Lower Ovens Groundwater Management Area

Technical Summary Report

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Executive Summary

A numerical model has been constructed, tested and validated to represent the hydrogeological and hydrologic processes occurring in the Ovens River Valley. Following a three stage process of model development and improvement, the numerical model has been used to test possible groundwater management scenarios to support the Lower Ovens Groundwater Management Area (GMA) Local Management Plan (the Local Management Plan).

Key findings of the Lower Ovens Valley model;

- Application of short-term restrictions that are based on a surface water trigger levels were found to be of little benefit, even during critically low flow periods.
- Impacts from groundwater extraction in the alluvial aquifers on the river are largely buffered by aquifer storage; reducing potential stress on surface water flows. .
- Extraction from the Deep Lead north of Wangaratta, as opposed to the Shepparton Formation, further reduces potential stress on river flows and riparian vegetation.

In response to these findings, the management objectives for the Local Management Plan support increased groundwater utilisation and development of the Deep Lead aquifer to the north of the catchment. While encouraging greater utilisation of the Deep Lead, the Local Management Plan sets caps for maximum resource development in other management zones. Furthermore, the plan caps groundwater extraction in a 2 km buffer around the lower reaches of the Ovens River, in the shallow alluvial aquifer to protect the high value riparian and groundwater dependent ecosystems.

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1 Introduction

This report provides a summary of the technical work that underpins the development of the Lower Ovens Groundwater Management Area (GMA) Local Management Plan. This report should be read in conjunction with the Lower Ovens GMA Local Management Plan (LMP).

This technical report will:

- provide a summary of technical work that has been undertaken (Section 2)
- Outline how the findings from the technical work support the management decisions
- provide an assessment of the numerical model calibration and uncertainties, and identify how a risk based approach should be used when amending the Local Management Plan (Section 4)
- detail recommendations for future work to assist in a review of the Local Management Plan (Section 5).

2 Summary of Water Resource Studies in the Lower Ovens GMA

In 2008 Goulburn-Murray Water (G-MW) and the Department of Sustainability and Environment (DSE) with funding from the National Water Commission, began a program to assess the groundwater resources within the Ovens catchment in North East Victoria. Consultants GHD were commissioned to undertake the modelling of the catchment water balance and to test different management scenarios. The model was created to provide analysis of the dynamic nature of the Ovens catchment and to take into account changes in the water balance in both dry and wet years.

The study area included both the Upper Ovens Water Supply Protection Area (WSPA) and the Lower Ovens GMA.

This section gives a brief summary of the technical reports produced as part of the Ovens Valley Water Resource Appraisal. These documents provide the scientific foundation on which the management decisions of the Local Management Plan are based. The Ovens Valley Water Resource Appraisal was completed in three stages;

1. Stage A – All existing data and knowledge was collated to create a conceptual model of the water resources in the Ovens Valley. The conceptual model was then used to construct a preliminary numerical model that considered both groundwater and surface water. *Section 2.1*
2. Stage B – The numerical model from Stage A was refined using a number of fieldwork investigations and improved resource knowledge within the study area. *Section 2.2*
3. Stage C – The updated numerical model from Stage B was then used to run several scenarios to test possible management rules for the Lower Ovens LMP. *Section 2.3*

2.1 Ovens Valley Water Resource Appraisal (Stage A)

Stage A of the Ovens Valley Water Resource Appraisal developed a conceptual and numerical model of the Ovens Catchment. The numerical model is a 'hybrid' model that includes a rainfall-runoff-recharge model and a model that simulates groundwater flow and interaction between groundwater and surface water[1].This method was chosen as the most effective way to determine a catchment water balance for the project.

After the model was calibrated a number of different groundwater extraction and climate scenarios were run to test the availability of water resources in the Ovens Valley.

Four groundwater extraction scenarios were tested using the numerical model developed in Stage A.

1. no licensed groundwater extraction (only domestic and stock extraction)
2. estimated groundwater use (inc. current licensed use and domestic and stock)
3. extraction of full groundwater licence entitlement[2]
4. assuming full Permissible Consumptive Volume (PCV) of groundwater entitlement is extracted

Three climate scenarios were also tested using the Stage A model.

1. continued recent drought conditions (based on 1996 – 2008 climate record)
2. a predicted 2050 climate after a decrease in fossil fuel reliance since 2008
3. a predicted 2050 climate after steady fossil fuel reliance since 2008

The future climate scenarios were derived from applying the CSIRO's OzClim service climate scenario methodology.[3] It predicts the "most likely" climate scenarios in the year 2050.

2.1.1 Key Findings from Stage A

The model found that the key differences between the groundwater extraction scenarios were the relative impacts on river flows. Under the 'full PCV' scenario, the extraction impacts are relatively small along most of the Ovens River, however impacts were more pronounced north of Wangaratta. Yet the model determined that an increase in extraction to the full PCV would not have a significant impact on groundwater in the Lower Ovens system except under the 'driest' climate scenario.

The third climate scenario (described above) suggested the hydrologic regime would be altered significantly, and if this climate was to become a reality, the current PCV (assuming full uptake and extraction) may not enable the current environmental, economic and social values of the river to be sustained.

All model scenarios clearly showed that climatic influences will be the strongest driver of groundwater level decline rather than extraction.

[1] The model combined the PERFECT & MODFLOW-SURFACT codes.
[2] The total licensed entitlement volume that is documented in the Ovens Valley WRA Stage A report (2008 – 09) has since been updated from 18,320 ML to 20,066 ML due to improved database accounting
[3] http://www.csiro.au/ozclim/home.do

2.1.2 Key Limitations from Stage A

The Stage A model tended to under-estimate stream flows during low-flow periods. This resulted in stream flow becoming dry more frequently than had been actually observed historically.

Another issue was that calibration between modelled and observed flow and water levels rated poorly. In particular, groundwater level representation along the river corridor was poorly calibrated. This made it difficult to define stream-aquifer interaction.

The aquifer mapping, a component of the model, had areas of uncertainty and this lead to a decreased confidence in these aspects of the model scenario results.

2.2 Ovens Valley Water Resource Appraisal (Stage B)

A series of recommendations were made in Stage A that were used to refine the conceptual and numerical models in Stage B. Stage B of the Ovens Valley Water Resource Appraisal was funded by the National Water Commission. Field investigations to gather new data, including drilling of observation bores, pump tests and analysis of water level and water chemistry, were undertaken during Stage B. The field investigations were the primary source to improve knowledge of the Ovens Valley in Stage B.

Professor Ian Cartwright from Monash University was commissioned to collect and analyse groundwater and surface water chemistry of the Ovens Valley. The aim was to determine the amount of water that goes in (recharge) and out (baseflow) of the aquifers using radon sampling and environmental isotopes. His findings were incorporated into the numerical model.

The discrepancies between the modelled and observed groundwater levels in some parts of the Stage A numerical model were investigated further in Stage B.

2.2.1 Key Findings from Stage B

Drilling investigations improved spatial knowledge of the aquifers which enhanced the conceptual model. The presence of a continuous confining clay layer between the shallow and deep aquifers was confirmed to be approximately 30 m thick in the lower reaches of the Ovens Valley, and approximately 15 m thick in the mid Ovens valley. The numerical model was improved by the inclusion of an aquitard layer between the Shepparton Formation and Deep Lead aquifer.

This conceptual understanding was confirmed by chemical analysis of deep and shallow aquifers. The analysis demonstrated different chemical signatures between the shallow and deep aquifers in the lower reaches of the Ovens Valley (north of Wangaratta) where the clay layer is most prominent. Further up the valley where there is no confining layer, there was little variation in the chemical signatures of the deep and shallow aquifers.

Chemical analysis also provided estimates of modern groundwater recharge rates and baseflow contributions to streams. These rates were used to further develop and re-calibrate the numerical model. Adjustment of parameters such as recharge, runoff, and evapotranspiration from the refined conceptual model improved confidence in the model results.

Finding more accurate data relating to stream gauges and the operation of major storages, Lake William Hovell and Lake Buffalo was important in enhancing understanding of groundwater/surface water relationships. The more accurate data supported the analyses of the fieldwork component and increased confidence in the model.

2.2.2 Key Limitations from Stage B

The Stage B numerical model produces excessive rates of runoff in the alpine hills resulting in modelled run-off and rainfall 'flooding' the valley. This was overcome by restricting the rate at which 'runoff recharge' can occur in the model.

The plausible range in recharge and baseflow is quite large at 10 – 30%. The model applied baseflow values from the upper end of this range. Whilst the range is large, it is an improvement from the Stage A model range of 20 – 60%.

Some limitations in the geological mapping and conceptual model could not be improved even with the fieldwork investigations. Issues such as relying on historic drill logs and third party pump tests and the simplification of complex aquifer systems are accepted and are factored in to model uncertainty. However, no specific analysis was undertaken within the stage to quantify model uncertainty.

2.3 Scenario Model Runs to inform the Local Management Plan in the Lower Ovens GMA (Stage C)

Stage C used the refined numerical model produced in Stage B to test possible management rules and to quantify the impact of groundwater extraction at current entitlement levels on the aquifers and streams.

'Baseline' scenarios were compared to management option scenarios to quantify the benefits and impacts of each management option (Appendix 1). The management options tested focussed on the return of baseflow to the Ovens River during critical low flow periods.

During Stage C minor improvements were made to update the model including minor adjustments to the aquitard layer separating the Shepparton and Deep Lead aquifers, to the north of Wangaratta.

2.3.1 Key Findings from Stage C

The findings from the Stage C modelling were critical in understanding the resources of the Lower Ovens and subsequently supported the management decisions of the Local Management Plan. The following sections discuss the key findings from Stage C.

2.3.1.1 Investigation of short-term restrictions

It was initially thought the most efficient way of maintaining baseflow to the river would be to restrict the rate of extraction during periods of drought. Following on from this initial hypothesis, short-term restrictions at 50% allocation were investigated.

The findings from Stage C found that short-term restrictions imposed on groundwater extractions during critical droughts have only a marginal benefit on river flows of about 5% of the restricted volume within the low-flow period.

The flow duration curve illustrated in Figure 1 represents the modelled impact that different groundwater scenarios will have on flows in the Ovens River during low-flow periods (e.g. summer). The diagram inset on the top right hand corner shows that there is little distinguishable difference between pumping at the current entitlement and pumping at 50% (restriction) of that volume (Run 04 and 05) during critical low flow periods. Run 01 is representative of ‘natural’ conditions with no licensed groundwater extraction; it sits above the other scenarios.

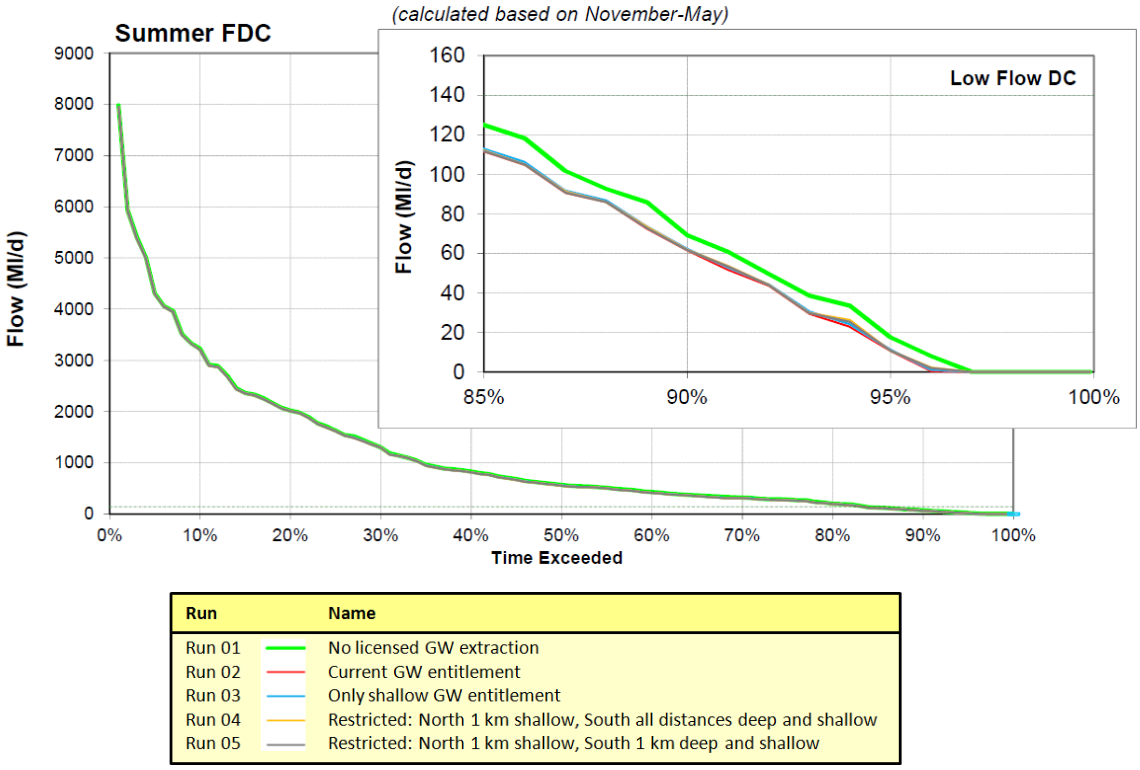

Figure 1 Flow Duration Curve for summer in the Ovens Valley

This means that restrictions imposed on groundwater extraction such as those modelled in Runs 04 and Run 05 (Appendix 1) would contribute very little in terms of baseflow to the Ovens River in the Lower Ovens GMA. As these scenarios are based on extraction of the full licence entitlement (rather than current use, which is significantly less than entitlement), imposing such restrictions would appear to be a relatively ineffective management option.

In summary the scenario results show little benefit to surface water flows and GDEs by placing short-term (surface water driven) restrictions on groundwater extractions upon users.

The Local Management Plan will therefore not propose groundwater restrictions based surface water based triggers during critical low-flow periods.

2.3.1.2 Buffering from aquifer storage

The modelling showed that potential impacts to river flows from groundwater extraction in the alluvial aquifer are buffered by aquifer storage. As extraction occurs, additional water is released from the aquifer structure and baseflow to rivers is largely maintained during the irrigation season,
Figure 2 illustrates the changes in the hydrological regime as groundwater extraction occurs. The figures show the impacts on river flows, changes in riparian evapotranspiration and the buffering effects of aquifer storage as groundwater extraction occurs.

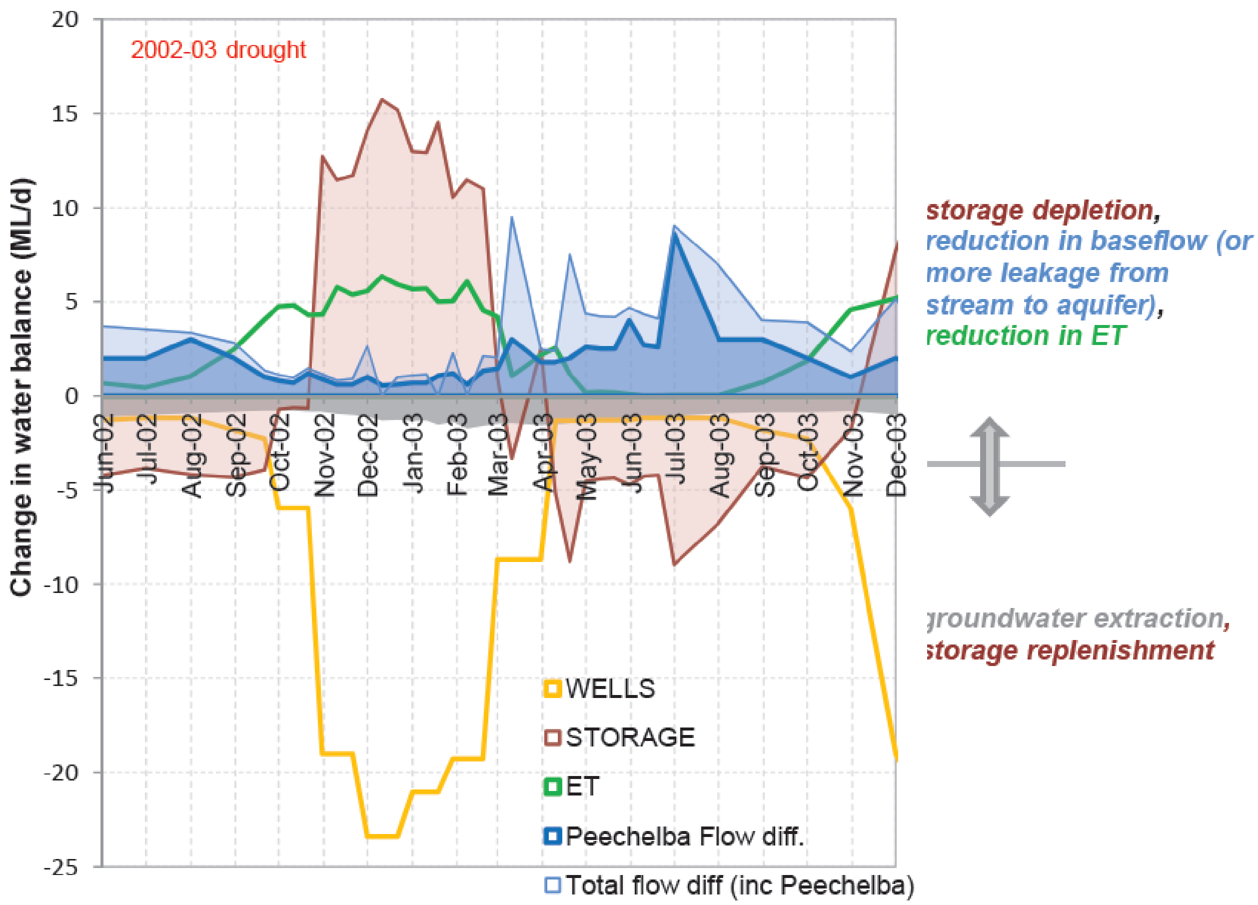

Figure 2 Modelled change in water balance of "Deep" groundwater extractions in the Lower Ovens

Figure 2 shows that extraction (yellow line) is met by a reduction in aquifer storage of a similar magnitude during the pumping period, thus buffering the potential impacts that extraction could have on baseflow contributions to river flows. After the irrigation season baseflow contributions reduce further – this is actually the process of aquifer storage replenishment (as shown by the brown line beneath the x axis).

Although there is a reduction in baseflow after the irrigation season, it occurs during the winter when GDEs and river flows are supported by the climatic conditions with higher rainfalls and less evaporation. Similar plots were created to show the change in the water balance of "shallow" groundwater extractions. These plots show similar trends to the "Deep" plots.

2.3.1.3 Investigation of development in the Deep Lead

After better parameterisation of the aquitard layer, present to the north of Wangaratta, modelling scenarios for the Ovens Plain and Murray Zone could occur. In these two zones the Deep Lead becomes semi-confined and behaves differently to the overlying Shepparton Formation.

The scenario modelling suggests that, in terms of contribution to river low flows, Deep Lead extraction is comparatively more beneficial than extraction of a similar volume from the Shepparton Formation in close proximity to the river (about 5% more beneficial as a percentage of extracted volume and about a 10% improvement in terms of riparian ET).

Figure 3 illustrates a comparison of impact of shallow extraction and extraction from the Deep Lead on river flows as a percentage extracted volume. The benefits of extraction from the Deep Lead rather than shallow extraction, in terms of the volume extracted, are higher during the first 3 – 4 months of pumping,

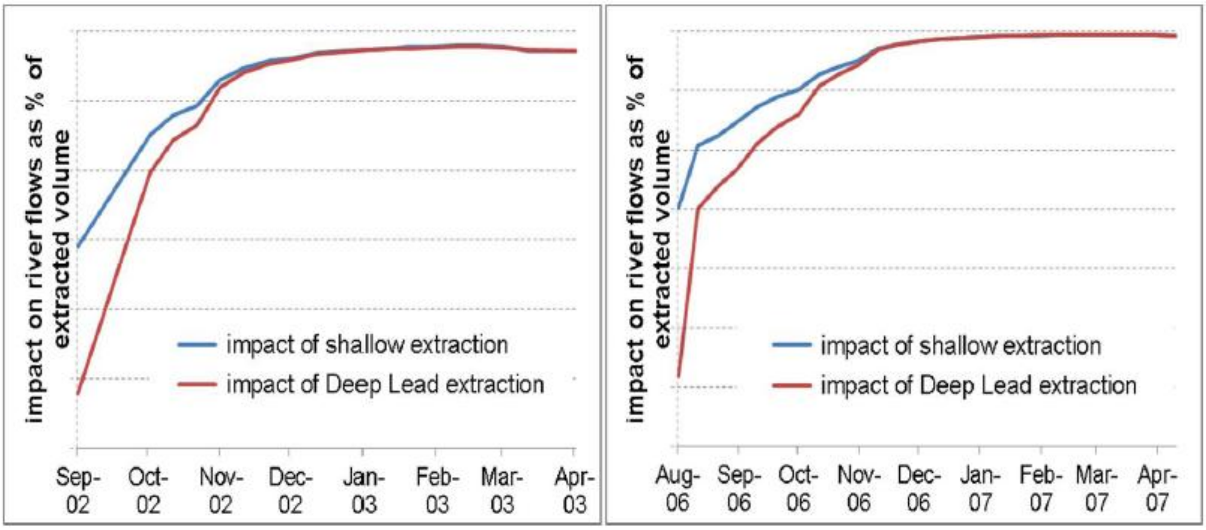

Figure 3 Modelled impact of Deep Lead extractions compared to shallow extractions

Another way to express this is that pumping from the Deep Lead has slightly less adverse impact on river flows within an irrigation season than comparable extraction from shallow alluvial aquifers in the Shepparton Formation. Encouraging development in the Deep Lead will lessen the time over which impacts are felt to GDEs in comparison to impacts resulting from extraction from the Shepparton Formation.

The results from Stage C have influenced a key objective of the proposed Local Management Plan which is to encourage further utilisation of the Deep Lead aquifer in the Lower Ovens GMA.

2.3.2 Key Limitations from Stage C

The sustainable yield of the Deep Lead aquifer has not yet been defined. Further technical work has been recommended to better understand the Deep Lead resources; this is further discussed in Section 4. The model does not incorporate the NSW groundwater extractions adjacent to the River Murray. This has been identified as a priority for increasing understanding of the resources in the Murray Zone in the Lower Ovens GMA.

For all the stages of the groundwater resource appraisal there was no formal uncertainty analysis undertaken. A recommendation from the report suggested that uncertainty be quantified using the PEST[4] software. Using PEST may help provide quantification about uncertainty relating to model calibration and predictions as well as the significance of uncertainty associated with the current conceptual understanding of the complex alluvial deposits in the Ovens Valley, particularly the Ovens Graben[5].

[4] Parameter estimation and uncertainty analysis software.

[5] The Ovens Graben is a thick sequence of alluvial deposits between block faulting in the bedrock.

3 Management Decisions

The intention of the Ovens Valley Resource Appraisal, undertaken in three stages over three years, was to provide a sound scientific foundation on which to base appropriate resource management decisions on. The technical work undertaken by consultants GHD has been critical to the development of the Local Management Plan for the Lower Ovens GMA.

The three stage program culminated in the Stage C modelling that tested potential management scenarios applicable to the Lower Ovens GMA. The key objective for Stage C was to maintain baseflow to the Ovens River, during the critical low-flow periods such as those experienced during the last drought in the years 2002-03 and 2006-07. Management scenarios were tested in light of this objective. The results of the management options modelled directly influenced the management decisions made.

Table 1 summarises how the key findings from the technical work links directly to the management decisions for the Local Management Plan.

Table 1 Summary of key findings and management decision

<table>
<tr><th>Key finding</th><th>Management decision</th></tr>
<tr><td>Marginal benefit found from imposing surface water driven restrictions at 50% allocation.</td><td rowspan="2">Surface water levels triggers are not used in the Plan
Trigger levels that would impose restrictions have not been established for the Deep Lead and Shepparton Formation in the Mid Ovens Zone, a cap on maximum entitlement has been established
Trigger levels that would impose restrictions have not been established in the Shepparton Formation in the Ovens Plain Zone and Murray Zone, a cap on maximum entitlement has been established.</td></tr>
<tr><td>Potential impacts of groundwater extraction on baseflow are largely buffered by aquifer storage</td></tr>
<tr><td>The benefits of extraction from the Deep Lead compared to shallow extraction is that impacts on GDEs from shallow extraction are higher during the first 3 – 4 months of pumping,</td><td>Development in the Deep Lead is encouraged through the rules in the Plan
The Shepparton Formation has been capped within 2km of the Ovens River in the Ovens Plain Zone and the Murray Zone to prevent further potential impacts to GDEs surrounding the Ovens River.</td></tr>
<tr><td>The 30m semi confining clay layer reduces impact from extraction within deep lead upon the Shepparton formation</td><td>Trigger levels that would impose restrictions have been established for the Deep Lead in the Ovens Plain and Murray Zone as a precautionary approach</td></tr>
</table>

	• Restrictions will be imposed if a fall in maximum recovery level over two successive seasons is greater than 1 meter in nominated bores
Modelling was completed to full PCV and extraction impacts were relatively small within the deep lead.	• Introduction for Carryover is to be considered within the Deep Lead and will be examined by G-MW in detail during the next 12 months.

4 Model Uncertainty and Performance

The Stage C numerical model that tested these scenarios has been greatly improved from the initial Stage A model (GHD, 2010). The Stage A model has been tested, improved and validated through field studies investigating groundwater baseflow and recharge rates through groundwater and surface water chemistry analysis to produce the Stage C model (GHD, 2012). Low flow periods are better simulated and groundwater levels are much better represented, particularly along the Ovens River corridor.[6]

An assessment of the performance of the Stage C model was undertaken. The model performance was calculated using scaled RMS[7] error to rate the groundwater levels for the Stage C model. The result was 2.8 %. This statistic compares favourably with guidelines which recommended that a risk rating should fall below 5 – 10 % for this transient type model.[8]

As discussed previously, formal model uncertainty analysis has not yet been quantified. Uncertainty analysis quantifies the model's performance with respect to predicting groundwater levels, river flows or water balances. Quantifying model uncertainty using software such as PEST has been recommended for further work. Without formally quantifying model uncertainty, it can be assumed the level of risk associated with the scenario model outputs is considered minimal given that groundwater extraction makes up a minor component in the water balance.

[6] Providing a better match of modelled to observed flow at river gauges and a better match of modelled groundwater levels to observed groundwater levels in State Observation Bores

[7] sRMS is the scaled Root Mean Square of the residual, in this case, the residual is between the modelled and observed groundwater levels.

[8] MDBC Groundwater Modelling Guidelines (Middlemis, Merrick and Ross, 2000)

5 Recommendations for further work to inform the Local Management Plan

There were several recommendations for further technical work made from the Ovens Valley Groundwater Resource Appraisal. These recommendations are discussed below.

5.1 Consideration of a Cap for the Deep Lead North of Wangaratta

The groundwater resources of the Lower Ovens GMA are managed through the rules included in the Local Management Plan. The impact of extracting the current licence entitlement has been tested using model scenarios. These scenarios have been summarised in this report. The technical work and model scenarios clearly shows the potential for greater utilisation of the Deep Lead aquifer in the Ovens Plain Zone.

The extent of development potential in the Deep Lead aquifer has not yet been quantified. As a precautionary measure, this Local Management Plan sets trigger levels, beyond which access to groundwater is restricted through seasonal allocations. Once a better understanding of the Deep Lead aquifer's long term sustainable extraction volume is achieved, the application of a maximum extraction volume or cap may be possible.

Quantification of a cap for the Deep Lead could be achieved through further scenario model runs using the Lower Ovens numerical model and will be completed within the review period of the Plan.

5.2 Monitoring Water Quality in the Deep Lead North of Wangaratta

A resource concern is the need to ensure the quality of groundwater in the Deep Lead does not deteriorate due to increased development in the Deep Lead aquifer. Extraction should not induce an unacceptable change in salinity in the Deep Lead via leakage from the Shepparton Formation. In recognition of the need to monitor the quality of the Deep Lead groundwater resource, it is recommended that historical groundwater quality data be reviewed and enquiries be made in relation to current monitoring program and related projects. If further water quality monitoring is required key bores from within schedule 1 (Appendix 2) will be identified and monitored. This process will be completed within the first 12 months of the Plan.

5.3 Consideration of NSW groundwater extraction on the Murray Zone

The management plan has applied the precautionary principle by capping the Murray Zone entitlement at current entitlement. Extractions have been capped at the current licensed entitlement in an effort to protect the Murray River corridor and through flow into NSW as well as important wetlands and GDEs.

Within the modelled scenarios NSW groundwater extraction was not initially included. It is recommended to revise the model in the future to include cross-border groundwater extraction so there is better calibration between modelled and observed groundwater levels in the Murray Zone. The current partnership in the 'Aligning Victorian and New South Wales Cross Border Management' will help to improve our knowledge bank of cross-border issues and technical considerations. This developing partnership between organisations will further develop their aims and objectives over the next few years.

5.4 Assessment for Groundwater Carryover in the Lower Ovens GMA

Carryover is a licence holder's unused allocated groundwater entitlement that may be used in subsequent seasons. Carryover can provide increased security of access during times of water shortage. If development increases to the Deep Lead aquifer and groundwater use approaches licensed entitlement volume, it is recommended that the irrigation community be informed of the benefits of groundwater carryover.

Carryover can provide

- Greater flexibility for licence holders to manage their entitlement;
- Reduce the reliance upon finding someone from whom to transfer entitlement;
- Increase opportunities for transfer of groundwater;
- Provide investment opportunities where licence holders might choose to carryover and transfer in dry seasons

At this stage the introduction of carryover is currently being considered within the Deep Lead (Calivil Formation) and will be examined by G-MW in detail during the next 12 months, with the potential for introduction in 2013. A carryover limit will be assessed which will provide some control over the potential fall in groundwater levels when carryover is used in a dry season. It also reduces the likelihood of restrictions due to carryover use.

5.5 Boundary Review of the Lower Ovens GMA

It is recommended that the boundary of the Lower Ovens GMA be reviewed in the future. Any changes to the Lower Ovens GMA boundary are likely to be based on:

- The need to better managing groundwater interaction with the River Murray;
- The need for a more coordinated approach to managing shared groundwater resources with NSW (noting that groundwater from the Shepparton and Deep Lead aquifers flows north and northwest into NSW);
- The need to transition to any boundary changes required by changes to Victoria's groundwater management framework as described in the Department of Sustainability and Environment's, *Secure Allocations Future Entitlements* (SAFE) project.

6 Appendices

Appendix 1. Baseline and management option scenarios undertaken in Stage C (GHD, 2012)

1.	**No licensed groundwater extraction**	Baseline scenarios
2.	**Current entitlement**	Baseline scenarios
3.	**Current entitlement for ‘shallow’ extractions only**[9]	Scenario runs
4.	**Current entitlement except during critical ‘low flow’ periods** – 50% restriction applied to all alluvial extractions within the ‘Ovens Highlands and Mid Ovens’ trading zone and to shallow alluvial extractions within 1 km of major waterways in the ‘Lower Ovens Plains’ trading zone.	Scenario runs
5.	**Current entitlement except during critical ‘low flow’ periods** – 50% restriction applied to all alluvial extractions within 1 km of the major waterways in the ‘Ovens Highlands and Mid Ovens’ trading zone and to shallow alluvial extractions within 1 km of major waterways in the ‘Lower Ovens Plains’ trading zone.	Scenario runs
7.	**Current Entitlement with transfer from Deep Lead to Shepparton Formation**	Scenario runs

[9] To isolate the benefits and impacts from a particular management option the scenarios where treated like an equation. For example:

Run03 Current Entitlement for ‘shallow’ extractions only **minus**
Run02 Current entitlement **equals**
The impact of all ‘deep’ groundwater extractions in the Lower Ovens

Appendix 2 Schedule 1

State observation bores

50788	113690
50789	113691
50834	113692
50893*	113693
52896	113694
52897	113695
52898	114129
54981	114138
62863*	114952
62864*	135123
73832	139328
73833	302296*
82095	WRK053382*
86160	WRK053412*
86887	WRK053413
98865	WRK053414*
98866	WRK053415
98867	WRK053419
98873	WRK053420
98874	WRK053427*
99102	WRK053428*
102873	WRK053434
108201	WRK053435
108202	WRK053436
108203	WRK054465*
110666	WRK054466
110738	WRK054467*
110739	WRK054468*
110740	WRK054545
111542	WRK054546*
111543	WRK054547*
111549	WRK056929
111550	WRK056982
111552	WRK060757*

* Key bores to be included in annual reporting

7 Glossary of Terms

This section defines the terms used throughout the document.

Term/Acronym	Description
Act	*Victorian Water Act 1989*
AHD	The Australian Height Datum is a geodetic datum for altitude measurement in Australia. It is the mean sea level for 1966-1968 and is assigned the value of zero.
Aquifer	An underground layer of rock or sand or other geological unit that contains water
Aquifer storage	
Aquitard or confining layer	A solid rock or clay layer that restricts flow of water from one aquifer to another. It acts as barrier to the flow of groundwater.
Aquitard, semi-confining	Also referred to as a 'semi-confining layer'. This layer is an aquitard that partially restricts the flow of water from one aquifer to another.
Available drawdown	The depth of water in the bore minus 2 metres to account for pump depth setting
Baseflow	
Carryover	Is the unused allocation that may be used in subsequent years
Conceptual model	
Drawdown	Groundwater level fall from the standing water level due to groundwater extraction
Entitlement	Licensed volume of groundwater specified as megalitres per year
Evapotranspiration	
GDE	Groundwater dependent ecosystem. An ecosystem that relies on access to groundwater for some or all of its water needs to maintain health and vitality.
GMA	Groundwater Management Area
Goulburn-Murray Water	Goulburn-Murray Water Rural Water Corporation acting as a delegate of the Minister
Groundwater licence	Licence issued to take and use groundwater under section 51 of the Act
Groundwater Reference Group	A group of stakeholder representatives consulted during the development and implementation of the Local Management Plan
Hydrologic regime	
Local Management Plan	The Lower Ovens Groundwater Management Area Local Management Plan
Numerical model	
PCV	Permissible Consumptive Volume is the volume of groundwater that the Minister has declared may be extracted from a defined area in a season
Pump test	
Recharge	
Riparian vegetation	
Seasonal Allocation	The amount licence entitlement that can be used in any given season eg. during times of water shortage a seasonal allocation may be 75% of the licensed entitlement.
Transfer	Transfer of licensed groundwater entitlement from one licence holder to another
ML	Megalitre or one million litres
Maximum groundwater level recovery	The highest level to which the groundwater will return to after pumping has ceased
Season	Period of 12 months commencing 1 July
NRSWS	The Northern Region Sustainable Water Strategy
Zone	A part of the groundwater management area defined for management purposes

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based on DSE Victorian Water Accounts data from 2009-10