

Offshore Gas Extraction – Onshore Impacts, Otway Basin.





A wetland in the Otway Ranges impacted by lowered levels and depressurising of groundwater.

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By M.Th.



Acknowledgement.

I acknowledge and respect the Traditional Owners and especially the Gulidjan Traditional Owners as original custodians of a greater part of the area of the Otway Ranges dealt with in Otway Water Books.

INTRODUCTION.

Some years ago I was asked whether I knew why there would be a dramatic decrease in flows in the Johanna River along the Otway Ranges coast. I had no answer to this. However, when the Gippsland fires of 2019 devastated the area, this prompted a memory of a friend at a Barwon Water meeting mentioning offshore gas extraction causing detrimental onshore impact to groundwater in Gippsland. On closer investigation and coupled with the fact that there had been an offshore gas extraction taking place along the Otway Ranges coast since the 1960s, the question arose, was it possible that the Otway Ranges groundwaters were being impacted in a similar fashion to those in Gippsland? Another question also came to mind, was this lowering of the groundwater level in any way connected to the Gippsland fires? This prompted the writing of Otway Water Books 57⁽¹⁾ and 57B⁽³⁾. However, distributing Book 57 and Book 57B far and wide drew very little comment. In fact none. As with so many things in this day and age, comment has to be short, catchy, punchy and right to the point. Too much is too much no matter how important. Hopefully, Otway Water Book 57C is closer to a quick, punchy readable precise of concerns.

A Short History Lesson.

Water driven offshore gas and oil extraction has been taking place in the Gippsland Basin since 1965 with devastating results impacting onshore groundwater resources.

A CSIRO study in 2004 found that despite:

- climate change,
- industrial and agricultural groundwater extractions, and
- land use change,

the Gippsland Basin offshore fluid extraction was the only plausible cause of the onshore observable groundwater impact changes. In 2008 the Federal and State Governments combined to provide a \$5 million assistance package as compensation to onshore landholders.

Offshore gas extraction has been taking place in the Otway Basin for a similar amount of time.

Victorian Gas Exploration and Extraction Moratorium is Lifted.

In 2017 or thereabouts, due to public concern the Victorian State Government placed a moratorium on gas exploration and extraction in Victoria. Once this was done the State Government set in motion *“A new evidence base of scientific research on which to make better decisions, taking into account the interests of the environment, communities and the economy.”*⁽²⁾

“In 2017, the Geological Survey of Victoria embarked on a three-year suite of geoscientific, environmental and social studies known as the Victorian Gas Program.”⁽²⁾

At the conclusion of this program (December 2020) the Victorian Gas Program (VGP) recommended it “safe” to lift the moratorium on offshore exploration and extraction of gas in the Otway Basin.

The Victorian Gas Program (VGP) also prompted an...

“Orderly restart of onshore conventional gas industry – a science-led decision.”⁽²⁾

Considerable Doubt Regarding the VGP Findings.

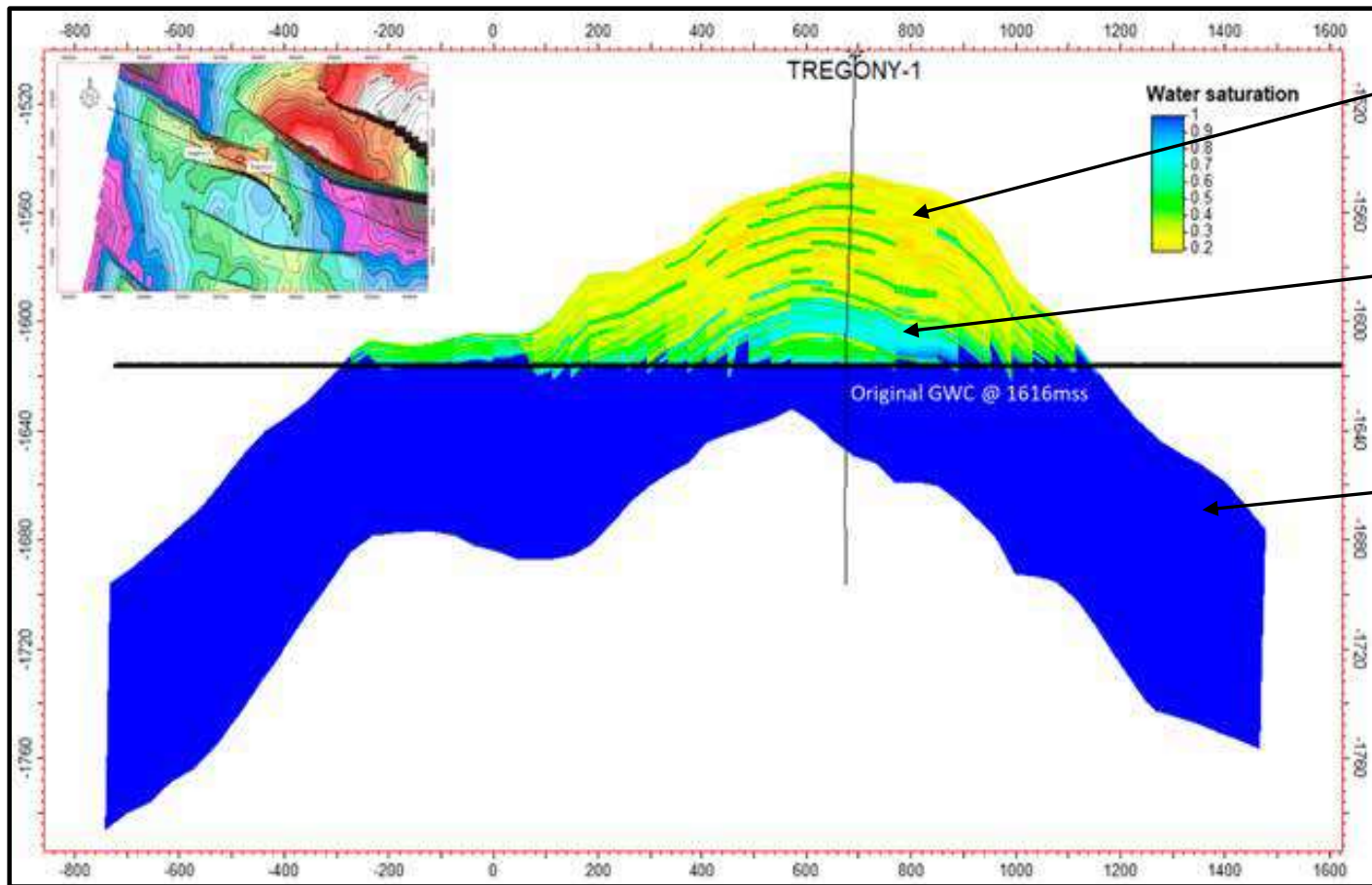
Otway Water Books 57 and 57B discuss some serious concerns regarding the rigour of some aspects of the Victorian Gas Program deliberations. Social engineering (B57pp85-90. B57Bp19), inadequate stygofauna studies (B57pp65-84) and little to no environmental risks report (B57bp27-28) to name but a few.

(B57p45) – would be a reference to Otway Water Book 57, page 45.

(B57bp29) – is a reference to Otway Water Book 57B, page 29.

Gas Extraction is Water Driven.

In most situations gas sits above oil. Oil sits above water. In the Gippsland and Otway Basins' once the gas layer is tapped into, the extreme water pressure from below forces the gas to the surface. These Gippsland and Otway Basins' gas fields are water driven, not requiring the use of extraction pumps.



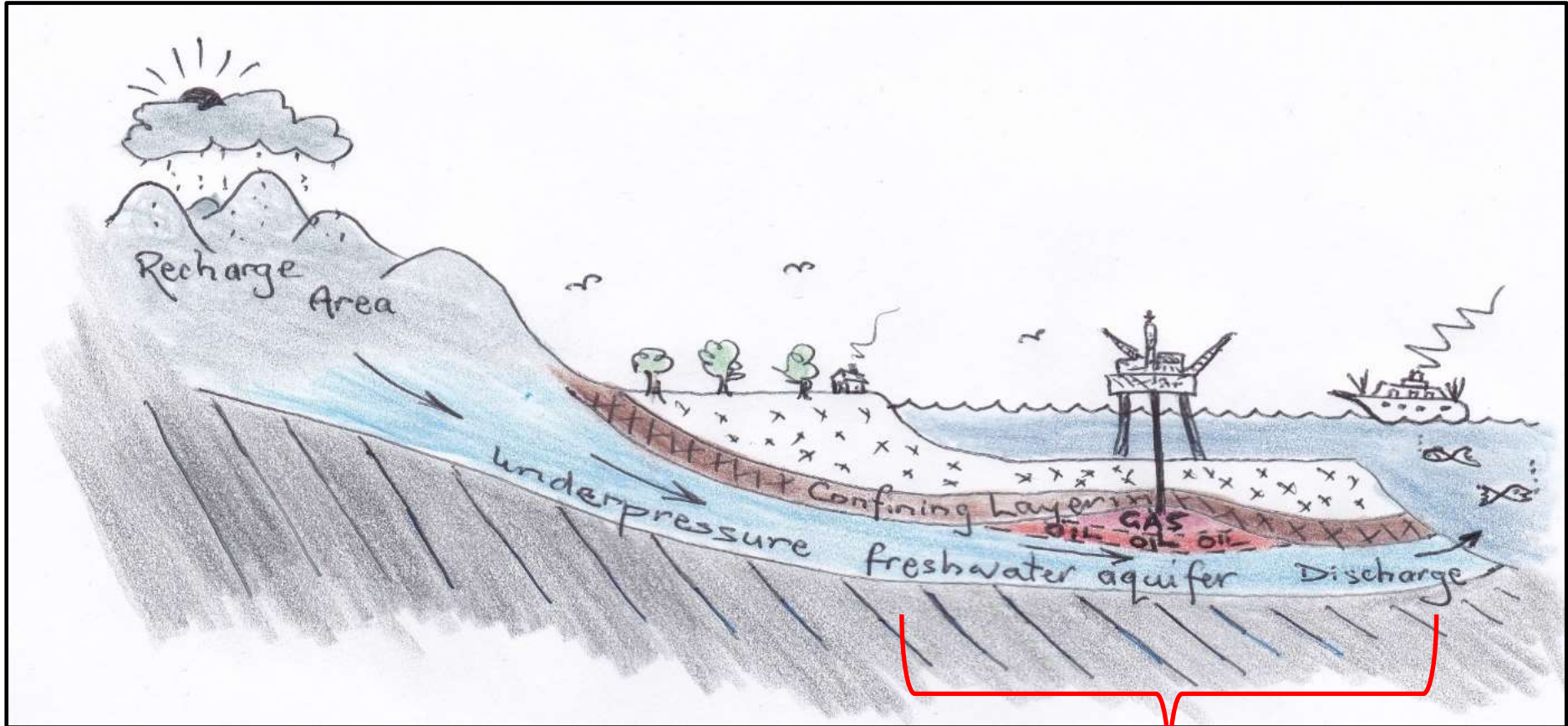
Gas.

Oil.

Water.

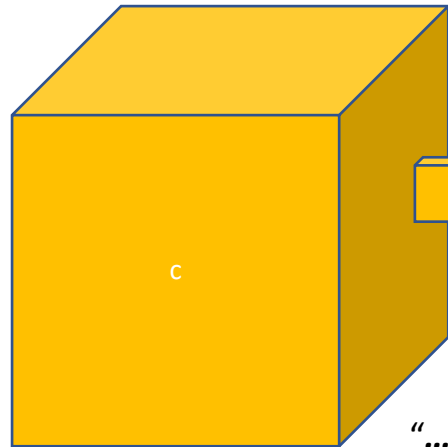
The offshore gas fields of Victoria are under enormous groundwater pressure. In the Gippsland offshore gas fields *“...offshore oil and gas production extracts a water equivalent volume of approximately 100,000 ML per year.”*⁽⁶⁾ This causes a massive depressurising of the groundwater aquifers.

Depressurising the groundwater reduces baseflow in rivers and creeks, can stop springs flowing, can decimate wetlands with industrial and agricultural enterprises compromised.



Depending on the data source, the freshwater aquifers discharge into the ocean at various points off the Victorian coast. This discharge can be as far offshore to the 120 km mark.

The Gippsland Experience.



It has been calculated that 0.0064 of a cubic metre of gas extracted from the ground expands to one cubic metre at the surface. Before extraction the gas is under enormous pressure.

This bar approximately represents 0.0064 of a cubic metre.

In 2004 CSIRO completed an investigation aimed at determining why onshore groundwater levels were in serious decline.⁽⁴⁾

“...result fails to support the hypothesis of climate change”⁽⁴⁾ as the reason for this impact.

“A CSIRO study found that the major cause of the falling groundwater levels was off-shore oil and gas extraction activities from the Commonwealth Government.” (Victoria Government media release Sept. 2008 re \$5 million Assistance package regarding the gas field onshore impacts.)

“Groundwater levels in the WSPA have been in decline for approximately 40 years, mainly as a result of offshore fluid extraction from oil and gas production.”⁽⁵⁾ (Yarrum - Water Supply Protection Area - WSPA)

“Water level declines are expected to continue in the WSPA, irrespective of the activities of groundwater users, due to offshore fluid extractions.”⁽⁵⁾

“...was presented with sufficient evidence to conclude that over the last few decades the extraction of fluids (oil, gas and water) offshore for petroleum production has made a significant and consistent contribution to the decline of groundwater levels onshore.”⁽⁵⁾

The CSIRO report concluded that after looking at all possibilities, offshore extractions best explained the onshore groundwater impacts. ***“... no other hypothesis seems to even remotely explain observed declines.”***⁽⁴⁾

The Otway Ranges Experience.

The extraction of offshore gas along the coast of the Otway Ranges and Gippsland fields is driven by water under pressure, “...*the extraction method is the same.*”⁽³⁾

Despite the fact that onshore groundwater conditions in Gippsland have been impacted from offshore gas extraction, this statement found in a Victorian Groundwater Program document seems quite incredible. “*The potential groundwater impact was considered in the Port Campbell Embayment (Otway Basin) and the Seaspray Depression (Gippsland Basin). Results found there is no evidence that the environment has altered as a result of these drilling activities over the past 100 years.*”⁽⁷⁾

This may well be the case in regard to drilling of exploration bores but to use it in such a way as to give the impression the gas extraction industry as a whole has had no environment impact is wrong. This coupled with completely overlooking the 2004 CSIRO Gippsland report, tends to suggest the Victorian Gas Program deliberations were skewed towards renewing gas exploration and extraction. No environmental ecosystem impact studies have been presented in the VGP.

The bottom line is that any subterranean extraction of water, gas or oil has the potential to impact both at the surface and in the subterranean. But if no studies are done, or done poorly, then it is much easier to say there are no impacts.

“*All forms of natural gas development have the potential to impact groundwater users, surface water users and ecosystems as a result of aquifer depressurisation.*”⁽⁸⁾

Model Input Wanting.

For the Victorian Gas Program to rely on output from a model that is fed limited data and misinformation and then to regard output as reliable enough to make far reaching decisions, defies scientific and technical rigour. Garbage into a model will only spit garbage out (B57bpp24-32).

Some examples of limited data and misinformation discussed in Otway Water Book 57B:

1. Reports not referenced (B57bp28,30). Others not finished (B57bp28-31). Some not locatable (B57bp28).
2. Numerical model not finished (B57bp27-28).
3. An aquifer reported as a aquitard (B57bp18), and, an aquitard referred to as an aquifer (B57bp18).

4. An appropriate working environment for humans can not be used as a substitute for a healthy and sustainable ecosystem for other life forms (B57bp19).
5. The presentation of extremely limited study of environmental risks, benefits and associated impacts (B57bpp19-20, 27).
6. The rainfall groundwater hydrograph (observation bore water levels) correlation has doubtful connection with what is actually happening (B57bpp31-42).

The conceptual model on which the numerical model is based states that “...*water levels in the LTA show a distinct correlation with rainfall.*” Numerous other hydrographs of bores at numerous depth levels are presented with the rainfall patterns and most show a very close correlation, but not all of them.

There are problems with reaching a conclusion that this correlation has a very strong connection.

- i) The correlation is plotted over the same time period whereas the deeper the bore the longer the period it takes rainfall to recharge these aquifers. For example the LTA groundwater in the Gellibrand area is reported as over 20,000 years old.⁽⁹⁾
- ii) The hydrographs are matched to a bore hydrograph that are in most occasions a considerable distance apart.
- iii) The BOM isohyet map does not go close to matching other isohyet data.
- iv) Some of the rainfall/hydrograph graphs show no correlation.
- v) There is no data regarding the correlation between the hydrograph and the rainfall in the recharge area for the observation bore being discussed. It appears the rainfall data used for comparison has been chosen haphazardly.
- vi) Upward and downward vertical leakage considerations between aquifers and aquitards has to be taken into account. The interrelation between structures and rainfall hydrograph correlation lacks data.

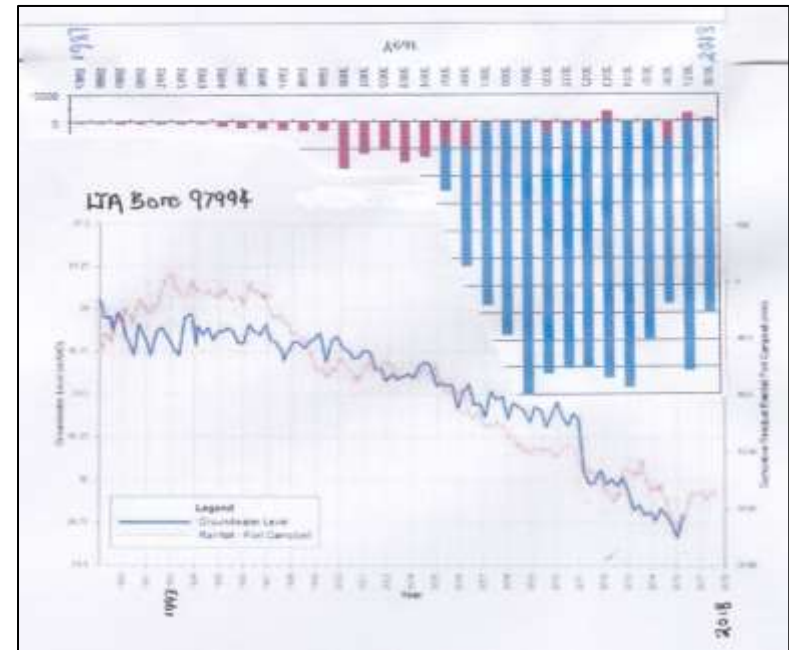
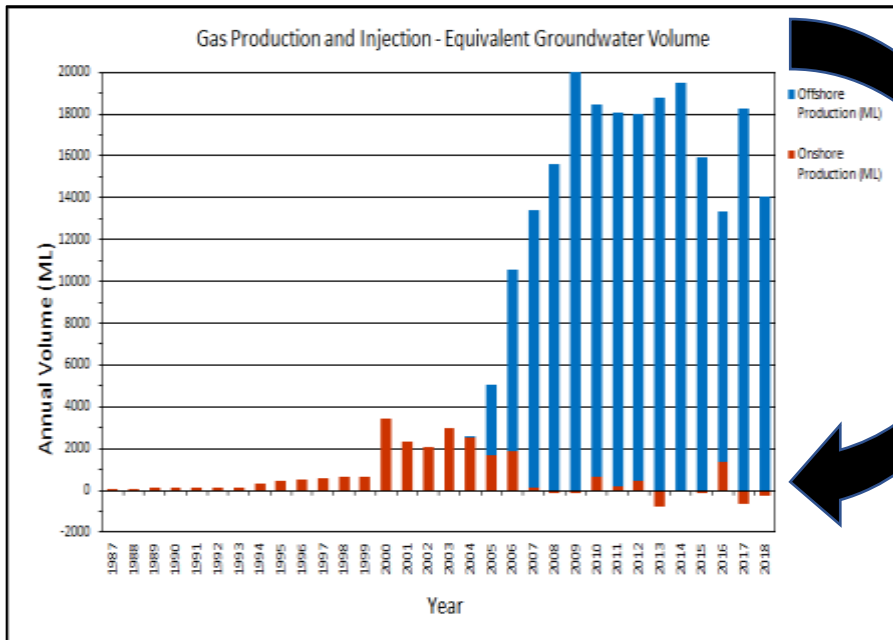
“Groundwater recharge is a complex variable that can change in time due to prevailing conditions and is the subject of many studies beyond the scope of this assessment.”⁽¹⁰⁾

“There is a lack of hydrological information available to enable the incorporation of fault structures into the regional model.”⁽¹⁰⁾

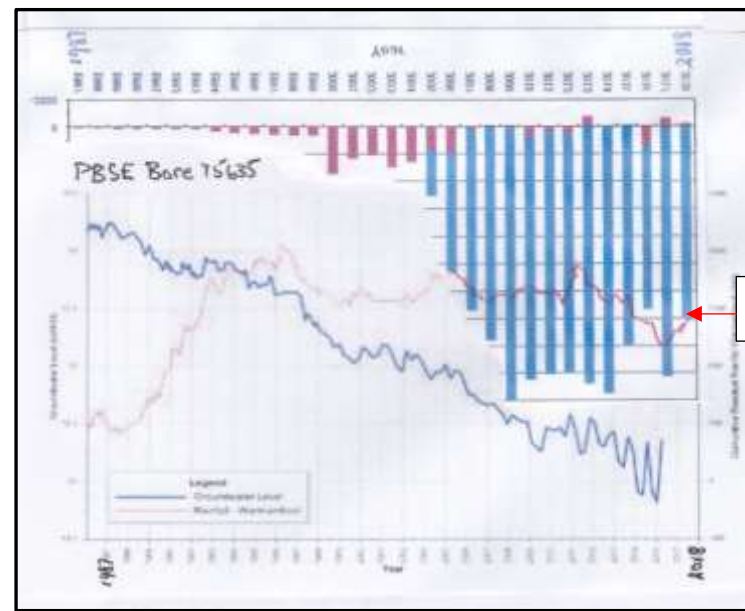
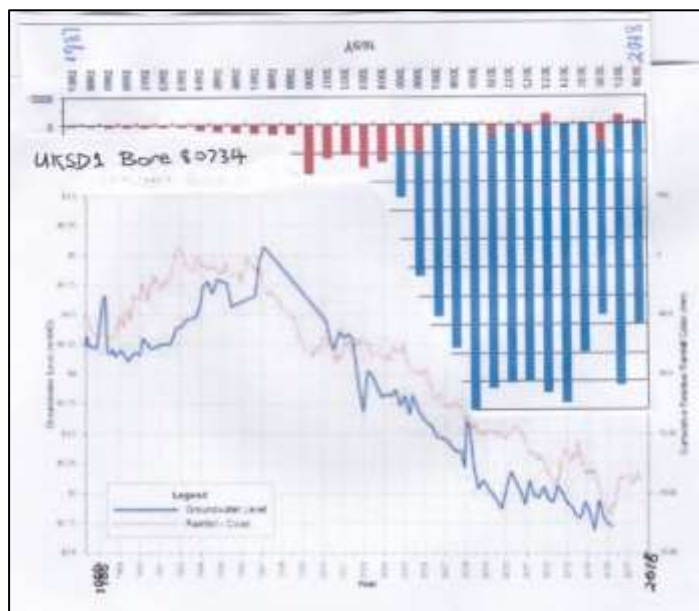
“Structural geological features such as regional faults may influence groundwater processes via the displacement of hydrostratigraphic units, and by providing potential conduits for flow between separate aquifers.”⁽¹⁰⁾

- By far a better correlation with the groundwater hydrographs is gas extraction, although this may be as inappropriate as the rainfall comparison (B57bpp43-47).

If the gas extraction graph is flipped horizontally and placed over the groundwater hydrographs the correlation is by far a much better fit than the one presented by the VGP comparing the hydrographs with rainfall.



However, this correlation would require close analysis as to its relevance.



Rainfall trend.

8. No data presented on changes to river baseflows (B57bp23). Conceptual Groundwater Model “...*will be used to quantify groundwater and surface water impacts of potential onshore conventional gas developments in the basin. The model is required to quantify individual and cumulative impacts from potential developments, including changes to groundwater levels and pressures, and changes to river baseflows.*”⁽¹⁰⁾

9. In 2019 the 3rd VGP report states that a refined 3D geological framework model would “...*seamlessly join the new onshore map with the existing offshore Gippsland Basin 3D geological model.*”⁽¹¹⁾ (B57bp48) No comment has been made since then. Whether this has been done or not is anyone’s guess.
This very thing was muted 17 years ago in the 2004 CSIRO report⁽⁷⁾ when recommending a “...*coupling the offshore and onshore reservoir and aquifer models...*”⁽⁴⁾

Consequences resulting from depressurising and dropping the onshore water tables.

- ***Dropping and depressurising the water tables*** in the lower sections of groundwater flowpaths sees the water table level dropping in the higher recharge regions, usually at higher points than on the plains.⁽¹⁴⁾ This places the vegetation in the recharge area and other spots where springs, creeks and wetlands are impacted, under stress and more ***susceptible to fire.***⁽¹⁵⁾ Add dry conditions such as experienced during the Millennium Drought and the results from fire can be catastrophic.
This map shows the extent of the 2019-20 ***Gippsland fires.***



Map courtesy of the ABC.

The fires were horrific in tinder dry forests after three years of drought. No doubt the lack of rain and climate change were the major contributing factors but there can be little doubt that extensive fluid extraction offshore dropping the water tables in the region to unprecedented levels, was also a factor.

- **Surface/subterranean ecosystems Impacted.**

“All forms of natural gas development have the potential to impact groundwater users, surface water users and ecosystems as a result of aquifer depressurisation.”⁽⁸⁾ Not only is the impact felt at the surface (area – 2 dimensional) but in the subterranean ecosystems (volumetric -3 dimensional).⁽¹⁴⁾

- **Baseflow change** to rivers, springs and wetlands are the most obvious and observable impacts.
- **Agriculture and industry** based water enterprises are compromised.⁽¹⁶⁾⁽¹⁷⁾
- **Salt water intrusion** back through the aquifers pollutes and renders freshwater aquifers useless.
- **Subsidence** is an always present threat. The 2004 CSIRO report⁽⁴⁾ recommended regional 4D subsidence modelling and concluded that *“...the potential scale of subsidence is significant and warranted detailed technical investigation.”* An SKM⁽¹³⁾ report quoted in the CSIRO report concluded that *“...there was a 50:50 chance that this critical threshold (of subsidence) would be exceeded within 30 years and thus subsidence would accelerate.”*⁽¹³⁾ The same SKM report stated a *“...pre-consolidation stress has yet to be reached through aquifer depressurisation...”*⁽¹²⁾ and *“...there is a reasonable probability of significant subsidence occurring.”*⁽¹³⁾ The critical threshold outlined in the CSIRO document will not be exceeded until 2035. Gas extraction continues unabated and there is not one mention of subsidence in the 4th Victorian Gas Program report. Perhaps there is nothing to report as yet because 2022 is just over half way through the 30 year probability cycle, after which subsidence is predicted to accelerate.

The reduction of pore water pressure can lead to subsidence.
“Effective stress increases when water is pumped from an aquifer, because the pumping reduces pore water pressure P. Withdrawals of oil and gas also reduce pore fluid pressures in the formation being pumped, and reduced P in nearby water-bearing zones.”⁽¹²⁾

Seismic Testing has its own set of impacts to be considered.

Colac Herald 26 August 2022, front page, “...*gas explorers’ plans to seismic blast an area of the Otway Basin that’s bigger than Tasmania.*” Seismic testing impact is another story.

Conclusion

It has been proven beyond any doubt that the major reason for the depressurisation and dropping of groundwater levels in the Gippsland region is the result of offshore gas extraction. This offshore gas extraction is water driven and there is also no doubt that the gas extraction in the Otway Basin involves exactly the same water driven processes. At this stage however, impact from gas extraction in the Otway Basin and on the Otway Ranges has not been identified or recognised. In fact the findings of the Victorian Gas Program say the exact opposite.

After sketchy and poor scientific and technical research, the Victorian Gas Program recommendations to the Victorian State Government facilitated the lifting of the moratorium on onshore gas exploration and encouraged the continued offshore gas exploration and extraction.

Unfortunately, the Victorian Gas Program failed to complete tasks; singled out preferred data; ignored other data; accepted certain assumptions; generalised and drew conclusions that verge on, if not sitting directly in, the realm of epistemic theory. Resource management decisions arrived at in this way are fraught with wrong decision making, and can, more often than not, end in disastrous situations.

The Otway Basin gas extraction has not had its risks, benefits or impacts thoroughly examined. All gas extraction should be halted until this is done. The biggest possible loser is the depressurising and dropping of onshore potable groundwater resources across the Western District including the Otway Ranges. Impacts can be catastrophic.

References.

1. Gardiner M. J., November 2020: Are the Otway Ranges, Threatened by Wildfire resulting from Subterranean Water, Oil and Gas Extraction Just Like in Gippsland? . Otway Water Book 57. www.otwaywater.com.au
2. Geological Survey of Victoria, December 2020: Victorian Gas Program, Progress Report No. 5.
3. Gardiner M. J., Revised May 2021: Otway Basin – Gas Exploration and Groundwater Impact. Otway Water Book 57B. www.otwaywater.com.au
4. Hatton, T., Otto, C., Unterschultz, J. 13 September 2004: Falling Water Levels in the Latrobe Aquifer, Gippsland Basin: Determination of Cause and Recommendations for Future Work. CSIRO.
5. Southern Rural Water, 14 October 2010: Groundwater Management Plan – Yarram Water Supply Protection Area.
6. Department of Environment, Land, Water and Planning and the Geological Survey of Victoria, 2015: Onshore natural gas water science studies – Gippsland region synthesis report. Department of Environment, Land, Water and Planning and the Department of Economic Development, Jobs, Transport and Resources, Melbourne. June 2015.(2)
7. Victorian Gas Program. March 2020: Progress Report, Report Number 4. Final. Geological Survey of Victoria.
8. Department of Environment, Land, Water and Planning and the Geological Survey of Victoria, 2015: Onshore natural gas water science studies – Gippsland region synthesis report. Department of Environment, Land, Water and Planning and the Department of Economic Development, Jobs, Transport and Resources, Melbourne. June 2015.(2)
9. Petrides B., Cartwright I., 2006: The hydrogeology and hydrochemistry of the Barwon Downs Graben aquifer, southwestern Victoria, Australia.
10. Victorian Gas Program, Technical Report 34 September 2020: Groundwater Impact Assessment – Conceptual report. Onshore Otway Basin , Victoria.
11. Victorian Gas Program. October 2019: Progress report, Report Number 3. Geological Survey of Victoria.
12. Fitts. Charles R., 2002: Groundwater Science. Academic Press. ISBN 0-12-257855-4.
13. Sinclair Knight Merz (1999a): Risk Analysis for Possible Subsidence along the Gippsland Coast. Final Report June 1999, revised May 2001.

14. Gardiner M. J., June 2017: Flow Paths, Drawdown, Recharge, Vertical Leakage and Perched Swamps, within the Drawdown Influence of the Barwon Downs Borefield. Otway Water Book 35. www.otwaywater.com.au
15. Gardiner M.J., November 2011: Fire. Otway Water Book 15. www.otwaywater.com.au
16. Gardiner M.J., April 2018: Impacts on Farming. Otway Water Book 44. www.otwaywater.com.au
17. Gardiner M. J., June 2019: Seven Dead Calves along Boundary Creek – You be the judge. Otway Water Book 44B. www.otwaywater.com.au