INTEGRATED WATER CYCLE MANAGEMENT STUDY

Prepared by
Woodlots & Wetlands Pty Ltd

for

Gunnedah Shire Council

Document Registration

Client	Gunnedah Shire Council
Prepared By	**Woodlots & Wetlands** 67 David Road Castle Hill NSW 2154 Telephone (02) 96512931 Facsimile (02) 96512918 E mail woodlots@optusnet.com.au
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Glossary[1]

ABS Australian Bureau of Statistics
Acidity: The chemical activity of hydrogen ions in soil. Usually expressed in pH units.
ADWF Average volume of sewage arranging at the STP during dry weather (usually in ML/day)
AWWF Average volume of sewage arranging at the STP during wet weather (usually in ML/day)
AHD Australian Height Datum
Al: Aluminium
ANZECC Australian and New Zealand Environment and Conservation Council
ARI Average Recurrence Interval
Biological Oxygen Demand (BOD) is a measure of the extent of organic contamination in water.
C Carbon
Ca Calcium
Cation Exchange Capacity. The total quantity of exchangeable cations that the soil can absorb. Includes Ca, Mg, Na, K, H and Al.
Cl Chloride
cm centimetres
Coarse sediment. Gravel coarse sand and 50% of fine sand
Constructed wetland. An artificially created system that includes ponds and shallow vegetated areas
Continuous Deflective Separation (CDS). Compact gross pollutant traps that operate by deflecting stormwater in a centrifugal flow, separating out the litter.
Crusting (surface sealing). The nearly horizontal orientation and packing of dispersed soil particles on in the immediate surface layer of soil. This greatly reduces water penetration, encouraging runoff.
CRC Co-operative Research Centre
CSIRO Commonwealth Scientific and Industrial Research Organisation
DEC NSW Department of Environment and Conservation. A mixed department containing EPA, NPWS, SCA and other authorities
Denitrification. A process of anaerobic respiration whereby microbes use oxidised nitrogen (nitrate) in the absence of oxygen. The nitrogenous gases produced by this process escape to the atmosphere.
Detention time. The time it takes for a 'parcel' of water to flow from the inlet to the outlet of a system
DEUS NSW Department of Energy, Utilities and Sustainability
dS/m decisiemens/metre A measure of electrical conductivity (1 dS/m=1000 microsiemens/cm)
Dispersion. The breakdown of soil particles into constituents such as clay, silt and sand via the process of deflocculation. Dispersion can lead to erosion, high rainfall runoff and turbid waters.
DNR NSW Department of Natural Resources, formerly DIPNR, DLWC, CaLM, WC&IC, SCS, etc
DSS Decision Support System
EP Equivalent person
Erodability. The susceptibility of soil to detachment and transport by water and wind. (The K value in the Universal Soil Loss Equation).
Faecal coliforms. A group of bacteria common in faecal material. Their presence in large numbers indicates contamination
G gram
Gross pollutant trap (GPT). A device to trap debris>5mm from stormwater. Normally it has a trash rack immediately upstream
ha hectare (1 ha=100m*100m)
IWCM Integrated Water Cycle Management
Infiltration basins. Relatively large shallow pond with pervious floors that enable filtration of stormwater into the underlying strata
K Potassium
Kg kilogram
KL Kilolitre (1000 L)
km kilometre

[1] Where possible definitions and abbreviations are from widely available industry sources

L litre
LEP Local Environment Plan
LGA Local Government Area
Litter basket. A basket installed below an inlet pit to collect rubbish directly entering the stormwater system from roads
Litter boom. A floating device placed in drainage lines to capture floating litter and oil
LWU Local Water Utility
m metre
mg milligrams (1/1000 g)
Mg magnesium
mL millilitres (10^{-3}L)
ML megalitres (10^{6}L)
mm millimetres
Na Sodium
Nitrogen (N) includes organic N plus mineral N forms such as nitrate, ammonia and nitrite.
Oil/ grit separators. Baffled chambers designed to separate both floating oils and coarse sediments from stormwater exiting roads and parking lots.
On site sewage management based on treatment and return of sewage to the environment in a decentralised system
OSD Onsite detention. Typically involves a vault to capture a portion of stormwater and release it a t a rate that does no cause down slope erosion.
P Phosphorus
Percentile The percentage
pH A measure of acidity
POEO Protection of the Environment Operations Act 1997, NSW
Porous pavement. Pavement that allows water to enter the underlying strata rather than runoff.
PRG Project Reference Group
Riparian zone Lands adjacent to streams that are directly influenced by the stream
SAR sodium adsorption ratio. A measure of the ratio of sodium to calcium plus magnesium. It is used in conjunction with salinity data to determine the stability of irrigation water.
Sediment trap. A structure placed within a drainage line to capture coarse sediment
Slaking. The partial breakdown of soil aggregates in water due to clay swelling and soil gas pressure.
Sodic soil. A soil whose structure is degraded due to excess exchangeable sodium. Usually applies to soils where more than 6% of exchangeable cations are sodium.
Stakeholder Persons, organisations and authorities who have an interest in or are likely to be impacted by an event or project outcome.
STP Sewage Treatment Plant
t Metric tonne
t/ha tonnes/ha
Trash rack. A series of vertical bars with 40 mm spaces between them. Extends the width of a drainage line and is designed to retain gross pollutants such as PET bottles.
TSS Total Suspended Solids (usually in mg/L)
WSUD Water Sensitive Urban Design
WTP Water Treatment Plan

Table of Contents

1. INTRODUCTION

Gunnedah Shire Council in conjunction with Department of Energy, Utilities and sustainability, has undertaken an Integrated Water Cycle Management (IWCM) study to aid in the identification and development of strategies to increase sustainable use of water resources. This IWCM study identifies local issues including:

- Security of water supplies
- Raw water quality
- Leakage and blockage of sewers and potable water pipes.
- Lack of a trade waste policy
- Relatively high use of water on residential allotments
- Heavy use of water in some parks and gardens and in some commercial and industrial premises
- Stormwater management, especially peak flow rates

1.1 WHAT IS IWCM?

Integrated water cycle management is a way for Gunnedah Shire Council to manage its water systems to maximise benefits. It involves the integration of Council's three main services – water supply, sewerage and stormwater – so that water is used optimally. It also involves the integration of these three services with other services (e.g. roads and drainage, trade waste collection) and with various external requirements, particularly the NSW Water Reforms (DEUS, 2004).

Integrated water cycle management aims to minimise the potential for poor or ill-informed decisions by ensuring that decision makers are aware of the broader 'context' within which resource based decisions, options and option implementation are to be made. The key goal of IWCM is to

1. provide access to all relevant information,
2. improve interactions with other systems,
3. ensure information is transparent to stakeholders, and to
4. ensure balanced decisions are made.

The way IWCM achieves these aims is by adopting the following basic principles:

1. Consideration of all water sources (including waste-water) in water planning;
2. The sustainable and equitable use of all water sources;
3. Consideration of all water users;
4. Integration of water use and natural water processes; and
5. A whole of catchment integration of natural resource use and management.

1.2 THE INTEGRATED WATER CYCLE MANAGEMENT PROCESS

The process is in two parts:

Part 1 is the Concept Plan (the current report). This plan gives an overview of the current conditions at both catchment and individual urban area scales. It then undertakes an audit to the data, identifies issues and potential solutions. It undertakes a preliminary TBL assessment and offers recommendations.

Part 2 investigates solutions in more detail.

1.3 STRUCTURE OF THIS DOCUMENT

This document aims to answer two questions:

1. What are the key urban water cycle issues in Gunnedah Shire?
2. How do we address these issues?

Section 2 of this Plan identifies catchment and local conditions relevance to water cycle management.
Section 3 identifies issues
Section 4 identifies options
Section 5 provides a Triple Bottom line assessment
Section 6 provides recommended actions

2. GUNNEDAH-BACKGROUND INFORMATION

This section characterises conditions in Gunnedah and in the region.

2.1 CATCHMENT CONTEXT

Location

The Shire of Gunnedah is located within the Namoi River Catchment, some 470 km NW of Sydney. The shire covers an area of 5,092 square kilometres. Figure 2.1 shows the shire location within the Namoi Catchment. Figure 2.2 shows Gunnedah Shire is bordered by the Tamworth Regional Council and Shires of Liverpool Plains (Quirindi), Narrabri and Coonabarabran.

Gunnedah is the service hub of the Shire. Outlying villages include Curlewis and Breeza to the southeast, Carroll to the east and Tambar Springs and Mullaley to the southwest.

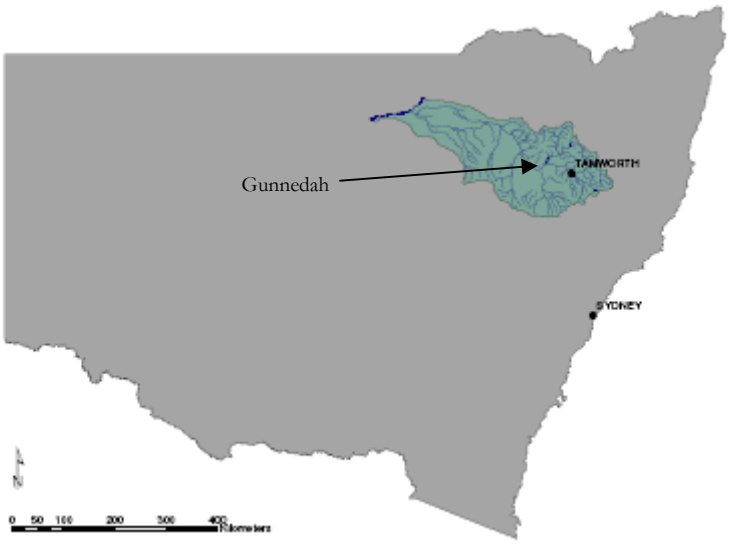


Figure 2.1. Gunnedah and its position within the Namoi Catchment (Source: River Styles Report for Namoi CMA).

This IWCMS is concerned all areas of the catchment related to the water supply, and all areas of the water utility business that impact on the catchment.

Population

Shire population in 1996 was 12,819 (ABS, 1997). This fell by 6.4% to 11,993 in 2001 (ABS, 2002). The non rural population has fluctuated considerably over the past few decades, having declined following closure of the Gunnedah abattoir and some coal mines. The proposed opening of new mines and other industries is likely to stabilise the population near its current numbers.

Rural industry employs 19% of the population. Other significant employers include retail (18%), manufacturing (11%) and community services (11%). Employment in mines can be significant at times (5% in 1996).

The populations supplied with reticulated water are: Gunnedah, Curlewis, Mullaley; and Tambar Springs.

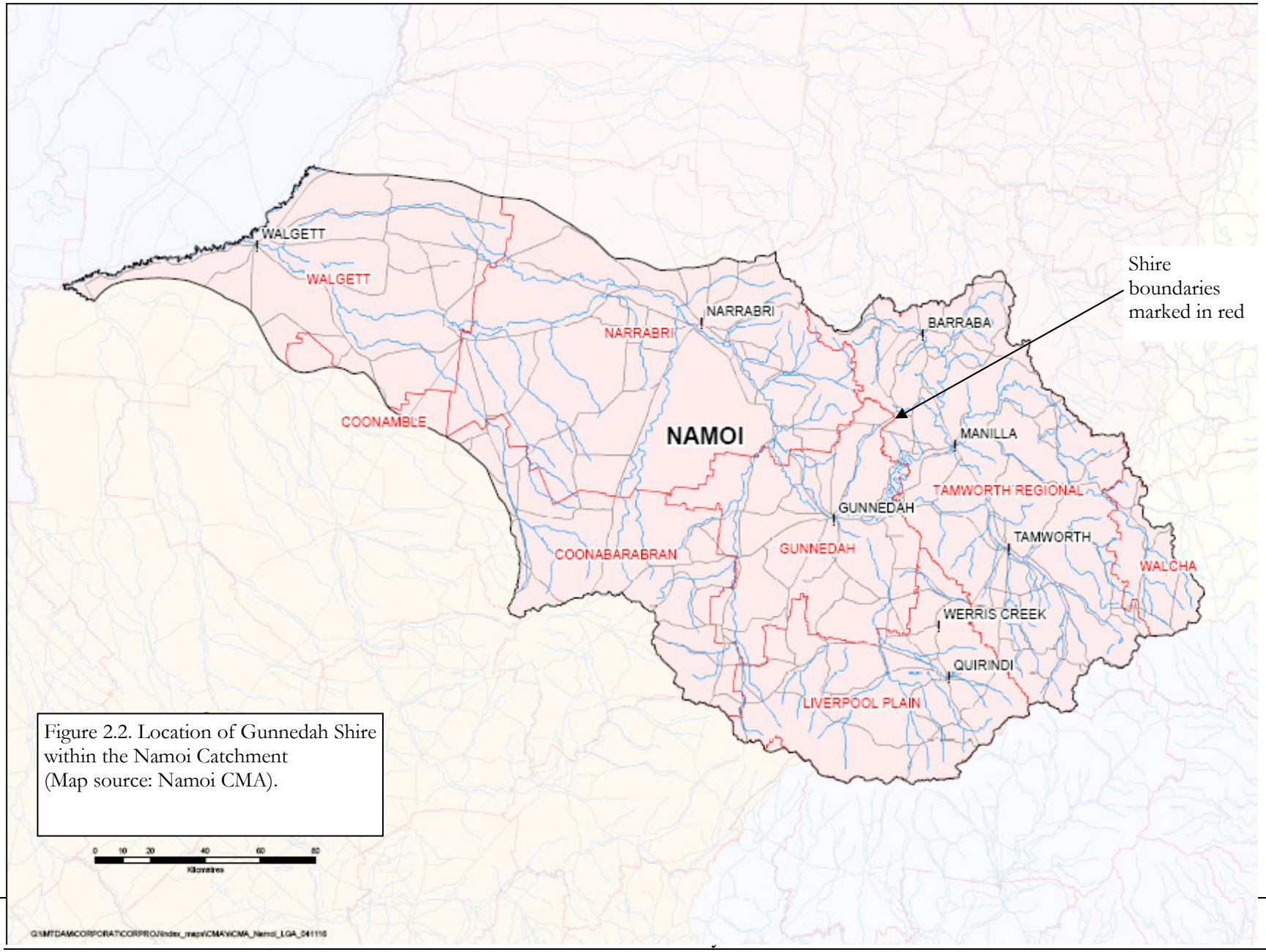


Figure 2.2. Location of Gunnedah Shire within the Namoi Catchment (Map source: Namoi CMA).

Economic environment

Agriculture is the major industry, generating some $220 million/year. Crop production contributes 78% of agricultural value, while livestock and livestock products contribute 18% and 4% respectively (ABS, 1997). Mining contributes $15 to $35 million/year. Other industries contribute $60m. However these figures are almost 10 years old and a combination of abattoir closure, increased coal mining and increased tourism is likely to have changed the relative contributions from different industries.

Landuse

Table 2.1 shows the area utilised by different rural production and the value of the output. Wheat is the major crop; however Cotton production is becoming increasingly important. Other summer crops such as sorghum are grown in response to anticipated market requirements.

Table 2.1. Crop production, area planted and gross value in the Gunnedah Shire (Source DPI).

Crop	Production		Gross Value ($'000)
	Hectares	Tonnes	($'000)
Wheat	51,647	105,428	26,122
Barley	16,972	29,888	6,447
Oats	3,276	4,197	509
Triticale	0	0	0
Chickpeas	186	148	47
Faba Beans	12	6	2
Field Peas	74	61	14
Lupins	0	0	0
Canola	238	106	38
Safflower	174	87	32
Soybean	332	548	217
Sunflower	7,897	6,725	231
Sorghum	14,232	45,912	9,129
Maize	854	6,728	1,547
Mungbeans	571	277	156
Cotton Seed	20,811	54,640	?
Vegetables	26	519	298
Total	117,302	255,270	44,789

EPA licenses

The licenses listed as current on the EPA website are shown below.

11222 CARROLL COTTON COMPANY PTY LTD licence summary CLIFTON ROAD CARROLL 2340

- Main issue: Largely concerned with air quality. Some contamination concentrations in water. No volume given).

Issued 11561 GUNNEDAH SHIRE COUNCIL licence summary KAMILAROI HIGHWAY GUNNEDAH 2380

- Saleyards. Issues include effluent disposal and ground water monitoring.

Issued 5940 GUNNEDAH SHIRE COUNCIL licence summary LOT 11 and Lot 12, QUIA ROAD GUNNEDAH 2380

- Landfill site. Leachate collection an issue.

Issued 831 GUNNEDAH SHIRE COUNCIL licence summary BOGGABRI ROAD GUNNEDAH 2380

- STP. LBL system in place. STP has exceeded N &P loads in the past.

Issued 1838 HANSON CONSTRUCTION MATERIALS PTY LTD licence summary RACECOURSE ROAD GUNNEDAH 2380

- Concrete batching. License refers to discharge of high pH, high TSS waters.

Issued 7193 HUNTER AND NEW ENGLAND AREA HEALTH SERVICE licence summary MARQUIS STREET GUNNEDAH 2380

- Main issue: Hospital waste.

Issued 1465 NAMOI FLOUR MILLS PTY LTD licence summary 91 - 93 BARBER ST GUNNEDAH 2380

- Largely concerned with dust and noise.

Issued 1863 NAMOI MINING PTY. LTD. licence summary BLACK JACK ROAD GUNNEDAH 2380

- Sedimentation pond discharges

Issued 2298 NAMOI MINING PTY. LTD. licence summary QUIA ROAD GUNNEDAH 2380

- Discharge to drain near coal loader

Issued 2634 NEW WAVE LEATHERS PTY LTD licence summary QUIA ROAD GUNNEDAH 2380

- Main issue: effluent discharge onto land.

Issued 3637 WHITEHAVEN COAL MINING LIMITED licence summary BOGGABRI ROAD GUNNEDAH 2380 Issued

- Main issue: dust

Effluent discharge from premises such as New Wave Leather Pty Ltd is typically as irrigation onto surrounding lands.

Climate

Climatic information is available from two stations in Gunnedah. Table 2.2 summarises key climate attributes. Gunnedah Shire has a warm continental climate with a typical daily range of 13 degrees. Average temperature varies from 25 degrees in summer to 10 degrees in winter.

Rainfall is highest in late summer. This often occurs within a series of thunderstorms, when the relatively intense rainfall of 12 mm/wet day can generate significant runoff and potential erosion. Average rainfall is lowest in late winter and an average of 6 mm falls each wet day. The 10 and

90%ile annual rainfalls are 74 and 174% of the mean annual rainfall. This suggests rainfall is moderately consistent among years.

Monthly pan evaporation ranges from 245 mm in December to less than 60 mm in winter. January evaporation is slightly less than December's reflecting higher humidity and rainfall in late summer. Moisture deficit was calculated by comparing rainfall less estimated runoff with 80% of pan evaporation. Table 21. shows there is an irrigation deficit under average conditions in each month. However there is also a very strong seasonal influence. Minimal irrigation is required in the average winter, while in summer over 100 mm of water is required each month.

Table 2.2. Climate conditions in the Gunnedah area (Source: BoM).

Attribute	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Daily Max Temp (deg C)	32	31	29	25	20	17	16	18	21	25	28	31	25
Mean Daily Min Temp (deg C)	19	19	17	13	9	6	5	6	8	12	15	17	12
Mean Daily Temp (deg C)	25	25	23	19	15	11	10	12	15	18	22	24	18
Mean Rainfall (mm)	89	72	42	41	47	37	43	36	38	61	66	65	636
Median (Decile 5) Rainfall (mm)	74	61	36	22	41	35	30	32	31	57	62	59	649
Decile 9 Rainfall (mm)	202	140	97	126	99	76	91	82	77	114	134	126	859
Decile 1 Rainfall (mm)	17	9	1	2	2	4	7	4	4	12	13	16	365
Mean no. of Raindays	7	6	5	4	5	6	6	6	6	7	7	7	72
Mean Monthly Evaporation (mm)	239	188	186	129	84	57	59	84	117	164	198	245	1752
Estimated irrigation deficit (mm/month)	111	85	111	66	25	12	8	34	59	77	99	138	829

The results above indicate Gunnedah has a moderately dry warm climate. Rainfall is reasonably reliable, at least on an annual basis. Irrigation is required every month in the average year.

Geology

The Shire is within the Gunnedah Basin. This basin extends from Bellata in the north to the Liverpool Ranges to the south (Harrington, 1977). The basin was formed in the late Carboniferous / Early Permian period and involved overlying a volcanic chain which supplied sediments to the region in the Devonian and Carboniferous periods.

According to Harrington (1977) a shallow sea covered the region in the early Permian period. Infilling of this sea with organic material created extensive peat deposits that have now been converted to coal. Widespread deposition of sandstone and mudstone occurred during the Triassic period.

There was intermittent volcanic activity between the late Triassic and the Tertiary periods. Sediments were eroded from the New England Tablelands and the Liverpool Ranges, and these have now been covered with Quaternary alluvium, creating the Liverpool Plains. The stratigraphy of the region is described in Packham (1969).

Figure 2.XX shows that much of the Shire is flat and covered with alluvium. There are isolated areas of steep metasediments to the south of Gunnedah township. Volcanic remnants occur near Mullaley. Figure 2.XXY indicated that the bulk of the Shire is within the Liverpool Plains landscape.

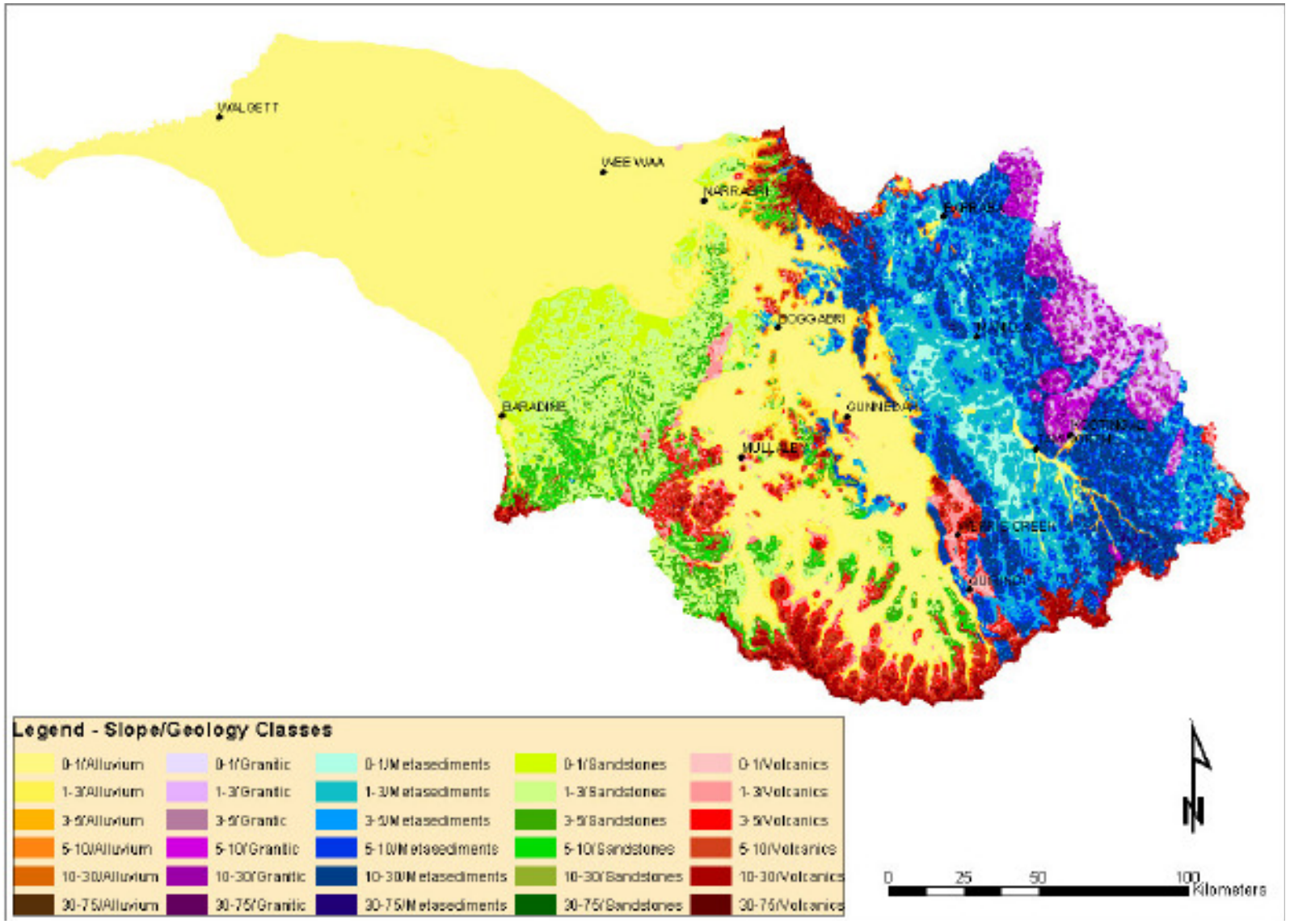


Figure. 2.3 Slope and geology classes within the Namoi catchment. (Source: River Styles Report for Namoi CMA).

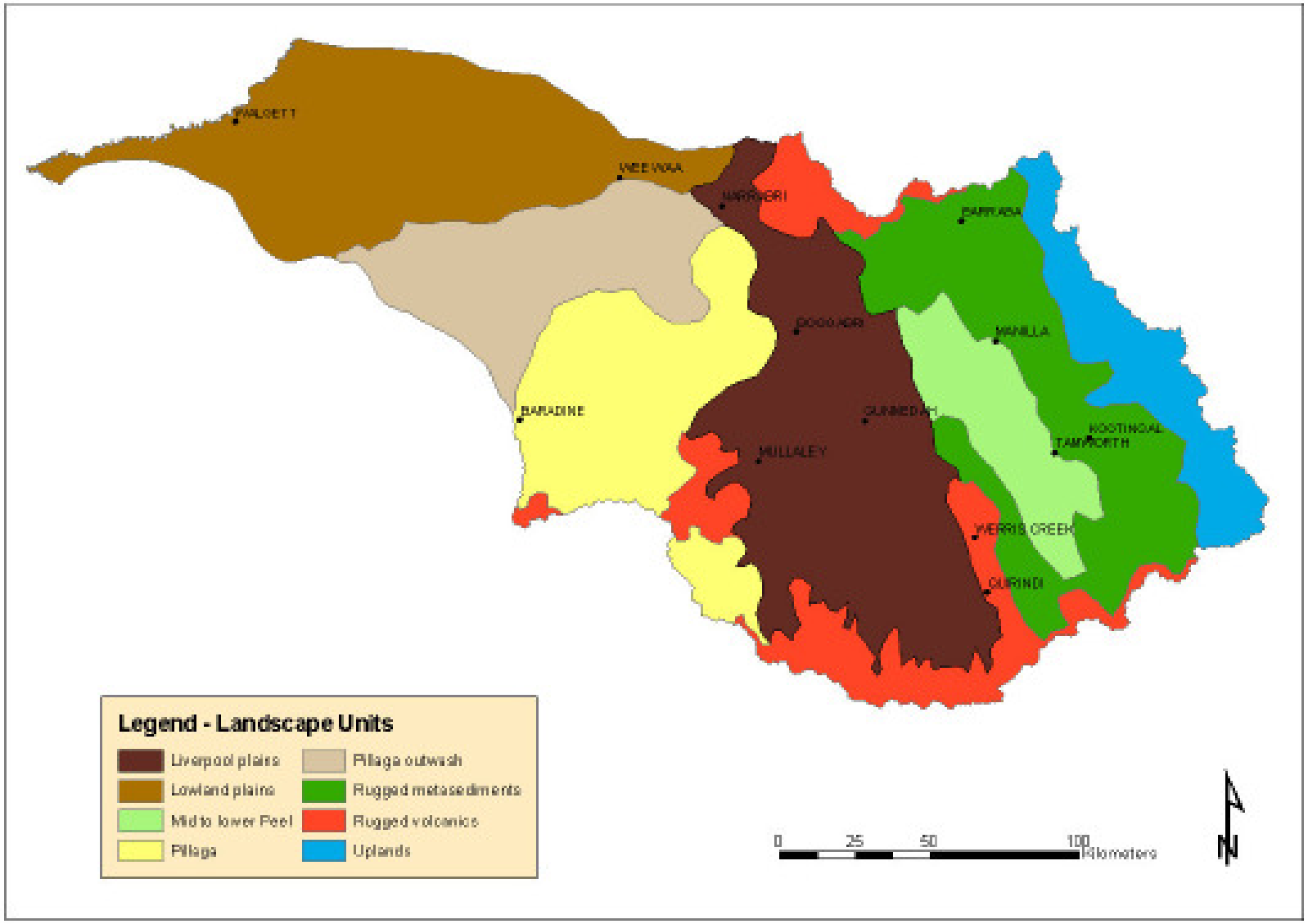


Figure 2.4. Landscape units within the Namoi Catchment (Source: River Styles Report for Namoi CMA).

Soils

Detailed soil landscape information is available for the southern portion of the shire in the Curlewis Soil Landscape book (Banks, 1995). Northern portions of the Shire are included in the unpublished Soil Landscape Book for the Boggabri area.

Soil types in the shire are summarised in table 2.3. Soils with uniform texture (vertosols and kandosols) cover 80% of the shire. The soils are usually relatively recently formed and can be fertile. Sketal soils such as the Pilliga Soil Landscape Group, are common in the south west portion of the shire as figure 2.4 shows. These soils are usually infertile.

Table 2.3 Major soil types in the Gunnedah Shire. (Source: derived from Bailey, 1995)

Great soil group	Classification based on Isbell (1996)	Percentage of shire covered (%)
Black Earth	Vertosols	30
Brown and Grey Clays	Vertosols	18
Red Earth/Brown Earth	Kandosols	28
Gravelly Red Earths	Kandosols	4
Skeletal	Tenosols and Rudosols	9
Gravelly Solodics	Sodosols	3
Euchrozems	Ferrosols	5
Sandy Yellow Solodics	Sodosols	2
Disturbed and others	Various	1

Erosion

According to Bailey (1995) over 9000 ha of the Shire had severe to extreme sheet or rill erosion. This erosion would contribute to a significant sediment load reaching the Namoi and its tributaries. These sediments would contain nutrients that facilitate algal blooms. Table 2.4 shows that less than 1% of the Shire had salinisation in 1995. It is likely that this has increased appreciable in the past decade.

Changes in agricultural activity and more widespread use of conservation farming may have reduced the spread of erosion over the past decade; however areas of severe to extreme erosion will remains a threat to land utility and water resources for decades to come.

Bailey (pers comm) suggested that salinisation and waterlogging is likely to be more obvious now than in 1995.

Salinity is largely confined to the break of slope between the metasedimentary rock and the soils of the Liverpool Plain. These occur where the lower hill slopes intersect the Liverpool Plain.

Bailey (1995) also examined stream bank erosion. He reported that over 120 km of stream banks within the Shire had vertical banks in excess of 3m. Table 2.5 shows this is 26% of the total stream length examined. The result suggests stream bank collapse can be a major sediment management issue

Table 2.4 Erosion type and severity as a percentage of shire area (Source: derived from Bailey, 1995).

Erosion type and severity	Percentage of shire affected
No appreciable erosion	57
Minor sheet and rill erosion	34
Moderate sheet and rill erosion	7
Severe sheet and rill erosion	2
Extreme sheet and rill erosion	<1
Wind erosion	Nil
Salinisation	<1
Mass movement(slides, slumps, rock debris)	<1

Table 2.5. Stream bank heights in Gunnedah Shire. (Source: Based on investigations reported by Bailey, 1995).

Height of stream bank	Length of streams with this height class (km)	Percentage of stream banks with this height class.	
<1.5m	161	35	
1.5 to 3m	178	39	
3 to 6m	86	19	
>6m	34	7	

Gully erosion is another significant land management issue in Gunnedah Shire. Bailey (1995) reported there was almost 200 km of moderate to extreme erosion gullies over 1.5m deep in the Shire. All of these gullies were active at the time of the survey.

Topography

Much of the shire is associated with alluvial plains of the Namoi and Mooki River systems. The area is described in Greenwood (1982) as near level plains developed from deposition of alluvium during the Quaternary period. Table 2.4 shows 85% of the shire has slopes less than 5%. The lack of slope in much of the LGA is demonstrated in figure 2.3.

In some areas the Mesozoic surface protrudes as strongly weathered residual ridges of low isolated hills. The hill ridge systems are asymmetrical in form with steep to precipitous slopes on the eastern faces and relatively gentle western slopes. Table 2.6 shows over 4% of the shire has slopes exceeding 20%.

The major peaks of the Shire are Tulcumba (885m), Mount surprise (647m), King Jack Mountain (761m) and Tambar Mountain (805m) (Gunnedah Shire Council, SoE, 2003/04).

Highest points in the Gunnedah township area include Blackjack Mountain (670m), Porcupine Hill (450 m) to the south-east of Gunnedah, and Borethistles Hill (360 m) and Pensioners Hill (340 m) the west of Gunnedah (Planning Workshop, 1981).

Table 2.6. Slope classes in the Shire. (Source: Copied from Bailey, 1995).

Slope range	Percentage of shire
<2%	64
2 to 5%	21
5 to 10%	7
10 to 20%	4
20-33%	2
33-50%	2
>50%	<1%

Terrain

Bailey(1995) divided the terrain of the shire into various types. The main ones are shown in table 2.7. Over 95% of the Shire consists of plains, floodplains, footslopes and side slopes.

Table 2.7 Major types of terrain in Gunnedah Shire (derived from Bailey, 1995).

Terrain type	Percentage
Floodplain	37
Plain	3
Drainage plain	1
Footslope	35
Side slope	19
Water bodies	2
Other	3

Table 2.7 shows that floodplains are a major feature of the Gunnedah Shire. These plains extend up to 20 km on either site of the main stream lines.

Drainage systems

The Namoi and Mooki Rivers and Cox's Creek flow through the northern, south-eastern and western sections of the Shire respectively (Gunnedah Shire Council web site accessed 20.2.06).

The Namoi River rises as the MacDonald River in the New England Plateau and flows over the lower slopes of the Great Dividing and Liverpool Ranges to the Barwon floodplain at elevations of less than 150 metres. It is one of the main tributaries of the Barwon-Darling River System, draining an approximate area of 43,000 square kilometres (17,100 square kilometres at Gunnedah), starting near Walcha in the east and flowing in a north-westerly direction to Walgett in the west of NSW.

The Mooki River drains the south-eastern portion of the Shire, including the Liverpool Plain downstream of Breeza. It enters the Namoi River four kilometres upstream of Gunnedah.

Cox's Creek flows through the west of the Shire passing Tambar Springs, Mullaley and Boggabri, where it enters the Namoi River.

Impact of Keepit Dam

Keepit Dam is the major storage on the Namoi River and it lies partly within the Shire, upstream of Gunnedah. The 423,000 ML storage covers some 4,400 ha and is designed to regulate water supply to cotton farmers. Figure 2.5 shows the percentile distribution of flows in the river at Gunnedah before 1960 and since 1990. There has been a small decrease in flow over much of the curve. For example at the 50% flow (i.e. half the time the flow exceeded this rate), prior to the dam there was around 452 ML/day. Since 1990 the 50% flow is 347 ML/day.

Figure 2.5 . Percentile flow distribution in the Namoi River at Gunnedah for pre (1891 to 1960) and post dam (1990 to 2006) periods (Source: DNR).

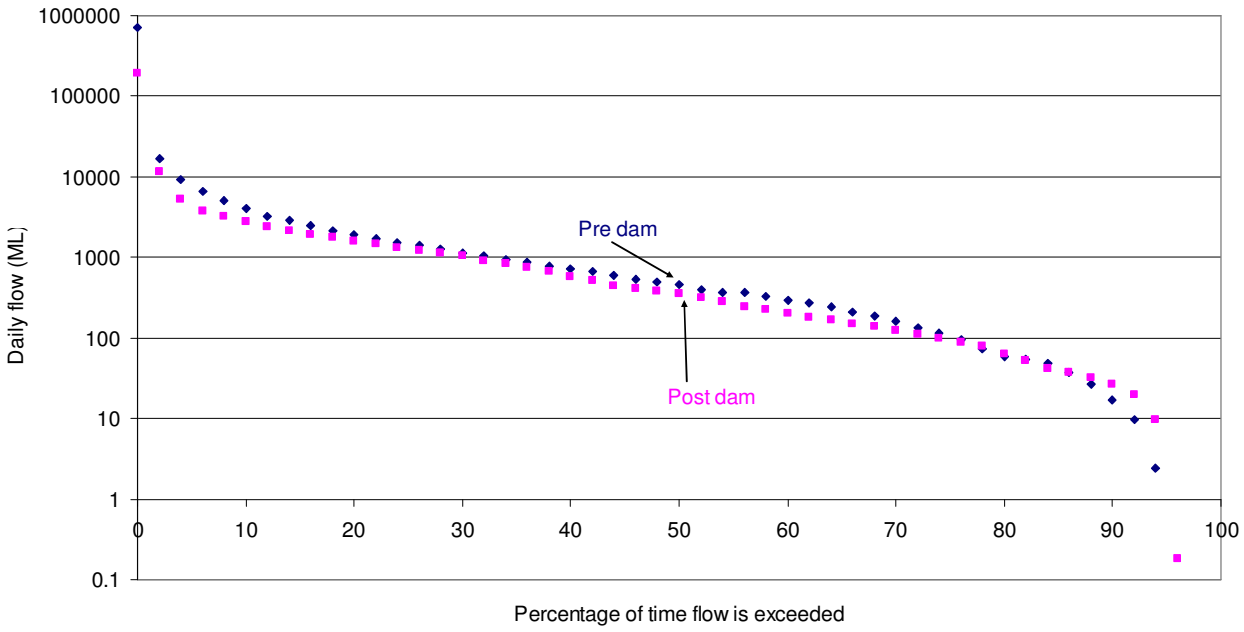
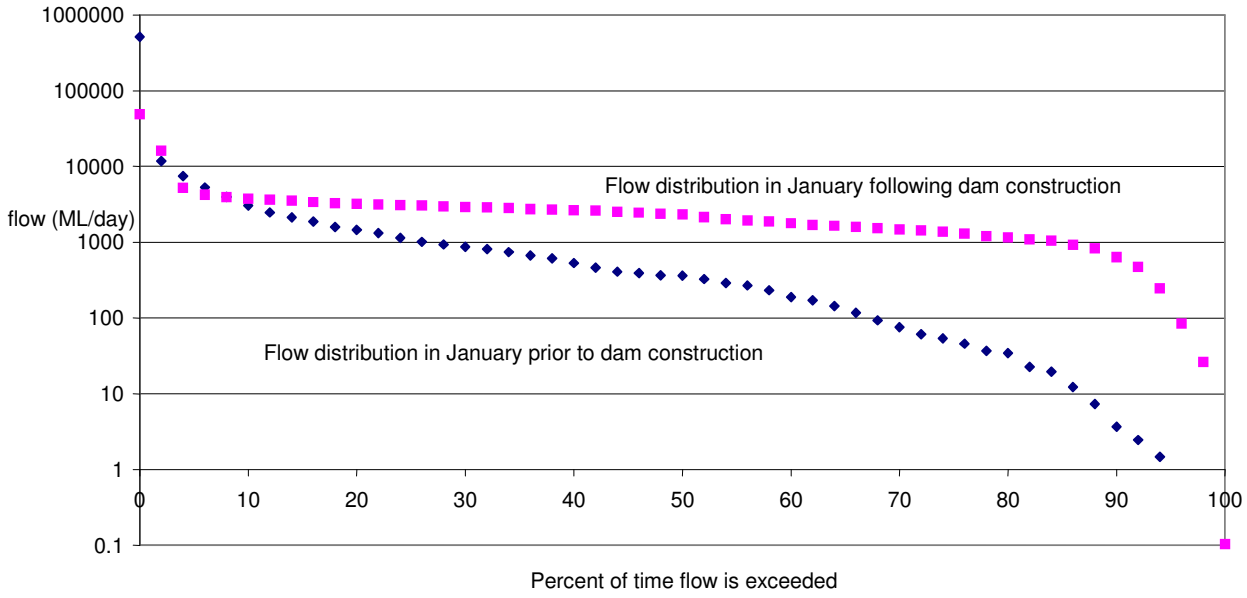


Figure 2.6 shows the effect of the dam management is very marked during the irrigation season. For example in January prior to 1906 median flow was 362 ML/day. Since 1990 it has been 2333 ML/day. Figure 2.6 also shows the flow is less variable since dam construction. For example the 10% exceedance for January flow pre 1960 was 3077 ML/day. This fell 34 fold to 34 ML/day for the 80% exceedance flow. In contrast the flow since 1990 is 3770 ML/day while the 80% flow rate is 1152 ML/day. That is, under natural conditions there is a 99% fall in rate between 10% and 80% flow exceedance. This is much greater than the 70% fall in rate between 10% and 80% flow in January since 1990. Continuous unseasonal high flows in January can result in marked changes in river ecology. For example it can increase habitat for European Carp.

Figure 2.6. Percentile flow distribution during January in the Namoi River at Gunnedah for pre (1891 to 1960) and post dam construction (1990 to 2006) periods (Source: DNR).



River styles

A river styles assessment was recently prepared for the Namoi CMA. This assessment is designed to identify stream conditions and assist in setting remediation priorities for the Namoi Catchment. Figure 2.7 shows the Namoi River within its catchment context.

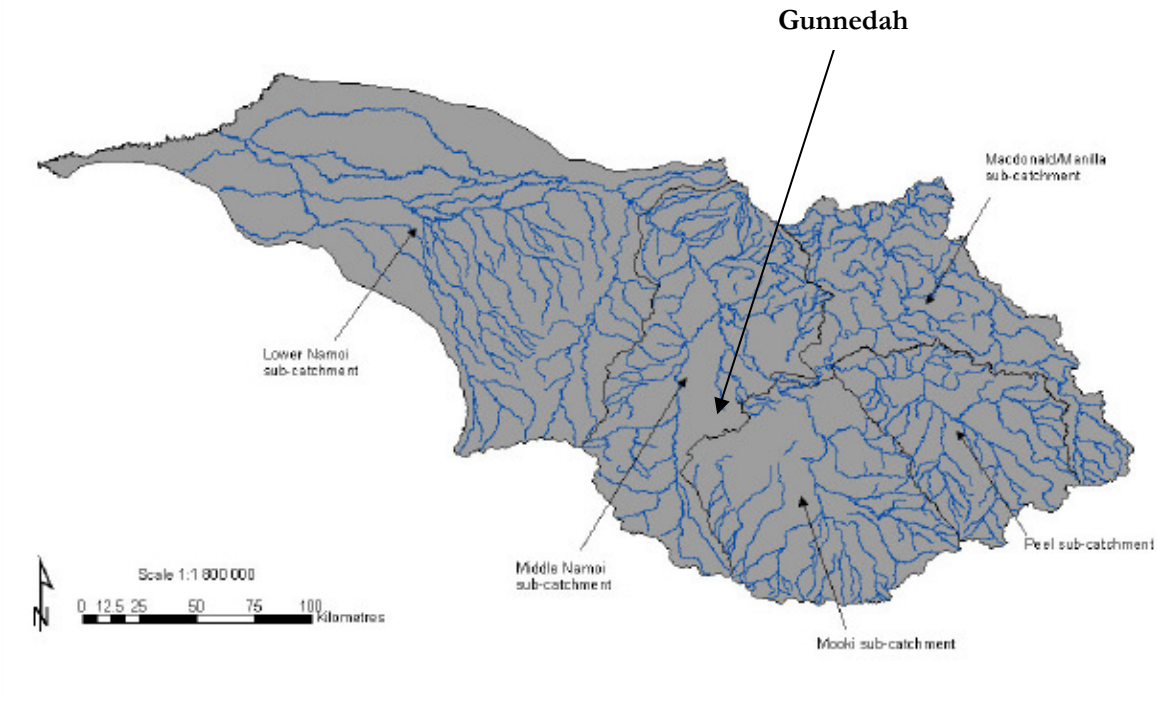


Figure 2.7. Namoi Catchment drainage system (Source: Namoi River Styles Report Namoi CMA).

Figure 2.8 shows the long profile of the Namoi River as well as that of Mooki River and Coxs Creek. Near Gunnedah township the Namoi River is a low slope, low sinuosity, gravel based river.

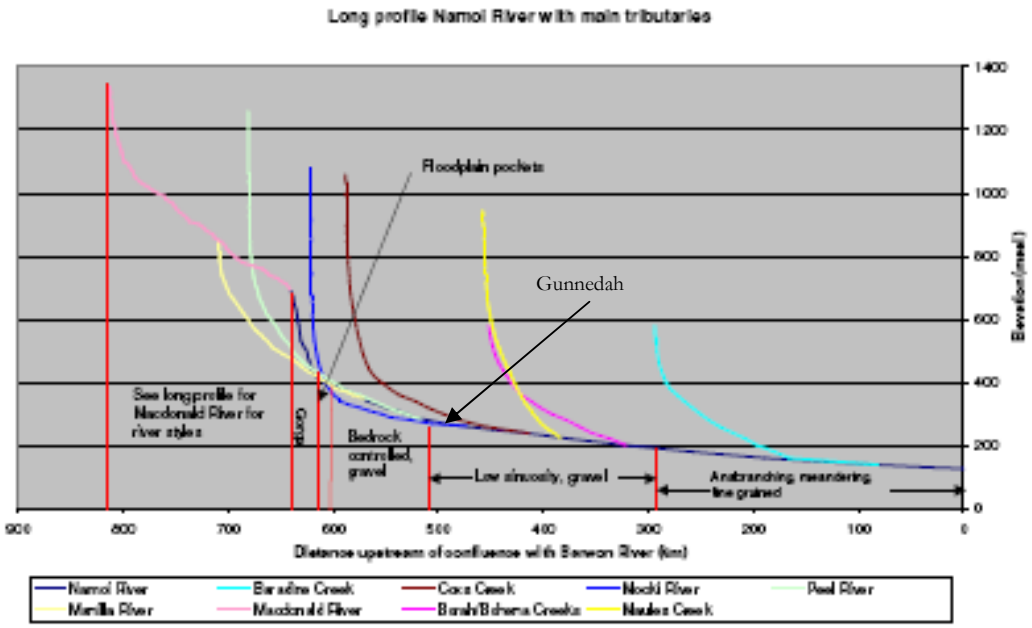


Figure 2.8. Long profiles of the Namoi and Mooki River and of Coxs Creek.
(Source: copied from Riverstyles Report for Namoi CMA.

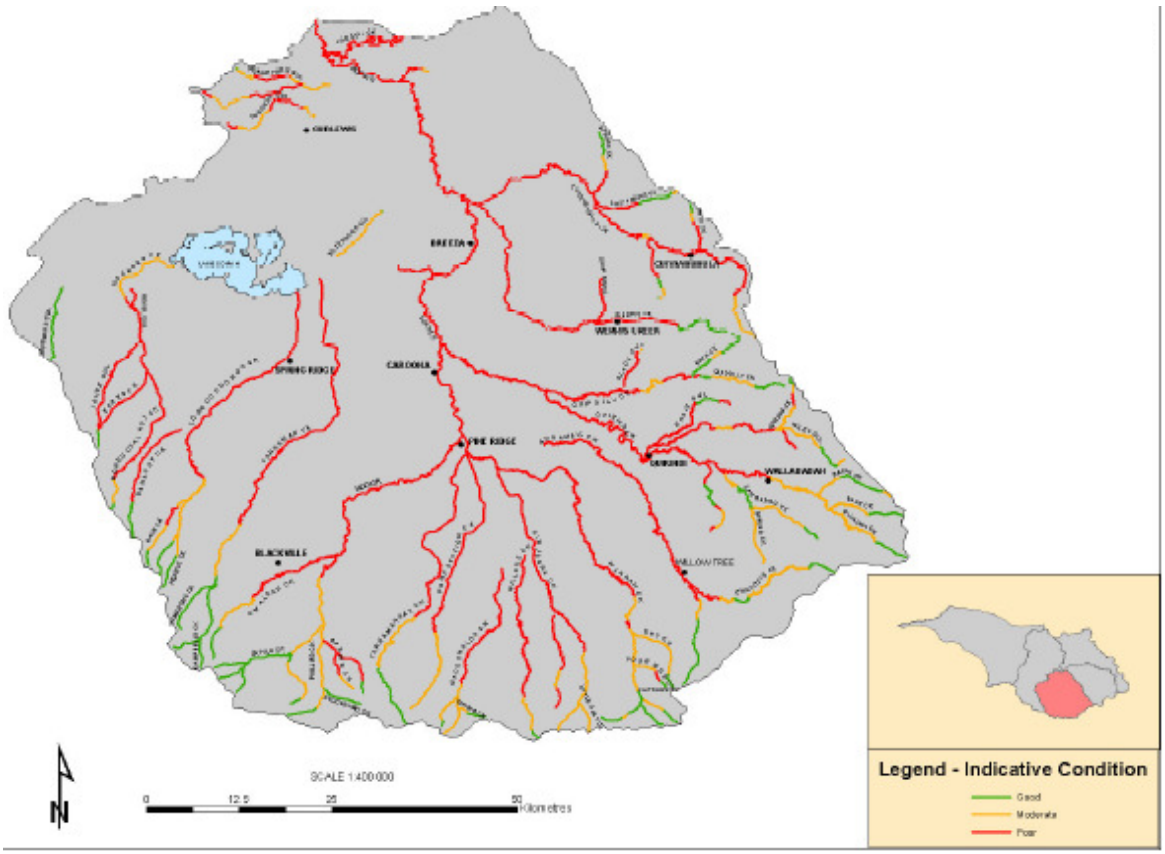


Figure 2.9. Indicative river conditions in the Mooki River subcatchment. (Source: Namoi River Styles Report for Namoi CMA).

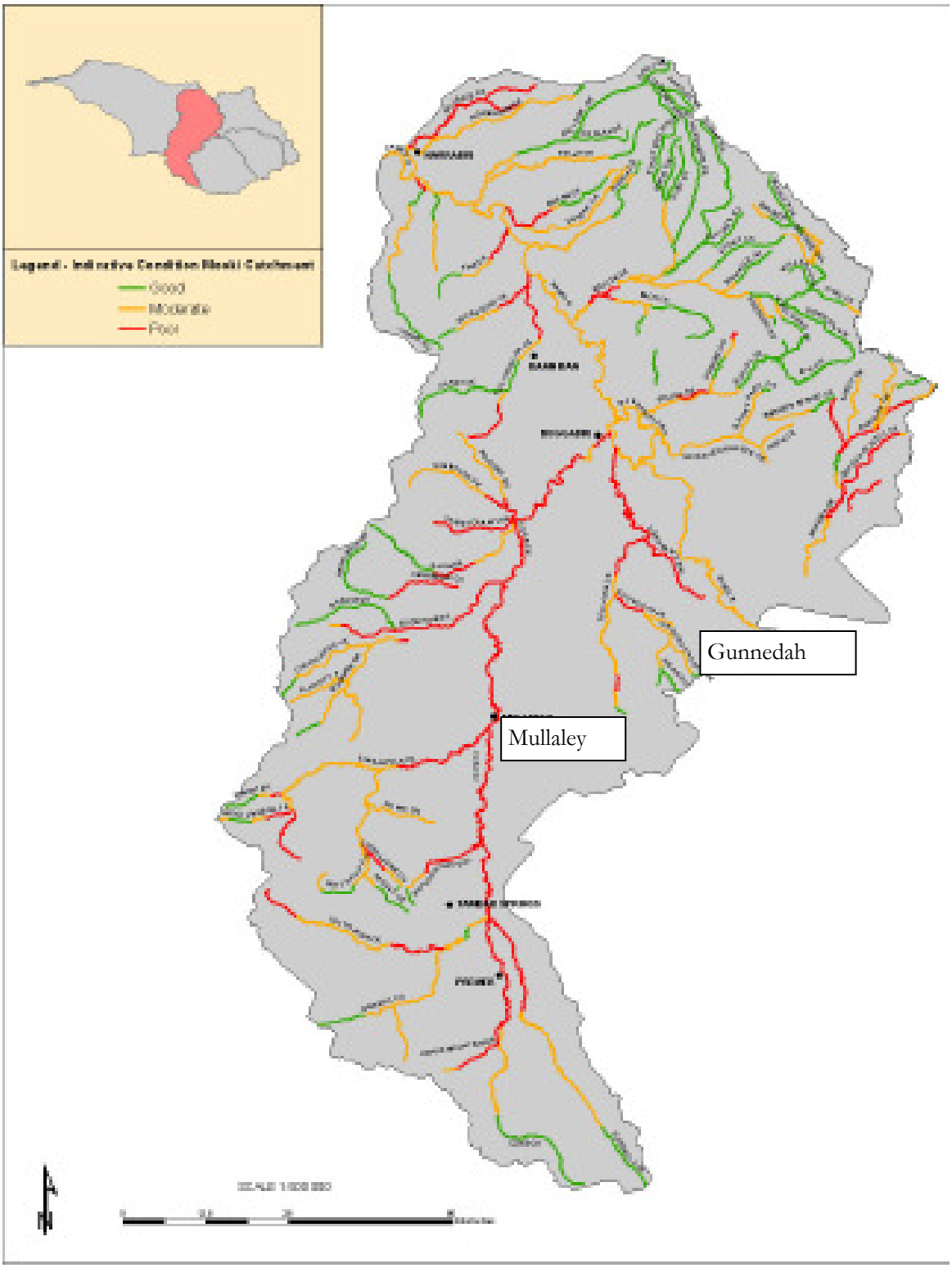


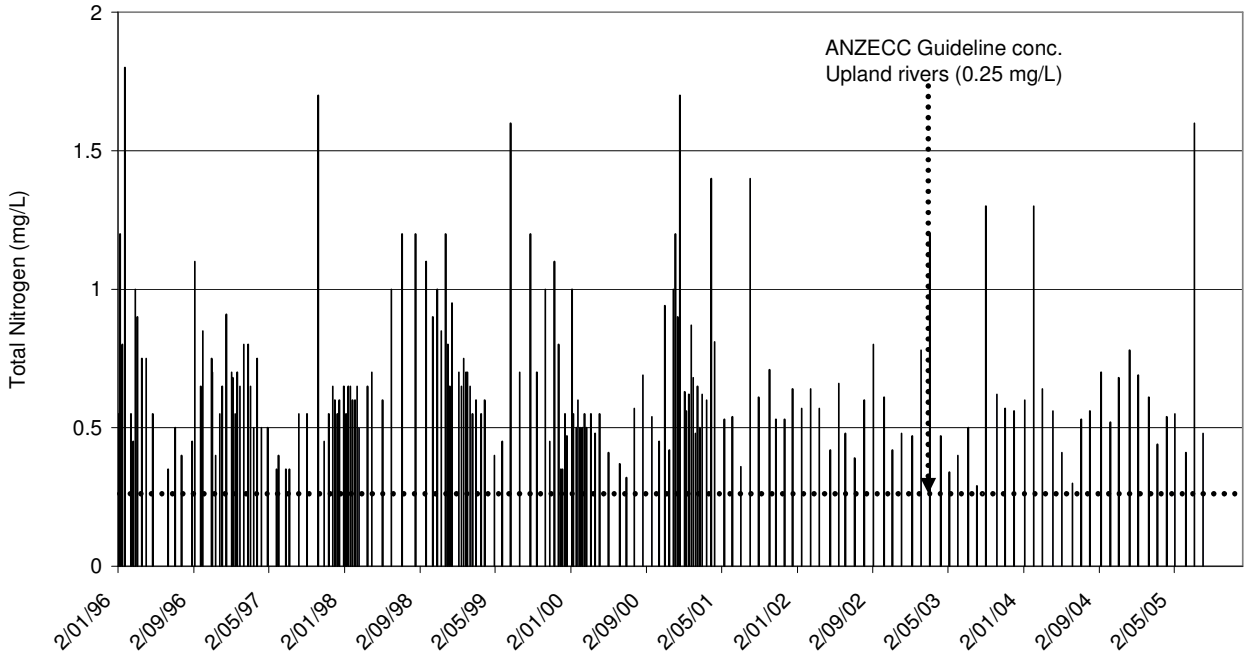
Figure 2.10. Indicative river conditions in the Mooki River subcatchment. (Source: Namoi River Styles Report for Namoi CMA).

Figure 2.9 shows the river condition in the Mooki subcatchment while figure 2.10 shows conditions downstream of Gunnedah. It is obvious that much of the stream length within the Liverpool Plains is in poor condition. This is correlated with loss of the stipa grasslands (Wallbrink, et al, 1998).

Water quality in the Namoi River

Figure 2.11 shows Nitrogen concentration in the Namoi River at Gunnedah virtually always exceeds the ANZECC Guideline for Aquatic Ecosystem Protection (ANZECC, 2000). The elevated nitrogen concentration is likely to reflect the intensive irrigation found in the catchment.

Figure 2.11. Total Nitrogen concentration in the Namoi River at Gunnedah.



Phosphorus concentration is also very high compared with the ANZECC Guideline concentration for aquatic ecosystem protection as figure 2.12 shows. The high phosphorus concentration can result in algal blooms. These blooms can make treatment of water for potable use difficult and expensive.

Figure 2.12. Phosphorus concentrations (mg/L) in the Namoi River at Gunnedah.

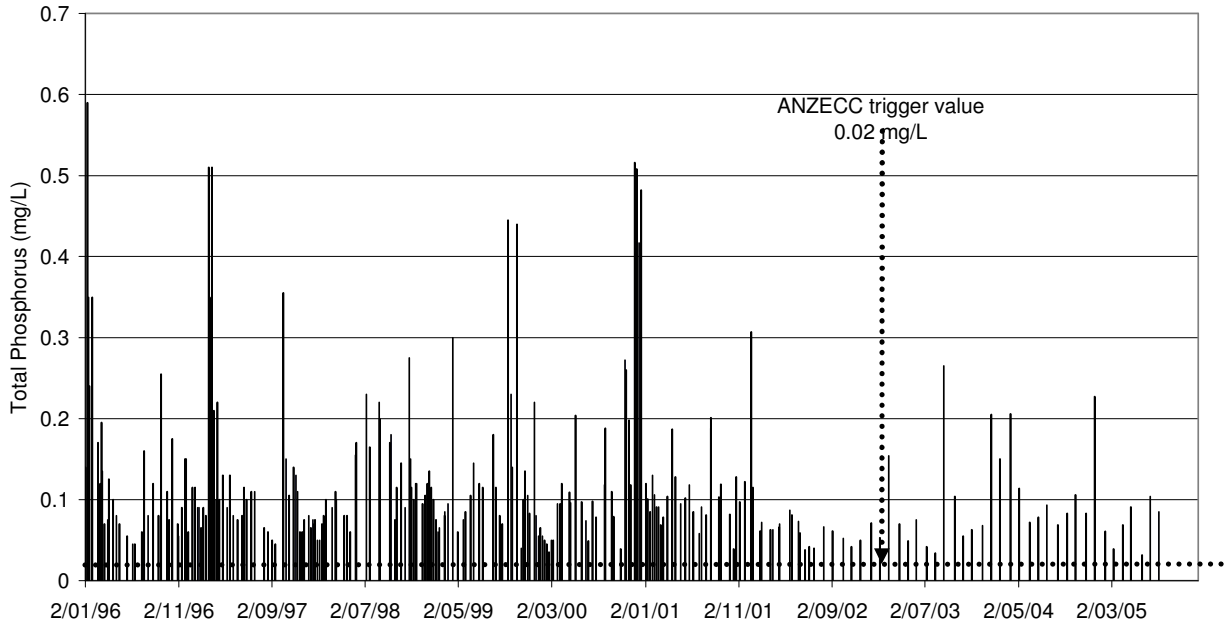
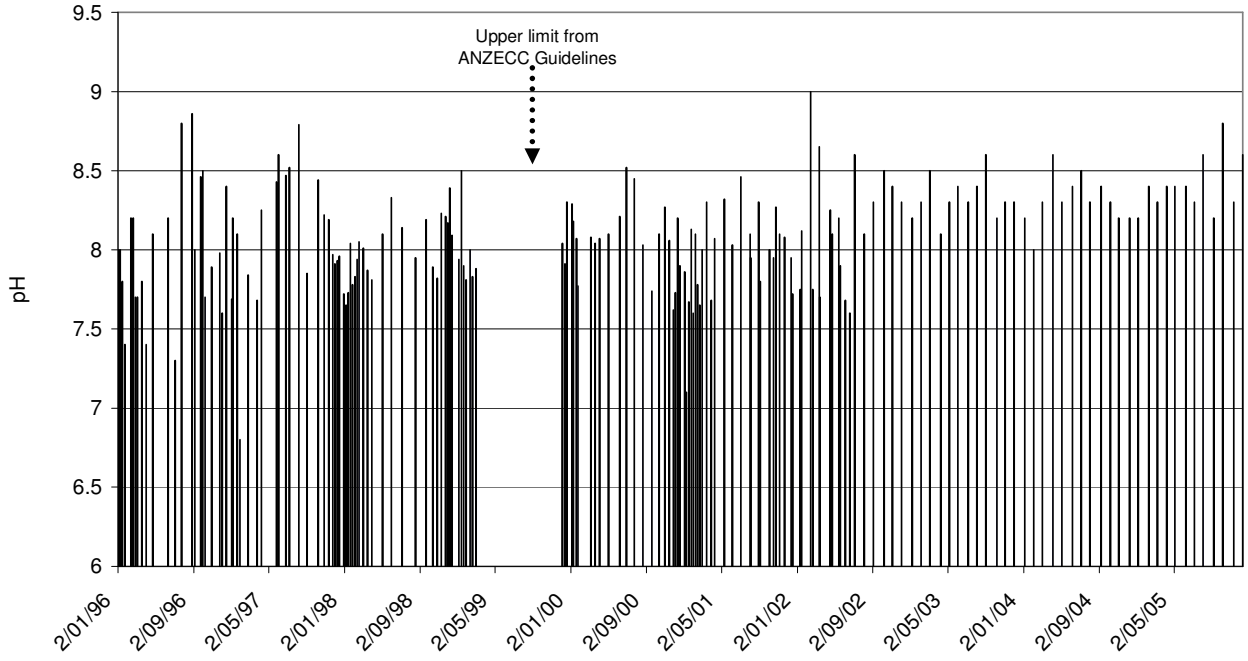


Figure 2.13. pH in the Namoi River at Gunnedah.



According to the ANZECC guidelines the pH should not exceed 8.5, however figure 2.13 shows the pH in the Namoi River exceeds this value on numerous occasions. Intermittent high pH is commonly associated with algal blooms.

Figure 2.14. Relationship between stream level (gauge height) and Phosphorus concentration at Gunnedah since 1996.

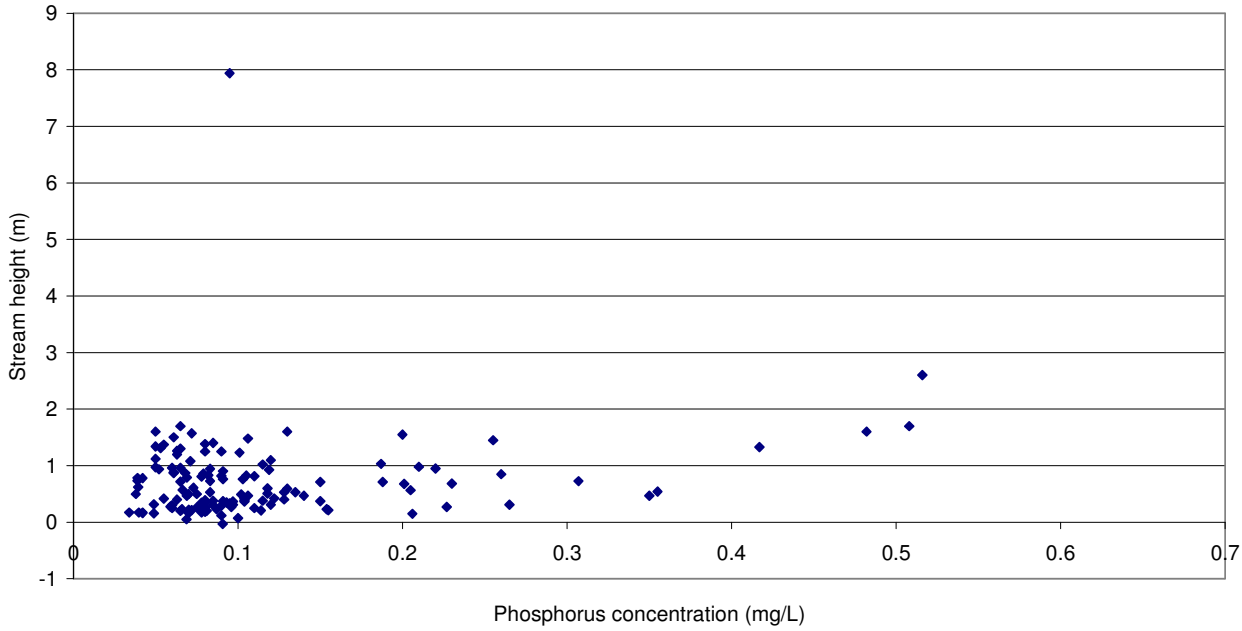


Figure 2.14 shows there is minimal relationship between river height and Phosphorus concentration in the Namoi River at Gunnedah. The river always contains elevated Phosphorus concentrations.

Catchment water quality objectives

Interim catchment water quality objectives were established by the EPA (now DEC) in 1997. These are shown in figure 2.15. Figure 2.16 shows the assessment of the Namoi catchment near Gunnedah in 1997.

Mooki River had moderate salinity and rarely met the water quality criteria for aquatic ecosystem protection. There was no information on Coxs Creek. There was a Namoi River sampling site within Gunnedah and one immediately downstream. The site within Gunnedah meets water quality criteria for primary contact recreation (e.g. swimming) and for aquatic ecosystem protection in less than 50% of samples. Downstream of Gunnedah the water quality improved slightly and it met quality criteria for swimming in over 75% of samples. Salinity was moderate at all sites.

The results indicate Gunnedah township has a minor impact on Namoi River water quality. This is likely to be due to a combination of urban stormwater and salt incursion.

Salinity is a regional issue that occurs naturally. However land clearing and irrigation will have increased its severity.

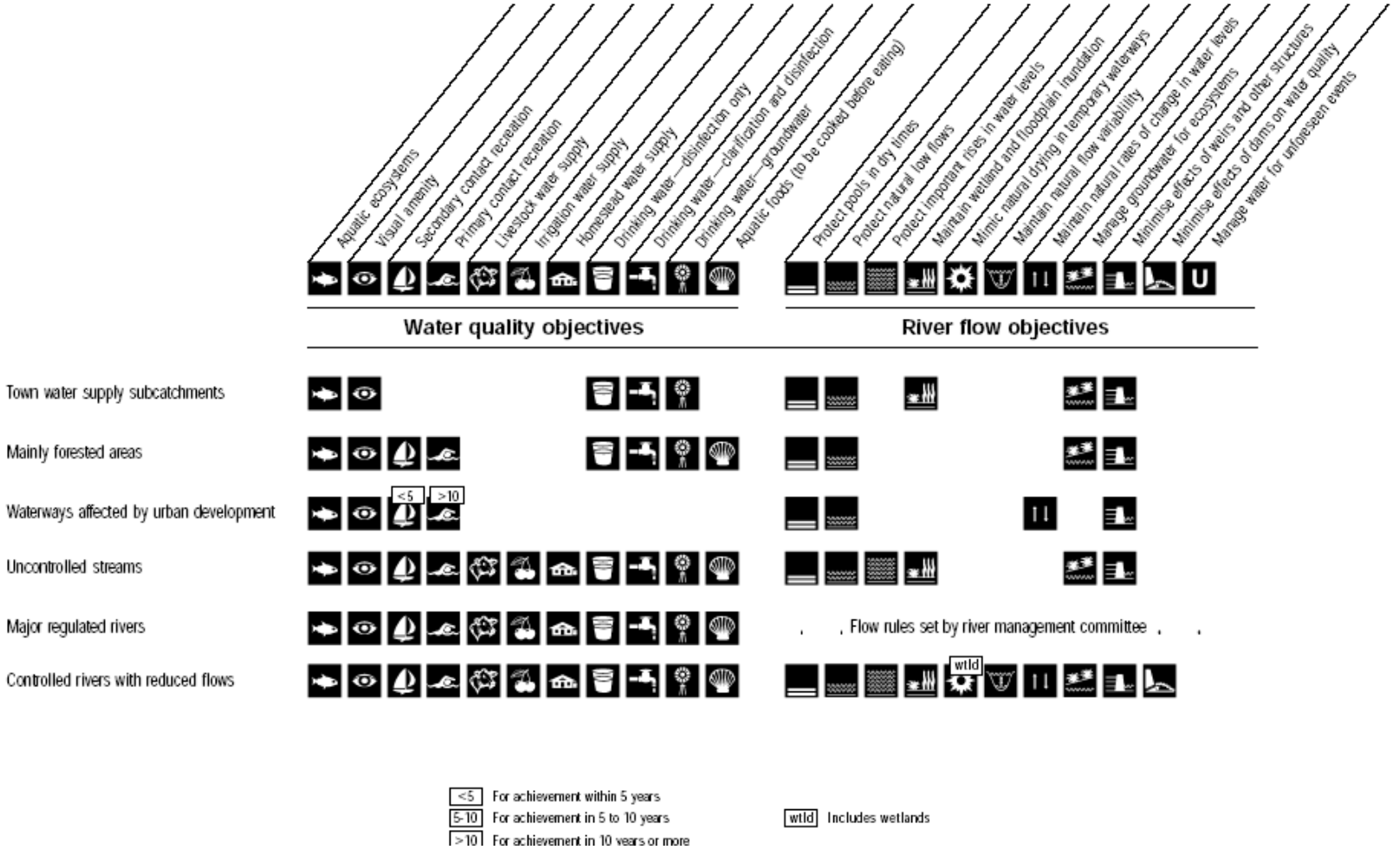


Figure 2.15. Namoi Water quality objectives for different end uses (Source: EPA, 1997).

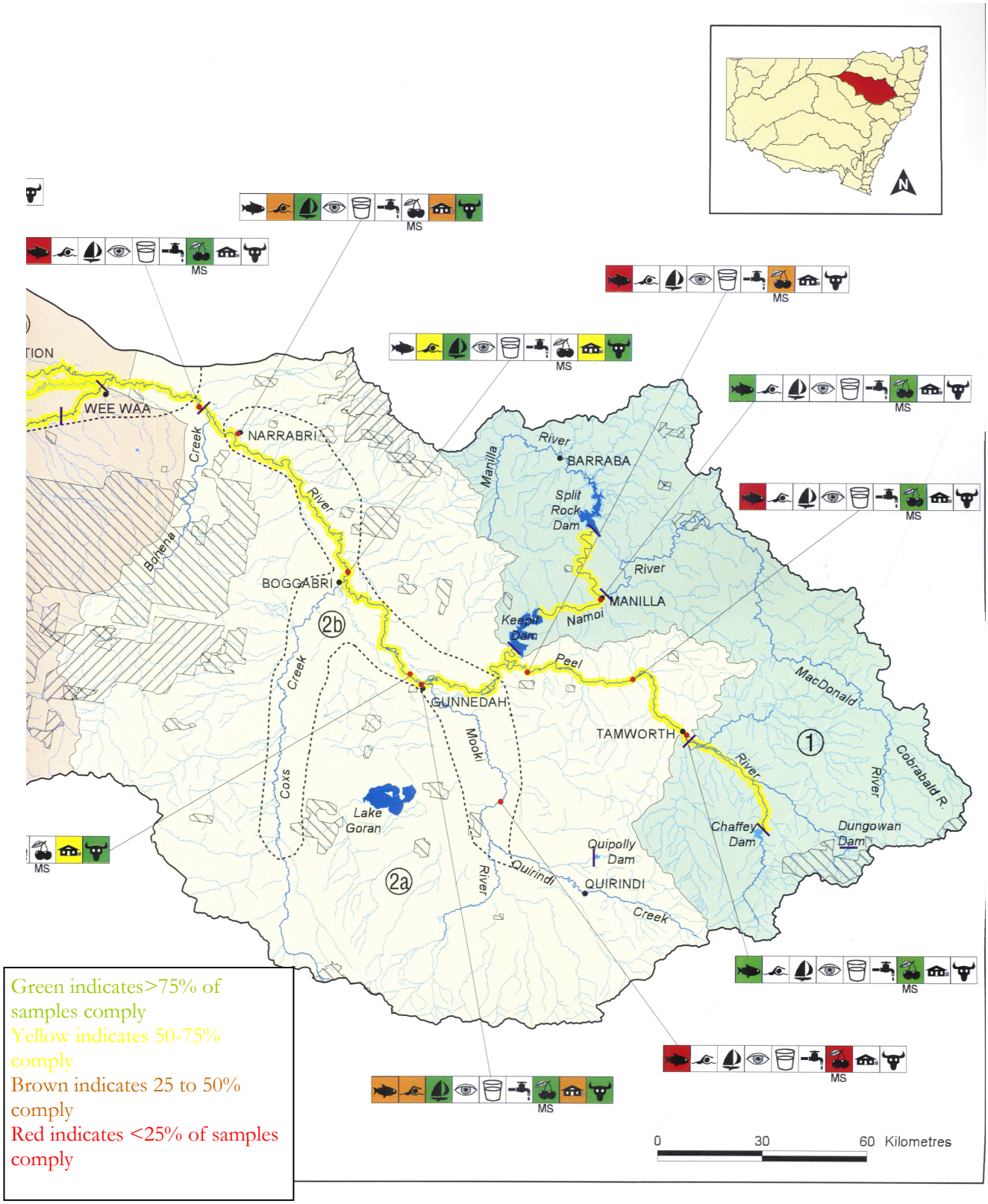
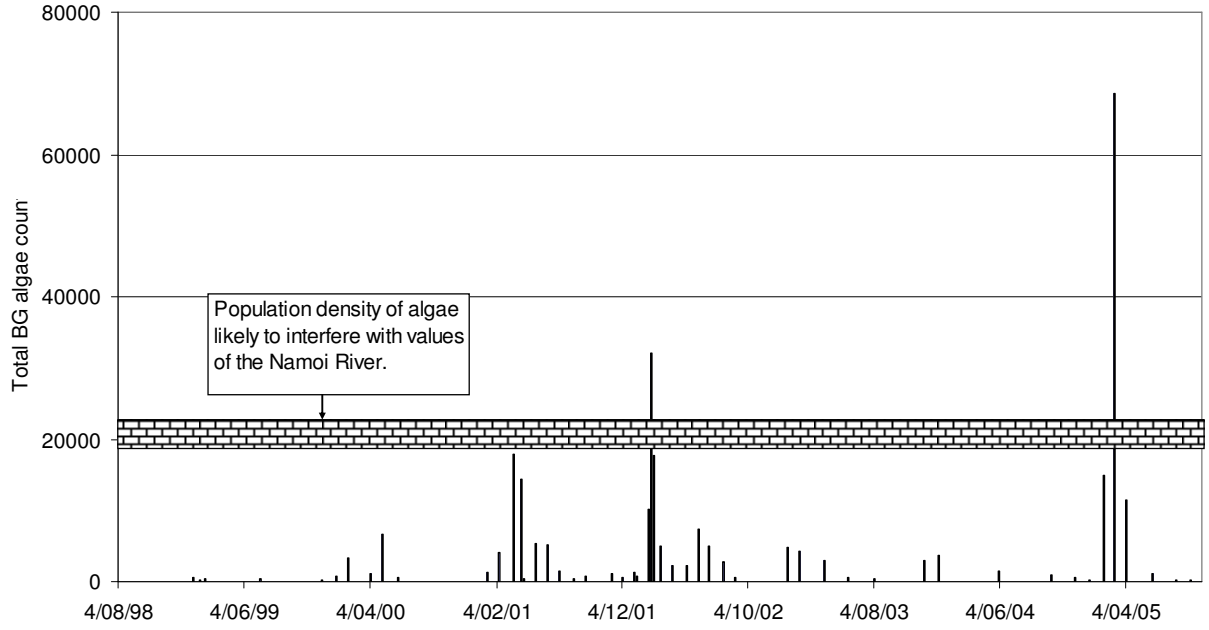


Figure 2.16. Extent of compliance with Interim Water Quality Objectives in streams in the Gunnedah region of the Namoi River Catchment (Source: EPA, 1997). .

Presence of algae in the Namoi River

Blue green algae population can increase to nuisance values in some rivers. Impacts of the algae include obstruction of waterways, clogging of filtration systems, reduction in fish habitat, odour production and the potential for releasing toxins into water supplies making them unfit for consumption (ANZECC, 2000). Figure 2.17 shows the algae count in the Namoi River downstream of Keepit Dam.

Figure 2.17. Total Blue-green algae count in water down stream of Keepit Dam since 1998.



There are periods in 2001, 2003 and 2005 when the indicative threshold of 15,000 to 20,000 cells/mL were exceeded. The presence of algae in the Namoi River is not a direct threat to Gunnedah water supply, however it can make the river less attractive for swimming and passive recreation (ANZECC, 2000).

Salinity hazard

Salinity hazard mapping has been carried out on a regional, 1:250,000 scale (Collins and Donaldson, 2002). The mapping utilised modelling that incorporated geological complexity, lithology, soil salt load, soil permeability, change in slope and rainfall. Anthropogenic impacts such as vegetation clearing, urbanisation, dam construction and irrigation are not considered. Figure 2. shows there is an area of moderate to very high salinity hazard land in the triangle between Breeza, Gunnedah and Mullaley. This result is consistent with the moderate salinity reported in Mooki River and Coxs Creek that flow on either side of the salinity hazard belt shown in figure 2.18.

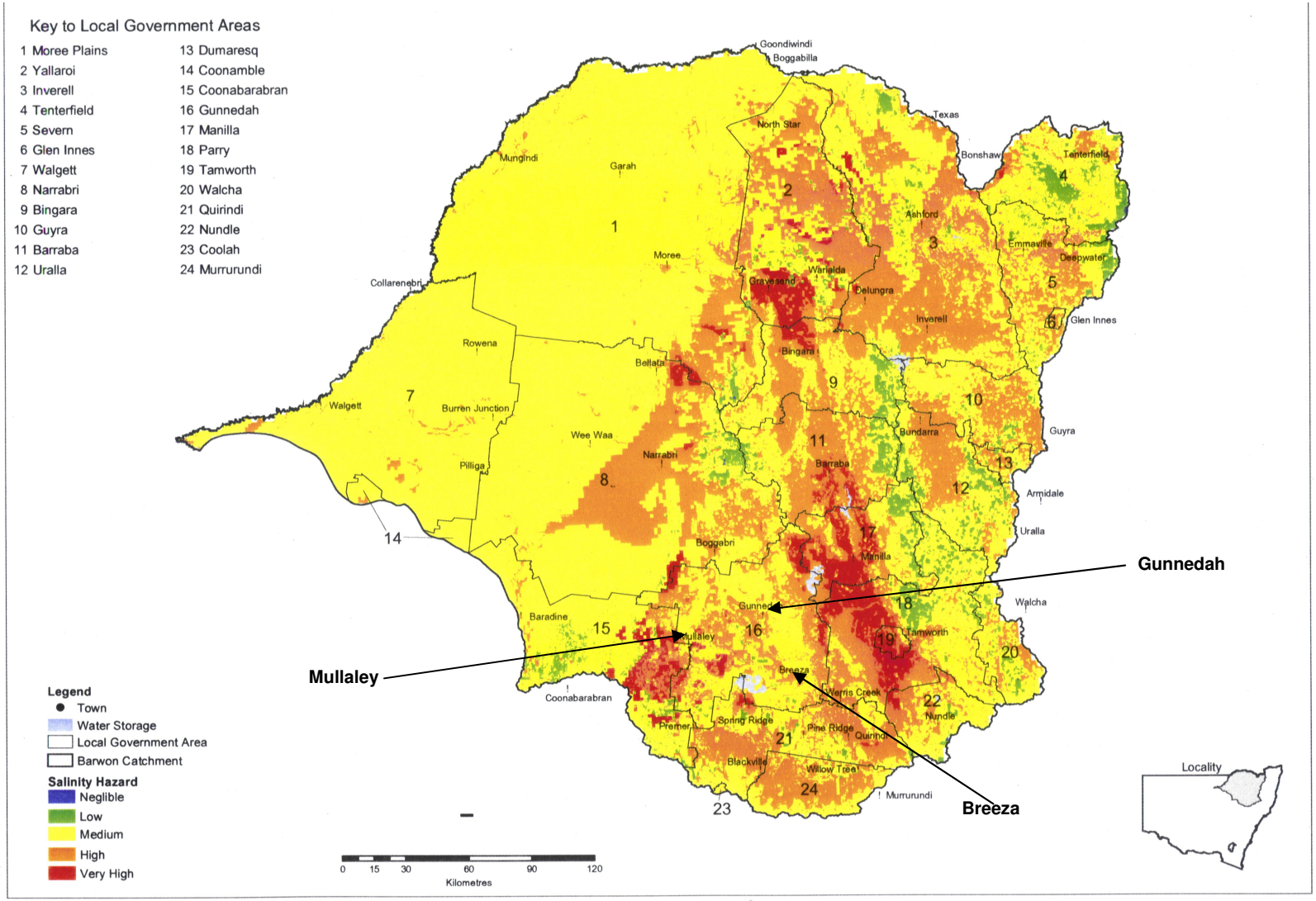


Figure 2.18. Regional salinity hazard map (Source: Collins and Donaldson, 2002).

Groundwater resources

Groundwater in the Namoi Catchment is vital for both agricultural and urban use. The 2003 Water Sharing Plan for the Upper and lower Namoi Groundwater Sources (DLWC, 2003) recognises the importance of the groundwater and the Plan identifies the very substantial fall in agricultural use of groundwater that is required to ensure long term resource sustainability. It is understood that the volume of water that can be extracted by individuals will be reduced to be consistent with the sustainable yield. The historic extraction rate will be used to adjust extraction allocations. Plan implementation has been suspended until July 2006 to allow stakeholder consultation (DNR, 2006). Table 2.8 shows the estimate recharge and the potential water extraction rate based on access licenses in different zones along the Namoi Catchment.

Table 2.8. Estimated water store recharge, licence allocation, volumes of water on town water licenses and the % reduction in access licence volume (DLWC, 2003).

Zone	Estimate recharge to each zone and proposed extraction limits. (ML/year)	Domestic and stock right (ML/year)	Water requirements based on access licenses (ML/year)	Town water access licenses and allocation volumes	Reduction in agricultural access license volume as given in the Namoi Groundwater Sharing Plan
1	2100	39	8510	1650 (Quirindi) and 66 (Willow Tree)	87%
2	7200	359	23801	59 Mullaley	70%
3	17300	470	56017	199 Curlewis	69%
4	27500	667	82590	3900 Gunnedah, 760 Boggabri	73%
5	16000	262	36042		45%
6	14000	272	11448		0%
7	3700	89	6321		41%
8	16000	166	48204	56 Caroona	67%
9	11400	187	11342	42 Tambar Springs, 55 Premer	0%
10	4500	36	1420		0%
11	2200	210	8740		75%
12	2000	73	7487		73%
Lower Namoi	86000	3304	172187	3500 Narrabri, 900 Wee Waa, 7 Rowena.	51%
Total	209900	6134	474109		

It is obvious from table 2.8 that allocations are more than twice the sustainable yield. Town use is less than 10% of sustainable yield, and is guaranteed under the Plan. . However town supply is put at risk when actual extraction exceeds recharge estimates. In the case of Zone 4 (the one containing Gunnedah township), the current extraction of around 35,000 ML/year exceeds the estimated sustainable yield of 25,700 ML by 30%. The Groundwater Sharing Plan has reduction in extraction rate to 100% of average annual recharge as its first target. This is considered critically important for the maintenance of town water quality in the long term.

Groundwater vulnerability

Groundwater vulnerability has been assessed in portions of the Gunnedah Shire. The results are shown below. Figure 2.19 shows groundwater resources near Gunnedah township is classified as having moderately low risk and groundwater contamination must be avoided.

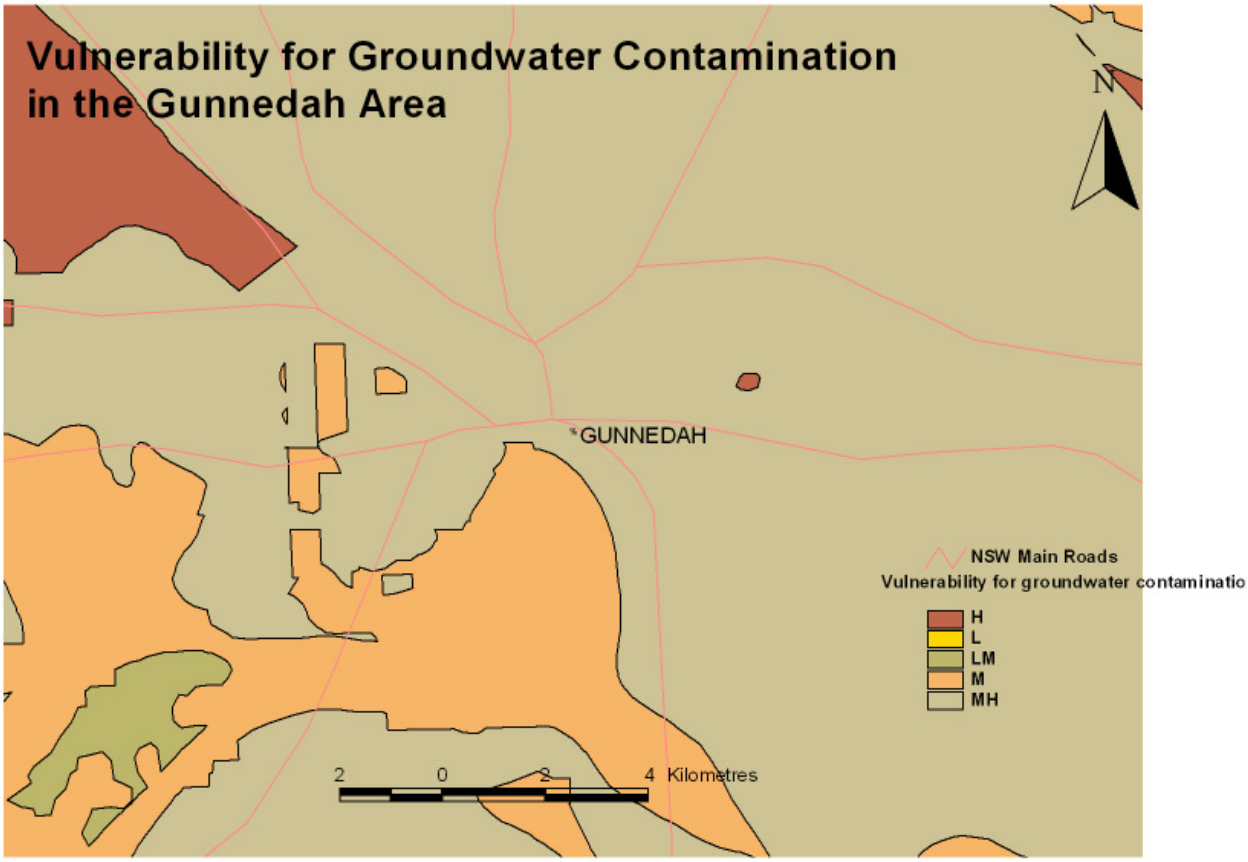


Figure 2.19. Groundwater vulnerability to contamination in area around Gunnedah township (Source: DNR).

Figure 2.20 shows the groundwater vulnerability to contamination in area around Mullaley is in the moderate range. While figure 2.21 shows the area around Tambar Springs has moderately low risk.

These results suggest the risk to groundwater resources near urban areas is low to moderate. The main concern is to reduce extraction rates so that water quality is maintained.

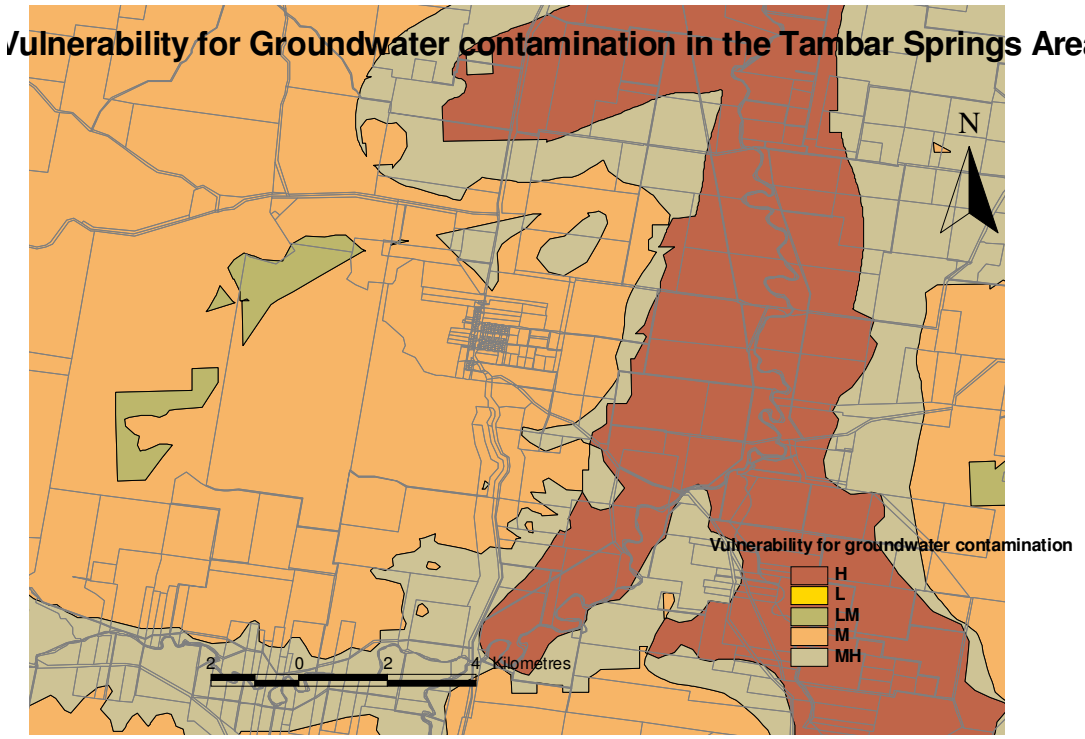


Figure 2.20. Groundwater vulnerability to contamination in area around Mullaley (Source : DNR)

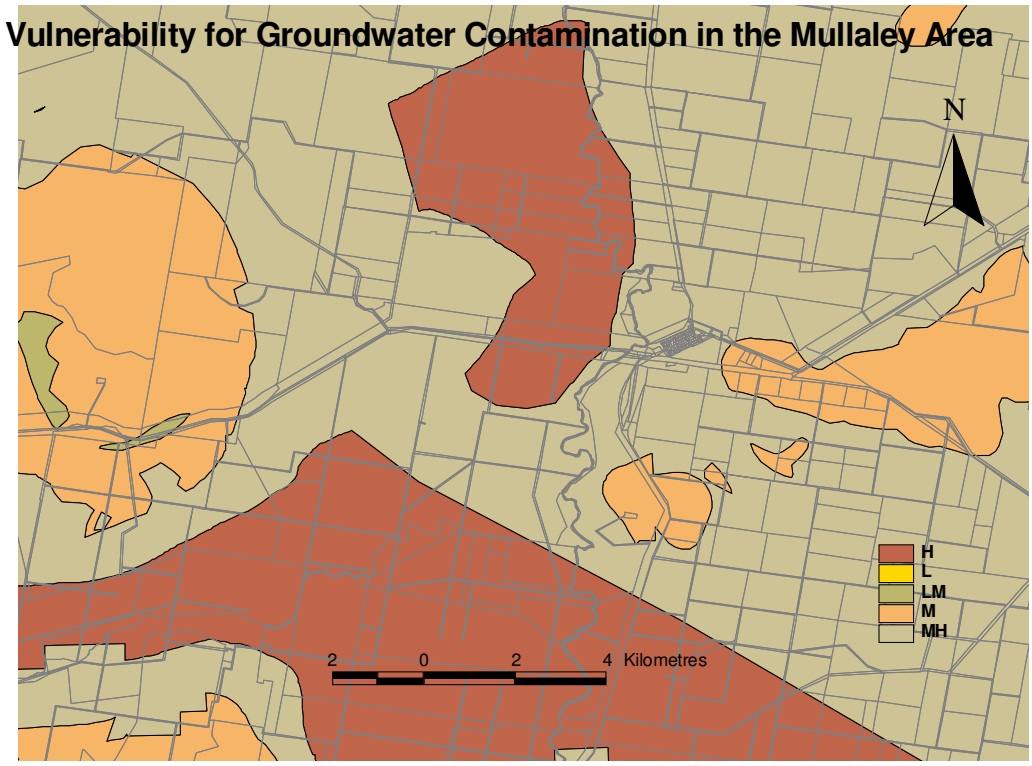


Figure 2.21. Groundwater vulnerability to contamination in area around Tambar Springs (Source : DNR).

Vegetation

General information on natural vegetation in Gunnedah Shire is largely derived from the standard Soil Conservation Service manual for the Gunnedah district (SCS, 1976). Four major plant communities were identified in 1976 by the Department of Conservation and Land Management. The four communities have distinctive on structural form and species composition.

These four categories are:

1. Plains Grasses (*Stipa aristiglumis*), Dry Tussock Grassland.-Largely located on the Liverpool Plains

2. White Box (*E. albens*), Tall Woodland and Savannah Woodland - elevated lands

3. White Cypress Pine (*C. hugelli*), Tall Woodland and Shrub Woodland – elevated lands with poorer soils

4. Yellow Box - White Box - Bimble Box (*E. melliodora - E. albens - E. populinea*), Tall Woodland and Savannah Woodland. - elevated lands

A 1971 grassland survey reported by the Planning Workshop (1981) indicated there were large areas of plains grass (Stipa spp.), within the Shire. By 1981 these areas had largely ceased to exist (Urwin, 1981). Remnants are now found in sites such as Mount Kaputar National Park and in isolated alluvial fans and flood prone lands that are unsuited to cropping (Caitechton, et al, 1999). Around 12% of this association is still intact (DLWC, 2003b). Loss of these grasslands is important for water management as they would have provided an effective mechanism for slowing floodwaters, facilitating infiltration into the soil (Wallbrink et al, 1999).

Table 2.9 summarises the results of an evaluation by Bailey (1995). Over half the Shire has no tree cover, while another 34% has scattered trees. Bailey estimated that only 10% of the shire is shaded by trees. This lack of trees is due to a combination of low rainfall, unsuitable soils, wildfire and deliberate clearing.

Table 2.9. Tree cover type and percent coverage in Gunnedah Shire (Source: Bailey, 1995).

Type of tree cover	Percentage of shire with this vegetation type
Undisturbed Dry Sclerophyll Forest	8
Undisturbed Native Pine Forest	<1
Undisturbed Heath or Scrub	<1
Tree lots	<1
Road Reserves	2
Scattered timber (typically 5% cover)	34
Mature trees in clumps (typically 25% cover)	3
No mature trees (approximately 50% of this area has some regenerating trees)	52

According to Bailey (1995) there was 45 km sq of native reserves, 33 km sq of recreation areas and 193 km sq of State forests in the Shire in 1995. Some of these reserves and State Forested may now be classified as part of the National Park system, however the area involved is likely to have increased rather than decreased. Rivers and other protected water bodies covered another 99 sq km. So the total protected area in the Shire was 371 km sq or some 7% of the shire area. This is consistent with the indicative 2 to 10% protected lands in zone BBS in figure 2.22.

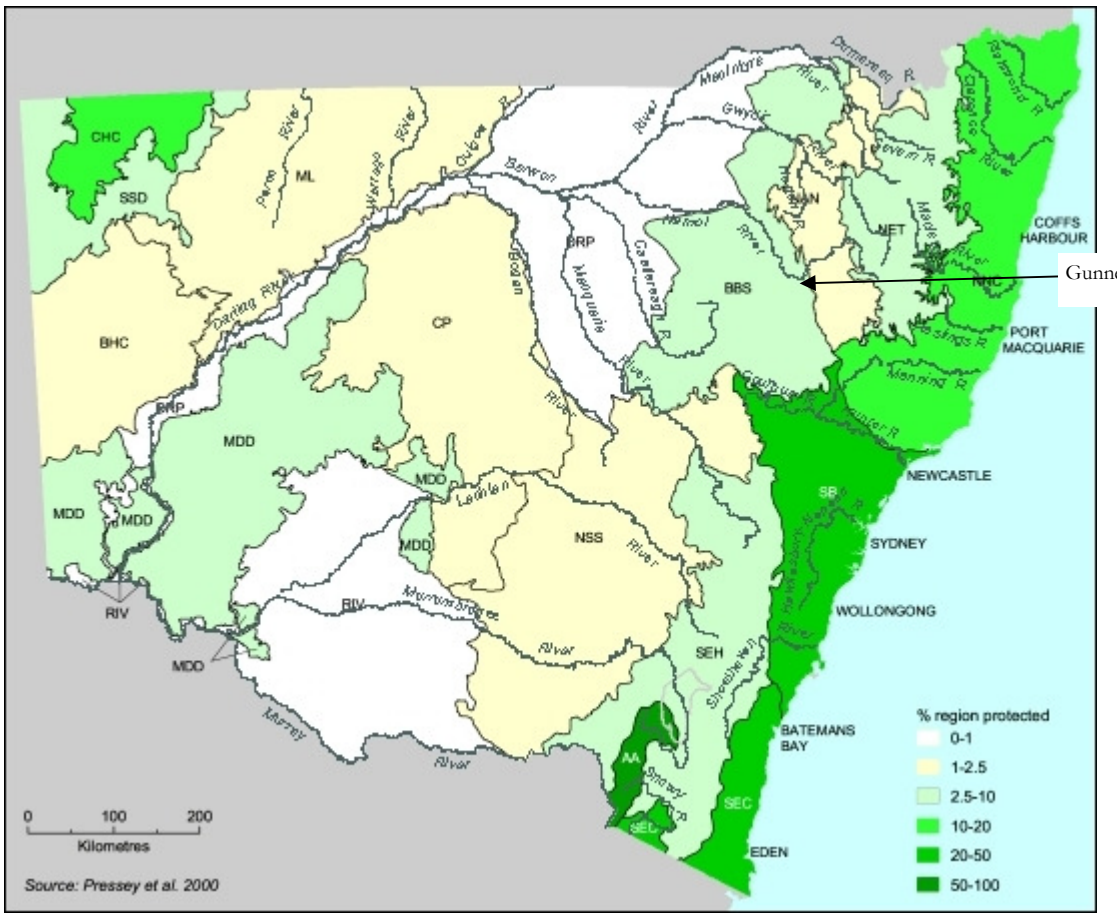


Figure 2.22. Extent of protected lands in the Namoi Catchment. (Zone BBS)

2.2 URBAN CONTEXT

Groundwater quality

Gunnedah, Curlewis, Mullaley and Tambar Springs water supplies are pumped from nearby aquifers. Consequently groundwater quality and quantity is a vital concern.

Gunnedah groundwater quality

Table 2.10 shows quality attributes of groundwater from near Gunnedah boreholes since 2000. The only attributes to exceed ADWG (NHMRC, 2004) were Chloride, TSS and Hardness. This occurred in early 2003 during a major drought. The results suggest susceptibility of Gunnedah Water quality to reduced quality during drought.

Curlewis groundwater quality

Table 2. 1 shows the quality attributes of groundwater from Curlewis since 2000. Nitrite-N exceeded ADWG (NHMRC, 2004) in 2000 and 2001. However the result is unusual, especially as Nitrate-N concentration was very low. (It may be due to transcription error).

Total Dissolved Solids (TDS) concentration has always exceeded the criteria. In some cases the difference is over 3 fold. Sodium and Chloride concentration also exceeds ADWG values. The results indicate a serious problem with the Curlewis water supply. Residents with severe hypertension or congestive heart failure may be at risk, if is this is their sole source of water. (It is noted that Curlewis residents largely rely on rainwater tanks for this potable water).

The hardness is also higher that the ADWG criteria. Concentrations in excesses of 500 mg/L results in severe scaling of pipes and valves, especially those associated with the hot water system.

Discussions with DNR hydrologeolists suggest the Curlewis bore is susceptible to saline water influx during drought periods.

Mullaley groundwater quality

Table 2.12 shows the quality attributes of groundwater from Mullaley bores since 2003. TDS and Total Hardness exceed guideline criteria. However the exceedance is relatively small. pH is close to the upper limit.

The results suggest the water will have a slight taste and there is a need to uses 'salt' resistant anodes in hot water services.

Tambar Springs groundwater quality

Table 2.13 shows the quality attributes of groundwater from Tambar Springs since 2003. Iron and lead concentrations have exceeded ADWG criteria on isolated occasions. According to ADWG iron is not a health issue, but lead is, especially for infants, foetuses and pregnant women. Lead concentration is close to the limit of detection, so there may be some doubt as to the accuracy of the results, but it is an element of concern at Tambar Springs. Use of rainwater tanks to supply drinking needs can be encouraged.

Hardness and turbidity also exceed the ADWG criteria, but the difference is small and is not a major issue.

Table 2.10 Groundwater quality supplied to Gunnedah since 2000 (Source: Gunnedah Shire Council).

Test	Units	ADWG	Result 17/9/00	Result 12/9/00	Result 18/9/01	Result 22/11/02	Result 18/2/03	Result 28/1/04	Result 11/5/04	Result 16/2/05	Result 1/6/05
Aluminium	mg/L	0.20		0.05			0.05	0.07	0.01	0.03	0.02
Antimony	mg/L	0.003	0.001			0.001	0.001	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.00			0.00	1.00	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.04			0.04	0.12	0.04	0.03	0.02	0.02
Boron	mg/L	4.00	0.10			0.10	0.10	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00
Calcium	mg/L	9999		42			141	42	35	27	34
Chloride	mg/L	250		35			**338**	45	35	21	39
Chromium	mg/L	0.05	0.01			0.01	0.03	0.01	0.01	0.01	0.01
Copper	mg/L	2.00	0.22	0.05	0.02	0.02	0.04	0.02	0.03	0.03	0.02
Cyanide	mg/L	0.08					0.01	0.01			
Fluoride	mg/L	1.50	0.15	0.10	0.10	0.15	0.16	0.10	0.15	0.18	0.17
Iodine	mg/L	0.10					0.03	0.02	0.02	0.02	0.02
Iron	mg/L	0.30		0.05			0.09	0.05	0.50	0.01	0.01
Lead	mg/L	0.01	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	mg/L	9999		21			79	23	19	14	18
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mercury	mg/L	0.00	0.00			0.00	0.00	0.00	0.00	0.00	0.00
Molybdenum	mg/L	0.05	0.01			0.01	0.01	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01			0.01	0.01	0.01	0.01	0.01	0.01
Nitrate	mg/L	50	10	2	8	10	31	10	5	5	10
Nitrite	mg/L	3.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
pH		6.5-8.5	7.3	7.5	7.4	7.0	7.0	7.0	7.2	7.1	7.2
Selenium	mg/L	0.01	0.00			0.00	0.00	0.00	0.00	0.00	0.00
Silver	mg/L	0.10					0.00	0.00	0.00	0.00	0.00
Sodium	mg/L	180	44	29		53	109	34	35	25	29
Sulphate	mg/L	500	53	38		60	139	47	34	23	42
TDS	mg/L	500	362		294	416	**877**	278	238	193	233
Total Hardness	mg/L	200		190			**679**	197	167	126	161

True Colour	H U	15.00		3.00				1.00	1.00	1.00	1.00
Turbidity	NTU	5.00	0.10	0.20	0.10	0.10	1.50	0.60	4.80	0.10	0.10
Zinc	mg/L	3.00		0.05			0.01	0.10	0.02	0.02	0.01

Table 2.11. Groundwater quality supplied to Curlewis since 2001 (Source: Gunnedah Shire Council).

Test	Units	ADWG	Result 18/9/01	Result 22/11/02	Result 18/02/03	Result 11/11/03	Result 28/1/04	Result 11/5/04	Result 16/2/05	Result 11/5/05
Aluminium	mg/L	0.20			0.03	0.03	0.08	0.01	0.03	0.02
Antimony	mg/L	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic	mg/L	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.14	0.16	0.15	0.11	0.18	0.14	0.09	0.14
Boron	mg/L	4.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Calcium	mg/L	9999.00			124.30	85.58	145.00	122.60	70.05	123.50
Chloride	mg/L	250.00			**685.70**	**465.20**	**884.40**	**685.00**	**361.50**	**764.40**
Chromium	mg/L	0.05	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01
Copper	mg/L	2.00	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.02
Cyanide	mg/L	0.08			0.01	0.01	0.01			
Fluoride	mg/L	1.50	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Iodine	mg/L	0.10			0.04	0.03	0.03	0.03	0.03	0.04
Iron	mg/L	0.30			0.01	0.01	0.01	0.01	0.01	0.02
Lead	mg/L	0.01	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.002
Magnesium	mg/L	9999			82	51	96	83	45	80
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Mercury	mg/L	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Molybdenum	mg/L	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrate	mg/L	50.0	0.1	0.1	8.4	5.6	11.6	5.2	2.9	3.3
Nitrite	mg/L	3.00	**6.00**	**7.90**	0.10	0.10	0.10	0.10	0.10	0.10
pH		6.5-8.5	7.60	7.20	7.40	7.60	7.90	7.80	7.60	7.90
Selenium	mg/L	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver	mg/L	0.10			0.00	0.00	0.00	0.00	0.00	0.00
Sodium	mg/L	180	**226**	**291**	**240**	178	**291**	**279**	163	**285**

Sulphate	mg/L	500	85	93	100	64	116	101	48	92
TDS	mg/L	500	1263	1292	1227	916	1502	1259	784	1319
Total Hardness	mg/L	200			646	422	759	847	359	638
True Colour	H U	15.00				1.00	1.00	1.00	1.00	1.00
Turbidity	NTU	5.00	0.10	0.20	0.10	0.10	0.20	0.10	0.10	0.10
Zinc	mg/L	3.00			0.02	0.06	0.10	0.01	0.02	0.02

Table 2.12. Groundwater quality supplied to Mullaley since 2003. (Source: Gunnedah Shire Council).

Test	Units	ADWG	Result 11/11/03	Result 28/1/04	Result 16/2/05	Result 1/6/05
Aluminium	mg/L	0.20	0.04	0.09	0.03	0.01
Antimony	mg/L	0.003	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.08	0.09	0.08	0.10
Boron	mg/L	4.00	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.002	0.001	0.001	0.001	0.001
Calcium	mg/L	9999	38	40	40	40
Chloride	mg/L	250	114	110	107	107
Chromium	mg/L	0.05	0.02	0.03	0.03	0.04
Copper	mg/L	2.00	0.01	0.01	0.01	0.01
Cyanide	mg/L	0.08	0.01	0.01		
Fluoride	mg/L	1.50	0.11	0.10	0.13	0.11
Iodine	mg/L	0.10	0.03	0.04	0.03	0.04
Iron	mg/L	0.30	0.01	0.01	0.02	0.02
Lead	mg/L	0.01	0.00	0.00	0.00	0.00
Magnesium	mg/L	9999	46	52	52	46
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01
Mercury	mg/L	0.001	0.000	0.000	0.000	0.000
Molybdenum	mg/L	0.05	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01	0.01	0.01	0.01
Nitrate	mg/L	50.00	3.30	3.10	3.20	3.30
Nitrite	mg/L	3.00	0.10	0.10	0.10	0.10

pH		6.5-8.5	7.70	7.80	8.20	8.30
Selenium	mg/L	0.01	0.00	0.00	0.00	0.00
Silver	mg/L	0.10	0.00	0.00	0.00	0.00
Sodium	mg/L	180	135	145	142	147
Sulphate	mg/L	500	14	13	13	13
TDS	mg/L	500	**602**	**596**	**591**	**590**
Total Hardness	mg/L	200	**285**	**312**	**314**	**288**
True Colour	H U	15.00	1.00	1.00	1.00	1.00
Turbidity	NTU	5.00	0.20	0.10	0.20	0.30
Zinc	mg/L	3.00	0.07	0.09	0.02	0.01

Table 2. 13. Groundwater quality supplied to Tambar Springs since 2003 (Source: Gunnedah Shire Council)

Test	Units	ADWG	Result 11/11/03	Result 28/1/04	Result 11/5/04	Result 1/6/05
Aluminium	mg/L	0.20	0.04	0.08	0.04	0.01
Antimony	mg/L	0.003	0.001	0.001	0.001	0.001
Arsenic	mg/L	0.01	0.00	0.00	0.00	0.00
Barium	mg/L	0.70	0.10	0.10	0.10	0.11
Boron	mg/L	4.00	0.10	0.10	0.10	0.10
Cadmium	mg/L	0.002	0.001	0.001	0.001	0.001
Calcium	mg/L	9999	49	51	53	51
Chloride	mg/L	250	71	62	57	64
Chromium	mg/L	0.05	0.01	0.02	0.02	0.03
Copper	mg/L	2.00	0.17	0.04	0.02	0.11
Cyanide	mg/L	0.08	0.01	0.01	0.00	0.00
Fluoride	mg/L	1.50	0.12	0.12	0.11	0.13
Iodine	mg/L	0.10	0.03	0.04	0.03	0.04
Iron	mg/L	0.30	**2.30**	0.03	0.06	0.14
Lead	mg/L	0.01	**0.04**	0.00	0.01	**0.02**
Magnesium	mg/L	9999	38	40	38	38
Manganese	mg/L	0.10	0.01	0.01	0.01	0.01
Mercury	mg/L	0.00	0.00	0.00	0.00	0.00

Molybdenum	mg/L	0.05	0.01	0.01	0.01	0.01
Nickel	mg/L	0.02	0.01	0.01	0.01	0.01
Nitrate	mg/L	50.00	1.00	1.00	1.00	1.00
Nitrite	mg/L	3.00	0.10	0.10	0.10	0.10
pH		6.5-8.5	7.50	7.80	7.80	7.80
Selenium	mg/L	0.01	0.00	0.00	0.00	0.00
Silver	mg/L	0.10	0.00	0.00	0.00	0.00
Sodium	mg/L	180	71	76	79	79
Sulphate	mg/L	500	8	8	8	8
TDS	mg/L	500	446	434	437	439
Total Hardness	mg/L	200	**278**	**291**	**289**	**284**
True Colour	H U	15.00	1.00	1.00	1.00	1.10
Turbidity	NTU	5.00	**13.90**	0.30	0.50	1.20
Zinc	mg/L	3.00	1.51	0.23	0.06	0.66

Table 2.14. Static heights in water supply bores since 2002. The date used to compare current levels with past ones is shaded.

Date	G1	G2	G3	G4	G5	G6	G7	G8	G9	G11	Cur1	Cur2	Car1
11/12/02	8.9	0.0	11.5	11.2	0.0	10.4	12.0	16.2	16.1	9.5	16.0	26.1	0.0
11/02/03	9.0	10.5	11.8	11.8	12.2	11.7	14.0	21.0	20.0	9.9	23.7	26.1	0.0
17/03/03	9.1	10.3	11.4	10.7	11.3	11.5	11.6	13.2	13.6	9.7	22.0	22.2	15.6
1/07/03	9.0	9.0	10.9	10.9	10.9	10.7	10.7	13.6	13.2	9.7	23.1	23.7	14.6
15/09/03	8.9	10.7	11.0	10.9	11.0	10.6	10.5	12.1	12.1	9.7	24.2	25.1	14.7
29-Mar-2004	9.0	9.9	11.1	11.2	11.6	11.1	10.9	13.3	13.3	10.0	20.6	20.6	14.8
24-Sep-04	8.7	9.8	11.0	11.1	11.3	10.9	10.7	12.8	12.4	9.9	26.7	28.1	14.0
16.03.05	9.0	10.5	11.8	11.9	12.3	11.6	12.2	19.3	19.0	10.0	20.5	21.1	15.1
6.9.05	8.8	9.8	11.5	11.9	12.3	11.4	10.6	12.0	11.8	9.8	21.8	24.0	13.7
6.3.06	9.7	11.0	12.4	12.1	12.5	12.0	11.6	15.0	15.1	9.8	27.2	28.6	15.3
Trend 2002 to 3/2006	-0.8	-0.6	-0.9	-0.9	-0.4	-1.6	0.4	1.2	1.0	-0.3	-3.5	-2.5	0.3

Depth to groundwater

Depth to groundwater measurement and drawdown tests are conducted on the potable water supply bores twice each year.

Table 2.13 shows that while the depths vary markedly over time, static water levels have fallen in most sites since 2002. Levels in the Gunnedah bore field have fallen by 0.3m over the past 3.5 years. Static levels in the Curlewis bores have fallen by an average of 3.5m.

Potable water supply and infrastructure within the urban areas of Gunnedah Shire

Table 2.15 shows the water allocation and volume supplied each year since 1996. Water supplied is markedly less than allocation in all years.

Table 2.15 . Water allocation and potable water supplied to different urban centres in Gunnedah Shire (Source: Gunnedah Shire Council)

Urban area	Allocation	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	**Ave.**
Gunnedah	3900	3145	2632	1586	2324	2431	2522	2912	3159	2276	2446	2280	**2781**
Curlewis	198	228	216	124	153	84	75	142	171	115	112	131	**142**
Mullaley	59	31	36	29	27	35	19	33	36	25	25	24	**29**
Tambar Springs	42	20	20	14	18	18	15	21	22	19	21	20	**20**

Gunnedah

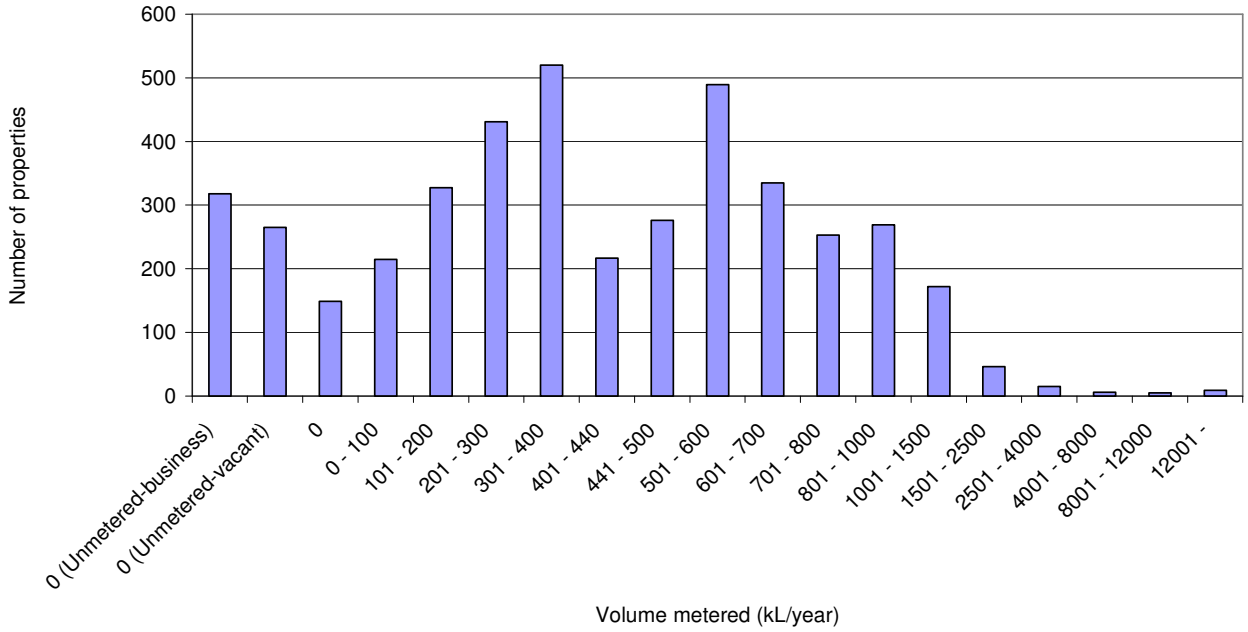
The Gunnedah scheme was established in 1900 (Gunnedah Shire Council Strategic Business Plan for Water Supply 2003/4). Council extracts groundwater using 11 bores. These bore have a capacity of 20 ML/day. Flow from the bores has recently been augmented by the installation of an additional 500 mm main. The water is transferred via three pump stations to 5 reservoirs. The reservoirs have a total capacity of 19.5 ML. Gunnedah has 140 km of mains with pipe sizes ranging from 80 to 500 mm. The water supplies are currently not chlorinated.

There are 2623 connections to the Gunnedah water supply system (Gunnedah Shire Council Management Plan 2005/06). Rating is two tiered, with \$0.45/kL for water use less than 450 kL/y and \$0.9/kL for water use in excess of 450 kL/year. Industrial companies and sporting bodies are charged \$0.51/kL for use in excess of 440 kL. Figure 2.23 shows the distribution of water usage in Gunnedah in 2004/5. Council's aim is to cover costs plus anticipated inflation. Total metered usage in Gunnedah was 2181 ML so the unaccounted water was 265 ML or 11% of the estimated supply.

Some of the apparent fluctuation in Gunnedah water use since 2000 is due to shut down and start of various industries. It also reflects periods of incomplete data collection.

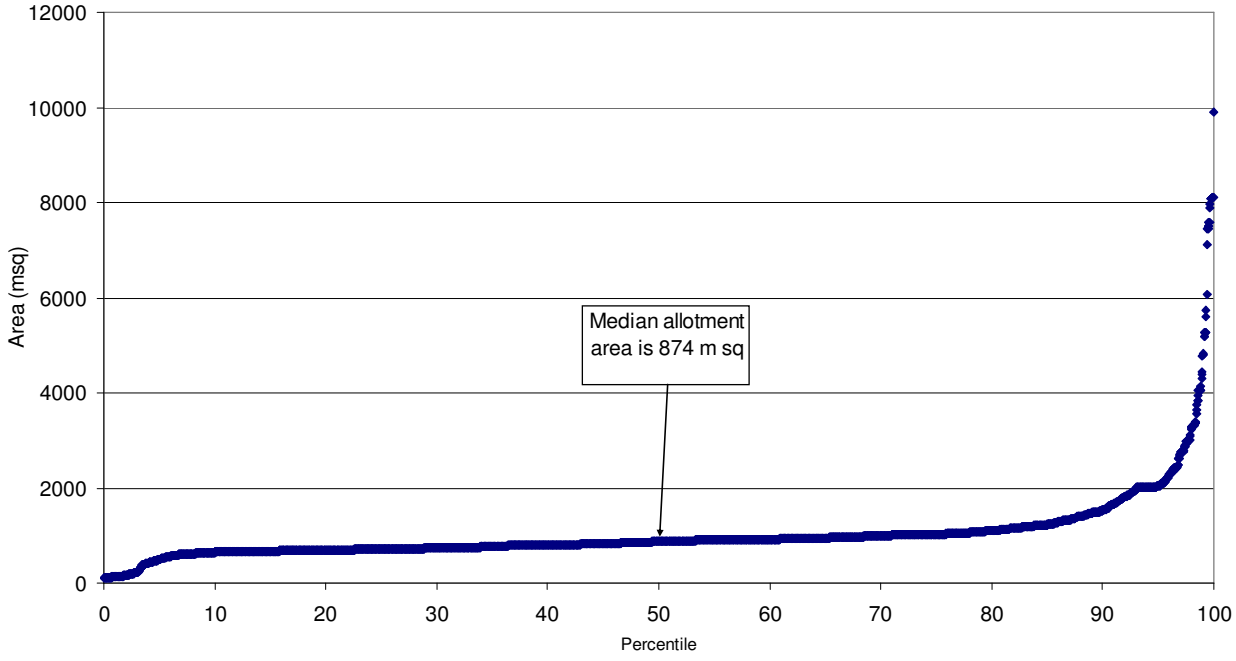
Figure 2.22 shows the distribution of water usage in Gunnedah. There are 308 businesses that pay water rates but do not have meters. There are some 103 sites/ activities in town that do not pay rates but have received a total of 100 ML/year of water. These include public facilities such as ovals and swimming pools. The lack of water meters on Gunnedah businesses is an issue. According to the Strategic Business Plan for Water Services (2003/04), meters were to be installed in the CBD by June 2005. This has not been done.

Figure 2.22. Distribution of metered water usage from Gunnedah town water supply in 2004/5.



Individual domestic premises have 20 mm connections and these consume the bulk of the potable water. However there are also premises with 50, 80 and 100 mm connections. Some of these premises consume many ML/year of potable water. Some 1917 ML was withdrawn via 20 mm connections, while another 54 ML was by 50 mm connections. A further 11 ML was via 80 mm to three properties, while another 4 sites with 100 mm connections utilised 200 ML. One site with a 100 mm connection utilised 153 ML. This site (Number 45008610005) paid $270 in water rates or $1.76/ML. In 2001/02 the leather factory used 233 ML.

Figure 2.23. Percentile distribution of rateable allotments in Gunnedah.



Council is currently investigating options to introduce a more equitable user pays system, consistent with reducing consumption where possible. Water supply charge rates to business is an issue.

The percentile distribution of rateable Gunnedah allotments in excess of 100 msq is shown in figure 2.24. The median property area is 873 msq. This is relatively large and assists in explaining the volume of potable water being used on Gunnedah properties. A combination of large property area and high evaporation can result in large volumes of water being irrigated.

The Strategic Business Plan for Water supply (Gunnedah Shire Council , 2003/04) identifies a program for mains replacement within Gunnedah. It also identified the need for a 5 ML reservoir at Borthistle. Figure 2.24 shows the layout of the Tambar Springs water distribution system.

Table 2.16 shows the quality of Gunnedah's raw water supply since 2001. The third column shows the percentage of samples that meet Australian Drinking Water Guidelines (NHMRC/ARMCANZ (2004)). Total dissolved solids, Chloride, Iron and hardness criteria were occasionally exceeded. However coliforms were present in 88% of the samples. This result emphasises the need for disinfection. It also raises concerns regarding the source of this contamination. Gunnedah water is sourced from deep bores so the groundwater is unlikely to be biologically contaminated. This indicates the contamination is occurring after extraction. This is a significant issue.

Curlewis

The Curlewis water supply system was established in 1972. Table 2.14 shows water allocation and usage. Groundwater is extracted using 2 bores. These have a daily capacity of 2 ML. The water is conveyed to three reservoirs which have a total capacity of 1.4 ML. The water is chlorinated. Curlewis has 19.3 km of pipes, with diameters ranging from 100 to 150 mm. Figure 2.25 shows the layout of the Curlewis water distribution system.

Table 2.17 shows quality attributes of the Curlewis water supply. It has significant microbial contamination. It also has elevated Na, Cl, TDS and Hardness values. This is consistent with the Council bore data in table 2.11 and emphasises the need for alternative potable water sources in Curlewis.

Mullaley

The Mullaley water supply system was established in 1972. Table 2.15 shows water allocation and usage. Groundwater is extracted using 2 bores. These have a daily capacity of 0.4 ML. The water is conveyed to a reservoir which has a capacity of 0.2 ML. Mullaley has 3.8 km of pipes. Pipe diameter is 100mm. Figure 2.26 shows the layout of the Mullaley water distribution system. The water is chlorinated.

Table 2.18 shows quality attributes of the Mullaley water supply. It has significant microbial contamination. It also has elevated TDS and Hardness values. This is consistent with the Council bore data in table 2.12.

Tambar Springs

The Tambar Springs water supply system was established in 1990. Table 2.14 shows water allocation and usage. Groundwater is extracted using 2 bores. These have a daily capacity of 4 ML. The water is conveyed to three reservoirs which have a capacity of 0.3 ML. Tambar Springs has 11.5 km of pipes. Pipe diameters range from 100 to 150 mm diameter. Figure 2.27 shows the layout of the Tambar Springs water distribution system.

Table 2.18 shows quality attributes of the Tambar Springs water supply. It has significant microbial contamination. It also has elevated lead and Hardness values compared with the ADWG. This is

consistent with the Council bore data in table 2.13. The elevated lead concentration is an immediate health risk that needs investigation.

Note that the consistancy between bore data and raw water results at all four urban centres suggests there is duplication of analysis. The need for a full analytical suite for both groundwater and town water is questioned.

The Gunnedah and Mullaley water supplies contain thermotolerant coliforms in 7 and 43% of samples respectively. The Mullaley and Tambar Springs water supplies contain thermotolerant coliforms in 14 and 13% of samples respectively. According to the ADWG (2004), there should be zero faecal coliforms. The presence of these microflora indicate faecal contamination. The source of this contamination should be determined and rectified as a matter of urgency.

Table 2.16. Results of Gunnedah township water quality testing since 2001 (Source: Gunnedah Shire Council).

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.0429	0.03	0.0325	0.01	0.1	7	0	0.0962	0.0145
Antimony	0.0030 mg/L	100	0.001	0.001	0	0.001	0.001	9	0	0.001	0.001
Arsenic	0.0070 mg/L	100	0.001	0.001	0	0.001	0.001	9	0	0.001	0.001
Barium	0.7000 mg/L	100	0.0467	0.036	0.0378	0.013	0.116	9	0	0.1087	0.0182
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	9	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	5E-04	9	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	62.24	35.43	49.5704	27.19	140.8	7	0	143.5355	32.8705
Chloride	250.0000 mg/L	71	112.157	38.6	137.96	20.9	337.6	7	2	338.4113	36.735
Chromium	0.0500 mg/L	100	0.0113	0.009	0.0076	0.006	0.031	9	0	0.0239	0.0073
Copper	2.0000 mg/L	100	0.0482	0.0245	0.0601	0.012	0.22	12	0	0.1467	0.0224
Cyanide	0.0800 mg/L	100	0.0099	0.0099	0	0.01	0.01	3	0	0.0099	0.0099
E. coli	0.0000 cfu/100 mL	88	0.6324	0	2.5633	0	24	185	22	4.8363	1.2
Fluoride	1.5000 mg/L	100	0.1498	0.155	0.0337	0.099	0.2	12	0	0.205	0.1041
Iodine	0.1000 mg/L	100	0.022	0.0198	0.004	0.02	0.03	7	0	0.0286	0.0203
Iron	0.3000 mg/L	86	0.1	0.02	0.1787	0.01	0.5	7	1	0.3931	0.0344
Lead	0.0100 mg/L	100	0.0023	0.002	0.0009	0.002	0.005	12	0	0.0037	0.0022
Magnesium	9999.0000 mg/L	100	34.9471	18.98	29.8826	13.79	79.39	7	0	83.9546	17.07
Manganese	0.5000 mg/L	100	0.0063	0.005	0.0022	0.005	0.01	12	0	0.0099	0.0052
Mercury	0.0010 mg/L	100	0.0001	0.0001	0.0001	1E-04	5E-04	9	0	0.0004	0.0001
Molybdenum	0.0500 mg/L	100	0.005	0.005	0	0.005	0.005	8	0	0.005	0.005
Nickel	0.0200 mg/L	100	0.0099	0.0099	0	0.01	0.01	9	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	11.125	9.3	9.3804	3	31	12	0	26.5088	4.4
Nitrite	3.0000 mg/L	100	0.099	0.099	0	0.099	0.099	12	0	0.099	0.099

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
pH	6.5 - 8.5	100	7.1667	7.15	0.1557	7	7.4	12	0	7.422	7.02
Selenium	0.0100 mg/L	100	0.0023	0.002	0.0007	0.002	0.004	9	0	0.0035	0.0021
Silver	0.1000 mg/L	100	0.002	0.002	0	0.002	0.002	7	0	0.002	0.002
Sodium	180.0000 mg/L	100	50.9222	34.8	33.4401	23.2	109.1	9	0	105.764	27.495
Sulfate	500.0000 mg/L	100	62.2125	44.25	45.8874	23.4	139	8	0	137.4678	29.18
Thermotolerant Coliforms	0.0000 cfu/100 mL	93	0.1447	0	0.6262	0	4	76	5	1.1717	0.2
Total Coliforms	0.0000 cfu/100 mL	28	26.1611	5.5	46.9242	0	202	180	129	103.1168	10.1
Total Dissolved Solids (TDS)	500.0000 mg/L	82	384.182	294	249.166	179	877	11	2	792.8136	213.9
Total Hardness as CaCO3	200.0000 mg/L	71	299.329	166.6	246.727	126.1	678.5	7	2	703.9609	153.72
True Colour	15.0000 Hazen Units (HU)	100	0.99	0.99	0	0.99	0.99	5	0	0.99	0.99
Turbidity	5.0000 NTU	100	0.6829	0.15	1.3579	0.099	4.8	12	0	2.9099	0.334
Zinc	3.0000 mg/L	100	0.03	0.02	0.0316	0.01	0.1	7	0	0.0819	0.0145

Table 2.17. Results of Curlewis water quality testing since 2001 (Source: Gunnedah Shire Council).

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.0333	0.03	0.0242	0.01	0.08	6	0	0.0731	0.0135
Antimony	0.0030 mg/L	100	0.001	0.001	0.0001	0.001	0.001	8	0	0.0011	0.001
Arsenic	0.0070 mg/L	100	0.0011	0.001	0.0004	0.001	0.002	8	0	0.0017	0.0011
Barium	0.7000 mg/L	100	0.137	0.14	0.0294	0.087	0.18	8	0	0.1853	0.0917
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	8	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	5E-04	8	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	111.838	123.05	28.0805	70.05	145	6	0	157.8903	73.7975
Chloride	250.0000 mg/L	0	641.033	685.35	193.614	361.5	884.4	6	6	958.5596	387.645
Chromium	0.0500 mg/L	100	0.0113	0.0095	0.007	0.005	0.027	8	0	0.0227	0.0061
Copper	2.0000 mg/L	100	0.0121	0.0105	0.0054	0.006	0.02	8	0	0.021	0.0067
Cyanide	0.0800 mg/L	100	0.0099	0.0099	0	0.01	0.01	3	0	0.0099	0.0099
E. coli	0.0000 cfu/100 mL	67	4.5	0	12.9361	0	101	164	54	25.7153	5.05
Fluoride	1.5000 mg/L	100	0.099	0.099	0	0.099	0.099	8	0	0.099	0.099
Iodine	0.1000 mg/L	100	0.033	0.0295	0.0083	0.025	0.044	6	0	0.0466	0.026
Iron	0.3000 mg/L	100	0.0116	0.01	0.0041	0.01	0.02	6	0	0.0184	0.0104
Lead	0.0100 mg/L	100	0.0021	0.002	0.0004	0.002	0.003	8	0	0.0027	0.0021
Magnesium	9999.0000 mg/L	100	72.6483	80.8	20.3433	44.7	96.4	6	0	106.0114	47.285
Manganese	0.5000 mg/L	100	0.0056	0.005	0.0017	0.005	0.01	8	0	0.0085	0.0052
Mercury	0.0010 mg/L	100	0.0002	0.0001	0.0001	1E-04	5E-04	8	0	0.0004	0.0001
Molybdenum	0.0500 mg/L	100	0.005	0.005	0	0.005	0.005	7	0	0.005	0.005
Nickel	0.0200 mg/L	100	0.01	0.01	0.0001	0.01	0.01	8	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	6.3625	5.8	2.863	2.9	11.6	8	0	11.0579	3.335

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Nitrite	3.0000 mg/L	100	0.099	0.099	0	0.099	0.099	8	0	0.099	0.099
pH	6.5 - 8.5	100	7.625	7.6	0.2435	7.2	7.9	8	0	8.0243	7.235
Selenium	0.0100 mg/L	100	0.002	0.002	0	0.002	0.002	8	0	0.002	0.002
Silver	0.1000 mg/L	100	0.002	0.002	0	0.002	0.002	6	0	0.002	0.002
Sodium	180.0000 mg/L	25	244	259	51	163	291	8	6	328.5356	169.42
Sulfate	500.0000 mg/L	100	87	93	23.3	48.4	115.5	7	0	125.8299	51.755
Thermotolerant Coliforms	0.0000 cfu/100 mL	57	7.5	0	17.5	0	101	72	31	36.2417	5.05
Total Coliforms	0.0000 cfu/100 mL	45	19.5	1	41.7	0	202	156	86	87.9468	10.1
Total Dissolved Solids (TDS)	500.0000 mg/L	0	1195	1261	231	784	1502	8	8	1575.109	819.9
Total Hardness as CaCO3	200.0000 mg/L	0	578	642.1	153	359	759	6	6	830.4699	379
True Colour	15.0000 Hazen Units (HU)	100	0.99	0.99	0	0.99	0.99	5	0	0.99	0.99
Turbidity	5.0000 NTU	100	0.1243	0.099	0.0468	0.099	0.2	8	0	0.2009	0.1041
Zinc	3.0000 mg/L	100	0.0383	0.02	0.0349	0.01	0.1	6	0	0.0955	0.0145

Table 2.18. Results of Mullaley water quality testing since 2001 (Source: Gunnedah Shire Council).

.Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.046	0.04	0.0305	0.01	0.09	5	0	0.096	0.014
Antimony	0.0030 mg/L	100	0.001	0.001	0	0.001	0.001	6	0	0.001	0.001
Arsenic	0.0070 mg/L	100	0.001	0.001	0	0.001	0.001	6	0	0.001	0.001
Barium	0.7000 mg/L	100	0.0875	0.086	0.0048	0.083	0.096	6	0	0.0955	0.0837
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	6	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	5E-04	6	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	39.674	40.01	1.0951	37.74	40.39	5	0	41.47	37.8725
Chloride	250.0000 mg/L	100	109.78	109.6	3.0712	106.7	114.2	5	0	114.8167	107.075
Chromium	0.0500 mg/L	100	0.026	0.0255	0.0061	0.017	0.036	6	0	0.0359	0.018
Copper	2.0000 mg/L	100	0.0073	0.007	0.0024	0.005	0.011	6	0	0.0113	0.0053
Cyanide	0.0800 mg/L	100	0.0099	0.0099	0	0.01	0.01	3	0	0.0099	0.0099
E. coli	0.0000 cfu/100 mL	83	3.3611	0	15.9341	0	95	36	6	29.493	4.75
Fluoride	1.5000 mg/L	100	0.1147	0.11	0.0168	0.099	0.14	6	0	0.1422	0.1011
Iodine	0.1000 mg/L	100	0.0348	0.036	0.0016	0.033	0.036	5	0	0.0375	0.0332
Iron	0.3000 mg/L	100	0.018	0.02	0.0084	0.01	0.03	5	0	0.0317	0.011
Lead	0.0100 mg/L	100	0.002	0.002	0	0.002	0.002	6	0	0.002	0.002
Magnesium	9999.0000 mg/L	100	49.554	51.6	3.3249	45.55	52.59	5	0	55.0069	45.902
Manganese	0.5000 mg/L	100	0.005	0.005	0	0.005	0.005	6	0	0.005	0.005
Mercury	0.0010 mg/L	100	0.0002	0.0001	0.0002	1E-04	5E-04	6	0	0.0004	0.0001
Molybdenum	0.0500 mg/L	100	0.005	0.005	0	0.005	0.005	6	0	0.005	0.005
Nickel	0.0200 mg/L	100	0.0099	0.0099	0	0.01	0.01	6	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	3.4	3.25	0.4472	3.1	4.3	6	0	4.1334	3.16

.Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Nitrite	3.0000 mg/L	100	0.099	0.099	0	0.099	0.099	6	0	0.099	0.099
pH	6.5 - 8.5	100	8.0833	8.2	0.2639	7.7	8.3	6	0	8.5162	7.73
Selenium	0.0100 mg/L	100	0.002	0.002	0	0.002	0.002	6	0	0.002	0.002
Silver	0.1000 mg/L	100	0.002	0.002	0	0.002	0.002	5	0	0.002	0.002
Sodium	180.0000 mg/L	100	142.3	143.4	4.502	134.8	146.9	6	0	149.6833	135.405
Sulfate	500.0000 mg/L	100	13.2	13	0.6928	12.6	14.4	6	0	14.3362	12.69
Thermotolerant Coliforms	0.0000 cfu/100 mL	86	0.3571	0	1.0818	0	4	14	2	2.1313	0.2
Total Coliforms	0.0000 cfu/100 mL	28	55.806	19.5	74.9086	0	202	36	26	178.6557	10.1
Total Dissolved Solids (TDS)	500.0000 mg/L	0	595.6	596	5.1284	590	602	5	5	604.0105	590.6
Total Hardness as CaCO3	200.0000 mg/L	0	303.14	312.3	15.2114	285.1	316.5	5	5	328.0868	286.67
True Colour	15.0000 Hazen Units (HU)	100	0.99	0.99	0	0.99	0.99	5	0	0.99	0.99
Turbidity	5.0000 NTU	100	0.2665	0.2	0.1753	0.099	0.6	6	0	0.554	0.1241
Zinc	3.0000 mg/L	100	0.056	0.07	0.0385	0.01	0.09	5	0	0.1191	0.014

Table 2.19. Results of Tambar Springs water quality testing since 2001 (Source: Gunnedah Shire Council).

Parameter	Guideline Value	% meeting guideline values	Mean	Median	Standard deviation	Min.	Max.	Number of samples	Number of exceptions	95th percentile	5th percentile
Aluminium	0.2000 mg/L	100	0.0425	0.04	0.029	0.01	0.08	4	0	0.0896	0.0135
Antimony	0.0030 mg/L	100	0.0013	0.001	8E-04	0.001	0.003	6	0	0.0027	0.0011
Arsenic	0.0070 mg/L	100	0.0017	0.001	0.002	0.001	0.005	6	0	0.0043	0.0012
Barium	0.7000 mg/L	100	0.1033	0.102	0.008	0.094	0.114	6	0	0.1156	0.095
Boron	4.0000 mg/L	100	0.099	0.099	0	0.099	0.099	6	0	0.099	0.099
Cadmium	0.0020 mg/L	100	0.0005	0.0005	0	5E-04	0.0005	6	0	0.0005	0.0005
Calcium	9999.0000 mg/L	100	51.16	51.265	1.414	49.33	52.78	4	0	53.4792	49.5025
Chloride	250.0000 mg/L	100	63.5	62.9	5.859	57	71.2	4	0	73.1086	57.71
Chromium	0.0500 mg/L	100	0.0178	0.0195	0.008	0.005	0.028	6	0	0.0305	0.0062
Copper	2.0000 mg/L	100	0.0664	0.0443	0.061	0.014	0.168	6	0	0.1668	0.0217
Cyanide	0.0800 mg/L	100	0.0066	0.0099	0.006	0	0.0099	3	0	0.016	0.0005
E. coli	0.0000 cfu/100 mL	74	3.0263	0	14.88	0	92	38	10	27.4215	4.6
Fluoride	1.5000 mg/L	100	0.1295	0.12	0.035	0.099	0.198	6	0	0.1872	0.104
Iodine	0.1000 mg/L	100	0.0276	0.034	0.016	0	0.037	5	0	0.0531	0.0019
Iron	0.3000 mg/L	75	0.6325	0.1	1.113	0.03	2.3	4	1	2.4572	0.1435
Lead	0.0100 mg/L	50	0.0143	0.0115	0.014	0.002	0.04	6	3	0.0376	0.0039
Magnesium	9999.0000 mg/L	100	38.33	38.07	0.837	37.65	39.53	4	0	39.7029	37.744
Manganese	0.5000 mg/L	100	0.0108	0.005	0.014	0.005	0.04	6	0	0.0343	0.0068
Mercury	0.0010 mg/L	100	0.0002	0.0001	2E-04	1E-04	0.0005	6	0	0.0006	0.0001

Parameter	Guideline	% meeting	Mean	Median	Standard	Min.	Max.	Number	Number	95th	5th
Molybdenum	0.0500 mg/L	100	0.0058	0.005	0.002	0.005	0.0099	6	0	0.0091	0.0052
Nickel	0.0200 mg/L	100	0.0099	0.0099	0	0.01	0.01	5	0	0.01	0.0099
Nitrate	50.0000 mg/L	100	0.9075	0.99	0.202	0.495	0.99	6	0	1.2389	0.5198
Nitrite	3.0000 mg/L	100	0.132	0.099	0.081	0.099	0.297	6	0	0.2646	0.1089
pH	6.5 - 8.5	100	7.7667	7.8	0.207	7.5	8.1	6	0	8.1054	7.53
Selenium	0.0100 mg/L	100	0.0025	0.002	0.001	0.002	0.005	6	0	0.0045	0.0022
Silver	0.1000 mg/L	100	0.0036	0.002	0.004	0.002	0.0099	5	0	0.0094	0.0024
Sodium	180.0000 mg/L	100	76.05	76.7	3.003	71.3	79.2	6	0	80.9741	71.695
Sulfate	500.0000 mg/L	100	7.85	7.8	0.217	7.6	8.2	6	0	8.2055	7.63
Thermotolerant Coliforms	0.0000 cfu/100 mL	87	6.4	0	23.7	0	92	15	2	45.2728	4.6
Total Coliforms	0.0000 cfu/100 mL	32	51.189	8	75.07	0	230	37	25	174.3044	11.5
Total Dissolved Solids (TDS)	500.0000 mg/L	100	435.8	437	8.408	423	446	5	0	449.5897	424.15
Total Hardness as CaCO3	200.0000 mg/L	0	285.58	286.6	5.757	278.2	290.9	4	4	295.0164	278.835
True Colour	15.0000 Hazen Units (HU)	100	1.0175	0.99	0.055	0.99	1.1	4	0	1.1077	0.9955
Turbidity	5.0000 NTU	83	2.95	0.85	5.392	0.2	13.9	6	1	11.7931	0.885
Zinc	3.0000 mg/L	100	0.615	0.445	0.648	0.06	1.51	4	0	1.6775	0.1325

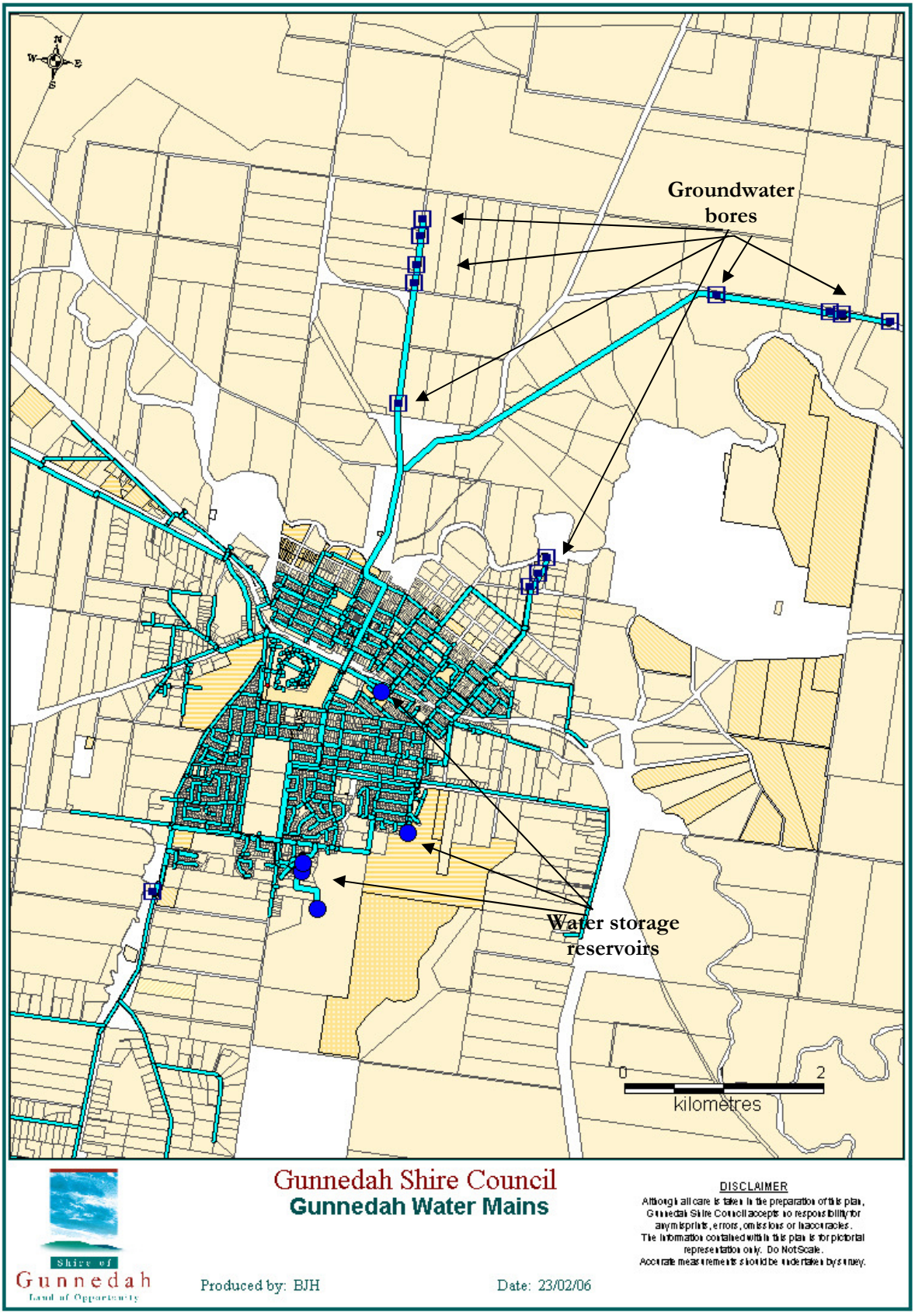


Figure 2.24. Gunnedah Water supply and distribution system (Source: Gunnedah Shire Council).

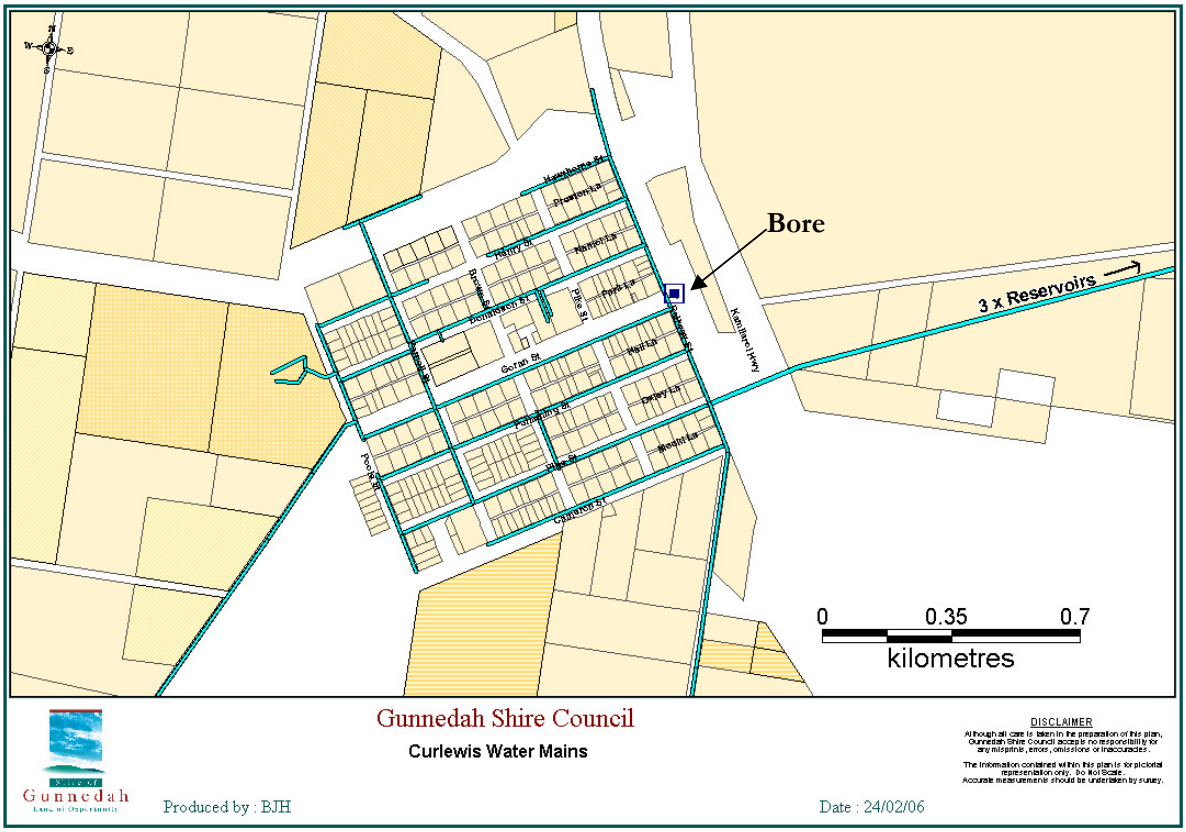


Figure 2.25. Curlewis water supply and distribution system.

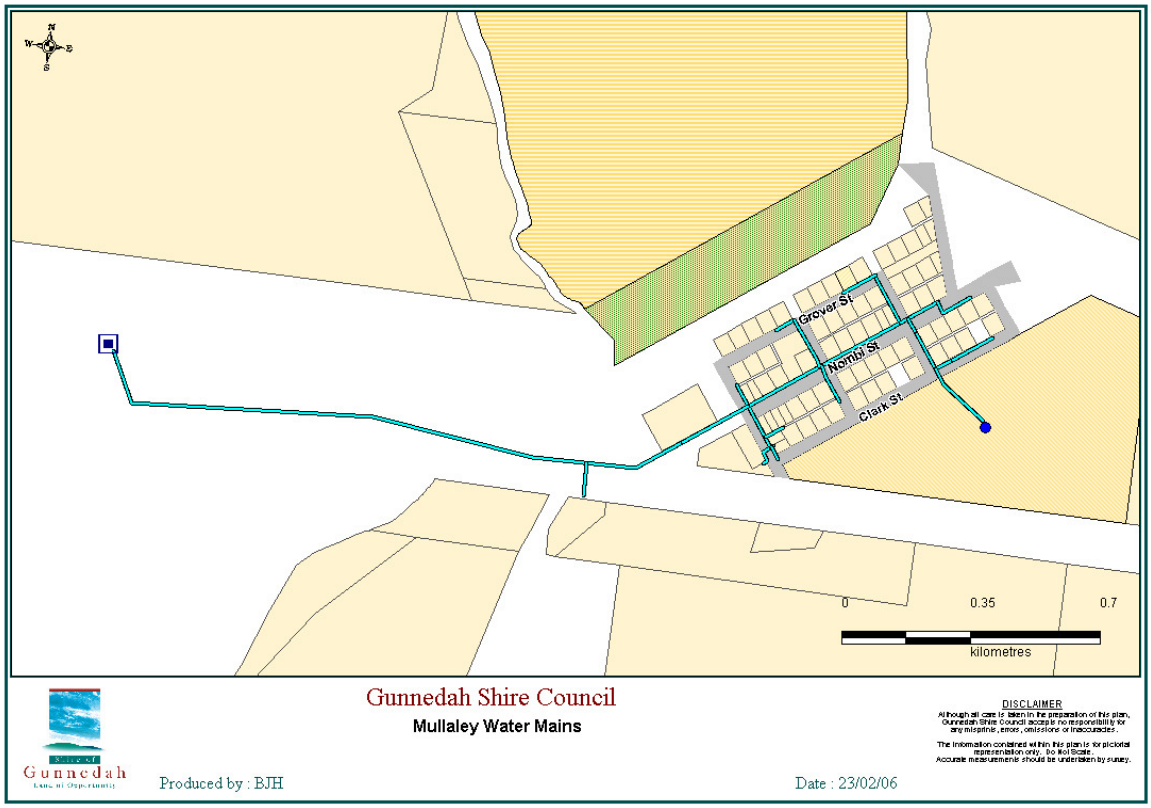


Figure 2.26. Mullaley water supply and distribution system.

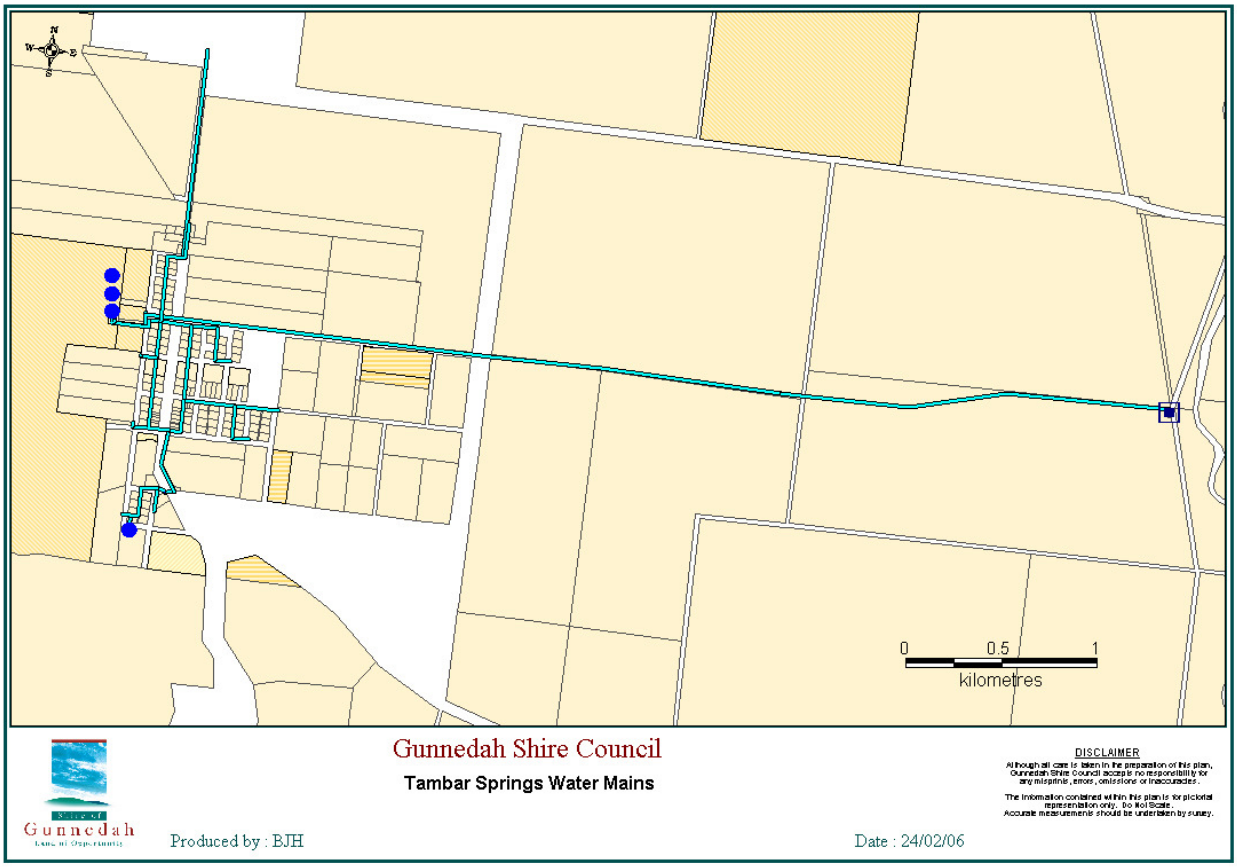


Figure 2.27. Tambar Springs water supply and distribution system.

System performance

The Strategic Business Plan for Water Services (Gunnedah Shire Council , 2003/04), compared actual and targeted performance. According to this Plan there is minimal interruption to services as Gunnedah has a ring main system that enables alternative water sourcing should a breakdown occur. There were a total of 7 interruptions in the 2003/04 year. In the period from Jan 2005 to Feb 2006 there were 28 line breaks, 17 leaks and 213 service breaks in Gunnedah. Curlewis has 7 repair incidents while Carroll had one.

The number of taste and odour complaints exceeded the target of less than five, with 24 being recorded in 2002.

The principal issues identified in the Strategic Business Plan were:

1. Reduce the number of mainbreaks
2. Upgrade selected water services
3. Reduce annual water consumptions
4. Implement new pricing structure
5. Develop asset management system and to value assets.

Table 2.20 compares the triple bottom line (TBL) performance of the Gunnedah Shire water supply system compared with the state median. The results identify the number of mainbreaks as being unsatisfactory. The introduction of a two tiered pricing system will help reduce water consumption per allotment.

Table 2.20. Triple bottom Line (TBL) performance of the Gunnedah Shire water supply system compared with the state median (LGA/ SANSW, 2003/2004).

Attribute	State median (most recently available data March 2000/01)	Gunnedah	Comment
Water quality complaints (27)	2.5	1.9	Better than median
Customer interruption frequency(29)	4	4	Similar to median
Mainbreaks (31)	18	36	Poor performance
Total days lost (33)	2.3	1.1	Better than median
Average residential consumption (34) kL	220	460	Poor performance. However consumption has fallen with introduction of 2 tiered pricing.
Operating cost (OMA) (51) $/assessment	200	182	Similar to median
Pumping cost (55) $/assessment	20	68	Poor performance, but cost is falling
Treatment cost (54) $/assessment	30	Nil	Minimal treatment required
Typical residential bill (15) $	315	255	Better than median
Typical developer charges (16) $	2350	2500	Similar to median
Economic real rate of return (47)	2.6%	3.66	Better than median
Management cost (53) $/assessment	80	47	Better than median

Sewerage services in Gunnedah Shire

The Sewerage Services in Gunnedah Shire are detailed in the document Strategic Business Plan for Sewerage Services 2003/04. Council operates schemes in Gunnedah and in Curlewis. Mullaley, Tambar Springs and other hamlets rely on on-site systems.

Gunnedah Sewerage System

The Gunnedah Sewerage System was constructed in 1938 and was augmented to an 11,000 EP capacity in 1968. The plant is based on a conventional trickling filter.

The town has 3510 sewerage connections. There are some 85 km of sewer mains ranging in size from 150 to 600 mm. The system is largely gravity feed and there is only one major pump station. Figure 2.28 shows the layout of the sewer system in Gunnedah.

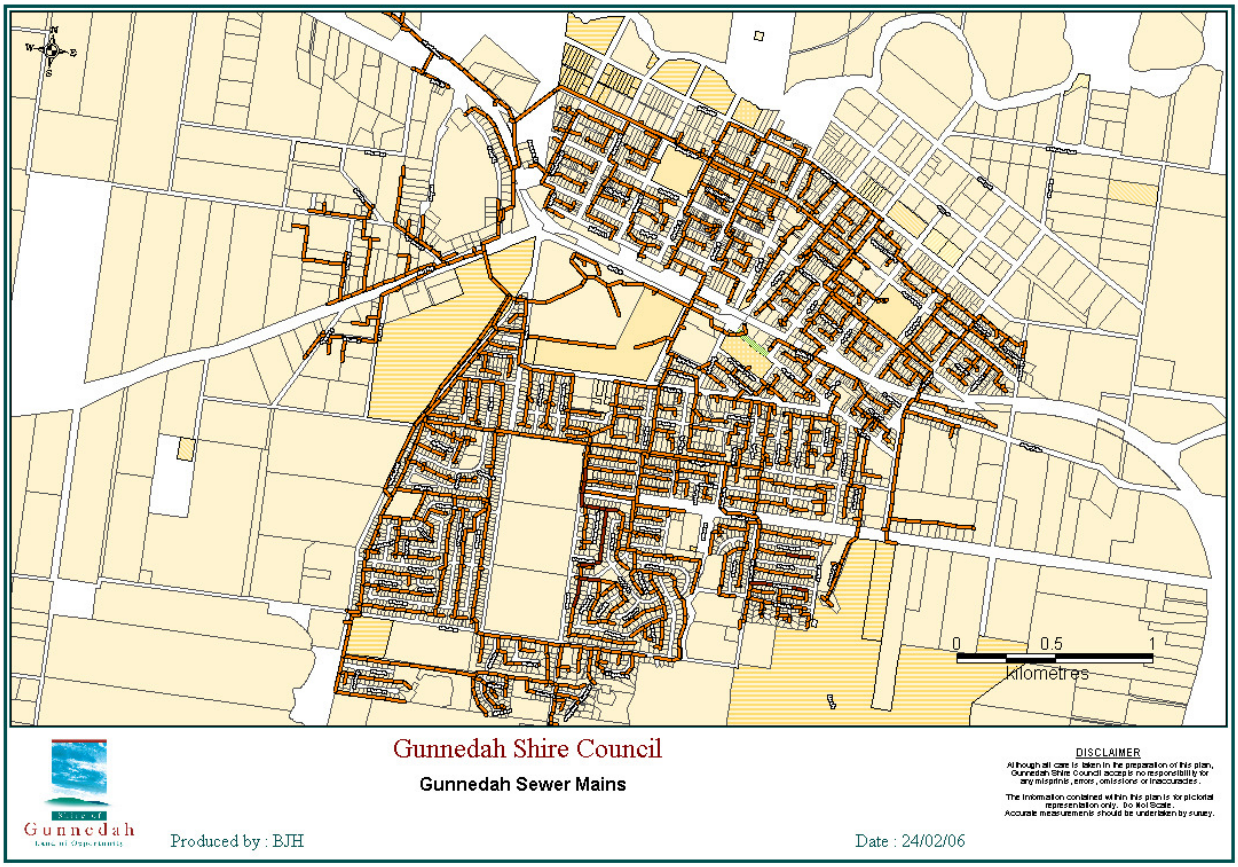


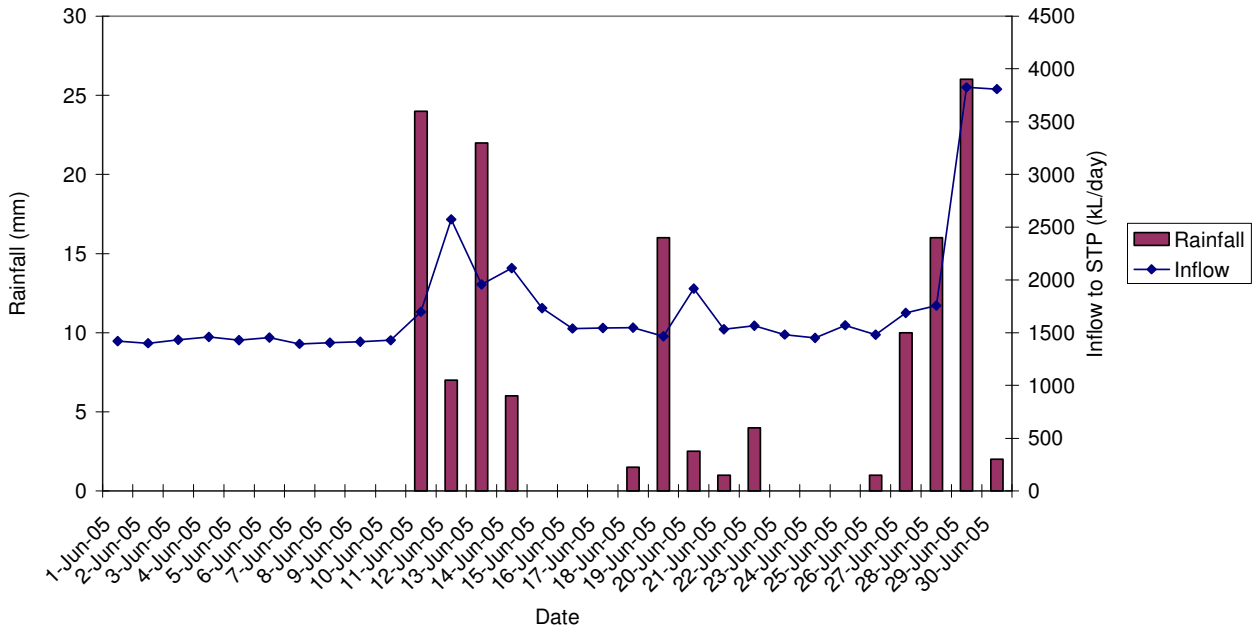
Figure 2.28. Sewer mains in Gunnedah. The system is clustered on the left bank of the Namoi River. (Source: Gunnedah Shire Council GIS).

Total flow between Feb 2005 to January 2006 was 573 ML or 1.7 ML/day. Average dry weather flow to the STP is 45 L/sec. Wet weather increases this over three fold to 130 L/sec.

Figure 2.29 shows the relationship between rainfall and total volume delivered to the STP each day. A series of wet days can more than double inflow. However there is often a delay of a day or more between rainfall and peak flow. This suggests there is slow infiltration into the system from the surrounding soil rather than simply direction connection of stormwater pipes, etc to the sewer.

Council does not have a trade waste policy. There is no monitoring of grease trap management. Large scale waste-producing industries such as the tannery are not connected to the town sewer system.

Figure 2.29. Rainfall and sewer inflows each day at Gunnedah STP in June 2005.



Effluent quality

Gunnedah Shire Council measures effluent quality monthly. The results for 2005 are shown below in table 2.21.

Table 2.21. Contaminant concentrations in Gunnedah effluent during 2005. (Units all mg/L) (Source: Gunnedah Shire Council)

Month:	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05	Mean	Annual load (kg)
BOD_5	5	10	4	8	7	6	4	4	5	6	9	*6*	*3047*
Suspended Solids	31	30	14	20	13	13	62	29	21	38	26	*25*	*15446*
Total Nitrogen	5	6	10	16	9	11	6	8	6	5	5	*7*	*3818*
Total Phosphorus	1	2	4	6	5	6	3	2	3	3	2	*3*	*1671*
Oil & Grease	2	2	5	5	5	5	5	5	5	5	5	*4*	*2440*

Suspended solids concentration exceeds the indicative 30 mg/L for secondary treated effluent in 4 months. The high concentration in August 2005 suggest an algal bloom.

Total Nitrogen and Phosphorous concentrations are low compared with many secondary treated effluent, and the results suggest the STP is well operated and/or there is a high inflow of uncontaminated water that dilutes the contaminant concentrations. Oil and Grease concentration is low suggesting the STP is not receiving unacceptably large loads of commercial waste.

The data in table 2.22 shows Gunnible farm received 3.8 t of Nitrogen and 1.7 t of Phosphorus in the 2005 effluent. The estimated value of this is around $3000. Table 2.21 also shows that in 2005

STP approached its licence load limits for Suspended Solids and exceeded the limit for oil and grease. Whilst the oil and grease loads were lower in previous years the results suggest the need for a combination of reduced inflowing contamination and improved treatment efficiency at the STP. A trade waste audit could assist in reducing the inflowing load.

The EPA license records indicate periods of non conformance in the past. These were related to high N, P and BOD loads. It is fortunate that the effluent is being beneficially utilised rather than discharged to the Namoi River.

Table 2.22. Comparison between calculated annual load since 2003 and the load limits given in Licence 831 L2.2.

Attribute	Annual load (kg) 2003	Annual load (kg) 2004	Annual load (kg) 2005	Load limit from EPA licence (No 831, Page 9)
BOD_5	3040	5008	3047	7104
Suspended Solids	6422	13459	15446	16824
Total Nitrogen	5381	5869	3818	7337
Total Phosphorus	2532	2283	1671	3165
Oil & Grease	942	993	2440	1750

Reuse

Council has a 5 year contract to supply all of its effluent to an irrigation farm owned by Savekemp Pty Ltd. The farm is some 10 km to the north of the town. Council is paid $55/ ML for the water, with the average annual volume being 600 ML. This covers pumping costs and avoids the obligation to pay DEC load based licensing fees.

Effluent is stored in Gunnedah for 28 days then pumped to Gunnible Farm. The farm then stores the water and utilises it to irrigate a variety of crops. There is formal Environmental Management Plan and a Monitoring program for the site (Gunnedah Shire Council, undated).

The soil monitoring results indicate soil physical stability is good and table 2.23 shows there is low salinity. There is minimal accumulation of phosphorous. Nitrate-N has accumulated in the soil, but there is minimal evidence of accumulation in groundwater. It is likely that crop uptake and denitrification have removed Nitrate from the soil before it can leach to the watertable.

Table 2.23. Results of 2005 monitoring program in effluent irrigated fields at Gunnible Farm (Source: Unpl. Data Gunnedah Shire Council, 2006).

Attribute	Units	Paddock 1 Sample depth 0.4 to 0.6m	Comments
Salinity as EC	dS/m (5:1, Water: soil)	0.13	Low and OK
Cation Exchange	Cmol(+)/kg	43	High and good

Capacity (CEC)			
Exchangeable Sodium Percentage	% of CEC	4	Slightly elevated, check next year
Available P (Bray)	mg/kg	1	Low. P in effluent will provide needed nutrients (note sample depth)
P sorption capacity	mg/kg	182	Medium, suggests long term ability to retain and supply P to plants
Nitrate-N	mg/kg	9	Medium. There could be some leaching of Nitrate to the water table.

System performance

The Strategic Business Plan for Sewerage Services (Gunnedah Shire Council 2003/04) indicates the number of failures due to rainfall and insufficient capacity was 3 per year. This is 50% higher than the 2/year target and is consistent with the high inflows that occur after significant rainfall events. There were some 150 failures/year due to blockages. This is well in excess of the <100 target for Gunnedah. In the 12 months to end of February 2006 there were 34 sideline chokes, 116 mains chokes, 48 boundary shaft blockages and 7 other types of chokes.

Table 2.24. Triple bottom Line (TBL) performance of the Gunnedah Shire sewerage system compared with the state median (LGA/ SANSW, 2003/2004)

Attribute	State median (most recently available data in March 2006)	Gunnedah	Comment
Employees /1000 properties	1.5	1.5	Median performance
Typical residential bill $/assessment	380	220	Better than median performance
Typical developer charges$/assessment	2800	200	Better than median performance
Odour complaints/1000 properties	0.4	0.2	Better than median performance
Days lost (%)	2.9	1.2	Better than median performance
Compliance with BOD licence % of samples	100	100	Good

Compliance with SS licence % of samples	99	90	Lower than median
Sewer chokes/100 km of mains	20	55	Markedly worse than median
Sewer overflow to the environment/100 km of mains	2	25	Markedly worse than median
Economic real rate of return (%)	1.9	1.7	Worse than median
Operating cost ($/property)	260	120	Better than median performance
Management cost ($/property)	96	22	Better than median performance
Treatment cost	90	42	Better than median performance
Pumping cost	36	15	Better than median performance

The results in table 2.24 show economic performance of the Gunnedah Shire sewerage system was better then the NSW median. However sewer chokes and quality of discharged effluent were below the median. Sewer chokes are being addressed, while the 100% reuse of the effluent means the occasional elevated suspended solids concentration is not creating an environmental issue in the receiving waters.

Response times, odour complaints and contaminant concentrations in discharges were within target values.

Key sewerage issues identified in the Business Plan

The key issues identified in the Strategic Businesses Plan are shown in table 2.25.

Table 2.25. Key issues identified for the Gunnedah sewerage system (Source: Gunnedah Strategic Business Plan for Sewerage Services 2003/04).

Issue	Response so far
Extension of sewerage services to industrial area	Forecast for 2005 to 2010 period. No action so far (March 2006)
Reduction in area flows and illegal connections	CCTV used to identify blockages. Council spending $250,000/year on a program expected to last 10 years. Individual home connections not yet tested
Development of asset management system and value	Required strategic maintenance plan (Page 54 of Strategy) partly implemented.

assets	Review and update asset management plan annually ???
Update plans and policies including trade waste	Council has approved policy in principle (Jul 2003). No further development (See page 36 of Strategy report for proposed sequences).

Curlewis

The Curlewis sewerage scheme was constructed in 1990. It has a capacity of 1650 EP and serves a population of 610. Total length of the mains is 9.2 km. Figure 2.30 shows the sewer mains in Curlewis. This is a simple gravity feed system.

Sewage is directed to evaporation ponds. Overtopping is extremely infrequent except during periods of prolonged wet weather. Consequently there is effectively no water available for irrigation.

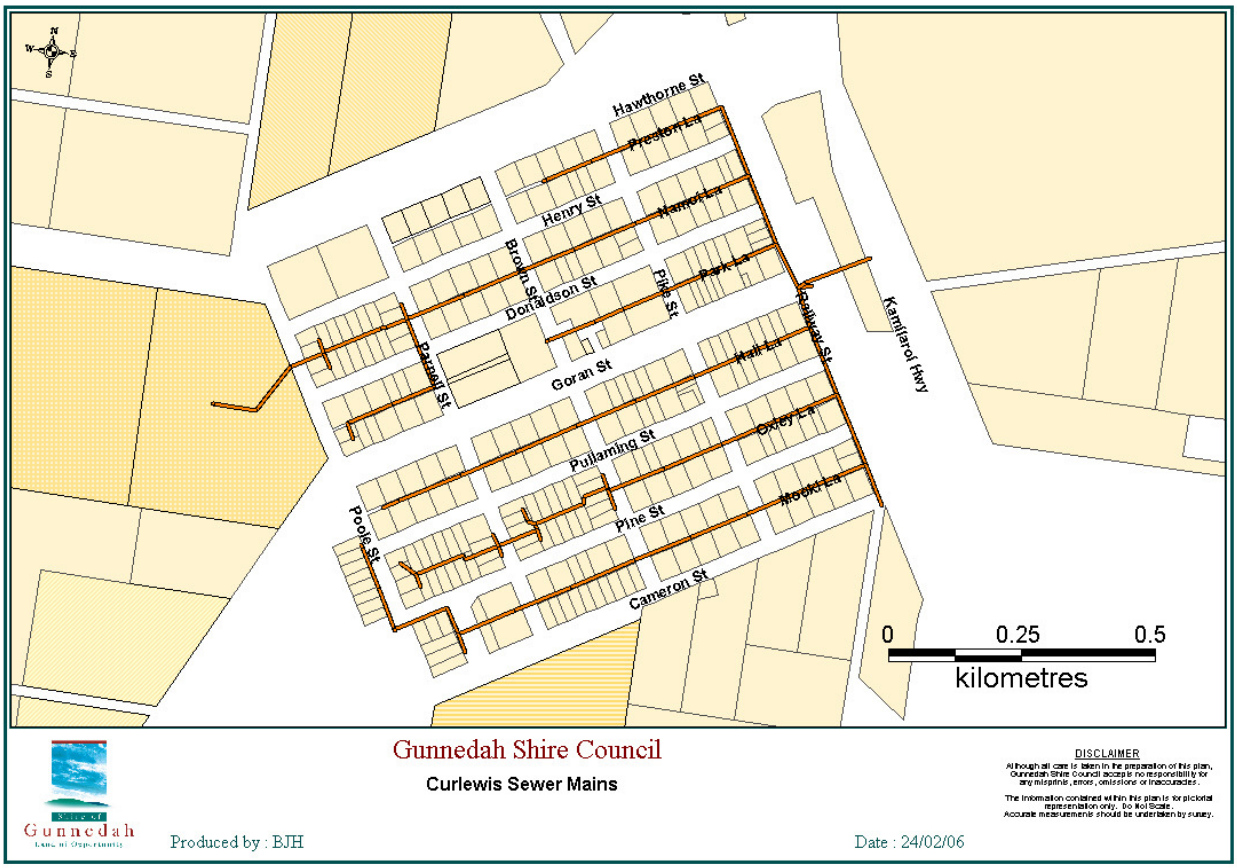


Figure 2.30. The Curlewis sewer main system. (Source : Gunnedah Shire Council GIS).

Onsite sewage management

Council does not have an onsite sewage management strategy. Most of the septic tanks in the Shire have been registered. However, they are not inspected unless the property is sold and a certificate on the septic is requested or there is a complaint.

There is no evidence that the Gunnedah water supply has had a problem from septic contamination. Mullaley and Curlewis water supplies are chlorinated as E. coli has been detected. This contamination may be from rural land use more than sewerage as the supplies are not located near any on site septics.

Stormwater within Gunnedah urban area

Runoff rate

The NSW Farm Dams Assessment Guide (DLWC, 1999) can be used to estimate natural runoff According to this guide Gunnedah Shire has a typical annual runoff of 65 mm or 0.65 ML/ha/y/year. Runoff in urban areas will be almost 10 times this figure.

Drainage systems within Gunnedah

The drainage systems in and around Gunnedah township are described in the Planning Workshop (1981). All the catchment systems drain to the Namoi River. Blackjack Creek Catchment is the largest local system. It arises in Blackjack State forest and extends to the north. Portions of west Gunnedah lie on relatively flat lands near the northern edge of this catchment.

Flooding is an issue in the lower, northern part of the township, and inundation of the CBD can occur in heavy flooding. Figure 2.31 shows the flooded areas in response to different river heights. During heavy rainfall there are major increases in sewage flow rate. Manhole surcharge can also occur. General inundation of the lower parts of Gunnedah would increase wet weather flows.

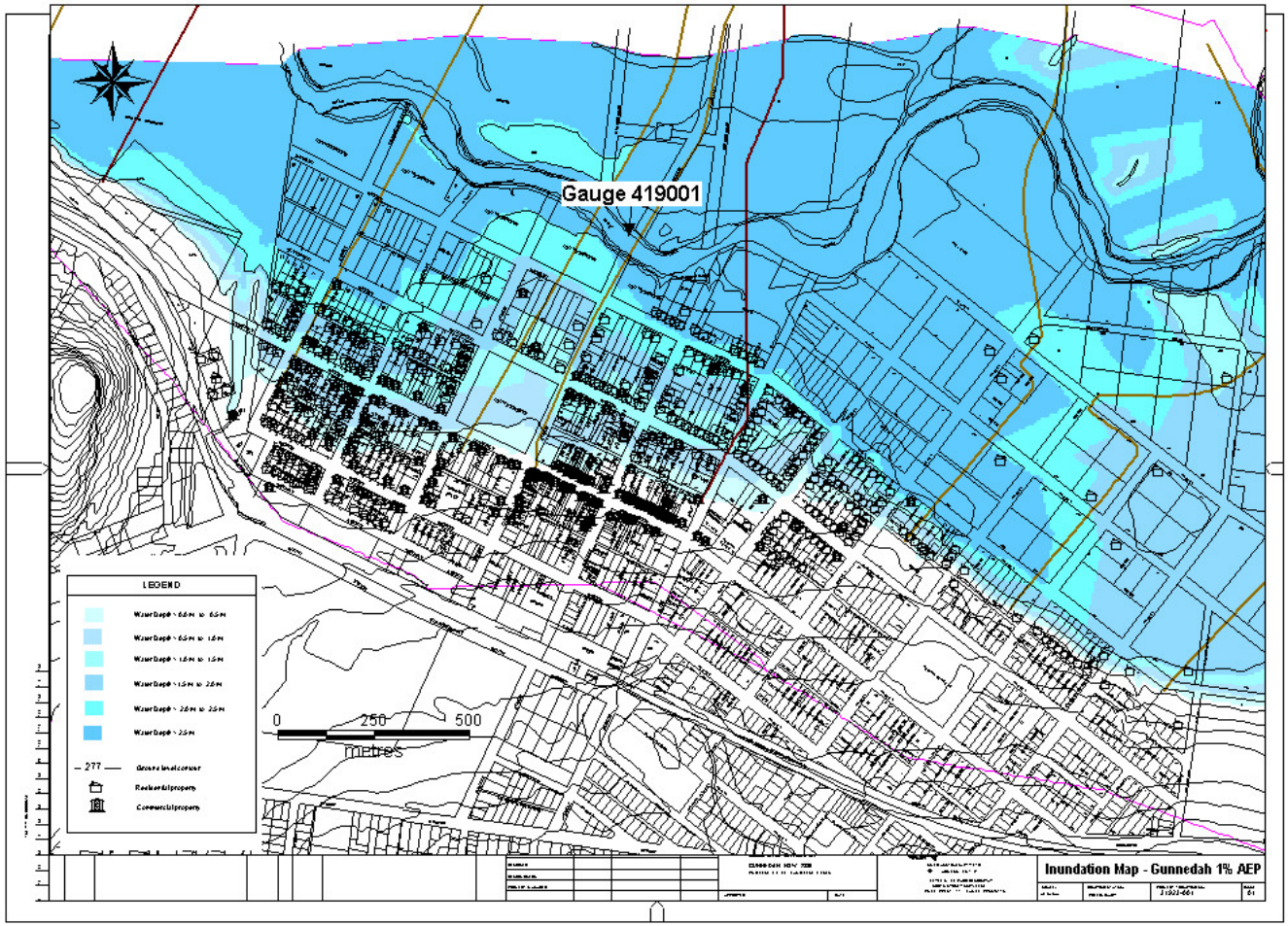


Figure 2.31. Flood inundation map of Gunnedah (Source: Gunnedah Shire Council).

Ashford Catchment covers some 330 ha and is bounded by hills to the south of Gunnedah. Ashford Creek flows through Gunnedah to the east of Links Road via a series of channels, pipes and box culverts. Eventually the creek joins Blackjack Creek and then proceeds to the Namoi River. Flooding with runoff from Ashford Creek is an issue in the lower part of the catchment.

Osric Street Catchment covers some 240 ha. It rises in hills south east of Gunnedah. As with the other catchments there is a marked reduction in slope towards within the township. South of the railway culvert the catchment includes some residential areas as far as Maitland Street. The area downslope of Maitland Street is floodplain. An isolated meander was augmented in 1999 to provide stormwater detention and treatment prior to discharge into the Namoi River. This wetland is known as Mullibah Lagoon.

Stock Road Catchment arises on Porcupine Hill. This catchment drains the eastern edge of Gunnedah and covers some 200 ha. There is only limited urban development in this catchment.
There is limited information on stormwater quality within Gunnedah township. Table 2.26 shows Phosphorus concentration is unusually high and may be due to sampling equipment error.

Table 2.26 Stormwater quality as measured by St Mary School students in 1995. Data is compared with ANZECC Guidelines for aquatic ecosystem protection (ANZECC, 2000) and with Duncan (1999).

Attribute	Oxygen (% sat)	pH	Total P (mg/L)	Nitrate-N (mg/L)	Turbidity (NTU)	Total SS (mg/L)	BOD (mg/L)
Median at Osric St drain Oct- Nov 1995.	68	7	1	0.1	68	251	20
ANZECC Guidelines for aquatic ecosystem protection (ANZECC, 2000).	>90%	<7.5	0.02	0.015	<25	Not given	Not given
Urban runoff (Duncan, 1999) median values	Not given	6.7	0.39	Not given	68	110	3
Comments	Below optimal	OK	High	High	OK	High	High

The results in table 2.26 show the stormwater has low oxygen saturation. This is consistent with the high BOD concentration. Total suspended solids load is higher than many urban areas, however the turbidity is lower. This suggests much of the TSS consists of relatively coarse particles. Total Phosphorus concentration is very high compared with other urban sites (Duncan, 1999).

The high BOD would make water storage a challenge as it would tend to become anaerobic.

Stormwater reuse and substitution

DCP 14 (Gunnedah Shire Council, 2005) aims to conserve water supplies and to complement the provisions of the BASIX Code. It requires every new home or homes undergoing significant extensions to have a 5,000 to 10,000 L rainwater tank. The tank can be connected to toilets and washing machines. Additionally an outdoor supply point is needed. The DCP applies to the entire shire, but is especially important for the urban areas where the reticulated groundwater has significant contamination issues. Note that BASIX is implemented through a SEPP and so overrides local planning instruments. As such, it should form key elements of the Gunnedah Shire urban water management strategy.

The Gunnedah golf course lies downslope of developing residential lands. It currently irrigates with bore water. However, runoff from the area will increase as the number of homes in the catchment

increase. Therefore there is an opportunity to capture urban runoff on the golf course. This would assist in reducing urban stormwater impacts on the lower parts of the town.

Urban salinity

Gunnedah township has a small but significant urban salinity issue (Heath, 2003). The main areas of concern are around Gunnedah High School, within the Wandobah Reserve and in the CBD.

Salinisation is related to shallow aquifers, and is the result of a combination of natural and anthropogenic processes. Groundwater salinity ranges from a low 1 dS/m to a very high 29 dS/m.

The recharge to the groundwater that is driving the salinisation is estimated to be 60% from rainfall, 30% from leakage of water and sewer pipes and 10% over irrigation (Berhane, et al, 2000). Improved water management is required to reduce the recharge rate.

2.3 Adequacy of data

Population assessment

Population growth rate estimates for Gunnedah Shire vary from a predicted decline to virtually static. Between 1981 and 1986 it increased by 1.92%. However it fell by 1.96% over the next 5 years and by another 3.2% between 1991 and 1996. NSWPlanning suggests a shire population of around 10,700 by 2021 (Cited in Strategic business Plan for Sewerage, 2003/04). This represents a 15% fall on current population figures. Gunnedah Shire Council predicts minimal change in population. The projections both suggest there will not be a significant increase in population.

Conclusion

There is no need for major augmentation of services to meet increased demand.

Groundwater supply security

Gunnedah urban water supply is completely reliant on groundwater sources. Increased salinity and reduced bore water heights during the recent drought highlighted the need to maximise supply security.

Recommendations

Council make continued representations to the DNR, Tamworth regarding the proposed reduction in water extraction rate to sustainable volumes.

Council make representations to the DNR to ensure the estimate of sustainable extraction rate is as accurate as possible. This may require more sophisticated analysis; for example use mathematical modelling rather than the 'hill' method.

Groundwater quality

Groundwater extracted for Curlewis is not meeting ADWG for sodium, Chloride TDS or Total Hardness. The reasons for this need investigation.

Groundwater at Tambar Springs has elevated concentrations of Lead. This is a health issue that needs to be investigated.

Recommendations

Council make continued representations to the DNR Tamworth regarding water quality at Curlewis.

Council make representations to the Department of Health regarding water quality at Tambar Springs.

Use of rainwater tanks

The introduction of DCP14 will gradually increase the number of rainwater tanks, however tank use is already widespread in Curlewis and other small urban centres. This is important as it means there is less reliance on subsurface supplies for drinking water.

There is a need to establish the extent of tank use and its likely implications for stormwater management as well as for human health.

Recommendation

Council identify the use of rainwater tanks in the urban areas of the shire.

Urban Stormwater information

The Gunnedah Stormwater Management Plan is a generic document that contains minimal data specific to Gunnedah. For example there is no information on flows in the major catchment within the town. Nor is there any estimate of benefits that could arise is various stormwater management systems were installed.

There is minimal stormwater quality information, and the information collected shows entirely high contamination with Phosphorus.

Recommendations

Council identify the value of installing stormwater management devices and policies before resource allocation. For example, what is the value of requiring on-site detention systems for new large buildings? Is there a need to require new developments to demonstrate that peak runoff will not be increased as a result of increased impervious surfaces?

Council should introduce a simple stormwater data collection system. This would be designed to measure any change in quality as different devices and policies are introduced.

Trade waste management audit

The concentration of Oil and Grease at the Gunnedah SPT exceeded the licence limit in 2005. This may be due to trade waste dumping.

Recommendation

Council to institute a trade waste audit and develop a trade waste agreement

2.4 Audit of data

DUES Guidelines (2004) Appendix provides a series of audit questions. The response to them is given in table 2.27

Table 2.27. Responses to questions in the DEUS Audit list (Appendix I DEUS, 2004).

Ref	Factor	Information	Information source
		Landscape characteristics	
1.1	What is the forested area of your catchment	371 km sq or some 7% of the shire area. Is protected. 34% has scattered trees	Bailey (1995)
1.2	Is catchment area currently subject to clearing	Yes, but relatively small and scattered as most of the catchment is already cleared	Bailey pers comm 2006.
1.3	What is the upstream extent of your estuary (tidal and saline)	Not applicable	
1.4	Are there wetlands in your catchment	Yes. Goran Lake is the largest wetland within the Shire It covers some 6000 ha	Bacon and Briggs (1995)
1.5	What are the predominant vegetation types in your catchment	Liverpool Plains were largely covered with Stipa spp grasslands. These have been cleared for agriculture. Scattered Eucalypts (E alba and E melliodora) occur on medium to heavy soil while pine occurs on sandy elevated sites.	SCS (1976)
1.6	Does your catchment have potential acid sulphate soils	No	
1.7	Are there acid impacts in your catchment waters	No	
1.8	Are urban areas located in areas of potential acid soil	No	
1.9	Are there acid impacts in your urban areas	No	
1.10	Does either dryland or irrigation salinity occur in your catchment	Yes. Salinity occurs naturally at the break of slope between hills overlying sedimentary rock and the Liverpool Plain. Bailey (1995) identified salinity from irrigation as a potential issue in 1995. Urban salinity in Gunnedah is considered to be 60% due to natural processes, 30% to leaking pipes and 10% to overwatering	Bailey (1995) Berhane et al (2000)
1.11	What is the area of catchment salt affected	Not available	CMA
1.12	Are urban areas salt affected	Yes. A small area near Gunnedah High School	Berhane et al (2000)
1.13	Are there salinity targets for waterways	Not known	DIPNR
1.14	What are predominant soil types in your catchment	See Section 2.1.7	Bailey (1995)
1.15	Are there national parks in your catchment	Yes, see section 2.1.16	Bailey (1995)

Ref	Factor	Information	Information source
1.16	Are there protected areas (including water supply catchments, aquifers and marine areas) in your catchment	Yes, approximately was 371 km sq or some 7% of the shire area.	Bailey (1995)
1.17	Are there any threatened species or critical habitats in your catchment	Stipa grass plains are considered threatened	DEC (NPWS)
1.18	What is the topography of your catchment	See Section 2.1.9. More than 80% has slopes <5%. 4% has slopes>20%	Bailey (1995)
1.19	What is the average catchment runoff	0.65 ML/ha/y or around 10% of median rainfall	DLWC (1999)
	2.0 Urban and Agriculture		
2.1	Are there STPs in your catchment	Yes, see Section 2.2.3. One in Gunnedah, one in Curlewis	Gunnedah Shire Council. (2003/04) Strategic Business Plan for Sewerage Services.
2.2	Is STP effluent quality monitored	Yes. See section 2.2.3. STPs produce secondary treatment quality effluent	Council records
2.3	Is the STP discharge volume monitored	Yes. See section 2.2.3.	Council records
2.4	Where are the STP discharge locations	There is NO discharge. Gunnedah effluent is 100% utilised on north Gunnible Farm. Curlewis effluent is evaporated	Council records
2.5	What is the load of nutrients and any other monitored contaminants from the STP discharge	No discharge occurs. See section 2.2.3.	Council records
2.6	What is the expected effluent flow (total and dry weather only) in 25 years time	See section 2.2.3. 573 ML/year in 2005. Likely to be similar in 2030.	Council records
2.7	What is the expected load of nutrients and any other monitored contaminants in 25 years time	See section 2.2.3. 573 ML/year in 2005. Likely to be similar in 2030: BOD: 3T, TSS :16T, N: 4T, P 1.7T and O&G 2T	Council records assuming zero population change and no new treatment technology

Ref	Factor	Information	Information source
2.8	Are there WTPs in your catchment	No (see Section 2.2.2). Water is obtained from bores.	Gunnedah Shire Council
2.9	Is WTP final water quality monitored	Yes. See Section 2.2.2	Council records and Dept of Health
2.10	What is the WTP treatment capacity	See Section 2.2.2. Peak day flow in Gunnedah is 2,800 L/dwelling	Gunnedah Shire Council. (2003/04) Strategic Business Plan for Water Services.
Ref	Factor	Information	Information source
2.11	Size and location of aquaculture	NA	DPI
2.12	What is the urban area in your catchment	See Section 2.2.4	Gunnedah Shire Council
2.13	What types of agriculture are there in your catchment	See section 2.1.4. Irrigated cropping is the most valuable enterprise. Some dryland cropping and pasture usage occurs	DPI
2.14	What is the location and area of this agriculture	See section 2.1.4.	Dept of Primary Industries (Agriculture)
2.15	Is there modified or contaminated runoff or wastewater generated from this agriculture	No the main concern is salinisation and over use of groundwater resources.	CMA
2.16	What is the catchment population	See Section 2.1.2. Gunnedah Shire had 12819 in 2001.	ABS
2.17	What is the urban population	Gunnedah: 9000, Curlewis: 600, Mullaley: 80, Tambar Springs: 100.	Gunnedah Shire Council
2.18	What is the expected urban population growth	Zero to decline of around 1%/year	ABS, Gunnedah Shire Council
2.19	What is the expected rural (non-urban)population growth	Zero to decline of around 1%/year	ABS, Gunnedah Shire Council
2.20	How many on-site sewage systems (septic) operate in the catchment	Not known	
2.21	What types of industry operate within the catchment	There are two operating coal mines and a tannery.	Gunnedah Shire Council

Ref	Factor	Information	Information source
2.22	Where is this industry located	Mines are to the North and West of Gunnedah township.. The tannery is on the edge of Gunnedah.	Gunnedah Shire Council
2.23	Is the volume of industry waste discharge monitored	No monitoring of industrial waste discharge in undertaken by council	Gunnedah Shire Council
2.24	Where is industry wastewater discharged	Typically discharged as irrigation onto surrounding lands	DEC website
2.25	Is there wastewater/reclaimed water use in the catchment	Yes. See Section 2.3.3	Gunnedah Shire Council
2.26	Is reuse water monitored	Yes. 600 ML is produced from Gunnedah in the average year. Table 2.20 shows the contaminant load	Gunnedah Shire Council
2.27	What is the volume of urban stormwater generated by each urban centre	Not known. Runoff from 'natural' lands is estimated at 0.65 ML/ha/y. Urban runoff could be up to 6ML/ha/y from sites with 100% imperviousness.	DLWC (1999)
2.28	Is stormwater quality monitored	No. Indicative low urban median contaminant concentrations are: TSS 110 mg/L, P 0.39 mg/L, N 2.5 mg/L, BOD 3 gm/L, O&G 9 mg/L, Faecal coliforms 17,000 CFU/100 mL.	Duncan (1999)
2.29	What is the expected stormwater flow volume in 25 years time	No change	Gunnedah Shire Council
2.30	What is the expected stormwater load of nutrients and any other monitored contaminants in 25 years time	No change	Gunnedah Shire Council
2.31	Are there any contaminated sites in your Catchment?	No sites are listed in the DEC Contaminated Lands Register	DEC
2.32	Does flooding occur in urban areas?	Figure 2.dg shows the extent of flooding. The 100Y ARI flood will result in extensive shallow flooding in the business district.	Gunnedah Shire Council
2.33	Have algal blooms been recorded in your Catchment?	Yes, see section 2.1.13	DNR
2.34	What are your water demands?	Demand estimate is based on pump run times. Results for each urban area are given in Section 2.2.2	Gunnedah Shire Council
2.35	What is your water consumption?	See section 2.2.2	Gunnedah Shire Council

Ref	Factor	Information	Information source
2.36	What is your energy consumption (kWh/ML) for your water and wastewater facilities and what is your bill for each?	Water costs = $254,346 (2004/05) Sewerage costs = $38,933 Pump energy costs for water averages 2.3 kW/kL	Gunnedah Shire Council
2.37	What is your sewerage and water supply operating cost per 100 km of mains?	Total costs Water $1.564 m ($894,000/100 km) Total sewer costs $1.037m ($1.09m/100 km of mains)	Gunnedah Shire Council
2.38	What is your sewerage and water supply operating cost per property?	2623 water connections in Gunnedah township. Operating cost is $97/ connection. Sewer operating cost is $110/ connection.	LGA (1002/03
2.39	Sewerage and water supply service complaints	Separate totals for sewerage and water supply complaints. 25 complaints per 1000 properties for water supply and 3 complaints per 1000 properties for sewerage	Local Government or LWU
2.40	Water supply quality complaints	5 complaints per 1000 properties for water supply	Local Government or LWU
2.41	Number of supply main breaks	21 per 100 km of main	Local Government or LWU
2.42	Sewer chokes and collapses	34 per 100 km of main	Local Government or LWU
2.43	Sewer overflows to the environment	16 per 100 km of main	Local Government or LWU
2.44	Are sewer overflows monitored	Individually records are kept of all incidents	Local Government or LWU
2.45	Typical developer charges for sewerage and water supply	Water $3392 Sewer $1343.5	Local Government or LWU
2.46	Average residential bill for sewerage services	$245/connected property	Local Government or LWU
2.47	Volume of sewage treated per property	157 kL/year. See Appendix 1 for spreadsheet of daily treated water production volumes for last 3-5 yrs	Local Government or LWU

Ref	Factor	Information	Information source
2.48	Urban properties without reticulated public sewerage and water supply	None	Gunnedah Shire Council
2.49	Water usage charge	45 cents/kL	Gunnedah Shire Council
2.50	Annual water allowance (if given)	450 KL/assessment	Gunnedah Shire Council
2.51	Access charge	$270/assessment	Gunnedah Shire Council
2.52	Drinking water quality tests	See section 2.2.2	Gunnedah Shire Council
2.53	Raw water quality data at extraction point	See section 2.2.1	Gunnedah Shire Council
2.54	STP effluent quality licence monitoring results	See section 2.2.3	Gunnedah Shire Council
2.55	Water quality monitoring results for local waterways	See section 2.1.12	Gunnedah Shire Council
2.56	Water supply, sewerage & stormwater system maps	See sections 2.2.2 and 2.2.3	Gunnedah Shire Council
2.57	Number of residential dwellings	2632 based on water use in Gunnedah township	Gunnedah Shire Council
2.58	Range of typical residential block sizes	See figure in section 2.2.2 Median area is 872 msq.	Gunnedah Shire Council
2.59	Number and size of rainwater tanks	Not known. DCP only recently introduced requiring 5 kL tanks	Gunnedah Shire Council
2.60	Number of tanks commented to the potable system for top up	Not known	Gunnedah Shire Council

Ref	Factor	Information	Information source
2.61	Rainwater Tank rebate	Nil	Gunnedah Shire Council
2.62	Is there polluted atmospheric fallout over the urban area	No	Gunnedah Shire Council
2.63	Is there an on site detention policy (OSD)	No	Gunnedah Shire Council
	3.0 Climate		
3.1	What is the mean annual rainfall for the catchment or catchment regions	636 mm	Bureau of Meteorology (BOM)
3.2	What is the mean annual evaporation for the catchment or catchment regions	1752 mm	BOM, DIPNR
3.3	What is the seasonality of the rainfall	See Table 2.2. Highest in late summer.	BOM
3.4	What is the maximum temperature and annual temperature range	January 19-32 degrees, July 5-16 degrees	BOM
	4.0 River and groundwater		
4.1	What is the water quality of dry weather river flows	Figures in section 2.1.12 show water quality was less than the ANZECC Guideline values for aquatic ecosystem protection at virtually all samplings.	DIPNR
4.2	What is the total annual dry weather discharge volume	See section 2.1.12 for discussion of river flows	DIPNR
4.3	What is the annual dry weather contaminant load	Not relevant as flows adjusted to meet irrigation demand	DIPNR
4.4	What is the water quality of wet weather river flows	See section 2.1.12	DIPNR

Ref	Factor	Information	Information source
4.5	What is the wet weather mean annual discharge	Depends on irrigation demand	DIPNR
4.6	What is the annual wet weather contaminant load	Depends on irrigation demand	DIPNR
4.7	Have environmental flow requirements been identified for catchment streams	No but water quality objectives have been determined	DIPNR
4.8	What is the location of all catchment dams	Keepit is the main dam. It is located on the NE boundary of Gunnedah Shire.	DIPNR
4.9	What is the capacity of each catchment dam	Volume is 436,000 ML	State Water (SW)
4.10	What is the secure yield of each catchment dam	Not known	DIPNR
4.11	What is the water quality in each dam	Algae have been an issue in 3 out of the 5 past years	DIPNR
4.12	What is the location of all catchment weirs	Not known	DIPNR
4.13	What is the capacity of all catchment weirs	Not known	DIPNR,
4.14	What is the secure yield of all catchment weirs	Not known	DIPNR
4.15	What is the water quality in each weir	Not known	DIPNR
4.16	Are returned flows provided from, or intended to be provided from catchment storage/s or weirs	No	DIPNR

Ref	Factor	Information	Information source
4.17	Is the water quality of the return flows expected to be the same as the water quality in dam or weir	No	DIPNR
4.18	What is the extent and nature of groundwater resources within the catchment	Based on Namoi Groundwater sharing Plan indicates a recharge rate of 209,900 ML/y. This is less than half the 474,109 ML/y in allocated licenses	DIPNR
4.19	Does catchment include one or more estuary habitats	No	Gunnedah Shire Council
4.2	Are there licensed extractions in the catchment	474,109 ML in total. 2% for urban use (11194ML)	DIPNR
4.21	Are there licensed town water extractions in the catchment	Yes 11194 ML	DIPNR
2.22	What is the projected town water demand over the next 25 years?	No change from the current rate of 2531 ML	Gunnedah Shire Council

3 ISSUES AND OBJECTIVES

Issues influencing the IWCM within Gunnedah Shire can be considered in three components:

- Catchment
- Water resources
- Urban Area.

3.1 CATCHMENT

Namoi CMA released its Catchment Action Plan Part B-Natural Resources Management Plan in January 2006. This plan identifies a series of impacts as well as management actions to address these issues. A key issue relating to Gunnedah Shire IWCM is that management of water quality and flows within the Namoi River is at a catchment level and therefore outside the control of mid catchment LGAs such as Gunnedah.

Secondly catchment landuse is outside Council's control. Activities such as land clearing, irrigation, over cultivation or overstocking can all impact on Gunnedah Shire water resources yet the Shire has no control over the activities.

As an organisation with a vital interest in the well being of its constituents, Gunnedah Shire Council should ensure it participates in the decision making and prioritisation processes of the CMA.

The catchment based issues, targets and proposed management activities are summarised below. These focus on the catchment based actions upon which Gunnedah Shire Council could have some impact.

Table 3.1 Catchment based issues, targets and management actions to achieve the targets (Source: Namoi CMA, 2006).

Issues	Targets	CMA Management Actions	Potential actions for Gunnedah Shire Council
Poor management of soil resources including Over irrigation Over stocking Salinisation Soil sodicity Soil acidification Loss of soil structure Erosion Soil contamination	Adoption of BMP (Best Management Practices)	Develop/extend BMP in industry based partnerships Provide technical support to adopt BMP	Ensure active participation of appropriately qualified staff at stakeholder meetings. This can be via NROC or by requesting participation in stakeholder discussions. Ensure mining and construction industry follow appropriate BMPs

Issues	Targets	CMA Management Actions	Potential actions for Gunnedah Shire Council
Land is not being utilised within its capability	Increase percentage of land being utilised within its capability	Assist property planning Change landuse to suit capability	Encourage CMA activity in Gunnedah Shire. Involve CMA in IWCM and application of urban BMPs including environmentally sustainable urban development. Develop LEPs that reflect CMA issues, for example addressing urban salinity.
Water quality commonly does not meet ANZECC guideline criteria for salinity, P and N	Increase the proportion of time that surface waters meet ANZECC criteria	Rehabilitate and protect riparian zones Undertake some structural works Reduce both point and non point pollution Improve river flow	Actively manage council lands adjacent to waterbodies. Ensure Mullibah Lagoon is functioning adequately Adopt BMP for urban areas. For example use of OSD for commercial developments. (designed to reduce local flooding and downslope scour due to high flow rates) Develop maintenance plan to ensure adequate performance of stormwater assets such as GPTs.
Hydrological stress due to extraction and altered stream flows	Ensure groundwater extraction rate is similar to recharge rate Set salinity targets in line with MDBC salinity audit	Encourage rapid adoption of the Namoi Groundwater Sharing Plan (DLWC, 2003). Request improved dam discharges to allow for environmental flows, flushing and minimal thermal pollution.	Actively lobby CMA and DNR to accelerate the rate of adoption of the Namoi Groundwater Sharing Plan. Ensure residents understand where town water comes from. (The Namoi CMA is implementing a community based water eduction plan in July 2006. Council should cooperate with this). Publicise BMPs such as use of rainwater tanks, garden mulching and avoidance of overwatering. Limit water supplies to rural residential areas

Outcomes

Gunnedah Shire Council has little control over catchment activities outside its boundaries. However it can lobby the CMA to ensure the Groundwater Sharing Plan is implemented in full.

Within shire boundaries Council can ensure stormwater impacts are minimised. For example runoff from rural roads can be dispersed to minimise sediment yield to streams. Stormwater reuse can be encouraged, for example on the golf course.

3.2 WATER RESOURCES

Water quality in streams

Figures 2.11, 2.12, 2.13 and 2.17 all indicate surface water rarely meets ANZECC guidelines. Similarly the Interim Water Quality Objectives for various end uses are not always met as figure 2.17 shows. Issues include: Elevated salinity, Phosphorus, Nitrogen, Total Suspended Solids and algal blooms.

Elevated salinity is due to a combination of natural salinisation plus accelerated movement of salt as it is flushed from the soil during irrigation. Dryland salinity has increased following clearing of deep rooted perennial vegetation. Elevated Phosphorus and Nitrogen concentrations appear to be largely due to erosion and inefficient use of fertiliser. The Nitrogen and Phosphorus is lost from the farms and eventually reaches surface waters.

Total suspended solids load arises from two major sources. There are substantial areas of erosion and some of this material reaches surface waters. Secondly there is erosion of stream banks and bases. A high proportion of this material is directly added to surface waters.

Erosion of stream banks is facilitated by the elevated sodium content in the water. The sodium encourages dispersion of the soil particles, and the fine particles are easier to transport.

Algal blooms occur in response to a wide range of environmental parameters including warm weather, sunlight and an excess of Phosphorus.

Outcomes

Gunnedah Shire Council has little control over water quality in the surface waters. However Gunnedah can reduce its impact by ensuring council owned lands are adequately vegetated and that excessive irrigation does not occur. .

Water quality in aquifers

Section 2.2.1 discusses groundwater quality for each of the urban centres. The results are summarised in table 3.2

Table 3.2. Instances where groundwater attributes that exceed ADWG (2004) criteria.

Urban centre	Table in IWCM report	Issues	Objectives
Gunnedah	2.10	Occasionally elevated Hardness, TDS and Cl compared with ADWG. Appears related to drought.	To provide each urban centre with water that meets ADWG for as high a proportion of time as practical. An efficient disinfection system may be required. To ensure residents know and understand what is happening to their water supplies To encourage use of rainwater tanks throughout the shire, but, especially in
Curlewis	2.11	Values of Cl, Na TDS and Total Hardness always exceed ADWG.	
Mullaley	2.12	TDS and Total Hardness occasionally exceed ADWG criteria. Appears related to drought.	

Tambar Springs	2.13	Total Hardness exceeds ADWG criteria. Lead concentration exceeds ADWG in 2 out of 4 samples	Curlewis and Tambar Springs

Elevated total Hardness and TDS occur at all sites, especially during drought. There is evidence, especially at Curlewis, that saline water incursion is affecting bore water quality. The incursion is likely to be most severe during drought when demand is high and there is minimal recharge.

Elevated lead concentration may be an issue at Tambar Springs.

Outcomes

Gunnedah Shire Council has little control over water quality in the aquifers. However, the quality of this water is critical to the existence of the urban centres in the Shire. Council needs to actively lobby the CMA to ensure water quality is maintained.

Council should also consider keeping residents informed regarding potable water quality issues. It should consider improved disinfection, and the use of rainwater tanks to reduce reliance on bores for drinking water.

Water volume in streams

Keepit Dam is operated to satisfy irrigation demand. Consequently flows during the irrigation season are typically elevated above natural flows and are maintained at these levels for long periods figure 26 shows.

The impacts of prolonged unseasonal high flows is not discussed in detail in the Catchment Action Plan, but it can include drowning of native riparian species such as River Red gum (E camaldulensis), increased bank erosion and increased presence of European Carp. The release of large qualities of cold water can also inhibit breeding of native aquatic fauna.

Outcomes

Gunnedah Shire Council has no control over water volumes in the Namoi River. However the river can be an important resource for recreation and tourism. Council should actively participate in CMA stakeholder groups especially those that are concerned with continued health of the river.

Water volume in aquifers

According to the Namoi Groundwater Sharing Plan the extraction rate from the aquifer is more than double the recharge rate. Table 2.8 shows the allocated volume and the estimated recharge rates. The table also shows the reduction in allocation to sustainable rates. Near Gunnedah, Curlewis and Mullaley around 70% reduction is required to match allocation and recharge rate. Council's water abstraction is small compared with the total removal rate. However improved demand management within urban areas would demonstrate its commitment to sustainable use of water resources.

Over extraction lowers the water table and encourages incursion of surrounding groundwater. This water can be saline or even contain trace metal contaminants.

There is an obvious imperative to ensure potable supplies do not deteriorate any further.

Outcomes

Gunnedah Shire Council has no control over groundwater yet it is totally dependant on a secure supply. Active participation in the CMA is essential to ensure Council's concerns are noted and acted upon. Council is undertaking demand management as part of its contribution to ensuring sustainable water supplies

Town water allocation

Section 2.2.2 discusses water supplies for the four urban areas with reticulated supplies. Annual water use is markedly lower than the allocated volumes: Even during 2003, in the middle of the drought water use in Gunnedah was only 81% of the allocated volume. The anticipated development of an ethanol plant will increase water demand by up to 400 ML/year. The actual volume required is currently being determined. It is suggested that the EIS demonstrate the development with use BMPs to ensure minimum water use/ML of effluent produced.

Even with the ethanol plant in full production, the total water use is likely to be less than 3600 ML or 92% of allocation.

Town water allocations are 'secure' under the Namoi Water Sharing Plan. However this simply means the towns can extract up to a specific volume/year. It does not guarantee that the water will be present to enable extraction or that the water is safe to drink.

While supplies are likely to remain adequate, there is still a need for the urban community to play its role in sustainable management of natural resources.

Outcomes

Assuming the Namoi Groundwater Sharing Plan is implemented there will always be sufficient water available for the urban areas of Gunnedah Shire. Water quality is likely to remain an issue unless extraction near council bores can be reduced.

The Demand Management Plan should assist Council in reducing water consumption without negatively impacting on its revenue base.

3.3 URBAN AREAS

Issue identification is based on the assessment of impacts the existing urban areas have on water resources and a comparison between the performance of Council's water supply and sewerage against state and other agreed benchmarks.

Urban impacts on water resources

Volume

Table 3.3 shows the water allocation to the towns compared with the anticipated sustainable yield for this specific catchment zone. The allocation varies from 1 to 14% of the recharge volume. This suggests extraction of groundwater for urban use has limited effect on resource sustainability. However equity suggests both urban and non urban stakeholders should be concerned with sustainable use of natural resources.

Table 3.3 also shows the area of crops that cannot be irrigated because the water is allocated to the urban centres (Note that 560 ML/y of effluent is utilised for irrigation). The urban centres have a net water utilisation equivalent to some 700 ha of cropping. There are over 100,000 ha of cropping in the area, so the impact of the urban water removal is less than 1% of the cropping area.

Table 3.3. Relationship between estimated recharge and volume of water utilised within urban centres. The number of ha of irrigation that is forgone is also shown (Source: Namoi Groundwater Sharing Plan, DLWC, 2003).

Urban centre	Estimated annual recharge (ML/y)	Town water allocation	% of recharge	No. of ha of cropping forgone (assume 5 ML/ha of irrigation)
Gunnedah	27500	3900	14%	780 ha (net is 668 ha as 560 ML/y is used for irrigated agriculture)
Curlewis	17300	199	1%	40 ha
Mullaley	7200	59	1%	12 ha
Tambar Springs	11400	42	1%	8 ha

Contaminant loads

The median flow in the Namoi River at Gunnedah since 1990 is 347 ML/day, while the median Nitrogen and Phosphorous concentrations are 0.60 and 0.095 mg/L respectively. So the annual load 'passing' Gunnedah is 76 T of Nitrogen and 12 T of Phosphorus.

Table 2.20 shows the reuse scheme diverts some 560 ML/year containing 4 T of Nitrogen and 1.7 T of Phosphorus from being added to the Namoi River. This is equivalent to an additional 5% of the Nitrogen load and 14% of the Phosphorus loads.

Table 3.4 shows the estimated mass of Nitrogen and Phosphorus in town stormwater. The town is estimated to add 6% of Nitrogen and 8% of the current nutrient loads to the Namoi River.

Table 3.4. Estimated mass of Nitrogen and Phosphorus in town stormwater assuming 50% runoff coefficient in the urban area.

Town area (ha)	Rainfall (mm/y)	Rainfall coeff	Runoff (ML/y)	N (mg/L)	P (mg/L)	N (T/y)	P (T/Y)
700	663	0.5	2320.5	2	0.4	4.6	0.93

The results above demonstrate the importance of recycling of effluent to reducing contaminant load in the Namoi River. The results also indicate the potential contribution of the town stormwater. Systems such as swales and wetlands that retain runoff allowing contaminant removal will assist in reducing contaminant loads. Options to reuse stormwater and reduce stormwater yield could also be considered.

Outcomes

Sewage effluent is not returned to the river except when a major sewer overflow event occurs. While these overflows occur more frequently than expected, the volume involved is small compared with the total load.

Diversion of effluent to irrigated cropping plays a significant role in reducing impacts of Gunnedah on quality in the Namoi River.

Conversely the urban runoff is adding substantial loads to the river. Council should consider introduction of BMPs to reduce total loads in the runoff. Components could include golf course irrigation, rainwater tanks and encouraging maximum grass cover

3.4 URBAN PERFORMANCE ASSESSMENT

The Strategic Business Plan for Water and for Sewerage Services includes an assessment of Council's performance against agreed targets. Similarly the NSW Water Supply and Sewerage Performance Monitoring reports (LGA, SA, 2002/03) enable comparison between Gunnedah Shire Council's performance and those of similar shires. The business plans for water and sewerage are discussed in Sections 2.2.2 and 2.2.3 respectively.

Water supply

The principal issues identified in the Strategic Business Plan for Water Services are shown in table 3.5.

Table 3.5. Issues identified in the Strategic Business Plan for Water Services (LGA/SA 2002/03).

Issue	Response as at March 2006
Reduce the number of mainbreaks	No change
Upgrade selected water services	No change
Reduce annual water consumption/ allotment	Some reduction following introduction of tiered pricing. But still high
Implement new pricing structure	As above
Develop asset management system and to value assets.	Currently underway.

The additional issues identified in the current document that were not commented upon in the business plan are:

1 Security of groundwater supplies

2 Quality of groundwater especially in areas where ADWG criteria are not being met

3 Urban salinity

4 Aging infrastructure

5 Adequacy of pressure to new subdivision in more elevated portions of Gunnedah

6 Water use is high despite the drought

7 Water loss as a % of volume pumped

Potential solutions to each of these issues are discussed in Section 4 of this IWCM report.

Sewage

The principal issues identified in the Strategic Business Plan for Sewerage Services are shown in table 3.6.

Table 3.6. Issues identified in the Strategic Business Plan for Sewerage Services (LGA/SA 2002/03).

Issue	Response as at March 2006
Chokes and overflows	Council has commenced a 10 year program to reline leaking sewers
Extension of sewerage services to industrial area	Forecast for 2005 to 2010 period. No action so far (March 2006)

Reduce illegal connections	Individual home connections not yet tested
Update plans and policies including trade waste	Council has approved policy in principle (Jul 2003). No further development (See page 36 of Strategy report for proposed sequences).
Development of asset management system and value assets	Required strategic maintenance plan (Page 54 of Strategy) partly implemented. Review and update asset management plan annually. Plan currently being implemented

The additional issues identified in the current document that were not commented upon in the business plan are:

1 Aging infrastructure

2 Security of the reuse scheme

3 Impacts of infiltration and leaks on the environment

4 Design of new subdivisions to ensure adequacy of services

Potential solutions to each of these issues are discussed in Section 4 of this IWCM report.

Stormwater

There is minimal information of stormwater despite Council commissioning an Urban Stormwater Management Plan. This lack of knowledge is a serious issue as information on catchment sizes, runoff coefficients and contaminant concentrations are needed to ensure all structural improvements are adequately sized.

The issues can be itemised as:

1 Almost no data on runoff volumes or contaminant loads, yet initial calculations suggest urban stormwater runoff is adding significant contaminant loads to the Namoi River.

2 No On Site Detention (OSD) Policy yet local flooding occurs during moderate rainfall events

3 Urban salinity is a highly significant issue in parts of Gunnedah. Urban stormwater can contribute to this problem

4 Rainwater tanks need to be more widely used and to be connected to toilets and washing machines as well as to garden taps in Gunnedah. This is considered an important way to reduce peak flows during storms. Their use to provide potable water in urban areas where bore water does not meet ADWG criteria should be actively encouraged. BASIX addresses rainwater tanks for new development, but Council should encourage shire wide adoption.

5 Subdivisions need to be designed using WSUD principles

6 Opportunities for stormwater capture and reuse need to be explored (eg the Golf Club).

Potential solutions to each of these issues are discussed in Section 4 of this IWCM report.

4 OPTIONS AND INTEGRATED SOLUTIONS

The Audit in Section 3 of this report identified IWCM issues applying to Gunnedah Shire. This section identifies actions needed to address the issues, thereby improving or at least maintaining system performance. Where practical the section aims to establish links that integrate portions of the water cycle.

Table 4.1 sets out each of the issues identified in Section 3. It then 'scores' them for impact on Human, Ecological and Economic values. Management options and performance indicators are then provided.

It is emphasised that while each option has been prioritised within its issues group, most options are linked both in activity and outcome. A key outcome is the integration of water management. For example a Demand Management Plan and a Drought Management Plan are considered essential and are currently being developed.

Table 4.1 Importance of issues to human, environmental and economic values, management options and performance indicators for a range of identified issues. The number of 'stars' indicate the relative importance of the issue to human, environmental and economic values.

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
Catchment based land management issues					
1. Over irrigation leading to salinisation	**	***	**	• Implement CMA Action Plan. Industry based EMPs	• Yield/ML of water. • No increase in salinisation as per EM39 survey or piezometric water levels
2. Increased sodicity, leading to more plant moisture stress, accelerated erosion and increased runoff	*	*	**		• Depth of water penetration/irrigation. Crop yield.
3. Erosion, including effects on farm productivity and stream bed smothering	*	**	**		• Suspended solids/ turbidity in farm runoff. Minimal increase in stream turbidity during rain events
4. Over utilisation of land	*	**	**		• Lower erosion and salinisation rates. • Less fluctuation in yield
5. Chemical contamination of waters (typically associated with intensive farming and trace metal mining)	*	***			• No environmentally significant off farm or mine site movement of potentially toxic chemicals

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
Catchment based water resource issues					
1. Groundwater resources severely over-committed	***	*	***	• Implement Water Sharing Plan for the Upper and Lower Namoi Groundwater Sources	• Plan implemented in full
2. Hydrological stress on the Namoi	*	***		• Implement CMA Action Plan. Gunnedah Shire Council to improve riparian zone protection	• Adequate environmental flows are provided for the Namoi system • Flow duration curve and seasonality become more closely aligned with pre-regulation conditions
3. Surface water quality low (contaminant concentrations exceed NAZECC guidelines)	*	***	*	• Implement CMA Action Plan.	• Increase in proportion of time streams comply with water quality objectives
Shire based water resource issues					
1. Contaminant concentrations in aquifers supplying reticulated water exceed ADWG	***	*	***	• Identify and remove potential sources of faecal contamination (e.g. Onsite sewage systems, animals in reservoirs, etc)	• Increase in proportion of time bore waters comply with ADWG criteria
2. Water supply security in aquifers at risk from over allocation	***		***	• Encourage implementation in full of Namoi Groundwater Sharing Plan. • Encourage DNR investigation to ensure proposed extraction rates are sustainable • Investigate need for alternative bore sites	• Minimal change in piezometric water levels during drought. • Minimal change in water quality during drought
3. Urban stormwater system increases contaminant yield and stormwater peak	*	**	*	• OSD, Water tanks, WSUD, inline wetlands, restrictions on % impervious surfaces/allotment • Introduce a trade waste policy and reduce	• Gunnedah Shire Council to implement water management policies (e. g. widen and redevelop DCP 14), consistent with BASIX

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
flows				sewer overflows	• Trade waste policy • Sewer overflows/100 km of sewer line falling towards state median frequency. • Gunnedah Shire Council managed riparian lands always has 100% grass cover
Urban area potable water management issues					
1. Potable water in towns often do not meet ANZECC Guidelines for faecal contamination	***		**	• Identify potential sources of faecal contamination (e.g. Onsite sewage systems, animals in reservoirs, etc) • Disinfect potable water supplies • Encourage rainwater for potable use especially where issue is trace metal contamination.	• Achieve 100% ADWG compliance for faecal contamination • All villages with ADWG non compliance due to trace metal concentrations have access to rainwater.
2. The number of water mainbreaks is high compared with similar towns	***	*	**	• Review causes of mainbreaks • Develop pre-emptive maintenance protocol	• Mainbreaks/100 km of water mains decrease towards state median frequency.
3. Pricing structure does not encourage sufficient water conservation	**	**	*	• Adjust pricing structure to encourage more water conservation e.g. reduce the point at which the higher rate cut in to state median consumption rate (220 kL). • Charge council garden sections full price for water	• Revenue neutral pricing structure • Fall in domestic water use down towards state median • Fall in commercial use • Metering of commercial properties

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
4. Town water use is very high compared with some neighbouring LGAs.	*	***	*	• Implement demand strategy currently being developed. • Encourage rainwater tanks connected to WC, washing machine and garden tap for all homes in Gunnedah. (Note villages with water exceeding ADWG should retain rainwater for potable sues only, and use bore water for toilet flushing, clothes washing, etc). • Notice to residents re sources of water and need for adopting water conservation methods • Notice to commercial users requesting a reduction in water use • Install meters on commercial premises • Change pricing to cut in high tariff at state median water use (220 kL/tenement/Y). • Publicise water conservation measures. • Implement water conservation for Council lands • Target industries with high usage	• Use per domestic customer approaches state median volume • Use per commercial customers is less. • Use on playing fields more closely matches demand • Develop and implement opportunities for using stormwater as a non potable source (eg golf course & playing fields)
5. No asset management system	*		**	• Council currently implementing this. The system to be used to reassess the balance between service levels, service charges and financial position of Council. It should enable prioritisation of an integrated sewer, water and stormwater management system. It is especially important in view of the aging infrastructure.	• An data base, integrated across the three water services, that clearly identifies Council's assets, their condition, their capital and ongoing costs and their scheduled replacement date. • The system performance to be benchmarked against similar LGAs. • Impacts of service integration to be identified, for example impact of OSD and rainwater tanks on stormwater pipe size requirements.

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
6. Increased salinisation within portions of Gunnedah township	***	**	***	• Note that conditions in the three areas of concern (high school, Wandobah Reserve and CBD) vary markedly so no blanket solution. • Options include reduce recharge by structural and non structural actions such as-install rainwater tanks and connect impervious surfaces to SW system, schedule irrigation to avoid overwatering, minimise pipe leakage, remove sorption systems, plant more trees, require OSD in premises with >300 msq roof, fix leaks eg in Council swimming pool, improve drainage of salt affected sites. Community education –be alert to salt • Investigate options for supplying Savekemp Pty Ltd with stormwater runoff (e.g. pump from Mullibah Lagoon?)	• Reduction in sewer leaks and in mainbreaks. • Increased capacity of stormwater system to convey all water up to at least 5 YARI ToC storms. • OSD systems installed on all new large premises. • Irrigation BMPs introduced • Reduction in water use per allotment • Isolation of all SW sorption pits and connection of runoff system to stormwater pipes. • Install subsurface drainage where required • Consider groundwater removal via • Community salt education program.
7. Some water services are insufficient to supply local demand	*		*	• Develop strategic plan, including funding requirements for provision of water services over a 30 Y horizon (Needs to be consistent with zoning provisions)	• An agreed development strategy ensuring service adequacy. The strategy to be sufficiently flexible to allow for changes in population and industry
8. Aging infrastructure is creating problems such as increased leakage, poor water quality, urban salinisation and increased future funding liability for	**	*	***	• Council is already addressing this issue. However performance is still well below benchmarks. • Use results of asset management review to seek State funding assistance for this program. • Develop strategic maintenance plans that include prioritised actions across the three water systems.	• An integrated water asset management plan (as discussed above). • A prioritised action list that includes the three water systems. The action list to be prioritised against cost and TBL

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
mains replacement					
9. Water loss is higher than state averages as a % of volume pumped			***	• Asset management review and review of leaks to ensure strategic maintenance. • Check of excess pressure • Audit water users • Check for illegal connections	• A reduction in % of unaccounted water to below state median.
10. Inadequate pressure to new subdivision in more elevated portions of Gunnedah	***		*	• Build another reservoir at a high point • Reduce expectations, e.g. require elevated allotments to have their own water storage and pressure systems • Encourage development on lower parts of the landscape • Use pumps	• New developments all have at least 200 kPa pressure when delivering 0.15 L/s/tenement. • Static pressure <100 kPa. • Development orderly, consistent with zoning and with Council's proposed service extensions.
Sewerage system management issues					
1. The reuse scheme relies totally on one end user and on a single 5 year contract	*	***	***	• In consultation with Savekemp Pty Ltd develop 5 year rolling agreement for effluent supply. • Consider expending the scheme to include stormwater runoff	• Increased security of reuse system • Increased security of supply for Savekemp Pty Ltd • Reduction in stormwater impacts on the Namoi River
2. Sewer chokes and overflows occur at higher than the state median/100 km of sewer pipeline	***	**	**	• Asset management review and review of chokes and overflows to ensure strategic maintenance. • Accelerate sewer relining, targeting areas of concern (should address sewerage leakage in areas of high urban salinity). • Use results of asset management review to seek State funding assistance for this program. • Develop strategic maintenance plans that include prioritised actions across the three water systems.	• A reduction in number of chokes and overflows to below state median/100 km of pipe. • An integrated water asset management plan (as discussed above). • A prioritised action list that includes the three water systems. The action list to be prioritised against cost and TBL

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
3. No trade waste policy	*	**	***	• Institute a Trade Waste Policy • Audit commercial premises, requiring documentation of Oil and Grease removal frequency • Audit sullage and pumpout activity to ensure illegal dumping is not occurring	• A trade waste policy. • A reduction in O&G at the STP • A reduction in trade waste liquids at the STP (likely to show up in reduced contamination of sludge) • Reduced contaminant load in effluent without increased treatment cost to Council.
4. Illegal connection of stormwater to sewers may be adding significantly to sewer overflows that occur during wet weather	*	***	***	• Audit commercial premises for stormwater connections (smoke test) • Institute Trade Waste Policy • Publicise Council's concerns re illegal connections • Audit sewer and water systems to identify unusual flows • Audit water ratings to identify unusually high or low water use	• Reduction in illegal connections to water mains and to sewers • Reduction in sewer overflows due to stormwater addition
5. Extension of sewerage services to industrial area	*		***	• Develop strategic plan for service provision to new areas	• A strategic plan for services provision consistent with Council's asset management plans. The plan to integrate sewer, water and stormwater management using WSUD.
1. Urban salinisation as a result of stormwater flows	**	*	***	• Minimise leaks for the SW system • Encourage OSD, including rainwater tanks • Consider groundwater pumping	• No further increase in urban salinisation • A reduction in groundwater accumulation at vulnerable sites (See Section 2.3.23)
Stormwater system management issues					
2. Urban salinisation as a result of	**	*	***	• Minimise leaks for the SW system • Encourage OSD, including rainwater tanks	• No further increase in urban salinisation

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
stormwater flows				• Consider groundwater pumping	• A reduction in groundwater accumulation at vulnerable sites (See Section 2.3.23)
3. Rainwater tanks are not yet widely used. Many are not connected to toilets and washing machines.	***	*	***	• Adjust tiered pricing to encourage installation of rainwater tanks • Model tank performance to ensure adequate size (is 10,000 L preferable?) • Provide residents with warnings when ADWG criteria are exceeded • Enforce DCP 14 re tank installation for renovated and new premises. • Include commercial premises in DCP14, based on a pro rate tank size to roof area.	• Increased numbers of rainwater tanks in urban centres • Optimised tank size for Gunnedah Shire conditions • Increased awareness of water quality impacts on residents' health • Reduction in peak runoff from commercial premises
4. No On Site Detention (OSD) Policy		**	**	• Institute policy for new buildings having more than 300 m sq of impervious surfaces. • Incorporate policy into a DCP	• New buildings in Gunnedah township comply with DCP • Reduction in peak stormwater outflows to wards pre development rates.
5. Subdivisions are not required to have services consistent with WSUD	**	**	***	• Use results of asset management review to ensure adequacy of the three water services • Develop and enforce WSUD DCP	• New subdivisions have an adequate set of integrated water services • Subdivisions are designed utilising WSUD principles. • Results include: 1. peak runoff similar to pre development conditions, 2. downslope salinisation risk is not increased, 3. water use per allotment approaches NSW median volume. • Revenue neutral for Council

Issue (in order of priority)	Human values	Environmental values	Economic values	Management options	Performance indicators
6. Insufficient data on stormwater flows or quality to enable water service integration	*	**	*	• Establish stormwater monitoring plan, including infrastructure adequacy, performance and management of GPTs and Mullibah lagoon (eg, no. of times/year systems are cleaned out, volume removed) and some reliable stormwater quality and quantity data at key discharge points. • Evaluate performance of Mullibah lagoon • Undertake basic modelling of the stormwater system to identify adequacy and potential impacts.	• Reliable estimate of runoff volume and contaminant loads in Gunnedah township stormwater system. • Identification of any needed changes in management practices to improve stormwater quality.

5 PRELIMINARY TBL CRITERIA

Table 4.1 provides a range of options that Gunnedah Shire Council could undertake in order to improve water service management. Many of the options are linked with each other so there are opportunities to create 'bundled' options that address issues across two or three water service components. As a first step it is necessary to assess the proposed options against a set of TBL assessment criteria. DEUS has produced several sets of criteria for assessing TBL impacts of IWCM activities. A proposed set for Gunnedah Shire IWSMS is presented below. The use of this set should be evaluated by the PRG.

Table 5.1 Potential assessment criteria for IWCM actions (Source: Adapted from DEUS, 2002)

No.	Category	Criterion	Descriptor
1	Human	Promotes public health	Options that increase proportion of time reticulated water is safe to drink. Options that minimise public health risks
2	Human	Security of reticulated supply	Options that ensure adequate water volume to urban centres in Gunnedah Shire
3	Human	Complies with legislation and regulations	Options that promote the objectives and take into account the clauses of relevant legislation (eg WMA, 2000, POEO, 1997, NPWS Act 1975)
4	Human	Considers policies and guidelines	Options which are consistent with accepted policy and guidelines, e.g. COAG, Water Reforms, Groundwater protection, Namoi CAP, Sewage Management guidelines, Namoi Groundwater Sharing Plan
5	Human	Promotes transparency in decision making	Options that encourage stakeholder participation in decision making including promoting balanced outcomes, eg pricing reform to encourage reduce consumption of water.
6	Human	Builds community capacity	Options that increase individuals understanding of the water cycle, e.g. options that improve understanding of where the sewerage and stormwater goes and why it is important to limit water consumption.
7	Human	Promotes community ownership	Options that require community acceptance and participation, eg WSUD, OSD management, rainwater tank management, reduction in water consumption and litter management and reduction in O&G entering the sewerage system
8	Environmental	Protects natural resources of the catchment	Options that maintain/ enhance natural resources, eg reduced salinisation, reduced waterlogging, reduce erosion, revegetation
9	Environmental	Protects river and riparian zone health	Options that maintain/ enhance stream health, eg environmental flows, caps on irrigation extraction, reduced contaminant loads from towns, stabilised riparian zones.
10	Environmental	Protects groundwater resources	Options that reduce extraction to sustainable rates. Options that improve efficiency of groundwater use
11	Environmental	Promotes efficient resource use	Options that result in savings in other resources e.g. delayed or avoided augmentation of the stormwater system. Substitution of effluent and stormwater for pumped river water
12	Environmental	Promotes efficient water use	Options that reduce water consumption e.g. low flow showers, dual flush toilets, rainwater tanks
13	Environmental	Maintains resource integrity	Options that improve the quality or quantity of available resources, e.g. prevention of Namoi River contamination with effluent or stormwater
14	Environmental	Protects environmental health	Options which protect water quality and provide for environmental flows, e.g. reduced extraction for reticulated supplies due to demand management and improved management of point source discharges.

No.	Category	Criterion	Descriptor
15	Economic	Promotes full-cost reflective pricing	Options that involve water reform, water resource valuation, pricing to differentiate water being fit for purpose
16	Economic	Promotes recognition of externalities	Options that internalise costs previously not incorporated in price, e.g. Demand management that helps avoid environmental impacts of constructing infrastructure such as storages and pipelines, reduces the size of the sewage or stormwater infrastructure, and decreases customer bill due to lower water use and lower consumption of hot water
17	Economic	Promotes user pays principle	Options that require the resource users to pay for the privilege rather that socialise the costs: e.g. matching the size of the option to the size and resources of the community, preventing cross subsidy , encouraging tourists to minimise water consumption
18	Economic	Promotes transparency in costing	Options that are transparent in the development of their cost profiles, e.g. options that compare technologies to common benchmarks, and cost water to reflect the source, the supply costs and the potential uses. If there are subsidies, e.g. for retirees then they need to be explicitly stated and quantified.
19	Economic	Promotes equity in distribution of costs	Options that fairly spread costs across users; e.g. options which remove cross subsidies and consider inter and intra generation equity.

6 RECOMMENDATIONS

Recommendations have been developed based on potential ability to address issues identified in the study. The potential impacts of the issues on the human, environmental and economic values have been identified in table 4.1. A serries of management options and performance indicators were then listed. Table 6.1 has an amalgamated series of goal together with recommended actions and the human, environmental and economic outcomes that the goals will assist in achieving.

Note that these recommended actions are yet to be agreed upon by stakeholders.

Table 5.2 Relevance of various performance goals and recommended actions to human, environmental and economic based outcomes from table 5.1.

Note the number of outcomes attained by achieving a particular goal does not necessarily provide a basis for prioritisation.

Urban area performance goals

Goal (& priority number)	Recommended actions	Human	Environment	Economic
		1. Promotes public health 2. Security of reticulated supply 3. Complies with legislation and regulations 4. Considers policies and guidelines 5. Promotes transparency in decision making 6. Builds community capacity 7. Promotes community ownership	8. Protects natural resources of the catchment 9. Protects river and riparian zone health 10. Protects groundwater resources 11. Promotes efficient resource use 12. Promotes efficient water use 13. Maintains resource integrity 14. Protects environmental health	15. Promotes full-cost reflective pricing 16. Promotes recognition of externalities 17. Promotes user pays principle 18. Promotes transparency in costing 19. Promotes equity in distribution of costs
1. Long term security of supply for urban areas is assured	• Council to actively participate in Namoi Water Sharing Plan • Lobby for its implementation in full	2, 6, 7	8, 9, 10, 14	17
2. Potable water meets ADWG throughout the shire	• Identify sources of faecal and trace metal contamination • Disinfection of water supplies where necessary • Encourage use of rainwater tanks as the main potable water source where necessary	1, 3, 4, 7	12, 14	17

Goal (& priority number)	Recommended actions	Human	Environment	Economic
3. Reduction in the number of mainbreaks to below state median/100 km	• Review causes of mainbreaks • Develop pre-emptive maintenance protocol	2, 3, 4	8, 10, 11. 12, 13	16, 19
4. Reduction in the annual water consumption in urban areas to below state median	• Implement the demand management plan that is currently being developed • Water tanks connected to WC, washing machine and garden tap in Gunnedah. • Notice to residents re sources of water and need for adopting water conservation methods • Notice to commercial users requesting a reduction in water use • Notice to Council departments regarding use of water on parks • Change pricing to cut in the high tariff rate at state median water use (220 kL/tenement/Y). • Publicise water conservation measures. • Implement water conservation for Council lands • Target industries with high usage • Encourage tank installation for older dwellings	2, 4, 5, 6, 7	10, 11. 12	16, 17, 19
5. Sewer chokes and overflows are reduced below state median	• Asset management review and review of chokes and overflows to ensure strategic maintenance. • Accelerate sewer relining, targeting areas of concern	1, 3, 4	9, 13,	16, 17

Goal (& priority number)	Recommended actions	Human	Environment	Economic
6. Reduction in urban salinity to non significant levels	• Reduce recharge by structural and non structural actions such as-install rainwater tanks and connect impervious surfaces to SW system, schedule irrigation to avoid overwatering, minimise pipe leakage, remove sorption systems, plant more trees, require OSD in premises with >300 msq roof, fix leaks eg in Council swimming pool, improve drainage of salt affected sites. Community education –be alert to salt. (Note that conditions in the three areas of concern (high school, Wandobah Reserve and CBD) vary markedly so no blanket solution.) • Investigate options for supplying Savekemp Pty Ltd with stormwater runoff (e.g. pump from Mullibah Lagoon?) This water would be in addition to the effluent already being supplied.	6, 7	8, 9, 13, 14	16,
7. Implementation of new pricing structure	• Adjust pricing structure to encourage more water conservation e.g. reduce the point at which the higher rate cut in to state median consumption rate (220 kL). • Charge council garden sections full price for water	2, 4, 5, 6	10, 11, 12, 14	15, 16, 17, 18, 19
8. Asset management system developed.	• Council to continue implementation. The system to be used to reassess the balance between service levels, service charges and financial position of Council. It should enable prioritisation of an integrated sewer, water and stormwater management system.	3, 4	10, 11	14, 15, 16, 17, 18
9. Security of the reuse scheme is ensured	• Consult Savekemp Pty Ltd to develop 5 year rolling agreement for effluent supply. • Consider expending the scheme to include some stormwater runoff	1, 3, 4	8, 9, 11, 13, 14	15
10. Develop and implement an	• Use results of asset management review to seek State funding assistance for this program. • Develop a strategic maintenance plan that	3, 4	10, 11, 12, 13, 14	17, 18, 19

Goal (& priority number)	Recommended actions	Human	Environment	Economic
infrastructure plan	includes prioritised actions across the three water systems.			
11. Water loss as a % of volume pumped is reduced below state median	• Asset management review and review of leaks to ensure strategic maintenance. • Check of excess pressure • Audit water users • Check for illegal connections	2, 4, 6, 7	9, 10, 11, 13,14	16, 17, 18, 19
12. Upgrading of selected water services to ensure adequate supply to new developments	• Develop strategic plan, including funding requirements for provision of water services over a 30 Y horizon (Needs to be consistent with zoning provisions)	2, 3, 4		15, 16, 17, 18, 19
13. Adequacy of pressure to new subdivision in more elevated portions of Gunnedah is assured	• Build another reservoir at a high point • Reduce expectations, e.g. require elevated allotments to have their own water storage and pressure systems • Encourage development on lower parts of the landscape • Use pumps	2, 4, 5, 7	12	15, 16, 17, 18, 19
14. Extension of sewerage services to industrial area	• Develop strategic plan for service provision to new areas	3, 4	9, 13, 14	16, 17
15. Reduction in illegal connections	• Audit commercial premises for stormwater connections (smoke test) • Institute Trade Waste Policy • Publicise Council's concerns re illegal connections • Audit sewer and water systems to identify unusual flows • Audit water ratings to identify unusually high or low water use	1, 3, 4, 6	11, 13, 14	16, 17,18

Goal (& priority number)	Recommended actions	Human	Environment	Economic
16. Updating of plans and policies including trade waste	• Institute a Trade Waste Policy • Audit commercial premises, requiring documentation of Oil and Grease removal frequency • Audit sullage and pumpout activity to ensure illegal dumping is not occurring	1, 3, 4, 6	11, 13, 14	16, 17,18
17. Impacts of infiltration and sewer leaks on the environment are addressed	• Council is already addressing this issue. However performance is still well below benchmarks. • Use results of asset management review to seek State funding assistance for this program. • Develop a strategic maintenance plan that includes prioritised actions across the three water systems.	1, 3, 4	9, 13	17
18. New subdivisions are designed to ensure adequacy of services	• Use results of asset management review to ensure adequacy of the three water services	2, 3, 4		15, 16, 17, 18, 19
19. Lack of data on stormwater flows or quality is addressed	• Establish stormwater monitoring plan, including infrastructure adequacy, performance and management of GPTs and Mullibah lagoon (eg, no. of times/year systems are cleaned out, volume removed) and some reliable stormwater quality and quantity data at key discharge points. • Evaluate performance of Mullibah lagoon • Undertake basic modelling of the stormwater system to identify adequacy and potential impacts.	3, 4, 5, 6, 7	13	16, 18, 19
20. On Site Detention (OSD) Policy is introduced	• Institute policy for new buildings having more than 300 m sq of impervious surfaces. • Incorporate policy into a DCP	3, 4, 6, 7	11, 13, 14	17, 18, 19

Goal (& priority number)	Recommended actions	Human	Environment	Economic
21. Subdivisions are designed using WSUD principles	• Develop and enforce WSUD DCP	2, 3, 4, 6, 7	8, 9, 11, 12, 13, 14	16, 17, 18, 19

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APPENDICES

Appendix 1. Sewer inlet flow 2004.

DATE	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
1	1476	1400	1395	1558	1386	1447	1450	1659	1548	1375	3890	1375
2	1507	1400	1460	1511	1393	1482	1535	1480	1461	1296	1444	1487
3	1304	1400	1479	1450	1462	1515	1427	1386	1285	1385	1410	1574
4	1513	1400	1430	1799	1505	1397	1411	1466	1375	1399	1431	1546
5	1520	1400	1467	1405	1520	1476	1410	1455	1347	3731	1576	1585
6	1533	1398	1430	1388	1457	1396	1506	1468	1373	1674	1500	1481
7	1486	1444	1449	1361	1476	1409	1478	1395	1367	1453	3008	1460
8	1525	1554	1411	1459	1427	1389	1430	1913	1441	1448	1509	1404
9	1532	1485	1371	1388	1411	1404	1464	2285	1325	1387	2139	1354
10	1504	1500	1299	1530	1422	1455	1400	1655	1423	1407	10718	1455
11	1512	1436	1228	1437	1430	1613	1417	1579	1469	1427	2888	1474
12	1513	1422	1389	1415	1490	1516	1489	1507	1369	1398	2022	1433
13	1513	1421	1392	1395	1388	1431	1431	1510	1386	1402	1867	1442
14	1473	2047	1341	1399	1487	1405	1476	1426	1404	1406	1717	1475
15	1524	1562	1384	1407	1478	1410	1510	1518	1329	1400	1637	1286
16	1638	1575	1349	1429	1418	1429	1567	1440	1387	1400	1596	1458
17	1667	1480	1334	1434	1407	1425	1487	1444	1460	1400	1576	1899
18	1505	1493	1369	1403	1415	1433	1576	1428	1463	1430	1588	1582
19	1486	1475	1400	1439	1469	1417	1655	1482	1354	1409	1565	1486
20	1469	1414	1344	1393	1512	1480	1771	1506	1367	1502	1614	1551
21	1469	1428	1399	1365	1501	1443	1528	1396	1419	1398	1573	1484
22	1476	1495	1391	1434	1473	1399	1460	1418	1375	1513	1560	1441
23	1492	1416	1365	1472	1482	1407	1467	1415	1381	1421	1552	1462
24	5053	1506	1419	1434	1573	1422	1374	1432	1390	1400	2662	1463
25	3298	1428	1340	1488	1433	1375	1438	1419	1455	1400	1371	1386
26	1864	1398	1447	1576	1488	1889	1424	1353	1386	1400	1500	1400
27	1646	1443	1347	1414	1552	1815	1372	1464	1397	1400	1616	1426
28	1555	1479	1374	1432	1499	1512	1429	1385	1395	1400	1630	1448
29	1523	1504	1543	1497	1450	1471	1411	1381	1384	1400	1450	1444
30	0	1442	1462	1452	1430	1442	1548	1397	1380	1400	1417	1465
31	0	1435	0	1456	0	1536	1845	0	1349	0	1409	1508
TOTAL	49576	45680	41808	45020	43834	45640	46186	45062	43244	44861	64435	45734

Annual TOTAL 561 ML

Sewer inlet flow 2005.

DATE	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
1	1506	1407	1413	1473	1420	2097	1581	1478	1438	2056	1559	1288
2	1494	1421	1429	1446	1400	1985	1527	1447	1378	1698	2099	1479
3	1416	1416	1408	1400	1432	1739	1540	1559	1479	1583	1647	1501
4	1410	1394	1464	1398	1460	1696	1811	3772	1590	1572	1512	1377
5	1410	1419	1442	1400	1431	1649	1627	2138	1492	2940	1554	1387
6	1431	1461	1397	1412	1455	1568	1589	1584	1522	2037	1567	1385
7	1453	1431	1406	1467	1395	1791	1551	1535	1460	1957	1567	1384
8	1446	1389	1410	1385	1404	1559	1730	1520	1341	1756	1561	1365
9	1426	1394	1407	1471	1415	1658	1529	1541	1541	1745	1549	1438
10	1504	1402	1395	1754	1428	1613	1576	1589	1546	1678	1504	1415
11	1444	1423	1421	1499	1697	1638	1549	2086	1448	1646	1471	1447
12	1442	1425	1366	1495	2575	1530	1490	1654	1463	1557	1553	1430
13	1437	1434	1338	1500	1957	4972	1536	1559	1471	1564	1536	1455
14	1461	1465	1367	1617	2111	2342	1520	1609	1451	1602	1544	1451
15	1418	1410	1405	1505	1731	1909	1581	1566	1462	1548	1513	1453
16	1421	1449	1419	1499	1540	1812	1504	1787	2277	1551	2166	1472
17	1446	1401	1411	1499	1544	1732	1518	1706	1784	1543	1592	1425
18	1462	1482	1393	1443	1548	1734	1519	1667	1600	1533	1554	1540
19	1339	1521	1343	1426	1467	1678	1477	1653	1508	1540	1496	1433
20	1621	1499	1324	1445	1918	1642	1531	1589	1499	1520	1491	1428
21	1527	1462	1362	1434	1531	1610	1652	1547	1584	1591	1591	1416
22	1422	1389	1409	1441	1566	1610	1658	1528	1585	1498	1589	1372
23	1439	1418	1403	1306	1483	1620	1588	1553	1503	1534	1916	1451
24	1393	1380	1347	1462	1450	1602	1639	1537	1582	1490	1627	1457
25	1468	1353	1438	1430	1570	1660	1637	1460	1572	1736	1251	1522
26	1460	1328	1399	1402	1481	1578	1724	1559	1498	1663	1462	1456
27	1433	1296	1390	1386	1687	1544	1525	1560	1507	1787	1491	1497
28	1485	1498	1393	1401	1758	1549	1493	1563	1477	1668	1478	1432
29	0	1456	1352	1434	3825	1552	1515	1672	1476	1532	1463	2166
30	0	1487	1397	1449	3809	1558	1493	1564	1629	1580	1448	1620
31	0	1467	0	1411	0	1521	1486	0	2761	0	1357	1522
Sum	**40614**	**44177**	**41848**	**45090**	**52488**	**55748**	**48696**	**50582**	**48924**	**50705**	**48708**	**45464**

Annual total 2005 license year 573 ML