Submission Cover Sheet

Fingerboards Mineral Sands Project Inquiry and Advisory Committee - EES

533

Request to be heard?: Yes

Full Name: Ken White

Organisation: Riviera Farms Pty Ltd

Affected property: [redacted] Hillside VIC 3875

Attachment 1: SKM_Report.pdf

Attachment 2:

Attachment 3:

Comments: Riviera Farms are 5th generation, vertically integrated vegetable farmers with over 4,000 acres of intensive agriculture, spread across Lindenow Valley, Perry Bridge and the Macalister Irrigation District. We have been involved in the consultation process, including attending a variety information meetings. We have been open minded about the proposed mine from day one, and have just been interested in gathering our own facts and making informed decisions about our willingness to either support or oppose the mine. In essence, as vegetable growers who have invested in, and rely on, a reliable water supply, our key concern is the potential impact on water resources. Kalbar is proposing that its primary source would become an off river water storage fed from winter fill taken from the Mitchell River, and secondly water extracted from a bore field targeting the Latrobe Group aquifer. We have no objection to the proposal to build an off river water storage. There is capacity in the Mitchell River to deliver winter flows sufficient to meet this demand, it is a studied and known resource, extraction during peaks flows of winter have no impact on reduced volume for irrigators who need water over Summer, and a legacy can be left behind in terms of a large water body for future use post mine. The potential use of Latrobe Aquifer water we have concerns with. This aquifer is an enormous body of water which has significant use by large licence holders to the South and West of the Lindenow Area. The interaction between the Lindenow/Mitchell Catchments and the Latrobe Group Aquifer was considered in a Sinclair Knight Merz report in 2008/09 - attached that report for your reference. In that report it is considered that "the interaction between the Mitchell River, Quarternary Aquifers and the deeper aquifers in the study area are not well understood". This specifically refers to the interaction of the Lindenow area to the Latrobe Group aquifer. This report also states (Item 2.8) "The groundwater trends in the deeper aquifers are declining, and this could potentially impact groundwater levels in the shallow aquifer and river levels". The extraction of large volumes of water from an unstudied and declining aquifer we believe will impact shallower aquifers above and therefore we do not support Kalbar's borefield option of water use. The majority of agricultural use of aquifer water is in the shallow aquifers above the Latrobe Group aquifer and with the inherent uncertainty of the interaction between aquifers we need more certainty of no impact before we could support the use of Latrobe Aquifer water. We encourage industry development in our area and have contributed to the same ourselves. If we can see this matter resolved we would be supportive of the development of this mine which will provide significant employment and economic benefit to the region.

m+k

Your ref:
Our ref: OSK:yxm:179449
REPLY TO DANDENONG OFFICE

19 January, 2009

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BY EXPRESS POST

Mr Nelson Cox
165 Settlement Road
BAIRNSDALE VIC 3875

Also by facsimile: 5157 1880

Dear Mr Cox,

SOUTHERN RURAL WATER ATS NELSON COX
VCAT PROCEEDING NO. P2316/2008
HEARING: 2 FEBRUARY 2009

Please find enclosed, by way of service, the following documents:

1. Witness Statement of Andrew Harrison dated 16 January 2009;
2. Witness Statement of Trevor McDevitt dated 19 January 2009; and
3. Witness Statement of Terrence Anthony Flynn dated 19 January 2009.

We advise that the above documents have been filed at VCAT on even date.

Should you have any questions, please contact Olga Koskie.

Yours faithfully

Olga Koskie

Macpherson + Kelley
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Senior Associate
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encl.

File Note

SKM

Date	16th January 2009
Project No	
Subject	Expert Witness Statement

1) The name and address of the expert

Andrew Harrison
Senior Hydrogeologist
Sinclair Knight Merz
119 Johnson Street
Maffra VIC 3860

2) The expert's qualifications and experience

I am a hydrogeologist with more than 16 years of experience in various groundwater and environmental fields. I am currently the manager of the Maffra office of Sinclair Knight Merz in Gippsland.

Qualifications:

- Bachelor of Science (Hons) majoring in Geology, University of Melbourne, 1986
- Masters of Environmental Science, Monash University, 1994

Affiliations:

- Member of the International Association of Hydrogeologists

3) A statement identifying the expert's area of expertise

Attached is a copy of my curriculum vitae which details my main area of expertise and experience.

In summary, my main areas of expertise are:

- groundwater resource investigation and management,
- salinity investigation and mitigation,

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- strategic planning for natural resource management,
- groundwater/surface water interaction,
- irrigation management and
- wetland hydrology.

Key projects which demonstrate this experience include:

- Hydrogeological mapping of Southern Victoria which involved working in a team of hydrogeologists and GIS technicians to map the groundwater aquifers in Southern Victoria. Client: Southern Rural Water
- Investigation into declining groundwater levels in the Yarram area involving the analysis of stratigraphic and groundwater information to determine the distribution of the main aquifers and the impact of declining groundwater levels in the region. Client: Department of Sustainability and Environment.
- Review of the groundwater monitoring network in the Yarram Water Supply Protection Area and Stratford Groundwater Management Area which involved developing a conceptual groundwater model of the region and evaluating the groundwater monitoring network required to adequately monitor the sustainability of the groundwater resource. Client: Southern Rural Water.
- The Tarra River baseflow analysis, South Gippsland which involved analysis of surface water flow and groundwater level data to determine the nature of groundwater/ surface water interaction in the region and the impact of declining groundwater levels. Client: Department of Sustainability and Environment.
- Leongatha groundwater investigation including the exploration of groundwater resource for town water supply in the region through drilling investigations and determining the impact of pumping on the local and regional groundwater resource. Client: South Gippsland Water
- The West Gippsland groundwater flow systems study which involved defining and characterising the shallow recharge and discharge processes in the region mainly for salinity purposes. Client: West Gippsland CMA
- A groundwater resource appraisal of the Sale Groundwater Management Area involving the collation and analysis of groundwater and aquifer data to determine the current and potential future impacts of groundwater pumping from the Boisdale Aquifer in the central Gippsland region. Client: Southern Rural Water.

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4) A statement setting out the expert's expertise to make the report

I am a hydrogeologist with more than 16 years of experience in a variety of groundwater and environmental fields with particular expertise in the area of groundwater resource assessment and appraisal. Of particular relevance to this issue is my experience in providing technical advice on groundwater management issues in Gippsland especially for Southern Rural Water and the Department of Sustainability and Environment. This has included the investigation of the nature of groundwater resources, the threats to the sustainability of the resource and the sustainable management of the resource. I am based in Gippsland and have a particular interest and expertise in the local hydrogeology of the Gippsland region.

More details can be found in the attached curriculum vitae.

5) All instructions that define the scope of the report (original and supplementary and whether in writing or oral);

SKM was engaged under the instructions of Mr Terry Flynn of Southern Rural Water to investigate the groundwater resource in and around the Mitchell River flats extending from Bairnsdale to the east to Glenaladale in the west.

The objectives of the report were:

- to characterise the aquifers beneath the shallow alluvial aquifer in and around the Mitchell River alluvial plain; and,
- to assess the potential impacts of additional groundwater extraction in the region

The scope of this study was to provide technical information from which Southern Rural Water could then use to base a decision on the current groundwater licence applications. The scope of this study was NOT to provide opinion nor recommendations on whether the groundwater licence applications should be granted.

My role on this project was as Project Manager. This involved managing a team of hydrogeologists to undertake the investigation, review the evidence and findings and review the report.

The final report is attached to this statement.

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6) The facts, matters and all assumptions upon which the report proceeds

The report is largely based on interpretation of geological logs of bore holes from drillers' records. Although drillers' have significant experience in describing drilling samples, their logs are often open to interpretation and can be a very basic summary of the lithologies encountered. The lack of detailed bore logs was a severe limitation to the interpretation of the geology and hydrogeology in this study.

7) Reference to those documents and other materials the expert has been instructed to consider or take into account in preparing his or her report and the literature or other material used in making the report.

The report is based on interpretations of:

- Drillers' logs of various bore holes drilled in the region.
- Previous studies in the area
- Water levels from State Observation Bores in the region from the State Groundwater Management System

Reference list

- Geological Survey of Victoria, 1960. Bairnsdale. 1 mile to 1 inch, geological map. Department of Mines, Victoria.
- GHD 2004a Munro Technical Groundwater Assessment. Report to Southern Rural Water. April 2004
- GHD 2004b. Forge Creek Technical Hydrogeological Assessment. Report to Southern Rural Water. August 2004.
- Holdgate, G.R., Wallace, M.W., Gallagher, S.J., Smith, A.J., Keene, J.B., Moore, D. and Shafik, S., 2003. Plio-Pleistocene tectonics and eustasy in the Gippsland Basin, southeast Australia: evidence from magnetic imagery and marine geological data. Aust. J. Earth Sci, 50, 403-426.
- Hydrotechnology, 1994 Boisdale aquifer groundwater resource - Regional hydrogeololcal assessment. Report for the Department of Conservation and Natural Resources. Unpublished.

- Leonard, J.G. 2004. Groundwater – A Vital Renewable Resource, In J.G. Douglas & J.A. Ferguson (eds). Geology of Victoria. Victoria Division, Geological Society of Australia inc.
- Nahm, Y. 1997. Groundwater Resources in Gippsland. Geological Survey Report. Mines Department Victoria.
- SKM, 1998. Monitoring Bore Assessment Wy Yung GMA. Southern Rural Water. WC 00759.
- SKM, 1998. PAV The Sale, GMA. Department of Natural Resources and Environment.
- SKM, 1999. Rosedale GMA PVA report. Department of Natural Resources and Environment.
- SKM 1999. Monitoring Bore Assessment Program, Sale GMA- Further Assessment. Report prepared for SWR.
- SKM, 2006. Sale Water Supply Protection Area, Groundwater Resource Appraisal. Report for Southern Rural Water.
- SKM 2007 Regional Groundwater Monitoring Network Review – Latrobe Group Aquifer, Gippsland, Draft A, July 2007. Draft report to DSE (yet to be reviewed by DSE), 24th July 2007
- Thompson, B.R. 1973, The Geology and Hydrogeology of the Mitchell River flats and a study of Artificial Recharge.
- Walker G. & Mollica F. 1989. A Review of the groundwater resources in the South East region. Investigation Branch Report No. 1989/40.
- VandenBerg, A.H.M., 1997. Bairnsdale SJ 55-7 Edition 2, 1:250 000 Geological Map Series. 1:250 000 geological map. Geological Survey of Victoria.

8) The identity of the person who carried out any tests or experiments upon which the expert relied in making the report and the qualifications of that person

The report was entirely based on interpretation of existing information and no new information was collected as part of this project

9) A summary of the opinion or opinions of the expert

9.1 Opinion summary

I have assessed the available data to form an opinion on the potential impact of issuing all of the requested licences including the applications by Mr Kerton and Mr Cox. Although the area

is geologically complex, the target aquifer for Mr Cox's and Mr Kerton's application is likely to be the Latrobe Valley Coal Measures and Latrobe Valley Coal Measures/Balook respectively. In my opinion the target aquifer systems that would supply the licences is currently over-drawn, as indicated by the declining water levels in the nearby observation bores screened in the target aquifer. In my opinion the granting of any of the requested licences will increase the already present over-draw on the target aquifer in the local area. Increasing the overdraw of the aquifer is also likely to have impacts on the availability of water for users in other aquifers, especially down-basin users in the Latrobe Group Aquifer, Latrobe Valley Coal Measures and Balook Aquifers. The area containing the new groundwater applications is likely to be an important recharge area for these regional aquifers. The Latrobe Group Aquifer in particular is already stressed with significant regional declines observed over a number of years. Conversely, the down-basin Boisdale Aquifer is not likely to be affected by either of Mr Kerton's or Mr Cox's application despite there being evidence that some of the other applications may impact this aquifer.

I have also reviewed the potential for the two licences to affect the Mitchell River and in my opinion this risk is low.

Based on the above considerations, it is my opinion that additional groundwater allocation in the area would exacerbate the already emerging local and regional groundwater sustainability issues with the potential to impact on down-basin groundwater users.

More details on the above conclusions are given below which is a summary of the following report (attached):

- Sinclair Knight Merz (2008), Groundwater Resource Assessment of Deeper Aquifers in the Lindenow region, East Gippsland. Final 4, August 2008. SKM unpubl report to SRW. Rep No. VW04107; R01_kmb_lindenow_final4.doc

9.2 Detailed findings

At the time of the writing the technical report, Southern Rural Water had received seven applications for new groundwater licences from bores in the 40m to 340m depth range in a relatively concentrated area along the Mitchell River stretching from Bairnsdale in the east to Woodglen in the west. The total volume applied for was 3,197ML/yr. The current allocation from bores greater than 25m deep in the area is approximately 1,082ML/yr. I am now aware that there are additional applications received by Southern Rural Water in this area since the

original technical report was compiled. The information below and in the attached report is based on the original seven applications.

The area encompassing the new groundwater applications is on the edge of the Gippsland Basin and a number of regional aquifers either lense out or come close to the surface against the outcropping bedrock to the north. From youngest to oldest, these aquifers are:

- The Quaternary alluvial aquifer within the Mitchell River Valley
- The Upper Tertiary aged Haunted Hills Formation
- The Upper Tertiary aged Boisdale Formation
- The Mid Tertiary aged Latrobe Valley Coal Measures, Balook and Gippsland Limestone Aquifers (laterally equivalent)
- The Lower Tertiary aged Latrobe Group

In the study area on the basin margin, these aquifers are difficult to distinguish from each other due to their lensoidal nature and similar lithologies. In contrast, further south towards the centre of the basin, the aquifers are much thicker and easier to distinguish from each other. Therefore, there is significant uncertainty into the nature of the aquifers being targeted for irrigation and town water supply in the study area and their hydraulic connection to other regional aquifers. However, based on interpretation of drillers' logs, it appears that most existing and pending groundwater extraction licences are targeting the Latrobe Valley Coal Measures or the Balook aquifers in the western and northern parts of the study area and the Latrobe Valley Coal Measures/ Latrobe Aquifer in the west. The table below indicates the expected target aquifer for each of the new applications:

GW Licence No	Proposed Depth	Applicant Volume (ML)	Expected Target Aquifer
384881	40 m	100	Latrobe Valley Coal Measures
449530	75 m	2500	Latrobe Valley Coal Measures
426497	120 m	63	Latrobe Valley Coal Measures
332604 (Mr Cox)	75 m	67	Latrobe Valley Coal Measures
408730	85 m	67	Latrobe Valley Coal Measures
441933 (Mr Kerton)	140-340 m	300	Latrobe Valley Coal Measures/Balook
331733	200 m	100	Balook
444091	120 m	20	Gippsland Limestone/Latrobe Group?

Note: This table was correct for the 7 applications received at the time of writing of the attached technical report. I am now aware that there have been subsequent groundwater applications made in this area.

From bore logs in the area, Mr Cox's application (332604) appears to be targeting the Latrobe Valley Coal Measures Aquifer while Mr Kerton's application (441933) appears to be targeting the Latrobe Valley Coal Measures or Balook Aquifers.

The potential adverse impacts of additional allocation considered in this study included:

- The impact on local groundwater levels;
- The impact on other regional aquifers hydraulically connected to the target aquifer;
- The impact on surface water.

Impact on local groundwater levels

The sustainable yield of the Latrobe Valley Coal Measure/Balook aquifers in the local area is estimated to range between 1,900 and 4,700 ML/yr based on crude calculations of vertical recharge to the aquifer. The large range in values of vertical recharge reflects the high degree of uncertainty in the calculation which is based on the following assumptions:

- The proportion of rainfall recharging the aquifer is between 2% to 5% (values often used to calculate recharge)
- The recharge area is approximately 150km^2 based on the area of outcropping or near-surface aquifer from bore interpretations undertaken as part of this study. This does not include the area covered by the Boisdale Formation to the south.
- The average annual rainfall of 622mm/year for the last 10 years for station number 85050 located at Lindenow. Although the last 10 years of rainfall is not reflective of the longer term historical averages, it was considered that it approximately represents the potential future rainfall patterns under climate change.

The current allocation plus pending applications total approximately 4,279ML/yr[1] which is close to the upper range of calculated vertical recharge suggesting that if all pending applications were granted, the sustainable yield of the aquifer may be exceeded. In addition observation bore data in the area shows that the groundwater levels in the Latrobe Valley Coal Measures/Balook Aquifer have dropped by approximately 0.2m/year since the commencement of monitoring in 1992 although it is unclear whether this decline is due to hydraulic connection to the regional aquifer system or the below average rainfall over this period. Either way, additional allocation in the area is likely to put further pressure on already declining water levels in the area.

Note 1: The figure of 4,279ML/yr being the total of the current allocation plus 7 new applications was correct at the time of technical report compilation. I am now aware that there have been more applications received by Southern Rural Water in this area thus increasing this value.

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Impact on other regional aquifers

This study reviewed the potential for groundwater extraction in the Latrobe Valley Coal Measures or Balook Formation Aquifers to impact on the down-basin regional Boisdale Formation and Latrobe Group Aquifers.

From inspection of the available bore logs, the Boisdale Formation is expected to be hydraulically isolated from the aquifer targeted by Mr Cox's and Mr Kerton's application by the relatively impermeable Gippsland Limestone unit. Therefore, pumping from the target aquifer at these two locations is not expected to affect the Boisdale Aquifer. For the applications further west, there may be some hydraulic connection between the target aquifer and the Boisdale Aquifer so the impact is less certain.

Although it is difficult to determine the extent of the Latrobe Aquifer or the nature of the hydraulic connection between the Latrobe Aquifer and the target aquifer, in my opinion, the area containing the new groundwater licences is likely to be an important recharge area for the Latrobe Aquifer. Therefore, pumping from the target aquifer is likely to remove groundwater which would have otherwise reached the Latrobe Aquifer. In my opinion, additional pumping from the target aquifer in this area is likely to exacerbate the significant declines in water levels observed in the Latrobe Aquifer across Gippsland.

Impact on surface water

There is a strong hydraulic connection between the Quaternary Alluvial Aquifer in the Mitchell River Valley and the Mitchell River itself. However, the hydraulic connection between the Quaternary Alluvial Aquifer and the underlying Latrobe Valley Coal Measures/Balook Formation is difficult to determine. In some cases, there are significant thicknesses of clay separating the Quaternary sediments from the underlying target aquifers suggesting that pumping from the target aquifer is unlikely to cause significant impacts on the water levels in the Quaternary aquifer or the Mitchell River. In other cases, the deeper aquifers are known to subcrop beneath the Quaternary alluvial aquifer and could therefore interact with the shallow aquifer and the river. The study recommends that potential for new applications to interact with the Mitchell River be assessed on a case by case basis.

The following assessment on the specific effects of Mr Kerton's and Mr Cox's application on the Mitchell River is new information developed specifically for this expert witness statement and is not contained within the attached technical report:

In the case of Mr Kerton's and Mr Cox's applications, they are both located close to the Mitchell River so if there is vertical connection between the target Latrobe Valley Coal Measures/ Balook Aquifer and the Quaternary water table aquifer, then there could potentially be interference with the river. Driller's logs of bores 110978, 111800 and 105478 all located within a 5km radius of the two applications show that there are interlayered clays, marl and sand/gravel separating the target aquifer from the water table aquifer with the clay layers totalling not less than 15m to 20m total thickness. The clay layers in particular are likely to either partially or completely hydraulically separate the target aquifer and water table. At worst, there may be a leaky connection between the two aquifers which may have some influence on the water table aquifer although the effect is likely to be negligible compared to the effect of pumping water table bores in the Mitchell River Valley. Therefore, in my opinion, the effect of these two applications on the Mitchell River is likely to be negligible and significantly less important than the issue of local and regional sustainability described above.

Recommendations

The study makes a number of recommendations on additional drilling to address some of the knowledge gaps in extent and hydraulic connection between aquifers. Based on the drilling results, the study also recommends that the boundaries of the Sale WSPA and Stratford GMA be extended to cover the known extents of the Boisdale Aquifer and Latrobe Aquifer respectively.

10) A statement identifying any provisional opinions that are not fully researched for any reason (identifying the reason why such opinions have not been or cannot be fully researched)

All reasonable efforts were made to access publicly available data for this interpretation. There may be information pertinent to this study which, for commercial in confidence reasons, was not available for this study.

11) A statement setting out any questions falling outside the expert's expertise and also a statement indicating whether the report is incomplete or inaccurate in any respect.

It is my belief that the report is a technically rigorous interpretation of the publicly available data in the region and highlights the assumptions made and the degree of uncertainty.

"I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant to my knowledge have been withheld from the Tribunal"

Andrew Harrison
Senior Hydrogeologist
Phone: +61 3 5141 1868
Fax: + 61 3 5147 3322
E-mail: aharrison@skm.com.au

SINCLAIR KNIGHT MERZ SKM

Andrew Harrison

Company: Sinclair Knight Merz

SENIOR HYDROGEOLOGIST AND MANAGER OF MAFFRA OFFICE

QUALIFICATIONS

Bachelor of Science, University of Melbourne, 1986

Masters of Environmental Science, Monash University, 1994

CURRENT POSITION

Senior Hydrogeologist

FIELDS OF SPECIAL COMPETENCE

Salinity Investigation and Mitigation

Groundwater-Surface water interaction

Groundwater Resource Investigation and Management

Geotechnical Assessment

Groundwater Modelling

Irrigation Management

Wetland Hydrology

SUMMARY OF COMPETENCIES

Andrew has more than sixteen years of experience in environmental and hydrogeological related projects obtained from a broad range of studies conducted throughout Australia. His areas of expertise are salinity investigation and mitigation, groundwater/surface water interaction, groundwater resource investigation and management, geotechnical assessment, groundwater modelling, irrigation management, wetland hydrology.

RECENT RELEVANT PROJECT EXPERIENCE INCLUDES:

Sinclair Knight Merz, Maffra (November 1998 to date):

Senior Hydrogeologist and Manager of Maffra Office

Significant projects:

- Project manager for the development of the West Gippsland Salinity Management Plan for the West Gippsland CMA;
- Project manager for a salt and water balance study of Dowd Morass;
- Project manager for a salt and water balance study of Lake Coleman;
- Project manager for West Gippsland "State of the Catchment" report for the West Gippsland Catchment Management Authority
- Project manager for on-going salinity investigations for the Lake Wellington Catchment Salinity Management Plan
- Project manager for the investigation into potential contamination around the Dutson Downs Waste Water Treatment Plant for Gippsland Water
- Managing the groundwater pumping program for the Wellington Salinity Management Plan
- Provision of technical advice for the establishment of Groundwater Management Areas in the Gippsland region including Bairnsdale and Orbost areas.

- Advising Southern Rural Water on appropriate monitoring programs for the Macalister Irrigation District Nutrient Reduction Plan
- Study into the water management options available for Clydebank Morass in the Lake Wellington Area.
- Study into water use and economics of spray irrigation and re-use systems in the Macalister Irrigation District for the Nutrient Reduction Plan.

Sinclair Knight Merz, Melbourne (June 1995 to November 1998):

- Involved in a variety of hydrogeological investigations including groundwater modelling, salinity investigation and remediation, geotechnical assessment and groundwater resource assessment. Significant studies include:
- Study of groundwater/river interaction in the Ovens Basin including a quantitative estimate of groundwater discharge to the Ovens River using an analytical model.
- Review of sustainable yield of the Tertiary Limestone Aquifer along the South Australian/Victorian Border.
- Investigation of groundwater/lake interaction at Lake Tutchewop in north-central Victoria. The investigation involved analysing lake and groundwater data and the construction of a 3 layer groundwater/surface water computer model.
- Salinity investigations in the Wimmera area including recharge mapping and evaluating the effect of salinity control options;
- Establishment of a field trial to study the groundwater recharge and eventual discharge to streams in small sub-catchments. The study also measures the effect of salinity control measures on the groundwater discharge.

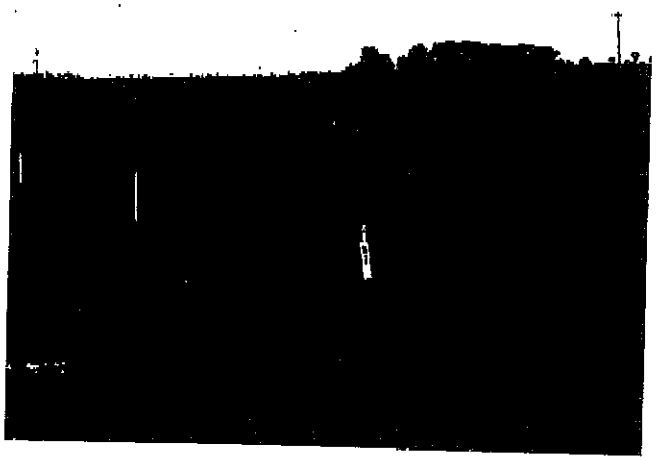
Hydrotechnology (A business unit of the Rural Water Corporation) (November 1992 to June 1995):

- Hydrogeological and geotechnical investigations relating to salinity control, groundwater resource assessment and dam surveillance including computer manipulation of data and groundwater modelling;
- Design, implementation and supervision of drilling programs; and,
- Policy studies relating to management of State's groundwater bore network.

Papers and Presentations

- Harrison, A, Blake, A, Sommerville, H and Summerell, G (2007) "Variations in catchment outlet base flow salinities and the relationship to spatial salinity distribution within the catchment,- A study within the Murrumbidgee Valley NSW and the implications for salinity control works." Paper to the Adelaide National Salinity Conference, April 2008
- Harrison, A. K and Hook, K. A., (2004) "Groundwater pumping for salinity control in the Macalister Irrigation District, Gippsland, Victoria" Paper to the 1st National Salinity Engineering Conference, 9–12 November 2004 Perth, Western Australia
- Harrison, A. K. (2000), 'Subsurface drainage in the Macallster Irrigation District'. Paper presented to CSIRO workshop on subsurface drainage, Tatura, 6th and 7th June 2000.
- Harrison, A.K., and Hoxley, G.P. (1997), 'Modelling the effect of perennial pastures on recharge in the Mount William Creek and Upper Wimmera Catchments in Western Victoria.' Proc of Murray Darling Workshop, Toowoomba, August 1997.
- Harrison, A.K., and Hoxley, G.P., 1995, 'Lake Tutchewop Salt Disposal Complex - Groundwater Modelling Study', Proc of MDBC Groundwater Workshop, Wagga Wagga, Sept 1995.

Groundwater Resource Assessment of Deeper Aquifers in the Lindenow region, East Gippsland



- Final 4
- 5th August 2008

SKM

Groundwater Resource Assessment of Deeper Aquifers in the Lindenow region, East Gippsland

- Final 4
- 5th August 2008

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Contents

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Document history and status

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Draft 3	24/08/2007	A Harrison	A Harrison	29/08/2007	PD review
Draft 4	3/09/2007	A Harrison	A Harrison	3/09/2007	PD review
Draft 5 (Draft to client)	5/09/2007	A Harrison	A Harrison	5/09/2007	PD review
Final 1	23/10/2007	A Harrison	A Harrison	23/10/2007	Additional interpretation of logs provided by SRW
Final 2	9th Nov 2007	A. Harrison	A. Harrison	9/11/2007	Addition of Exec Summary
Final 3	12th Feb 2008	A Harrison	A Harrison	12/02/2008	Addition to Section 1.3 and 3.5
Final 4	5th August 2008	A Harrison	A Harrison	5/08/2005	Updated Figure 2.7 and Section 3.5

Distribution of copies

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Final 1	23/10/2007	Email	Terry Flynn (SRW)
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Final 4	5/8/2008	Email	T Flynn

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Name of document:	Hydrogeological Investigation
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Project number:	VW04107

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Executive Summary

This report details the hydrogeology of the deeper aquifers in and around the Lindenow Flats near Bairnsdale. The study was commissioned by Southern Rural Water in response to a number of recent applications for groundwater licences in the area. The study provides a new conceptual hydrogeological model for the area based on an interpretation of existing information such as bore logs and groundwater level data.

The area is on the edge of the Gippsland Basin and a number of regional aquifers either lense out or come close to the surface against the outcropping bedrock to the north. From youngest to oldest, these aquifers are:

- The Quaternary alluvial aquifer within the Mitchell River Valley
- The Upper Tertiary aged Haunted Hills Formation
- The Upper Tertiary aged Boisdale Formation
- The Mid Tertiary aged Latrobe Valley Coal Measures, Balook and Gippsland Limestone Aquifers (laterally equivalent)
- The Lower Tertiary aged Latrobe Group

Southern Rural Water have recently received seven applications for new groundwater licences from bores in the 40m to 340m depth range in a relatively concentrated area along the Mitchell River stretching from Bairnsdale in the east to Woodglen in the west. The total volume applied for is 3,197ML/yr. The current allocation from bores greater than 25m deep in the area is approximately 1,082ML/yr. Based on interpretation of drillers' logs, it appears that most existing and pending groundwater extraction licences are targeting the Latrobe Valley Coal Measures or the Balook aquifers in the western and northern parts of the study area and the Latrobe Valley Coal Measures/ Latrobe Aquifer in the west.

The potential adverse impacts of additional allocation considered in this study included:

- The impact on local groundwater levels;
- The impact on other regional aquifers hydraulically connected to the target aquifer;
- The impact on surface water.

Impact on local groundwater levels

The sustainable yield of the Latrobe Valley Coal Measure/Balook aquifers in the local area is estimated to range between 1,900 and 4,700 ML/yr based on crude calculations of vertical recharge

to the aquifer. The current plus pending applications total approximately 4,279ML/yr suggesting that if all pending applications were granted, the sustainable yield of the aquifer may be exceeded. In addition observation bore data in the area shows that the groundwater levels in the Latrobe Valley Coal Measures/Balook Aquifer have dropped by approximately 0.2m/year since the commencement of monitoring in 1992 although it is unclear whether this decline is due to hydraulic connection to the regional aquifer system or the below average rainfall over this period. Either way, additional allocation in the area is likely to put further pressure on already declining water levels in the area.

Impact on other regional aquifers

This study reviewed the potential for groundwater extraction in the Latrobe Valley Coal Measures or Balook Formation Aquifers to impact on the down-gradient regional Boisdale Formation and Latrobe Group Aquifers.

Interpretation of geological logs in the area suggest that to the east of the Coongulmerang/ Wuk Wuk area (cross-section line A-B in Figure 2-2), the Boisdale Formation is likely to wedge out against the Gippsland Limestone unit hydraulically separating it from the Latrobe Valley Coal Measures/Balook Formation aquifer. This is consistent with the interpretation of GHD (2004a). In this area, groundwater pumping from the Latrobe Valley Coal Measures/Balook Formation aquifer is unlikely to have any impact on the down-gradient Boisdale Aquifer. This applies to six of the new applications totalling approximately 350ML/year. The other 3,929ML/year of groundwater applied for is west of this area where interpretation of sparse bore log information is inconclusive on the nature of the hydraulic connection between Boisdale and the Latrobe Valley Coal Measures/Balook Aquifer. Although unlikely, there is a small risk that pumping from the Latrobe Valley Coal Measures/Balook Aquifer in this western area may impact the down-gradient Boisdale Aquifer. However, additional drilling information is required to confirm this.

Although the Latrobe Aquifer can be identified in the bore logs in the east of the study area where it underlies the Gippsland Limestone Aquifer, in the west of the area, the aquifer is either not present or is not distinguishable from the overlying Latrobe Valley Coal Measures/Balook Formation Aquifer. There is potential for pumping from the targeted aquifer to affect water levels in the Latrobe Aquifer which is already under significant stress from over-extraction (both on-shore and off-shore).

Impact on surface water

There is a strong hydraulic connection between the Quaternary Alluvial Aquifer in the Mitchell River Valley and the Mitchell River. However, the hydraulic connection between the Quaternary

Alluvial Aquifer and the underlying Latrobe Valley Coal Measures/Balook Formation is difficult to determine. However, in some cases, there are significant thicknesses of clay separating the Quaternary sediments from the underlying target aquifers suggesting that pumping from these aquifer is unlikely to cause significant impacts on the water levels in the Quaternary aquifer or the Mitchell River. In other cases, the deeper aquifers are known to subcrop beneath the Quaternary alluvial aquifer and could therefore interact with the shallow aquifer and the river. This study recommends that potential for new applications to interact with the Mitchell River be assessed on a case by case basis.

Recommendations

The study makes a number of recommendations on additional drilling to address some of the knowledge gaps in extent and hydraulic connection between aquifers. Based on the drilling results, the study also recommends that the boundaries of the Sale WSPA and Stratford GMA be extended to cover the known extents of the Boisdale Aquifer and Latrobe Aquifer respectively.

SKM

1. Introduction

1.1 Background

Sinclair Knight Merz (SKM) was commissioned by Southern Rural Water (SRW) to undertake a hydrogeological assessment of deeper aquifers in and around the Lindenow Flats near Bairnsdale. The most well known and utilised aquifer in the region is the shallow alluvial aquifer which is covered by the Wy Yung Groundwater Management Area (GMA). However the Wy Yung GMA is now fully allocated and groundwater users are looking to the deeper aquifers in the region for water supply purposes.

SRW are concerned that the existing licence volume, together with the pending applications, may be unsustainable. SKM was requested to undertake a desktop investigation of the aquifers underlying the shallow alluvial aquifer to develop a conceptual hydrogeological model for the area and identify whether additional groundwater licences in the area are likely to cause local and regional impacts.

1.2 Objectives and Scope

The primary objective of this study is to characterise the aquifers beneath the shallow alluvial aquifer at Lindenow Flats and assess the potential impacts of additional groundwater extraction. This study focuses on the areas to the north of the Lindenow Flats before the bedrock outcrops on the highlands. The scope of work is as follows:

- Task 1 – Collate and review existing information;
- Task 2 – Develop conceptual hydrogeological model;
- Task 3 – Assess potential impact of proposed groundwater extraction; and
- Task 4 – Reporting.

1.3 Lindenow Flats

The Lindenow Flats are located along the Mitchell River, west of Bairnsdale in the east Gippsland region (Figure 1-1).The Mitchell River is one of the major rivers draining the southern slopes of the Eastern Highlands. The river drains from a catchment of 4,400 km^2 and flows in a southerly direction until it enters the coastal plain near Glenaladale. It then flows east until it reaches Bairnsdale and drains to the Gippsland Lakes.

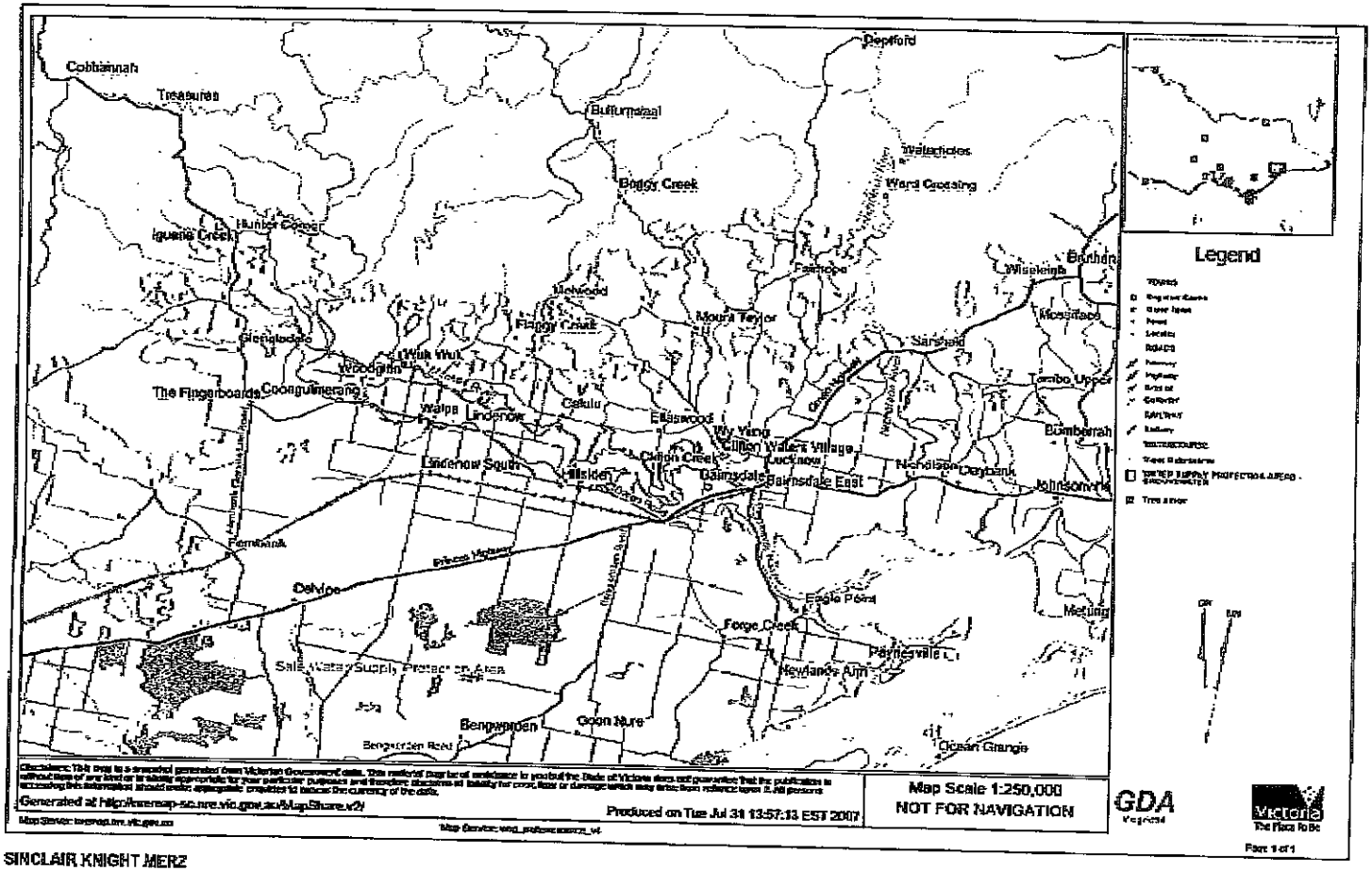
The Lindenow Flats form a narrow steep sided valley, where the river has carved into the Tertiary sediments. The valley is almost 3 km wide and the terraces are 10 m high near Glenaladale, but as the river flows east, the valley narrows to less than 800 m near Bairnsdale (Thompson, 1973). There are a number of tributaries that drain into the Mitchell River in the Lindenow area. However most of these are ephemeral streams and only flow in wetter months.

Landuse in the area primarily consists of dryland and irrigated farming, with the fertile soils making it suitable for dairy farming or vegetable growing when irrigated.

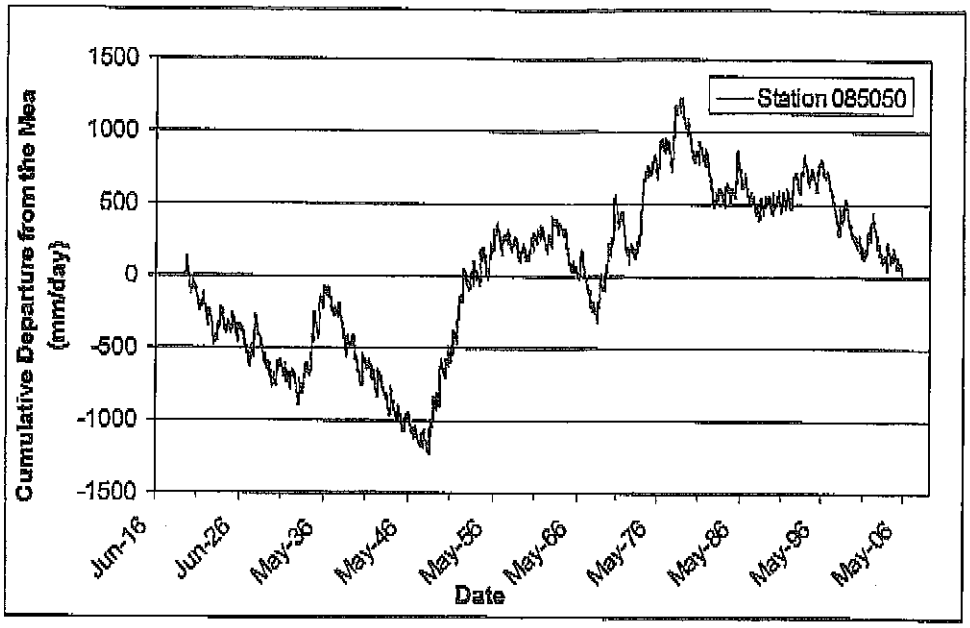
The area is in a temperate zone which varies from a maximum average daily temperate of 18.5°C in January to a minimum of 8°C in July (Thompson, 1973). Average annual rainfall at Lindenow (station number 085050) is 636 mm/year. Figure 1-2 shows the long term rainfall data plotted as cumulative departure from the mean. This highlights that rainfall was above average in the 1960's and 1970's and since 1972 rainfall has generally been below average.

Evaporation data has been monitored at Bairnsdale waterworks (site number 084100) since 1970, and the average annual evaporation 1,266 mm/year. This varies seasonally from a minimum average in June of 44 mm/month to a maximum of 178 mm/month in January (Figure 1-3).

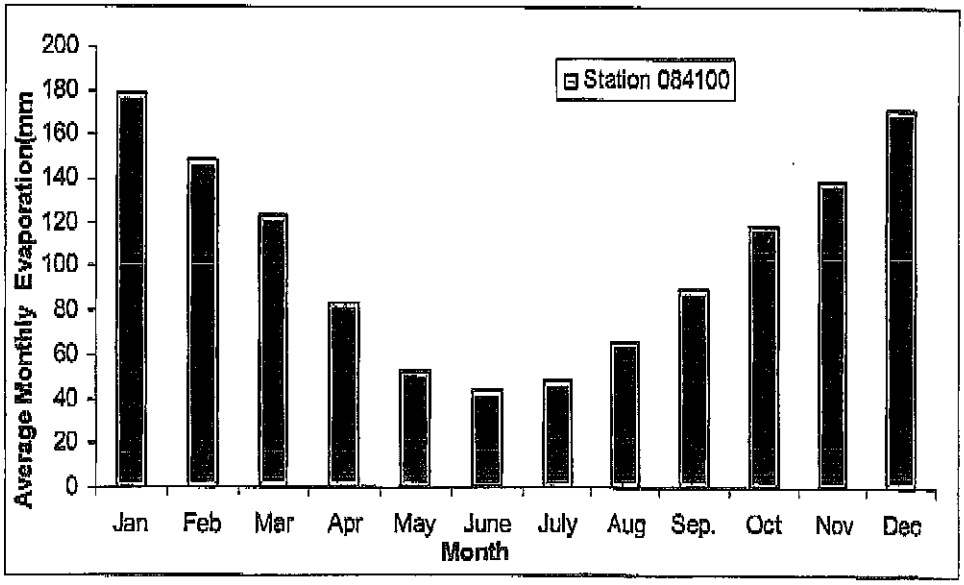
- **Figure 1-1 Study Area and Wy Yung GMA Boundary**



- Figure 1-2 Rainfall Data as a Cumulative Depart from the Mean



- Figure 1-3 Monthly Average Evaporation



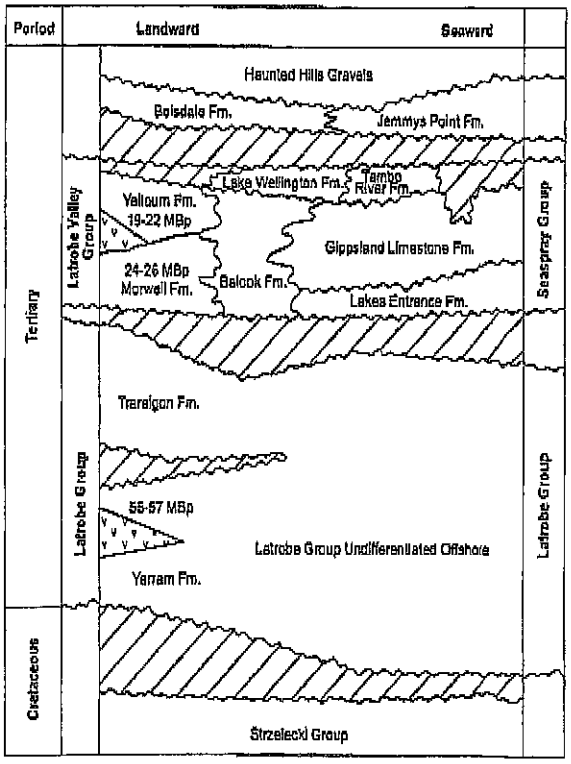
2. Geology and Hydrogeology

2.1 General Stratigraphy

The Lindenow Flats are located in the northern margin of the Gippsland Basin. The Gippsland Basin is a large sedimentary basin covering over 46,000 km^2 of which 70% occurs offshore. The onshore part of the basin comprises up to 2,000 m thickness of Tertiary sediments overlain by thin Quaternary sediments. The Tertiary sediments are underlain by sandstone and mudstone of the Palaeozoic sediments and granite. The Palaeozoic sediments form the basement bedrock for the Tertiary sequence and also outcrop to the north as part of the Eastern Highlands.

The Lindenow Flats overlie a structural high of the basin known as the Lakes Entrance Platform which forms the north eastern extent of the Gippsland Basin. The general stratigraphy across the region is shown in Figure 2-1. The Tertiary sequence consists of lower Tertiary basal unit known as the Latrobe Group. This is overlain by middle Tertiary marine facies, marginal marine and a non marine facies known as the Gippsland Limestone Formation, Balook Formation and the Latrobe Valley Coal Measures respectively and an upper Tertiary unit consisting of marine and non marine facies known respectively as the Jemmy's Point Formation and Boisdale formation.

Figure 2-1 Stratigraphic Chart of the Gippsland Basin (Taken from SKM, 1999)



Using the 1:63,360 scale and the 1:250,000 scale Bairnsdale geological map sheets, the stratigraphy in the area comprises the following formations:

- Quaternary sediments;
- Haunted Hills Gravels
- Boisdale Formation;
- Jemmy's Point Formation;
- Tambo River Formation;
- Gippsland Limestone;
- Latrobe Valley Coal Measures;
- Balook Formation; and
- Latrobe Group.

These are discussed in detail in the following sections.

2.2 Quaternary Aquifers

2.2.1 Extent and Lithology

The Lindenow Flats form a narrow steep sided valley, where the river has carved into the Tertiary sediments. There are two Quaternary aquifers; the shallow river alluvium and the Haunted Hills Formation. The Haunted Hills Formation directly underlie the alluvial aquifer. Both aquifers cover much of the Mitchell River Valley and may also continue south east of Bairnsdale towards Lake King (Walker & Mollica, 1989).

The river alluvium is terraced and up to 10 m thick. The formation typically comprises 3 to 8 m of coarse gravels and sands which overlie up to 5 m of medium to fine silt and sand (Thompson, 1973).

The Haunted Hill Formation in the Lindenow Flats area consists of silts and clays which are commonly oxidised to produce brown, yellow, red or mottled sediments with ironstone near the top. Elsewhere, the formation comprises predominantly sands, gravels, clay and silt (Leonard, 2004). They reach a maximum thickness of 30 m south of Coongulmerang near Bairnsdale and decreases southwards to around 15 m thick (Thompson, 1973). The formation is characterised by a wide range of poorly sorted particles sizes.

2.2.2 Recharge and Aquifer Flow

The Quaternary aquifers are generally unconfined, although they can become semi-confined in local areas. The primary recharge mechanism for the Quaternary aquifers is via rainfall recharge,

although significant flood events also provide recharge to the aquifer over short durations. Groundwater within the aquifer flows in a south easterly direction.

2.2.3 Groundwater Trends

There are 30 SOBN bores in the Quaternary aquifers which monitor groundwater levels on a monthly basis. Selected hydrographs for six of these bores are shown in Appendix A. The majority of bores show declining trends resulting from below average rainfall conditions experienced since monitoring commenced in 1970. The shallow alluvial aquifer is recharged primarily from rainfall recharge with local flooding providing episodic recharge events. Significant flood events are clearly recognised in the bore hydrographs in 1974, 1978, 1998 and recently in 2007.

2.2.4 Hydraulic Characteristics

The permeability and porosity of the alluvial aquifer varies considerably across the study area (SKM, 1998). SKM (1998) determined the hydraulic conductivity and specific yield of the aquifer to be 30 m/day and 0.1 respectively.

2.2.5 Groundwater Quality and Use

The alluvial aquifer is the most utilised aquifer in the Lindenow Flats area. The aquifer is generally high yielding (10 – 50 L/sec) and the groundwater salinity is generally less than 1,000 mg/L TDS making it suitable for irrigation purposes. The aquifer is covered by the Wy Yung WSPA which covers the Mitchell River flats and extends to a depth of 25 metres. Groundwater management areas are discussed in more detail in Chapter 3.

2.3 Boisdale Aquifer

2.3.1 Extent and Lithology

The Boisdale Formation consists of two units, the lower Wurruk Sand Member and the upper Nuntin Clay Member. The formation grades laterally to the east into the fine grained marine sediments of the Jemmy's Point and Tambo River Formations and consists of well rounded, well sorted course sands with interbedded clay beds which contain ligneous clays and gravels in some places. The formation is not exposed at the surface and only subcrops north of Sale where it wedges out and thins beneath the overlying Quaternary sediments. The formation is thickest near Sale where it reaches up to 200 m, and thins to the east and west towards Seaspray and Woodside (SKM, 2006).

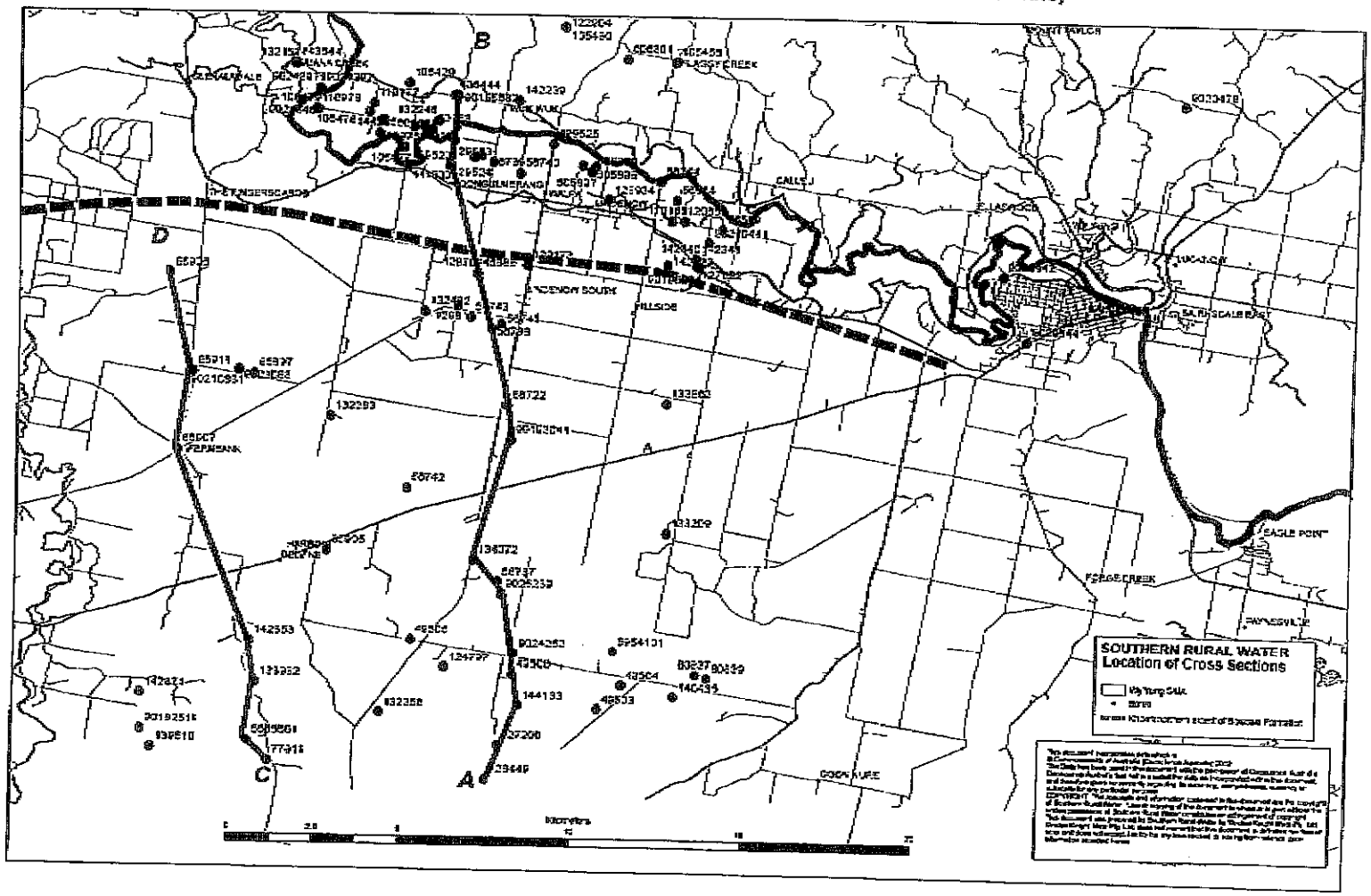
The northern extent of the Boisdale formation is not well understood. Hydrotechnology (1994) suggest the Boisdale aquifer extends north of the Princess Highway, leaving a thin zone outside the Sale WSPA boundary. A more recent investigation undertaken by GHD (2004b) revealed two bores in the south western corner of the study area with 50 m of sand rich sediment overlying shell

beds of the Jemmy's Point Formation or Tambo River Formations (Bore 304653 and 304654). The logs for these bores are not on the GMS, however GHD (2004b) reported sands, gravels and clays to 65 m overlying marine sediments. The Haunted Hills Formation is typically thinner than this suggesting either a thin section of the Boisdale Formation or sandier sections of the Jemmy's Point Formation exist north of the Princess Highway.

This study also found evidence of the Boisdale aquifer in a similar area. The drillers logs for Bores 56525 and 56702 show a thick sequence of sand overlying shells, marls and limestone, which is interpreted to be Boisdale Formation overlying the Jemmy's Point Formation or Gippsland Limestone. However the formation pinches out towards the Mitchell River, as there is no evidence of the formation in the terraces of the Mitchell River Valley or north of the River. The logs for these bores are shown in Appendix B.

Figure 2-2 shows the current understanding of the northern extent of the Boisdale aquifer in the region. In order to confirm the extent of the Boisdale aquifer, two north south cross sections were prepared. The cross sections are presented in Figure 2-3 and Figure 2-4 and their location is shown in Figure 2-2.

Figure 2-2 Location of North South Cross Sections in the Study Area (known extent of Boisadle)



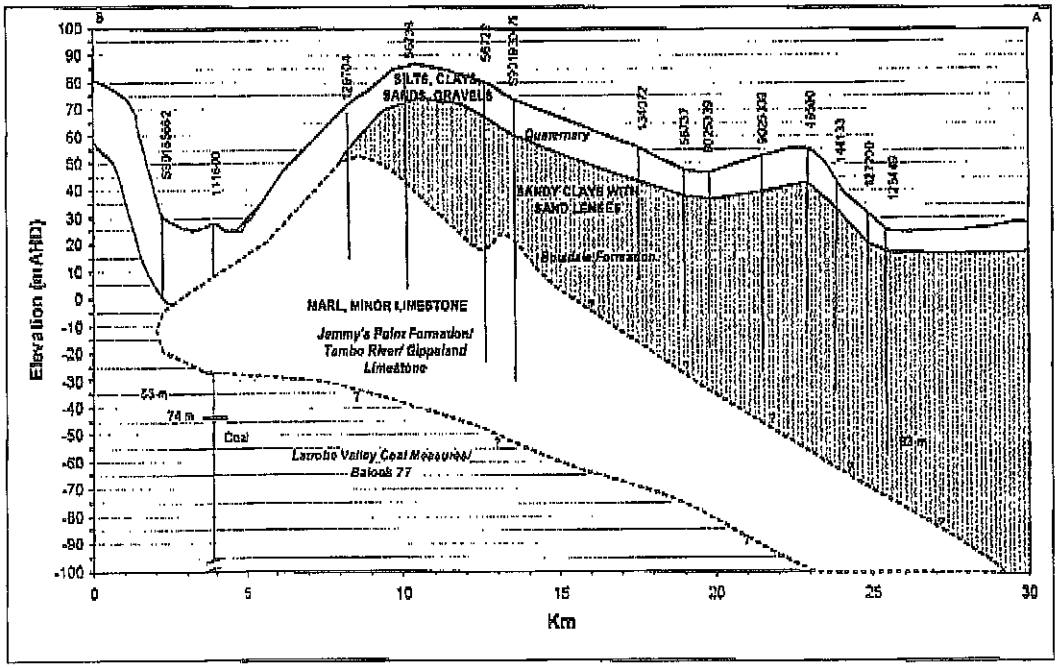
Cross section A-B (Figure 2-3) shows that the surficial geology comprises Quaternary sediments which are assumed to be around 10 to 15 metres thick. The Quaternary sediments are underlain by a sequence of sandy clay/clayey sand sediments with sand lenses. This has been interpreted to be the Boisdale Formation which thickens to the south of the study area towards the Sale WSPA. The Boisdale Formation thins to the north and is not present in the Mitchell River valley.

The Boisdale Formation is underlain by a sequence of marl, which could represent the Jemmy's Point Formation, Tambo River Formation or the Gippsland Limestone. The top of this formation was intersected in five bores south of the Mitchell River, however the thickness of the formation is not known as only one bore in the Mitchell River valley penetrates through the marl layer. The southern bores were not drilled deep enough to intersect any marl.

As mentioned, only one bore was drilled through the entire thickness of the marl layer. Bore 111800 is located in the Mitchell River valley and penetrated 21 metres of marl before intersecting sandy clay, coal and sand lenses, which is interpreted to be the Latrobe Valley Coal Measures, Balook Formation or Latrobe Group.

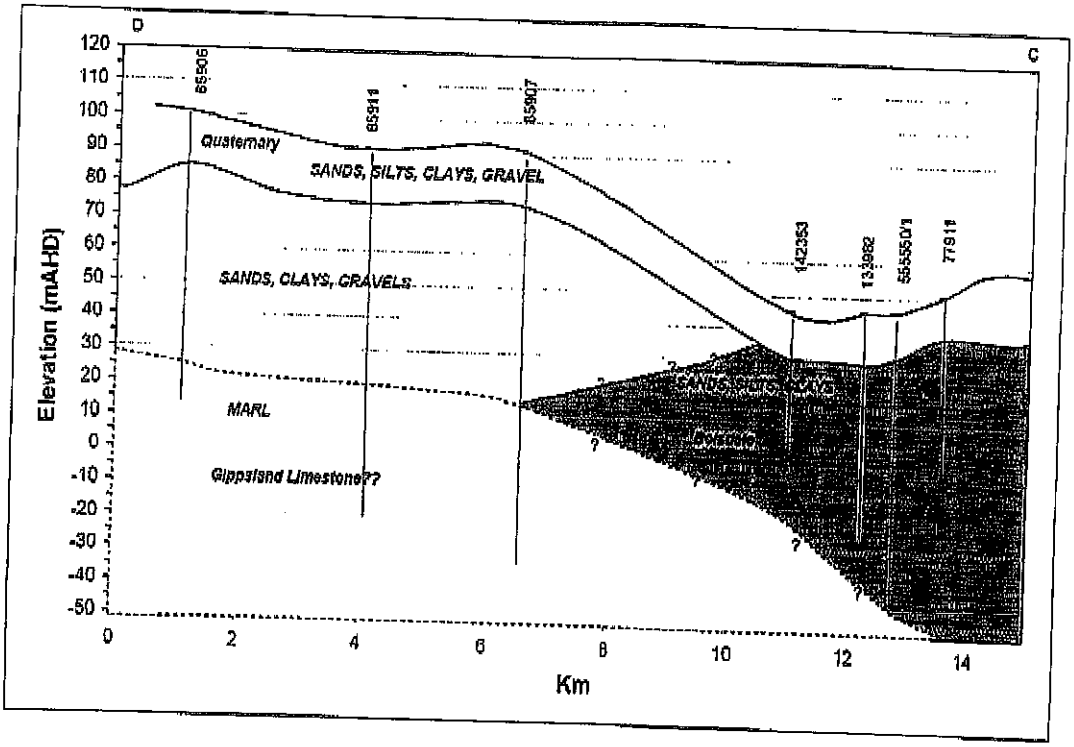
This cross section indicates that the Boisdale Formation does not directly overlie the Latrobe Valley Coal Measures and/or Balook in this part of the study area.

- **Figure 2-3 Cross Section A-B**



Cross section C-D (Figure 2-4) also shows Quaternary sediments overlying Boisdale Formation in the southern half of the cross section. However it is unclear how far north the Boisdale Formation extends. Bore logs of Bores 85907, 85911 and 85906 located in the northern half of the cross section also show a sequence of sands, clays and gravels overlying marl which could also to represent the Boisdale Formation. However the geology to the north of Bore 85907 and west of the Mitchell River is not clear as no bores have been drilled in the area. Of particular concern is the lack of information about the connectively between the Boisdale aquifer and the Latrobe Valley Coal Measures and/or Balook Formations in this area. Bores drilled just west of the Mitchell River do not intersect any marl, which suggests that the two aquifers could potentially be connected.

- **Figure 2-4 Cross Section C-D**



Essentially there are two hydrogeological scenarios for the northern extension of cross-section C-D:

- Scenario 1 - Boisdale and Latrobe Valley Coal Measures/Balook aquifers are hydraulically separated by lower permeability marl associated with the marine deposits of the Jemmy's Point/Gippsland Limestone; or
- Scenario 2 – Boisdale and Latrobe Valley Coal Measures/Balook aquifers are hydraulically connected in western part of study area.

Figure 2-5 Scenario 1 Boisdale and Latrobe Valley Coal Measures/Balook aquifer are hydraulically separate

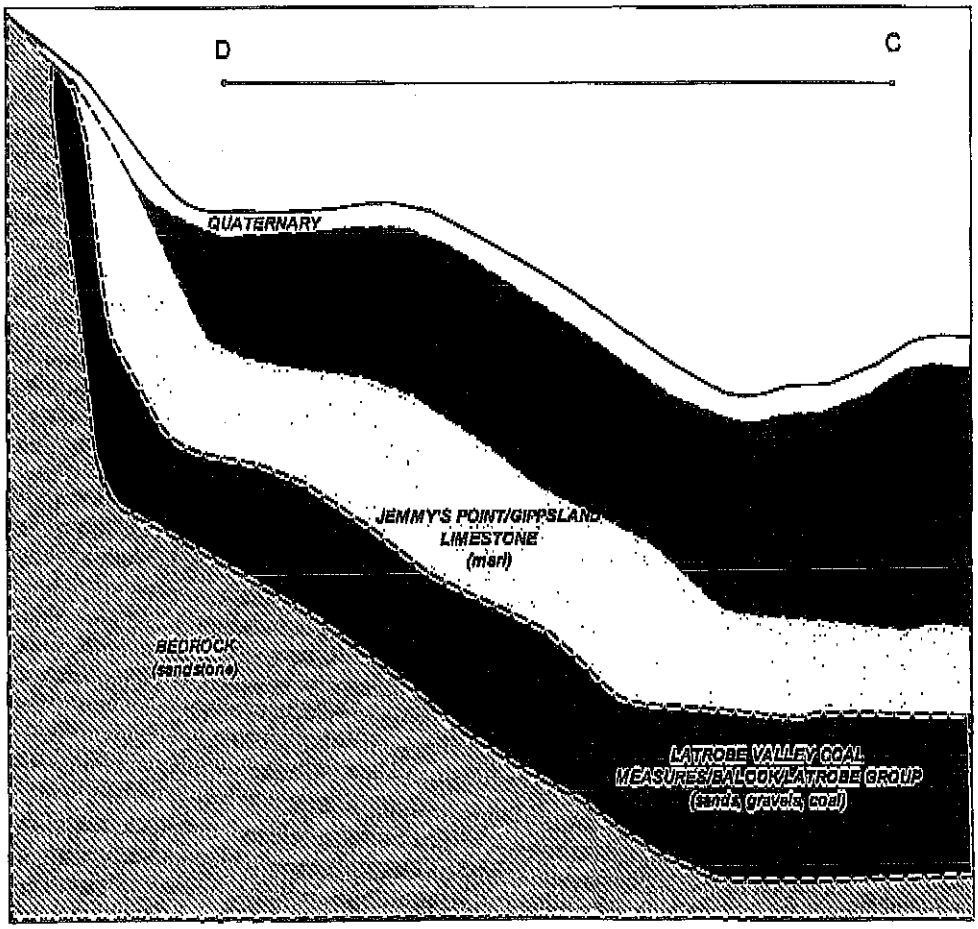
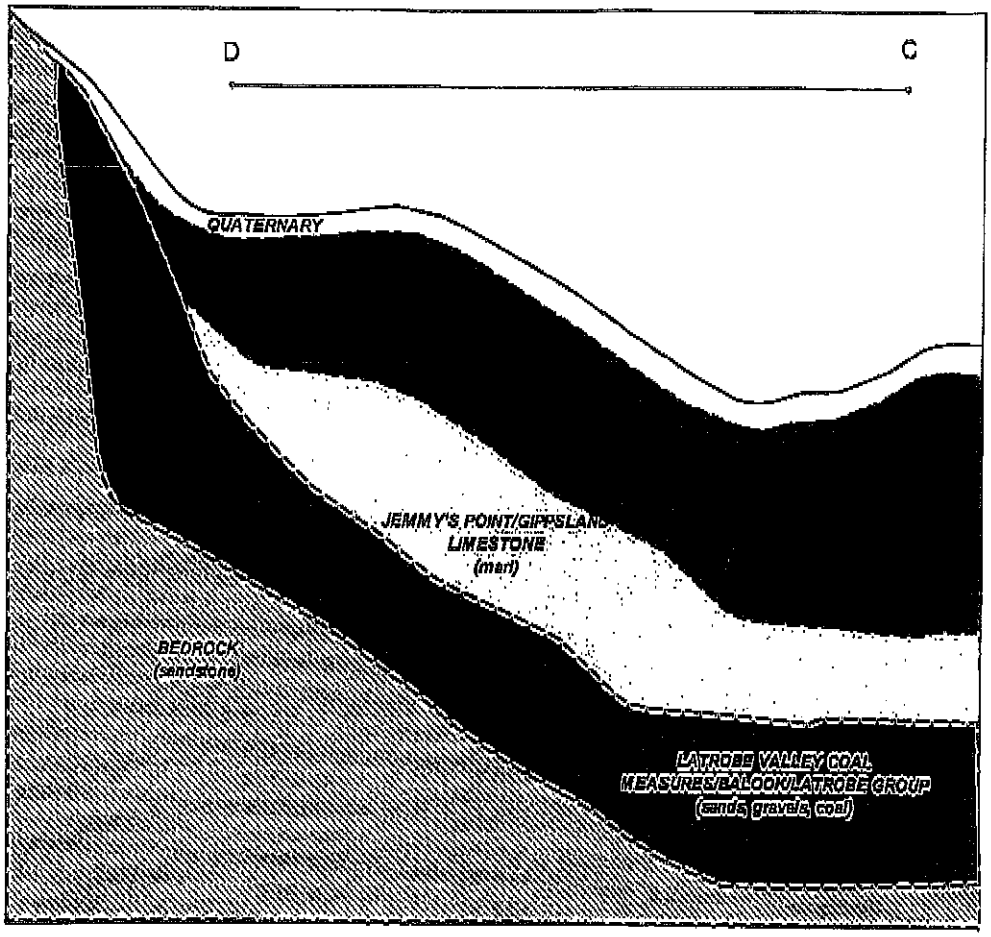


Figure 2-6 Scenario 2 Boisdale and Latrobe Valley Coal Measures/Balook aquifer are hydraulically connected in western part of study area



Scenario 1 (Figure 2-5) shows the Boisdale Formation and the underlying marl associated with the Jemmy's Point/Gippsland Limestone Formation pinching out to the north and beneath the Quaternary sediments near the bedrock outcrop. This scenario suggests that the Latrobe Valley Coal Measures and/or Balook aquifers are hydraulically isolated from the overlying Boisdale Formation by the marl associated with the marine deposits.

However, the Scenario 2 presented in Figure 2-6 shows the marl pinching out before the Boisdale Formation. This would allow a hydraulic connection between the two aquifers of concern. Given the largest pending groundwater extraction licence is located just east of the Mitchell River, it is important to confirm the connection extent of the marine deposits and the connection between the Latrobe Valley Coal Measures and the Boisdale aquifers in this part of the study area.

2.3.2 Recharge and groundwater flow

Regionally, the Boisdale aquifer is considered to be mainly recharged along the northern margin of the aquifer between the Thomson and Avon Rivers and the region south of Sale (SKM, 2006). However, SKM (2006) also found the area to the north of the Princes Highway between Stratford and Bairnsdale to be an important recharge area for the aquifer, because the aquifer is likely to be recharged from rainfall infiltration, as well as from adjacent aquifers. The cross sections discussed in the previous section suggest that the Boisdale aquifer is not hydraulically connected to the deeper aquifers (Latrobe Valley Coal Measures and Balook aquifers) in the study area. Therefore rainfall recharge is likely to be the most important recharge mechanism for the aquifer is this region.

Groundwater flow within the Boisdale aquifer is generally to the south east where it discharges to the Gippsland Lakes and /or the ocean.

2.3.3 Hydraulic Characteristics

The Boisdale aquifer is the best understood in the Sale region where it used for the town's water supply. Pumping tests in the Sale area have determined hydraulic conductivity to be approximately 24 m/day and storage coefficients of 10^{-4} although the transmissivity has been measured up to 1,300 m^2/day (Walker and Mollica 1989; SKM, 1998b). However, the aquifer transmissivity is not expected to be as high in the study area where the aquifer thins and wedges out against the mid-Tertiary Latrobe Valley Coal Measures, Balook and Gippsland Limestone Aquifers.

2.3.4 Groundwater Quality and Use

There is little information of the groundwater quality of the Boisdale aquifer in the study area. However, in the Sale area, the salinity is typically less than 500 mg/L TDS (SKM, 1998). The two bores in the study area thought to intersect the Boisdale aquifer (Bores 56525 and 56702) have salinities measurements of 400 and 800 mg/L, which is suitable for irrigation and stock purposes.

The Boisdale aquifer is utilised extensively in the Sale area, where it forms the water supply for the township. In the south western corner of the study area, the sandy Boisdale aquifer offers the most viable potential groundwater resource. The aquifer thins to the north and west. There are a number of stock and domestic bores that are thought to intersect the Boisdale Formation in the southern area of the study area. SKM (2006) recommended further work in this region to confirm the extent of the Boisdale aquifer in this area.

SKM

2.4 Gippsland Limestone and Jemmy's Point Aquifer System

2.4.1 Extent and Lithology

The Gippsland Formation, together with the overlying Tambo River Formation and Jemmy's Point Formation, form the Seaspray Group Aquifer System. These formations are only present in the south half of the study area, as there is no evidence of these formations north of the Mitchell River. The Gippsland Limestone is the offshore equivalent of the on shore deposits of the Latrobe Valley Coal Measures and Balook Formation, which are discussed further in the following section.

Figure 2-7 shows the bores that have intersected either limestone and marls beneath Quaternary sediments in dark blue and limestone and marls beneath sand sequences in light blue. Where the limestone and marls are overlain by sand sequences in the south western corner, the overlying sand sequences are thought to be Boisdale aquifer and Quaternary sediments. This figure also shows that the lack of information in the north western corner of the study area. The extent of the Latrobe Valley Coal Measures and the Balook Formation are discussed in Section 2.5.

The Jemmy's Point formation extends south to a maximum thickness of 110 m in the Golden Beach area, east of Lake Wellington and grades into the Boisdale formation (SKM, 2007). Beneath the Jemmy's Point Formation are marine sediments of the Tambo River Formation. These are further underlain by the non marine sediments of the Latrobe Valley Coal Measures to the west of Walpa and marine sediments of the Gippsland Limestone to the east Walpa (SKM, 1998). The Gippsland Limestone grades laterally into the Balook Formation and Latrobe Valley Coal Measures (refer to Figure 2-7).

The Gippsland Limestone consists of two middle to late Miocene units; the Bairnsdale Limestone and the Wuk Wuk Marl. Both units outcrop in thin beds along the southern side of the Mitchell River, underlying Jemmy's Point Formation where it reaches a maximum thickness of 33 m thick formation (Holdgate *et. al*, 2003). The extent of the Gippsland Limestone in the Bairnsdale area is not accurately known due to the lack of detailed mapping. A 1:63,360 scale geological map sheet was produced for Bairnsdale, although does not extend across all of the Lindenow Flats. The formation is known to reach a maximum thickness of 800 m around Lake Wellington. The full extent of the aquifer is not fully known, although the Jemmy's Point Formation and Gippsland Limestone both outcrops in the terraces along the Lindenow Flats.

The Jemmy's Point formation consists of grey to brown shelly and sandy marl, marly or calcareous sandstone, succeeded by shelly sand and minor gravel (SKM, 1998b). The marls typically show intergranular porosity with little evidence of secondary solution porosity (SKM, 1998). The Tambo River Formation consists of a mixture of shelly marl, marly limestone and ferruginous fine sandstone. The Bairnsdale Limestone consists of bryzoal shelly limestone and marly limestone, while the Wuk Wuk Marl consists of fossiliferous marl and is commonly unconsolidated (Nahm, 1971).

2.4.2 Recharge and groundwater flow

The sequence is mainly recharged from surface infiltration where the formations outcrop or subcrop at shallow depth. The vertical hydraulic relationship between various aquifers is not well understood. Regional groundwater flow is thought to occur towards the sea.

2.4.3 Hydraulic parameters

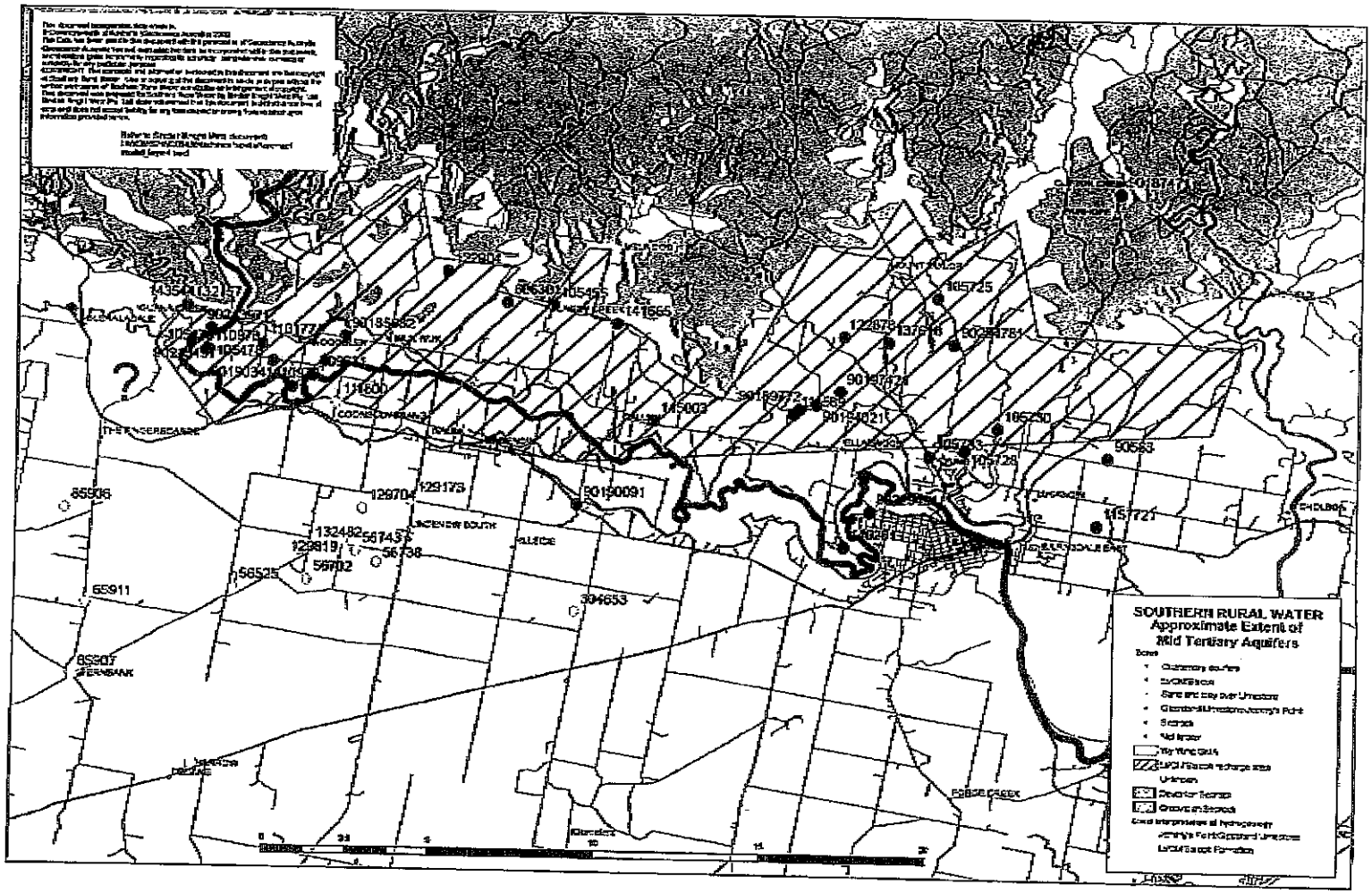
The Jemmy's Point Formation and the underlying Gippsland Limestone are generally considered to be hydraulically connected in the study area. Further south, the aquifer system is also connected to the Lakes Entrance Formation aquifer. Together these formations are generally considered to be a low yielding aquifer and in many places, an aquitard. The hydraulic parameters are highly variable and not well known. Where the formations consist predominantly of marl or marly limestone, it is a poor aquifer in terms of yield and groundwater quality. However, where pockets of limestone and shelly sands exist the aquifer can yield up to 10 L/sec.

2.4.4 Groundwater Quality and Use

Salinities in the Gippsland Limestone are variable between 1,000 to 2,500mg/L TDS (Leonard, 2004). Only one bore is thought to be screen in the marine aquifer and this bore has a salinity reading of 3,100 mg/L.

Groundwater extractions mainly occur in the Mitchell river area, west of Bairnsdale, where the unit sub crops and other more productive aquifers are too deep and uneconomical to intersect.

Figure 2-7 Approximate Extent of Mid-Tertiary Aquifers in Study Area



2.5 Latrobe Valley Coal Measures and Balook Aquifers

2.5.1 Extent and Lithology

The Latrobe Valley Coal Measures grades laterally into the Balook Formation and Gippsland Limestone to the east of Walpa (SKM, 1998). As mentioned previously, the Latrobe Valley Coal Measures, Balook Formation and Gippsland Limestone were deposited around the same time and respectively they represent on the shore, beach/sand dunes and offshore deposits.

The Latrobe Valley Coal Measures and Balook Formation have very similar lithology, making it difficult to distinguish between the two formations. In the Bairnsdale area the Latrobe Valley Coal Measures consists of well rounded coarse to medium fine sand interbedded with sequences of sands, lignites, ligneous mudstones and brown coals which are mined in the Latrobe Valley. The Balook Formation comprises relatively homogenous, fine to medium grained sands.

The extents of the two formations are not accurately known, nor are the thicknesses due to a lack of detailed mapping, particularly in the central and western regions of the study areas. The Bairnsdale geological map (1:63,360 scale) shows that the Latrobe Valley Coal Measures is not present in the eastern half of the study area. The Balook Formation is a thin formation generally found in the northern half of the study area.

Figure 2-7 shows that several bores around Woodglen have intersected ligneous sands (shown in red), which suggests that the Latrobe Valley Coal Measures extends into the western edge of study area. Several other bores drilled north of the Mitchell River have also intersected ligneous sands and clays overlying sands and gravels. These bores are shown in orange in Figure 2-7 and have been interpreted to be either the Latrobe Valley Coal Measures and/or Balook. In addition to these bores, there are seven bores that have intersected up to 90 m of sands and clays which is consistent with Haunted Hills overlying Balook Formation and suggests that the Balook Formation is also present in the central study area. Potentially this suggests that the Latrobe Valley Coal Measures extends around the northern boundary of the study area, however there is insufficient information in the north western corner of the study area to confirm this.

The drillers logs for all bores shown in Figure 2-7 are provided in Appendix B.

2.5.2 Recharge and Groundwater Flow

Recharge to the aquifers is uncertain, but thought to occur at the margins of the basin from rivers and infiltration from precipitation. Vertical recharge from the overlying aquifers is thought to also be an important source of recharge. SKM (2006) found the area north of the Princess Highway between Stratford and Bairnsdale is likely to be an important recharge area not only for the Boisdale Formation but also for the Latrobe Valley Coal Measures and Balook aquifers. In the

Lindenow area, vertical recharge is likely to occur where there is no overlying Jemmy's Point/Tambo River Formations (see Figure 2-7).

Groundwater flow in the regional aquifer system is generally to the south east where it discharges to the Gippsland Lakes and/or the ocean. Walker and Mollica (1989) suggest that groundwater flow in the Latrobe Valley Coal Measures and the Balook aquifers is deflected upwards into the Boisdale aquifer near the boundary between the Balook aquifer and the lower permeability Gippsland Limestone aquifer. However, bore logs in the study area indicate that the Boisdale aquifer does not directly overlie the Latrobe Valley Coal Measures/Balook and therefore flow between aquifers is likely to be limited within the study area.

2.5.3 Hydraulic Characteristics

Aquifer parameters for the Latrobe Valley Coal Measures have only been determined in the Latrobe Valley where hydraulic conductivities of up to 22 m/day are recorded and storage coefficients of 10^{-4} and 10^{-5}. The hydraulic properties of the Balook aquifer are not well known. Regionally, the Balook Formation is considered a significant aquifer and is expected to have a greater transmissivity than the Latrobe Valley Coal Measures.

2.5.4 Groundwater Quality

In the study area groundwater salinity in the Latrobe Valley Coal Measures and Balook Formation range between 820 to 3,100 mg/L.

2.5.5 Groundwater Use

To the west of Walpa the Latrobe Valley Coal Measures aquifer represents a viable aquifer in the Lindenow Flats area. In the study area between Glenaladale and Walpa, there are approximately 14 bores in the area. GHD (2007) reports on four bores drilled at Woodglen for East Gippsland Water, which recorded yields of 12 – 18 L/sec in two bores screened at 50 to 70 m below the surface. GHD (2007) suggest the bores are screened in the Latrobe Valley Coal Measures

2.6 Latrobe Group Aquifer

2.6.1 Extent and Lithology

The Latrobe Group aquifer covers the majority of the onshore basin and thickens towards the coastline where it overlies the Palaeozoic basement. The Latrobe Group aquifer consists of three distinguishable units the Colquhoun Gravels, undifferentiated Latrobe Group and older Volcanics and forms the basal unit of the unconsolidated sedimentary sequence in the Gippsland Basin.

The extent of the formation is difficult to determine in the Lindenow flats area. Petroleum exploration drilling to the north west of Bairnsdale and RWC stratigraphic bores located near the Mitchell River Valley failed to intersect the Latrobe Group sediments where the Gippsland Limestone was reported to lie directly upon the basement rocks (GHD, 2005). However in the Bairnsdale area, drill logs from bores (105733, 105728, 300998 and 51964) all show coarse sands believed to be the Latrobe Group underlying the Gippsland Limestone at 150 to 300 m deep. This information suggests that the Latrobe Group aquifer is present at depth in the eastern half of the study area. A map showing the location of these bores is provided in Figure 2-8. The presence or absence of the formation in the western half of the study area is not able to be confirmed.

The formation consists of sands, clays and brown coals and has a similar lithology to the overlying Latrobe Valley Coal Measures and Balook Formation making it difficult to distinguish between the formations.

2.6.2 Recharge and groundwater flow

The Latrobe Group aquifer is confined by the overlying Gippsland Limestone aquifer/aquitard. Although not well understood, the Latrobe Group aquifer has the potential to be hydraulically connected to the Balook and Latrobe Valley Coal Measures where the aquifers overlie each other (SKM, 2007). However it is difficult to distinguish the Latrobe Group aquifer from the overlying Latrobe Valley Coal Measures and Balook Formations because their lithologies are very similar.

Recharge to the aquifer system is likely to occur in areas where the formation outcrops and subcrops. If the Latrobe Group is present beneath the Lindenow Flats, the aquifer could rise close to the surface making the area an important recharge area for the aquifer. However there is no direct evidence to determine if this scenario occurs within the study area. SKM (2007) suggest that there could also be a zone of localised recharge to the north east of Bairnsdale near Clifton Creek, where a paleochannel may exist. Recharge throughout the basin is estimated to be in the order of 100,000 ML/yr based on aquifer throughflow (SKM, 2007). Vertical recharge from leakage from overlying aquifers may also be an important source of recharge.

Over the past 30 years groundwater levels in the Latrobe Group aquifer have declined by an average of 1.1 m/year (SKM, 2007). The decline is likely to be due to the combination of

dewatering in the Latrobe Valley, local extraction for irrigation purposes and oil and gas extraction offshore and this is discussed more in Section 2.7.

2.6.3 Hydraulic Parameters

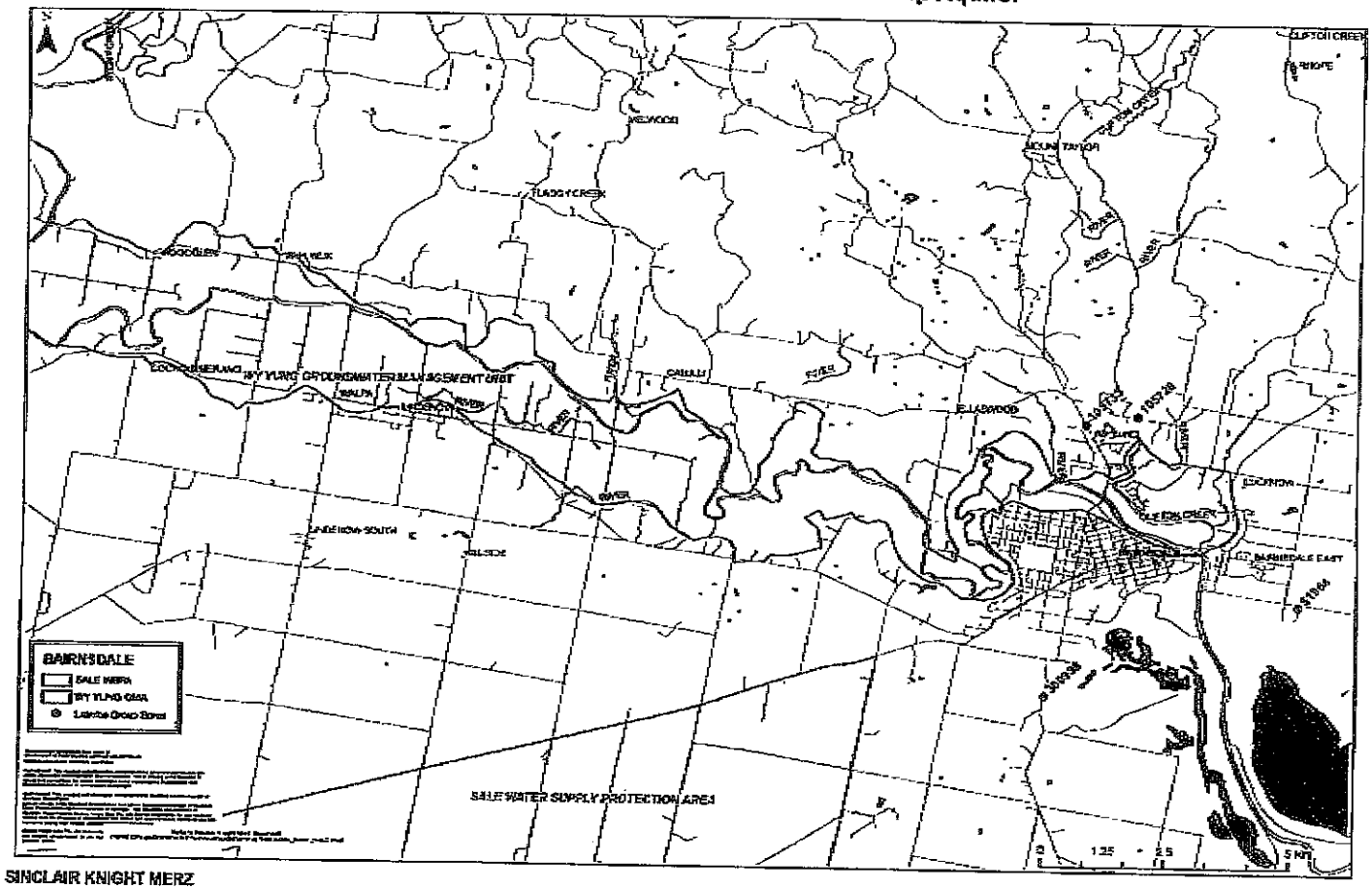
Aquifer parameters have been determined mainly in the Latrobe Valley where hydraulic conductivities vary between 7.5 to 88 m/day and storage coefficients of 10^{-4} to 10^{-5}. No information is available the hydraulic properties of the aquifer in the study area.

2.6.4 Groundwater Usage and Salinity

Walker and Mollica (1989) suggest groundwater in the Latrobe Group aquifer is around 1000 mg/L TDS in the Bairnsdale/ Lakes Entrance area.

Two bores have groundwater salinity measurements of 700 and 850 mg/L and both bores are located around Bairnsdale. In the eastern region of the study area, the Latrobe Group may represent a possible viable aquifer at depths greater than 150 m. This aquifer is pumped extensively in the Latrobe Valley for mine de pressuriation, and is used as a source of oil and gas reserves off-shore.

- **Figure 2-8 Location of bores interpreted to be drilled into the Latrobe Group Aquifer**



2.7 Groundwater Trends

In the Lindenow area there are 45 State Observation Network Bores (SOBN), of which 11 bores are monitoring deeper aquifers below the Quaternary aquifer (Table 2-1). Monitoring commenced in 1970 and most bores are monitored on a monthly or quarterly basis. Table 2-1 lists the SOBN bores in the Lindenow area monitoring the deeper aquifers. Three SOBN bores have no drill log so the screened aquifer is uncertain. Hydrographs of bores interpreted to be monitoring the Latrobe Valley Coal Measures /Balook aquifers are shown in Appendix A.

Table 2-1 Monitored Bores in the Lindenow Flats area

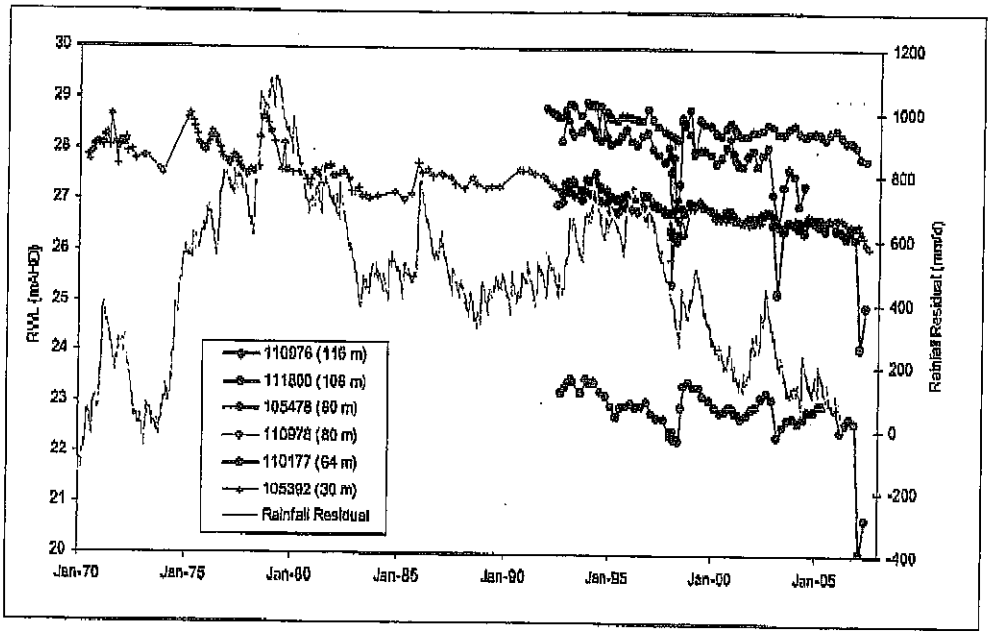
Bore Number	Bore Depth (m)	Aquifer Screened	Monitoring Period
105392	31	Latrobe Valley Coal Measures (location & depth)	1970 – 2007
105479	34	Latrobe Valley Coal Measures	1991 – 2007
105725	45	??	1975 – 2007
110177	64	Bedrock	1992 – 2007
105478	80	Latrobe Valley Coal Measures	1992 – 2007
110978	80	Latrobe Valley Coal Measures	1992 – 2004
111800	109	Latrobe Valley Coal Measures	1992 – 2007
110976	116	Latrobe Valley Coal Measures	1992 – 1999
105730	138	Latrobe Group	1975 – 2007
105728	142	Latrobe Group	1975 – 2007
105733	260	Latrobe Group	1975 – 1980

Hydrographs of the deeper monitoring bores are shown in Figure 2-9 to Figure 2-11. Figure 2-9 shows the hydrographs of five bores thought to be screened in the Latrobe Valley Coal Measures. All of these bores show declining trends since monitoring commenced in the mid 1990s. Figure 2-10 shows the hydrographs of bores thought to be screened in the Latrobe Group aquifer and these bores also show significant declining trends. This is consistent with other regional observation bores monitoring this aquifer, where declines average 1.1 m/year. This suggests that the declining trends in the Latrobe Valley Coal Measures aquifer could be the result of the regional decline observed in the Latrobe Group aquifer, which would suggest that the aquifers are hydraulically connected in the study area.

Figure 2-11 shows several hydrograph of other monitoring bores in the region. These bores also show slight declining trends. However, these declining trends are not as significant as those bores monitoring the Latrobe Valley Coal Measures and Latrobe Group aquifers.

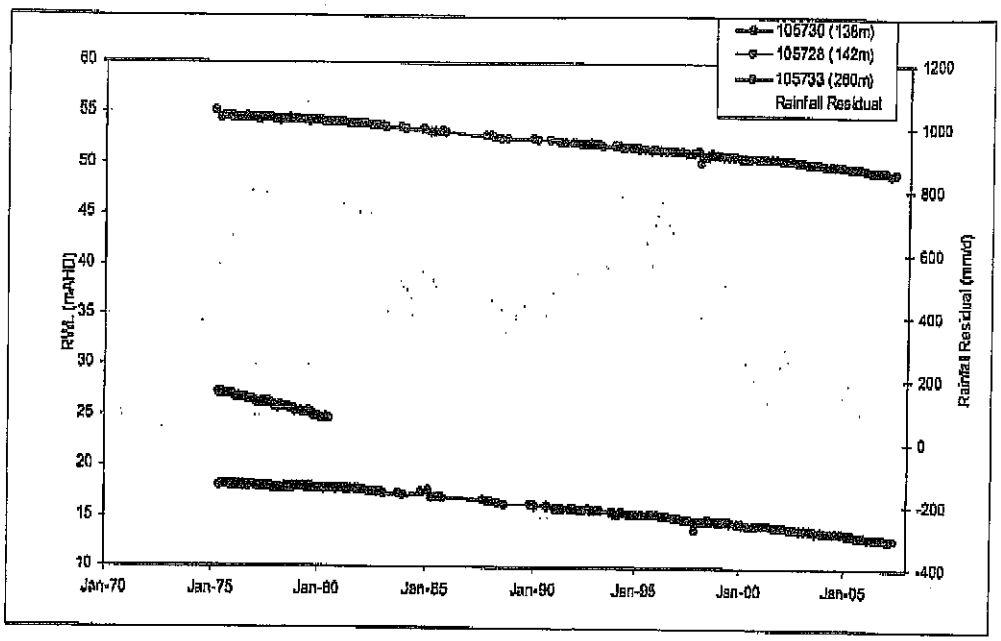
It appears that all monitoring bores in the region show declining groundwater level trends, which is likely to be a combination of below average rainfall and high groundwater usage

Figure 2-9 Hydrographs of monitoring bores thought to be Latrobe Valley Coal Measures/Balook aquifer



SKM

- **Figure 2-10 Hydrographs of monitoring bores thought to be Latrobe Group**



- **Figure 2-11 Hydrographs of monitoring bores in other aquifers**

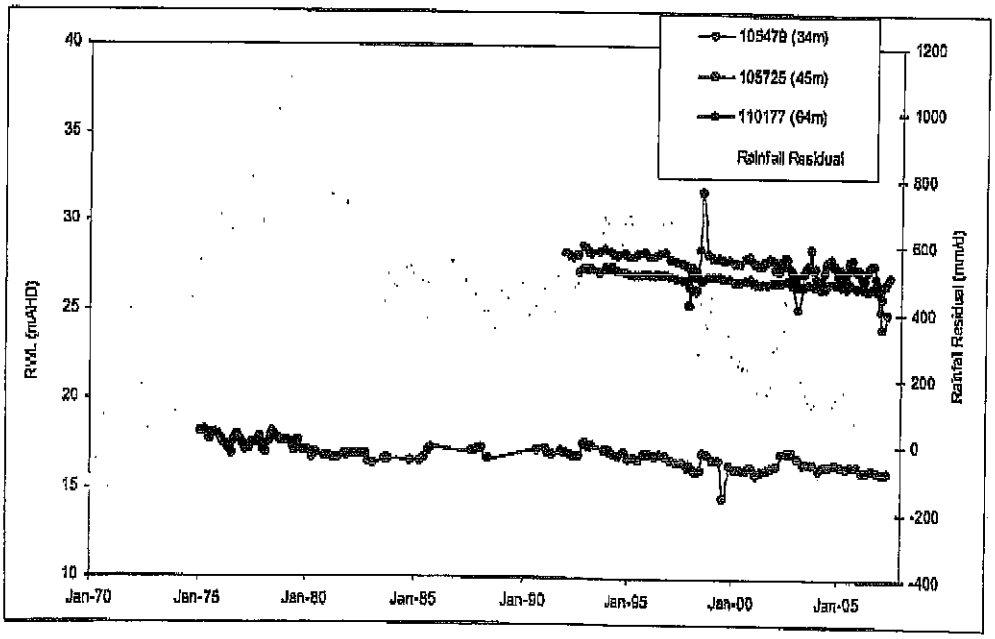
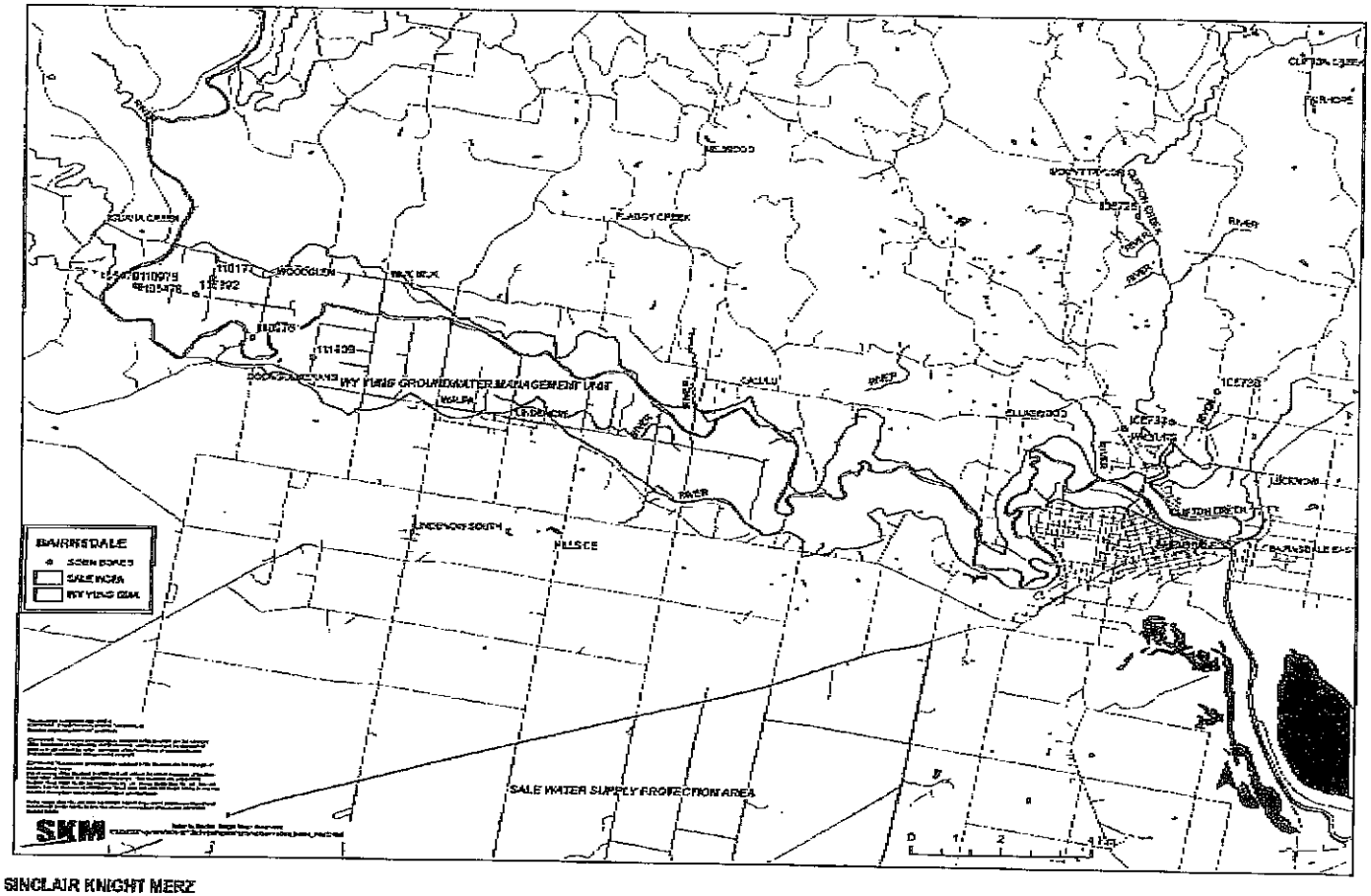


Figure 2-12 Location of deep (>25 m) SOBN bores



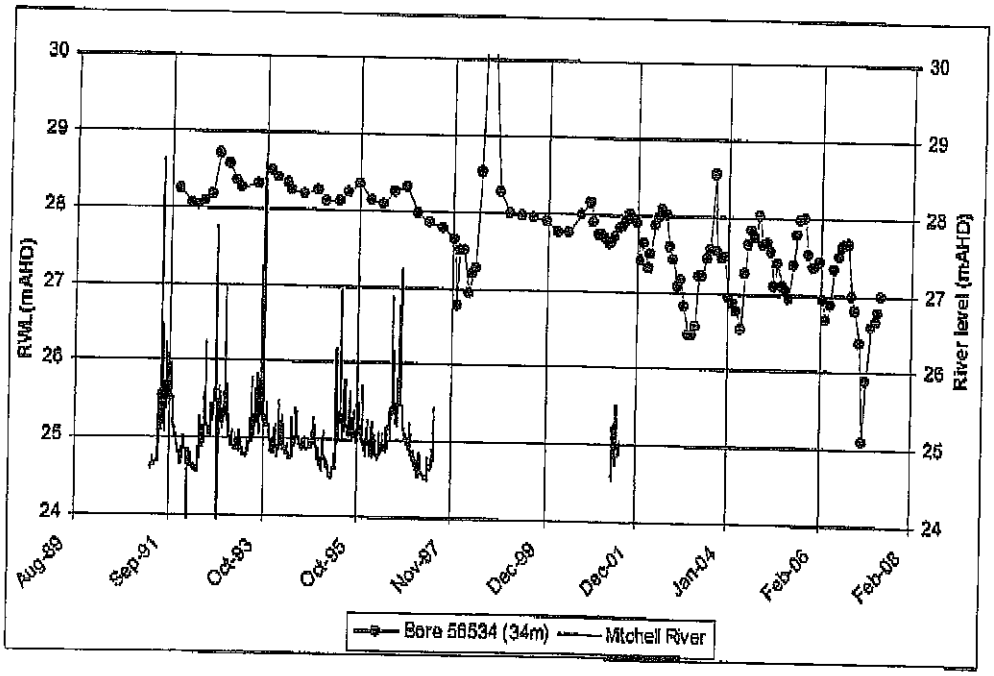
2.8 Groundwater/Surface water Interaction

The strong hydraulic connection between the shallow groundwater system (Quaternary alluvial aquifer) and the Mitchell River is well understood (Thompson, 1973; Hydrotechnology, 1995; SKM, 1998). Generally the aquifer provides baseflow to the Mitchell River. However during floods, the river is likely to recharge the shallow groundwater for short durations.

There are three gauging stations along the Mitchell River in the study area at Bairnsdale, Lindenow and Wuk Wuk. Figure 2-13 shows river water levels with the hydrograph of Bore 56534, which is located 800 m south of the station slightly downstream. This shows that the groundwater level is above the river level, demonstrating that the aquifer discharges to the Mitchell River.

However the interaction between the Mitchell River, Quaternary aquifers and the deeper aquifers in the study area is not well understood. Some of the deeper aquifers are known to subcrop beneath the Quaternary alluvial aquifer and could therefore interact with the shallow aquifer and the River. The groundwater trends in the deeper aquifers are declining, and this could potentially impact groundwater levels in the shallow aquifer and river levels.

Figure 2-13 Mitchell River Level at Wuk Wuk Station



SKM

3. Groundwater Use and Management

3.1 Groundwater Management

There are two groundwater management areas in close proximity to the Lindenow Flats, Wy Yung Groundwater Managament Area (GMA) and Sale Water Supply Protection Area (WSPA) (Figure 3-1). The Wy Yung GMA covers the Quaternary aquifers in the Mitchell River valley to 25 m depth and the Sale WSPA covers the Boisdale aquifer between 25 and 200 m depth to the south of the study area.

The location of these groundwater management areas means that aquifers in the study area between 25 m and 300 m depth are not currently incorporated into a management area. Consequently, there is no cap on the overall volume of groundwater that can be allocated in this region. However, SKM (2006) recommended that the northern boundary of the Sale WSPA be extended to the southern boundary of the Wy Yung GMA, which would incorporate aquifers between 25 and 200 m depth to the south of the Wy Yung GMA (see Figure 3-1). If this recommendation is implemented, aquifers directly beneath the Wy Yung GMA (greater than 25 m depth) would still not be incorporated into a groundwater management area.

3.1.1 Wy Yung GMA

The Wy Yung GMA covers the shallow alluvial aquifer system in the Mitchell River Valley and has a vertical limit of 25 m. Spatially the GMA covers an area of 90 km^2 and is divided into three zones corresponding to the groundwater usage (Figure 3-1). There is significantly greater usage in the central zone (Zone 2). The Permissible Consumptive Volume (PCV) for the Wy Yung GMA has been estimated at 9,099 ML/year and is fully allocated (SKM, 1998).

3.1.2 Sale WSPA

The Sale WPSA covers the Boisdale aquifer system between Rosedale and Bairnsdale (Figure 3-1). Whilst the Boisdale aquifer system covers a large area of the Gippsland Basin, the WPSA has been restricted to an area where it is high yielding, good quality and has been extensively developed for irrigation and urban supply (SKM, 2006). The WSPA has vertical limits of between 25 and 200 m which correspond with the thicker sections of the aquifer system.

SKM (2007) have recommended that the northern boundary of the Sale WSPA extends further north of the Princess Highway to the margin of the Wy Yung GMA, when drilling possibly intersected the Boisdale aquifer north and east of the current WSPA boundary (GHD 2007).

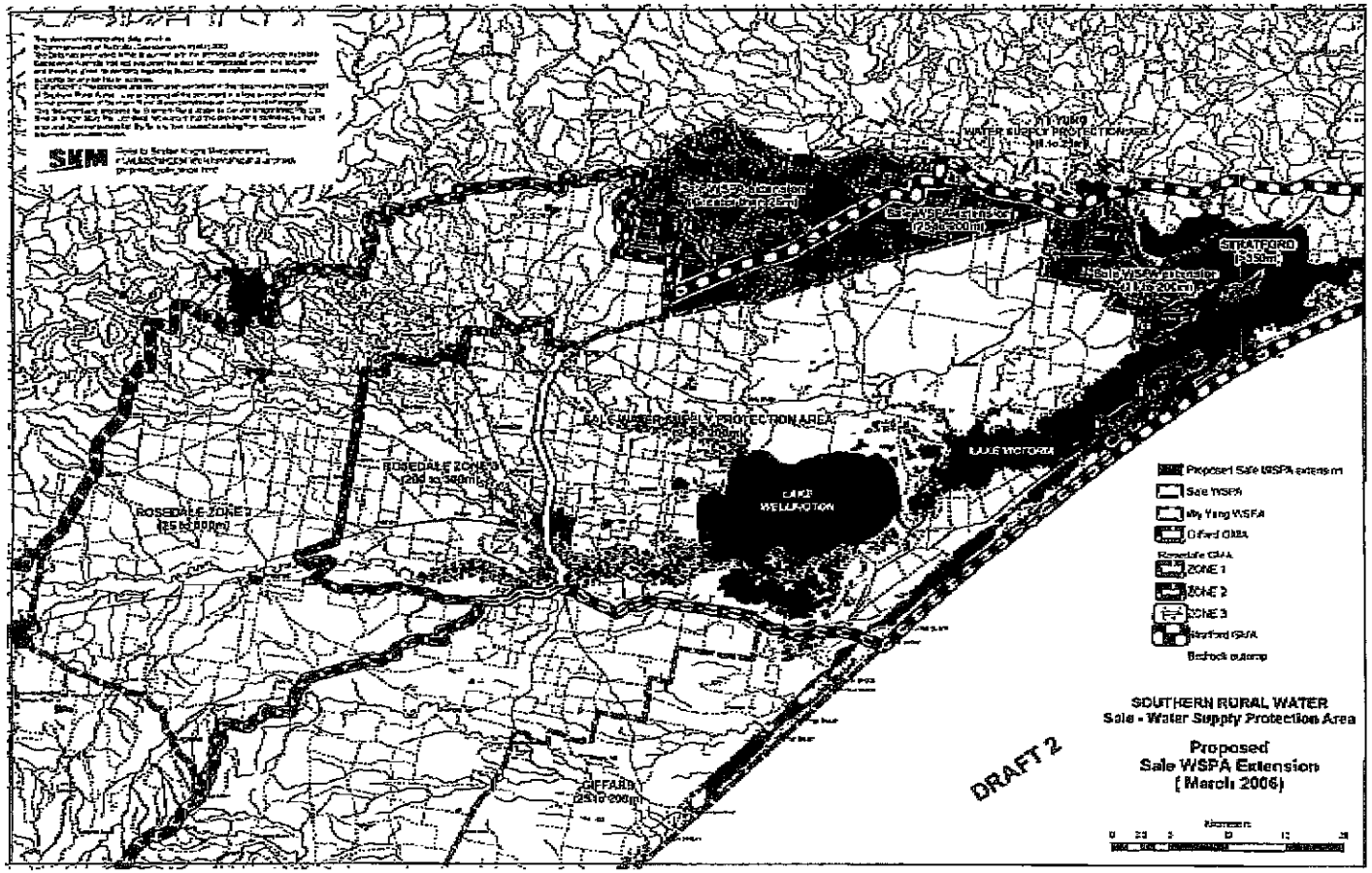
The Sale WSPA is currently fully allocated, with a Permissible Consumptive Volume of 21,213 ML (per comms, Southern Rural Water, September 2007).

3.1.3 Other Groundwater Protection Areas

Other groundwater protection areas include the Rosedale GMA and Stratford GMA (Figure 3-1). The Rosedale GMA covers the Balook and Latrobe Valley Coal Measures aquifers west of Sale and has a depth criteria in the Sale area of 200 to 300 m (see Figure 3-1). The western boundary of the GMA is located approximately 20 km south east of the Wy Yung GMA.

The Stratford GMA covers the Latrobe Group aquifer and extends beneath the Rosedale GMA and the Sale WSPA with a depth criteria of greater than 350 m (see Figure 3-1). The northern boundary of the Stratford GMA runs along the southern boundary of the Wy Yung GMA between Lindenow and Bairnsdale. The south eastern corner of the study area below 350 m depth therefore falls within the Stratford GMA.

Figure 3-1 Location of GMAs and WPSAs around Baimsdale (from SKM 2006)



3.2 Groundwater Use

The groundwater resources around Lindenow Flats are heavily utilised, particularly the shallow Quaternary aquifer in the Wy Yung GMA. There are a total of 513 registered bores in the study area, of which 102 bores intersect the deeper aquifers. The majority of bores are utilised for stock and domestic purposes and for irrigation. The locations of the deep bores is shown in Figure 3-2.

Table 3-1 Bore uses around Lindenow Flats

Bore Use	No. of Deep Bores (>25 m)	No. of Shallow Bores (<25 m)
Stock and Domestic	41	191
Commercial	1	0
Irrigation	31	125
Miscellaneous	1	0
Not Known	17	65
SOBN	11	30
Total	102	411

3.3 Existing Groundwater Licences

Figure 3-3 and Table 3-2 show that there are 16 groundwater extraction licences in the deeper aquifers around Lindenow Flats. The majority of existing groundwater licences are located north of the Mitchell River.

The location, depth and drilling logs (where available) were used to interpret the aquifer intersected. Three bores are interpreted to extract water from the Boisdale aquifer with a total allocated volume around 440 ML/year. There are an additional four bores thought to be extracting from the Latrobe Valley Coal Measures, with a total allocated volume around 350 ML/year. Another three bores are interpreted to extract from the Latrobe Group or Balook aquifer with a much smaller allocated volume around 340 ML/year. The remaining five bores are thought to extract from the Gippsland Limestone aquifer. These bores have much smaller allocated volumes (total around 250 ML/year), consistent with a lower yielding aquifer.

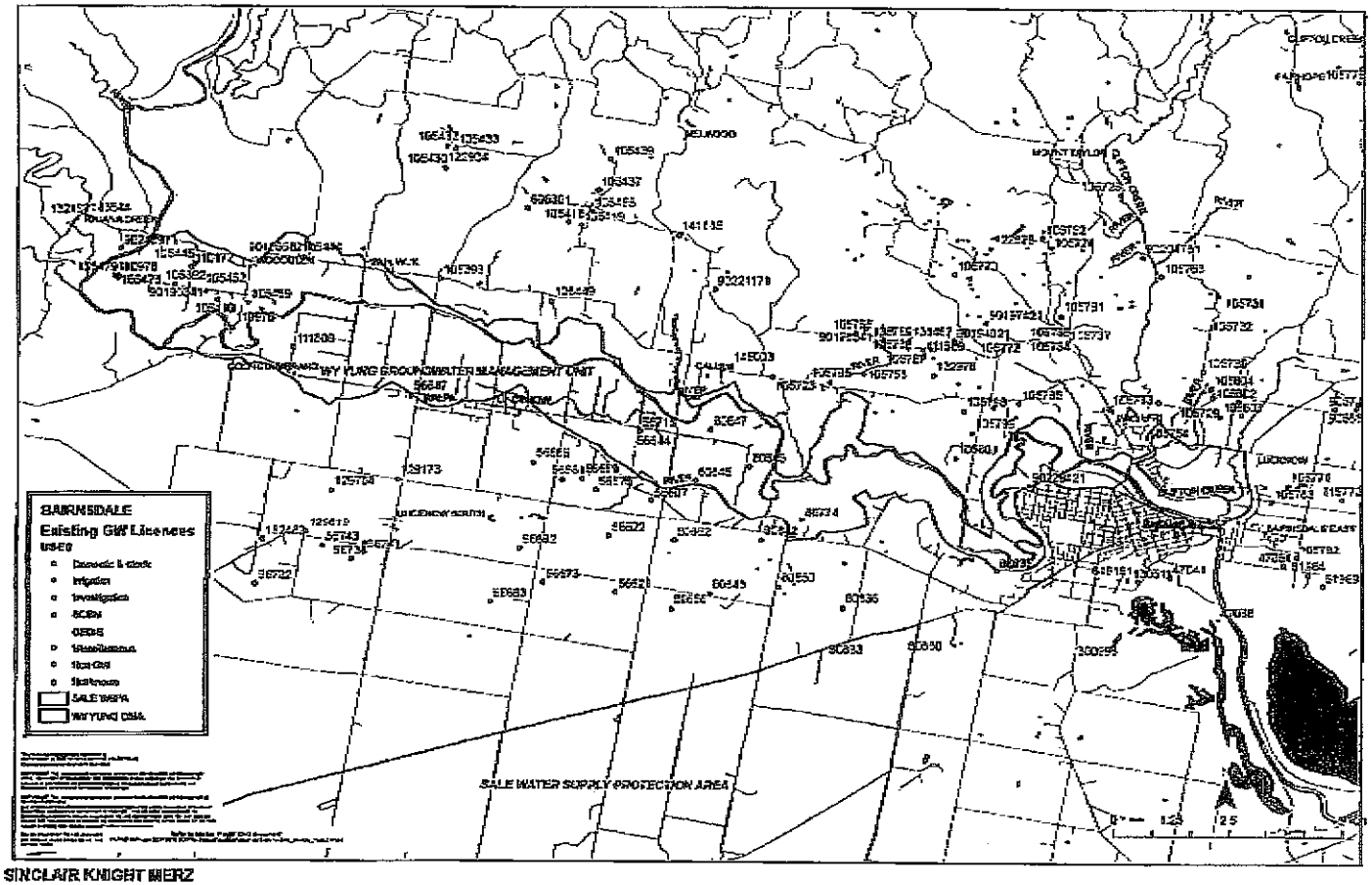
In summary, in the western and northern half of the study area the groundwater appears to be extracted from the Boisdale and the Latrobe Valley Coal Measures aquifers, although similar volumes are extracted from the Latrobe Group and Gippsland Limestone aquifer in the eastern half of the study area.

SKM

Table 3-2 Existing groundwater extraction licences around Lindenow Flats

Bore ID	Depth (m)	Licence entitlement (ML/Year)	Aquifer	Comments
105444	36	100	Latrobe Valley Coal Measures	Aquifer interpreted from drillers log
105445	34	75	Latrobe Valley Coal Measures	Aquifer interpreted based on location and depth
143544	51	85	Latrobe Valley Coal Measures	Aquifer interpreted from drillers log
132157	36	85	Latrobe Valley Coal Measures	Aquifer interpreted from drillers log
122904	27	100	Latrobe Valley Coal Measures	Aquifer interpreted from drillers log
105455	57	25	Latrobe Valley Coal Measures/Balook	Bore located in Tertiary sands in north east of study area. Exact formation/aquifer difficult to determine.
122878	90	49	Latrobe Valley Coal Measures/Balook	Bore located in Tertiary sands in north east of study area. Exact formation/aquifer difficult to determine.
131467	68	51	Latrobe Valley Coal Measures/Balook	Aquifer interpreted from drillers log
105418	25	97	Latrobe Valley Coal Measures/Balook	No drillers log, interpretation based on location and depth.
105756	32	106	Balook	Aquifer interpreted based on depth and location
105753	31	241	Balook	Aquifer interpreted depth and location. Large volume consistent with high yielding aquifer
132978	48	60	Balook	Bore located in Tertiary sands in north east of study area. Exact formation/aquifer difficult to determine.
105767	35	8	Balook	Aquifer interpreted based on location and depth
80835	205	73	Gippsland Limestone	Aquifer interpreted based on location and depth
105783	26	12	Gippsland Limestone	Aquifer interpreted from drillers log
51964	345	212	Latrobe Group	Aquifer interpreted based on location and depth

Figure 3-2 Deep groundwater bores in the Lindenow Flats area



3.4 Pending Groundwater Licences

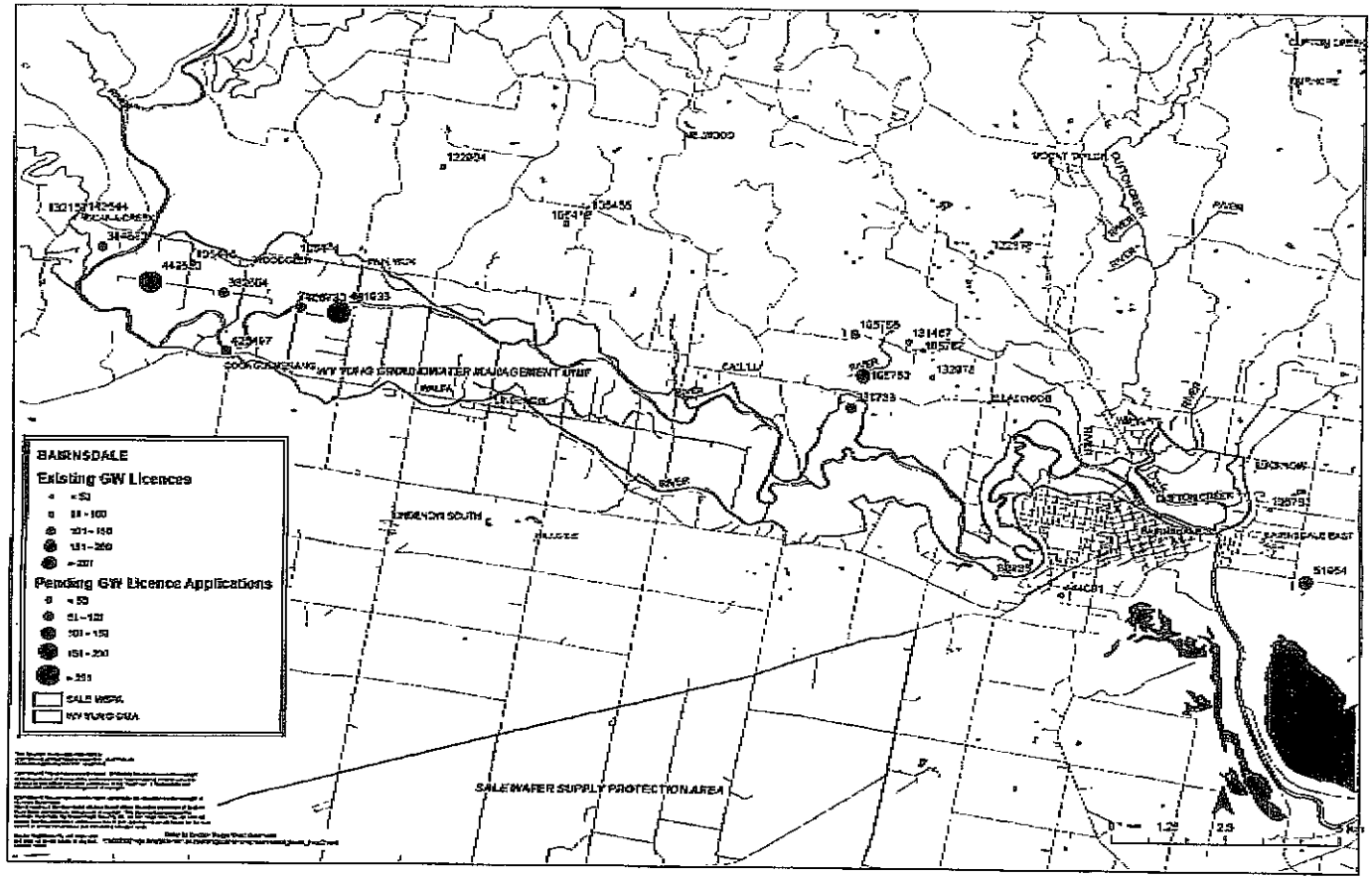
SRW have received several licence applications for groundwater extraction from the deeper aquifers around Lindenow Flats. Figure 3-3 shows the locations of the proposed groundwater extraction. In the western region of the study area, the main aquifer targeted appears to be the Latrobe Valley Coal Measures. Five of the applications are clusted in the Coongulmerang area. One of these applications is for a very large volume for the Bairnsdale town water supply (2,500 ML/yr). The other applications in this area are for volumes ranging between 63 to 100 ML/year.

In the eastern region of the study area, the target aquifers appear to be the Latrobe Group aquifer (Figure 3-3). Bores drilled into the Latrobe Valley Coal Measures in the west, have greatest potential for acquiring high yielding good quality water. Bores drill in the east have less potential, particularly if screened in the Gippsland Limestone, rather than the deeper Latrobe Group aquifer. In the east of the study area, around bore 444091, bores drilled greater than 100 m have the potential to encounter the Latrobe Group Aquifer which could be a highly yielding good quality source of water although are likely to be affected by regional groundwater level declines in the aquifer.

Table 3-3: Current applications for groundwater licences in the study area greater than 25m deep

GW Licence No	Proposed Depth	Applicant Volume (ML)	Target Aquifer
384881	40 m	100	Latrobe Valley Coal Measures
449530	75 m	2500	Latrobe Valley Coal Measures
426497	120 m	63	Latrobe Valley Coal Measures
332604	75 m	67	Latrobe Valley Coal Measures
408730	85 m	67	Latrobe Valley Coal Measures
441933	140-340 m	300	Latrobe Valley Coal Measures/Balook
331733	200 m	100	Balook
444091	120 m	20	Gippsland Limestone/Latrobe Group?

- **Figure 3-3 Existing and proposed groundwater extraction licences (from SRW)**



3.5 Sustainable Yield Estimates

3.5.1 Boisdale Aquifer

The Boisdale aquifer is believed to be recharged from rainfall infiltration in the study area. Therefore the sustainable yield estimate has been estimated rainfall recharge. Due to scarcity of data on the extent of the Boisdale aquifer in the Lindenow Flats area, only tentative values can be assigned.

The volume of recharge from rainfall infiltration was estimated assuming a recharge area of 100 km^2 and a recharge rate ranging between 2 and 5% of rainfall. This equates to between 1,240 and 3,110 ML/year. There is significant uncertainty associated with this estimate and additional field investigations are required to determine with more accuracy the recharge mechanisms of the Boisdale aquifer in this area.

3.5.2 Latrobe Valley Coal Measures and Balook Aquifers

Where the Latrobe Valley Coal Measures and Balook aquifer is unconfined or semi-confined (i.e. no overlying Jemmy's Point/Tambo River aquitards), recharge can be calculated using the hydrograph fluctuation method. This method assumes that the rise in aquifer potentiometric level will be related to the volume of voids being filled and the amount of water entering them.

Between May and November 2001 there was a watertable rise of 0.3 m in bore 110978 drilled into the Latrobe Valley Coal Measures. In the same time period, the rainfall was 463 mm. Assuming 5% of rainfall is recharge to the aquifer, gives a recharge value of 23 mm. Assuming a specific yield of 0.05 to 0.1 the watertable will rise by between 0.46 to 0.23 m, which is similar to the observed trend seen in the hydrograph of 0.3 m. These calculations indicate that assigning 5% rainfall as recharge to the aquifer is a plausible figure. As a conservative estimate, the sustainable yield was estimated assuming the recharge rate ranges between 2% and 5% of rainfall.

The recharge area of the outcropping/subcropping aquifers was estimated to be approximately 150 km^2. This includes outcropping aquifer to the north of the Wy Yung GMA and sub-cropping aquifer within the GMA (Figure 2-7). Potential recharge areas where the Boisdale aquifer overlies the LVCM/Balook Formations is not included in the sustainable yield estimate. Based on the 10 years average annual rainfall measured at Station 85050 (622 mm/year), the sustainable yield of the aquifer is estimated to range between 1,900 and 4,700 ML/year. There significant uncertainty surrounding this sustainable yield estimate and field investigations are required to confirm the extent and thickness of the aquifers and the hydraulic connection with adjacent aquifers.

3.5.3 Latrobe Group Aqulfer

With the current knowledge it would futile to estimate a sustainable yield from the available data, given the uncertainty as to whether the aquifers are even present in the Lindenow Flats area. More information is needed before the sustainable yield can even be estimated.

4. Threats to Sustainability

4.1 Groundwater Surface Water Interaction

The potential impacts on groundwater surface water interactions are difficult to quantify because the relationship between the deeper aquifers and the Mitchell River is largely unknown. As mentioned previously, the Quaternary alluvial aquifer provides significant recharge to the river. However, the interaction between the shallow and deeper aquifers is also largely unknown.

The primary recharge mechanism for the Quaternary aquifer is via rainfall recharge, although significant flood events also provide recharge to the aquifer over short durations. Monitoring bores in the Quaternary aquifers generally display declining trends which are consistent with below average rainfall conditions over the past few decades.

Declining trends have also been observed in the deeper aquifers. Bores monitoring the Latrobe Valley Coal Measures aquifer show declining trends that could be influenced by below average rainfall conditions or by the steadily declining trends observed in the Latrobe Group aquifer. If the Latrobe Valley Coal Measures is influenced by rainfall trends (and therefore outcrop or subcrop), it is more likely that this aquifer could interact with both the Quaternary aquifer and the Mitchell River. If this is the case, groundwater extractions from the Latrobe Valley Coal Measures and Balook aquifers could have the potential to reduce water levels in the overlying Quaternary aquifers, which could then reduce baseflow to the Mitchell River. However this would need to be confirmed by further investigations.

It is unlikely that groundwater extractions from the Boisdale or Latrobe aquifers would have a significant impact on the Quaternary alluvial aquifer or the Mitchell River because the aquifers either don't extend this far or are two deep to directly interact with the River.

In summary, field investigations would be required to determine the hydraulic connection between the Latrobe Valley Coal Measures and Balook aquifers with the Quaternary aquifers and Mitchell River to assess the interaction.

4.2 Local Groundwater Levels Decline

As mentioned in previous sections, groundwater levels in most of the aquifers in the study area are declining. The declining trends observed in the Quaternary aquifer are likely to be the result of below average rainfall conditions. However declining trends observed in deeper aquifers are more likely to be the result of regional groundwater use. Additional groundwater extractions from these deeper aquifers will stress the groundwater resource even more which could exacerbate the declining trends.

The Boisdale aquifer is believed to be recharged primarily from rainfall infiltration. The sustainable yield of the aquifer was estimated to range between 1,240 and 3,110 ML/year. Currently there are no existing or pending groundwater licence application in the Boisdale aquifer, however given the uncertainty surrounding the sustainable yield estimate and the aquifers connection with the Latrobe Valley Coal Measures/Balook aquifer in the north western corner of the catchment, it is recommended that further investigations are undertaken before any new groundwater extraction licences are issued for the aquifer in the part of the study area to confirm the recharge process for the aquifer in the study area.

The sustainable yield of the Latrobe Valley Coal Measures and Balook aquifer was estimated to range between 1,900 and 4,700 ML/year. Table 4-1 shows a summary of the existing and pending licences interpreted to be in the Latrobe Valley Coal Measure and/or Balook aquifers. This shows that the existing volume of groundwater licences interpreted to be allocated to these aquifers is around 1,080 ML/year. This is over half of the lower estimate of the sustainable yield.

SRW have also received five groundwater extraction licence applications in this aquifer, all located around Woodglen. Table 4-1 shows that the majority of pending licences are for volumes less than 100 ML/yr, however one application is for 2,500 ML/year from East Gippsland Water to secure Bairnsdale's town water supply. The total volume in pending applications is 3,197 ML/year.

The combined volume of existing and pending applications is around 4,300 ML/year, which exceeds the lower estimate of the sustainable yield and is 90% of the higher estimate.

While these extractions could be within the sustainable yield of the aquifer in the local area, this does not take into account that some of the groundwater throughflow in the Latrobe Valley Coal Measures and Balook Formation could recharge the underlying Latrobe Group (if present in the western half of the study area) or even the Boisdale aquifer in the north western part of the study area. Further investigations are recommended in the northern western corner of the study area to confirm the hydraulic connection between the Latrobe Valley Coal Measures and the Boisdale aquifer. In the mean time, to ensure a conservative management approach, it may be prudent to not fully allocate the calculated available groundwater resource in the acknowledgement that this is likely to be an important regional recharge area.

The primary cause of the declining groundwater trends in the Latrobe Valley Coal Measures should be determined before large volumes of groundwater are allocated. For example, if the groundwater levels are declining as a result of below average rainfall conditions, then the sustainable yield of the local aquifer could be revised to ensure that the aquifer is not placed under addition stress. Conversely, if the groundwater levels are declining as a result of the hydraulic connection to the underlying Latrobe Group, then further allocations should be assessed carefully. Field

investigations are required to determine the extent of the Latrobe Group aquifer and its hydraulic connection with the Latrobe Valley Coal Measures.

Table 4-1 Summary of GW Extraction Licences in the Latrobe Valley Coal Measure and Balook Aquifers

Existing Licences		Pending Licences	
Licence No	Volume (ML/yr)	Licence No	Volume (ML/yr)
105444	100	384881	100
105445	75	449530	2500
143544	85	426487	63
132157	85	332604	67
122904	100	408730	67
105455	25	441933	300
122878	49	331733	100
131467	51		
105418	97		
105756	106		
105753	241		
132978	60		
105767	8		
Total existing licenced volume (ML/yr)	1,082	Total pending licenced volume (ML/yr)	3,197

Due to the uncertainty around the extent of the Latrobe Group aquifer, there is only one bore known to intersect the Latrobe Group aquifer in the study area. This bore is located in the south east of the study area and is 345 m deep, with an allocated volume of 212 ML/year. There are several other small groundwater extraction licences located in the north eastern corner of the study area but the actual aquifer that these bore extract from is very difficult to determine. It could be that these bore extract from the Latrobe Group as it rises to the surface near the edge of the Gippsland Basin, or it could be that these bore extract from the Balook Formation. Regardless, these licences are much smaller (<100 ML/year). Of those pending groundwater extraction licences, none are considered to be in the Latrobe Group aquifer. This is primarily because the aquifer is thought to be present only in the eastern half of the study area and at significant depths (i.e. greater than 200 m).

Groundwater levels in the Latrobe Group aquifer show significant declining trends, consistent with trends observed in regional aquifer. This aquifer is heavily utilised off shore and on shore and appears to be under significant stress. Given this region may be a recharge area for the aquifer, and

that the aquifer appears to be already stressed, it is recommended that additional allocation are assessed carefully and regular monitoring is undertaken.

4.3 Bore Interference

When bores are located close together and are pumped simultaneously, they can interfere with each other causing a reduction in available drawdown and reduced yields. Given the close proximity of some of the pending applications with each other and existing bores, there is potential for unacceptable interference between bores. This study recommends that potential interference be determined on a case by case basis initially using the Thies equation with a range of aquifer hydraulic properties as inputs either determined locally from pumping tests or using regional values. If this initial calculation suggests that local bore interference is possible or probable, then a local pumping test should be undertaken and the potential interference re-calculated.

4.4 Regional Impacts on Groundwater Levels

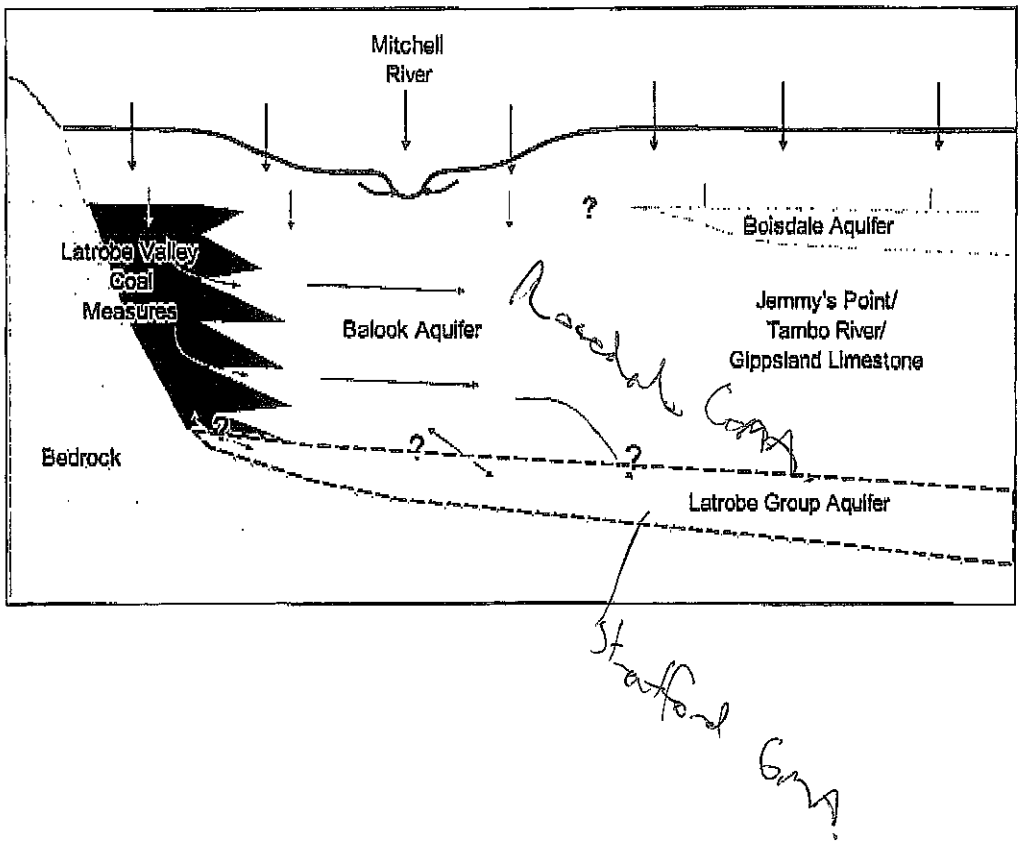
SKM (2006) suggested that this region could potentially be an important recharge area for the Boisdale aquifer, Latrobe Valley Coal Measures, the Balook and possibly the Latrobe Group aquifers. The Lindenow Flats are located near the edge of the Gippsland Basin and these aquifers all rise to surface and therefore have the potential to receive recharge from rainfall infiltration and leakage through the overlying aquifers. Assessment of bore logs in the area has shown that the Latrobe Valley Coal Measures and Balook aquifers subcrop beneath the Quaternary formations across most of the study area. This region is therefore likely to be a significant recharge area for the Latrobe Valley Coal Measures and Balook aquifers both on a local and regional scale.

As discussed in Section 2.7, most monitoring bores in all aquifers show declining groundwater trends since monitoring commenced. This indicates that the aquifers are already under stress, either from below average rainfall conditions or due to a regional connection with the Latrobe Group aquifer.

Figure 4-1 shows a conceptual north south cross section A-B (see Figure 2-2) illustrating the recharge processes and the potential hydraulic connection between the aquifers. This shows that the Boisdale aquifer is hydraulically separated from the Latrobe Valley Coal Measures and Balook aquifers by the marine deposits associated with the Jemmy's Point Formation, Tambo River and Gipspland Limestone. However this may not be the case further west where the relationship between the Boisdale and the Latrobe Valley Coal Measures/Balook is uncertain (see discussion on cross-section C-D in Section 2.3.1). In this area, there may or may not be hydraulic connection between the Boisdale Aquifer and the Latrobe Valley Coal Measures depending on the lateral extent of the Boisdale Formation which can't be determined with the current data. Given the largest pending groundwater licence application is in this region, further investigations are recommended to confirm the extent of the Boisdale and marine deposits in this region. The

Latrobe Valley Coal Measures and Balook aquifers could also be connected to the underlying Latrobe Group aquifer, where this aquifer is present.

- **Figure 4-1 Conceptual cross section (A-B) showing recharge processes and hydraulic connection between aquifers in the study area**



however given the aquifer's limited in extent in the study area, its water supply potential may also be limited. Although there is limited information on yields, the groundwater salinity is less than 1,000 mg/L.

Ligneous sands and clays interpreted to be associated with the Latrobe Valley Coal Measures have been found in bore logs in the western part of the study area around Woodglen and north of the Mitchell River. This suggests that the formation extends much further east than previously thought. The formation outcrops and subcrops beneath Quaternary sediments suggesting that this area is likely to be an important recharge area for aquifer. The aquifer is known to yield up to 20 L/sec and the groundwater salinity is generally less than 1,200 mg/L

The Balook Formation is very difficult to distinguish from the Latrobe Valley Coal Measures. However bores with up to 90 m of sand and gravel have been reported throughout the centre of the study area and this is interpreted to be the Balook Formation. The Balook aquifer is assumed to be hydraulically connected to the Latrobe Valley Coal Measures where the aquifers are present. The groundwater salinity is similar to the Latrobe Valley Coal Measures aquifer (typically less than 1,000 mg/L).

The marine deposits of the Jemmy's Point Formation and the Gippsland Limestone are generally confined to south of the Mitchell River. These formations have limited potential for water supply as groundwater quality and yields are variable. Nonetheless, in some regions the aquifer may be a suitable resource. The extent of these deposits in the north western corner of the study area needs to be confirmed to determine the connection between the Latrobe Valley Coal Measures/Balook aquifer and the Boisdale aquifer.

The Latrobe Group aquifer is also difficult to distinguish from the Balook and Latrobe Valley Coal Measures aquifers. Only four bores have been interpreted to intersect this aquifer. These bores are all located around Bairnsdale and the driller's logs describe sand at 200 m depth underlying limestone. Whether the aquifer is present elsewhere in the study area is difficult to determine. The aquifer could potentially exist below the Balook Formation, however it is not possible to identify using drillers logs. The aquifer is likely to be a high yielding aquifer and salinity measurements of bores interpreted to be intersecting this aquifer are around 850 mg/L.

5.2 Implications for Increased Groundwater Use

The Lindenow Flats are located near the edge of the Gippsland Basin and the Mid Tertiary aquifers all rise to surface and, therefore, have the potential to receive recharge from rainfall infiltration and leakage from overlying aquifers. To the east of cross-section A-B shown in Figure 2-2, the Boisdale Aquifer is likely to be hydraulically separated from the Latrobe Valley Coal Measures/Balook by the marls of the Jemmy's Point and Gippsland Limestone Formation. However, to the west of this line, the hydraulic connection is uncertain and as most of the pending

licenses are in this area, the effect of additional groundwater pumping on the down-gradient Boisdale Formation is also uncertain. The extent of the Latrobe Group aquifer in the study area is also uncertain and if the Latrobe Group aquifer is present in the western half of the study area and hydraulically connected to the Latrobe Valley Coal Measures and the Balook aquifers, some of the pending licence applications could also have the potential to impact this aquifer.

Most monitoring bores also show declining groundwater trends, which indicates that the aquifers are already under stress, either from below average rainfall conditions or potentially due to a regional connection with the Latrobe Group aquifer.

Based on interpretation of drillers' logs, it appears that most existing and pending groundwater extraction licences are targeting the Latrobe Valley Coal Measures or the Balook aquifers in the western and northern parts of the study area. The sustainable yield of these aquifers is estimated to range between 1,900 and 4,700 ML/yr. Existing licences total 1,082 ML/yr and pending licences would increase this volume to 4,279 ML/yr. This exceeds the lower sustainable yield estimate and is 90% of the higher estimate. The largest pending application of 2,500 ML/yr is located in the northern western corner of the study area where the hydraulic connection between the Latrobe Valley Coal Measures and Boisdale aquifers is not known. To ensure a conservative management approach, it may be prudent to not fully allocate the calculated available groundwater resource in the acknowledgement that this is likely to be an important regional recharge area for the regional Latrobe Group Aquifer and possibly the Boisdale aquifer. Given the uncertainty in the aquifer extents, their hydraulic connection with other aquifers (Latrobe Group and Boisdale) and the sustainable yield estimate, addition applications should be assessed carefully. Drilling investigations are recommended to confirm the extent of the marine deposits and the potential connection between the Boisdale aquifer and Latrobe Group aquifers with the Balook and Latrobe Valley Coal Measures. This is discussed further in the following section.

A sustainable yield estimate was also calculated for the Boisdale aquifer, however at this stage there are no existing or pending groundwater extraction licences in the area where this aquifer is present.

Groundwater surface water interaction is also very difficult to assess due to the lack of understanding about the hydraulic connection between the Latrobe Valley Coal Measures/Balook aquifers with the Quaternary aquifer that interacts with the Mitchell River. SRW have received several applications for groundwater extraction licence in close proximity to the Mitchell River. While these bores would be targeting the deeper aquifers, the hydraulic connection between the Latrobe Valley Coal Measure and/or Balook with the Quaternary aquifer is not well understood. If there is a strong connection, these applications have the potential to impact the baseflow to the Mitchell River. The potential impacts of these applications on the Quaternary aquifer and Mitchell River should be assessed on an individual basis.

6. Recommendations

This report makes the following recommendations:

- Extend the Sale WSPA boundary further north to the currently known northern extent of the Boisdale aquifer as recommended in SKM (2006).
- Define the northern extent of the Boisdale Formation and marine deposits in north western corner of the study area through the following drilling investigations:
  - Two exploratory holes between Bore 85906 and bedrock outcrop to north to confirm extent of marl and hydraulic connection between Boisdale aquifer and Latrobe Valley Coal Measures/Balook aquifers.
- Define the northern extent of the Latrobe Group aquifer through the following drilling investigations:
  - The new Latrobe Group observation bore sites recommended in SKM (2007) including:.
    - One exploratory hole north of Lindenow was recommended in the south western corner of the study area to determine the stratigraphy and recharge systems along the northern basin margins;
    - A nested site recommended between Lindenow and Bairnsdale to clarify the vertical hydraulic gradient between the Latrobe Group, Jemmys Point Formation and shallow aquifer of the Wy Yung WSPA and delineate the northern extent of the Latrobe Aquifer.
  - An additional two sites should also be drilled north of the Mitchell River to determine the extent of the Latrobe Group aquifer and hydraulic connection with the Balook and/or Latrobe Valley Coal Measures.
- Once the extent of the Latrobe Group Aquifer is known from the additional drilling, extend the Stratford GMA north to cover the Latrobe Group aquifer.
- Consider developing a new GMA extending from bedrock outcrop to the proposed northern boundary of the Sale WSPA covering the occurrences of the Balook Formation and Latrobe Valley Coal Measures. Future allocations in this new GMA should take into account the sutainable yield calculations in this study, the general declining groundwater levels in the aquifer and the potential hydraulic connection between the Latrobe Valley Coal Measures/Balook Aquifer and the down-gradient Latrobe and Boisdale Aquifers (if proven).

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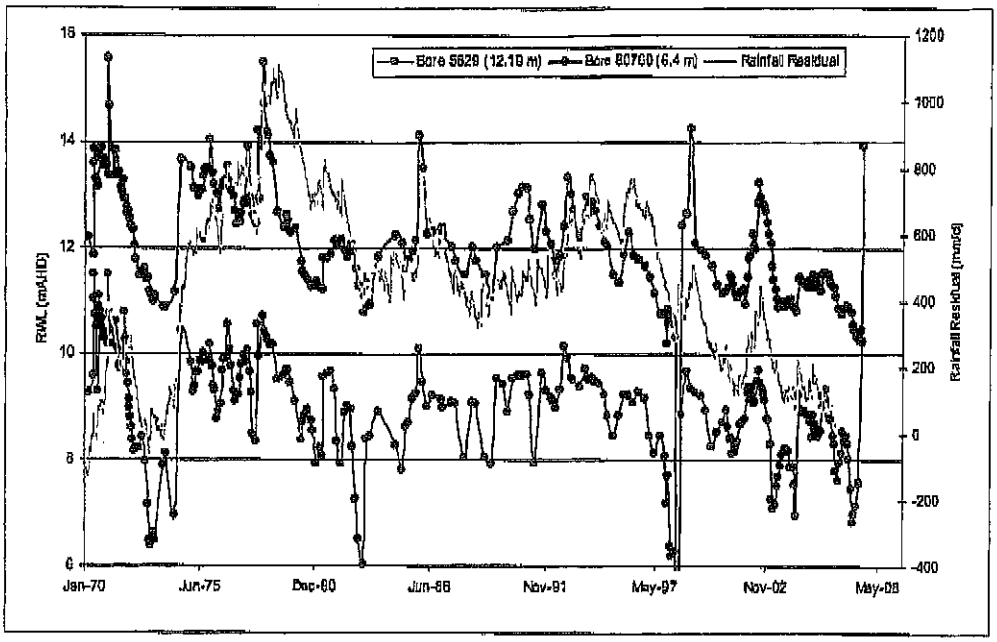
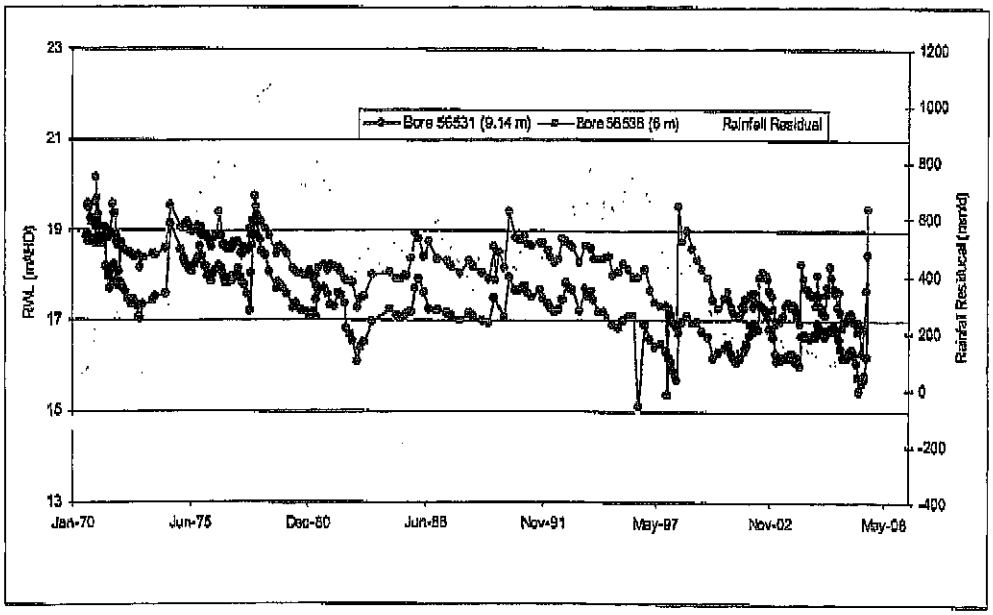
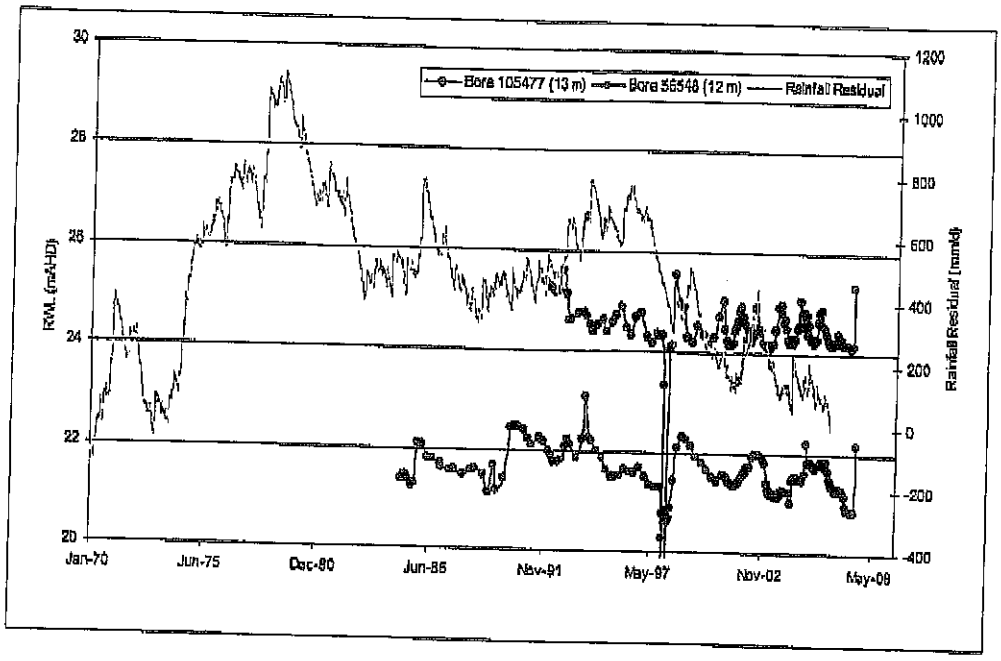
Appendix A Hydrographs of Shallow Monitoring Bores in the Wy Yung GMA






Bore 105477 (13 m)
Bore 56548 (12 m)
Rainfall Residual
RWL (mAHD)
Rainfall Residual (mm/d)
30
28
26
24
22
20
1200
1000
800
600
400
200
0
-200
-400
Jan-70
Jun-75
Dec-80
Jun-86
Nov-91
May-97
Nov-02
May-08

SKM

Appendix B Bore logs

Depth From (m)	Depth To (m)	Description
Bore 105478		
0.5	5.3	BROWN SILTY CLAY
5.3	8	COARSE GRAVEL & STONES
8	9	DARK GREY CLAY
9	14	COARSE GRAVEL& CLAY
14	20	COARSE GRAVEL & STONES
20	21	GREY CLAY
21	30	COARSE GRAVEL
30	31.2	GREY CLAY
31.2	32	COARSE GRAVEL
32	37	YELLOW & GREY MOTTLE CLAY
37	42	GREY CLAY
42	47.3	LIGNEOUS CLAY
47.3	63	COARSE GRAVEL & STONES
63	66	COARSE GRAVEL
66	66.5	BROWN SILTY CLAY
66.5	77	COARSE GRAVEL & STONES
77	80	SLATE (BEDROCK)
Bore 105479		
0	0.3	TOP SOIL
0.3	5.5	BROWN SILTY CLAY
5.5	8.2	COARSE GRAVEL & STONES
8.2	12.5	DARK GREY CLAY
12.5	19.5	COARSE GRAVEL & CLAY
19.5	22	GREY CLAY
22	28.2	COARSE GRAVEL
28.2	29.5	LIGNEOUS CLAY
29.5	31.2	COARSE GRAVEL
31.2	34	YELLOW & GREY CLAY
Bore 110177		
0	0.3	TOP SOIL
0.3	4.5	BROWN SANDY CLAY
4.5	12	COARSE GRAVEL
12	15	GREY SANDY CLAY
15	20.2	DARK GREY CLAY
20.2	35.5	CLAY
35.5	36	GREY CLAY
36	57	CLAY
57	64	BEDROCK
Bore 110976		
0	2.5	TOP SOIL
2.5	5	BROWN CL;AYS
5	5.5	GREY CLAYS

5.5	10.5	GRAVELS
10.5	15	CLAYS
Bore 110978		
0	0.3	TOP SOIL
0.3	2	BROWN SANDY CLAY
2	11	COARSE GRAVEL & STONES
11	12	YELLOW CLAYEY SAND
12	15	MARL
15	25	FINE GREY SAND
25	39.5	GREY SILTY CLAY
39.5	41	FINE CLAYEY SAND
41	50	LIGNEOUS CLAY
50	53.3	GREY CLAY
53.3	97	COARSE GRAVEL & STONES
97	98	GREY CLAY
98	104	COARSE GRAVEL & STONES
104	113.5	GREY CLAY
113.5	116	BEDROCK
Bore 111800		
0	0.3	TOP SOIL
0.3	1.5	BROWN CLAYEY SAND
1.5	7.8	SAND & COARSE GRAVEL
7.8	53.5	MARL
53.5	56	CLAY & GRAVEL
56	58	GREY CLAY
58	62.7	FINE & MEDIUM SAND
62.7	65	GREY CLAY
65	74.5	COARSE SAND
74.5	80	COAL
80	85	LIGNEOUS CLAY
85	93.5	LIGHT GREY CLAY
93.5	93.8	SANDSTONE
93.8	105	LIGHT GREY CLAY
105	108.5	BEDROCK
Bore 105455		
0	1	SANDY LOAM
1	24	SANDY CLAYS
24	25	COR SANDS
25	27	CLAYS
27	27.8	FINE SANDS - (WATER)
27.8	38	CLAY & STONES
38	45	SANDY CLAYS
45	53.5	SAND STONE
53.5	56.5	COARSE SANDS - (WATER) TO CLAYS
Bore 132978		
0	1	TOP SOIL
1	2	SAND CLAY

2	5	CLAY
5	10	SAND CLAY
10	17	SAND CLAY WHITE
17	30	CORES CLAY SAND
30	41	CLAY
41	48	MED SANDS
Bore 122878		
0	0.3	TOP SOIL
0.3	10	ORANGE CLAYS
10	45	SANDY CLAYS
45	52	RED CLAYS
52	53	GRAVEL - NO WATER
53	73	SANDY CLAYS
73	90	WATER BEARING SANDS WITH COAL SCAMS
0	1.5	TOP SOIL
1.5	4.6	GREY BASALT
1.5	9	RIVER SILT
4.6	15.2	BROWN WEATHER BASALT
9	17	GRAVEL (COARSE) & LIMESTONE
15.2	38	BLUE BASALT
38	38.5	BASEMENT
Bore 131467		
0	0.5	TOP SOIL
0.5	6	SANDY CLAYS
6	18	FINE CLAY SAND
18	24	YELLOW CLAY AND SAND
24	40	CLAY AND SANDS
40	61.5	LIGNITE SANDS
61.5	63	FINE GRAVEL SANDS
63	68	COARSE GRAVEL
Bores 105783		
0	0.5	TOPSOIL
0.5	13.5	CLAYS
13.5	14	CLAY AND GRAVELS
14	15.8	RIVER GRAVELS
15.8	16	CLAYS AND LIMESTONE
16	16.3	VERY HARD LIMESTONE
16.3	19	CAVERNOUS LIMESTONE
19	26.3	SHELLY LIMESTONE

Bore 132157		
0	3	TOP SOIL
3	6	ROCK SANDY SILT
6	9	ROCK HARD
9	10	GRAVEL
10	29	CLAY
29	30	FINE SANDS
30	36	COKS SANDS
Bore 143544		
0	1.9	TOP SOIL
1.9	6.2	BIG GRAVEL WITH CLAY
6.2	11.5	SAND STONE
11.5	30.2	GREY CLAY WITH YELLOW STREEKS
30.2	48	MED GRAVEL & SAND
48	50.5	GREY CLAY
Bore 105444		
0	5.5	TOP SOIL
5.5	7	GRAVEL
7	22.8	CLAY
22.8	36	WATER BEARING SANDS AND GRAVEL
Bore 122904		
0	0.3	SUBSOIL
0.3	1.2	TOUGH CLAY
1.2	3.1	SANDY MOTTLED CLAY
3.1	5.5	CLAYEY SAND & STONES
5.5	7.3	MOTTLED SANDY CLAY
7.3	8.5	SANDSTONE
8.5	13.4	LIGNEOUS SILTED CLAYS
13.4	15.2	COARSE MUDDED SAND
15.2	19.2	TOUGH SILTED GREY CLAY
19.2	20.7	SILTED CLAY
20.7	24.7	LIGNEOUS SILTED CLAYS
24.7	26.2	MUDDED COARSE SAND & GRAVEL
26.2	26.5	SILTED CLAY
Bore 300998		
0	0.61	SURFACE SOIL
0.61	4.27	SAND, COARSE GRAVEL AND BOULDERS
4.27	5.49	CLAY
5.49	16.46	FINE SAND.
16.46	21.64	CLAY
21.64	32.31	MARL
32.31	36.88	LIMESTONE WITH ALTERNATIE BANDS OF MARL
36.88	110.03	MARL
110.03	118.87	LIMESTONE AND MARL BANDS
118.87	134.72	MARL
134.72	142.95	LIMESTONE

142.95	147.52	MARL AND LIMESTONE BANDS
147.52	149.66	LIMESTONE
149.66	155.45	MARL AND LIMESTONE BANDS
155.45	160.93	MARL
160.93	163.98	LIMESTONE
163.98	164.59	MARL
164.59	211.23	MARL AND LIMESTONE BANDS
211.23	218.54	MARL
218.54	238.66	MARL AND LIMESTONE BANDS
238.66	244.75	SOFT MARL
244.75	250.85	LIMESTONE AND MARL
250.85	255.73	HARD LIMESTONE AND MARL
255.73	258.17	SAND
258.17	259.69	CLAY
259.69	263.96	CLAY AND GRAVEL.
263.96	275.54	SAND
Bore 51964		
0	15.24	SANDY CLAY WITH BANDS OF MARL
15.24	31.39	MARL MEDIUM TO HARD
31.39	100.27	SANDY CLAY WITH BANDS OF MEDIUM TO HARD HARD MARL
100.27	109.42	SANDY CLAY WITH BANDS OF MARL & TRACES OF OF LIMESTONE
109.42	148.13	SOFT LIMESTONE & SANDY CLAY
148.13	167.64	SANDY CLAY WITH BANDS OF HARD LIMESTONE
167.64	176.78	WHITE LIMESTONE & SHALE HARD
176.78	225.55	SANDY CLAY WITH BANDS OF LIMESTONE & MARL
225.55	245.66	SANDY CLAY & SILT
245.66	252.98	COARSE & FINE QUARTZ SAND
252.98	283.46	FINE QUARTZ SAND WITH BANDS OF COARSE SAND
283.46	306.01	COARSE & FINE QUARTZ SAND
306.01	320.95	CLAY & SILTY SAND WITH SMALL BANDS OF COARSE SAND & TRACES OF BROWN COAL
320.95	330.7	CLAY & FINE QUARTZ SAND, MARL & PYRITES
330.7	336.49	CLAY & SHALE WITH BANDS OF FRACTURED QUARTZ
336.49	340.46	SHALE WITH CLAYS & MARL HARD
340.46	344.42	BROWN HARD ROCK
Bore 56525		
0	0.31	SURFACE SOIL
0.31	4.57	YELLOW MOTTLED SANDY CLAY
4.57	19.81	YELLOW AND WHITE SANDY CLAY
19.81	27.43	YELLOW CLAYEY SAND
27.43	47.55	YELLOW SAND
47.55	49.38	GREY CLAYEY SAND
49.38	57.91	YELLOW CLAYEY SAND
57.91	64.01	YELLOW CLAYEY SAND WITH SHELLS
64.01	99.06	GREY CLAYEY SILT WITH BANDS OF STONE AN SHELLS
99.06	106.68	MARL WATER STRUCK AT 305 FEET

IN THE VICTORIAN CIVIL AND ADMINISTRATIVE TRIBUNAL
AT MELBOURNE
PLANNING & ENVIRONMENT LIST

No. P2316/2008

BETWEEN

NELSON COX Applicant

and

SOUTHERN RURAL WATER

and

No. P2312/2008

BETWEEN

TREVOR KERTON Applicant

and

SOUTHERN RURAL WATER

Respondent

WITNESS STATEMENT

Date of document:	19 January 2009
Filed on behalf of:	The Respondent
Macpherson + Kelley	Solicitor's Code: 040032
Solicitors	DX 17501 Dandenong
40-42 Scott Street	Tel: 9794 2622
DANDENONG 3175	Ref: OSK:161451 Olga Koskie

I, **TREVOR MCDEVITT** of 88 Johnson Street, Maffra, in the State of Victoria, Manager Licensing Administration, state as follows:

1. I make this statement from my own knowledge and on the basis of records held by the Respondent, except where otherwise indicated.

2. I am the Manager of Licensing Administration of the Respondent ("SRW") and have been so for approximately 8 years. In that position I am responsible for:

   - determining licence applications under delegation;

- representing the Respondent before the Victorian Civil and Administrative Tribunal, Planning Panels Victoria and in other relevant forums;

- managing water licence and licence administration;

- management of staff, revenue and budgets.

As the Manager of Licensing Administration of SRW I have delegated authority to consider and determine applications for water licences.

The Applications for review

3. An opportunity for review of the Respondents decision to refuse the licences for bore construction and to take and use groundwater for the purposes of irrigation is provided by section 64(1)(d) of the **Water Act** 1989 ("the Act").

Application by Nelson Cox

4. On or about 30 May 2006, SRW received an application from Mr Nelson Cox for permission to construct a bore and to take and use 67 ML of water annually for the purpose of irrigation for vegetable/pasture over an area of approximately 27 hectares. The proposed maximum depth of the bore was stated to be 75 metres.

5. The address of the property at which the water is proposed to be used is stated as 95 Woodglen Road, Woodglen which is in the area known as the Lindenow flats and has a direct abuttal to the Mitchell River.

6. The application had not reached the point of being advertised as part of the assessment process however a notice has now been placed in the local newspaper in accordance with orders made by the Tribunal.

7. By letter dated 28 December 2006, the Applicant was informed of the process for determination of the application, relevant fees, notification process and the need to provide a farm plan illustrating the purpose for which the water is to be used, and a groundwater hydro-geological report covering matters identified in that letter.

8. No farm plan or hydro-geological report has been received from the Applicant in respect of this application.

9. By letter dated 30 July 2007, the Applicant was informed that SRW was concerned to ensure that the extraction of groundwater from this deep aquifer was appropriate and did not have the potential to affect other water supplies, place stress on the aquifer to threaten the security of existing water users. This letter informed the Applicant, that in view of the number of applications targeting water in the area, the Respondent had commissioned a ground water study and was deferring processing of applications until the outcome of the studies was known.

10. By letter dated 7 April 2008 the Respondent informed the Applicant that a preliminary report had been received from Sinclair Knight Merz and that further clarification was being sought.

11. By letter dated 11 July 2008 Mr Cox was informed of the Respondent's decision. This correspondence enclosed a statement of reasons outlining the matters considered in reaching the Respondent's decision.

Application by Trevor Kerton.

12. On or about 21 Februry 2007, SRW received an application from Mr Trevor Kerton for permission to construct a bore and to take and use 150 ML of water annually for the purpose of irrigation for vegetable production over an area of approximately 40 hectares. The proposed maximum depth of the bore was stated to be 140 – 150 metres.

13. The Applicant later indicated that he wished to amend this application to allow extraction of 300ML of water and a bore depth of 340m and the application has been assessed on that basis.

14. The address of the property at which the water is proposed to be used is stated as 145 Bonaccord Road, Walpa which is in the area known as the Lindenow flats and has a direct abuttal to the Mitchell River.

15. The application was not advertised as part of the assessment process however a notice has now been placed in the local newspaper in accordance with orders made by the Tribunal.

16. By letter dated 26 April 2007, the Applicant was informed of the process for determination of the application, relevant fees, notification process and the need to provide a farm plan illustrating the purpose for which the water is to be used and a groundwater hydro-geological report covering matters identified in that letter.

17. No farm plan or hydro-geological report has been received from the Applicant in respect of this application.

18. By letter dated 30 July 2007, the Applicant was informed that SRW was concerned to ensure that the extraction of groundwater from this deep aquifer was appropriate and did not have the potential to affect other water supplies, place stress on the acquirer to threaten the security of existing water users. This letter informed the Applicant, that in view of the number of applications targeting water in the area, the Respondent had commissioned a ground water study and was deferring processing of applications until the outcome of the studies was known.

19. By letter dated 7 April 2008 the Respondent informed the Applicant that a preliminary report had been received from Sinclair Knight Merz and that further clarification was being sought.

20. By letter dated 11 July 2008 Mr Kerton was informed of the Respondent's decision. This correspondence enclosed a statement of reasons outlining the matters considered in reaching the Respondent's decision.

Background to these decisions

21. These applications are two of a number of applications to construct bores and to take and use water in the Lindenow region adjacent to the Mitchell River.

22. A map showing the location of the Applicant's properties and proposed bores is Attachment 1 to this Statement.

23. In view of the large number of applications received targeting this area, the Respondent sought technical advice to:

- Characterise the aquifers beneath the shallow alluvial aquifer in and around the Mitchell River alluvial plain; and

- To assess the potential impacts of additional groundwater extraction in the region.

24. The results of this investigation are contained in the report prepared by Sinclair Knight Merz entitled *Groundwater Resource Assessment in Deeper Aquifers in the Lindenow Region, East Gippsland* ("**SKM Report**"). Further advice in relation to technical matters relating to the extent and capacity of the relevant aquifers was provided to me by Mr Terry Flynn a hydrologist employed by the Respondent.

25. I took the SKM Report and the advice provided to me by Mr Flynn into account when making my decision in relation to this matter together with other relevant factors set out below. The findings of these reports and the relevance of these finding to these applications will be the subject of evidence to be given by others in these proceedings.

Reasons for decision

26. When considering an application for a groundwater licence, section 53 sets out the matters which the Respondent must take into account. Section 53 of the Act provides that:

> *"(1) In considering an application under section 51 or 52, the Minister must have regard to the following matters—*
>
> *(a) the report of any panel appointed under section 50;*
>
> *(ab) any advice and comments received within the period of 30 days referred to in section 51C(1);*
>
> *(b) the matters mentioned in paragraphs (b) to (m) of section 40(1);*
>
> *(e) any other matter that the Minister thinks fit to have regard to."*

Section 53(2) of the Act provides that:

> *"(2) In considering an application under section 51 or 52, the Minister must give effect to-*
>
> *(a) any relevant Order under section 52A; and*
>
> *(b) any relevant Order made by the Governor in Council under section 49A of the* **Groundwater Act 1969** *specifying on annual reserve volume of groundwater; and*
>
> *(c) any relevant prescription made under section 62(1) of the* **Groundwater Act 1969** *in respect of a groundwater conservation area declared under section 61 of that Act; and*
>
> *(d) any water resource management plan for the area approved under Section 64A; and*
>
> *(e) any approved management plan for any relevant water supply protection area."*

27. Pursuant to section 306 of the Act, the Minister has delegated his power under these sections to me, as an officer of SRW.

28. In making the decisions not to issue the licences sought by the Applicants I had regard to the matters specified in section 53 of the Act. The matters to which regard must be had are addressed briefly in relation to each application in Appendices A and B to this report.

Applicant's Grounds of Review

East Gippsland Water's application

29. The Applicant's grounds of review appear to centre around concerns they express about the approval of applications by East Gippsland Water to drill bores and extract water for the provision of town water following the summer bushfires in 2006/2007. This application was necessitated by the sudden drop in the quality of water available from the Mitchell River as a result of floods washing material created by bushfires into the river.

30. While this is an application to review applications for licences made by the Applicants and not that of East Gippsland Water, in view of the focus of the Applicant's grounds of review I shall address this issue briefly.

31. East Gippsland Water made application on 8 March 2007 to construct up to 5 bores to extract up to 2,500 megalitres (ML) of water from beneath the Wy

Yung Groundwater Management Area to supplement urban water supply for Bairnsdale and surrounding towns. At this point East Gippsland Water had 8 – 10 weeks of water left in storage to provide urban water to these towns including Bairnsdale, and could not pump from the Mitchell River due to the extremely poor quality of water as a result of ash and other contaminants being washed downstream from the 06/07 bushfires.

32. Construction licences for 5 investigation bores were issued on 9 March 2007 and construction started shortly thereafter.

33. East Gippsland Water had secured two temporary transfers from other licence holders in the area from 20 March 2007 to 30 June 2007 one for 50ML the other 116ML.

34. East Gippsland Water was required to provide an extensive hydro geological assessment. As they were seeking a large allocation of water (ie 2500ML per annum) they were required to provide the results of pump tests together with a draft monitoring program and other documentation.

35. In view of the critical urban water supply situation the Respondent in consultation with the Secretary of the Department of Sustainability and Environment decided to issue a temporary licence to allow an extended pump test from these bores which allowed extraction of a maximum of 500 ML between 8 May 2007 to 31 December 2007.

36. It was agreed to allow East Gippsland Water to pump to their storage using the temporary licences they had secured plus the 500ML permitted to be extracted in order to provide water for the town water supply during the period required for the installation of water filters and/or the Mitchell River to cleanse.

37. As discussed above it was as a result of receiving this application and applications such as the applications the subject of this review, a "hot spot" (or area in which a significant volume of water was sought) was identified. It was considered that there was insufficient research and information about the aquifers and area from which the water was proposed to be taken. As a result of this, a report covering relevant issues was sought from SKM and considered by SRW and myself before making the decision to refuse the licences the subject

of this review together with the on-going licence sought by East Gippsland Water.

Relevance of proposed "emergency use"

38. I understand that the Applicants assert that the application is intended to allow the Applicant to extract groundwater when the Applicant are unable to obtain water directly from the Mitchell River in accordance with other entitlements. I do not consider this to be a sufficient reason for granting this allocation. The times at which flows from the Mitchell River are not available for allocation are not times at which it is appropriate to permit extensive extraction from the groundwater resource.

Licensing of above ground water storages

39. I understand the Applicants take issue with the approval of above ground water resources granted to other Applicants. This application for review is not concerned with the review of other decisions made by the Respondent.

Conclusion

40. The Respondent's decision was the correct decision taking into account the applicable matters and the decision to refuse to grant the licences sought remains the correct and preferable precautionary decision taking into account all the relevant considerations.

APPENDIX 1

Consideration of applicable matters- COX

Section 53

53(1)(a) - the report of any panel appointed under section 50.

1. This sub-section does not apply to this application as no panel was appointed under section 50.

53(1)(ab) - any advice and comments received within the period of 30 days referred to in section 51C(1).

2. This sub-section does not apply to this application.

53(1)(b) - the matters mentioned in paragraphs (b) to (m) of section 40(1).

3. I have addressed these matters below.

53(1)(e) - any other matter that the Minister thinks fit to have regard to.

4. I considered the various policies and decisions of Southern Rural Water in considering this decision as relevant to ensuring that water users and potential water users were treated consistently in respect of decisions made in respect of a licence application.

5. Section 53(2) provides that effect must be given to the matters set out in that section. I have addressed these matters in turn:

53(2)(a) any relevant Order under section 52A.

6. This applies only to a registration licence or a licence in respect of a licence issued under section 51(1)(ba) in respect of a spring or soak or dam and does not apply to this Application.

53(2)(b) - any relevant Order made by the Governor in Council under section 49A of the Groundwater Act 1969 specifying an annual reserve volume of groundwater.

7. This provision does not apply to this application because this application is not in a declared groundwater conservation area.

Section 53(2)(c) - any relevant prescription made under section 62(1) of the Groundwater Act 1969 in respect of a groundwater conservation area declared under section 61 of that Act.

8. This provision does not apply to this application because this application is not in a declared groundwater conservation area.

Section 53(2)(d) - any water resource management plan for the area approved under section 64A.

9. This provision does not apply to this application.

Section 53(2)(e) - an approved management plan for any relevant water supply protection area.

10. This provision does not apply to this application because there is no management plan in place for this aquifer system.

Paragraphs (b) to (m) of Section 40(1)

Section 40(1)(b) - existing and projected availability of water in the area.

11. The hydro-geological advice I have received has indicated that there is sufficient certainty about the extent of connectivity between the aquifers targeted by this application and the surrounding aquifers to indicate that further allocations of groundwater in this area would have a detrimental effect on the projected availability of water in the area. I have also considered the cumulative effect of allocating more groundwater within this basin.

12. I have also been conscious of the need to replenish groundwater resources in the area and the declining groundwater levels and the effect of lower than average rainfall over the past decade.

Section 40(1)(ba) - the permissible annual volume, if any, for the area.

13. There is no permissible annual volume gazetted in respect of the area in which this application is located. However, in the context of considering the existing and projected availability of water, I have taken into account the likely effect of extraction on the surrounding groundwater management areas. The surrounding groundwater management areas are considered to be fully allocated in that the sum of the volumes for which licenses have been allocated equals the permissive consumptive volumes allocated for these areas (that is the cap on the amount of water permitted to be allocated from these areas has been reached). Given the degree of connectivity between the aquifers targeted by this application and the aquifers in the surrounding groundwater management areas which are recording declining groundwater levels, this matter has significance in the assessment of this application.

Section 40(1)(c) - the existing and projected quality of water in the area.

14. The hydro-geological information available to date does not raise any direct concerns about water quality in the area.

Section 40(1)(d) - any adverse effect that the allocation or use of water under the entitlement is likely to have on—

(i) existing authorised uses of water; or

(ii) a waterway or an aquifer; or

(iii) the drainage regime within the meaning of section 12(1); or

(iv) the maintenance of the environmental water reserve in accordance with the environmental water reserve objective.

15. In considering this application I was conscious that over-allocation of water in the area had the potential to affect the viability of the aquifer. Should damage to the aquifer result, this would be likely to have an adverse impact on existing authorised uses of water.

16. In making this consideration, I applied an approach consistent with the approach taken by Southern Rural Water as set out in its Guidelines for Surface and Groundwater Licensing including those principles set out in pages 2 and 3 which include:

Water Availability

SRW will:

1. *ensure that, within the environmental limits agreed with government, water is available to meet existing and future demands; and*

2. *share information about the availability of water resources with existing and prospective users*

Information

1. *base decisions on "best available" technical advice, recognising the uncertainties in available information;*

2. *not avoid decisions if information is lacking – but if there could be significant impacts on water users or the environment take a precautionary approach consistent with our information; and*

3. *collect extra information where justified by better resource management decisions*

Section 40(1)(e) - any water to which the Applicant is already entitled.

17. It is understood that Mr Cox and associated entities have access to the following water:

Licence No	Licence Holder	Type	Use	Volume
830755	Nelson Cox	Surfacewater	Irrigation	101.1 ML
830666	JF Cox	Surfacewater	Irrigation	87.0 ML
717959	Nelson Cox	Surfacewater	Irrigation	3.0 ML

757241	NB, L, MJ, and AL Cox	Surfacewater	Irrigation	60.0 ML
904813	Nelson Cox	Groundwater	Irrigation	30.0 ML
867136	JF Cox	Groundwater	Irrigation	30.0 ML
9032972	NB, L, MJ and AL Cox	Groundwater	Irrigation	57.0 ML
9031245	Nelson Cox	Groundwater	Irrigation	78.0 ML
757241	NB, L, MJ and AL Cox	Surfacewater	Irrigation	60.0 ML
9034770	Riviera Farms P/L	Groundwater	Irrigation	160.0 ML
9036400	Riviera Farms P/L	Surfacewater	Irrigation	150.0 ML

The above entitlements do not all relate to the property at which the water (which is the subject of this Application) is proposed to be used at.

18. The licences outlined in paragraph 17 herein, do not include any water the Applicant may have access to through private/commercial arrangements.

Section 40(1)(f) - any volume of water that is allocated for sale under section 222(1)(c).

19. This does not apply to this application.

Section 40(1)(g) - the need to protect the environment, including the riverine and riparian environment.

20. I was required to consider, in particular, the need to protect the aquifer from unsustainable extraction, particularly as long term damage could result from extended extraction. I took this into account when considering this application.

Section 40(1)(i) - conservation policy of the government.

21. It is not government policy to allocate water from over allocated or over stressed water sources.

Section 40(1)(j) - government policies concerning the preferred allocation or use of water resources.

22. In making my decision I considered that there is concern with allocating further water in the area because of the potential effects on existing users and the aquifer. Long-term damage to the aquifer and interconnecting aquifer could result from over-extraction from this area.

23. In addition I considered relevant government policy relating to water allocation including:

- Victorian Government White Paper – Securing our Water Future Together;
- Ministerial Guidelines for the Performance of the Groundwater Function issued by the Minister for Agriculture and Resources;
- Other relevant ministerial policy statements and SEPPs.

Section 40(1)(ja) - whether the proposed source of water is within a heritage river area or natural catchment area within the meaning of the Heritage Rivers Act 1992 and whether there is any restriction on the use of the area under that Act.

24. The Mitchell River which is adjacent to this site is heritage listed; however, I do not understand this area to be subject to any restriction on the use of the area under that Act which is relevant to this application.

Section 40(1)(k) - the proper management of the waterway and its surrounds or of the aquifer.

25. In order to properly manage the aquifer and surrounding aquifers, there should be no further allocation of water within this area on the basis of the hydro-geological assessments available.

Section 40(1)(l) - the purposes for which the water is to be used.

26. In making my decision, I considered that the water which is the subject of the application would be used for irrigation purposes. I note that while this is a legitimate purpose for the use of groundwater, other uses such as the guarantee of water supply for urban purposes is regarded as having priority over the provision of water for irrigation purposes.

Section 40(1)(m) - the needs of other potential Applicants.

27. Overuse or damage to the aquifer would disadvantage the other users. I considered this when making my decision.

28. In particular I was aware that this decision requires the balancing of the interests of various people within the framework of the *Water Act* 1989.

29. Within the area adjacent to the property to which this application relates a series of applications have been made and refused which target groundwater resources in the area. These are summarised in the table below[1]:

Current applications for groundwater licences in the relevant area

Reference No	Proposed Depth	Applicant Volume (ML)
384880	40 m	100
449530	75 m	2500
426497	120 m	63
332604	75 m	67
408730	85 m	67
441932	340 m	300
331733	200 m	100
444091	120 m	20
497400	50 m	114
540773	120 m	10
518259	125 m	107
474718	Unknown	50
523147	50 m	30

[1] This table contains additional applications to those in table 3.3 of the SKM Report as additional applications were received by the Respondent after it had initially instructed SKM to prepare its Report.

Reference No	Proposed Depth	Applicant Volume (ML)
315973	130 m	20

30. I was particularly aware of the need to balance the needs of the following categories of people:

- Other people who had applied for extra allocations of water and been refused such an allocation;
- People who had secured water by means of transfer of existing water allocations;
- Those who had or have been dissuaded from applying for a further allocation of water on the basis that it would not be or would be unlikely to be granted.
- The likely impact of the granting of other licences on an application by East Gippsland Water for the use of groundwater to guarantee urban water supply.

Section 40(1)(n) provides that regard must be had to

(i) any relevant report or statement prepared under any Act; or

(ii) the findings of, or any evidence given or submission made to, any relevant investigation or inquiry held under any Act or held by any Committee of the Cabinet, government department or public statutory body whether or not under an Act.

31. I considered relevant government policy relating to water allocation including:

- Victorian Government White Paper – Securing our Water Future Together;
- Ministerial Guidelines for the Performance of the Groundwater Function issued by the Minister for Agriculture and Resources;
- other relevant ministerial policy statements and SEPPs.

Section 40(1)(o) – any other matter that the Minister or Governor in Council thinks fit to have regard to.

32. In making the decision not to grant the licence I had regard to the matters specified in section 40(1) paragraphs (b) to (m) and section 53 of the Act.

APPENDIX 2

Consideration of applicable matters- KERTON

Section 53

53(1)(a) - the report of any panel appointed under section 50.

1. This sub-section does not apply to this application as no panel was appointed under section 50.

53(1)(ab) - any advice and comments received within the period of 30 days referred to in section 51C(1).

2. This sub-section does not apply to this application.

53(1)(b) - the matters mentioned in paragraphs (b) to (m) of section 40(1).

3. I have addressed these matters below.

53(1)(e) - any other matter that the Minister thinks fit to have regard to.

4. I considered the various policies and decisions of Southern Rural Water in considering this decision as relevant to ensuring that water users and potential water users were treated consistently in respect of decisions made in respect of a licence application.

5. Section 53(2) provides that effect must be given to the matters set out in that section. I have addressed these matters in turn:

53(2)(a) any relevant Order under section 52A.

6. This applies only to a registration licence or a licence in respect of a licence issued under section 51(1)(ba) in respect of a spring or soak or dam and does not apply to this Application.

53(2)(b) - any relevant Order made by the Governor in Council under section 49A of the Groundwater Act 1969 specifying an annual reserve volume of groundwater.

7. This provision does not apply to this application because this application is not in a declared groundwater conservation area.

Section 53(2)(c) - any relevant prescription made under section 62(1) of the Groundwater Act 1969 in respect of a groundwater conservation area declared under section 61 of that Act.

8. This provision does not apply to this application because this application is not in a declared groundwater conservation area.

Section 53(2)(d) - any water resource management plan for the area approved under section 64A.

9. This provision does not apply to this application.

Section 53(2)(e) - an approved management plan for any relevant water supply protection area.

10. This provision does not apply to this application because there is no management plan in place for this aquifer system.

Paragraphs (b) to (m) of Section 40(1)

Section 40(1)(b) - existing and projected availability of water in the area.

11. The hydro-geological advice I have received has indicated that there is sufficient certainty about the extent of connectivity between the aquifers targeted by this application and the surrounding aquifers to indicate that further allocations of groundwater in this area would have a detrimental effect on the projected availability of water in the area. I have also considered the cumulative effect of allocating more groundwater within this basin.

12. I have also been conscious of the need to replenish groundwater resources in the area and the declining groundwater levels and the effect of lower than average rainfall over the past decade.

Section 40(1)(ba) - the permissible annual volume, if any, for the area.

13. There is no permissible annual volume gazetted in respect of the area in which this application is located. However, in the context of considering the existing and projected availability of water, I have taken into account the likely effect of extraction on the surrounding groundwater management areas. The surrounding groundwater management areas are considered to be fully allocated in that the sum of the volumes for which licenses have been allocated equals the permissive consumptive volumes allocated for these areas (that is the cap on the amount of water permitted to be allocated from these areas has been reached). Given the degree of connectivity between the aquifers targeted by this application and the aquifers in the surrounding groundwater management areas which are recording declining groundwater levels, this matter has significance in the assessment of this application.

Section 40(1) (c) - the existing and projected quality of water in the area.

14. The hydro-geological information available to date does not raise any direct concerns about water quality in the area.

Section 40(1)(d) - any adverse effect that the allocation or use of water under the entitlement is likely to have on—

(i) existing authorised uses of water; or

(ii) a waterway or an aquifer; or

(iii) the drainage regime within the meaning of section 12(1); or

(iv) the maintenance of the environmental water reserve in accordance with the environmental water reserve objective.

15. In considering this application I was conscious that over-allocation of water in the area had the potential to affect the viability of the aquifer. Should damage to the aquifer result, this would be likely to have an adverse impact on existing authorised uses of water.

16. In making this consideration, I applied an approach consistent with the approach taken by Southern Rural Water as set out in its Guidelines for Surface and Groundwater Licensing including those principles set out in pages 2 and 3 which include:

Water Availability

SRW will:

1. *ensure that, within the environmental limits agreed with government, water is available to meet existing and future demands; and*

2. *share information about the availability of water resources with existing and prospective users*

Information

1. *base decisions on "best available" technical advice, recognising the uncertainties in available information;*

2. *not avoid decisions if information is lacking – but if there could be significant impacts on water users or the environment take a precautionary approach consistent with our information; and*

3. *collect extra information where justified by better resource management decisions*

Section 40(1)(e) - any water to which the Applicant is already entitled.

17. It is understood that Mr Kerton and associated entities have access to the following water:

Licence No	Licence Holder	Type	Use	Volume
823228	Trevor N & Paula M Kerton	Surfacewater	Irrigation	62.0 ML
830895	Trevor N & Paula M Kerton	Surfacewater	Irrigation	57.0 ML

9015035	Trevor N & Paula M Kerton	Surfacewater	Domestic and Stock	2.2 ML
745367	Trevor Kerton	Surfacewater	Dairy	4.4 ML
778419	Trevor Kerton	Surfacewater	Irrigation	36.0 ML
824291	Trevor Kerton	Surfacewater	Irrigation	62.0 ML
830690	Trevor Kerton	Surfacewater	Irrigation	388.0 ML
830690	Trevor Kerton	Surfacewater	Domestic and Stock	2.5 ML
865850	Trevor Kerton	Groundwater	Irrigation	215.0 ML

The above entitlements do not all relate to the property at which the water (which is the subject of this Application) is proposed to be used at.

18. The licences outlined in paragraph 17 herein, do not include any water the Applicant may have access to through private/commercial arrangements.

Section 40(1)(f) - any volume of water that is allocated for sale under section 222(1)(c).

19. This does not apply to this application.

Section 40(1)(g) - the need to protect the environment, including the riverine and riparian environment.

20. I was required to consider, in particular, the need to protect the aquifer from unsustainable extraction, particularly as long term damage could result from extended extraction. I took this into account when considering this application.

Section 40(1)(i) - conservation policy of the government.

21. It is not government policy to allocate water from over allocated or over stressed water sources.

Section 40(1)(j) - government policies concerning the preferred allocation or use of water resources.

22. In making my decision I considered that there is concern with allocating further water in the area because of the potential effects on existing users and the aquifer. Long-term damage to the aquifer and interconnecting aquifer could result from over-extraction from this area.

23. In addition I considered relevant government policy relating to water allocation including;

- Victorian Government White Paper – Securing our Water Future Together;
- Ministerial Guidelines for the Performance of the Groundwater Function issued by the Minister for Agriculture and Resources;
- Other relevant ministerial policy statements and SEPPs.

Section 40(1)(ja) - whether the proposed source of water is within a heritage river area or natural catchment area within the meaning of the Heritage Rivers Act 1992 and whether there is any restriction on the use of the area under that Act.

24. The Mitchell River which is adjacent to this site is heritage listed; however, I do not understand this area to be subject to any restriction on the use of the area under that Act which is relevant to this application.

Section 40(1)(k) - the proper management of the waterway and its surrounds or of the aquifer.

25. In order to properly manage the aquifer and surrounding aquifers, there should be no further allocation of water within this area on the basis of the hydro-geological assessments available.

Section 40(1)(l) - the purposes for which the water is to be used.

26. In making my decision, I considered that the water which is the subject of the application would be used for irrigation purposes. I note that while this is a legitimate purpose for the use of groundwater, other uses such as the guarantee of water supply for urban purposes is regarded as having priority over the provision of water for irrigation purposes.

Section 40(1)(m) - the needs of other potential Applicants.

27. Overuse or damage to the aquifer would disadvantage the other users. I considered this when making my decision.

28. In particular I was aware that this decision requires the balancing of the interests of various people within the framework of the *Water Act* 1989.

29. Within the area adjacent to the property to which this application relates a series of applications have been made and refused which target groundwater resources in the area. These are summarised in the table below[2]:

Current applications for groundwater licences in the relevant area

GW Licence No	Proposed Depth	Applicant Volume (ML)
384880	40 m	100
449530	75 m	2500
426497	120 m	63
332604	75 m	67
408730	85 m	67
441933	340 m	300
331732	200 m	100
444091	120 m	20
497400	50 m	114

[2] This table contains additional applications to those in table 3.3 of the SKM Report as additional applications were received by the Respondent after it had initially instructed SKM to prepare its Report.

GW Licence No	Proposed Depth	Applicant Volume (ML)
540773	120 m	10
518259	125 m	107
474718	Unknown	50
523147	50 m	30
315973	130 m	20

30. I was particularly aware of the need to balance the needs of the following categories of people:

- Other people who had applied for extra allocations of water and been refused such and allocation;
- People who had secured water by means of transfer of existing water allocations;
- Those who had or have been dissuaded from applying for a further allocation of water on the basis that it would not be or would be unlikely to be granted.

Section 40(1)(n) provides that regard must be had to

(i) any relevant report or statement prepared under any Act; or

(ii) the findings of, or any evidence given or submission made to, any relevant investigation or inquiry held under any Act or held by any Committee of the Cabinet, government department or public statutory body whether or not under an Act.

31. I considered relevant government policy relating to water allocation including:

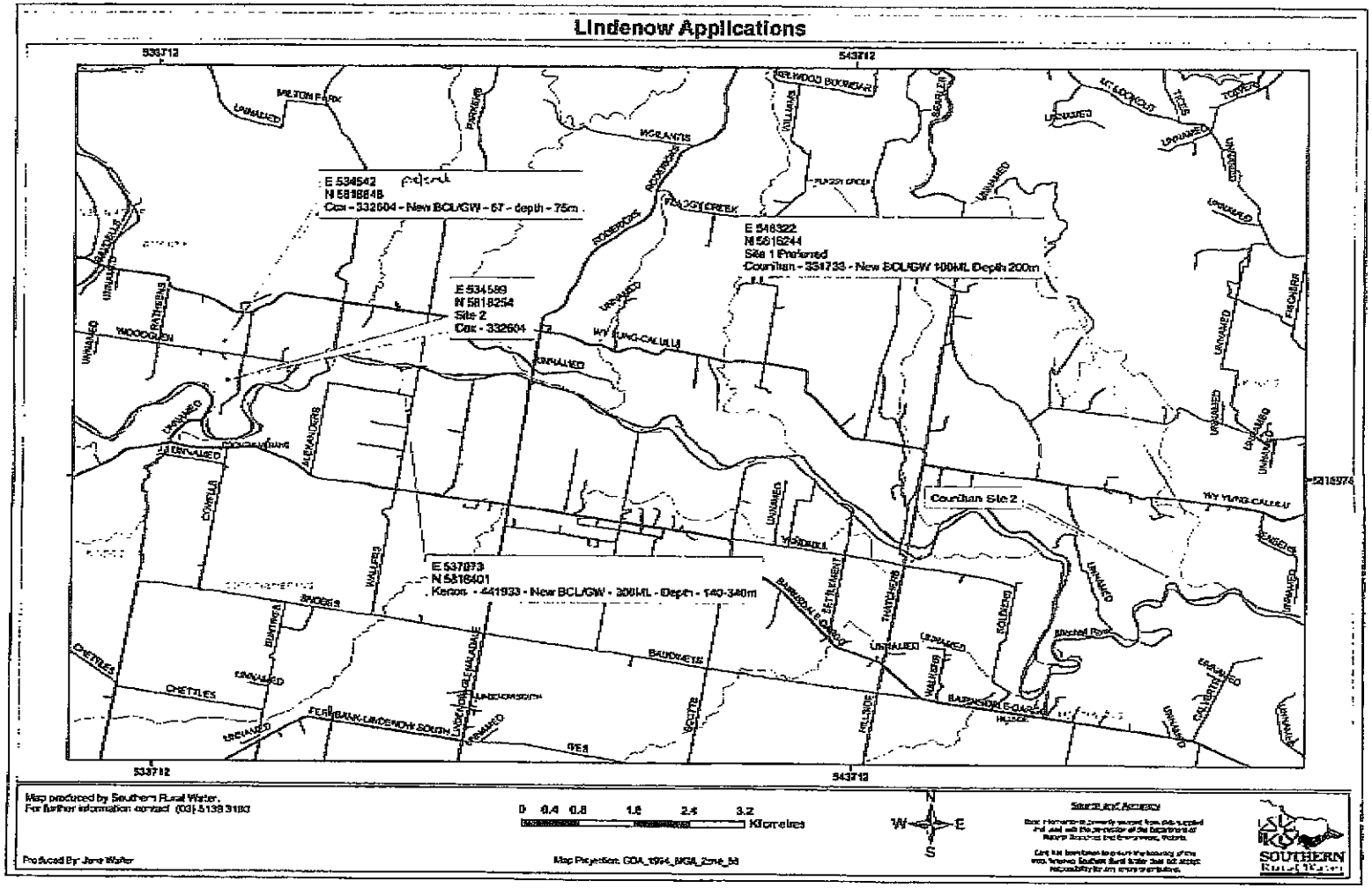
- Victorian Government White Paper – Securing our Water Future Together;
- Ministerial Guidelines for the Performance of the Groundwater Function issued by the Minister for Agriculture and Resources;
- other relevant ministerial policy statements and SEPPs.

Section 40(1)(o) – any other matter that the Minister or Governor in Council thinks fit to have regard to.

32. In making the decision not to grant the licence sought I had regard to the matters specified in section 40(1) paragraphs (b) to (m) and section 53 of the Act.

"ATTACHMENT 1"

Map showing location of the Applicant's properties and proposed bores



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VICTORIA CIVIL AND ADMINISTRATIVE TRIBUNAL

BETWEEN

COX & KERTON

Applicant

-and-

SOUTHERN RURAL WATER

Respondent

WITNESS STATEMENT OF TERENCE ANTHONY FLYNN

1. **The name and address of the expert**

   Terence Anthony Flynn, Southern Rural Water, 88 Johnson St Maffra, Victoria.

2. **The expert's qualifications and experience**

   Refer to the attached CV for my qualifications

3. **A statement identifying the expert's area of expertise**

   My primary areas of expertise are hydrogeology and natural resource management.

4. **A statement setting out the expert's expertise to make the report**

   As Manager Water Resources Management at Southern Rural Water (SRW), I provide strategic technical and policy advice to the organisation. I assist in the preparation of licence conditions to ensure that water is managed sustainably and equitably. I also undertake aquifer risk assessments to provide advice to SRW's Groundwater and Rivers Business.

5. **All instructions that define the scope of the report (original and supplementary and whether in writing or oral);**

   Southern Rural Water's Manager of Licensing Administration East, Mr Trevor McDevitt, verbally requested that I seek technical advice, interpret the advice and make recommendations that best manage the allocation of groundwater from the aquifers in the Lindenow area. In particular the points of interest were:

   - The potential impact the extraction of groundwater in this area would have on the Sale WSPA, Rosedale GMA and the Stratford GMA; and
   - The potential impact groundwater pumping has on the Mitchell River; and
   - The sustainable yield from the local aquifers; and
   - If further allocations were not permitted could transfers of entitlement occur?

6. **The facts, matters and all assumptions upon which the report proceeds**

The facts, matters and all assumptions upon which my advice proceed are set out in the attached report (attachments 2 and 3) and include:

- An assumption there is a connection between the deeper aquifer(s) in the Lindenow area and other aquifers in the Gippsland basin.
- Hydrographs of state observation bores in the Lindenow area and in other regional aquifers display a long term declining trend in groundwater levels.
- Mapping of the Latrobe aquifer shown on Department of Primary Industries' website shows that this regional system of aquifers extends across the Lindenow area under consideration.

7. **Reference to those documents and other materials the expert has been instructed to consider or take into account in preparing his or her report and the literature or other material used in making the report.**

The documents referenced in consideration of my advice are:

"Groundwater Resource Assessment of Deeper aquifers in the Lindenow Region, East Gippsland", SKM 2008 (and previous versions)
State observation bore hydrographs, SRW data 2008
"Sale Groundwater Management Area Groundwater Resource Appraisal" SKM 2008
"Hawkesdale Groundwater Resource Appraisal" SKM 2007
Gippsland Basin Top Latrobe Structure Map (1:1,000,000), Department of Primary Industries, (Current)

8. **The identity of the person who carried out any tests or experiments upon which the expert relied in making the report and the qualifications of that person**

The groundwater level information was derived from the state observation bore network which is owned and monitored by the Department of Sustainability and Environment.

The mapping of the Latrobe Group aquifer was obtained from the Department of Primary Industries. The Department is responsible for its accuracy and currency.

9. **A summary of the opinion or opinions of the expert**

The basis for the decision not to allocate further groundwater is described in "Review of the SKM Lindenow Study (2007) and Recommendations" November 2007 and "Addendum to Review of the SKM Lindenow Study (2007) and Recommendations" (both attached).

These documents explain that there is a likelihood that extraction from the deeper aquifers in the Lindenow area will contribute to regional declines in other aquifers including the Boisdale Formation, Latrobe Valley Coal Measures/Balook Formation and the Latrobe Group aquifers which fall within the Sale WSPA, Rosedale GMA and the Stratford GMA respectively. The SKM study (2008) suggests that the Cox and Kerton applications are from within the Latrobe Valley Coal Measures/Balook Formation aquifers which is protected further to the west by the Rosedale GMA.

The state observation bore network in the area has a relatively long and continuous record of groundwater level measurement. These local bores display an underlying declining groundwater trend over a long period which elevates the concern. The period of decline is consistent with the observed levels in state bores in adjacent aquifers already capped from further allocation.

The SKM studies also indicate there may be a connection between the aquifer targeted by Cox and Kerton and the Mitchell River. SRW needs to ensure new applications will not have an unacceptably, adverse impact on waterways.

A local sustainable yield was adopted by SRW to manage the existing volumes and any allocation transferred into the area. The SKM groundwater study (2008) recommended a local sustainable yield of between 1,900 to 4,700 ML/yr. A conservative value of 1,900 ML/yr was assumed to allow for land use and climate impacts not accounted for in the SKM study.

Balancing the considerations SRW has prepared guidelines which may allow groundwater from other areas to be transferred into the Lindenow area to provide for some development of groundwater resources (attachment 4), but nevertheless has refused the Cox and Kerton applications as they are new applications for previously unallocated groundwater.

10. **A statement identifying any provisional opinions that are not fully researched for any reason (identifying the reason why such opinions have not been or cannot be fully researched)**

The advice I provided included reference to a climate study in Hawkesdale western Victoria. This was a significant and sophisticated analysis of climate change and land use impacts on groundwater. Although the study is remote from Gippsland its outcomes are relevant to assessment of groundwater availability in other areas. It is the intention of the Department of Sustainability and Environment to undertake such studies across SRW's region.

11. **A statement setting out any questions falling outside the expert's expertise and also a statement indicating whether the report is incomplete or inaccurate in any respect.**

I have not made any conclusions that fall outside my expertise and believe the review to be complete and accurate at the time of its preparation.

"I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant to my knowledge have been withheld from the Tribunal"

.....
TERENCE ANTHONY FLYNN

DATED this 19th day of January 2009

Attachment I

Curriculum Vitae

Qualifications

Bachelor of Civil Engineering, Swinburne (graduated in 1988)
Master of Engineering Science in Hydrogeology, Melbourne University, 1995

Experience

I am a qualified civil engineer and hydrogeologist and provide technical advice relating to water resource management for Southern Rural Water (SRW) and our stakeholders. I have been employed by SRW for ten years, prior to that I was employed at Sinclair Knight Merz (SKM) for three years, Hydrotechnology one year, as well as South East Regional Refuse Disposal Group, AS James Geotechnical Engineers and SEC Victoria.

Relevant Projects

Hydrogeological Mapping of southern Victoria (current)
Yarram Water Supply Protection Area Groundwater Management Plan (current)
Preparation of Sale Groundwater Restricted Use Zone 2003
Impacts of Aquifer Drawdown Sale WSPA 2003
Review of numerous groundwater licence applications
Review of numerous technical studies into Gippsland aquifers

Attachment 2

REVIEW OF THE SKM LINDENOW STUDY (2007) AND RECOMMENDATIONS
Prepared by Manager Water Resources and Environment November 2007

This brief report reviews the SKM Lindenow Study for SRW "Groundwater Resource Assessment of Deeper aquifers in the Lindenow Region, East Gippsland", November 2007. The study assessed the occurrence and connection of aquifers and the potential for further allocation.

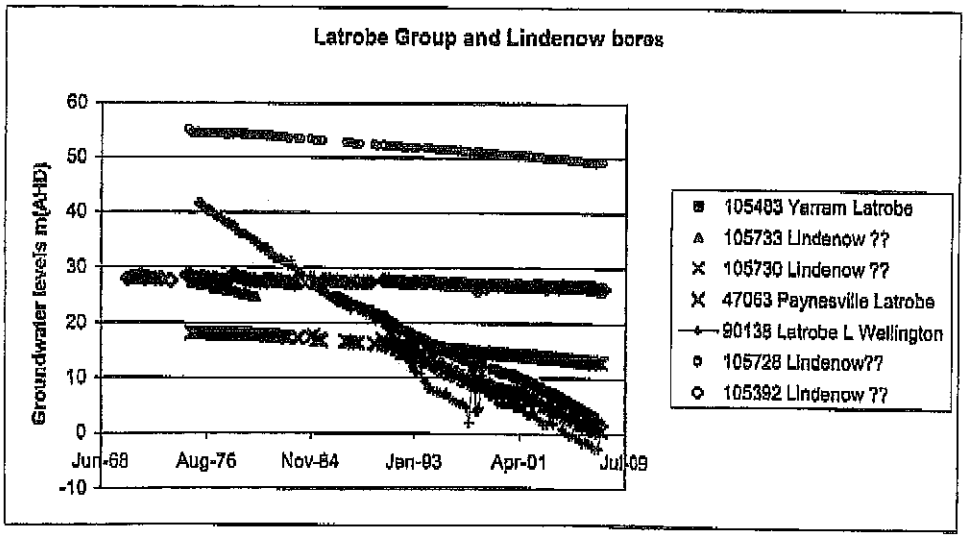
Connectivity of Aquifers

The proponents are applying to drill bores into aquifers that underlie the Wy Yung WSPA, designed to protect a shallow alluvial aquifer across the Lindenow Flats.

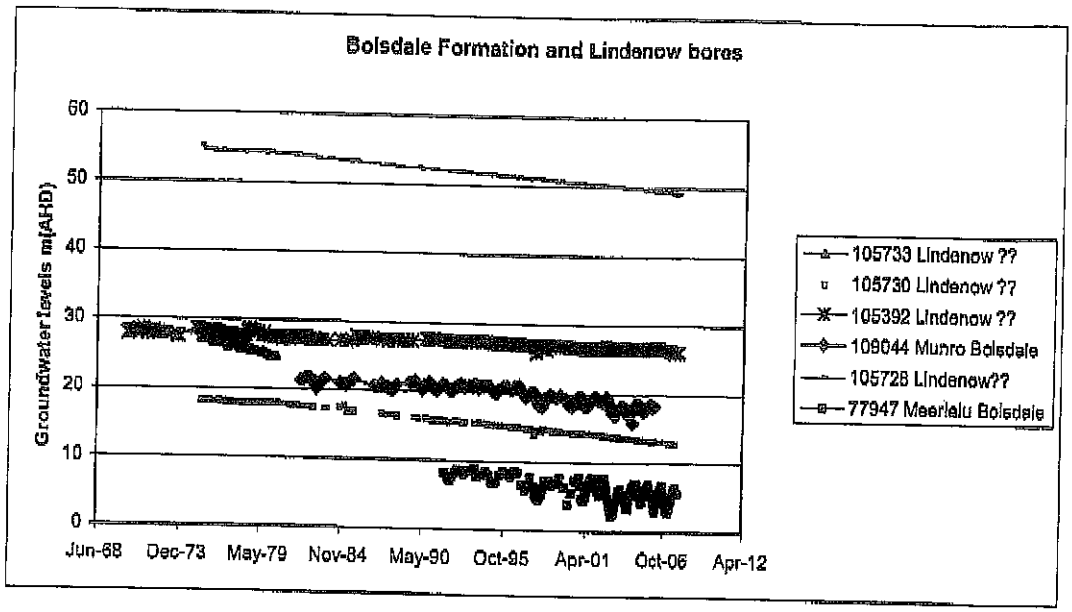
The analysis of SKM provides evidence that the target aquifer is connected to the Gippsland Basin through either the Balook and Latrobe Valley Coal Measures or Latrobe Group aquifers. It is not a locally occurring, isolated group of aquifers.

The analysis indicates that it is less likely that the target aquifer is connected either directly or indirectly to the Boisdale Formation but is not conclusive.

To further analyse the issue of relationship to other aquifers, hydrographs screened in the Latrobe Group and Boisdale Formations outside the study area were compared to the Lindenow hydrographs.



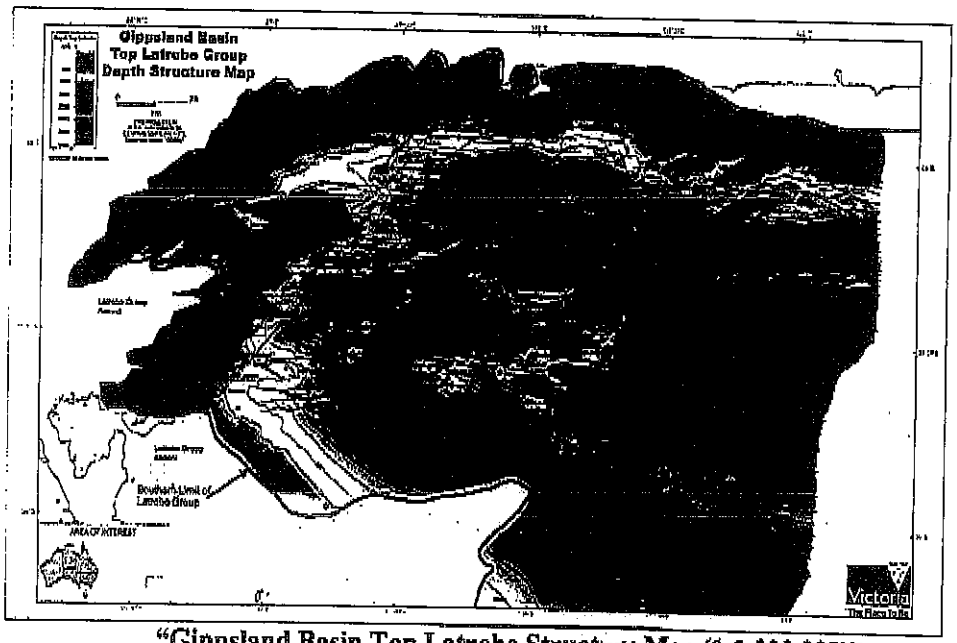
The Lindenow bores are in a decline but not at the same rate as the Latrobe Group. The deepest of the Lindenow bores 105733 (260m) near Wy Yung has no measurement since 1980 and a steeper decline more like the Latrobe Group aquifer. A comparison with the Balook/LVCM bores is not included because it is difficult to differentiate from the Latrobe Group and there is a strong connection between these aquifers



Comparison with the Boisdale Formation bores shows a similar change in levels over the same period. A feature of the Boisdale bores is that prior to 1997 the trend is relatively flat with a step and decline post 1997. This change is not apparent in the Lindenow bores.

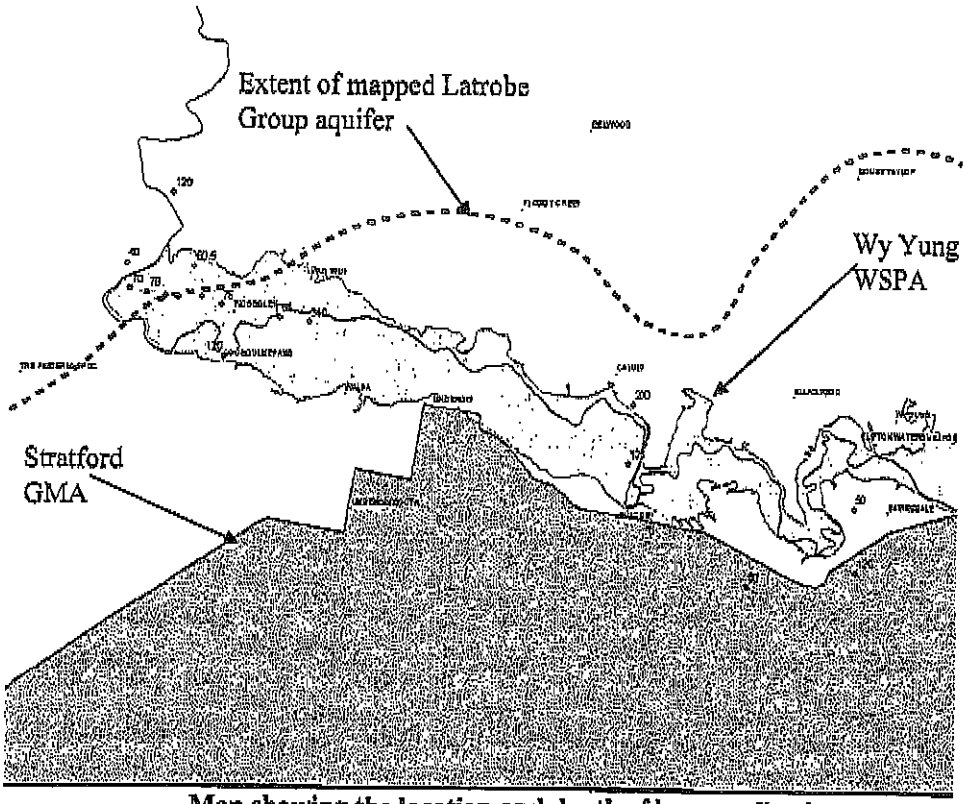
Based on the SKM cross sections and the hydrographs there is sufficient reason to believe the Lindenow aquifers are not in direct connection with the Boisdale Formation but are declining at a similar rate.

The SKM report concludes it is most likely the Lindenow aquifer is a part of the LVCM/Balook formation and in connection with the regional Latrobe aquifer system



"Gippsland Basin Top Latrobe Structure Map (1:1,000,000)", Department of Primary Industries

The differentiation between the LVCM/Balook and the Latrobe Group in Lindenow is academic. The concern with the Lindenow aquifers is the underlying decline which has been occurring over the thirty years of recorded levels which suggests it is not a consequence of local groundwater pumping but that the aquifer is draining due to external influences. Mapping taken from DPI's website illustrates that nearly all of the Lindenow Flats overly the Latrobe Group aquifer and that the aquifer comes towards the surface in this area. This is sufficient evidence that the bores are targeting regional aquifers. These regional aquifers are capped from further allocation.



Map showing the location and depth of bore applications

There are five applications to the north west of the mapped extent of the Latrobe Group aquifer. The bores closest to the boundary are likely to be chasing the same formation. The bore furthest to the north may not intersect the aquifer as it is located on or close to the mudstone bed rock that is visible on the banks of the Mitchell River.

Climate Change and Land Use Change Impacts

The report did not address climate variability and land use change. These impacts were out of the scope of the brief but results from other studies provide insights to their relevance. SRW recently undertook a study of the impact of plantations and climate change and variability in an area near Portland (Hawkesdale Groundwater Resource Appraisal SKM 2007). The study found that although climate change may result in more rainfall during wet periods it would lead to lower rainfall in the long term. Even without climate change, longer drier periods like the past decade are probable due to climate variability. It also showed that large scale plantation forestry located in areas with shallow water tables depleted

groundwater resources. There is a significant conversion of pastured land to forest plantations occurring in the Bairnsdale region that will inevitably affect the water balance of its aquifers.

Potential Allocation

The SKM report suggests that all applications are from the LVCM/Balook Formations and that a volume of between 2,500 and 6,300 ML/yr could be available with qualifications about the thickness of the aquifer and its connection to other aquifers. The estimate is based on rainfall recharge and the response in one bore alone and does not account for the record of declining groundwater levels.

The declining groundwater levels in the Gippsland Basin are believed to be caused by a combination of dewatering for minerals and petroleum and extraction for irrigation. Because there is no summer flux in the local monitoring bores it is reasonable to conclude that local pumping is not a major contribution to declines. Local pumping does however contribute to the cumulative impact.

In the Stratford GMA and Yarram WSPA which apply to the Latrobe Group aquifer elsewhere in Gippsland, a decision has been made not to allocate more groundwater because the underlying trend is declining and it is not sustainable to allocate more water.

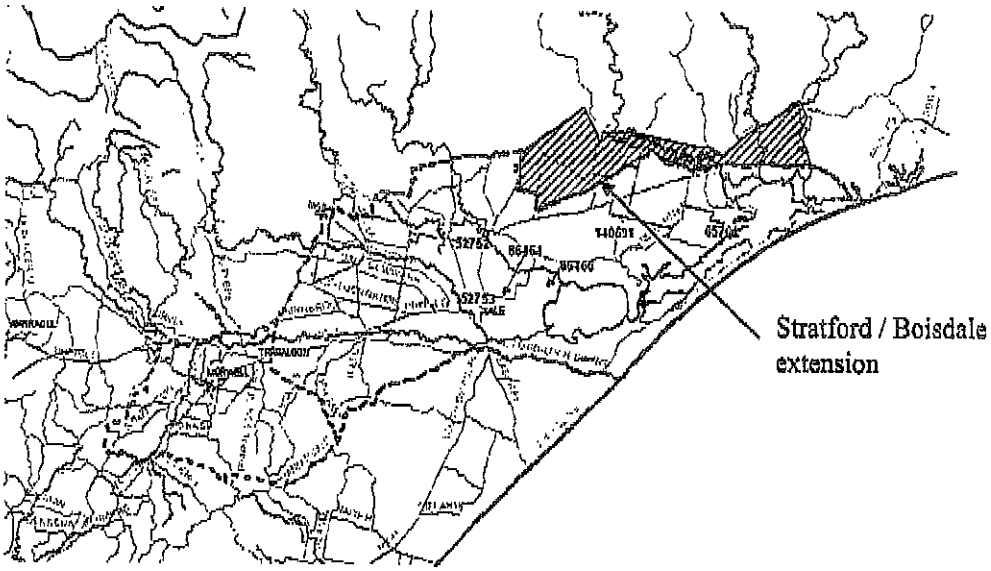
Recommendation

The SKM report makes a number of recommendations some of which suggest creation of a new GMA and boundary changes to the Sale and Stratford GMAs. Other recommendations constitute a works program but do not assist with the determination of applications.

The recommendation of this review refers to the need to determine applications and how to respond to new applications.

There is sufficient certainty about the connection between the Lindenow aquifers and the Gippsland Basin to say that it would be inconsistent to allocate more water from the mapped area of the Latrobe Group aquifer and surrounding sediments because of the cumulative impact of allocating more groundwater out of the Gippsland Basin.

If a cap on further allocations is applied, it is important that either a groundwater management area is created for the aquifer or the boundary of the Stratford GMA or Sale WSPA is extended to cover the northern areas of the Gippsland Basin. This will deal with refusal of applications and allow transfers of entitlement to occur.


Stratford / Boisdale
extension

Attachment 3

ADDENDUM TO REVIEW OF THE SKM LINDENOW STUDY (2007) AND RECOMMENDATIONS

This addendum was prepared to update the "Review of the SKM Lindenow Study (2007) and Recommendations" November 2007 which has been amended to the final version "Review of the SKM Lindenow Study (2008) and Recommendations". The addendum takes into account a recalculation of the recharge estimate of the 2007 SKM report.

Potential Allocation

The SKM report suggests that all applications are from the LVCM/Balook Formations and that a volume of between 1,900 to 4,700 ML/yr could be available with qualifications about the thickness of the aquifer and its connection to other aquifers. The estimate is based on rainfall recharge and the response in one bore alone and does not account for the record of declining groundwater levels.

The declining groundwater levels in the Gippsland Basin are believed to be caused by a combination of dewatering for minerals and petroleum and extraction for irrigation. Because there is no summer flux in the local monitoring bores it is reasonable to conclude that local pumping is not a major contribution to declines. Local pumping does however contribute to the cumulative impact.

In the Stratford GMA and Yarram WSPA which apply to the Latrobe Group aquifer elsewhere in Gippsland, a decision has been made not to allocate more groundwater because the underlying trend is declining and it is not sustainable to allocate more water.

Attachment 4