Lower Namoi Groundwater Source

Groundwater Management Area 001

Groundwater Status Report – 2008

NSW Government
Department of Water & Energy

Publisher

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Lower Namoi Groundwater Source: Groundwater Management Area 001
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June 2009

ISBN 978 1 921546 17 4

This publication may be cited as:

Smithson, A., 2009, *Lower Namoi Groundwater Source: Groundwater Management Area 001 Groundwater Status Report 2008*, NSW Department of Water and Energy, Sydney

DWE 09_041

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Executive summary

This report presents the status of the Lower Namoi Groundwater Source, Groundwater Management Area 001, for 2006–2008. From 1 November 2006, the Lower Namoi Groundwater Source has been managed under the *Water Management Act 2000* through a water sharing plan for the Upper and Lower Namoi Groundwater Sources (the Plan). The Plan sets the framework for managing groundwater in the Lower Namoi until 30 June 2017. The Lower Namoi Groundwater Source includes all water in the unconsolidated alluvial sediment aquifers associated with the Namoi River and its tributaries. The Plan allows for the estimated average annual recharge of 86,000 ML per year and a defined volume from storage to be extracted each year. The remaining water in aquifer storage is reserved as planned environmental water.

In addition to stock and domestic rights, three categories of groundwater access licence are held in the Lower Namoi Groundwater Source. These are aquifer access licences, supplementary water access licences, and local water utility access licences. At the start of the 2008–09 water year there were 210 aquifer access licences with a total of 81,593 unit shares, 130 supplementary water access licences with a total of 21,005 unit shares, and three local water utility access licences with a total volume of 4,407 ML. Supplementary water access licence allocations reduce by 0.1 ML per unit of share component each year until 2015, after which there will be no groundwater available under these licences. At the start of the 2008–09 water year, 170.7 GL of groundwater was held in accounts, with 161.3 GL of that being available for use.

Under the Plan, extraction limits have been set at the supplementary water access allocations plus the estimated average annual recharge. As the supplementary water allocations are reduced, the extraction limit also reduces until it reaches 86,000 ML in 2015, Year 10 of the Plan. The water sharing plan aims to manage overall extraction to within 5 per cent of the extraction limit over a three-year period. Extraction of more than 95,686 ML in the 2008–09 water year will trigger a reduction in aquifer access licence share component in 2010.

Since commencement of the Plan, groundwater trading has been active, with five permanent transfers of 968 ML and 75 temporary transfers of 18,396 ML. During the 2006–07 water year, groundwater usage was 125.7 GL; and in the 2007–08 year, it was 102.4 GL.

In general, since the late 1960s and early 1970s, groundwater levels throughout the aquifer have been declining. During the wetter years of 1996–2001 there was a period of reduced extraction, and water levels in most parts of the aquifer stabilised or recovered. However, since the onset of the drought in 2001 water levels have continued to decline, and in the 2006–07 water year many areas experienced their lowest water levels since monitoring commenced. One part of the pumped aquifer south of Wee Waa has become unconfined due to declining water levels. Reduced pressure in the deep aquifer due to extraction is inducing downwards leakage from the shallow aquifer, resulting in long-term shallow water level decline.

Potentiometric surface and groundwater flow directions show areas in the aquifer where groundwater flow is being reversed during pumping. In sizeable areas of the catchment, drawdown has reached 40 per cent of the saturated thickness, and in places up to 60 per cent of the saturated thickness is being drawn down during pumping. Areas of recovery decline greater than 10m and up to 30m correspond closely with the areas showing significant drawdowns. In places, recovery decline has reached up to 40 per cent of the saturated thickness that existed before the aquifer was developed for extraction of irrigation water supplies.

The findings of this 2006–2008 assessment of groundwater status were presented to the Lower Namoi groundwater community on 11 September 2008 at Wee Waa. The presentation included a discussion of groundwater management and acceptable impacts. As a result of the levels of impact occurring, trade restrictions were proposed for areas where drawdowns had reached 40 per cent and 50 per cent of saturated thickness, and were showing recovery decline. The intention of these restrictions is to limit further drawdown from additional water being traded into these areas of greater impact. Revised criteria for dealings assessments in the Lower Namoi, including trade restricted areas, took effect on 10 November 2008.

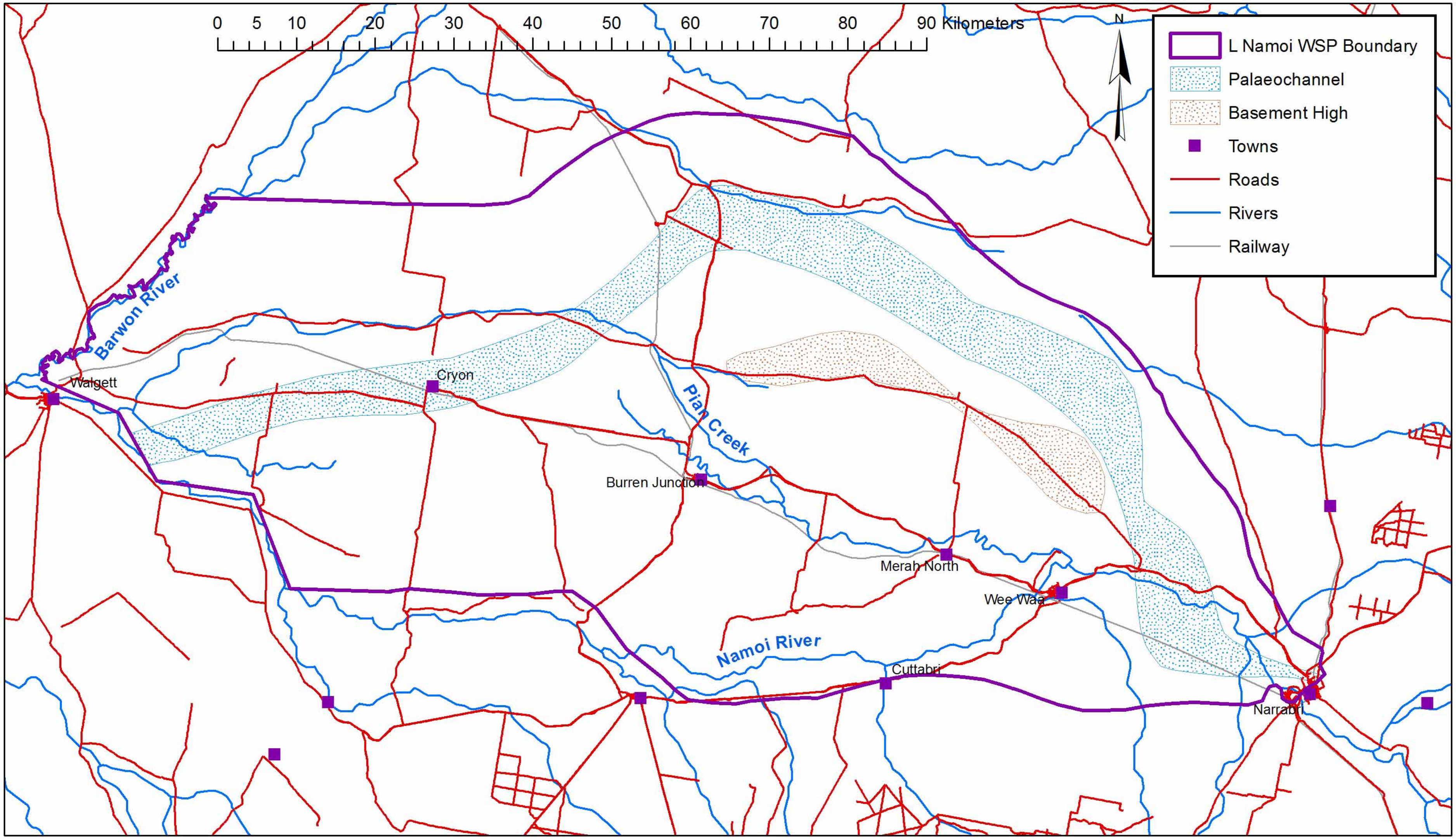
1 Water sharing plan

The water sharing plan for the Upper and Lower Namoi Groundwater Sources (the Plan) commenced on 1 November 2006. Since commencement of the Plan, the Lower Namoi has been managed under the *Water Management Act 2000*. The water sharing plan for the Lower Namoi Groundwater Source covers the area shown in Figure 1. The Plan sets the framework for managing groundwater in the Lower Namoi until 30 June 2017. The Lower Namoi Groundwater Source includes all water in the unconsolidated alluvial sediment aquifers associated with the Namoi River and its tributaries. The lower boundary of the water source is defined by the formations of the Great Artesian Basin.

The Plan sets the rules for sharing the resource between extractive users and that which is reserved in the aquifer. The basis for water sharing is the estimated average annual recharge of 86,000 ML per year. This is made available for extraction in conjunction with a defined volume of groundwater from aquifer storage each year. The remaining water in storage is not available for extraction, and is reserved as 'planned environmental water'.

At the commencement of the Plan, the water requirement for domestic and stock supplies extracted as landholder's basic rights was estimated to be 3,304 ML per year. The Plan recognises that the exercise of basic landholder rights may increase during the term of the Plan.

Figure 1 Location of the Lower Namoi Groundwater Source



2 Groundwater access licences

Three categories of groundwater access licence (WAL) are held in the Lower Namoi area. These are local water utility access licences (LWUAL), aquifer access licences (AAL) and supplementary water access licences (SWAL).

The local water utility access licences are held by local government and are for town water supply purposes. The share component of these licences is for a specified volume of groundwater. The share components of aquifer access licences and supplementary water access licences are issued for a specified number of unit shares. Table 1 gives the number of licences and unit shares for each licence type at the start of the 2008–09 water year.

Table 1 The number of water access licences and unit shares at the start of the 2008–09 water year

Licence type	July 1 2008	
	Number of groundwater access licences	Total unit shares
Aquifer access licence	210	81593
Local water utility access licence	3	4407
Supplementary water access licence	130	21005

The total number of licences may change during the term of the Plan as a result of the granting, surrender or cancellation of access licences, and the variation of local water utility access licences.

3 Groundwater allocations

At the start of each water year an available water determination (AWD) is made which sets the allocation of groundwater for the different categories of access licences.

For supplementary water access licences, the water sharing plan has already set the available water determination s for each year of the Plan. Table 2 lists these determinations. The available water determination for supplementary water access licences at the commencement of the Plan was 0.9 ML per unit of share component. This will reduce by a further 0.1 ML per unit of share component each year until 2015. After the 2014–15 water year there will be no groundwater available under supplementary water access licences.

The 2007–08 available water determination for aquifer access licences was 1 ML per unit share. The 2007–08 available water determination for local water utility access licences was 100 per cent of the share component.

Table 2 Available water determinations for supplementary water access licences

Year of the Plan	Water year	AWD for supplementary water access licences (ML per unit share)	Volume of water available for supplementary water access licences (ML)
1 (8 months)	2006–07	0.9	18,904.5
2	2007–08	0.8	16,804.0
3	2008–09	0.7	14,703.5
4	2009–10	0.6	12,603.0
5	2010–11	0.5	10,502.5
6	2011–12	0.4	8,402.0
7	2012–13	0.3	6,301.5
8	2013–14	0.2	4,201.0
9	2014–15	0.1	2,100.5
10	2015–16	0	0
11	2016–17	0	0

4 Groundwater accounts

Unused allocation in aquifer access licence accounts may be carried over into the following water year. There is an account limit of 3 ML per unit share so that any water carried over into the account in excess of that limit is forfeited. There is also a limit of 2 ML per unit share that can be debited from the account in one water year. This includes water that is traded out. A volume greater than 2 ML per unit share may be taken from the account if additional allocation is assigned to the account by a temporary transfer.

There is no carry-over of allocation in local water utility and supplementary water access licence accounts. For those landholders that have both supplementary water and aquifer access licences, usage is deducted from the supplementary water account first. Table 3 summarises the volumes per unit of share component that may be held, used and carried over in accounts under the water sharing plan. Table 4 summarises the volumes of water held in accounts for the water years 2006–07, 2007–08, and 2008–09.

Table 3 Summary of account rules for the Lower Namoi Water Sharing Plan

Licence	Water that may be held in an account (ML per unit of share component)	Water that may used (ML per unit of share component)	Water that may be carried over (ML per unit of share component)
Aquifer access licence	3	2	2
Supplementary water access licence	1	1	0
Local water utility access licence	1	1	0

Table 4 Summary of water held in accounts from 2006–2008

Account type	2006–07 (GL)	2007–08 (GL)	2008–09 (GL)
Local water utility access licence	4.4	4.4	4.4
Aquifer access licence: total water in accounts (AWD + carry-over capped at 2 ML per unit of share component)	211.1	183.9	172.9
Aquifer access licence: water available for use (use limit)	155.9	149.3	142.2
Supplementary water access licence	18.9	16.9	14.7
Total water available for use:	179.2	170.7	161.3

5 Extraction limits

The water sharing plan sets an extraction limit for each year of the Plan. Table 5 gives these extraction limits. The extraction limit is equivalent to the sum of the supplementary water access allocations and the estimated average annual recharge of 86,000 ML per year. As the supplementary water allocations are reduced, the extraction limit also reduces until it reaches 86,000 ML in 2015, Year 10 of the Plan.

Over the 11-year period of the Plan, a total of 1040.5 GL is available for extraction. This compares with the 853.4 GL of groundwater that was extracted over the 11 years prior to the start of the Plan.

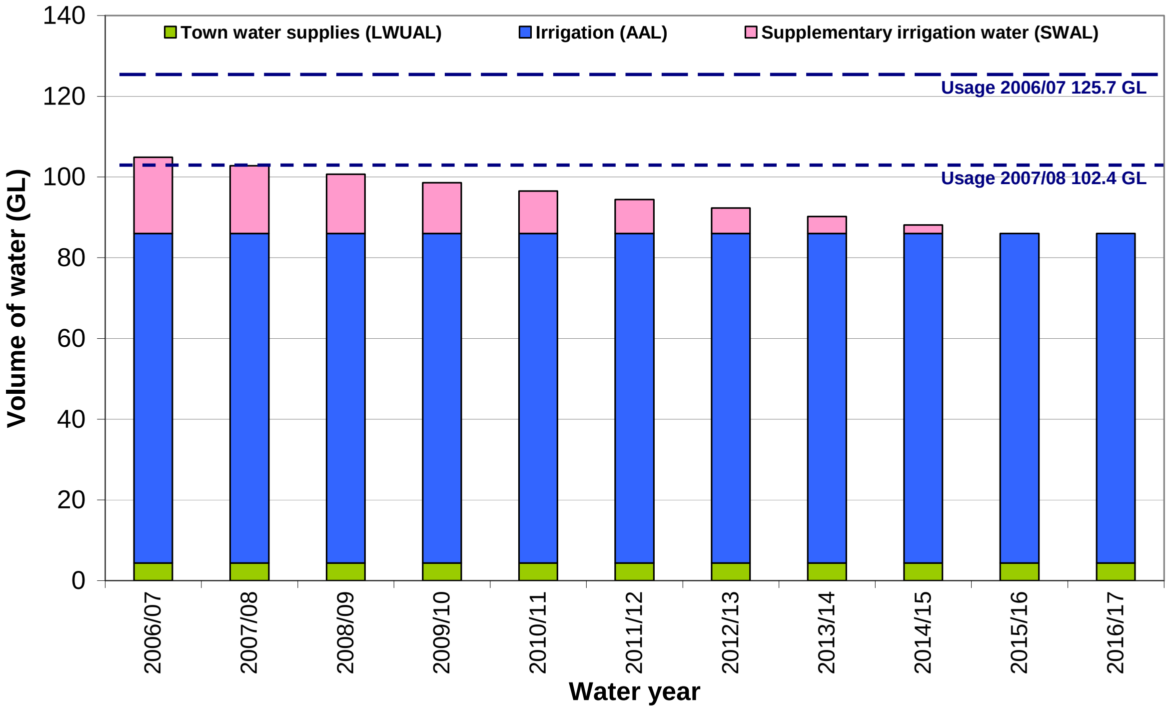
The Plan aims to manage the overall extraction to within 5 per cent of the extraction limit over a three-year period. The rolling three-year average allows for some fluctuation in usage from one year to the next. If usage does exceed the three-year average extraction limit, then the Plan requires that an available water determination be made for aquifer access licences for the following water year to reduce the subsequent total water extraction to the extraction limit. The start of the three-year rolling average period was 2006–07. Extraction of more than 95,686 ML in the 2008–09 water year will trigger a reduction in the aquifer access licence share component in 2010.

Figure 2 shows the annual extraction limits and their component aquifer access licences, local water utility access licences, and supplementary water access licences.

Table 5 Annual extraction limits under the Lower Namoi Water Sharing Plan

Year of Plan	Extraction limit (ML)
2006–07	104,900
2007–08	102,800
2008–09	100,700
2009–10	98,600
2010–11	96,500
2011–12	94,400
2012–13	92,300
2013–14	90,200
2014–15	88,100
2015–16	86,000
2016–17	86,000

Figure 2 Annual extraction limits for the Lower Namoi Groundwater Source



6 Groundwater dealings and assignments

Under the *Water Management Act 2000*, temporary transfers are referred to as an 'Assignment of Allocation'. The transfer of allocation from supplementary water access licence accounts is not permitted. Local Government may transfer allocation between their local water utility access licence accounts with Ministerial approval in certain circumstances.

Assignments of allocation (or temporary transfers) are received by State Water Corporation. Permanent trading, and subdivision and amalgamation of licences are received by the Department of Water and Energy (DWE). Permanent and temporary dealings are assessed under an operational dealings policy for the Lower Namoi.

Table 6 summarises the permanent dealings since the Plan commenced. Table 7 summarises the temporary dealings since the Plan commenced.

Table 6 Permanent dealings since commencement of the water sharing plan

Water year	Number of permanent transfers	Volume (ML)
2006–07	2	688
2007–08	3	280
2008–09	0	0

Table 7 Temporary dealings since commencement of the water sharing plan

Water year	Number of temporary transfers	Volume (ML)
2006–07	27	5957
2007–08	30	8608
2008–09 (until 21/11/08)	18	3831

7 Groundwater usage

In the Lower Namoi a combined total of 228 GL was pumped in the two seasons 2006–07 and 2007–08. Table 8 gives the groundwater usage from the Lower Namoi since commencement of the Plan. Figure 3 shows the annual groundwater usage since 1991. Figure 4 shows the distribution of average usage for 2002–2007.

Table 8 Groundwater usage since commencement of the water sharing plan

Year	Licence	Usage (ML)	Annual extraction limit (ML)
2006–07			
	Local water utility access licence	5,647	–
	Aquifer access licence	102,070	–
	Supplementary water access licence	18,009	–
Total		**125,726**	**104,900**
2007–08			
	Local water utility access licence	2,498	–
	Aquifer access licence	84,056	–
	Supplementary water access licence	15,854	–
Total		**102,408**	**102,800**

Figure 3 Lower Namoi groundwater usage since 1991–92

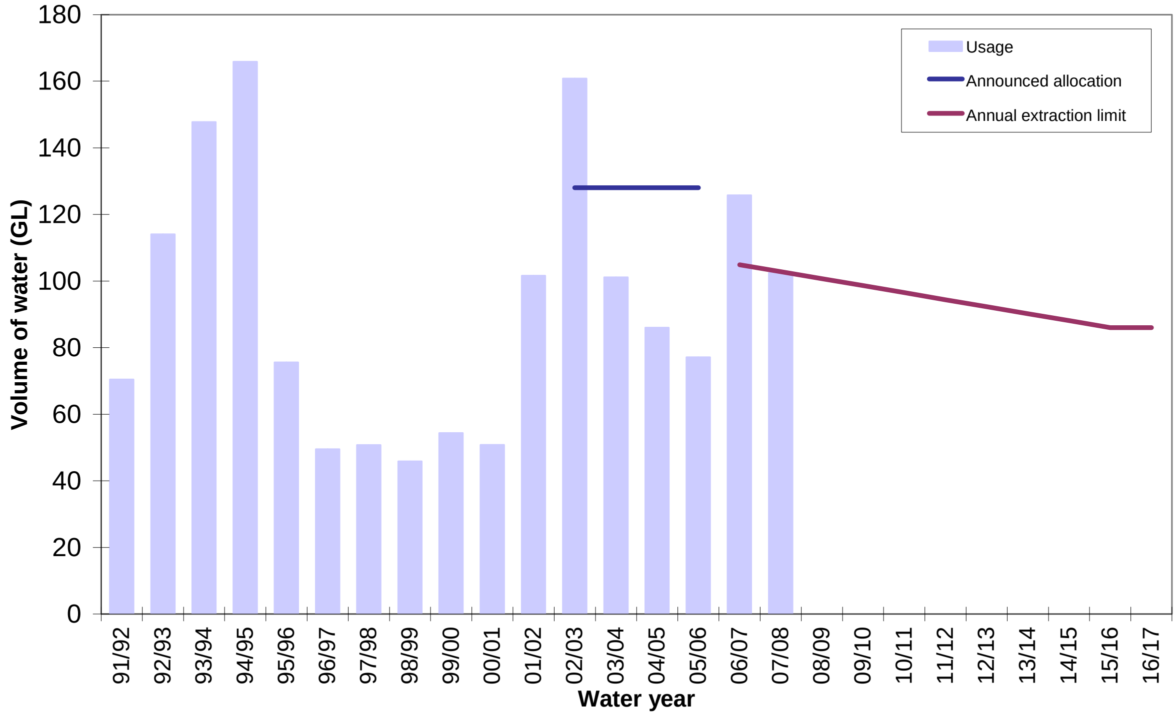
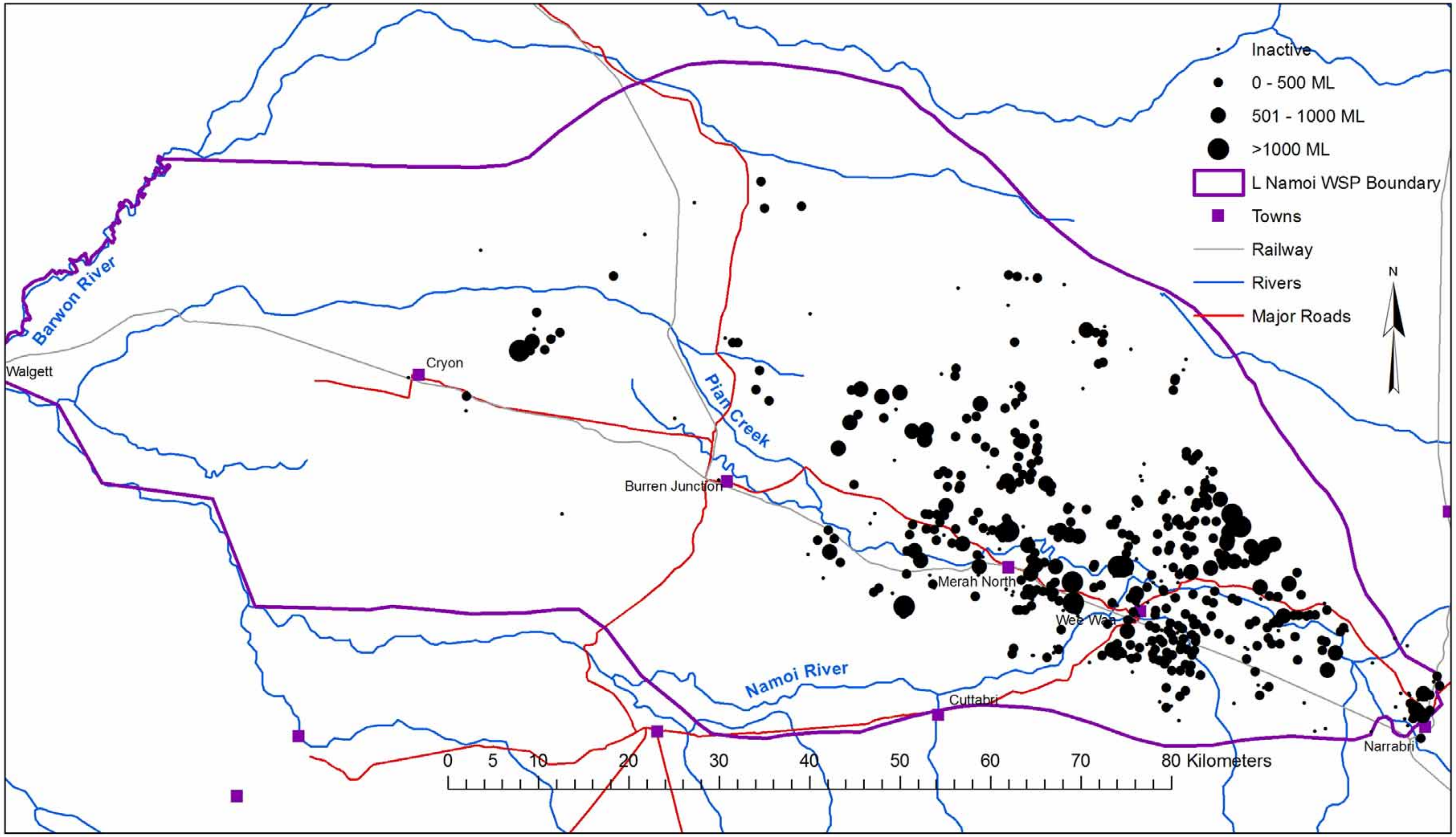


Figure 4 Average groundwater usage 2002–2007 in the Lower Namoi



8 Rainfall

Rainfall data was available for Wee Waa at George Street (Station 53044) from the Queensland Department of Natural Resources Mines and Energy. This station has recordings dating from 1889 onwards.

The rainfall is summer-dominant and the average annual rainfall is 586mm. The annual rainfall for 2006 was 361.6mm, for 2007 it was 451.5mm, and for 2008 until 30 November it was 617.8mm. The average for the last three years was 477mm. Figure 5 shows the annual rainfall since 1965, when groundwater monitoring commenced. Figure 6 shows the monthly rainfall since 1965.

Figure 5 Annual rainfall at Wee Waa 1965–2008

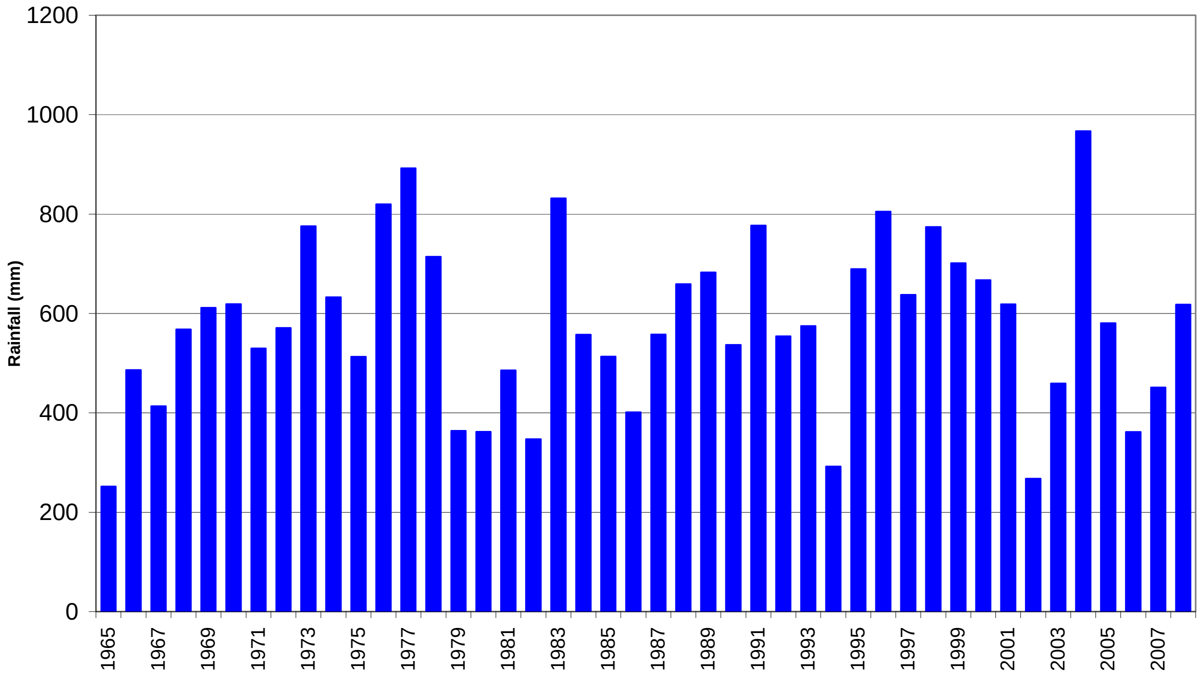


Figure 7 shows the residual mass curve of monthly rainfall during the past 43 years. This figure shows the deviation of actual monthly rainfall from the mean monthly rainfall. The slope of the curve indicates whether the area was experiencing a relatively wetter or drier time compared to the average for the past 43 years. For the periods from 1965–1971 and from 1978–1983, rainfall in Wee Waa tended to be less than the long-term average. For the periods from 1971–1977 and from 1995–2000, annual rainfall has tended to be higher than the long-term average.

Figure 6 Monthly rainfall at Wee Waa 1965–2008

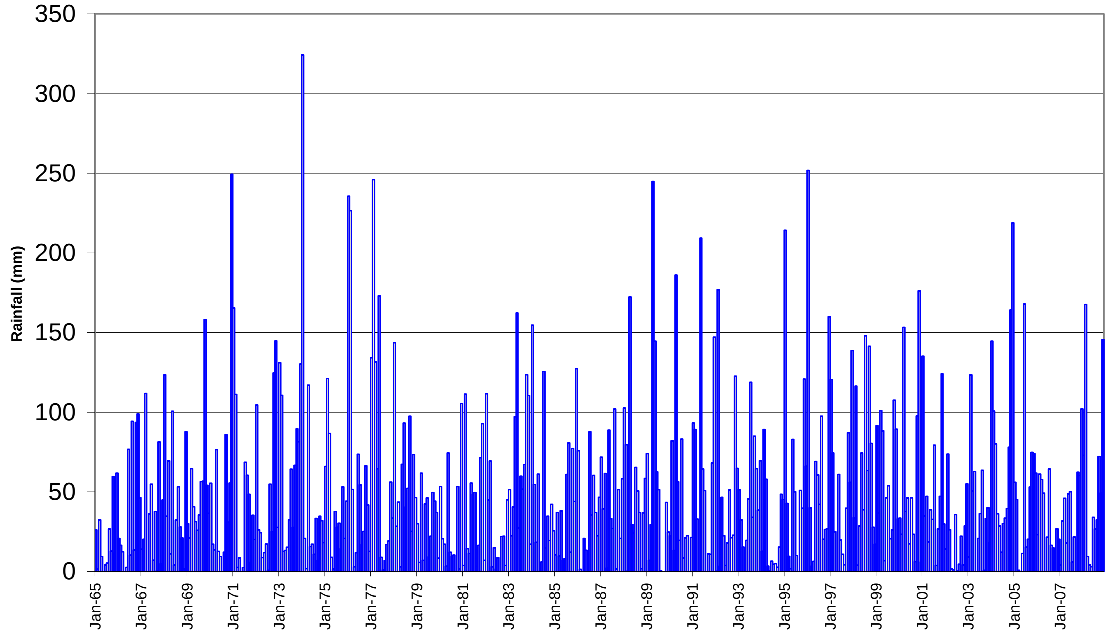
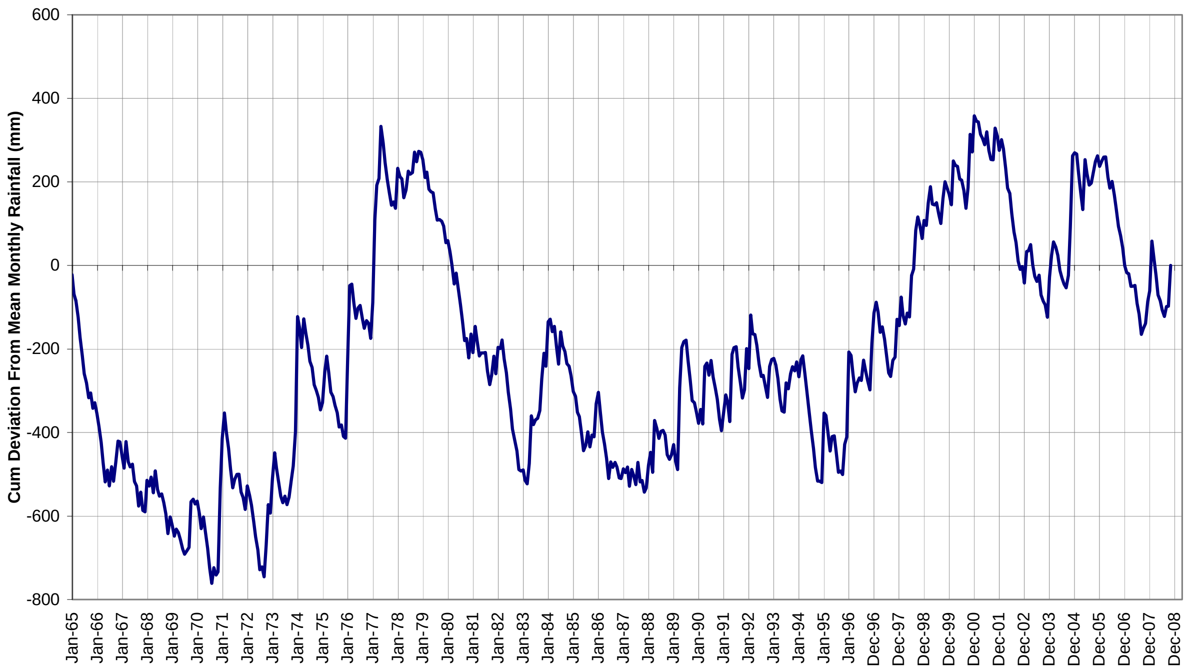


Figure 7 Cumulative deviation from mean monthly rainfall at Wee Waa 1965–2008



9 Groundwater levels

9.1 Overview

Groundwater levels have been monitored since the late 1960s and early 1970s at 256 monitoring bore locations throughout the Lower Namoi Groundwater Source. Water level records are held for the past 30–40 years for most sites. Monitoring is conducted more frequently at seven locations where bores are equipped with data loggers (GW25055-1, GW25138-1, GW25327-2, GW25329-1 and -3, GW30295-1, GW3604-2 and GW36043-2).

Figure 8 shows the locations of all monitoring sites and key representative sites. Figures 9–20 show hydrographs for representative monitoring bores. For comparison, all hydrographs have been plotted at the same vertical scale.

Groundwater levels are generally shallower at the eastern, upper end of the catchment. At Narrabri they are around 4–12m below ground level in the deep[1] and shallow aquifers. Groundwater levels in both aquifers become progressively deeper towards the west, and are around 25–34m below ground level at Cryon. Long-term groundwater level declines at the western end of the valley, where usage is low, are most likely related to extraction higher in the valley limiting throughflow.

In general, since commencement of monitoring in the late 1960s and early 1970s, groundwater levels throughout the aquifer have been declining. During the wetter years of 1996–2001 there was a period of reduced extraction, and water levels in most parts of the aquifer stabilised or recovered. However, since the onset of the drought in 2001 water levels have continued to decline. In the 2006–07 water year, many areas experienced their lowest water levels since monitoring commenced.

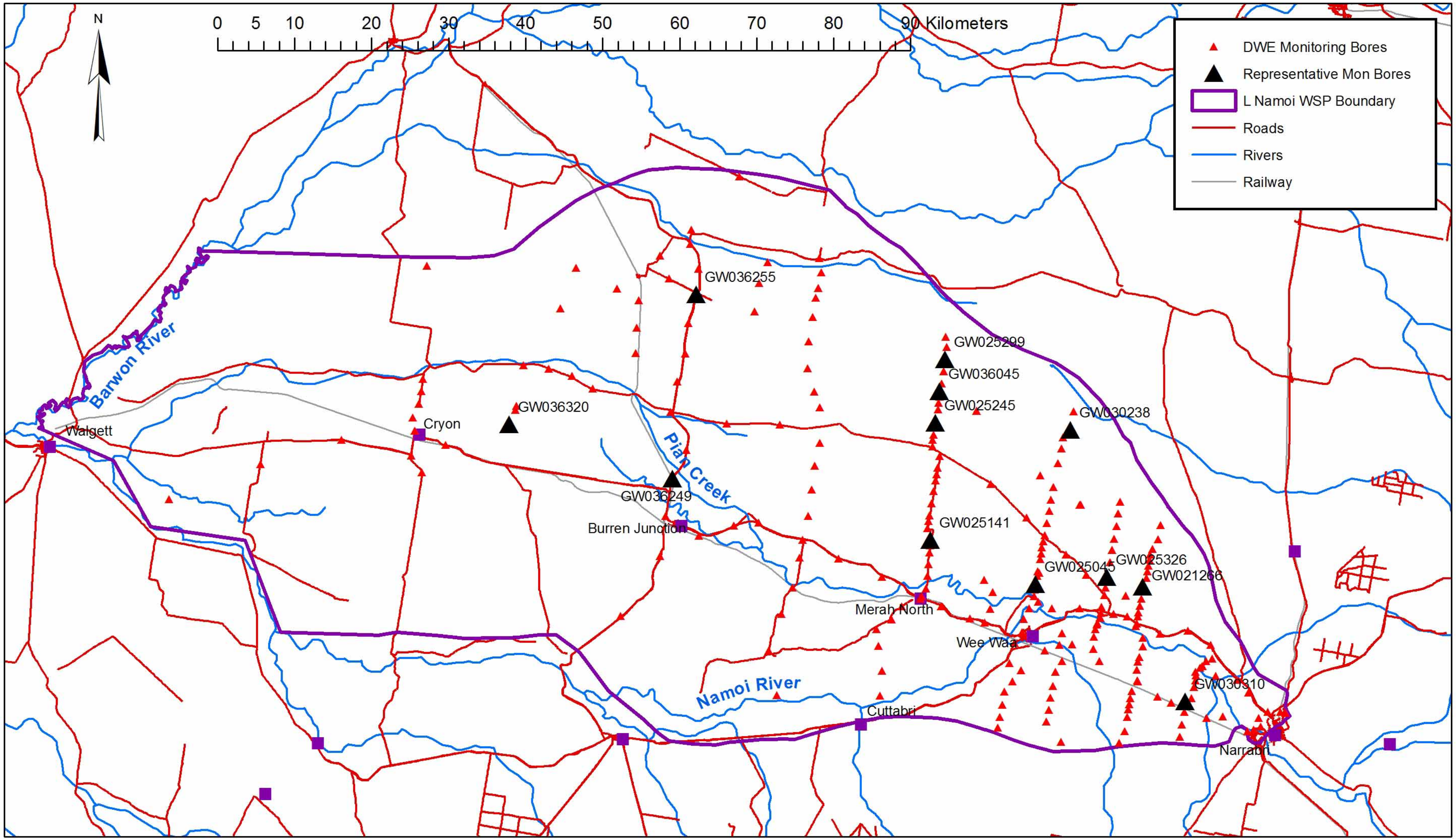
Strong drawdowns occur in the area of the palaeochannel between the Narrabri and Wee Waa sections, where the deep aquifer is vertically confined by overlying clays. With the increase in groundwater usage from the deep aquifer since the 1960s, the pressure in this aquifer has fallen due to extraction. This is inducing downwards leakage from the shallow aquifer, causing its water levels to decline. The reduction in deep aquifer pressure is increasing the separation of groundwater heads between the shallow and deep aquifers, and has caused head reversal in some places.

A few kilometres south of Wee Waa, declining groundwater levels have caused the pumped aquifer to become unconfined over an area that is about 30km long by 15km wide. Figure 21 shows this area.

Groundwater levels show a rising trend in an area along the southern margin of the groundwater source between Cuttabri and Pilliga, possibly related to recharge from the regulated Namoi River. Figure 22 shows this area.

[1] For the purposes of this report 'deep' aquifer refers to the Gunnedah and Cubbaroo Formations, and 'shallow' aquifer refers to the Narrabri Formation.

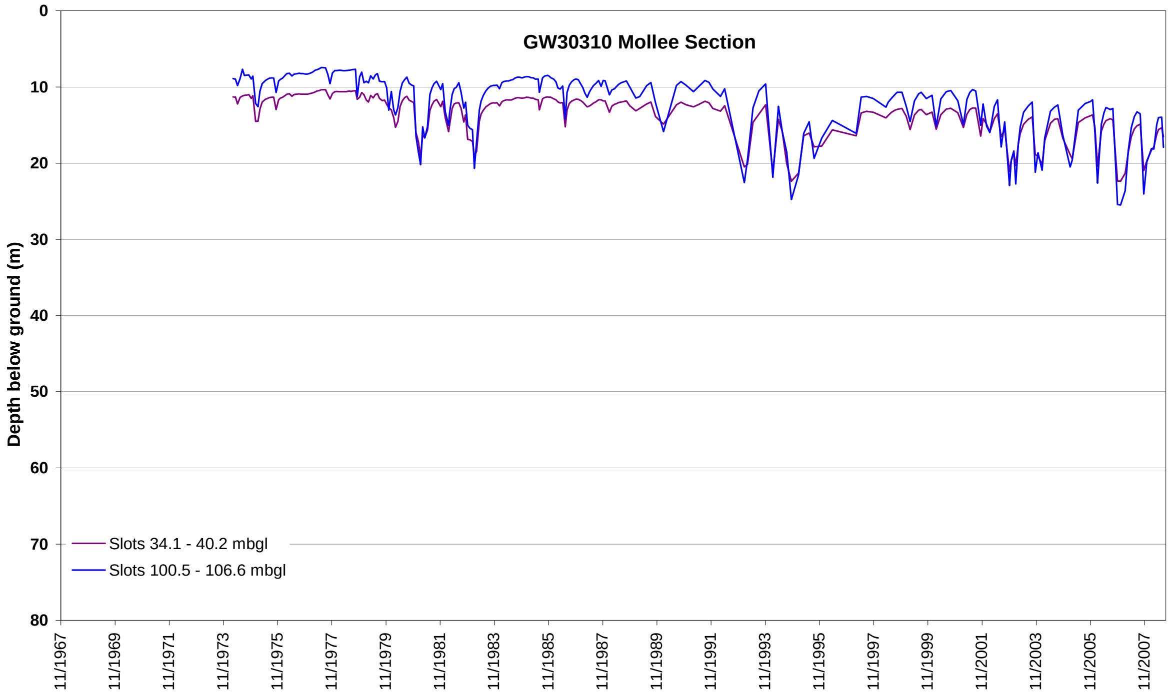
Figure 8 The locations of monitoring bores and representative monitoring bore sites



9.2 Hydrographs

The data for Figure 9 was collected from a bore with a shallow pipe screened in the Narrabri Formation and a deep pipe screened in the Cubbaroo Formation (palaeochannel). The similar behaviour of water levels in both pipes shows that at this location the formations are in good hydraulic connection and are partially confined. Prior to development[2], the head of the deep aquifer was about 2.4m higher than the head of the shallow aquifer. Since extraction commenced, this pressure difference has reduced to 1.4 m. In the 2006–07 pumping season, drawdown in the deep aquifer was around 12m (16 per cent of the saturated thickness[3]). Since development, the long-term trend has been a decline in water levels, and the recovery decline[4] in the deep aquifer is 4.3m (4 per cent of the saturated thickness).

Figure 9 Hydrograph for groundwater monitoring site GW30310



The data for Figure 10 was collected from a bore with two shallow pipes screened in the Narrabri Formation and two deeper pipes screened in the Gunnedah and Cubbaroo Formations. The difference in water level behaviour between the shallower and deeper aquifers at this location shows that these formations have limited hydraulic connection. The deepest aquifer (palaeochannel) is highly confined as shown by the pronounced pressure drawdowns during pumping. Prior to development, the head of the deep aquifer was about 3m higher than the head of the shallow aquifer. Since development, this pressure difference has reversed. The deeper aquifer now has a head around 9m lower than that of the shallow aquifer. In the 2006–07 pumping season, drawdown in the deep aquifer was around 47.8m (58 per cent of saturated thickness). Since development, the long-term trend has been a decline in water levels and the recovery decline in the deep aquifer is 10.8m (11 per cent of saturated thickness).

[2] The commencement of extraction of irrigation water supplies
[3] The thickness between the predevelopment water level and the base of the aquifer
[4] Where water levels do not recover to predevelopment level after each pumping season

Figure 10 Hydrograph for groundwater monitoring site GW21266

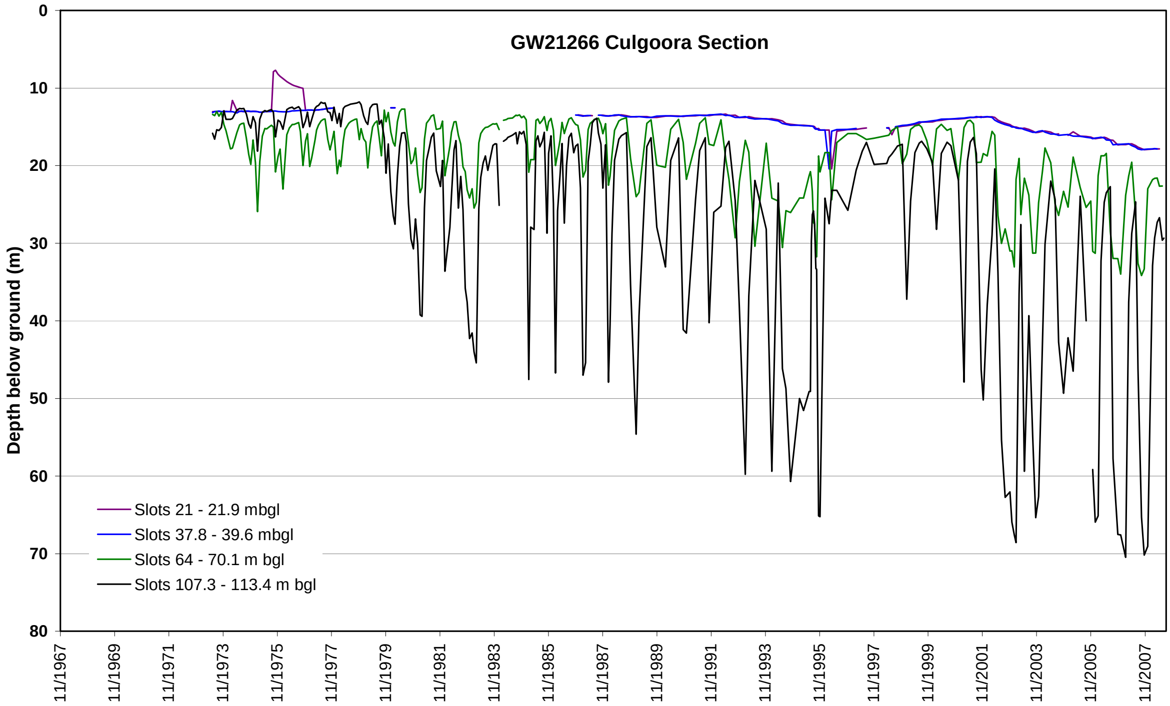


Figure 11 Hydrograph for groundwater monitoring site GW25326

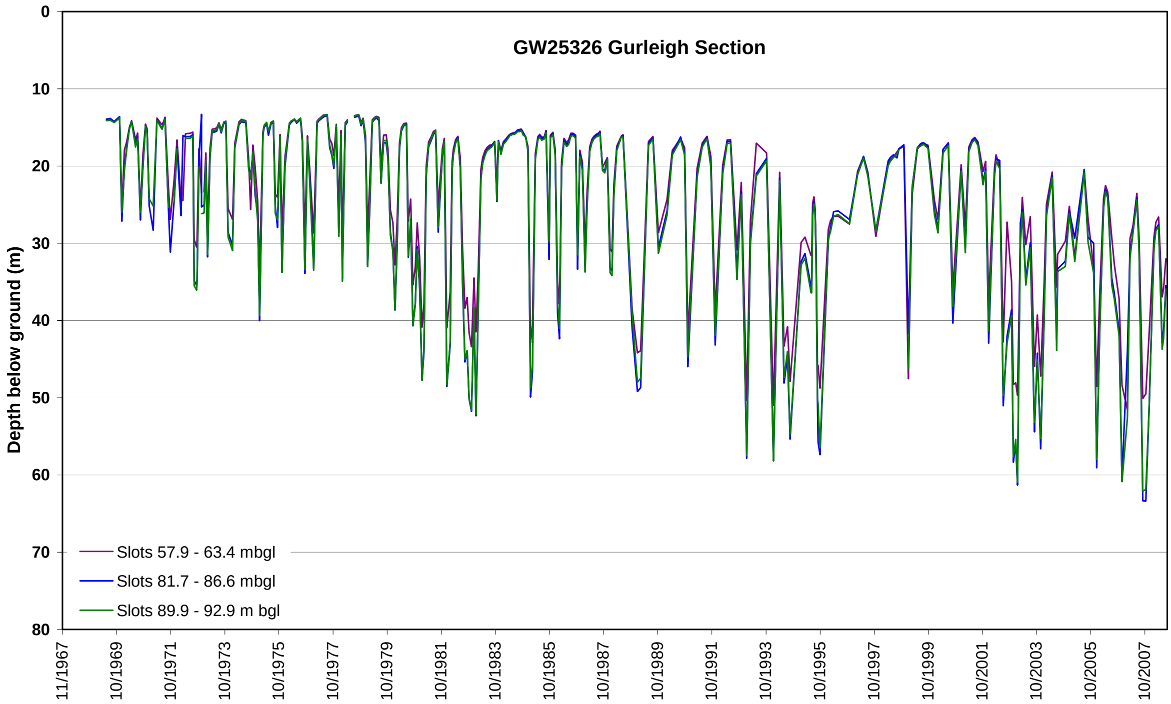
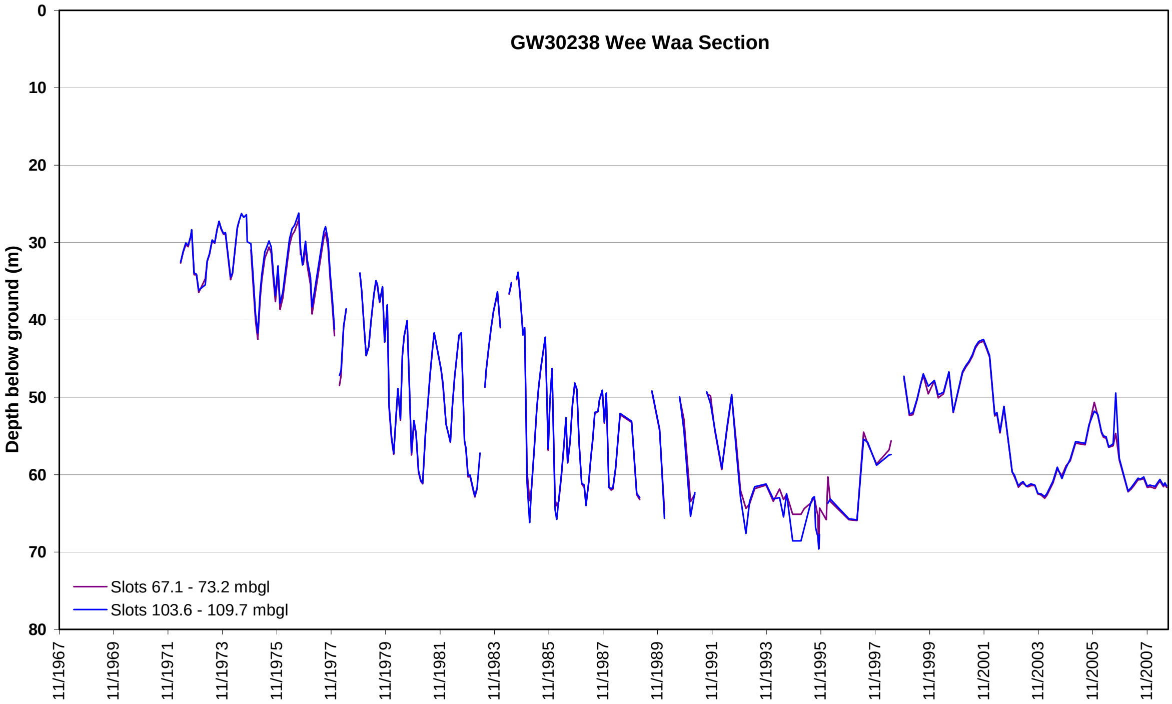


Figure 11 shows the hydrograph for site GW 25326. At this site all three bore pipes are screened in the Gunnedah and Cubbaroo Formations. The very similar behaviour of water levels shows that at this location these formations are in good hydraulic connection. The deeper aquifers are highly confined here, as shown by the pronounced pressure drawdowns during pumping. In the 2006–07 pumping season, drawdown in the deepest aquifer was around 39.3m (59 per cent of saturated thickness). Since development, the long-term trend has been a decline in water levels and the recovery decline in the deep aquifer is 9.3m (12 per cent of saturated thickness).

The data for Figure 12 was collected from a bore with pipes screened in the Gunnedah and Cubbaroo Formations. The very similar behaviour in water levels shows that at this location these formations are in good hydraulic connection and the deeper aquifers are partially to fully confined. A reduction in groundwater between 1994 and 2001 resulted in a significant recovery in groundwater pressures during that period. In the 2006–07 pumping season, water levels in the deep aquifer reached 62m below ground level (41 per cent of saturated thickness). Since development, the long-term trend has been a decline in water levels and the recovery decline in the deep aquifer is 28.5m (33 per cent of saturated thickness).

Figure 12 Hydrograph for groundwater monitoring site GW30238



The data for Figure 13 was collected from a bore with a shallow pipe screened in the Narrabri Formation and a deeper pipe in the Gunnedah Formation. The difference in the behaviour of water levels between the shallow and deeper aquifers shows that at this location the shallower and deeper formations are in limited hydraulic connection. The deeper aquifer is partially confined. Lower pressures in the deeper aquifer are inducing leakage from the shallower aquifer, and there is a long-term trend of declining water levels in both aquifers. During the pumping season of 2006–07, drawdown in the deep aquifer was around 7m (25 per cent of saturated thickness). Since development, the recovery decline in the deep aquifer is 8.7m (16 per cent of saturated thickness).

Figure 13 Hydrograph for groundwater monitoring site GW25045

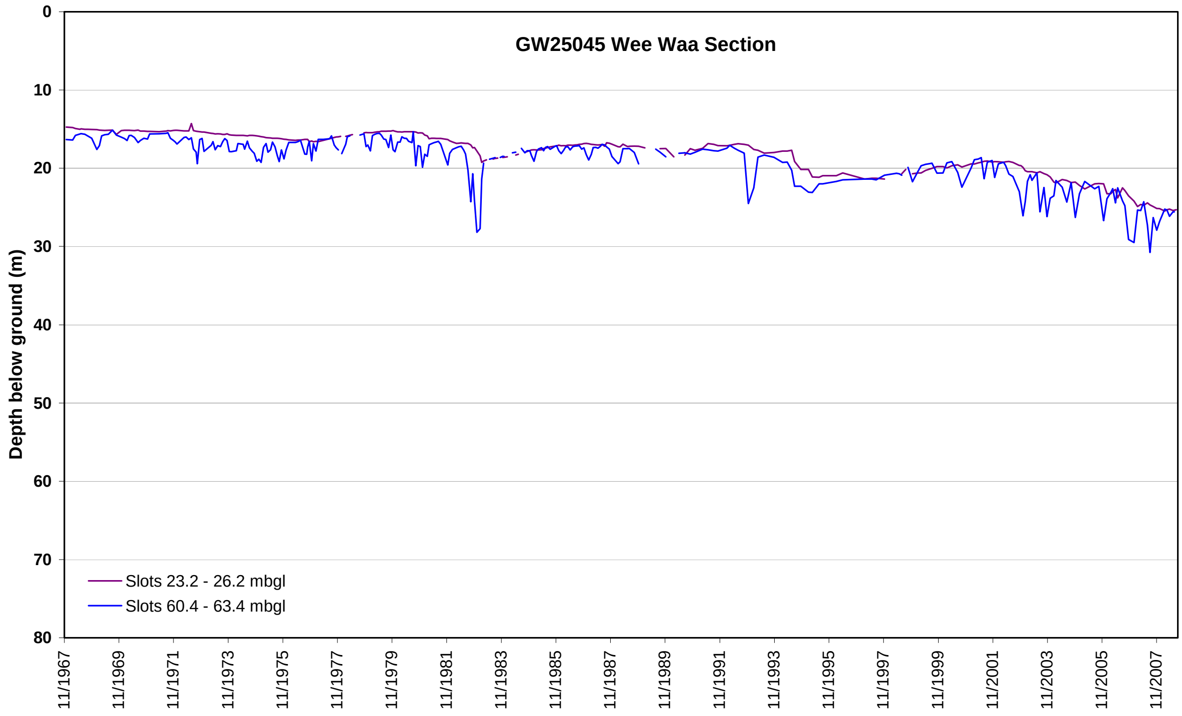
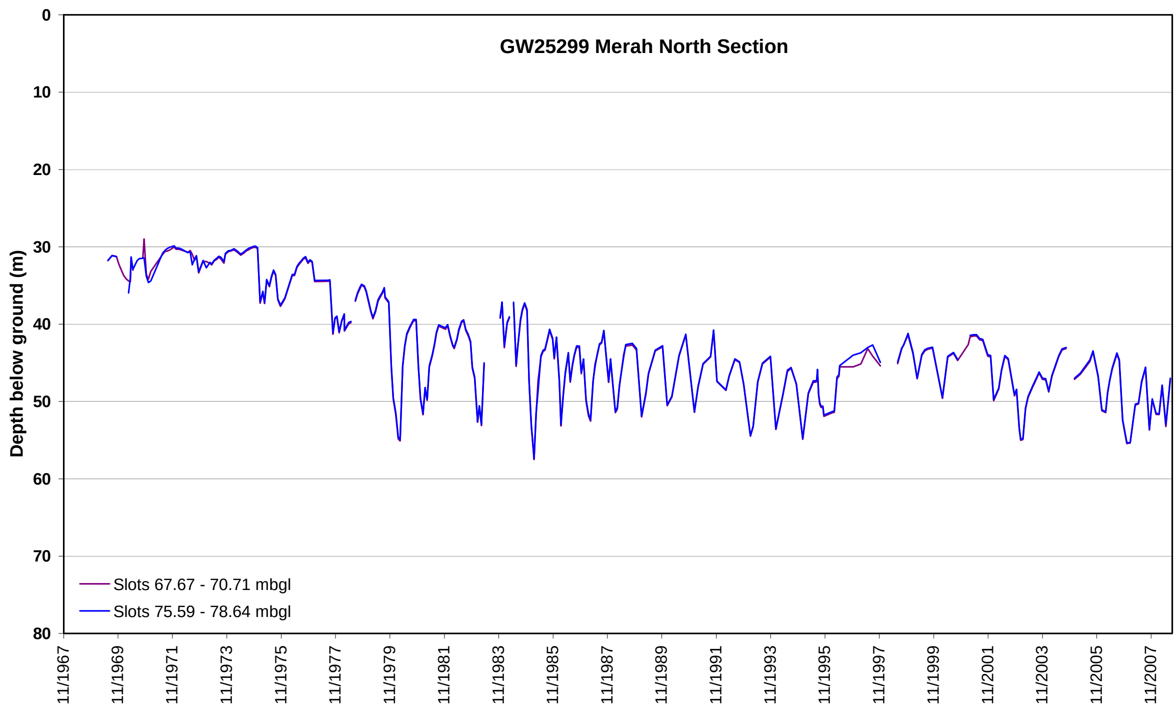


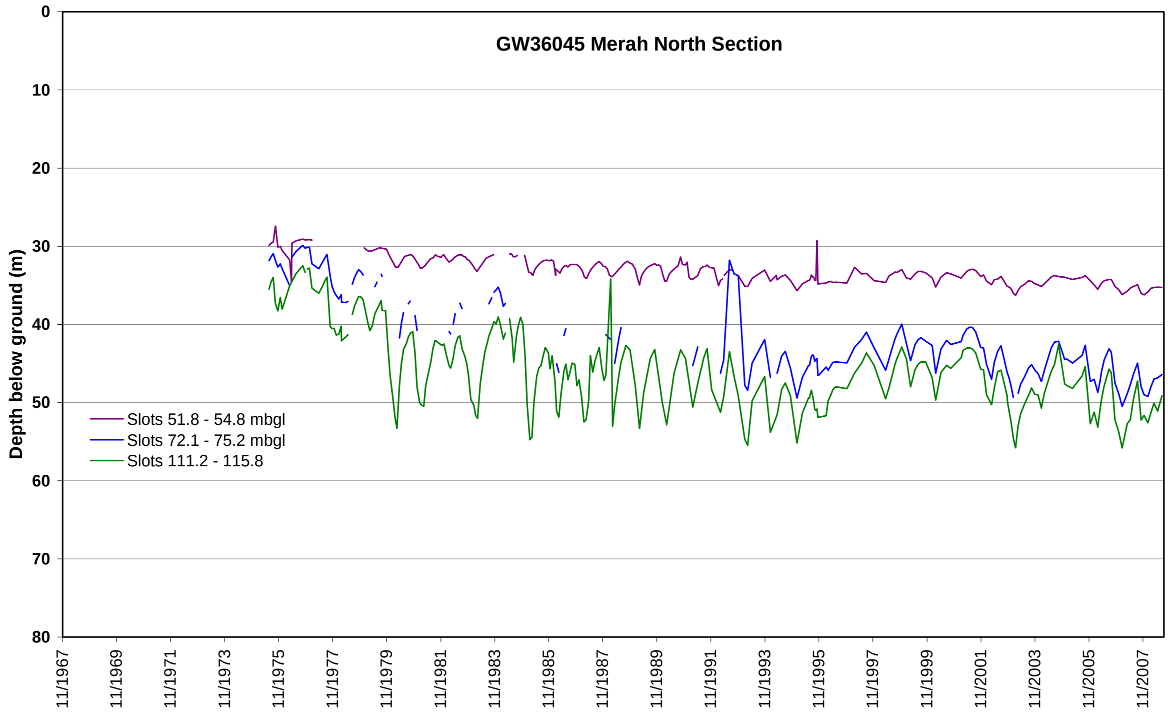
Figure 14 Hydrograph for groundwater monitoring site GW25299



The data for Figure 14 was collected from a bore with two pipes screened in the Gunnedah Formation. At this location this aquifer is partially to fully confined. A reduction in groundwater extraction between 1994 and 2001 resulted in a recovery in groundwater pressures during that period. In the 2006–07 pumping season, drawdown in the deep aquifer was around 11.6m (44 per cent of saturated thickness). Since development, the long-term trend has been a decline in water levels and the recovery decline in the deep aquifer is 13.8m (24 per cent of saturated thickness).

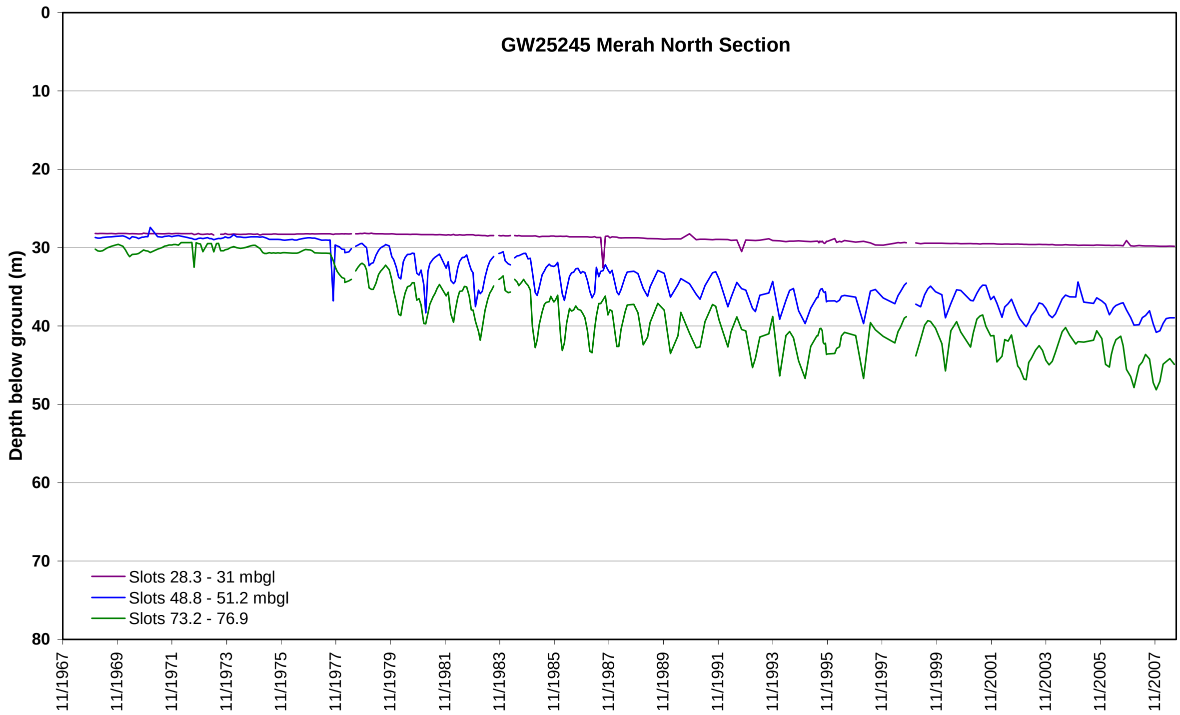
The data for Figure 15 was collected from a bore with pipes screened in the Gunnedah and Cubbaroo Formations. The slight difference in water level behaviour between the shallowest pipe and the two deeper pipes shows that there is limited hydraulic connection between these parts of the aquifer. The shallower part of the aquifer is only partially confined. The more similar behaviour in water levels in the deeper pipes shows that these parts of the formation are in good hydraulic connection and are partially to fully confined. Prior to development, the head difference between the shallower and deeper parts of the aquifer was 5.9m, with a downwards hydraulic gradient. Since extraction commenced, this pressure difference has increased to 13.8m. In the 2006–07 pumping season, drawdown in the deepest aquifer was around 9.6m (28 per cent of saturated thickness). Since development, the long-term trend has been a decline in water levels and the recovery decline in the deep aquifer is 13.6m (16 per cent of saturated thickness).

Figure 15 Hydrograph for groundwater monitoring site GW36045



The data for Figure 16 was collected from a bore with pipes screened in the Narrabri and Gunnedah Formations. The different behaviour in water levels in the shallowest pipe compared to the two deeper pipes shows that there is limited hydraulic connection between the two formations. The more similar behaviour of water levels in the two deeper pipes shows that these parts of the formation are in relatively good hydraulic connection, and are partially confined. Prior to development, the difference in the heads of the shallower and deeper parts of the aquifer was 1.8m, with a downwards hydraulic gradient. Since extraction commenced, this pressure difference has increased to 15m. In the wetter years of 1996–2001, when extraction was reduced, the water levels in the deeper aquifer stabilised, however, they continued to decline in the shallow aquifer. In the 2006–07 pumping season, drawdown in the deepest aquifer was around 6.6m (40 per cent of saturated thickness). Since development, the long-term trend has been a decline in water levels and the recovery decline in the deep aquifer is 12.8m (27 per cent of saturated thickness).

Figure 16 Hydrograph for groundwater monitoring site GW25245



The data for Figure 17 was collected from a bore with a shallow pipe screened in the Narrabri Formation and a deeper pipe screened in the Gunnedah Formation. The difference in behaviour of water levels shows that at this location the shallower and deeper formations are in limited hydraulic connection, with the deeper aquifer being partially confined. Lower pressures in the deeper aquifer are inducing leakage from the shallower aquifer, and both aquifers show a long-term declining trend. Prior to development, the head of the deep aquifer was about 0.02m higher than the head of the shallow aquifer. Since extraction commenced, this pressure difference has reversed. The deeper aquifer now has a head around 4.5m below that of the shallow aquifer. Since 2005, water levels have fallen below the screened interval in the shallow pipe, and no readings have been possible. In the 2006–07 pumping season, drawdown in the deeper aquifer was around 6.5m (47 per cent of saturated thickness). Prior to development, the available head at this location was 32m. In 2008 this has reduced to 20.8m. Since development, the recovery decline in the deep aquifer has been 11m (34 per cent of saturated thickness).

Figure 17 Hydrograph for groundwater monitoring site GW25141

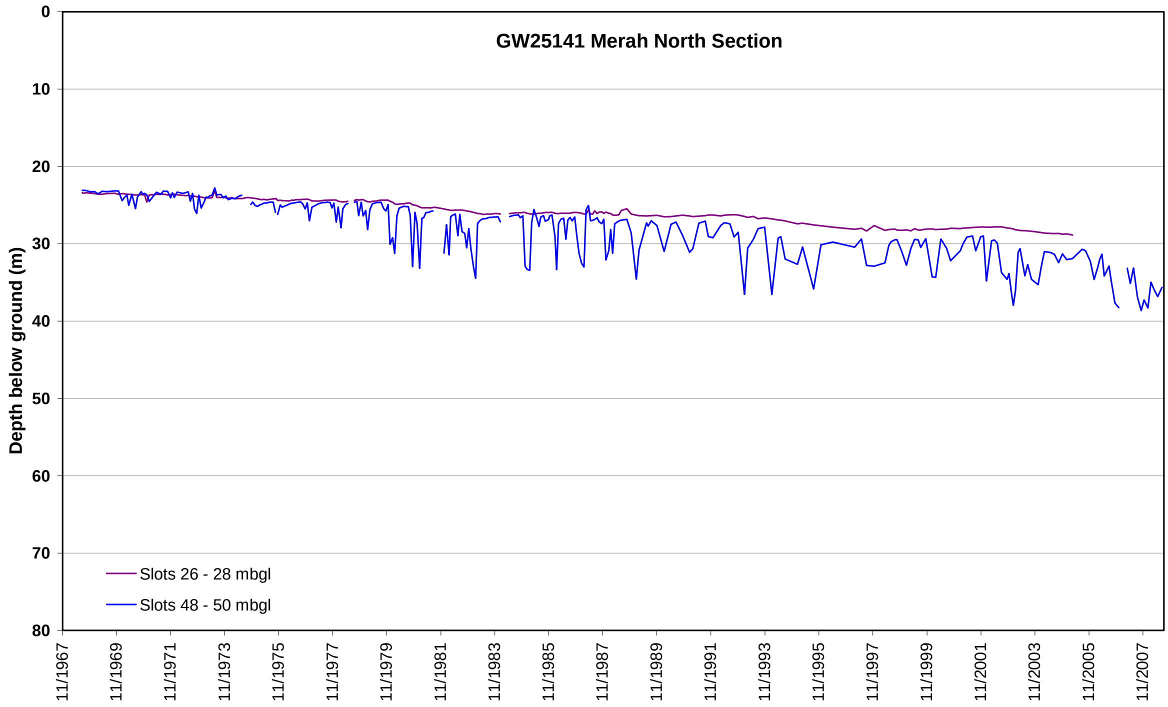
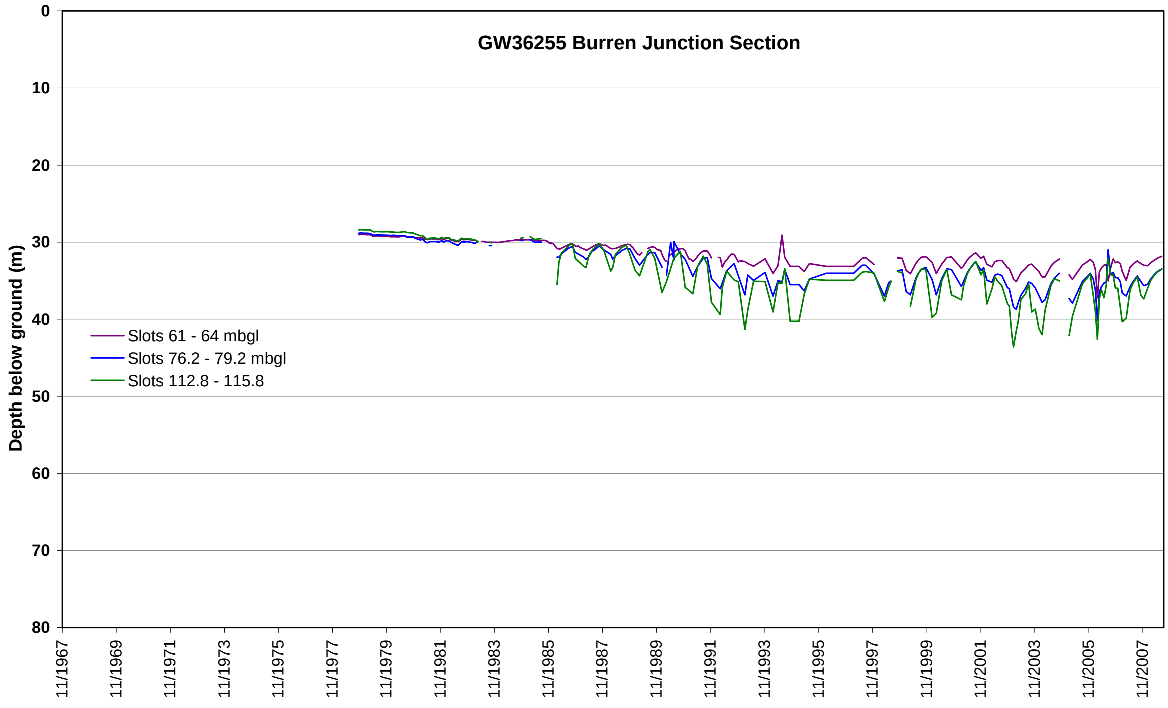


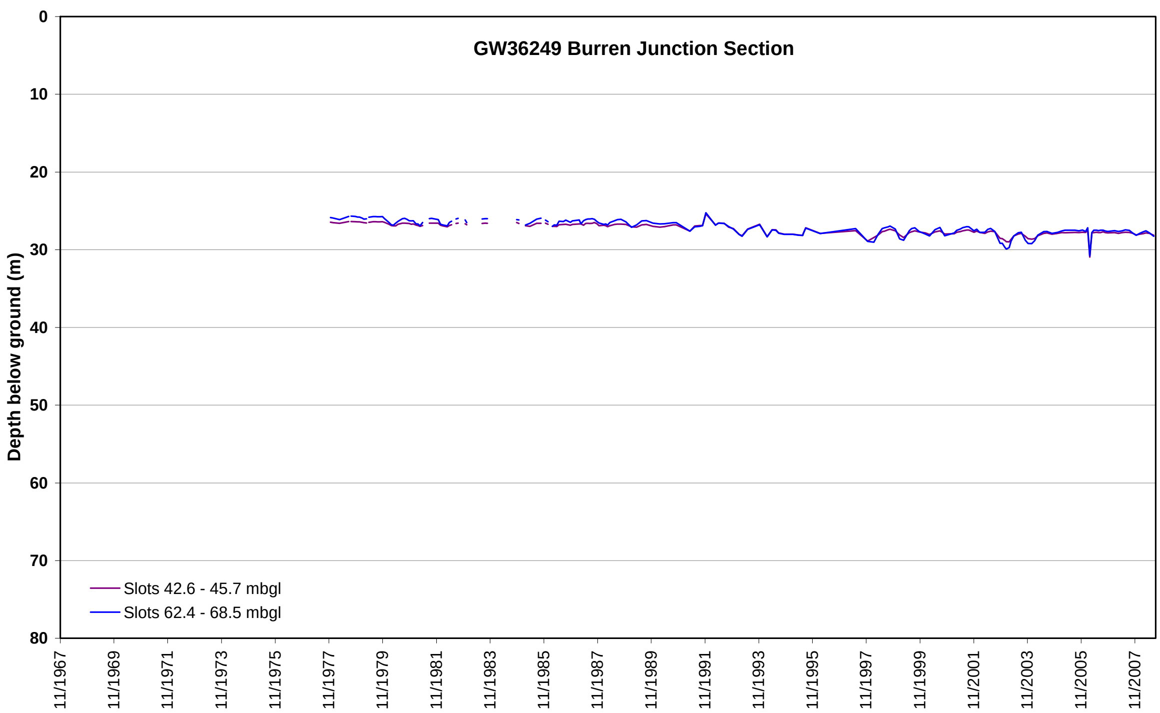
Figure 18 Hydrograph for groundwater monitoring site GW36255



The data for Figure 18 was collected from a bore with pipes screened in the Gunnedah and Cubbaroo Formations. The similar behaviour of water levels in the pipes shows that the formations are in relatively good hydraulic connection, and are partially to fully confined. Prior to development, the difference between the heads in the shallower and deeper parts of the aquifer was 0.4m, with a downwards hydraulic gradient. Since extraction commenced, this pressure difference has increased to 1.7m. Since the wetter years of 1996–2001, when extraction was reduced, the water levels in all aquifers have stabilised. In the 2006–07 pumping season, drawdown in the deepest aquifer was around 6m (13 per cent of the saturated thickness). Since development, the recovery decline in the deep aquifer is 6m (7 per cent of saturated thickness).

The data for Figure 19 was collected from a bore with two pipes screened in the Gunnedah Formation. The similarity in behaviour of water levels shows that the shallower and deeper formations are in relatively good hydraulic connection at this location. Both parts of the aquifer show a long-term declining trend in water levels. Prior to development, the head of the deeper aquifer was 0.6m higher than the head of the shallow aquifer. Since extraction commenced, this pressure difference has reduced. The head of the deeper aquifer is now around 0.14m below that of the shallower aquifer. Since development, the recovery decline in the deeper aquifer is 1.6m (4 per cent of saturated thickness).

Figure 19 Hydrograph for groundwater monitoring site GW36249



The data for Figure 20 was collected from a bore with pipes screened in the Narrabri and Gunnedah Formations. The dampened response of water levels in the shallowest pipe indicates that it has a limited connection with the deeper aquifers. The similar behaviour in water levels in the two deeper pipes shows that these formations are in relatively good hydraulic connection and that the deeper aquifers are partially to fully confined. Prior to development, the head of the deep aquifer was about 0.3m higher than the head of the shallow aquifer. Since development, the pressure difference has reversed and the head of the deeper aquifer is now around 3.5m below that of the shallow aquifer. In the 2006–07 pumping season, drawdown in the deepest aquifer was around 12.5m (39 per cent of saturated thickness). Since development, the recovery decline in the deep aquifer is 8.7m (19 per cent of saturated thickness).

Figure 20 Hydrograph for groundwater monitoring site GW36320

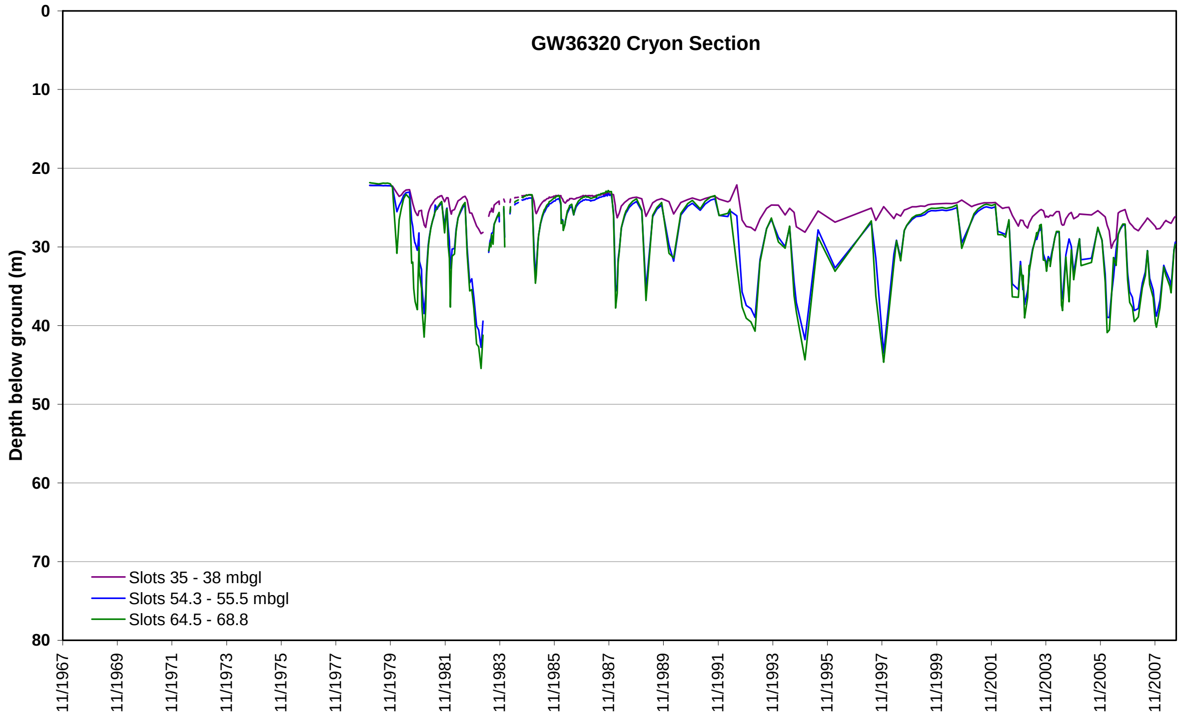


Figure 21 The area where the pumped aquifer has become unconfined

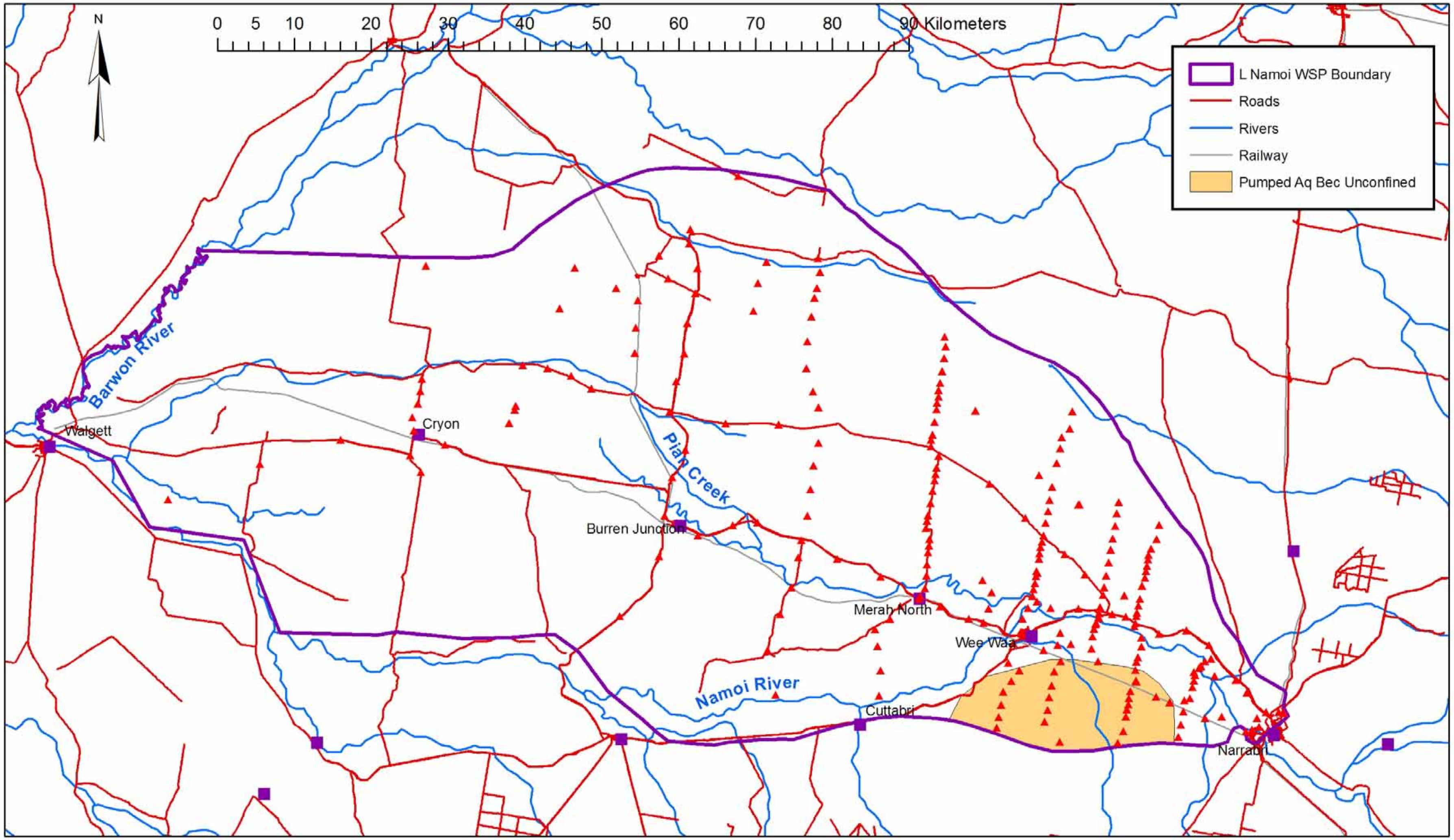
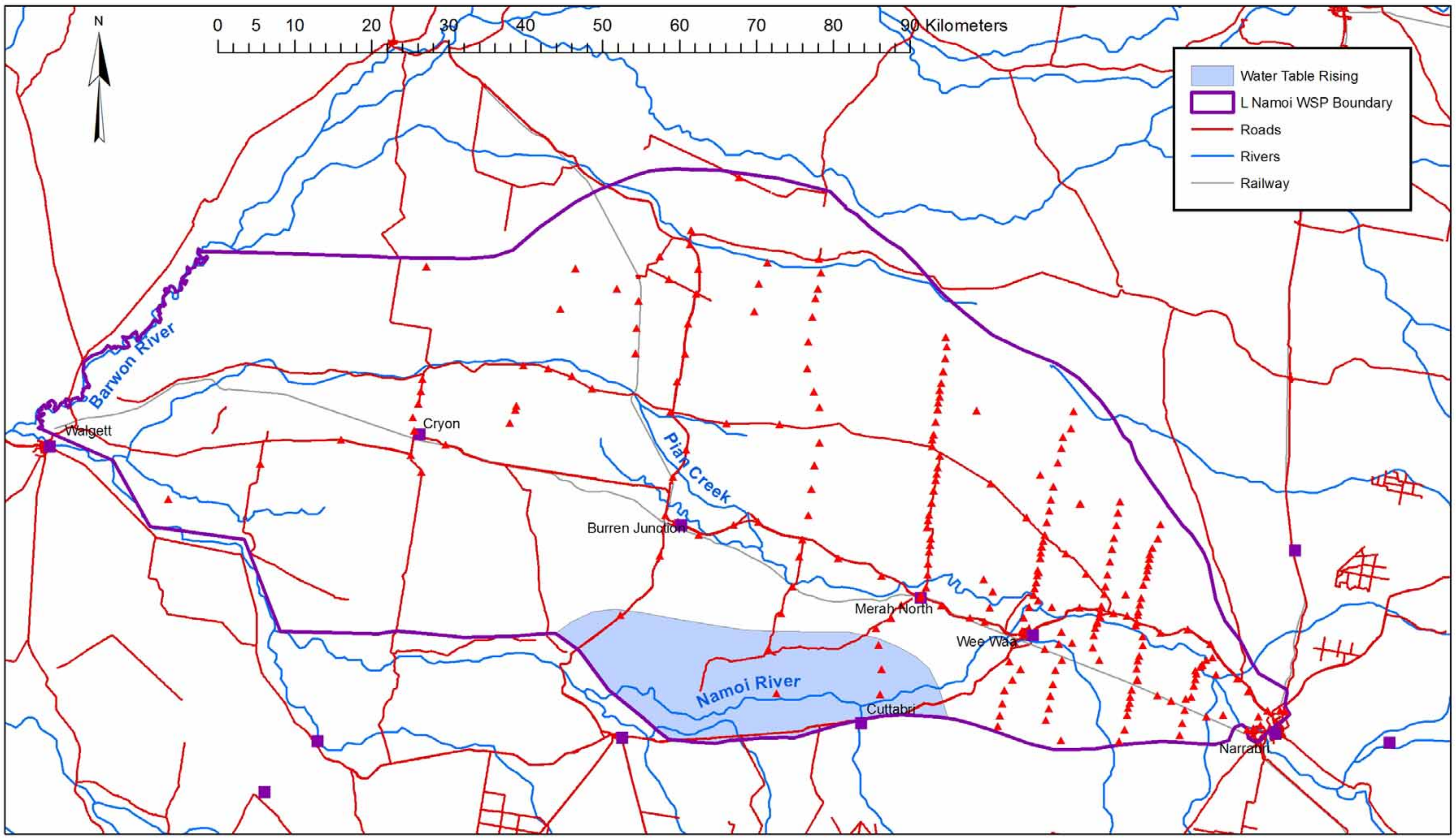


Figure 22 The area where groundwater levels show a rising trend



9.3 Drawdown and recovery

An unconfined aquifer is a groundwater system, usually near the ground surface, which is in connection with atmospheric pressure and whose upper level is represented by the water table. The water table is the upper surface of groundwater or the level below which an unconfined aquifer is saturated with water. A confined aquifer is a groundwater system which is isolated from atmospheric pressure by a layer of relatively impermeable material, and whose upper pressure level is represented by the potentiometric surface. The potentiometric surface is a pressure surface that represents the total head of groundwater, and is defined by the level to which water will rise in a bore. The potentiometric surface indicates the pressure or head of water at a given location and depth, it does not necessarily represent the top of the saturated zone. Potentiometric surfaces are presented in this report in metres Australian Height Datum (AHD), where mean sea level is 0m. This provides a reference level for the measurement of groundwater height that is independent of topography.

Figure 23 shows the potentiometric surface and groundwater flow directions for the deep aquifer (Gunnedah and Cubbaroo Formations) prior to its development. Figure 24 shows the potentiometric surface and groundwater flow directions for the deep aquifer during the 2006–07 pumping season.

Prior to development of the aquifer, groundwater heads and flow directions were primarily in a westerly to north-westerly direction. Pumping has reduced the pressures in some areas and caused the potentiometric surface to change shape, resulting in changed groundwater flow directions. Comparison of the groundwater heads and flow directions shown in and Figure 24, confirms several areas where pre-development groundwater flow directions were being reversed during the 2006–07 pumping season.

Figure 23 The potentiometric surface and groundwater flow directions in the deep aquifer prior to its development

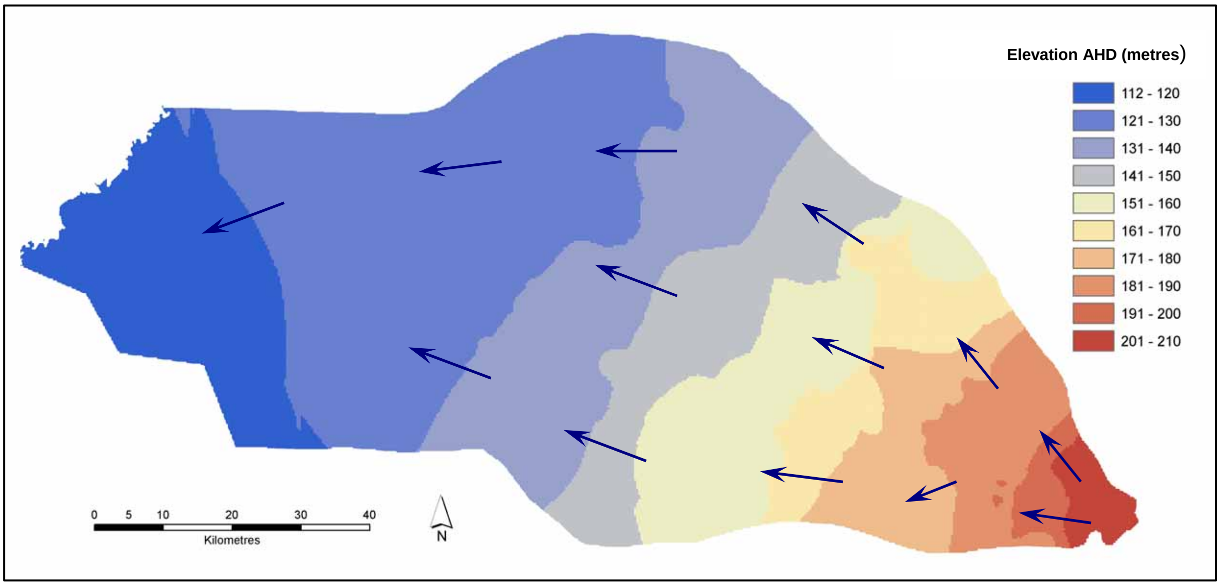


Figure 24 The potentiometric surface and groundwater flow directions in the deep aquifer during the 2006–07 pumping season

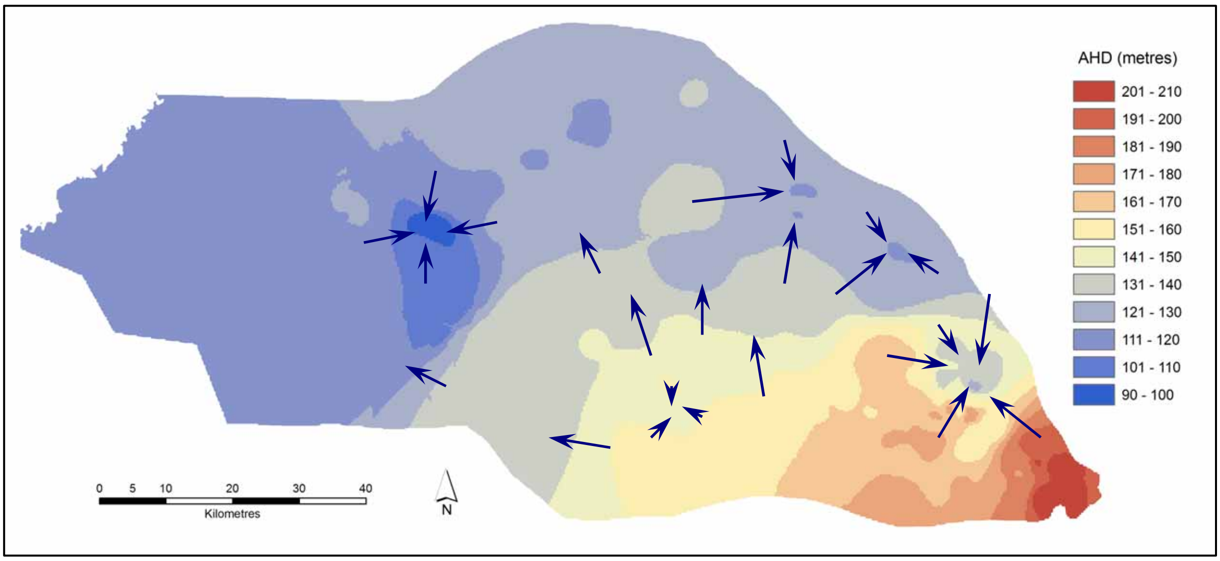
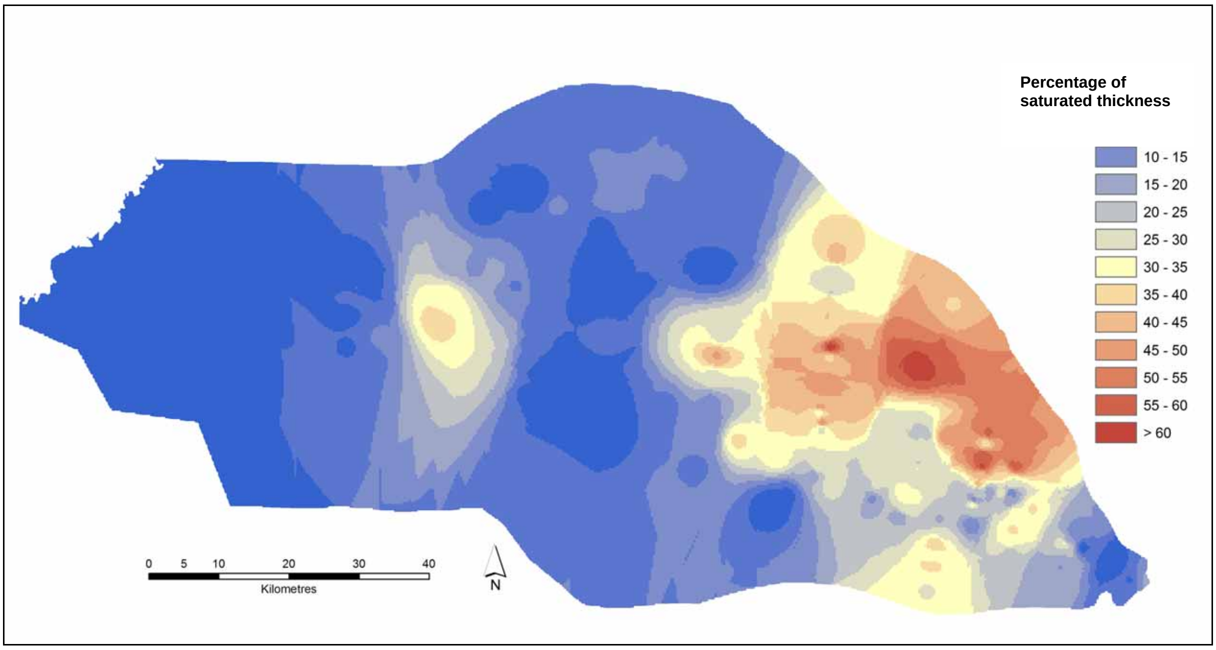


Figure 25 Drawdown as a percentage of saturated thickness in the deep aquifer during the 2006–07 pumping season



The saturated thickness of an aquifer is defined as the area between the pre-development potentiometric surface and the base of the aquifer. The saturated thickness is important because it controls the amount of available drawdown in bores and the depth at which pump intakes must be set. Figure 25 shows drawdown as a percentage of the saturated thickness in the deep aquifer during the 2006–07 pumping season. This figure shows sizeable areas in the catchment where drawdown has reached 40 per cent of the saturated thickness, and places where up to 60 per cent of the saturated thickness is being drawn down during pumping.

The recovered head is the level to which the potentiometric surface recovers at the end of each pumping season. Recovery of water levels is important for the health and functioning of the aquifer and for the economic benefit of its users. Figure 26 shows the potentiometric surface of the recovered head of the deep aquifer in 2007.

The recovery decline is the difference between the pre-development potentiometric surface and the recovered potentiometric surface. When the groundwater head does not recover to the level of pre-development over time, this indicates potential for a long-term decline in groundwater levels. Figure 27 shows the recovery decline in the deep aquifer since its development. Figure 28 shows the recovery decline in the deep aquifer as a percentage of the pre-development saturated thickness.

Figure 27 shows areas where recovery decline is more than 10m, and up to 30m. The location of these areas corresponds closely with the location of the areas with significant drawdowns, shown in Figure 25. In some parts of the aquifer, recovery decline has reached up to 40 per cent of the predevelopment saturated thickness.

Figure 26 The recovered head of the deep aquifer in 2007

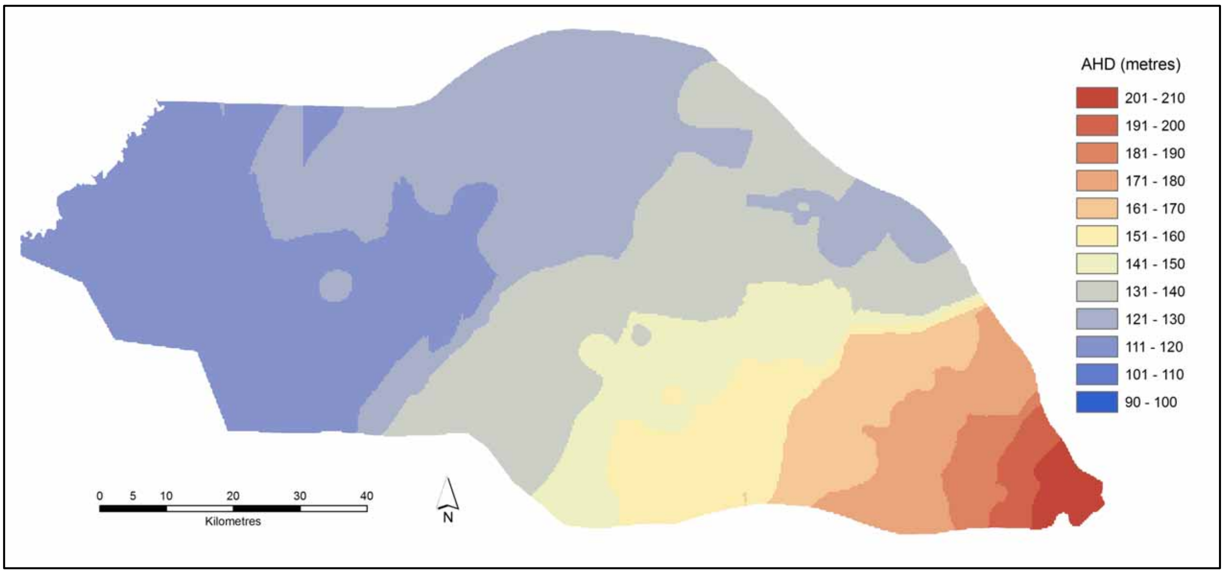


Figure 27 Recovery decline in the deep aquifer since its development

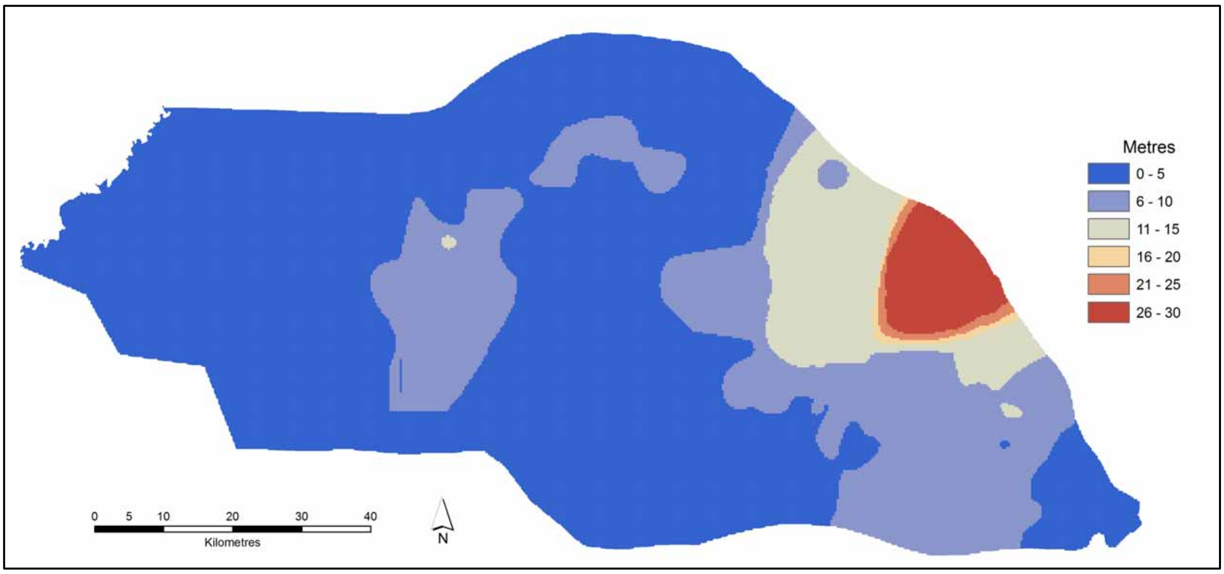
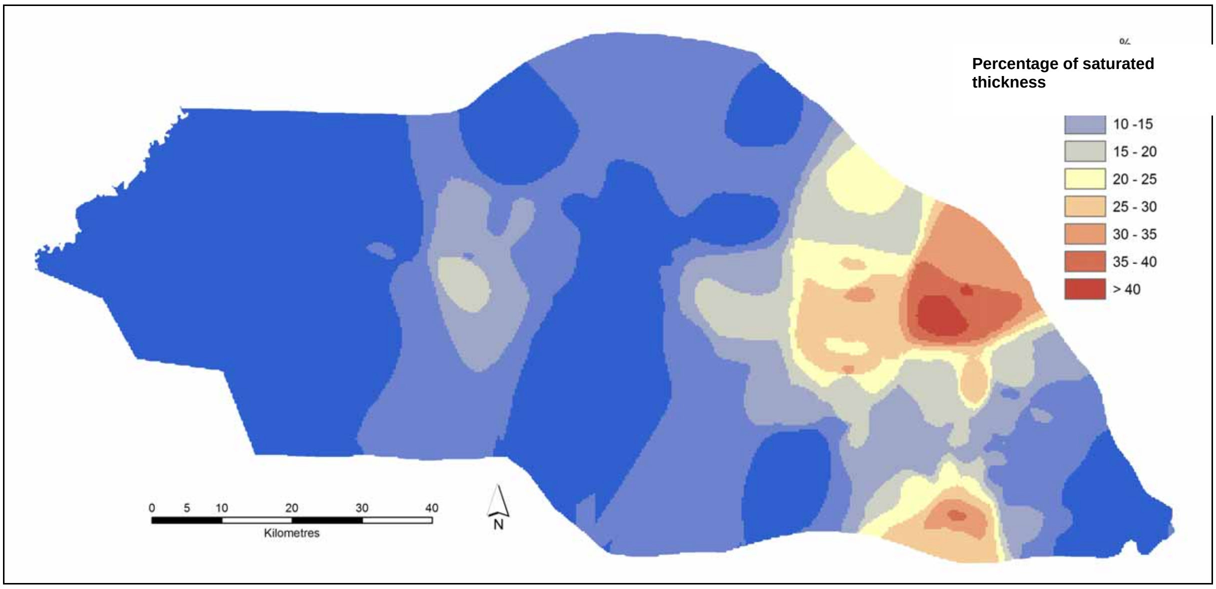


Figure 28 Recovery decline as a percentage of saturated thickness



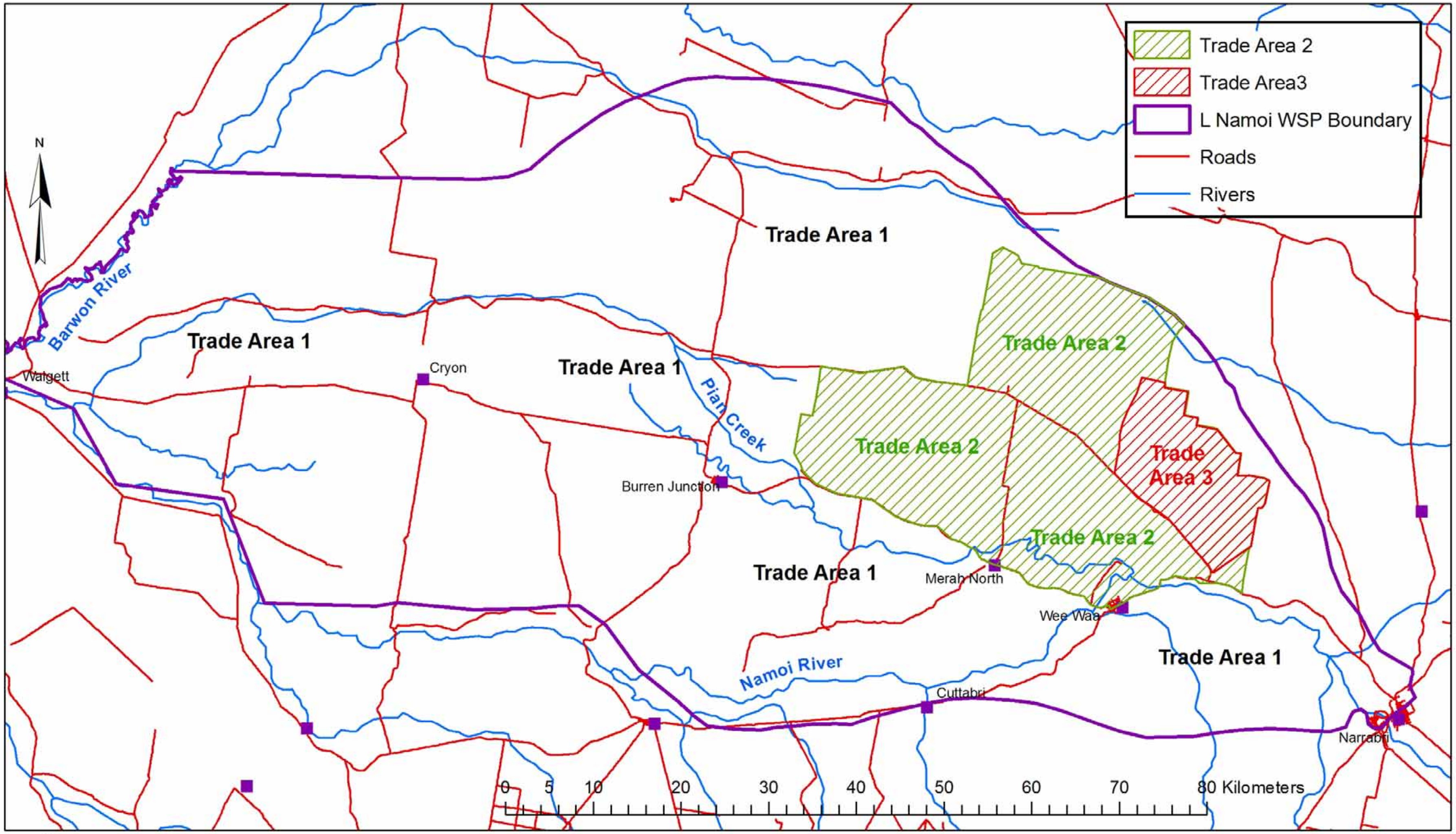
10 Community consultation and management of drawdown impacts

The findings of the 2006–2008 assessment of groundwater status were presented to the Lower Namoi groundwater community on 11 September 2008 at Wee Waa. The presentation included a discussion of groundwater management and acceptable impacts.

As a result of the levels of impact occurring, trade restricted areas were proposed for the areas where drawdowns have reached 40 per cent and 50 per cent of saturated thickness and show recovery decline. The intention of these restrictions is to limit further impacts from additional water being traded into these areas of greater impact. The proposed trade restricted areas were presented at the community meeting for discussion and comment.

The criteria for dealings assessments in the Lower Namoi, including trade restricted areas, took effect on 10 November 2008. Figure 29 shows the trade restricted areas. Appendix A gives the dealings assessment criteria and an explanation of the trade restricted areas.

Figure 29 Trade restricted areas in the Lower Namoi Groundwater Source



11 References

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Williams, RM 1997, *The Cainozoic geology, hydrogeology and hydrochemistry of the unconsolidated sediments associated with the Namoi River in the Lower Namoi Valley, NSW,* NSW Department of Land and Water Conservation, Sydney, NSW.

State of Queensland (Natural Resources and Mines, on behalf of the Climate Impacts and Natural Resource Systems, 2000), 1998 (Cited 4 December 2008) *The SILO Patched Point Dataset (PPD)*

Appendix A. Lower Namoi Groundwater Source: Dealing assessment criteria

(Effective 10 November 2008.)

Introduction

Trade areas have been established in the Lower Namoi Groundwater Source to manage the impacts of additional extraction from groundwater trading. Dealings received by State Water Corporation from the date that this policy takes effect will be assessed in accordance with the criteria set out below.

Permanent dealings (71M, 71N, 71Q and 71W)

- Permanent dealings may be permitted:
  - between properties within the same trading zone
  - from Area 3 into Areas 1 and 2
  - from Area 2 into Area 1
  - from Area 1 into Area 2, or from Area 2 into Area 3, where seller and buyer properties are contiguous and are run as a single farming unit, but are dissected by a trade area boundary.

- All permanent dealings will be subject to a full assessment by DWE. Permanent dealings that are assessed as having an adverse impact may still be refused by DWE.
- All assessments for permanent trades will be done on the following criteria calculated at the end of a 10-year period:
  - The calculated drawdown at 200m from any production bore will not exceed 40 per cent of the saturated thickness of the alluvium.
  - The additional drawdown at the nearest neighbouring bore screened in the same aquifer will not exceed 2m.
- A dealing may be approved subject to licence conditions being placed on nominated work or combined approvals such as bore extraction limits to minimise potential impact on neighbouring bores.

Temporary dealings (71T)

- Temporary trades may be permitted:
  - between properties within the same trading zone
  - from Area 3 into Areas 1 and 2
  - from Area 2 into Area 1
  - from Area 1 into Area 2, or from Area 2 into Area 3, where seller and buyer properties are contiguous and are run as a single farming unit, but are dissected by a trade area boundary.

Temporary dealings that are permitted by these assessment criteria will be received by DWE and processed without hydrogeological assessment.