Environmental flow response and socio-economic monitoring
Namoi Valley - progress report 2009
The NSW Office of Water is a separate office within the Department of Environment, Climate Change and Water. The Office manages the policy and regulatory frameworks for the State’s surface water and groundwater resources to provide a secure and sustainable water supply for all users. The Office also supports water utilities in the provision of water and sewerage services throughout New South Wales.

Environmental flow response and socio-economic monitoring.
Namoi Valley - progress report 2009
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Introduction

WHAT IS THE PURPOSE OF THIS REPORT?
This report provides an update on the monitoring and evaluation activities undertaken in 2008–09 to assess the ecological and socio-economic performance of the water sharing plans adopted in the Namoi Valley. It provides an interim assessment of outcomes from the investigations and identifies priority needs for future monitoring and evaluation activities in the Namoi Valley.

WHY DO WE NEED TO MONITOR WATER SHARING PLANS?
Water sharing plans provide water to meet environmental and socio-economic needs, and spell out the rules governing access to water. The Namoi Valley contains a number of important environmental assets and supports a valuable irrigation industry. Important environmental assets include surface ecosystems and groundwater-dependent ecosystems such as karst areas and springs. The surface ecosystems include billabongs and wetlands that provide the river with dissolved organic matter. Lake Goran, adjacent to the Liverpool Plains, is recognised as a nationally significant wetland. The aquifers of the Upper Namoi comprise unconsolidated sediments associated with the river and its tributaries (Mooki River and Coxs Creek). The aquifers of the Lower Namoi occur downstream of Narrabri. These aquifers have the highest level of groundwater development in NSW.
It is important to know whether the water sharing plans are meeting their environmental objectives, so that their effectiveness can be reviewed at the end of their 10-year period of operation. This information will be used to make informed decisions on how the plans might be improved when they are renewed. To achieve this, the NSW Office of Water undertakes ecological monitoring and evaluation activities focused on specific clauses and performance indicators within the plans.

WHAT WATER SHARING PLANS ARE CURRENTLY IN PLACE?
Four water sharing plans in the Namoi Valley are currently gazetted (Figure 2):
- Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2003
- Water Sharing Plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources 2003 (Unregulated River)
- Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources 2003

More details of these plans can be found on the NSW Office of Water’s website www.water.nsw.gov.au
FIGURE 2
Location of the current water sharing plans in the Namoi Valley.

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- Upper Namoi and Lower Namoi Regulated Water Sources
- Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources
- Upper Namoi Groundwater Source
- Lower Namoi Groundwater Source
FIGURE 3
Monitoring sites for the Lower Namoi Regulated River Water Source.

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 Monitoring sites for the Wetting of Terrestrial Organic Matter project
available water determinations

**WHAT HAS INFLUENCED THE WATER SHARING PLANS’ OPERATIONS IN 2008–09?**

**Regulated rivers—water availability**
Owing to lack of sufficient rain and inflows, annual allocations for general security access licences for the Upper Namoi and Lower Namoi Regulated River Water Sources were 0 per cent at the start of the 2008–09 water year and reached only 23.6 per cent by January 2009, remaining at this level till June 2009 (Figure 4).

In July 2007, a 323 Order (Supplementary Water Access) was imposed under the *Water Management Act 2000* on the Lower Namoi Regulated River Water Source, suspending access by water access licencees on the basis of a critical water shortage in Broken Hill. The order was lifted in December 2008 after heavy rain generated sufficient flow to assure inflow to Lake Wetherill (Menindee) and supplementary access. Licencees were not granted greater access once the order was lifted.

**Unregulated rivers—water availability**
Annual allocations to all categories of access licences for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources were 100 per cent, although given the low flows in most streams in these sources this may not have been extractable.

**Groundwater—water availability**
NSW Great Artesian Basin Groundwater Sources
Two of the five Great Artesian Basin Groundwater Sources underlie the Namoi Valley: the Surat Groundwater Source (mainly) and the Southern Recharge Groundwater Source. In both regions, local water utility and domestic and stock (conveyance)
access license holders received 100 per cent of their entitlements. The share components of aquifer access licences authorised to extract from these two groundwater sources received 1 megalitres per share unit.

Upper and Lower Namoi Groundwater Sources

The Upper Namoi Groundwater Source has an extraction limit of 122.1 gigalitres per year, although in 2009–10 this was increased by 24.4 gigalitres owing to the supplementary water provision in the water sharing plan. The historic metered usage is shown Figure 5. Groundwater trading transferred 3,040 megalitres temporarily and 90 megalitres permanently in 2009–10.

The Lower Namoi Groundwater Source has an extraction limit of 86 gigalitres per year, although in 2009–10 this was increased to 98.6 gigalitres owing to the supplementary water provision in the water sharing plan. The historic metered usage is shown Figure 6. Groundwater trading transferred 4,126 megalitres temporarily and 181 megalitres permanently in 2009–10.
WHAT ENVIRONMENTAL ISSUES ARE ADDRESSED BY THE WATER SHARING PLANS?

Regulated rivers water sharing plans
The water sharing plan for the Upper Namoi and Lower Namoi Regulated River Water Sources aims at reserving a percentage of each flow event within the Lower Namoi for the environment. The rules limit the extraction of medium and high flows that have entered the Lower Namoi from unregulated tributaries downstream of Keepit Dam when access to uncontrolled flows or by supplementary access licensees is announced. The proportions of flows protected from extraction for a particular event are:

- 90 per cent of each event between 1 July and 31 October
- 50 per cent of each event between 1 November and 30 June.

The environmental benefit gained is increased connectivity with billabongs, floodplains and wetlands, thus enhancing aquatic–terrestrial linkages and improving the overall health of the riverine environment.

Unregulated rivers water sharing plans
The water sharing plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources sets very low flow cease-to-pump rules to protect low flows, and establishes daily flow sharing rules to protect a proportion of flows for the environment on any given day.

Groundwater water sharing plans
Upper and Lower Namoi Groundwater Sources
The proportion of recharge water that can be extracted without compromising the integrity of the
water source and the ecosystems that depend on it is the extraction limit or sustainable yield. At the start of the water sharing plan for the Upper and Lower Namoi Groundwater Sources, extraction limits were above the sustainable yield (over-allocated), with the exception of zones 6, 9 and 10 in the Upper Namoi. To reduce the impacts of over-allocation, entitlements will be reduced to a sustainable yield over the life of the plan. The water sharing plan provides for the needs of groundwater-dependent ecosystems to be reviewed within five years of commencement, and for the proportion of the recharge reserved for the environment to be adjusted to meet these needs.

In keeping with the principle of adaptive management, the plan allows for the recharge and the proportion of the recharge reserved for the environment to be varied. In most cases, any variation is to be based on further assessments of groundwater-dependent ecosystems.

Monitoring projects under way include a study of recharge and environmental water in the Upper Namoi using a groundwater flow model to determine recharge volumes from the various sources, and assessment of recharge in the Maules and Coxs Creek alluvial aquifers.

NSW Great Artesian Basin Groundwater Sources

The water sharing plan for the NSW Great Artesian Basin Groundwater Sources requires that water be allocated for the fundamental health of a water source and its dependent ecosystems as a first priority. The plan identified 37 geothermal springs as high-priority groundwater-dependent ecosystems which need a high level of protection. The plan also recognises that the upward leakage contributes base flows to water courses. To protect the geothermal springs and water courses, the plan sets distance rules for granting work approvals.

The plan reserves the long-term average storage component of the groundwater sources and 30 per cent of the long-term average annual net recharge for the environment in the Southern Recharge Groundwater Source. In the Surat Groundwater Source, the volume set aside for the environment is that required to maintain 1990 pressure levels, minus increased extraction from 1990 until the end of June 2008, plus savings made under the Cap and Pipe the Bores program between 1990 and 1999, plus 70 per cent of water savings made under that program since 1999.

For more information on the water sharing plans visit the NSW Office of Water’s website www.water.nsw.gov.au
WHAT ECOLOGICAL MONITORING IS OCCURRING?

Regulated rivers water sharing plans
The Integrated Monitoring of Environmental Flows scientific program was established in 1997 to assess the ecological benefits of environmental flow rules in the State’s regulated rivers and the Barwon-Darling River. The program has since been reviewed to monitor and evaluate the ecological performance of the water sharing plans for regulated rivers.

The Wetting of Terrestrial Organic Matter project is currently under way in the Lower Namoi Regulated River Water Source (Figure 3). This project focuses on the role that wetting of riparian litter may play in stimulating riverine food webs. It proposes that those flow rules that protect a proportion of freshes and high flows (clause 15 of the water sharing plan for supplementary environmental water) will result in more frequent wetting of river banks, benches and in some cases floodplains than would otherwise occur. A conceptual model of instream dissolved organic carbon (DOC) concentration (a measure of the input of riparian litter into rivers) following flow events is shown in Figure 8. The wetting of benches and floodplains should make terrestrial carbon sources more accessible to aquatic leaf-shredding invertebrates. It should also result in the leaching of DOC and other organic matter, which may pass up the planktonic food web (e.g. via heterotrophic bacteria), addressing some of the environmental performance indicators in clause 12 of the water sharing plan. In addition, frequent wetting may be important in ensuring continuity of terrestrial carbon supply.

Unregulated rivers water sharing plans
The NSW Office of Water has established a program to assess the ecological outcomes of the 20 water sharing plans for unregulated water sources that were gazetted in 2004. The first aim of ecological monitoring in unregulated rivers is to determine whether the environmental objectives of the water sharing plans are being achieved.

A monitoring program is being established in the unregulated river sections covered by the water sharing plan for the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources. Due to begin in 2010–11, it will consist primarily of a field verification study to assess the adequacy of the cease-to-pump levels in meeting the water sharing plan’s environmental objectives. Initial work will involve the establishment of photo-point monitoring sites and an assessment of the catchment hydrology during periods of low flow. Depending on the results of these initial studies, more detailed monitoring of vulnerable habitats may be undertaken during the term of the plan.

Planned fish sampling will support predictive ecological modelling for existing unregulated water sources. This new approach will attempt to determine whether water extraction has affected the fish communities in the unregulated river sections covered by the plan.
Groundwater water sharing plans

Upper and Lower Namoi Groundwater Sources

A biological study of groundwater-dependent communities is in progress. The subsurface (stygofauna) communities (Figure 9) are intrinsically adapted to their environment through specialised morphology, physiology, habitat requirements and long life cycles. Such communities are used as indicators of groundwater–surface water connectivity and responses to environmental change. Linkages were investigated along a one kilometre reach of Maules Creek, a small, essentially ephemeral, tributary of the Namoi River. The aim of this study was to examine the potential impacts on groundwater-dependent ecosystems in relation to changes in water chemistry when groundwater sources are over-allocated and not managed appropriately. This information plays a key role in reporting on the ecological condition of groundwater-dependent ecosystems.

**Figure 8**

Conceptual flow diagram outlining possible dissolved organic carbon (DOC) concentration responses in the Namoi River when “flow rules” with an environmental water provision are used (compared with flows without rules). For more information visit [www.water.nsw.gov.au](http://www.water.nsw.gov.au)

**Increased flow event**

Flow rules with environmental water provisions

**Possible effects**

**Effect 1. DOC decreases**

due to dilution effect, this will also depend on riparian vegetation extant and type which it can be linked to land management

**Effect 2. DOC concentration does not change significantly**

possibly due to effect 1 (dilution) offsetting effect 3 (run-off and wetting). Also rapid uptake of bio-available DOC by heterotrophic bacteria

**Effect 3. DOC concentration increases**

due to runoff and wetting of terrestrial organic matter - will be reflective of duration/magnitude of flood and extant riparian cover

**DOC remains decreased**

for a period after the flow event

**Increases in DOC**

(pulse) detected at tail end or shortly after the event (eg. from groundwater inputs, connectivity with wetlands - billabongs, gradual leaching from large woody debris)

**DOC concentration drops off**

at the end of the flow event to baseline concentrations (eg. assimilated)

**DOC concentration remains increased**

for a period after the flow event (eg. gradual leaching of large woody material in the main channel)

*Quality and concentration of bio-available DOC may also vary for each EFFECT*
Over 500 flowing bores in the NSW Great Artesian Basin Groundwater Sources have been monitored for pressure, flow, temperature and groundwater quality since the 1990s. Monitoring was discontinued in many bores as they were plugged, became sub-artesian or became unsuitable owing to the poor condition of the bore head. At present, 65 bores are being monitored at least once in every two years. Currently, seven bores are being monitored in NSW Great Artesian Basin Groundwater Sources underlying the Namoi Valley. One out of them is being fixed with data loggers for real-time monitoring. The location of monitoring bores in the Namoi Valley is provided in Figure 10.

**FIGURE 9**
An amphipod, an example of groundwater-dependent stygofauna

*Image courtesy of Peter Serov*
Monitoring bores

Namoi catchment

Upper and Lower Namoi Groundwater Sources

GREAT ARTESIAN BASIN WATER SHARING PLAN

Eastern Recharge Groundwater Source

Southern Recharge Groundwater Source

Surat Groundwater Source

Data source: NSW Office of Water
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FIGURE 10
Approximate locations of monitoring bores in the Great Artesian Basin Groundwater Sources.

LEGEND

0 40 80
kilometres
1:3,000,000

GW004442
GW040942
GW040944
GW965064
GW004413
GW004378
GW004431
GW061681
GW040929
GW040921
GW004413
GW004378
GW004431
GW061681
GW004106
GW901961
GW273024
GW004460
GW040929
GW040921
GW004413
GW004378
GW004431
GW061681
GW004106
GW901961
GW273024
GW004460
GW040929
GW040921
GW004413
GW004378
GW004431
GW061681
GW004106
GW901961
GW273024
GW004460
GW040929
GW040921
GW004413
GW004378
GW004431
GW061681
GW004106
GW901961
GW273024
GW004460
GW040929
GW040921
GW004413
GW004378
GW004431
GW061681
GW004106
GW901961
GW273024
GW004460
Plan provisions being monitored

Which plan provisions are we monitoring?

Regulated rivers water sharing plans

Water sharing plan for Upper Namoi and Lower Namoi Regulated River

Water Sources

The major environmental benefits provided by the plan come from the rules that apply to the extraction of water under supplementary water access licences. These rules build on the environmental flow rules for extraction of ‘off-allocation’ water, first applied in 1998. The plan also includes a new environmental provision that requires a small flow to be maintained at Walgett during winter. The effectiveness of these provisions, in particular the ‘off-allocation’ supplementary access licences, can only be assessed through long-term monitoring to determine the ecological responses to increased environmental water. This can then be linked to the Integrated Quantity and Quality Model (a river hydrology and water quality model) to help define when (seasonal) and where (within the catchment) the best ecological gains can be achieved.

Provisions have not been directly evaluated (e.g. minimum daily end-of-system flows required under clause 15), but research addressing some of the environmental performance indicators (clause 12) has shown that maintaining or increasing flows within the Lower Namoi enhances ecological condition.

Clause 12: Environmental performance indicators

The performance of the plan is assessed against:

(a) change in the ecological condition of these water sources and dependent ecosystems
(b) change in low flow regime
(c) change in moderate to high flow regime
(d) change in water quality in these water sources
(e) change in economic benefits derived from water extraction and use.

The Integrated Monitoring of Environmental Flows work primarily addresses objectives (a) and (c). It also includes water quality sampling, with the potential to link this to the Integrated Quantity and Quality Model.

Clause 14: Planned environmental water

The plan establishes the following planned environmental water rules:

(a) water volume in excess of the long-term extraction limit may not be taken from these water sources and used for any purpose
(b) water availability is to be managed to ensure that water volume in excess of the long-term extraction limit is not being taken.

By limiting long-term average extractions to an estimated 238,000 megalitres per year, this plan ensures that approximately 73 per cent of the long-term average annual flow in these water sources (estimated to be 870,000 megalitres per year) will be preserved and will contribute to the maintenance of basic ecosystem health.

Clause 15: Supplementary environmental water

The plan establishes a planned environmental water rule that in June, July and August, a minimum daily flow equivalent to 75 per cent
of the natural 95th percentile daily flow for each month shall be maintained in the Namoi River at Walgett. This, however, shall not apply when the sum of the water stored in Keepit Dam and Split Rock Dam is less than 120,000 megalitres.

The plan specifies limits to total extractions by all Lower Namoi supplementary water access licences to periods when flows are above specified thresholds. These rules contribute to:
- protecting important rises in water levels
- maintaining wetland and floodplain inundation
- maintaining natural flow variability.

Unregulated rivers water sharing plans

Water Sharing Plan for Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources

Clause 13: Environmental performance indicators

The performance of the plan is assessed against:

(a) change in low flows
(b) change in moderate to high flows
(c) change in ecological condition of these water sources and dependent ecosystems
(d) change in economic benefits derived from water extraction and use.

Clause 17: Flow classes

The plan establishes the flow classes for all management zones as the basis for sharing of daily flows.

Clause 21: Planned environmental water

The plan establishes a number of flow limits within each flow class (distinct to each water source) that are designed to maintain water necessary to environmental health within a water source.

Clause 45: Total daily extraction limits

The plan establishes a total daily extraction limit for each flow class within each water source established in clause 17.

Clause 72 (1): Amendment of very low flow provisions

The Minister may vary the very low flow levels established in clause 17 and consequently the bottom of A Class established in clause 17, following field verification.

Clause 75 (1): Amendment relating to planned environmental water

The Minister may amend the plan to provide for the recovery of planned environmental water.

Groundwater water sharing plans

Water sharing plan for Upper and Lower Namoi Groundwater Sources

Clause 13: Environmental performance indicators

The performance of the plan is assessed against:

(a) change in groundwater extraction relative to the extraction limits
(b) change in climate-adjusted groundwater levels
(c) change in water levels adjacent to identified groundwater-dependent ecosystems
(d) change in groundwater quality
(e) change in economic benefits derived from groundwater extraction and use
(f) change in structural integrity of the aquifers.

Clause 16 (2): Recharge

The Minister should review recharge for each groundwater source (excluding Zone 1) after 30 June 2010 to adjust the average annual recharge values following further recharge studies by the Minister.

Clause 18 (1): Planned environmental water

The plan establishes planned environmental water rules to ensure that:

(a) the physical water contained in the storage component of Zones 1 to 12, minus the amount required for supplementary water access, will be reserved for the environment.
(b) the long-term average storage component of the groundwater in the aquifers of the Lower Namoi Groundwater Source, minus the amount required for supplementary water access, will be reserved for the environment.

Access to water under supplementary water access licences in the water source will not be permitted after 30 June 2015, and the physical water contained in the storage component of this groundwater source will be reserved for the environment.

Clause 18 (2): Planned environmental water

After 30 June 2010, the Minister may include a portion of the average annual recharge to the groundwater source as planned environmental water, on the basis of further studies of groundwater ecosystem dependency by the Minister.

The studies may recommend management options other than reservation of a portion of recharge to protect groundwater-dependent ecosystems. The plan limits the extent to which this change may affect access licences.

Part 10, Division 2, clauses 35 to 43 local impact rules

The plans set rules to ensure that each groundwater source is also managed sustainably at a local scale. They do this by allowing for the establishment of local impact management areas. The triggers to identify when a local impact management area should be established depend on the plan. Once established, a local impact management area can have specific rules designed:

- to protect water levels by restricting pumping when water levels have reduced
- to protect water quality by restricting pumping when water quality has declined
- to protect priority groundwater-dependent ecosystems by pumping or other restrictions.

The plans also specify buffer conditions or distance restrictions for the construction of new and, in some cases, replacement bores. These conditions protect existing users, local water quality and quantity, and priority groundwater-dependent ecosystems.

Water sharing plan for NSW Great Artesian Basin Groundwater Sources

Clause 11: Performance indicators

The performance of the plan is assessed against:

(a) change in groundwater extraction volume relative to the long-term average extraction limit
(b) change in groundwater levels and pressures
(c) change in groundwater levels and pressures adjacent to identified groundwater-dependent ecosystems
(d) change in groundwater quality
(e) change in economic benefits derived from groundwater extraction and use.

Clause 12: Basis for water sharing

The basis for water sharing in the Southern Recharge Groundwater Source is the long-term average annual net recharge, which is estimated to be 42,400 megalitres per year. The Minister may vary this estimate after year 5 of the plan, following further recharge studies that are acceptable to the Minister.

The basis for water sharing in the Surat Groundwater Source is the volume of water required to maintain pressures experienced under the level of water extraction associated with the water entitlements, infrastructure and management rules in place at 1990 (sustainable pressure estimate equivalent) within the groundwater source, which is estimated to be 75,000 megalitres per year.

The estimated volumes for water sharing in the Surat Groundwater Source may be varied through the granting of aquifer access.
licences and dealings so that they are equal to or greater than 67,500 megalitres per year, provided that the combined total of the volumes for in the Surat, Warrego and Central Groundwater Sources does not exceed 105,300 megalitres per year.

The Minister may vary the sustainable pressure estimate equivalent in the Surat Groundwater Source after year 5 of the plan, following further pressure studies that are acceptable to the Minister.

Clause 15: Planned environmental water
The planned volume of environmental water in the Southern Recharge Groundwater Sources is:

(a) the long-term average storage component of the respective groundwater source
(b) plus 30% of the long-term average annual net recharge to the groundwater source.

The planned volume of environmental water in the Surat Groundwater Source is:

(a) the sustainable pressure estimate equivalent
(b) minus the increased extraction from 1990 until the commencement of this plan
(c) plus the water savings made through the capping and piping of any bores from 1990 to 30 June 1999
(d) plus 70% of the water savings made through the capping and piping of any bores from 1 July 1999.

The Minister may vary the proportion of long-term average annual net recharge and/or the percentage of water savings made available through the capping and piping of any water bores that is reserved as planned environmental water after year 5 of the plan, on the basis of further studies of groundwater ecosystem dependency that are acceptable to the Minister. The Minister will determine the extent of any variation after considering the needs of the environment and the socio-economic impacts of the proposed variation.

For more information on water sharing plans visit www.water.nsw.gov.au
WHAT HAS ECOLOGICAL MONITORING TOLD US SO FAR?

Regulated rivers water sharing plan

Monitoring activities
Owing to the continued drought, only limited environmental monitoring of surface waters (Figure 11) has been undertaken to assess the water sharing plan for the Upper Namoi and Lower Namoi Regulated River Water Sources in 2008–09. The ecological benefits arising from a 50 per cent sharing of supplementary water between irrigators and the environment were able to be partially assessed when dissolved organic carbon (DOC) was sampled during a flood event at Bugilbone. DOC concentrations were sampled 4-hourly (36 times) from 11:30 am, 6 December 2008, to 07:00 am, 12 December 2008. The two months before the flood were characterised by extremely low flows (mean of 90 megalitres per day). DOC data revealed that even a minor flood event in the Lower Namoi River can mobilise increased concentrations of DOC (12.6 ± 0.2 milligram per litre) from adjacent benches and banks, well above mean ambient DOC concentrations (6.8 ± 0.4 milligrams per litre) detected in long-term low flow monitoring (Figure 12). More detailed studies in previous years have shown that DOC derived from common riparian vegetation (e.g. red gums and willows) stimulates heterotrophic bacteria to out-compete phytoplankton for inorganic nutrients, creating a system driven by organic matter derived from outside the ecosystem that results in heterotrophic dominance for some time after an event.

**FIGURE 12**
Mean flow (megalitres per day) and DOC concentrations (milligrams per litre) measured in the Namoi River at Bugilbone during minor flooding in December 2008

**FIGURE 11**
Sampling for zooplankton, Namoi River, Boggabri

Image courtesy of Doug Westhorpe
Links to other projects
The findings relating to the increased delivery of DOC through increased aquatic–terrestrial linkages via the provisions for supplementary environmental water and uncontrolled flow event access is also applicable to the water provisions and ecological outcomes addressed in the water sharing plan for the NSW Gwydir Regulated River Water Source.

Unregulated rivers water sharing plans
Monitoring activities
No monitoring was undertaken in the Phillips Creek, Mooki River, Quirindi Creek and Warrah Creek Water Sources during 2008–09. A monitoring program consisting primarily of photo-point monitoring is being established within this plan area in 2010–11.

Links to other projects
Further information on monitoring of unregulated river water sharing plans visit the NSW Office of Water’s website www.water.nsw.gov.au

Groundwater water sharing plans
Upper and Lower Namoi Groundwater Sources
Monitoring activities
Changes in the community composition (species diversity and abundance) of stygofauna (animals that live in groundwater, including crustaceans, worms, snails and insects) are directly reflected in changes in water chemistry. Monitoring data suggest that changes in catchment water management such as reducing base flow through abstraction in a hydraulically connected system can affect streambed and aquifer ecosystems by inducing changes in water chemistry.

Links to other projects
Several projects currently under way, including projects funded by the National Water Commission (National GDE Atlas) and Catchment Management Authorities (river studies), will allow the broad identification of groundwater-dependent ecosystems by mid 2011. The NSW Macro Plan process is expected to put plans in place for all groundwater sources in the Namoi Valley by the end of 2010. The plans will set long-term average annual extraction limits and rules that will allow only acceptable impacts on users and the environment. Groundwater sources that are highly connected to the rivers will be subject to cease-to-pump criteria. A variety of environmental parameters, including electrical conductivity and temperature, are being used to study surface–groundwater connectivity in focus catchments. In particular changes in temperature or heat can quantify groundwater surface connectivity and thus the movement of water to and from groundwater systems. Preliminary analysis of a study of streambed temperature in the Cockburn Valley (an unregulated system) and in the Upper and Lower Peel Valley suggests that down-welling is the dominant hydrological process, implying that the system is losing water to the groundwater system or hyporheic zone (wetted area in sediments below and alongside rivers). However, individual sites can switch from losing to gaining, depending on the difference between stream and groundwater heads. To capture different hydrological processes occurring on different land forms and geological features, the monitoring network has been extended to the regulated subcatchments of the Peel Valley, with additional monitoring points established near existing gauging stations. The results suggest that using temperature as a surrogate is a robust and affordable method for estimating infiltration/discharge and for assessing the effects of drought on surface–groundwater connectivity and flow regimes. The recharge/discharge estimates based on temperature can be enhanced...
when used in conjunction with other methods such as chemical and isotopic tracers.

The Cockburn Valley, which represents the unregulated section of the Peel Valley, was targeted for detailed monitoring. The parameters being monitored are groundwater and stream levels, electrical conductivity of surface water and groundwater, and temperatures of the stream, streambed and groundwater.

The main objectives of the surface–groundwater connectivity study are:

(a) to demonstrate the potential application of the temperature method in ephemeral and intermittent streams

(b) to estimate stream leakage during flood events

(c) to delineate gaining and losing reaches.

Information gathered to date is relevant for water resource managers working on the current water sharing plans. The methods developed can also be used:

- to estimate infiltration rates
- to estimate near-streambed water fluxes (Cockburn River and Maules Creek)
- to estimate hydraulic parameters (Cockburn Valley).

**NSW Great Artesian Basin Groundwater Sources**

Monitoring activities

Although none of the high-priority geothermal springs identified in the plan lie within the Namoi catchment, seven free-flowing bores in the valley have a significant impact on the protected geothermal springs outside the valley. The pressure head in the Great Artesian Basin Groundwater Sources in the Namoi Valley rose by about 6 metres in the last decade. Signs of pressure recovery in the aquifer are noticeable near where many free-flowing bores were plugged under Cap and Pipe the Bores program.

**Links to other projects**

The statewide groundwater monitoring network in the NSW Great Artesian Basin Groundwater Sources is linked to the federally funded, nationwide Great Artesian Basin monitoring network. Twenty-nine bores of the statewide monitoring network are being used for monitoring of the whole Great Artesian Basin.
Gulligal Lagoon, on the floodplain near Gunnedah is an important refuge for fish and waterbirds.
In 2005, the NSW Office of Water began a statewide project to monitor changes in the NSW irrigation industry following the introduction of water sharing plans. The project is designed to:

- monitor key social and economic changes at the farm and regional levels arising from water sharing plans
- provide data for the NSW Office of Water’s review and evaluation of water sharing plans
- provide data for the Natural Resources Commission’s review of water sharing plans
- provide a benchmark for other economic and social monitoring exercises in natural resource management.

The project was developed after extensive consultation with stakeholders, including the NSW Irrigators’ Council and the Primary Industries and Economic Development Standing Committee of the NSW Natural Resources Advisory Council. The project reports on changes in a number of identified social and economic indicators. The data used to report on these indicators are primarily collected in a 20-minute telephone survey of irrigators who responded to an invitation to participate. A sample size of approximately 10 per cent of the eligible irrigators is targeted for each survey. Additional customised data from the Australian Bureau of Statistics Agricultural Census is also used.

The first of the surveys, in 2006, targeted irrigators in areas where the first 31 water sharing plans were implemented in July 2004. These plans included all major regulated rivers in NSW, and represented approximately 80 per cent of the extractive water use in NSW. The 2006 survey collected baseline data reflecting the socio-economic conditions of farms in these areas.

In 2009, a companion baseline survey targeted irrigators in the remaining areas of the State, where water sharing plans were implemented after 2004 or are about to be implemented. This survey covered irrigators whose water sources are predominately unregulated rivers or major inland groundwater systems.

The combined 2006 and 2009 survey data will provide a complete statewide baseline data set to be used in the socio-economic indicator reporting of plan performance.

For reporting purposes the results of the irrigator surveys are tabulated by catchment management authority (CMA) area. The Namoi Valley data are reported for the combined Border Rivers–Gwydir and Namoi CMAs for 2006 and for the Namoi CMA for 2009.

The 2006 survey results included irrigators from the regulated Gwydir, Namoi and Border Rivers:

- The median irrigation farm size was 526 hectares, with a 25th to 75th percentile range of 117 to 1,560 hectares.

The statewide median farm size was 158 hectares (range 26 to 620 hectares).
Figure 14 shows types of irrigation system used by respondents from the 2006 survey for the Border Rivers–Gwydir and Namoi CMA areas and compare this to statewide results.

- Irrigators derived an average 49 per cent of total farm income from irrigated crops and pastures. The statewide average was 51 per cent.
- 60 per cent of irrigators employ non-family members on farm, and the percentage increases as entitlements increase. The statewide average was 52 per cent.
- Full-time employment of family and non-family members (excluding casuals) per irrigation farm is 4.0 equivalent full-time (EFT) positions. The statewide average was 3.9 EFTs.

The ratio of water entitlement to EFT employees was 435 megalitres per EFT employee. The statewide ratio was 270 megalitres per EFT.

29 per cent of irrigators had used their water entitlement as security for a loan. The statewide average was 30 per cent.

Figure 15 shows the irrigators’ responses to the statement ‘The water sharing plan had made a lot of difference to water use in this catchment’.

The 2009 survey included irrigators in the remaining unregulated rivers and inland groundwater areas:

- The median irrigation farm size was 172 hectares, with a 25th
to 75th percentile range of 40 to 820 hectares. The statewide median was 81 hectares (percentile range 28 to 81 hectares)

- Figure 16 shows types of irrigation systems in the unregulated and groundwater areas in the Namoi CMA areas with comparison to statewide results

- Irrigators derived an average 38 per cent of total farm income from irrigated crops and pastures. The statewide average was 30 per cent

- 48 per cent of irrigators employ non-family members on farm, and the percentage increases as entitlements increase. The statewide average was 45 per cent

- Full-time employment of family and non family members (excluding casuals) per irrigation farm is 2.2 EFT positions. The statewide average was 2.1 EFTs

- The ratio of water entitlement to EFT employees was 170 megalitres per EFT employee. The statewide ratio was 136 megalitres per EFT

- 30 per cent of irrigators had used their water entitlement as security for a loan. The statewide average was 17 per cent

- Figure 17 shows the irrigators’ responses to the statement ‘The water sharing plan made or will make a lot of difference to water use in my catchment’.

Detailed reports of the 2006 and 2009 surveys are available at www.water.nsw.gov.au
monitoring plans for 2009-10

WHAT ECOLOGICAL MONITORING IS PLANNED FOR 2009–10?

Regulated rivers water sharing plans
The next step in the dissolved organic carbon (DOC) research is to link current DOC models to river hydrology models (Integrated Quantity and Quality Model (IQQM) in order to understand the effects of rules within the current water sharing plan. Current flow rules are not based on informed ecological modelling, and are only loosely based on the premise that natural flow variability is beneficial.

During large flows (for example, summer 2009–10), the operation of clause 15 (maintaining minimal end-of-system flows at Walgett) limits the amount of supplementary water that is taken, and therefore increases the frequency and size of floodplain–river connections. Developing linkages of current Integrated Monitoring of Environmental Flows and DOC work with the IQQM will allow the long-term ecological implications of this rule for floodplain–river connectivity and productivity to be explored. Such modelling could be used to refine the current rules for the extraction of supplementary water. Further enhancement of this modelling will be achieved by including riparian coverage, which has been determined by the NSW Office of Water’s Spatial Analysis Group. This work has the capacity to build on previous wetland–IQQM links developed within the NSW Office of Water, for example for the responses of billabongs and colonial nesting birds.

Unregulated rivers water sharing plans
A predominantly photo-point monitoring program was established within this plan area in 2009–10. Monitoring sites were selected to cover all the subcatchments (zones) within a water source, focusing in particular on subcatchments where there is a high demand for water (e.g. greatest development, many active licences, demand for water during periods of low flow). Monitoring will also be undertaken in zones that are deemed ‘ecologically sensitive’, with a focus on monitoring natural low flows and on monitoring water levels in natural river pools during periods of no flow.

Groundwater water sharing plans
The NSW Office of Water will continue to monitor the usage, wastage, water savings, pressure, flow, temperature and water quality in the NSW Great Artesian Basin Groundwater Sources.

Regional monitoring of groundwater levels and metered usage from production bores in the Upper and Lower Namoi Groundwater Sources will continue. Monitoring of groundwater quality change at Breeza and Cryon will continue but will be reviewed at the end of 2010–11. Projects monitoring surface water and groundwater to quantify stream–aquifer interactions will continue at Mollee Weir, Maules Creek and the Cockburn River.
WHAT SOCIO-ECONOMIC MONITORING IS PLANNED FOR 2009–10?
The NSW Office of Water commissioned the Australian Bureau of Statistics to customise the 2006 Agricultural Census data to the water sharing plans’ boundaries and related water sources. The data will be made available in 2010 and will be used to ground-truth components of the survey data set. It will also provide additional secondary socio-economic data to be used to monitor the performance of water sharing plans against their stated objectives. The third of the planned irrigator surveys was undertaken in 2010. It targeted the irrigators surveyed in 2006. The results will be compared against the benchmark surveys, and will be used to report against the water sharing plans’ performance reporting requirements.

Socio-economic work to support development of the water sharing plan for the Peel Valley Regulated, Unregulated, Alluvial and Fractured Rock Water Sources
Two studies were undertaken to provide further information to support the development of the water sharing plan for the Peel Valley:

- Socio-economic impacts in Cockburn River and Goonoo Goonoo Creek
  This study predicted the socio-economic changes in the Cockburn River and Goonoo Goonoo Creek area as a result of the water access conditions in the draft water sharing plan for the Peel Valley. It assessed the economic impacts associated with changing the groundwater access rules from the current allocation-based rules, which have no daily constraints, to the proposed water sharing plan rules, which impose cease-to-pump rules that have daily constraints linked to the adjacent unregulated creek.

- Revised socio-economic impacts in Goonoo Goonoo Creek
  A revised study was undertaken at the request of the Peel Interagency Regional Panel to further investigate the potential impacts from the proposed changes to specific flow access conditions in the Goonoo Goonoo Creek area. Its aim was to understand the socio-economic impacts that may arise from changing the regulatory flow access point on the unregulated Goonoo Goonoo Creek from the previously reported Meadows Lane gauge to a location higher in the catchment.

WHAT IS PLANNED FOR FUTURE WATER SHARING PLANS?
Five additional water sharing plans covering the Namoi Valley are currently being developed for:

- Namoi River Unregulated and Alluvial Water Sources
- Peel Valley Regulated, Unregulated, Alluvial and Fractured Rock Water Sources
- Murray–Darling Basin Fractured Rock Groundwater Sources
- Murray–Darling Basin Porous Rock Groundwater Sources
- NSW Great Artesian Basin Alluvium and Cap Rock Groundwater Sources.

FUTURE PRIORITY NEEDS FOR ECOLOGICAL MONITORING AND EVALUATION IN THE NAMOI VALLEY
Potentially high-priority water sources are those identified as being at high risk to instream environmental values by water extraction, in accordance with the publication ‘Macro Water Sharing Plans—the approach for unregulated rivers (2nd edition, NOW 2009). Report to assist community consultation. This report is available at www.water.nsw.gov.au

Both the Lake Goran Water Source and the Spring Bobbiwaa Water Source were identified as potentially high-priority water sources.
Additional information on water sharing plans and socio-economic assessment is available on the NSW Office of Water’s website -
www.water.nsw.gov.au