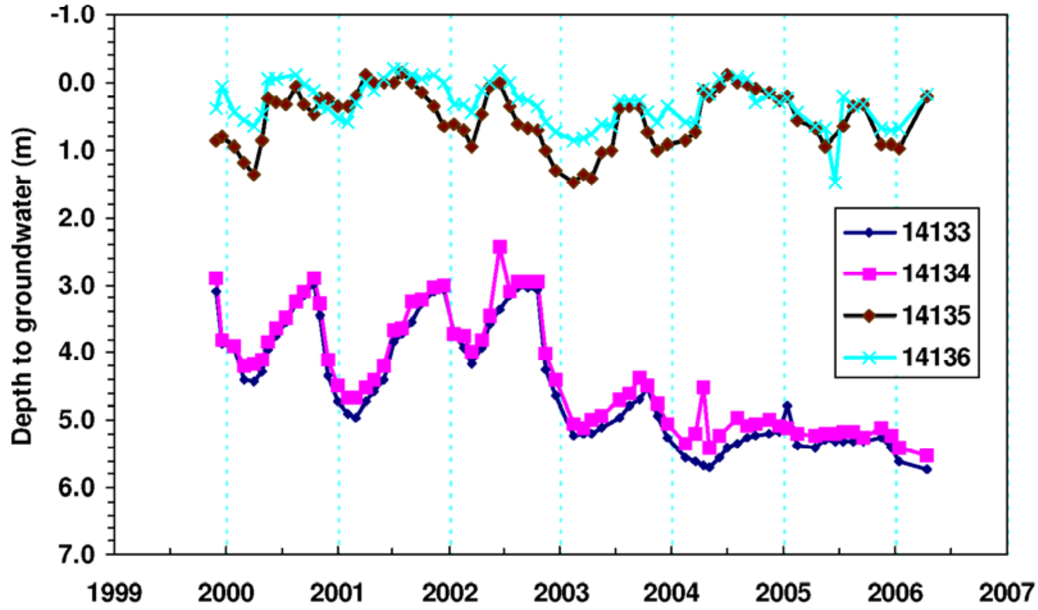

Figure 28. Hydrograph of selected groundwater monitoring bores at Yarram

4.3. Yarram - Results of modelling

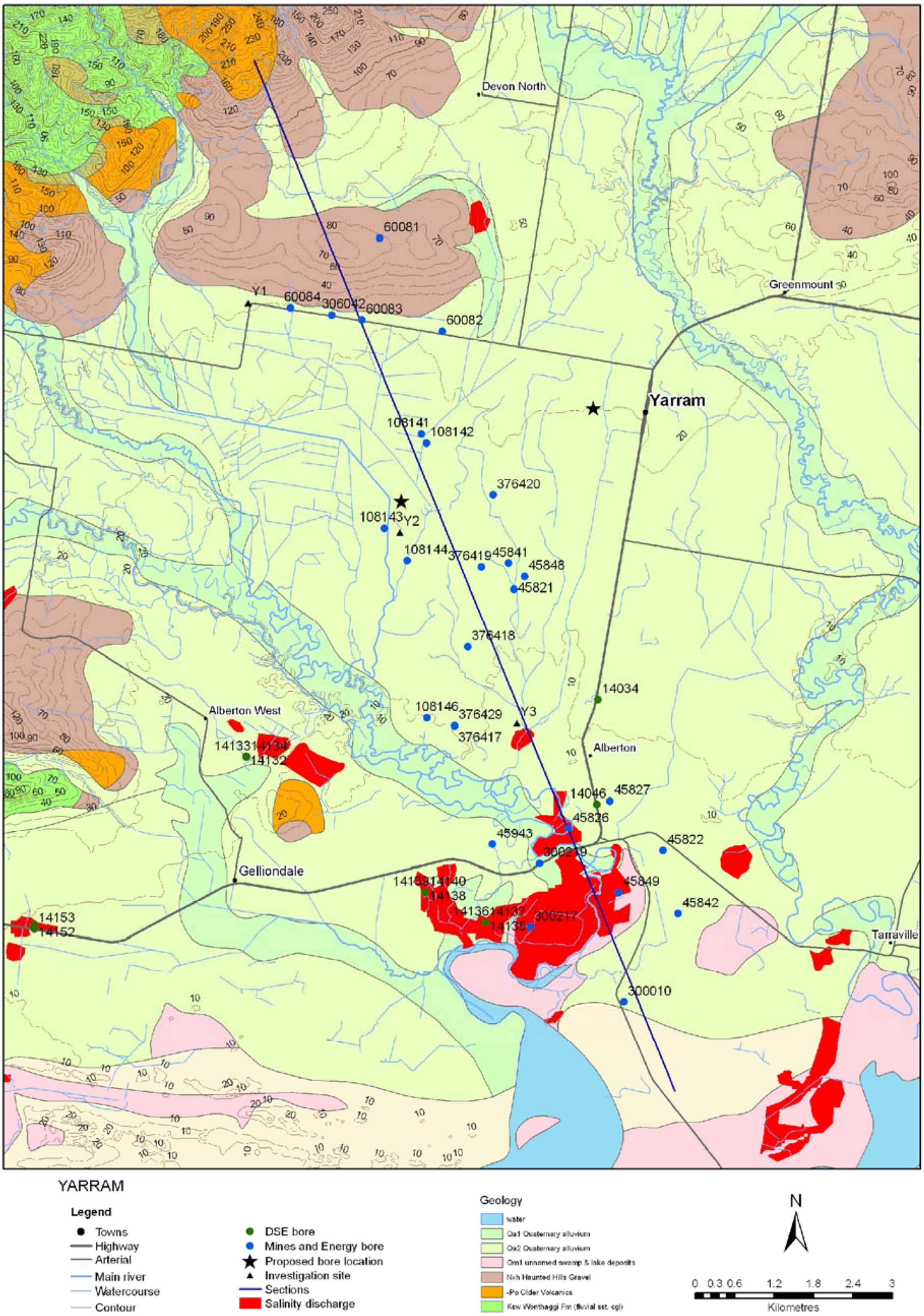

Figure 29. Yarram locality Plan

A cross-sectional landscape profile (along the line in **figure 29**) up-gradient of the Alberton area discharge sites was created in FLOWTUBE based on topography, groundwater flow system description, geological bore data and groundwater bore data. A schematic cross-section (**Figure 30**) was constructed based on the bore lithology logs to provide an understanding of below surface stratigraphy. The aquifer in FLOWTUBE has been represented as a two layer system, thinning towards the discharge site near Alberton.

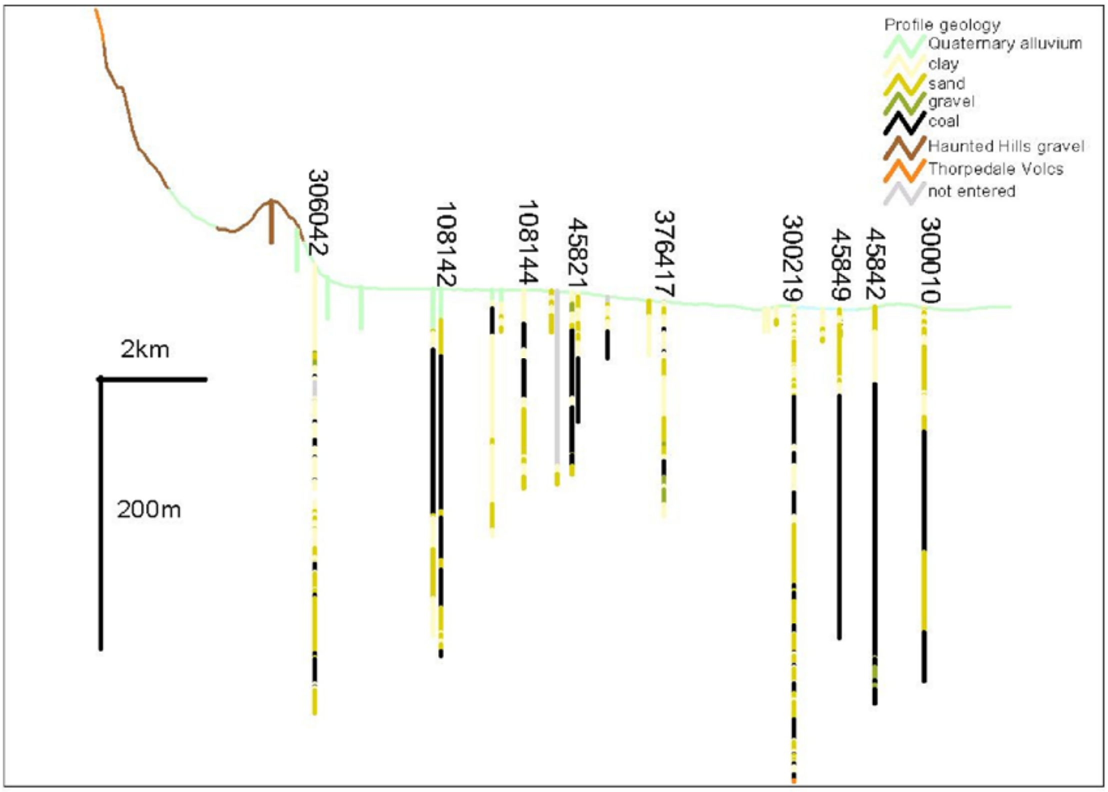

Figure 30. Geological cross-section though the Yarram site

The 'initial' model was designed and input to the program to replicate existing groundwater conditions, (**Figure 31)**. The model is made up of 13 sections each of which have been assigned aquifer parameters according to **Table 5**. The end of the "flowtube" has been designated as a free flow aquifer boundary. The groundwater surface has been modelled as an inclined surface based on existing bore data and the recent depth of groundwater investigation at the study site.

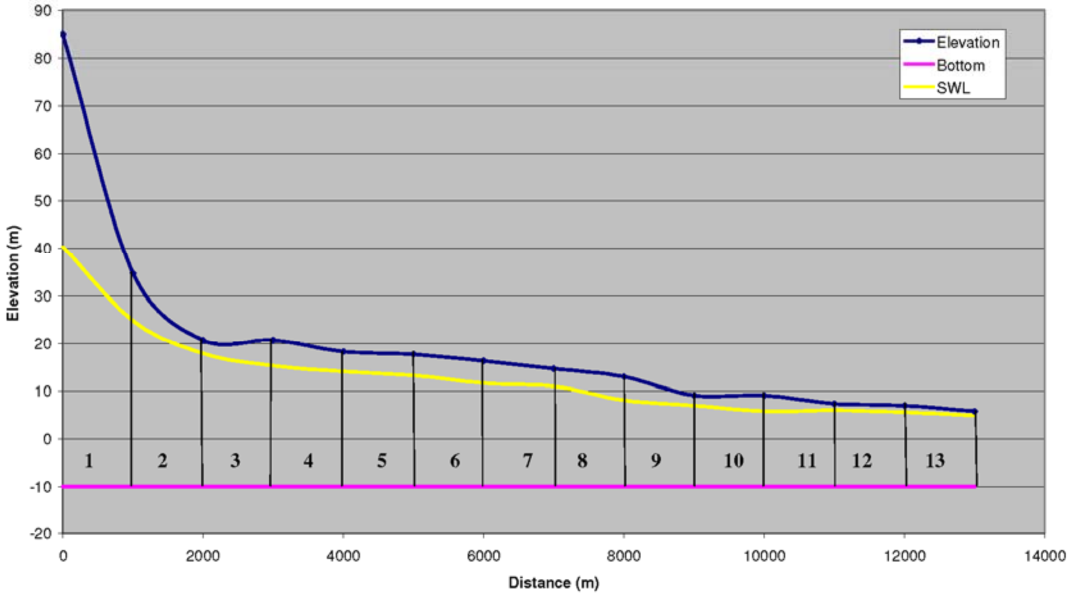

Figure 31. Initial groundwater conditions at the Yarram site showing model design and current standing water level

Table 5. Yarram aquifer parameters

Section	Aquifer thickness (m)	Upper layer K* (m/day)	Lower layer K (m/day)	Mean specific yield %
1	65	0.1	0.5	0.03
2	35	0.1	0.5	0.03
3	30	0.1	0.5	0.03
4	30	0.1	0.5	0.03
5	30	0.1	0.5	0.03
6	25	0.1	0.5	0.03
7	25	0.07	0.5	0.03
8	25	0.07	0.5	0.03
9	25	0.07	0.5	0.03
10	20	0.05	0.5	0.03
11	20	0.05	0.5	0.03
12	15	0.05	0.5	0.03
13	15	0.05	0.5	0.03

The “do nothing” scenario has been modelled using a recharge value of 50mm under annual pasture across each section, excluding the discharge site. The model was run for a 50year period, with the 10, 20 and 50 year water levels graphed on **Figure 32**. This simulation suggests a theoretical 4 metre rise of groundwater levels below at the discharge site after 50 years is possible. While such a level is clearly above ground surface, it equates to a linear increase in the size of the discharge area of some 1000m after 50 years. This means that if nothing further is done to control recharge rates, the area affected by salinity will expand in size.

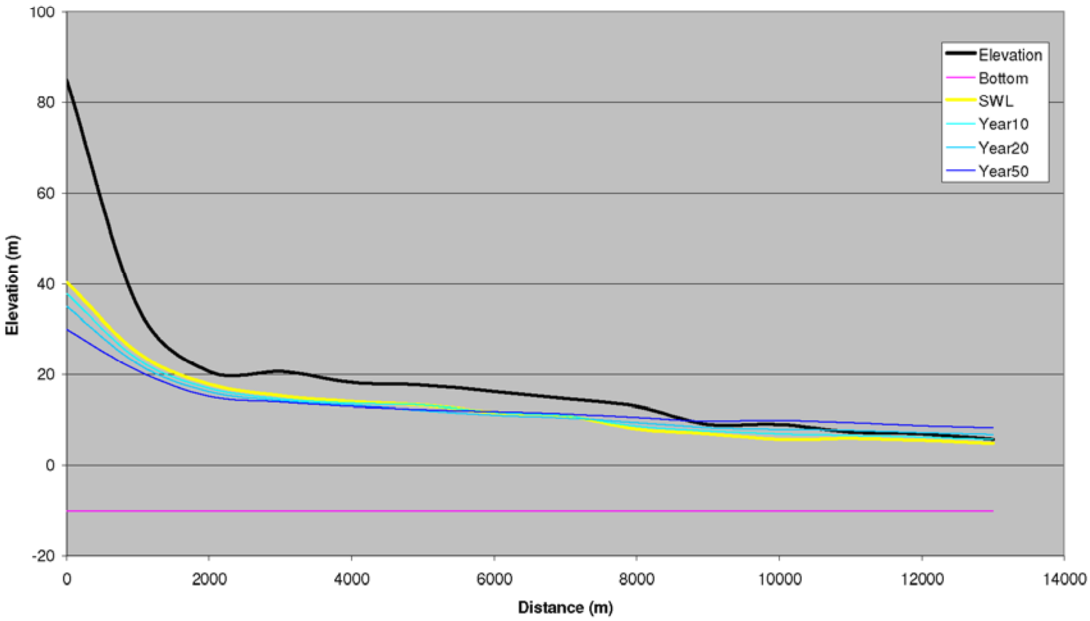

Figure 32. Yarram site modelled groundwater behaviour under a “do nothing” scenario

To assess the effect of reducing recharge through changed land management practice, a number of scenarios were tested based on a standardised volume of recharge beneath the various vegetative options (using the model defaults). The recharge values assigned to each scenario are based on previous modelling studies conducted by the FLOWTUBE developers, and may or may not be appropriate for the West Gippsland area.

Figure 33 shows the replacement of annual pasture with perennial pasture over the total length of the model domain using a recharge value of 5mm/year. The model was run for 20 years with two-year output frequency plots. This results in a total lowering of the water level below the discharge site of approximately 5.5 metres at 20 years. Note that the model assumes an instantaneous reduction of recharge of 75% at year 1 and does not allow for an establishment period to achieve maximum plant-water use.

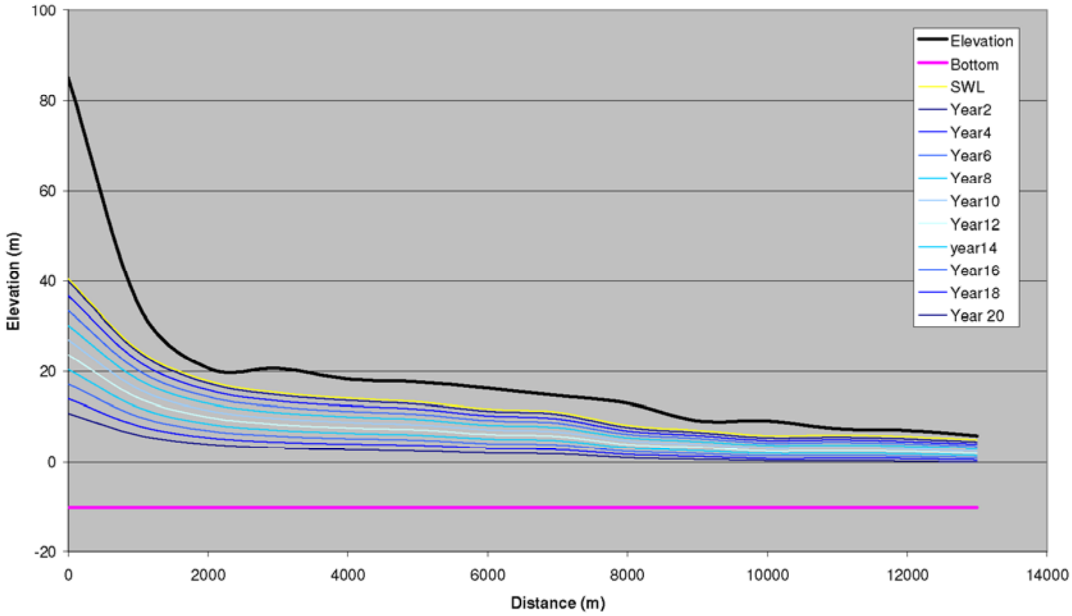

Figure 33. The Yarram site modelled under perennial pasture with 5mm / year recharge

The model was also run for a 20 year period to simulate a tree/pasture scenario of 50% of the landscape with trees and 50% with perennial pasture. The trees were positioned in the upper landscape and assigned a lower recharge value of 3mm / year. Perennial pastures are established on the slope leading to the discharge site and assigned a recharge value of 5mm/year.

The groundwater response under this scenario (see **Figure 34**) showed a greatly increased decline in water level below the treed 'ridge' section (compared to the perennial pasture only option) of approximately 14 metres. Under the perennial pasture (lower) section, the standing water level impact is similar to the all perennial scenario, with a fall in groundwater level of up to 7 metres at the discharge zone. The results of the modelling are summarised in **Table 6**

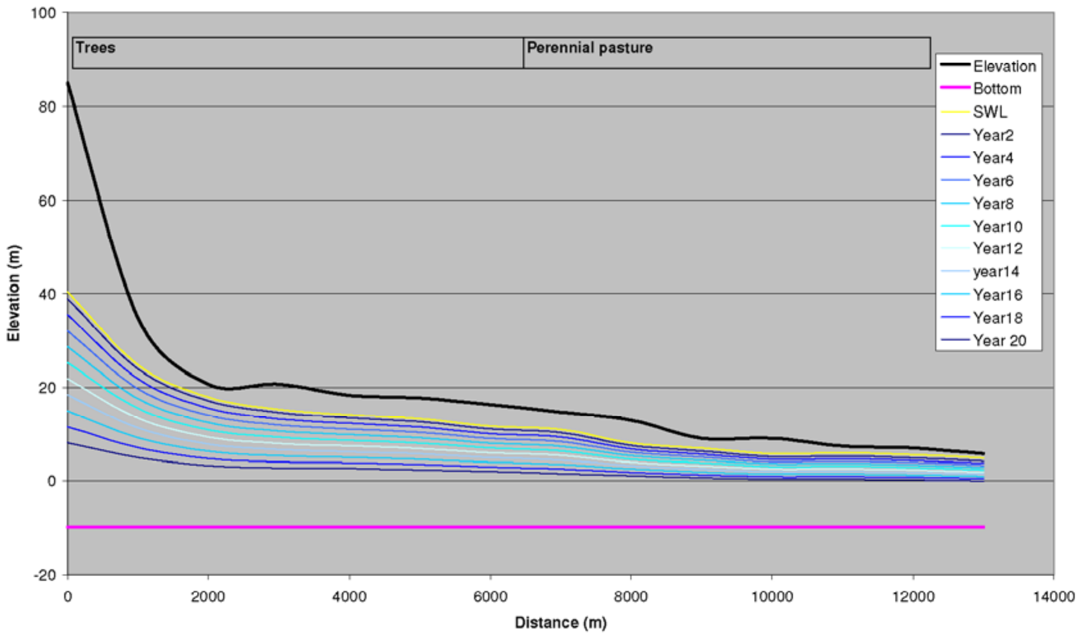

Figure 34. The Yarram site modelled under 50% trees and 50% perennial pasture

Table 6. Summary of Yarram FLOWTUBE results.

Scenario	**Change in depth to groundwater from initial conditions (m)**								
Landscape position	**Ridge**			**Mid slope**			**Discharge zone**		
Time step (years)	**10**	**20**	**50**	**10**	**20**	**50**	**10**	**20**	**50**
"do nothing"	-2.62	-5.45	-10.4	0.0	-0.62	0.21	0.91	2.01	3.55
Time step (years)	**10**	**15**	**20**	**10**	**15**	**20**	**10**	**15**	**20**
All perennial pasture	-2.32	-3.25	-4.65	-2.51	-3.53	-5.45	-2.52	-3.54	-5.46
50% tree 50% perennial	-7.42	-10.4	-14.9	-2.95	-4.13	-5.99	-3.55	-4.97	-7.11

4.4. Discussion of Yarram FLOWTUBE results

A FLOWTUBE model of the Yarram site was constructed from the ridge approximately 13 kilometres to the north of the study area towards the Alberton area discharge zone. The depth to groundwater investigation successfully intersected the groundwater levels over the floodplain to the north west of the township of Alberton. Groundwater levels in the three soil investigation core holes were measured from 1–4 metres from natural surface. In combination with existing bore data, the FLOWTUBE model was able to simulate the current groundwater surface. The model has been constructed with a free flow boundary at the end of the "flowtube" to simulate the estuarine environment adjacent to the discharge zones.

The "do nothing" scenario suggests an increase in up-slope extent of the discharge zone of approximately 1000 metres is possible in 50 years. The current shallow depth to groundwater and flat topography means that minor rises in groundwater level will result in a substantial increase in discharge area extent.

To simulate changed management impact on groundwater levels over time at the discharge zone, various vegetative salinity mitigation options have been trialled. The establishment of perennial pastures should lower groundwater levels at the discharge zone by approximately 5 metres over a twenty year period. Perennial pastures in combination with trees slightly improved the ability to lower groundwater levels at the discharge site compared to perennial pastures only.