From: [redacted]
Sent: Monday, 30 March 2020 10:13 AM
To: Samantha McLean <[redacted]>
Cc: 'David And Janet' <[redacted]>; 'Jenny Darley' [redacted]>;
[redacted]
Subject: Vickery Extension Project assessment

Professor Samantha McLean,
A/Chair
Independent Planning Commission

Dear Samantha,

The Liverpool Plains community is patiently waiting for the IPC determination after the 'all of government report 'by the department
My view, is that the hydrology and hydrogeological field investigations, already undertaken, clearly show that the risk to erosional flooding and aquifer recharge is too high.
I have determined this on a risk/benefit analysis, bot short term and long term.
Sustainable agriculture is the outcome that the people of the plains are looking for in terms of 'intergenerational equity'.

I have attached just three of my papers dealing with this location as my case study area in the course Doctor of Sustainable Agriculture.
In 2009 I was awarded Master of Sustainable Agriculture, Sydney University.
My academic studies have always been 'needs driven' and practical.
And more than ever I need this now!

My wife and I have worked on our farm for 46 years and it is our superannuation and children's inheritance.
I appeal to you to carefully consider this Project before giving your determination.
My view is clearly stated in my papers.
In particular look at side slope aquifer recharge as it is often overlooked in assessing the cumulative risk of large coal seam and coal mine proposals.

Yours Sincerely
Ken Crawford

WATER WARS

In this column, irrigator, researcher and MacLean-Iedema Award winner Ken Crawford gives his view on the clash between the interests of coal mining and water users.

Agriculture and mining are important contributors to the Australian economy. Iron ore and coal combined make up almost a quarter of the value of our export income, and agriculture about 14 per cent (2016-17).

The expansion of mining in the last two decades and pressure on irrigators to improve irrigation water use efficiency have seen growing competition in regional Australia between rural communities and mining for water and land resources.

With a range of applications for new coal mines and extensions to existing mines and coal seam gas projects currently being assessed, and different water access rules for mining and agriculture in some instances, rural communities are understandably very concerned by the potential risks to town drinking water, as well as supplies for irrigation and stock use.

Against this backdrop of competition between sectors for water, unprecedented drought, bushfires and hailstorms heralded in the new decade. For the irrigation and water sectors, these climatic challenges added to those of policy development and implementation at state and federal level.

This has intensified the competition we see today - from the Galilee Basin in north Queensland to the Gunnedah Basin and Hunter Valley in New South Wales - in securing our scarce natural resources for productive use. Often, water simply goes to the highest bidder.

Complete understanding of resource necessary

Before any new development it is crucial that costs – both short and long-term - are considered, as well as their benefits. This applies particularly to our precious freshwater resources, especially groundwater. Any assessment must understand the nature of these resources and the impact of development, including on what is below the surface as well as what is above.

While regulatory and approving authorities have a reasonably good understanding of surface water resources, understanding of underground resources is problematic. For this reason, mapping the underground bedrock landscape, as has been done in some valleys such as the Upper Namoi, should have a high priority before mining goes ahead in any area and be considered in any assessment process.

Is there a solution?

The stage is set in 2020 for many valleys in Australia to decide what they want. The question is, do we need more new coal mines and coal seam gas proposals at the expense of access to surface water and groundwater? Fossil fuel or water; can rural communities have both?

I believe that agriculture and mining can co-exist if there is mutual understanding and respect. Understanding surface water and groundwater in the real catchments of valleys is paramount. Hydrology and hydrogeological field studies are the key and political expediency must be put aside.

The science must be presented to assure the catchment communities that their voice will be heard and that the assessment process will be transparent and accountable.

Part of the northern area of the Liverpool Plains, where an extension to a coal mine is being considered. The black soil plains shown overlie quality alluvial groundwater. *Photo: Ken Crawford 1991.*

Principles important to apply include: not crossing prime agricultural floodplain land with mining infrastructure; no longwall coal mining under the plains; no large, open cut mines in the aquifer recharge areas of the side-slope catchment; and assessing aquifer interference through run-off and deep drainage recharge in all new proposals, including extensions to approved mines. Eyewitness accounts of flooding in the valleys must be listened to and acted upon. Built infrastructure on our dynamic floodplains should always be closely examined and, above all, the 'precautionary principle' should apply.

Groundwater is as precious as buried treasure, so we must value it.

We should be applying these principles currently to the Upper Namoi Valley, where an extension to the Vickery coal mine is being considered. The project includes building a coal handling and preparation plant, a train load-out facility and a spur rail line across the Liverpool Plains. It will take coal across the Namoi River and the river floodplain to Emerald Hill, where it will join the Mungindi to Werris Creek railway then to Newcastle.

If approved, this spur rail line will take coal from several mines across the river to create a mega mine. This will not do. The plains communities of Boggabri, Gulligal and Emerald Hill are understandably upset. They have been dealing with this threat to their livelihoods and families for over two years, as well as the unprecedented drought.

In my view, the science of the catchment - above and below ground - is not being considered by mine owners, who have instead relied on transient numerical models to predict future flood heights.

A safer option is to keep off the floodplain and use the alternative access already approved. In this manner the Namoi River and its floodplain will remain connected and the ecology of the river and its floodplain will be preserved in accordance with long-term planning principles.

These black-soil plains will be farmed for thousands of years if we care for them, while the coal mine is projected to last for 25 years. This raises the question of 'intergenerational equity'. We are custodians of this area for our children and grandchildren and we must take this responsibility seriously and not allow the northern end of the Liverpool Plains to be compromised in terms of land and water.

The Independent Planning Commission (IPC) will soon make the determination whether to give development consent. My view is that science should be allowed to prevail. This will assure the people who live and work on the plains that their voice will be heard and that the process is transparent and accountable.

Ken Crawford

Water Wars 2020

Ken Crawford

Agriculture and Mining make a big contribution towards our export earnings. There is increasing competition in Australia between rural communities and mining for water and land resources. Surface water and especially groundwater is precious and there is a price to pay under our current regulations, both in the short term and the long term. There is an economic price to pay in the short term and ecological price in the long term. This has led to a bidding war for water and land.

There are many new coal mines and extensions to existing mines and coal seam gas projects undergoing the process of approval right now. Rural communities are understandably very concerned by these proposals that pose a high risk to their water supplies, for town drinking water, irrigation and stock and domestic productive use.

Mapping the underground bedrock landscape should have a high priority before mining goes ahead. In some valleys like the Upper Namoi Valley this has already been done. The findings should be considered front and centre of the assessment process. The battle between science and politics is ongoing and the future of our children in terms of 'intergenerational equity' is at stake.

Unprecedented drought, bushfires and hailstorms heralded in the new decade. It is obvious to most people in Australia that an age of extreme weather events and climate change has arrived. For the irrigation and water sectors, these climatic challenges add to those of policy development and implementation at state and federal level. This has brought us to the price war we see today in securing our scarce natural resources for productive use. Water goes to the highest bidder.

From the Galilee Basin in north Queensland to the Gunnedah Basin and Hunter Valley in New South Wales, we see rural communities and mining interests at war contesting access to water and land. The stage is set in 2020 for many valleys in Australia to decide what they want. The question is; do we need more new coal mines and coal seam gas proposals at the expense of access to surface water and groundwater? Fossil fuel or water: rural communities must choose.

The cumulative risk of large-scale coal mines and coal seam gas proposals is placing rural communities under threat in terms of social, environmental and economic outcomes. The risk to surface/groundwater supplies and their sustainable use is extremely high. Is there a solution to the problem facing rural communities right now?

Can there be peace in the valley?

I believe that agriculture and mining can co-exist if there is mutual understanding and respect. Understanding surface water and groundwater in the real catchments of valleys is paramount. Hydrology and hydrogeological field studies are the key and political expediency must be put to one side.

The science must be presented to assure the catchment communities that their voice will be heard and transparency and accountability in the assessment process will be adhered to. Prime agricultural floodplain land must not be crossed with mining infrastructure. Longwall coal mining should not be allowed under the plains.

Large open cut mines should not be allowed in the aquifer recharge areas of the sideslope catchment. Aquifer interference through run-off and deep drainage recharge should be assessed in all new proposals including extensions to approved mines. Groundwater is as precious as buried treasure so we should value it.

Eyewitness accounts of flooding in the valleys must be listened to and acted upon.
Built infrastructure on our dynamic floodplains should always be closely examined. The 'precautionary principle' should always apply.

Judgment day in the valley of decision

There is a very relevant case study in the Upper Namoi Valley involving the Vickery Extension Project. It is in the process of assessment right now. The Project, which is really a new mine application, includes the construction of a Coal Handling and Preparation Plant (CHPP), a train load-out facility and a spur rail line across the Liverpool Plains. It will take coal across the Namoi River and the river floodplain to Emerald Hill where it will join the Mungindi to Werris Creek railway then to Newcastle.

If approved, this spur rail line will take coal from a number of mines across the river to create a mega mine. This will not do. The plains communities of Boggabri, Gulligal and Emerald Hill are understandably upset. They have been dealing with this threat to their livelihoods and families for over two years. Together with the unprecedented drought the strain is almost too much for the people of the Liverpool Plains.

There has been a complete lack of empathy from the coal mine and a refusal to listen to the science of the catchment above and below ground. Instead they have relied on transient numerical models to predict future flood heights. This is completely unacceptable and, in my opinion, the Vickery Extension Project should not be given 'development consent'.

Furthermore, in these days of extreme weather events and climate change great care should be taken in examining this Project. The safer option for all concerned is to keep off the floodplain and use the alternative access already approved. In this manner the Namoi River and its floodplain will remain connected. The ecology of the river and its floodplain will be preserved in accordance with long-term planning principles.

Part of the northern area of the Liverpool Plains. Photo source Ken Crawford 1991. Black soil plains overlying quality alluvial groundwater. Emerald Hill in background.

Unintended consequences during flooding will lead to breaches of the Water Act 1912 due to illegal diversion of water. The water spreading principles in the Water Management Act 2000 will attract a non-compliance order if the spur rail line goes ahead. Prime Agricultural Land (PAL) of national significance makes this an 'exclusion zone' for mining and mining infrastructure.

The black soil plains will be farmed for thousands of years if we care for them and I really care for them. The Vickery Extension Project is said to last just 25 years, which raises the question of 'intergenerational equity'. What will we tell our children and grandchildren if we allow the northern end of the Liverpool Plains to be compromised, in terms of land and water? And I will remember the land!

The compromise is that mining should be allowed to continue under the terms of the 2014 approval for the Vickery Coal Mine. The Blue Vale road access to the existing coal loader in Gunnedah using the already approved Kamilaroi Highway overpass is a solution to Vickery's problems and the protection of the Namoi River floodplain.

The Independent Planning Commission (IPC) will make the determination whether or not to give 'development consent'. If the politicians keep out of the multi-stage process the science will prevail. The IPC should be allowed to finish its work without interference. This will assure the people who live and work on the plains that their voice will be heard and that the process is transparent and accountable.

References and further reading

Crawford K, L, (2011) *A new approach to surface/groundwater connectivity mapping*
NSW IAH Symposium 2011 Hydrogeology in NSW
The Challenge of Uncertainty 5-6 September, Dockside, Sydney

Geoscience Australia, (2015) AIG News No 120 May 2015 IAH Seven Wonders
Gins Leap Gap number seven Ken Crawford

Pigram J, J, (2006) *Australia's Water Resources; from use to management*
Upper Namoi Groundwater page 146
CSIRO Publishing

Implications of aquifer recharge for water sharing plans:

a case study from the Upper Namoi Valley

K. Crawford, Principal Consultant, KLC Environmental, J. Ross, Principal Hydrogeologist, Parsons Brinckerhoff (formerly PPK) and Dr W. Timms, Senior Project Engineer, UNSW Water Research Laboratory

The sustainable yield (SY) estimates that are the basis of the many groundwater water sharing plans (WSP) across NSW are strongly influenced by calculations of estimated annual average recharge (EAAR). SY is usually assessed to be a proportion of the EAAR (allowing for environmental requirements) but in the Namoi Valley for the current WSP, the EAAR is assumed to be the SY because there are no identifiable dependent ecosystems.

Groundwater recharge in the Namoi Valley is a complex process that depends on many factors. The processes at work include rainfall recharge, flood recharge, regulated stream flow losses, irrigation returns and valley side-slope runoff. These sources of recharge vary with the area and seasonal climatic conditions.

In the area between Emerald Hill and Gin's Leap (around Boggabri), there are numerous recharge and discharge processes at work that are understood but poorly quantified at this time. The most significant processes are thought to include rainfall (and vertical infiltration across the floodplain), leakage from the Namoi River, flood recharge and side-slope sources. Local flood and side-slope recharge is considered to be undervalued.

This paper examines the Upper Namoi groundwater Zone 4 West (see Figure 1) to demonstrate that the current EAAR calculations may have been underestimated, in part as a result of the effects of soils and underlying layers as a 'pathway' for recharge from rainfall, irrigation returns or flooding not being considered. Gulligal Lagoon fills often as a result of flooding and the extensive catchment areas of ephemeral streams, Collygra Creek and Deadman's Gully are important contributors. Runoff from these local catchments feed the aquifer recharge system (see Figure 2).

Aquifer recharge pathway

Leakage through clay-rich soils and sediments is often overlooked as a source of recharge. In the context of the WSP, quantifying all recharge sources on a local scale, particularly the extra aquifer

Figure 1. Location of the Upper Namoi groundwater Zone 4 West

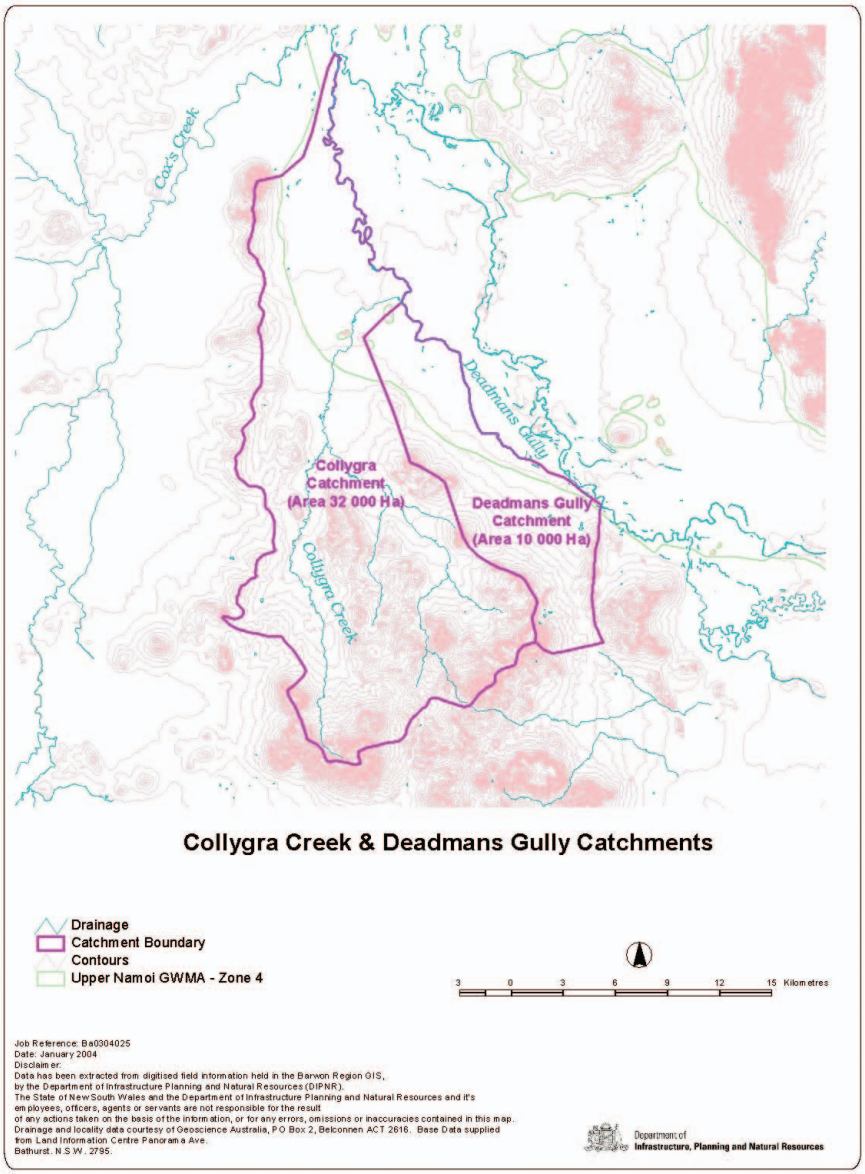


Figure 2. Boundaries and extent of Collygra Creek and Deadman's Gully catchments

recharge by leakage from local sources, may help balance the pumping of groundwater. Consequently, understanding how, where and when leakage occurs is important for effective groundwater management.

It is a myth that all clay is impermeable. Swelling calcium smectite clay (black vertisol) may leak in two ways: through relatively open pore structure, and occasionally through rapid flow pathways such as fractures. However, not all leakage through a thick unsaturated zone becomes aquifer recharge because some water contributes to storage in partially filled pores.

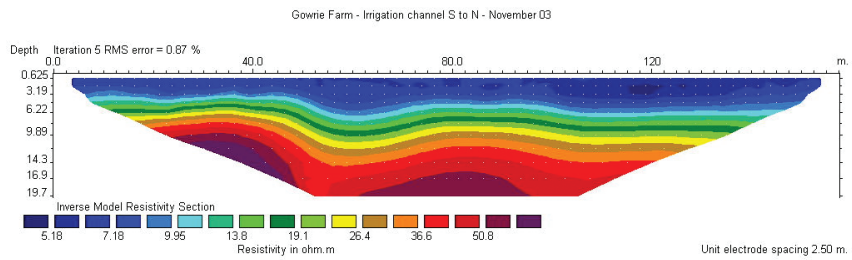
Leakage is possible where clay layers are relatively thin, discontinuous and are prone to fracturing. For example, the variable distribution of a clay rich layer overlying a shallow palaeochannel was revealed by recent geophysical investigations at 'Gowrie', a local property. An electrical image (length 120 m, depth 20 m) along an irrigation channel revealed shallow sandy clay (Figure 3). This clay was about 8 m thick, confirmed by bore drill records, and thinned to 5 m towards the south. Drying of the soil to this depth could result in fracture leakage.

While leakage through clay may be small under natural conditions, it increases in response to flood irrigation and increased deep drainage below the rootzone. At an irrigation site near Gunnedah, increased leakage through clay sediments to at least 34 m depth was caused by flood irrigation (Figure 4). Hydraulic and hydrochemical evidence indicated that by the end of the irrigation season, a third of storage in the shallow aquifer was replaced by leakage water. Estimated recharge accounted for 12 to 30 per cent of irrigation supply.

Enhanced leakage is currently not included in the EAAR, nor is it reflected in the sustainable yield estimate. Ongoing investigation, strategic monitoring, and transient groundwater models that include leakage are required to improve sustainable yield estimates.

To illustrate this point, in July 2003 a channel leakage trial was conducted on 1 km of open head ditch on fields 2 and 3 at 'Gowrie', Boggabri. A standard delver was used to construct the channel. The channel was filled with water for one week before the experiment to give an indication of leakage under saturated conditions. A survey peg was driven in at normal water level and head when irrigating. A transfer pump was then used to maintain that level with no siphons running. The pump discharge, less a figure for evaporation, was deemed the channel leakage. This was about 10 L a second for 1 km of channel. The groundwater pump discharge is 100 L a second so about 10 per cent loss of the raw water that is pumped and delivered for irrigation is occurring in every 1 km of head ditch under normal irrigation conditions. Similarly, there may also be losses of up to 10 per cent as water leaks below the rootzone and perhaps 7 to 8 per cent as leakage from the tail drains. Not all the loss is downwards; some occurs laterally and may not return to the aquifer. It should be noted that these losses are occurring under conditions of industry best practice and not due to inefficiency.

It is estimated that losses or returns back to the aquifer may be as high as 20 to 30 per cent on 'Gowrie', expressed as a percentage of groundwater pumping volume. These irrigation losses should be taken into account in estimating annual average recharge. It is important that all



recharge sources on a local scale are identified and fully accounted for in any numerical groundwater modeling that quantifies EAAR.

Note that these estimates have been obtained after highly efficient laser scraping and tailwater returns systems were in place and are considered representative of farms in Zone 4 West, using industry best practice.

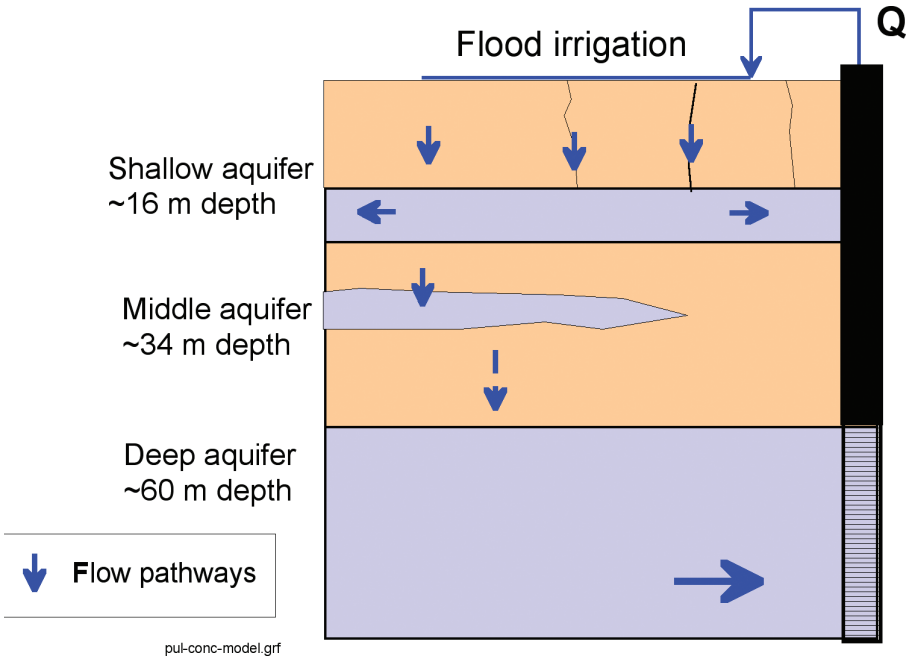
In view of the irrigation returns, and the rainfall and side-slope runoff sources of aquifer recharge in Zone 4 West, a system of aquifer response management needs to be put in place to confirm the findings of this paper and to closely monitor the test bores. It is the irrigator's position that test bores could be automatically logged in conjunction with an automatic weather station so that readings could be taken and allocations adjusted accordingly on a seasonal basis. In this way the sustainability of the aquifer could be proven and entitlements could remain until a more reliable sustainable yield figure is obtained.

Current sustainable yield estimates are an oversimplification of conditions across the whole of Zone 4. These first estimates may underestimate rainfall, flooding and river recharge rates unique to Zone 4 West. Electrical imaging, bore logs and excavations such as tail water dams show shallow soils over permeable layers leading to the shallow aquifer, clearly identifying the potential for enhanced recharge locally.

An evaluation of historical use and comparison with water level data over the period of record suggests a SY for Zone 4 West, of at least 16,000 ML/year with an upper limit of 20,000 ML/year. This is much higher than the current Department of Infrastructure, Planning and Natural Resources (DIPNR) estimate of 8,600 ML/year. Hydrographs over the last two years show that groundwater levels have not changed significantly, even though we have come through a 1-in-200 year drought.

Aquifer recharge sources

The general groundwater flow direction is down-valley. There are apparent natural river losses from the Namoi River immediately east and north of Emerald Hill. In this area, the stream is a connected losing stream. Closer towards Boggabri and Gin's Leap, where the alluvial valley constricts (natural dam site), groundwater discharges to the Namoi River. In this area, the stream is a connected gaining stream. This close association with the river makes for a high recharge and a sustainable surface water/groundwater system if managed properly.



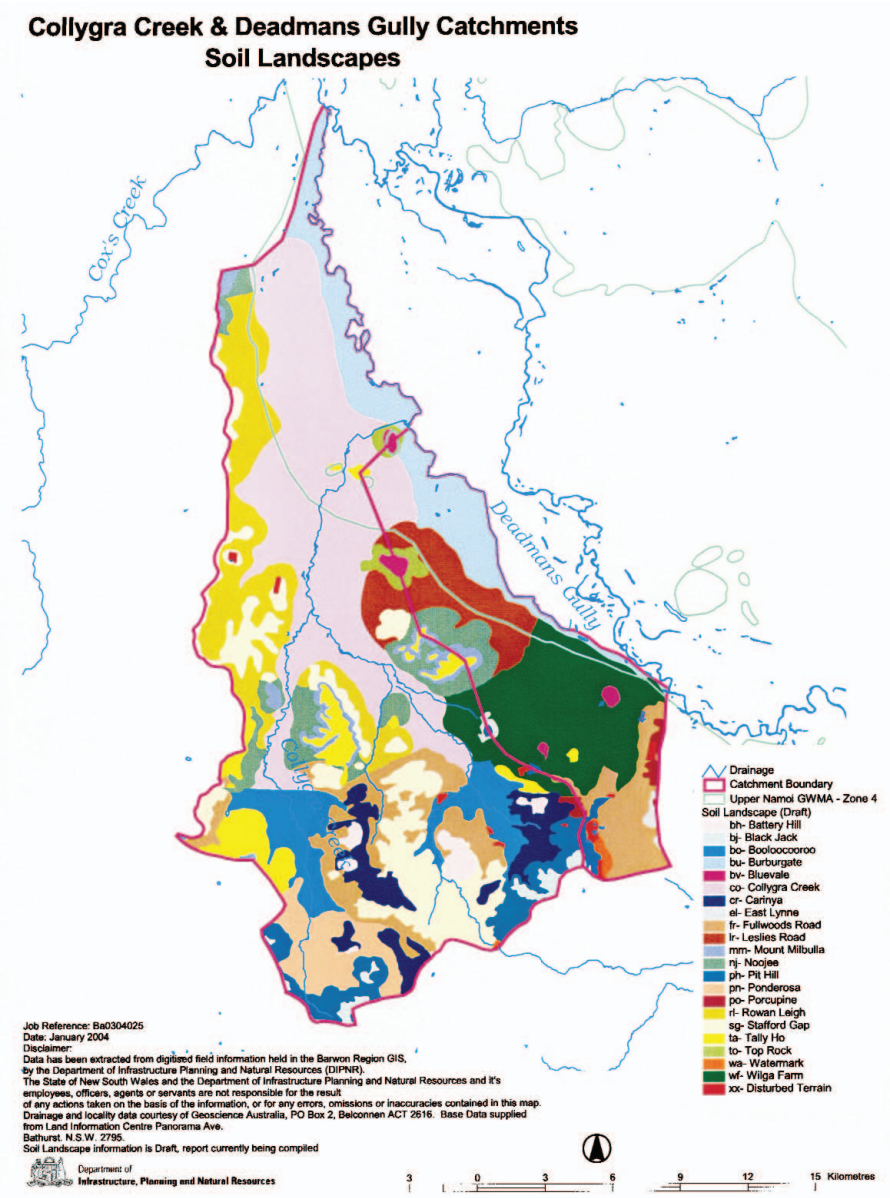


Figure 5. Soil landscapes for Collygra Creek and Deadman's Gully catchments

Recharge from flooding (not only large catchment floods but smaller local events as well) is thought to be significant now that the potential of the soils to leak is known. Recharge areas like Gulligal Lagoon, Thompson's Lagoon, Driggle Draggle Creek and Barbers Lagoon all play their part in storing water and then slowly releasing it to the shallow aquifer. Deadman's Gully and the surrounding lowlying areas similarly store runoff and slowly release water to the aquifer. These lagoons are filled at minor flood heights e.g. Gulligal Lagoon recently filled at the Gunnedah river gauge height of only 5 m. Most of the river had not broken its banks.

The catchment areas of the ephemeral streams Collygra Creek and Deadman's Gully are extensive (see Figure 2); Collygra Creek has 32,000 ha and Deadman's Gully has 10,000 ha. These are important side-slope runoff sources of aquifer recharge. The superimposed soil landscapes contributed by Robert Banks, DIPNR give some idea of likely potential run-off into the recharge area of Deadman's Gully (see Figure 5).

The total area of catchment is 42,000 ha. Using an average coefficient of runoff value of 0.4 multiplied by the annual average rainfall of 600 mm the annual discharge is 10080 ML. This is a lot of runoff. Often, only a small percentage of this water contributes to stream flows in the Namoi. Most runoff simply flows onto the floodplain and stays in lowlying areas and gullies. A percentage of this runoff must leak to the aquifer of Zone 4 West. More detailed work should be done using climatic data, data logger responses and the soil landscapes to give a more accurate prediction of runoff and associated recharge under given rainfall events. These 'what if' calculations become very complex and outcome results are best recorded in a matrix of infinitely variable inputs. Alternatively, the test bores in Zone 4 West could be monitored more often to assess the aquifer response after significant rainfall events. This would be invaluable in determining EAAR. It is not just the rainfall that falls on Zone 4 West itself, but the combined catchment draining into this sub-zone.

The extent to which irrigation returns are a factor in aquifer recharge needs quantifying. However, as in side-slope run-off, a percentage will find its way into the aquifer. Irrigation returns may amount to up to 30 per cent of the groundwater pumped now that it has been established that these soils leak.

Conclusions

Zone 4 West aquifer recharge pathway. From anecdotal evidence and the scientific studies described in this paper, it is known that major flood runners and soils across the floodplain leak in the western area of Zone 4. These are aquifer recharge pathways during high rainfall and flood events. Even irrigation returns contribute to the shallow water tables. There are extensive local catchments feeding the aquifer recharge system which provide additional water volumes for recharge.

Zone 4 West is a very favourable groundwater irrigation area. The shallow aquifer system is within 10 m of the surface in the Namoi floodplain area. Extensive shallow permeable sediments, and a variety of recharge sources, ensure that the Boggabri area is one of the more sustainable areas within the Upper Namoi alluvial aquifer system.

Review EAAR Zone 4 West before 1 July 2004. The EAAR figure may have been underestimated because of a lack of information being available at the time. Now that the unique aquifer recharge conditions are better understood in Zone 4 West, an urgent review of the EAAR (using this local knowledge and applying it to numerical models) should occur before the 73 per cent cut to entitlement is implemented 1 July 2004 under the Water Sharing Plan. A 30 per cent cut would be more in keeping with what is now known about the aquifer.

Study the aquifer recharge sources to obtain more reliable SY estimates. In time a better understanding of aquifer recharge (particularly the contribution of *ALL* recharge sources and processes), as more scientific information becomes available, will lead to more reliable sustainable yield estimates and in turn more equitable water sharing plans.

Draw-down based allocation is a simple concept. Irrigators believe that an alternative base for water sharing plans is to measure and monitor the aquifer itself. Local management groups would consider aquifer levels from automatically logged test bores and make decisions on allocations accordingly. A senior hydrogeologist would be part of the team. In this way a 'draw-down' based allocation system would give early warning when action needed to be taken. Over a number of years the sustainable yield would be evident and entitlements could be adjusted accordingly. In view of the complexities of estimating recharge, the 'draw-down' based allocation system appears to be the simplest in concept, the easiest to manage and the most equitable base for any water sharing plan.

References

Acworth, R.I., 1999 Journal of Soil Research, 37:623-636

Aquilina, J., Minister for Land and Water Conservation. Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003 Order under the Water Management Act 2000

Boggabri Irrigators 2000. Irrigators Aquifer Response Management (ARM) Proposal-

Alternative Management System 2000, Zone 2 and 4 Upper Namoi Water Users

Ross, J 2002 Regional Groundwater Data Review - Central Namoi Valley

PPK for Boggabri Irrigators and Department of Land and Water Conservation

Timms, W and Acworth R.I., 2002 UNSW Water Research Laboratory

Research Report No 208 (http://www.wrl.unsw.edu.au/publications)

Timms, W. and Acworth, R.I., 2004. 9th Murray Darling Basin Groundwater Workshop, Bendigo 17-20th February.

Acknowledgments

The Department of Infrastructure, Planning and Natural Resources for their help with catchment area and Soil Landscapes, especially Rob Banks and Angela McCormack.

Barwon Resource Information Unit, Gunnedah Research Centre for supplying hydrographs.

Boggabri Irrigators for anecdotal evidence of the sustainability of the aquifer in Zone 4 West.