

**MONITORING AND MODELLING NATURAL AND ANTHROPOGENIC
INPUTS OF NITROGEN INTO AN UNCONFINED AQUIFER IN THE
SOUTH EAST OF SOUTH AUSTRALIA**

Submitted by

Phil Gorey, B.App.Sc. (Nat. Res. Man.) (Hon.)

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ABSTRACT

The aim of this study was to apply a variety of investigative methods to identify the causes of elevated concentrations of nitrate reported in an unconfined aquifer around the township of Coonawarra in the South East region of South Australia. For nearly 30 years elevated nitrate concentrations have been of concern to Government Departments, however the source of these elevated nitrate concentrations remained unknown.

Examination of an extensive historical water quality dataset for the study area identified that while nitrate concentrations were elevated during the late 1970s – early 1980s, they have declined since this time. The study demonstrates a variety of inherent biases that can exist within nitrate groundwater datasets, and presents methods that can be used for determining temporal trends in concentration that minimise the impacts of these characteristics.

The quantification and spatial variability of diffuse recharge was investigated using groundwater tritium concentrations measured in the aquifer during the late 1970s. The modelling produced estimated recharge rates that were generally below those now adopted for the study area, and the methodology may not be appropriate in areas where high irrigation rates are occurring. The assessment of the variability of recharge illustrates that the high recharge areas corresponded to the previously identified areas of higher nitrate concentrations in groundwater.

This correlation was further investigated statistically, and used a dual isotopic technique that applied the natural variability of nitrogen and oxygen isotopes (of nitrate) to source determination. The statistical approach was only able to explain 39% of the variability observed in groundwater nitrate concentrations using field observations. This approach indicated that there was a significant spatial relationship between bores located in close proximity to septic tanks and elevated nitrate concentrations in groundwater. The applications of the dual nitrate isotopic method further demonstrated that nitrate in the

groundwater is from multiple sources, with septic tanks being a probable source of nitrate. This isotopic method is shown to be effective in source determination, with the results comparing well to literature and field observations.

Modelling of diffuse inputs from the main landuse types supports the conclusion that the elevated nitrate levels are most likely due to localised sources.

It is concluded that while high nitrate concentrations have existed within the Coonawarra area, the data interpretation methods previously used to report the 'plume' of nitrate contamination have over-estimated the extent of nitrate in groundwater. The elevated nitrate concentrations in the groundwater are primarily the result of anthropogenic sources (e.g. septic tanks) and natural sources (e.g. the mineralisation of soil organic nitrogen).

CANDIDATE DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief does not contain any material previously published or written by another person except where due reference is made in the text.

Full Name: Phillip Galvin Gorey

Signed.....

Date..... *30 November 2008*

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THE REPORTED NITROGEN CONCENTRATIONS

A variety of methods have been used to report the concentration of nitrogen compounds in previous investigative studies and research, and it is recognised that a range of previous studies within the region have reported nitrate concentrations as nitrate; i.e. mg/L (as NO₃). Recently, the preference has been to report the concentration of nitrate and nitrite as the mass of only the nitrogen atoms; i.e. mg/L (as N).

In order to assist in interpretation of this thesis, all nitrogen species are reported as concentrations of nitrogen unless otherwise noted. The nomenclature adopted for reporting these concentrations within this thesis is *mg/L (as N)*.

THE REPORTED BOREHOLE REFERENCES

Up until the early 1980s, boreholes were referenced in a variety of ways (i.e. various numbering systems, names). The convention used in this study is the full unique well bore identifier allocated by the Department for Water, Land and Biodiversity Conservation. This convention has the first four numbers as the 1:100,000 map number (the study area is within the 7023 map sheet), and the remaining five numbers being the incremental counter of bores within the 1:100,000 map sheet. Observation bore numbers and names are included as a secondary name (when known).