ACTEW CORPORATION

INQUIRY INTO ECOLOGICAL CARRYING CAPACITY OF THE ACT

Legislative Assembly Standing Committee On Climate Change, Environment And Water.

November 2010

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Abbreviations

ACT	Australian Capital Territory
ACTEW	ACTEW Corporation Ltd
ActewAGL	Public/private company operating ACT water supply under contract
ACTPLA	ACT Planning and Land Authority
ADR	Accelerated Demand Reduction
BOM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CGBT	Cotter Googong Bulk Transfer
DAFF	Dissolved air flotation filtration
e-flows	Environmental Flows
ECGBT	Extended Cotter Googong Bulk Transfer
EPBC Act	Environmental Protection and Biodiversity Conservation Act, 1989
EIS	Environment Impact Statement
FWO	Future Water Options
GHG	Greenhouse Gas
GL	Gigalitre (1,000,000,000 litres)
GL/yr	Gigalitre per year
Ha	Hectare
ICRC	Independent Competition and Regulatory Commission
km	Kilometre
LOS	Level of Service
L	Litre
L/c/d	Litres per capita per day
LMWQCC	Lower Molonglo Water Quality Control Centre
m	Metre
MDBA	Murray Darling Basin Authority
ML	Megalitre (1,000,000 litres)
ML/d	Megalitre per day
mm	Millimetre
NCP	National Capital Plan
NEB	Net Economic Benefit
NPR	Non-Potable Reuse
NSW	New South Wales
PWCM	Permanent Water Conservation Measures
QCC	Queanbeyan City Council
SDL	Sustainable Diversion Limit (from the MDBA Basin Plan)
SEACI	South East Australia Climate Initiative
SKM	Sinclair Knight Merz Pty Ltd
TBL	Triple Bottom Line
TWAW	*Think water, act water*
UV	Ultraviolet light
WPP	Water Purification Plant
WSAA	Water Services Association of Australia
WTP	Water Treatment Plant

1 Introduction – ACTEW and its submission

ACTEW Corporation Limited (ACTEW) is an unlisted public company with assets and investments in water, sewerage, electricity, gas and telecommunications. The company is owned by the ACT Government and has two voting shareholders: the Chief Minister and Deputy Chief Minister of the ACT.

ACTEW owns the water and sewerage business and assets in the ACT. Investments include a 50% ownership of ActewAGL and an 18% shareholding in TransACT Communications Pty Limited.

The mission of ACTEW includes:

- Ensuring a safe and reliable water supply for the ACT and Region.
- Maximising the efficiency, reliability and sustainability of water and sewerage services to the ACT and Region in accordance with environmentally sustainable principles.
- Achieving a satisfactory return on ACT water, sewerage, energy and communication investments.

ACTEW operates under the *Utilities Act 2000*, and is subject to independent regulation on prices, public health requirements, environmental requirements and technical regulation, as set out in the 2010 study report *Future Options Review: Canberra Sewerage Strategy 2010-2060.*

Figure 1 Legislative Framework for ACT Water and Sewerage Services

ACTEW regularly carries out strategic planning studies of the water available to the ACT and various development possibilities, to ensure that the ACT and Queanbeyan continue to have a safe and reliable water supply. A summary of the current situation is presented in this submission for the information of the *Inquiry into the Ecological Carrying Capacity of the ACT.*

ACTEW has recently completed a study of possible future scenarios for sewerage over the next 50 years The study examined alternatives to the current sewerage system, whether continued use of a water-flushed sewerage system was sustainable, possibilities for expanding recycling with the water reclaimed by treatment, and the possible impacts of discharge of the recycled water effluent on water quality and the ecosystems of the Murrumbidgee River. . A summary of the findings are presented in this submission for the information of the *Inquiry into the Ecological Carrying Capacity of the ACT.*

Hence the ACTEW submission focuses on:

- potable water supply, and
- recycling and discharge of Canberra’s reclaimed water.

In addition, this submission provides information on energy use in the water and sewerage systems, and a contribution to the assessment of ecological footprint and carrying capacity in terms of water resources.

2 Background

The ACT sits within the Upper Murrumbidgee catchment, between Tantangara and Burrinjuck dams. The Murrumbidgee Catchment is part of the Murray-Darling Basin. More details on the Upper Murrumbidgee catchment are given in Appendix A.

The Federal Parliament established the ACT as the National Capital in 1908 and in 1911 NSW transferred 2,358 km^2 of land in the catchment of the upper Murrumbidgee River to the Commonwealth. The ACT was established at the end of a long drought (known as the Federation Drought), and a secure water supply was an essential consideration in defining the boundaries of the Territory. The area allocated to the ACT included the catchments of the Cotter, Gudgenby, Naas and Paddy's Rivers, to provide water for the capital.

In 1909, it was proposed that the catchments of the Molonglo and Queanbeyan Rivers also should be included in the ACT, but NSW was unwilling to transfer any land south of the Queanbeyan railway. However, it was agreed that the ACT had the right to water from the Molonglo and Queanbeyan catchments, with the residual water to remain the property of New South Wales. This remains the situation today and all water supplied to the ACT and Queanbeyan comes from ACT catchments or water belonging to the ACT.

Because of its elevation (650 m above sea level) and distance from the coast, the ACT has four distinct seasons, unlike many other Australian cities where the climate is moderated by proximity to the sea. Canberra has hot, dry summers, and cold winters with occasional mornings of fog and frequent frosts.

ACTEW supplies the ACT and Queanbeyan with water from dams on the Cotter River, Googong dam on the Queanbeyan River, and water pumped from the Murrumbidgee River within the ACT.[1] The water extraction has averaged 65 GL/yr over the last 20 years.

All water used inside the house flows to LMWQCC (except any on-block greywater use), is treated and returned via the sewers to the Molonglo River via Canberra's sewage treatment plant, LMWQCC. All rain falling on Canberra (roofs and pavements) is returned to the Murrumbidgee River (or direct tributaries) via the stormwater system and/or captured in rainwater tanks, stormwater ponds and Canberra's lakes.

LMWQCC was built to serve a population of 269,000 persons, with provision for the plant to be extended to serve a population of one million persons. It was designed to treat and filter the wastewater to achieve an effluent quality matching the background water quality found in the surrounding streams. Typically 30 GL/yr of reclaimed water from the treatment processes is discharged to the Molonglo and Murrumbidgee Rivers.

An audit of LMWQCC carried out in 1992 by a consortium of Australian and international consultants concluded that the plant consistently produced the best effluent quality of any plant in Australia, and at that time was equal to any in the world.

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[1] Point 2.5 of the Discussion Paper states "the majority of the ACT's water supply comes from dams within NSW". This is not entirely correct. The majority of water for the ACT is sourced from the dams in the Cotter River catchment (68 per cent from 1928 to 2008 and 92 per cent from 2002-2008). Googong Dam is the only dam in NSW but all Googong infrastructure and associated water rights are owned by the ACT.

3 Water Available to the ACT

This section of the report deals with part 1) a) of the terms of reference, *"the resources available to the ACT in terms of water …. Sourced from within the Territory and outside it;"*.

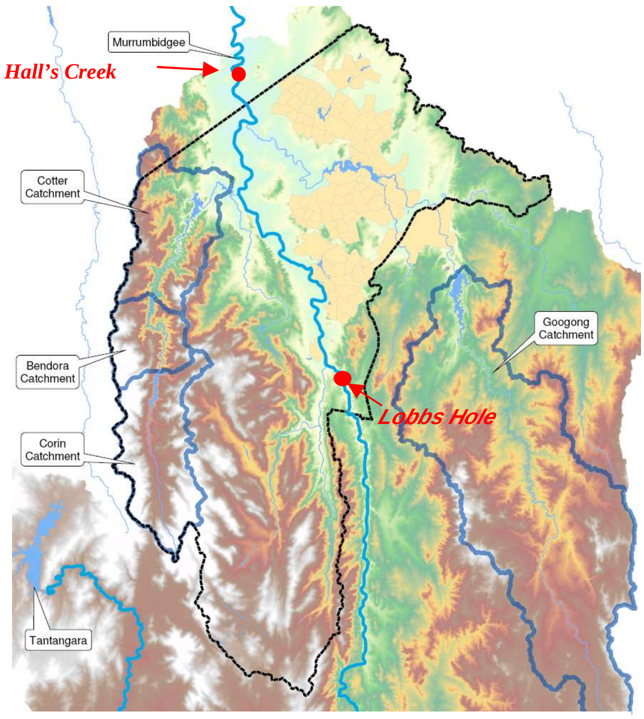

Figure 2– Measurement points – Approximate Net ACT Contribution to Murray Darling Basin Flows to MDB flows

As part of the Seat of Government Act, 1909 the ACT has the right to extract water from the Queanbeyan and Molonglo Rivers, for the purposes of water supply. Therefore the Queanbeyan and Molonglo Rivers are considered part of the ACT resource for this calculation.

Inflow to the ACT comes from the Cotter, Molonglo (including Jerrabomberra Creek), Queanbeyan and Murrumbidgee rivers. Outflow from the ACT is via the Murrumbidgee, plus a small amount from Ginninderra Creek. Water is extracted from dams and rivers, and treated sewage effluent returned to the Molonglo River.

Hence the net amount of water the ACT contributes to the MDB is;

Net contribution to MDB = **ACT Outflow – ACT inflow**,

where;

- **ACT Outflow** = measured flow in Murrumbidgee River at Halls Creek – a very slight over estimate of the actual outflow as it also includes a small contribution from some ephemeral creeks in NSW;
- **ACT Inflow** = measured flow in Murrumbidgee River at Lobbs Hole – a very slight over estimate of the inflow as it contains some ephemeral creeks in the ACT.

The net contribution calculation automatically includes the extraction of water for the potable supply (65 to 75 GL/yr) and the return of reclaimed water from LMWQCC (around 30 GL/yr). The difference (35 to 45 GL/yr) is used on private and public gardens and sportsfields or other uses outside the home.

The following graph shows the net contribution of the ACT to the MDB annually since 1970, calculated using the ***outflow – inflow*** approach. The Net Contribution is a measure of the amount of ACT water that is not used for consumption.

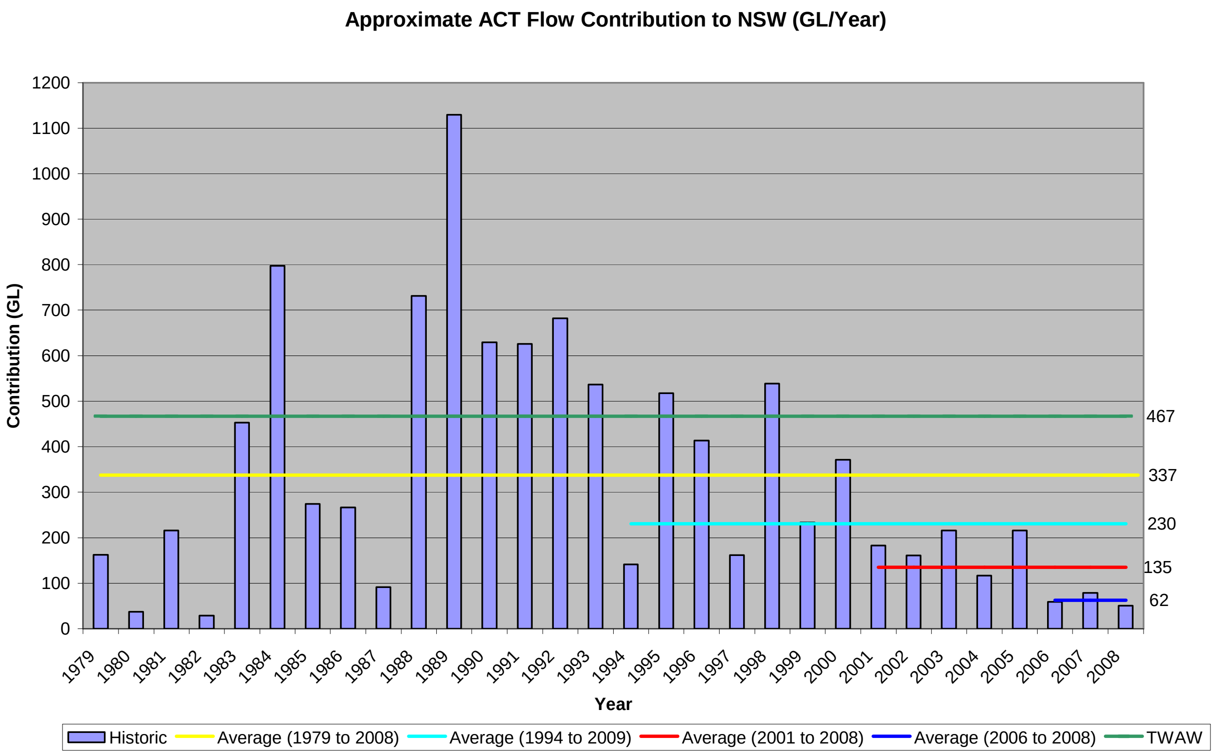

Figure 3 – Approximate net ACT Contribution to Murray Darling Basin Flows

Figure 3 shows the annual contribution to the Murray Darling Basin, plus lines showing the average contribution over different time periods. The figure was produced in 2009, hence does not contain 2009 or 2010 end of year annual net contribution. However the 2009 net contribution was only 41 GL and the 2010 contribution is likely to be around 340 GL (corresponding to the average from 1979-2008). Table 1 summarises the net contribution over different periods.

Table 1 Summary of ACT Water Resource over Different Periods

Period	Average Net Contribution to Murrumbidgee River (GL/yr)	Estimated Available Water Resource (GL/yr)
1979 to 2008	337	367
1994 to 2008	230	260
2001 to 2008	135	165
2006 to 2008	62	92
Think Water, Act Water[2]	467	497

Adding the net use (around 30 GL/yr) to the net contribution gives an estimate of the water resource available to the ACT. Thus over the period 1979 to 2008, the average net contribution was 337 GL/yr and the estimated available ACT water resource was 367 GL/yr.

[2] This figure was calculated for the ACT Water Strategy "Think water, act water" (TWAW). ACTEW are currently working with DECCEW to calculate an updated number for the review of TWAW.

The water resource shown in the ACT Government's strategic planning document *Think Water, Act Water* is higher at 467 GL/yr, as it was calculated over a longer period of record, when there were more years with higher river flows.

The figures are much lower for the 2006-2008 drought period, when the average net contribution was only 62 GL/yr and the estimated available ACT water resource was 92 GL/yr. Over this period, ACTEW drew on the water stored in the dams to maintain the water supply.

The figures Table 1 for the period 1994 to 2008 best represent ACTEW's projection for future climate. **Hence, for the purposes of estimating a figure that is useful for the questions asked by this Inquiry, ACTEW project the future long term average water resource available in the ACT is around 260 GL/yr**.

Current extraction of 60 to 70 GL/yr corresponds to around 23 to 27 per cent of the long term average water resource for consumptive use. Of course, this is an average and the proportion is higher in dry periods and lower in wet years.

When allowance is made for around 30 GL/yr of reclaimed water returned to the rivers, the estimated current net water use of 30 to 40 GL/yr corresponds to around 12 to 15 per cent of the long term average water resource. Again, this is an average and the proportion is higher in dry periods and lower in wet years.

3.1 Constraints on potable water supply

Even though the available ACT water resource is estimated to average around 260 GL/yr, only a proportion of this can be extracted for use in the ACT. The limits are imposed by:

- Protection of ACT Aquatic Ecosystems: - These limits are set by the 2006 Environmental Flow Guidelines (Disallowable Instrument under the *Water Resources Act 2007*) which specify the amount of water to be released from dams in terms of a base, flood and special purpose flows. They also specify the minimum amount of water required to be retained in the Murrumbidgee after extraction;
- Protection of the rights of downstream water users: - This limit is set in negotiations between the ACT Government and the Murray Darling Basin Authority on conditions and limits as set out in Cap and in the future in the Basin Plan, and;
- ACTEW Infrastructure: - The capacity of ACTEW's infrastructure to store and/or extract potable water.

The carrying capacity of the ACT, in terms of available water resources, depends on decisions made by the ACT Government and the Murray Darling Basin Authority as to what proportion of the available resource allocated to extracted. An estimate of the carrying capacity, based on one possible allocation of water resources, is given in Section 3.2 of this report.

Whilst infrastructure is also a constraint, ACTEW is constantly assessing the capacity of its infrastructure to meet potable water demand, amid changing demand and climate, and will bring forward proposals to expand this capacity as needed. Of course the infrastructure requirement will necessarily be matched to the allowable extraction.

3.2 Climate impact on water availability

Climate is by far the most significant modelling variable in determining the amount of water available for potable water supply. There are two aspects of climate to be considered when selecting a future climate for modelling purposes: *climate variability* and *climate change.*

3.2.1 Climate variability

Climate variability is the natural variation of climate observed over time; it includes the familiar seasonal variations and less familiar longer term variations that climate experts are still to fully understand.

ACT has over 130 years of recorded climate data. Although this period of historic record covers three major droughts, paleoclimate studies suggest ACT can reasonably expect to experience more frequent and more severe wet or dry periods in the long term future than have been recorded to date.

To address this possibility, ACTEW has used its historic climate record to create a long period (10,000 years) of reasonably expected climate data for use in projecting future water supply and demands. This data is developed using a standard hydrological technique (SKM 2004). The result is that 10,000 years of synthetic (stochastic) climate have been created with the same average rainfall, evaporation and variability characteristics as the historic record, but with a greater range of climate events including longer periods of drought. This stochastic data allows ACTEW to test the performance of Canberra's potable water supply system (using computer modelling) under extreme conditions. This accounts for climate variability, but not climate change, as it is based on historic climate.

3.2.2 Climate change

Climate change is the longer-term climate trend generally accepted as resulting from anthropogenic (human induced) factors. It is now widely accepted that global warming is fact and that it should be addressed in any future climate related studies (IPCC 2007).

In 2003, ACTEW engaged CSIRO to project climate change scenarios for ACT. The CSIRO conclusions for 2030 are summarised in the figure below (Bates, et al 2003). ACTEW chose to use an annual average rainfall decrease of 9% and annual evaporation increase of 9% as its 'most likely' case, based on the climate and science post the CSIRO report being published in 2003. Using these figures ACTEW then developed a new climate sequence, *2030 climate* to incorporate climate change and climate variability.

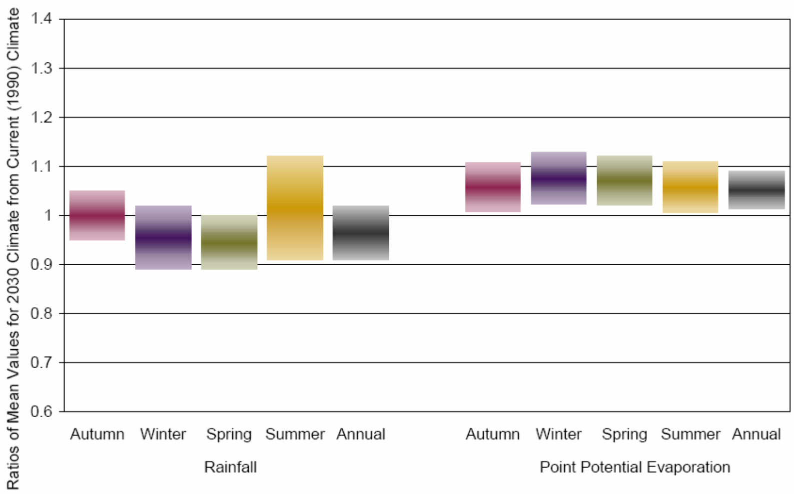

Figure 4: CSIRO predictions for climate change by 2030

Over the past 12 years there has been an apparent shift to a warmer and drier climate here, which has had major impacts on ACT water resources. These changes have come about earlier and to a larger extent than climate change scientists had expected.

The baseline climate used in many climate change studies is the period 1961–1990. However, for south-eastern Australia this is the wettest period over the last century, and is not representative of the current climate of the region. The last decade has seen a prolonged period of reduced rainfall, especially in autumn. The past eight years (including 2008) have all had autumn rainfall below the previous long term average (1961 to 1990). In recent years spring rainfall has also been declining steadily. Eleven of the past 12 years rank among the 12 warmest years since records began and Australia has experienced warmer than average mean annual temperatures for 17 of the past 19 years.[3]

The South East Australia Climate Initiative (SEACI) is a partnership between CSIRO, the Australian Government's Department of Climate Change and Energy Efficiency, the Murray–Darling Basin Authority, the Australian Government Bureau of Meteorology and the Victorian Department of Sustainability and Environment. SEACI Phase 1 concluded in 2009, and the phase 1 synthesis report was published this year[4]. The flyer supporting the detailed report suggests that "*in the absence of definite evidence of a permanent climate shift, the current baseline is better defined by using the longest possible climatic record including prior dry period (such as the 1940s) as well as the current dry conditions. However, if it is assumed that most of the recent change in climate is due to a long term trend (probably global warming) there is also a case for using just the last 10-15 years as a baseline, since this could be more representative of the future than the climate 30 to 40 years ago. Further research to determine the causes of recent climate changes is required.*

ACTEW considers the recent change in climate is *due to a long term trend* (reference the quote above), and therefore uses a projected climate that produces dam inflows close to (just above) the average for the ACT for the last 15 years. The average annual inflow for the four water supply dams, in the 200 weather sequences over 50 year periods varies between 50 GL/year and 200 GL/year. The average of all 200 sequences is 123 GL/year. The 123 GL/year inflow average represents an average 9 per cent decline in rainfall and a 9 per cent increase in evaporation (relative to the 26 years centred on 1990).

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[3] South East Australia Climate Initiative (SEACI) (CSIRO, BOM, MDBA, Federal and Victorian Governments) – Flyer, available from http://www.seaci.org/publications/documents/SEACI-1%20Reports/SEACI-1_Flyer.pdf

[4] Available at www.seaci.org

Figure 5 below shows the records of historic flows into the existing Cotter River and Googong dams. The historic (1871 – 1993) average annual inflow is 242 GL/year, while the average of the last 16 years (1994-2009) is 111 GL/year.

In summary, ACTEW's view of the most likely future climate for the ACT projects around a 50% drop in long term average reservoir inflows from the historic average. Such a climate is very similar, on average, to the weather experienced in the ACT since 1994. The wetter weather experienced in 2010 is also consistent with this statement. Although 2010 is not over yet, so an annual inflow figure is not complete, current inflows are around 200GL, and may finish in the range 220 to 300 GL. This would maintain the average (1994 – 2010) at close to or less than ACTEW's projected average.

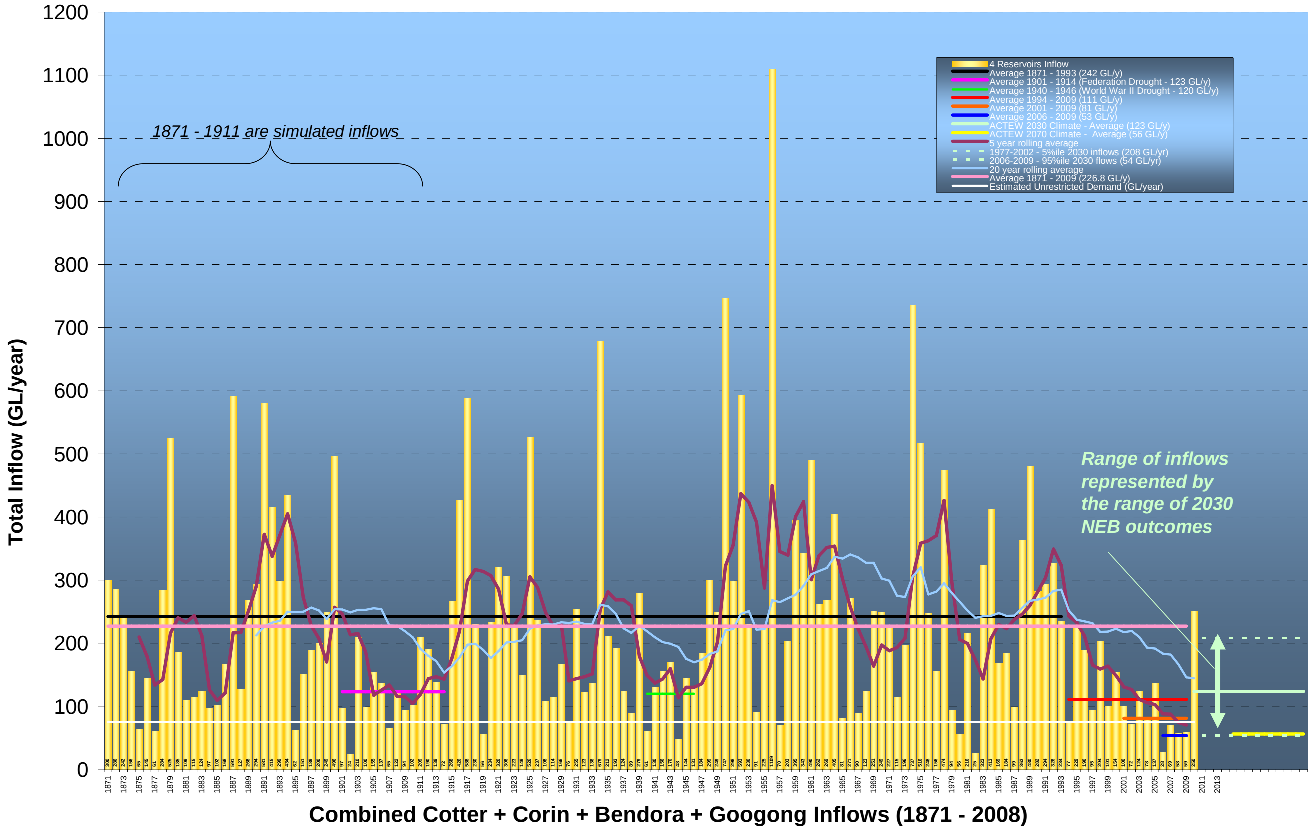


Figure 5: Four Dam inflow 1871 to 2009

3.3 Water reuse as an alternate supply

In April 2004, the ACT Government released the *Think water, act water* strategy; a strategy for the management and conservation of water resources in the ACT to the year 2050 (ACT Government 2004). The long-term strategy sets a target to increase recycled water use in Canberra to 20 per cent (of 2003 volumes). This corresponds to a recycling target of 6.0 GL/yr. Currently, *Think water, act water* is under review by ACT government agencies. One of the options to consider is the net overall impact of reuse. Is it better to put treated effluent on grass, into the drinking water or into the Murrumbidgee River? It is a difficult policy choice, however if, as a result of this review it is decided to pursue reuse of recycled water for irrigation then ACTEW can make the following observations arising from work done in recent years.

Canberra currently has three non-potable reuse schemes, supplying about 4.2 GL/yr in total, which represents two-thirds of the proposed recycling target. The largest use is at LMWQCC, where about 10 ML/d of the reclaimed water is reused in the plant, including screen washing, dissolving chemicals, operating the wet scrubber, sprays on primary tanks and plant washdown. Apart from some evaporation from the sprays and wet scrubber, most of the reused effluent returns to the sewage treatment processes after use and is treated again and available for further reuse.

About 0.5 GL/yr is supplied from the Fyshwick recycled water plant and the Southwell Park water mining plant for irrigation of public open space.

ACTEW has recently completed a study of options to increase the reuse of reclaimed water from the present 7 per cent (average over recent years) of effluent to higher proportions. The baseline option was to increase average reuse to 10 per cent of effluent by extending the North Canberra Recycled Water Scheme. The next nine reuse options increase the number of Canberra suburbs supplied with reclaimed water for irrigation of parks and public open space until about 40 per cent of effluent is recycled.

Two further options are examined, involving reuse of reclaimed effluent on agricultural land in the ACT (or in nearby NSW) with storage of the reclaimed water in winter months. The largest agricultural option would reuse 100 per cent of the effluent, with no discharge to the river.

Supply and Demand for Recycled Water

The supply of recycled water is relatively constant throughout the year, with sewage flows in winter being only a few per cent higher than sewage flows in summer. The demand for recycled water is very seasonal, with high demand in summer and negligible demand in winter. Hot dry summers have greater demand than cool wet summers.

The most economical reuse system is to supply the peak week demand from the discharge from the reclaimed water plant, allowing a storage volume of only 2 to 3 days to allow the peak hour demand to be supplied. The supply is lower in winter and spring, and negligible in winter, so that, over a typical year about 35 to 40 per cent of the treated effluent will be reused.

If all open space in Canberra is irrigated with recycled water, the peak week demand will exceed the supply. Thus either storage of recycled water from the winter period will be needed, or some combination of recycling treated effluent and stored stormwater adopted as the optimum solution to irrigate public open space in Canberra.

The cost of supplying reclaimed water for irrigation increases with the extent of area supplied and the length of the pipelines. The appraisal indicates that supply of reclaimed water to all of the northern suburbs and the central and inner south areas of Canberra is estimated to have a capital cost in the order of $150M to $200M, with substantial operating cost. Storage and recycling of stormwater is likely to be more economic in Tuggeranong and Woden Valley, as this area is further from the treated effluent supply, and hence more costly to service.

Other considerations when deciding on the merits of reuse are;

- Potable Water Substitution – reuse is only an effective measure in terms of water quantity if it substitutes for potable water use. If, in using recycled water, customers increase total use (e.g. by thinking of it as "free" or by not complying with the same restrictions regime as potable water) the net impact is an increase in water use, and hence a decrease in downstream river flows;
- Total water cycle – if it is assumed (an assumption yet to be fully tested) that stormwater and sewerage effluent could both be beneficially used downstream of the point they are extracted for re-use (e.g. for environmental and agrarian use);
- Energy – recycling water from LMWQCC is likely to be more energy intensive than the supply of potable water as the supply point (LMWQCC outflow) is at the lowest point in the ACT, hence effluent needs to be treated then pumped;
- Cost – the cost or retrofitting pipework in suburbs and operating (pricing, regulation, water quality monitoring etc) is an additional cost;
- Fit for Purpose - Treated effluent is an ideal "product" for applying to lawns and gardens, the major outdoor water use in the ACT;
- Impact on the impending Basin Plan.

3.4 Other alternative supply options

Additional sources of water for use in Canberra are roof water, greywater and urban stormwater.

The *Think water, act water* (ACT Government 2004) strategy sets out initiatives to achieve a reduction in mains water use per person of 12 per cent by 2013 and 25 per cent by 2023 (compared to 2003 usage). To implement this strategy, ACTPLA requires all new developments in the ACT to target a 40 per cent reduction in water use from 2003 mains water use levels. The reduction is to be achieved by installing water-efficient showerheads and appliances, and by collecting and using rainwater and greywater. Rainwater can be used for toilet flushing, garden and lawn watering, and laundries. Greywater collected from the bathroom and laundry can be treated to Class A standard and used for toilet flushing, and watering lawns and gardens.

The *Think water, act water* report lists the average runoff in all catchments of the ACT (ACT Government 2004c). The urban catchments cover an area of 44,177 ha (approximately 20 km by 22 km) and the annual runoff from urban catchments averages 54 GL/yr. In drought periods, urban runoff may well be reduced to 15 GL/yr, a significant water resource. However infrastructure constraints (e.g. size of stormwater ponds required to catch flows for reuse) would likely reduce the amount that could be extracted to well below 15 GL/yr.

The issue with stormwater is can it be captured, stored and recycled at a reasonable capital and economic cost. Stormwater also has the same total water cycle management issues as reuse, it makes a contribution to downstream flows. However, interestingly, the MDBA Guide does not count stormwater inputs from the ACT in its net calculation of water use in the ACT. DECCEW are seeking to remedy this.

3.5 Conclusion –Availability of Potable water supply for Canberra

ACTEW has made a series of broad assumptions in order to give the Inquiry some idea of the amount of water available to the ACT. The volume of water available each year depends greatly on climatic conditions. Based on conditions for the period 1994 to 2008, ACTEW's projection of the future long term average water resource available in the ACT is around 260 GL/yr. Projections based averages should be done with care as the design criteria for potable water supplies are driven by the length and severity of dry spells, not averages.

The current net water use of around 30 to 40 GL/yr corresponds to 12 to 15 per cent of the long term average water resource. This is an average and the proportion is higher in dry periods and lower in wet years.

Other sources of water are roof water (1 to 3 GL/yr) and urban stormwater (can capture some proportion of 15 GL/yr in dry years, but at high cost). In order not to raise overall water use in the ACT, reuse (stormwater, roof water, effluent etc) should be aimed at displacing current and future potable water use on a one for one basis.

All extractions of water in the ACT reduce flows in the rivers downstream of the ACT unless the water is used, returned to the sewer, treated to a high standard and discharged to the river.

4 Ecological Footprint

4.1 Potential Footprint Issues

This section addresses measures for assessing the ecological footprint of the ACT water and sewerage system. The assessment must be made in the context of the inland location of Canberra on the Murrumbidgee-Murray River system, and recognizing that, in the greater Murrumbidgee River system, the demand for water exceeds the supply, and there are major concerns about the environmental impact of excessive abstraction of water from the rivers.

4.2 Footprint 1 – Volume of Water Abstracted

Possibly the simplest measure of the ecological footprint of water abstraction by the ACT is to consider the ratio of: (1) the volume of water abstracted to (2) the volume of water available for abstraction.

The volume of water abstracted is simply the sum of: (1) the volume captured in storage dams; (2) the volume collected in rainwater tanks; (3) the volume captured in urban stormwater systems; (4) the volume captured in farm dams and other artificial storages; and (5) the volume required to replace pumped groundwater. It may be reasonable to apply a credit for the increase in runoff from hard urban surfaces of urban Canberra compared to the natural runoff volume.

Based on the available data, the gross volume of water that would have been abstracted in the ACT in recent years (without water restrictions) is estimated to be approximately 75 GL/yr (without the credit for increased urban runoff). This comprises 65 GL/yr for the urban supply, 5 GL/yr for agriculture and 5 GL/yr miscellaneous abstractions (roofwater, farm dams, urban lakes and stormwater ponds). This figure is a matter for debate, but is presented here as an indicator or how this footprint might be derived.

The volume of water available for abstraction requires value judgments to be made about the minimum requirements to maintain aquatic ecosystems through the river systems and the reasonable demands of downstream water users. As proposed earlier in this submission, for the purposes of answering questions for this Inquiry ACTEW is assuming that the estimated total available water resource for the ACT averages around 260 GL/yr.

In this example calculation, the footprint of water extraction would be 75 GL/yr divided by 260 GL/yr. To get this in terms of an area it would then be multiplied by the area of the ACT. Assuming the area of the ACT is 2358 square kilometres, this footprint would therefore be 680 square kilometres.

4.3 Footprint 2 – Net Volume of Water Abstracted

For the situation of Canberra where a high quality reclaimed water is produced for return to the Murrumbidgee-Murray River system, it is may be more appropriate to define the volume of water abstracted taking account of the volume returned to the rivers by the LMWQCC discharge and the Queanbeyan treatment plant discharge. A further 3 GL/yr is discharged from the Queanbeyan plant to the Molonglo River upstream of Lake Burley Griffin.

Taking account of the current flow returns, the net volume of water abstracted is 42 GL/yr (75 GL/yr less 30 GL/yr less 3 GL/yr). Thus the footprint of water use would be 42 GL/yr divided by 260 GL/yr (multiplied by the area of the ACT). This gives a footprint of 381 square kilometres.

4.4 Footprint 3 – Storage Dams

The preceding footprints were based on annual flows in the Murrumbidgee River. Another type of ecological footprint of the ACT water system is the change from river (to stream) conditions to storages. The basis for the calculation of this footprint could be by area (as set out in Table 2) or by length of stream.

Table 2 Areas in ACT Water Storages

Storage	Area, km^2
Corin Dam	20
Bendora Dam	30
Cotter Dam (new)	30
Googong Dam (in NSW)	40
Lake Burley Griffin	7
Other Urban Lakes	3
Total Storage Area	**130**
Area of ACT	2,358
Proportion of ACT	**2 %**

Whether the area or length of stream method is used, the footprint for storages is likely to be of the order of 2 per cent of the ACT.

It should be noted that the change from a river system to a storage is favourable for some species and ecosystems and unfavourable for others. The barriers that storages create on river systems are generally considered to be unfavourable for the species of native fish that rely on upstream migration to spawn. On the other hand, storages are more favourable for some species of birds and can provide a refuge for native fish in times of drought or bushfires. The Cotter Dam, which was built in 1917, has been found to provide a haven for two native species of fish (Macquarie perch and two-spined blackfish) that are now rare, but were protected in Cotter Dam from the invasion of competing pest species (eg, carp).

The environmental effects of a storage depend also on how it is operated – for example, whether or not releases of cold water from the lower layer of the storage are routinely released, or more natural temperatures are achieved in the discharged waters. This footprint does not take account of these important management practices.

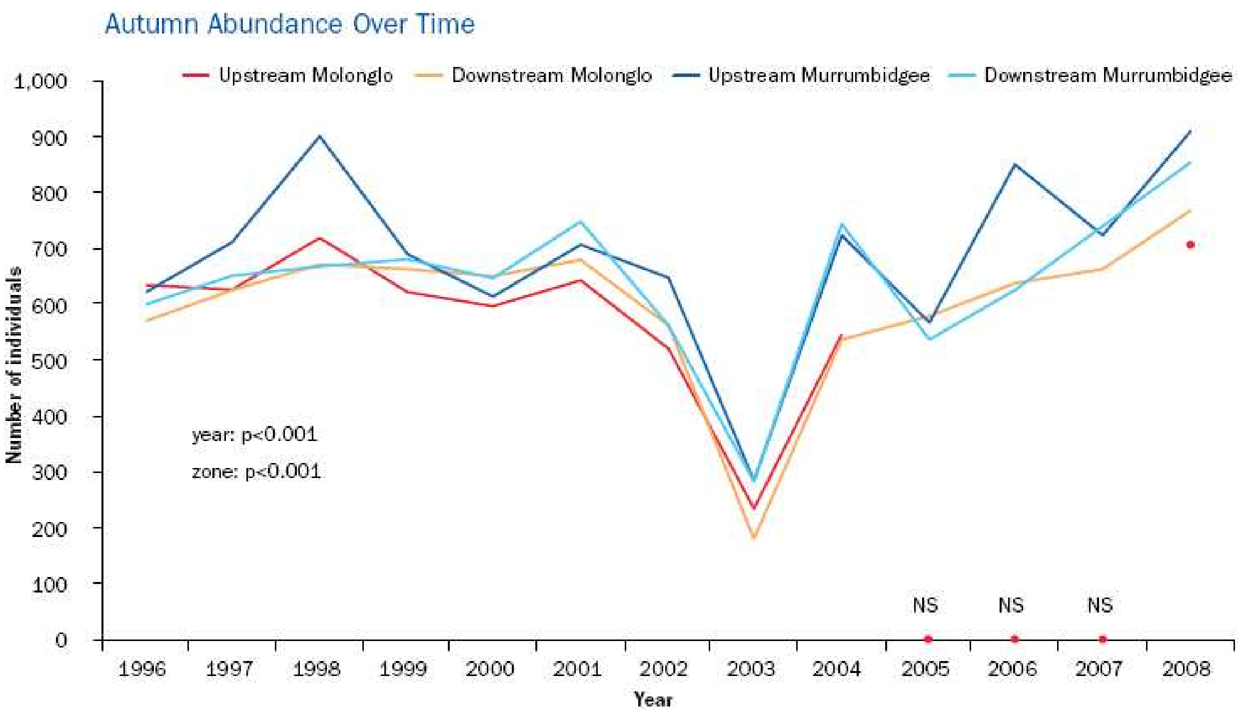
4.5 Footprint 4 – River Flow Patterns

Flows in the upper Murrumbidgee River have been reduced by around 50% due to the diversion of water in the Snowy Scheme. The flow rate in the river varies substantially from day to day and week to week, in response to rainfall patterns and snow melt. Thus, over a year, virtually all of the original flow conditions will occur on some days and the variation in flow over time will be similar to natural conditions, but with a lower magnitude.

We do not know the extent to which changes in the magnitude of river flows has altered aquatic communities. There are other changes in the catchment that are likely to have had much greater impacts (land use changes, agricultural runoff, erosion of the river channel, increased turbidity of river water, increased salinity, bushfires, introduction of exotic and pest species). The community structure of macroinvertebrates in the Murrumbidgee River indicates *moderately stressed* conditions, although the contribution of changed flow patterns to this situation is not known.

The January 2003 bushfires resulted in increased sediment and nutrient runoff from the catchment. Macroinvertebrate communities were adversely affected, with a rapid decline in the number of individuals per sample in the Murrumbidgee River, but recovery within six months (see Figure 6). River health would be indicated by a combination of the amount and composition of the Macroinvertebrate community.

Figure 6. Changes in Macroinvertebrate Community in Response to 2003 Bushfires



Hence it would be possible to develop a footprint measure that is some combination of the number and composition of Macroinvertebrates.

4.6 Footprint 5 – Aquatic Ecosystems

The estimations of ecological footprints presented above are essentially estimates of the area where, from a consideration of physico-chemical conditions, there may be some ecological impact. How can an assessment of changes in ecological conditions be made to derive the footprint in a more direct manner?

This is a very difficult question to answer. Aquatic communities respond to the combined stresses that they experience and it is often impossible to establish the effect of one particular stress unless there are observations before and after the introduction of that stress, with little change in other factors. ACTEW is part of a program of work currently underway in the Cotter system with the aim of doing this.

Studies of aquatic communities upstream and downstream of a storage can generally identify the extent of effects (the 'footprint') of a storage. Adverse effects can result from low temperatures or dissolved oxygen in the discharged waters; positive effects can result from the more reliable flows downstream of a storage in times of drought. Often it is difficult to determine whether such changes are considered to be 'negative' or 'adaptation' or just 'changes'.

Based on current knowledge, the following tentative conclusions are drawn concerning ecological footprints of water storage and abstraction on rivers in the ACT:

- Changes in aquatic communities can be observed for several kilometres below storages – hence the footprint of a storage should also include part of the river or stream downstream of the storage;
- The footprint caused by capturing peak flows in a storage is very difficult to discern in the rivers downstream if the storage has mixing to avoid thermal stratification and manages releases in accordance with the Environmental Flow Guidelines;
- Based on the available macroinvertebrate and fish monitoring data in the ACT, the ecological footprint of water abstraction from rivers (including the effects of storages) will be much smaller than calculated from an analysis of physico-chemical factors.

While an exact quantitative analysis of the footprint of the ACT water supply using the ecological impact technique is challenging, it is clear that the effective management of water extraction and storage with regard to ecological protection is vital in minimsing the footprint size. ACTEW undertakes extensive ecological monitoring and assessment in order to ensure the environmental impacts of the water supply business are understood and minimised.

The science of understanding the linkages between water extraction/storage and ecological protection has recently revealed that base flows and variable higher flows are the highest priority for protection. Hence, extraction of water at high flow events is becoming an increasingly important capability.

5 Carrying Capacity

This section considers the question: "How many people can the ACT water resources supply"?

5.1 Future Potable Water Demand

In determining how much water is required to meet ongoing demand, the following assumptions are made:

- There will be climate change – ACTEW has adopted as its "most likely" case the CSIRO (Bates, et al. 2003) pessimistic 2030 outcome of an annual average of 9% reduction in rainfall and 9% increase in evaporation;
- ACT population will grow to 500,000 persons by 2032 as proposed in the Canberra Plan high population growth scenario (ACTPLA 2004);
- Relatively small additional water supply will be provided outside ACT;
- Per person water consumption will reduce by 25% by 2023, consistent with the ACT Government's target set out in *Think water, act water*;
- Bushfires in the Cotter catchment will impact on water availability from time to time, including the long term effects of the 2003 fires; and
- Continued compliance with the Government's current *Environmental Flow Guidelines*.

ACTEW report on progress of these assumptions every year. The reports are available on the ACTEW website[5].

ACTEW use computer modelling to predict the future water needs of the ACT, and hence the infrastructure required to meet the assumed demand. Determining water needs requires a definition of when there is not enough water, the point at which needs are no longer met. The ACT Government has defined this point as when water restrictions are required, on average, more frequently than 1 year in 20 years.

Adopting the prudent planning population growth and climate scenarios gives the estimations of future unrestricted water demand shown in Table 3. The average unrestricted demand is relatively constant until 2023, as the impact population growth is approximately cancelled by the demand reduction of 25% by 2023. Beyond 2023 total demand increases.

[5] http://www.actew.com.au/publications/WaterPlanning2009Review_WaterSupplyandDemandAssessment.pdf.

Table 3: Future unrestricted water demand

Annual water demand	2007*	2012	2017	2022	2027
			(GL/yr)		
Average *2030 climate*	65.5	67.3	68.0	68.1	71.8
Dry *2030 climate*	68.2	68.9	70.3	69.2	74.8
Extreme dry *"2030 climate"*	68.6	72.8	72.8	72.2	75.6

Note: * represents estimated demand for water in 2007; the consumption was lower due to temporary water restrictions applied in the current drought.

For the assumptions listed above, and including the Enlarged Cotter Dam, Murrumbidgee to Googong and Tantangara projects, ACTEW's infrastructure can supply water to around 600,000 people. The number of people could be increased if the weather is wetter than projected, or reduced if the weather is drier. Similarly if demand reduces by more than the projected 25% more people can be served and vice versa.

5.2 Carrying Capacity

To estimate the "carrying capacity" of the ACT in terms of water resources, it is necessary to ask the question "what proportion of the ACT's water resource will be used for consumptive purposes?".

While this question remains unanswered, in order to give an indication of the carrying capacity of the ACT (and only for this reason) ACTEW has projected that one-third of ACT water is available for extraction and use in the ACT, one third is allocated to environmental purposes in and downstream of the ACT and one-third is allocated to downstream users. It also is assumed that ACTEW develops infrastructure to meet the allowable extraction. On this basis, the available ACT water resource of 260 GL/yr converts to an allowable gross water extraction of around 87 GL/yr, one-third of the projected 260 GL/yr available to the ACT.

Other gross assumptions used in order to derive a future carrying capacity are;

- future domestic water use will not exceed 100 kL/person/year.
- the capacity limit of 87 GL/yr is set on the net total water extraction, giving a gross potable supply of 110 GL/yr (87, less 7 from other sources, plus 35 returned to river)

With these estimates the resultant estimated carrying capacity of the ACT would be around 1,000,000 people[6].

In summary, a great number of assumptions need to be made to derive an estimate of the carrying capacity of the ACT in terms of the available water supply. As a guide and based on the assumptions listed above, an estimate of the carrying capacity is around 1,000,000 people.

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[6] Note: The calculation results in an answer of 1,100,000 people, but given the nature of the assumption inherit in the result, 1,000,000 seems a convenient way to express the answer.

6 Current Levels of Potable Water use

6.1 Current Levels of Resource Use – Water

Water consumption in the ACT is similar to that in Sydney and Adelaide, slightly higher than in Melbourne and slightly lower than in Adelaide. The patterns generally reflect climatic conditions and the stringency of water restrictions. In unrestricted times the ACT is generally a higher per capita user than other jurisdictions due to our hot dry (inland) summers and the proportion of open space in Canberra.

Table 4 Use of Water (kL/property/day) in Australian Cities

W12 – Average annual residential water supplied (kL/property)
For utilities with 100 000+ connected properties

Utility	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09
Sydney Water	224	211	203	199	182	198
WC – Perth	285	277	268	281	268	277
Yarra Valley Water	204	193	198	178	157	151
South East Water	186	184	187	167	152	143
SA Water – Adelaide	245	235	233	235	194	190
Brisbane Water	258	264	185	153	128	133
City West Water	188	187	183	163	149	146
Gold Coast Water	198	244	200	183	149	166
Hunter Water	208	197	205	195	177	180
ACTEW	248	240	261	240	195	201
Barwon Water	218	206	216	169	156	156

6.2 Trends in potable water use in the ACT

In recent years potable water demand has been driven down by Temporary Water Restrictions. (TWR). In the medium to long term a trend down will continue with the ACT community striving to meet the Government's 25% demand reduction by 2023. Permanent Water Conservation Measures (PWCM), managed by ACTEW, will be an important contributor to this target and trend.

In the period from now until 2023 overall demand is projected to remain steady, with the 25% target offsetting population growth. The policy question is what to do after 2023? Of course the answer is partly dependent on progress toward the 25% target, but also the broader National water initiatives with the Basin Plan, and the economics of demand and supply of water.

7 What is a sustainable level of use?

7.1 Sustainable Level of Resource Use – Water

For the purpose of answering the important questions raised in this Inquiry ACTEW have projected a sustainable net abstraction of water from ACT water sources of around 87 GL/yr. This is based on the prevailing climate delivering an average of 260 GL/year to the ACT, and nominally capping use to 1/3 of that figure. ACTEW has no basis for choosing 1/3 other than the notional concept that 1/3 of the resource would be available for extractive use, 1/3 for environmental flows in the ACT and 1/3 for downstream users. Of course this is debateable, and is used in this report merely as some assumption of the allowable extractive use is necessary to answer the questions the inquiry has asked.

Note that the extraction rate is a long term average, and must be adjusted each year in response to actual river flows.

This figure is not an ACTEW policy, or a figure ACTEW is in any way wedded to, simply a calculation to help in the discussion of what the sustainable level of water use might be.

7.2 Sustainable Level of Resource Use – Reclaimed Water Discharge

There are positive and negative aspects of the discharge of reclaimed effluent from LMWQCC to the river. The main positive aspects are that the water is available to downstream users and that the water provides habitat for aquatic communities at times when river flows are very low.

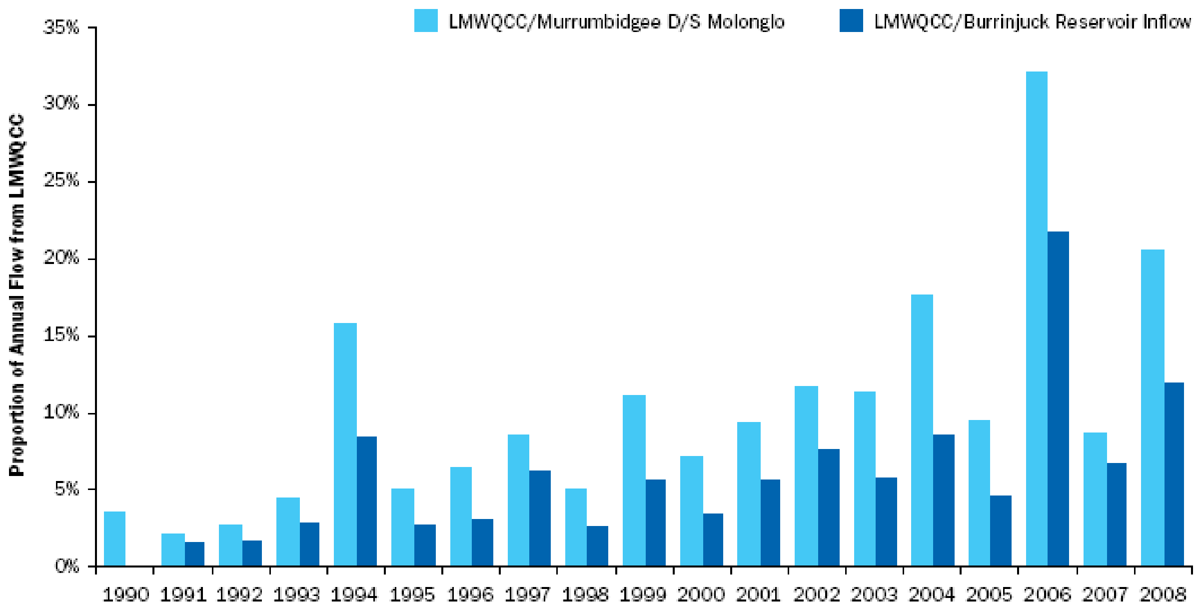
Figure 13 illustrates the contribution of the LMWQCC discharge expressed as a percentage of the total flow in the Murrumbidgee River at two locations: (1) downstream of the Molonglo River; and (2) at Burrinjuck Reservoir.

It can be seen that the relative contribution of the LMWQCC discharge to flow in the Murrumbidgee River has increased from a long-term average of about 3 per cent of river flow to a much higher proportion of 15 per cent of river flow during the drought period 2002-2008. For four months (March 1998, January 2003, February 2009 and March 2009), the LMWQCC discharge comprised the majority of flow in the Murrumbidgee River in the ACT.

This indicates that LMWQCC discharge makes a contribution to flow in the Murrumbidgee River downstream of the ACT, particularly during the drought, and it is important to count this contribution when looking at the total water cycle for the ACT. Flow from LMWQCC generally contribute 30 to 40 per cent of river flow in the summer months, whilst reaching up to 90 per cent of flow during very dry periods.

Burrinjuck Reservoir receives flows from the Murrumbidgee, Goodradigbee and Yass Rivers, and there appears to have been a gradual increase in the relative contribution of the LMWQCC discharge over time.

Figure 7 LMWQCC Contribution to Murrumbidgee River Flow



The main negative aspects of the discharge of reclaimed effluent from LMWQCC to the river are that algal communities in the river (and possibly Lake Burrinjuck) may be stimulated by the higher nutrient levels. Monitoring data show that green algae counts in the Murrumbidgee River are typically 100 to 2,000 cells/mL upstream of Canberra and 200 to 3,000 cells/mL downstream of Canberra, showing some increase in algal productivity. Similarly, monitoring data show that diatom algae counts in the Murrumbidgee River are typically 100 to 5,000 cells/mL upstream of Canberra and 200 to 6,000 cells/mL downstream of Canberra. The effect of the LMWQCC discharge relative to that of urban runoff and agricultural inputs is not known.

7.3 Discharge of Treated Effluent

As recommended in the ANZECC Guidelines, the biological components of the Murrumbidgee River are monitored in an extensive and long-running program and the data are analysed to derive locally relevant criteria for protection of the aquatic ecosystems.

The results from the review of 20 years of water quality monitoring data and 14 years of biological monitoring data are summarised in the table below.

Table 5 Summary of Results of Murrumbidgee River Monitoring Program

Parameter	**Observed Effects from Monitoring**
BOD and Dissolved Oxygen	Very low BOD in effluent. No change in dissolved oxygen in the river
Suspended Solids (SS)	Very low BOD in effluent. No change in dissolved oxygen in the river
Turbidity	Effluent has lower turbidity than river waters.
pH (acidity or alkalinity)	Effluent is neutral and there is no change to pH in the river waters
Phosphorus (TP)	Small increase in TP levels in river due to effluent discharge
Total Nitrogen (TN)	Significant increase in nitrogen levels due to discharge, but algal response limited by light and high TN/TP ratio, reducing blue-green algae. Natural loss of nitrogen from river to the atmosphere.
Ammonia	Significant increase in ammonia levels due to discharge, but decreases with distance downstream, due to biological uptake
Metals	Minimal difference observed between sites upstream and downstream of LMWQCC
Other Toxicants	Negligible quantities in the effluent
Total Dissolved Solids	Effluent contains elevated levels of nitrates, carbonates and calcium, due to use of lime in treatment. Minimal effects on river. The calcium carbonate is beneficial for irrigation
Bacteria	Effluent is disinfected and has negligible effect on river waters
Green Algae	Small increase in green algae count downstream of ACT, possibly due to input of nutrients from LMWQCC and urban runoff.
Diatoms	Small increase in green algae count in river downstream of ACT (to Burrinjuck Dam), possibly due to input of nutrients from LMWQCC and urban runoff.
Macroinvertebrates	The LMWQCC discharge has no measurable effect on macroinvertebrate communities. There are similar proportions of sensitive species upstream and downstream of the discharge.
Fish	Results suggest LMWQCC discharge may be having a small positive effect on fish populations
Monotremes (platypus)	There are more platypus living near the LNMWQCC discharge than at other sites in the river.

Footprint from Environmental Studies

The footprint of elevated nitrogen concentrations as a result of the discharge extends from the Molonglo River to Lake Burrinjuck. Natural denitrification processes in the river and lake mean that the nitrogen load discharged by LMWQCC is returned to the atmosphere by natural processes before the flow leaves Lake Burrinjuck.

The footprint of LMWQCC discharge does not extend beyond Lake Burrinjuck, and for some measures not as far as Lake Burrinjuck.

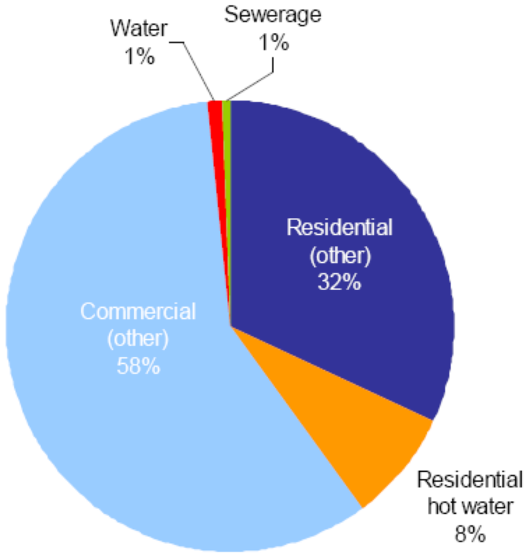
ACTEW manages the discharge from LMWQCC in accordance with the best scientific advice to minimise the environmental effects and meet the discharge licence issued by the EPA. ACTEW is also in the process of setting down a longer term plan for LMWQCC that will include identification and precautionary actions to further improve treatment to minimise future risks.

7.4 Energy Use in Water and Sewerage

7.4.1 ACT Energy Use in Water and Sewerage

Figure 8 shows that, as a proportion of total electricity use in the ACT, water supply and sewerage services each amount to only 1 per cent, compared to 8 per cent for residential water heating. The average Canberra household uses about 20 per cent of its total energy consumption for water heating (Anderson 2009).

Figure 8 ACT Electricity Consumption



Source: DECCEW (2009), ActewAGL (2009)

Energy use by the water and sewerage networks can be assessed both by total consumption, and in terms of energy intensity of major operational activities. In terms of total electricity consumption, LMWQCC was the highest consumer of electricity of any area within the water and sewerage networks in 2009, using about 22,000 kWh, or 22 GWh. The next highest energy use was pumping water from Cotter Dam to the Mt Stromlo water treatment plant. Very little energy is required for sewage collection and pumping due to Canberra's gravity collection network, and the limited need for pumping. Similarly Canberra's main source of water, Corin and Bendora dams, require little of no pumping, as does distribution of water to customers.

8 Reducing the footprint

8.1 Effective measures for reducing the Footprint – Potable Water

Reducing the water footprint is reliant on;

- mostly about reducing water demand and hence the amount of water extracted;
- carefully managing the extraction of water

In considering demand reduction it is important to note that, in general, ACTEW's regulatory framework is set up in such a way that ACTEW does not gain financially from increased water consumption. In principle ACTEW is regulated on income, not on water price. Hence, if water sales go up the water price will come down to keep income constant. Whilst there might be some detailed technical debate on the margins of this issue, the point is that ACTEW does not act to increase water demand, as this is not part of its mission or of any long term financial benefit.

Demand management

ACTEW's role in demand management is the development and implementation of Permanent Water Conservation Measures (PWCM), and working with the ICRC to allow the ICRC to set the price of water. There is an additional demand management program in DECCEW, plus ACTPLA planning rules help ensure suburban structure and building design also take water demand into account. There is no formal process for managing demand for either stormwater or recycled water. DECCEW's demand management program does include some subsidies for "on-block" private infrastructure for managing demand, including rainwater tank connected to the house and the Federal Government offers rebates for rainwater and greywater systems. Some of these demand management activities have recently been the subject of an inquiry by the Auditor General.

The ACT is a relatively small jurisdiction, and water management, including demand management and the development and implementation of projects requires considerable expertise and investment. One question worth consideration is how best to manage water across the whole water cycle (water, sewerage, stormwater, stormwater reuse, effluent reuse etc), and who (ratepayers, taxpayers or water users) should pay for what aspects of water cycle management?

Another question for water managers in the ACT is how to get prices more closely coupled with water demand and current supply conditions. The current price setting mechanism has considerable inertia, and a more responsive system could allow pricing of water that is more closely linked with water demand and therefore have a greater demand management impact. Charging for sewerage on a pro-rata water use basis, , is also worth consideration as a way to increase the water price signal to customers and therefore reduce demand.

In many ways the issues facing the water industry are similar to those facing the energy industry, and it is also worth considering what energy demand management initiatives can also migrate to the water industry.

Management of water extraction

Minimising the impact of water extraction is an ongoing management issue for ACTEW. The development and implementation of environmental flows in the ACT has made the management of river flow patterns an important day to day consideration for those involved in water management. ACTEW continue to measure and improve performance

8.2 Reducing the Footprint - wastewater

ACTEW are constantly reviewing the performance of LMWQCC to see what improvements or new technologies can be adopted to improve effluent water quality, including a recently completed complete review of the strategic direction of the development of the entire sewerage system. The footprint of wastewater could potentially be reduced by;

- Improved sewage treatment technologies;
- Better control on input to the sewerage system – trade waste policy;
- Reduced output by use of effluent for irrigation as potable water substitution (given this is an agreed policy direction, noting the pros and cons made in Section 3.3)

8.3 Reducing the Energy Footprint - water

ACTEW have finalised plans to abate the additional greenhouse gas (GHG) emissions from the Water Security Major Projects (WSMP, Enlarged Cotter Dam and Murrumbidgee to Googong). The mix of initiatives to achieve the offsets are;

- Carbon Sink Forestry Offsets – contract developed and signed, and trees planted;
- Mini Hydro – The Murrumbidgee to Googong project incorporates a mini hydro to recover some of the pumping energy used in the project;
- Biodiesel – construction work includes the use of biodiesel to power some of the construction equipment

ACTEW are currently in the planning stage for a further round of abatements, this time offsetting the GHG emissions from normal operation of the water supply system.

ACTEW are also acutely aware that, in the planning for any future water supply options that may be required, energy use and GHG production will remain an important issue in the choice of the next best scheme for the ACT.

8.4 Reducing the Energy Footprint - wastewater

ACTEW carried out a detailed study of options to recovery energy from sewage in 2010. The study explored ways to minimise energy use and increase the generation of power from wastes.

Nine options were explored ranging from household scale heat recovery from shower and bath water to a large anaerobic treatment facility handling all Canberra's wastewater plus green waste plus forest waste (and generating 5 MW of power).

Household Heat Recovery

The analysis of energy consumption in Canberra showed that hot water systems used more energy than the total sewerage system (8 per cent of ACT energy use compared to 1 per cent of ACT energy use). Thus recovery of heat from hot water as it enters the sewerage system was investigated.

Alternative Treatment Options Using Less Energy

Larger scale low energy treatment options involved replacing LMWQCC with a large scale facultative or aerated pond system, or replacing the primary and part of the secondary treatment processes with an anaerobic treatment system (with the aim of recovering energy from the biogas produced).

To maximise the potential for energy generation, the anaerobic treatment options explored the following possibilities:

- Treating wastewater only;
- Treating wastewater plus 5,000 t/yr of green waste;
- Treating wastewater plus 10,000 t/yr of forest waste; and
- Treating wastewater plus 5,000 t/yr of green waste and 10,000 t/yr of forest waste.

The process options for anaerobic treatment are anaerobic lagoons or upward flow anaerobic sludge blanket reactors (UASB). The anaerobic lagoons or UASB reactors require a large flat area. Possible sites investigated were the Molonglo Valley, Uriarra and in NSW, to the northwest of LMWQCC. Large pumps would be required to transfer the sewage to the anaerobic lagoons or UASB reactors and then back again to LMWQCC for secondary and tertiary treatment, with consequent high use of energy. Fugitive losses of methane from the anaerobic processes would significantly add to greenhouse gas emissions (as methane is 21 times more greenhouse warming than carbon dioxide).

The effluent quality from anaerobic treatment is similar to the present primary effluent quality. Thus additional secondary and tertiary treatment would be required to meet the standards for discharge to the river or for supply of reclaimed water to customers.

The capital cost of a UASB reactor system would be $560 million for treating wastewater and $620 million for treating wastewater plus green wastes plus forest wastes. A pond system would cost approximately $1,100 million, but would have lower operating costs than a UASB system.

In overall terms, the anaerobic treatment options produced about 5 MW of energy. This was offset by 4.5 MW being required to operate the treatment processes and 0.5 MW being required for pumping.

Conclusion

The low winter temperature in Canberra is a particular constraint and large lagoon and reactor volumes are needed to achieve the required treatment efficiency and biogas production. The hilly nature of Canberra, particularly in the area of LMWQCC means that ponds must be constructed on terraces or at some distance from LMWQCC involving pumping the wastewater to and from the ponds.

Given the climate, site and topographical constraints in the ACT, and that the wastewater has low organic strength, the analysis established that anaerobic treatment in Canberra would not generate extra energy, whether or not green wastes and forest wastes were added to the sewage. Sadly, the anaerobic treatment and pond treatment energy options do not achieve a net production in energy and hence cannot be considered viable.

The steps forward to reduce the energy footprint are to:

- Continue to use a gravity sewerage network for as much of the city as possible;
- Conduct a detailed energy audit of LMWQCC to identify ways to use energy more efficiently and reduce total energy use;
- Upgrade the furnaces to reduce the need for fuel and explore opportunities to capture and use the waste heat;
- Investigate sludge gasification as a possible long term option.

9 The environmental, economic and social impacts of reduced potable water consumption and a sustainable population

ACTEW has led the Australian water utilities in combining water resource planning and economics to only build infrastructure where the balance between reducing demand and increasing supply is maintained. This is ACTEW's Net Economic Benefit approach, where the cost of supply is balanced against the cost of not supplying, whilst incorporating the Government's level of service target and consumption reduction target.

The Government's current 25% demand reduction target balances increased water use efficiency against population growth. The projected result is no growth in overall total demand until 2023. Hence, until 2023, reduced per capita water consumption offsets increased population. The ability of the ACT to continue this approach of offsetting population growth with increase water use efficiency beyond 2023 is unknown. Much will be learnt from the performance against the current target in the coming years, and hence the potential to continue to save water with minimal social and economic cost.

An ever increased focus on demand management (increasing effectiveness, better measurement of outcomes etc) is key to minimising the impact of growing population on water resources.

Reduced potable water demand results in reduced flow in Canberra's sewers, potentially well below the flows the sewers were designed for. ACTEW will need to keep abreast of this impact, and develop innovative solutions, to find ways to avoid it becoming a significant cost to the community.

10 The role of the ACT in the region in relation to potable water supply

ACTEW currently supplies Queanbeyan with water, and has a history of discussion with neighbouring regions regarding water supply. Notional schemes have been developed for Yass, Bungendore, Sutton and Goulburn. In its future planning ACTEW has made a small allowance for supply across the border into NSW. Any such supply would need to meet the agreed ACT/NSW planning requirements, and set out in the MOU between the ACT and NSW.

Hence, as it is in accord with the MOU, ACT water can be supplied to neighbouring communities, so long as those communities pay the full price for such a supply (i.e. there is no cross-subsidy by ACT residents). To date no proposed scheme has been able to meet these criteria and also be the best financial and economic outcome for the proposing entity.

Appendix A

The Upper Murrumbidgee River Catchment

Part of a Very Large River System

The Murrumbidgee River, located in south-west NSW, is almost 1,600 kilometres in length from its source in the Snowy Mountains to its junction with the Murray River. It drains an area of some 84,000 square kilometres and is a major tributary of the Murray - Darling River system.

Figure 9 shows the Murrumbidgee Catchment with respect to all catchments which comprise the Murray-Darling Basin.

The total annual inflow in the MDB averages around 25,000GL with a range between 5,000 and 57,000 GL. The natural outflow at the sea is about 13,000GL. The Murrumbidgee River contributes about 20% of the total MDB annual inflow from about 10% of the catchment area.

It may be seen from the longitudinal river section in **Figure 10** that the river rises at about 1600m elevation in the Snowy Mountains above Tantangara Dam and drops about 1200 m in the first 240km above Burrinjuck Dam. From there to Balranald around 1,100 km further on it drops only 350m.

The ACT is located in a very steep section of the river and hence the travel time for flows from Tantangara Dam to the ACT border is around two days, in small rainfall events.

The Murrumbidgee River lies totally within NSW (except for the ACT section) and in addition to the Federal controls, falls under the Water Management Controls of NSW. It contains two major irrigation schemes; the Murrumbidgee Irrigation Area and the Coleambally Irrigation Area. The only major city downstream of Canberra is Wagga Wagga.

Figure 9: The Murray-Darling Basin

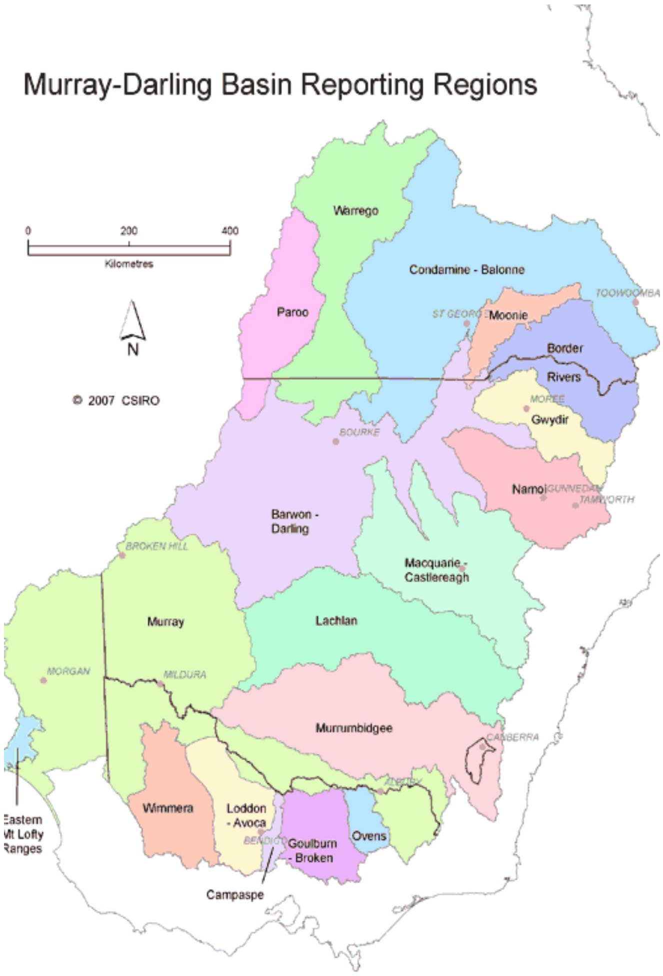
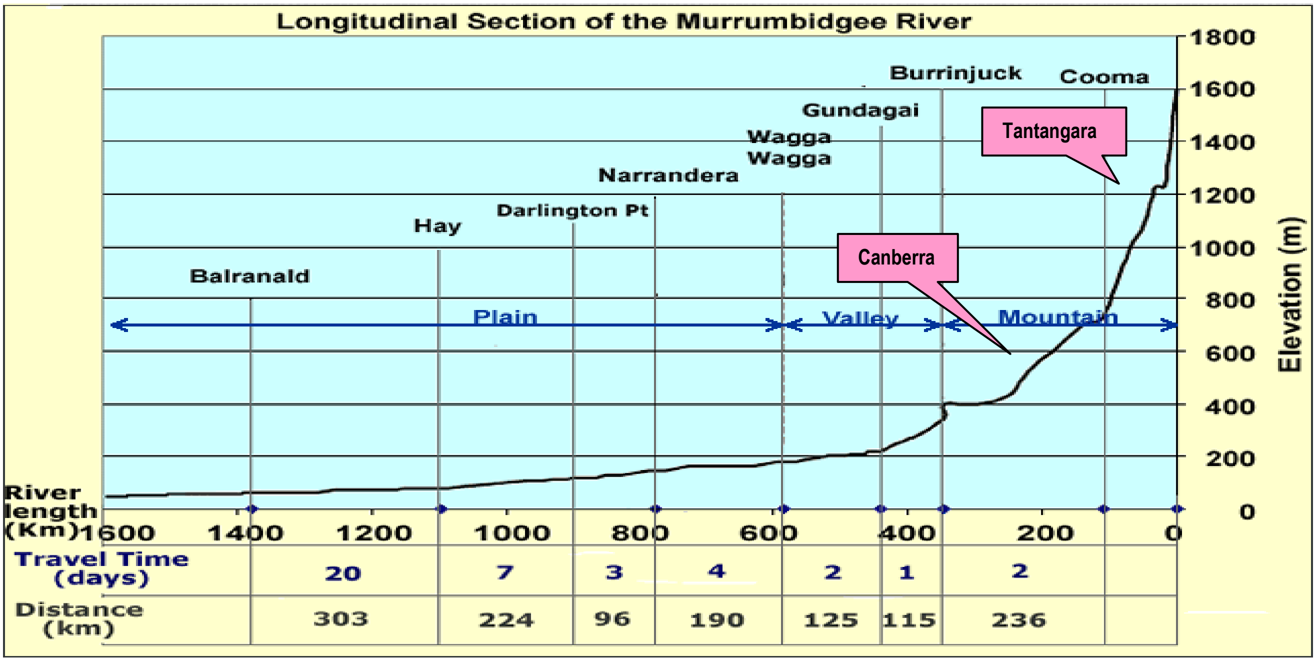


Figure 10: Longitudinal Section of the Murrumbidgee River

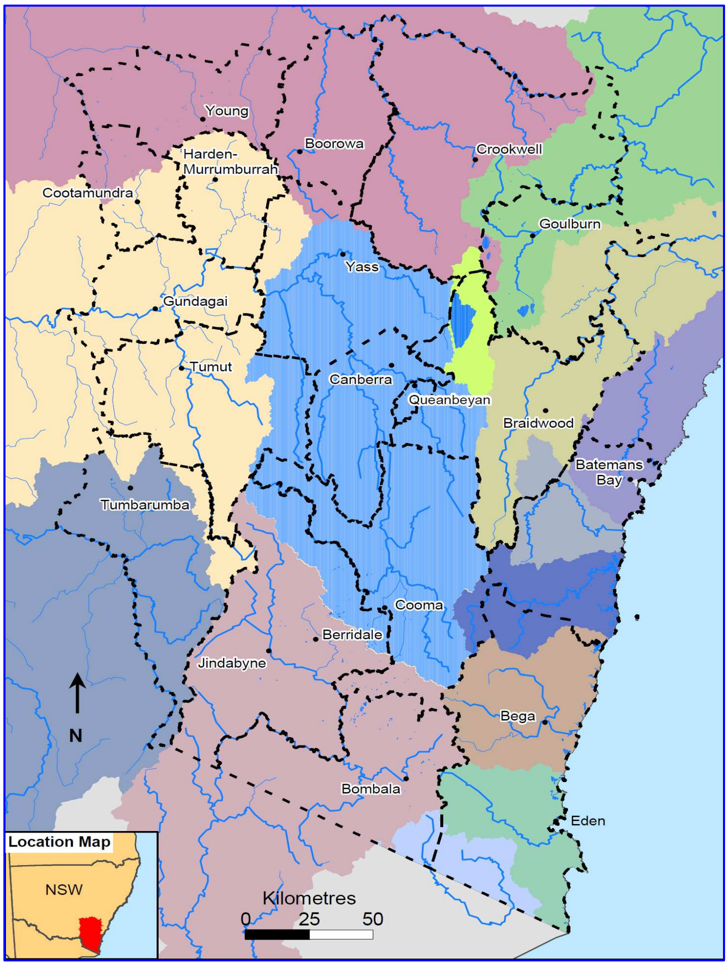


The Upper Murrumbidgee River Catchment

Regulated Murrumbidgee versus Upper (Unregulated) Murrumbidgee

The Murrumbidgee River has been divided into two sections for purposes of water management in the MDB and NSW. The section from Balranald up to and including the Blowering and Burrinjuck Dams is called the **Regulated Murrumbidgee River,** because flows and water allocations can be controlled by these two sources. Volumes in the two dams are assessed annually at the 1st July, with the start of each official water year and reviewed fortnightly. They are compared to the requirements of different classes of need (i.e. environment, human consumption, various licence rights and the maintenance of minimum flows below Balranald Weir) and released in a predictable and agreed schedule over the water year. The Regulated Murrumbidgee River is managed by a **Water Sharing Plan**, developed by NSW Office of Water (NOW) according to the Water Management Act 2000.

Figure 11: The Upper (Unregulated) Murrumbidgee



The Murrumbidgee River, from the Burrinjuck Dam (Taemus Bridge) up to the Tantangara Dam, and including the major tributaries of the Yass, Goodradigbee, Molonglo, Cotter, Naas, Bredbo and Numeralla Rivers is referred to by NOW as the **Unregulated Murrumbidgee River,** because there is no source controlling the flow in this section of the river. ACTEW refers to this section of river as the **Upper Murrumbidgee** as flows are regulated by Tangarara Dam and ACTEW dams. The blue area in **Figure 11** shows the Upper (Unregulated) Murrumbidgee catchment and represents about 13,000km^2.

A **Water Sharing Plan** for this section of the river is under development by NOW (Draft for public comment expected in December 2010). This plan will determine the inflows, outflows and diversion limits of existing users and licences (including the impacts from the ACT). Water Sharing Plans have a nominal period of tenure of 10 years, at the end of which they are reviewed.

Flow in the Upper Murrumbidgee

The volume and pattern of flows in the Murrumbidgee River have been significantly altered by; the construction and operation of Burrinjuck Dam on the Murrumbidgee River, Blowering Dam on the Tumut River to supply water to downstream users and the diversion of water from the Snowy River through the Snowy Mountains Scheme into the Murrumbidgee River.

Prior to 1958 (before the Tantangara Dam was built) the average daily flow of the Murrumbidgee River above Cooma was 1.2GL/day. Subsequently, the flow at Cooma (Mittagang Weir) averages 0.4GL/day. Snowy Hydro Ltd (SHL) is required to maintain a flow of at least 32 ML/day at this point. However, the majority of water contributing to this flow comes from catchments directly downstream of Tantangara Dam and virtually 99% of water released from Tantangara, goes south to Lake Eucumbene, to be used in the Snowy Hydro Scheme. Water released in this way is used by SHL to produce electricity, before being passed on to irrigators via Blowering Dam or the Murray River.

Figure 12 shows the typical Murrumbidgee River flow pattern over a year at Cooma. It also shows the significant decline in long term monthly averages before and after the construction of Tantangara Dam. The Spring flow peak in September/October is a reaction to the Spring rainfall and snow melt and the river is at its lowest through March – May. Despite the Tantangara Dam there is still a substantial Spring flush, although the Autumn flows have virtually disappeared. In the past decade the low - flow period has extended out to July and is much flatter.

Figure 12: Average Monthly Murrumbidgee River Flow at Cooma (Mittagang Weir)

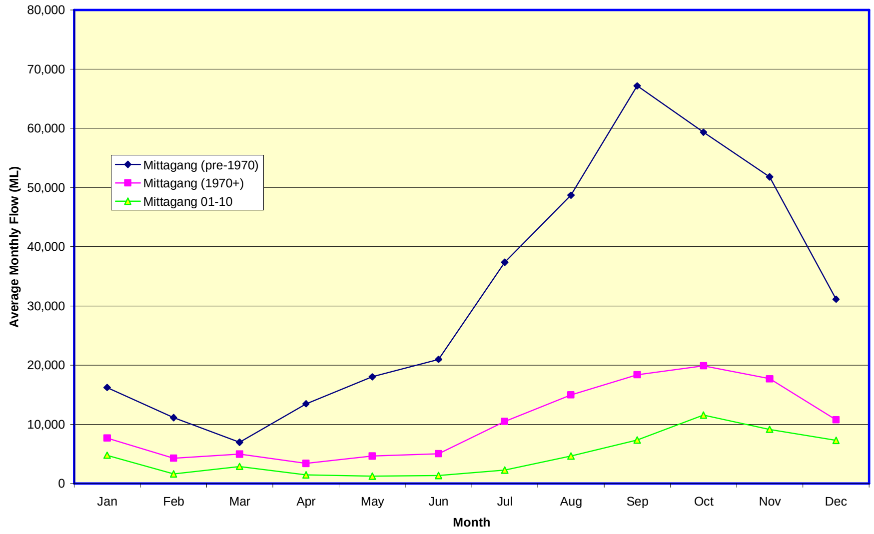
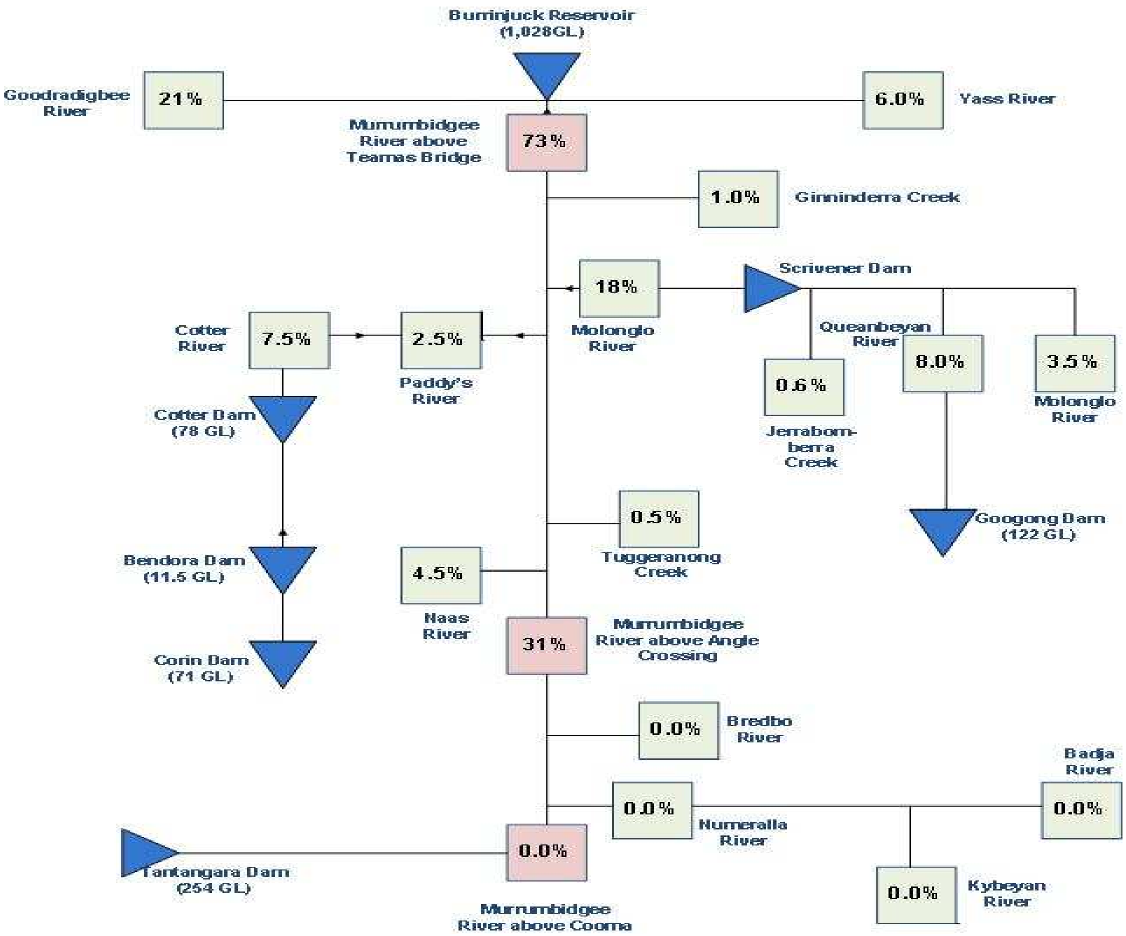


Figure 13 presents the estimated proportional contribution of Murrumbidgee tributaries to the total flow into Burrinjuck Dam above Teamas Bridge. The long term average daily inflow at this point is around 3.2GL. It may be seen that around 42% of the natural inflow into Burrinjuck Dam is from catchments within the ACT and managed by the ACT.

Figure 13: Estimated contribution of tributaries to the Murrumbidgee (post Tantangara Dam) flow and Burrinjuck Dam



The Upper Murrumbidgee River Catchment

Climate, Topography and Rainfall

It has been observed that the regional rainfall pattern and the topography are intimately connected in the Upper Murrumbidgee catchment. **6** and **7** present the Rainfall Distribution and Topographic Elevation Maps and it can be clearly seen that the most obvious feature is the rain caused by orographic lifting in from the Snowy Mountains to the west and ranges to the east. While this is a disadvantage to the rainfall over Canberra it means that the Murrumbidgee and Canberra's other water supply catchments are fed by significant precipitation (Rain and Snow).

Figure 14: Rainfall Distribution

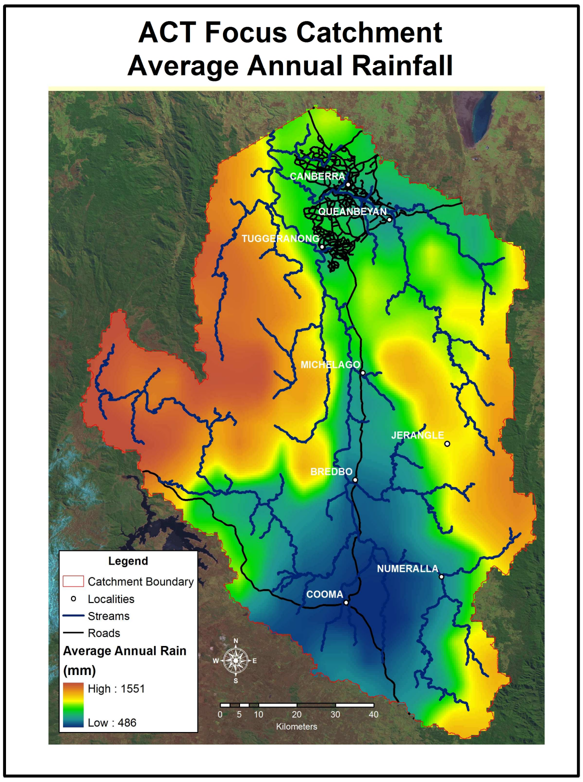
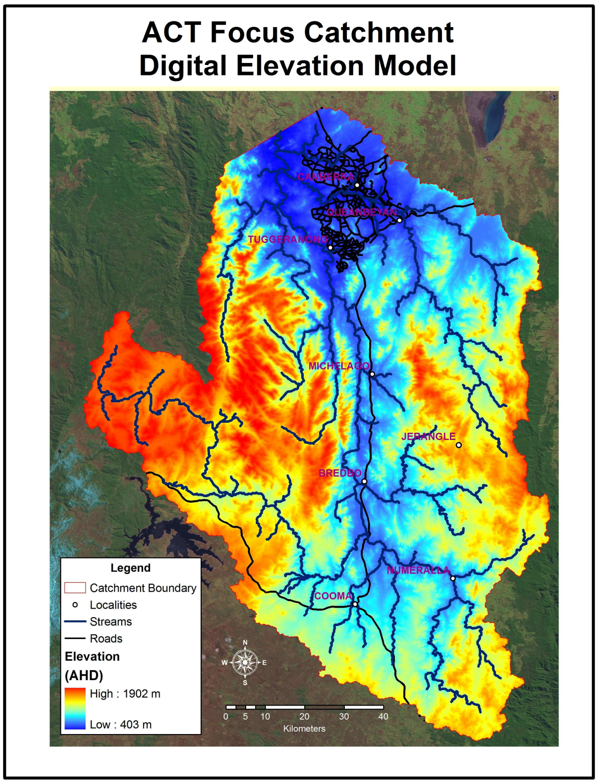
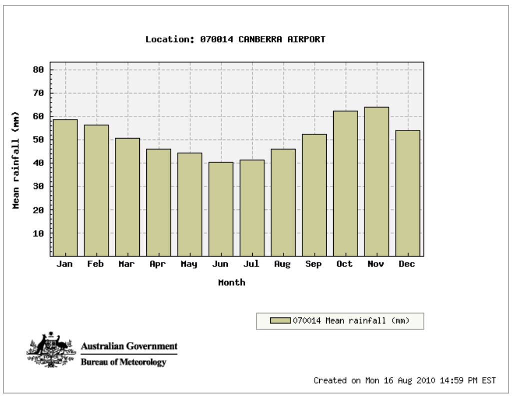


Figure 15: Topography



Historically on average the spring months are the wettest months of the year. The long term average monthly rainfall for Canberra ranges from around 40 mm in June to around 63 mm in November with a Spring peak. **Figure 16** presents the long term average monthly rainfall at Canberra airport.

Figure 16: Rainfall at Canberra Airport



The drought of the past decade has seen a reduction in annual rainfall in the ACT of about 15% in the Cotter River catchment to the west of Canberra and 17% in the Googong Dam catchment to the east. However, this alone does not explain the reduction in stream flows and inflows into our dams of 46% in the Cotter and 84% in Googong. The CSIRO has predicted that the Upper Cotter Catchment will experience climate change such that there could be a reduction of rainfall however we are most likely to see the pattern of recent times continue with a decline in Autumn rainfall and an increase in the intensity of storms at any time of the year.