

OTWAY WATER BOOK 73. Decommission & Dismantle the Barwon Downs Borefield

“Yes or No?”



Most definitely... **YES.**

Decommission – “...to restore, as far as possible, the aquifers isolation that existed before the bores were drilled and constructed.”

Dismantle – “... to break up, demolish, destroy, take apart, disassemble.”

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January 2022.

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By M.Th.



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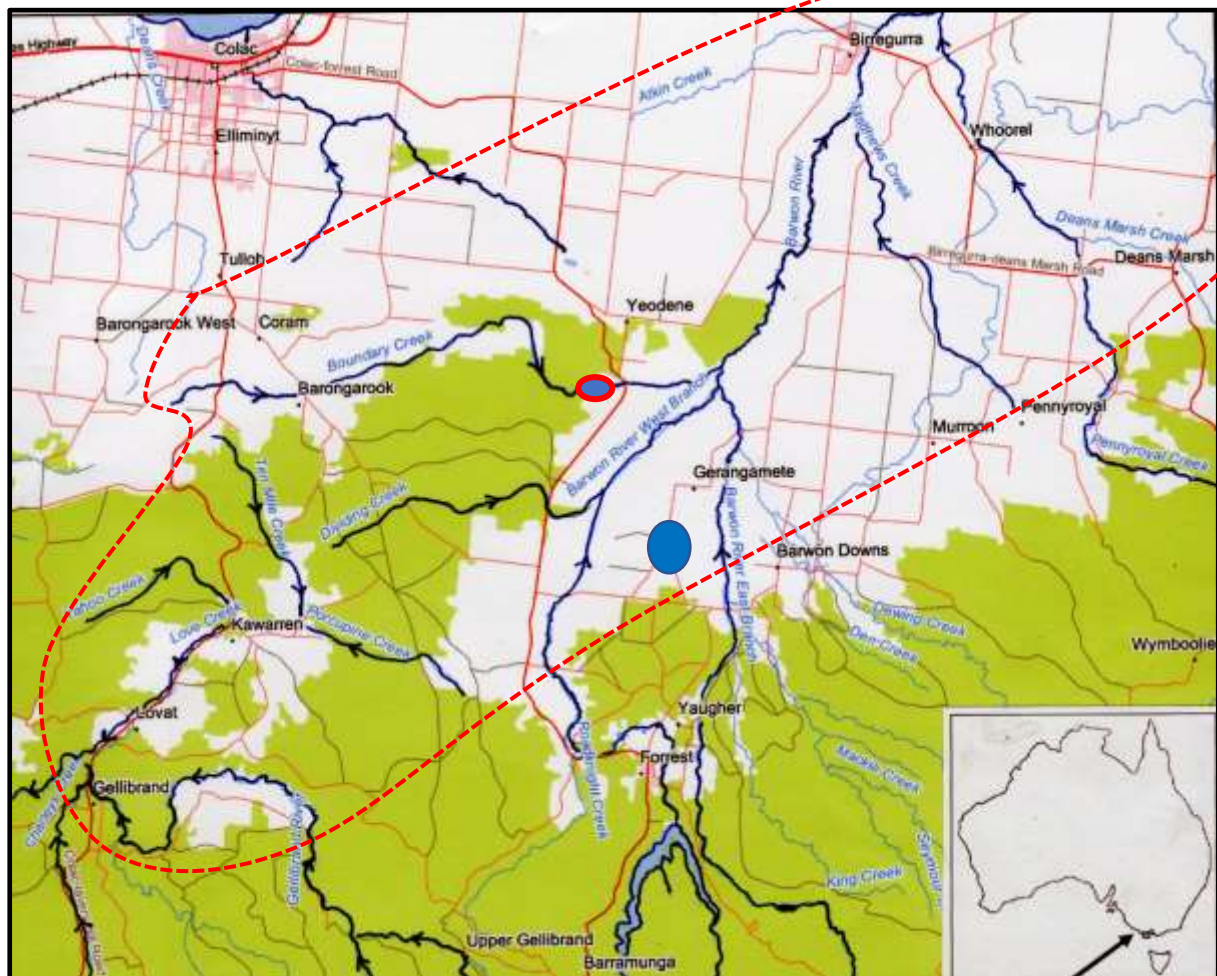
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INTRODUCTION.


There are many reasons why the Barwon Downs Borefield should be decommissioned and dismantled.

Location Map.



 Big Swamp.

 Barwon Downs Borefield.

 Approximate area of drawdown influence from the Barwon Downs Borefield.

Background Information.

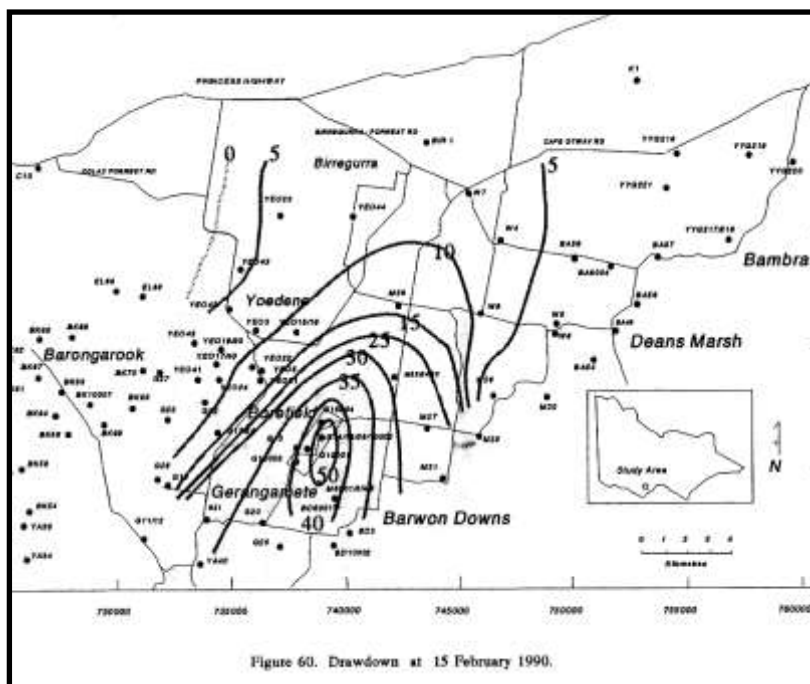
The information in this section provides the background that leads into the Discussion section on page 32.

1990 Area of Influence and Cone(s) of Depression.

When the Department of Natural Resources and Environment (now called the Department of Environment, Land, Water and Planning - DELWP) commissioned Witebsky et al.⁽¹⁾ to analyse the results of a stress test pump conducted at Barwon Downs between 1987 and 1990, the following drawdown map was included in the report. It took the team five years to produce this report⁽¹⁾. It was a comprehensive document that has stood the test of time. In 2018 when Dahlhaus was reviewing Barwon Downs Borefield issues for Southern Rural Water, his literature review including 166 documents⁽¹¹⁾ found the Witebsky et al. report to be a sound document.

("More than 250 documents, publications and web-resources were evaluated for this Literature Review and 166 items, comprising around 12,300 pages, were selected as having some context and relevance to the Barwon Downs borefield, in terms of the licence renewal application. An annotated bibliography of these items has been prepared and appended."⁽¹¹⁾)

"The last well-documented conceptual model is that of Witebsky et al. (1996), also partly published by Shugg and Jayatilaka (1998)."⁽¹¹⁾

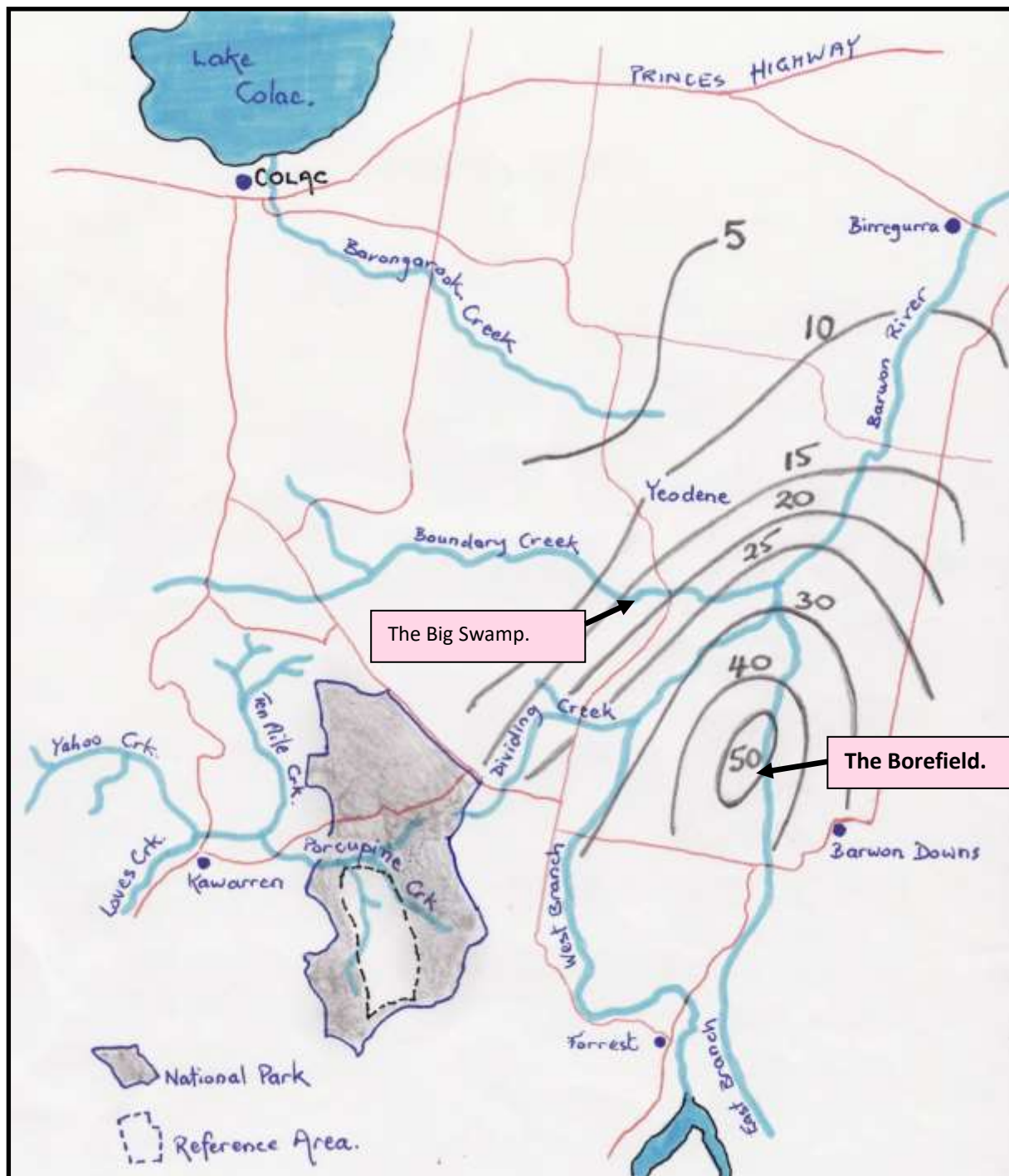


Source: Witebsky.⁽¹⁾

The drawdown levels on this map were calculated after the stress test extraction of groundwater between 1987-1990⁽¹⁾. In the vicinity of the Barwon Downs Borefield the water table had been lowered at least 50 metres in the Lower Tertiary Aquifer.

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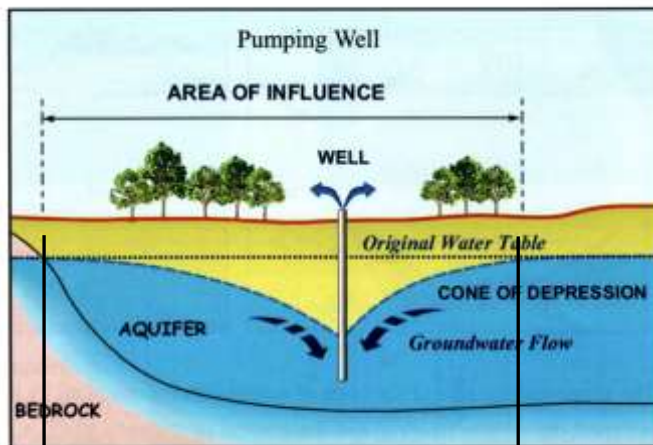
These Witebsky et al.⁽¹⁾ drawdown figures have been superimposed over another map of the area.



The deepest part of the cone of depression at 50 metres is indicated at the site of the Barwon Downs 5 extraction bores. Another extraction bore was added later.

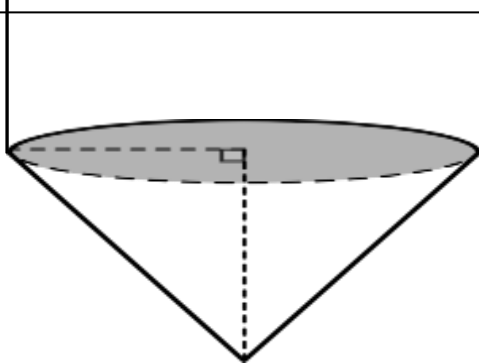
A Cone of Depression.

Once an extraction bore begins pumping water out of an aquifer a cone of depression begins to form directly under and around the bore site.



When groundwater is being extracted observation bores within the cone of depression can be felt sucking air. When the pumps stop and the cone begins to fill/recharge, air in the cone of depression space is blown out and replaced with water.

The area of drawdown influence and impact increases when extraction exceeds recharge.



In simplified terms the impact roughly takes on the volumetric shape of an ice-cream cone. Thus called a cone of depression. Appendix Five, page 60, shows the irregular shape of one of the cones depicted in 2000.

Area of Impact.

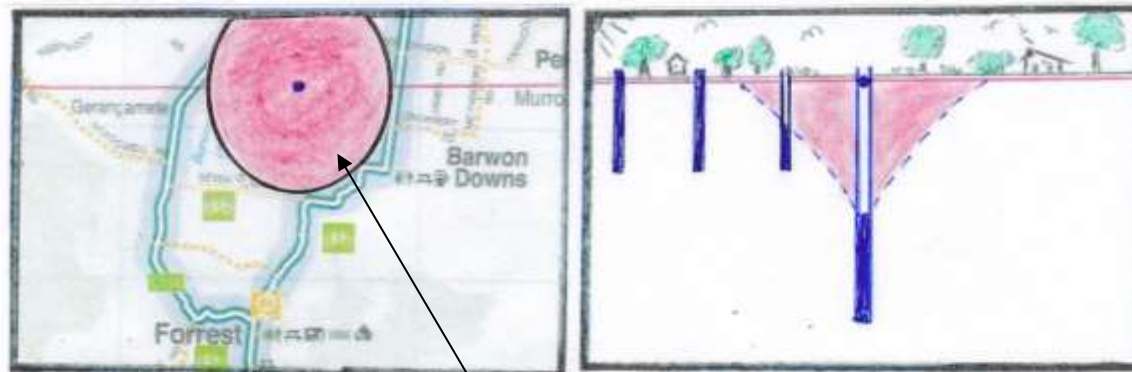
The impact at the surface extends out to the point of zero drawdown. It has been accepted that as at 2019, the surface area impacted from the Barwon Downs Borefield out to the 4 metre drawdown mark, was 480 km².⁽¹⁵⁾⁽¹⁶⁾⁽¹⁷⁾

Recharge and Recovery.

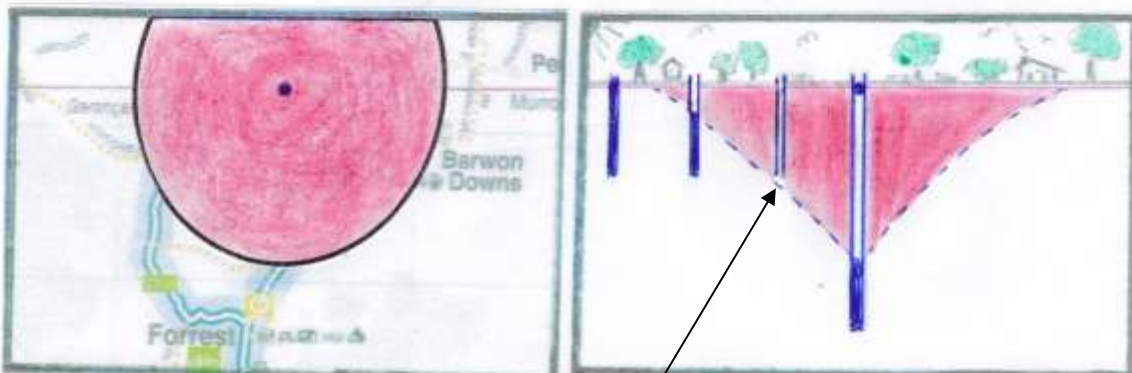
Even when an aquifer begins to recover the extremities of the cone can continue to expand outwards. Also, in most cases the extremities are the last to recover. Recovery can take decades after extractions cease.



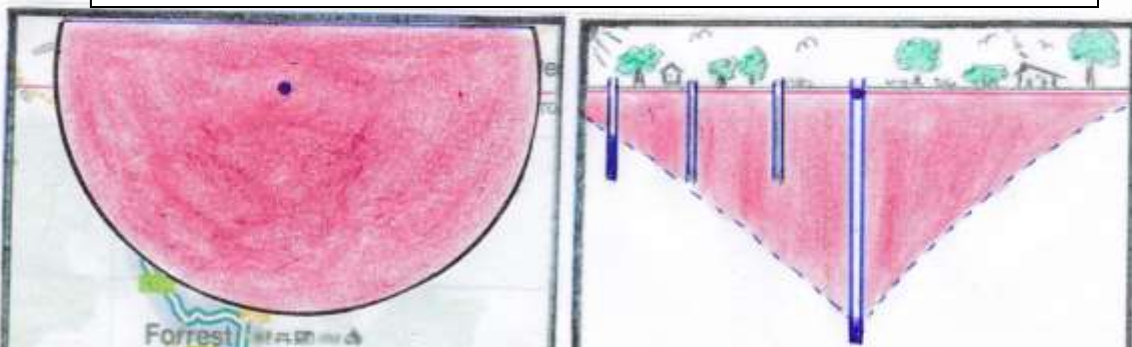
In the early stages of groundwater extraction the cone of drawdown is small.



As the extraction proceeds the area of influence expands further and further out.



Bores, springs, creeks and wetland are impacted and begin to dry up

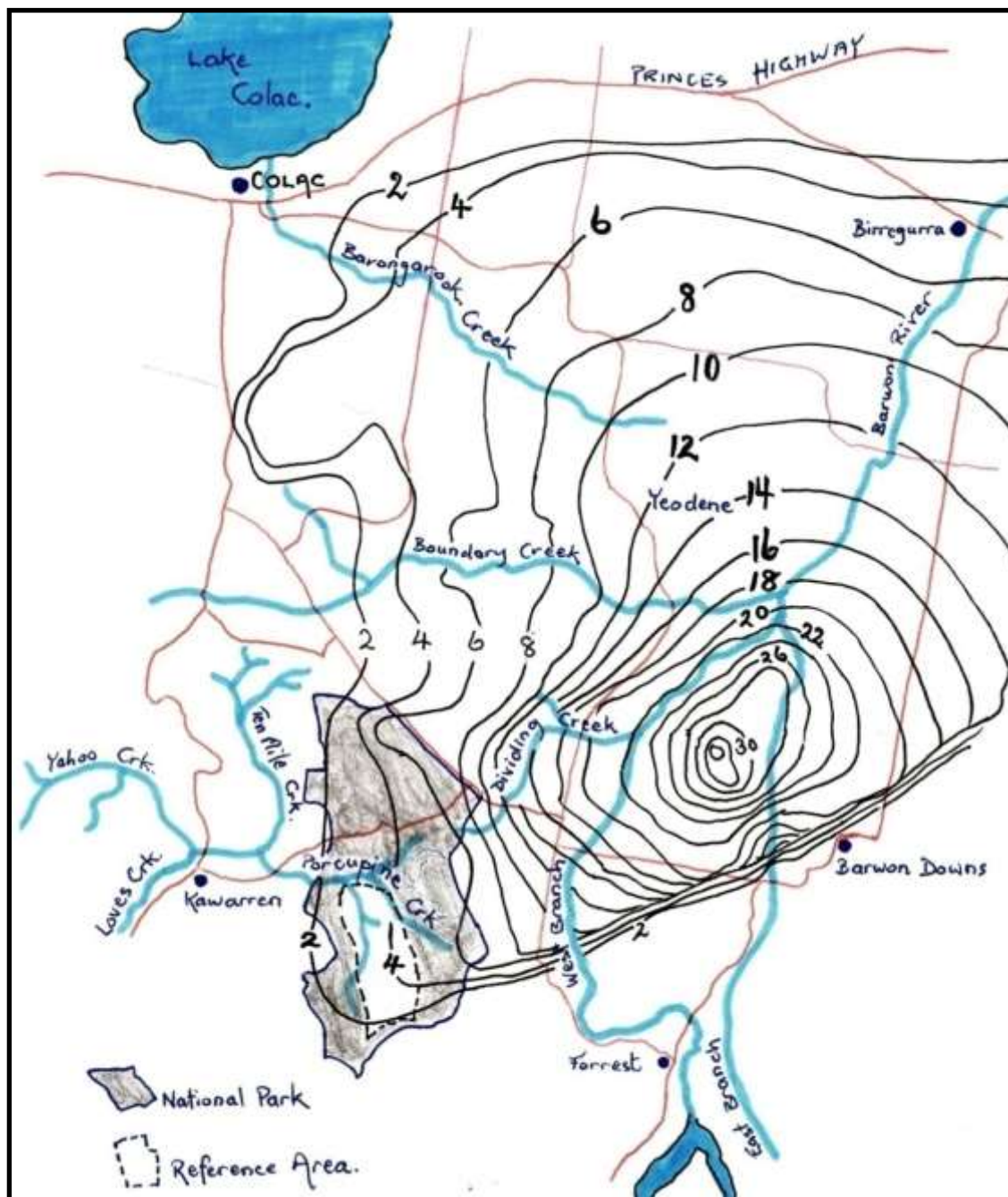


By 2016 the Barwon Downs Borefield sphere of influence extended over a very large area
"...drawdown in the LTA has extended to where the aquifer outcrops (around the Barongarook High)..."⁽⁴⁾

2000.

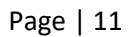
In the lead up to renewing the groundwater extraction licence for the Barwon Downs Borefield residual contour drawdown extraction maps were produced. These maps indicated the amount of drawdown impact earlier extractions from the Borefield had on the surrounding area. The contours of one of these drawdown maps was then super imposed upon a local map.

Page | 10



SOURCE: Barwon Water contours from a handout map (~ 2000) superimposed over a local map.

Around 2001 – 2002 these two maps were presented as background information as part of the renewal of the 2004 groundwater extraction licence application process.



This map shows the residual contour drawdown in the Dilwyn Aquifer Formation.

The Pebble Point and the Dilwyn Formations are two of the three aquifers the Barwon Downs Borefield extracted water from.

2004 - 2012 Description of Area of Influence and Cone(s) of Depression.

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2004-2005. Residual contour drawdown Map.

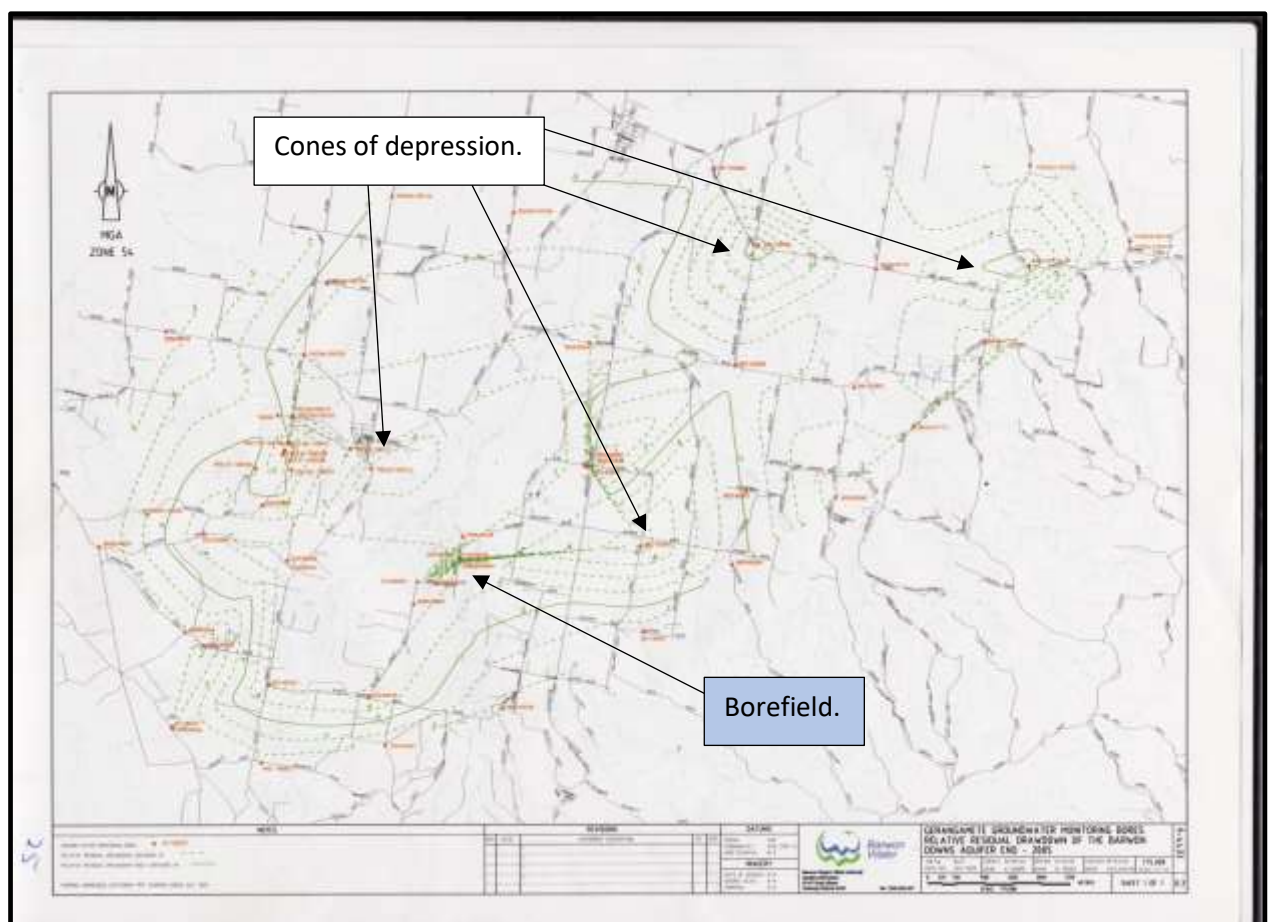
Barwon Water's 2004-2005 Gerangamete Groundwater Management Area Groundwater Licence No. 893889 report(s) to Southern Rural Water, created some confusion⁽⁶⁾. Through FOI requests two different copies of this report were obtained. However, the following map was the same in both reports.

Four Cones of Depression.

The residual contour drawdown contours in this map indicated at least four cones of depression.

SOURCE: The 2004-2005 Gerangamete Groundwater report to Southern Rural Water.

(Gained under FOI, Southern Rural Water FOI References 409667 & 559928).

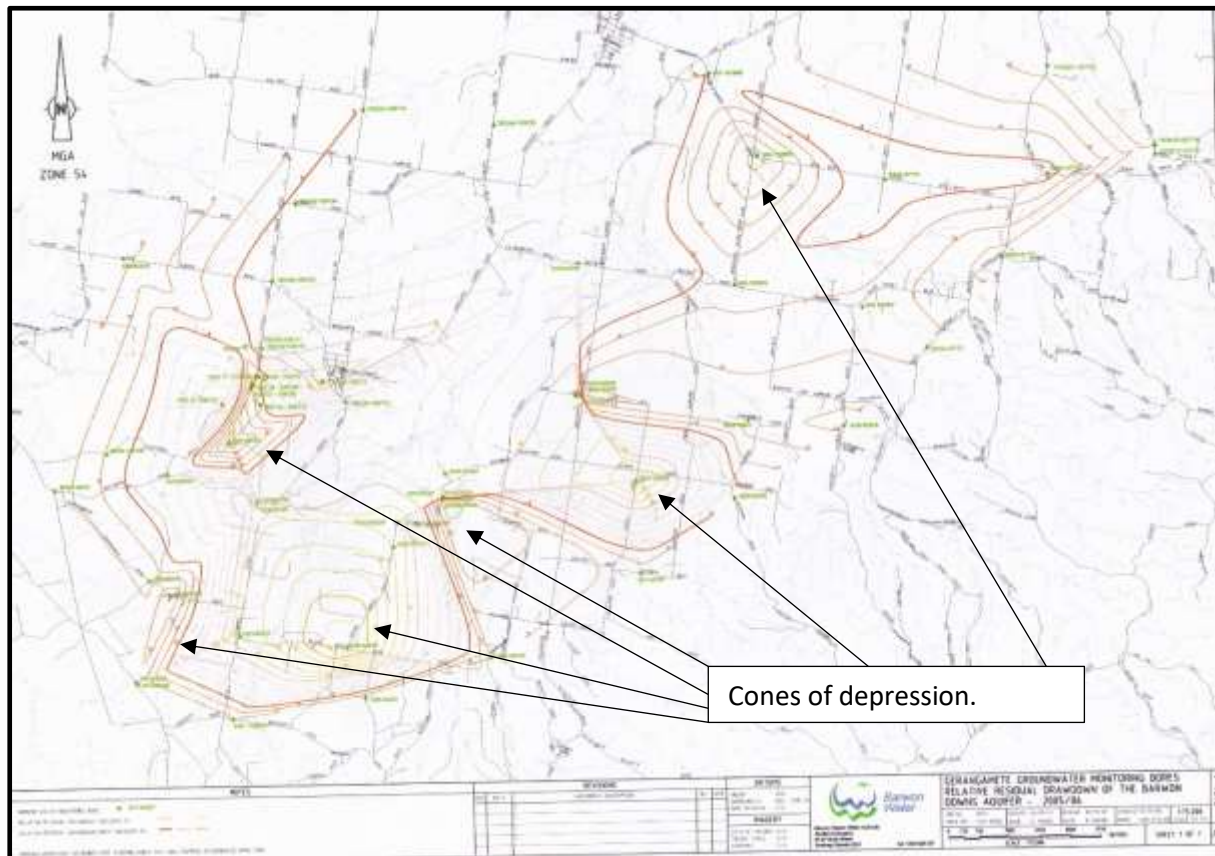


Four cones of depression can be seen. This indicates four extraction bores. None of them are at the site of the Borefield.

2005-2006. Residual contour drawdown Map.

SOURCE: The 2005-2006 Gerangamete Groundwater report to Southern Rural Water.
(Gained under FOI, Southern Rural Water Reference 409667).

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There are at least six cones of depression in this map. One cone is centred over the Barwon Downs Borefield.

SOURCE: The 2006-2007 Gerangamete Groundwater report to Southern Rural Water.

[illegible]

As with earlier reports the 2006- 2007 report included only one residual contour drawdown map.

2007. The Standard of Gerangamete Reports Queried.

The extremely poor standard and non-compliance with the Licence Conditions for the Barwon Water Gerangamete Groundwater Extraction Licence was first brought to the attention of Southern Rural Water in 2007.⁽³⁾

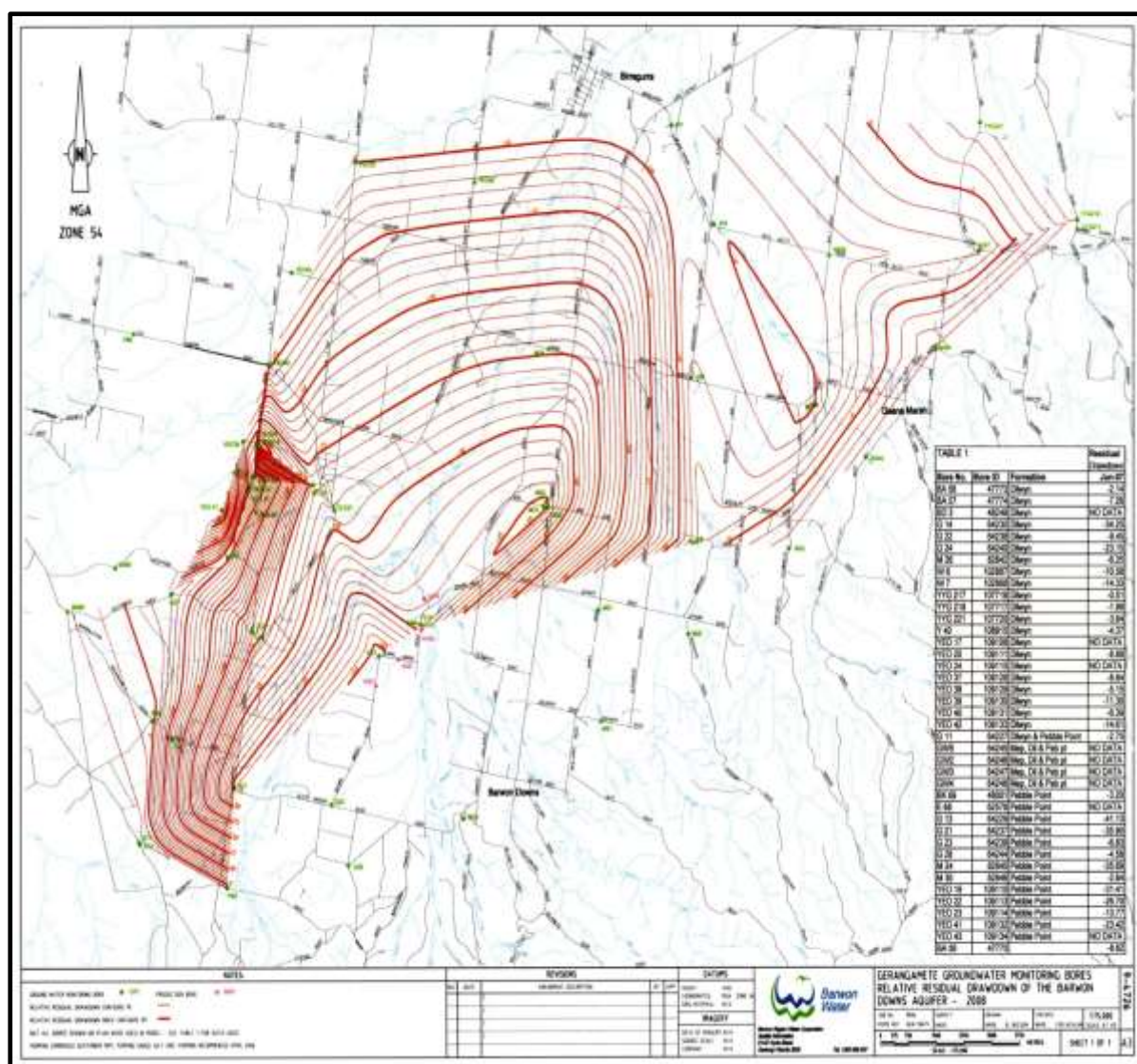
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The Number of Cones of Depression Queried.

The number of cones of depression being one of the problems prompting the State Ombudsman to review and help gain answers to queries.⁽⁶⁾⁽⁹⁾

2007-2008. Residual contour drawdown Map.

SOURCE: The 2007-2008 Gerangamete Groundwater report to Southern Rural Water.



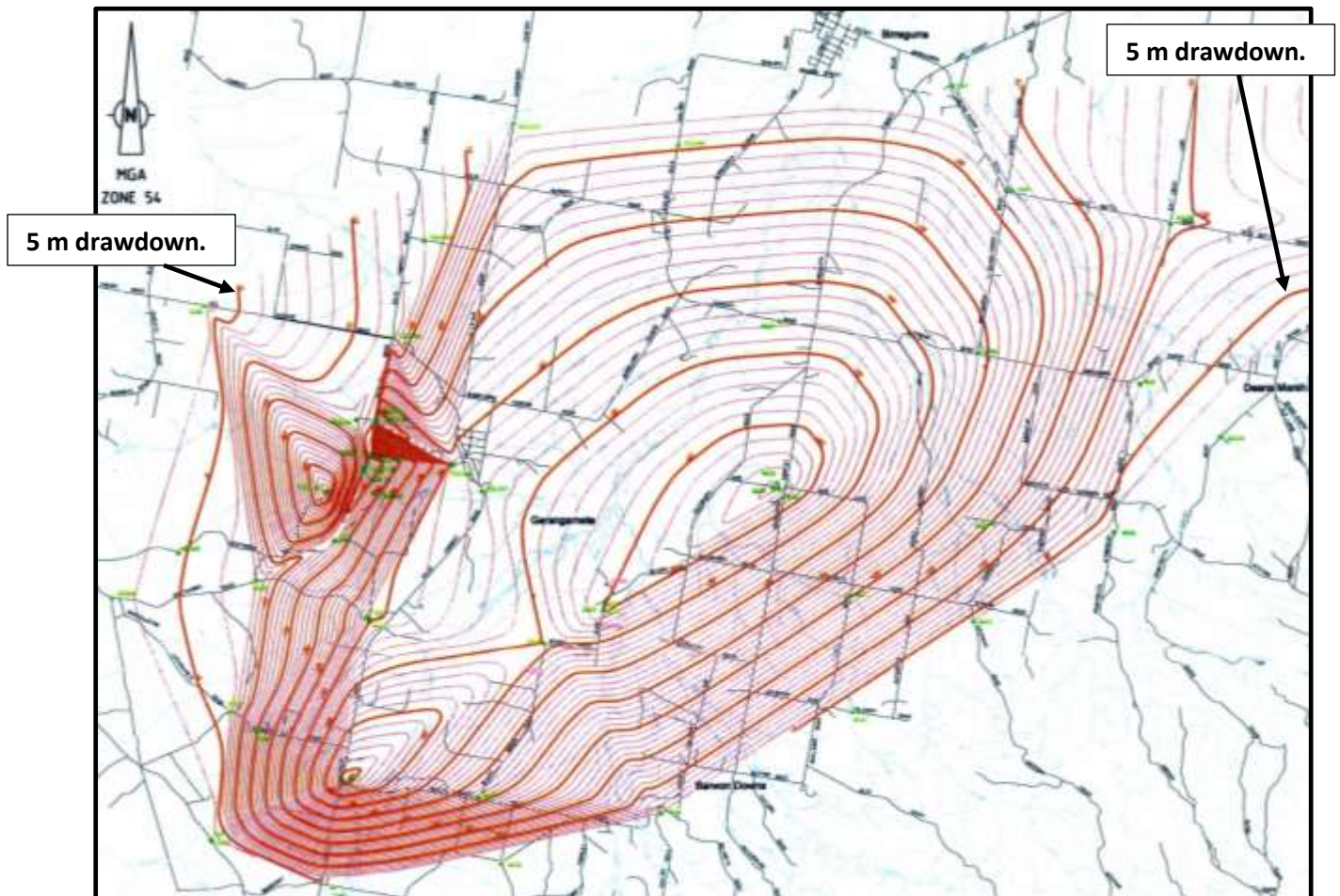
Why this residual contour drawdown map was depicted like this has never been explained.

2008-2009. Residual contour drawdown Map.

SOURCE: The 2008-2009 Gerangamete Groundwater report to Southern Rural Water.

This map was set out and presented on an A3 sheet. The full map was difficult to reproduce and thus has only partially been represented here.

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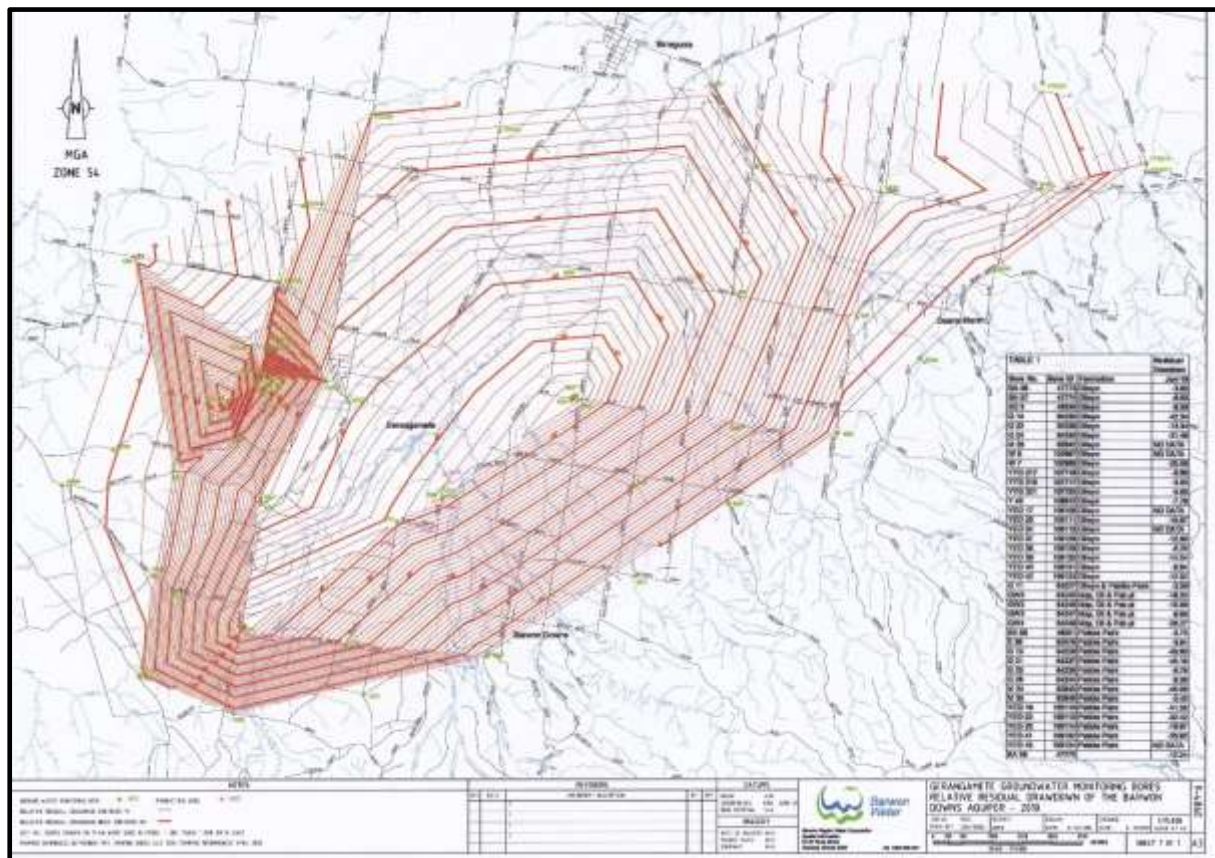


At least three cones of depression are shown on this residual contour drawdown map.

Drawdown contours have been shown out to the 5 metre mark.

2009-2010. Residual contour drawdown Map.

SOURCE: The 2009-2010 Gerangamete Groundwater report to Southern Rural Water.



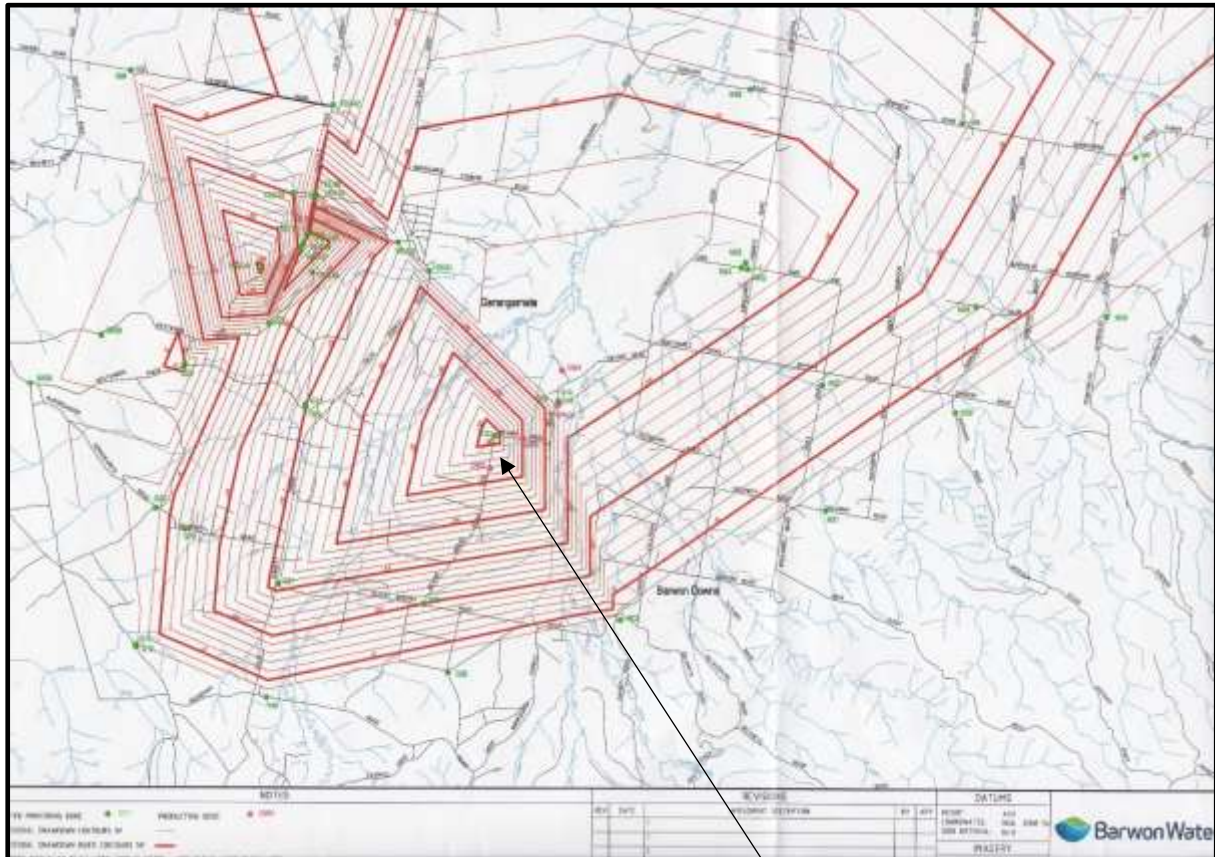
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This map shows at least three cones of depression and none of them are where they should be in relation to the extraction bores.

2010-2011. Residual contour drawdown Map.

SOURCE: The 2010-2011 Gerangamete Groundwater report to Southern Rural Water.

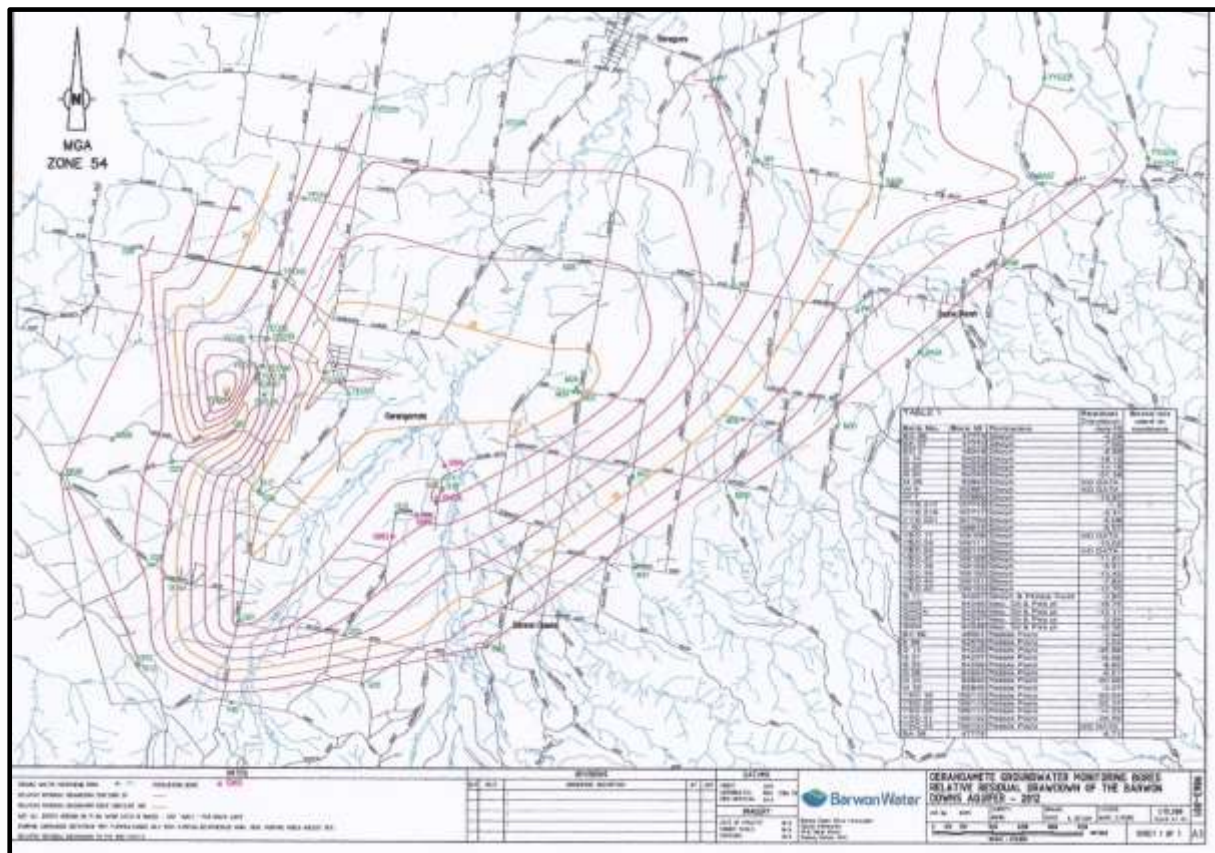
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This map shows at least two cones of depression and this cone is shown as sitting over the extraction bores.

2011-2012. Residual contour drawdown Map.

SOURCE: The 2011-2012 Gerangamete Groundwater report to Southern Rural Water.



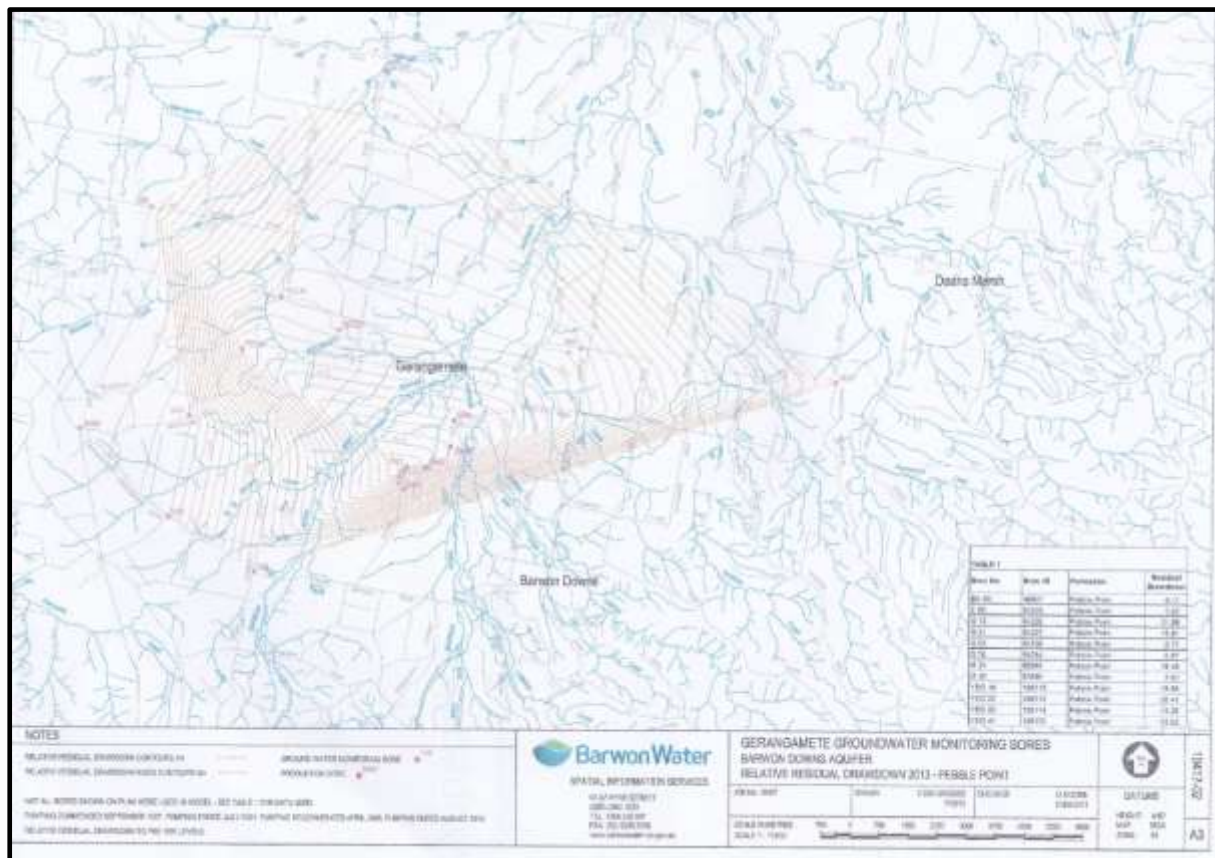
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Overall Sound Management and Reporting was Lacking.

Over the course of reviewing the annual Gerangamete Groundwater Extraction reports submitted to Southern Rural Water, not only have the drawdown maps been badly done there have been numerous other examples of “poor” procedural reporting.⁽⁶⁾⁽⁹⁾⁽¹²⁾ Another example of this became apparent when two different copies of the 2011-2012 report were distributed as the final report (see Appendix One, pages 45-48). In this example it would appear the draft was released but thankfully it was substantially the same as the final illustrated copy. This highlighted the ongoing concern that proofing of reporting and scrutiny of management of the Borefield by Southern Rural Water for correctness was lacking.

2012-2013. Residual contour drawdown Map.

SOURCE: The 2012-2013 Gerangamete Groundwater report to Southern Rural Water.



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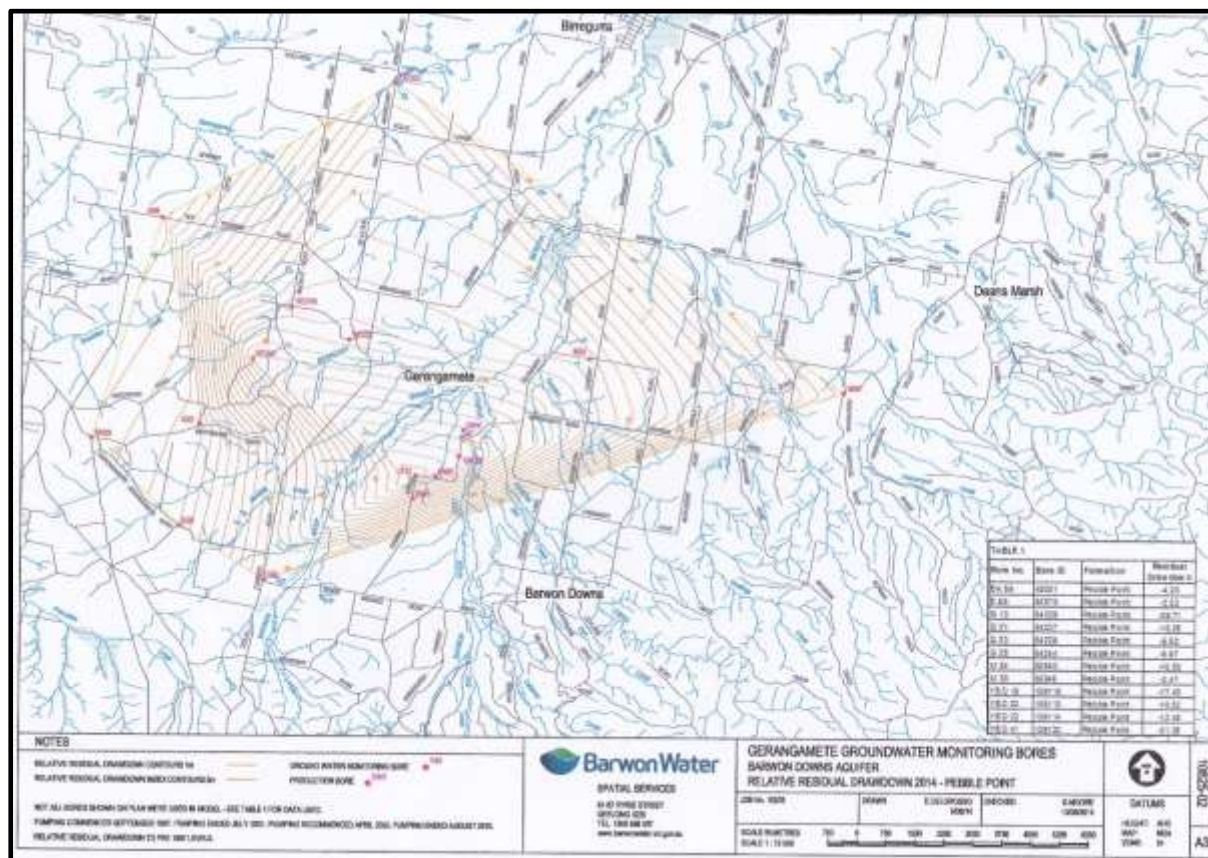
Up to this period the residual contour drawdown maps depicted and were titled *“Relative Residual contour drawdown for the Barwon Downs Aquifer.”*

For the first time in an annual report the residual contour drawdown map depicted only the residual contour drawdown contours in the Pebble Point Aquifer Formation.

Although difficult to see there is only one cone of depression and this is centred over the borefield site.

2013-2014. Residual contour drawdown Map.

SOURCE: The 2013-2014 Gerangamete Groundwater report to Southern Rural Water.



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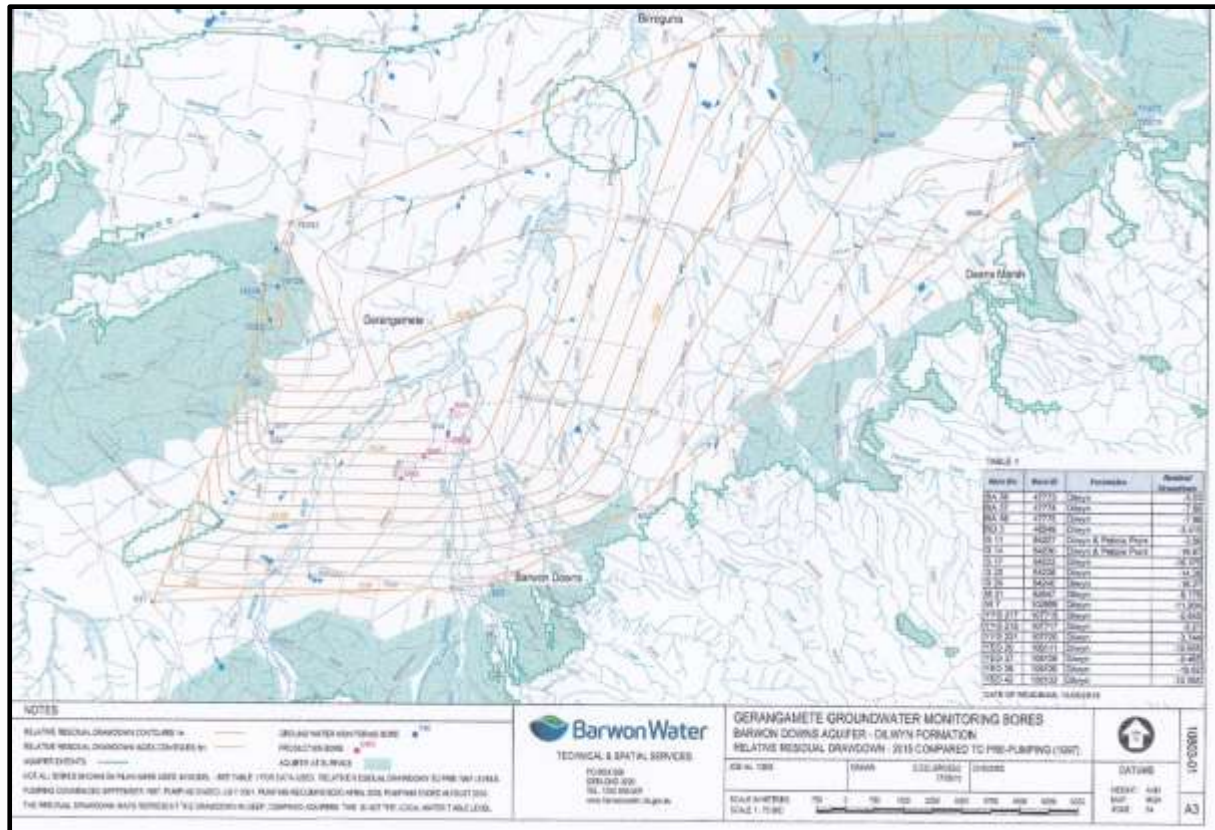
The 2013-2014 report included the one residual contour drawdown map and it was also for the Pebble Point Aquifer Formation, with one cone of depression.

The gaining of this report was facilitated through the assistance of the Victorian State Ombudsman.⁽¹²⁾

They Know Not What They Do.

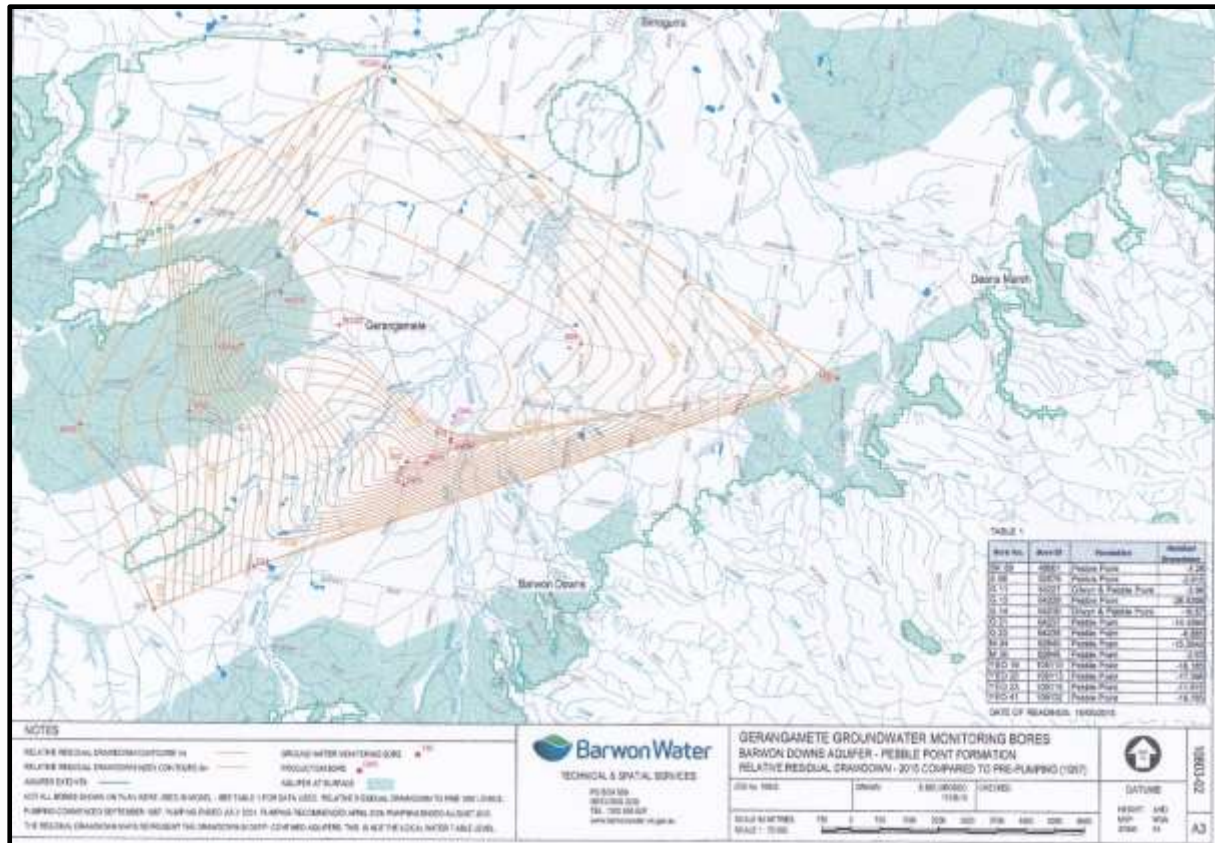
If not already apparent the discussion section will highlight why the 2004-2013 drawdown maps confirm the findings of a Victorian Auditor's report of 2010 that **".. and water corporations do not know whether groundwater use is sustainable."** (see Discussion section, page 33)

SOURCE: The 2014-2015 Gerangamete Groundwater report to Southern Rural Water, Dilwyn Aquifer Formation.



The Dilwyn Aquifer relative residual contour drawdown map. One cone of depression and sitting over the borefield. Different to the Mepunga drawdown map.

SOURCE: The 2014-2015 Gerangamete Groundwater report to Southern Rural Water, Pebble Point Aquifer Formation.



The Pebble Point relative residual contour drawdown map was also included. Each of the three aquifer's relative residual contour drawdown contour maps were distinctly different.

Residual contour drawdown Maps From 2014-2015.

For each of the 2015-2016, 2016-2017, 2017-2018 and the 2018-2019 reports there were three individual residual contour drawdown maps for the Mepunga, Dilwyn and Pebble Point Aquifers.

The Final report.

The 2018-2019 report was the last report. The Barwon Downs Groundwater Extraction licence was not renewed.

The following three residual contour drawdown maps have been taken from the 2018-2019 Barwon Downs Groundwater report.

GERANGAMETE GROUNDWATER MONITORING BORES
RELATIVE RESIDUAL DEPTHS - 2018 COMPAS31 TO PRE-PUMPING (1987)

Legend:

- Production Bore (Red dot)
- Injection Bore (Blue dot)
- Observation Bore (Green dot)
- Watercourse (Blue line)
- Road (Black line)
- Boundary (Black line)

Table 1: Bore Details

Bore No.	Bore ID	Description	Relative Depth (m)
BA 10	2777-02m	Production Bore	-4.10
BA 11	2777-02m	Production Bore	-4.10
BA 12	2777-02m	Production Bore	-4.10
BA 13	2777-02m	Production Bore	-4.10
BA 14	2777-02m	Production Bore	-4.10
BA 15	2777-02m	Production Bore	-4.10
BA 16	2777-02m	Production Bore	-4.10
BA 17	2777-02m	Production Bore	-4.10
BA 18	2777-02m	Production Bore	-4.10
BA 19	2777-02m	Production Bore	-4.10
BA 20	2777-02m	Production Bore	-4.10
BA 21	2777-02m	Production Bore	-4.10
BA 22	2777-02m	Production Bore	-4.10
BA 23	2777-02m	Production Bore	-4.10
BA 24	2777-02m	Production Bore	-4.10
BA 25	2777-02m	Production Bore	-4.10
BA 26	2777-02m	Production Bore	-4.10
BA 27	2777-02m	Production Bore	-4.10
BA 28	2777-02m	Production Bore	-4.10
BA 29	2777-02m	Production Bore	-4.10
BA 30	2777-02m	Production Bore	-4.10
BA 31	2777-02m	Production Bore	-4.10
BA 32	2777-02m	Production Bore	-4.10
BA 33	2777-02m	Production Bore	-4.10
BA 34	2777-02m	Production Bore	-4.10
BA 35	2777-02m	Production Bore	-4.10
BA 36	2777-02m	Production Bore	-4.10
BA 37	2777-02m	Production Bore	-4.10
BA 38	2777-02m	Production Bore	-4.10
BA 39	2777-02m	Production Bore	-4.10
BA 40	2777-02m	Production Bore	-4.10
BA 41	2777-02m	Production Bore	-4.10
BA 42	2777-02m	Production Bore	-4.10
BA 43	2777-02m	Production Bore	-4.10
BA 44	2777-02m	Production Bore	-4.10
BA 45	2777-02m	Production Bore	-4.10
BA 46	2777-02m	Production Bore	-4.10
BA 47	2777-02m	Production Bore	-4.10
BA 48	2777-02m	Production Bore	-4.10
BA 49	2777-02m	Production Bore	-4.10
BA 50	2777-02m	Production Bore	-4.10
BA 51	2777-02m	Production Bore	-4.10
BA 52	2777-02m	Production Bore	-4.10
BA 53	2777-02m	Production Bore	-4.10
BA 54	2777-02m	Production Bore	-4.10
BA 55	2777-02m	Production Bore	-4.10
BA 56	2777-02m	Production Bore	-4.10
BA 57	2777-02m	Production Bore	-4.10
BA 58	2777-02m	Production Bore	-4.10
BA 59	2777-02m	Production Bore	-4.10
BA 60	2777-02m	Production Bore	-4.10
BA 61	2777-02m	Production Bore	-4.10
BA 62	2777-02m	Production Bore	-4.10
BA 63	2777-02m	Production Bore	-4.10
BA 64	2777-02m	Production Bore	-4.10
BA 65	2777-02m	Production Bore	-4.10
BA 66	2777-02m	Production Bore	-4.10
BA 67	2777-02m	Production Bore	-4.10
BA 68	2777-02m	Production Bore	-4.10
BA 69	2777-02m	Production Bore	-4.10
BA 70	2777-02m	Production Bore	-4.10
BA 71	2777-02m	Production Bore	-4.10
BA 72	2777-02m	Production Bore	-4.10
BA 73	2777-02m	Production Bore	-4.10
BA 74	2777-02m	Production Bore	-4.10
BA 75	2777-02m	Production Bore	-4.10
BA 76	2777-02m	Production Bore	-4.10
BA 77	2777-02m	Production Bore	-4.10
BA 78	2777-02m	Production Bore	-4.10
BA 79	2777-02m	Production Bore	-4.10
BA 80	2777-02m	Production Bore	-4.10
BA 81	2777-02m	Production Bore	-4.10
BA 82	2777-02m	Production Bore	-4.10
BA 83	2777-02m	Production Bore	-4.10
BA 84	2777-02m	Production Bore</	



The 2018-2019 Pebble Point Aquifer Formation.

Comparison Between the 2014-21015 and 2015-2016 Drawdown Maps. Drawdown Influence Clearly Shown to Vary with Each Aquifer.

Appendix Four, pages **54-59** shows the comparison between the 2014-2015 residual contour drawdown maps for the three aquifers and those for the following year, 2015-2016. For the period that elapsed between the presentation of these two maps, 1902.7 ML was extracted from the Barwon Downs Borefield.

When viewing these two sets of maps several things are worthy of note.

- The cones of depression after a relatively small extraction dramatically declined. The Mepunga Aquifer dropped 8 m. The Dilwyn dropped 34 m. The Pebble Point dropped 23 m.
- The 2015-2016 drawdown contours in each aquifer is quite different to the preceding year.
- Each aquifer reacts markedly different to groundwater extractions.
- There is only one cone of depression for each aquifer.
- Each cone is situation in the vicinity of the Borefield.

Stratigraphic Sequence of the Area.

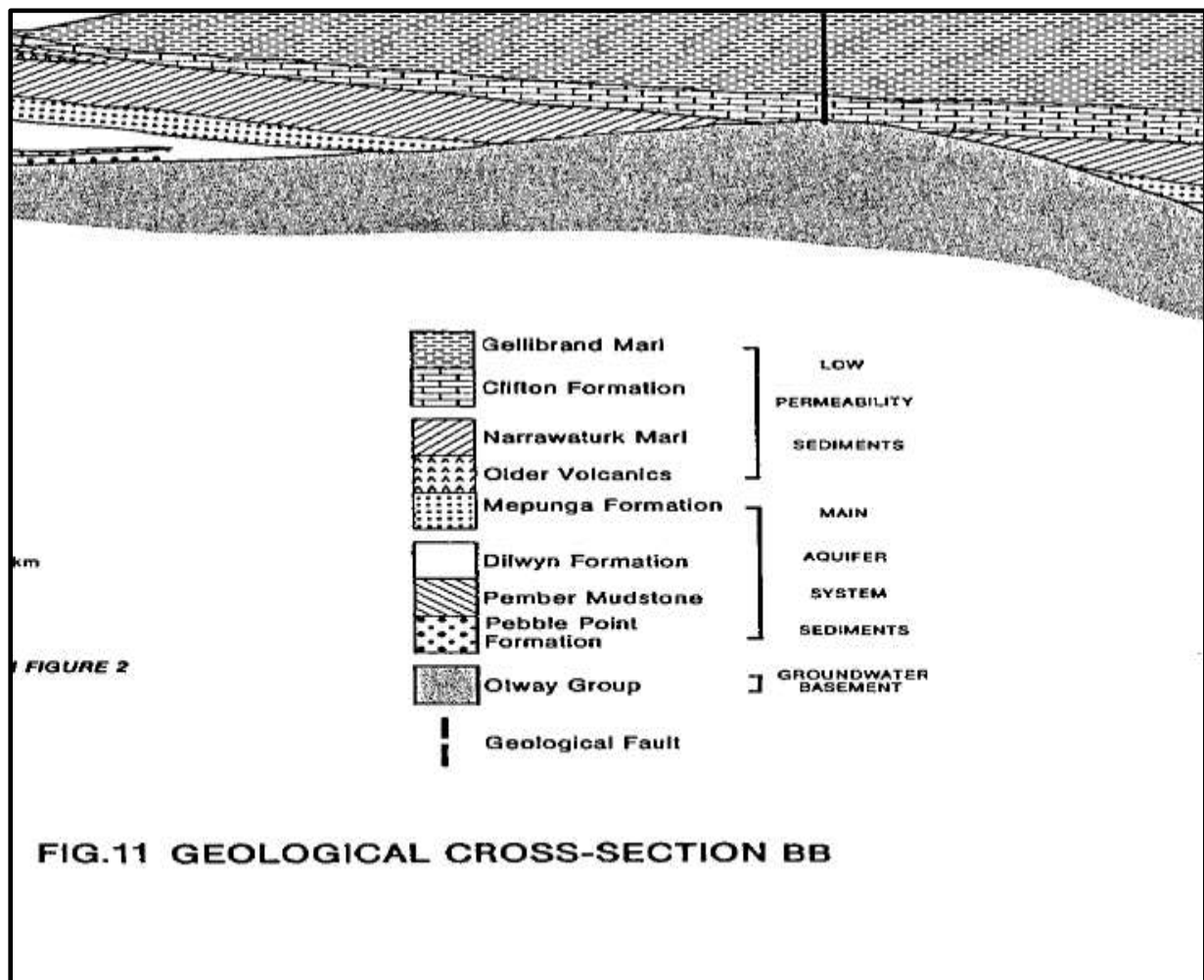
In his 1984 diagram John Leonard indicated that the main Lower Tertiary Aquifer(s) system sediments in the area comprised the Mepunga Aquifer, sitting above the Dilwyn Aquifer; with both these aquifers sitting above the Pember Mudstone Aquitard. The Pember Mudstone then sits above the third aquifer of the Lower Tertiary Aquifer(s) called the Pebble Point Aquifer.

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These three aquifers and the Pember Mudstone have been labelled the Lower Tertiary Aquifer (LTA). Unfortunately, using the term Lower Tertiary AQUIFER gives the impression there is only one aquifer in this formation. The LTA would be better named the Lower Tertiary Aquifers (LTAs).

Diagrams on ages **28** and **29** provide easier to understand structural layers.

SOURCE: John Leonard 1984 submission to the NREC⁽²⁾



At the Borefield the Lower Tertiary Aquifer is approximately 400 to 600 metres below the surface.

Geologic unit		Type
SKY		
Quaternary		Aquifer
Gelli Marl		Aquitard
Clifton		Aquifer
Narrawaturk		Aquitard
Mepunga		Aquifer
Dilwyn		Aquifer
Pember		Aquitard
Pebb lepoint		Aquifer
Bedrock		Aquitard

Lower Tertiary
Aquifers (LTA).

Aquitards can be full of water but are less permeable, restricting water movement through or from them.

This is another way of depicting the Lower Tertiary Aquifers.

SOURCE: Barwon Downs Flora Study 2008⁽⁷⁾

Table 2 Aquifers and Aquitards ¹ present in Study Area			
Geological Unit	Description	Type	System
Quaternary Alluvium	Sands, silts and gravels.	Aquifer (minor)	Minor surficial aquifer restricted to river and creek channels
Gellibrand Marl	Calcareous silty clay and clayey silt. Fossiliferous.	Aquitard	Mid Tertiary Aquitard (MTD)
Clifton Formation	Calcareous mudstone with marine fossils and minor quartz and limonite sands	Aquifer (minor)	
Narrawaturk Marl	Calcareous mudstone with thin carbonaceous beds, sand beds and fossiliferous beds	Aquitard	
Mepunga Formation	Medium to coarse grained quartz sand with some carbonaceous clays and silt layers	Aquifer	Lower Tertiary Aquifer (LTA)
Dilwyn Formation ²	Carbonaceous, sandy clays and silts, with some quartz sand and silty sand beds, and minor gravel. Coal and carbonaceous clays also occur in this unit.	Aquifer	
Pember Mudstone	Clays, silts and fine grained sand with carbonaceous, micaceous and pyritic horizons.	Aquitard (minor)	
Pebble Point Formation ²	Fine-grained sand with carbonaceous silt and quartz pebble beds. This unit is an equivalent to the Moomowroong Sand Member, Wiridjil Gravels that occur in the Gellibrand sub-basin to the south west of the study area.	Aquifer (minor)	
Bedrock	Sandstone, siltstone and mudstone with feldspar and quartz grains, well-bedded and consolidated.	Aquitard	

1. Aquitards are shaded grey
2. These geological units may also be referred to as the Eastern View Formation

Ignore my pen marks.

Screening of the Barwon Downs Borefield Extraction Bores.

At the time of Barwon Downs Borefield licence expiry date in 2019 there were six production bores capable of extracting water from the Lower Tertiary Aquifers. Five of them were screened in each of the three aquifers. The remaining production bore was screened in two of these aquifers.

The following two pages indicate the bores; the aquifers they are screened in and the depths and length of the screenings.

Production Bore	Screen Interval		Aquifer formation
GW2A	401.02m	406.03m	Mepunga
	419.07m	428.1m	Mepunga
	431.12m	449.18m	Dilwyn
	455.2m	481.28m	Dilwyn
	484.31m	493.32m	Dilwyn
	497.34m	503.36m	Dilwyn
	526.41m	535.45m	Pebble Point
GW3	378.2m	384.3m	Mepunga
	390.3m	396.4m	Mepunga
	402.5m	414.6m	Dilwyn
	417.7m	439.0m	Dilwyn
	445.1m	466.4m	Dilwyn
	481.6m	487.7m	Dilwyn
	509.0m	527.2m	Pebble Point
GW4	489.94m	499.96m	Mepunga
	504.96m	523.99m	Dilwyn
	526.99m	541.01m	Dilwyn
	544.02m	550.03m	Dilwyn
	559.05m	565.06m	Dilwyn
	599.1m	608.19m	Pebble Point
	608.19m	611.13m	Pebble Point
GW5	611.13m	620.14m	Pebble Point
	361.51m	365.52m	Mepunga
	372.05m	377.06m	Mepunga
	382.07m	393.09m	Mepunga
	397.1m	411.11m	Dilwyn
	421.17m	424.18m	Dilwyn
	427.24m	442.28m	Dilwyn
	445.34m	448.35m	Dilwyn
	451.4m	454.41m	Dilwyn
	458.42m	461.43m	Dilwyn
	474.56m	477.57m	Dilwyn
	482.08m	486.09m	Dilwyn
	488.57m	491.6m	Pebble Point
	493.6m	501.62m	Pebble Point
GW6	354.7m	360.7m	Mepunga
	366.7m	374.7m	Mepunga-Dilwyn
	380.7m	396.7m	Dilwyn
	410.7m	413.7m	Dilwyn
	416.7m	423.7m	Dilwyn
	432.7m	436.7m	Dilwyn
	441.7m	444.7m	Dilwyn
	468.2m	477.2m	Dilwyn

Production Bore	Screen Interval		Aquifer formation
GW8	396.5m	401.0m	Mepunga
	416.5m	419.5m	Mepunga
	431.5m	442.5m	Mepunga
	445.5m	459.5m	Dilwyn
	468.5m	476.5m	Dilwyn
	479.5m	491.5m	Dilwyn
	536.5m	544.5m	Pebble Point

SOURCE: Barwon Water email to Otway Water, 18-02-2020.

This meant that each production bore was extracting water from two or more aquifers at the same time.

Discussion.

From the very start Southern Rural Water the regulator and “enforcer”, and Barwon Water, both failed to adopt and implement sound technical management processes at the Barwon Downs Borefield.

To make matters worse Southern Rural Water (SRW) steadfastly maintained the view for many years that Barwon Water was abiding by the licence conditions even though there were numerous non compliance issues with the licence brought to SRW’s attention.⁽⁹⁾ For ten years little action was taken to rectify any poor management decisions.

Victorian Auditor General 2010.

With regard to the sustainability of groundwater extraction it is interesting to note a quote in a Victorian Auditor General’s report tabled in Parliament in 2010.⁽⁸⁾

The report, *Audit Summary of Management of Victoria’s Groundwater Resources*, can best be summed up in one sentence taken from page (vii) of this work.

“The Department of Sustainability and Environment (DSE) and water corporations do not know whether groundwater use is sustainable.”

This report was damning enough but it would appear that the problems with groundwater extraction management at the Barwon Downs Borefield went a lot further than just problems with unsustainable management.

Residual contour drawdown reporting as per the Licence Conditions.

For ten years the reporting of the residual contour drawdown was technically very poorly done. Pages **10-26** clearly provides material supporting this as fact.

In 1995 the Witebsky et al.⁽¹⁾ report indicated that the previous groundwater extractions (stress test pump) from the Barwon Downs Borefield had created a cone of depression at the borefield site to the depth of 50 metres (see page **6**).

In a lead up to the renewal of the Borefield licence due in 2002, several drawdown maps were distributed as part of the community consultation. Page **10** shows one example of this with the contours super-imposed on a local map. The drawdown was to a depth of 30 metres. There was only one cone of depression and this was directly over the Borefield site. As it should be.

The maps on page **11** show two different drawdown contour maps. One labelled as the Pebble Point Aquifer Formation. The drawdown was approximately 30 metres and had only one cone of depression, as would be

expected. The other contour map depicts the Dilwyn Aquifer formation with an approximate drawdown the same as the Pebble Point Aquifer. It also showed only one cone of depression. The cone formation for each of these two aquifers is also distinctly and significantly different. This is expected as they are different aquifer formations and at different depths.

The Licence is Finally Renewed.

After several extensions of an out of date groundwater extraction licence the new 15 year licence to 2019 was granted in 2004. One of the conditions of this licence under the Second Schedule, was to provide Southern Rural Water (SRW) with an annual report including a map of residual contour drawdown. The condition states - “**Reporting 1.3 c. *a map of residual contour drawdown for the year.***”

This was complied with for 10 years but was inherently wrong. Providing one single map for those ten annual reports only provided a misrepresentation of what was actually taking place and unfolding. Attempting to include the data from three different aquifers on one residual contour drawdown map was an impossible task.

The 2004-2005 residual contour drawdown map seen on page **12** contained at least four cones of depression. This indicated there should have been four different borefields. One at each cone of depression. However, there has only been one borefield. Not only that, not one of these cones was centred over the actual Barwon Downs Borefield. Something with this depiction was terribly wrong and should never have passed Southern Rural Water’s scrutiny in repeated annual reports.

This situation existed for ten years despite the regular request to Barwon Water and Southern Rural Water to review how the residual contour drawdown contours were being calculated. Otway Water Book 20⁽⁵⁾, pages 71-76 relates some of the efforts to have this issue resolved. These efforts led up to the release of the 2010-2011 Gerangamete Groundwater extraction report. And...

in September 2011 the 2010-2011 Gerangamete report still had multiple cones of depression on one residual contour drawdown map.

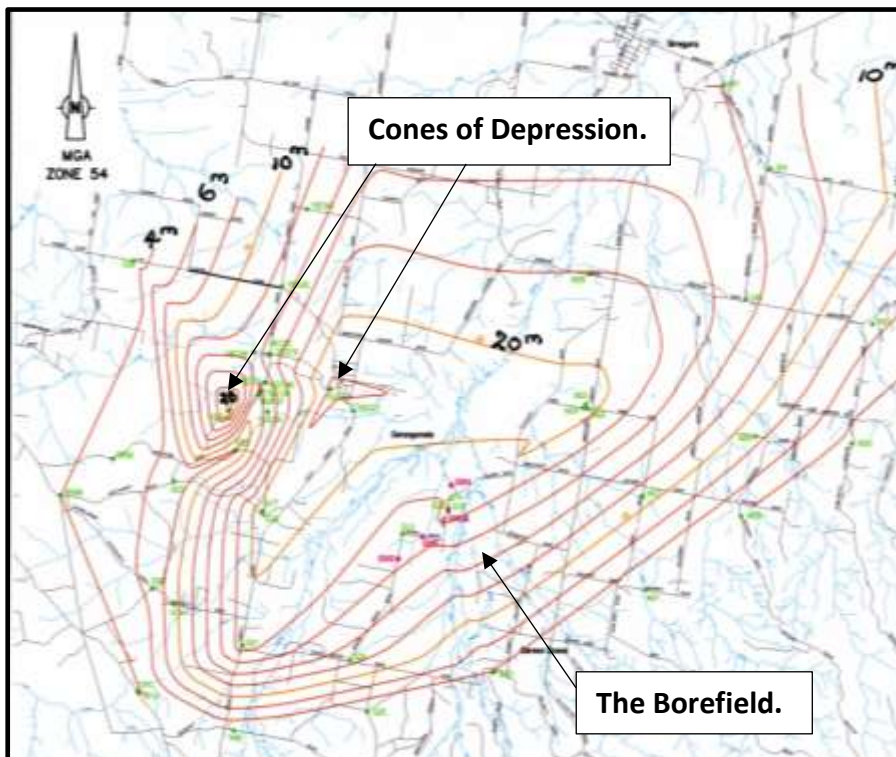
Any further pursuit of this issue with Southern Rural Water or Barwon Water was shelved. Little was being achieved and other pressing water issues took precedent.

However, on **Tuesday 1 May 2012** in the Legislative Council, MLA Minister for Water Walsh, was asked to comment on the multiple cones of depression in the Barwon Water annual reports sent to Southern Rural Water. His reply is most interesting...

"It is correct that you would expect to see only a single cone of depression on the relative residual contour drawdown maps in the annual reports from 2004/05 to 2010/11. This would be the large regional cone of depression directly under the borefield which is consistent with the predicted draw down.

The second cone of depression, which appears on the maps, is based on the observations from a single monitoring bore which is consistent with monitoring data collected for neighbouring bores. It brings into question the integrity of the bore itself. The integrity of this bore, which is part of the state observation bore network, cannot be verified without an expensive investigation."

Not easy to understand exactly what Minister Walsh was saying but it is gratifying to see that, yes, there should be only one cone of depression if there



is only one borefield. Why neither of the cones of depression for the 2010/11 period (see page **18**) falls directly over the Borefield was not commented on.

But unfortunately, the next year's map of 2011-2012 still had two cones of depression. Neither cone was

SOURCE: Barwon Water 2011-2012 Gerangamete Report.

It would appear despite the Minister's attention being brought to the situation, nothing changed.

Other Comment on the Minister's Reply.

1. There are no extraction bore(s) at either of the cones of depression depicted in the 2010-2011 map.
2. Barwon Water was monitoring over 60 bores in relation to the Borefield drawdown. How the integrity of one observation bore could be credited with causing such wide misrepresentation is hard to justify.
3. It is also extremely difficult to understand how this whole issue had anything to do with cost. The issue was to do with not having a clear understanding of the most basic groundwater theory and practice.

The annual residual contour drawdown maps from 2005 to 2011 (see pages **12-18**) depicted numerous changing cones of depression; dramatic changes in drawdown from year to year; in many cases no cone of depression at the Borefield and in at least one case large unexplained sections of the drawdown contours missing. Who was taking responsibility for this management fiasco? It would appear no one was.

Isn't it Ironic.

If the Liberal Minister for Water (2012) was unable to clarify and or provide a satisfactory answer when in office, then who would have the resources and expertise to do so? Also, back in September 2010 when Minister Walsh's political party was in opposition and leading up to the State elections, he had this to say of the then Labour Party and Minister for Water...

"Put simply the Government does not have the skills to manage groundwater in the state effectively." Thirty months later when Peter Walsh was the Minister for Water, things appeared to be no different.

We Will Investigate the Issue.

Seventeen months prior to Minister Walsh's reply, Southern Rural Water held a Warrion Aquifer groundwater information night in the COPAC building in Colac in December 2010. Southern Rural Water officials Angus Ramsey and Elissa McNamara, undertook to investigate the multiple cones of depression query posed to them regarding the Barwon Downs Borefield. It was my understanding that Elissa said there was no possibility of multiple cones and that Barwon Water would be involved in discussion to seek out an answer to this concern.

However, despite all attempts to clear up this predicament, it took until the 2012-2013 annual report before any change appeared to finally be happening. But, even this was a half-hearted effort.

As explained to me years before, using one residual contour drawdown map and combining all the observation bore readings from the three different aquifers, would give a nonsense output.

Some Sense of Resolution.

The 2012-2013 annual report (see page 20) included one residual contour drawdown map but only for one aquifer. It was for the Pebble Point Aquifer Formation. Only one cone of depression on this map. Excellent. And it was over the Borefield site. Great. The residual contour maps from the other two aquifers were not included in the report. Still some way to go.

The following year 2013-2014 still only one residual contour drawdown map (see page 21) and once again it was just for the Pebble Point Aquifer Formation. The cone of depression had not moved. As it should not have. Right over the Borefield.

A New Management Team.

By the time the 2014-2015 annual report was due Barwon Water administration had undergone significant change. Community participation was actively sought. This was reflected in the manner the annual reports for the Gerangamete Borefield were prepared. Three residual contour drawdown maps were included. One for each of the aquifer formations that the Borefield was extracting water from – the Mepunga, Dilwyn and the Pebble Point Aquifers.

Each map depicted a significantly different cone of depression but each cone was located above the Borefield as they should have been.

An Early Failure to Implement, Supervise and Manage the Borefield.

It took to the 11th year of a 15 year licence to get the depiction of the residual contour drawdown contours correct. Beside all of the other issues of mis-management, the lack of scrutiny and correctness signified a “dodgy brothers” type attitude adopted by both Southern Rural Water and Barwon Water in the early years of the 2004 licence. The early reporting of the residual contour drawdown data...

1. showed a distinct lack of understanding of the impact groundwater has in relation to a cone of depression,
2. the reports should never have left the Barwon Downs offices in such a jumbled state,
3. should never have then been passed as acceptable by the Southern Rural Water regulators, resource managers and scrutineers, and
4. most definitely should not have been left to a member of the public to spend years getting Southern Rural Water and Barwon Water to present

the residual contour drawdown data in an accurate and acceptable state.

The manner in which Southern Rural Water and Barwon Water handled the interpretation of groundwater drawdown data partially confirms the findings of the Victoria Auditor General 2010 investigation into the management of Victoria's groundwater resources. Poorly understood and poorly managed.

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How management decisions could be made regarding the impact of groundwater extraction is impossible to tell.

However, there Exists a Larger and more Pressing Problem.

The fact that from the very beginning of the life of the Borefield all extraction bores have been screened across more than one aquifer is of considerable concern. Seemingly without any effort to prevent interflow between aquifers. Five of the six bores are screened in three aquifers and one bore is screened in two aquifers.

What is Wrong With This?

Firstly, the three aquifers react to extractions totally differently. See the pages **22-27** & **54-59** showing the differences. They have different pressure heads; the physical and chemicals characteristics of the water are different and the Minimum Requirements⁽¹⁰⁾ for good management practice require that aquifers must be not be able to intermix.

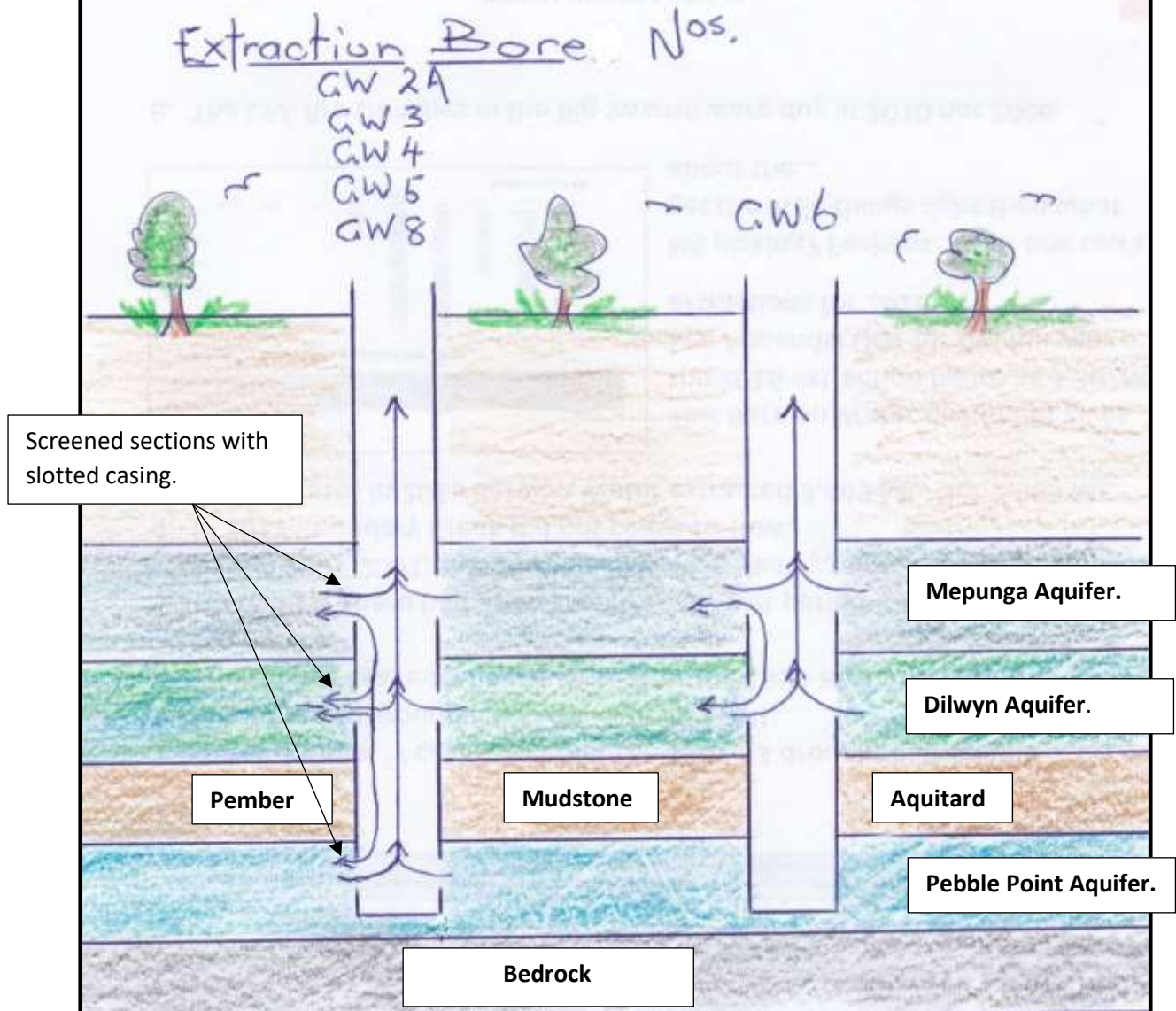
However, water resource managers including the Minister for Water are still evidently treating the three aquifers as one continuous aquifer unit. This is unacceptable.

Are the Screening Across Aquifers Another Disaster in the Making?

Unless the decommissioning of the 6 extraction bores at the Barwon Downs Borefield is carried out as a matter of urgency an unseen and unrealised disaster may very well be taking place hundreds of metres below the ground at Barwon Downs.

Barwon Downs Extraction Bores' Screening.

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Each of the five bores GW2A, GW3, GW4, GW5 and GW8 are screened into three aquifers. GW6 is screened in two of the three aquifers (see page **29-31** for the various formation structure).

Problems with screening into more than one aquifer.

Generally, screening into multiple aquifers in the same bore is considered problematic for the following reasons.

1. Water from any aquifer can move freely between aquifers.

2. Water pressures between aquifers can be quite different as displayed with the 2014-2015 residual contour drawdown maps (see pages **22-26**).
3. If there are concerns with water quality differences between aquifers then allowing free flow between aquifers is a problem.
4. Without a full and comprehensive understanding of the water parameters of each aquifer then allowing transfer and mixing of water from one aquifer to another is mostly guesswork as to the suitability to do this. This is the major reason why bores should not be screened into more than one aquifer.
5. Contamination, recharge movement through vertical leakage with free flow of water between aquifers is not desirable.
6. To know with any accuracy exactly what is actually happening 400 to 600 metres below ground level is almost an impossible task. Monitoring infrastructure at the Barwon Downs Borefield is incapable of determining this.

Considering the water resource managers involved in operating the borefield had little idea of how to go about representing the residual contour drawdown for these three aquifers, it is not a far stretch of the imagination to suggest that having individual bores screened in more than one aquifer also indicates a lack of understanding and application of technical expertise regarding groundwater. From a purist point of view each extraction bore should have been screened in only one aquifer per bore.

Expedience and Lower Costs?

However, at the time of implementing the Borefield it may have been seen as cost effective, more productive and expedient to multiple-port (screen in various aquifers) in each extraction bore .

Multi-port Monitoring Bores.

Even with multi-port bores (Screening in more than one aquifer) every effort must be taken to allow no intermixing or contamination occurring between aquifer zones.

“Experience has shown that it is sometimes quicker and more secure to drill multiple holes if room permits, as any drilling time saved with a single hole can be taken up with the setting of multiple casing strings and annular cement grout seals.”⁽⁹⁾

How many of the Barwon Downs Borefield extraction bores have been set up with multiple casing strings and annular cement grout seals?

Minimum Construction Requirements for Water Bores in Australia⁽⁹⁾.

The third edition of the “*Minimum Construction Requirements for Water Bores in Australia*” sets out, as the title suggests, minimum requirements regarding bore construction and use in Australia.

“This book outlines the minimum requirements for constructing, maintaining, rehabilitating, and decommissioning water bores in Australia.”⁽⁹⁾

This is an authoritative document on mandatory and good industry practice.

Don't Allow Free Flow of Water Between Aquifers.

When reading this Minimum Requirements manual⁽⁹⁾, it is apparent that screening in multiple aquifers in the one bore has to be conducted with extreme care.

“Where multiple aquifers are encountered the key element of the bore design for aquifer protection is to ensure that waters of different aquifers do not mix, either in the bore casing or in the annulus between the casing and the borehole.”⁽⁹⁾

“In multiple aquifer bores there shall also be a seal between the aquifers and permeable zones to prevent intermixing, flow, and contamination.”⁽⁹⁾

And, with artesian bores... “ *preventing any intermixing of waters of different quality or pressure from one aquifer to another*”⁽¹⁰⁾ is to be avoided at all cost.

The Barwon Downs Borefield taps into artesian waters requiring extra precaution.

There is every indication that the extraction bores at the Barwon Downs Borefield have not followed some of these basic rules.

SRW Had this to Say...

In an email on the 3rd of February 2020 Southern Rural Water (the regulator) had this to say when asked whether multiple screening can be done in one extraction bore.

“In multiple aquifer bores a seal is required between the aquifers to prevent intermixing, flow, and contamination.

However, it is acceptable to have multiple screen sections within the same aquifer/groundwater resource, for example to target zones of higher permeability, and to avoid fine sand and clay which cannot be screened.”

The question soliciting this answer did not specifically refer to the Barwon Downs Borefield. It should have. And, it should have been asked are the Barwon Downs extraction bores screened appropriately?

However, DELWP May have Provided the Answer...

In February 2020 DELWP (Department of Environment, Water, Land Planning) replied to a specific query on the screening of the aquifers at the Barwon Downs Borefield. Extract from an email included this...

“You asked why Barwon Waters production bores are screened at different intervals/formations in the same bore. Noting that Minimum Construction Requirements for bores seeks to ensure the protection of the groundwater resource from contamination, intermixing, and uncontrolled flow.

Barwon Water production bores (variously screened between 350-650m below natural surface) intersect the Eastern View Formation which consists of Pebble Point, Dilwyn, Mepunga and Pember mudstone Formations.

According to the annual report for the Gerangamete GMA Licence no.

BEE32496 for 2013-2014, these formations are interbedded and have been reworked, with an absence of a continuous layer. These formations hence are treated as one hydraulically connected aquifer unit.”

For some reason the 2013-2014 Licence report only includes the Pebble Point Aquifer drawdown data. The other two aquifer formations were ignored. However, once the residual contour drawdown maps for the other aquifers were included, they graphically indicated they were not one hydraulic connected unit (see pages **22-26**). The differences were significant.

The 2017 – 2018 Report Puts a Completely Different Slant on this Notion of One Hydraulically Connected Aquifer Unit.

In the extract below taken from the 2017-2018 Barwon Water report, there appears to be a contradiction with this notion of one hydraulically connected

unit. It is stated in the 2017-2018 report that the three aquifer formations in the Lower Tertiary Aquifer have significant lithological differences (see the star below ★). The last sentence would also appear to be supporting this, stating that these aquifers do not form a continuous single layer .

Formation	Group	Period	
Gellibrand Marl	Heysterbury	Quaternary	Aquitard
Clifton Formation		Tertiary	Minor aquifer
Demon Bluff (Narrawaturk Marl)	Nirranda	Tertiary	Aquitard
Eastern View	Wangerrip	Tertiary	Principal aquifer
Eumeralla	Otway	Cretaceous	Basement rocks

The principal aquifer in Barwon Downs is the Eastern View Formation. This is the basal tertiary unit of alluvial or fluvial deposits containing predominantly quartz, sand, gravel, minor clay and brown coal believed to be deposited during the Palaeocene and Eocene at the start of the tertiary. Tickell et al. (1991) states the lower, middle and upper Eastern View Formations are equivalent to the Pebble Point, Dilwyn and Mepunga Formations respectively. These formations have been renamed as there are significant lithological difference between these layers and the lateral equivalent layers found in the Port Campbell Embayment. The Pebble Point, Dilwyn, Mepunga and Pember Mudstone Formations represent deposits of marine or marginal marine environments. Constant process of deposition, erosion, and reworking of the deposits resulted in interbedded, moderately to poorly sorted, unconsolidated sand gravel, silt, clay and brown coal and an absence of a single continuous layer. ★

SOURCE: Barwon Water's 2017-2018 Gerangamete Report to SRW, page 5.

Absence of a Continuous Layer?

This notion of treating the Lower Tertiary Aquifers as one hydraulically connected aquifer unit dates back to at least 2003. ★

It would appear that when the Borefield was first put in, the poorly sorted structures were indeed regarded as one single unit. But, by 2019 significant lithological differences between the aquifers were recognised.

It took over ten years to correct the Barwon Downs Borefield annual drawdown maps. The first change appeared in the 2013-2014 report. And, this was only for the one aquifer, the Pebble Point drawdown (see pages 20 and 21). Up to this particular time the three aquifers were treated as **one hydraulically connected aquifer unit** with a combined one map presentation of

residual contour drawdown data. Thus, producing numerous phantom cones of depression and other misinformation (see pages 12 to 19).

Definitely not one Hydraulically Connected Aquifer.

If the three aquifers, Mepunga, Dilwyn and Pebble Point were one aquifer unit, the early residual contour drawdown maps reported in the Gerangamete annual reports may have shown one cone of depression. But this was not the case. Representing the drawdown impact of the three different aquifers on one map could not be accomplished. However, in the 2014-2015 report when each of the three aquifers were represented separately, the residual contour drawdown maps clearly indicate different and individual characteristics (see page 22 to 26). Only one cone of depression for each aquifer. Each aquifer's cone was centred over the Borefield. But however, each aquifer's cone of depression was distinctly different. Also, the physical and chemical characteristics of the water found in the various aquifers may well provide other dissimilarities.

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Decommissioning a Borefield.

The Minimum Requirements manual⁽⁹⁾ states that decommissioning of a borefield should “... *restore, as far as possible, the aquifer isolation that existed before the bore was drilled and constructed.*”

This is what should be done.

Reasons Why this Borefield Should be Decommissioned & Dismantled.

1. Unless the Borefield is decommissioned the risk of restarting the pumps with over extraction and groundwater mining is far too great.
2. Barwon Water has indicated that there will be no further water extracted from the Barwon Downs Borefield. Not even in an emergency situation. Therefore it would be sensible to decommission the borefield before any deterioration takes place
Decommission – “...to restore, as far as possible, the aquifers isolation that existed before the bores were drilled and constructed.”
3. Barwon Water has planned its future water demand that does not include the Barwon Downs Borefield.
4. The extraction pumps have been withdrawn.
5. The aquifers in the region will be given a chance to recover as will the area of drawdown influence.
6. Hopefully it will send the message that a similar set of mistakes must not be made again.

7. It would be a landmark confirmation that a borefield in the region cannot sustain such a large amount of extraction.
8. Interflow between aquifers needs to be stopped.
This should be a high priority.
9. Decommissioning would ratify Barwon Water's "pledge" of no more extractions as seen in point 2 above.
10. This would be an enormous boost to the communities' trust in Barwon Water's word.
11. Communities in the region would give this move a tick of social licence.
12. Time, effort and expense spent by local community members monitoring the Barwon Downs Borefield situation could cease.
13. The bores will deteriorate over time and exacerbate any inherent issues.

CONCLUSION.

The Barwon Downs Borefield has served its purpose supplying and ensuring Geelong's water supply was maintained during crisis periods of water shortage, particularly through the 1982-1983 and Millennium droughts. Pleasingly, Barwon Water has secured and planned its water demands for the next few decades and this does not include the use of groundwater from the Barwon Downs Borefield. *It is time to move on and decommission this Borefield.*

The history of this Borefield is littered with a multitude of problems. Environmental impacts including the decimation of wetlands and fish kills down the Barwon River. Creeks and springs drying up. Farmers' Domestic and Stock water supplies disappearing. Farm economies compromised. At least 480 km² of impacted area. Prospects of remediation from the drawdown impacts persisting for many decades. *It is time to move on and decommission this Borefield.*

Leaving the extraction bores to remain and the three aquifers not returned to those conditions that existed before the bores were drilled, is fraught with continued disastrous outcomes.

It really is time to move on and decommission this Borefield.

APPENDIX ONE. Two different 2011-2012 Reports obtained.

Although nothing like the discrepancies between the two different annual 2004-2005 reports⁽⁶⁾⁽¹³⁾⁽¹⁴⁾, the difference between the two 2011-2012 reports is mild in comparison.

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GERANGAMETE

GROUNDWATER MANAGEMENT AREA

GROUNDWATER LICENCE

NO: BEE032496

2011/2012 REPORT



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APPENDIX TWO.

Ms Tracey Slatter
Managing Director
Barwon Water
55-67 Ryrie Street
Geelong VIC 3220
December 2021



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c.c. Minister Lisa Neville
Minister Lily D'Ambrosio
Dr Samantha Ratnam MLC

Dear Ms Slatter,

We write to congratulate Barwon Water on the Draft 2022 Urban Water Strategy. The draft strategy indicates the transitioning of the authority from over-reliance on rivers and groundwaters, the cause of widespread environmental degradation, to greater use of other sources of water including climate independent supplies and to water-valuing processes. We note the prevalent community support for this direction as embedded in the draft strategy's Vision for the Future: 'A secure water future where our rivers flow, our foods grow and our impact is low etc.'

In particular we are pleased to see that Barwon Water 'have ruled out the use of the Barwon Downs borefield as a source of urban supply in this Water for our Future strategy'. We trust this exclusion will apply permanently in line with the 50year Vision for the Future. As stated in the draft strategy, remediation is underway on the environmental impacts on Boundary Creek's Big Swamp.

We note that the conditions of the bulk entitlement in regard to the Anglesea borefield are very different to those that governed Barwon Water's historical use of groundwater from the Barwon Downs borefield. The explicit involvement of the Anglesea River Working Group to minimise the risk of environmental impact is essential, and we further note the authority's commitment 'we will only ever operate it in a way that protects the environment and in consultation with the community'.

Finally, we would like to put forward our strong view that 'adaptive planning to manage uncertainty' must never again default - especially in the light of expected climate change caused drought and significant population increase - to the over-extraction regimes which saw the Otways aquifer systems/ecosystems bear the brunt of poor water authority management, such as occurred especially during the millennium drought.

In this regard we note the strong statements made by Barwon Water's Mr Seamus Butcher that the authority has no intention to return to the Barwon Downs borefield, not even in an emergency as currently permitted under the Ministerial s.78 directive (Water for our Future Community Panel discussion 29.11.21). As LAWROC has long argued, the aquifer system and it's interdependent and uniquely biodiverse ecosystems must be left in perpetuity to recover as best as possible under accelerating climate changes.

It is evident, as Mr Butcher noted, that the borefield infrastructure involved is deteriorating beyond use and, with the wider remediation in mind as designated in the Ministerial s.78, we request that the bores be actively decommissioned and dismantled to stabilise the impacted area and prevent further aquifer structural harms and environmental damage. Decommissioning and dismantling of

the Barwon Downs borefield is a matter of high priority for Otways communities and LAWROC will be pursuing this outcome, bearing in mind that pumps have been removed and the bores are screened in each aquifer. In order to rehabilitate the surrounding area associated with the drawdown due to the previous pumping actions, these bores must be completely removed and rehabilitated to ensure that they are not cross-contaminating the three known aquifers in this area.

Such pro-active decommissioning and dismantling on the part of the water authority/authorities would also offer a significant restoration of trust to Otways communities themselves impacted by normative water industry dismissal of what were very serious environmental concerns.

We would appreciate your response to this letter before the end of the year.

Your sincerely,

Malcolm Gardiner,
Chairperson LAWROC Landcare Group.

Dr. Marina Lewis,
LAWROC Executive Member & Member of the Barwon Water “Water for Our Future” Panel.



APPENDIX THREE.



Our reference:
Your reference:
Enquiries to: Seamus Butcher

22 December 2021

LAWROC
C/o Malcolm Gardiner
1805 Colac-Lavers Hill Road
Kawarren VIC 3249

Dear Malcolm & Marina,

Re: Draft Water for our Future Strategy

Thank you for your feedback on our *Draft Water for our Future Strategy*. This strategy has been informed by you, our community, and proposes adaptive plans to ensure a secure water future for each of the systems in our region, based on what our community has told us is important to them.

I can confirm that, consistent with our *Draft Water for our Future Strategy*, Barwon Water has no intention of extracting groundwater from the Barwon Downs Borefield for water supply purposes now or in the future. This intent can also be applied to emergency situations.

The key purpose of the *Water for our Future* program is to ensure we do not enter an emergency situation, by putting in place a plan that ensures our region has secure and reliable water in both the short and long-term. To deliver this, Barwon Water plans to undertake a number of key initiatives in the coming years, including:

- Extending the reach of the Melbourne-Geelong Pipeline (MGP), and obtaining a small increase to Barwon Water's share of water in Melbourne, so that the MGP can supply more of the Geelong, Golden Plains, Bellarine and Surf Coast system and reduce the current reliance on the Moorabool and Barwon Rivers;

- Increasing integrated water management across our region, including recycled water and stormwater initiatives, such as delivering the integrated water management plan for the Northern and Western Geelong Growth Areas and putting an extra 1,000 ML of recycled water to productive use over the next five years;
- Continuing our focus on reducing demand and improving system efficiency across our region, with an extra 1,000 ML of water savings expected across all our systems over the next five years through our Sustainable Water Use Program;
- Reducing our reliance on rainfall dependent sources of water and allowing water to be returned to rivers, including the proposal to return 3,700 ML of Barwon Water's entitlements in the Moorabool catchment to the Moorabool River for Traditional Owner cultural values and environmental needs; and
- Continuing to work with the State Government to access a share of the State's next major water supply augmentation.

These initiatives mean that it is highly unlikely that we will find ourselves in an emergency situation in either the short or long-term.

Our modelling shows that water restrictions are expected to be very rare over the next five years (<1%, or 3 weeks out of 5 years), with our current diversified infrastructure like the MGP and Anglesea Borefield already providing valuable water security in the event of localised dry conditions like the record, hot dry summer of 2019. To support this approach, we are currently undertaking a Bulk Entitlement review of the Anglesea Borefield supply, to ensure any operation remains conservative and sustainable and does not impact Groundwater Dependent Ecosystems.

Our modelling also shows that the combination of the above initiatives will ensure we can reliably meet the future water needs of customers in our Geelong, Golden Plains, Bellarine and Surf Coast system, even under a worst-case scenario of high climate change and high population growth.

In regard to the existing Barwon Downs groundwater extraction infrastructure, we can confirm that no active maintenance of this infrastructure is currently being undertaken. Further to this, I can also confirm that we will be working to determine the requirements for decommissioning of the groundwater extraction bores at the Barwon Downs Borefield, and whether there are any benefits or risks (as you suggest) in retaining or modifying any of these bores to allow ongoing monitoring of groundwater level recovery in the Lower Tertiary Aquifer as part of our Boundary Creek, Big Swamp and Surrounding Environment Remediation and Environmental Protection Plan.

We propose that any decommissioning works would be scheduled to occur in the 2023-2028 Pricing Submission period, so we can appropriately budget for these works, in addition this will ensure alignment with the water supply system augmentation works identified above.

Again, I wish to thank you for your ongoing involvement in the development and implementation of our remediation strategy and the development the Draft *Water for our Future Strategy* and we look forward to continuing to work with you.

If you have any further questions regarding the above please don't hesitate to contact Seamus Butcher, General Manager Strategy, Systems and Environment at seamus.butcher@barwonwater.vic.gov.au.

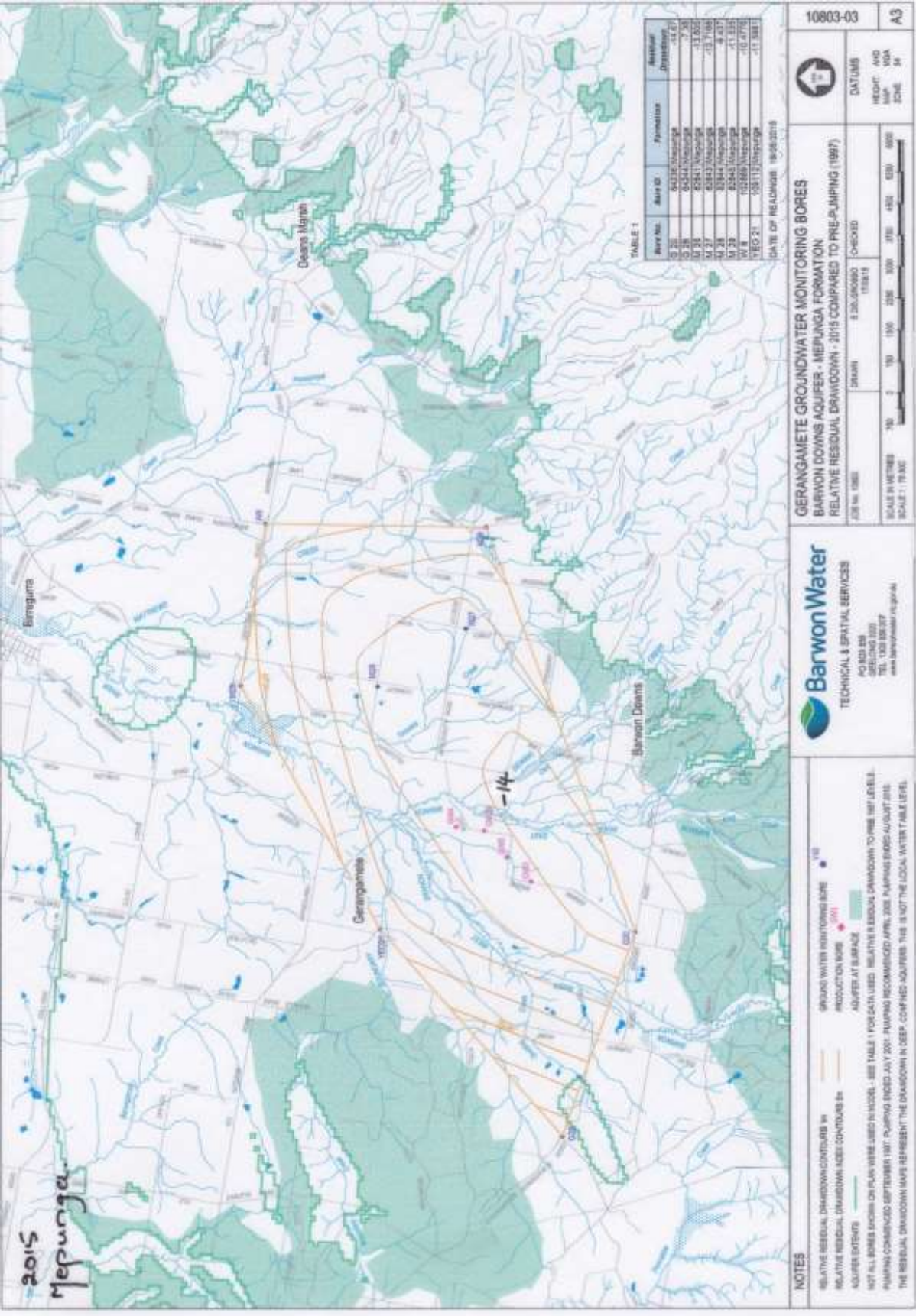
Yours sincerely,

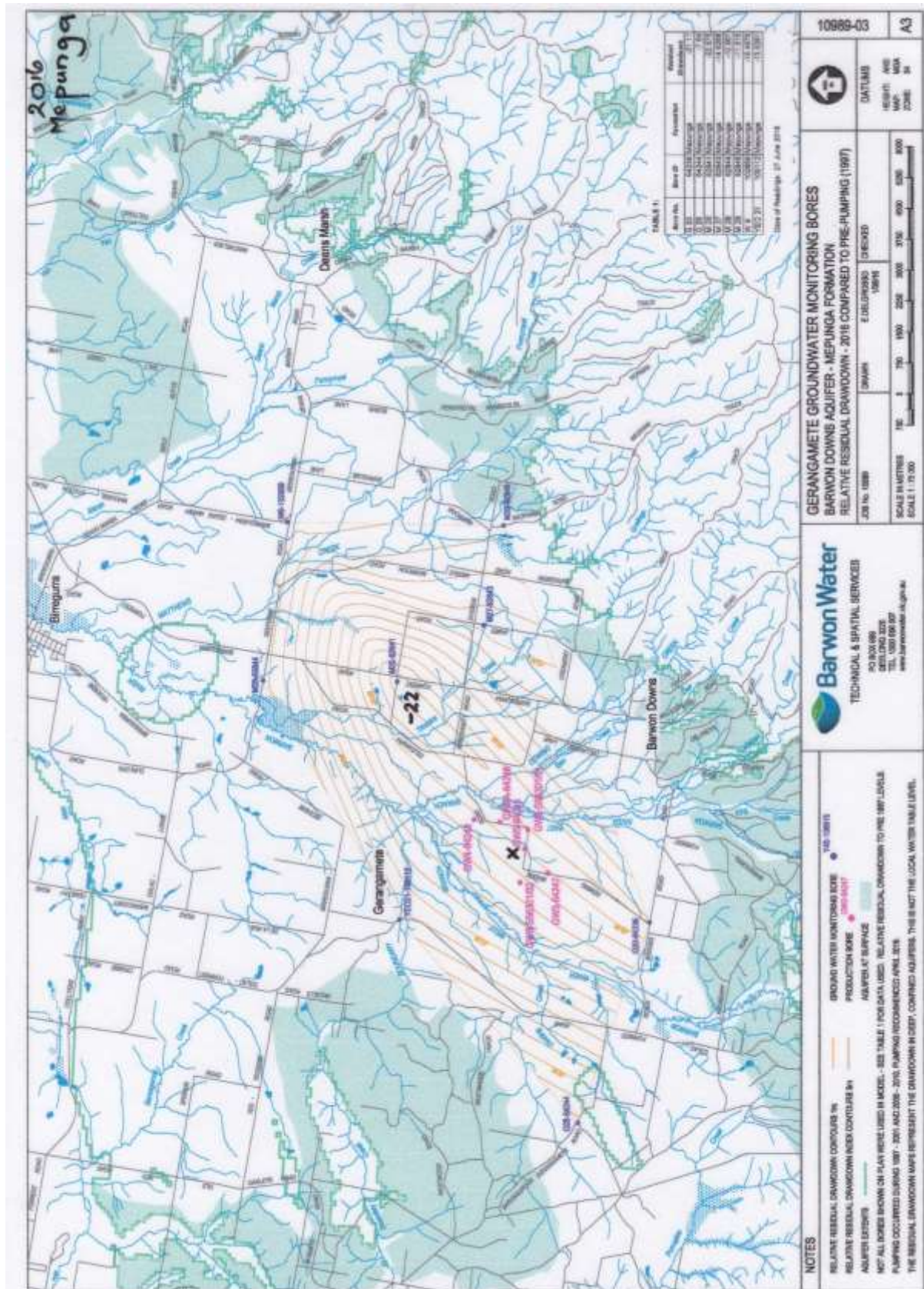


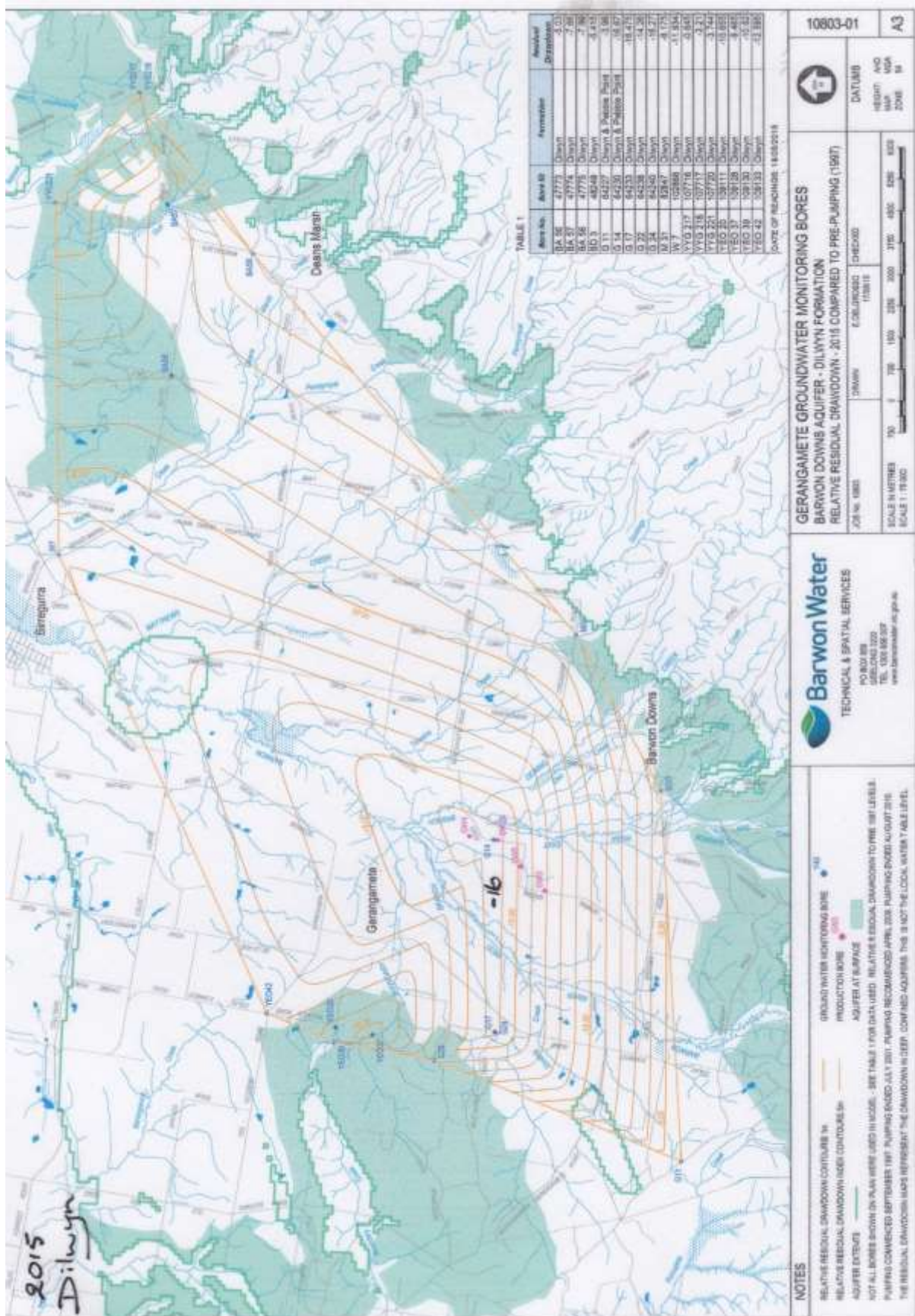
Tracey Slater
Managing Director

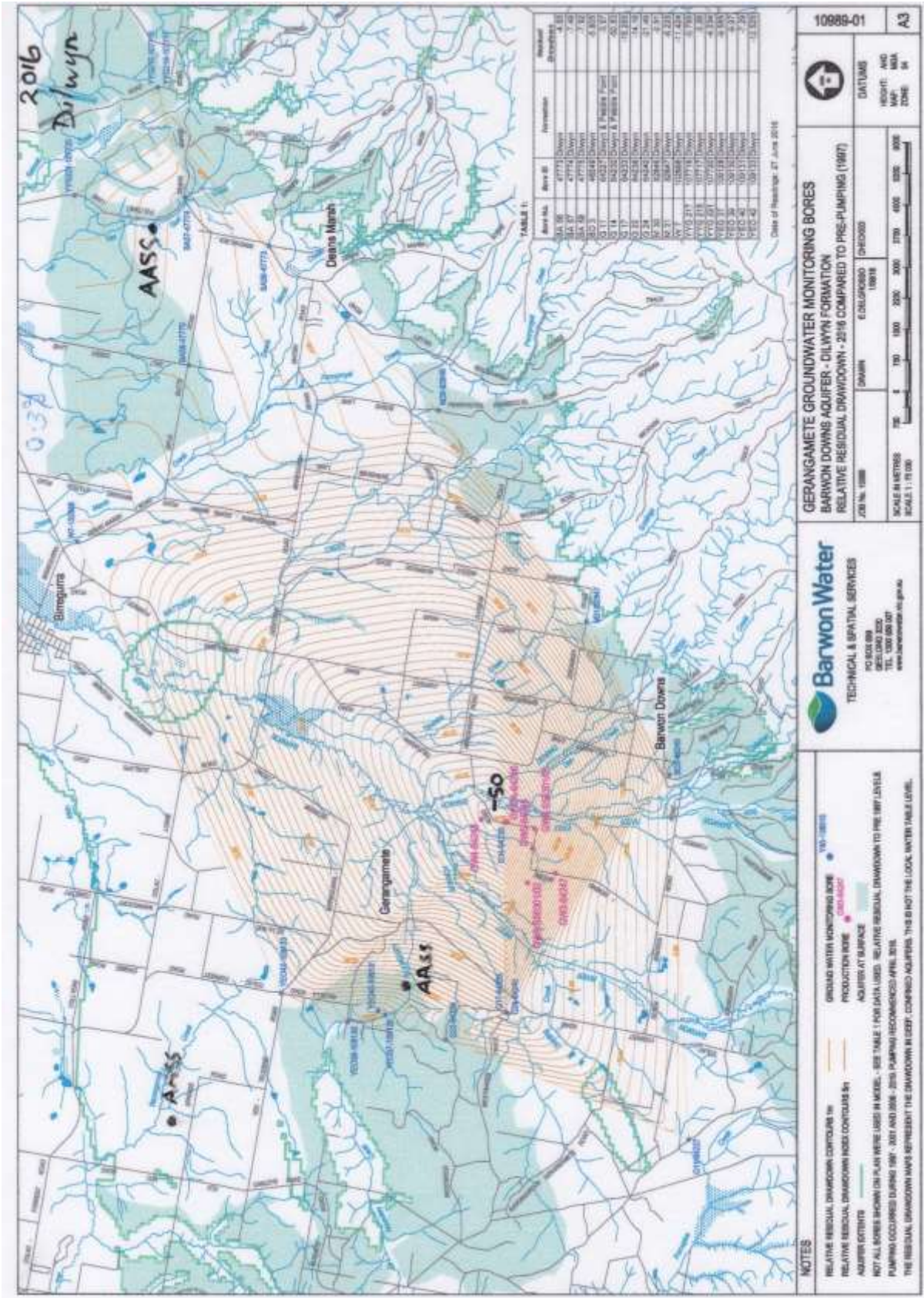
CC: The Hon. Lisa Neville MLA, Minister for Police and Water
The Hon. Lily D'Ambrosio MLA, Minister for Energy, Environment & Climate Change and Solar Homes
Dr Samantha Ratnam MLC, Leader of The Victorian Greens

APPENDIX FOUR. The 2014-2015 and 2015-2016 Drawdown Maps.



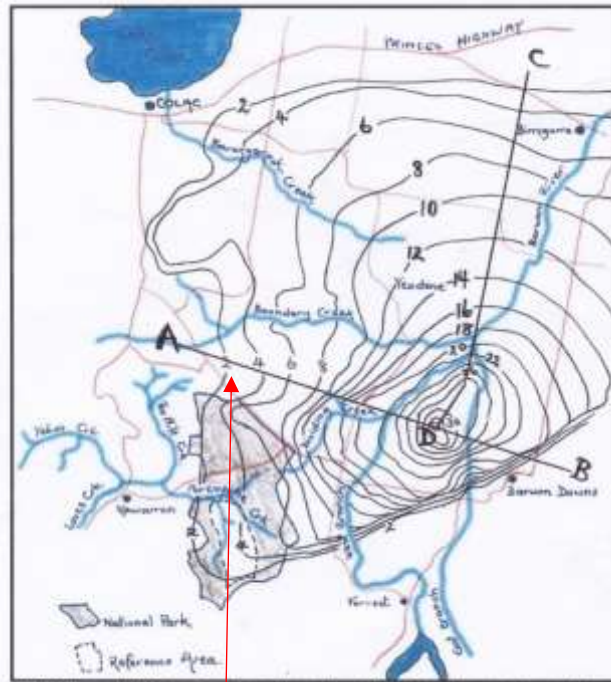




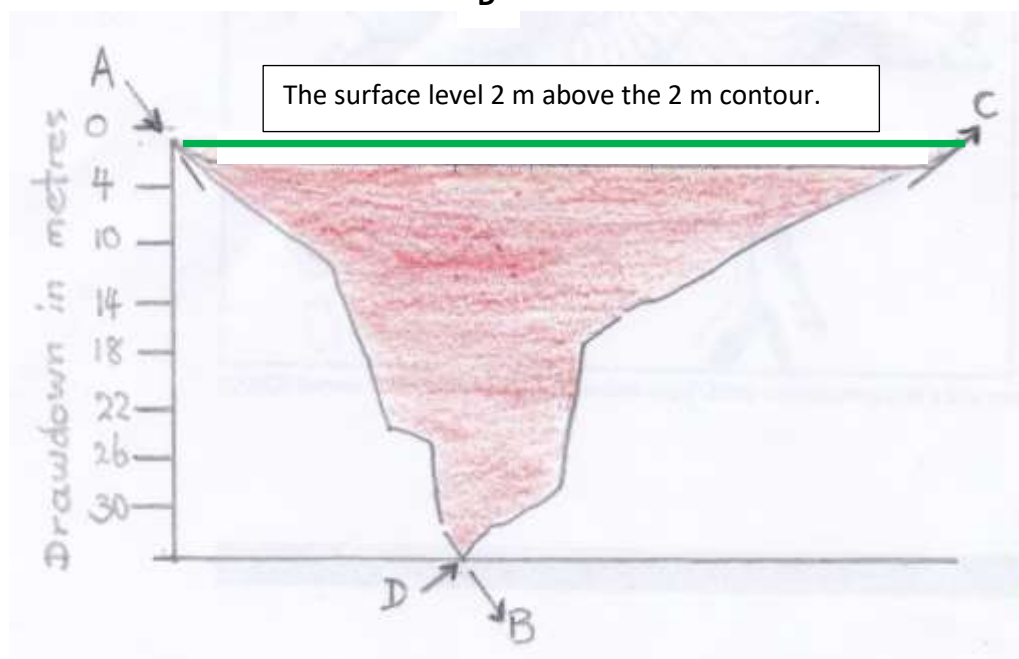
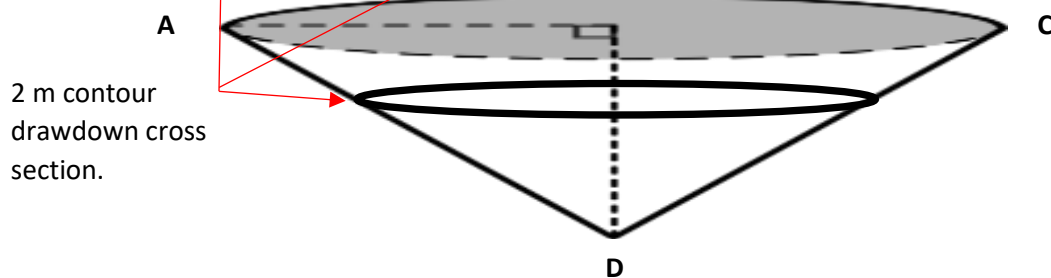
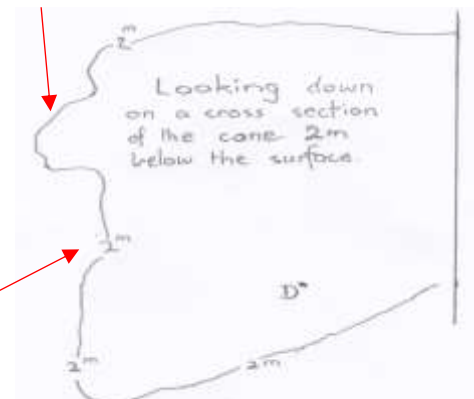


APPENDIX FIVE.

The cross section lines ADB and DC on this drawdown map, when drawn as a two dimensional shape below, show how the sides of the cone of depression take on an irregular shape. Also, cross view sections of the cone looking down have irregular shapes, e.g. the 2 m contour.



SOURCE: Barwon Water contours from a handout map (~ 2000) superimposed over a local map.



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