OTWAY WATER BOOK 19

Groundwater Extraction and the Drying Out of the Big Swamp.

Evans[22] states that, "*The time lag between the starting pumping groundwater and the resulting effects on a stream can vary from only hours to many centuries.*"

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Introduction

Historically the approach used to determine the sustainability of groundwater extraction at the Barwon Downs Borefield has been based purely on hydrological properties. Pumping from this deep water aquifer is regarded as sustainable until there is no more water that can be extracted.

The word "sustainable" gives the impression that some action can be repeated over and over again where the impacts on the resource being exploited are minimal. The resource can be tapped into indefinitely without causing serious problems. In many cases the use of the word conjures up the mental picture that there will be no impact or such a small one that it really doesn't matter. An example highlighting the inadequacy and failure of this type of approach is most apparent along Boundary Creek in the vicinity of the Big Swamp wetlands, Yeodene, Victoria, Australia. For many years Boundary Creek has been within the area of influence created by the cone of depression resulting from the Barwon Downs Borefield groundwater extraction. The extraction bores have not pumped the aquifer dry, and under the historical definition used, the groundwater extraction at the Barwon Downs Borefield is seen to be sustainable. However, the environmental, social and economic impacts at the surface have been quite profound.

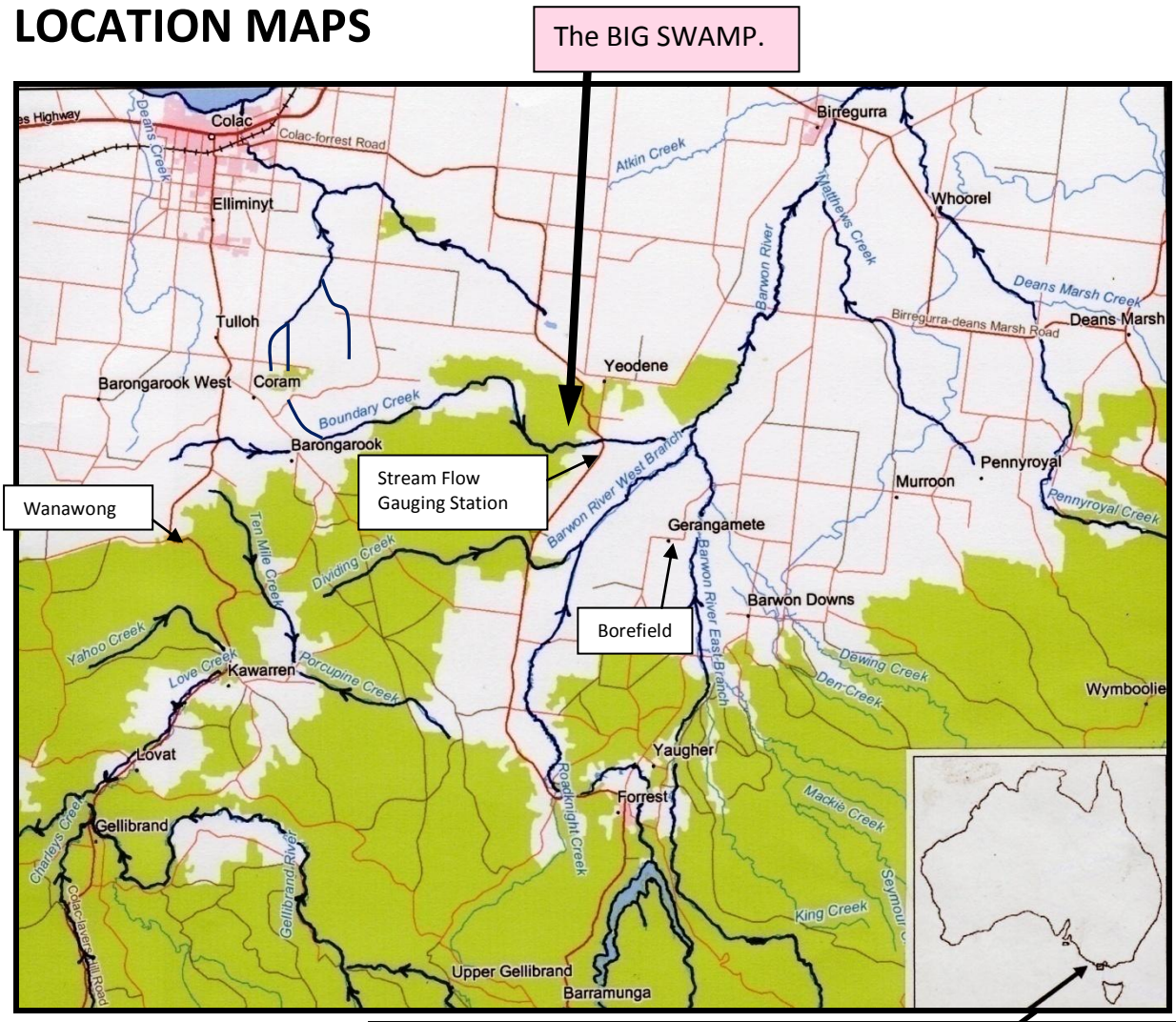
This method of determining sustainability is an outdated definition and most often ignores natural geochemical interactions between groundwater and aquifer sediments, and between aquifers and overlying soils including groundwater and surface water dependent ecosystem requirements. In actuality, in October 2010 the Victorian Auditor General's Office (VAGO) found that the Victorian Department of Sustainability and the Victorian Water Corporations did not know whether groundwater extraction was sustainable or not.[59]

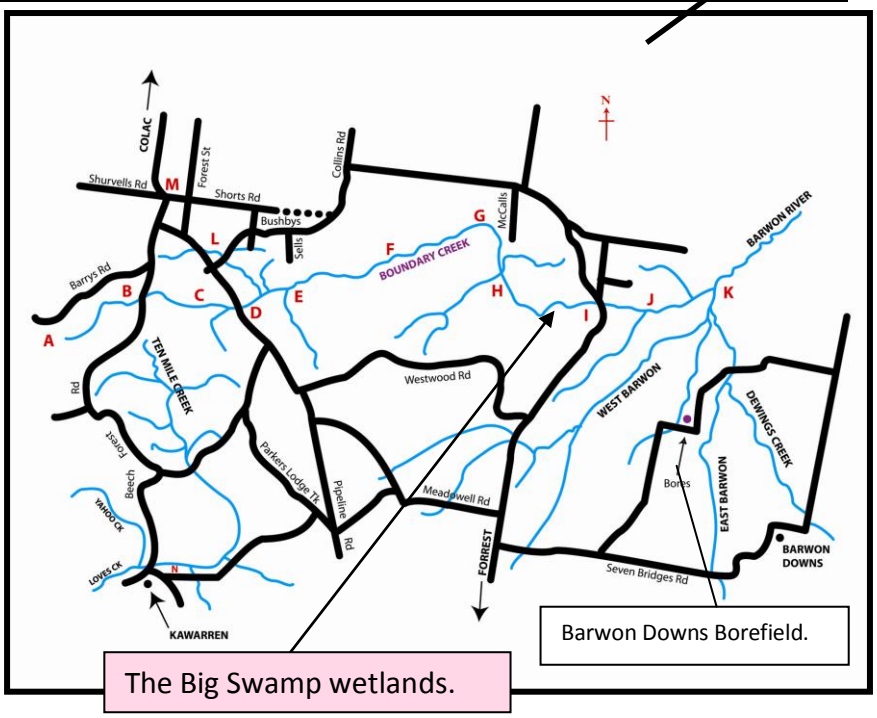
"***The Department of Sustainability and Environment (DSE) and water corporations do not know whether groundwater use is sustainable***."

If the 30 years of researched data referred to in this document has any foundation then this book demonstrates that as a result of the groundwater extraction at the Barwon Downs Borefield, Boundary Creek and the Big Swamp have been changed from a perennial and saturated water system to an ephemeral one.

Figures and material referred to in this book have been sourced from the best available and confirmed data.

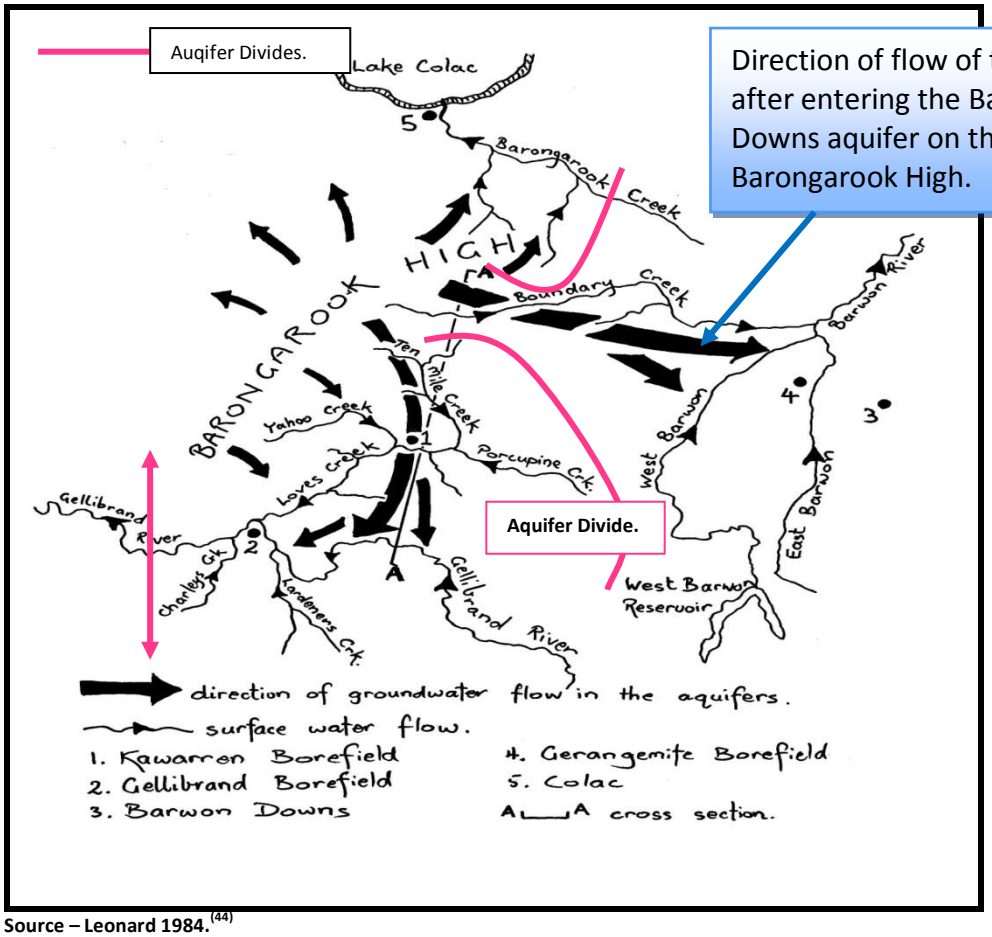
LOCATION MAPS





Boundary Creek is a tributary of the Barwon River (Victoria, Australia) and is approximately 19 kilometres long. The headwaters start in the Barongarook High area(see page 5). The average daily flow down Boundary Creek before pumping was 3.2 megalitres (ML).[63]

L Supplementary Flow release point.
G MacDonald's Dam
I Stream Gauging Station



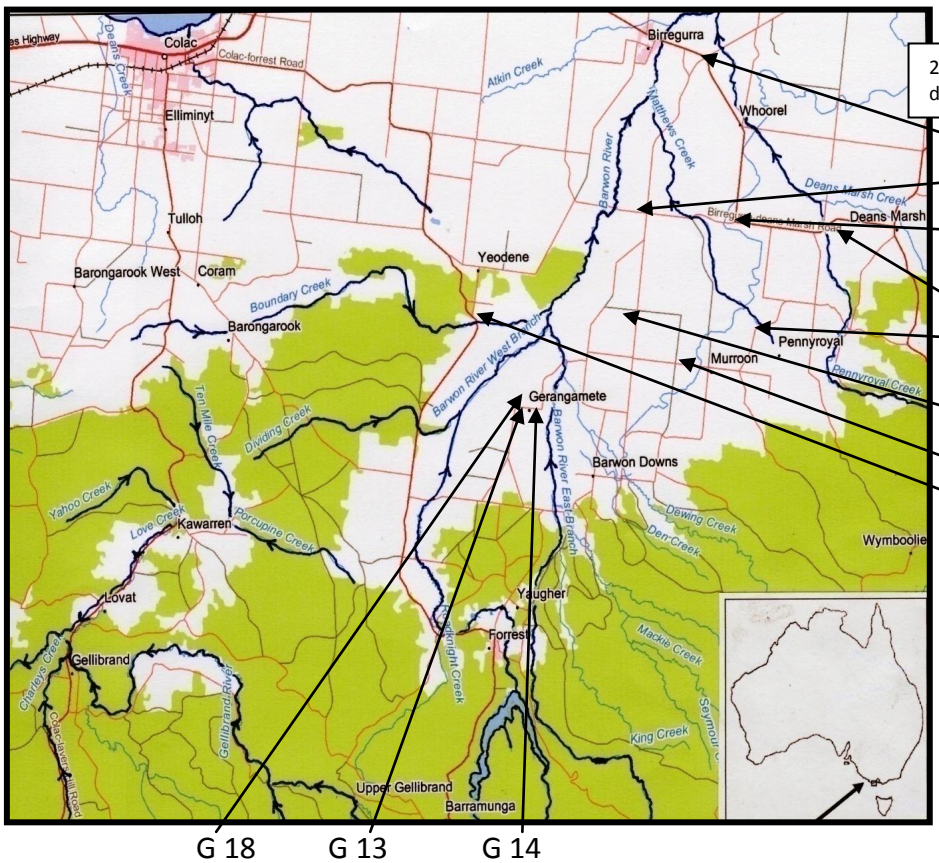
Direction of flow of the rainfall after entering the Barwon Downs aquifer on the Barongarook High.

Rainfall Recharge to Aquifer.

Estimates range from 13% to 28%[43][44][56].

Source – Leonard 1984.[44]

Artesian Observation and Extraction Bores.



YYG 221

221 is Some distance away.

W 7

M 28(B82840)

W 9

W6

M 26

M 24

M 27

Yeo21

G 18 G 13 G 14

1912 to present day.

Since 1912 the Shalley family has owned land bounding the lower reaches of Boundary Creek down to the confluence with the Barwon River (see page 4, points J to K).

1965-1978

Between 1965 and 1978 Donald Whitehead and his family owned the property bounding Boundary Creek on the east side of the Colac to Forrest Road Bridge (the land between points I and J on the map , page 4). Donald's family farmed this land and relied on Boundary Creek to provide a permanent and continuous water flow for stock and domestic purposes.

State of Victoria – Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, Donald Francis Whitehead. , [full name]

of 9 McAdam Cresent COLAC Victoria 3250 , [address]

Retired Dairy Farmer. , do solemnly and sincerely declare that:- [occupation]

Between 1965 and 1979 I owned and lived on the property now owned by the Day family. This property is on the east side of the Colac to Forrest Road, Yeodene. The property has Boundary Creek running through it from the west to the east boundaries.

At no stage during the period I owned this land did Boundary Creek stop flowing. It was a permanent flowing stream that could be relied upon for a constant supply of water for stock. In this regard Boundary Creek made the property drought proof.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at COLAC

in the State of Victoria, this 2ND day of MAY 20 11

D Whitehead

Signature of person making this declaration
[to be signed in front of an authorised witness]

Before me,

Signature of authorised witness

FCIPTA.

The authorised witness must print or stamp his or her name, address, and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

1975, 1977 and 1978.

Early Test Pumps.

Witebsky et al.[63] when evaluating the results of the 1986-91 test pump conducted at the Barwon Downs Borefield, mentions that there were periods of pumping from the deep water aquifer in the Barwon Downs region in 1975 (6 months), 1977 (3 months) and again in 1978 (1 month). No record of these volumes extracted can be found. Under a Freedom Of Information (FOI) request in 2006 Barwon Water was unable to provide extraction figures pre 1988.

The reply to the FOI request asking for the historical groundwater extraction figures for the Barwon Downs Borefield included this statement,

"Please note there are no records prior to 1988."[35]

This is quite unusual as the data from the 1986-1990 test pump formed the basis for the granting of the 1995 Stage One groundwater extraction licence issued by Southern Rural Water.

Throughout the 1986-90 test pump regular progress reports were compiled. *"Barwon Downs Groundwater Test Pump Program Progress Reports Numbers 7 an 8"* were obtained and filed by M. Gardiner under FOI back in the early 1990s. Report Number 8, 1989 indicated that there would have been many more reports before the conclusion of the 1987-91 test pump. None of these reports could be found by Barwon Water.[35] Even the Number 8 report could not be found. The earliest recorded groundwater extraction figures that could be found under the 2006 FOI request stated that 5565 ML were extracted in 1988. However, Groundwater Test Pumping Progress Report Number 8 states that 6148 ML were in fact extracted that year. In figures made public by Barwon Water there are other instances of discrepancies for amounts of groundwater extracted. For example Barwon Water's August 2006 Annual Update states that the Barwon Downs Borefield had not been used between July 2001 and April 2006. Over 2 000 ML had been extracted in this period (see graphs pages 39, 51 & 66).

1979.

Land Purchased Because of Reliable Water Supply

Graeme and Leila Day and their son purchased their Boundary Creek property in 1979 from the Whitehead's because of its permanent running and reliable water supply. A bonus was the abundant water life – platypus, blackfish, trout and fresh-water-cray. Graeme states that back in the 1980s in warmest of weather he would often observe many crayfish floating on top of the water. However today he has no such pleasure when he reminisces over the creek he now calls "Dead Creek."

Graeme's son, John, made the following Statutory Declaration.

State of Victoria – Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, John Graeme Day
[full name],

of 1645 Colac Forrest Rd Yeodene
[address],

Dairy Farmer.
[occupation], do solemnly and sincerely declare that:-

Re: Boundary Creek, Yeodene, Victoria, post code 3249, Australia.

In 1979 my parents and I purchased the property on Boundary Creek, Yeodene. We came from a high rainfall area and looked for a new home with permanent water. The biggest asset to us with this farm was the permanent water flowing down Boundary Creek. The property came with good fishing (blackfish, eels and fresh water crayfish). On many nights, cars would park on the side of the road to fish these waters just as our family did. We made use of the swimming holes to cool off in the heat of the day during summer. With irrigation equipment we were able to irrigate from the creek in mid summer.

In the years 1982-1983 it was very dry and our investment in a permanent water supply became apparent. The Boundary Creek flow was still very strong whilst the area was in the grips of drought. Late in summer it still had sufficient flow to irrigate. However, we did not take advantage of this.

It was soon after the 1982-83 drought however that for some reason Boundary Creek rapidly died. I witnessed the death of many eels in small muddied pools at this time. Boundary Creek has gone as a permanent creek, it now exists as a lifeless open stormwater drain. Boundary Creek is now often dry for months at a time during periods of no rain.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Colac

in the State of Victoria, this 16th day of November 2011

Signature of person making this declaration
[to be signed in front of an authorised witness]

Before me,

Signature of authorised witness

TRACEY WILLIAMS
PHARMACIST

The authorised witness must print or stamp his or her name, address and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

Colac Healthwise Pharmacy
Charlie Tomeo, B.Pharm.
ABN 62 551 908 022 Approval Number 23419N

Late in the 1970s McDonald's Dam is Consrtucted.

Towards the end of the 1970s the McDonald family built a substantial dam across the flow path of Boundary Creek approximately two kilometres above the Big Swamp. However, Boundary Creek is still regarded as an unregulated creek by the water regulator, Southern Rural Water. The amount of summer flow entering the dam must be allowed to continue

past the dam down Boundary Creek. This is done either through a gate valve release or by natural means by an overflow over the dam wall.

McDonadl's Dam overflow. Location see page 4 point G. McDonald's Dam has new owners and is now called Buttegieg's Dam.

1982-1983. Drought

The drought of 1967-68 prompted serious groundwater extraction investigations at Gerangamete (Barwon Downs) as a possible source of water for urban use. Up until 1982 very little groundwater extraction had been undertaken in the Gerangamete Groundwater Management Area(see page 4). The first significant extraction was prompted by the drought of 1982-83 when Barwon Water extracted approximately 8 000 ML of groundwater.[63] This borefield at Gerangamete is locally called the Barwon Downs Borefield. Witebsky et al.[63]

reported that this 1982-83 extraction provided half of Geelong's domestic supply and was a "life-saving" event. During the next drought the extractions provided up to 70% of Geelong's water supply (CEO of Barwon Water 10 October 2008 ABC television Stateline, Victoria).
Little thought was given to any other consideration than providing potable water for Geelong consumers.

1912 to 1984.

- Boundary Creek had continued to flow throughout this period and was a permanent and reliable source of fresh water.
- Witebsky et al[63] calculated this flow to be 3.2 ML average daily summer flow.
- Artesian bores throughout this section of the Barwon River catchment were in some places squirting up to 20 metres above ground-level. The Dilwyn, Mepunga and Pebble Point aquifers that these bores were tapped into were full and overflowing (see pages 60 & 79).
- The pH levels in Boundary Creek oscillated between slightly acid to slightly alkaline (see page 78).
- Creeks and artesian bores in the adjoining Loves Creek catchment to the south of Boundary Creek were experiencing the same conditions and status (see page 101, streams marked E, G, F,& H, and artesian bores 114168 & 108910).
- Tributaries of Barongarook Creek to the north of Boundary Creek were also permanent (see page 101 streams A, B, C and D).

1984. Boundary Creek Dries Up.

- For the first time in the Shalley family's history (see page 57, Nellie's statutory declaration) Boundary Creek was dry for 4 days.
  In 2007 Evans[22] in his Senior Research Fellowship Study, referred to Boundary Creek drying up as an example of a creek being impacted one year following groundwater extraction.

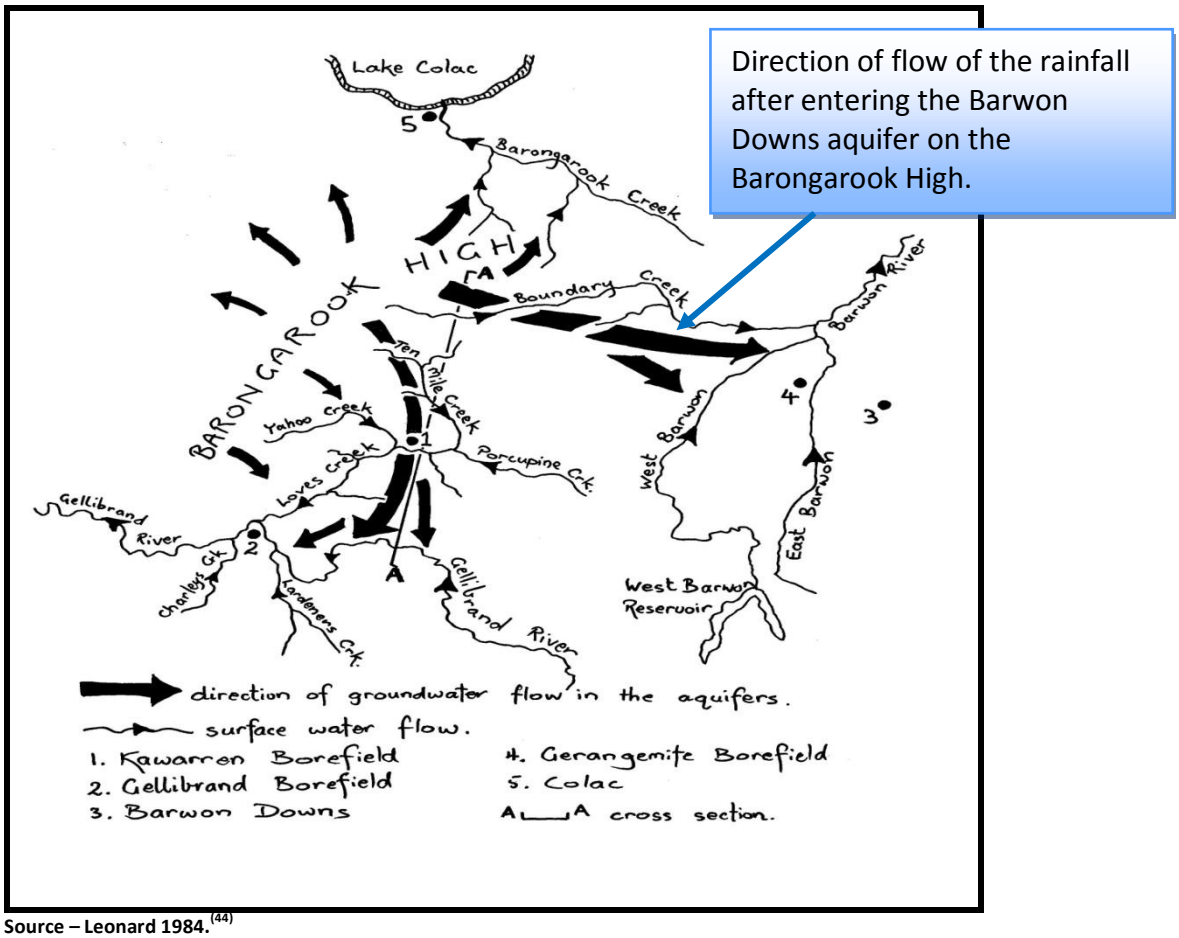
  "***Another example is from Geelong, where the predicted drying up of Boundary Creek by Barwon Downs bore field five kilometres away occurred after a lag of about one year***."

- The potentiometric water level of the deep water aquifer throughout the Barwon Downs valley was in the order of 160 metres AHD. Water from any bore drilled into this aquifer with a surface level lower than 160 AHD would be artesian. For example bore number 82840 that is lower than 160AHD, squirted water 8.7 metres into the air (see pages 63 & 64) and observation bore 109112 squirted water over 18 metres above the ground (see page 88).
- Originally the upper reaches of Boundary Creek were swamplands. The actual formation of a creek bed was formed by early settlers in attempts to drain the swamp waters away. In the upper reaches this was largely successful, however, the Big Swamp had resisted all attempts to drain it.
- The pH levels in Boundary Creek were similar to other creeks in the area – alkaline to neutral to slightly acidic.
- In 2006 Science for Decision Makers, "Managing Connected Surface Water and Groundwater Resources," Commonwealth of Australia[52] stated,

"*In Australia, the development of the Barwon Downs bore-field in south western Victoria resulted in the drying up of Boundary Creek within a year*."

1984. Leonard.

In 1984 John Leonard[44] indicated that the deep water aquifer under the Barwon Downs Borefield gained the majority of its recharge waters from rain falling onto the sands in the Barongarook High region. Leonard's work has been substantiated numerous times since.[17][42][53] The Barongarook High region is approximately 28 km^2 of which 10 km^2 are associated with the Barwon Downs Borefield.



Source – Leonard 1984.[44]

Documentation indicate that the amount of rainfall soaking into and replenishing the deep water aquifer ranges from 13% to 28% of the total rain that falls.[43][44][53][56]

1985.

Next Significant Groundwater Extraction.

The next significant groundwater extraction took place in 1985 and Boundary Creek was dry on seven occasions (see graph page 87).

Environmental Studies.

It is extremely important to note that the environmental surveys and studies that Barwon Water often refer to have never been implemented or contain limited, inadequate and flawed material (see pages 37- 40). Unfortunately these works are then used and quoted to justify the notion that there has been no environmental degradation linked to the drawdown effects and operation of the Barwon Downs Borerfield. This documentation spans a time period from 1986 to 2012. As recent as February 2012 Barwon Water states,[6] and maintains the stance that...

> "***water table drawdown occurs during pumping, but no long-term environmental impacts have been linked to borefield operations***."

Otway Water Books 8 to 12[64] graphically illustrate that there has been drastic and long-term environmental impacts and degradation, impacts that will be extremely difficult to reverse.

Reference to these environmental surveys and studies or lack thereof, form a direct link and are indicators highlighting the impact of groundwater extraction.

1986.

Studies Recommended Before Any Further Groundwater Extraction.

The Department of Minerals and Energy recognised the fact that sustained pumping from the borefield at Barwon Downs could have noticeable impact on the environment within the Boundary Creek catchment. Quentin Farmar-Bowers was commissioned to look at environmental issues that could arise as a result of any pumping.[25]

The **OBJECTIVE** of his work was to...

> "***Develop a program to clarify the environmental issues relevant to the groundwater investigations in the Barwon Downs area and assist in the directing the establishment of the appropriate monitoring program***."

From these findings it was anticipated that various scenarios regarding the sustainability of the aquifer could be drawn.

Farmar-Bowers[25] completed a comprehensive report recommending studies to be completed before any further groundwater extraction was to take place. The results of these studies would provide the necessary pre-pumping comparative data. He found that from the limited data available Boundary Creek had sufficient environmental value to warrant concern.

Farmar-Bowers was explicit when stating that environmental flows for Boundary Creek should be established pre-pumping. Environmental flows have never been allocated.

However, a farcical attempt at recommending environmental flows was made in 2006 (see page 54).
None of Farmar-Bower's recommendations were conducted before the test pump of 1987 commenced.[33]
From his investigations and figures available to him, Farmar-Bowers stated that the sustainable extraction that the aquifer was capable of producing was 1600 ML/year.[25]

Farmar Bowers also made these important comments in his report:

- The pumping of the Barwon Downs wellfield is likely to create changes in groundwater levels in the order of 25 to 50 metres at the site.
- Aquifer pumping during droughts, as is proposed, would tend to exacerbate the effect of natural variation by extending the effects of drought.
- If there is a deficit of natural flow into wetlands over an extended period some of the environmental changes would become entrenched and would not be easily reversed.
- Changes may occur quite rapidly within a few years.
- Some of the Boundary Creek riparian area is swamp with fine mud, rich in organic matter several metres deep.
- The dense swamp vegetation prevents floods occurring.
- The saturated zone may shrink in size.
- Aquatic vegetation at spring and swampy areas may be affected as these areas dry out.
- In most of the areas, the change may be gradual, one habitat being replaced by another, however, in the wetter areas, (riparian zones adjacent to springs and wet areas), the change may be quite rapid.
- The area has a low agricultural and timber production value as soil fertility is low and some low lying areas are often waterlogged.
- From an agricultural aspect the lowering of the water table in the water logged areas may allow this land to be utilised for agricultural production.

From these comments and observations made by Farmar-Bowers it can be safely said that there were areas that never dried out and the vegetation in the swamps and wetlands was dense, vigorous and healthy. This area was unsuitable for agriculture because of the water logging.
The importance of this report is the descriptive nature of the wetlands abounding Boundary Creek pre the 25 000 mega litres extracted in the test pump period (1987-1990). One of the most significant statements made in the whole of Farmar-Bowers report would have to be this one...

"***Currently water tables appear to be quite stable and there is little movement between seasons or years***."

The Following quotes have been taken directly from Farmar-Bowers report:

- ***"The recharge area has been identified... adjacent to the middle reaches of Boundary Creek where the aquifer formations outcrop ."*** **(page 1 of his report)**
- ***"The way the resource is used will influence the nature and degree of many of the environmental impacts."*** **(page 1)**

- *"... some environmental effects may become apparent within a few weeks of commencement of pumping."* **(page 3)**
- *"However if the deficit period is substantial, some of the environmental changes will have become entrenched and will not easily reverse."* **(page 6)**
- *"Lower areas in the topography are influenced by groundwater. Near Boundary Creek water is released from the water table forming springs and waterlogged areas at least during winter and spring. These areas support forms of vegetation that cope with the periodically (or constantly) wet conditions."* **(page8)**
- *"Lowering the watertable below the stream stage in Boundary Creek may result in significant induced streambed infiltration. This could make a substantial difference to streamflows and would be most noticeable during periods of natural low flows. The creek may become dry in summer or in drought periods."* **(page 13)**
- *"Seepage entering Boundary Creek from the recharge area would probably stop with prolonged pumping and some infiltration from the creek to groundwater may occur where the creek flows through the recharge area. In other words, the creek flow may decline as it passes through the research area rather than increase as it does now. The view currently held in D.I.T.R. is that infiltration from the creek bed to the aquifer as a result of lowering the water table may be significant."* **(page 11)**
- *"Riparian vegetation in the recharge area and aquatic vegetation at spring and swampy areas may be affected as these areas dry out."* **(page12)**
- *"There are three aspects to the Creek*(Boundary Creek)*. The first is the water flow in the creek itself and its habitat value, second is the riparian vegetation the creek supports, especially the tea tree swamp down stream*(The Big Swamp)*. The third is the contribution Boundary Creek makes to the low flow in the Barwon River."* **(page 15)**
- *"Summer flows in Boundary Creek are small, about 1 ML per day during dry periods."* **(page18)**
- *"The effects are likely to be chronic but could, in the end, result in significant changes. The information currently available shows that the area has sufficient environmental value to warrant some concern."* **(page40)**
- *"The existing information provided an inadequate base for determining the detailed environmental effects of the proposed projects."* **(page40)**
- *"The changes in landscape as a result of dead and dying vegetation as the country dries may be one of the more noticeable aspects of the project."* **(page40)**

In 1989 Barwon Water officers stated at the Natural Environmental Resources Committee (NREC) hearing that Farmar-Bowers's recommendations had been implemented. Farmar-Bowers's recommendations had not been implemented [36] and never have been.

1986-87.

- **Tunbridge Fish Study.[58]**

  Farmar-Bower states that when preparing his 1986 report he had made personal contact with Tunbridge and was told that in the winter of 1986 Tunbridge had recorded freshwater crayfish, brown trout, short finned eel, mountain galaxias, southern pigmy perch and blackfish in Boundary Creek.
  In the summer of 1986-1987 Barry Tunbridge conducted fish studies in the Barwon River catchment. He states in this report[58] that Boundary Creek was the only tributary of the Barwon River that he had studied that contained blackfish.
  Paradoxically Barwon Water part funded this study[30] in conjunction with the Arthur Rylah Institute, an authority of the State Government of Victoria. When the Arthur Rylah Institute was commissioned by Barwon Water to conduct the 1990s studies Tunbridge's earlier studies were not recognised.

1986/87. Artificial Recharge into the Deep Water Aquifer.

Because Boundary Creek runs across the deep water aquifer where it outcrops on the surface (see pages 90, 91 & 92) it was thought that the simple construction of pits to increase the portion of creek water which naturally infiltrates down into the aquifer would be possible.[51] However, because the water table levels were higher than Boundary Creek, meaning that the aquifer was overflowing into Boundary Creek and was fully recharged at that point, artificial recharge under these conditions would be pointless[51] (see page 20 for the next attempt at artificial recharge).

1987- 1991. Groundwater Extraction Test Pump.

The pressing argument to augment Geelong's existing water supply and especially so during drought, prompted the implementation of an investigative test pump. On March the 10th pumping commenced at the Barwon Downs borefield extracting 25 000 ML of groundwater over a 4 year period.

In the 1995[63] report evaluating this test pump it was stated...

"***The overall objective of the groundwater study was to quantitatively assess the groundwater resource potential of the Barwon Downs Graben***."

SUBSIDIARY OBJECTIVES[63] were...

1. To determine the extent of the aquifers in the Graben and the quantity and quality of the groundwater.
2. To identify the flow patterns within the Graben.
3. To quantify the recharge to the Lower Tertiary aquifer from direct precipitation and influent surface streams. (Influent – gaining of water to the aquifer).
4. To examine groundwater movement between the Lower tertiary aquifer and the confining formations. (vertical leakage).
5. To examine the interaction between groundwater and surface water systems.

6. To develop a reliable numerical model with which to assess the response of the Lower tertiary aquifer to different pumping regimes.

By conducting this test pump it was hoped that it would be established that the aquifer could sustain considerable groundwater extraction, enough to satisfy Geelong's requirements for many years. Any groundwater extraction rates were to be designed to prevent decimation of creeks and wetlands.

1988.

- **Submission to the South Western Regional Water Enquiry.**

  In August, a year after the test pump commenced, the Geelong and District Water Board, now Barwon Water, reported to the Natural Resources and Environment Committee (NREC), a Victorian bi-partisan Government committee investigating the water resources of the South Western Region of Victoria, that the environment in the Boundary Creek area was being studied, "***... monitoring impact and changes with regular reports and upgrades.***"[30][27][36] When Barwon Water was asked for copies of the environmental studies, observations and recordings, none could be produced. Barwon Water stated that the Rural Water Commission, now Southern Rural Water was doing them. Southern Rural Water said the Department of Agriculture and Rural Affairs (DARA) was doing them. Both the Colac and Geelong branches of DARA had no idea about these studies. Nothing had been done.[30] The recommendations made by Farmar-Bowers[25] had never been commenced. Vital pre testing pumping data had not been collected.

- **A Fatal Mistake**(1988)**.**

  The following quote was to be repeated over and over again in Victorian Government documents[21] and became a commonly held belief being accepted as true and accurate.

  "Because the use of groundwater usually has few adverse environmental effects, it is often favoured over surface sources which can have marked effects."

However well intentioned, this is not true nor is it accurate. The urban policy makers of the time appeared to have taken this as a green light to exploit groundwater resources while paying little or no attention to the springs, wetlands, creeks and associated ecosystems that relied on groundwater discharge along Boundary Creek. Having a plentiful supply of reticulated water on tap in the cities and towns fostered a very limited understanding of the importance placed on these sources of groundwater discharge by rural folk and the environment.

Unfortunately it has only been in the last few years some recognition of groundwater and surface water connectedness has been accepted.[22]

1989. Bi-partisan Government Committee.

In March Barwon Water officers reported to the Natural Resources and Environment Committee (NREC) again stating,

"As indicated previously in evidence to the Committee, the Board wishes to ensure that environmental needs are adequately recognised and safeguarded in any water resource development that it may seek to undertake."(37)
Barwon Water has never provided any evidence to support this statement.

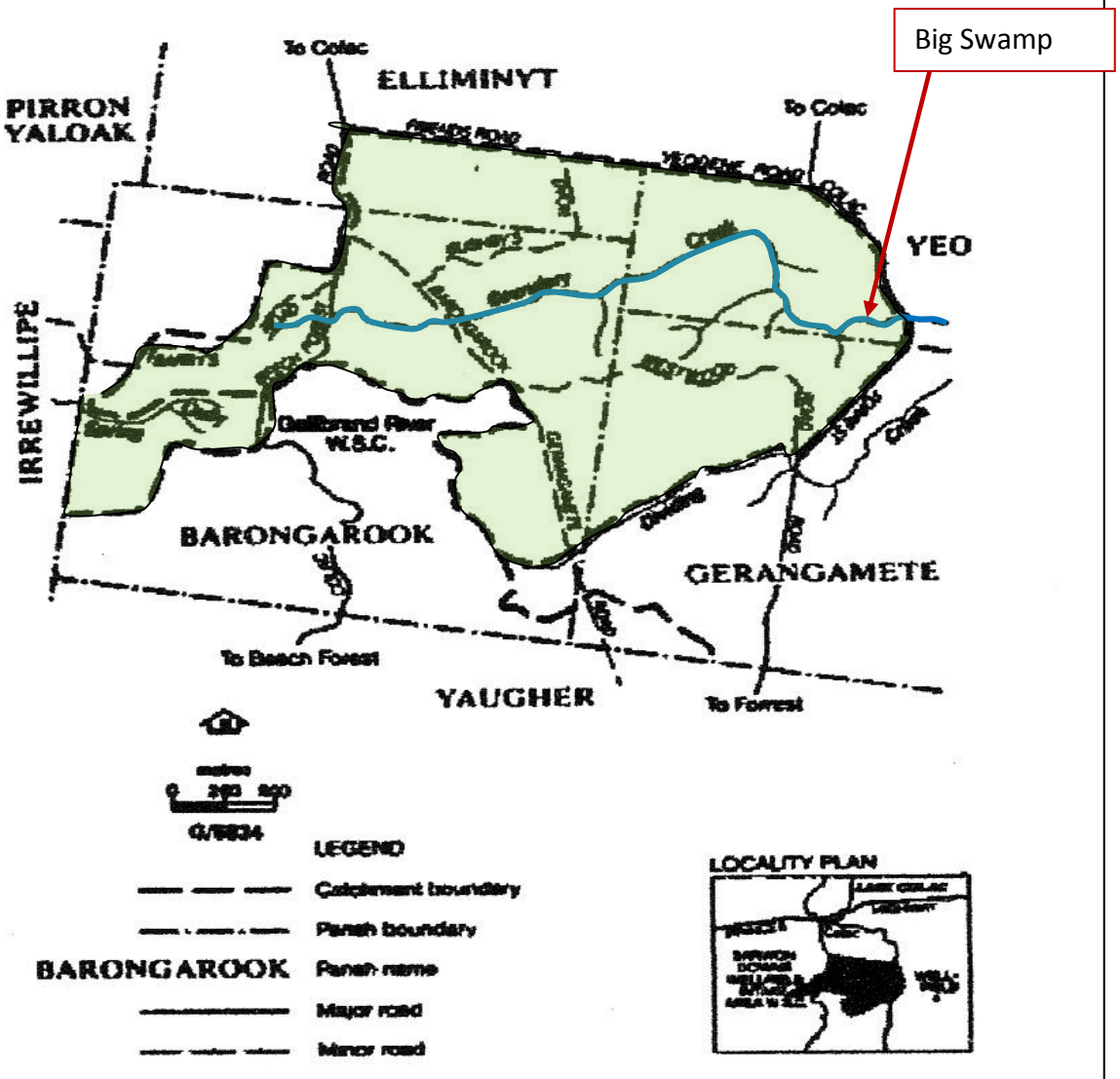
1989

- **Wellfield Intake Area Government Gazetted**(see next page)**.**
  In the Victorian Government Gazette G11 15 March 1989 page 558, it was gazetted that a Barwon Downs Wellfield Intake Area (Geelong) water supply catchment area be declared. The following page is an extract from this gazette. Boundary Creek has been marked in blue and the intake area has been shaded in green to assist the poor quality reproduction of the extract. The approximate site of the Big Swamp has also been marked in.

  As of April 2012 this special area plan " ...*triggers referral powers to the Water Authority (in this case Barwon Water) on matters dealing with Land and Planning provisions within the special area*."(per.com. Simon Baker – DSE 4-4-2012 email).

BARWON DOWNS WELLFIELD INTAKE AREA (GEELONG) WATER SUPPLY CATCHMENT

The catchment (intake area) to a wellfield located within the Parish of Gerangamete and controlled by the Geelong and District Water Board, the catchment being situated within the Barongarook Hills and consisting of parts of the parishes of Barongarook, Elliminyt, Gerangamete and Yeo and as inidicated on Plan No. S–1483, hereunder, to be known as the Barwon Downs Wellfield Intake Area (Geelong) water supply catchment area.



1990.

- **Days of No Flow Along Boundary Creek Increase Dramatically.**
  As the groundwater extraction period increased the number of days that Boundary Creek did not flow also increased. 17 more dry days in 1990 (see page 87). Creeks in the Loves Creek Catchment to the south and tributaries of the Barongarook Creek to the north continued to flow.

- **Drawdown as at 15 February**(1990)**.**
  When the Department of Natural Resources and Environment (now called the Department of Sustainability & Environment) commissioned Witebsky et al.[63] to analyse the results of the test pump at Barwon Downs (1987-1990) the following drawdown map was included in this 1995 report.

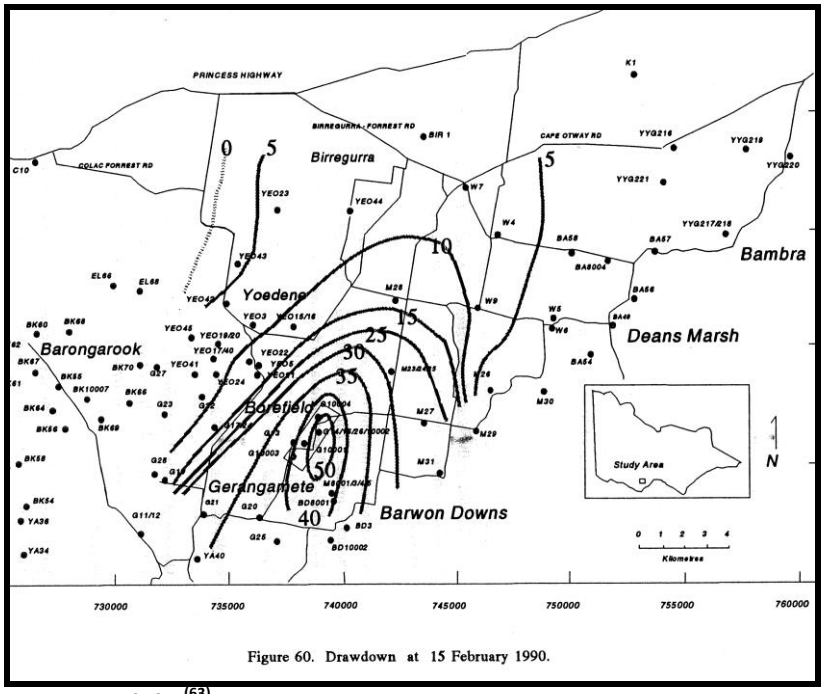
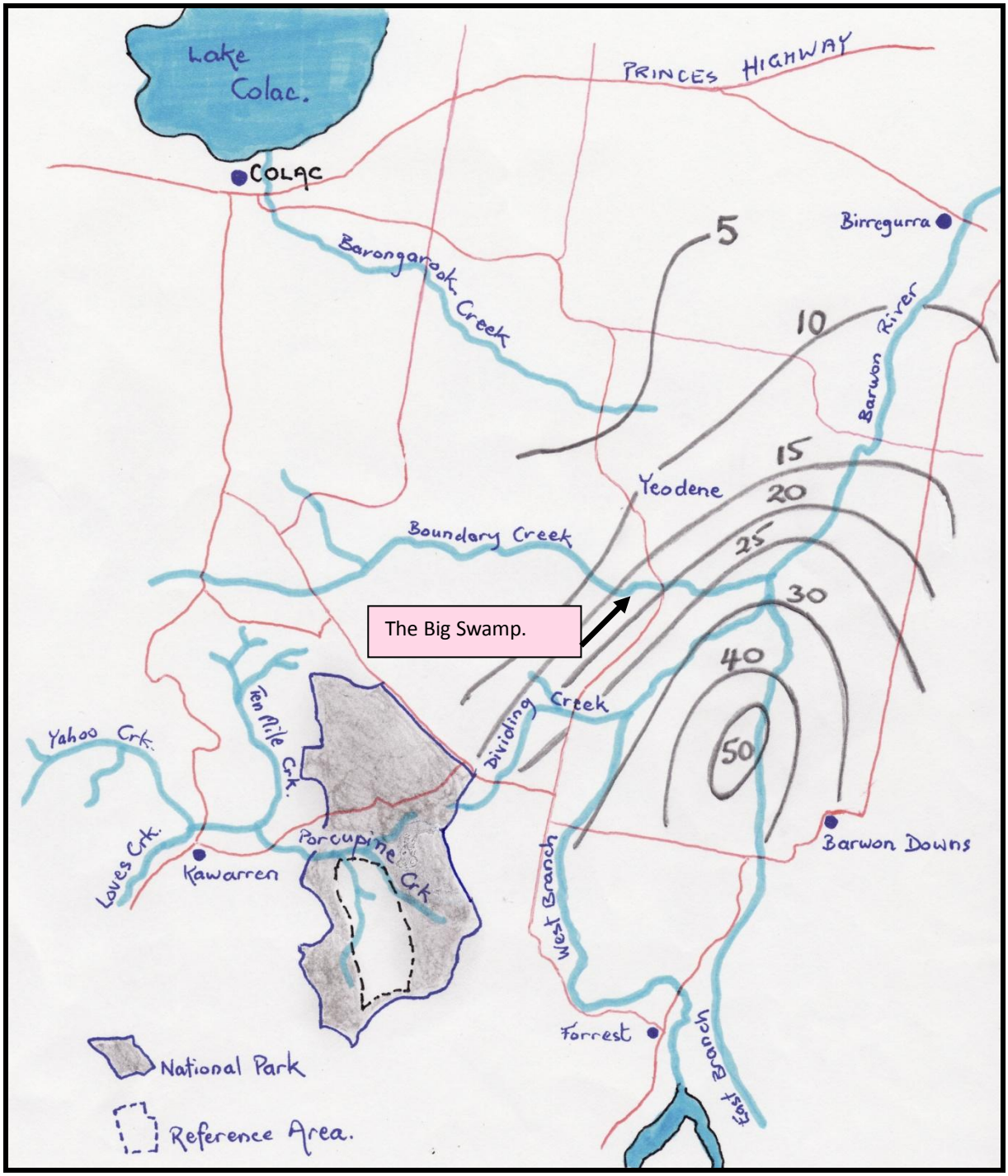


Figure 60. Drawdown at 15 February 1990.

Source: Witebsky.[63]

These drawdown levels were calculated after the extraction of approximately 25 000 ML of groundwater between 1987-1990.[65] In the vicinity of the Barwon Downs Borefield the water tabled had been lowered at least 50 metres in the deep water aquifer.

The map below has these Witebsky drawdown figures superimposed upon it.



Other drawdown maps can be found on pages 36, 67, 68, 86, , 90, 91.

- **Artificial Recharge Useless**(1990)**.**

After lowering the water table during the 1987-90 test pump at Barwon Downs, the next lot of recharge trials were conducted (see page 15 for earlier trials). Recharge pits were dug into the outcropping aquifer in the Barongarook High area in the McDonald's Dam site area. However, the site chosen indicated that artificial infiltration of 1000 ML/year would require several kilometres of pits (see map pages 44, 45). The notion was abandoned.[49]

1991. Board Accepts Blame.

In the Colac Herald 18 January on page 3 the headline ran with "**Board Accepts Blame For Dry Creek**." The creek being Boundary Creek.

1991-1994 Studies.

Even though Barwon Water representatives steadfastly maintained that Barwon Water was extremely environmentally conscious and had made adequate provisions to protect the environment these studies of the early 1990s were the first ones conducted by Barwon Water.

Fish Studies conducted by Arthur Rylah Institute.

Fish studies were conducted in May 1992, October 1992, and June 1993. There was no mention of Barry Tunbridge's 1986-87 findings.[58] None of the large species that Barry found were found in the survey.(see page 15). In fact no reference was made of Barry's report even though Barwon Water had part funded this work years before. This was a significant omission.

Aquatic Invertebrate Studies.

The Department of Conservation and Environment, now called the Department of Sustainability and Environment, were to conduct these studies but they were never done.

Flora Studies (Carr and Muir[11]).

Flora studies were conducted in June 1994. Recommendations were made but none have been followed up. Otway Water Book 9[36] is entirely dedicated to the flora studies of 1986, 1994, 2002 and 2009 (The inadequacies of these studies is summarised on pages 37-40).

Fauna Studies.

Amphibians, reptiles, birds and mammals were studied in 1993. In the follow up study in 2001 it was stated that this 1993 survey was conducted prior to groundwater extraction. The groundwater extraction graphs on pages 51, 66 show this to be nonsense. Extensive groundwater pumping had been done.

Before any of these studies had been conducted the flows in Boundary Creek and its adjoining wetlands had already been seriously compromised by extended periods of no flow (see pages 82 & 87).

Based on this false assumption and as the surveys conducted in the 1993 and 2001 studies found little change in the fauna compositions in the area, no further studies of fauna have ever done.

1993.

Acid Levels in Boundary Creek Begin to Rise.(see graph page 78).

In 1993 the acid levels in the water of Boundary Creek started to drop below the 4 pH critical level for instream biota survival. The cause of these dropping pH levels was not being investigated at this time. The longer this situation continued to show up on the regular monitoring at the stream flow gauging station on Boundary Creek, the more obvious it should have been that there was something seriously wrong upstream.

A test strip indicating a pH between 3 and 4 that would have been similar to that experienced along Boundary Creek in 1993.

1994.

- ## Recognised that Creeks Will Dry Up.

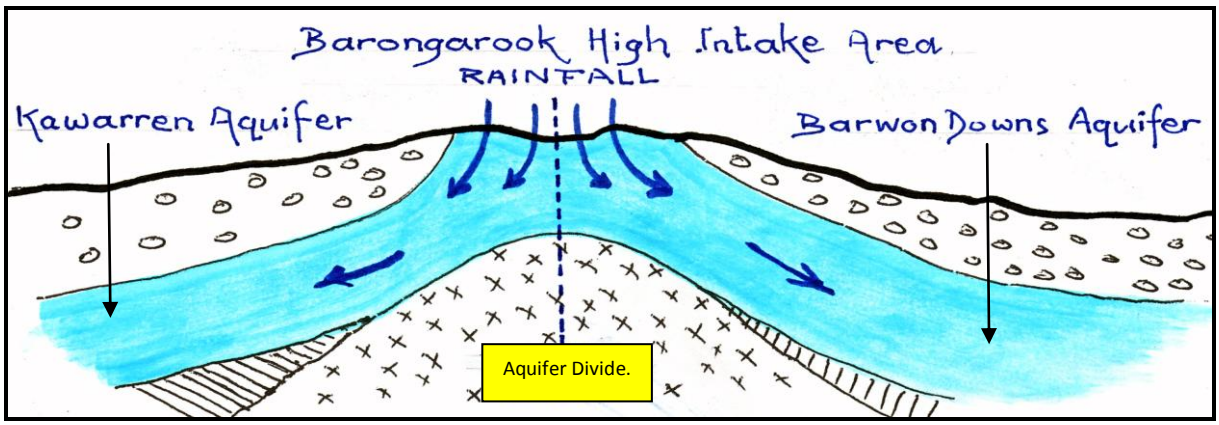
  When reporting on a proposal to conduct a test pump at Kawarren, Hydro Technology[(42)] was concerned that sustained pumping at the Kawarren and or the Gellibrand Borefields would have serious impacts drying up creeks such as the Yahoo, Ten Mile and Loves. Also flows in the Gellibrand River were anticipated to be significantly reduced. The most disturbing quote found in the 1994 Hydro Technology report is, "***It is anticipated that large scale extraction in the Gellibrand-Kawarren region will have an influence on flow, in particular Yahoo and Ten Mile Creeks, similar to the effects noted at Boundary Creek due to pumping at the Barwon Downs wellfield.***"

There seems little doubt that the impacts along Boundary Creek were recognised in the early 1990s. However, it is doubtful that the extent of the impact to follow was ever anticipated.

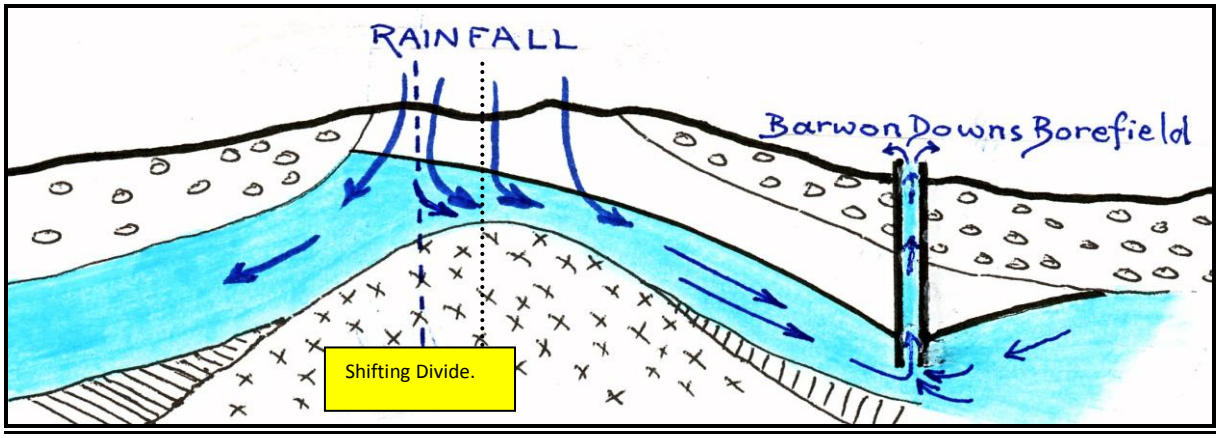
- ## Aquifer Divide will shift(1994).

  In 1994 it was anticipated that the aquifer divide between the Kawarren Ten Mile and Boundary Creek catchments would shift towards the Ten Mile Creek Catchment as pumping from the Barwon Downs Borefield progressed.[(42)(63)] Page 5 indicates the approximate area of this aquifer divide.
  The diagram below is a representation of the concepts involving the aquifer divide between the Kawarren and Barwon Downs branches of the aquifer. The aquifer

divide will shift towards the Kawarren area in relation to the amount and duration of groundwater extracted.



This conceptual diagram represents the position of the aquifer divide pre groundwater extraction.



This diagram illustrates how the cone of depression draws water towards the Barwon Downs Borefield shifting the aquifer divide closer to Kawarren in the Ten Mile Creek Catchment. The amount of recharge going into the Kawarren region of the aquifer will be lessened.

June 1994. Carr and Muir Report for Barwon water.

Carr & Muir[11] included the following statement when reporting on a flora and fauna survey they conducted for Barwon Water.

"***Another highly significant modification to the physical environment is predictable if watertables are lowered in swampy locations, especially those supporting Scented Paperbark – Woolly Tea-Tree and other wetland vegetation communities. This is the accelerated oxidation of the organic sediments, i.e. peats of several types – see Gibbons and Rowan (1993). When drained, peats become oxidised, lose the greater part of their bulk resulting in slumping of the landscape, and are much more prone to burning – peat fires (Gibbons and Rowan 1993). The particular physico-chemical conditions prevailing in peaty substrates (e.g. pH, aeration, water and nutrient availability) determine the highly distinctive vegetation of these environments.***" The Big Swamp being a typical example containing this type of vegetation.

This statement is particularly relevant to the peat fires of 1997, 1998 and 2010 (see page 28).

Scented Paperbark and Wolly Tea-tree in the Big Swamp area.

Effects of Actual Inland Acid Sulfate soils in the upper reaches of the Big Swamp.

This picture was taken further downstream where the drying out influences upstream were still taking affect. The pH levels of the water at this site were 2.5 when the photograph was taken in 2008.

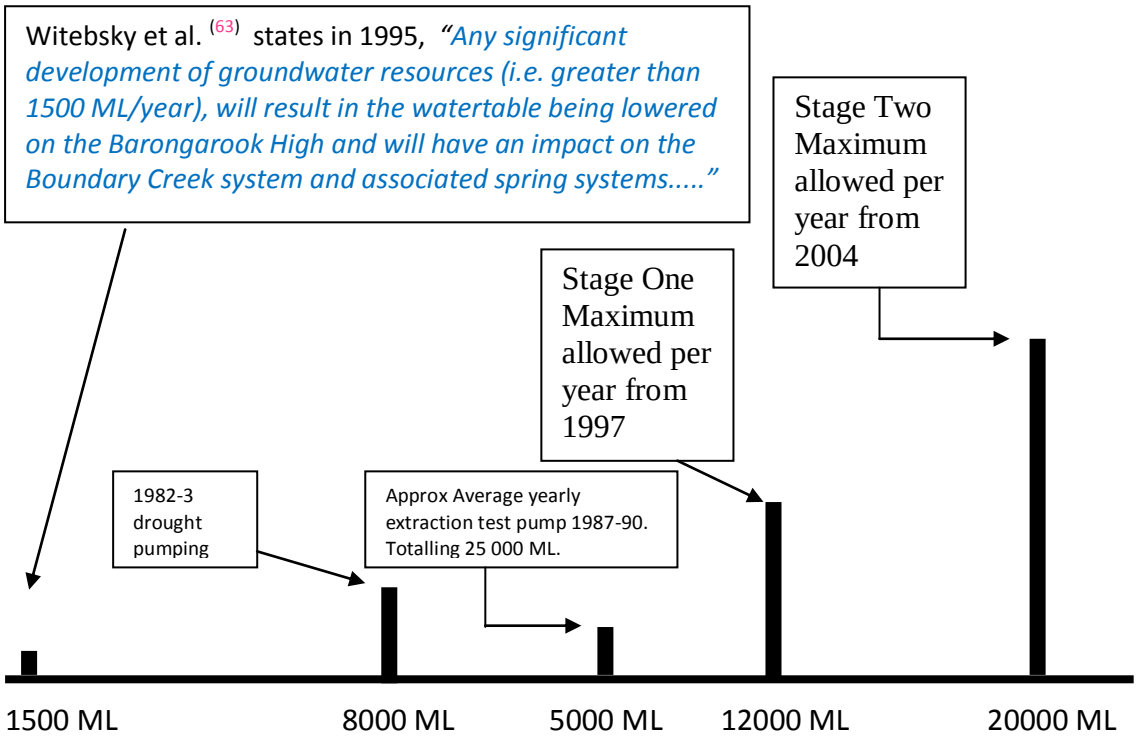
1995.

The Department of Natural Resources and Environment (DNRE) Test Pump results.

The DNRE now known as the Department of Sustainability and Environment, tabled an extensive report in 1995 prepared by Witebsky et al.[63] on the 1987-91 groundwater extraction test pump conducted at the Barwon Downs Borefield.
The Preface of this report had this to say,

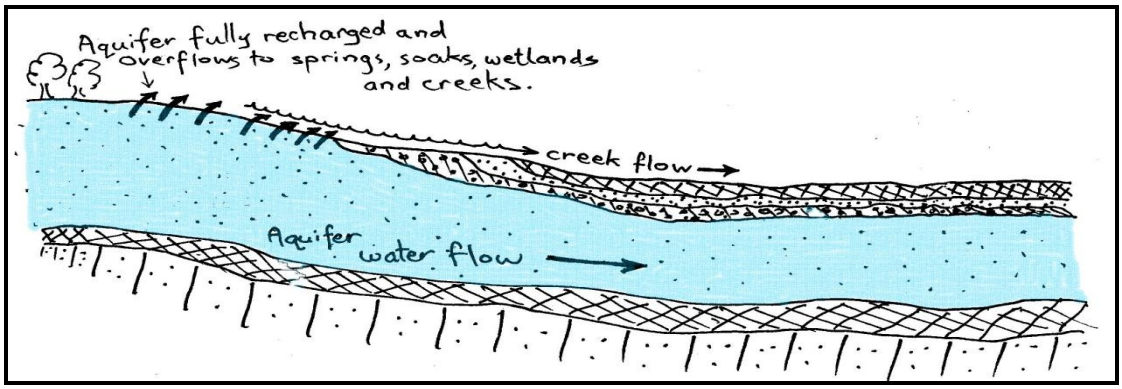
> *"**The information presented here represents a significant contribution to our understanding of the groundwater systems of the region. It provides a sound technical basis for the establishment of a bulk groundwater entitlement for the groundwater resources within the graben and adjoining areas, under the Water Act 1989.**"*

This 300 page report established that pre pumping Boundary Creek had an average summer flow of 3.2 ML/day and that there were extensive swampy marsh areas adjacent to Boundary Creek. Any significant development of groundwater extraction greater than 1500 ML/year would result in the watertable being lowered on the Barongarook High and would have an impact on Boundary Creek and associated spring systems. 4 000 ML/year extraction would see a noticeable impact on the flows in Boundary Creek (see graph on page 51). In 1986 Farmar-Bowers calculated the sustainable yield to be around 1600 ML/year.

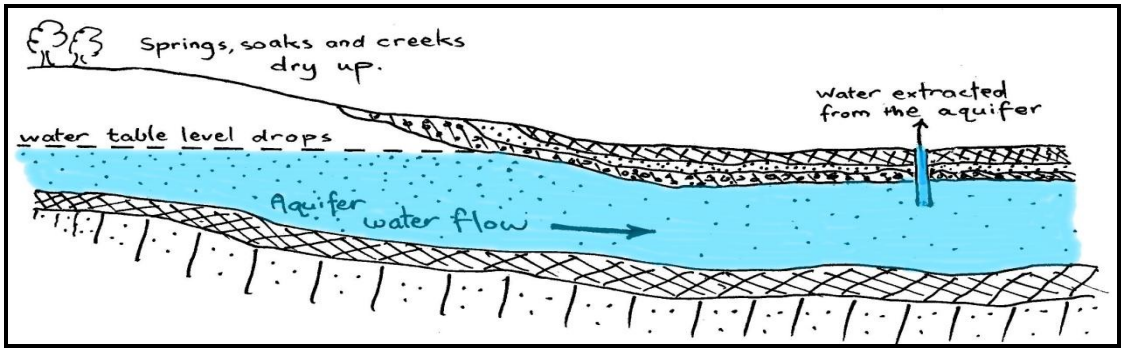


This graph clearly shows that from an environmental point of view the Witebsky et al. recommendations and findings have been completely ignored.

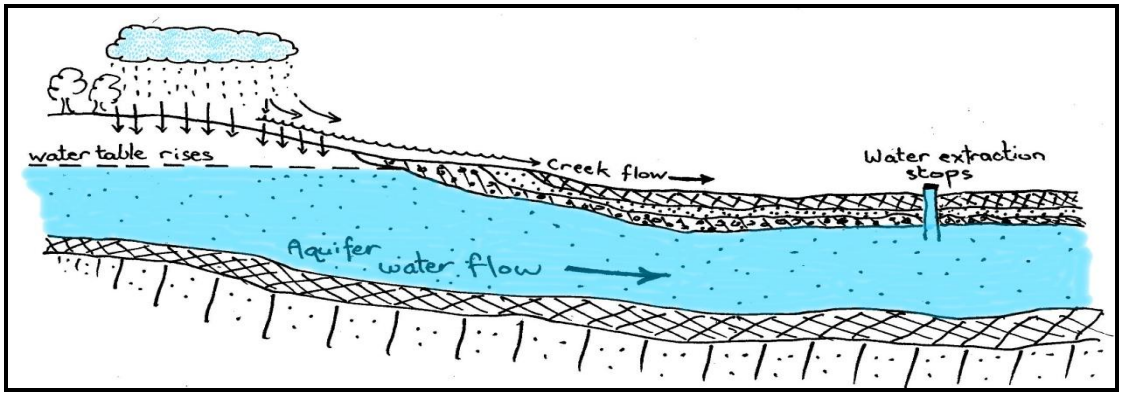
Witebsky et al.[63] found that diminished flows in Boundary Creek were directly attributed to the pumping of groundwater at Barwon Downs and that adverse impacts could take years to reverse.
It will be demonstrated that when the water table is lowered enough Boundary Creek ceases to flow and the adjacent wetlands begin to dry out. This area no longer discharges water from the aquifer but becomes an important source of groundwater recharge where any surface water seeps downwards replenishing the depleted aquifer below. This concept is conceptually presented below.



If the aquifer is full during summer it naturally overflows into springs, soaks, swamps, wetlands and creeks.

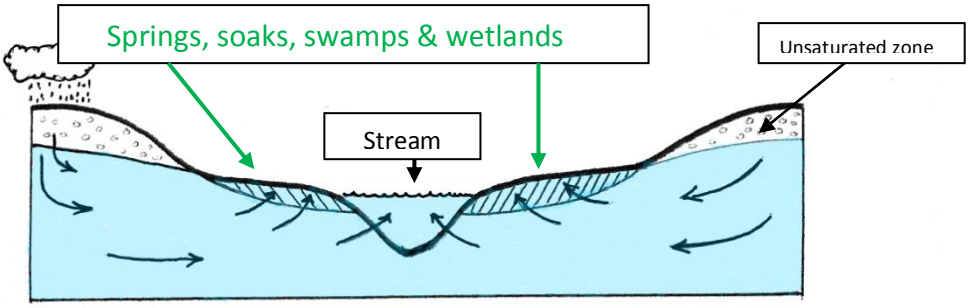


Any time water is pumped from an aquifer at a faster rate than it is recharged from rain falling onto the unconfined aquifer the water table level in the aquifer drops. If it drops below the surface it will no longer discharge or overflow into the springs, soaks, swamps, wetlands and creeks - they will dry up.

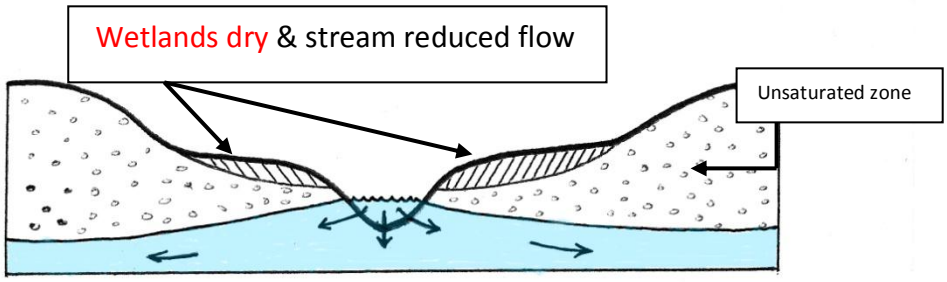


Once the water table has fallen below the stream bed of the creek and the creek flows as a result of rainfall, a percentage of the creek water can infiltrate down into the unconfined aquifer and speed up the aquifer's recharge.

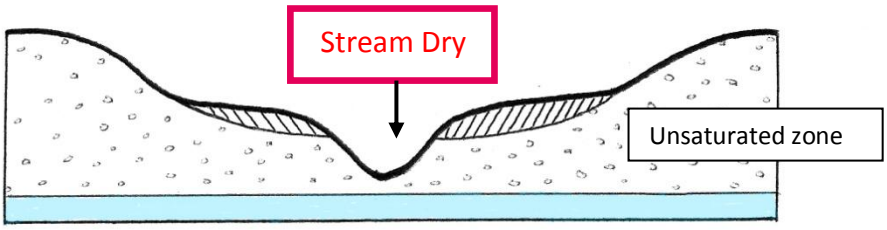
These diagrams look at the above process from a different perspective.



Wetlands and stream interaction with groundwater. In this situation they are regarded as gaining or influent – aquifer overflows.



Lower the water table by extracting groundwater and the wetlands and stream are affected when enough water is pumped from the aquifer. The stream is now a losing or effluent stream and is recharging the aquifer.



Lower the water table to this degree and the stream will cease to flow in periods of no rain – the baseflow from the aquifer is totally eliminated.

The Witebsky et al. report[63] stated that depending on a reliable rainfall and the amount of water extraction at Barwon Downs, watertable recovery in the Boundary Creek area may take several years to recover after the cessation of pumping.

Spring Monitoring.

In regard to spring monitoring Witebsky et al. found that on the basis of limited data available, borefield pumping did not appear to have had a significant impact on springs in

the Boundary Creek spring monitoring area. However, it was stated that insufficient monitoring of spring systems had occurred to enable the impact of pumping on spring flow to be accurately determined. The spring monitoring mentioned by Witebsky et al. as insufficient, was suspended in 1994. Otway Water Book 1[30] page 78 describes this spring survey work that was conducted as walking into a wet area and seeing how far the water reaches up one's gum boots. The survey work was spasmodic, random and superficial.

Comparative Study – Groundwater/Surface Water.
Witebsky et al.[63] decided that if significant groundwater extraction development occurred, it would be appropriate to compare environmental impacts with a surface water development such as a dam. In fact the report concludes that the environmental impacts of groundwater development in the Barwon Downs borefield must be weighed against impacts of comparable surface water developments. This report states it is unfortunate that the scope of the report did not permit such a comparative study.
As it turned out and after this 1995 report was tabled, significant groundwater extraction development did occur at the Barwon Downs borefield between 1997 and 2004. This Stage One development was largely based on the Witebsky report. However, this decision to proceed with groundwater extraction was made without a comparative study being conducted.

1995.

Groundwater Extraction Licence Issued - 12 000 ML/year.

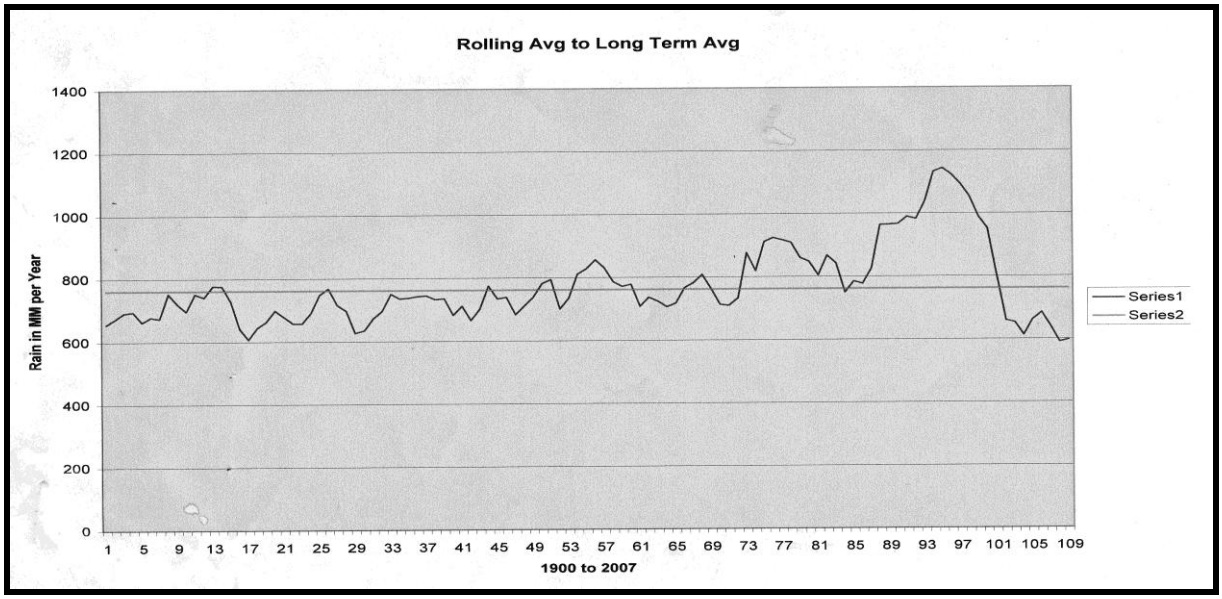
Southern Rural Water issued Barwon Water with a licence to extract 12 000 ML/year from the Barwon Downs Borefield. This groundwater extraction was named Stage One. The 1995 Department of Sustainability and Environment report by Witebsky et al. [63] recommended a limit of 4000 ML/year.

1996, 1997 and 1998

Fires Along Boundary Creek.

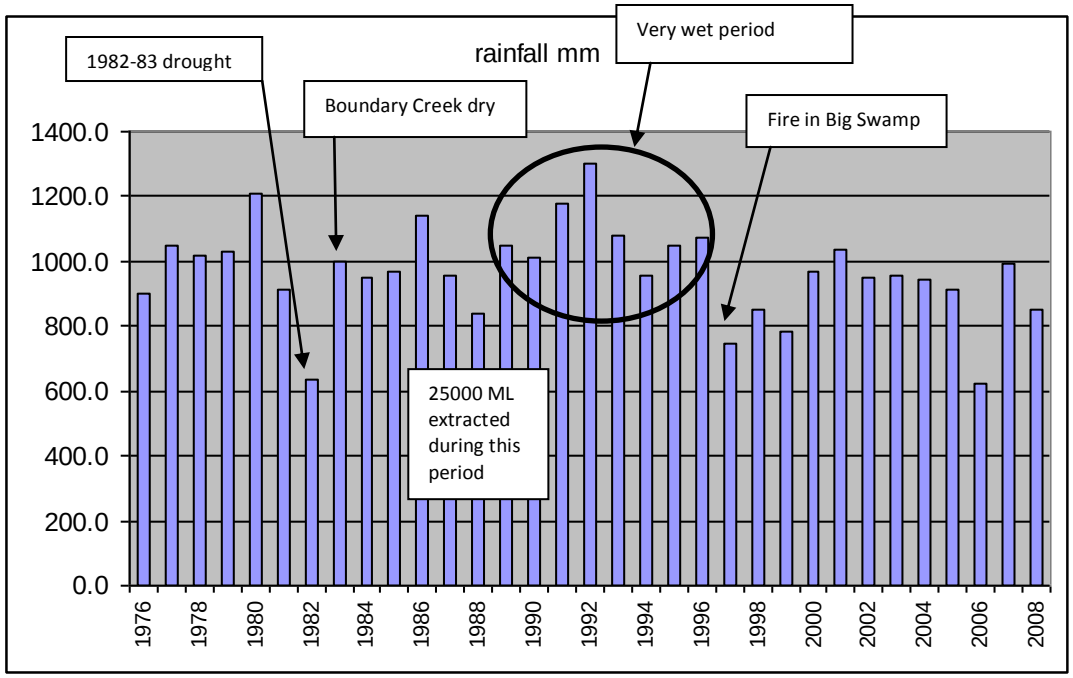
There is still some dispute when the Big Swamp first caught fire. The official CFA records state that the first episode was in 1997.[24] Irrespective of whether the Big Swamp first caught fire in 1996 or 1997 it is most difficult to explain how the top end of this swamp caught after one of the wettest periods on

record.



Source: to be confirmed.

The significance of this being the drying out of the Big Swamp cannot be attributed to low rainfall or drought as it so often is. Considering that Boundary Creek had never dried up before 1984 indicates that lack of rainfall was not the contributing factor.

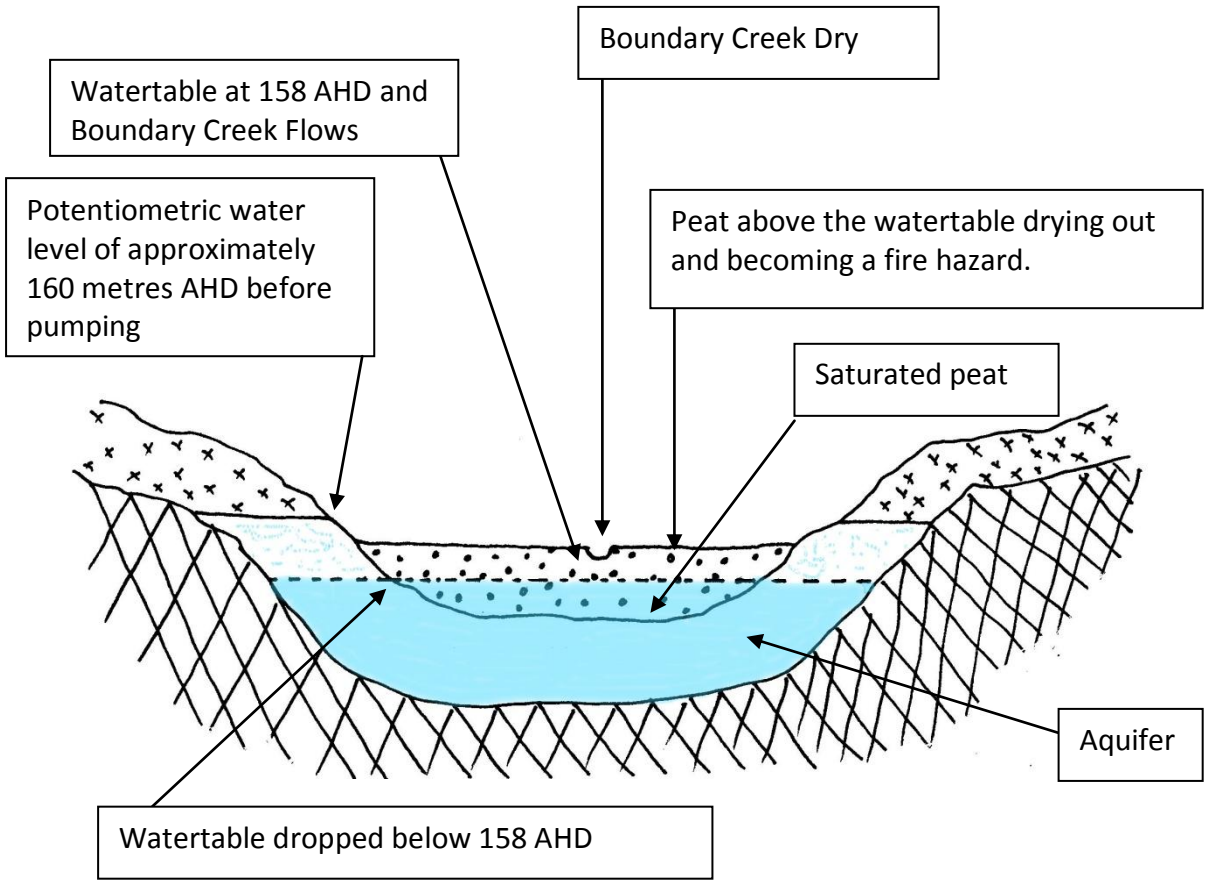


Source: 'Wanawong" property (see page 4) Rainfall Chart at Burton's Lookout collected by David Hopkins.

In 1986 Farmar-Bowers[25] wrote that if Boundary Creek were to become dry environmental changes could become entrenched and not easily reversed. He also indicated that under these circumstances increased fire intensity and occurrences could become a problem.
In the Boundary Creek wetlands he found swamps rich and dense in organic matter several metres deep. In this area water was released from the aquifer forming springs and waterlogged areas (see pages 44, 45 & 90, 91). These areas were supporting types of vegetation that coped with periodically or constantly wet conditions and that these areas would be affected by a fall in groundwater level. Farmar-Bowers stated that these saturated zones were likely

to dry out or at least shrink in size with groundwater pumping. In the wetter areas the change could be expected to be rapid but whatever the speed of change the wetter dependent vegetation types would be replaced by vegetation of a drier habitat. He also stated that 2 000 ML extraction per year would alter the flow regime of Boundary Creek substantially. Farmar-Bowers[25] calculated the summer base flow from the groundwater source into Boundary Creek to be approximately one megalitre a day.
From an agricultural point of view Farmar-Bowers noted that waterlogging was a major problem along the flats adjacent to Boundary Creek. He believed that lowering the watertable would have improved the land for agricultural production.
Acknowledging the work of Quentin Farmer-Bowers, and years of local resident observation and photographic depiction, it is blatantly obvious that the integrity of the wetlands has not been maintained. Waterlogging is no longer a major problem and the swamps rich and dense in organic matter, commonly called peat, had become a major fire risk despite "normal" rainfall conditions.
Gibbons et al.[38] writes about drained peat oxidising that results in the lowering of the landscape and the increased risk of burning.
In **1996/97** a nearby fire spotted into the area known as The Big Swamp igniting the peat (see map page 4, half way between points H & L). From local knowledge The Big Swamp had always been waterlogged and for it to catch alight was unheard of, it was totally unexpected. It took many days and huge volumes of water to put the peat out. The creek bed of Boundary Creek ran through the peat fire location. Huge volumes of water had to be found to put this fire out. (CFA records state that the Big Swamp was first alight on October 10 **1997** not 1996**.)** However, this fire had not been extinguished and on 12 March 1998 the smouldering peat, along Boundary Creek in the Big Swamp, once again ignited and caused extensive wildfire in the area. An early wind change prevented mass evacuation (pers com. John Modra who was present at the Country Fire Authority headquarters).

"In 1996 the total rainfall for Colac was 1129 mm compared to the long term average of 762 mm. For the four years prior to 1996 the rainfall for 1995 was 1067 mm, for 1994 it was 843 mm, for 1993 it was 1077 mm and for 1992 it was 1286 mm, all four years well above the long term average rainfall of 762 mm. The long drought in Colac did not in fact start until 1999 when only 470 mm fell," Roger Blake (pers com).
Roger Blake was involved in the development of the bore observation network in the Barwon Downs area and features in a photograph on the front page of the 1995 Witebsky et al report.[63] Roger was a director of Exploration and Development Essential Petroleum Resources Ltd and has done extensive work for the Government including work as Roger Blake and Associates, Petroleum and Hydrogeological Consultants.



Representation of the concepts being involved – drop the watertable below 158 AHD and Boundary Creek and the adjoining wetlands begin to dry out ***(see page 51).***

In an attempt to blade off the dry peat to get at the fire sources a bulldozer became hopelessly bogged once it broke into the saturated peat below. In this situation a bulldozer was found to be useless. An excavator had to be used to cross the peat to get at the fire hot spots by laying a timber corduroy road on the peat. Without this the excavator would also have become hopelessly bogged. The previously top saturated but now dry layer of peat gave the impression that this top end of the Big Swamp was navigable by heavy machinery.

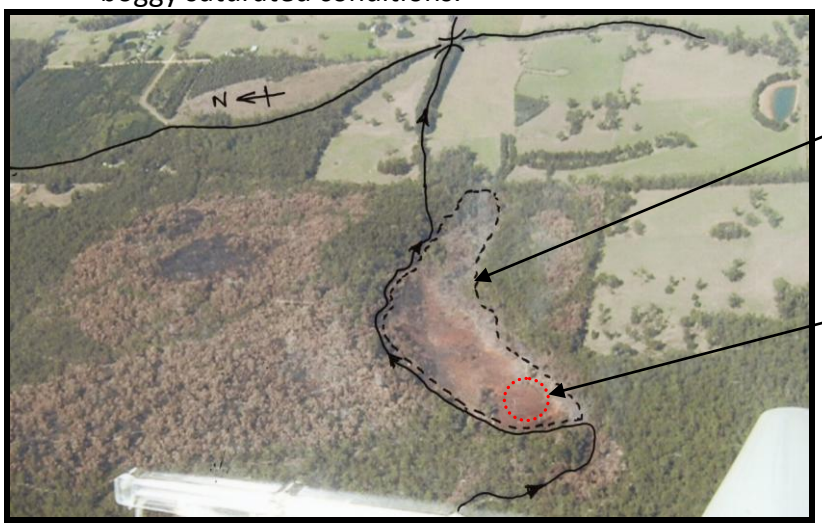
Jim Speirs an Otway forester who started with the Forest Commission of Victoria in 1954, was involved in fire hazard reduction burns in the Boundary Creek Big Swamp area. Jim retells that throughout the period up to 1991, when he retired, the foresters would do fuel reduction burns in the Big Swamp area in rubber boots. The foresters would be working in water. Leaves, grass and other matter would burn off down to the water level (J. Speirs. Pers. Com. October 2008).

Extracts from the CFA "*Yeodene Peat Swamp Fire History Risk Identification and Mitigation Plan Discussion Paper April 2010,*"[24] confirm that...

- Only a small section of the Big Swamp caught fire,"...***approx 1 ha of peat become involved in wildfire.***"
  (The total area of the Big Swamp has been estimated to be 7 hectares)

- On the eastern edge of this 1 hectare of the Big Swamp, "***CFA crews worked for a number of days running a hoselay and water relay operation to attempt to secure the eastern edge of the fire in the peat swamp that at this stage did not have a mineral earth control line along it due to the boggy nature of the ground. This was eventually abandoned***..." Only the higher AHD zone of the Big Swamp had dried out sufficiently enough to burn.
- A fuel reduction burn was attempted in this eastern sector of the Big Swamp, however, "***This was partially successful as in some areas in the peat swamp it was too wet to burn due to the amount of water covering the surface of the swamp.***"

The upper section of the Big Swamp had been dried out after one of the wettest periods on record. Coincidently between 1986-91 Barwon Water had extracted over 25 000 million litres of groundwater. By the time the Big Swamp caught fire Boundary Creek had many days of no flow through the Big Swamp. However, the middle to lower section of the swamp had remained too wet to burn because of the boggy saturated conditions.



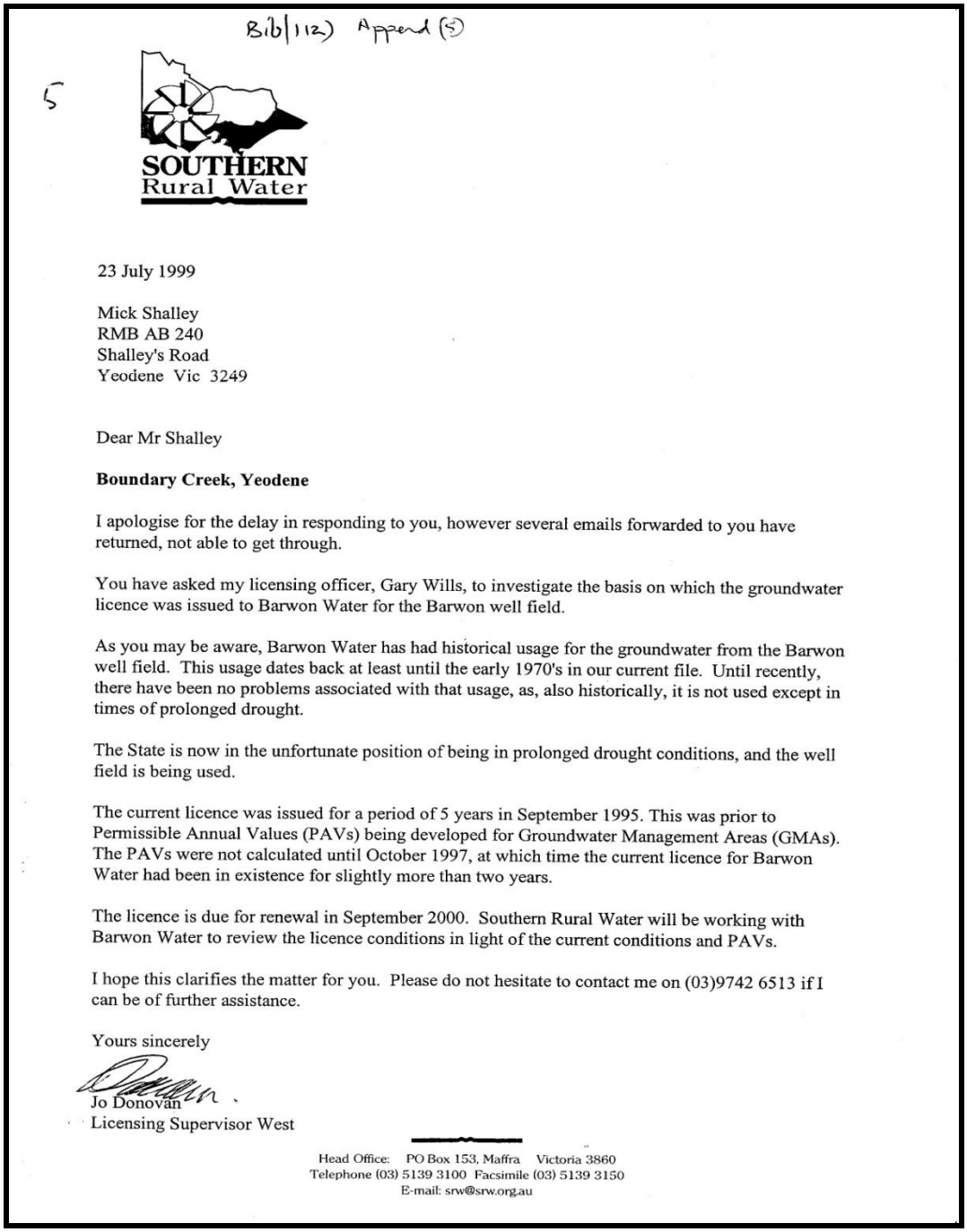
1997.

- **September 1997 Barwon Water Begins Pumping Again – Stage One.**

  One month before the Permissible Annual Volume was set at 4 000 ML/year for groundwater extraction at the Barwon Downs Borefield, Barwon Water began to pump from the borefield exercising for the first time a 12 000 ML/year licence granted 2 years previous.

- **October 1997 Permissible Annual Volume (PAV) Established.**

  The PAV was set at 4 000 ML/year.[30] However, because Barwon Water was exercising the licence given in 1995 Southern Rural water ruled that the imposing of the 4 000 ML/year PAV would not be applicable until this licence ran out in 2002 (see letter page 33).



Bib/112) Append (5)

5

SOUTHERN
Rural Water

23 July 1999

Mick Shalley
RMB AB 240
Shalley's Road
Yeodene Vic 3249

Dear Mr Shalley

Boundary Creek, Yeodene

I apologise for the delay in responding to you, however several emails forwarded to you have returned, not able to get through.

You have asked my licensing officer, Gary Wills, to investigate the basis on which the groundwater licence was issued to Barwon Water for the Barwon well field.

As you may be aware, Barwon Water has had historical usage for the groundwater from the Barwon well field. This usage dates back at least until the early 1970's in our current file. Until recently, there have been no problems associated with that usage, as, also historically, it is not used except in times of prolonged drought.

The State is now in the unfortunate position of being in prolonged drought conditions, and the well field is being used.

The current licence was issued for a period of 5 years in September 1995. This was prior to Permissible Annual Values (PAVs) being developed for Groundwater Management Areas (GMAs). The PAVs were not calculated until October 1997, at which time the current licence for Barwon Water had been in existence for slightly more than two years.

The licence is due for renewal in September 2000. Southern Rural Water will be working with Barwon Water to review the licence conditions in light of the current conditions and PAVs.

I hope this clarifies the matter for you. Please do not hesitate to contact me on (03)9742 6513 if I can be of further assistance.

Yours sincerely

Jo Donovan
Licensing Supervisor West

Head Office: PO Box 153, Maffra Victoria 3860
Telephone (03) 5139 3100 Facsimile (03) 5139 3150
E-mail: srw@srw.org.au

The Department of Natural Resources and the Environment (DNRE), Victoria, commissioned Sinclair Knight Merz to calculate a PAV for the Gerangamete Groundwater Management Area.[17] This area includes the township of Barwon Downs and covers the Boundary Creek catchment and the Gerangamete borefield, which is more commonly known as the Barwon Downs Borefield. This particular document was dated January 1998. However, the PAV was calculated and stated as policy in October 1997 (see letter above).

In the 1998 DNRE document it states, ***"The purpose of the PAV is to provide the rural water authority with a limit to which groundwater licences may be issued within the GMA, based on the long term sustainable yield of the aquifer system."*** (GMA - Groundwater Management Area).

The Gerangamete GMA Permissible Annual Volume was calculated primarily as a result of Barwon Water needing groundwater from Barwon Downs as a water supply for communities in Geelong, across the Bellarine Peninsular, Surf Coast and parts of Golden Plains Shire.[6]

As part of its Gerangamete GMA Permissible Annual Volume determination Sinclair Knight Merz[17] referred to a Department of Natural Resources and Environment (DNRE) document [18] and quoted this, *"**The report concluded that the long term sustainable yield under conditions of natural recharge, with acceptable environmental impact should be 4 000 ML/year for the aquifer system**."*

There was no mention that huge amounts could be extracted in any one year, for example 12 000 ML/year. In 2004 the licence was set at 20 000 ML/year with no more than 80 000 ML in a ten year period and no more than 400 000 ML over one hundred years. Huge extractions like this were totally in conflict with the notion of a Permissible Annual Volume. Annual - being defined as 4 000 ML a year; 4 000 ML a year and no more. Anything over this limit would be in direct conflict with the spirit of the PAV.

December Special Gazette Number S 160(1997).

The Victorian Government published a Special Gazette, Number S 160,[62] specifying certain management principles to be applied to groundwaters of Victoria.

- The protection of existing and potential beneficial uses, including:
  - Ecosystems,
  - Stock and domestic water,
  - Agriculture, and
  - Primary contact recreation.
- The intergenerational equity and precautionary principle.
  - An interpretative definition of the precautionary principle is, "There is a problem until it is proven otherwise, NOT that there is **no** problem until one is created."
- Protection agencies (e.g. Southern Rural Water, the Environment and Protection Authority, the Department of Sustainability and Environment, the Corangamite Catchment Management Authority and the Colac Otway Shire) must implement the policy.

The implementing of these and other specifications to the management of groundwaters were based on sound management practice of the time and should have been strictly adhered to with any new groundwater project. When renewing the groundwater extraction licence between 2000 and 2004 it would appear that the intent of this Special Gazette was largely ignored.

1998.

- **Long Term Impacts Significant.**

  Hatton (CSIRO) and Evans[40] (Sinclair Knight Merz) wrote in 1998, "***It is clear that long term and permanent use at the Barwon Downs borefield would have a significant impact on ecosystems in Boundary Creek and adjacent vegetation.***"

- **Permissible Annual Volume Project.**

The Permissible Annual Volume[17] report was distributed January 1998. Three quotes from this report are worthy of particular note.

1. Page 7. "***A comprehensive review of the hydrological and sustainable yield of the Barwon Downs Graben, which included groundwater modelling was undertaken by DNRE (1995). The review examined the recharge to the basin and constraints to development of groundwater, such as the potential for subsidence and the reduction in surface flows. Due to the nature of this work which conforms with the general thrust of the PAV project, it is proposed to adopt the conclusions from this report as it represents a far more sophisticated examination of sustainable use of the resource, than can be undertaken by the PAV project***."
2. Page 9. "***It was concluded in the study that flow in Boundary Creek (located on the Barongarook High) would be affected by extraction at a rate of 4,000 ML/year, and that springs in the area and domestic and stock users extracting from shallow bores may be affected***."
3. Page 10. "***The volume (4 000 ML/year) has been adopted from the results of a comprehensive study of the groundwater resources, which included groundwater modelling in the Barwon Downs Graben undertaken by DNRE (1995)***."

(DNRE – Department of Natural Resources – now called the Department of Sustainability and Environment.)

1999. Supplementary Flow Trials.[30]

Because Boundary Creek was regularly drying up and farmers' stock and domestic supplies were being seriously impacted Barwon Water began supplementing flows in Boundary Creek by releasing water from the Colac Otway pipeline (see page 4, point L).

2000.

- **Barwon Water Seeks Change to Planning Scheme.**

The Gerangamete Flats Landcare Group presented a submission to the Colac Otway Shire when Barwon Water was seeking a change to the Planning Scheme C5. The Landcare Group was concerned with loss of aquatic life, loss of riparian habitat, creek-bank subsidence and farm water shortages that this Group attributed to groundwater extraction at Barwon Downs. The submission also made a point of lack of public consultation, little concern for the environment or the local and regional landholders.

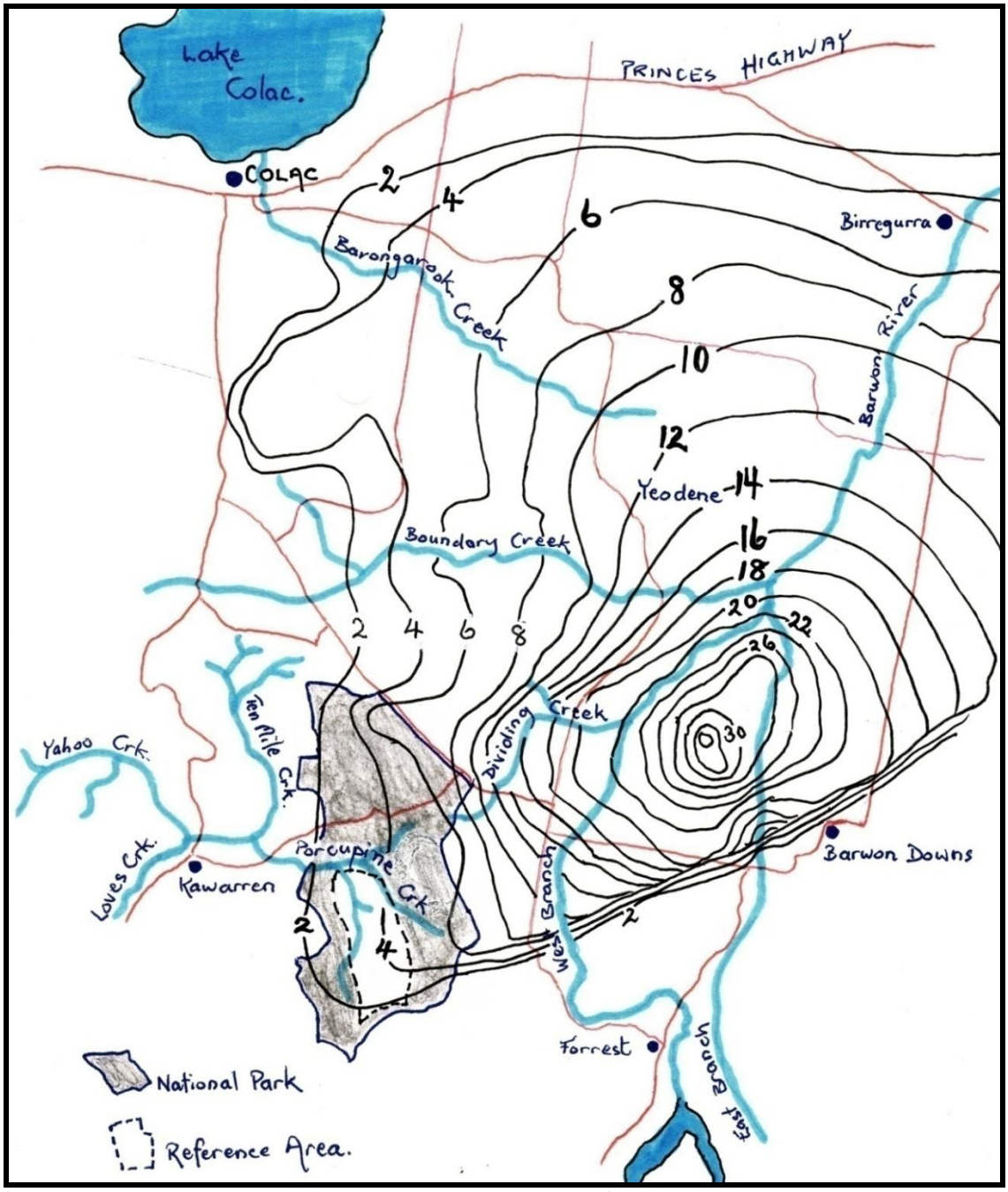
Creek Bank Subsidence.

Boulton et al.[9] refers to river bank storage of water and where a river summer base flow is uncoupled from the river there is quite often physical changes in the stream bed and banks. In all probability the wetted banks of Boundary Creek maintained their integrity through capillary action. However, once the creek dried out the

witnessing of the crumbling banks became quite obvious to farmers with years of local knowledge.

- **Stage One Licence Due for Review.**
  The extraction licence at Barwon Downs was due for review in September 2000 but for some reason the process did not appear to start until 2002. One reason could have been that it was deemed desirable to have completed fish, flora and fauna studies (see page 37).

- **Drawdown Figures.**



(Source: Barwon Water handout 2000 superimposed over local map.)

Groundwater extraction between 1998 and 2000 was approximately 28 000 ML. The drawdown figures in this map indicate a lowering of the deepwater aquifer to be in the order of 34 metres in the vincinity of the Barwon Downs Borefield. Also there is only one cone of depression.

2001.

- **Boundary Creek Dry 280 days.**
  Since the summer of 1984 Boundary Creek had been dry on 280 days (see page 87). Creeks in the Loves Creek Catchment to the south and tributaries of the Barongarook Creek to the north continued to flow.

2001 -2002.

- **Gerangamete Flats Landcare Group.**
  The Colac Herald ran with two reports, 20 July 2001 and 15 May 2002 where the Gerangamete Flats Landcare Group was claiming that groundwater extraction was affecting riparian vegetation along Boundary Creek and had killed aquatic life including platypus and fish species.

- **Studies Completed.**
  There was no doubt that there were extensive reserves of groundwater that could be extracted from the Barwon Downs Borefield. However, before a new licence was to be issued for Stage Two, attempts were made to determine the up to date sustainability of the aquifer. As part of this renewal process Barwon Water needed supporting evidence to justify an increase in the amount of water that could be pumped from the aquifer at the Barwon Downs borefield. Many studies and reports were prepared and scrutinised in this process.

  During this period the use of the word sustainable came in vogue. Unfortunately the term sustainability is often defined depending on the result required. From a hydrological sense the water reserves in the aquifer were sustainable for many, many years. Under the definition used by Barwon Water any extra water sucked down from surface flow or vertical downwards leakage from higher aquifer formations, was regarded as part of the sustainability process.[54][55] If sustained pumping from a deep water aquifer caused springs, streams and wetlands to dry up and become recharging sources for the aquifer below, this was seen as adding to the sustainability of the resource. However, environmental and social values would not be sustained under this regime.

  In other words the groundwater could be pumped from the deep water aquifer for an indefinite period as long as the pumps extracted water. However, when reviewing the extraction licence for the Barwon Downs Borefield the environmental and social impact should have been considered as well. An the Evans report[23] states the

nationally agreed definition of sustainable yield for groundwater systems is as follows, *"The groundwater extraction regime, measured over a specified planning timeframe that allows acceptable levels of stress and protects dependent economic, social and environmental values."* To increase an aquifer's "sustainability" by drying up streams, springs and wetlands could not be regarded as protecting environmental or social values. Neither should causing higher aquifers to vertically leak down into the lower deep water aquifer be regarded as increasing the aquifer's sustainability under the nationally agreed definition.
The environment was reportedly being catered for through fish, flora and fauna studies and by representation from the various environmental Government authorities.
However, from an environmental viewpoint this whole process was farcical.

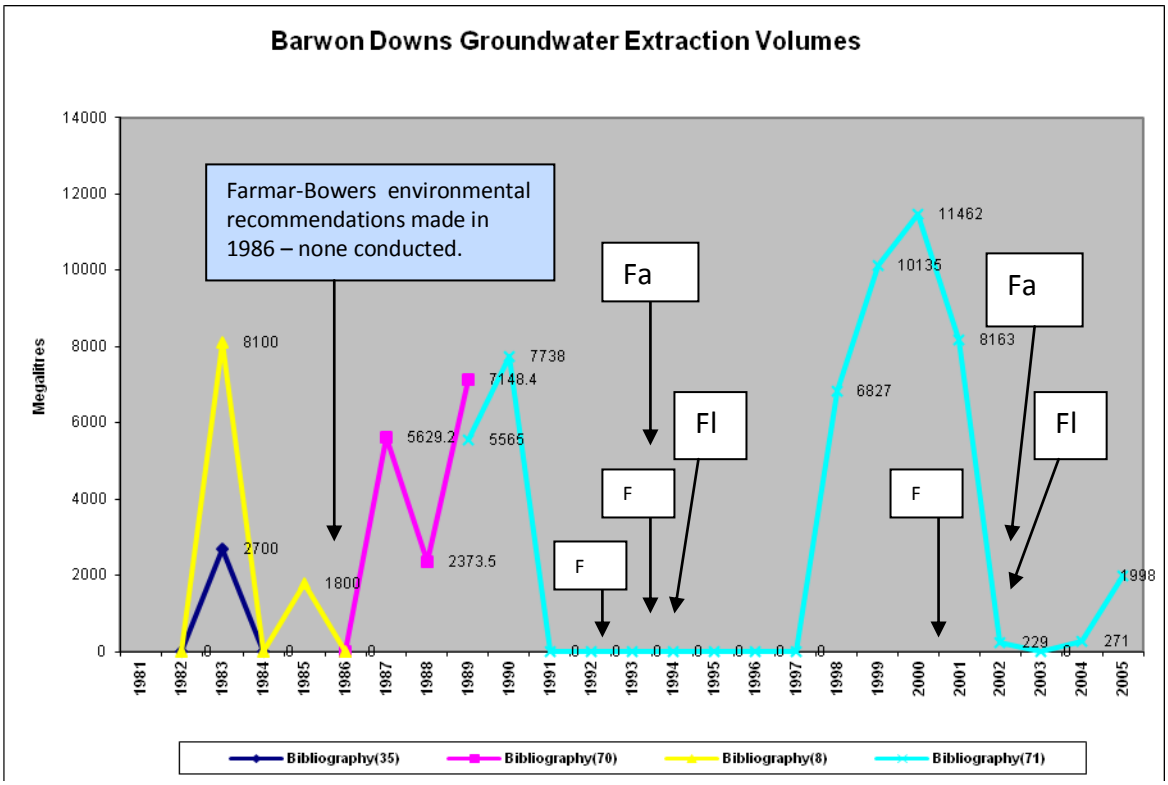
2001 Fish Studies.
This study summarised the 1992-93 and 2001 findings and stated that a total of four fish species were captured, little difference between the two survey periods.
Three indigenous species – Mountain galaxias (Galaxias olidus), Short-finned eel (Anguilla australis) and Southern pigmy perch (Nannoperca australis). An introduced species being Redfin (Perca fluviatilis).
Indigenous crustacean species Land yabby (Engaeus sp.) and Freshwater shrimp (Paratya australiensis) were also captured.
The 2001 report concluded that in general, there was at that stage not enough data to suggest that the population structure of density of aquatic fauna had altered significantly within Boundary Creek since the surveys were initiated in May 1992.
The report went on to say there were some anomalies and suggested that follow up studies be carried out.
None of the recommendations in this report were ever implemented; Barry Tunbridge's report was still overlooked and local landholder's (Nellie Shalley) assertion that there used to be abundant blackfish pre pumping was ignored (see page 57).

Flora Studies.
The 2002 report was aimed at concentrating on hydrological sensitive vegetation sites in the Boundary Creek area. 32 of the 1994 study sites were chosen to be resurveyed. Recommendations made in 1994 were mirrored in the recommendations made in this report. The 1994 recommendations had not been implemented.
It is most intriguing that the 2002 flora survey found Scented Paperbark species being affected by increased insect and pathogen attack. These symptoms were predicted by Farmar-Bowers back in 1986 as signs of a lowered water table due to groundwater extraction.

Fauna Studies.
The 2002 report stated that compared to the initial survey of 1993 it suggested that the extraction of groundwater had not had a long term impact on the fauna dependent aquatic and riparian habitats. It was also stated that the 1993 survey was carried out before any groundwater extraction had been undertaken.
The report concluded that because of a lack of control sites it was difficult to draw any definite conclusions on the impact of pumping groundwater. Difficulties encountered were to become an often used excuse justifying inconclusive results.

To provide an accurate pre pumping data base these studies should have been done prior to the 8 000 ML extracted in the drought of 1982-83. At the very least Farmar-Bowers's 1986 recommendations should have been carried out pre the stress test pump that extracted over 25 000 ML between 1987-1990. Farmar-Bowers had found the Big Swamp and flows of Boundary Creek in relatively good condition.
It is also nonsense when this 2002 report states that the fauna surveys were commenced prior to groundwater extraction (see graph page 51 "Barwon Downs Groundwater Extraction Volumes"). Huge volumes had been extracted.
Appropriate control sites had never been established nor had there been any follow up fauna studies. Aquatic Inverte4brate Studies recommended a decade earlier still had not commenced.

The graph below clearly shows that the various environmental studies conducted by Barwon Water took place long after extensive groundwater extractions had taken place. It is most apparent that if the people conducting these studies had been made aware of earlier facts, studies and local knowledge they would have reached markedly different conclusions. The results of these studies did not indicate the devastation that was taking place along Boundary Creek and in the adjoining wetlands. Perhaps the study briefs were too limiting. However, Barwon Water was able to claim little environmental impact and maintains this is still the case in 2012. In 2004 a greatly increased extraction licence was to be issued as a result. The 12 600 ML/year was increased to 20 000 ML/year.



(F *indicates when the fish studies were done;* Fa *the Fauna studies and* Fl *the flora studies.)*

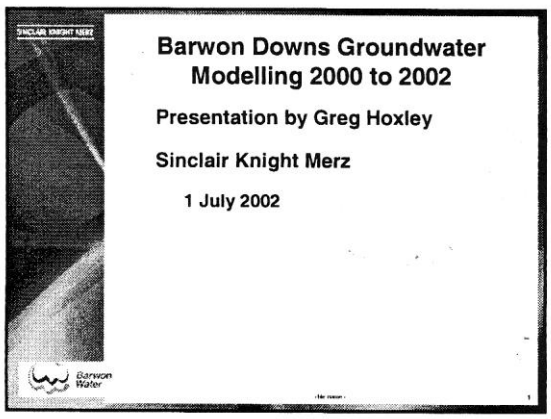
Bibliography (35) - figures from the June 2002 Northey briefing on the Barwon Water Licence Renewal Project. **Bibliography (70) -** figures from the June 1989 Barwon Downs Groundwater Test Pumping Progress Report No. 8. **Bibliography (8)** - 1995 figures calculated from a Department of Natural Resources and Environment Report (Witebsky et al.) **Bibliography (71)** – figures from a

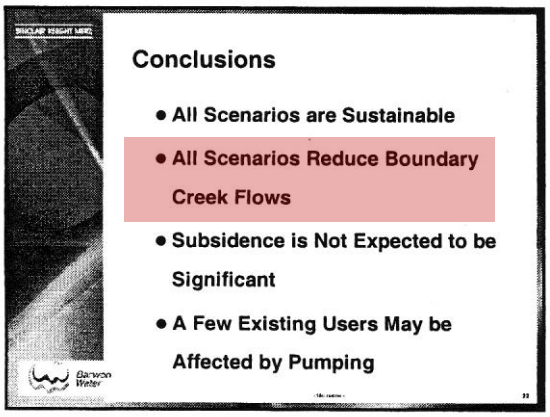
Freedom of Information reply from Barwon Water November 2006 (Barwon Water Reference 15/260/0003X(3)).

NOTE: The bibliography references in the above graph refer to bibliographies found in "Otway Water Book 1."[30]

2002

- **Greg Hoxley (SKM) reports.**
  In 2002 Greg Hoxley presents a Powerpoint presentation in which he clearly demonstrates that Boundary Creek is affected from groundwater pumping at The Barwon Downs Borefield.





- **February. Impacts on Boundary Creek Barely Discernable Over 100 Years**(2002)**.**
  In February 2002 Sinclair Knight Merz[55] table a report concluding that for all of the pumping scenarios investigated impacts, from a hydrological point of view, would be barely discernable along Boundary Creek when taken over a 100 year period. Vertical leakage downwards from upper levels would help sustain the deep water aquifer. Perched aquifers, saturated and semi saturated sediments, springs and creek would leak downwards helping to sustain and replenish the depleted aquifer below. Reports of this ilk may have prompted the changing of the Permissible Annual Volume to a Permissible Consumptive Volume (see page50).
  However, from an environmental point of view detrimental impacts have been enormous whereby the environmental integrity at a surface level has not been maintained.

- **June – Paul Northey Presentation at 1st Meeting, Stage One Licence Review**(2002)**.**
  On 17 June 2002 Paul Northey of Barwon Water, delivered a Powerpoint presentation titled, "Barwon Downs Aquifer-Historical, Existing and Future Development," as a briefing at the Barwon Downs Licence Renewal Project-1st

meeting. Slide 13 of this presentation stated that studies conducted by Barwon Water concluded that drawdown ***does*** occur in the recharge areas and Boundary Creek ***is*** affected by pumping at the Barwon Downs borefield.

- **Department of Sustainability and Environment Concerned.**
  Ian Smith of DSE was a member of the Barwon Downs Borefield licence review steering committee reported in documentation to the committee 20 August 2002, "***There is general concern regarding the compound effect on sensitive swamp habitats through repeated and prolonged lowering of water tables***."
  This committee identified several areas to be particularly concerned about and a site that was designated as Site 25, was in proximity of the Big Swamp.
  Ian also wrote, "***Options for providing wetting of sensitive swamp are to be explored if found to be severely impacted by lowered groundwater.***" This lead to the release of supplementary flows in an attempt to keep this sensitive swamp area wetted (see page 78).
- **Department of Sustainability and Environment Concerned.**
  At another review steering committee meeting Ian recommended that vertical leakage type studies be conducted. "***Monthly monitoring of regional water table to include monitoring shallow water table to demonstrate non-connectivity.***" This has never been done and has been a recommendation in each of the four environmental surveys and studies done between 1986 and 2009.
- **Concerns of the Upper Barwon Landcare Network**(2002)**.**
  In 2002, Peter Greig President of the Upper Barwon Landcare Network, in a submission[39] to Barwon Regional Water Authority's Licence Renewal Panel, reported that groundwater extraction effects similar to those being experienced along Boundary Creek were apparent along many creeks including Barongarook Creek. Looking at the map on page 36 would indicate that there is also considerable influence in the National Park vicinity. If this is the case it would appear that the Gellibrand Groundwater Managment Area is being impacted upon from groundwater extraction at Barwon Downs.

- **Licence Increased** (2002)**.**
  By the time the Barwon Downs Borefield licence was due for review the licence had been increased to 12 600 ML/year.
  The lengthy process of reviewing the groundwater extraction licence took another two years to complete.

- **SKM[55] reported** (2002)**...**
  when dealing with impacts on Boundary Creek:
  - ... there is a direct hydraulic connection between the aquifer and Boundary Creek.
  - ... generally the baseflow from the aquifer represents a relativley **stable** and **constant** streamflow component.

- "***It has been noted that during periods of significant pumping from the aquifer, the flow in Boundary Creek is reduced and in some instances it has ceased flowing altogether***."

- **In another SKM[54] report** (2002)
  It was calculated the baseflow from the aquifer into Boundary Creek to be approximately 2 ML/day.
  This confirms earlier calculations and clearly shows that Boundary Creek is an accepting stream as long as the poteniometric water level remains higher than the bed of the creek.

- **Spread of the Impact** (2002)**.**
  It is feasible to suggest that there is a drawdown affect well outside the expected area of impact. Thompson[57] in 1971 calculated that 3000 acre feet of groundwater was flowing into Lake Colac. He also stated that the seepage losses of lakes in the area to groundwater could range between 12 and 20 % in drier periods. Blake[8] as late as November 1995 made a recommendation that groundwater discharging into Lake Colac should be quatified. He also makes mention that the drying out of wetlands and the lowering of lake levels in the area are the main risk if there is an over exploitation of the groundwater.

2003.

- **Barwon Water Resource Development Plan.**[7]
  Between 1982 and when this Plan was written Boundary Creek had been dry on 407 days and 64 900 000 000 litres of groundwater had been pumped out of the aquifer at Barwon Downs. Creeks in the Loves Creek Catchment and tributaries of the Barongarook Creek continued to flow.
  Barwon Water's 2003 Water Resources Development Plan states that the Barwon Downs Borefield is sustainable, "***Extensive studies indicate the proposal is sustainable,***" (Page iv of the Plan) and that Barwon Water "***... perform***(s) ***its functions in an environmental way***." (Page 3 of the Plan)
  The Plan states that groundwater extraction from the Barwon Downs Borefield reduces the baseflows in Boundary Creek by about one megalitre a day. No mention is made that Boundary Creek has been drying up.
  This Plan also had this to say, "***No long-term flora and fauna impacts have been detected in the Boundary Creek area resulting from the operation of the Barwon Downs wellfield.***"
  This is not surprising considering recommendations made in 1986 and the early 1990s to conduct studies that would provide adequate longitudinal comparative data were never implemented.[36]
  Barwon Water's 2003 "Water Resources Development Plan"[7] also states that.
  "***Additional flora and fauna surveys could be carried out, although by supplementing flows in Boundary Creek impacts on flora and fauna should be eliminated.***" A statement such as this is based on wishful thinking. Unfortunately the

studies and research required to reach such a conclusion that the supplementary flows eliminate the impacts on flora and fauna have never been done.
The "Water Resources Development Plan"[7] also stated this,'**...operation of the Barwon Downs wellfield does reduce baseflows in Boundary Creek by about 1 megalitre a day.**" This Plan was sending mixed and contradictory messages.

Although no photographs have been found showing the state of Boundary Creek when it was dry in 2003, it can be assumed that it would be very little different to these pictures taken in 2007.

Photos *taken at Boundary Creek on the 15 May 2007 at the stream flow gauging station Number 233228 immediately below the bridge on the Colac to Forrest Road* *(see page 4 point I).*

Photos *taken looking east.*

There can be little doubt that there is an environmental impact on this creek.

- **Maintenance of Stream Flow Trigger Level Recommendation**(2003)**.**

  In 2003 the impact on Boundary Creek was recognised to such an extent that a trigger level for the release of a supplementary flow down Boundary Creek was being investigated. In an SKM letter from Brian Barnett Senior hydrogeologist, to Paul Northey, Barwon Water, 23 May 2003 (cond_Letter.Doc WC01986), re: Recommendations for Groundwater Licence Conditions, contained the following statement.

"The bore used to monitor the trigger level for supplementary flow in Boundary Creek should be located near the creek and should be in the region where the aquifer is unconfined so that a direct connection between the creek and the bore can be assured."

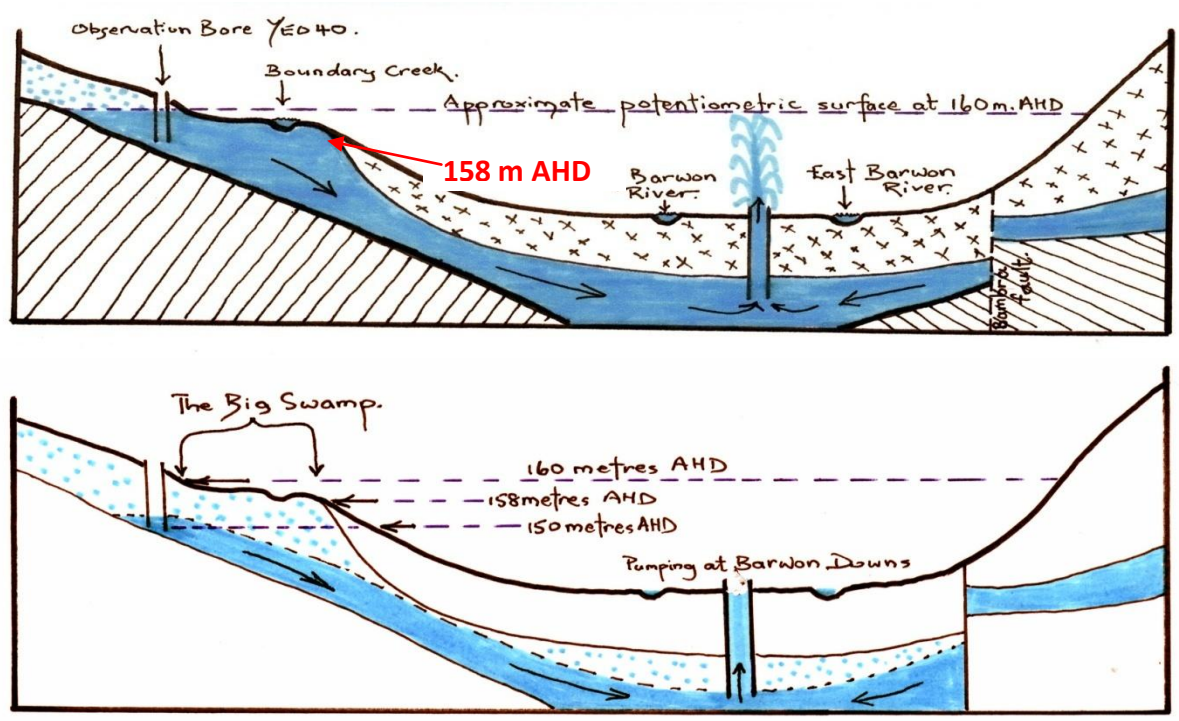
- **Maintenance of Stream Flow Trigger Level Recommendation Yeo 40**(2003)**.**

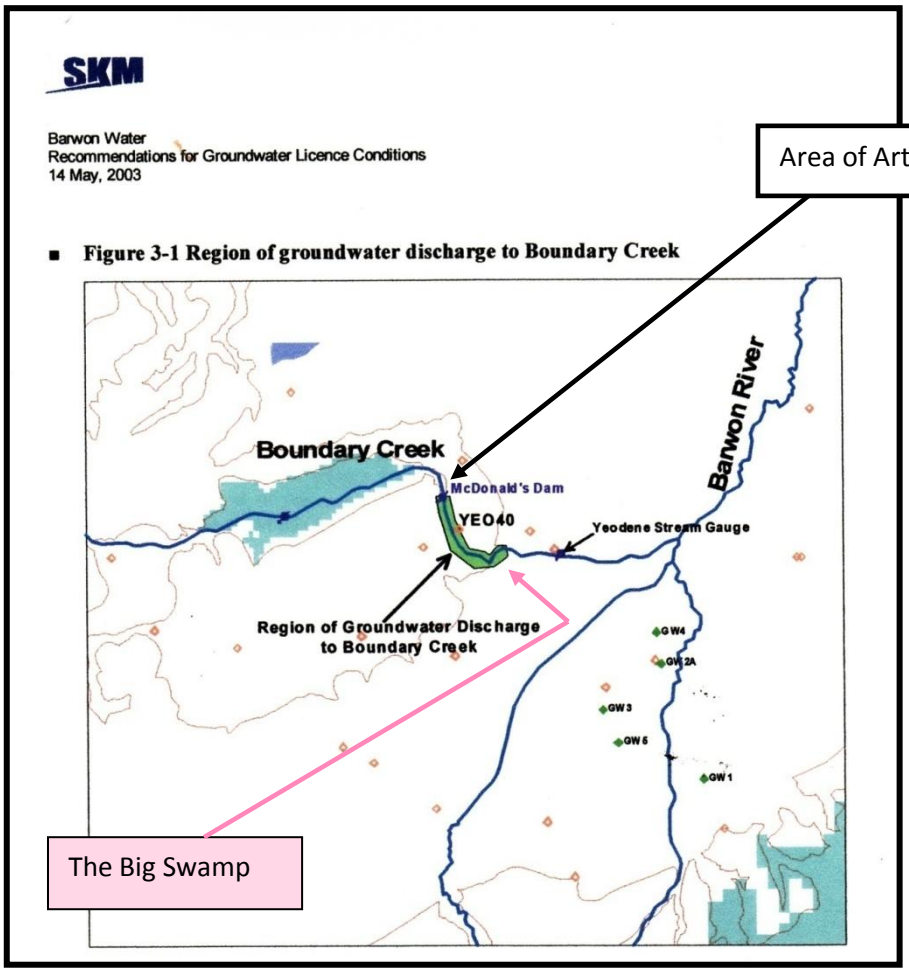
  As a result of this concern and discussion Sinclair Knight Merz[(1)] recommended that observation bore Yeo 40 be chosen as the trigger bore and have a maintenance of stream flow trigger level for Boundary Creek set at 158.5 metres Australian Height Datum (AHD).

  Sinclair Knight Merz (SKM) calculated that if the potentiometric level of the water held in the deep water aquifer dropped below 158 m AHD then Boundary Creek would most likely cease to flow. A half metre tolerance was allowed making the critical trigger level 158.5 m AHD.

  The SKM[(1)] report stated that, "***Pumping from the Barwon Downs borefield reduces groundwater discharge to Boundary Creek. Barwon Water will be required to supply water to the creek at times when groundwater pumping is causing unacceptable impacts on the stream.***"

These two diagrams below are representative of the concepts involve. If pumping at the Barwon Downs Borefield lowers the potentiometric level below 158 m then Boundary Creek dries up.





Area of Artificial Recharge Trials 1990

The green section on this map clearly shows the area where the deep water aquifer discharges into Boundary Creek. This area covers the Big Swamp wetlands.

For an indication of the impact the residual drawdown of extractions at the Barwon Downs Borefield is having on this area go to page 91.

- **Barwon Downs Groundwater Extraction Licence Increased**(2003).
  On 18 August 2003 Southern Rural Water increased Barwon Water's ground water extraction licence from 12 000 ML/year to 12600 ML/year.

- **Licence Renewal Reports.**
  The following two inserts preceded the Panel's final Licence Renewal in an August 2003 Draft Renewal. They formed part of the work leading up to the preparation of the conditions that were to be placed on the final licence.
  The highlighted sections make it abundantly clear that groundwater extraction at the Barwon Downs Borefield ceases the flows in Boundary Creek at certain times of the year.

LICENCE CONDITION: Maintenance of Flow in Boundary Creek

Background

Groundwater extraction at the borefield reduces groundwater levels beneath Boundary Creek such that groundwater discharge ceases and the creek stops flowing in summer
Groundwater levels are drawn down quickly during pumping and recover more slowly when pumping ceases
To maintain flow in the creek BW will need to supply water to the creek to compensate for the loss of baseflow until groundwater levels recover sufficiently
A minimum flow needs to be provided along the creek to Yeodene, for environmental and D&S purposes
To achieve a minimum flow at Yeodene will require a greater input flow in the headwaters of the creek
Stream gauging at Yeodene is undertaken by DSE and information is currently obtained by BW quarterly
Water is taken from the creek above the Yeodene gauge for domestic and stock use and there is an on stream dam on the creek
It is considered unreasonable for BW to have to guarantee a flow at the Yeodene gauge as BW has no control over the amount of water taken from the creek.

1. Setting Objectives and Prescribing Limits

Objective : To maintain a minimum flow in Boundary Creek for the environment and D&S users

Limits: A flow of 2 ML/d must be provided at the head waters of the creek unless:

- groundwater levels the bores x, y and z have recovered to within ? m of full recovery level, or
- flow at the Yeodene gauge exceeds 1 ML/d between the 1st May and 31st November of each year.

Reporting and Review of Monitoring

Reporting: BW must fit a meter at the point of water inflow at the head of the creek
The meter must be read weekly by BW
The metered data must be provided quarterly to the Authority
Stream gauging data from the Yeodene gauge (233228) must be obtained from the monitoring contractor at least at monthly intervals and provided to the Authority quarterly.

3. Compliance

Notification of exceedance: If the flow provided to Boundary Creek by BW falls below 2ML/d and the bores have not recovered sufficiently, or there is insufficient flow at the Yeodene gauge as described above, the Authority must be notified within 7 days of this occurrence.

LICENCE CONDITION: Protection of Riparian Vegetation

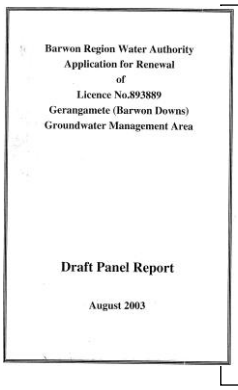
Background

Declining water levels below Boundary Creek due to pumping result in a lowered water table beneath vegetation adjacent to the creek
Whilst it is thought that such lowered groundwater levels are likely to affect the vegetation, the extent to which the vegetation is dependent on continuous high groundwater levels is not known
To determine whether or not the vegetation is dependent on high water tables, it is intended to undertake floral and groundwater level monitoring at Flora Site 25, as well as at another site to be selected on the creek, and compare changes with vegetation at similar control sites away from the influence of pumping
As the determination of dependency is likely to require a period of time similar to the term of this licence, the intention of this condition is to provide sufficient information to be able to implement protection measures, if required, upon licence renewal.

1. Setting Objectives and Prescribing Limits

Objective : To protect vegetation adjacent to Boundary Creek if it is found to be groundwater dependent

- **Draft Panel Reports Tabled** (2003).
  The August 2003 Draft Panel report included the following statement:


Barwon Region Water Authority
Application for Renewal
of
Licence No.893889
Gerangamete (Barwon Downs)
Groundwater Management Area

Draft Panel Report

August 2003

LICENCE CONDITION: Maintenance of Flow in Boundary Creek

Background

Groundwater extraction at the borefield reduces groundwater levels beneath Boundary Creek such that groundwater discharge ceases and the creek stops flowing in summer

Groundwater levels are drawn down quickly during pumping and recover more slowly when pumping ceases

To maintain flow in the creek BW will need to supply water to the creek to compensate for the loss of baseflow up to the point that groundwater levels recover sufficiently

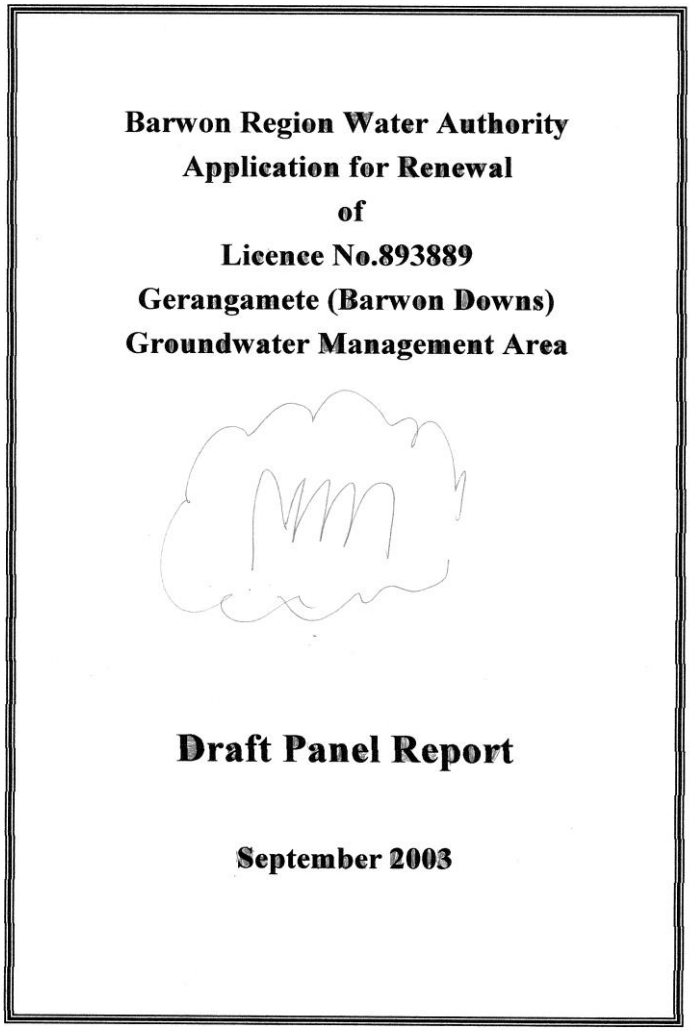
A minimum flow needs to be provided along the creek to Yeodene, for environmental and D&S purposes

To achieve a minimum flow at Yeodene will require a greater input flow in the headwaters of the creek

Stream gauging at Yeodene is undertaken by DSE

The following three inserts have been taken from the September 2003 Draft Panel Report Application for Renewal of Licence No. 893889 at the Barwon Downs Borefield.

Front Cover


Barwon Region Water Authority
Application for Renewal
of
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Gerangamete (Barwon Downs)
Groundwater Management Area

Draft Panel Report

September 2003

7.1.7 Specific Impact Assessment

Consideration has been given to the concerns raised in submissions and through Panel discussion about a number of specific possible impacts of groundwater extraction. The following table presents these concerns and the extent of risk based on investigations and consideration by the Technical Groups.

Concern	Description of Risk	Risk Assessment[1]
Aquifer depletion	Risks include dewatering of the aquifer and irreversible damage to the hydraulic properties of the aquifer	**Low** – modelling and monitoring show the water levels will not fall below top of the aquifer and will recover during non-pumping periods.
Subsidence	Risks include reduction in surface drainage capacity and damage to buildings, roads and other infrastructure	**Low** - The predicted extent of subsidence will not be sufficient to cause drainage problems. The subsidence will be uniformly spread and not expected to damage infrastructure.
Boundary Creek flows	Loss of base flow	**High** – established impact.
Wetland water table decline	Risk to dependent wetland flora and fauna	**Low** – all identified important wetlands are "perched" and not connected with the regional water table.
Riparian vegetation	Risk to vegetation from lowered water table	**Probably Low** – reports show that flora variation responds to climatic variation. Control sites needed to confirm this.
Stock and domestic bore levels	Lowered water table reduces/prevents pumping	**Low** – bores unlikely to be in regional water table. Specific investigations have not revealed any affected bores.
East and West Barwon River – loss of flow	Reduction in groundwater discharge to river and losses from river due to lowered water table.	**Low** – impact on West Barwon River is unlikely because water table is well below river level. Small impact estimated for East Barwon River.
Lateral salinisation of the aquifer	Saline groundwater drawn into the aquifer from beyond the northern limits of the aquifer.	**Low** – because drawdown along the northern margin is small and will enduce low rates of lateral movement.
Vertical salinisation of the aquifer	Vertical seepage of saline groundwater to the aquifer through confining layers	**Very low** – vertical seepage rates are small and any downward seepage is reversed on recovery of the aquifer levels.
Seawater inflow	Inflow from Angelsea area resulting from drawdown below sea level.	**None** – drawdown does not extend to the coast and Otway Ranges are an impermeable barrier along the southern margin.

Note: 1. Based on investigations and Technical Group deliberations.

12

This page 12 of the report states that the ***Technical Group*** found that flow loss to Boundary Creek had been established.

Concern	Submissions and Panel Views	Technical Assessment & Technical Group Advice	Conclusions & Resulting Licence Condition
Aquifer depletion	No submission explicitly addressed this impact. Some submissions suggested that the proposed maximum extraction rate of 20,000 ML/year was too high and should not be greater than 4,000 ML/year. Some Panel members have expressed the view that 4,000 ML/year as a long term average extraction rate is acceptable but that proposed maximum annual pumping rate of 20,000 ML is too high.	Groundwater modelling demonstrates that long term extraction in excess of 4,000 ML/year will not deplete the aquifer. The modelling also demonstrated that proposed short term high pumping rate will not cause aquifer depletion at intended frequency of application. High rate extraction (1997 to 2001) was used in model calibration and increase confidence in results. Panel Hydrogeological Group assessed the groundwater model is the best available technology for assessing aquifer performance. Findings are consistent with earlier investigations in particular the 1995 DNRE investigations. Independent audit confirmed technical adequacy of the modelling.	Long term aquifer depletion not likely at proposed pumping rates. The technical work does not support the concerns expressed in some submissions and by some panel members that the maximum annual pumping rate is too high. The proposed monitoring and review process (Section 7.2.2) can address the concerns about annual pumping rate.
Subsidence	One submission specifically concerned with subsidence. Not identified as an impact but concern expressed by some Panel members that it could be for proposed higher maximum annual pumping rate.	Monitoring shows subsidence during recent high rate pumping is within acceptable levels. Subsidence modelling integrated with flow modelling, shows that subsidence is recoverable and unlikely to result in damage to infrastructure or cause unacceptable drainage problems.	Long term subsidence at proposed pumping rates will not exceed acceptable levels or result in irreversible subsidence. The proposed monitoring and review process (Section 7.2.2) can address the concerns about subsidence.
Boundary Creek flows	Pumping is known to reduce flow in Boundary Creek. Submissions did not raise this issue. Panel members sought assurances that adequate provision is made to compensate for loss of flow in creek.	Observed impact on Boundary Creek confirmed by technical (flow) studies. Panel Hydrogeological Group formulated rules for supplementary flow.	Impact of pumping on Boundary Creek flows confirmed. Arrangements for providing compensating supplementary flow determined by the Panel. Licence conditions specify rules for initiation and stopping of supplementary flow
Wetland water table decline	Potential impact of extraction on wetlands in general raised in two submissions.	Environmental and Hydrogeological Group reviewed known wetlands which were assessed as "perched" and therefore unlikely to be affected by pumping	Groundwater monitoring would confirm this assessment. Technical Groups did not consider licence condition was needed for this concern.

The Big Swamp was not identified as one of these "*known wetlands*."

15

The confirmation of this flow reduction in Boundary Creek had taken place after extractions over a 20 year period, 1982-2003, of approximately 70 000 ML. Between 2003 and 2010 the extraction had risen to well over 120 000 ML. The stress placed on the aquifer system since 2003 has been dramatic.

- **Victorian Government Special Gazette Number S 107**(2003)**.**

  The year before Southern Rural Water granted the 2004 Stage Two licence to extract 20 000 ML/year from the Barwon Downs borefield, the Victorian Government published the Victorian Government Gazette Number S 107[60] and included these items to be addressed when dealing with waters of Victoria:

  - ***The principle of integration of economic, social and environmental considerations.***
    - *Sound environmental practices and procedures should be adopted*
    - *Effective integration of economic, social and environmental considerations in decision-making processes with the need to improve community well-being and the benefit of future generations.*
  - ***The precautionary principle.***

    - *If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*
    - *Decision making should be guided by a careful evaluation to avoid serious or irreversible damage to the environment wherever practicable.*
- ***The principle of intergenerational equity.***
    - *The present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.*
- ***The principle of conservation of biological diversity and ecological integrity.***
    - *The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision making.*
- ***The principle of shared responsibility.***
    - *Protection of the environment is a responsibility shared by all levels of government and industry, business, communities and the people of Victoria.*
- ***The principle of enforcement.***
    - *Environmental requirements should be enforced.*
- ***Principle of accountability.***
    - *Access to reliable and relevant information in appropriate forms to facilitate a good understanding of environmental issues.*
    - *The opportunities to participate in policy and program development.*
- ***There should be no increased water allocation approved unless it is subject to a process which is designed to provide environmental flows.***
- *Groundwater managers need to ensure that their activities do not pose an environmental risk to surface water beneficial uses, particularly through the excessive extraction of water and the subsequent prevention of surface water environmental flows, and through reducing the quality of adjoining surface waters.*
- *Water managers must ensure that groundwater quality does not impact on the beneficial uses of surface waters and vice versa.*
- *Persons who generate pollution and waste should bear the cost of containment, avoidance and abatement.*

Implementing these principles and intentions outlined in Government Gazette S 107, would have ensured sustainable groundwater extraction management practices in the true sense of sustainability. Unfortunately, it would appear that the decisions makers granting the Stage Two licence were ignorant of this Gazette and its rulings. Determining and allocating environmental flows to streams should have been done as a matter of course even if there was not a Government ruling saying this should be done.

2004.

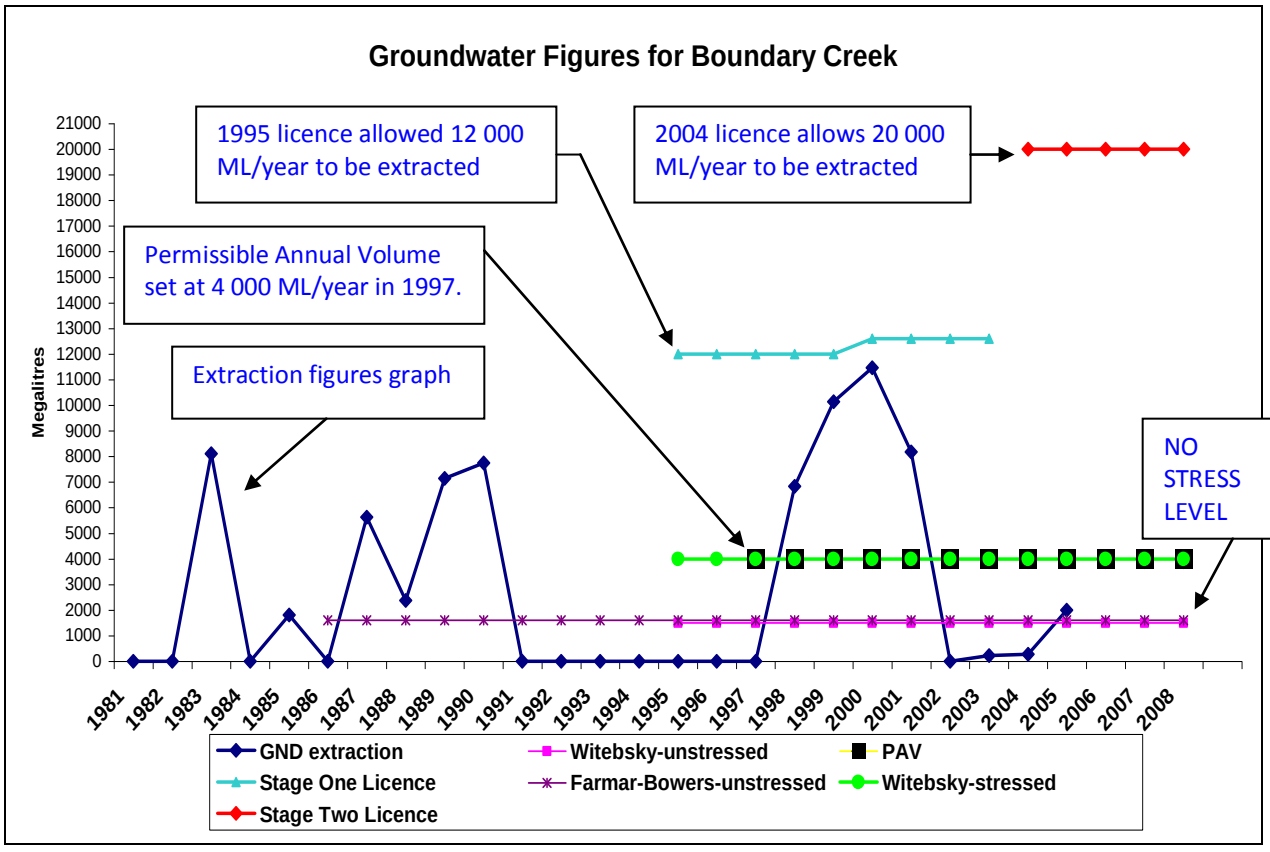
- **PAV changed to PCV.**

  Pre the granting of the 2004 licence to extract 20 000 ML/year from the Barwon Downs Borefield the State Government changed the term Permissible Annual Volume (PAV) to a Permissible Consumptive Volume (PCV). This amendment to the

Water Bill took the emphasis away from an environmentally sensitive ***yearly*** extraction rate to an extraction rate that can be averaged out over a given number of years. This allows the yearly extraction to be significantly higher than the yearly environmentally sustainable level(PAV). Paradoxically the 100 year extraction limit under the PCV is 400 000 ML and when averaged out it comes to 4 000 ML/year.

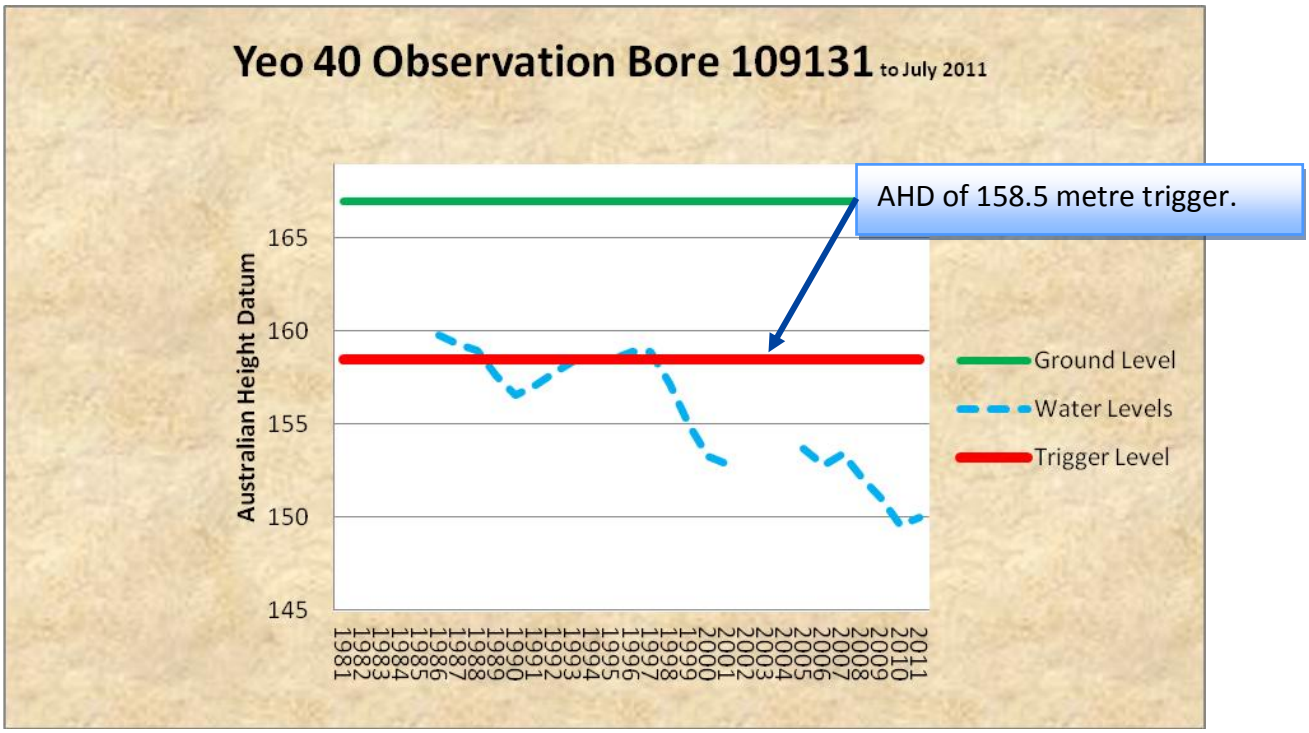
- **A 20 000 ML/year Licence Issued – Stage Two**(2004)**.**
  Barwon Water was issued with a licence for 15 years allowing 50 ML/day to be pumped; with a maximum of 20 000 ML/year; a maximum of 80 000 ML in any ten year period and no more than 400 000 ML over 100 years.

  The red line on this graph shows the 2004 allowable extraction rate; the green line the Permissible Annual Volume set in 1997 and the no stress pink line of 1500 ML/year. The dark blue line indicates the extraction amounts. Considering the impacts experienced from these amounts it is frightening to contemplate the impacts if the full 20 000 ML/year were extracted.



- **Yeo 40 Observation Bore Designated as A Trigger Bore for Maintenance of Flows in Boundary Creek**(2004)**.**
  Yeo 40, Observation Bore 109131 (see point H page 4) was chosen as the trigger level bore for the maintenance of flows in Boundary Creek.

Bore 109112 (see point I page 4) near the Colac to Forrest Road Bridge over Boundary Creek would have been more convenient except that it was artesian pre pumping, squirting around 18 metres into the air(see graph page 88).



Source: Vic Water Data & Barwon Water Gerangamete Groundwater Management Area Reports to Southern Rural Water re: Licence 893889.

Yeo 40, high on a hill above Boundary Creek, has never been an artesian bore. Its natural ground surface level was at approximately 167.34 metres above sea level. Because the water table level was at approximately 160 metres the water in Yeo 40 was initially around 7.34 metres below ground level.

Farmar-Bowers[25] in 1986 had these things to say in his report...

- *"Currently water tables appear to be quite stable and there is little movement between seasons or years. (J. Leonard Pers. Com.)."*
  The graph above clearly indicates that this is no longer the case.
- *"Map 2*(this map is one referred to in the Farmar-Bowers report) *gives information on groundwater levels in the area adjacent to the middle reaches of Boundary Creek. The levels are taken from current (1986) readings of D.I.T.R. bores. They indicate that groundwater adjacent to the creek is artesian*."

Comparing the work of Farmar-Bowers with the water table graph of Yeo 40 above it should have been most obvious to the decision makers looking at the Stage Two licence that the 158.5 metres trigger level was regularly being breeched and that Boundary Creek and its adjoining wetlands were in desperate trouble.

2005.

Groundwater Almost Fully Allocated.

In Our Water Our Future[61] it states that groundwater in Victoria is almost fully allocated and that groundwater is an important water resource for agricultural and rural stock and domestic supplies. This document also states that, "***In addition groundwater provides an excellent drought reserve (for example in Geelong) where use above the average sustainable volumes can be allowed provided there is no significant environmental impacts and the resource is allowed to recover in subsequent years.***"

When this document was tabled in April 2006 Boundary Creek had been dry on 530 days, acidic waters created in the Big Swamp were leaching out heavy metals from the soil and the oxidising peat was releasing previously locked up carbon, into the atmosphere. These were easily recognisable "*environmental impacts*," not to mention the long term visually obvious devastation caused from the 1998 fire(see page 73).

2006.

- ## Groundwater Extraction re-commenced.

  Petrides et al.[49] wrote that the age of the water, more than 20 000 years old, being pumped from the Barwon Downs Borefield indicates that the recharge rates may be low and that the resource could easily be over-exploited.

  In August of this year Barwon Water's Annual Update states that pumping had recommenced in April because reservoir levels had recovered. As the West Barwon Reservoir had not recovered it was assumed that this reference was in regard to the aquifer levels. However, if the flows in Boundary Creek were used as a reference point indicating recovery then the Charts on pages 87, 88 tends to contradict this notion. Boundary Creek was still experiencing many days of no flow. If aquifer water levels had recovered then Boundary Creek should have been experiencing an average daily groundwater flow of 3.2 ML.

Extracted groundwater being delivered to the holding ponds at the Barwon Downs Borefield.

- **More Peat on Fire**(2006)**.**

  On 19 September **2006** and within 800 metres upstream of the original fires in the Big Swamp, the peat in another swamp was ablaze. The Colac Herald in an article on the 20 November 2006, stated it took 22 days to extinguish. Once the fire was under control thermal imaging couldn't detect any smouldering activity but no guarantee could be given that the fire in the peat was finally out. To reduce the likelihood of reoccurrence the Country Fire Authority successfully argued that a mineral earth policy be adopted. This involved extensive clearing and removal of vegetation in the 2006 peat fire area.

  Local farmer, Michael McDonald, owner of the land where the 2006 peat fire took place, was completely taken by surprise that this area could burn. He had unsuccessfully attempted to drain this area pre the test pump groundwater extraction period. Attempts were made several times including during the 1967 drought. His equipment was unable to do the drainage work because of continually becoming bogged. Eventually taking heed of family history and through his own experiences, Michael had come to accept the fact that this area of his farm could never be farmed, or so he thought (pers. com).

  When the 2002 Flora study[10] was conducted a survey site (Number 25) located in this vicinity was noted as having significant reduction in waterlogged area.

- **Environmental Flows recommended for Boundary Creek**(2006)**.**

  The Corangamite Catchment Management Authority (CCMA) commissioned Lloyd Environmental, Fluvial Systems and Ecologiclal Associates to prepare the following report, February 2006.[13]

  "**Environmental Flow Recommendations for the Barwon River: Final Report – Flow Recommendations**."

  The section dealing with Boundary Creek is most disturbing and the following discussion concentrates on the Boundary Creek research section of this document. An objective of the CCMA report includes the development of Environmental Flow Objectives. Farmar-Bowers recommended that this be done in 1986.

  The objectives of this study were reported to have taken into account current social, econmic and environmental values of the river. It was designed to cover the research and classification of flows, to predict the frequency, duration and seasonality of each flow band required to sustain the ecosystems along the various streams dealt with. The report compiled by the ***Environmental Flows Technical Panel***, involved literature review, field assessments, consultations with agencies and community members, topographic surveys of each site, hydraulic modelling and a scientific panel workshop to make environmental flow recommendations. Having read these ascertions the reader would have every confidence that a thorough study had been undertaken. However, on closer examination this is not the case.

  1. On page 22 the report mentions that the cessation of flows in Boundary Creek during summer and autumn are "***natural characteristics***." It goes on to state that ***if*** the reach studied along Boundary Creek flowed ***all year*** and ***did not stop*** flowing it would cause changes in vegetation assemblages and may degrade

habitiat for platypus, larger fish species, such as Blackfish, and macroinvertebrates.

Comment: *Considering that all balckfish, larger fish species and platypus had already been decimated these assertions are pure nonsense*.

2. Table 18 states that Boundary Creek has a summer flow of 1 ML/day or more, 40% of the time, which is stated as about natural frequency. Page 64 states that the recommendations provided in this CCMA report are based on long-term statistics.

Comment: *Unfortunately it would appear that long-tern statistics only go back as far as 1984, if that far. Boundary Creek never stopped flowing prior to this period.*

3. The conclusions section states that the flow recommendations for the tributaries of the Barwon River are largely met by the current flow.

Comment: *For Boundary Creek this cannot be substantiated.*

4. It also states that recommendations are based on the long-term statistics that are described as an "*average year*."

Comment: *How an "average year" is determined has not been stated and considering the material presented in this book, it appears that serious miscalculations have been made.*

5. The report states that Boundary Creek has a summer flow of more than 1 ML/day 40% of the time.

Comment: *This may have been the case since serious groundwater extraction has taken place but it is most definitely not true for the decades pre-pumping. The low flow periods occurr at or following groundwater extraction times and it is beyond any doubt that the 40% is not based on "**long-term statistics**." The average daily summer flow used to be 3.2 ML.*

6. The natural characteristics for Boundary Creek is that it stops flowing at regular periods during the summer.

Comment: *The finding that it is a natural characteristic for Boundary Creek to cease flowing is most definitely not correct. To recommend periods of **NO FLOW** to potect vegetaion and life forms in the creek is nonsense and beyond belief.*

How the CCMA literature review, the consultants, the historical statistic analysis and the ***Enviornmental Flows Technical Pane***l missed the following historical data is puzzling to say the least.

1. An 2002 SKM[55] report dealing with impacts on Boundary Creek had these things to say:

a. ... there is a direct hydraulic connection between the aquifer and Boundary Creek.
b. ... generally the baseflow from the aquifer represents a relativley **stable** and **constant** streamflow component.
c. "***It has been noted that during periods of significant pumping from the aquifer, the flow in Boundary Creek is reduced and in some instances it has ceased flowing altogether***."

2. Witebsky et al.[63] reported in 1995 that the average daily summer flow pre-pumping was 3.2 ML.

3. In 2002 SKM[54] calculated the baseflow from the aquifer into Boundary Creek to be approximately 2 ML/day.

4. Acid levels increasing since the mid 1990s making it difficult for anything to survive in Boundary Creek (see page 78).

5. Local knowledge ignored.

If local knolwdge had actually been asked for, collected and recorded as the introduction to this study lead the reader to believe, many of the mistakes made recommending environmental flows for Boundary Creek could have been avoided. To make the recommendation for an environmental flow for Boundary Creek to include **two fortnightly periods of NO FLOW** is astoudning to say the least.

6. Landholder, Nellie Shalley, with the longest history and who is most affected by cessation of flows in Boundary Creek is the person who gave permission to enter her property to study the reach of Boundary Creek (pers. com). There is no evidence that points to Nellie having been interviewed with the specific task of gaining an insight into her long standing knowledge of the area. Naming Nellie as a member of a Community Advisory Committee gives the impression that Nellie was part of a thorough data collecting process. This was not the case (pers. com.).

By ingoring historical facts, failing to do a thorough literature review and not adequately involving the community, a skewed and incorrect benchmark has been calculated for numerous aspects of Boundary Creek. Rigorous scientific disciplines appear to have been ignored. This report is laugable and the section on Boundary Creek is most definitely not a credible piece of research.

2006 cont.

In a paper in the Hydorgeology Journal[49] Petrides and Cartwright state this.

"***Pumping from the borefield has lowered the water table on Barongarook High and reduced baseflow to these streams. If enough stress is placed on the system, the water table will fall below the elevation of the creek and the entire area of outcropping aquifer will provide recharge to the Barwon Downs Graben aquifer.***"

State of Victoria – Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, Petronella Cornelia Shalley
[full name]

of "Sunny Side" Yeodene Lot 45 Parish of Yeo. 125 Shalleys Road, Yeodene, Victoria 3249
[address]

Farmer
[occupation], do solemnly and sincerely declare that:-

I have lived at the above address for 44 years. This property abounds both sides of Boundary Creek and on the north west boundary of the West Branch of the Barwon River. My late husband's family have owned this property since 1912. Frank, my husband, and I wrote to Mr. Whiteside of the Geelong Water Trust on the 29th of January 1990 and informed him that Boundary Creek continued to flow through the 1914 drought and the 1967-1968 drought even when the West Barwon River became dry and dusty. The West Barwon forms our south eastern boundary. Boundary Creek was the salvation of our property through these droughts. Our family has relied on this permanent water for three generations.

We had relied on the continuos flow in Boundary Creek all the time that I have been on this property up until the year after Barwon Water pumped water from the ground at Gerangamete during the 1982-1983 drought. On the 19th of February 1991 we wrote to Mr K Maxwell of the Rural Water Commission in Camperdown because we were gaining no satisfaction from the Geelong and District Water Board. We stated that since water was being pumped from the Gerangamete wells in 1988 Boundary Creek ceased to flow in the summer of 1989-1990 and was bone dry by the 10th of January 1990.

This has happened numerous times since. After many discussions and hours spent Barwon Water agreed to release supplementary water using discharge from the Colac pipeline. A trial was conducted in 1999 but repairs had to be done to the Colac pipeline late in 1999. A meeting with Barwon Water and Sinclair Knight Merz with results that showed groundwater pumping affects Boundary Creek. Water was again released from the Colac pipeline in May 2002 but was very slow to reach our home farm.

In February 2003 water was trucked in because Barwon Water could not release the water from the Colac pipeline because I was told it was affecting the Colac supply. This scenario of trucking water in went on until 2006. Barwon Water has been now releasing 2 ML a day as per the requirement of their Licence Number 893889. However, the water doesn't reach the lower parts of Boundary Creek until it rains so the released water is of no value to our farm, to the creek and its environment, nor can we rely on Boundary Creek as a water supply.

Before Boundary Creek ran dry during 1984 there were colonies of platypus along our stretch of the creek. There were many blackfish, trout, red fin and brown trout. None of these animals have been able to live in a dry creek bed and disappeared soon after Boundary Creek dried up.

After rains and when the creek begins to flow again I am unable to use the water for stock from the creek until 4-5 inches of rain has flushed away the unpalatable water.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Forrest

in the State of Victoria, this 19TH day of September 2009

P O Shalley
Signature of person making this declaration
[to be signed in front of an authorised witness]

Before me,

Signature of authorised witness

DR. R. SARKIS
Grant & Henry Street,
Forrest Vic. 3236
Ph. 052-366 355
Prov. No. 0108014 H

2006 cont.

- **Regional Groundwater Decline.**

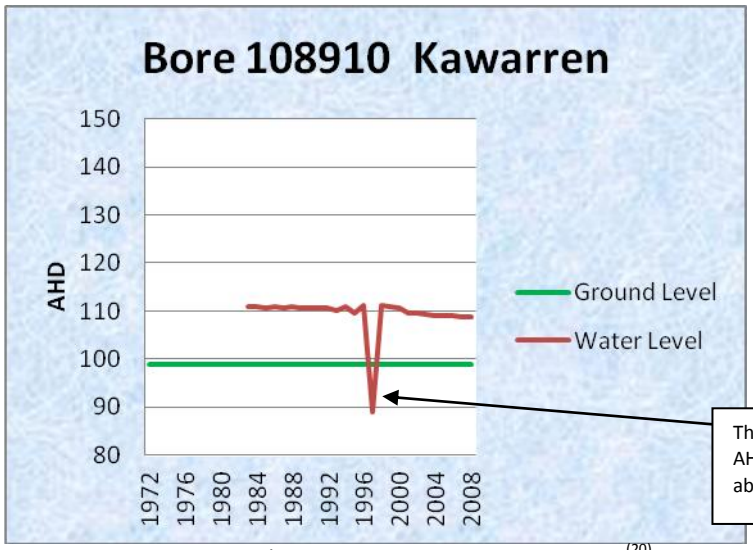
  In December 2006 the Department of Sustainability & Environment (DSE) tabled a report "Regional Groundwater Monitoring Network Review for the Deep Water Aquifer System in South West Victoria."[19] This report states that the groundwater is declining generally at rates less than 10 centimetres a year. This report goes on to say that at the current rate of decline watertables will drop in the order of one metre in ten years. This was taking into account climate change and present groundwater extraction in the South West. However, this study did not included the Barwon Downs borefield area of influence.

  Kawarren Borefield Area with no groundwater extraction.

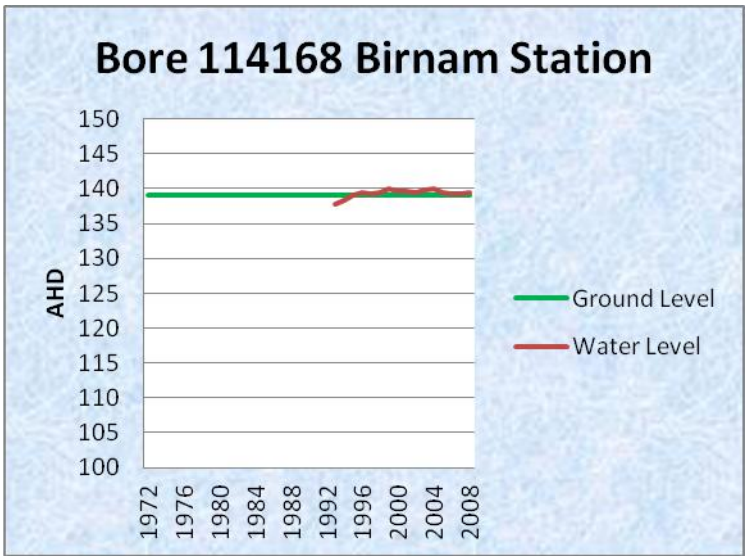
  The Birnam Station and Kawarren artesian observation bores on the Ten Mile Creek and Loves Creek verges and supposedly outside the area of drawdown from the Barwon Downs Borefield, have remained relatively stable and around the same levels throughout this period.

  Bore 109810 and Bore 114168 in the Kawarren/Gellibrand area, are artesian. There is a distinct difference between the water table graphs of these bores, where there has been negligible groundwater extraction, to the ones in the Barwon Downs area where there has been significant groundwater extraction. From this limited data it would appear most obvious that groundwater extraction in the Barwon Downs area is having a significant impact. At the very least this comparison requires further investigation. It must also be noted that these two Kawarren bores have shown little effect from the worst drought on record.

Bore 108910 at Kawarren



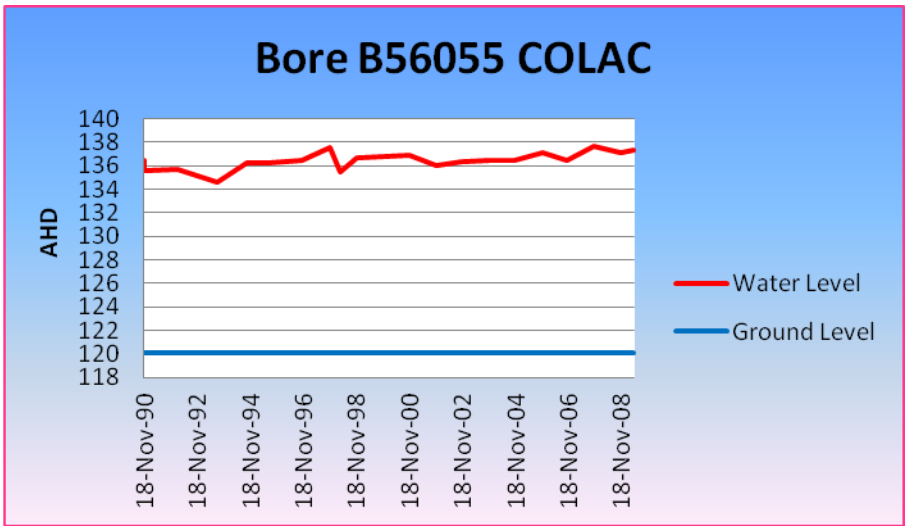
This bore is in the Kawarren/Gellibrand aquifer area. Source: DSE[20]



This bore is in the Kawarren/Gellibrand aquifer area. Source: DSE[20].

The locations of these two bores are marked on the map on page 101.

Colac Artesian Observation Bore.



Source: www.vicwaterdata.net

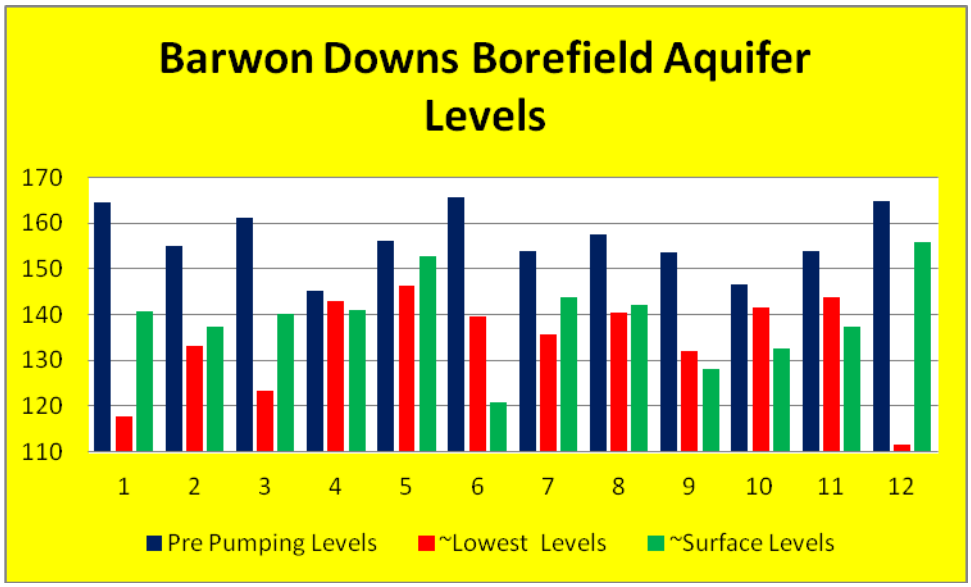
This Artesian Observation Bore in Colac shows no signs of decline.

Barwon Downs Borefield Observation Bores with Extensive Groundwater Extraction.

In contrast the bores in the Barwon Downs Borefield area of influence show a significantly marked watertable drop. In some observation bores the drop has been over 50 metres (see pages 52, 64, 66 & 88).

As part of the 2004 licence granted to Barwon Water for the extraction of groundwater from the Barwon Downs Borefield, Barwon Water had to monitor and report on 56 observation and extraction bores. In May/June 2008 (sender receipts CV9201839 & CV9120201), Barwon Water was asked to provide the drawdown data on the artesian observation bores that Barwon Water was monitoring(see page 5). Due to discrepancies between data bases the following graph is representative only and is a combination of the Barwon Water data and that found on the Vicwaterdata web

site. Bores numbered 4, 6, 9, 10 and 11 are still artesian though significantly lower when compared to those observation bores in the adjoining catchments.

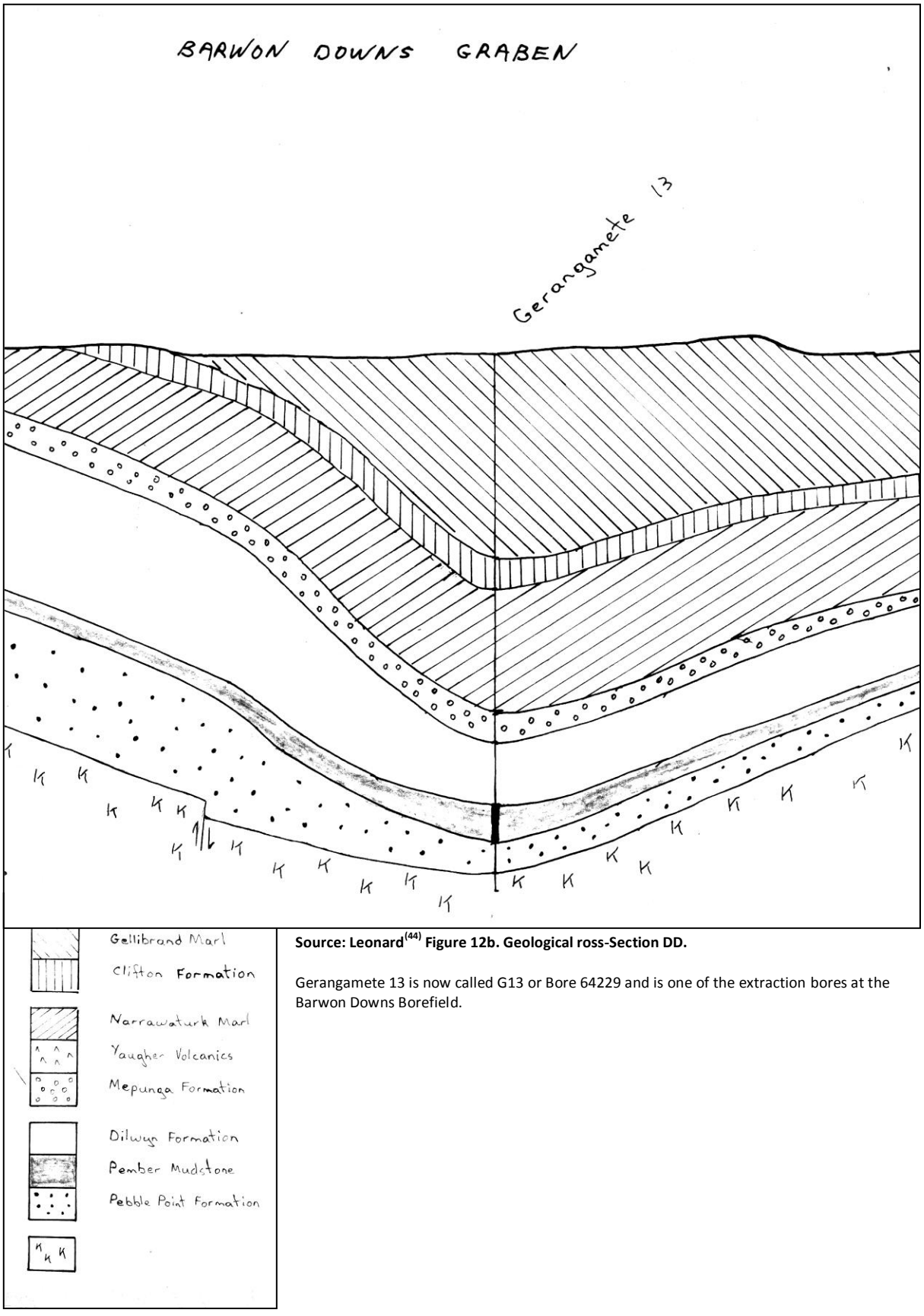


Data Source: Barwon Water (2008) and Vicwaterdata website (2012).

Bore Number	BarwonWater ID	Vicwater ID	Formation	Commissioned	Still Monitored
1	G 13	B 64229	Dilwyn	1973	yes
2	Yeo 21	B 109112	Mepunga	1984	yes
3	G 14	B 64230	Dilwyn	1979	yes
4	G 18	B 64234	Clifton	1983	yes
5	M 26	B 82842	Dilwyn	1985	yes
6	W 7	B 102868	Dilwyn	1984	yes
7	W 9	B 102869	Mepunga	1986	yes
8	M 27	B 82843	Mepunga	1986	yes
9	M 28	B 82844	Mepunga	1985	yes
10	YYG 221	B 107720	Dilwyn	1988	yes
11	W 6	B 102867	Dilwyn	1974	no
12	M 24	B 82840		1973	yes

Data Source: Barwon Water (2008) and Vicwaterdata website (2012). A detailed graph of Bore 2 (Yeo 21/Bore 109112) can be see on page 88.

Even if the 2006 DSE report[19] on regional groundwater decline is wrong by a factor of 10, the Barwon Downs Borefield aquifer levels graph (above)indicates that groundwater extraction in the Barwon Downs area significantly differs to the trend in the rest of South Western Victoria.



Source: Leonard[44] Figure 12b. Geological ross-Section DD.

Gerangamete 13 is now called G13 or Bore 64229 and is one of the extraction bores at the Barwon Downs Borefield.

2007.

- ## Evans's Response Ratio.

In 2007 Evans[22] reported in his Land & Water Senior Research Fellowship Report that one way to understand the relationship between groundwater and surface water is to calculate the response ratio. Evans worked this out to be a factor of 0.3. If Witebsky's unstressed 1500 ML/year extraction was pumped from the ground each year for ten years the following response would take place.

> **1500 ML** divided by 365 days and multiplied by 0.3 would see after ten years, a daily decrease in stream flow from groundwater extraction by 1.2 ML. Boundary Creek had an annual summer flow pre-pumping of 3.2 ML/day. At an extraction rate of 1500 ML/year Boundary Creek would have been unstressed just as Witebsky determined.
>
> **If Farmar-Bowers[25] 1600 ML** figure or **Leonard's[44] 1800 ML** figure were correct and used in this calculation, Boundary Creek would still flow during dry summer months.
>
> **However**, using the 4000 ML/year extraction rate, divided by 365 and multiplied by 0.3 would see a reduction in the daily stream flow by 3.28 ML/day after ten years which is 80 000 litres more than the 3.2 ML calculated by Witebsky as the daily discharge.

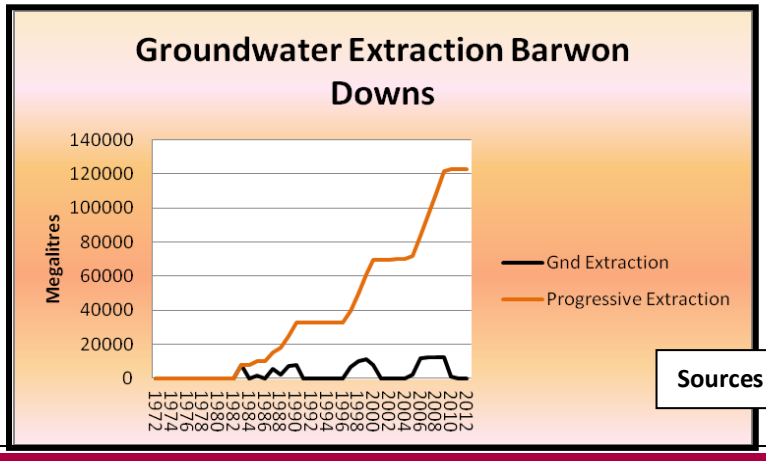
Comparing the findings of Evans with Witebsky's recommendations (see pages 25 -27, 51) it would appear to indicate that a 12000 ML/year licence to extract groundwater at Barwon Downs, issued in 1995, was to shift from extraction and sustainability to exploitation with the expectations of impending disaster. With all the indicators pointing to the fact that disasters had taken place, renewing the licence in 2004 allowing 20 000 ML/year to be extracted was madness.

If there is any substance and applicability of the work carried out by Rassam[50] then the daily reduction in stream flow of Boundary Creek would exceed the actual daily summer flow by over double (see page 100).

- ## By June Boundary Creek Dry 714 Days(2007).

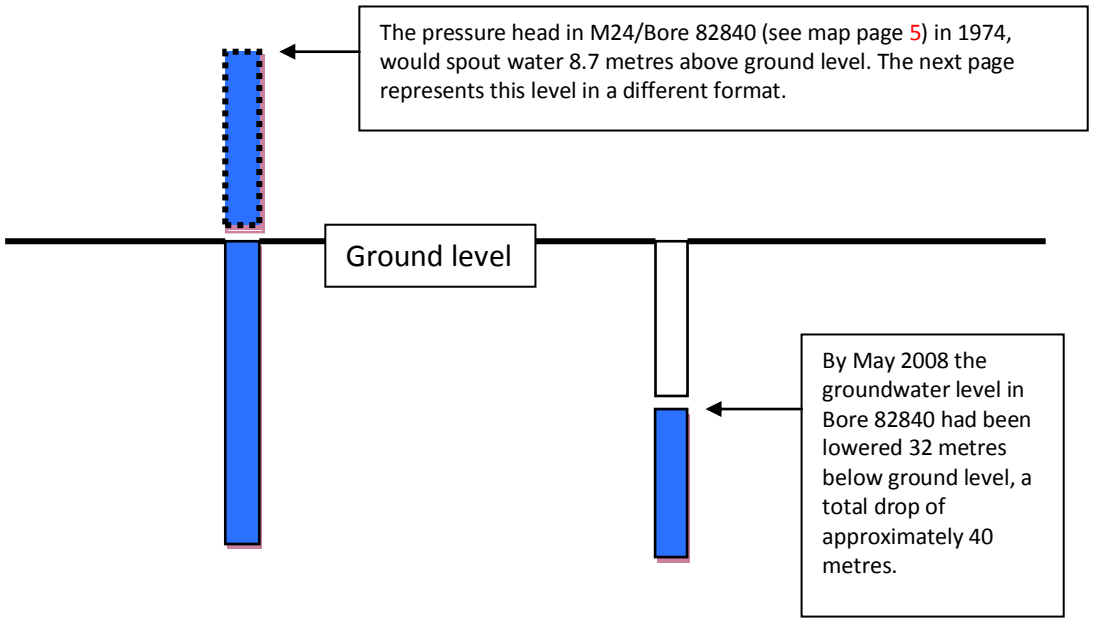
As the groundwater pumping progressed so do the days of no flow in Boundary Creek increase (see page 87). Creeks in the Loves Creek Catchment and tributaries of the Barongarook Creek continued to flow.

Until the drought of 1982-83 when Barwon Water extracted huge amounts of groundwater from the Barwon Downs borefield, the groundwater resources from this aquifer were relatively untouched.



By the end of the 2006-07 reporting period approximately 83 000 ML had been extracted. Drawdown influence was being experienced throughout the Barwon Downs district.

In simplistic terms the following sketch gives some indication of the extent that this extraction has had on the drawdown of the water table in the deep water aquifer.



In the same way the drawdown graphs for Yeo 40 (see page 52) and Bore 109112 (see page 88) clearly show the same influence.

When Bore 82840 was first drilled into the aquifer this was the height of the water spurting out of the ground, 8.7 metres above ground level. This is the same aquifer that Barwon Water extracts groundwater from. As at November 2007 this extraction had lowered the water table point at least 40 metres lower.

0.9 metres.

Bore Number M24/82840 along Wire Lane (see map page 5).

A similar drawdown in the water table is apparent throughout the area as a result of groundwater extraction at Barwon Downs. At the point of extraction the drawdown has been in the order of 50 metres.

Declaration Re: Artesian Bore M24/B82840 along Wire Lane

M J Freshwater
519 St Michael St
Deniliquin NSW 2710

June 11, 2008

To whom it may concern:

From the early 1970s until 1988 our family owned and operated a property on the corner of Wire Lane and Barwon Downs Road at Murroon, Victoria. Observation bores were drilled in the early 1970s on Wire Lane, adjacent to that property.

When bore 82839 and bore 82840 were drilled they were observed by me to be artesian with streams of free flowing water. These bores were capped and fitted with gate valves. For many years (until the gate valves were locked in the mid 1980s) opening the gate valves resulted in water escaping under considerable pressure, with no obvious loss of pressure over time.

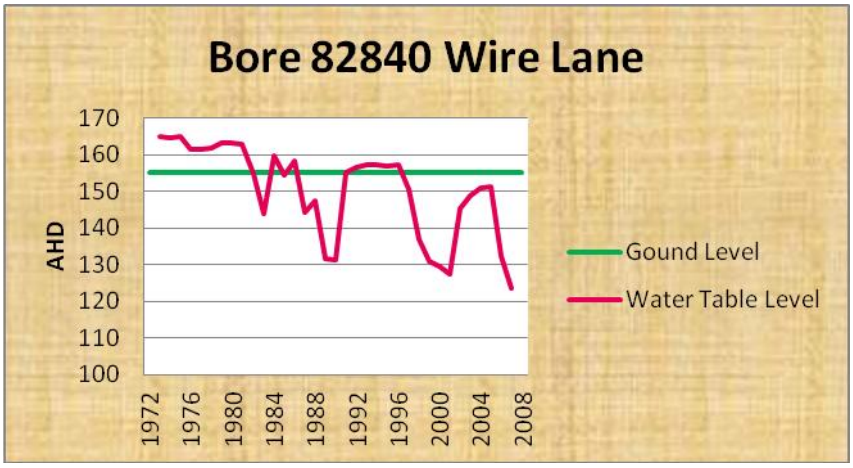
It is still my belief that these bores remained artesian in nature at least until I left the district in 1989.

Yours sincerely,

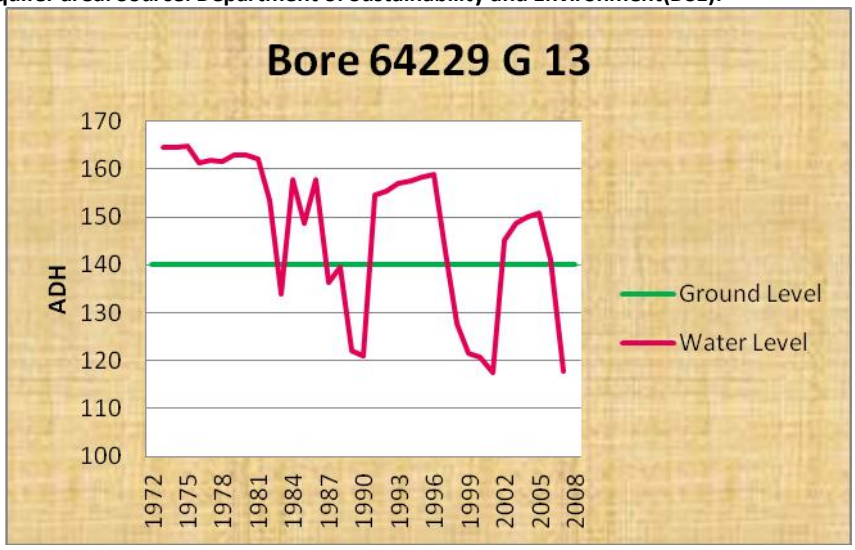
Murray James Freshwater

Witnessed by: J.P. 12/6/08

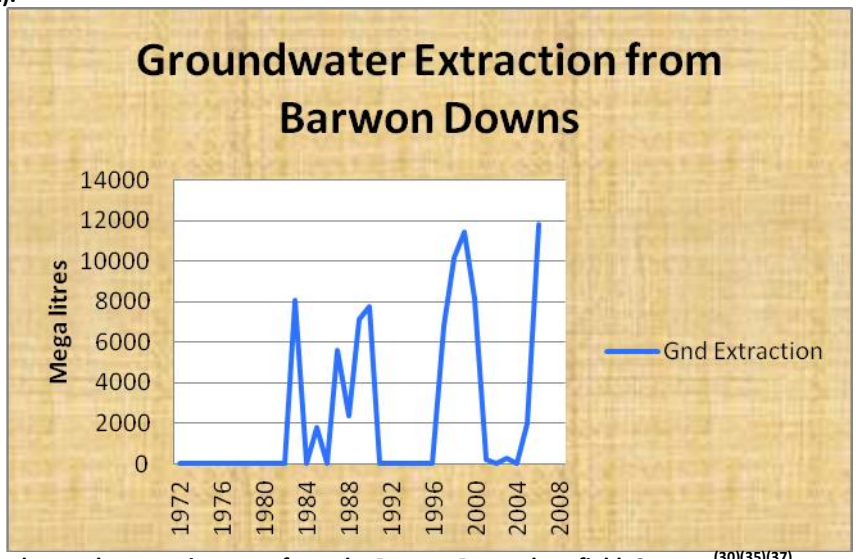
Kathy M Henderson JP 137876



This Wire Lane bore is approximately 4 km from the extraction bores at the Barwon Downs borefield. This bore is in the Barwon Downs aquifer area. Source: Department of Sustainability and Environment(DSE). [20]



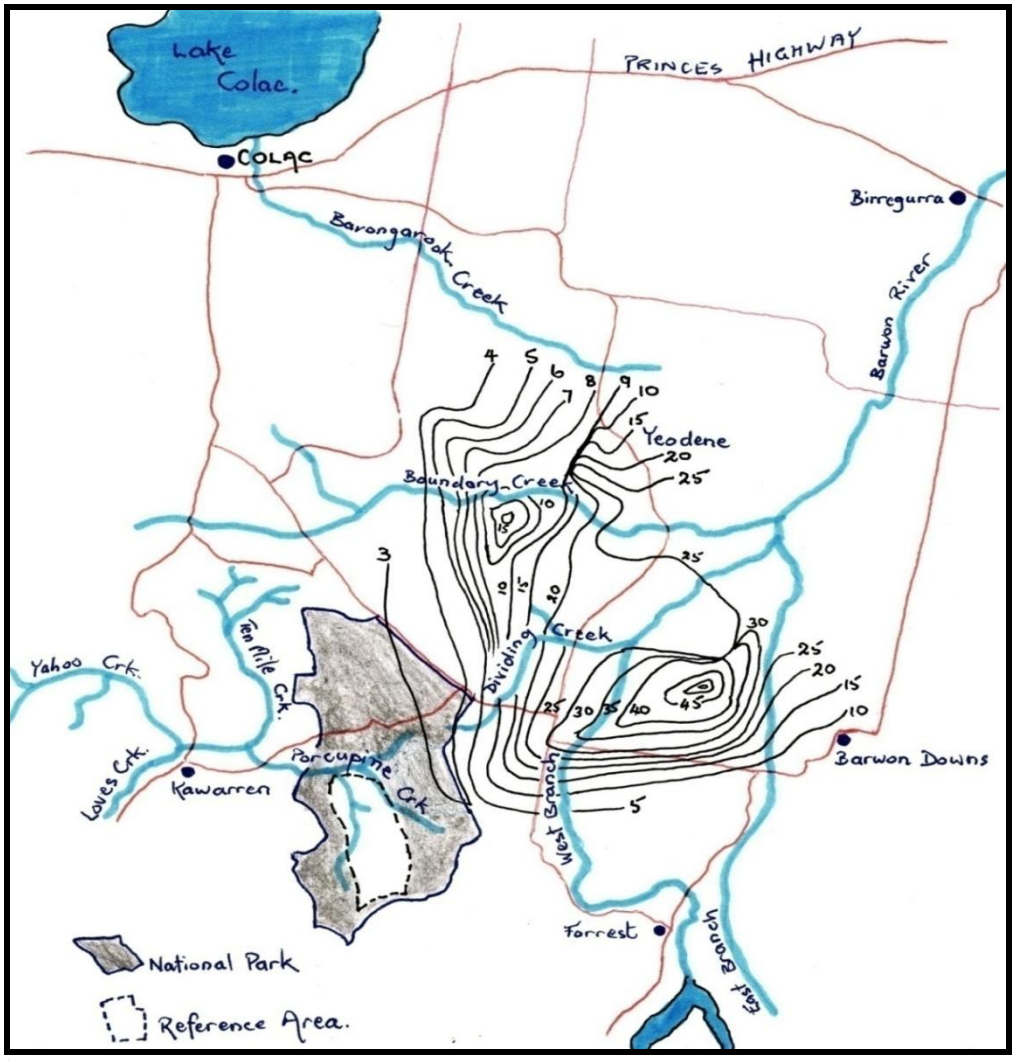
G 13 is at the extraction point at the Barwon Downs Borefield.. Source: Department of Sustainability and Environment(DSE). [20]



This graph depicts the yearly extraction rates from the Barwon Downs borefield. Source: [30][35][37].

The drawdown graphs in red, closely follow the inverse to the extraction rates from the Barwon Downs borefield as seen in blue. As the extraction of groundwater increases the lower the water table drops.
When groundwater is extracted from the deep water aquifer the pressure head is lowered and the dynamics of the earth's crust of sedimentary layers and crystalline rock that floats on the Moho begin to undergo subtle changes. The greater the amount of deep aquifer water that is extracted the more the dynamics in the crust are altered. Taking out sizeable amounts of groundwater makes the symptoms of these changes blatantly apparent. They are no longer subtle. The crust above the depleted aquifer begins to dry as the water from the saturated sediments begin to leak downwards. As these sediments dry out they begin to shrink and crack. Impacts such as creeks, wetlands and springs drying up; increased peat wild fire; fire intensity; vegetation changes and creek bank subsidence start to become apparent.
In times of drought this situation is further compounded with the lack of rain water percolating down from precipitation.

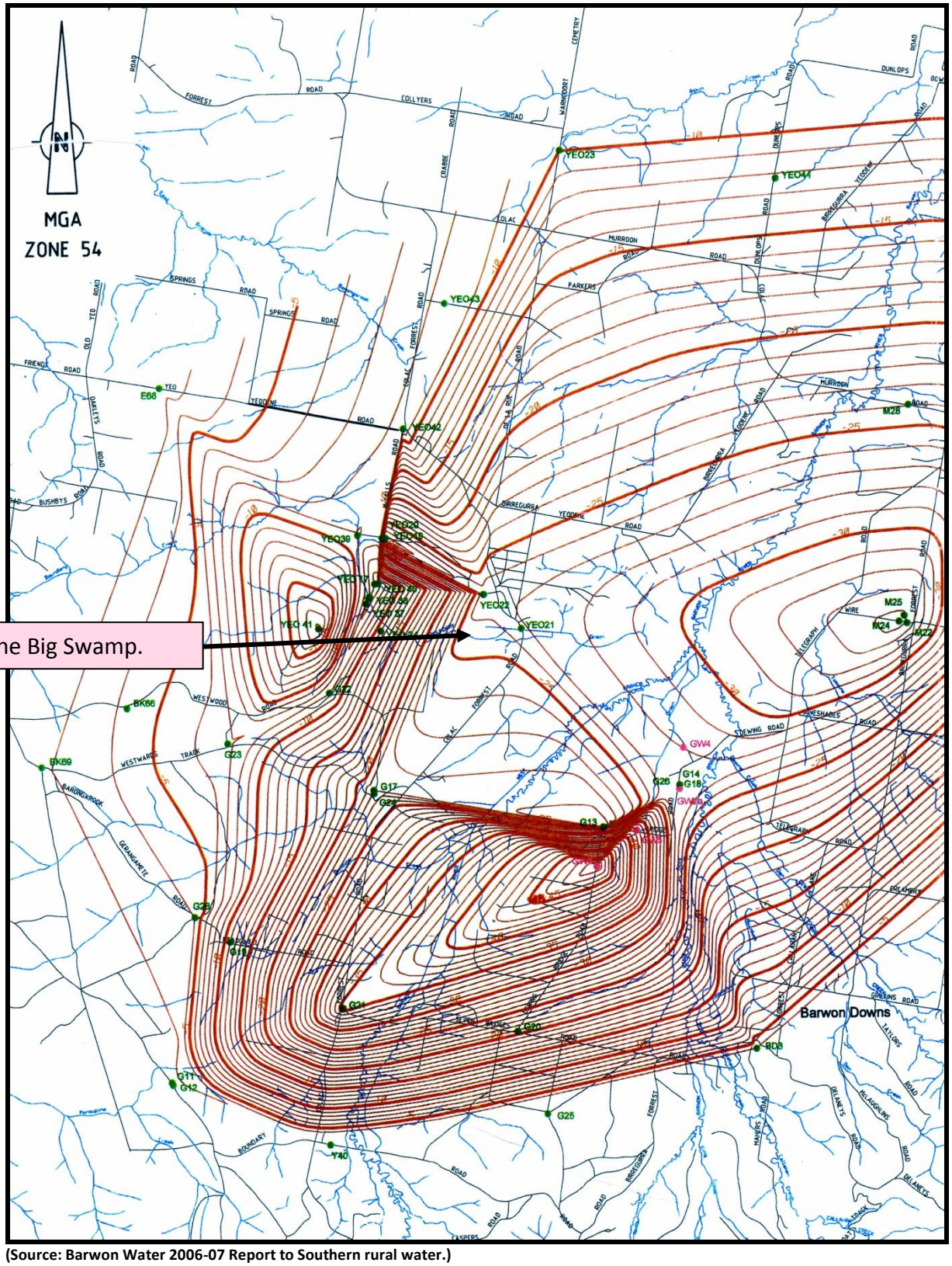
June 2007. Groundwater Drawdown.



(The drawdown contours on this map have been superimposed from the contours from the map found on page 68.)

Between 2005 and June 2007 groundwater extraction has been approximately 14 000ML.

These groundwater drawdown figures are the only ones Barwon Water will release as the officers of Barwon Water relate they are the only ones that have to be supplied under the 2004 “licence requirements.”



(Source: Barwon Water 2006-07 Report to Southern rural water.)

July 2007. Statement of Obligations.

On 1 July 2007 the Victorian State Government Gazetted the latest Statement Of Obligations – Barwon Region Water Authority. It is an interesting 13 page document. Some extracts from it are relevant:

Page 8 Point 24 Sustainable Management.

24.1 The Authority must:

(a) in performing its functions, exercising its powers and carrying out its duties, apply the Sustainable Management Principles: and

(b) demonstrate in its Water Plan how the Authority proposes to apply these principles.

24.2 In applying the Sustainable Management Principles the Authority must develop and implement programs for assessing, monitoring and continuously improving the Authority's sustainability performance, including:

(a) responding to climate change;

(b) maintaining and restoring natural assets;

(c) using resources more efficiently; and

(d) managing everyday environmental impacts, and

Must include those programs in its Water Plan.

Page 9, Part 6 – Environmental Management.

28 River and Aquifer Health.

28.1 The Authority must manage the impact of its activities on any waterway, aquifer or wetland to minimise environmental impacts on and risks to the aquatic ecosystem.

SCHEDULE A. Page 12-13 Definitions.

"Sustainable Management Principles" are:

- the need to ensure that water resources are conserved and properly managed for sustainable use and for the benefit of present and future generations, and
- the need to encourage and facilitate community involvement in the making and implementation of the arrangements relating to the use, conservation and management of water resources; and
- the need to integrate both long-term and short-term economic, environmental, social and equitable considerations; and
- the need for the conservation of biological diversity and ecological integrity to be a fundamental consideration; and
- if there are threats of serious or irreversible environmental damage, lack of full scientific certainty as to measures to address the threat should not be used as a reason for postponing such measures.

John McDonald Has His Say.

The Geelong Advertiser 7 December 2007 in the Perspective section reported that, "***Barwon Water has compiled extensive data and knowledge on the Barwon Downs aquifer over more than three decades. This information has been crucial in determining how and when to operate the wellfield under licence.***"

In the same article it states, "***Research gleaned from numerous studies and constant monitoring has concluded the current yield is sustainable.***" (In 2007 John McDonald was deputy chair of Barwon Water.)

There is that loosely used word "sustainable" again. Unfortunately in this situation when not defined, the word sustainable gives the impression that the activity being conducted can be continued indefinitely with little impact on the resource being exploited. As already stated the use of the word conjures up the mental picture that there will be no impact or such a small one that it really doesn't matter.
To have ready access through an open and transparent process to the extensive data that Barwon Water has compiled over the decades and evidence to support the complying with the Statement of Obligations can best be described as a fanciful dream. Such access and evidence has never been given.

2007. Anglesea Community Bulletin – Anglesea Borefield.

The Barwon Water's April 2007 Community Info Bulletin on the Anglesea Borefield Project states, *"**To make sure groundwater is extracted sustainably, recharge rates are measured (the rate at which the aquifer replenishes itself). This is used to calculate the Permissible Annual Volume (PAV), the amount of water that can be extracted annually from the aquifer**."*

Back in 1997 the Permissible Annual Volume for the Barwon Downs aquifer was set at 4 000 ML/year. The present licence that runs until 2019 allows 20 000 ML/year. The current average extraction for the years 2008 to 2010 was well over the 10 000 ML/year mark (see pages 87 & 89).
There is considerable doubt that the PAV was seriously taken any notice of in the Boundary Creek scenario for long-term summer extractions. 20 000 ML/year is far in excess of the PAV. It was successfully argued by Barwon Water that if an extraction rate of 400 000 ML is spread over 100 years then periodic large summer volumes shouldn't create serious environmental impacts. From a hydrological sense the aquifer would appear to be sustainable using this regime. However, it is doubtful that anyone arguing the case for instream biota, flora and water dependent ecosystems would agree (see photographs on pages 24, 32, 43, 76, 81, 102, 116 - 121). Groundwater and surface water dependent ecosystems disappear completely when their habitat is dried out and decimated.

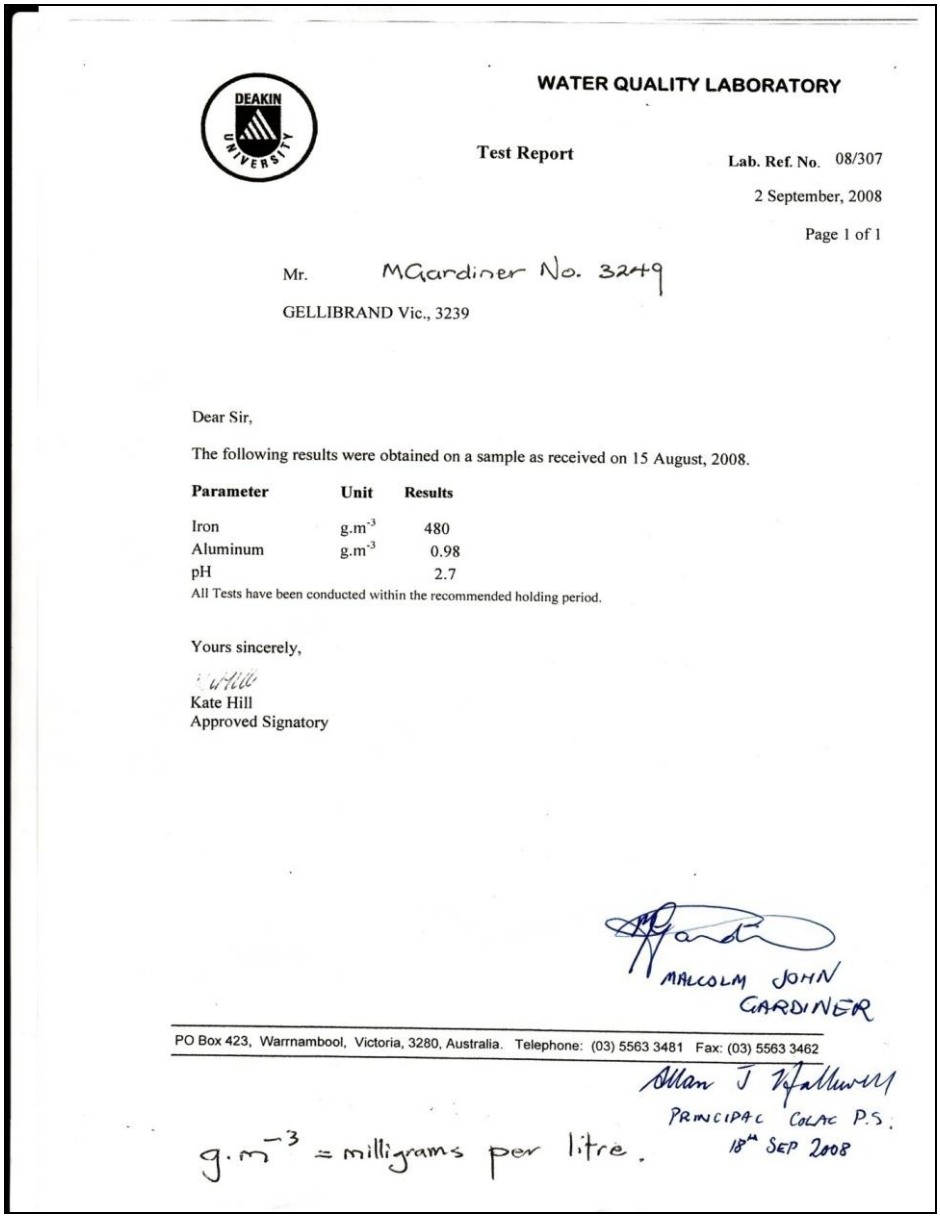
2008.

By April Boundary Creek Dry 900 Days.

The no flow days in Boundary Creek increase (see page 87) to 900. Creeks in the Loves Creek Catchment and tributaries of the Barongarook Creek continued to flow.

2008. Potential Inland Acid Sulphate Soils Discovered in the Big Swamp.

In 2008 Boundary Creek had stopped flowing for many months (see graph page 87) despite Barwon Water releasing 2 ML/day of supplementary water from the Otway to Colac pipeline (see the map on page 81 point L for the release site). It rained at the end of May, early June 2008 and Boundary Creek began to flow. The water was deceptively crystal clean looking but on examination proved to be extremely acidic and containing elevated levels of heavy metals (also see pages 72, 74, 75 & 77)



WATER QUALITY LABORATORY

Test Report

Lab. Ref. No. 08/307

2 September, 2008

Page 1 of 1

Mr. MGardiner No. 3249

GELLIBRAND Vic., 3239

Dear Sir,

The following results were obtained on a sample as received on 15 August, 2008.

Parameter	Unit	Results
Iron	$g.m^{-3}$	480
Aluminum	$g.m^{-3}$	0.98
pH		2.7

All Tests have been conducted within the recommended holding period.

Yours sincerely,

Kate Hill
Approved Signatory

MALCOLM JOHN GARDINER

PO Box 423, Warrnambool, Victoria, 3280, Australia. Telephone: (03) 5563 3481 Fax: (03) 5563 3462

Allan J Wallwork
PRINCIPAL COLAC P.S.
18TH SEP 2008

$g.m^{-3}$ = milligrams per litre.

Because of this very high acid reading taken from the waters below the Colac to Forrest Road bridge over Boundary Creek, it was decided to make an attempt to ascertain the source of this acid. After speaking to fire fighters who fought the Big Swamp peat fires in the late 1990s the prospect of going into this area was daunting. The fire fighters found the Big Swamp to be like a jungle and named it Jurassic Park.

With this impression of a vibrant, dense and healthy wetland ecosystem in mind an "expedition" was planned for exploration along Boundary Creek west of the Colac to Forrest Road. It was anticipated that this would not be an easy task to carry out. The flora survey done back in 2002[10] spoke of "***impenetrable vegetation***" in this area. As it turned out the opposite was the case.

A four wheel drive vehicle had to be used traversing overgrown fire tracks as access to the Big Swamp was difficult. However, once into the top end of the Big Swamp area the scenery

changed dramatically. In the top end of the Big Swamp there was a dry area completely denuded of all life. Downstream from this section of the Big Swamp there was layer upon layer of dead and dying vegetation.

From several visits to the site, digging into the dry peat for some depth and waiting for the holes to partially fill, water samples were taken. The test results can be seen on pages 72-77.

These test results appeared to indicate that there was an extremely convincing argument that there should be further investigation of these wetlands along Boundary Creek.

WATER QUALITY LABORATORY

Test Report **Lab. Ref. No.** 08/347

1 October, 2008

Mr. Malcom Gardiner,
18/05 Colac-Lavers Hills Rd,
KAWARREN Vic., 3249

Dear Sir,

The following results were obtained on samples as received on 15 September, 2008.

Method	Parameter	Unit	Sample 1-A 14/9	Sample 1-B 14/9	Sample 1-C 14/9
4500-H^+ B	pH		3.3	4.2	3.3
2510 B	Elec. Conductivity	$\mu S.cm^{-1}$	1,900	2,060	1,960
3500-Na B	Sodium	mg/L	170	170	160
3500-K B	Potassium	mg/L	3.7	3.8	3.6
4500-$SO_4^{=}$ E	Sulfate	mg/L	270	470	440
EG005T #	Iron	mg/L	104	40.5	28.2
EG020T #	Aluminum	mg/L	29.0	14.8	15.3
EG020T #	Arsenic	mg/L	0.018	0.002	0.003
EG020T #	Cadmium	mg/L	0.0006	0.0005	0.0006
EG020T #	Chromium	mg/L	0.012	<0.001	<0.001
EG020T #	Copper	mg/L	0.154	0.463	0.165
EG020T #	Lead	mg/L	0.022	0.024	0.016
EG020T #	Manganese	mg/L	0.565	0.526	0.508
EG020T #	Nickel	mg/L	0.182	0.171	0.159
EG020T #	Zinc	mg/L	0.782	0.586	0.520
EG020T #	Boron	mg/L	<0.05	<0.05	<0.05

Analysis performed by Accredited Laboratory NO. 825 and shown on report No. EM0807013.
All Tests have been conducted within the recommended holding period.

Yours sincerely,

Kate Hill
Approved Signatory

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PO Box 423, Warrnambool, Victoria, 3280, Australia Telephone: (03) 5563 3481 Fax: (03) 5563 3462

WATER QUALITY LABORATORY

Test Report Lab. Ref. No. 08/347b

22 October, 2008

Mr. Malcom Gardiner,
1805 Colac-Lavers Hills Rd,
KAWARREN Vic., 3249

Page 1 of 1

Dear Sir,

The following results were obtained on samples as received on 15 September, 2008.

Method	Parameter	Sample 2-A 13/9	Sample 2-B 13/9	Sample 3 13/9
4500-H^+ B	pH	2.7	2.5	2.6

All Tests have been conducted within the recommended holding period.

Yours sincerely,

Kate Hill
Approved Signatory

NATA
WORLD RECOGNISED ACCREDITATION

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PO Box 423, Warrnambool, Victoria, 3280, Australia Telephone: (03) 5563 3481 Fax: (03) 5563 3462

This water sample was taken at the bottom end of the Big Swamp. The vegetation at this site was not looking that healthy as can be seen in the following

photograph.

WATER QUALITY LABORATORY

Test Report

Lab. Ref. No. 08/388

31 October, 2008

Mr. Malcom Gardiner,
1805 Colac-Lavers Hills Rd,
KAWARREN Vic., 3249

Dear Sir,

The following results were obtained on samples as received on 9 October, 2008.

Method	Parameter	Unit	Sample 1.	Sample 2.
4500-H^+ B	pH		2.6	2.6
2510 B	Elec. Conductivity	$\mu S.cm^{-1}$	2,160	2,140
3500-Na B	Sodium	mg/L	90	90
3500-K B	Potassium	mg/L	4.8	12
4500-$SO_4^{=}$ E	Sulfate	mg/L	390	325
EG005T #	Iron	mg/L	372	354
EG020T #	Aluminum	mg/L	6.93	12.6
EG020T #	Arsenic	mg/L	0.193	0.222
EG020T #	Cadmium	mg/L	0.0020	0.0026
EG020T #	Chromium	mg/L	0.010	0.012
EG020T #	Lead	mg/L	0.017	0.016
EG020T #	Manganese	mg/L	0.339	0.384
EG020T #	Nickel	mg/L	0.091	0.140
EG020T #	Zinc	mg/L	0.854	1.08
EG020T #	Boron	mg/L	<0.05	<0.05

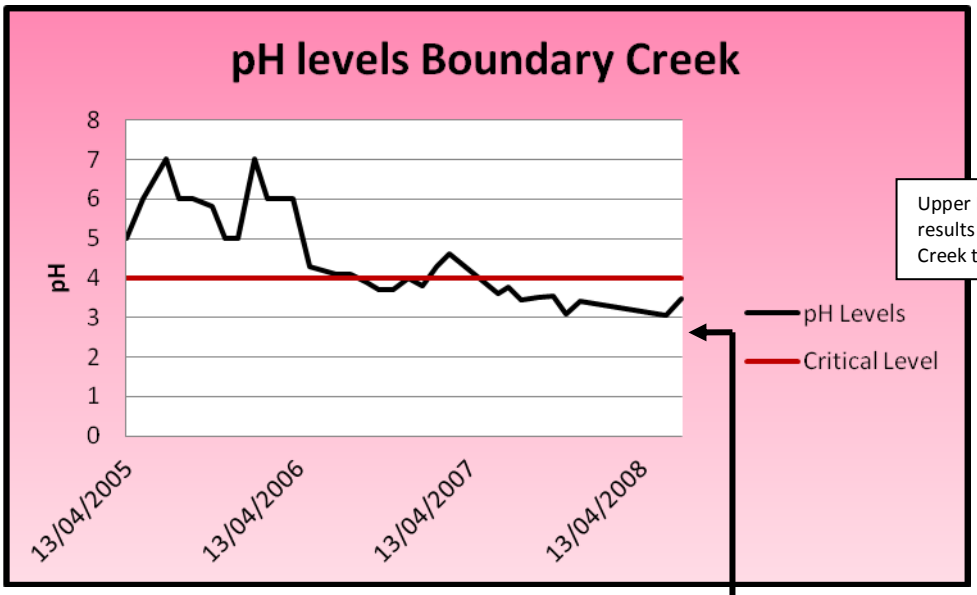
Analysis performed by Accredited Laboratory NO. 825 and shown on report No. EM0808632
All Tests have been conducted within the recommended holding period.

Yours sincerely,

Kate Hill
Approved Signatory

PO Box 423, Warrnambool, Victoria, 3280, Australia Telephone: (03) 5563 3481 Fax: (03) 5563 3462

This graph shows Boundary Creek has been under a pH reading of 4 on numerous occasions since September 2006.

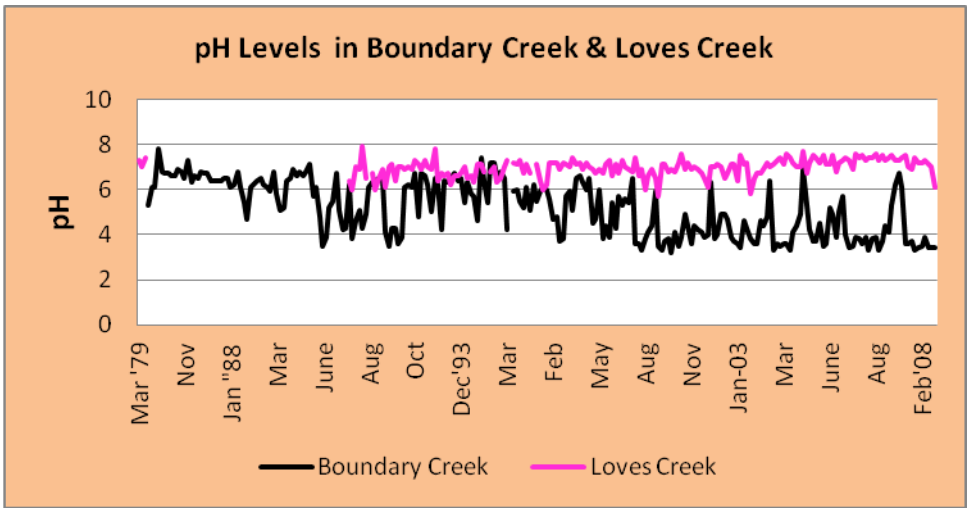


Upper Barwon Landcare Network results show the water in Boundary Creek to have been down as low as 2.5

Source: Upper Barwon Landcare Network[46].

September 2008 a test done on an opaque "slug" was 2.7 (see page 72).

This graph below depicts acid problems in Boundary Creek since the late 1980s. The latest water tests suggest the pH has not stopped falling. Loves Creek the other side of the aquifer divide (see page 5) has remained relatively stable and healthy throughout the same period.

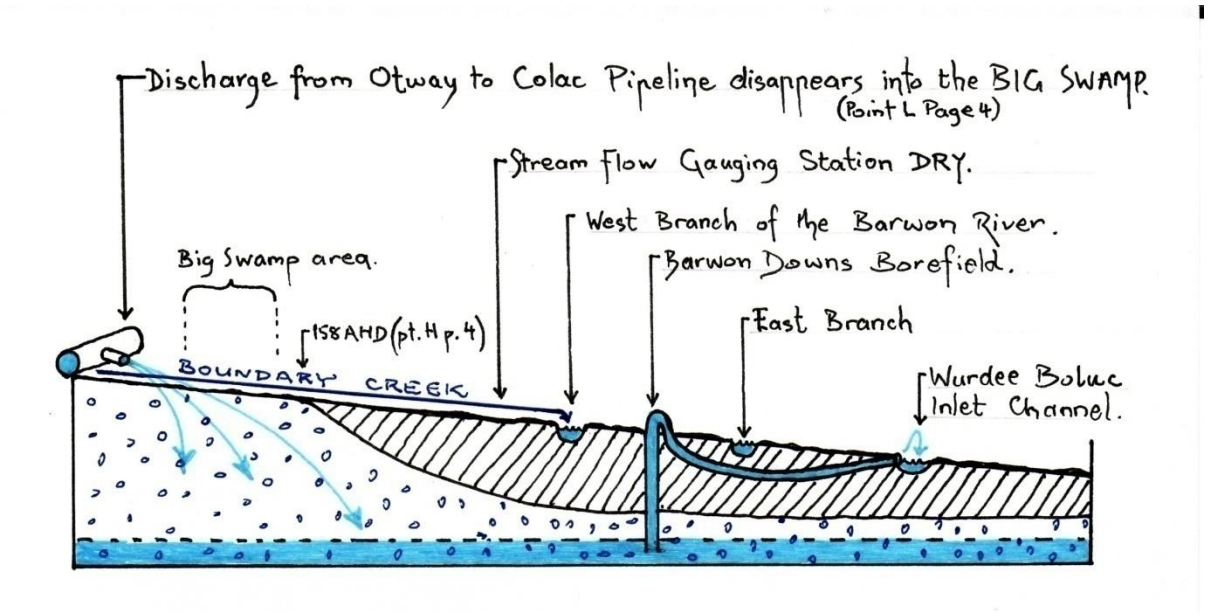


Source: www.vicwaterdata.net Boundary Creek@Yeodene Site Code 233228. Loves Creek@ Kawarren Site Code 235234.

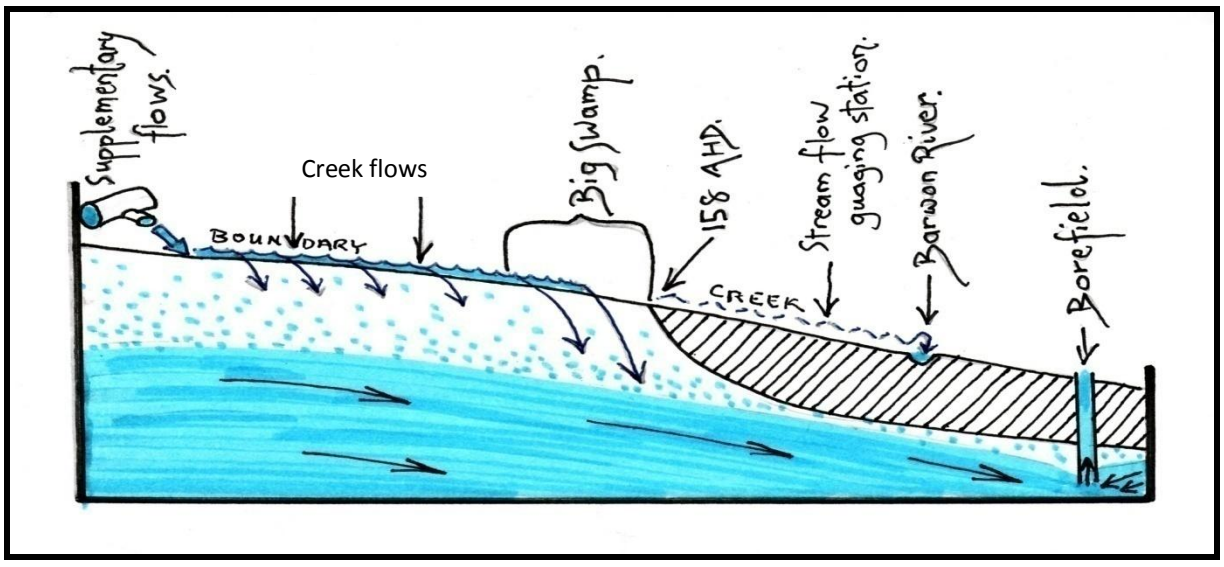
2008 - 2012. Supplementary Flows into Boundary Creek.

Whenever the Trigger Point in the Yeo 40 observation bore dropped below the 158.5 metre mark supplementary flows had to be released into Boundary Creek until there was a flow of

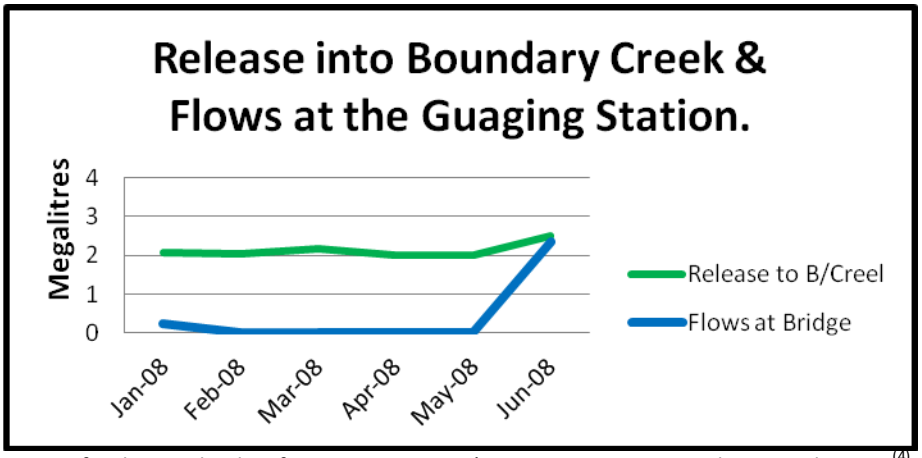
at least one ML/day at the Yeodene stream flow gauging station on the Colac Forrest Road (see map page 4 point I).
The following graph and diagrams highlights the futility of this venture.



Diagrams representative of the process. (Not to scale)



The diagrams above are representative of the flow paths of the supplementary water releases from the Colac Otway pipeline. As the released water flows down Boundary Creek, wherever the creek bed is in direct connection with the depleted aquifer, the water seeps into the ground. In the Big Swamp area the water table has been lowered to such a degree this area has dried out. As a consequence the peat in the Big Swamp acts like a giant sponge. In periods of low rainfall the supplementary water completely disappears into this area never reaching the stream flow gauging station at the Colac Forrest Road Bridge.
The green line on the next graph displays the megalitres of water released each day. The blue line clearly indicates that this supplementary water disappeared before reaching the stream flow gauging station. This is also graphically shown in the chart on page 82.



Data for this graph taken from Barwon Water's 2007-08 report to Southern Rural Water.[4]

Between February and the end of May 2008 there was negligible rain. During this same 3 month period zero flows (blue) were recorded at the Colac Forrest Road bridge stream flow gauging station. The supplementary flows disappeared into the depleted aquifer at the Big Swamp. This has been a regular occurrence during low rainfall episodes.

To illustrate the disappearance of the supplementary flows a series of pictures were taken on 21 January 2010 (see page 81). These photographs show;

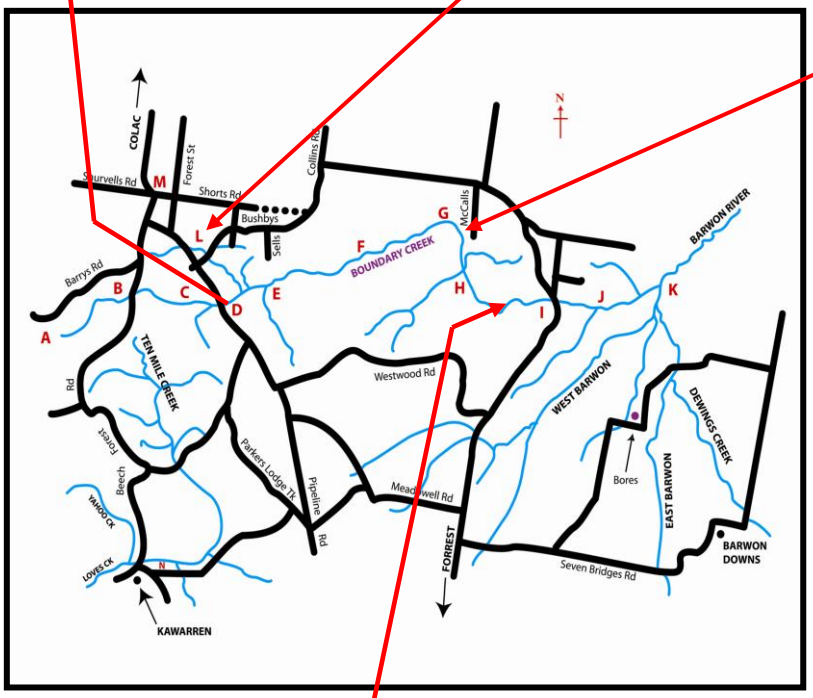
- Boundary Creek **dry** in the Barongarook High area at the bridge on the Colac to Barongarook Road.
- 2 ML/day supplementary releases from the Colac Otway Pipeline into Sandy Creek, a tributary of Boundary Creek. The licence conditions intention is that one megalitre of this water reaches the Colac Forrest Road Bridge gauging station at Yeodene.
- Overflowing water from the dam built across Boundary Creek. The water from the supplementary flows released at Sandy Creek makes it this far.
- The overflow or gate valve release from McDonald's dam.
- A **dry** Boundary Creek as it passes through the Big Swamp. The water has disappeared.
- A galvanised steel dropper plunged deep into the peat of the swamp showing dampness at its lower end but definitely not into water. Groundwater level way below the 158.5 metres AHD trigger level at this point.
- Boundary Creek dry from the Big Swamp wetlands all the way to the Barwon River.

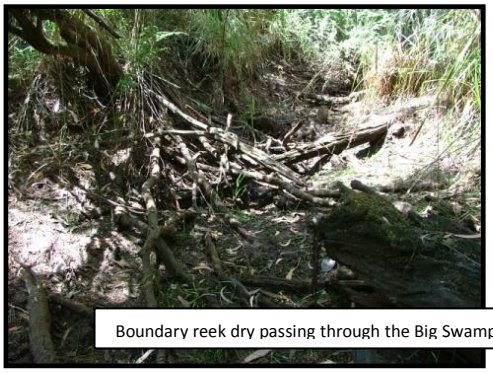
This event of Boundary Creek having no flows during dry periods has been a regular occurrence for many of the summer months since 1984.

Boundary Creek dry at Barongarook Bridge.

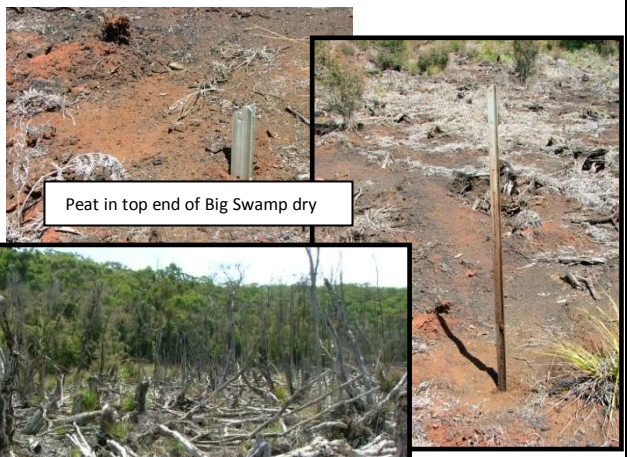
Supplementary releases of water.

Water reaches McDonalds Dam & overflows towards the Big



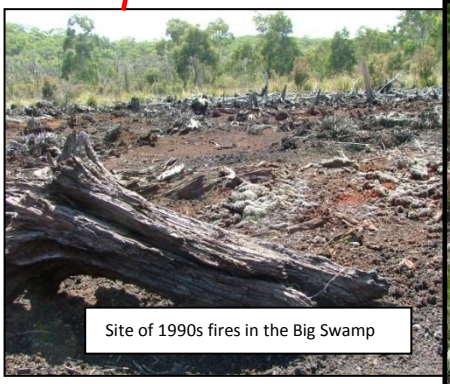


Boundary reek dry passing through the Big Swamp

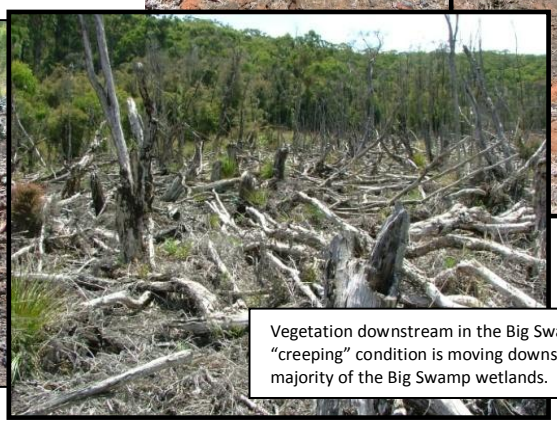


Peat in top end of Big Swamp dry

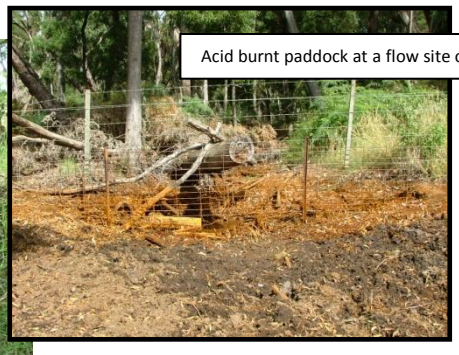
All of these photos taken 21 January 2010



Site of 1990s fires in the Big Swamp



Vegetation downstream in the Big Swamp being killed. This "creeping" condition is moving downstream & is over the majority of the Big Swamp wetlands.



Acid burnt paddock at a flow site out of the Big Swamp into pasture land

The main branch of Boundary Creek exiting the Big Swamp

Stream flow gauging station dry @ point I

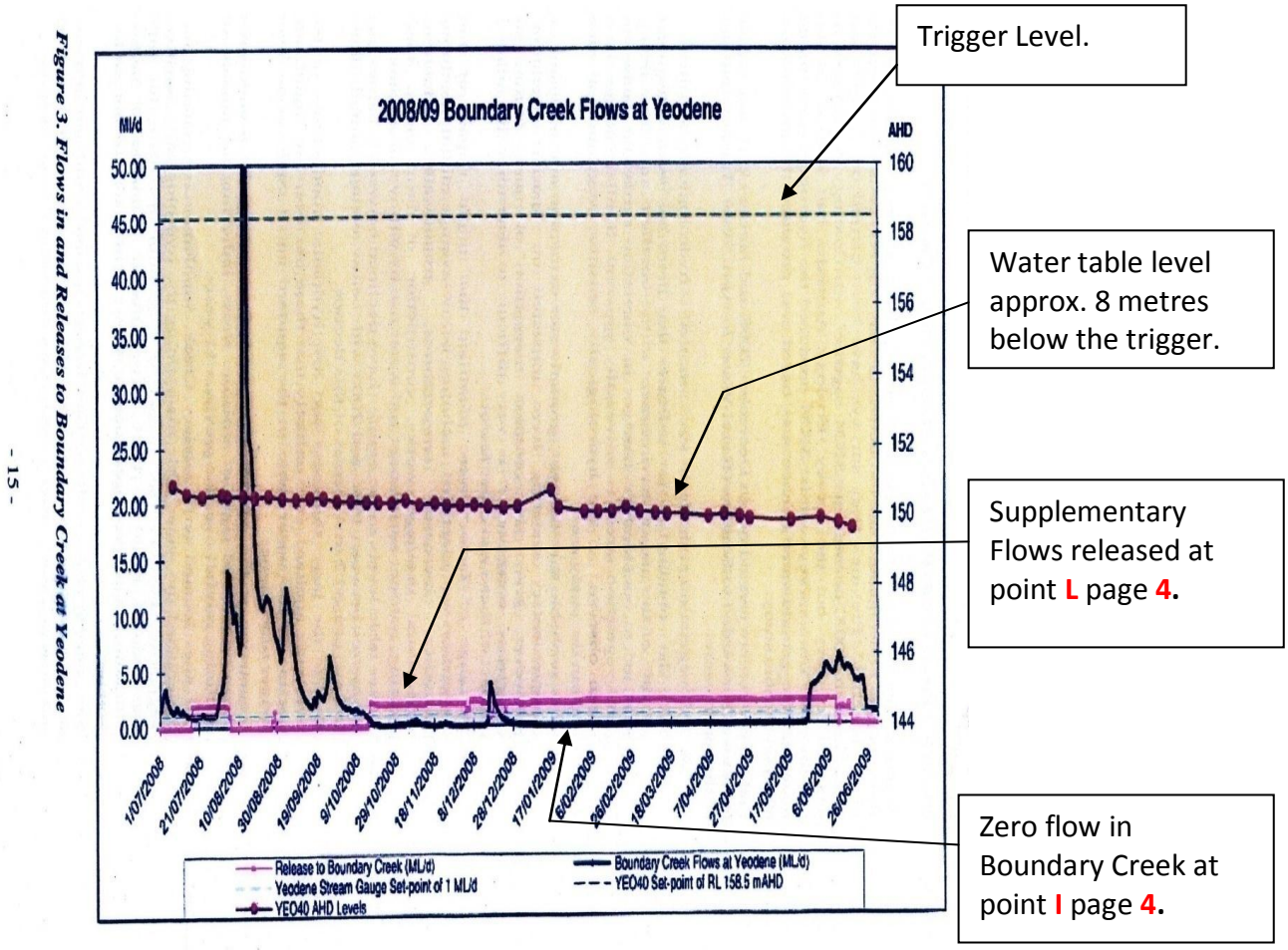


Figure 3. Flows in and Releases to Boundary Creek at Yeodene

- 15 -

Source: Barwon Water's 2008-09 report to Southern Rural Water.[5]

This chart taken from the 2008-09 Barwon Water report[5] to Southern Rural Water shows a very similar scenario to the one that happened between February 2008 and June 2008. The pink line indicates supplementary flows, around the 2 ML/day rate, and the Boundary Creek flow at the Colac to Forrest Road Bridge stream flow gauging station Yeodene No 233228, as zero.

The data sheet on the next page is taken from the Barwon Water's 2009-10 report to Southern Rural Water and depicts a very similar pattern. Even with high rainfall flows past the gauging station in July, August, September and October, during the following summer months there were many days of no flow despite 2 ML/day releases of supplementary flows from the Colac to Otway Pipeline.

Appendix F

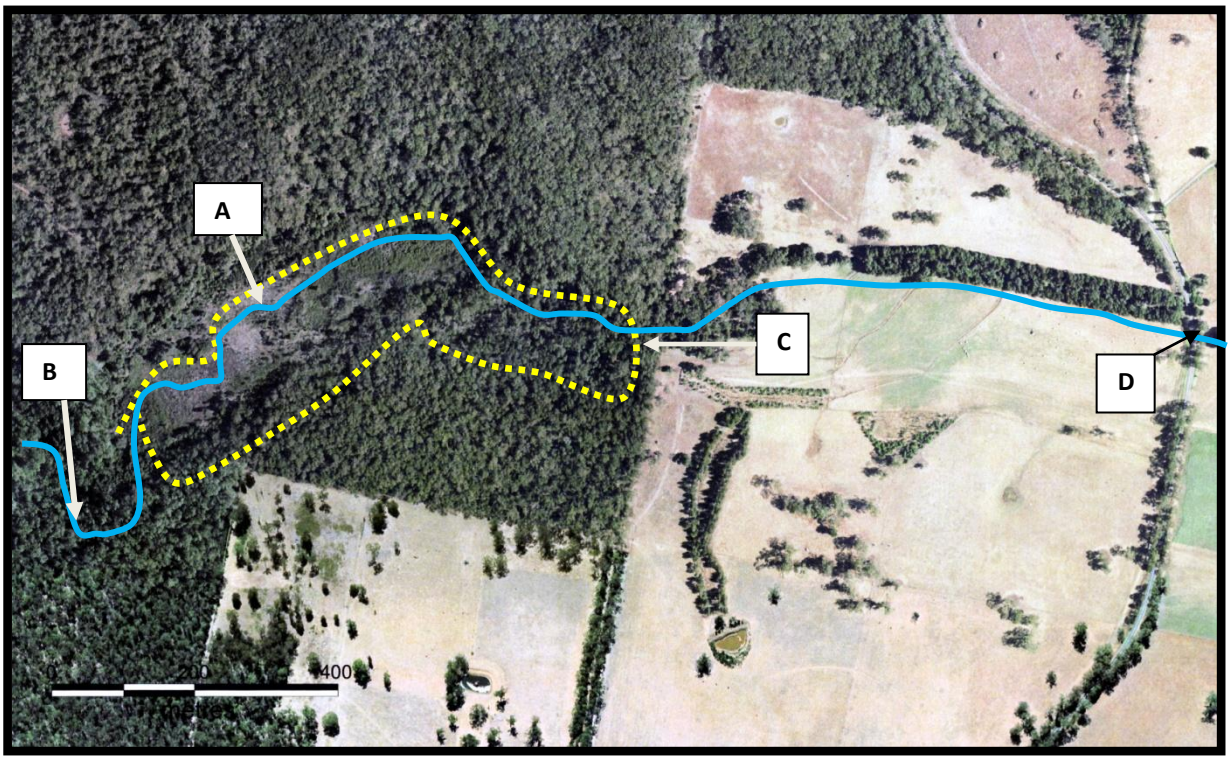
Flows in Boundary Creek at Yeodene Stream Gauge 233228 (ML/day)

Date	July-09	August	September	October	November	December	January	February	March	April	May	June-10
1	1.13	5.98	72.50	18.67	1.27	4.40	0.02	0.00	0.00	1.98	0.24	2.60
2	2.28	8.35	43.98	12.71	1.30	2.91	0.03	0.00	0.00	1.87	0.22	2.73
3	3.19	9.40	27.82	9.54	1.26	1.83	0.03	0.00	0.00	1.89	0.21	2.57
4	4.27	9.68	19.15	8.17	0.95	1.31	0.00	0.00	0.00	1.91	0.18	2.20
5	2.79	10.63	14.32	6.79	1.07	0.78	0.00	0.00	0.00	1.85	0.19	1.96
6	2.19	8.87	11.57	5.75	1.16	0.52	0.00	0.00	0.00	1.82	0.17	1.78
7	1.95	7.05	10.45	5.25	1.08	0.39	0.00	0.00	0.00	1.96	0.14	1.73
8	1.81	6.37	10.91	5.28	0.83	0.32	0.00	0.00	0.00	3.66	0.11	1.69
9	1.66	6.16	15.82	5.64	0.60	0.26	0.00	0.00	0.00	2.57	0.13	1.65
10	1.58	6.40	19.29	5.47	0.48	0.21	0.00	0.00	0.00	1.29	0.15	2.02
11	1.53	6.24	15.90	4.34	0.41	0.18	0.00	0.00	0.00	0.84	0.19	2.93
12	2.18	6.13	11.43	3.58	0.34	0.15	0.00	0.00	0.00	0.68	0.46	3.93
13	2.71	6.36	8.87	3.16	0.27	0.13	0.00	0.00	0.00	0.56	0.63	4.24
14	4.30	6.93	7.27	3.35	0.27	0.11	0.00	0.00	0.00	0.45	0.73	3.94
15	5.71	7.35	5.98	4.65	0.19	0.10	0.00	0.00	0.00	0.36	0.64	3.07
16	5.66	7.24	4.94	9.41	0.12	0.08	0.00	0.00	0.00	0.28	0.64	2.14
17	4.93	7.18	4.09	30.95	0.08	0.07	0.00	0.00	0.00	0.22	0.58	1.30
18	4.78	7.75	8.58	30.31	0.07	0.14	0.00	0.00	0.00	0.26	0.86	1.41
19	4.07	9.35	32.03	16.14	0.05	0.15	0.00	0.00	0.00	0.25	1.13	1.90
20	3.46	8.14	30.49	9.68	0.04	0.18	0.00	0.00	0.00	0.20	1.13	2.96
21	3.11	7.55	17.65	6.85	0.04	0.17	0.00	0.00	0.00	0.17	1.17	3.15
22	2.90	18.28	12.00	4.87	0.05	0.20	0.00	0.00	0.00	0.17	1.20	2.88
23	2.92	55.90	18.73	3.52	0.07	0.23	0.00	0.00	0.10	0.23	1.24	2.74
24	3.68	30.38	32.72	3.16	0.06	0.18	0.00	0.00	0.62	0.44	1.24	2.01
25	5.48	18.77	20.43	2.90	0.07	0.15	0.00	0.00	0.60	0.48	1.24	1.39
26	5.94	21.35	19.55	2.61	0.07	0.11	0.00	0.00	0.76	0.65	1.24	1.14
27	5.27	66.29	58.73	2.25	0.08	0.08	0.00	0.00	0.91	0.45	1.31	1.17
28	4.87	57.13	56.82	1.90	0.09	0.07	0.00	0.00	1.31	0.38	1.35	1.12
29	4.63	36.20	47.67	1.65	0.10	0.06	0.00	0.00	2.15	0.39	1.37	1.48
30	4.43	43.78	30.51	1.44	2.41	0.06	0.00		2.88	0.56	1.66	1.49
31	4.53	101.60		1.29		0.05	0.00		2.29		2.19	
Total	109.90	608.76	690.20	231.28	14.87	15.55	0.08	0.00	11.62	28.81	23.95	67.33

Release to Boundary Creek (ML/day)

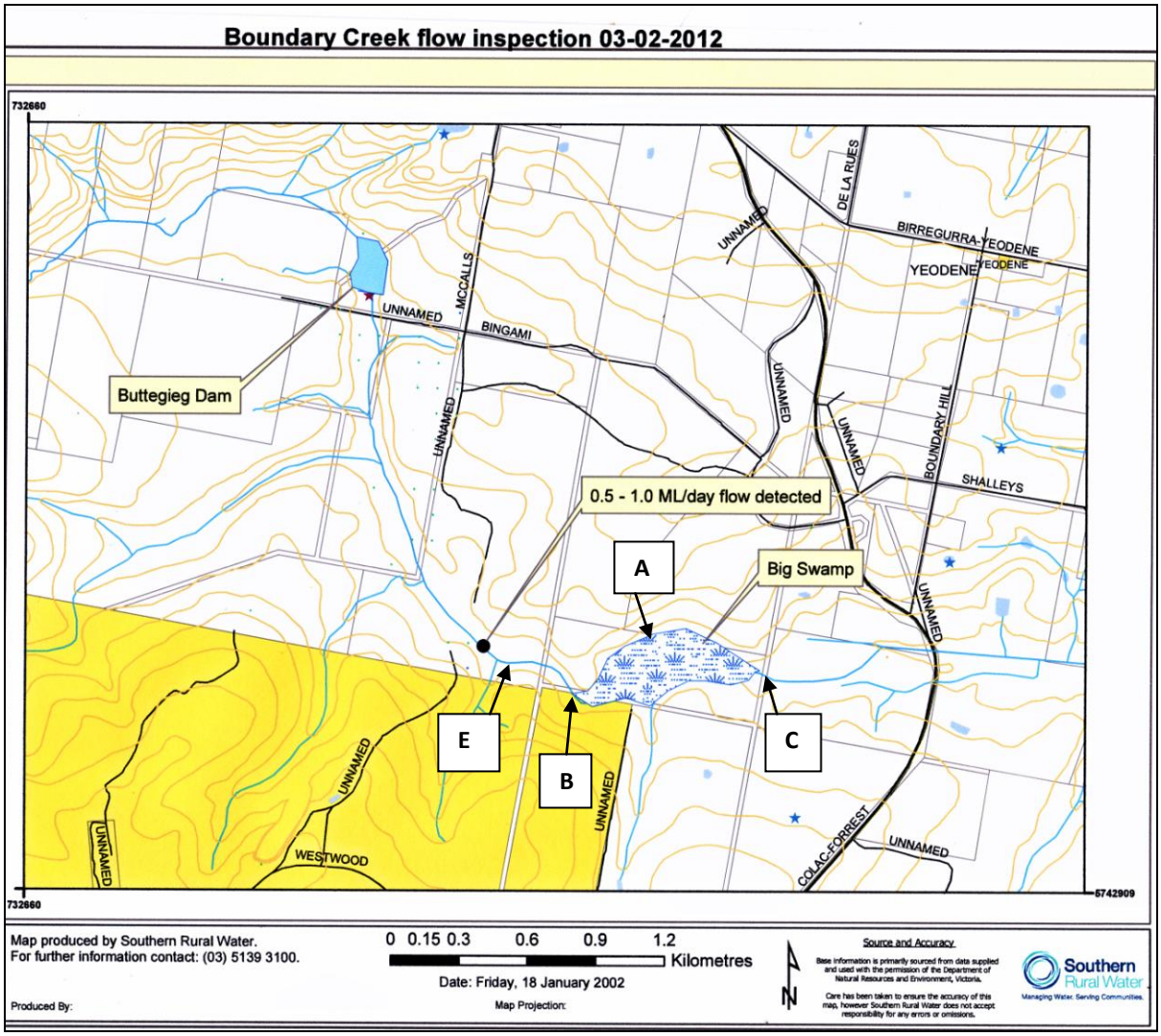
Date	July-09	August	September	October	November	December	January	February	March	April	May	June-10
1	0.00	2.13	2.21	2.02	3.35	2.04	2.06	2.07	2.09	2.07	2.06	2.13
2	1.23	2.15	1.09	2.03	3.36	1.26	2.09	2.07	2.22	2.07	2.06	2.13
3	2.07	2.15	0.00	2.00	3.35	0.00	2.09	2.07	2.23	2.06	2.06	2.13
4	2.12	2.14	0.00	1.98	3.30	1.31	2.09	2.07	2.23	2.06	2.07	2.13
5	2.12	2.13	0.00	1.99	2.84	2.09	2.08	2.06	2.22	2.06	2.10	1.97
6	2.12	1.77	0.00	1.99	2.07	2.09	2.07	2.06	2.22	2.06	2.10	2.14
7	2.11	0.05	0.00	0.74	2.07	2.06	2.07	2.06	2.22	2.06	2.10	2.14
8	2.08	0.00	0.00	0.00	2.07	2.06	2.04	2.05	2.22	2.06	2.10	2.14
9	2.05	0.00	0.00	0.00	2.07	2.06	2.01	2.05	2.22	1.87	2.10	2.14
10	2.08	0.00	0.00	0.00	2.07	2.02	2.02	2.06	2.23	0.00	2.11	2.14
11	2.08	0.00	0.00	0.00	2.09	2.04	2.03	2.04	2.15	0.00	2.11	2.05
12	2.08	0.35	0.00	0.00	2.08	2.09	2.02	2.06	2.08	0.00	2.11	2.01
13	1.88	2.11	0.00	0.00	2.04	2.08	2.03	2.05	2.09	0.00	2.11	0.01
14	2.08	2.02	0.00	0.00	2.02	2.06	2.03	2.05	2.09	0.00	2.11	0.00
15	2.06	2.10	0.00	0.00	2.05	2.05	2.03	2.05	2.08	0.00	2.11	0.00
16	2.07	2.18	0.00	0.00	2.04	2.17	2.03	2.06	2.09	0.00	2.11	0.00
17	2.06	2.18	0.00	0.00	2.06	2.32	2.03	2.06	2.08	0.00	2.11	0.00
18	2.06	2.18	0.00	0.00	1.99	2.21	2.08	2.06	2.08	0.00	2.11	0.00
19	2.05	2.19	0.00	0.00	1.37	2.08	2.09	2.05	2.08	0.00	2.11	0.00
20	2.04	2.15	0.00	0.00	0.56	2.07	2.07	2.06	2.07	0.00	2.11	0.00
21	2.05	2.19	0.00	1.27	2.09	2.07	2.07	2.05	2.08	0.00	2.12	0.00
22	2.05	2.18	0.91	3.33	2.03	2.07	2.05	2.06	2.08	0.00	2.13	0.00
23	2.06	2.19	2.08	3.33	2.05	2.07	2.02	2.06	2.08	0.00	2.13	0.00
24	2.06	2.20	2.04	3.33	2.10	2.07	2.01	1.92	1.98	0.73	2.13	0.00
25	2.07	2.20	2.03	3.33	2.14	2.07	2.01	1.78	0.68	1.87	2.12	0.00
26	2.07	2.20	2.03	3.33	2.19	2.07	2.04	1.77	1.42	1.84	2.12	0.00
27	2.06	2.20	2.03	3.33	2.21	2.07	2.07	1.95	2.07	2.08	2.13	0.00
28	2.05	2.20	2.04	3.33	2.15	2.07	2.07	2.08	2.06	2.08	2.13	0.00
29	2.05	2.20	2.04	3.34	2.04	2.07	1.81		2.07	2.08	2.13	0.00
30	2.05	2.20	2.03	3.34	2.04	2.07	2.06		2.06	2.08	2.13	0.00
31	2.08	2.20		3.35		2.07	2.07		2.06		2.13	
Total	61.07	54.13	20.51	47.35	65.91	60.94	63.33	56.81	63.63	31.15	65.31	25.26

Since 1984 Boundary Creek was often dry at point C. In 2004 the extraction licence contained a condition that if there was a flow of less than 1 ML/day at the stream flow gauging station 233228 at point D, then supplementary waters had to be released into Boundary Creek. Despite this condition being met during dry summer months, the 2 ML/day supplementary water never went any further than the Big Swamp at point A. Even throughout the worst drought on record the water had completely disappeared at point A (also see page 118).



In late January 2012 when inspecting the flows in Boundary Creek it was noted that there was no flow at point B (also see page 118). This was most unusual as there had been continuos flows at this point throughout the drought. Going upstream for approximately 500 metres to point E (see next page) still no flow could be detected. Being perplexed by this Southern Rural Water was approached to investigate this happening. Southern rural Water reported back that the supplementary releases were as per the licence conditions, 2 ML/day or more, and releases from McDonald's Dam (now called Buttegieg Dam – new owners) were being appropriately managed. No explanation could be given for this flow now disappearing hundreds of metres further upstream other than to say that it is most probably due to dry conditions. This explanation does not seem feasible. Flows were reaching point B and then disappearing into the Big Swamp by point A despite the worst drought on record. Then after two reasonably wet winters of 2010 and 2011 the flows were not even reaching point E (see next page).

Another possible scenario is that the sphere of influence from the aquifer equalising is radiating out as the cone of depression fills (see pages 122 – 124). With this scenario the supplementary water is being drawn down into the depleting aquifer further and further upstream as the outer edges of the drawdown influence continues to spread.

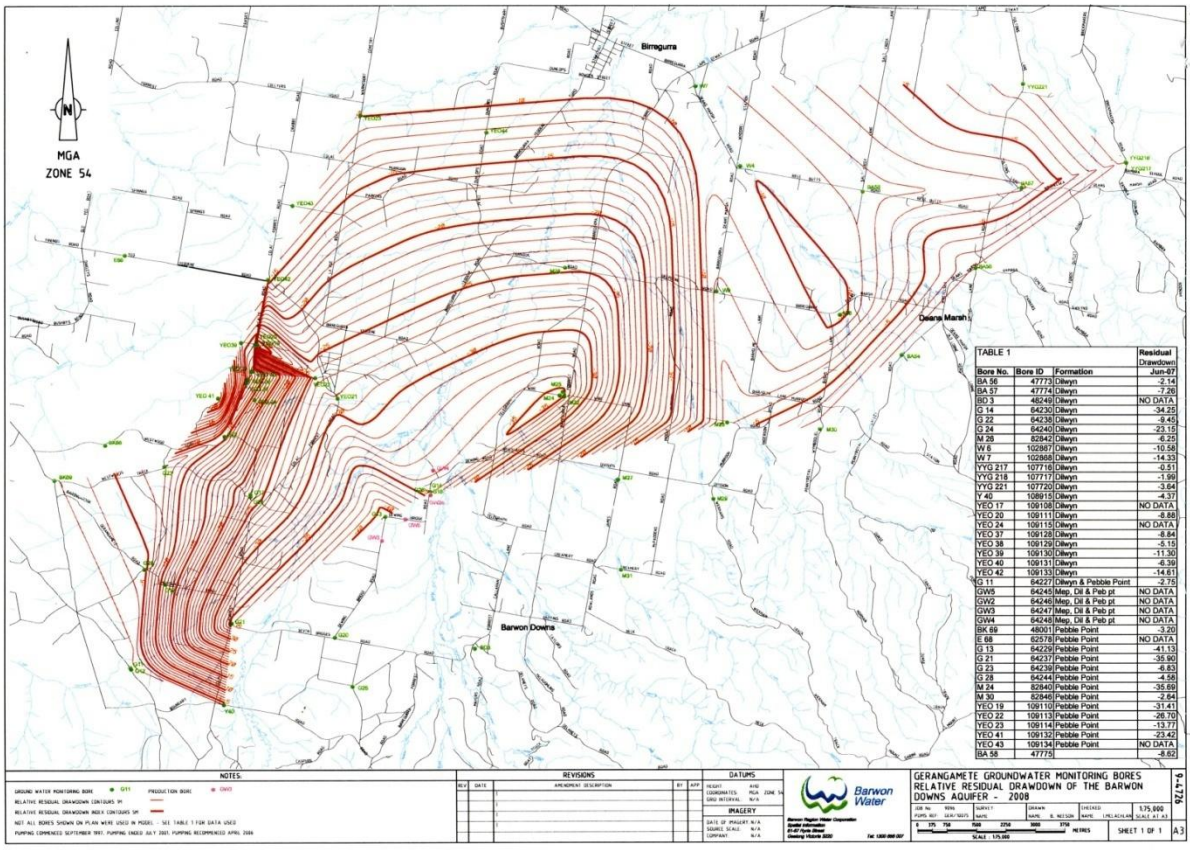


Ecological Flows.

A Barwon Water report completed in 2009[53] states that the reasons for the supplementary flows were to maintain ecological conditions. If this is the case it was not spelt out in the 2004 Licence Number 893889. It is more likely that the supplementary flows were to protect domestic and stock use as described under Section 8 of the licence. In this section it clearly states that Barwon Water must ensure access is maintained for Domestic & Stock use along Boundary Creek. When water fails to reach point "J" (see map, page 81) Barwon Water has been obliged to cart truck loads of water at huge cost, into at least one farmer on Boundary Creek located below the Big Swamp. There can be no doubt that groundwater extraction at Barwon Downs has had dramatic impact on this area as a result of significantly drawing down the water table in the deep water aquifer.

On page 22 of this same report[53] it has this to say, "***This reversal of groundwater flow has caused this reach of Boundary Creek to change from a gaining stream to a losing stream***."

2008. Drawdown Figures.



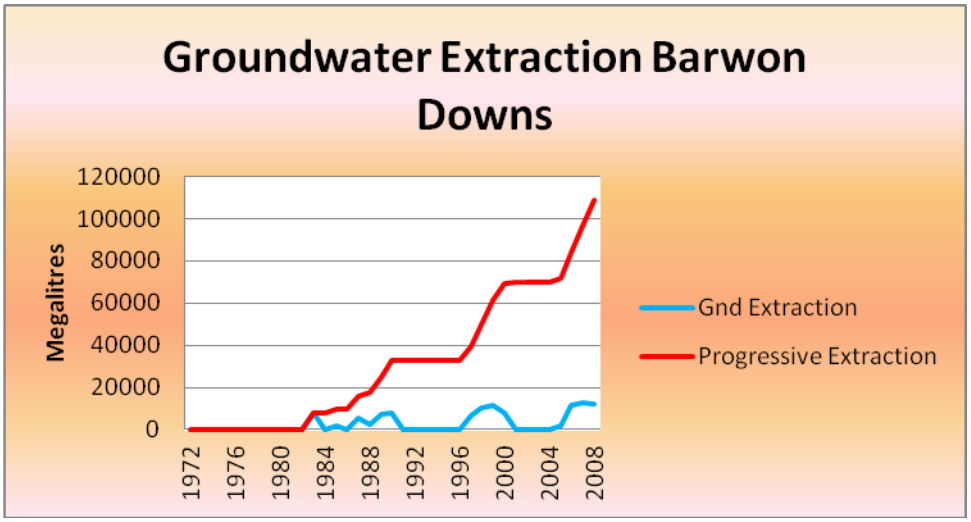
This map was taken from the Barwon Downs annual report to Southern Rural Water.[4] There was no explanation why the drawdown contours had been dramatically reduced on this map. The drawdown contours do not even cover the deepest drawdown "hole" under the actually borefield pumps when compared with the maps on pages 68 and 90.

2008-2009. Formal Complaints of Possible Actual Inland Acid Sulfate Soils.

After consultation with various statutory government bodies asking for the Big Swamp area to at least be visited and at best tested for Actual Inland Acid Sulfate Soils and having no success, formal complaints were sent to the Environment Protection Authority (EPA), Barwon Water, the Department of Sustainability, Southern Rural Water and the Colac Otway Shire. The Colac Otway Shire is attempting to co-ordinate these statutory authorities into some action. The first formal complaint was delivered to the EPA over 40 months ago and still the site has not been visited by the EPA.
A full account of this tardiness can be found in "Otway Water – One Giant environmental Footprint – Book 8" and "Otway Water – Waves of Obfuscation – Book 10."

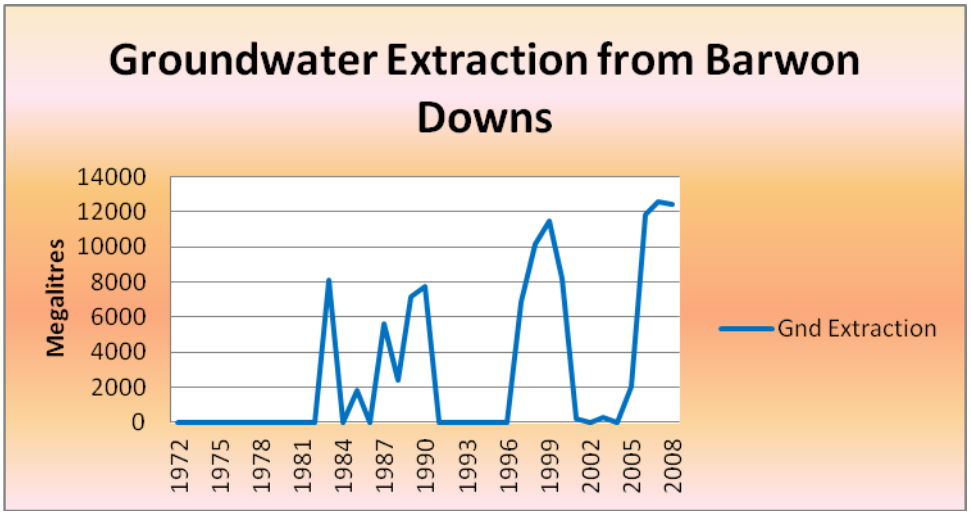
June 2009 Groundwater Water Extraction from the Borefield.

The following graphs include the latest data provided in the 2008/2009 Barwon Downs Gerangamete Groundwater Management Area Groundwater Licence No. 893889 report[5] to Southern Rural Water. Gaps in data have been filled from the Victorian water data website.[20]



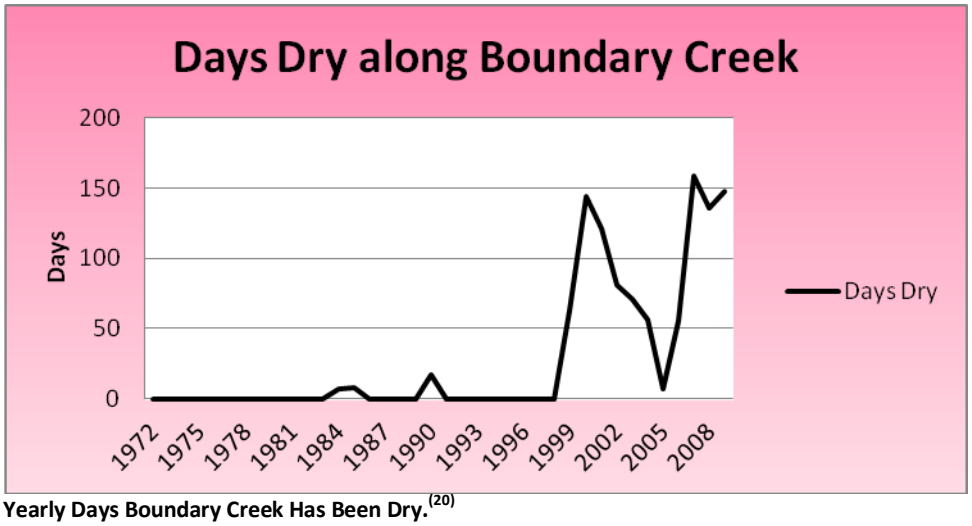
Yearly Groundwater Extractions & the Progressive Total.

The progressive total of groundwater extracted up to June 2009 was 108 722 million litres.



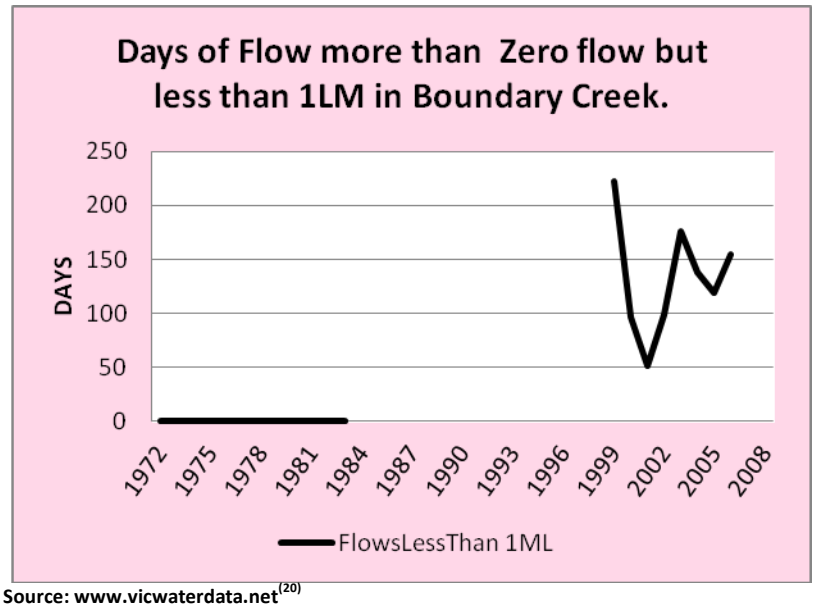
Yearly groundwater Extractions form the Barwon Downs Borefield.

The days Boundary Creek are dry closely mirrors the yearly extractions graph above.



Yearly Days Boundary Creek Has Been Dry.[20]

The Barwon Water reports to Southern Rural Water from 2004 to 2006 should have included data on the flows in Boundary Creek but failed to do so. When compiling this missing and other data from Government records, the days of flows less than one megalitre but more than a zero flow were also recorded. The days of no flow are not included in this graph. If combined the two sets of data would paint an extraordinary dismal picture of flows in Boundary Creek.

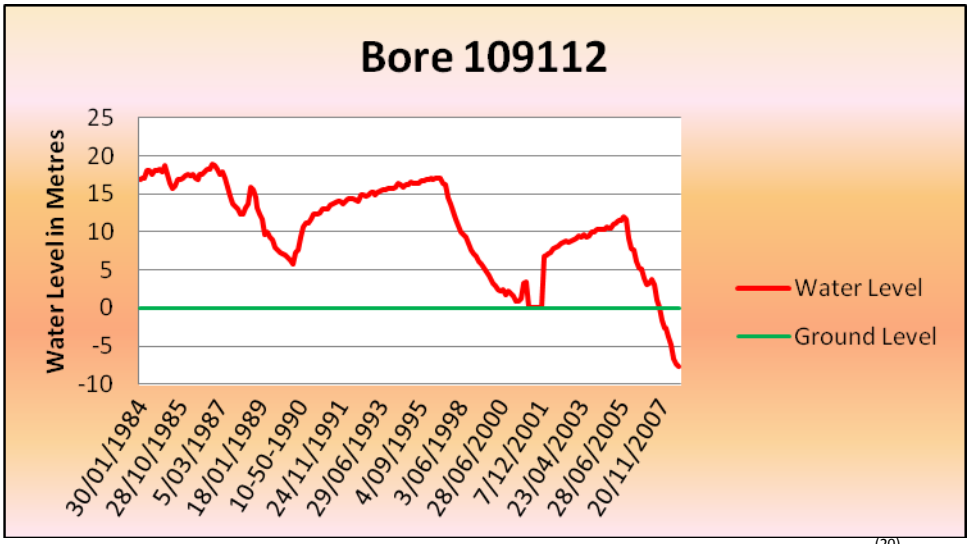


Source: www.vicwaterdata.net[20]

The period 1972 to 1984 has been shown as days of no flows less than 1 ML based on local knowledge and the Witebsky et al.[63] report. Witebsky stated that the daily average summer flow was in the order of 3.2 ML. Farmar-Bowers[21] also confirms a vibrant healthy Boundary Creek pre 1986.

November 2009. Bore 109112.

Bore 109112 is in very close proximity to Boundary Creek on the Colac to Forrest Road just upstream of the Yeodene stream flow gauging station on Boundary Creek (see page 4 point I). The decline in water table level is dramatic.



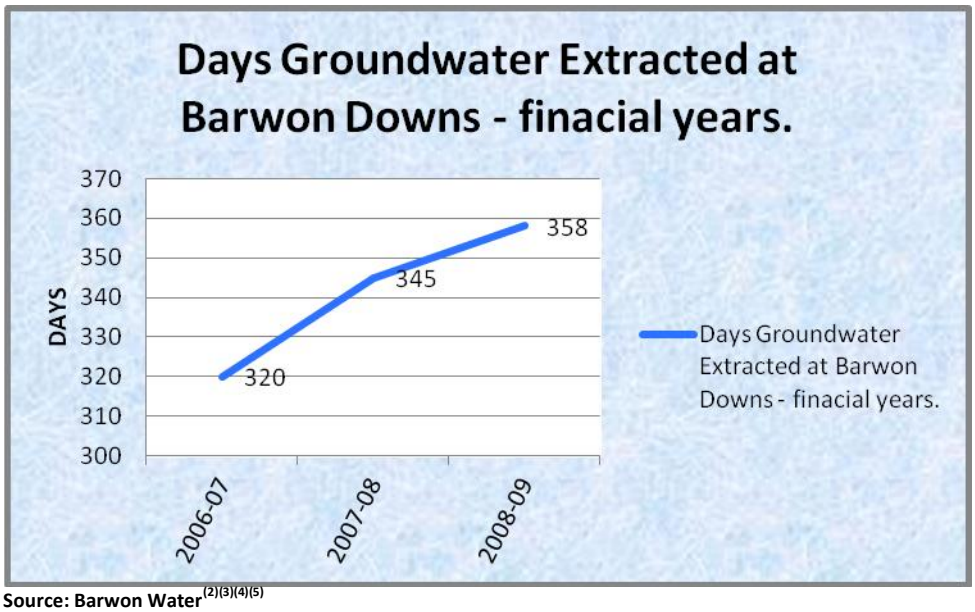
Bore 109112 Adjacent to the Stream Flow Gauging Station at Point I on the map Page 4.[20]

This Bore 109112, pre-pumping was squirting water into the air to a height of nearly 20 metres. The water level as at November 2009 was down to 7.69 metres below ground level.

Bore 109112 is approximately 2 kilometres downstream of the Big Swamp. The water level is so far below ground level at this point that the only time Boundary Creek flows is during rain episodes.

From August 2006 - 2009 Continuous Groundwater Extraction.

From August 2006 groundwater from the Barwon Downs Borefield has been extracted virtually no stop. Not only is the pumping continuous except for a few days each year, it would appear from observation of the



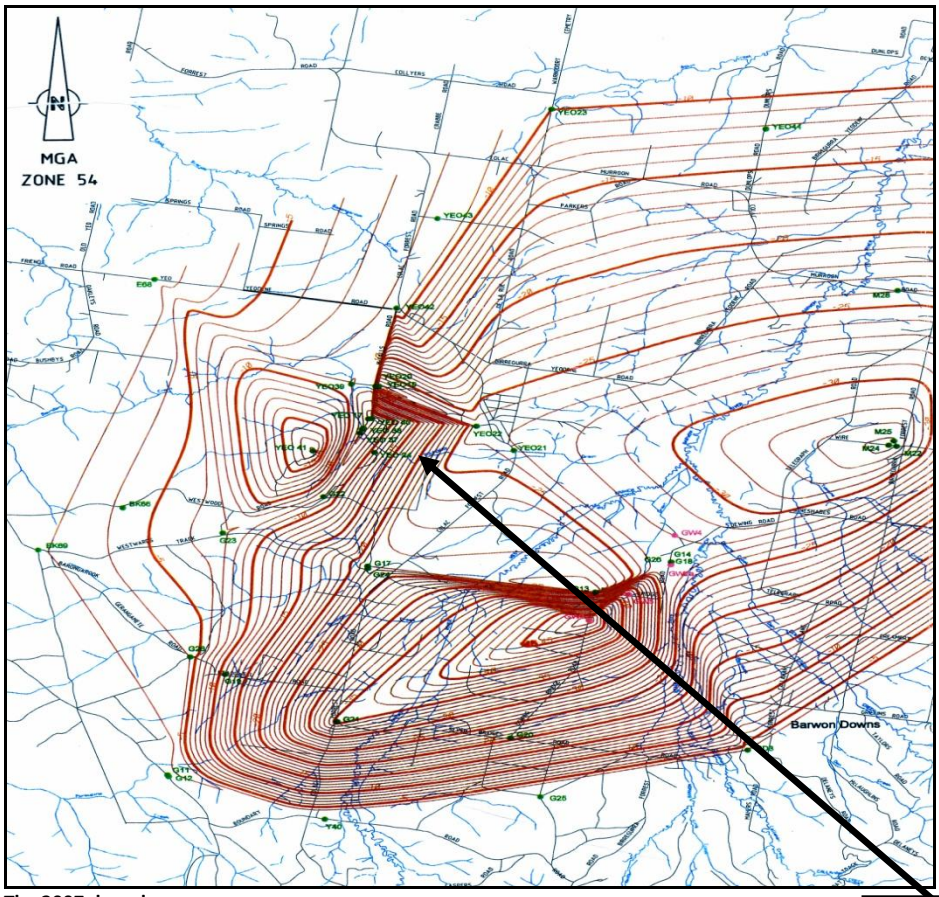
Source: Barwon Water[2][3][4][5]

outflow pipes that the rate of extraction has also increased (see picture page 53) since early January 2009.[28] In the financial years 2006/07, 11 807 ML were extracted; 2007/08, 12 604 ML and last financial year 12 438 ML were extracted.
Barwon Water has licence rights to extract 20 000 ML/year. To step the extraction up to 20 000 ML/year would almost double the amount being sent to Geelong. The impact on Boundary Creek at 11 000 ML/year is horrific enough but extraction at 20 000 ML/year can only be imagined.

2009 Drawdown Figures.

The two maps on page 90 have been combined. The 2009 drawdown map[5] has been superimposed over the SKM 2003 map.[1]

Two sections of the red drawdown contours that depict drawdown holes in the Yeodene area are almost directly under the Big Swamp wetlands. This fact alone clearly demonstrates how the drawdown from the Barwon Downs Borefield is having a direct and detrimental impact on the Big Swamp wetlands. There is little doubt that the deep water aquifer outcrops in the Big Swamp and that there has been significant drawdown in this very same area.
Note: however, there is considerable doubt that there can be multiple cones of depression as shown in the residual drawdown maps provided by Barwon Water when there is only one clearly defined water extraction area at Gerangamete. There should by all accounts, be only one cone of depression.



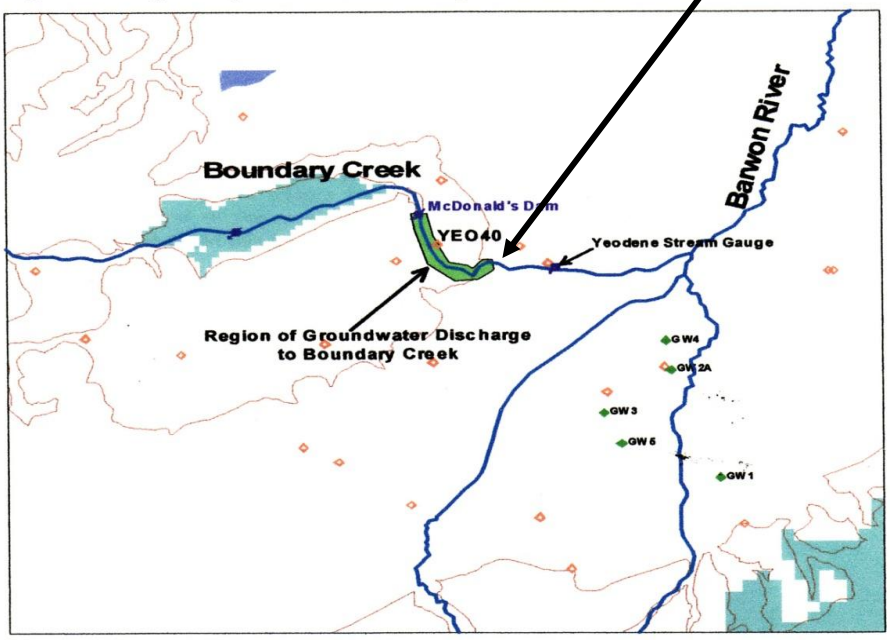
The 2007 drawdown map.

The Big Swamp.

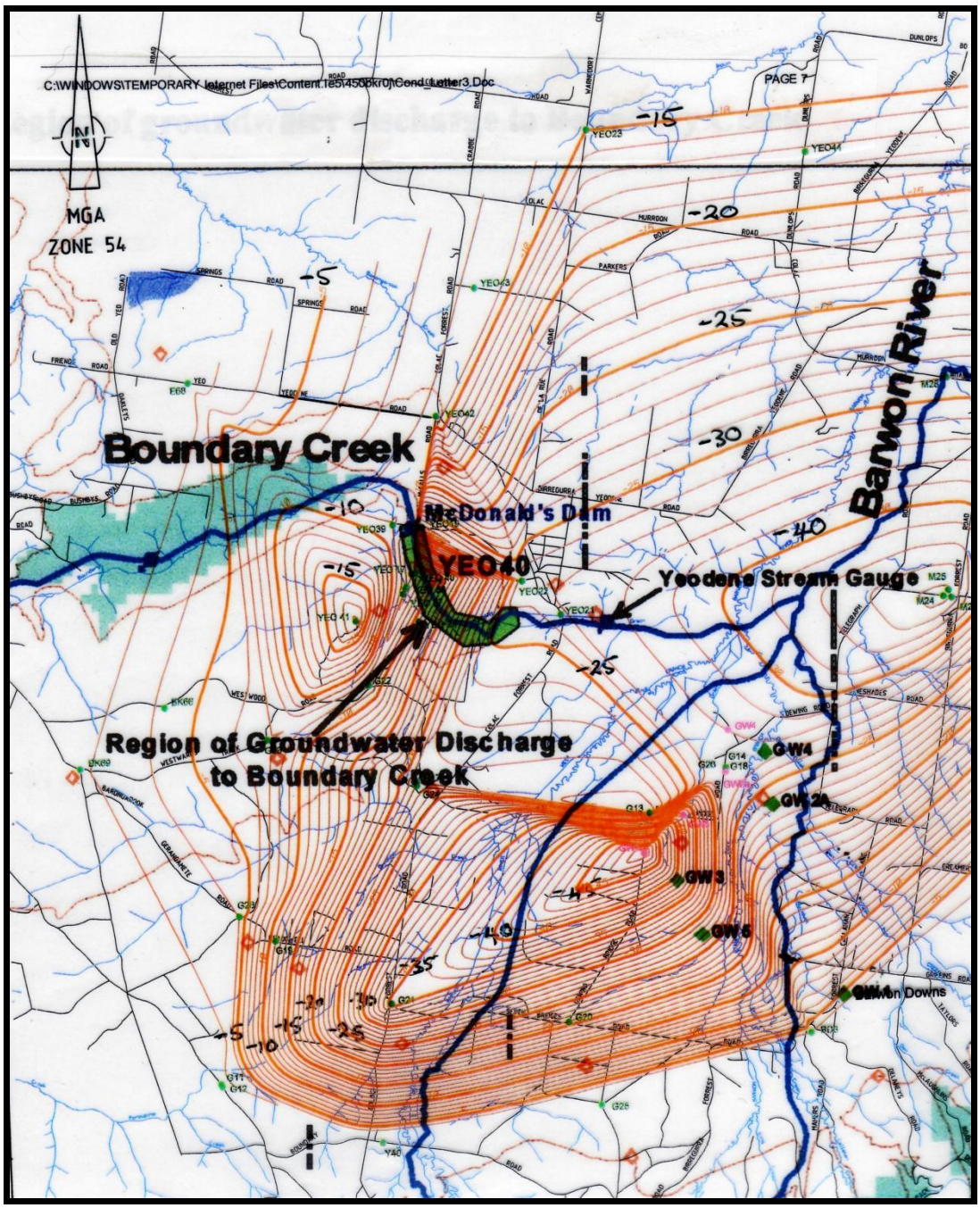
SKM

Barwon Water
Recommendations for Groundwater Licence Conditions
14 May, 2003

■ **Figure 3-1 Region of groundwater discharge to Boundary Creek**

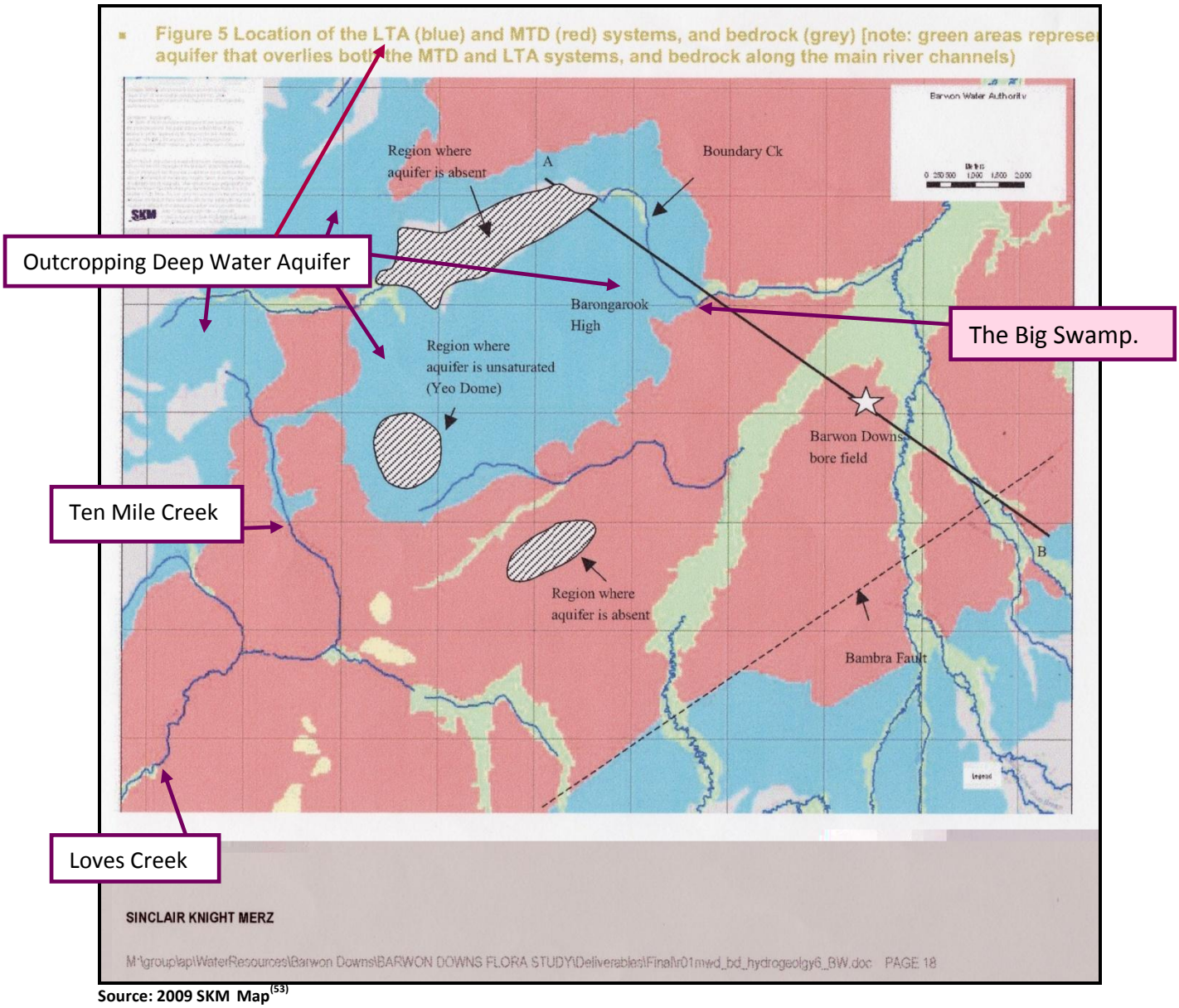


There can be little doubt that the outcropping deep water aquifer has been lowered many metres below where the groundwater discharges into Boundary Creek. Much of the water entering this green area on the map will soak down into the depleted aquifer. The only time Boundary Creek will flow will be during high rainfall events. In the first rainfall flushes there will be elevated acid levels and significant loads of heavy metals flowing down the creek and into the Barwon River. Boundary Creek is a "Dead Creek."



Superimposed maps found on page 90.

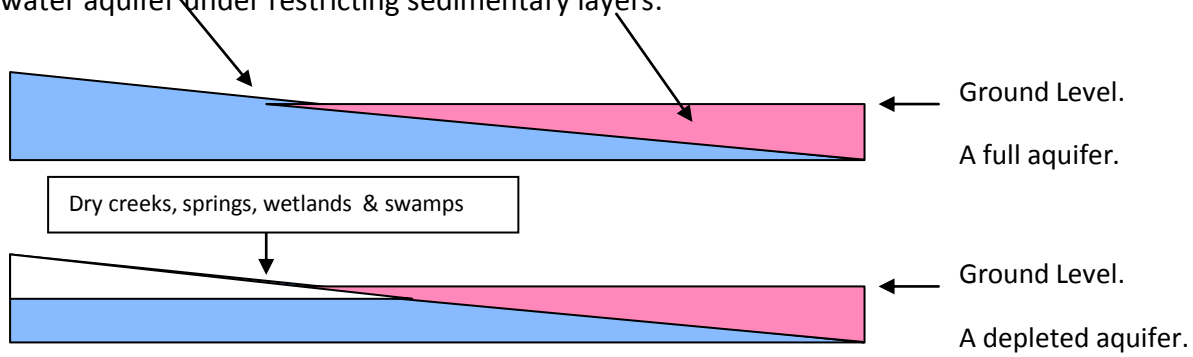
As with much of the data obtained from Barwon Water detail is quite often difficult to read. Some of the red drawdown contours have been marked in in black (e.g. -25) to assist with the understanding of the "holes" created by the groundwater extraction.



Source: 2009 SKM Map[53]

The blue shaded area indicates where the deep water aquifer outcrops at the surface. The pink shaded areas are overlaying the blue aquifer.

The Big Swamp would be in the region between the outcropping and confining of the deep water aquifer under restricting sedimentary layers.



The diagrams on pages 26, 27 also depict these phenomena.

2009. Flora Study Completed.[53]

"Otway Water – Barwon Water Flora Studies 1986-2009 , Book 9"[36] presents an entirely different result to the published results of a study[53] conducted by Sinclair Knight Merz (SKM) on behalf of Barwon Water. The 2008-09 SKM study centred on the Boundary Creek Catchment.

After the Sinclair Knight Merz report[53] was tabled Barwon Water released a media statement (April 23, 2009. REF: 063/09). The release contained half truths, misleading information and incorrect statements that masks some incredibly poor research. The media release was headed "**Flora study inconclusive**."

Otway Water Book 9[36] demonstrates that conducted differently, this flora study would have had another and more plausible result. If the "***conducted field surveys, reviewed groundwater levels and assessed new and previous data***,"[53] had been completed as suggested it was, the results would have shown Boundary Creek and the Big Swamp to be seriously degraded from groundwater extraction at the Barwon Downs Borefield. However, an inconclusive finding is to Barwon Water's favour as it does not reflect badly on the management and operation of the borefield. Such a finding is not unexpected.

Suffice is to say, however, conclusive results would have been reached if the will to do so was present. Narrow study briefs and lack of effort to implement recommendations made over the last 2 decades reflects badly on the groundwater extraction management at Barwon Downs.

The 2009 recommendations outlining future studies that would enable a conclusive result to be arrived at, are mirror images of those recommendations that were made in 1986, 1991 and 2002, recommendations that have never been implemented. The fact that recommendation after recommendation have been mirrored over a three decade period and have never been implemented suggests that a conclusive result will never be arrived at if Barwon Water continues to be responsible for the conducting and commissioning of the studies.

However, there are statements within the SKM Flora Study 2008, Final 1, 14 April 2009 report[53] that are worthy of note.

a. Page 2. "*The interconnectivity between this surface water supplementary flow and the groundwater system is unknown, but the shape of the groundwater elevation model around Boundary Creek indicates that leakage from the creek to the LTA (Lower Tertiary Aquifer) is occurring*."
   NOTE: During dry periods the supplementary flows that are released from the Colac Otway Pipeline into Boundary Creek disappear into the unconfined aquifer disappearing into the Big Swamp. On these occasions Boundary Creek is dry below the Big Swamp.
b. Page 5. "*The data obtained indicates that there has been widespread drying of the natural environment in the borefield area, both in the recharge area and above the aquitard*."
   NOTE: This may be true but streams to the north and south have continued to flow from the Barongarook High intake region.

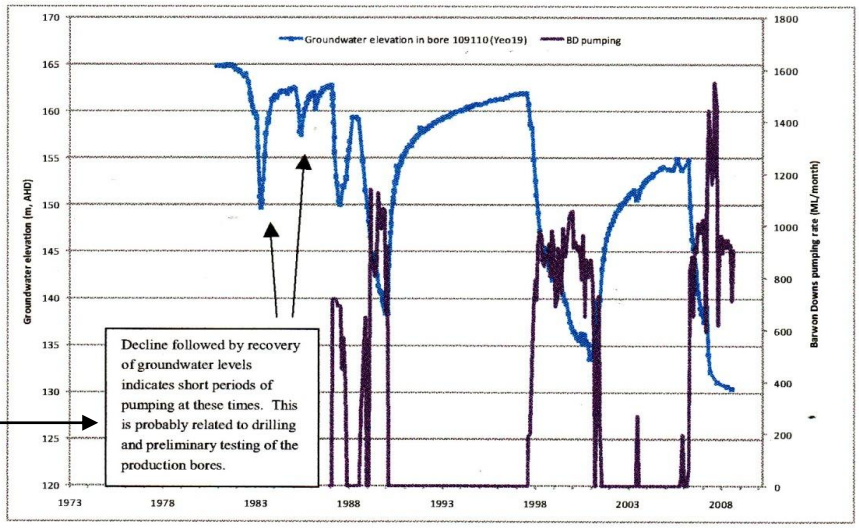
c. Page 19. "*Groundwater discharge (or baseflow) to Boundary Creek in the absence of groundwater pumping was calculated using the baseflow separation techniques to be approximately 60 ML/month or 2 ML/day SKM, 2002a).*"
NOTE: It was stated that these figures should be considered to be indicative only. However, this statement appears to be saying that there should be approximately 2 ML/day flow if there was no groundwater extraction taking place. A dry Boundary Creek would suggest that groundwater extraction is preventing this baseflow discharging into the creek.

d. Page 22. "*On the western flank of the Barongarook High groundwater levels have a poor correlation to pumping*."
NOTE: This "poor correlation" tends to agree rather strongly with the findings of the Department of Sustainability and Environment report of 2006 that groundwater decline in the South-Western region of Victoria is in the order of 10 cm a year(see page58).
NOTE: On this same page 22, it goes on to state that any decline in groundwater levels on the unconfined deep water aquifer western and central area of Barongarook High are primarily due to rainfall changes, NOT groundwater pumping **(see fig. 9 page 95)**. The changes in the western and central regions of Barongarook High are extremely small when compared with the graphs of the changes in the eastern section of the Barongarook High where groundwater extraction is being conducted **(see fig. 8 page 95)**.

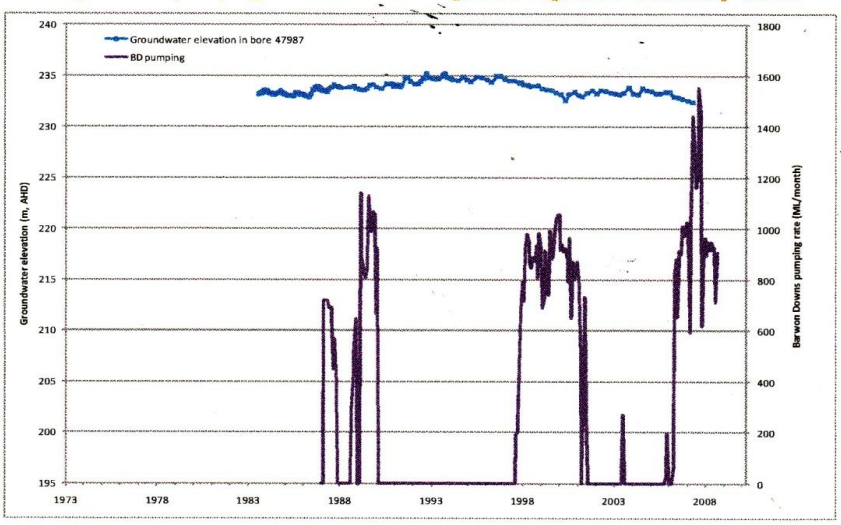
e. Page 22. "*This reversal of groundwater flow has caused this reach of Boundary Creek to change from a gaining stream (i.e. releasing groundwater discharge) to a losing stream (i.e. losing flow to the aquifer...)*."
NOTE: The fact that Boundary Creek is often a losing stream is not apparently in dispute but the cause of this phenomena is not clearly defined nor is the cause(s) being considered.

SKM

- **Figure 8 Pumping from the Barwon Downs borefield (ML/month) and groundwater level response in the LTA to pumping on eastern flank of Barongarook High near Boundary Creek**



- **Figure 9 Pumping from the Barwon Downs borefield (ML/month) and groundwater level response to pumping on western Barongarook High near Boundary Creek**



SINCLAIR KNIGHT MERZ

M:\grouplap\WaterResources\Barwon Downs\BARWON DOWNS FLORA STUDY\Deliverables\Final\r01mwd_bd_hydrogeology6_BW.doc PAGE 24

This box contains these words. "***Decline followed by recovery of groundwater levels indicates short periods of pumping at these times. This is probably related to drilling and preliminary testing of the production bores***." During this period of time Barwon Water extracted 10 000 ML of water including at least 50% of the Greater Geelong's water supply through the 1982-83 drought. In reality this is "*probably*

related" to the cause of the graph in Figure 8 above having these sharp water level declines.

Three Recurring Aspects.

This is an appropriate time to draw together three aspects of the draining of the Big Swamp that have been closely related and recurring since 1984.

1. Vertical leakage,
2. Sustainability, and
3. Recommendations for future studies.

Vertical Leakage, Sustainability & Recommendations.

The two maps on pages 67 & 68 show the drawdown impact out to the 3 metre mark to the west. It is significant that Barwon Water will not provide the drawdown figures out to the zero mark especially when considering the diagrams below. The area of the Big Swamp is being influenced in two ways. The first is the lowering of the deep water aquifer where it outcrops at the surface and the much more subtle influence of the drying out that takes place at higher levels as moisture is drawn down filling the void.

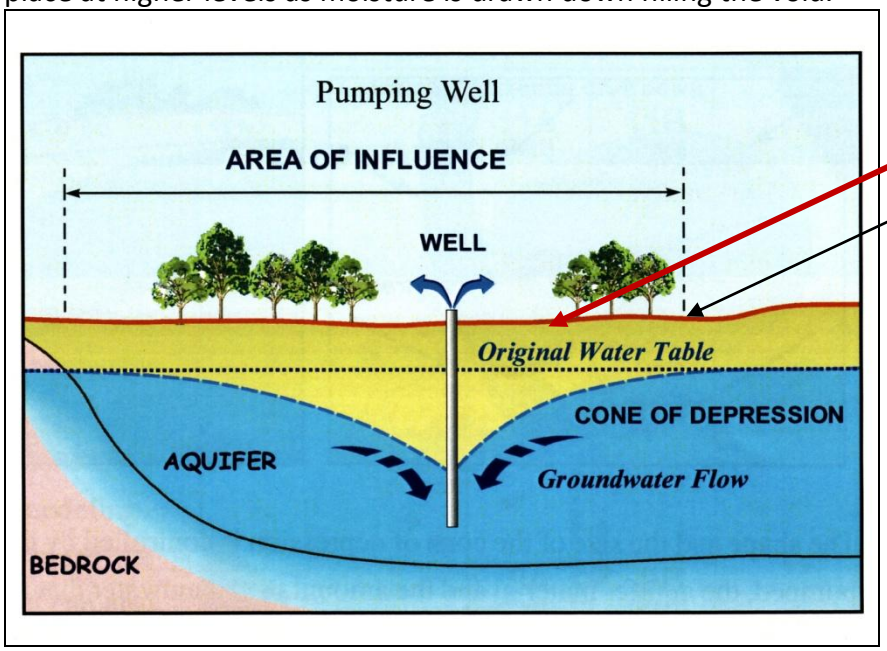


Diagram Source –Centre for Groundwater Studies, Blackwood South Australia.

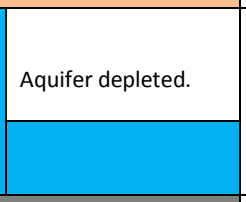
The area of drawdown influence goes right out to the point of zero drawdown effect. The diagram above, from the Australian Centre for Groundwater Studies highlights this fact. If the Big Swamp was to be marked in on the diagram above it would be well inside the cone of depression, a considerable distance from the zero area of influence.

When a confined aquifer is full it forces water up into the layers above and over time reaches a state of relative equilibrium. The unsaturated zone at the surface oscillates between being relatively dry during summer and relatively saturated during winter. However, this equilibrium can be upset with regular and sustained amounts of groundwater extraction from the deep water aquifer below. As the aquifer is depleted the phenomenon of vertical leakage downwards takes place. Over an extended period the aquitard above the confined aquifer begins to dry out and causes a similar downwards leakage effect to take place all the way from the surface. Considering the amount of water extracted from the Barwon Downs borefield and the extended period of 24 hours a day, 365 days a year

pumping for some years, the probability of vertical leakage is beyond dispute. This vertical leakage downwards has been defined by SKM as one form making the deep water aquifer that Barwon Water is pumping from sustainable.[55]

During rainfall events even when the sediments are seriously drying out below, the surface layer supporting lush pastures and maintenance of vegetation, can give the false impression that things are returning to "normal." However, a slow and insidious drying out of deeper layers may take years to impact and become apparent at the surface.

Vertical Leakage from One Layer to Another.

Sky – rainfall soaks into the ground 	A certain amount of rain falling soaks into the ground.
Unsaturated zone 	In the gaps between particles of soil this zone contains both air and water.
Aquiclude/Aquitard 	An aquitard is a confining bed but can be saturated and can allow water to move slowly vertically through it An aquiclude is a confining bed that can be saturated allowing little water to pass through it at a greatly reduced speed.
Confined Aquifer  Aquifer depleted.	Confined aquifers are usually full of water. These aquifers are recharged where they are exposed at the surface and from leaky confining beds or aquitards above.
Aquifuge	An aquifuge is a layer containing minute amounts of water and doesn't allow water to pass through easily e.g. solid granite.

The blue and black arrows indicate movement of water in an unexploited aquifer. The Blue and red arrows indicate the movement of water when the deep water aquifer is unnaturally being depleted.

Leonard[44] discussed the distinct possibilities of vertical leakage in the district in 1984. A subsidiary objective of the 1987-91 test pump conducted at the Barwon Downs borefield was to examine groundwater movement between the deep water aquifer and the confining formations above. This has never been done. When Witebsky et al.[63] summarised and made recommendations for Stage One groundwater extraction in 1995, it was found that the there was insufficient monitoring done during the test pump to gain a clear understanding of the amount and influence of vertical leakage down into the deep water aquifer. Consequently the recommendation was made that in the advent of any revision of Barwon Water's licence, it should include a requirement to provide and monitor bore(s)

constructed into the overlaying clays to determine the amount of vertical leakage. To date there is no indication that this has ever been done, 23 years after it was first recommended.

Barwon Water was asked in February 2010, "*Is it also possible to have a copy of any work done or commissioned by Barwon Water, on vertical leakage between aquifers in the Barwon Downs borefield investigations?*"
Dated 16 February 2010, Barwon Water Ref: 55/100/0001C, the reply was, "*In relation to your request regarding any investigations Barwon Water has conducted with respect to vertical leakage between aquifers in the Barwon Downs borefield, there have been no such studies since the pre-licence renewal investigations in 2002-03.*" As far as can be determined this Otway Water Book covers all known pre 2002 investigations. These amount to none. In 2009 (see recommendations in red below) recommendations were once again being made to begin this work.

In 1984 Leonard[44] suggested that the Barwon Downs Borefield sustainability could include the following groundwater recharge abilities after borefield development:

- "***Enhanced natural recharge as a consequence of lowered water tables in the intake area and a reduction in rejected recharge and evapotranspiration losses,***
- ***Induced streambed infiltration from Boundary Creek and its tributaries,***
- ***Leakage from the overlying silty marl members,***
- ***Leakage from intercalated clay and silt layers within the basal Tertiary aquifer system,***
- ***Leakage from the fractures Otway Group basement rocks underlying the flanking graben, and***
- ***Natural recharge from possible as yet undelineated recharge zones along the Bambra Fault and other bounding structures***."

Following is a copy in full, of SKM's (**red** type) recommendations taken from pages 62-63 of the Barwon Downs Flora Study 2008 – Report 2009.[53]

6.Recommendations

The following recommendations are made to further investigate potential hydrological impacts on sensitive vegetation from ground-water extraction and other causes.

1. ***In consultation with relevant parties, design and implement a long term vegetation and hydrological monitoring program similar to that proposed for the Anglesea borefield (by Ecology Australia in 2008. This would involve:***
    - ***Evaluating the potential for pumping in the LTA*** (Lower Tertiary Aquifer) ***to cause a significant water table decline in the MTD*** (Mid Tertiary Aquitard)
    - ***Selecting a range of sites carrying hydrological sensitive vegetation with permanently-marked replicated plots of suitable size which would be monitored at a pre-determined frequency in late spring or early summer (November or December)***
    - ***Monitoring of floristic composition and cover/abundance of plant species using a higher resolution scale – the Domin-***

Krajina cover/abundance scale (Mueller-Dombois and Ellenberg 1974).

- ***Establishing where possible, control plots in comparable vegetation at sites as near as possible in the Otway Ranges which have not been subjected to hydrological modifications:***
- ***Installation and monitoring of bores to document the water table at the sites where vegetation is monitored.***

2. ***In conjunction with recommendations 1 a study should be undertaken of the whole of range of factors contributing to drying the catchment, and an assessment of their relative contributions to the drying conditions and consequent vegetation impacts, with a view to developing strategies (where possible) to ameliorate negative impacts.***
3. ***A study should be conducted to determine the merits – from a biological viewpoint – of supplementary flows in Boundary Creek. This would need to include investigations to evaluate the effect of Boundary Creek supplementary flows on the water table depth along the Boundary Creek channel where it directly overlays the LTA. The investigations should also assess the volume of supplementary flows required to maintain the desired the water table depth.***
4. ***On the basis of circumstantial evidence observed outside the sites surveyed for this study, it is recommended that a study be undertaken to determine whether acid sulfate soils are present in the catchment and assess the effect of drying conditions may have on these soils and the associated surface water systems (i.e. wetland and streams). The assessment should include the outcomes from the study identified in recommendations 1 to determine the key drivers of any identified impacts or risk due to the presence of acid sulfate soils.***

The similarity of these recommendations with ones made in 1984,[44] 1986[25], 1994,[11] 1995[63] and 2002[10] is remarkable.
The monitoring and evaluation of vertical leakage has been a constant; the 1994/2002 reports recommended to

- Select hydrological sensitive vegetation
- Have permanently marked plots
- Control plots
- Ameliorate impacts
- Choose a floristic composition
- Use the same cover/abundance scales
- Monitoring water table at vegetation sites;

and the 2002 report recommended that the details and implications of the supplementary flows need to be dealt with.
In regard to the Acid Sulfate Soils (ASS) a local Landcare Group, LAWROC, had provided definitive proof (see pages 72-77) that there was a serious problem within the Boundary Creek Catchment that should be investigated as part of Barwon Water's 2008 study.[53] This was never done despite the regulator, Southern Rural Water, making the assurances that the ASS in the Big Swamp would be investigated as part of the 2008 work.

The following extract is taken from correspondence from Chris Hughes, Manager Field Operations & Compliance, Southern Rural Water...

> Acid Sulphate Soils
>
> In accordance with condition 7 of the licence, SRW has required Barwon Water to undertake a detailed Flora Survey. Barwon Water has sought tenders from suitably qualified expert consultants and the successful tender has not yet been appointed. Barwon Water must consult with the Department of Sustainability and Environment regarding suitable consultants. The investigation into Acid Sulphate soils will be incorporated into the consultant's analysis and the completed report is expected by mid-2009.

Source: Extract from letter found in Otway Water Book 11, pages 96 to 98 at www.otwaywater.com.au

The CEO of Barwon Water was aware of the LAWROC Landcare's concern over Actual Inland Acid Sulfate Soils when denying on the 7:30 Stateline ABC program on 10 October 2008 that there was an ASS problem.

It would appear that vertical leakage, sustainability and the lack of implementation of recommendations are interwoven and require serious consideration when the tenure of this book is being evaluated.

2010.

Astounding CSIRO Finding.

In an address to the 2010 Groundwater Conference in Canberra, CSIRO Water for Healthy Country Flagship scientists spoke of a stream in New South Wales where it was found that increasing groundwater pumping by extracting over 40% of the calculated recharge amount will cause a 93% reduction in base-flow in the stream.[50]

If this same influence affected the flows in Boundary Creek with a recharge value in the order or 4 000 ML/year and with a 12 000 ML/year extraction, it would be expected that there would be profound influence on the Big Swamp wetlands.

The drying up of the Big Swamp when applying the Evans Response Ratio (see page 62) would be a mild impact in comparison with this Rassam et al.[50] report.

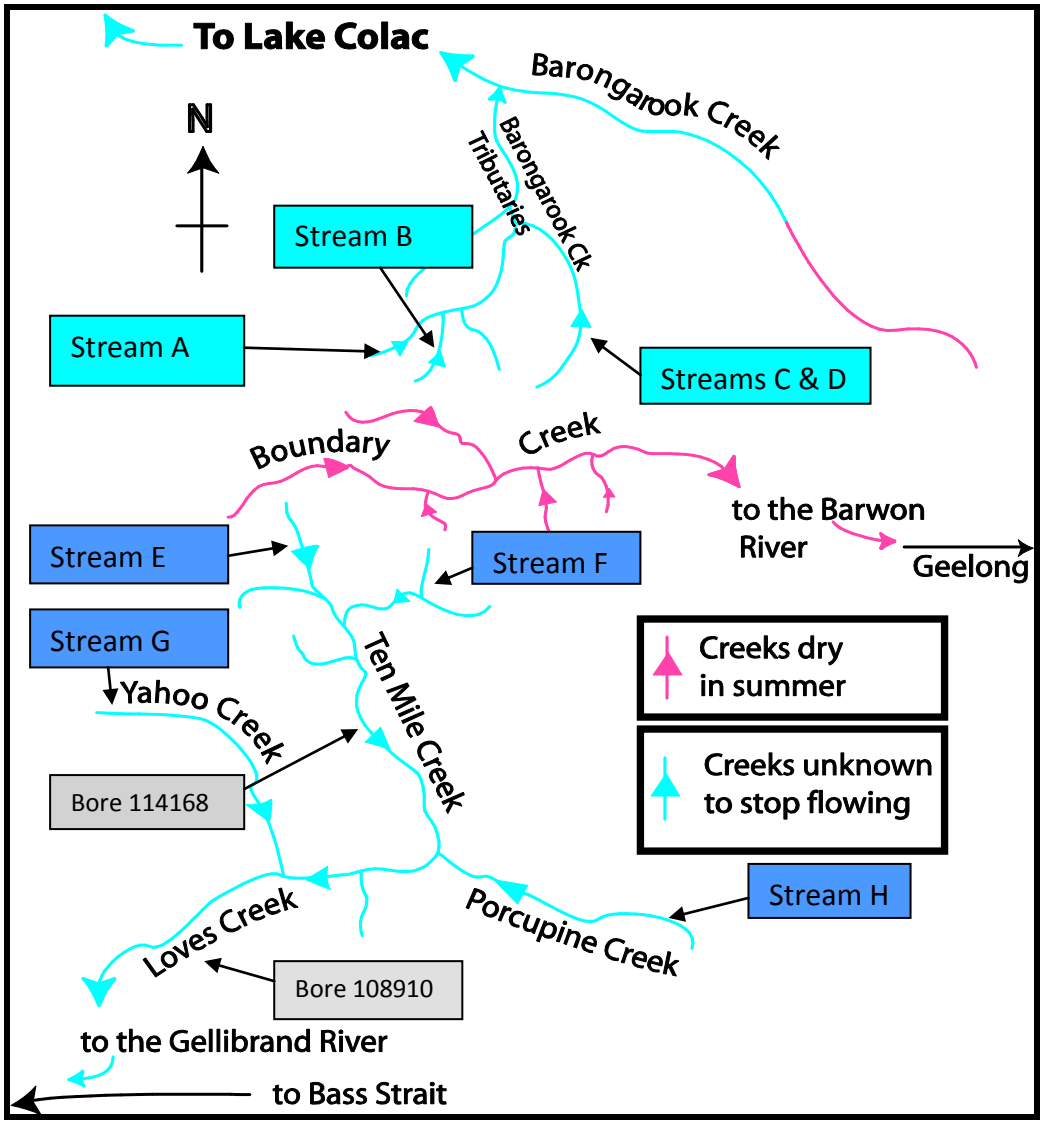
Creeks in the Loves Creek Catchment and tributaries of the Barongarook Creek continue to flow(2010).

Since groundwater extraction started from the borefield at Barwon Downs, Boundary Creek had been dry on at least 1000 days. However, the streams to the north and south of the Boundary Creek Catchment continued to flow through one of the worst droughts, 1997 – 2009, on record.

The map on page 5 indicates that there is an aquifer divide between the tributaries of Barongarook Creek to the north of the Boundary Creek Catchment and an aquifer divide between the tributaries of Loves Creek and the Boundary Creek Catchment to the south. In essence an aquifer divide splits the aquifer into parts. This can be the result of faults,

volcanic action, uplifts and other movements that have occurred in the earth's crust. Often the divides are poorly understood and as often are loosely defined. However, there is no doubt from the work so far conducted that there exists aquifer divides in these areas below.

The streams to the north of the Boundary Creek Catchment are marked on the map as Streams A, B, C and D. The streams to the south are marked as Streams E, F, G and H.



The headwaters of Streams A-G start in the Barongarook High area as do the headwaters of Boundary Creek. The streams A-G continued to flow whereas Boundary Creek regularly dried up. Considering that Barongarook High is the highest point in this section of the foothills of the Otway Ranges, and it is an accepted fact that rain falling on the sands of the Barongarook High replenishes the same aquifer formation that rejects water into these streams,[(42)(43)(55)] the only differing factor is that Boundary Creek is affected by extensive groundwater extraction at the Barwon Downs Borefield.

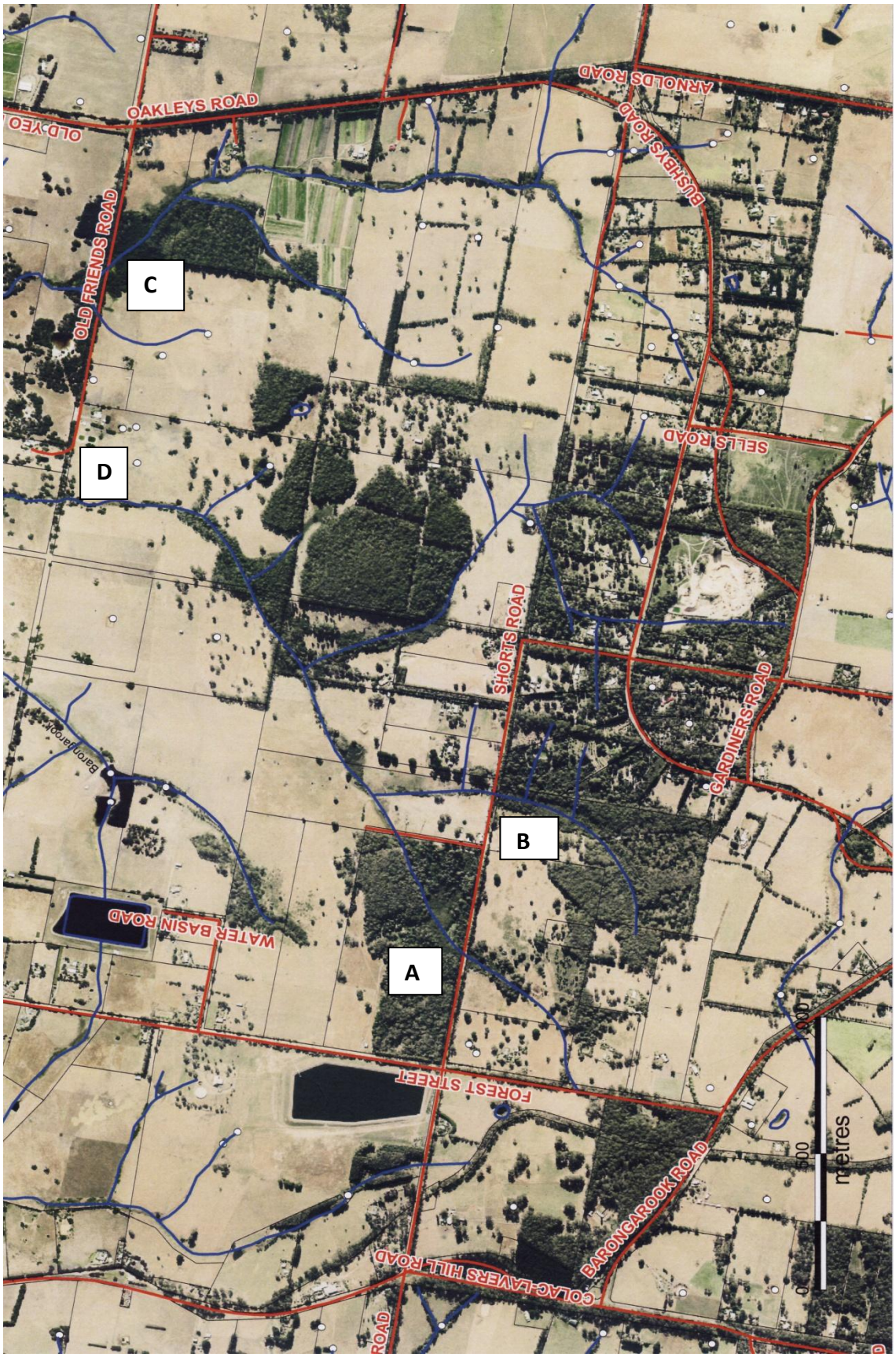
BOUNDARY CREEK.

Boundary Creek as it begins to dry after a rainfall episode. The toxic looking " sludge" evident in this picture, comes from upstream out of the Big Swamp.

Boundary Creek no longer flowing over the spillway at the Yeodene stream flow gauging station at the Colac to Forrest Road bridge. This has been a regular occurrence since groundwater extraction at the Barwon Downs Borefield.

THE BIG SWAMP – seriously impacted by acid water and acid creep.

Tributaries of Barongarook Creek to the north of the Boundary Creek Catchment.



STREAM A.

This stream has never been known to dry up. It has continued to flow through this latest drought as the following statutory declarations indicate. The photographs show vibrant healthy wetlands from where this stream originates and flows through.

I, MICHAEL RICHARD KENNETH POTTER.

of TINTERN LOOP. HILLSIDE in the State of Victoria do solemnly and

sincerely declare

THAT I previously owned a property on the corner of Forest Street South and Shorts Road Ellimeyt. I purchased this property in 1997 and sold it in August 2007. A significant part of the land was covered in bush surrounding an old quarry site that has long ago become overgrown with many species of native vegetation. There was always numerous wildlife in this bushland and was a major attraction of the property. Springs originated from this area and a creek flows into it from the south and out of it to the east into the neighbouring property as indicated on the accompanying map marked MAP ONE. Throughout the period of my ownership this creek never stopped flowing to the best of my knowledge. I did not check it everyday, but everytime I checked it, it was flowing. Even in summer from December to February and March, when rainfall was at its lowest.

AND I make this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of an Act of the Parliament of Victoria rendering persons making a false declaration punishable for wilful and corrupt perjury.

DECLARED at KEILOR DOWNS in the State of Victoria this FOURTEENTH day of JANUARY in the year of 2010

Michael R.K. Potter

Before me

A JUSTICE OF THE PEACE FOR VICTORIA
Reg No 11755
Donald Richard Larter
221/111-139 Coburns Rd,
Brookfield 3338

J.P.

These two photographs were taken from Shorts Road. They show a lush, vibrant and healthy wetland compared to the Boundary Creek wetlands in the Big Swamp.

State of Victoria – Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, Jan maree Scoble [full name],

of 305 Forest Street, Ellimiyt [address],

Lending Officer [occupation], do solemnly and sincerely declare that:-

I have been the owner of the above mentioned property since October 2007 & from that time until now the water supply running through my property has been continual. The creek runs constantly & always has fresh running water.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Colac

in the State of Victoria, this 11th day of

February 2010

Signature of person making this declaration
[to be signed in front of an authorised witness]

Before me, (CPA)

Signature of authorised witness

CHRISTOPHER ALLAN KEMP
175 BROMFIELD STREET, COLAC VIC 3250

The authorised witness must print or stamp his or her name; address, and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

Jan Scoble purchased Michael Potter's property.

STREAM B.

This stream passes under Shorts Road a little further to the east and has also never been known to dry up.

At the culverts on Shorts road. The wetlands to the south of Shorts Road are very similar to the ones on the Potter/Scoble property, Stream A.

State of Victoria – Evidence Act 1958

STATUTORY DECLARATION

I, John E. Duggan. [full name],

of 185 Shorts Road Barongarook. Victoria 3249 [address],

Retired [occupation], do solemnly and sincerely declare that:-

We have lived at the above address since we purchased this property from Mr Ron Phillips in 2001, who told us this creek has never run dry.

Since our tenure this creek has never run dry, and has been a source of water for our horses and cattle. It has also attracted the wild-life of the area as well as seasonal ducks.

We hope this healthy state of the creek will continue for ourselves and for many others who share the asset with us.

We are. Yours faithfully.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Colac.

in the State of Victoria, this 25 day of January 2010

J Duggan

Signature of person making this declaration [to be signed in front of an authorised witness]

Before me,

Signature of authorised witness

R.P. Hynes HealthWise Pharmacy
Alex Pappas, B Pharm., M.P.S.
56 Corangamite Street
Colac 3250
Telephone: 5231 2041

The authorised witness must print or stamp his or her name, address, and title under section 107A of the Evidence Act 1958 [Vic.] (eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

STREAM C & D.

Olive Parker's property has two tributaries flowing through it. The stream to the west that Olive writes about is marked **D** on the map and the stream to the east is marked **C**.

The middle of summer with springs running out of the bank.

These photographs are all at site C.

Looking down over the wetlands to the south of the Bridge.

State of Victoria – Evidence Act 1958

BP DOLL 26

STATUTORY DECLARATION

I, Olive Stella Parker.
[full name]

of 115 Old Friends Rd Yeo
[address]

Farmer.
[occupation], do solemnly and sincerely declare that:-

I have lived at the above address for 59 years. When my husband and I purchased this property we were told that the creek to the west of the house was known to have never run dry as far back as 1903. Since arriving at this property in 1950 the creek has never stopped flowing and has been an invaluable water supply for our stock. During the recent dry years our dams haven't filled. Due to this the creek has been very important to us.
In 1968 we purchased the O'Reillys property to the east of our property. This land also has a permanat creek on it. This creek has a large wetland area which is home to numerous birds. This water supply is also valuable to us.

I acknowledge that this declaration is true and correct, and I make it with the understandin and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Colac

in the State of Victoria, this 16 day of September 2009

O. S. Parker
Signature of person making this declaration
(to be signed in front of an authorised witness)

Before me,

Signature of authorised witness

Joseph Sahhar

Colac HealthWise Pharmacy
Alex Pappas, B.Pharm., M.P.S.
S 3-7 Safeway Complex 52 Bromfield St. Colac Tel: 5231 4022
21586D

The authorised witness must print or stamp his or her name, address, and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

Commonwealth of Australia

STATUTORY DECLARATION

Statutory Declarations Act 1959

1 *Insert the name, address and occupation of person making the declaration*

I,[1] Jennifer Rosemary Broome
110 Oakleys Rd
Yeo Farmer

make the following declaration under the *Statutory Declarations Act 1959:*

2 *Set out matter declared to in numbered paragraphs*

[2] During the period from 1938 until the date below, the creek that runs under the bridge on Old Friends Road at Barongarook, at S38 38748 E 143 62891 (Garmin etrex 12 GPS used) has never run dry.

I understand that a person who intentionally makes a false statement in a statutory declaration is guilty of an offence under section 11 of the *Statutory Declarations Act 1959*, and I believe that the statements in this declaration are true in every particular.

3 *Signature of person making the declaration*

[3] JBroome

4 *Place*
5 *Day*
6 *Month and year*

Declared at [4] COLAC on [5] 14TH of [6] JUNE 2007.

Before me,

7 *Signature of person before whom the declaration is made (see over)*

[7]

8 *Full name, qualification and address of person before whom the declaration is made (in printed letters)*

[8] ADAM JOHNSTON
SENIOR CONSTABLE 33642.

POLICE STATION
Queen St. Colac Vic 3250

Date: 14/6/07

Note 1 A person who intentionally makes a false statement in a statutory declaration is guilty of an offence, the punishment for which is imprisonment for a term of 4 years — see section 11 of the *Statutory Declarations Act 1959*.

Note 2 Chapter 2 of the *Criminal Code* applies to all offences against the *Statutory Declarations Act 1959* — see section 5A of the *Statutory Declarations Act 1959*.

Stream D.

The site Jennifer is referring to is Stream C.

The stream marked D has anecdotal history of being known to have run continuously since around 1903. The story goes that goats, horses, cattle, sheep and even camels were brought to this site to survive a severe drought sometime in the early 1900s.

Unfortunately any written record of this happening has not as yet been found.

Page 110

Tributaries of Loves Creek to the south of the Boundary Creek Catchment.

STREAM E.

Maggios Wetland and peat swamp.

Photos taken December 2009.

Maggios Wetland in the headwaters of Ten Mile Creek and at the top of the Barongarook High, has maintained its integrity throughout the worst drought on record. This wetland of peaty swamp has had the added pressure of being surrounded by intense agroforestry. Late in 2009 bluegum forest to the north and west were harvested. The pine tree plantation to the east is still standing. These plantations require considerable amounts of soil moisture to survive. Even with these plantations taking their share of water the wetland continues to thrive. The dense wetland vegetation in this swamp is comparable to what the Big Swamp used to be like pre groundwater extraction at the Barwon Downs Borefield. Because of the saturated peats this wetland has defied all efforts to clear it.

STREAM F.

State of Victoria – Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, RAY MOORFOOT
[full name]

of 250 ROBINSON RD BARONGAROOK
[address]

DRIVER
[occupation], do solemnly and sincerely declare that:-

I HAVE LIVED AT THE ABOVE ADDRESS FOR 20 YEARS. WHEN I FIRST ARRIVED THE WEATHER AND RAINFALL WAS GOOD AND WATER SUPPLY TO DAMS WAS GOOD AND ALL DAMS ALWAYS HAD WATER. DURING SUMMER MONTHS THERE WAS NEVER A PROBLEM WITH WATER AS THE LARGE DAM IN THE GULLY WAS SPRING FED. UNFORTUNATELY THE DAM WASHED AWAY DURING A VERY HEAVY STORM. BUT NOT TO WORRY BECAUSE THE GULLY ALWAYS HAD WATER FLOWING ALL YEAR ROUND, LESS IN SUMMER, BUT ALWAYS SMALL AMOUNT OF WATER FLOWING. DURING THE DROUGHT I HAVE HAD ONE SMALL STOCK DAM DRY UP. LARGE DAM IN PADDOCK VERY LOW, BUT THE GULLY, EVEN THOUGH SMALL, WATER STILL FLOWED. IN ALL THE TIME I HAVE LIVED HERE THE SPRINGS HAVE ALWAYS HAD WATER - AT VARIOUS FLOWS - BUT ALWAYS FLOWED

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at COLAC

in the State of Victoria, this 21st day of

JAN 20 10

R Moorfoot
.....
Signature of person making this declaration
[to be signed in front of an authorised witness]

Before me, P. [illegible]
.....
Signature of authorised witness

P. CRATE?
4515 C 24830

The authorised witness must print or stamp his or her name, address, and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

STREAM G.

The Yahoo Creek also sources it water from the Barongarook High and supports colonies of platypus and other significant stream biota. This creek although a small flowing stream has never run dry at any stage during this last drought.

State of Victoria – Evidence Act 1958

STATUTORY DECLARATION

I, Alan Alexander Porteous
[full name]

of 1430 Colac–Lavers Hill Rd Kawarren Vic 3249
[address]

Retired farmer
[occupation], do solemnly and sincerely declare that:-

In 2006 I started looking for a small Lifestyle property to retire on that had some permanent water on it. During the drought I kept my eye on this property which has the Yahoo Creek running through it (I had been told that the Yahoo creek had never dried up). At the northern end of my neighbours ~~my properties~~ there is about 4 Ha of wet land + from the wetland the creek starts flowing about 1.5 km down to Lower creek.
After seeing for myself that the creek +wetland didn't dry up in droughts I bought the place.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Colac,
in the State of Victoria, this 2 day of February 2010

Before me, ...
Signature of authorised witness

.....
Signature of person making this declaration
[to be signed in front of an authorised witness]

R.P. Hynes HealthWise Pharmacy
Alex Pappas, B.Pharm., M.P.S.
56 Corangamite Street
Colac 3250
Telephone: 5231 2041

The authorised witness must print or stamp his or her name; address, and title under section 107A of the Evidence Act 1958 [Vic.]
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manager, Medical Practitioner, Dentist)

STREAM H.

The Porcupine Creek flows out of a National Park and a declared Reference Area. Although there is an extremely convincing case that drawdown over an aquifer divide from the Barwon Downs Borefield is having a detrimental impact on the Porcupine Creek Catchment, the creek has continued to flow.

The daily summer flow in the Porcupine is quite low and runs at approximately 300000 litres but has never stopped flowing.

These pictures were taken at the stream flow gauging station just upstream of the confluence with the Ten Mile Creek.

State of Victoria — Evidence Act 1958

[JP/DOJ.1/2000]

STATUTORY DECLARATION

I, PETER GORDON MACDONALD,
[full name]

of 130 MACDONALD'S ROAD KAWARREN VIC 3249,
[address]

DAIRY FARMER, do solemnly and sincerely declare that: -
[occupation]

Our family first moved to Kawarren in February 1945. Grandad, Sydney MacDonald and Dad, Gordon MacDonald dairy farmed together at 195 MacDonald's road.
In 1971 due to ill health, Granddad Sydney MacDonald had to leave the farm. Then I Peter MacDonald joined the dairy farming partnership with Gordon MacDonald until 1979 when I purchased 190 MacDonald's road.
Since 1945 the pools in Porcupine creek have never been dry at the bridge on MacDonald's road.
Since the gauging station on Porcupine creek was installed beside the bridge, the only time the flow has stopped at the gauging station was when I have been pumping (diverting) water to the dairy tank.

I acknowledge that this declaration is true and correct, and I make it with the understanding and belief that a person who makes a false declaration is liable to the penalties of perjury.

Declared at Kawarren

in the State of Victoria, this 14th day of January 2009

Before me, ...
Signature of authorised witness

L/S/C 31609
Colac Police

.....
Signature of person making this declaration
[to be signed in front of an authorised witness]

The authorised witness must print or stamp his or her name, address and title under section 107A of the Evidence Act 1958
(eg. Justice of the Peace, Pharmacist, Police Officer, Court Registrar, Bank Manger, Medical Practitioner, Dentist)

Barongarook High Intake Area.

Southern Rural Water and Barwon Water maintain that the major influence causing the detrimental impacts apparent along Boundary Creek is the extended drought. Up to 2010 both these authorities have had difficulty separating the drought and groundwater drawdown influences. However, if a thorough investigation is never conducted then it is impossible to reach a conclusive result. For this very reason decades of Boundary Creek studies have been inconclusive and in the 2009 study[53] conducted by Barwon Water it would seem that inconclusive results favour the exploiter of the groundwater resource. Having ignored identical recommendations made in several studies going back to 1986 that would have provided the necessary data in a natural and easily retrieved progression, it is doubtful that any authority will ever conduct adequate studies.[29][36] However, as shown in this book there is an abundance of data available in scattered locations that can be retrieved and provide the answer to the major and most possibly the only reason for Boundary Creek drying up.

Perhaps the most convincing argument that groundwater extraction is the major cause of detrimental impacts is that the creeks to the north and south of Boundary Creek have continued to flow non-stop. These creeks and their wetlands elevated high in the Barongarook High area, should have been affected in a similar fashion to Boundary Creek if the major influence was the extended drought. This has not been the case.

i) The major recharge area to the aquifers for the westerly tributaries of the Barongarook Creek, the Barwon Downs Borefield and the Loves Creek Catchment streams are the sands of the Barongarook High.
ii) All of these streams have been under the same drought influences.
iii) The only difference is that the Boundary Creek Catchment has experienced extreme drawdown from groundwater extraction at the Barwon Downs Borefield.
iv) The integrity of the wetlands high in the headwaters of these streams to the north and south of the Boundary Creek Catchment have been maintained.
v) The Boundary Creek wetlands of the Big Swamp have been decimated.

2010 (cont.)

March 2010 - The Big Swamp reignites after 12 years.

The generally accepted explanation for the wildfire that started in the Big swamp on 2 March 2010 is that the swamp had been smouldering since the fire of 1998.[24] Because the total area of the Big Swamp wetlands had dried out and there were extensive layers of dead and dry vegetation, the fire that started at the site of the 1998 fire quickly spread.

Acid and heavy metal "kill" downstream.

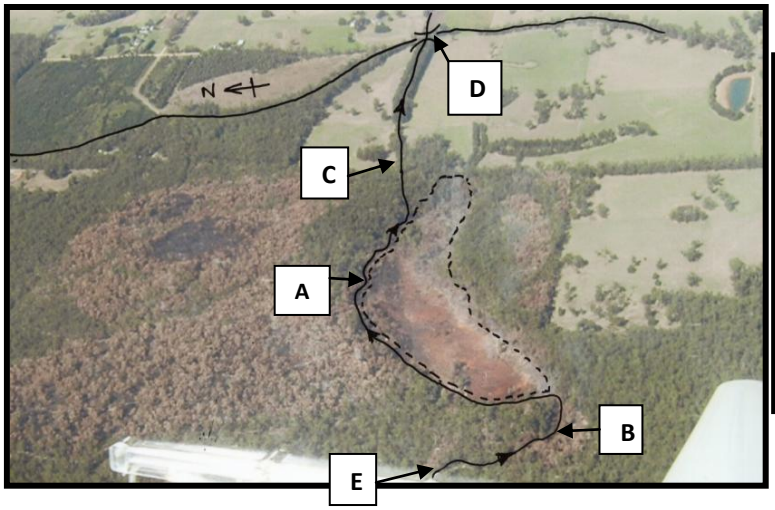
Big Swamp just before the 2010 fire.

Site of 1997 fire.

These two photographs are from the same site – before and after the March 2012 fires.

Dying and dead vegetation 2009.

After the 2010 winter.



Supplementary water disappears at site A along Boundary Creek on the north side of the Big Swamp.

Site B, supplementary water that was flowing throughout the drought of 1997-2009. It was never dry at this point.

Site B after the 2010 fires. Additional supplementary water was being released from McDonald's Dam. ⟶

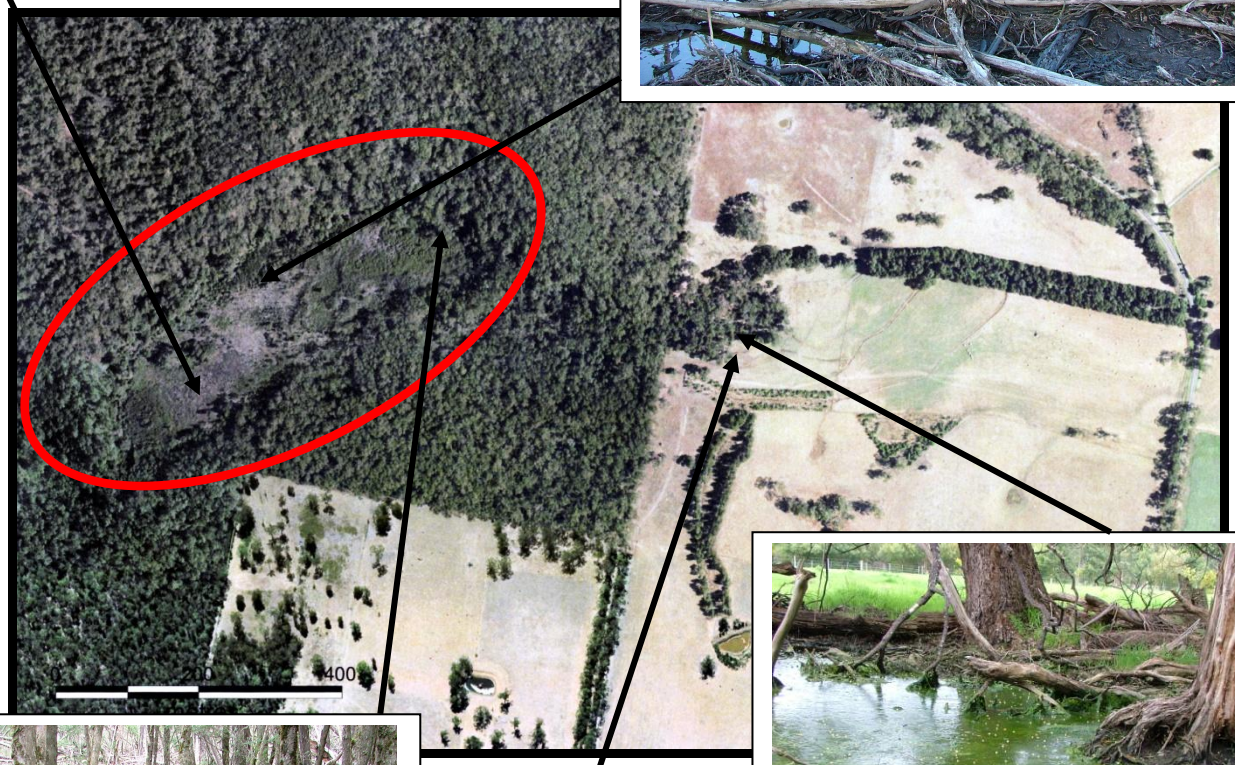
Flows at site B during the rainfall episode 15 January 2011.

Site B dry 1 February 2012 and dry at least as far upstream as site E.

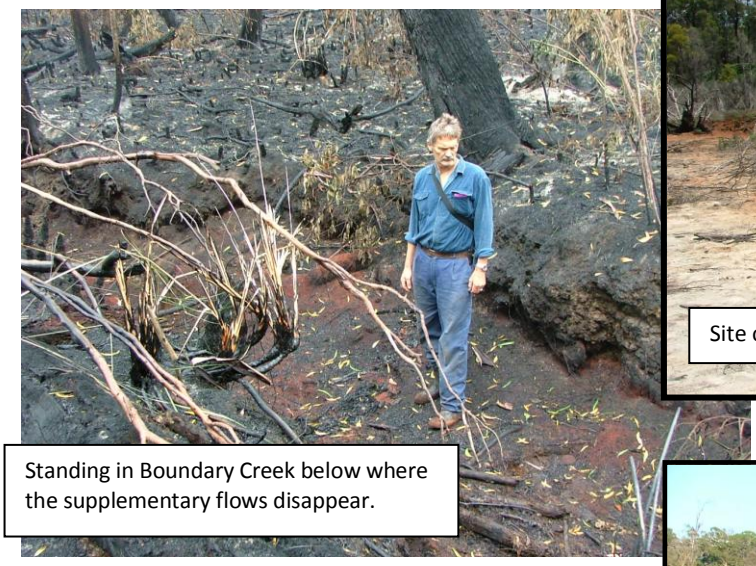
This area of the Big Swamp is south of site A (see page 118). Before the 2012 fires this site was experiencing acid and heavy metal “kill” downstream of the 1997-98 fire.

After the 2012 fire the peat had been burnt exposing the roots of the trees. This photograph was taken in the winter of 2011.

The Big Swamp 2009 before the March 2010 fires.



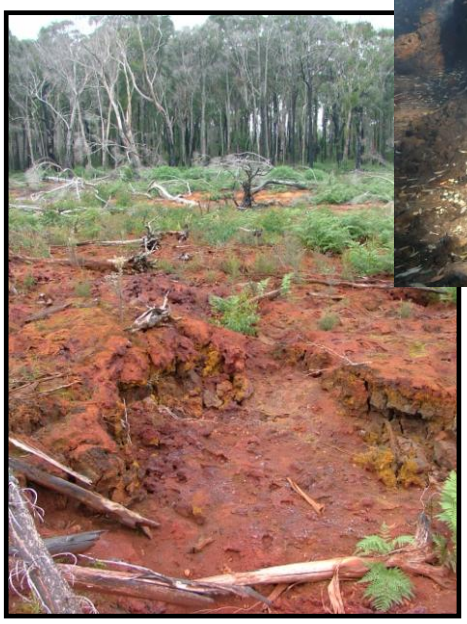
After the 2010 fires in the Big Swamp



Standing in Boundary Creek below where the supplementary flows disappear.

Site of the 1997-98 fire.

8 May 2011.



December 2010.

2011.

The Big Swamp Confirmed as an Actual Inland Acid Sulfate Soil Site.

In March 2010 scientists from the Southern Cross University, New South Wales, Environmental Analysis Laboratory collected Big Swamp samples and completed the report on these findings 25 February 2011.[16]

This report confirmed that the Big Swamp was an Actual Inland Acid Sulfate Soil site and in fact had one sample return a reading of over 16% S_{CR}. Only two other sites in Australia have recorded readings over 16%.

2011-2012.

Fire-fighters are blamed.

An interesting twist to the possible causes of the Big Swamp drying out became apparent in two documents of this period.

The Crawford et al.[14] document contained this statement:
"***It is understood that in Boundary Creek, AASS has been created by an unsuccessful attempt to extinguish a peat fire by draining the peat.***" (AASS – Actual Acid Sulfate Soil)

In Barwon Water's draft Water Supply Demand Strategy for the next 50 years[6] it states:
"***Q. What is the cause of acid sulphate soils at Big Swamp on Boundary Creek at Yeodene?***

A. A range of factors are likely to have contributed to changes at this site, including:

- ***An outbreak of fire on the swamp in 1997 which started in the adjacent private property***
- ***Extensive drainage works conducted for fire management purposes***
- ***Extensive on-site fire management burning within the swamp to reduce fire risk.***"

Any fire control activity has involved attempts to flood the Big Swamp to extinguish the fire and any attempt to burn within the swamp boundaries would only perpetuate the continuation of the smouldering of the peat leading to further outbreaks of wild fire.

Wanting to confirm this a letter was sent to the Colac Region 6 office asking for comment.

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Landcare Victoria

Date 12-03-2012

Brian Brady CFA
Bromfield Street
Colac
Vic 3250

Dear ~~Mike~~ Brian,

Re: cause of Actual Acid Sulfate Soils and fire fighters draining the peat.

It has come to my attention that there seems to be a concerted effort to suggest that the drying out and creation of an Actual Acid Sulfate Soil (AASS) site in the Big Swamp/Jurassic Park has been caused or partially caused by the efforts of fire fighting procedures.

Quote from source one:
"It is understood that in Boundary Creek, AASS has been created by an unsuccessful attempt to extinguish a peat fire by draining the peat."

Quote from source two:
*"**Q.** What is the cause of acid sulphate soils at Big Swamp on Boundary Creek at Yeodene?*
***A.** A range of factors are likely to have contributed to changes at this site, including:*

- *An outbreak of fire on the swamp in 1997 which started in the adjacent private property*
- *Extensive drainage works conducted for fire management purposes*
- *Extensive on-site fire management burning within the swamp to reduce fire risk."*

Brian, could you make comment on these above mentioned quotes, please?

Our Group would also like specific answers to the following questions.
Has the peat been drained to extinguish the fire? If so when?
Has extensive drainage works been conducted for fire management purposes? If so when?
Has there been extensive on-site fire management burning within the Big Swamp and if so when was this done?

Hoping to hear from you soon,
Regards,

Malcolm Gardiner.

In due course the following reply was received.

Subject: Reply to acid sulphate letter

From: Brian Brady (B.Brady@cfa.vic.gov.au)

To: otwaywater@yahoo.com.au;

Date: Tuesday, 24 April 2012 2:45 PM

Hi Malcolm, in response to the two quotes in your letter.

Quote 1..Draining the peat was never considered an option by CFA or any of the organisations that have been in a supporting role in dealing with this situation, it is certainly not documented as a control option, in fact it is quite the opposite to what we considered early on in the event and that was to flood the area, not to drain it.

Research has since indicated that the drier the peat the greater chance of it self combusting so draining it is not an option.

Quote 2..point two and three regarding the "drainage works" conducted, as in the first quote response, there were no drainage works conducted, the trench that was constructed was done so to create a physical break in the continuity of the peat so that it would burn to an edge and run out of "available fuel" when it reached the break. CFA have no technical expertise in draining swamps nor was any sought and, as above, draining the swamp would create more problems than it would have solved.

There was no fuel reduction burning (fire management burning in the quote) in the swamp area whatsoever. The area burnt within the swamp was that consumed during the two main fire events that occurred in the swamp area in October 1997 and March 2010.

One of the control strategies proposed after the 2010 fire was to burn out the dead vegetation within the swamp that had accumulated after the fire but this option was never acted on due to the fact that it may have set any unburnt peat alight and also it was considered too dangerous to have personnel walking on the peat surface in case the crust on the surface gave way and the personnel may have sunk into what may have been powdery ash under the crust which may still have been hot.

There is still the proposal to construct a clay plug along the eastern trench and part of the southern trench which is designed to increase the moisture level of the peat to prevent the peat drying out to the point of self combustion and to also extinguish any pockets of smouldering peat under the surface. The "plug" proposal is endorsed by Latrobe University and will be proceeded with if funding becomes available.

The matter of acid sulphate soils occurring after the fires and issues about the water table are completely outside CFA's scope of responsibility and expertise and therefore CFA will not involve itself in the resolution of these issues.

Regards

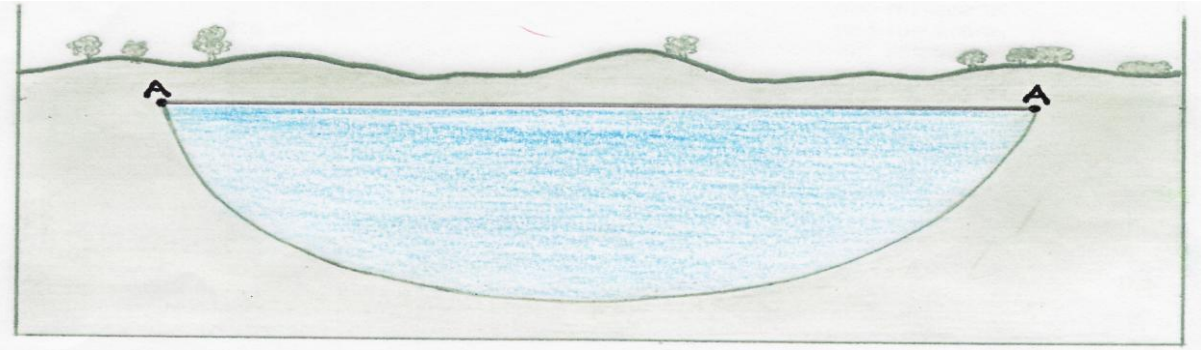
Brian Brady

2012.

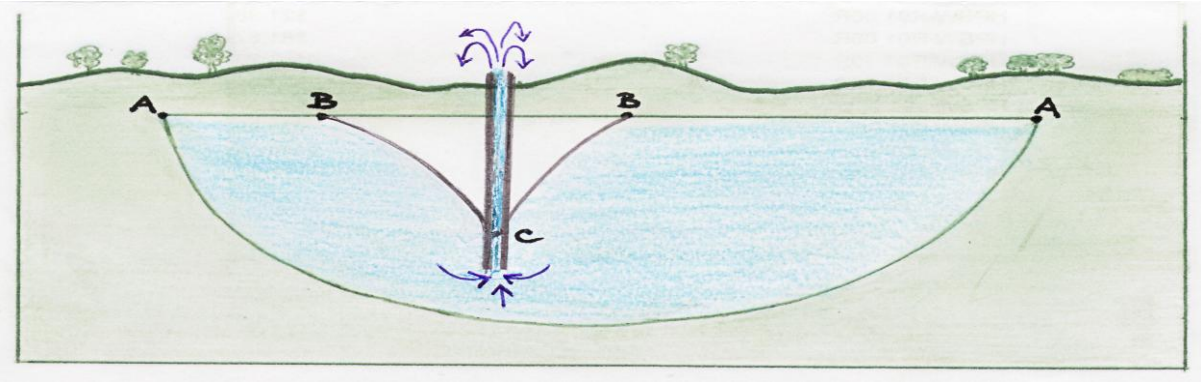
Groundwater extractions from the Barwon Downs Borefield were stopped 11 August 2010 and the explanation for this was that surface water reservoirs, extractions from the Anglesea Borefield and other water sources no longer necessitated the use of Barwon Downs into the near future.

On 1 February 2012, eighteen months after pumping had stopped the observation bore (see page 88. Bore Number 109112) at the Colac to Forrest Road Bridge over Boundary Creek was still sucking air, indicating that the aquifer water table was still levelling out.

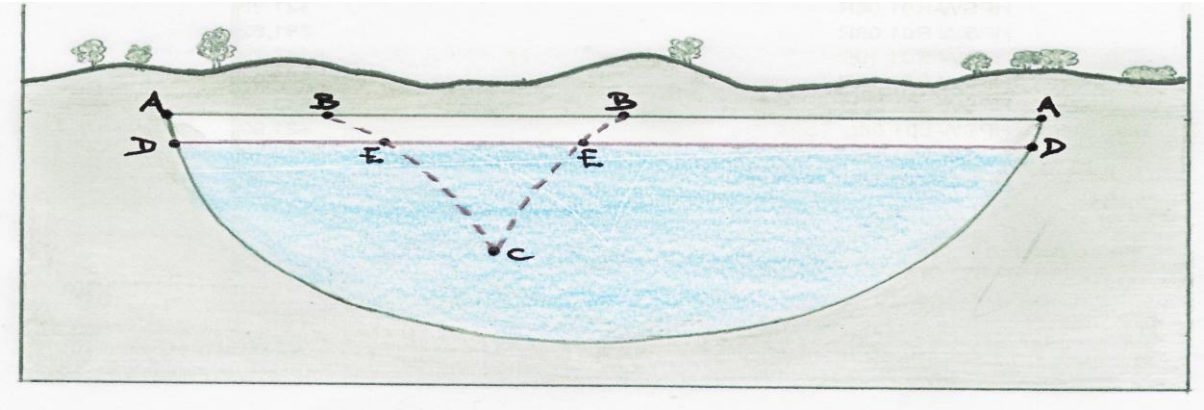
The reason why this bore was still sucking air can best be explained using these simplified conceptual drawings.



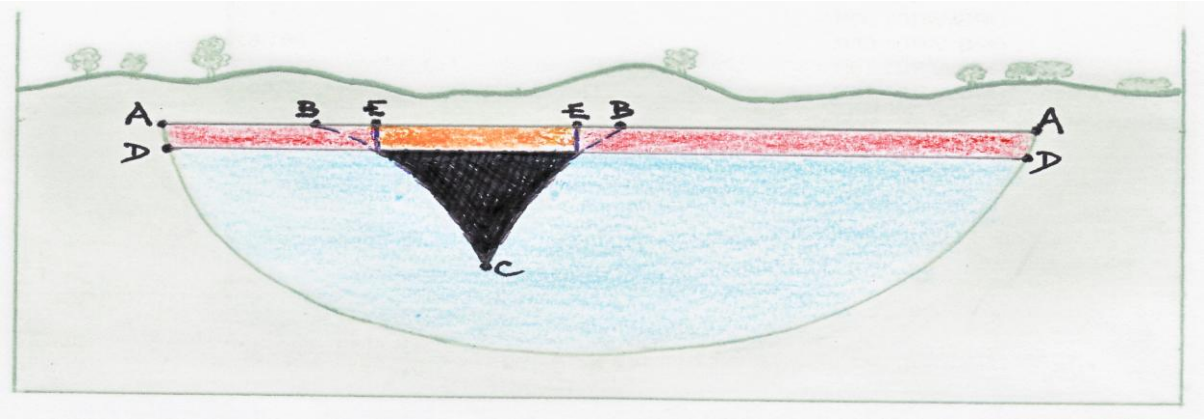
Before groundwater extraction takes place the aquifer has reached a relatively stable level, A to A.



Extraction of groundwater from the aquifer at point C creates a cone of depression B, C to B.



Once pumping ceases, water is sucked into the space created by the cone of depression and fills up the zone E, C to E. This water is sucked in from the boundaries of the aquifer as the aquifer finds its new water table level. Once in relative equilibrium the new water table will be lower at D to D. Until this process is complete some observation bores within the area of drawdown, will suck air while others will blow air. Throughout this process the area of influence from the groundwater extraction will expand.



As the new level D to D is happening the water table levels at any observation bores in the vicinity of points E will remain relatively stable. Water levels of any bores inside these points (orange and black) will rise and bores in the red marked zone will fall.

Once this relatively new water table level is reached the aquifer may then begin to recover to its former level at A to A. Aquifer divides, as described on pages 22-23 will shift as water is drawn from the outer zones of influence.

SUMMARY.

Pre-groundwater Extraction at Barwon Downs 1982-1983.

1. The Shalley family relied on the fact that Boundary Creek was a permanent flowing stream since 1912.
2. Numerous observation bores that were drilled in the area of the Barwon Downs Borefield were artesian, some squirting 10s of metres into the air.
3. The water tables in the district were stable with little variation between seasons and years.
4. All of the hydrological investigative studies indicated there would be serious impacts if more than 4000 ML/year were extracted from the borefield.

1984-1987.

5. Pre-pumping recommendations for studies and the collection of data were ignored and never implemented.
6. The recommendations to establish environmental flows were also ignored.
7. Boundary Creek extended periods of no flow for the first time since 1912.

1987-2012.

8. In 1987 artificial recharge attempts along Boundary Creek found that this was a waste of time, the Big Swamp was always saturated, overflowing and no more water could be forced into it. The overflow into Boundary Creek was the reason for an average daily summer flow of 3.2 ML.
9. Local knowledge, concerns and recommendations largely ignored during the Stage One Borefield development.
10. The word "annual" in the Permissible Annual Volume (PAV) was omitted and replaced to read Permissible Consumptive Volume (PCV). This gave justification to the authorities to "fiddle the books" as far as Boundary Creek flows were concerned. The PAV was 4000 ML/year and this was calculated to have "mild" effects on Boundary Creek. Anything over this 4000 a year and the creek was expected to encounter serious environmental problems. Changing the PAV to a PCV would allow the 4000 ML/year extraction to be averaged out over a set period. Consequently a 20 000 ML/year licence could be justified with no more than 80 000 ML over a ten year period and 400 000 ML over 100 years. To make things worse the ten year period worked in such a way that in the 11th year the 1st year of extraction could be left out of the calculations. In the 12th the 2nd year of extraction figures were no longer used to calculate the 80 000 ML extraction over ten years.
11. Drawdown "holes," or cones of depression, began to appear in the deep water aquifer in various locations.
    Several cones of depression some distance from the one borefield seemed impossible. However, extensive correspondence with Southern Rural Water and Barwon Water indicates that the residual drawdown charts showing this phenomena in the yearly reports since 2004, is quite in order and acceptable.
12. Many artesian bores stopped flowing.
13. Platypus, blackfish, trout and other water dependent species died out.
14. The Big Swamp began to dry out in its upper reaches with dramatic vegetation changes.
15. Fire caused serious problems in this previously saturated area of peat.

16. Maintenance of Stream Flow Trigger Levels were regularly breached.
17. Supplementary flows into Boundary Creek from the Otway to Colac Pipeline consistently disappeared into the Big Swamp during no rainfall periods.
18. Over the years Barwon Water had carted free of charge numerous tanker loads of fresh water into the Shalley farm to maintain it as a viable enterprise.
19. A 2006 study recommending environmental flow allocations for Boundary Creek was farcical.
20. Applying the Rick Evans Response Ratio confirms that Boundary Creek should run dry as a result of groundwater extraction.
21. The Rassam et al. findings suggest that this impact overflow into the Big Swamp and Boundary Creek could be many times worse than that calculated by Evans.
22. The Big Swamp and Boundary Creek are heavily polluted from influences taking place within the Big Swamp.
23. Creeks to the north and south of the Boundary Creek Catchment continue to maintain their integrity, flowing freely and supporting healthy wetlands.

CONCLUSION.

There can be no doubt that the Boundary Creek Catchment in the vicinity of the Big Swamp was a thriving and healthy wetland before groundwater extraction took place at the Barwon Downs Borefield. From the Big Swamp to the confluence with the Barwon River, Boundary Creek supported a diverse collection of water dependent flora and fauna. Platypus and blackfish were abundant, animals high in the food chain. The Big Swamp wetlands were "jungle" like supporting many water dependent species. Farmers downstream had a secure and reliable source of fresh water. The flood plains maintained a green summer pick for stock and the stream banks maintained their stability. The boggy dense wetlands did not have to be fenced out as domestic stock would not enter the treacherous peats. Numerous attempts to drain these peaty Big Swamp wetlands had failed. These things were known to have remained relatively stable since 1912. Until 1984 the waters of Boundary Creek had been the salvation to farmers through many serious droughts. Farmers with stock water bores found them to be as reliable as the creeks in the area.

Up to 1986 groundwater levels had varied very little. From this time on the Barwon Downs area has seen a dramatic decrease in water tables. Comparative deep water artesian bores in the Loves Creek Catchment, just south of the Boundary Creek Catchment, have maintained relatively stable water tables to the present day, February 2010.

During the 1982-83 drought Geelong was in desperate need of an additional water source. Groundwater from the Barwon Downs borefield was Geelong's salvation but started a series of events that has left Boundary Creek and the Big Swamp in a shockingly degraded state. Firstly the flows in Boundary Creek began to decrease and then dry up for short periods. The more water that was extracted from the borefield the longer the period of dry days for the creek. The water table was dropped to such a degree that the Big Swamp then started to dry out. The peat caught on fire, was hard to extinguish and was to become an ongoing area of concern. Vegetation in the big swamp began to die and the area of impact started to spread downstream killing the vegetation as it went. The acid levels in Boundary Creek sky rocketed to killer levels for instream animal life. River flats began to dry out and a summer

pick for stock disappeared. Creek banks began to crumble and at least one farmer's stock water bore became unreliable.

A stream flow maintenance trigger level was being breeched on numerous occasions. Supplementary flows released from the Otway to Colac pipeline were seen as the solution to the huge drawdown of the water table under Boundary Creek and the Big Swamp. However, as quick as the water was being released from the Otway to Colac pipeline it would disappear into the depleted peats of the Big Swamp. Boundary Creek would remain dry until excess runoff was experienced during substantial rainfall events.

Throughout this period of changing circumstances the long standing local landholders appeared to be largely ignored, treated with contempt or given token involvement by the regulatory authorities.

Over the decades social and environmental studies and recommendations that would have easily identified the impacts of groundwater extraction were never implemented. Throughout this period poorly designed environmental study briefs supported by half hearted political will ensured that inconclusive results were always obtained. Each environmental report made similar recommendations to the ones made earlier. At best, the authorities were able to state that the studies were being conducted even if in large part they were inconclusive and of little use .

Streams and wetlands in catchments to the north and south of the Boundary Creek Catchment have maintained a basic integrity despite the latest extended drought. All reports state that the streams in these three catchments gain their summer flows from excess overflow from the deepwater aquifer. The source of water for the various branches of this aquifer being rain falling onto the exposed aquifer sands of the Barongarook High. If drought was the major factor causing such impact in the Boundary Creek Catchment it is more than reasonable to expect the same degree of impact in the adjoining catchments to the north and south. This is not the case. 50, 40 and 30 metre drops of the water table in observations bores in the Barwon Downs borefield area are not happening in the adjoining catchments.

Numerous hydrological reports, including Barwon Water's own consultant Sinclair Knight Merz, predicted the devastation that could be caused from pumping more than the Permissible Annual Volume. Both Barwon Water and Southern Rural Water chose to ignore this fact and preceded with licence extraction rates 5 times this Permissible Annual Volume limit.

Even before the Stage One licence was issued in 1995 the danger signs from an economic, environmental and social perspective, were already becoming apparent and it should have been obvious that things were going terribly wrong. Acid levels were rising, the creek was drying up, vegetation was dying, farmers were running out of otherwise reliable water, summer feed on the flats was diminishing, creek banks were crumbling and platypus had disappeared from the creeks.

Piecing together a multitude of data from a wide variety of sources clearly demonstrates that the severe and detrimental impacts experienced along Boundary Creek and in the Big Swamp can squarely, convincingly and directly be related to the groundwater extraction from the borefield at Barwon Downs.

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