VICTORIAN CIVIL AND ADMINISTRATIVE TRIBUNAL

ADMINISTRATIVE DIVISION

PLANNING AND ENVIRONMENT LIST

VCAT REFERENCE NO. P2505/2008 & P166/2009

CATCHWORDS

Section 64 of the Water Act 1989. Review of grant of licences to extract groundwater. Goulburn Murray Water. Groundwater and surface water interaction. Ovens Groundwater Management Area. Assessment of seepage induced by extractions from a deep aquifer. Impact to shallow groundwater and surface water resources. Climate change impacts. Sustainability of water resources.

APPLICANT IN P2505/2008 AND P166/2009	Mr John Paul
RESPONSIBLE AUTHORITY IN P2505/2008 AND P166/2009	Goulburn Murray Water Corporation
RESPONDENT IN P2505/2008	Brendan and Gayle O'Keefe
RESPONDENT IN P166/2009	Brimin Sand and Haulage Pty Ltd
SUBJECT LAND IN P2505/2008	Crown Allotments 148A, 149, 150, 151A, 151B and 151C, Parish of Boorhaman.
SUBJECT LAND IN P166/2009	Parts of Crown Allotments 74 and 76, Parish of Boorhaman.
WHERE HELD	Melbourne
BEFORE	Ian Potts, Member
HEARING TYPE	Hearing
DATE OF HEARING	16 August 2010 to 20 August 2010
DATE OF ORDER	3 November 2010
CITATION	Paul v Goulburn Murray Water Corporation & Ors [2010] VCAT 1755

ORDER

1 In P2505/2008 and P166/2009 the decisions of the Responsible Authority are affirmed.

2 In licence application 8022310 a licence is granted and directed to be issued to Brendan O'Keefe of 1371 Boorhaman Road Boorhaman to take and use not more than 490 Ml in accordance with the schedules and conditions set out in the licence issued and dated 18 July 2008.

3 In licence application 80234000 a licence is granted and directed to be issued to Brimin Sand and Haulage Pty Ltd of 366 Development Road Springhurst to take and use not more than 594 Ml in accordance with the schedules and conditions set out in the licence issued and dated 12 November 2008.

4 Costs are reserved.

Ian Potts
Member

APPEARANCES

For John Paul	Mr Henry Jackson, barrister instructed by the Environment Defenders Office. He called the following witnesses: [35 17] Mr John Nolan, a hydrogeologist and engineer from John Nolan Consulting; and [35 17] Dr Anthony Kiem, a hydro-climatologist from the University of Newcastle.
For Goulburn Murray Water	Dr R J Sadler, barrister, instructed by Dawes & Vary Solicitors. He called the following witnesses: [35 17] Mr Simon Cowan, manager of groundwater and unregulated systems unit of Goulburn Murray Water; [35 17] Mr Damien Finlayson, a hydrogeologist from URS Consultants; and [35 17] Mr Will Minchin, a hydrogeologist and numerical modeller from GHD.
For Brendan and Gayle O'Keefe and Brimin Sand and Haulage Pty Ltd	Mr Ian Pitt, solicitor and barrister of Best Hooper. He called the following witness: [35 17] Mr Philip Beck, a hydro-geochemist from GHD.

INFORMATION

Background to the applications	Mr Paul seeks a review of the decision by the Goulburn Murray Water Corporation to grant two groundwater extraction licences to Brendan and Gayle O'Keefe and Brimin Sand and Haulage Pty Ltd. These licences permit the extraction of 490Ml and 594Ml (respectively) of groundwater for irrigation use on their properties. Mr Paul's grounds for review are that the allocations are an unstainable use of the resource and present an unacceptable risk of adverse environmental impact.
Nature of Review Application	Section 64 of the *Water Act 1989*.

Cases referred to	*Paul v Goulburn Murray Rural Water Corporation* [2009] VCAT 970; *Castle v Southern Rural Water* [2008] VCAT 2440; *Cox & Ors v Southern Rural Water* [2009] VCAT 1001; *Allanvale Pty Ltd & Anor v Southern Rural Water & Ors* [2010] VCAT 480; *Telstra Corporation v Hornsby Shire Council* [2006] NSWLEC 133; *Environment East Gippsland Inc v VicForests* [2010] VSC 335

REASONS

INTRODUCTION

1 In 2008 the Goulburn Murray Water Corporation (G-MW), acting as a delegate to the Minister for Water, issued licences to 'take and use' groundwater to Mr Brendan O'Keefe and Brimin Sands and Haulage Pty Ltd (the allocations). The allocations are for a maximum extraction of 490 Ml/yr and 594 Ml/yr[1] respectively from an aquifer located within the Ovens Valley in north east Victoria.

2 Mr Paul is a landowner in the area of the O'Keefe and Brimin Sands properties. He has applied for a review of the grant of these licences. His application in each case listed numerous grounds, however Mr Jackson says that Mr Paul's concerns distil down to the position that the allocations are inconsistent with the proper long term sustainable management of the aquifer and will have, or have a significant risk of adverse environmental impacts on the Ovens River.

3 The G-MW and the licence holders oppose the applications made by Mr Paul. They contend that the sustainability of the aquifer and potential impacts of the proposed extractions have been properly considered in the granting of the licences and refute that there will be adverse impacts.

4 The pursuit of each party's position, as is typical in these cases, is the subject of complex technical evidence about the hydrogeology and climate of the Ovens Valley, including the impacts that may occur from climate change. The application of the precautionary principle, which in turn raises issues about the levels of certainty to be afforded to the technical evidence, has also been raised.

5 I address these issues in these reasons.

6 It has also been necessary to attend to the question of Mr Paul's standing, as raised by Mr Pitt.

THE STANDING OF MR PAUL

7 Section 51 of the *Water Act* 1989 (the Water Act) provides for applications to be made by persons for a licence to 'take and use' water including groundwater. The Minister for Water or a delegate is to make the decision whether or not such a licence is to be granted or refused: Section 55(1) of the Water Act.

8 Section 64 provides an opportunity for a person 'whose interests may be affected by the decision' to approve or refuse the grant of such a licence to have that decision reviewed by the Tribunal. Mr Paul's review applications are made under this section of the Water Act.

1 1 Ml = 1 Mega Litre or 1 million litres.

9 His standing to make the review application in the O'Keefe proceeding was the subject of a preliminary hearing.[2] The decision of the Tribunal in that application was that Mr Paul's standing was satisfactorily established by the particular circumstances of the application. These circumstances included Mr Paul's ownership of land in the land in the vicinity of the O'Keefe site and in particular within the same groundwater system of the Ovens Valley. Mr Paul enjoys the benefit of surface diversion and groundwater 'take and uses' licences for this property. Such circumstances when read in conjunction with the purposes of the Water Act and the matters to be considered by the Minister in deciding on an application were found by the Tribunal to form a sufficient nexus to provide Mr Paul with more than just a personnel interest in this matter.

10 Mr Pitt submits that it has eventuated that Mr Paul's case has not raised any issues specific to the benefits Mr Paul enjoys from his own licences or any specific circumstances where his interests may be directly impacted. It is submitted that Mr Paul's only concerns are related to broader environmental and sustainability issues. Mr Pitt therefore questions Mr Paul's standing if these are his only 'interests'.

11 The reasons of the Tribunal in the hearing of standing are relevant in considering Mr Pitt's submissions. Of particular relevance is the view that:

> 35 17 A broad but not unlimited approach to the question of standing should be adopted;[3]
>
> 35 17 While 'in some cases the issue of standing can be determined through a *prima facie* consideration of the decision under review' in other cases 'the issue of standing and the underlying merits are so inextricably interwoven that the matter needs to proceed to a full hearing to determine both at once'.[4]

12 It is true that Mr Paul's case has proceeded on broader issues of sustainability of the aquifer system and the impact to the Lower Ovens River environment. However, it ought not be forgotten that Mr Paul has an interest in how the water resources of the Ovens Valley are managed, by way of his licences to take and use water from the Ovens River and the Ovens Groundwater Management Area (the Ovens GMA). The management of the water resources has the potential to affect the exercising of his rights under his existing licences or some future application for further licences.

13 Thus while not explicit in all that Mr Paul has sought to argue I find that there is a nexus between the decisions made by G-MW and Mr Paul's interests in current and future water allocations and the longer term sustainability of the water resources.

14 If it was beyond debate that Mr Paul's land was separate in geological and

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2 *Paul v Goulburn Murray Rural Water Corporation* [2009] VCAT 970.
3 Ibid at [12] to [16]
4 Ibid at [22].

hydrological terms from the O'Keefe and Brimin Sands properties then Mr Pitt's case may well have had merit. However, in the circumstances of these applications, I conclude that Mr Paul has standing to advance the case that he has.

THE LEVEL OF CERTAINTY

15 In these applications Mr Jackson has urged upon the Tribunal to proceed cautiously, applying the precautionary principle because there are threats of serious or irreversible environmental damage and there is scientific uncertainty.

16 Submissions from all the parties also address the meaning of 'likely' as it pertains to its use in section 40(1)(d) of the Water Act, which amongst other considerations calls for the decision maker to have regard to:

> 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;
>
> ….
>
> (iv) the maintenance of the environmental water reserve in accordance with the environmental water reserve objective;
>
> [Tribunal's emphasis]

Uncertainty and the precautionary principle

17 Recent tribunal cases such as *Castle*, *Cox* and *Allanvale*[5] have variously discussed and given weight to the levels of certainty or uncertainty about hydrogeological conditions and other factors that influence the sustainable allocation of groundwater resources. In those proceedings it was variously noted that some uncertainty exists in any hydrogeological assessment and the factors on which a licensing decision is to based. This is due to the nature of the assessment techniques available to the hydrogeologist and the inherent natural variability of groundwater systems.

18 In reflecting on these previous decisions and from the matters I have addressed in these reasons, it is apparent that the influence of uncertainty in decision making on hydrogeological matters is a question of degree and that any uncertainty leads to the application of the precautionary principle. .

19 Where there has been a good deal of investigation, long-term monitoring and data collection, uncertainties are likely to be more about the minutia rather than about the fundamental aspects of the character and behaviour of a hydrogeological system. Such uncertainty may be dealt with through

5 *Castle v Southern Rural Water* [2008] VCAT 2440 at [48] to [59]; *Cox & Ors v Southern Rural Water* [2009] VCAT 1001; *Allanvale Pty Ltd & Anor v Southern Rural Water & Ors* [2010] VCAT 480.

various techniques with varying levels of certainty that could influence decision making. Much would rest on how much weight these uncertainties in the minutia are relevant to the decision to be made.

20 Conversely uncertainties about the fundamental characteristics and behaviour of a hydrogeological system may be present because there has been little investigative work or data gathering about that system. Once can anticipate that the issues in such a situation may be of a broader scale and call for decision making in somewhat of a vacuum of information about cause and effect. A much higher degree of caution would be expected in such circumstances.

21 The level of uncertainty and its impact on decision making can thus be considered in terms of the scale and consequences of the decision to be made. To be of significance in the decision making process the uncertainties must also pertain to those matters that are relevant in the decision making process.[6] The precautionary principle provides a framework to work through such a decision making process and through the Water Act such principle may well be appropriate.

22 In these applications there are decisions to be made that require a consideration of the interaction between various hydrogeological layers and the surface water system. These interactions are to be considered within the context of the wider hydrogeological and surface water regimes of the Ovens GMA.

23 Having regard to the evidence presented by the experts, but most notably Mr Minchin's recent work,[7] it is apparent that the surface and groundwater regimes of the Ovens GMA have been the subject of many and varied assessments. To the use the parlance of Mr Minchin, the catchment is well instrumented. There has been a considerable amount of historical and contemporary drilling and monitoring of groundwater bores within the valley along with a large amount of private activity for groundwater use. Surface water flows are monitored at a number of gauging stations across the valley. Various studies and reports have been made about the hydrogeology and hydrology of the valley.

24 Specific to these applications, pump testing has been completed for the O'Keefe and Brimin Sand sites. The experts all agree these tests were completed in accordance with accepted industry standards. Ongoing monitoring of groundwater levels at the Brimin Sand's site has been undertaken and reported on. Climate data is available from a number of relevant stations in and around the Ovens Valley.

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6 *Castle v Southern Rural Water* [2008] VCAT 2440 (10 December 2008) at [45] to [47].

7 This work was commissioned by G-MW as part of a larger study to assess the long term sustainability of the groundwater resource using numerical modelling techniques. The work is presented in three volumes titled *Report for Ovens Valley Water Resources Appraisal [Volumes 1: Data Analysis and Conceptual Model Development; Volume 2: Groundwater-Surface Water Modelling report; and Volume 3:Figures to accompany Volumes 1 and 2]*. GHD Pty Ltd. May 2010.

25 It is also relevant to the consideration about certainty and likelihood of certain hydrogeological responses that the Ovens GMA is contained within the whole of one hydrogeological and hydrological system. There are no inflows from other up catchment sources to confuse or add complexity to the issue of resource sustainability and management. With the whole of the systems being contained within the boundaries of one GMA makes the process of assessment less complicated. This is to be contrasted with the context of upstream and/or downstream GMA's in the *Allanvale* and *Cox* proceedings.

26 For these reasons and others that I will come to shortly, I find that there is a suitable and reasonable level of understanding about the groundwater and surface water resources and their fundamental behaviour in this catchment. I thus concur with the submissions for the G-MW that seek to distinguish these proceedings from that of *Allanvale* or other similar proceedings such as *Castle* where much turned on the fact that the hydrogeology of the subject areas were poorly understood and there remained considerable uncertainty about impacts that could arise from proposed extractions.

27 Given this finding and others that I make in relation to the merits of the evidence and submissions put on Mr Paul's behalf, I concur with Dr Sadler that the two conditions precedent[8] necessary to trigger the application of the precautionary principle are not met. These conditions precedent are that:

35 17 There is a threat of serious or irreversible environmental harm; and

35 17 There is scientific uncertainty as to that harm.

28 Based on the findings I have made in relation to the evidence I do not conclude that there is a threat of serious or irreversible environmental harm arising from the allocations made to O'Keefe and Brimin Sand. It is my view that there is no threat because any potential impact from the extractions is so small as to be imperceptible. This finding is not changed by a consideration of the impacts of climate change. Thus while there may be some uncertainties in relation to the impacts of climate change, the first of the two conditions precent or thresholds needed to satisfy the trigger of the precautionary principle is not enlivened.

29 I conclude therefore that the decision to be made in these applications is to be considered in light of the terms of the Water Act and specifically any likely adverse impacts that may arise from the allocation of the licensed volumes.

The meaning of 'likely'

30 In response to the submissions about the meaning of 'likely' as set out earlier, I accept the submissions that 'likely' should be given its ordinary

8 I refer here to Dr Sadler's written submissions [63] to [69] and his analysis of the precautionary principle through the judgment of the NSWLEC in *Telstra Corporation v Hornsby Shire Council* [2006] NSWLEC 133 and, the Alanvale proceeding, and Osborne J discussion of the precautionary principle in *Environment East Gippsland Inc v VicForests* [2010] VSC 335.

meaning. I concur that this ordinary meaning is that of something being 'likely' means being 'probable rather than possible' or being 'a real and not remote chance'[9] It is also not something that is a perception of something being possible. I also accept that it is not appropriate to assign levels of probability or chance. Thus those matters relevant to the decision making process under section 40(1)(d) must meet the test of being probable rather than being possible.

THE MATTERS IN ISSUE

31 An application to take and use groundwater requires consideration of a wide range of matters set out under the Water Act. This includes those matters under section 40(1)(b) to (m) as well as sections 53 and 55.

32 Mr Jackson's submissions address these matters, most particularly those under section 40. As he noted, it is generally agreed that not all these matters under section 40 are relevant in any one decision about the allocation of a water licence.[10] His submissions and those of G-MW address the relevance and issues raised by each of these matters. I need not repeat those submissions here. It is apparent that the central issues in these applications focus on:

35 17 Any adverse effect that the extraction of groundwater under the entitlements are likely to have on the Ovens River;[11] and

35 17 The existing and projected availability of water in the region and the long term sustainability of the licensed extractions.[12]

33 The issue of availability has been addressed by the parties in terms of the current level of recharge that occurs to the aquifer systems in the Ovens Valley and the future likelihood of changes to that recharge regime under climate change. Resolution of this issue calls for a consideration of the nature of the groundwater systems in the Ovens Valley and how it responds to rainfall fed recharge that in turn is influenced by climate.

34 The potential for adverse impacts to the Ovens River arises from the potential for interaction between the Deep Lead aquifer that the licensees would extract from, the overlying Shepparton Formation aquifer and the Ovens River. In short, as Mr Jackson set out, 'the Tribunal must form a view as to the degree of connectivity between the Deep Lead aquifer and the Shepparton Formation'.[13]

THE ISSUE OF AQUIFER INTERCONNECTION AND THE OVENS RIVER

35 It is not necessary in these reasons to delve fully into all the complexities of

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9 Submissions of Dr Sadler, Mr Jackson and Mr Pitt concur on this point.

10 Mr Jackson makes reference here to the *obita* in *Castle v Southern Rural Water* [2008] VCAT 2440 at [38] to [47].

11 Relevant matters under sections 40(1)(d), 40(1)(g) and 40(1)(k).

12 Relevant under sections 40(1)(b), 40(1)(d)(ii) and 40(1)(k).

13 At [67] of his written submission.

the hydrogeology of the Ovens Valley. The substantive issue and area of disagreement between the expert hydrogeologists is about the interaction between the Deep Lead and the shallow groundwater and surface water systems. However some understanding of the framework in which this interaction is said to occur is important in understanding the issues raised by Mr Paul's application and reasons for my decision. I will therefore turn first to an overview of this framework.

The hydrogeological framework

36 The hydrogeological framework in the Ovens GMA is comprehensively set out in the evidence with Volume 1 of the Ovens Valley Water Resource Appraisal[14] prepared by Mr Minchin being particularly useful in this respect. Overall, there is general agreement about this conceptual framework between the experts.

37 At the surface of the mid to lower Ovens GMA is the Shepparton Formation and within the horizontal extent of the present day meander plain of the Ovens River is the Coonambidgal Formation. Both formations are said to act as aquifers, i.e. conduits from which groundwater might usefully be extracted from or which are conducive to water flowing through them.

38 The Shepparton Formation is a complex mix of clay and sand layers.[15] The clay layers act to retard groundwater flow.[16] The sand layers, sometimes termed shoe string sands, are more conducive to flow and are the targets for groundwater extraction. Typically, the sand layers have poor interconnection, with the clay layers between resulting in slow movement of groundwater through the Shepparton Formation.

39 However within the mid to lower Ovens GMA, a unit of the Shepparton Formation has been identified to be a more continuous sequence of sand and gravel. This unit is termed the Laceby Gravel. Mr Minchin's assessment indicates the Laceby Gravel to more less extend along the current extent of the Ovens River meander belt from Whoroully northward past Peechelba.[17]

40 Outside the extent of the Ovens River meander belt, the Shepparton Formation extends vertically from the surface to the underlying Deep Lead. It may also bound the Deep Lead on some sides. Within the extent of the Ovens River meander belt the Shepparton Formation, including the Laceby Gravel, underlies the Coonambidgal Formation.

41 The Coonambidgal Formation is considered to be a modern deposit similar in its complexity to the Shepparton Formation but formed from the

14 *Report for Ovens Valley Water Resources Appraisal Volume 1: Data Analysis and Conceptual Model Development.* GHD Pty Ltd. May 2010

15 Here I use the broad terms sand and clay to capture the range of lithologies cited by the experts including gravel, sand, clay and silty sand, sandy clay, silty clay and clay.

16 Such layers are termed aquitards.

17 Mr Minchin also highlighted some data suggests the Laceby Sand Member to be absent near Boorhaman, but further work was being undertaken to confirm this situation.

deposition and erosive actions of the modern Ovens River which is incised into it. This formation is a complex mix of gravel, sand and clay layers and is considered to have a direct hydraulic connection with the river.

42 In the mid to lower Ovens GMA, is the Deep Lead aquifer.[18] It is a formation of largely sand and gravel that has filled the paleo-channel of the Ovens River when it was incised into the underlying bedrock that formed surface of this valley in past times. It is considered by all the expert hydrogeologists to be an aquifer that is highly conducive to the horizontal movement of groundwater.

43 In the mid Ovens, i.e. between Whoroully and Myrtleford, the Deep Lead is in fact no longer deep. It is considered to be contiguous with and more or less have direct connection with surface sand and gravel deposited within the narrower walls and floor of this portion of the valley. The movement of groundwater within these upper valley gravel and sand deposits feeds directly into and forms the source of groundwater recharge into the Deep Lead lower in the valley.

44 Beneath and to at least some horizontal boundaries of the Deep Lead are much older consolidated sedimentary and igneous rocks that once formed the floor and sides of the ancient Ovens Valley. Collectively these formations are termed the bedrock. These formations extend to the surface and form the ranges that mark the southern, western and eastern boundaries of the present day Ovens Valley and the Ovens Valley surface water and groundwater catchments.

45 For all intents and purposes, the bedrock is considered to be an aquitard, i.e. it is not particularly conducive to groundwater flow or groundwater exchange with the overlying Deep Lead and Shepparton Formations. It is generally agreed between the experts that any groundwater flow within the bedrock is not of a consequence to the issues in these proceedings. However the shallow nature of the bedrock in the upper Ovens GMA gives rise to rapid shedding of runoff and development of interflow in the stony soils which feed the surface water systems and shallow sand/gravel aquifer within the narrow valley. This as discussed later has implications for the recharge of the Deep Lead system lower in the valley.

Overview of expert evidence

46 In classical hydrogeological terms, aquifers can be described as being ‘confined’ or ‘unconfined’. In simple terms, the concepts of confined and unconfined aquifers describe whether the boundaries to an aquifer[19] allow passage of water into or out of the aquifer.

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18 This formation is argued as being the physical if not necessarily the time equivalent of what is more widely termed the Calivil Formation, a formation that is found in buried river channels across the northern Victorian plains and north flowing valleys of major rivers such as the Goulburn, Campaspe and Loddon Rivers. For the purposes of these reasons, I will refer to this layer as the Deep Lead.

19 In this case a boundary will be the interface between one formation and another.

47 All the experts agree that because of the nature of the geological formations in the Ovens GMA it would be difficult to say that the formations display all the characteristics of being purely confined or unconfined. Such a distinction is important as this characterisation establishes at first principles whether and how these formations may interact. For example, if the Deep Lead was proven to be a fully confined aquifer then by definition there could be no expectation of any interaction with the upper impermeable layer that confines the aquifer or any layers above that confining layer.

48 Similarly by definition, a semi-confined aquifer implies some level of interaction can be expected with surrounding formations, including a lower permeable overlying layer. The fact that some confining is occurring implies that the difference between the aquifer and the lower permeability layer must be sufficient to retard any significant flows but will allow hydraulic transmission of pressure levels between the two units and some lesser order of seepage.

49 There exists strong evidence from drilling logs that within the lower Ovens GMA, a largely continuous clay layer of some 20m thickness is present at the boundary of the Shepparton Formation and the Deep Lead. The very fact that observed pressure levels[20] in bores monitoring the Deep Lead are above this clay layer indicates that the clay layer is of sufficiently low permeability to be restricting flow out of the Deep Lead. The Deep Lead is therefore said to be semi-confined.

50 It is acknowledged by all the experts that while this clay layer restricts flow, some vertical movement will be possible through the clay under certain conditions. Such conditions may include situations where the pressure in the Deep Lead is sufficiently reduced, such as through pumping, to result in large hydraulic gradients (i.e. differences in pressure levels) which would drive seepage through the clay layer. Such a mechanism for induced seepage forms the basis of evidence by Mr Finlayson and Mr Nolan that I will return to later in these reasons.

51 Like the clay overlying the Deep Lead, clay layers within the Shepparton Formation will also work to restrict vertical migration through the whole of this formation. Thus while sand units within the Shepparton Formation may be more conducive to migration of groundwater, it will the properties of the clay layers which will govern overall movement through this formation.

52 It is this characterisation that underpins Dr Beck's, Mr Minchin's and Mr Finlayson's assumption that any migration between the Deep Lead and the Shepparton Formation, and within the Shepparton Formation itself, will be at very low rates. At first principles, they are of the view that the interaction between the Deep Lead and the Shepparton Formation will not be so great that extraction from the Ovens Deep Lead is likely to cause adverse impacts to the Shepparton Formation groundwater resources or

20 Termed the potentiometric level.

ultimately to flows in the Ovens River.

53 Mr Nolan, while agreeing generally with the characterisation, contends that the amount of interaction and seepage could be larger when groundwater pumping from the Deep Lead bores occurs. This is because the change in hydraulic pressures arising from the pumping will induce higher rates of seepage from the Shepparton Formation into the Deep Lead. He postulates that this increase in seepage will risk depleting groundwater levels in the shallow aquifer system and in turn, deplete surface water flow in the Ovens River. Mr Nolan estimates that in the order of 50-150 Ml[21] per year of seepage could be induced from the Shepparton Formation, with 30%-50% of this volume being in turn drawn from the Ovens River.

54 To varying degrees, each of the experts relies on their respective assessments of hydraulic, geochemical and hydrogeological conditions to advance their respective positions beyond the first principles I have set out above. It is appropriate to consider these various lines of evidence in more detail.

The hydraulic analysis

55 On behalf of G-MW, Mr Finlayson undertook an analysis of potential interference to the Ovens River system when extracting groundwater from the Deep Lead at the Brimin Sands and O'Keefe bores. It is not necessary to delve into the details of the approach of Mr Finlayson, or many of the issued raised about this approach in Mr Nolan's evidence. Ultimately, much of Mr Finlayon's approach is not contested. Mr Nolan agrees that many of the parameters adopted by Mr Finlayson are a fair representation of expected hydrogeological conditions for the Deep Lead and Shepparton Formation.

56 In my view Mr Findlayson's assessment provides a sound and appropriate level of analysis. He has applied an accepted formula for assessing groundwater flow[22] and the 'Monte Carlo' statistical approach to account for the natural variability of key hydrogeological parameters.

57 The central issue that Mr Nolan raises about Mr Finlayson's approach is the extent of the influence of seepage that he has estimated between the Shepparton Formation and the Deep Lead and the resulting possible losses from the Ovens River.

58 Mr Finlayson assumes that the area of influence for any seepage from the Ovens River would occur from a 20m width of the river. Mr Nolan argues that the river is actually much wider, being a complex of various outer channels, ox-bow lakes cut offs and billabongs contained with a flood plain of some 2km width. Based on this wider area, and using the seepage values determined by Mr Finlayson, Mr Nolan estimates an annual induced seepage from the O'Keefe bore's operation of 141Ml/yr. Such a value is

21 Megalitres or one million litres.
22 The modified Theis non-equilibrium equation.

consistent with his broader assessment of seepage being between 50 Ml/yr to 150Ml/yr.

59 Mr Nolan is of the view that only a proportion, perhaps 30% to 50% of seepage he has calculated would derive directly from the Ovens River system. He provides no calculations for such a proportion other than ratio of the theoretical area of influence under the river versus the remaining area of influence. Such an assumption assumes that ultimately all the seepage from such an area must derive from the surface water flows. If it were so this proportion would equate to volumes of 30Ml to 70Ml or 0.2-0.5Ml/day based on his 140 days in the extraction scenario.

60 These losses leads Mr Nolan to conclude that such seepage volumes over the over summer (irrigation) periods will be critical, highlighting that river flows may be as low as 1Ml/day over these periods. He asserts that under such low flow regimes there is potential to cause harm to the Ovens River environment, although he acknowledges he does not have the expertise to identify what that harm could be. His view is based on the fact that the riparian and aquatic environment is dependant on water flow being maintained within the river and that the values of this environment are high given its heritage status.

61 I note that the flow of 1Ml/day or less on which Mr Nolan relies is the Q_{99} flow, i.e. that for 99% of the time the flow in the river near Peechelba will be greater than this and in fact the Q_{95} flow is 30Ml/day, i.e. for 95% the flow will be greater than 30Ml/day. These are the flows that are monitored in the main channel of the river and do not account for seepage flow through the overall meander plain of the river or water contained within the cut-off lakes and billabongs. Nor does it include any interflow within the Coonambidgal Formation.

62 In response to questions from the Tribunal, Mr Nolan agrees that the actual extent of the area of influence will be distorted from the theoretical uniform cone, with a greater extent being along the directions of preferential flow. In this case, this would be in the direction of the Deep Lead up and down the valley rather than across it. Thus the extent of influence extending under the reach of the Ovens River relied on by Mr Nolan is likely to be an overestimate.

63 For the purposes of these reasons I will for the moment adopt the estimates of induced seepage made by Mr Nolan and Mr Finlayson. These estimates range from 0.001mm/day to 0.029mm/day in the Finlayson analysis to 0.06mm/day to 4mm/day in the Nolan analysis. Mr Nolan also estimates an overall average seepage rate of 18mm/yr. Under cross examination Mr Nolan estimated that for a specific yield[23] of 0.03 in the Shepparton Formation, an estimate he considers reasonable, his gross seepage value of

23 Specific yield is defined as '..the volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline of the watertable… [or]… sometimes called effective porosity': Krusemane and De Ridder (revised 2000) page 23.

18mm/yr would be equivalent to a change in the Shepparton Formation water level of approximately 0.5metres.[24]

64 By his own more detailed analysis however, Mr Nolan acknowledges that this level of seepage and the corresponding decline in groundwater level would not occur evenly over the area of influence generated by the extraction from the Deep Lead. This is because the change in pressure level within the Deep Lead and hence the difference in gradient between the Deep Lead and the overlying Shepparton Formation declines logarithmically with distance. As a result, the greatest difference in levels will occur close the pump bore and be mush less toward and under the river. Using Mr Finlayson's assessment Mr Nolan estimates seepage of 4mm to 0.06mm per day from 100m to 2,000m radially from the O'Keefe extraction bore.

65 Applying the same specific yield value of 0.03 to Mr Nolan's more gross estimate of seepage rates, the equivalent change in groundwater levels would be in the range of 13mm per day (average for 100m from the bore) to 2mm per day when 1km to 2km from the extraction bore.

66 Thus while Mr Nolan makes much of the seepage volume of 141Ml over the summer irrigation periods, such a cumulative loss, if it were to occur, result in relatively small daily decreases in storage and water table levels within the Shepparton Formation and even smaller changes in water level from the river. Such losses would be subject to other influences such as rainfall, ongoing river flows and horizontal seepage. As set out earlier, the extent of the influence would also not extend evenly outward as theorised but preferentially be directed up and own the basin. Its extent under the river would therefore not be as great as assume by Mr Nolan.

67 Further, Mr Nolan's analysis is also based on a number of conservative assumptions. This includes that groundwater extraction will be continuous with little opportunity for recovery of potentiometric levels in the Deep Lead or standing water levels in the Shepparton Formation. He recognises that this assumption makes his estimates conservative (i.e. worst case) but says that this is balanced by other assumptions more favourable to a lesser impact, such as maintaining continuous extraction means pumping at lower rates than that assumed by Mr Finlayson.

68 I find that even if I were to accept Mr Nolan's assessment, the degree of impact, as set out above, is so small as to be inconsequential. However, I do not accept that Mr Nolan's assessment has been rigorous enough and does not accord with observations made during the pumping tests of both bores, ongoing monitoring and the conceptual understanding of the semi-confined character of the Deep Lead.

69 For example, a comparison of the behaviour of the potentiometric levels during and after the pumping tests, tests which Mr Nolan agrees were adequately conducted, indicate rapid recovery of these pressure levels to

24 The value would in fact be 0.6metres.

within 90% of the original level within 12 hours of extraction ceasing. While full recovery may not be achieved between extraction cycles, the pressure level differences between the Shepparton Formation and Deep Lead will not be as great as those assumed under the Finlayson and Nolan analysis.

70 That the scheduling and rate of extraction will vary from season to season, is evidenced in Figure 5.4 of Mr Nolan's witness statement.

71 Extraction rates that are lower than those assumed by Messrs Finlayson and Nolan also will mean lower pressure differences between the two aquifers and hence lower seepage rates and less time before recovery reduces these rates further.

72 While I concur with Mr Nolan that Mr Finlayson's analysis should more correctly account for the wider breadth of the Ovens River, ultimately this makes little difference to the overall conclusion as to the hydraulic interactions. A careful assessment of the evidence leads to the conclusion that even Mr Nolan's conservative estimate of total vertical seepage of 140Ml over the extraction season equates in daily terms to only minor decreases in standing water levels in the Shepparton Formation and ultimately the river. If operated in the manner suggested by Mr Finlayson, the areas of influence and drawdown around each bore will be less that than suggested by Mr Nolan's assessment and hence the impact will be less.

73 In such circumstances I accept any induced seepage would be so small as to be imperceptible.

The hydro-geochemical evidence

74 Dr Beck has undertaken an assessment of the chemistry of the groundwater within the Shepparton Formation and Deep Lead and water from the Ovens River. This assessment indicates that the Deep Lead chemistry displays a sodium-magnesium-bicarbonate character similar to that of the Ovens River water. The Shepparton Formation water has a sodium-chloride dominant chemistry with a substantially increased salinity concentration. Monitoring of groundwater extracted from the Brimin bore and other chemistry data has been interpreted by Dr Beck as not displaying any chemical characteristics of mixing occurring between groundwater from the Shepparton Formation and Deep Lead.

75 Based on this chemical characterisation, Dr Beck's evidence is that while some seepage may occur, it is at such a low rate that it is insufficient to make a noticeable difference to the Deep Lead water chemistry.

76 The chemistry of the Deep Lead groundwater is also consistent with rapid recharge by river water, the implications of which I will return to later in these reasons.

77 In terms of adding to the conceptual understanding of the interaction between the Deep Lead and the Shepparton Formation, the low salinity of

the Deep Lead groundwater is interpreted by Dr Beck to be indicative of a reasonably rapid (in geological terms) movement of groundwater within the Deep Lead. Thus, the salinity level is consistent with the conceptual framework outlined earlier for rapid recharge of the Deep Lead in the upper to mid catchment and a highly transmissive aquifer. This is opposed to the generally higher salinity levels of the Shepparton Formation, which are indicative of lower rates of aerial recharge and slow groundwater movement.[25]

78 Mr Nolan also makes reference to the age of the Deep Lead groundwater, reportedly to be of a 'few' thousand years in age,[26] as further evidence that seepage from the Shepparton Formation is occurring. Dr Beck notes that if the age of the groundwater in the Deep Lead is of this order then this indicates a reasonably transmissive flow from its recharge source in the upper Ovens valley. Such an interpretation is consistent with the groundwater's low salinity and sodium-bicarbonate character as set out earlier.

79 Dr Beck's evidence is that it must follow that within the Deep Lead the predominant flow is from the up valley sources of recharge horizontally through the aquifer rather than from vertical seepage from the Shepparton Formation.

80 I find Dr Beck's interpretation of the hydro-geochemistry and age dating of the groundwater to be preferred. His expertise in this field is acknowledged and his assessment of the data uses accepted industry practices. His interpretations are consistent with the generally agreed groundwater flow theory and the hydrogeological conditions in the Ovens Valley that I have set out earlier.

Monitoring of shallow groundwater levels during pump operations

81 Mr Nolan's evidence includes commentary on monitoring of shallow groundwater levels at the Brimin Sand's bore location, as is required under the licence conditions.[27] Plots of shallow groundwater level versus pumping periods and other groundwater level behaviour[28] are interpreted as indicating that longer term pumping is inducing seepage from the Shepparton Formation at sufficient levels to be at least partly a cause of localised lowering of shallower groundwater levels.

82 This interpretation is disputed by Mr Finlayson, Dr Beck and Mr Minchin. Their collective evidence is that while the fall in the groundwater level in

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25 The exception to this would be the Laceby Gravel unit, where the lower salinity is consistent with more rapid recharge consistent with its coarser nature and its location coincident with the Ovens River meander plain.

26 No source for this information was given by Mr Nolan, but it appears generally agreed between the Mr Nolan, Mr Minchin and Dr Beck that earlier studies have indicated this to be the age of Deep Lead groundwater in this area.

27 A copy of this report was tabled in the hearing. It is a letter report from GHD to G-MW on behalf of Brimin Sand dated 25 August 2009.

28 Presented in Figures 5.2, 5.3 and 5.4 of Mr Nolan's evidence statement.

this monitoring bore coincides with the pumping period the following are also relevant factors:

- The fall in groundwater level was occurring before pumping began, and there is no change in the rate of fall since the pumping commenced;
- The decrease is consistent with similar decreases monitored in other observation bores in the area and reflects seasonal and longer term trends across the riverine plain; and
- The shallow groundwater level does not show any recovery after pumping ceases, a response that would be expected if seepage greater than that which natural occurs was being induced.

83 The Brimin Sand's shallow monitoring bore is located approximately 10m from the Deep Lead extraction well and some 340m from the edge of the Ovens River system. A state observation bore screened across the Shepparton Formation, No 11306, is located to the north of the Brimin Sand's site. It is similarly located some 200m from the edge of the Ovens River system. It is evident that the groundwater level in this bore reflects the same pattern as that recorded from the Brimin Sands bore. The longer monitoring period of Bore 11306 and its pattern of rise and fall in groundwater levels correlates strongly with peaks and troughs in river levels as gauged at the nearby Peechelba station.

84 Given these correlations it would appear that a ready explanation for the behaviour of the Brimin Sand's observation bore levels is more to do with the response to river level influences than extraction from the Deep Lead. The reasonable rapid response of these bore levels to such an influence is consistent with the shallow system that it is monitoring as opposed to lagged responses which would be expected if it were due to influences from the low level of seepage into the Deep Lead.

85 Finally I turn to the an assessment of groundwater level behaviour during operation of the O'Keefe bore. This assessment shows no evidence of any movement in the Shepparton Formation groundwater levels that can be attributed to this bore's operation while falls in the order of 1.7m occurred in the potentiometric levels of two Deep Lead monitoring bores located some 500m to the south of the O'Keefe bore.

86 Taking the above facts and interpretations into account I find that there is little substantive evidence that the operation of the subject extraction bores is inducing any significant impacts to Shepparton Formation groundwater levels. Rather the groundwater levels are behaving in the manner expected with decreases in pressure levels being transmitted through the Deep Lead with no significant changes in the overlying formation. Changes in the shallow Shepparton Formation water levels observed in the vicinity of the extraction bores attributed to the extraction events can be plausibly explained for other reasons.

Findings and conclusions

87 I return then to the task of forming 'a view as to the degree of connectivity between the Deep Lead aquifer and the Shepparton Formation'. That task however extends beyond just forming a view about the degree of connectivity. It must also extend to consider what if any influence that connectivity is likely to have on the potential for impacts on the Shepparton Formation and the Ovens River flows due to extraction from the Deep Lead.

88 It follows from my consideration of the evidence set out above that there is a demonstrable hydraulic connection between the two geological formations. However the existence of such a connection does not mean that the two aquifers are so tightly interconnected that extraction from the Deep Lead will result in adverse impacts to the Shepparton Formation or ultimately, the Ovens River.

89 The findings I have set out in relation to the degree of interconnection leads me to conclude that the licensed extractions from the Deep Lead do not present a likely risk of detrimental impact on the overlying Shepparton Formation groundwater and surface water resources within the vicinity of the two bores.

SUSTAINABILITY OF THE RESOURCE

90 The second aspect of Mr Paul's application is that the extraction will have a detrimental impact on the sustainability of groundwater and surface water resources across the wider valley. Mr Paul's claim is that G-MW has failed to take proper account of:

- [35] [17] the proportion of the allocation against the overall availability of groundwater and surface water resources in the GMA; and
- [35] [17] the impacts of climate variability and climate change.

The impact of the allocations on the sustainability of river flows and groundwater resources

91 The submissions and evidence presented on behalf of Mr Paul have sought to demonstrate that the sustainability of the groundwater and surface systems are vulnerable to the extractions licensed to Mr O'Keefe and Brimin Sands. I find that when a full consideration of Dr Beck's and Mr Minchin's evidence is made, the position of Mr Paul cannot be sustained.

92 The Water Resources Appraisal I have referred to earlier that was undertaken by Mr Minchin was the subject of much scrutiny and evidence by all parties. I have noted earlier that this appraisal was commissioned to further the understanding of groundwater and surface water resources within the Ovens GMA and to assist in their integrated management. The three volume report tabled in these proceedings represents the first or Phase A component of the study. This component has comprised of two stages,

the first being data gathering to develop a conceptual understanding of the resources. The second stage has been the completion of numerical modelling to provide comparative assessment of various groundwater extraction and climate change scenarios. Recommendations for further field studies and modelling assessments have been made as a consequence of this work to support the next phase of the resource appraisal.

93 Mr Nolan and Dr Kiem have provided a critique of many aspects of modelling. In response, Mr Minchin acknowledges that the modelling exercise has highlighted areas of uncertainty with some inputs to the model. The underestimation of low river flows (notably those lower than the Q_{95} periods) and poor agreement with historical groundwater pressure and watertable levels in some providences of the model may arise from these and other uncertainties.

94 However Mr Minchin highlights that when calibrated against historical data the numerical model achieves an acceptable water balance between inputs and outputs. It therefore can be thought of as presenting a reasonable representation of the broad nature of the GMA, but requires some fine tuning to achieve better calibration of some of the provinces within the model. It is considered by Mr Minchin that having achieved a reasonable calibration the model is useful for comparative assessment of various extraction/resource use scenarios. He has undertaken such comparative modelling to assess the impacts of various groundwater extraction scenarios and the impact of climate change. Such scenarios have included increasing the amount of groundwater extraction to the full entitlement licensed as at 2009,[29] a volume of 17.4Gl/year.[30] This volume includes the two subject entitlements. Mr Minchin also assessed the impact of extraction at the Permissible Consumptive Volume (PCV), a volume of 25.5 Gl/year.

95 Relevant to the matters raised in Mr Paul's application, Mr Minchin's work indicates that:

- 35 17 Extraction to the full PCV amount does not result in mining of groundwater (i.e. unsustainable depletion), rather groundwater levels will equilibrate to new levels; some 0.1m to 0.3m lower in the shallow alluvial aquifers and 0.6m to 1.5m in the Deep Lead.
- 35 17 There is potential for groundwater extraction in the lower Ovens area to lower the levels of low surface flows in the Ovens River during extended dry periods, particularly when flows are less than 20Ml/day. The modelling indicates that this is largely due to extractions from the shallow aquifers near the river.
- 35 17 Extraction from the Deep Lead in the lower Ovens area, whether at current levels, increased levels under full 2009 entitlements or full

29 Monitoring of extractions has indicated that full entitlements have not been utilised but rather has been at some 26% of licensed levels, excluding allowances for unlicensed stock and domestic use.

30 Gl=Gigalitres. One Gigalitre is equal to 1,000 Megalitres.

take up of the PCV has little impact on surface water flows due to the 'disconnect' with the surface systems because of its confined nature.

35 17 The reach of the river between Wangaratta and Peechelba is a critical reach for future management of groundwater and surface water resources, however this is couched in terms of future management focussing on the shallow alluvial aquifers and the interaction with the river.

35 17 Future management options for addressing possible impacts to the surface water flows include directing more extraction from the Deep Lead rather than from the shallow Shepparton Formation and changes to up-catchment reservoir operations.

96 The resource assessment is relied on by Dr Beck to highlight the large storage of groundwater contained within the Ovens GMA. The combined estimates derived from the model for the upper and lower Ovens give a value of approximately 340Gl in the Deep Lead and 1,280Gl in the Shepparton Formation[31] or a total of 1,620Gl.

97 The PCV amount of 25.2Gl represents approximately 2% of the overall groundwater storage and, if it were to be all drawn from the Deep Lead would represent 8% of this aquifers storage. The allocation of groundwater under the PCV however makes no distinction between the Deep Lead and the shallower aquifers.

98 It is Dr Beck's view that the large volume of storage means the aquifer can buffer the small volume of extraction, i.e. has the capacity to carry over the small deficit arising from the extraction with no significant impacts on the lower Ovens water resources. This is because the volume of extraction translates into only a small depletion and hence small change in pressure levels within the Deep Lead. It is submitted that because of the nature of the Deep Lead, such small changes can be readily replenished by the up catchment recharge sources.

99 In Dr Beck's view there is little doubt that this recharge will regularly occur because of the high hydraulic conductivity of this formation throughout the valley, the exposure to rapid surface recharge and the physically elevated recharge source areas which drives the groundwater into the Deep Lead.

100 Mr Minchin's modelling results bear out this conceptual construct, as does the reasonably rapid recovery of Deep Lead groundwater levels recorded during the pumping tests compared to the lack of response from the overlying Shepparton Formation.

101 The question arises for such a system response as to whether there will be an eventual impact to the upper and mid Ovens groundwater levels and surface water flows. Mr Minchin's modelling answers that question in the negative.

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31 These values are rounded values taken from Figures 2 and 3 of Mr Minchin's expert evidence.

102 The modelling assessment supports the conceptual framework that the upper and mid Ovens River reaches are very responsive to rainfall and runoff generation which in turn recharge the Deep Lead system around the mid Ovens. This is due in no small part to the rapid shedding of rainfall runoff from the shallow, stony soils that flank the surface water systems and the interaction between the river and the unconfined deposits that feed into the lower Ovens system and the Deep Lead. Thus whenever there is flow in the river within the mid part of the catchment, where recharge to the Deep Lead occurs, a proportion of that flow will recharge and replenish the Deep Lead. It is only if there were extended periods of no river flow in this part of the catchment that such recharge would or could not occur. The assessment of historical flows and modelling under various supply and climate scenarios indicates that such 'no flow' events in the mid reaches of the catchment have not and are not expected to occur.

103 Thus the nature of the Deep Lead system and its hydrogeological setting give rise to a high degree of reliability in seasonal recharge.

104 Within the acknowledged limitations of the model I accept the findings that Mr Minchin and Dr Beck draw from the comparative scenarios about the degree of reliability the Deep Lead will have under current levels of allocated extraction. The agreement between the conceptual construct and numerical assessment, based as they are on well documented data, provides sufficient confidence to do so.

105 As a consequence of my earlier findings in relation to the degree of interconnection between the Deep Lead it follows that with sustained groundwater pressure levels in the Deep Lead, even under increased use scenarios, there is little opportunity for adverse impact to the Shepparton Formation or the Lower Ovens River flows by this path. Mr Minchin's modelling suggests that there may be some impacts from increased use of groundwater from the shallower Shepparton Formation but these impacts are not influenced by the extractions from the Deep Lead.

106 I am satisfied that in terms of the proposed extractions, there is an acceptable level of confidence that no detrimental impacts to the sustainable maintenance of surface water and groundwater resources in the Ovens GMA are likely to arise from the licensing of the O'Keefe and Brimin Sands extractions.

The influence of climate and climate change

107 In terms of climate change and the overall long terms sustainability of the groundwater (and surface water) resources, the question to be addressed is whether or not it is prudent to allocate the O'Keefe and Brimin Sand bores any or all of the applied for volumes in the face of possible climate change.

108 Submissions made on Mr Paul's behalf argue that the GHD modelling and Dr Kiem's evidence are consistent in that there is an increasing probability of drier conditions due to anthropogenic climate change. This will result in

decreasing water availability across the catchment.

109 There is of course some uncertainty as to the effects of climate change and the magnitude of changes to water availability. In the face of such uncertainty Mr Jackson argues that the precautionary principle should apply and actions, such as moderating the level of new allocations of water would be appropriate.

The relationship between rainfall and water resources in the Ovens catchment

110 Dr Kiem was called to give expert evidence as a hydro-climatologist. His expertise is in assessing climate variability and climate change impacts on water resources. Dr Kiem is critical of the climate scenario's adopted by Mr Minchin in the resource appraisal and highlights other areas of uncertainty.

111 In the main, Dr Kiem is critical of the adoption of the period of calibration (1995 to 2008) and baseline modelling (1980 to 2008) and the reliance Mr Minchin places on the climate variability over these periods to represent longer term natural variability, particularly the drought periods of 1982/83 and 1996 onwards. His evidence is that each of these drought periods and other iconic droughts that preceded them[32] have been due to different influences that have had different seasonality impacts. For example, the Federation drought (1895 – 1902) was primarily due to rainfall deficit over spring and summer while the recent Big Dry (1996-2008) has been due to declines in rainfall over autumn. He also highlights that daily rainfall variations over a month can make a difference to key hydrological responses such as soil wetting and runoff generation.

112 Dr Kiem submits that there is no single baseline period that can represent all drought conditions and that we may not have experienced the worst drought possible because records are not sufficiently long enough and there are numerous combinations of climate drivers that produce drought. In summary, his view is that even without anthropogenic climate change, climate is non-stationary and that the approach adopted by Mr Minchin in his model erroneously assumes that climate is stationary or perhaps better put as having repeatable patterns reflected over the period adopted in Mr Minchin's work.

113 In terms of anthropogenic climate change, Dr Kiem's view is that the most conservative scenario adopted in the GHD appraisal should be adopted as the most likely climate change impact given current monitoring trends of climate change responses and CO_2 emissions.

114 Dr Kiem also expressed concern that if the estimation of the PCV has not accounted for climate variability and climate change, the critical issue will be whether the PCV represents a sustainable limit to extraction. He gives evidence that groundwater and surface water are usually interconnected in a

32 The Federation Drought (1895 – 1902), and World War II Drought (1937-1945).

complex association and there are usually considerable time lags in the response of groundwater systems to rainfall and surface water conditions. He suggests that a sparseness of monitoring stations in the Ovens catchment compounds the problem of detecting groundwater responses to such changes.

115 Dr Kiem's evidence is useful in highlighting the uncertainty of climate influences and guiding which of the climate change scenarios should be focussed on. However I respectfully disagree with his view that this catchment is not well monitored or that there is insufficient data to assess rainfall-groundwater interactions and responses.

116 It is evident that there is sufficient spatial and temporal groundwater monitoring data available for this catchment. Such data is presented in Mr Minchin's appraisal of water resources.[33] The spread of monitoring provides an acceptable coverage of the shallow alluvial aquifers and the Deep Lead. As highlighted by all the hydrogeologists evidence, the data is sufficient to demonstrate a strong correlation between groundwater level or pressure behaviour and cumulative residual rainfall.[34] Long term decreases in cumulative residual rainfall are correlated with varying degrees of decline in groundwater levels and pressures. The reverse is also true. Imposed on these trends are seasonal cycles of rises over winter/spring and falls over summer/ autumn.

117 Mr Minchin's appraisal report also presents data for a number of surface water gauging stations of sufficient length of time and quality of data to correlate rainfall and flow regimes within the model to an acceptable level of agreement. The areas of low confidence in the model, as set out earlier, lie in the lower flow and peak high flows regimes of the upper and lower Ovens River while good agreement is retained in the mid Ovens, where much of the recharge to the Deep Lead is indicated to occur.

118 There is in my view sufficient monitoring to agree with the views of Dr Beck and Mr Minchin about the ability to reasonably define the relationship in this catchment between rainfall, surface water and groundwater responses.

119 While Dr Kiem's general hypothesis is true that groundwater and surface water interactions can be complex and poorly understood, in light of the other evidence presented in these proceedings, I find that this is not the case in this catchment. In fact, I find that understanding the response of this catchment's groundwater and surface water systems to rainfall is well advanced.

Climate change impacts

120 The evidence of Dr Kiem is that the 'A1Fi'[35] climate change scenario is the

33 See in particular the bore hydrographs in Appendix G of Volume 2.
34 Rainfall data being obtained from a number of stations within the catchment.
35 The climate change scenarios adopted by Mr Minchin are taken from the CSIRO OzClime

more appropriate scenario to adopt in view of current monitoring of CO_2 concentrations, atmospheric temperature rises and CO_2 reduction targets currently in play. The modelling undertaken by Mr Minchin indicates that under this scenario, there will be significant reductions in rainfall and hence recharge, runoff, interflow and overall total water yield within the whole of the Ovens GMA. A 45% reduction in catchment water yield is predicted by his modelling along with a 48% decrease in rainfall recharge.

121 Such a forecast is no doubt concerning. However how these changes impact on the various components of the catchment and water resources requires further consideration.

122 Mr Minchin's modelling indicates that much of the reduction in catchment yield will affect surface water flows and groundwater levels, particularly in the shallow alluvial aquifer of the lower Ovens, i.e. in the riverine plains province of this sub-catchment because 'the near surface processes are very sensitive to changes in rainfall'.

123 In respect to the Deep Lead system, Mr Minchin assessment identifies that:

> The climate under various scenarios tested here is sufficiently wet to maintain groundwater levels within the constricted highland valleys at or close to drainage elevations (i.e. riverbed/stage), i.e. the narrow nature of the alluvial aquifers filling the bedrock valleys means that there is only a relatively small volume of aquifer storage that requires recharging.[36]

124 While this recharge is derived from rainfall, which declines under the A1Fi scenario, Mr Minchin's evidence is that this apparently anomalous outcome is due to the fact that the recharge occurs in the mid reaches of the Ovens, as set out earlier in these reasons. Accordingly, the elevation at which this recharge occurs drives the hydraulic gradients, corresponding pressure levels and storage of groundwater within the Deep Lead. As a consequence the groundwater through flow and storage within the Deep Lead is less affected by the decrease in surface water flow due to such flows being maintained in this reach of the river.

125 The modelling indicates a small percentage change, of about 2%, in through flow and an even smaller change in storage under the A1Fi scenario with current levels of groundwater extraction. Extraction from the Deep Lead to the full amount of current allocations can also be maintained without apparent adverse impact.

126 The modelling indicates the greater impact of climate change is on surface water flows and the shallower alluvial aquifers. This is a result of decreases in upstream flow feeding into the lower Ovens, lower rainfall recharge across the lower Ovens plains and lower volumes of baseflow and

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programme. The A1Fi scenario is derived from the 2050 IPCC scenario resulting from static or increased future anthropogenic fossil fuel use and increasing or steady carbon emissions. The OzClime programme predicts 'hotter and drier' conditions under this scenario.

36 Cite op Error! Bookmark not defined.: Section 11.3.2.3 of Volume 2.

quickflow.[37] The impacts are likely to be most severe under summer/autumn periods, with increases in the percentage time that very low river flows occur over this period.

127 Mr Minchin's modelling indicates that a priority for managing climate change impacts is likely to focus on extractions from the shallower Shepparton Formation, allocations of surface water and the operation of the upstream storages.

128 Turning then to the issue about the impact from the O'Keefe and Brimin Sand's allocations, as Mr Minchin acknowledges the purpose of his modelling was not to assess individual applications and their impacts. His modelling is limited to comparative assessments of catchment wide impacts under various extraction and climate change scenarios. The modelling however assists with understanding the context in which the decision to licence is to be made. In this respect I accept that the numerical modelling of the A1Fi scenarios for the current levels of allocation remain sustainable. This level of allocation includes those made to O'Keefe and Brimin Sand.

129 I am therefore satisfied that the magnitude of the allocations is sustainable under a range of climate change scenarios, including those tracking toward the more likely, as indicated by Dr Kiem. It is evidence that the greater concern will be for the surface and shallow groundwater resources in the lower Ovens catchment. The focus for ongoing management under climate change regimes will be on the latter resources.

OTHER ISSUES

130 Aside from the merits of the issues about sustainability and other potential impacts, Mr Jackson raises issues that draw on other matters set out under section 40(1)(b) to (m) of the Water Act. These encompass issues about:

- 35 17 The purposes for which the water is to be used, with Mr Jackson suggesting that the irrigation of pastures and other agricultural production is of lower value return than could otherwise be achieved for such good quality groundwater;
- 35 17 Trading of underutilised water being a better outcome than allocating additional resources which would allow G-MW to maintain some unallocated volumes for 'unforseen contingencies' such as emergency town water supply; and
- 35 17 Giving away allocations on a first come first served basis not being an orderly, equitable and efficient allocation of water or a process that has regard to the proper management of the aquifer or the needs of future potential licence applicants.

131 Mr Pitt submits that agriculture is a valued activity in the region, and contributes to its economy. There is strong support at local and state

37 Runoff and soil/shallow interflow.

government levels for continuing and innovative agricultural use of water and land resources in the area. In this context seeking to use good quality water to support viable agricultural activities should not be seen as some lower order outcome.

132 As discussed earlier in these reasons, the breadth of considerations under section 40(1)(b) to (m) is extensive. Not all these considerations may be relevant. Where relevant they may have varying weight. Mr Jackson's submissions can be broadly summarised as raising issues about the equity of the groundwater use and gaining the best possible use for what is recognised as a scarce and valuable resource.

133 The consideration of use was discussed in the *Alanvale* decision.[38] I do not intend to repeat all that was said in that decision here, however that decision provides some potential guidance as to when the use may be a relevant consideration. Notably it may a consideration where there is competition between uses and the resource is scarce. Some decision may therefore be required as to which may be preferred over the other after having regard to a range of other matters.

134 In these applications Mr Jackson has not made out a case of competition between potential uses of the water. Indeed, it would appear from the evidence before me and the submissions of Mr Jackson that much of the allocated water is underutilised. Nothing has been presented to support the view that more pressing and urgent use of the water is competing with the proposed agricultural uses proposed under the O'Keefe and Brimin Sand allocations. In these circumstances, I do not consider that the proposed use is a factor that weights against the allocation. The availability of good quality water that can be extracted in a manner that, on the balance of the evidence before me, has limited capacity for adverse environmental outcomes and will support a valued agricultural activity weighs in support of the licence applications.

135 Mr Jackson's suggestion for trading in unused water in order to save unallocated water for some ill defined and 'unforseen' contingencies is not a test I give much weight to in these circumstances. No need for such a contingency has been made out.

136 In the *Alanvale* matter the Tribunal indicated that utilising unused allocations could be a more efficient use of the resource.[39] Indeed having regard to the likely outcomes of climate change impacts, a case may be made out that a transfer of underutilised shallow groundwater bore allocations to those who seek to utilise the Deep Lead may arguably be preferable.

137 However, I concur with Mr Pitt's submission that advocating for trading in the circumstances of Mr Paul's grounds is of little relevance when those grounds are about the environmental impacts said to arise from the

38 [2010] VCAT 480 at [188] to [192].
39 Ibid at [169].

extraction itself rather than from where the extraction is being drawn from. I find the issue to be of little weight in this decision.

LICENCE CONDITIONS

138 The Brimin Sand's allocation is based in part on licence conditions that require monitoring of the upper Shepparton Formation. It is submitted that such conditions, point to uncertainty and in line with the decision in the *Castle* matter, should weigh against granting a licence.

139 In response to this submission I concur with the submissions of Dr Sadler that there is a difference in requiring monitoring to see what happens in the absence of proper licence assessment and monitoring to ensure conditions remain as expected within the acceptable limits, i.e. compliance monitoring. The latter monitoring is prudent, and is consistent with many environmental management regimes. What is not acceptable is the 'suck as see approach' in place of proper testing and forecasting, as addressed by the Tribunal in the *Castle* matter.

140 I find that in this application the proposed monitoring conditions are about compliance rather than addressing significant uncertainties. In my view the conditions are appropriate and do not weigh against the grant of the licences

SUMMARY OF FINDINGS AND THE TRIBUNAL'S DECISION

141 Many previous Tribunal proceedings over the licensing of groundwater extractions have had to deal with levels of uncertainty that arise from a poor understanding of the hydrogeological system from which the resource is to be drawn from. These proceedings are not of that ilk. The Ovens GMA is a system that has been the subject of much assessment and monitoring and there is a reasonable understanding of the groundwater and surface water systems within it.

142 Mr Paul's applications for review have raised issues about the sustainability of the allocations made by the G-MW specifically to Mr O'Keefe and Brimin Sand for extraction from the Deep Lead aquifer in the Ovens Valley. However the submission made on Mr Paul's behalf not only raise issue about the possible environmental impacts arising from these allocations, issues are also raised about the uncertainty of impacts from climate change and long term sustainability of the water resources, the precautionary principle and a range of other matters. It is submitted that when a proper consideration is made of these issues, the allocations should be refused and no licences be granted.

143 Having considered the evidence and submissions presented in these proceedings I find that the claims that adverse environmental impacts are likely is not supported. The evidence leads me to conclude that the proposed allocations, that is to say the volumes and rates of extraction, are not likely to have an adverse impact on the shallow Shepparton Formation or the Ovens River water resources with in the immediate short term or

under future likely climate change scenarios.

144 Submissions have been made about the meaning of 'likely' in respect to its use in the Water Act and the likelihood of adverse impacts. I have also been invited to consider the application of the pre-cautionary principle to these matters.

145 I have indicated that I concur with the submissions that 'likely' should be given its ordinary meaning, that being that something is probable rather than possible. Mr Paul holds perceptions of adverse environmental impact because of the possible connection between the Deep Lead, the overlying Shepparton Formation and the river flows in the lower Ovens catchment. However I find from a consideration of the facts about the hydrogeological conditions of the Ovens Valley, the interpretation of these conditions using accepted hydrogeological concepts and theory, site testing and the wider resource appraisal that the degree of connection required for such impacts to be manifested is not likely. I also find that extractions to the current level of allocation are sustainable. I therefore conclude that a serious or irreversible risk to the resource is not likely with the allocations to O'Keefe and Brimin Sand.

146 It follows from my findings that it is appropriate to affirm the decisions made by G-MW. In doing so I have considered whether it is necessary to amend any licence conditions, as invited by G-MW. In the circumstance of these applications, I do not find there is any need to disturb these conditions.

Ian Potts
Member