2006

Preliminary groundwater investigation of the Beverley townsite

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ISSN 1039-7205

Resource Management Technical Report 306

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May 2006

Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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Summary

In 2004, the Shire of Beverley requested the Department of Agriculture and Food's Rural Towns Program to undertake a preliminary groundwater investigation to identify the hydrological issues that are likely to affect Beverley townsite in the short to medium term (two to 20 years).

A series of seven shallow monitoring bores (drilled to 3 m) were installed in the valley floor and in potentially vulnerable landscape positions throughout the town. A census of existing bores within the town was carried out at the same time. One existing bore was deemed suitable for use as a monitoring bore. These eight bores provide Beverley townsite with an effective monitoring network to observe changes in groundwater depth and salinity levels and to assess future salinity risks in the town.

The measurements recorded on 10 April 2006 suggest watertables are below critical depths at each bore; there are no visible indications of salinity around the bores. Given the substantial time since clearing and development of Beverley and the adjacent farm land, the area of salt affected land within the townsite at present is small. Considering these factors, the small area of the town's catchments, the thinness of soils on upslopes, the well incised creeklines flowing through town and the readily drainable soils on the flood plain, the salinity risk for most of Beverley appears very low.

No groundwater was intersected during the recent drilling program and rising damp was observed in only a few buildings. Any salinity that occurs in future will probably be confined to areas already affected, however an extended period of monitoring will be required to make a reliable risk assessment and establish if the groundwater system has reached equilibrium.

Recommendations for monitoring the salinity risk are provided.

Contents

1. Introduction and background

Beverley is located on the Avon River floodplain and encroaches on the adjacent low slopes. The townsite was founded in 1854.

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A series of seven shallow monitoring bores (drilled to 3 m) were installed in the valley floor and in potentially vulnerable landscape positions throughout the town. A census of existing bores within the town was carried out at the same time. One existing bore was deemed suitable for use as a monitoring bore. These eight bores provide Beverley townsite with an effective monitoring network to observe changes in groundwater depth and salinity levels and to assess future salinity risks in the town.

Section one of this report provides some background information on Beverley townsite and its catchments, section two and three describe the preliminary investigation and section four contains recommendations regarding monitoring of changing groundwater conditions over time.

1.1 Town of Beverley

Beverley was founded in 1854 on the banks of the Avon River and is situated 124 km east of Perth on the Great Southern Highway and the Great Southern Railway. Beverley services the local farming community being a base for stock firms, Cooperative Bulk Handling and Westrail. Beverley also contributes to the tourism industry through its aeronautical museum and nearby gliding club.

1.2 Hydrogeology

Two groundwater flow systems operate in the Beverley townsite; a local flow system operating in the thin regolith and geological formations on the surrounding hillslopes and a regional flow system operating within the sediments of the Avon River flood plain.

The hillslope system is characterised by outcropping rock and geological structures such as dykes and shear zones. This type of landscape could be expected to develop only small poorly connected aquifers in the weathered saprolite, fractured margins of dykes and in permeable surface and subsurface soils in winter. Discharge from these aquifers occurs where flow restrictions force water to the surface at bedrock highs, dykes and break of slope.

The valley is an intermediate to regional scale system located in the permeable sediments that underlie the Avon flood plain. Flow in this system is through a complex of relatively transmissive and interconnected aquifers that are recharged mainly from the Avon River, in turn fed by basal discharge from local aquifers upstream. Due to the large catchment upstream, large volumes of groundwater may be expected to flow within this system.

1.3 Natural drainage

Three creeklines flow through the town, two west of the Avon River and one on the east. From the west, one creek flows past the town reservoir, tennis club and bowling greens before entering the river just north of the Vincent Street Bridge. The other flows through the golf course. On the east side, a creek flows into the river adjacent to the old racecourse.

The catchments for these creeks are small; the biggest being the town reservoir catchment which (based on rough measurements) is less than 700 hectares. All three catchments appear to have a shallow regolith (indicated by outcropping rock). Consequently the groundwater discharging into creeklines from the catchments is unlikely to be saline.

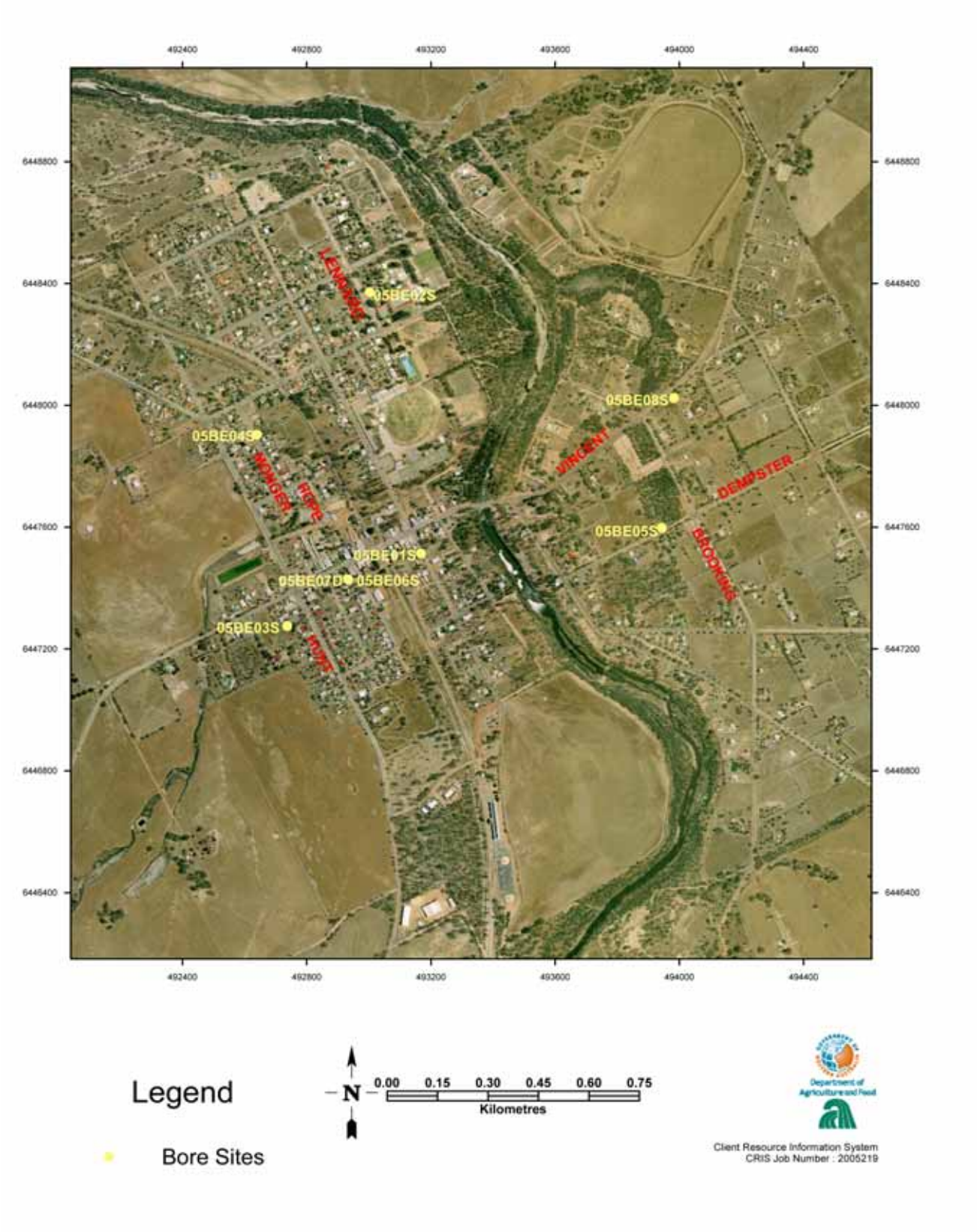


Figure 1. Monitoring bore locations in the Beverley townsite

2. Method

Aerial photography was examined to identify areas at risk of salinity in Beverley. A ground reconnaissance examined existing bores to determine if they were suitable for use as monitoring bores; static water levels were measured and the salinity status of areas identified in aerial photos was assessed. Six bore sites were chosen in potentially vulnerable areas. Bore holes were drilled with an auger rig and shallow observation bores were installed. At site 05BE07 a monitoring bore casing was installed in an existing uncased drill hole.

2.1 Selection of drill sites and existing bores

Existing bores were inspected to see which could be incorporated into a groundwater monitoring network. Potential bore sites were identified using aerial photo interpretation and selected during a reconnaissance visit.

New bores were located in high salinity risk areas to give early warning of emerging problems. A shallow bore was located beside the existing deep bore at the hotel to monitor the vertical hydrological gradient. This should establish whether recharge or discharge conditions prevail in the centre of the Beverley townsite. Refer to Figure 1 for location of existing and new bores.

2.2 Drilling methods and bore completion

Drilling was undertaken on 7 September 2005 by Soil Conservation Services using an auger rig. Bore holes 90 millimetres in diameter were drilled to a depth of 4 metres with a trailer-mounted auger rig and cased with class 9 PVC pipe with 2 m of slots at the bottom. Water was added to all holes to aid drilling. At site 05BE08 the casing was installed with 2 m of slotted section at the bottom. All bores were backfilled with 8-16 graded sand (1.2–2.4 mm).

Each bore was assigned a seven digit alphanumeric code formed from the year (05 for 2005), an abbreviation for Beverley (BE) and numbers 01 to 06 to differentiate the bores. An S suffix indicates a shallow bore; a D suffix indicates a deep bore. Pre-existing bores were given similar alpha numeric names but the year drilled was not indicated.

All new bores were developed using compressed air to blow out the bore contents. Steel headworks were erected for their protection.

2.3 Groundwater measurements

Initial bore water levels were recorded for all new bores and the existing deep bore 05BE07D on 10 April 2006. Depth and salinity measurements will be carried out by the Department of Agriculture and Food in association with the Shire of Beverley until December 2008.

Bore details and initial readings are recorded in Table 1.

Table 1: Bore locations and early watertable depths in Beverley

Bore no.	Easting	Northing	Total depth (m)	Top of screened interval (m)	SWL (10/04/06)
05BE01S	493168	6447515	3.55	1.55	2.65
05BE02S	493002	6448372	4.23	2.23	3.22
05BE03S	492736	6447277	3.88	1.88	Dry
05BE04S	492639	6447905	3.96	1.96	3.56
05BE05S	493945	6447599	4	2	Dry
05BE06S	492932	6447430	4	2	Dry
05BE07D	492933	6447430	14.64	8.64	5.6 3.33 m on 7/9/05
05BE08S	493984	6448025	4	2	Dry

SWL Static water level (depth from top of casing)
bgl = below ground level

3. Results and discussion

The soils at the drill sites were found to be duplex (varying depths of sand over clay) derived from alluvial sediments, except 05BE05, which was a deep sand. Soils on the slopes were found to be thin colluvial and alluvial sediments formed over granitic and gneissic bedrock. Bedrock exposed in a railway cutting northwest of the hospital was a combination of granite and gneiss (migmatite). The cutting showed that the bedrock to be well jointed and differentially weathered depending on the parent rock. The greatest amount of weathering occurred in stress lines and faults in the rock and in mafic bands within the bedrock matrix. Groundwater was observed discharging from a number of these weathered features. Outcrops in and around Beverley are similar to bedrock exposed in the railway cutting so bedrock composition is likely to be similar throughout the town.

Depth of regolith was not established during drilling however anecdotal reports place it at between 20 and 30 m on upper flood plain and break of slope positions. Crossley (2004) noted regolith up to 75 m in deep in a palaeochannel in York. Much thinner regolith is likely on the lower and mid slopes where bedrock outcrops are common. Drilling for piezometers indicated that the upper four metres of the regolith at all break of slope and upper flood terrace sites consists of sands and coarse light to heavy sandy clays. Bores in Vincent Street, Monger Street and Hunt Road were all located in heavy sandy clay. At these sites an iron and silica-rich hardpan up to 2.5 m thick was present within 2.5 m of the surface. At the break of slope sites, the hardpan was thickest and occurred 0.5 to 1 m below ground level.

The creek flowing past the reservoir is well incised, creating a strong gradient to deliver groundwater into the creek. This allows little opportunity for salinity to spread outward from the creek. However the creek flowing through the golf course is not at all incised and lateral groundwater gradients into the watercourse are much weaker. Consequently salinity is more evident in this watercourse. The watercourse east of the river flows through sandier soils where recharge conditions are likely to occur, minimising the salinity risk.

Due to the location and topography of the town, the underlying soils and geology and the size of the catchments, groundwater flow from local catchments surrounding the town is minimal. Geological structures were not mapped in this study; however a number of springs in the creek west of the reservoir appear to be associated with dykes. Dykes are common conduits for groundwater, so most of the upslope groundwater is likely to discharge into the creeks though some from lower slopes may discharge in break of slope areas.

Land affected by salinity in Beverley is small and confined to the creeklines and about 2 ha of land at Hope Street. Here the railway line appears to restrict surface water movement as well as a groundwater discharge site. Water levels measured in existing bores were all greater than 3 m below ground level and no groundwater was encountered during drilling.

Rising damp problems in buildings are minimal and restricted to the heavier soils around the centre of town. At one site, rising damp was thought by the owner to have been caused chiefly by leaky plumbing and over-watering of gardens next to buildings. Water was observed in the Beverley Hotel cellar and has been reported to occur in the cellars of the Masonic Lodge and old school building; however the source of this water was not confirmed. At the hospital, reported groundwater problems in the undercroft probably occur where building foundations intersected groundwater in weathered fractures in the bedrock. Groundwater levels measured in bores in April 06 were in all cases at least 3m below ground level, well below what would be considered as a critical depth leading to salinity in these soils. Further evidence of groundwater problems within Beverley may be found by examining the Shire's maintenance records to identify streets that receive regular repair due to groundwater damage.

4. Conclusions

Due to the small area of the town's catchments, shallow soils upslope, efficient functioning of creeklines flowing through town and the readily drainable soils of the flood plain, the salinity risk appears very low for most of Beverley.

Given the substantial time since clearing and development of Beverley and the adjacent farm land, the area of salt-affected land within the townsite at present is small.

No groundwater was intersected during the drilling program and rising damp is not widespread. The watertables measured on 10 April 2006 suggest that they are below critical depths at each bore; and there are no visible indications of salinity around the bores. Any salinity that occurs in future will probably be confined to areas already affected, however an extended period of monitoring will be required to make a reliable risk assessment and establish if the groundwater system has reached equilibrium.

Water in the hotel cellar is reportedly not saline so may be due to drainage from the street. Further investigation is required to verify this.

5. Recommendations

The following recommendations will allow the community to build on the existing data and maximise the value of the investment that has been made in the monitoring network.

1. Monitor watertable depth over time

The Department of Agriculture and Food will monitor the new bores quarterly; however value will be added to these data if the shire undertakes to monitor the bores more frequently. It may be appropriate for the council to direct the Shire Works Foreman to carry out the task as part of the works program.

The person responsible for the task should monitor the bores at least every two months (preferably monthly) for the first year and thereafter at least every three months for at least five years. This monitoring cycle should be restarted again after 10 and 20 years. Monitoring by the Shire should be coordinated with the Department to prevent doubling up and to share data.

Monitoring data should be recorded in a table as shown in Appendix 3 and hydrographs (graph of watertable depths) produced annually. Interpretation of these hydrographs should be confirmed by a hydrologist.

Water levels in cellars should be monitored carefully to establish the time delay between rain events and the increase in water levels. A rapid response to rainfall could indicate that the source of water entering cellars is surface water rather than groundwater.

2. Surface water audit

Consideration should be given to employing a consultant to undertake a surface water audit. This will identify where water accumulates within the town with the potential to cause recharge. The volume flowing in creeks and stormwater drains can be calculated and compared to the volume of run-off caused by rainfall to identify where losses are occurring and enable remedial action to be taken.

3. Sample groundwater for water quality

Bore water samples to measure salinity should be taken in summer and winter each year for a three-year period to establish if there is a trend in salinity changes. Salinity data will help to determine whether watertables are recharged from surface water (rainfall) or from deeper groundwater.

6. Reference

Crossley E.K. (2004) Groundwater Study of the York Townsite. Department of Agriculture, Western Australia, Resource Management Technical Report 261.

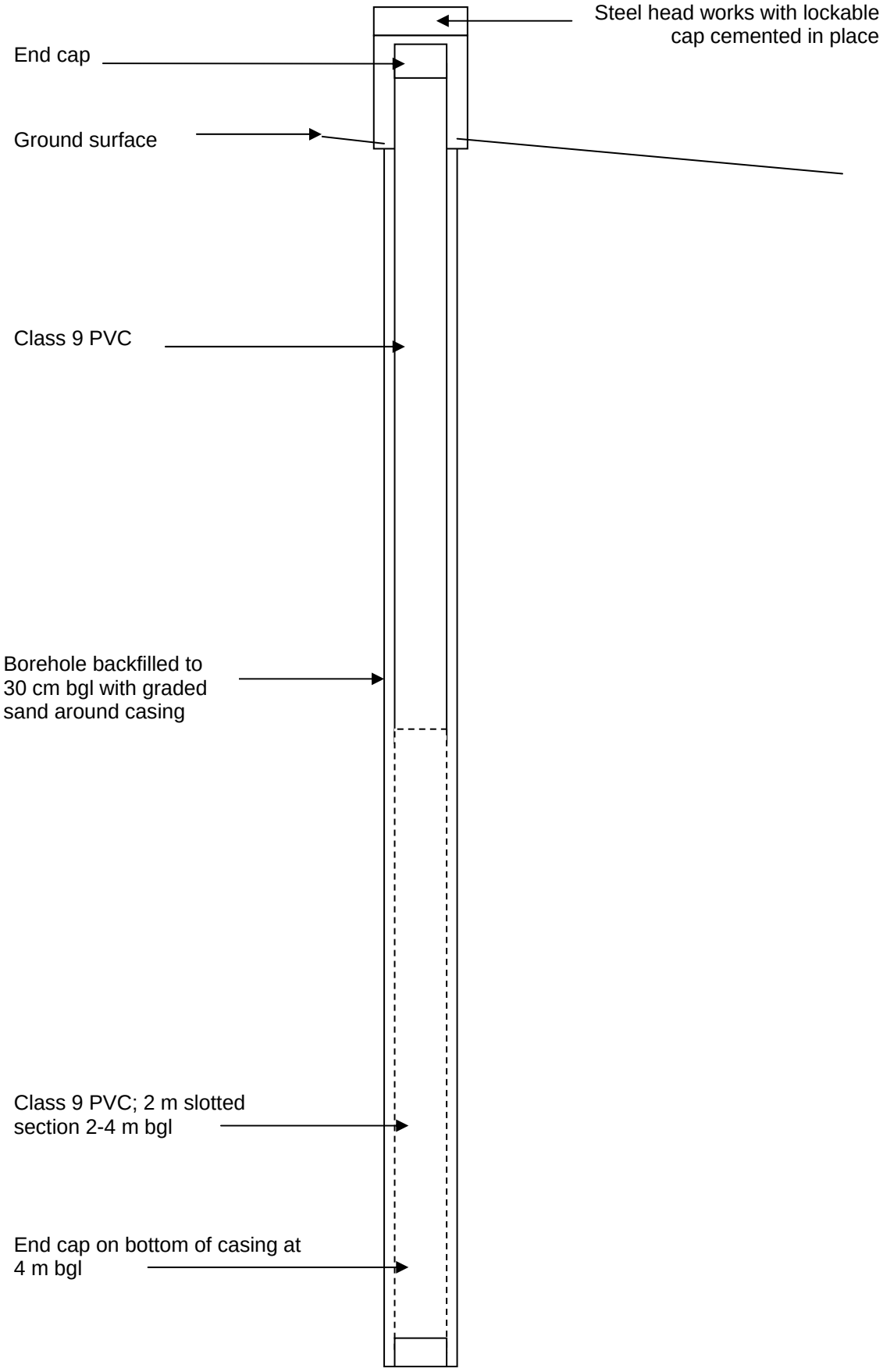
7. Acknowledgments

Thanks to Fred Bremner for his local knowledge and assistance in locating existing bores and to the Beverley towns people for their willing cooperation with the project.

Thanks to Rod Short for his useful comments on the draft, to Elvyn Wise for assistance with the maps, and to Georgina Wilson with editing.

8. Appendices

Appendix 1: Bore construction details (all bores)



Appendix 2: Drill logs

Catchment Hydrology Group: Drillers Field Log

Site Details	
Date: 7/9/05	Landform/Unit: Drainage line break-of-slope
Catchment/Project/Owner: Beverley Rural Towns Program	Year Cleared: Location: Rear Hardware Store Cnr Vincent and Forrest Streets
Local Bore #: 05BE01S	AMG Easting (m): 493168
W+R Bore # -	AMG Northing (m): 6447515
Driller: Fred Bremner	AHD (m):

Depth (m)	Sample Description and Drilling Comments	Geology
0	Orange light sandy clay	fill
.6	Brown course and medium sandy clay	mottled zone
1.2	Pale brown coarse sandy clay	
2.3	Coarse – gritty orange light sandy clay	
2.6	Dark grey to red ferricrete	ferricrete
4	Bottom of hole	

Bore Completion Details		
Depth Drilled (m) :	3.2 m	**Water** Injected at 1 m
Casing Total Length (m) :	3.55	Est. Watertable during drilling (m): none
A.G.L.(m) :	0.35	Casing Installation: **GOOD**/~~O.K./FORCED~~
Screen Length (m) :	2 m	Estimated Yield:
Material Screened:	ferricrete	S.W.L. at Completion (m) : DRY
Drill Method/Bit Size (Diam. mm): Auger 90 mm		
Casing Type & Diam. (mm): 50mm PVC		First SWL (m): 3.00 on 10/04/06

Catchment Hydrology Group: Drillers Field Log

Site Details	
Date : 07/09/05	Landform/Unit: Valley Floor
Catchment/Project/Owner :	Year Cleared:
Beverley Rural Towns Program	Location: West of school – Lennard St
Local Bore # : 05BE02S	AMG Easting (m): 493002
W+R Bore #	AMG Northing (m): 6448372
Driller: Fred Bremner	AHD (m) :

Depth (m)	Sample Description and Drilling Comments	Geology
0	Brown silty sandy clay	4° colluvium
0.5	Dark brown heavy sandy clay	mottled zone clay
1.5	Brown sandy clay (coarse to gritty)	3° sediments
3	Light brown sandy clay (gritty)	
4	Bottom of hole	

Bore Completion Details	
Depth Drilled (m): 4 23	**Water** Injected at 1 m
Casing Total Length (m): 4.65	Est. Watertable during drilling (m): none
A.G.L. (m): 0.42	Casing Installation: **GOOD**/~~O.K./FORCED~~
Screen Length (m): 2 m	Estimated Yield:
Material Screened: coarse sandy clay	S.W.L. at Completion (m): Dry
Drill Method/Bit Size (Diam. mm): Auger 90 mm	
Casing Type & Diam. (mm): 50 mm PVC	First SWL (m): 3.64 on 10/04/06

Catchment Hydrology Group: Drillers Field Log

Site Details	
Date : 7/9/05	Landform/Unit Break of slope
Catchment/Project/Owner: Beverley Rural Towns Program	Year Cleared: Location: Private house (Hutchinson's) opposite Masonic Lodge, Hunt Rd
Local Bore #: 05BE03S	AMG Easting (m): 492736
W+R Bore #	AMG Northing (m): 6447277
Driller: Fred Bremner	AHD (m):

Depth (m)	Sample Description and Drilling Comments	Geology
0	Brown sandy clay – clay sand	4° colluvium
0.5	Grey iron-rich (hard)	silcrete and ferricrete layers
1.5	Dark brown Fe rich (hard)	
3	Light brown clay	3° sediments
4	Bottom of hole	

Bore Completion Details		
Depth Drilled (m):	3.88	**Water** Injected at 1 m
Casing Total Length (m):	4.3	Est. Watertable during drilling (m): none
A.G.L. (m) :	0.42	Casing Installation: **GOOD**/~~O.K./FORCED~~
Screen Length (m):	2 m	Estimated Yield:
Material Screened:	clay	S.W.L. at Completion (m) : DRY
Drill Method/Bit Size (Diam. mm): Auger 90 mm		
Casing Type & Diam. (mm) : 50 mm PVC		First SWL (m): _DRY on 10/04/06

Catchment Hydrology Group: Drillers Field Log

Site Details	
Date : 07/09/05	Landform/Unit: Break of slope
Catchment/Project/Owner :	Year Cleared :
Beverley Rural Towns Program	Location: Public Open Space Monger St.
Local Bore #: 05BE04S	AMG Easting (m) : 492639
W+R Bore #	AMG Northing (m) : 6447905
Driller : Fred Bremner	AHD (m) :

Depth (m)	Sample Description and Drilling Comments	Geology
0	Dark brown silty sand	fill
0.2	Pale yellow coarse sand	4° colluvium
0.6	Red-yellow mottled sandy clay (tight)	mottled zone clay
1	Hard white cemented sandy clay	ferri-silcrete
2.5	Pink, orange, red coarse gritty sandy clay. Cemented fragments to 20 mm	3° sediments (ferri-silcrete)
4	Hard (bottom of hole)	silcrete

Bore Completion Details		
Depth Drilled (m) :	3.96	**Water** Injected at 1 m
Casing Total Length (m) :	4.3	Est. Watertable during drilling (m): none
A.G.L.(m) :	0.34	Casing Installation: **GOOD**/~~OK/FORCED~~
Screen Length (m) :	2 m	Estimated Yield:
Material Screened:	ferricrete/clay	S.W.L. at Completion (m): DRY
Drill Method/Bit Size (Diam. mm): Auger 90 mm		
Casing Type & Diam. (mm):	50 mm PVC	First SWL (m) : _3.9_on _10/04/06

Catchment Hydrology Group: Drillers Field Log

Site Details	
Date : 7/9/05	Landform/Unit : Break of slope/valley floor
Catchment/Project/Owner: Beverley Rural Towns Program	Year Cleared : Location: South side of Dempster St Reserve
Local Bore #: 05BE05S	AMG Easting (m): 493945
W+R Bore #	AMG Northing (m): 6447599
Driller: Fred Bremner	AHD (m) :

Depth (m)	Sample Description and Drilling Comments	Geology
0	Yellow sand – clay sand	3° Sediments
3	Brown sandy clay	3° Sediments
4	Bottom of hole	

Bore Completion Details		
Depth Drilled (m) :	4 m	**Water** Injected at 3 m
Casing Total Length (m) :	4.3	Est. Watertable during drilling (m): none
A.G.L.(m) :	0.3	Casing Installation: **GOOD**/~~O.K./FORCED~~
Screen Length (m) :	2 m	Estimated Yield:
Material Screened:	clay sand	S.W.L. at Completion (m): DRY
Drill Method/Bit Size (Diam. mm):	Auger 90 mm	
Casing Type & Diam. (mm): PVC 50 mm		First SWL (m) : DRY on _10/04/06

Catchment Hydrology Group: Drillers Field Log

Site Details	
Date : 7/9/05	Landform/Unit: Valley Floor
Catchment/Project/Owner : Beverley Rural Towns Program	Year Cleared:
	Location: Rear Beverley Hotel corner Vincent & Queen Streets
Local Bore #: 05BE06S	AMG Easting (m): 492932
W+R Bore #	AMG Northing (m): 6447430
Driller: Fred Bremner	AHD (m) :

Depth (m)	Sample Description and Drilling Comments	Geology
0	Brown clay sand	4° colluvium
0.5	Dark brown sandy clay	mottled zone clay
2.5	Very hard grey to red cemented clay	ferri-silcrete
3.3	Red clay – sandy clay	3° sediments
4	Bottom of hole	

Bore Completion Details		
Depth Drilled (m) :	4 m	**Water** Injected at 1 m
Casing Total Length (m) :	4.5 m	Est. Watertable during drilling (m): none
A.G.L.(m) :	0.5 m	Casing Installation: **GOOD**/~~O.K./FORCED~~
Screen Length (m) :	2 m	Estimated Yield :
Material Screened:	ferricrete/clay	S.W.L. at Completion (m): DRY
Drill Method/Bit Size (Diam. mm): Auger 90 mm		
Casing Type & Diam. (mm): 50 mm PVC		First SWL (m) : DRY on _10/ 04/06

Appendix 3: Sample Bore Monitoring Chart

Beverley Townsite Monitoring sheet
Monitoring date .....
Monitoring person's name.....

Bore name	Depth of bore (m)	Height of PVC above ground (m)	Depth to watertable from top of PVC (m)	Depth to watertable below ground level (m)	Salinity EC (mS/m)