ENVIRONMENT ACT

Water Resources Management Plan

16 August 1999

ACT GOVERNMENT

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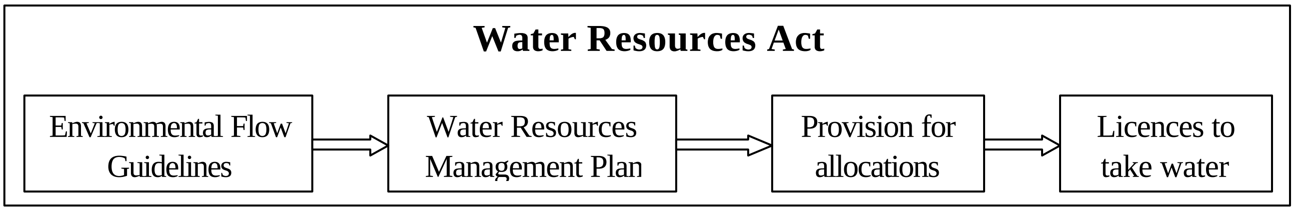
Executive Summary

The Water Resources Management Plan is one component of the legislative framework to manage the Territory's water resources. It takes as a starting point water set aside for the environmental flows then shows how the Government intends to manage the remainder of our water resources. A key part of the Plan is to make provision for water allocations over the next ten years. Allocations cannot be created and licences to take water granted unless they are provided for by the Plan.



The Plan shows that average annual water available from ACT controlled catchments is 465 gigalitres (GL). Of this, 272 GL is designated by the Environmental Flow Guidelines as environmental flow, leaving 193 GL available for consumptive use.

The Plan indicates that existing use of water totals about 65 GL. Provision is made for future allocations of around 1.9 GL to meet agricultural demand and 6.5 GL for water supply in the next 10 years leaving 120 GL unallocated.

The ACT component of the overall Murray-Darling Basin Commission cap on water extraction is currently being negotiated. The Cap is expressed in terms of net use and includes both taking water from, and the return of water to streams. This Plan only deals with the taking of water.

The Cap and the Plan are related but the Plan will not need to be changed depending on the outcome of the ACT's Cap negotiations. While the overall Cap cannot be increased, the ACT component of the Cap could be increased by the purchase of a water entitlement from elsewhere in the Basin. The use of a purchased water entitlement would be subject to the requirements of this Plan.

Information on existing water use included in the Plan is incomplete as many users do not yet measure quantities used. As a result provisions for future allocations are deliberately cautious and the Plan includes a requirement for a review after three years when it is expected additional information will be available.

WATER RESOURCES MANAGEMENT PLAN

1. BACKGROUND

1.1 Purpose of the Plan

The purpose of the Water Resources Management Plan is to provide the ACT Government with a decision making framework and strategic direction for the long term management of the Territory's water resources.

The Plan also promotes the objects of the *Water Resources Act 1998* which are:

- to ensure that the use and management of the water resources of the Territory sustains the physical, economic and social well being of the people of the Territory while protecting the ecosystems that depend on those resources;
- to protect waterways and aquifers from damage and, where practical, to reverse damage that has already occurred; and
- to ensure water resources are able to meet the reasonably foreseeable needs of future generations.

1.2 Scope of the Plan

The Water Resources Management Plan provides detailed information on the state of the Territory's water resources and some information on related matters such as soils, geology and land use for each of 32 sub-catchments in which the ACT has an interest.

For each sub-catchment, the Plan sets out estimates of total water resources, environmental flow requirements in accordance with the Environmental Flow Guidelines, and water available for non-environmental uses. The Plan then makes provision for the new water allocations which the Government expects to create over the next 10 years after the Plan is finalised and other actions to be taken by the Government to manage the water resources of the Territory.

The Plan sets out the Government's policy position in relation to water resource management and the achievement of the ecological outcomes set out in the Environmental Flow Guidelines. It includes requirements for monitoring, groundwater assessment and review of the plan.
This Plan does not seek to regulate the reuse of water or the

return of water to the environment after it has been used. This has been done deliberately to reduce the regulatory control of reuse to encourage its growth. At present the environmental impacts of reuse can be managed by using the provisions of the Environment Protection Act. Should this situation change in the future this Plan may need to be amended to permit the necessary controls.

While the plan has been prepared using the best available scientific knowledge, it acknowledges some gaps in information. The most significant of these is information on the existing use of surface and groundwater. Legislative support for the collection of usage information was not available prior to the passage of the Water Resources Act. Knowledge of the ACT's groundwater resource is also limited. Information on these and other areas is now being gathered and will contribute to the initial review of the plan.

2. LEGISLATIVE BACKGROUND

2.1 Water Resources Act 1998

The *Water Resources Act 1998* (the Act) was passed in November 1998 to allow for the effective management of the ACT's water resources and to ensure the health of waterways.

The Act lays the legal basis for the allocation of water, licences to take water, drillers' licences, bore construction permits and work permits to control the construction of water control structures. Significantly, the Act provides for the protection of the environment through recognising water for environmental purposes as a legitimate use of the resource. It also ensures that provisions made for the environment are not diminished by other users or changes in management.

The Act also sets the requirement for the preparation of this Plan which must include:

- a description of the water resources of the ACT in terms of quantity and seasonal distribution of flows on a sub-catchment by sub-catchment basis;
- a description of the flows required to meet the environmental needs of individual waterways and aquifers;
- proposed allocation for use of water in the ACT for the next 10 years;
- water allocations to be created for urban water supply, industry and other uses; and

- actions to be taken by the Authority to manage the water resources of the ACT.

The Environment Management Authority is given water management functions under the Act and provision is made for inspections and other functions to ensure that the Act is enforced.

The Act provides for a public consultation process followed by tabling of the Plan in the Legislative Assembly as a disallowable instrument.

2.2 Water ownership

The *Seat of Government Acceptance Act 1909* (Commonwealth) gave the Commonwealth paramount , for all purposes of the Australian Capital Territory, paramount right to the waters of the Queanbeyan and Molonglo Rivers. The Commonwealth exercised this right over the waters of the Queanbeyan River with the passage of the *Canberra Water Supply (Googong Dam) Act 1974* (Commonwealth) which declared the Commonwealth rights are exercisable by the ACT Executive on behalf of the Commonwealth subject to conditions set by the Commonwealth Minister and also provided for the construction of Googong Dam. Through ACT self-government legislation, the *Australian Capital Territory (Planning and Land Management) Act 1988* (Commonwealth), the Commonwealth delegated its power to control the waters of the Queanbeyan River (and Googong Dam) to the ACT.

The *Australian Capital Territory (Self Government) Act 1988* effectively passed control of all water resources other than water on or under National Land to the Territory Executive. National land in the ACT includes Lake Burley Griffin, Majura Field Firing Range and CSIRO land.

The *Water Resources Act 1998* provides that the right to the use, flow and control of all Territory water is vested in the Territory. This consists of the waters of the Googong Dam catchment and all water on or under Territory land. The application of the Act is constrained by the Commonwealth legislation described above.

A further complication of water ownership in the ACT is that all water under leases of Territory land granted before 11 December 1998 is controlled by the lessee because such leases did not specifically exclude the right to such water. The Act provides that leases granted after 11 December 1998 cannot confer the right to control water.

2.3 The Territory Plan

The Territory Plan sets out the principles and policies which guide the development of the ACT. Amongst the goals of the Territory Plan are:

- to conserve and enhance valued features of the Territory's natural environment; and
- to promote ecologically sustainable development, protect biodiversity, and provide for high standards of environmental amenity and landscape.

The *Water Use and Catchment Policies* of the Territory Plan recognise the competing and often conflicting demands made on the Territory's water resources. They protect the waters and catchments of the ACT by specifying permitted uses and environmental values for each water body. They have been divided into three types of Water Use Catchments according to the predominant water use or environmental value within that catchment. These are:

- conservation of aquatic habitat;
- provision of domestic water supply; and
- provision of drainage and open space.

Specific objectives are set for each category of use, along with a number of policies which are designed to facilitate meeting those objectives.

Secondary uses are also permitted for individual waterways so long as they do not compromise the maintenance of standards required to meet the primary environmental value.

The protection and conservation of the water quality of the groundwater resources of the ACT is a policy objective for all types of Water Use Catchment.

2.4 Environment Protection Act 1997

The *Environment Protection Act 1997* provides for the protection of the environment through a range of measures aimed principally at cooperation between the managers of activities which could harm the environment and the

Environment Management Authority. The Act also recognises the environmental duty of individual members of the community. Should this approach fail, the Act provides for strong penalties.

For water resources specifically, the Act contains water quality standards which must be achieved to meet particular environmental values. Thus, the Act specifies the indicators and the maximum concentrations of substances and materials in water which are acceptable for the maintenance of each environmental use or value.

2.5 ACT Nature Conservation Strategy

Water resources of the ACT must be managed in a manner which is sympathetic to the goal of the *ACT Nature Conservation Strategy,* which is to protect biological diversity and maintain ecological processes and systems. The Strategy identifies water management schemes which involve impounding or diverting water for use as posing a direct threat to aquatic habitats. Thus, including the provision of environmental flows as an essential element in the management of water resources is necessary to ensure that nature conservation requirements are given their just consideration. Further more, the degree to which biodiversity values are maintained must be included in the monitoring program which assesses the impacts of water allocation.

3. POLICY CONTEXT

3.1 COAG Water Reform Framework

In February 1994, the Council of Australian Governments (COAG) agreed to a *strategic framework for the efficient and sustainable reform of the Australian water industry*. COAG subsequently tied the reform framework to the National Competition Policy Agreement. The reforms are broad and have far reaching implications for the way in which natural resources will be managed in Australia. In the context of this Plan, the implementation of the reforms includes the requirement for individual States and Territories to set up a comprehensive water allocation system, including the allocation of water for the environment, which encourages the highest value sustainable use of the resource. The reforms also require that water property rights be separated from land title and arrangements be put in place for water trading to occur. Implementing the water allocation management system provided for in the *Water Resource Act 1998* will enable the ACT to meet its COAG commitments.

3.2 Integrated Catchment Management

Integrated Catchment Management (ICM) can be defined as the coordinated and sustainable management of land, water, vegetation and other natural resources, on a water catchment basis, to balance resource use and conservation. This approach is implied in the ACT Nature Conservation Strategy which recommends a cross sectoral approach to resource management, as well as the Territory Plan, which states that "Planning for land and water resources be integrated, based on total catchment principles".

The ACT Integrated Catchment Management Strategy, currently being prepared in consultation with the community, will take a holistic view and seek to draw together statutory and policy responsibilities to improve integration, catchment-wide across the ACT. The Strategy will ensure that decisions, policies, and practices to do with natural resource management occur according to the principles and objectives of ICM. This approach has been embraced in planning the management of water resources in the ACT. The adoption of a catchment approach in the Plan facilitates the achievement of a balance between water utilisation and conservation. Water allocation will be managed at a sub-catchment level and will take into account the various factors which contribute to catchment processes.

3.3 Water Trading

Where an allocation of water is required for consumptive use and an allocation is not available by grant or purchase from the Authority, all or part of an allocation may be purchased from an existing allocation holder except for those issued under transitional arrangements. The holder of an allocation may sell all or part of the allocation subject to the approval of the Authority. Where all, or part of an allocation is sold, any associated licence will be reduced by the amount sold. An allocation may be purchased from within the ACT, or in the future from interstate, subject to the approval of the Authority. The Authority may impose conditions on an approval. A licence relating to that allocation must be obtained before use of the allocation in the ACT. The trading of an allocation of water may be permanent or for a limited period. The same conditions apply to both permanent and temporary trade.

Trade within the ACT

Trading within the ACT is subject to the approval of the Authority which will generally be freely given unless the transfer would cause environmental harm. The Authority must be provided with the identity of the person to whom the allocation is being transferred before the transfer can be approved.

Interstate Trade

At present potential ACT water users are not able to trade water across the Territory border. Trade of water from Googong Dam is also constrained by the *Canberra Water Supply (Googong Dam) Act 1974*.

The Murray-Darling Basin Commission is currently undertaking a water trading trial project in the region on the borders between New South Wales, Victoria and South Australia. As principles and procedures are developed and tested during this trial, decisions will be made on when and how to extend water trading across the Basin. It is understood that trading across the Basin is not likely for between two and three years.

In any case, NSW has restrictions on trading, such as an embargo on trading between regulated and unregulated rivers, which would limit ACT's trading opportunities. It is intended not to allow interstate water trading either into or out of the ACT until agreement is reached in the MDBC that such trading should occur.

When it is approved, interstate water trading will be subject to the same requirements as trading within the ACT as well as the prior approval of the appropriate interstate Water Authority. Where water is traded over a significant distance, for example between Canberra and Narrandera, the volume of water traded may be subject to adjustment or discounting to compensate for system losses between the two locations. Additionally, where an interstate water trading register is established, interstate trade will need to be entered on the register prior to finalisation.

3.4 The Murray-Darling Basin Cap

Jurisdictions participating in the *Murray-Darling Basin Initiative* agreed in 1997 to place a Cap on the overall amount of water used in the Basin. When ACT joined the

Initiative in 1998, it also agreed to be subject to the Cap. Negotiations are now under way to determine the ACT component of the Cap and how it will be applied. The Cap and the Plan are related but the Plan will not need to be changed depending on the outcome of the ACT's Cap negotiations.

The Cap is expressed in terms of net use and includes both taking water from, and the return of water to streams. This Plan only deals with the taking of water and does not include corrections for water returned to the environment such as from the Lower Molonglo Sewerage Treatment Plant. As discussed in Section 1.2 this plan does not regulate reuse to encourage the further development of water recycling.

Overall, the Water Cap limits the amount of water that can be used in the Murray-Darling Basin. An individual jurisdiction can increase its Cap provided another jurisdiction reduces its Cap. The ACT's Cap will increase when someone buys a water entitlement from outside the ACT. Whether a water entitlement is purchased from outside the ACT or can already be accommodated in the ACT's Cap, provision must be made for it in this plan before an allocation can be created.

3.5 Priority of Use

The Water Resources Act 1998 gives clear priority to the environmental uses of water. The Environmental Flow Guidelines outline how much of the various elements of the flow regime will be reserved for the environment in each type of ecosystem.

Section 34 of the Act gives the Minister the power to restrict the taking of water during droughts or other situations when the environment is being adversely affected or the rights of other users are not being met equitibly. Principles are needed to indicate how the Minister will exercise this power.

Guidelines in NSW set priority for town and domestic consumption above that for commercial and recreational uses. Priorities for use in the ACT will generally follow a similar pattern but they will differ for each type of ecosystem. The structure of the Environmental Flow Guidelines lends itself to expansion to set different priorities of use for different types of ecosystems, Water Supply, Natural, Modified and Created.

The Guidelines for **Water Supply Ecosystems**, the Cotter

River catchment, give a clear priority to water supply needs after the environment, with some scope to encroach on environmental flows during dry periods. Other consumptive uses are prohibited.

Similarly the Guidelines for **Natural Ecosystems**, those areas within Namadgi National Park other than the Cotter River catchment, give the highest priority to environmental needs with other uses having lower priority.

The Guidelines for **Modified Ecosystems**, those rivers lakes and streams outside Namadgi National Park and the Canberra urban areas but including the Molonglo River, are diverse. The priority of use for Modified Ecosystems is set as:

- environmental needs as defined by the Environmental Flow Guidelines;
- stock and domestic needs including camping and travelling stock watering;
- commercial and irrigation uses within licence conditions; and
- recreational uses.

The Guidelines for **Created Ecosystems,** streams lakes and ponds within the urban area other than the Molonglo River and Lake Burley Griffin, are also diverse. The priority of use for Created Ecosystems is set as:

- environmental needs as defined by the Environmental Flow Guidelines;
- recreational and aesthetic needs;
- stock and domestic needs including camping and travelling stock watering; and
- commercial and irrigation uses within licence conditions.

During periods of drought or other significant water shortage, access to water within the **commercial and irrigation uses** and **stock and domestic needs** categories may be restricted. Restrictions will be introduced progressively and will be based on the exclusion of certain uses in the following order:

- pasture
- annual crops
- permanent crops not listed below;
- commercial non agricultural activity;
- permanent horticulture, viticulture and orchards;
- all uses other than domestic consumption.

In all cases, water may be used for emergency purposes such as fire fighting or for the protection of life even though these uses have not been included in the listed priorities for each type of ecosystem.

4. THE WATER RESOURCES OF THE ACT

4.1 General Features

Water Resources

Canberra is the largest inland city in Australia. Australia is the driest inhabited continent on earth. These two facts mean that the lakes and rivers of the ACT are key resources. They provide urban and rural water supply, and are a major recreation resource. They receive wastewater and stormwater discharges, and transfer flood waters through the ACT. The environmental, scenic and recreational values of the lakes and rivers are particularly important to an inland city such as Canberra.

The ACT is entirely within the Upper Murrumbidgee River Catchment. The Upper Murrumbidgee covers an area of 13,000 km^2, of which the ACT occupies 2,400 km^2. The Murrumbidgee River rises in the south-western part of the catchment. It flows some 30 km before reaching Tantangara Reservoir, where much of its flow is diverted to Lake Eucumbene. The river then flows umimpeded for 150 km to discharge into Burrinjuck Reservoir to the north of the ACT.

The combination of extended dry periods and major floods results in large ranges of flow in ACT rivers and streams. For example, in over 50 years of records at Cotter Crossing gauge, the annual discharge of the Murrumbidgee River has varied by factors of about 5 around the mean. Since 1927, there have been 52 days on which there has been no flow in the Murrumbidgee at Cotter Crossing. The mean annual flow of the Murrumbidgee at Burrinjuck Dam is 1383 GL of which 426 GL is contributed from water resources controlled by the Territory.

The average annual runoff from ACT controlled catchments is 465 GL. Of this, 272 GL is designated by the Environmental Flow Guidelines as environmental flow, leaving 193 GL available for consumptive use.

The drainage system of the Murrumbidgee basin has been modified as a result of the construction of dams for hydro-electricity generation, irrigation and municipal water supply and provision of ornamental lakes. Some 27 per cent of the runoff which would have reached the ACT, as measured at the Mount McDonald gauging station, is diverted from the catchment at Tantangara Dam for hydroelectricity and irrigation. The numerous farm dams and the clearing of native forest for other land uses has also had an impact on stream flows.

In addition, a number of dams have been constructed on the Cotter and Queanbeyan Rivers as part of the Canberra and Queanbeyan water supply and within the urban area as part of the stormwater system. The dimensions of the major storages are detailed in Table 1.

Table 1: ACT LAKES AND RESERVOIRS: USES AND DIMENSIONS

Lake or Reservoir	Primary Designated use	Sub-Basin	Volume (GL)	Mean Depth (m)	Mean Annual Inflow (GL)	Catchment Area (sq km)
Googong Reservoir	Municipal water supply	Queanbeyan	125	17.3	114	873
Corin Reservoir	Municipal water supply	Cotter	76	24	48	197
Bendora Reservoir	Municipal water supply	Cotter	11	14	106	290
Cotter Reservoir	Municipal water supply	Cotter	4.7	9	152	482
Lake Burley Griffin	Landscape & Recreation	Molonglo	33	4.7	265	1865
Lake Ginninderra	Pollution control, Landscape & Recreation	Ginninderra	3.7	3.5	7.1	92
Lake Tuggeranong	Pollution control, Landscape & Recreation	Tuggeranong	2.6	3.4	9.6	64

Mean annual inflow data in this table is draw from the Water Policy Plan (1989) and may not agree with data for individual catchments. Differences in data are the result of different and sometimes non overlapping periods of record.

The mean annual diversion for water supply of 66 GL accounts for just under 5 per cent of Upper Murrumbidgee Catchment runoff. A large proportion of the diverted water is returned to the Murrumbidgee as treated sewage (35 GL), groundwater outflow or irrigation runoff.

Climate

The climate is essentially continental, with hot summers and cold winters. Rainfall is fairly evenly distributed throughout the year, although the winter months are slightly drier. Mean annual precipitation in the ACT ranges from 950 mm in the mountains to 600 mm in the city. In common with the rest of inland Australia the region experiences extended drought periods, although summer rainfall tends to occur as storms, with more prolonged, but gentler, rainfall in winter.

Soils and Vegetation

Many of the soils of the upper Murrumbidgee basin have duplex profiles, with coarse-textured surface horizons and clay rich sub-soils. They are prone to sheet erosion and deep gullying. The dispersive clays of these soils are easily eroded and yield high sediment and turbidity levels. This is most pronounced in the gently sloping depressions subject to soil moisture saturation.

The problem of erosion is aggravated by disturbance of vegetation and soil. The most erodible soils are on steeper, cleared slopes and river bank areas. Undisturbed areas such as forested mountain slopes yield little material unless modified by logging operations or severe bushfires. Land use is the dominant factor determining the export of material such as soil, nutrients and soluble salts from catchments.

Vegetation

Vegetation is a significant determinant of water quality. It provides protection against soil erosion, intercepts precipitation and modifies soil composition. Vegetation types depend on many of the above factors, particularly climate, topography and soils. In the area, several vegetation patterns occur:

- **tall open forest (wet sclerophyll):** trees above 30 m tall; found in mountain areas, occurring on cool moist slopes (excluding the most exposed ridges) and in the mountain valleys, typical of Namadgi National Park and visible from Canberra on the Brindabella Range.
- **open forest (dry sclerophyll):** trees from 10-30 m tall which form a community at lower altitudes and under drier conditions. The most extensive areas occur on the lower Cotter River and the Bullen Range- visible from Kambah Pool.
- **woodland (savannah):** scattered trees 10-30 m tall; common throughout the tableland areas at lower altitudes on warm, dry, undulating to hilly terrain. Typical of the Naas Valley, with a prominent urban example being the lower slopes of the Ainslie-Majura reserve.
- **pine plantations:** extensively modified areas, generally undulating to hilly country with major concentrations in the lower Cotter Valley, Mount Stromlo and Kowen.
- **grassland**: occurs naturally in relatively few locations, usually wet alluvial flats or frost pockets where conditions are unfavourable for tree growth. Natural examples are the Orroral Valley and parts of the naval radio station in Belconnen. Many grasslands result from the clearing of woodland or

forests. Pasture improvement, which has largely replaced native grasses with introduced species, is characteristic of the northeastern third of the ACT including the urban areas.

- **sub-alpine complex:** occurs under the most extreme cold and exposed conditions above 1500 m on the ridges and peaks. Within the ACT this is restricted to numerous small pockets, particularly in the southwestern parts of Namadgi National Park.

Land Use

Land use is an important determinant of the pattern and quantity of runoff, as well as the nature of constituents transported by that runoff. A change in land use from rural to urban may have significant impacts on the pattern of streamflow and water quality of local waters. Canberra's expansion has led to large areas of land being modified for urban development and to increasing demands on limited water resources, including more water for domestic use, irrigation and more water-based recreation. There are also community pressures to ensure that the scenic and ecological values of the waterways are preserved.

4.2 Water Sub-Catchment Descriptions

Water resource allocation must be determined at sub-catchment level. A complication of this approach is that the larger rivers, notably the Murrumbidgee and Molonglo Rivers, have catchments which extend well beyond the ACT borders. Streamflow for these sub-catchments is determined by the nature of the contributing catchments and their land uses in both the ACT and NSW.

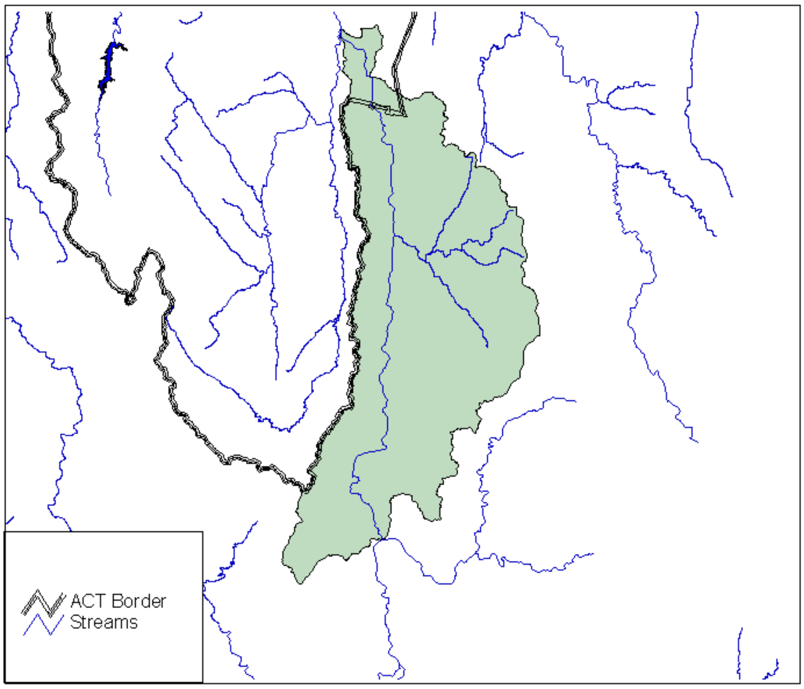
For the purposes of water resource management, resources which the ACT controls or has an interest in have been divided into the sub-catchments shown in Table 2 and detailed following the table.

Table 2: Sub-Catchments in which ACT is Interested or has Control

Sub-Catchment		Defined by
Murrumbidgee and tributaries		
1	Michelago	Murrumbidgee River; junction with Bredbo River to junction with Gudgenby River
2	Tharwa	Murrumbidgee River; junction with Gudgenby River to junction with Tuggeranong Creek
3	Kambah	Murrumbidgee River; junction with Tuggeranong Creek to junction with Cotter River
4	Uriarra	Murrumbidgee River; Cotter River to junction with Molonglo River
5	Woodstock	Murrumbidgee; junction with Molonglo River to junction with Ginninderra Creek
6	Guises	Guises Creek.; headwaters to junction with Murrumbidgee River
Gudgenby and tributaries		
7	Naas	Naas River; headwaters to junction with Gudgenby River

Sub-Catchment		Defined by
8	Gudgenby	Gudgenby River; headwaters to junction with Naas River
9	Tennent	Junction of the Naas and Gudgenby Rivers to junction with Murrumbidgee River
Cotter and tributaries		
10	Corin	Cotter River; headwaters to Corin Dam wall
11	Bendora	Cotter River; Corin Dam wall to Bendora Dam wall
12	Lower Cotter	Cotter River; Bendora Dam wall to Cotter Dam wall
13	Paddys	Paddys River; headwaters to junction with Cotter River
Tuggeranong Creek and tributaries		
14	Tuggeranong	Tuggeranong Creek; headwaters to junction with Murrumbidgee River
Molonglo and tributaries		
15	Upper Molonglo	Molonglo River; headwaters to Burbong Bridge
16	Kowen	Molonglo River; Burbong Bridge to junction with Queanbeyan River
17	Fyshwick	Molonglo River; junction with Queanbeyan River to Woolshed Creek junction
18	Jerrabomberra Headwaters	Jerrabomberra Creek; headwaters to ACT border
19	Jerrabomberra	Jerrabomberra Creek; ACT border to Canberra-Queanbeyan railway line
20	Lake Burley Griffin	Molonglo River; local drainage into Lake Burley Griffin, including Jerrabomberra Wetlands
21	Coppins	Molonglo; Scrivener dam wall to junction with Murrumbidgee River
22	Woolshed	Woolshed Creek; headwaters to junction with Molonglo River
23	Sullivans	Sullivans Creek; headwaters to Lake Burley Griffin
24	Woden	Yarralumla Creek; headwaters to junction with Molonglo River
25	Weston	Weston Creek; headwaters to junction with Molonglo River
Queanbeyan River and tributaries		
26	Tinderry	Queanbeyan River; Headwaters to upper end of Googong dam
27	Googong	Queanbeyan River; Upper end of Googong Dam to Googong Dam wall
28	Lower Queanbeyan	Queanbeyan River; Googong Dam wall to junction with Molonglo River
29	Burra	Burra Creek; headwaters to upper end of Googong Dam
Ginninderra Creek and Tributaries		
30	Gungahlin	Ginninderra Creek; headwaters to Gungahlin Pond dam wall
31	Lake Ginninderra	Ginninderra Creek; Gungahlin Pond dam wall to Lake Ginninderra dam wall
32	Parkwood	Ginninderra Creek; Lake Ginninderra Dam wall to junction with Murrumbidgee River

1. MICHELAGO



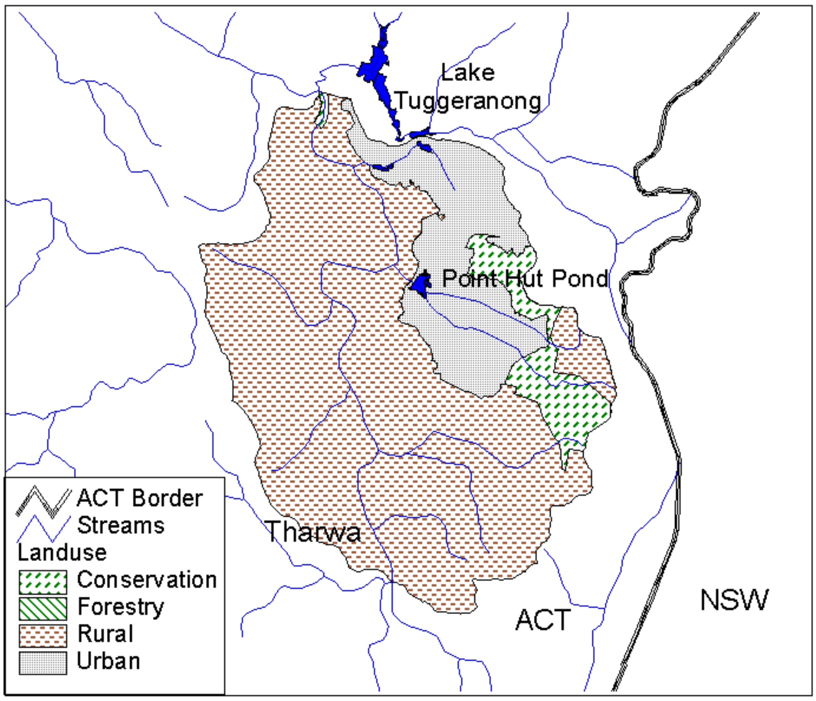
Location	Murrumbidgee River; junction with Bredbo River to junction with Gudgenby River
Area	Total – 61,596 ha ACT – 2,587 ha
Landuse	Rural, Conservation
Geology	Nungar Beds
Vegetation	50% Open Forest, 50% Mixed Grassland
Soils	Volcanics, Alluvium
Environmental Values	Primary: conservation Secondary: domestic water supply, irrigation and stock water, recreation – swimming and boating, waterscape, aquatic habitat, discharge – stormwater.

General Description

The Murrumbidgee valley is characterised by steep slopes, particularly on the western side which rises to the Clear Range. To the east of the river the land is flat to gently undulating until the slopes of the Tinderry Range are reached. In the ACT portion of the sub-catchment the Murrumbidgee flows through Gigerline Nature Reserve and the rugged landscape of Gigerline Gorge.

Soils tend to be shallow and stony on upper hill slopes and in gorges. Silty topsoil overlays thick clay subsoil on lower and more gentle slopes, while sandy alluvium is found along river banks.

2. THARWA



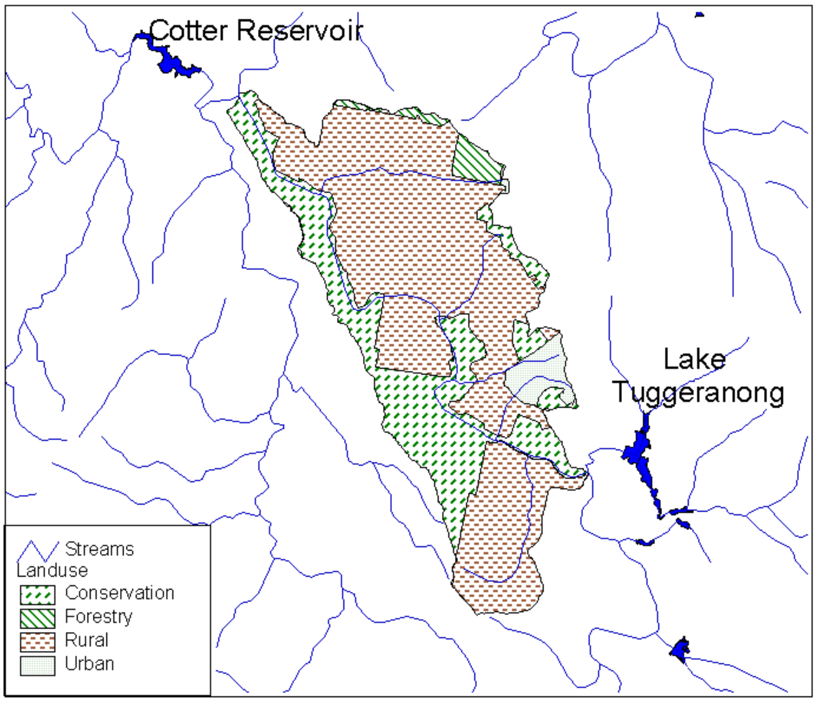
Location	Murrumbidgee River; junction with Gudgenby River to junction with Tuggeranong Creek
Area	8,055 ha
Landuse	60% Rural, 30% Urban, 10% Conservation
Geology	70% Volcanics, 30% Silt
Vegetation	50% Native Grassland, 30% Open Woodland, 20% Low Woodland
Soil	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: domestic water supply, irrigation and stock water, recreation – swimming and boating, waterscape, aquatic habitat, discharge – stormwater.

General Description

The topography is characterised by steep upper slopes, more gentle lower slopes and river flats.

Land management practices on some agricultural land have resulted in soil erosion, soil compaction and decline in soil structure

3. KAMBAH

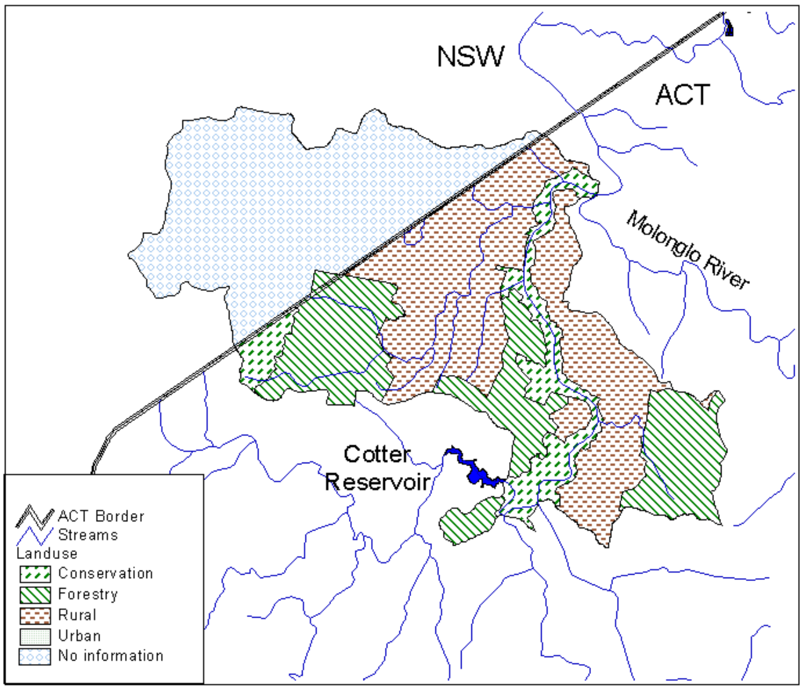


Location	Murrumbidgee River; junction with Tuggeranong Creek to junction with Cotter River
Area	6,063 ha
Landuse	70% Rural, 30% Conservation
Geology	80% Volcanics, 20% Nungar Beds
Vegetation	40% Open Woodland, 60% Mixed Grassland
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: domestic water supply, irrigation and stock water, recreation – swimming and boating, waterscape, aquatic habitat, discharge – stormwater

General Description

The terrain is generally low and hilly. The Murrumbidgee flows through the Bullen Range Nature Reserve, which includes Red Rocks Gorge, an area of high cliffs and rugged rock formations. River vegetation is well developed with stands of river oak extending along banks of large pools. Aquatic habitats are diverse and the large deep pools support native fish, crayfish, water birds, platypus and the eastern water rat.

4. URIARRA



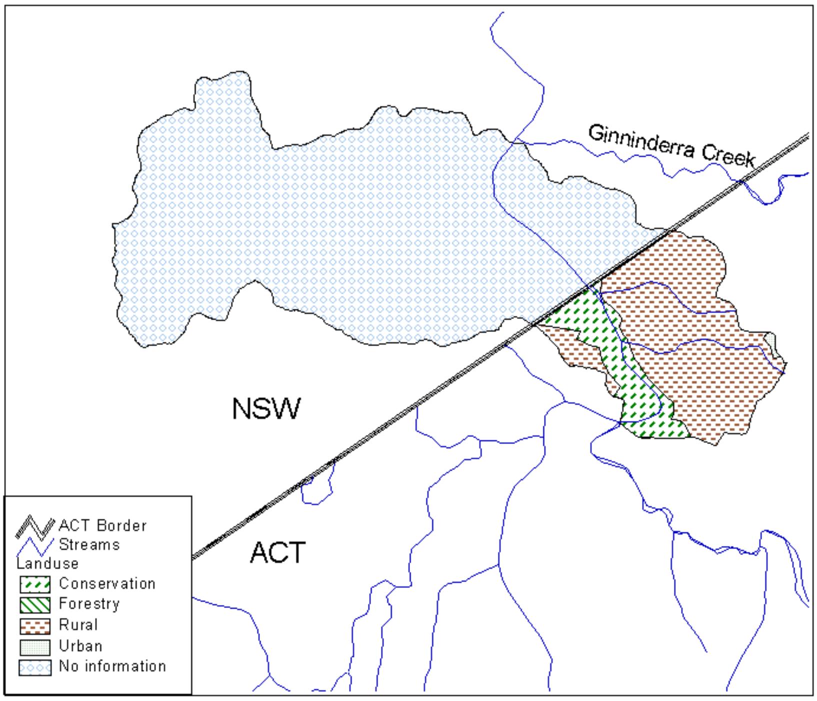
Location	Murrumbidgee River; Cotter River to junction with Molonglo River
Area	Total – 12,282 ha ACT – 7992 ha
Landuse	50% Rural, 50% Forestry
Geology	40% Paddys River Volcanics, 30% Nungar Beds, 30% Volcanics
Vegetation	30% Native Grassland, 30% Open Forest, 40% Open Woodland
Soil	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: domestic water supply, irrigation and stock water, recreation – swimming and boating, waterscape, aquatic habitat, discharge – stormwater

General Description

Small pools and rapids characterise this section of the Murrumbidgee, as it flows through Stony Creek Nature Reserve. Diverse aquatic habitats support populations of native fish and platypus. Steep forested slopes border a wide river channel with extensive sand and gravel margins. Remnant open forest is found on the steep slopes below Mount McDonald and on Stony Creek. Vegetation in the north of the sub-catchment consists of scattered trees, pasture and tea-tree.

Soils tend to be shallow and stony on upper hill slopes and in gorges. Silty topsoil overlays thick clay subsoil on lower and more gentle slopes, while sandy alluvium is found along river banks.

5. WOODSTOCK



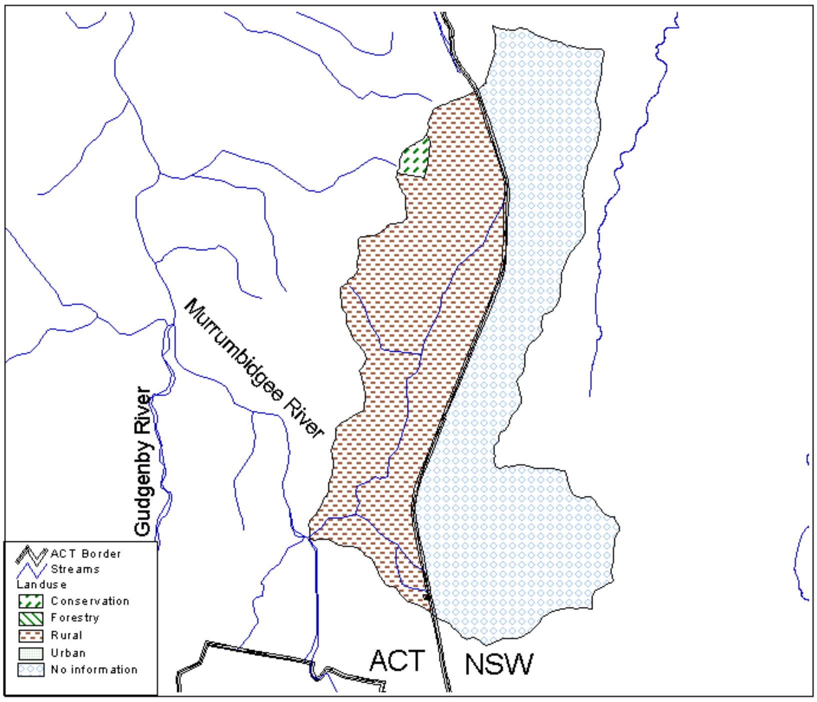
Location	Murrumbidgee River; junction with Molonglo River to junction with Ginninderra Creek
Area	Total – 4,232 ha ACT – 1,042 ha
Landuse	Rural, Conservation
Geology	40% Paddys River Volcanics, 30% Nungar Beds, 30% Volcanics
Vegetation	50% Open Forest, 50% Mixed Vegetation
Soil	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: stock water, recreation – swimming and boating, waterscape, aquatic habitat, discharge – wastewater.

General Description

The Murrumbidgee flows through Woodstock Nature Reserve until it reaches the NSW border. Diverse aquatic habitats support populations of native fish and platypus. Steep forested slopes border a wide river channel with extensive sand and gravel margins.

Sediments from soil erosion in new urban areas and nutrients from established urban areas enter this reach of the Murrumbidgee.

6. GUISE'S



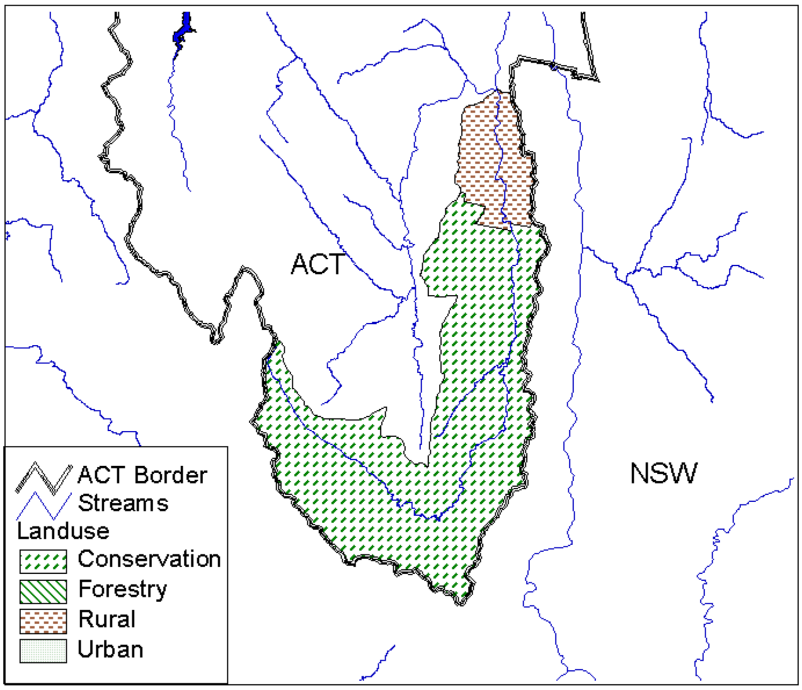
Location	Guises Creek.; headwaters to junction with Murrumbidgee River
Area	Total – 4,947 ha ACT – 2,172 ha
Landuse	Rural
Geology	Volcanics
Vegetation	50% Open Forest, 50% Open Woodland
Soil	50% Yellow Brown Red Duplex, 25% Red Brown Earths, 25% Yellow Podzolics
Environmental Values	Primary: conservation Secondary: domestic water supply, irrigation and stock water, recreation – swimming and boating, waterscape, aquatic habitat, discharge – stormwater

General Description

Gully and streambank erosion is common and there is minor dryland salinity resulting from past land management practices.

On the lower slopes topsoils are typically sandy with a bleached horizon overlying thick clay subsoil. Steeper upper slope and river gorge soils tend to be shallow, stony, sandy and silty.

7. NAAS



Location	Naas River; headwaters to junction with Gudgenby River
Area	28,927 ha
Landuse	20% Rural, 80% Conservation
Geology	80% Gingera-murrum bathol, 20% Nungar Beds
Vegetation	80% Open Forest, 10% Low Woodland, 10% Native Grassland
Soil	Red Brown Yellow Duplex
Environmental Values	Primary: conservation Secondary: domestic water supply, stock water, waterscape, aquatic habitat.

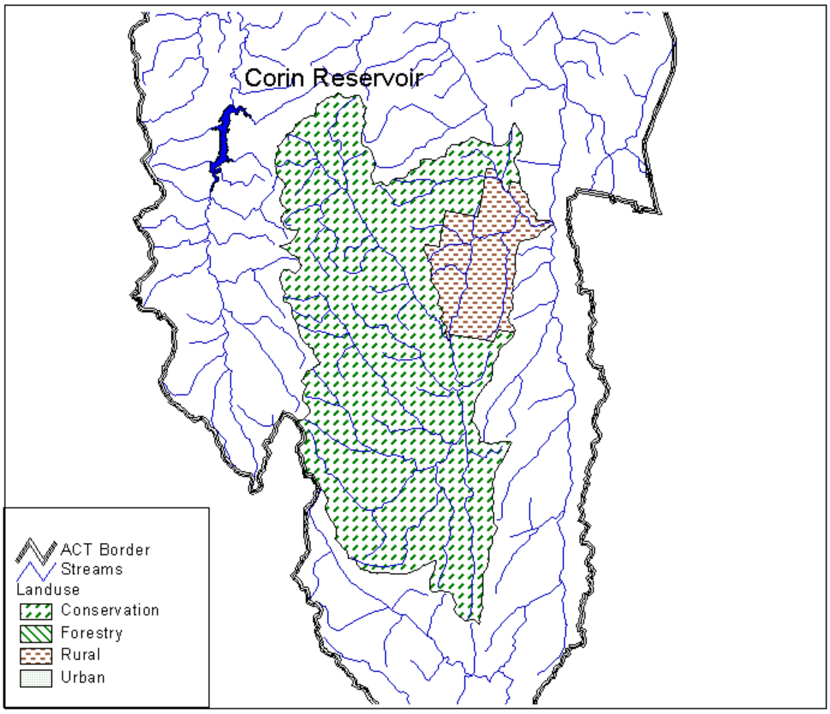
General Description

The Naas River flows predominantly through the forests of the Namadgi National Park. The sub-catchment is mountainous and the water quality is high. River flats and swamps are found along the major streams. The diverse aquatic communities and natural riverbank vegetation mean that the rivers in Namadgi are of high ecological value.

Soils on the steeper slopes in Namadgi tend to be shallow and stony. Sandy topsoil and clay subsoil is typical on the lower slopes while deep alluvium is found on the flats.

The rural part of the sub-catchment is undulating to hilly with a mixture of improved and native pasture and scattered trees. Topsoils are sandy and subsoils thick clay. Land management practices have resulted in sheet and gully erosion and stream bank erosion.

8. GUDGENBY



Location	Gudgenby River; headwaters to junction with Naas River
Area	37,216 ha
Landuse	70% Conservation, 30% Rural
Geology	80% Gingera-murrum bathol, 20% Nungar Beds
Vegetation	80% Open Forest, 10% Open Woodland, 10% Native Grassland
Soil	Red Brown Yellow Duplex
Environmental Values	Primary: conservation Secondary: domestic water supply, stock water, waterscape, aquatic habitat.

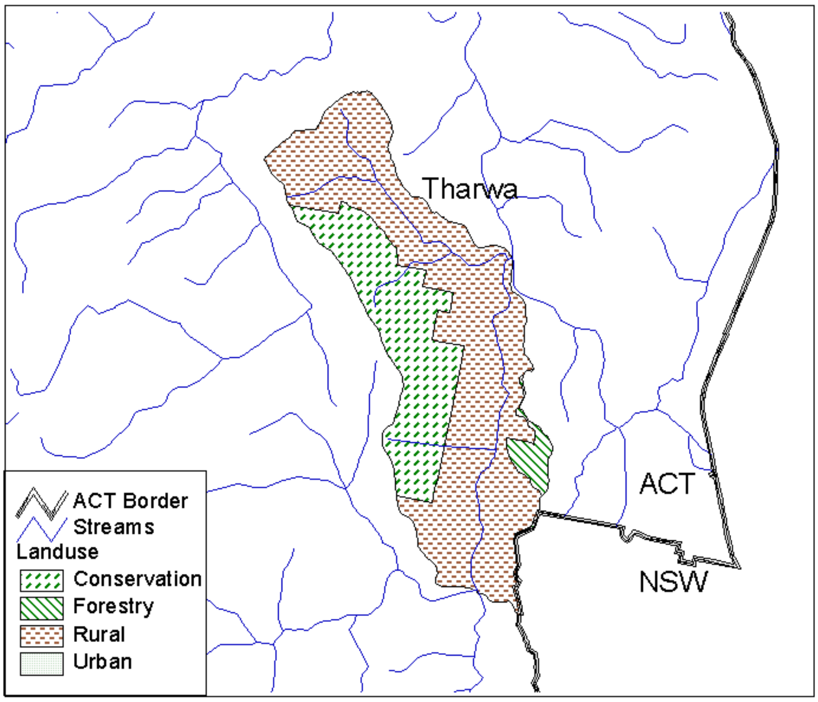
General Description

The Gudgenby River flows predominantly through the forests of the Namadgi National Park. The sub-catchments are mountainous and the water quality is high. The diverse aquatic communities and natural riverbank vegetation mean that the rivers in Namadgi are of high ecological value.

Soils on the steeper slopes in Namadgi tend to be shallow and stony. Sandy topsoil and clay subsoil is typical on the lower slopes while deep alluvium is found on the flats.

The rural part of the sub-catchment is undulating to hilly with a mixture of improved and native pasture and scattered trees. There is some streambank erosion due to stock damage.

9. TENNENT



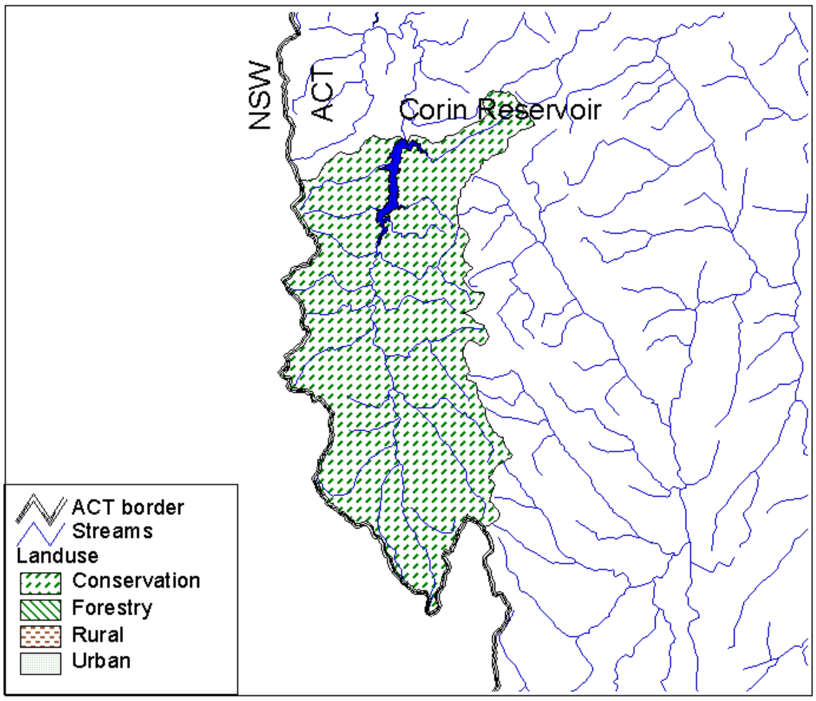
Location	Junction of the Naas and Gudgenby Rivers to junction with Murrumbidgee River
Area	4,504 ha
Landuse	60% Rural, 40% Conservation,
Geology	Gingera-murrum bathol
Vegetation	70% Open Woodland, 20% Open Forest
Soil	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: domestic water supply, stock water, recreation – swimming and boating, waterscape.

General Description

The lower reaches of the Gudgenby flow through rural lands where the natural communities may have been modified. The combination of high water quality in a modified environment makes the lower reaches a possible location for a future water storage.

Slopes are steep with flats along the valleys. Shallow, stony soils are found on the steep slopes and deep alluvial soils along the river flats.

10. CORIN

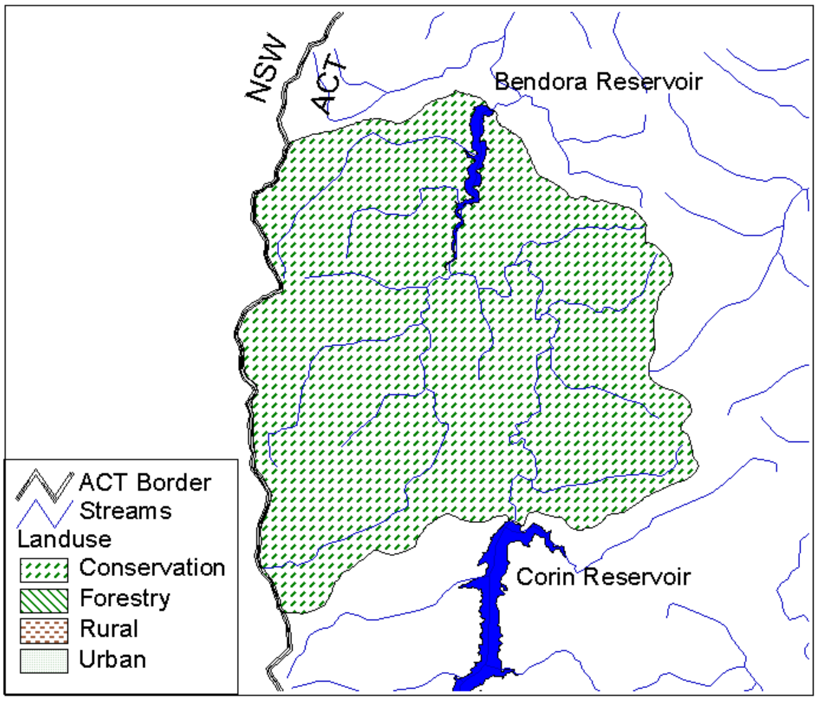


Location	Cotter River; headwaters to Corin Dam wall
Area	19,739 ha
Landuse	Conservation
Geology	50% Nungar Beds, 50% Gingera-murrum bathol
Vegetation	50% Open Forest, 40% Low Woodland, 10% Tall Open Forest
Soils	40% Red Yellow Earths, 30% Yellow Podzolics, 20% Alpine Humus/Brown Earths, 10% Yellow Red Earths
Environmental Values	Primary: water supply Secondary: aquatic habitat, waterscape

General Description

The sub-catchment is rugged and virtually unmodified. Slopes are steep with abundant rock outcrops. Shallow, stony and sandy soils are found on the upper slopes. Soils on the lower slopes are deeper, with clay subsoils. There is some localised soil erosion along tracks and firebreaks. Native fauna is abundant. Recreation is limited by the need to protect water quality.

11. BENDORA

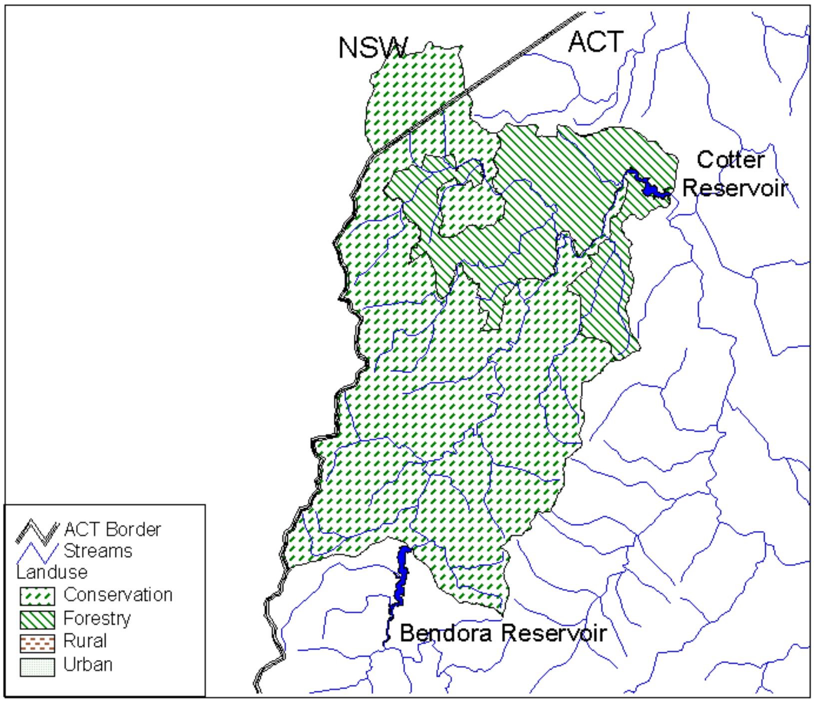


Location	Cotter River; Corin Dam wall to Bendora Dam wall
Area	9,079 ha
Landuse	Conservation
Geology	70% Nungar Beds, 30% Gingera-murrum bathol
Vegetation	60% Open Forest, 20% Low Woodland, 20% Tall Open Forest
Soils	60% Red Yellow Earths, 20% Yellow Red Earths, 10% Yellow Podzolics, 10% Alpine Humus/Brown Earths
Environmental Values	Primary: water supply Secondary: aquatic habitat, waterscape

General Description

The sub-catchment is rugged and virtually unmodified. Slopes are steep with abundant rock outcrops. Shallow, stony and sandy soils are found on the upper slopes. Soils on the lower slopes are deeper, with clay subsoils. There is some localised soil erosion along tracks and firebreaks. Native fauna is abundant. Recreation is limited by the need to protect water quality.

12. LOWER COTTER

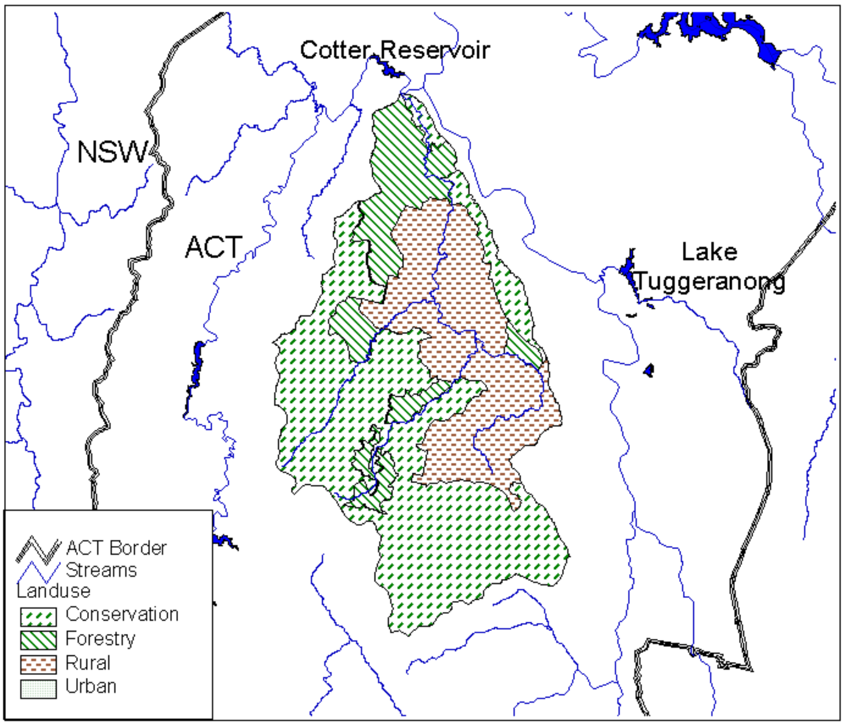


Location	Cotter River; Bendora Dam wall to Cotter Dam wall
Area	Total - 19,337 ha ACT – 18,221 ha
Landuse	70% Conservation, 30% Forestry
Geology	50% Nungar Beds, 20% Volcanics, 10% Gingera-murrum bathol, 10% Tidbinbilla Quartzite, 10% Paddys River Volcanics
Vegetation	50% Open Forest, 30% Softwood, 20% Tall Open Forest
Soils	50% Red Yellow Earths, 30% Yellow Earths, 10% Yellow Red Earths, 10% Yellow Podzolics,
Environmental Values	Primary: water supply Secondary: aquatic habitat, waterscape, hydro-electric power generation.

General Description

The lower section of the river near Cotter Dam contains large areas of pine forest and some sections of the river bank (below the dam) have been modified. The terrain is hilly with some steep slopes. Sandy topsoils overlay thick clay subsoils. There is some localised soil erosion from logged areas, tracks and firebreaks. This area is of lesser value ecologically than the Corin and Bendora sub-catchments, but provides a more diverse range of recreational activities.

13. PADDYS



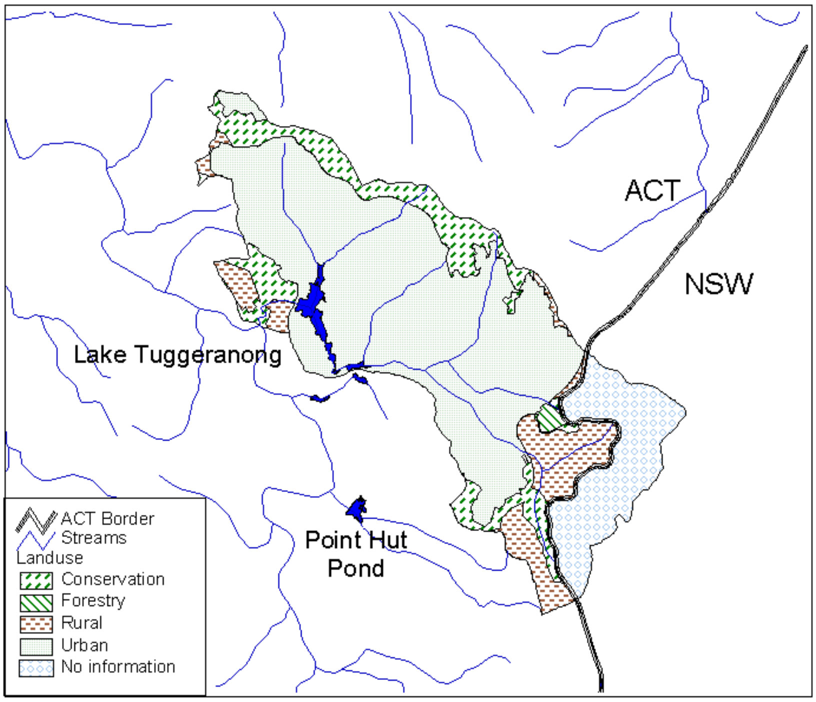
Location	Paddys River; headwaters to junction with Cotter River
Area	24,712 ha
Landuse	40% Conservation, 30% Rural, 30% Forestry
Geology	80% Gingera-murrum bathol, 20% Nungar Beds,
Vegetation	50% Open Forest, 20% Open Woodland, 30% Softwood
Soils	50% Red Brown Yellow Duplex, 50% Yellow Brown Red Duplex
Environmental Values	Primary: drainage Secondary: aquatic habitat, domestic water supply, stock water, recreation - swimming, waterscape.

General Description
The headwaters of Paddys River are in the forested zone of Namadgi National Park and Tidbinbilia Nature Reserve. The topography is undulating to steep. The water quality of the river is high.

The middle reaches run through a rural sub-catchment, although the river banks are largely unmodified. The topography is undulating to hilly. Vegetation is a mixture of improved and native pasture and scattered trees. Sandy topsoils overlay thick clay subsoils. Land management practices have resulted in sheet and gully erosion

The lower reaches are surrounded by natural forest and pine plantations. The topography is hilly to steep. Shallow sandy topsoils overlay clay subsoils. There is localised soil erosion from logged areas, track and firebreaks.

14. TUGGERANONG



Location	Tuggeranong Creek; headwaters to junction with Murrumbidgee River
Area	Total – 6,483 ha ACT – 5,560 ha
Landuse	80% Urban, 20% Conservation
Geology	80% Volcanics, 20% Silt
Vegetation	50% Urban, 50% Mixed Grassland
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: drainage Secondary: aquatic habitat, recreation – swimming and boating, waterscape, irrigation, discharge – stormwater.

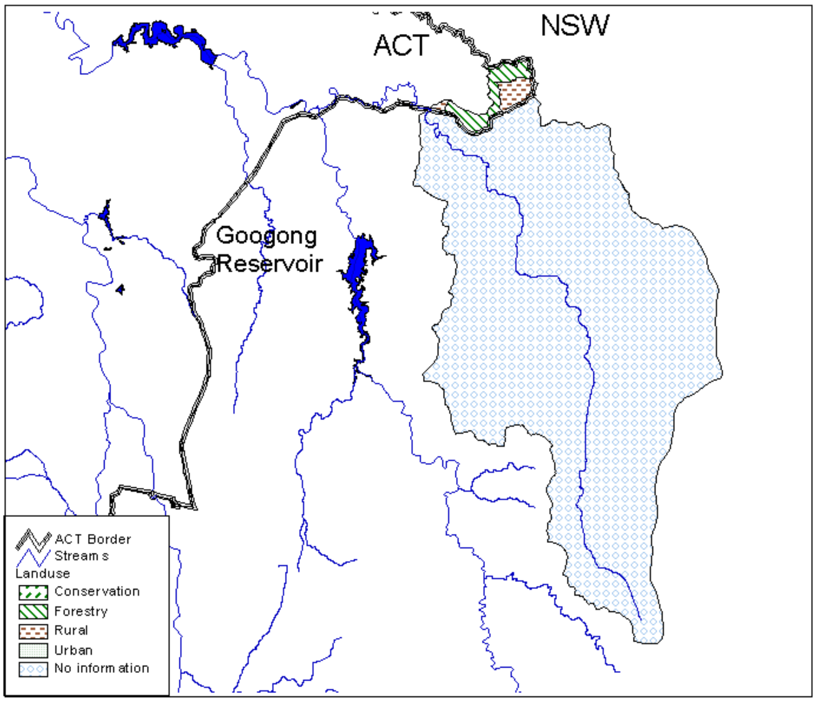
General Description

Tuggeranong Creek, a tributary of the Murrumbidgee River, rises in NSW to the east of Tuggeranong. The steep gradients through this rural area have been associated with sod erosion in the-past, although a number of remedial works have been undertaken.

The section through Tuggeranong has a gentle gradient, and the stream channel has been extensively modified. Waters draining to the creek frequently carry high loads of sediment from the surrounding urban areas.

The creek is intercepted by two water quality control ponds and Lake Tuggeranong. Below the dam wall, the creek travels a short distance through a natural channel to the Murrumbidgee River.

15. UPPER MOLONGLO

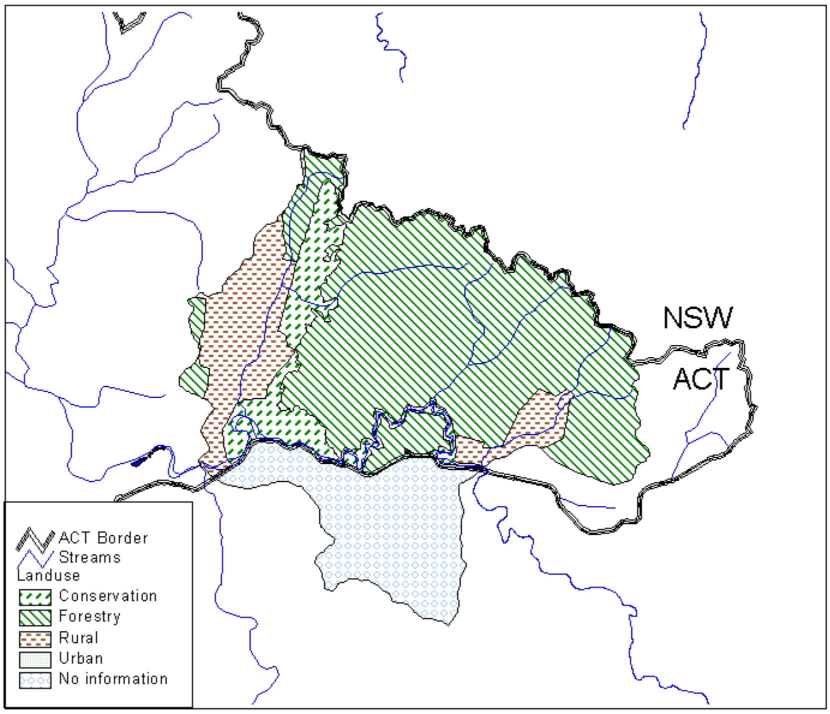


Location	Molonglo River; headwaters to Burbong Bridge
Area	Total – 48,086 ha ACT – 1,428 ha
Landuse	No Information
Geology	No Information
Vegetation	Native Grassland, Native Forest
Soils	Mostly Duplex and Gradational Soils
Environmental Values	sub-catchment is mostly in NSW, ACT portion is as follows:. Primary: Conservation Secondary: stock water, irrigation, waterscape, aquatic habitat.

General Description

The Molonglo River rises in the Great Dividing Range in NSW and flows in a northerly to north westerly direction towards the ACT. The ecology of the Molonglo River upstream of the ACT to Captains Flat has been extensively impaired by mine waste pollution. Although the pollution impacts have now been reduced, the riverine ecology has recovered only gradually. The river flows through generally undulating terrain.

16. KOWEN



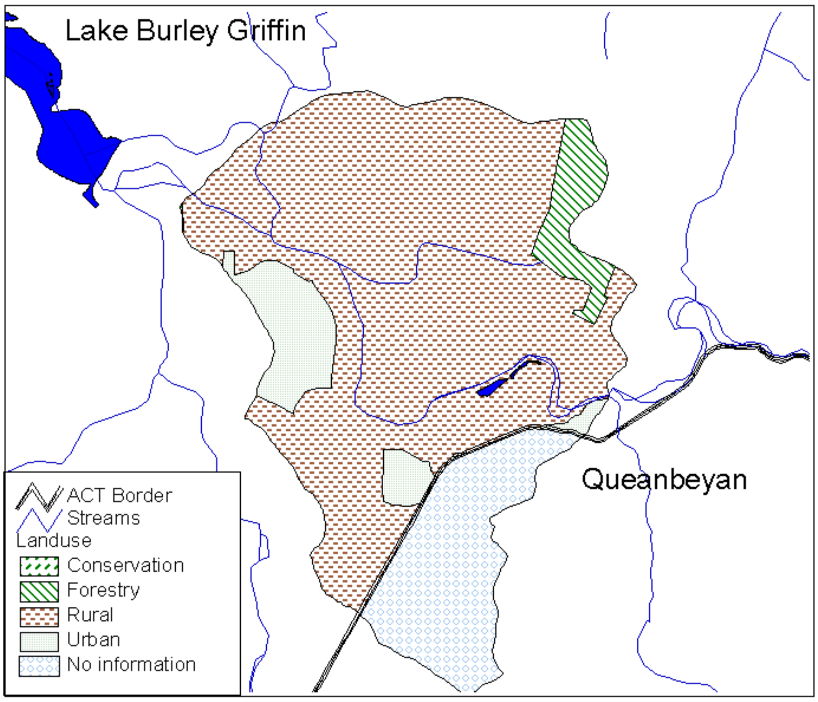
Location	Molonglo River; Burbong bridge to junction with Queanbeyan River
Area	Total - 9,080 ha ACT – 6590 ha
Landuse	80% Forestry, 20% Rural and Conservation
Geology	Nungar Beds
Vegetation	60% Softwood, 10% Native Grassland, 30% Open Woodland
Soils	60% Lithosols, 20% Alluvial, 20% Red Brown Earths
Environmental Values	Primary: Conservation Secondary: stock water, irrigation, waterscape, aquatic habitat.

General Description

The terrain is hilly to undulating. The sub-catchment includes the Kowen Escarpment and Molonglo Gorge which are of high scenic and natural heritage value.

Reedy Creek and Pialligo Creek enter the Molonglo in this section and land uses in their sub-catchments impact on water quality in the Molonglo before it flows into Lake Burley Griffin. Landuse in the Reedy Creek sub-catchment is predominantly forestry, and soil erosion from tracks, road networks and logging activities contribute to the sediment load which is carried into the river during rain events. Pialligo Creek drains a small area which includes the airport and a fertile floodplain with small agricultural holdings. The small size of the sub-divisions, the diversity and intensive nature of land management practices, and rising water table, have led to water quality problems such as high nutrient and organic levels.

17. FYSHWICK

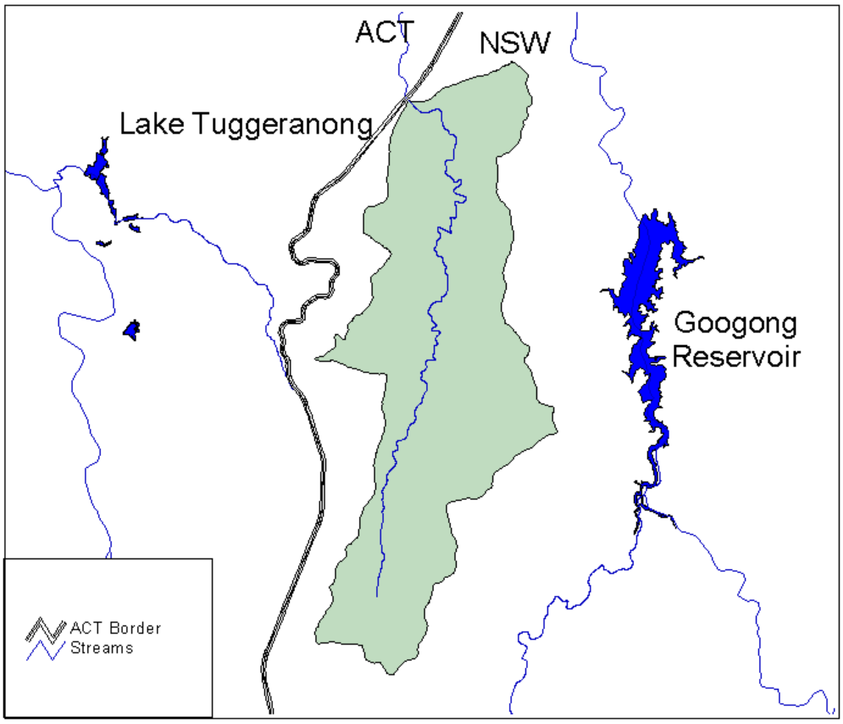


Location	Molonglo River; junction with Queanbeyan River to Woolshed Creek junction
Area	Total - 3,415 ha ACT – 2875 ha
Landuse	80% Rural, 20% Urban
Geology	Paddys River Volcanics
Vegetation	80% Mixed Grassland, 20% Open Forest
Soils	40% Lacustrian Solonetzic, 30% Alluvial, 30% Red Brown Earths
Environmental Values	Primary: conservation Secondary: aquatic habitat, stock water, irrigation, waterscape, recreation – boating and water skiing, discharge – stormwater and wastewater

General Description

The topography varies from gently sloping alluvial flats to moderately hilly. A range of agricultural activities is carried out including broadacre, horticulture, turf production, dairying and stock grazing. Sand dredging also takes place. The banks of the Molonglo River have been modified in places and willow trees have invaded several sections. There is soil erosion from intensively used areas and runoff of pesticides, weedicides and nutrients from horticultural areas of Pialligo. Treated sewage effluent enters this stretch of the river and there is runoff from residential and industrial areas.

18. JERRABOMBERRA HEADWATERS

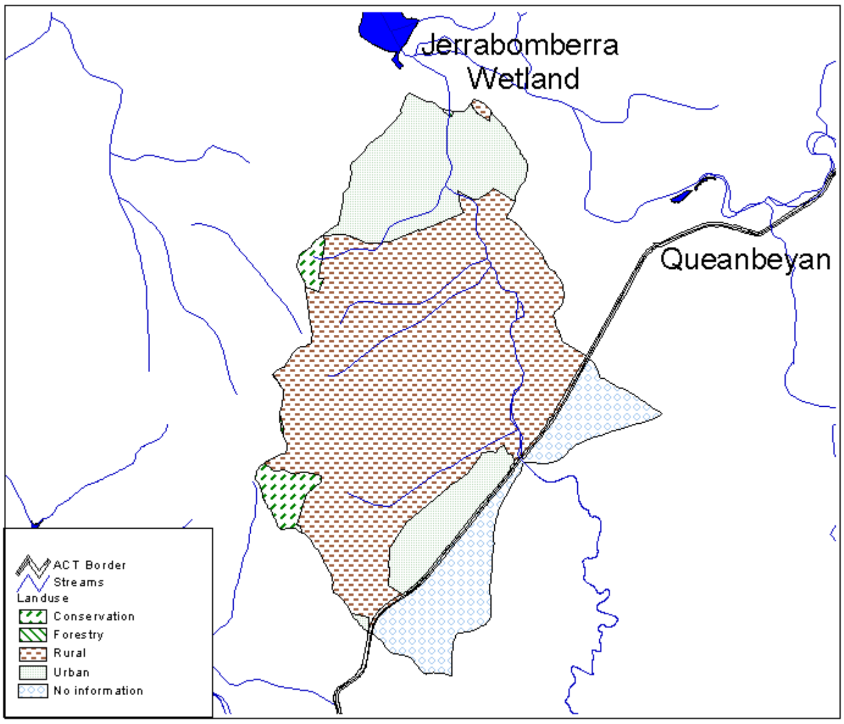


Location	Jerrabomberra Creek; headwaters to ACT border
Area	Total – 7,905 ha ACT – 0 ha
Landuse	Rural
Geology	Volcanics
Vegetation	Mixed Vegetation
Soils	80% Red Brown Earths, 20% Mixed Soils
Environmental Values	Not defined in Territory Plan - sub-catchment is in NSW.

General Description

The sub-catchment of Jerrabomberra Creek is primarily rural land in NSW. The landscape is one of open plains and gentle hills. Vegetation is mainly improved and native pasture. The channel form has been affected by soil erosion caused by vegetation loss due to grazing. There is gully erosion and soil compaction.

19. JERRABOMBERRA

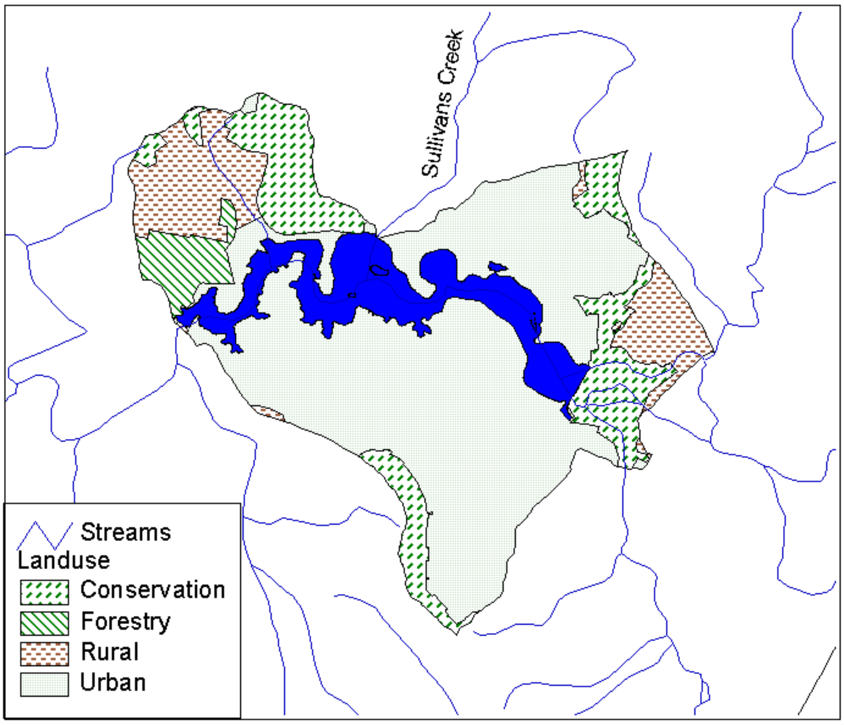


Location	Jerrabomberra Creek; ACT border to Canberra-Queanbeyan railway line
Area	Total – 4,935 ha ACT – 4,261 ha
Landuse	80% Rural, 20% Urban
Geology	50% Paddys River Volcanics, 50% Volcanics
Vegetation	10% Urban, 80% Mixed Grassland, 10% Open Forest
Soils	50% Lacustrian Solonetzic, 50% Mixed Soils
Environmental Values	<u>Primary</u>: drainage and open space <u>Secondary</u> stock water, irrigation, aquatic habitat, discharge- wastewater and stormwater.

General Description

The landscape is one of open plains and gentle hills. Vegetation is mainly improved and native pasture. The channel form has been affected by soil erosion and reduction of vegetation by grazing. There is gully erosion and soil compaction. Water quality in this section of Jerrabomberra Creek is poorer than in the headwaters due to stormwater from industrial and residential areas.

20. LAKE BURLEY GRIFFIN



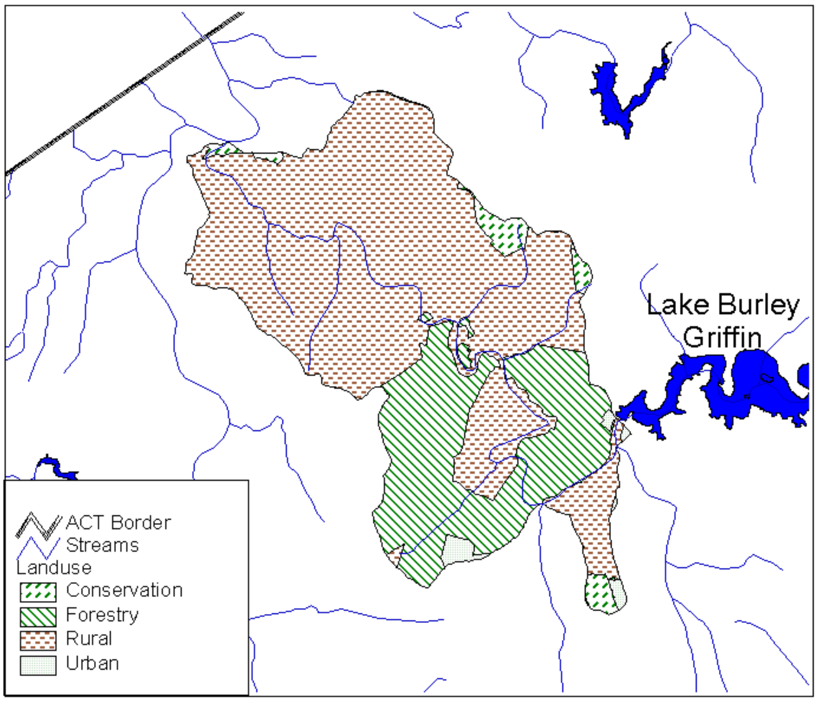
Location	Molonglo River; local drainage into Lake Burley Griffin, including Jerrabomberra wetlands
Area	Total - 5,088 ACT – 3675 ha
Landuse	Urban
Geology	Paddys River Volcanics
Vegetation	70% Urban, 30% Mixed Grassland
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: waterscape, aquatic habitat, stock water, discharge-stormwater, irrigation, recreation – swimming and boating, fishing, drainage.

General Description

The topography is characterised by gentle slopes and wide valleys. The sub-catchment includes Jerrabomberra wetlands which are of ecological and recreational value because the presence of a silt trap and the backwaters of the lake have provided habitats for waterfowl and other aquatic life.

Lake Burley Griffin acts as a vast water-detention basin, slowing water flow and diluting and settling pollutants, but the quality of water leaving Scrivener Dam is poor. The poor quality can be attributed to a variety of causes including the clearing of more than two-thirds of the sub-catchment, initially for grazing and more recently for urban and rural residential development, as well as the quality of water entering from the Molonglo and Queanbeyan catchments. Runoff of nutrients from local home gardens and parklands, and minor streambank erosion also affect water quality.

21. COPPINS



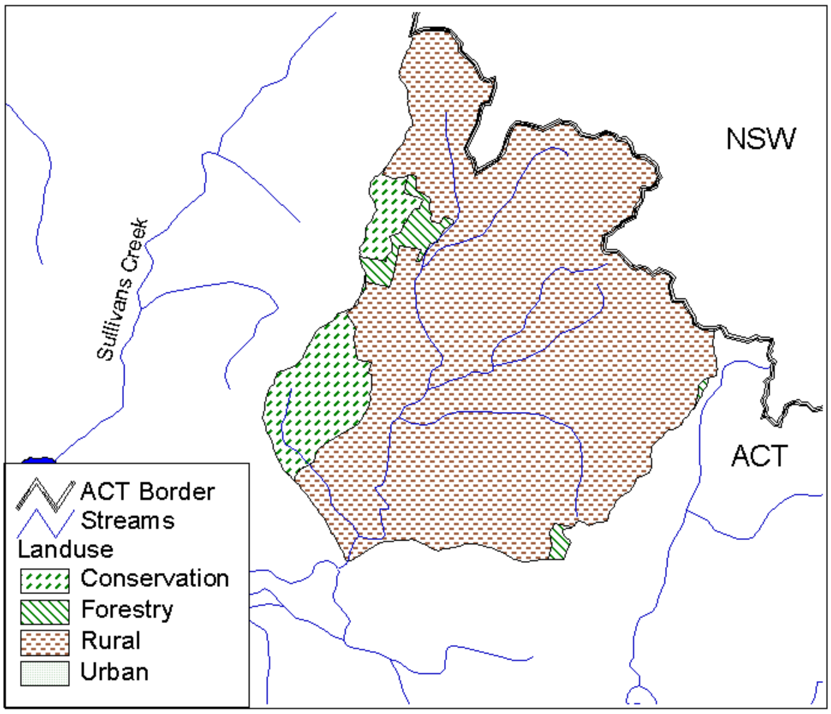
Location	Molonglo River; Scrivener dam wall to junction with Murrumbidgee River
Area	6,936 ha
Landuse	50% Rural, 50% Forestry
Geology	Paddys River Volcanics
Vegetation	30% Open Woodland, 30% Mixed Grassland, 30% Softwood
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: conservation Secondary: recreation - boating, waterscape, discharge – stormwater and wastewater, stock water, aquatic habitat.

General Description

The section of the Molonglo River below Scrivener Dam flows through undulating to hilly country, culminating in a series of rocky gorges and outcrops downstream. The reach from the dam to Coppins Crossing is modified by pine plantations, riverine willows and flow regimentation. Nevertheless, it has important scenic and recreational value, particularly in association with activities in the adjacent forests.

Downstream from Coppins Crossing the river has more natural character and increasing ecological potential. The valley surrounds have largely been cleared for rural uses. Close to the Murrumbidgee River confluence, treated effluent from the Lower Molonglo Water Quality Control Centre further modifies the streamflow and water quality.

22. WOOLSHED

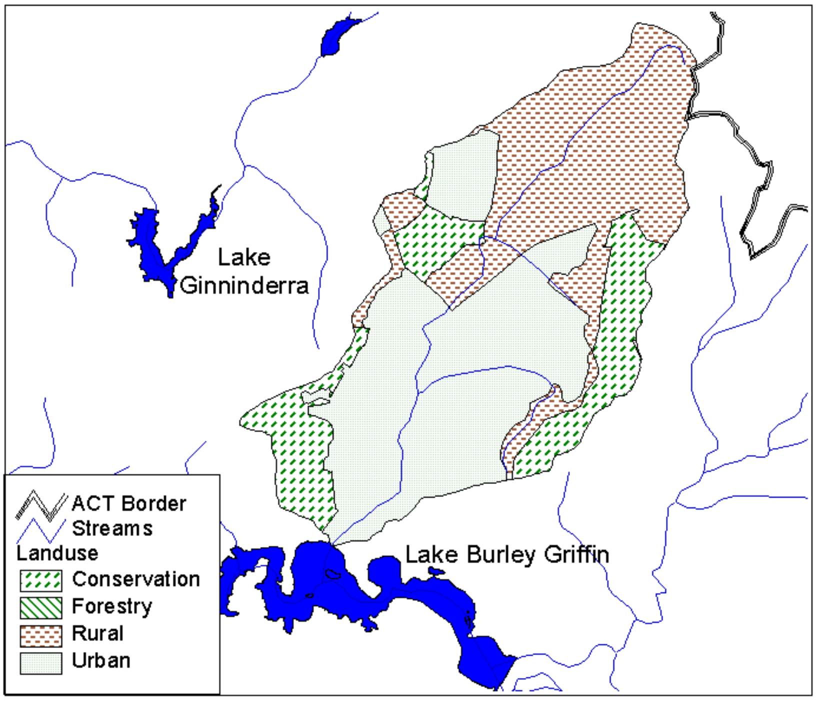


Location	Woolshed Creek; headwaters to junction with Molonglo River
Area	Total - 6,108 ha ACT – 2213 ha
Landuse	Rural
Geology	30% Silt, 40% Nungar Beds, 30% Paddys River Volcanics
Vegetation	70% Mixed Grassland, 10% Open Woodland, 20% Open Forest
Soils	40% Lacustrian Solonetzic, 30% Red Brown Earths, 30% Alluvial
Environmental Values	Primary: drainage and open space Secondary: stock water, aquatic habitat.

General Description

The topography is undulating to hilly with alluvial fans and terraces. Improved and native pasture dominates in the flatter areas with dry sclerophyll woodland on the steeper slopes. There is some gully erosion towards the bottom of steeper slopes and some soil erosion from agricultural uses which impairs water quality.

23. SULLIVANS

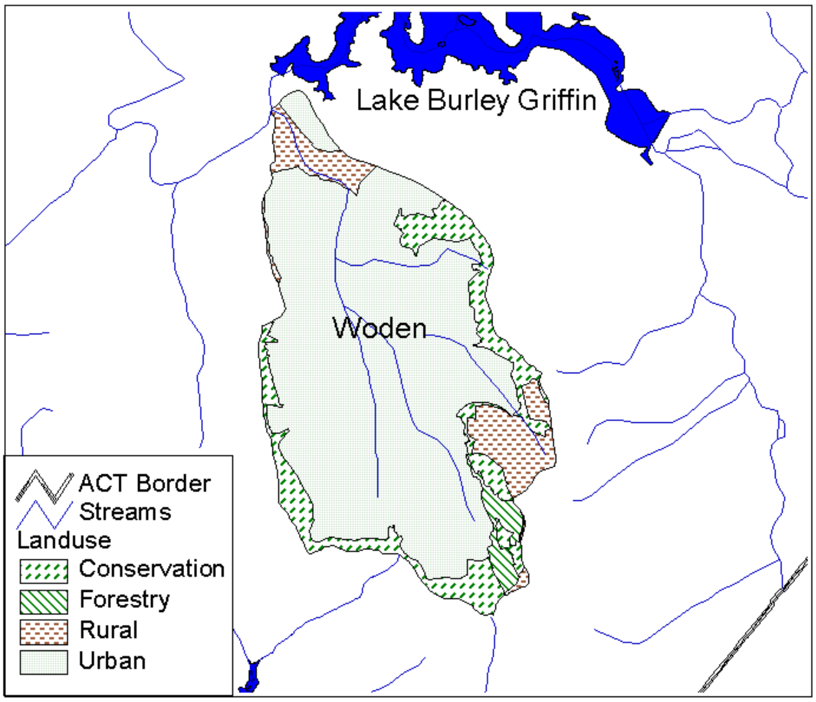


Location	Sullivans Creek; headwaters to Lake Burley Griffin
Area	5,232 ha
Landuse	40% Urban, 40% Rural, 20% Conservation
Geology	40% Silt, 60% Paddys River Volcanics
Vegetation	50% Urban, 50% Mixed Grassland
Soils	50% Yellow Brown Red Duplex, 50% Alluvial
Environmental Values	Primary: drainage and open space Secondary: aquatic habitat, stock water, irrigation, waterscape, discharge – stormwater.

General Description

Sullivans Creek flows through a broad plain with hills and steep slopes at the edges of the sub-catchment. The sub-catchment is predominantly urban and the channel has been extensively modified through the urban area. In the rural upper reaches vegetation consists of native grasses, pasture and scattered native trees. There is some soil erosion. The creek has limited ecological value and water quality is low in the urban area.

24. WODEN

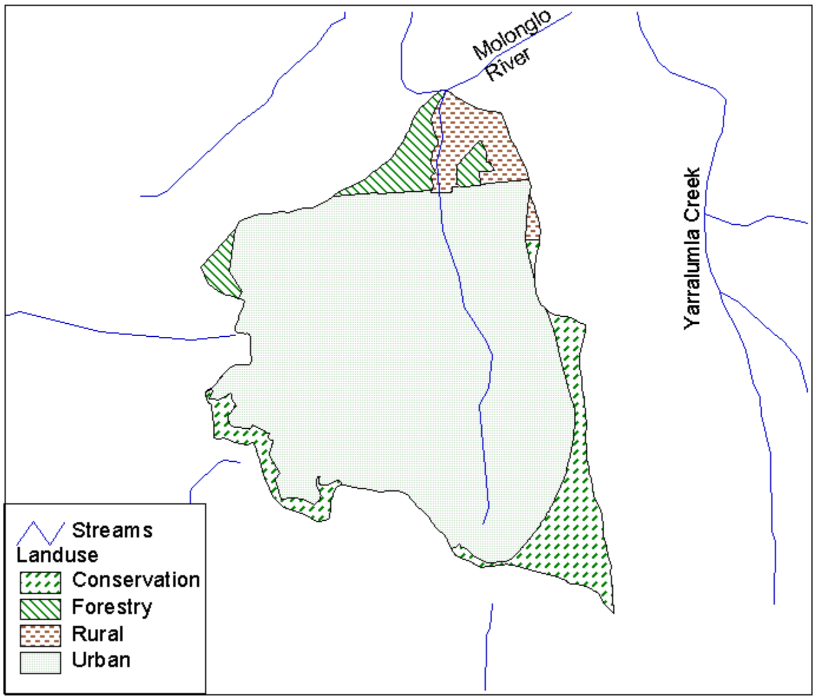


Location	Yarralumla Creek; headwaters to junction with Molonglo River
Area	3,435 ha
Landuse	Urban
Geology	70% Volcanics, 30% Silt,
Vegetation	50% Urban, 50% Mixed Grassland
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: drainage and open space Secondary: discharge – stormwater.

General Description

The topography is gently undulating with steeper hills at the edges of the sub-catchment. Yarralumla Creek bisects the Woden Valley and has a modified channel and low water quality due to urban runoff. The lower reaches are less modified, but are affected by extensive gully erosion.

25. WESTON

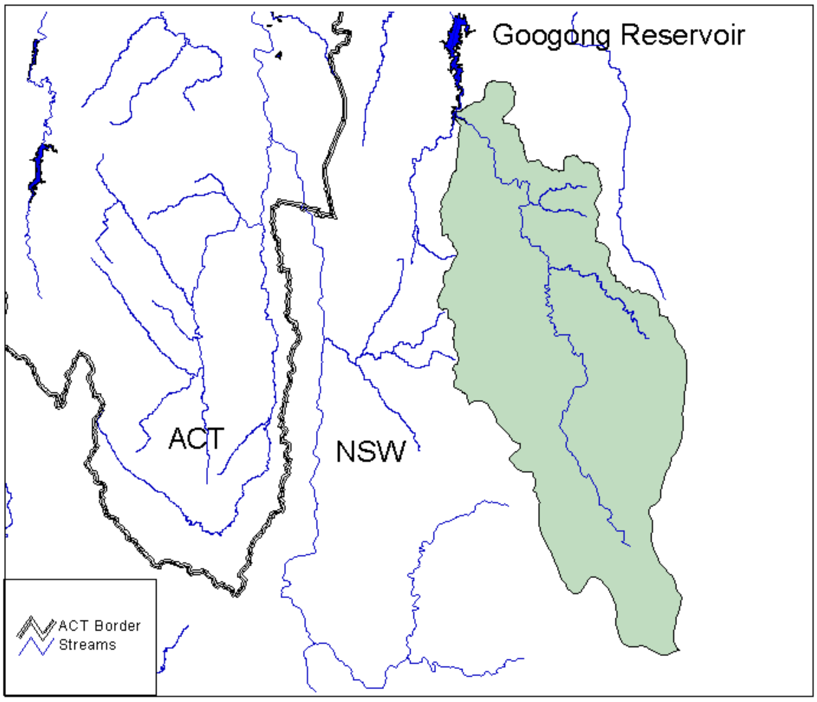


Location	Weston Creek; headwaters to junction with Molonglo River
Area	1,601 ha
Landuse	Urban
Geology	80% Volcanics, 20% Silt,
Vegetation	Urban
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: drainage and open space Secondary: discharge – stormwater.

General Description

The topography is flat to undulating with steeper slopes towards the edges of the sub-catchment. The sub-catchment is almost entirely urban and the creek channel retains almost no natural features. Water quality is low due to urban runoff.

26. TINDERRY



Location	Queanbeyan River; headwaters to upper end of Googong Dam
Area	Total – 70,695 ha ACT – 0 ha
Landuse	Agriculture, forestry
Geology	No Information
Vegetation	No Information
Soils	No Information
Environmental Values	Not defined in Territory Plan - sub-catchment is in NSW.

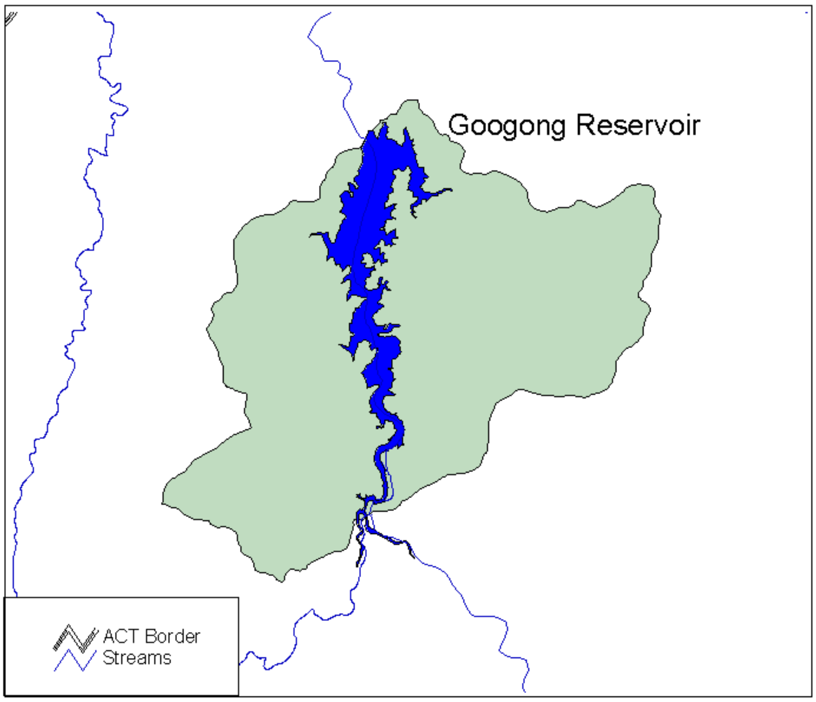
General Description

The catchment of the Queanbeyan River lies entirely in NSW. It consists of forested and rural lands in approximate equal proportions. It commences in the Gourock range where it initially flows through and undulating plain and then traverses a mixture of hilly to mountainous terrain dominated by the Tinderry Range.

Most of the sub-catchment is underlain by ancient sedimentary rocks of sandstone, shale and limestone, intruded by large masses of granite in the upper and middle reaches of the area. On the western margin of the sub-catchment there are some volcanic rocks which give rise to a variety of soils, mainly sandy loams. These are particularly susceptible to soil erosion following clearing and grazing of land.

The water quality is relatively high.

27. GOOGONG



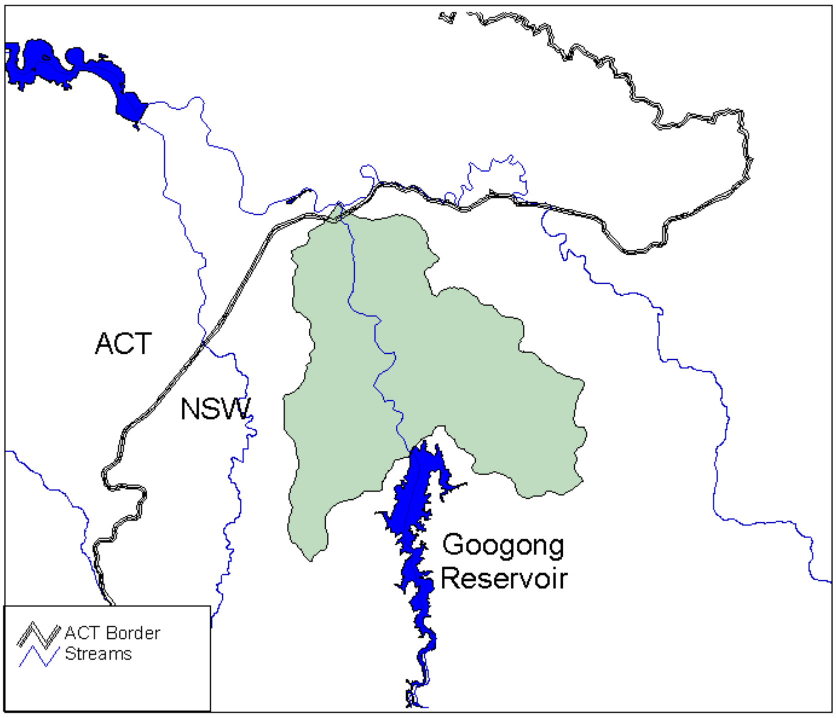
Location	Queanbeyan River; Upper end of Googong Dam to Googong Dam wall
Area	Total – 7,320 ha ACT – 0 ha
Landuse	No information
Geology	60% Nungar Beds, 40% Volcanics
Vegetation	50% Open Forest, 20% Native Grassland, 30% Open Woodland
Soils	50% Yellow Podzolics, 50% Red Brown earths
Environmental Values	Not defined in Territory Plan - sub-catchment is in NSW.

General Description

Within the foreshores, the terrain is generally undulating to hilly on the western side, with vegetation cover varying from dry sclerophyll forest upstream to cleared grazing land downstream. The eastern side of the foreshores is much steeper, with fairly uniform cover of dry sclerophyll forest.

The water quality in Googong Reservoir is relatively high. On behalf of the Commonwealth, the ACT controls approximately 5 000 ha which includes the water body and foreshores. The reservoir is suitable for a range of recreational activities and the upper reaches have a number of features of scenic and ecological value. The waters have been stocked with fish and are proving a valuable fishery.

28. LOWER QUEANBEYAN



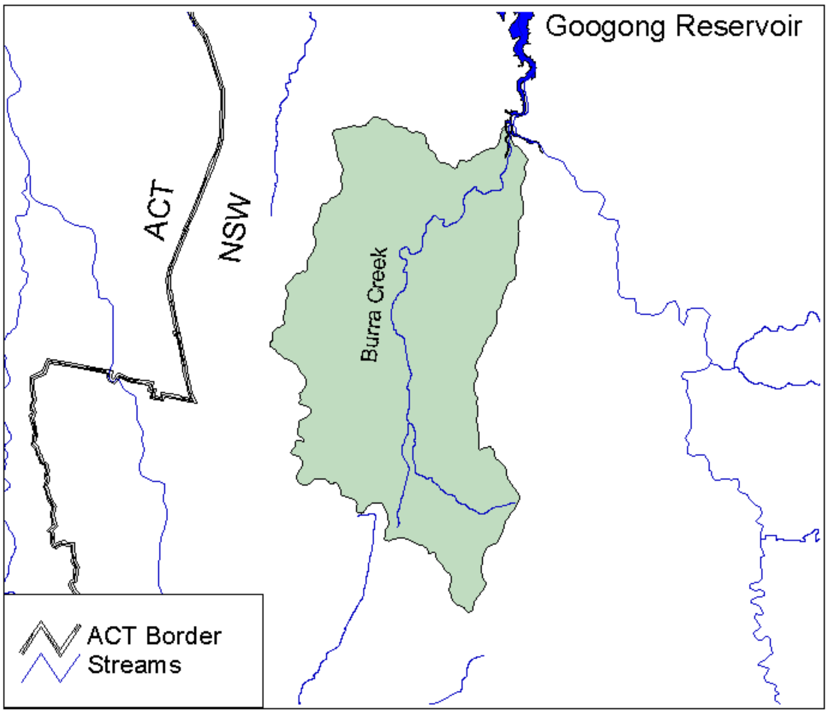
Location	Queanbeyan River; Googong Dam wall to junction with Molonglo River
Area	Total – 8,055 ha ACT – 19 ha
Landuse	Rural, Urban
Geology	50% Nungar Beds, 50% Volcanics
Vegetation	50% Open Forest, 50% Open Woodland
Soils	50% Yellow Podzolics, 50% Red Brown Earths
Environmental Values	Primary: Conservation Secondary: stock water, irrigation, waterscape, aquatic habitat, recreation – boating, discharge – stormwater.

General Description

The construction of Googong Dam has significantly altered the Queanbeyan River. Low flows have contributed to changes in channel morphology, which have led to habitat loss for fish and facilitated the colonisation of willows and other undesirable aquatic plants.

The river flows through rural land in the upper part of the sub-catchment, and a number of creeks and drainage lines enter the river along this section, some of which are undergoing erosion due to over clearing as well as being sites of illegal rubbish dumping. Downstream, the river forms the central natural feature of the open space corridor in Queanbeyan.

29. BURRA

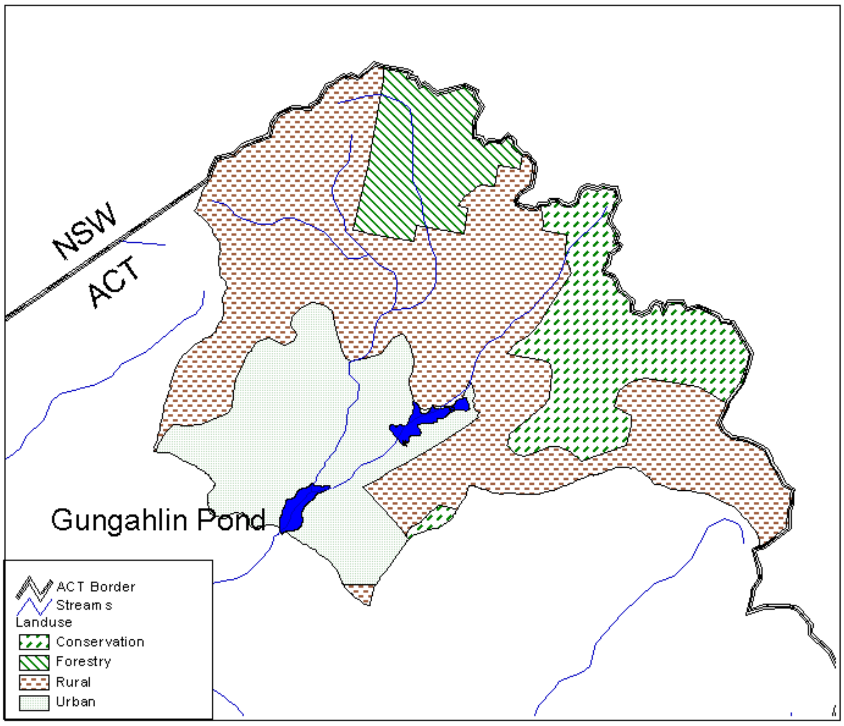


Location	Burra Creek; headwaters to upper end of Googong Dam
Area	Total – 10,062 ha ACT – 0 ha
Landuse	No information
Geology	50% Volcanics and Nungar Beds
Vegetation	50% Open Forest, 50% Low Woodland
Soils	30% Red Brown Earths, 30% Lithosols, 30% Lacustrian Solonetzic
Environmental Values	Not defined in Territory Plan - sub-catchment is in NSW.

General Description

A major tributary of the Queanbeyan River is Burra Creek which commences in heavily timbered country in the Tinderry Range and flows through the undulating plains of the Burra Valley to enter the Queanbeyan River at London Bridge. The landscape can be described as undulating to rolling low hills and alluvial fans.

30. GUNGAHLIN

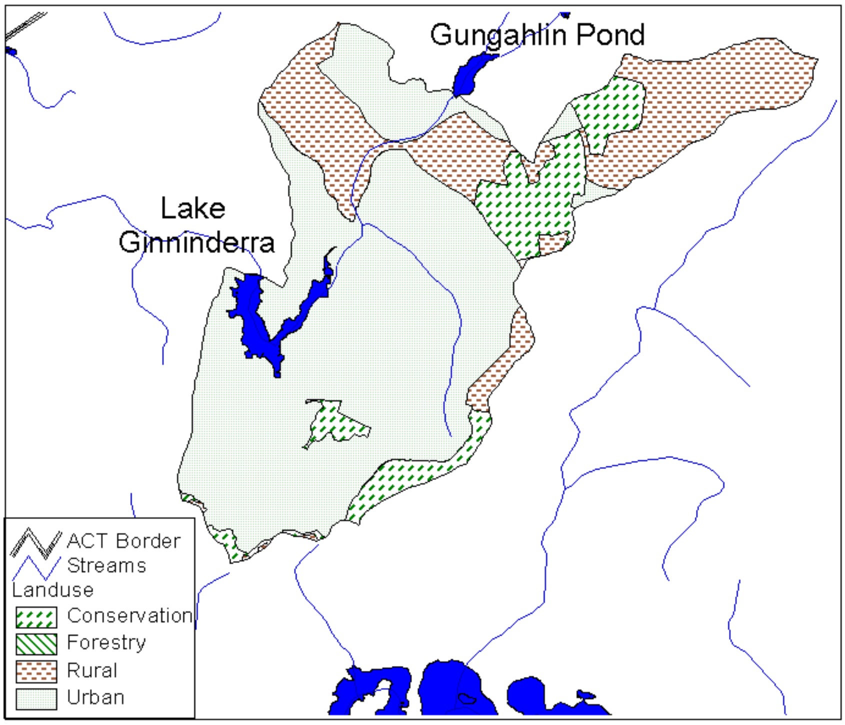


Location	Ginninderra Creek; headwaters to Gungahlin Pond dam wall
Area	4,989 ha
Landuse	50% Rural, 30% Urban, 10% Forestry, 10% Conservation
Geology	Sandstone
Vegetation	90% Mixed Grassland, 10% Open Forest
Soils	50% Alluvial
Environmental Values	Primary: drainage and open space Secondary: aquatic habitat, recreation - boating, waterscape, irrigation, discharge – stormwater.

General Description

Ginninderra Creek flows through a gently undulating floodplain. It has a modified sub-catchment, draining largely rural land in the upper reaches of the Gungahlin basin but then flowing through areas of urban development in Gungahlin. The creek is interrupted by Yerrabi and Gungahlin ponds. Yerrabi Pond captures runoff from the upper part of the sub-catchment, and the creek then runs through a golf course along a grassed floodway with small in-stream ponds until it enters Gungahlin Pond through a concrete lined channel. Sedimentation due to soil disturbances and erosion from construction sites cause both these ponds to have relatively high levels of turbidity.

31. LAKE GINNINDERRA

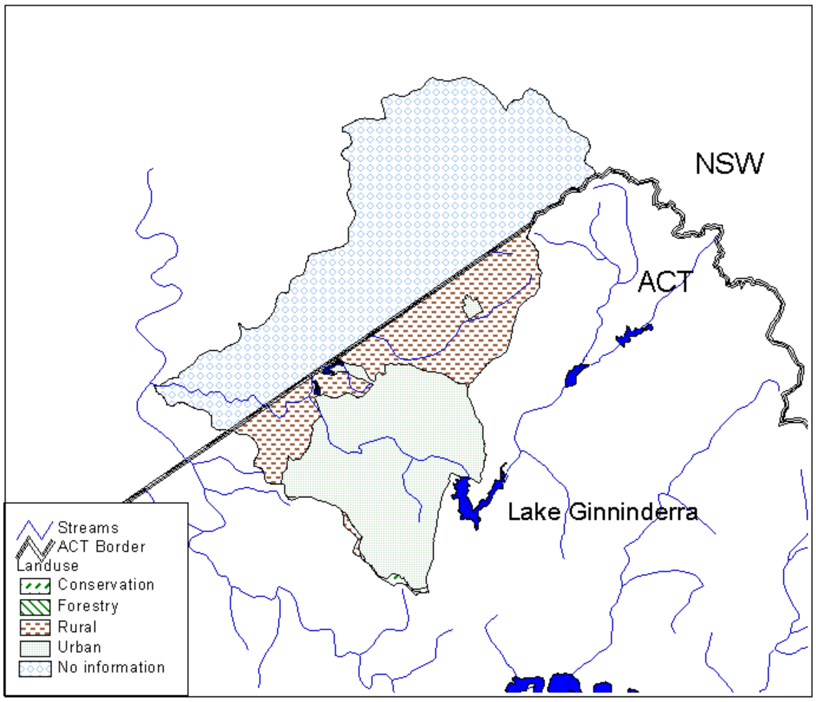


Location	Ginninderra Creek; Gungahlin Pond dam wall to Lake Ginninderra dam wall
Area	Total - 4,742 ha ACT – 4,200 ha
Landuse	70% Urban, 30% Conservation
Geology	80% Nungar Beds, 20% Volcanics
Vegetation	90% Mixed Grassland, 10% Urban
Soils	50% Yellow Brown Red Duplex, 50% Alluvial
Environmental Values	Primary: drainage and open space Secondary: aquatic habitat, recreation – swimming and boating, waterscape, irrigation, discharge – stormwater.

General Description

Ginninderra Creek flows through a hilly grassed area between Gungahlin Pond and Lake Ginninderra. Water quality in the lake is generally good, probably as a result of the stabilisation of the sub-catchment over time, except for some elevation in turbidity levels in the East Arm of the lake due to runoff from the Gungahlin development.

32. PARKWOOD



Location	Ginninderra Creek; Lake Ginninderra dam wall to junction with Murrumbidgee River
Area	Total - 12,664 ha ACT – 5358 ha
Landuse	70% Urban, 30% Urban
Geology	50% Paddys River Volcanics, 50% Volcanics
Vegetation	40% Mixed Grassland, 40% Low Woodland, 20% Urban
Soils	Yellow Brown Red Duplex
Environmental Values	Primary: drainage Secondary: aquatic habitat, irrigation, waterscape, discharge – stormwater.

General Description

The topography below Lake Ginninderra is undulating to hilly, with flats along the creek. The creek runs through settled residential areas as well as the new urban development in Dunlop. Shortly before the creek leaves the ACT, it flows through the minor industrial estate of Parkwood.

Stormwater from these areas is of poor quality and has a detrimental effect on the quality of water in the creek. The extent of urban development in the sub-catchment has a profound effect on flows in the creek with water levels raising dramatically during storm events.

4.3 Groundwater

Within the ACT groundwater has a number of uses. In urban areas groundwater is used by a number of institutions, including golf courses, either as a main supply or to supplement other supplies for irrigation. It is used by the lessees of detached homes to provide water for garden irrigation. Outside the urban area groundwater is used on a number of farms and rural settlements for domestic supply, irrigation and stock water.

In the ACT, groundwater occurs in two types of aquifer: fractured rock and alluvial. The area contains mainly fractured rock aquifers, with some scattered minor alluvial aquifers.

Fractured Rock Aquifers

The ACT is an area of folded sedimentary and volcanic rocks containing numerous geological units. The varying composition and structural history results in each geological unit having different water bearing characteristics.

Recharge of fractured rock aquifers is usually by the infiltration of rainwater into the fractured rock in hilly areas with thin permeable soils. There is usually a delay between the rainfall and the entry of water into the aquifer due to the time taken for water to travel through the surface material.

Water in fractured rock aquifers may flow significant distances before reaching the surface again and flow times may be up to 15 years. Flow rates and direction are dependent on geological structure rather than surface topography. Most discharge from fractured rock aquifers is in the form of base flow of surface streams.

The chemistry of water in fractured rock aquifers will vary between geological units. The majority of water has total dissolved solids (TDS) of 200-1100 mg/L with magnesium and calcium as being the dominant cations and bicarbonate and chloride the dominant anions. The variation in chemistry reflects complex geology and recharge conditions.

Aquifers in Alluvium

Alluvial aquifers occur in relatively recent unconsolidated deposits of silt, sand and gravel in river valleys and basins. They are easily exploited and are the major sources of fresh groundwater.

The recharge mechanisms of these aquifers are complex. Most of the recharge occurs by direct infiltration from the surface. Most alluvial aquifers occur in thin localised layers of gravel. They often contain only small volumes of water resulting in poor continuity of supply. It is difficult to analyse or generalise about these aquifers because they are small and scattered.

Yields and parameters of the aquifer

Bore yields are a function of aquifer hydraulic conductivity, storage capacity and bore siting and construction. Most bores in the ACT obtain yields within 40 m of the surface with fewer yielding water from below 100 m. In 1982 there were a total of 30 operating bores in fractured rock aquifers in the ACT with yields ranging from 0.25 to 5.68 L/s. The depths of the operating bores range from 15 to 85 m with a mean depth of 43m.

Quality

The quality of groundwater is within acceptable limits for human consumption and stock watering and has a low to moderate salinity hazard to irrigation. Most of the water is very hard with high cation concentrations of magnesium and calcium.

In the ACT groundwater in fractured rock aquifers constitutes a valuable resource with capacity for development for rural supplies or supplementary urban supplies. The main problems with groundwater are seepage affecting urban development and groundwater pollution that has occurred at landfill sites and from leakage or spilling of petrol and other hydrocarbon fuels.

5. SUB-CATCHMENT ENVIRONMENTAL FLOWS

5.1 Types of aquatic ecosystems and their location

Ecosystem	Description	Management goal	Water bodies in this category
Natural ecosystems	Ecosystems that have persisted from a period prior to European settlement.	Primary goal: Maintain ecosystems in their pristine state, Secondary goal: recreation.	Water bodies in Namadgi National Park, excepting the Cotter River catchment
Modified ecosystems	Ecosystems modified by catchment activities (land use change, discharges) or by changes to the flow regime.	Should meet a range of functions; recreation, conservation.	Rivers, lakes and streams outside Namadgi and the Canberra urban area including Molonglo (except Lake Burley Griffin) and Queanbeyan Rivers.
Water supply ecosystems	Ecosystems in catchments that provide the ACT water supply.	Primary goal: Provide water supply, Secondary goal: conservation.	Cotter River catchment.
Created ecosystems	Ecosystems in urban lakes, ponds and streams that have developed since urbanisation	Should meet a range of functions; recreation, conservation, irrigation.	All urban lakes and streams.

5.2 Environmental flows to be protected

For ACT waterbodies there are four elements that are built into any environmental flow, these are:

- **Low flows** are based on the 80^{th} percentile flows calculated on periods of not more than a month. The 80^{th} percentile flow is the flow which is exceeded 80% of the time.
- **Flushing flows** are required to ensure that channel structure and the dependent ecological processes are maintained. The discharge that research elsewhere has found to be the most critical is the 1 in 1.5 to 2.5 years annual recurrence interval flood event. In ACT rivers, other than water supply catchments, the short duration of high volume flows and a limit on abstraction of 10% of flows over the 80^{th} percentile will ensure that flushing flows occur with this frequency.
- **Special purpose flows** have not been set at this stage, except for the requirement of spawning flows in the Cotter River. A flow adequate for spawning

has been defined as the 50^{th} percentile[1] monthly flow during the spring months (September, October and November) and the 80^{th} percentile monthly flow for the months August and December to March. In two out of every five years flows are to be at or above the spawning level for each month in the August-to-March period.

- **Maintenance of impoundment levels** is required to protect macrophytes. For urban lakes and ponds the maximum drawdown as a result of abstraction is 0.20 m below spillway level

5.3 Allocations

10% of flows above the 80^{th} percentile has been selected as a suitable portion of water for abstraction in most sub-catchments. This 10% threshold has been selected using the best available scientific advice on the provision of habitat diversity and quality, nutrient and sediment cycling, movement of biota and connectivity between aquatic and terrestrial habitats.

For 'Water Supply Catchments' 100% of flows above the 80^{th} percentile are available for abstraction.

5.4 Groundwater recharge

The total amount of water available for consumptive use in each sub-catchment , based on the allowable proportion of surface water flow as set out in the Environmental Flow Guidelines, is set out from each sub-catchment in Section 5.6. The total may be made up of surface or groundwater. In addition the amount of groundwater available for extraction from each sub-catchment will be also be limited to a percentage of groundwater recharge as set out below.

Groundwater recharge is the entry of water into the saturated zone or water table and the associated flow away from the entry point within the saturated zone. Any assessment of recharge must based on long term data due to the slow recharge rates of most aquifers.

In urban areas, which represent around 20% of the total surface area of the ACT, recharge occurs very quickly in response to individual rain events, as a result of the concentration of runoff in open-jointed stormwater drains.

[1] The 50^{th} percentile flow is the flow which is exceeded 50% of the time. (also see Glossary)

Groundwater recharge in rural catchments occurs more slowly, mainly as a result of winter and spring rainfall, although there is some recharge from storm events during the summer.

The safe yield of an aquifer is equal to its long-term average recharge rate. Mean annual precipitation in the ACT ranges from over 1000 mm in the mountainous zone in the western part of the ACT to 600 mm in the urban zone in the north-eastern corner with an overall average of 718 mm. The mean annual potential evaporation across the ACT is about 1300 mm/year.

Quantitative estimation of groundwater recharge in the A.C.T

The estimation of groundwater available for allocation in this Plan was made using a water balance method. The results were checked by the use of a rainfall recharge method. Recharge rates for individual sub-catchments are shown in Table 3.

A comparison of results using the two methods is at Annex A

In line with the cautious approach taken in the calculation of environmental flows, groundwater abstraction will be limited to 10% of average annual recharge, around 7 GL/year.

The long-term average recharge rate is directly related to rainfall, infiltration characteristics and size of recharge zone. Generally, the larger the recharge zone, the higher the safe yield. However, safe yield should not be confused with the short-term yield obtained in order to establish pumping capacity of a bore. Where aquifers are small there is little buffer capacity against groundwater depletion during times of high withdrawal or low recharge.

Table 3: Calculation of groundwater recharge.

	Sub-catchment	A.C.T Area (ha)	A.C.T & NSW Area (ha)	Average Rainfall (mm/y)	Average Runoff (GL/y)	Actual Evapotranspiration (mm/y)	ACT & NSW Recharge (mm/y)	A.C.T Recharge (mm/y)	Recharge Volume A.C.T (GL/y)
1	Michelago	2,587	61,596	738	68.0	590	38	1.6	1.0
2	Tharwa	8,055	8,055	657	3.7	580	31	30.7	2.5
3	Kambah	6,063	6,063	649	3.1	570	29	28.6	1.7
4	Uriarra	7,992	12,282	819	25.5	590	22	14.3	1.8
5	Woodstock	1,042	4,232	789	7.3	590	27	6.6	0.3
6	Guise's	2,172	4,947	694	4.9	560	35	15.3	0.8
7	Naas	28,927	28,927	689	42.3	510	33	32.9	9.5
8	Gudgenby	37,216	37,216	720	50.4	550	35	34.9	13.0
9	Tennent	4,504	4,504	769	8.4	550	33	33.2	1.5
10	Corin	19,739	19,739	941	63.7	570	48	48.2	9.5
11	Bendora	9,079	9,079	1,059	44.9	510	55	54.6	5.0
12	Lower Cotter	19,337	19,337	808	46.4	535	33	31.0	6.0
13	Paddy's	24,712	24,712	812	42.2	600	41	41.0	10.1
14	Tuggeranong	5,560	6,483	694	11.2	510	11	9.2	0.6
15	Upper Molonglo	1,428	48,086	634	48.1	510	24	0.7	0.3
16	Kowen	6,590	9,080	676	7.5	570	24	17.2	1.6
17	Fyshwick	2,115	3,415	659	1.9	580	24	20.0	0.7
19	Jerrabomberra	4,261	4,935	674	4.7	550	29	24.7	1.2
20	Lake Burley Griffin	3,675	5,088	710	9.5	505	19	13.5	0.7
21	Coppins	6,936	6,936	652	5.9	550	17	17.1	1.2
22	Woolshed	2,213	6,108	666	6.9	525	29	10.4	0.6
23	Sullivan's	5,232	5,232	660	5.0	550	14	13.9	0.7
24	Woden	3,435	3,435	746	7.2	520	16	16.3	0.6
25	Weston	1,601	1,601	789	4.2	510	15	15.3	0.2
28	Lower Queanbeyan	19	8,055	613	6.9	505	23	0.1	0.0
30	Gungahlin	4,989	4,989	629	4.7	520	15	15.3	0.8
31	Lake Ginninderra	4,200	4,742	657	4.5	550	12	10.5	0.5
32	Parkwood	5,358	12,664	665	12.5	550	16	6.8	0.9
	Total/average	229,037	371,540	724	551.5	547	27	20.1	73.1

5.5 Surface water flow calculation for sub-catchments

The environmental flows and associated allocations for the 32 sub-catchments in the ACT have been calculated from the mean monthly flows over the longest period of available data. The use of mean monthly flows is considered the most effective long-term indicator of water availability. It should be noted that lower than mean flows occur more often than higher than mean flows in most streams. Various methods have been used to determine the mean monthly flows in the sub-catchments as follows:

Gauging station data has been used for sub-catchments that contain a station which represents a significant proportion of the sub-catchment. Gauging data is available for periods ranging from 5 years to 80 years at the various sites.

The area method is used where sub-catchments are self-contained yet do not contain a gauging station. A gauging station that represents a sub-catchment with similar characteristics (land use geology, soils and vegetation) is used. Based on the fact that the quantity of runoff varies with catchment area, this similar station's flow is varied proportional to the areas of the two sub-catchments.

$\text{Runoff (1)} = [\text{Area (1)}/\text{Area(2)}]^{0.7} * \text{Runoff(2)}$[2]

Rainfall data may also be used to calculate flow on the basis of the application of the catchment of the stream to a rainfall run-off model calibrated to regional parameters.

The reliability of estimates varies with the similarity of catchments and areas used for comparison. Table 4 shows the flow gauging stations which were used to calculate the flows for each sub-catchment.

5.6 Sub-catchment environmental flows and available allocations

Some of these sub-catchments are partially or completely located in NSW. Sub-catchments in NSW may be controlled by the ACT (such as the sub-catchment of Googong Reservoir). Sub-catchments may also straddle the border and be partially controlled by ACT and partially by NSW (such as Uriarra).

In sub-catchments controlled by the ACT, NSW will be advised of the maximum potential allocations for the sub-catchment and will be expected to ensure that allocations beyond that amount are not created. In the case of NSW sub-catchments which are of interest to the ACT, NSW will be advised that ACT would like to see the level of allocations remain below the maximum potential. For any portion of these cross border sub-catchments which is not completely controlled by the ACT, ACT will only create allocations up to the potential shown for the ACT portion of the sub-catchment.

[2] Overseas studies indicate 0.7 is an appropriate exponent in most circumstances. Independent studies in the local area have produced a range of results both higher and lower than 0.7. 0.7 has been used except where a specific study has produced a reliable alternative exponent.

Table 4: FLOW GAUGING STATIONS

Station Number	Station Name	Sub Catchment	Records Commenced	Records Ceased
410731	Gudgenby River at Tennent	Michelago	6/8/1963	
410772	Sullivans Ck at Southwell Park	Tharwa Kambah Fyshwick Woolshed Ck	18/8/1979	
410713	Paddy's River at Riverlea	Uriarra Woodstock Paddy's	29/3/1957	
410743	Jerrabomberra Ck at Four Mile Ck	Guises Kowen Jerrabomberra L Queanbeyan	5/6/1969	11/7/1997
410711	Gudgenby River at Naas	Naas Gudgenby	19/3/1957	
410736	Orroral River at crossing	Tennent	29/9/1967	
410730	Cotter River at Gingera	Corin Bendora	3/7/1963	
410733	Coree Ck at Threeways	Lower Cotter	29/7/1964	
410745	Yarrulumla Ck at Curtin	Tuggeranong L Burley Griffin Woden Weston	29/1/1970	
410705	Molonglo River at Burbong	Upper Molonglo	14/3/1929	
410751	Ginninderra Ck upstream Barton Hwy	Coppins Gungahlin L Ginninderra Part Parkwood	3/9/1979	
410775	Sullivan's Ck at Barry Drive	Sullivan's Ck	19/3/1986	
410781	Queanbeyan R U/S Googong Dam	Tinderry	2/2/1990	
410774	Burra Ck at Burra Rd	Googong Burra	1/3/1985	
410750	Ginninderra Ck U/S Charnwood Rd	Part Parkwood	9/12/1978	
410765	L Ginninderra at Dam	Part Parkwood	7/11/1973	

1. Michelago (modified)

The environmental flows and potential allocation for the Michelago sub-catchment have been estimated by using the area method and the gauging station 410731 on the Gudgenby River.

Allocations in Megalitres –Michelago

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	3,805	306	3,499	3,455	350
February	3,011	212	2,800	2,731	280
March	2,884	255	2,629	2,621	263
April	6,049	465	5,584	5,491	558
May	4,239	1,025	3,215	3,918	321
June	5,537	1,382	4,154	5,121	415
July	7,339	1,699	5,640	6,775	564
August	7,950	2,095	5,855	7,364	586
September	8,333	2,495	5,838	7,749	584
October	8,880	1,822	7,057	8,174	706
November	6,149	1,274	4,876	5,662	488
December	3,786	468	3,318	3,454	332
Total	**67,962**	**13,498**	**54,465**	**62,515**	**5447**

Note: some totals may not add up due to rounding.

2. Tharwa (predominantly modified, remainder created)

The Tharwa sub-catchment environmental flows and flows available for use have been estimated by using the area method and the gauging station 410772.

Allocations in Megalitres –Tharwa

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	326	7	318	294	32
February	146	6	140	132	14
March	299	5	294	270	29
April	423	5	418	381	42
May	194	6	188	175	19
June	203	11	193	184	19
July	594	15	579	536	58
August	347	19	328	315	33
September	408	18	390	369	39
October	266	12	254	241	25
November	307	9	297	277	30
December	217	8	209	196	21
Total	**3,731**	**122**	**3,609**	**3,370**	**361**

Note: some totals may not add up due to rounding.

3. Kambah (predominantly modified, remainder created)

The Kambah sub-catchment environmental flows and flows available for use have been estimated by using the area method and the gauging station 410772 on Sullivans Creek.

Allocations in Megalitres - Kambah

Month	Average Monthly Flow (A)	80^{th}%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	267	5	262	241	26
February	120	5	115	109	12
March	245	4	241	221	24
April	346	4	342	312	34
May	159	5	154	144	15
June	167	9	158	151	16
July	487	12	475	440	48
August	285	14	270	258	27
September	335	13	322	303	32
October	218	10	208	197	21
November	251	7	244	227	24
December	178	6.	171	160	17
Total	**3058**	**94**	**3058**	**2846**	**306**

Note: some totals may not add up due to rounding.

4. Uriarra (modified)

The environmental flows and potential allocation for the Uriarra sub-catchment have been estimated using the area method and the gauging station 410713 on Paddys River.

Allocations in Megalitres –Uriarra

Month	Average Monthly Flow (A)	80^{th}%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	1,751	207	1,544	1,597	154
February	1,144	117	1,027	1,041	103
March	1,157	119	1,038	1,053	104
April	2,198	204	1,994	1,999	199
May	1,315	320	995	1,216	100
June	1,430	483	948	1,336	95
July	3,095	611	2,484	2,847	248
August	3,107	764	2,342	2,872	234
September	3,164	791	2,373	2,926	237
October	3,162	659	2,503	2,912	250
November	2,182	460	1,722	2,010	172
December	1,778	270	1,508	1,628	151
Total	**25,483**	**5005**	**20,478**	**23,437**	**2047**

Note: some totals may not add up due to rounding.

5. Woodstock (modified)

The environmental flows and potential allocation for Woodstock have been estimated using the area method and the gauging station 410713 on Paddys River.

Allocations in Megalitres –Woodstock

Month	Average Monthly Flow (A)	80^{th}%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	501	59	442	457	44
February	327	34	294	298	29
March	331	34	297	301	30
April	629	58	571	572	57
May	376	92	285	348	28
June	409	138	271	382	27
July	886	175	711	815	71
August	889	219	670	822	67
September	905	226	679	838	68
October	905	189	716	833	72
November	624	132	493	575	49
December	509	77	432	466	43
Total	**7291**	**1433**	**5861**	**6707**	**585**

Note: some totals may not add up due to rounding.

6. Guise’s (modified)

The Guise’s sub-catchment flows have been estimated by the area method using a sub-catchment associated with the station 410743 on Jerrabomberra Creek. This sub-catchment was seen as an effective one to be used in a comparison with Guise’s because it has similar climatic characteristics, land use and is of a similar size.

Allocations in Megalitres - Guises

Month	Average Monthly Flow (A)	80^{th}%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	381	0.0	381	343	38.1
February	165	0.0	165	149	16.5
March	182	0.0	182	164	18.2
April	466	2.2	464	420	46.4
May	240	11.2	229	217	22.9
June	279	14.8	264	253	26.4
July	770	18.0	752	695	75.2
August	587	19.4	568	530	56.8
September	689	19.7	669	622	66.9
October	658	12.6	645	593	64.5
November	288	5.8	282	260	28.2
December	184	0.4	184	166	18.4
Total	**4889**	**104**	**4785**	**4412**	**478**

Note: some totals may not add up due to rounding.

7. Naas (predominantly natural, remainder modified)

The Naas sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410711 on the Gudgenby River.

Allocations in Megalitres –Naas

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	2,573	358	2,214	2,351	221
February	1,976	253	1,723	1,803	172
March	1,906	284	1,622	1,744	162
April	3,516	444	3,072	3,208	307
May	2,720	866	1,854	2,535	185
June	2,991	1,095	1,896	2,802	190
July	4,342	1,267	3,074	4,034	307
August	4,882	1,581	3,301	4,552	330
September	5,143	1,668	3,475	4,796	348
October	5,379	1,285	4,094	4,970	409
November	3,944	970	2,974	3,646	297
December	2,901	499	2,402	2,661	240
Total	**42,273**	**10,570**	**31,701**	**39,102**	**3168**

Note: some totals may not add up due to rounding.

8. Gudgenby (predominantly natural, remainder modified)

Gudgenby environmental flows and flows available for use have been estimated from the monthly and flow duration data of the 410711 station on the Gudgenby.

Allocations in Megalitres - Gudgenby

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	3,069	427	2,641	2,805	264
February	2,357	302	2,055	2,151	205
March	2,273	339	1,935	2,080	193
April	4,194	529	3,664	3,827	366
May	3,245	1,033	2,212	3,024	221
June	3,568	1,306	2,262	3,342	226
July	5,179	1,512	3,667	4,812	367
August	5,824	1,886	3,938	5,430	394
September	6,135	1,989	4,146	5,720	415
October	6,416	1,533	4,884	5,928	488
November	4,704	1,157	3,547	4,350	355
December	3,460	595	2,865	3,174	286
Total	**50,425**	**12,609**	**37,816**	**46,644**	**3,782**

Note: some totals may not add up due to rounding.

9. Tennent (predominantly modified, remainder natural)

The Tennent sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410736 on the Orroral River.

Allocations in Megalitres - Tennent

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	618	73	546	564	55
February	432	51	381	394	38
March	457	63	394	417	39
April	729	101	628	666	63
May	610	253	356	574	36
June	591	281	311	560	31
July	816	297	519	765	52
August	980	361	618	918	62
September	931	350	581	873	58
October	943	308	635	880	64
November	709	191	518	657	52
December	567	94	473	520	47
Total	**8,383**	**2,424**	**5,960**	**7,787**	**596**

Note: some totals may not add up due to rounding.

10. Corin (natural)

The Corin sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410730 on the Cotter River.

Allocations in Megalitres - Corin

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation (B)	Potential Allocation [100%(A-B)]
January	2,755	468	2,287	468	2,287
February	1,940	361	1,579	361	1,579
March	2,217	361	1,856	361	1,856
April	3,083	595	2,488	595	2,488
May	3,419	676	2,743	676	2,743
June	5,200	855	4,345	855	4,345
July	7,387	1,808	5,579	1,808	5,579
August	9,228	3,016	6,212	3,016	6,212
September	9,763	3,594	6,168	3,594	6,168
October	8,697	2,751	5,946	2,751	5,946
November	6,040	1,534	4,505	1,534	4,505
December	3,992	998	2,995	998	2,995
Total	63,722	17,018	46,704	17,018	46,704

Note: some totals may not add up due to rounding.

11. Bendora (water supply)

The Bendora sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410730 on the Cotter River.

Allocations in Megalitres - Bendora

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation (B)	Potential Allocation [100%(A-B)]
January	1,947	331	1,616	331	1,616
February	1,371	255	1,116	255	1,116
March	1,567	255	1,312	255	1,312
April	2,179	421	1,758	421	1,758
May	2,419	478	1,939	478	1,939
June	3,675	604	3,074	604	3,074
July	5,221	1,278	3,943	1,278	3,943
August	6,523	2,132	4,391	2,132	4,391
September	6,900	2,540	4,360	2,540	4,360
October	6,076	1,944	4,132	1,944	4,132
November	4,220	1,085	3,135	1,085	3,135
December	2,789	705	2,084	705	2,084
Total	44,886	12,028	32,858	12,028	32,858

Note: some totals may not add up due to rounding.

12. Lower Cotter (water supply)

The Lower Cotter sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410733 on Coree Creek. Spawning flows are required to be provided in the Cotter River.

Allocations in Megalitres –Lower Cotter

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation (B)	Potential Allocation [100%(A-B)]
January	2,015	342	1,672	342	1,672
February	1,418	264	1,155	264	1,155
March	1,621	264	1,357	264	1,357
April	2,254	435	1,819	435	1,819
May	2,500	494	2,006	494	2,006
June	3,802	625	3,177	625	3,177
July	5,401	1,322	4,079	1,322	4,079
August	6,747	2,205	4,542	2,205	4,542
September	7,138	2,628	4,510	2,628	4,510
October	6,286	2,011	4,274	2,011	4,274
November	4,365	1,122	3,243	1,122	3,243
December	2,886	729	2,156	729	2,156
Total	46,434	12,443	33,991	12,443	33,991

Note: some totals may not add up due to rounding.

13. Paddys (predominantly modified, remainder natural)

The Paddys sub-catchment environmental flows and flows available for use have been estimated by using the area method and the sub-catchment associated with the station 410713 on the Paddys River.

Allocations in Megalitres –Paddys

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	2,857	338	2,519	2,605	252
February	1,866	192	1,675	1,699	167
March	1,887	194	1,694	1,718	169
April	3,586	332	3,253	3,260	325
May	2,146	523	1,623	1,984	162
June	2,334	788	1,546	2,179	155
July	5,049	997	4,052	4,644	405
August	5,068	1,247	3,821	4,686	382
September	5,161	1,290	3,871	4,774	387
October	5,159	1,075	4,084	4,750	408
November	3,560	750	2,809	3,279	281
December	2,901	441	2,460	2,655	246
Total	**41,573**	**8,165**	**33,408**	**38,232**	**3,341**

Note: some totals may not add up due to rounding.

14. Tuggeranong (predominantly created, remainder modified)

The Tuggeranong sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data associated with the gauging station 410745 on Yarralumla Creek.

Allocations in Megalitres –Tuggeranong

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	1,169	156	1,013	1,067	101
February	920	134	786	841	79
March	822	129	693	753	69
April	914	102	812	833	81
May	750	122	628	687	63
June	615	115	500	565	50
July	981	122	859	895	86
August	881	139	741	806	74
September	1,078	148	930	985	93
October	1,225	147	1,079	1,118	108
November	1,041	140	901	951	90
December	838	161	677	770	68
Total	**11,234**	**1615**	**9,619**	**10,271**	**962**

Note: some totals may not add up due to rounding.

15. Upper Molonglo (modified)

The flows for the Upper Molonglo sub-catchment have been estimated by using the data from the gauging station 410705. The area method has not been used on this data since the gauging station appears to represent the Upper Molonglo sub-catchment well.

Allocations in Megalitres –Upper Molonglo

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	1,641	2	1,639	1,477	164
February	1,539	2	1,537	1,385	154
March	4,232	2	4,231	3,809	423
April	4,514	28	4,487	4,066	449
May	3,920	147	3,773	3,543	377
June	8,347	237	8,110	7,536	811
July	4,604	376	4,227	4,181	423
August	5,446	461	4,986	4,948	499
September	5,057	449	4,609	4,597	461
October	4,134	334	3,800	3,754	380
November	2,360	168	2,192	2,141	219
December	2,308	18	2,290	2,079	229
Total	**48,102**	**2224**	**45,881**	**43,516**	**4589**

Note: some totals may not add up due to rounding.

16. Kowen (modified)

The Kowen sub-catchment environmental flows and flows available for use have been estimated by using the area method and the gauging station 410743 on Jerrabomberra Creek.

Allocations in Megalitres - Kowen

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	582	0.0	582	524	58
February	253	0.0	253	228	25
March	278	0.0	278	250	28
April	713	3.4	709	642	71
May	367	17.1	350	332	35
June	427	22.6	404	387	40
July	1,178	27.5	1,150	1,063	115
August	898	29.7	868	811	87
September	1,054	30.2	1,023	951	102
October	1,006	19.2	987	907	99
November	441	8.9	432	398	43
December	281	0.6	281	253	28
Total	**7,478**	**159**	**7,319**	**6,746**	**732**

Note: some totals may not add up due to rounding.

17. Fyshwick (modified)

The environmental flows and potential allocation for the Fyshwick sub-catchment have been estimated using the area method and the gauging station 410772 on Sullivans Creek.

Allocations in Megalitres - Fyshwick

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	170	4	166	153	16
February	76	3	73	69	7
March	148	3	145	133	15
April	208	3	206	188	21
May	96	3	92	86	9.
June	100	6	945	91	10
July	293	8	285	265	28
August	172	10	162	155	16
September	213	9	204	192	20
October	139	7	132	125	13
November	160	5	155	144	16
December	113	4	108	102	11
Total	**1887**	**64**	**1823**	**1705**	**182**

Note: some totals may not add up due to rounding.

18. Jerrabomberra Headwaters (modified)

The environmental flows and potential allocation for the Jerrabomberra Headwaters catchment have been estimated by the area method and the gauging station 410743 on Jerrabomberra Creek.

Allocations in Megalitres – Jerrabomberra Headwaters

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	528	0	528	476	53
February	230	0	230	207	23
March	252	0	252	227	25
April	647	3	644	583	64
May	333	16	318	301	32
June	388	20	367	351	37
July	1,069	25	1,044	964	104
August	815	27	788	736	79
September	956	27	929	863	93
October	913	17	896	824	90
November	400	8	392	361	39
December	255	1	255	230	26
Total	**6,786**	**144**	**6,643**	**6123**	**664**

Note: some totals may not add up due to rounding.

19. Jerrabomberra (predominantly modified, remainder created)

The environmental flows and potential allocation for the Jerrabomberra catchment have been estimated by the area method and the gauging station 410743.

Allocations in Megalitres - Jerrabomberra

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	210	0	210	189	21
February	165	0	165	149	16
March	181	0	181	163	18
April	465	2	463	419	46
May	240	11	228	217	23
June	279	15	264	252	26
July	769	18	751	694	75
August	586	19	567	529	57
September	688	20	668	621	67
October	657	12	644	592	64
November	288	6	282	260	28
December	184	0	183	165	18
Total	**4712**	**104**	**4606**	**4250**	**461**

Note: some totals may not add up due to rounding.

20. Lake Burley Griffin (modified)

The environmental flows and potential allocation for the Lake Burley Griffin catchment have been estimated by the area method and the gauging station 410745 on Yarralumla Creek.

Allocations in Megalitres – Lake Burley Griffin

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	986	132	855	901	85
February	777	113	664	710	66
March	694	109	585	635	58
April	772	86	685	703	69
May	633	103	530	580	53
June	519	97	422	477	42
July	828	103	725	756	72
August	743	118	626	681	63
September	910	125	785	832	79
October	1,034	124	911	943	91
November	879	119	760	803	76
December	707	136	571	650	57
Total	**9,482**	**1,364**	**8,118**	**8,670**	**812**

Note: some totals may not add up due to rounding.

21. Coppins (modified)

The environmental flows and potential allocation for the Coppins catchment have been estimated using the area method and the gauging station 410751 on Ginninderra Creek.

Allocations in Megalitres - Coppins

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	322	0	322	290	32
February	74	1	73	66.	7.
March	440	0	440	396	44
April	643	0	643	579	64
May	282	0	282	254	28
June	326	0	326	293	33
July	1,128	0	1,128	1,015	113
August	933	3	930	840	93
September	740	0	740	666	74
October	317	0	317	285	32
November	395	0	395	356	39
December	290	0	290	261	29
Total	**5,890**	**5**	**5,885**	**5,301**	**589**

Note: some totals may not add up due to rounding.

22. Woolshed Creek (modified)

The environmental flow and potential allocation for the Woolshed Creek catchment have been estimated by using the area method and the gauging station 410772. However, in this analysis the exponent in the area method was calculated specifically as 1.908 which was derived from a specific study of this catchment instead of the default, 0.7.

Allocations in Megalitres –Woolshed Creek

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	599	13	586	541	59
February	270	12	258	244	26
March	551	9	542	497	54
April	778	9	768	701	77
May	357	11	346	322	35
June	374	19	355	339	35
July	1,094	28	1,066	987	107
August	640	36	604	579	60
September	752	33	719	680	72
October	490	23	467	443	47
November	564	17	548	510	55
December	399	14	385	360	38
Total	**6,867**	**224**	**6,643**	**6,203**	**664**

Note: some totals may not add up due to rounding.

23. Sullivans Creek (predominantly modified, remainder created)

The environmental flows and potential allocation for the Sullivans Creek catchment have been estimated by using the area method and the gauging station 410775 on Sullivans Creek.

Allocations in Megalitres –Sullivans Creek

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	468	13	455	423	45
February	234	12	222	212	22
March	431	12	420	390	42
April	567	8	559	511	56
May	290	10	280	262	28
June	320	13	307	289	31
July	671	17	654	606	65
August	421	25	396	381	40
September	398	19	380	360	38
October	350	19	331	317	33
November	508	16	493	459	49
December	382	13	370	345	37
Total	**5,042**	**177**	**4,865**	**4,555**	**486**

Note: some totals may not add up due to rounding.

24. Woden (created)

The Woden sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410745 on Yarralumla Creek.

Allocations in Megalitres –Woden

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	749	100	649	684	65
February	590	86	504	539	50
March	527	83	444	483	44
April	586	66	521	534	52
May	481	79	402	441	40
June	394	73	321	362	32
July	629	78	551	574	55
August	565	89	475	517	48
September	691	95	596	632	60
October	786	94	692	716	69
November	667	90	577	610	58
December	537	103	434	494	43
Total	**7202**	**1036**	**6166**	**6586**	**616**

Note: some totals may not add up due to rounding.

25. Weston (created)

The Weston sub-catchment environmental flows and flows available for use have been estimated by using the area method and the data obtained from station 410745 on Yarralumla Creek.

Allocations in Megalitres –Weston

Month	Average Monthly Flow (A)	80^{th}%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	439	59	380	401	38
February	346	50	295	316	30
March	309	49	260	283	26
April	344	38	305	313	31
May	282	46	236	258	24
June	231	43	188	212	19
July	369	46	323	336	32
August	331	52	278	303	28
September	405	56	349	370	35
October	460	55	405	420	41
November	391	53	338	357	34
December	315	60	254	289	25
Total	**4222**	**607**	**3611**	**3858**	**363**

Note: some totals may not add up due to rounding.

26. Tinderry (modified/water supply in NSW)

The flows for the Tinderry sub-catchment have been estimated directly from gauging station 410781.

Allocations in Megalitres –Tinderry

Month	Average Monthly Flow (A)	80^{th}%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [100%(A-B)]
January	6,463	484	5,979	484	5,979
February	2,729	637	2,093	637	2,093
March	2,421	568	1,853	568	1,853
April	3,237	537	2,701	537	2,701
May	2,724	747	1,977	747	1,977
June	8,855	994	7,861	994	7,861
July	10,242	1,338	8,905	1,338	8,905
August	6,601	1,484	5,117	1,484	5,117
September	4,760	1,609	3,151	1,609	3,151
October	4,386	1,406	2,979	1,406	2,979
November	3,993	929	3,064	929	3,064
December	5,183	626	4,557	626	4,557
Total	**61,594**	**11,359**	**50,237**	**11,359**	**50,237**

Note: some totals may not add up due to rounding.

27. Googong (modified/water supply in NSW)

The environmental flows and potential allocation for the Googong catchment have been estimated by the area method and the gauging station 410774 on Burra Creek.

Allocations in Megalitres - Googong

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation (B)	Potential Allocation [100%(A-B)]
January	505	16	489	16	489
February	91	13	78	13	78
March	316	17	300	17	300
April	1,018	23	995	23	995
May	318	46	272	46	272
June	399	49	350	49	350
July	821	61	760	61	760
August	354	93	261	93	261
September	497	70	427	70	427
October	368	61	307	61	307
November	444	34	410	34	410
December	476	25	451	25	451
Total	**5,607**	**508**	**5,100**	**508**	**5,100**

Note: some totals may not add up due to rounding.

28. Lower Queanbeyan (modified)

The environmental flows and potential allocation for the Lower Queanbeyan catchment have been estimated by the area method and the gauging station 410743 on Jerrabomberra Creek.

Allocations in Megalitres –Lower Queanbeyan

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	535	0.0	535	482	54
February	233	0.0	233	209	23
March	256	0.0	256	230	26
April	655	3.1	652	590	65
May	338	15.7	322	305	32
June	393	20.8	372	356	37
July	1,083	25.3	1,058	977	106
August	826	27.3	798	746	80
September	969	27.8	941	875	94
October	925	17.7	907	834	91
November	405	8.2	397	366	40
December	259	0.6	258	233	26
Total	**6,876**	**146**	**6,730**	**6,203**	**673**

Note: some totals may not add up due to rounding.

29. Burra (modified/water supply in NSW)

The environmental flows and potential allocation for the Burra sub-catchment have been estimated by using the area method and the gauging station 410774 on Burra Creek.

Allocations in Megalitres - Burra

Month	Average Monthly Flows(A)	80th %ile (B)	Difference (A-B)	Environment Allocation (B)	Potential allocation [100%(A-B)]
January	631	20	611	20	611
February	114	16	98	16	98
March	395	21	375	21	375
April	1,272	28	1,243	28	1,243
May	398	58	340	58	340
June	498	61	437	61	437
July	1,026	76	949	76	949
August	443	116	326	114	326
September	621	88	533	88	533
October	460	76	384	76	384
November	554	42	512	42	512
December	595	31	564	31	564
Total	**7,007**	**634**	**6,372**	**634**	**6,372**

Note: some totals may not add up due to rounding.

30. Gungahlin (predominantly modified, remainder created)

The environmental flows and potential allocation for the Gungahlin catchment area have been calculated using the area method and the pre-urban data from the gauging station 410751 on Ginninderra Creek. The two catchments are similar in area and land use.

Allocations in Megalitres - Gungahlin

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	256	0.0	256	230	25.6
February	58	0.7	58	53	5.8
March	349	0.2	349	314	34.9
April	510	0.0	510	459	51.0
May	224	0.2	224	202	22.4
June	259	0.0	259	233	25.9
July	895	0.0	895	806	89.5
August	741	2.6	738	667	73.8
September	587	0.1	587	529	58.7
October	252	0.0	252	226	25.2
November	314	0.0	314	282	31.4
December	230	0.0	230	207	23.0
Total	**4675**	**4**	**4672**	**4208**	**467**

Note: some totals may not add up due to rounding.

31. Lake Ginninderra (predominantly created, remainder modified)

The environmental flows and potential allocations of the lake Ginninderra sub-catchment have been estimated by the area method and the data from the gauging station 410751 Ginninderra Creek. Factors such as transpiration and ground water recharge have not been included in the mass balance.

Allocations in Megalitres – Lake Ginninderra

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation [B+90%(A-B)]	Potential Allocation [10%(A-B)]
January	247	0	247	222	25
February	56	0	56	51	6
March	337	0	337	303	34
April	493	0	493	443	49
May	216	0	216	195	22
June	250	0	250	225	25
July	864	0	864	778	86
August	715	2	712	644	71
September	567	0	567	510	57
October	243	0	243	219	24
November	303	0	303	272	30
December	222	0	222	200	22
Total	**4513**	**4**	**4510**	**4062**	**451**

Note: some totals may not add up due to rounding.

32. Parkwood (predominantly modified, remainder created)

The environmental flows and potential allocations for the Parkwood sub-catchment have been determined by dividing the catchment into two areas that have been calculated using the following methods and the data sets were added together:

Sub-catchment of station 410750 up to the dam;

- a mass balance was used with the dam spillage data from station 410765 and the station 410750. The 80th percentile of the water passing through 410750 was used to estimate the 80th percentile of the runoff for the sub-sub-catchment due to the low occurrence of dam spillage;

Remainder of the Parkwood sub-catchment ;

- the runoff for the remainder of the sub-catchment was estimated using the area method and the pre 1990 flow data from the gauging station 410751.

Allocations in Megalitres –Parkwood

Month	Average Monthly Flow (A)	80th%ile (B)	Difference (A-B)	Environment Allocation B+90%(A-B)	Potential Allocation [10%(A-B)]
January	1,143	27	1,117	1,032	112
February	386	6	379	348	38
March	1,238	7	1,231	1,115	123
April	1,466	16	1,450	1,321	145
May	552	28	524	500	52
June	685	55	631	622	63
July	2,008	78	1,929	1,815	193
August	1,320	174	1,145	1,205	115
September	1,002	164	838	918	84
October	637	90	547	582	55
November	1,134	56	1,078	1,026	108
December	962	20	942	868	94
Total	**12,533**	**721**	**11,811**	**11,352**	**1182**

Note: some totals may not add up due to rounding.

6. THE ALLOCATION OF WATER

Allocations provide a general right to take water under the control of the ACT Government and apply to all water in the Territory other than groundwater which is under land subject to a lease granted before 11 December 1998 when the Act was enacted. The formal allocation of water ensures that water resources are not adversely affected by over-usage and that aquatic ecosystems are protected and conserved. The allocation system will give greater certainty to users but with greater onus on stewardship. All allocations are based on average flows and water availability to allocation holders will be less during periods of below average rainfall.

The total quantity of water available for allocation and an accompanying set of rules have been determined for each sub catchment on a reach by reach basis. Allocations will only be made where provision for the allocation exists in the Plan and it is environmentally sound to do so. Allocations for water use which existed prior to 1 May 1998 do not need to be provided for in this Plan but they are taken into account when determining the total quantity of water available for allocation. In addition, formal allocations will be made to existing users and their requirements will be met before any further allocations are created.

In creating allocations, the following considerations will be taken into account:

- Groundwater and surface water are linked on a catchment basis and they must be considered together in determining an allocation;
- The provision of environmental flows must first be considered before water can be allocated for other uses. This requirement extends to the allocation of groundwater and surface water.

Each allocation will specify the quantity, the timing and the manner in which water may be taken.

Reduction of Allocation

In some circumstances it may be necessary to reduce allocations in order to protect the Territory's water resources from harm. Such reductions may be permanent or temporary depending on the circumstance which gave rise to the need to reduce the allocation.

The provision of environmental flows is a priority in the allocation of water and a cautious approach has been adopted to the allocation of water for other purposes. However, the Australian climate, and the consequent flows in streams, is notoriously variable and it is impossible to always make accurate predictions
.

It is possible that unforeseen impairment to the quality of water may occur as a result of allocation.

Considerable research effort is being devoted to better understand flow requirements of aquatic ecosystem. The Plan, therefore, allows for allocations to be reduced if emerging scientific evidence demonstrates that flows need to be adjusted in favour of the environment.

6.1 Provisions for New Allocations

Allocations for existing use are created without reference to the Water Resources Management Plan but provision must be made in the plan for any allocations for new uses. New uses are defined in the *Water Resources Act 1998* as those which commence on or after 1 May 1998. The Plan is required to contain provision for allocations expected to be created for the next ten years.

It is intended to make provision for new uses which have already been identified as likely in the next ten years and also to make provision within each sub-catchment for a reasonable level of new water use which has not yet been identified. This is necessary to not unduly delay developments which rely on water use and which would otherwise have to wait the six months or longer which it will take to modify this Plan.

Future Allocations for Urban Water Supply
Corin, Bendora, Tinderry, Googong and Burra sub-catchments provide water for the Canberra and Queanbeyan/Yarralumla urban water supply network. Average urban water use in the future is not expected to exceed the existing per capita consumption rate. In fact it is expected, through a combination of water conservation measures implemented by Government such as pricing and effluent reuse, that the per capita rate of urban water use will decline.

However, when the consumption rate might drop and by how much is speculation. It will still be necessary to ensure that adequate provision for allocations for future urban water use is made. As a result, provision for allocations in these urban water supply sub-catchments will be based on existing per capita rates of consumption. Provision will be made for new allocations to provide for expected population growth over the next ten years.

Future allocations for Other Sub-Catchments

Apart from the urban water supply sub-catchments, provision will be made for annual allocations within each sub-catchment based on existing land use capability, the area of land suitable for irrigation, projected growth in urban areas and known proposals for development or land use change. None of the provisions for future allocations within each sub-catchment can exceed the potential allocation set out in the tables for each sub-catchment in Section 5. Where no projected growth could be identified, a minimal allocation provision of 1 ML has been set aside for the sub-catchment so minor water use developments will not be impeded.

Provisions for allocations within each sub-catchment are as follows:

1. Michelago

In the ACT part of this sub-catchment, provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives. 20 megalitres will be set aside as an allocation provision for this sub-catchment.

2. Tharwa

Although this sub-catchment is predominantly rural potential future water uses in this sub-catchment are for urban irrigation. 100 megalitres will be set aside as an allocation provision for this sub-catchment.

3. Kambah

Provision will be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives. 100 megalitres will be set aside as an allocation provision for this sub-catchment.

4. Uriarra

In the ACT part of this sub-catchment agricultural use related to the growing of pasture or permanent crops such as grapes or olives is likely to expand. 100 megalitres will be set aside as an allocation provision for this sub-catchment.

5. Woodstock

In the ACT part of this sub-catchment provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives. 100 megalitres will be set aside as an allocation provision for this sub-catchment.

6. Guises

In the ACT part of this sub-catchment provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

7. Naas

Provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives in the northern part of this catchment. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

8. Gudgenby

No new water use is anticipated in the next ten years but a nominal provision for allocations of 1 megalitre will be made in case an appropriate demand such as a national park facility is identified.

9. Tennent

Provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives in this sub-catchment. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

10. Corin

Water resources from this sub-catchment are available for use only as part urban water supply for the Canberra and Queanbeyan/Yarralumla water supply network. Based on existing per capita water use and excepted population growth in the next ten years, further allocation of 1,800 ML will be required from the sub-catchment to meet the maximum expected growth in water use. Allocation provision of 1,800 ML will be set aside for this sub-catchment.

11. Bendora

Water resources from this sub-catchment are available for use only as part urban water supply for the Canberra and Queanbeyan/Yarralumla water supply network. Based on existing per capita water use and excepted population growth in the next ten years, further allocation of 1,200 ML will be required from the sub-catchment to meet the maximum expected growth in water use. Allocation provision of 1,200 ML will be set aside for this sub-catchment.

12. Lower Cotter

Apart from minor use for stock and domestic purposes at forestry settlements, water resources in this catchment are reserved for the urban water supply. Provision for an allocation of 10,000 megalitres will be made in case, under emergency conditions, the Cotter Reservoir is required for urban water supply. A significant emergency (such as major damage to the Bendora pipeline or a drought which emptied the other urban water supply reservoirs would need to occur before the Cotter Reservoir would be used. An allocation would not be created until such an emergency arose. Any allocations created must restrict use of the water to the Canberra and Queanbeyan/Yarralumla water supply network.

13. Paddys

Provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives in this sub-catchment. It is expected that the allocation of 200 megalitres will meet this demand.

14. Tuggeranong

Potential future water uses in this sub-catchment are the irrigation of urban parks and playing fields. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

15. Upper Molonglo

Minimal increases in future water use in the ACT portion of this sub-catchment are expected in the next 10 years. A nominal provision for allocations of 1 megalitre will be made.

16. Kowen

Provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives in this sub-catchment. 400 megalitres will be set aside as an allocation provision for this sub-catchment.

17. Fyshwick

Water available for use from this sub-catchment is already fully committed. Future expansion of water use in this area will need to be provided by provisions for allocations in other upstream sub-catchments.

18. Jerrabomberra Headwaters

ACT does not control the waters of this sub-catchment.

19. Jerrabomberra

Provision will be needed for some agricultural water use related to the growing of permanent crops such as grapes or olives in this sub-catchment. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

20. Lake Burley Griffin

Provision will be needed for some urban irrigation in this sub-catchment. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

21. Coppins

Provision may be needed for some agricultural water use related to the growing of pasture or permanent crops such as grapes or olives in this sub-catchment. 200 megalitres will be set aside as an allocation provision for this sub-catchment.

22. Woolshed

Water available for use from this sub-catchment is likely already fully committed. In the next three years, until the Plan is reviewed, it is not intended to permit any new water uses within this sub-catchment. This three year period will be used to collect information on existing water use so a more accurate assessment of actual use can be made. If the review shows that water is still available for use, provision for allocations can be included in the reviewed Plan.

23. Sullivans

Provision may be needed for some urban irrigation in this sub-catchment. 100 megalitres will be set aside as an allocation provision for this sub-catchment.

24. Woden

Potential future water uses in this sub-catchment are for urban irrigation. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

25. Weston

Potential future water uses in this sub-catchment are for urban irrigation. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

26. Tinderry

While not in the ACT, water use from this sub-catchment is under ACT control. Apart from some stock and domestic, and irrigation use, water resources in this catchment are reserved for the urban water supply. Provision for allocations totalling 500 megalitres will be made to cater for irrigation use.

Allocations of 2,700 megalitres will be needed to cater for increased urban water supply caused by population increases. A provision will be made for this purpose and any allocations created from this provision must restrict use of the water to the Canberra and Queanbeyan/Yarralumla water supply network.

27. Googong

While not in the ACT, water use from this sub-catchment is under ACT control. Apart from some stock and domestic, and irrigation use, water resources in this catchment are reserved for the urban water supply. Provision for allocations totalling 200 megalitres will be made to cater for irrigation use.

Allocations of 300 megalitres will be needed to cater for increased urban water supply caused by population increases.

A provision will be made for this purpose and any allocations created from this provision must restrict use of the water to the Canberra and Queanbeyan/Yarralumla water supply network.

28. Lower Queanbeyan

Any water use in this sub-catchment will be licensed by NSW so provision does not need to be made for ACT allocations.

29. Burra

While not in the ACT, water use from this sub-catchment is under ACT control. Allocations of 500 megalitres will be needed to cater for increased urban water supply caused by population increases. A provision will be made for this purpose and any allocations created from this provision must restrict use of the water to the Canberra and Queanbeyan/Yarralumla water supply network.

30. Gungahlin

Potential future water uses in this sub-catchment are for urban irrigation. 100 megalitres will be set aside as an allocation provision for this sub-catchment.

31. Lake Ginninderra

Potential future water uses in this sub-catchment are for urban irrigation. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

32. Parkwood

Potential future water uses in this sub-catchment are for urban irrigation. 50 megalitres will be set aside as an allocation provision for this sub-catchment.

Table 5 sets out the total water resource, environmental allocation, water available for use (from Section 5.6), potential allocations (from Section 6.1), existing ACT controlled use and ACT controlled water available for use by sub catchment.

Table 5: 1999 to 2009 Provisions for New Allocations

Catchment			Total ACT & NSW Water Resources (ML)	ACT & NSW Environment Allocation (ML)	Water Available for Use ACT & NSW (ML)	ACT Controlled Water Available for Use[1] (ML)	Existing ACT Controlled Water Use[2] (ML)	Allocation Provision 1999 – 2009 (ML)
Murrumbidgee and tributaries	1	Michelago	67,962	62,515	5,447	225	0	20
	2	Tharwa	3,731	3,370	361	361	125	100
	3	Kambah	3,058	2,762	296	296	180	100
	4	Uriarra	25,484	23,436	2,048	1,338	50	100
	5	Woodstock	7,294	6,707	586	142	0	100
	6	Guises	4,888	4,410	478	212	10	50
Gudgenby and tributaries	7	Naas	42,272	39,102	3,170	3,170	10	50
	8	Gudgenby	50,425	46,644	3,782	3,782	0	1
	9	Tennent	8,383	7,787	596	596	0	50
Cotter and tributaries	10	Corin	63,722	17,018	46,704	46,704	29,700	1,800
	11	Bendora	44,886	12,028	32,858	32,858	21,000	1,200
	12	Lower Cotter	46,434	12,443	33,991	32023	0	10,000[3]
	13	Paddys	41,573	38,233	3,341	3,341	100	200
Tuggeranong Ck and tributaries	14	Tuggeranong	11,235	10,273	962	823	100	50
Molonglo and tributaries	15	Upper Molonglo	48,102	43,514	4,588	135	0	1
	16	Kowen	7478	6746	732	732	0	400
	17	Fyshwick	1,887	1,705	182	113	113	0
	18	Jerrabomberra Headwaters	6,787	6,122	664	0	0	0
	19	Jerrabomberra	4,710	4,249	461	398	250	50
	20	Lake Burley Griffin	9,482	8,457	811	683	150	0
	21	Coppins	5,889	5,301	588	588	10	200
	22	Woolshed	6,867	6,203	664	241	250	0
	23	Sullivans	5,042	4,555	486	486	300	100
	24	Woden	7,202	6,586	617	617	150	50

Catchment			Total ACT & NSW Water Resources (ML)	ACT & NSW Environment Allocation (ML)	Water Available for Use ACT & NSW (ML)	ACT Controlled Water Available for Use[1] (ML)	Existing ACT Controlled Water Use[2] (ML)	Allocation Provision 1999 – 2009 (ML)
Queanbeyan River and	25	Weston	4,221	3,859	361	361	20	50
	26	Tinderry	61,594	11,356	50,238	50,238	9,697	2,700
	27	Googong	5,607	508	5,100	5,100	1,361	300
	28	Lower Queanbeyan	6,876	6,203	673	2	0	0
	29	Burra	7,006	634	6,372	6,372	1,600	500
Ginninderra Ck and tributaries	30	Gungahlin	4,676	4,209	467	467	200	100
	31	Lake Ginninderra	4,513	4,062	451	451	150	50
	32	Parkwood	12,533	11,352	1,181	548	100	50
Total						193,403	65,626	8372

Note 1: Based on proportion of sub-catchment area controlled by ACT against total area of sub-catchment.

Note 2: Existing use volumes are best estimates based on limited returns available to the Environmental Management Authority for all sub-catchments except those for water supply.

Note 3: Emergency water supply provision. Not included in total

7. MONITORING

A monitoring program designed to evaluate the effectiveness of the Water Resources Management Plan in achieving ecologically and socially sustainable water resources in the ACT includes a number of components. These components are required to ensure that the following objectives of the Water Management Plan and the Environment Flows Guidelines are achieved:

- protection of the environmental values of the waterways as outlined in the Territory Plan;
- maintenance of water quality in accordance with the ACT Water Quality Guidelines;
- provision of a suitable environment for spawning and migration of native fish species, and in particular, threatened species;
- protection of channel morphology and substrate; and
- sustainability of resource for the people of the ACT.

Under the principle of user pays, the responsibility for undertaking monitoring of the impact of water use will rest to a large extent with water users. As a result a monitoring program will be developed in conjunction with the setting of conditions in licences to take water which will be issued in December 1999.

7.1 Water Quantity

Surface Flows

Historical flow monitoring data is required to determine the level of flow in each reach of the rivers and streams in the ACT to be protected under the Environmental Flow Guidelines. Data from gauging stations is available for many sub-catchment from about the 1950s. Where no gauging stations exist, environmental flows will be estimated from data collected in comparable sub-catchments.

Current flow monitoring data is required to determine allocation of water resources in compliance with the Environmental Flow Guidelines. The ACT Government commissions a flow monitoring program which will provide this data. Lake and pond levels will also be monitored for compliance with the Guidelines.

The Environment Management Authority will assess the need for additional flow monitoring associated with a particular user.

Groundwater

Currently there is limited monitoring of groundwater usage in the ACT. Future monitoring will be carried out largely by water users under licence conditions. The ACT Government will carry out any necessary additional monitoring. This information will be used to determine sustainable yields and take into account the role of aquifers in sustaining base flows in the rivers and streams.

7.2 Water Use Metering

Individual water users of both surface and ground water are required to install meters which record their water use. Exceptions will be made in circumstances where it is not practical to do so because the expense is not justified and an accurate alternative is available. Alternative methods of determination of use will be permitted at the discretion of the Environment Management Authority. This data, along with rainfall and flow data will enable a water balance to be calculated for each sub-catchment and allow the Authority to manage the resource more effectively.

7.3 Register

Section 64 of the Act requires that a register of licences, water allocations, and permits granted, or transfers made will be established and maintained. The Authority will maintain this register in electronic form on a computer in the Authority's office at Macarthur House, 12 Wattle Street, Lyneham where it can be examined by the public.

7.4 Water Quality

A comprehensive program of water quality monitoring has been carried out in the ACT since the early 1970s. This program will be supplemented to assess the impact of environmental allocations and release from impoundments against the ACT Water Quality Standards contained in the *Environment Protection Regulations 1997*.

Currently there is limited monitoring of groundwater quality in the ACT. Monitoring is carried out at landfills as a condition of authorisation and ad hoc monitoring also occurs where contamination is suspected, for example for underground hydrocarbon storage.

The monitoring requirement associated with a licence to take water will provide on-going information on both water quality and quantity and the impacts of landuse and extraction can be assessed.

7.5 Biological Monitoring

Existing biological data includes that collected for the AUSRIVAS program, which uses macroinvertebrate data from unimpacted reference sites to assess the biological health of comparative test sites. This method of assessment may be used to compare test sites before and after the implementation of the guidelines. Sites outside the ACT which are not subject to the Guidelines may also be used for comparative assessment. The AUSRIVAS models have been found to be sensitive to low flows.

The ongoing monitoring of fish populations, health and spawning success will be important to determine if the environmental flows allocation for spawning and migration has been successful.

Monitoring of riparian, lake and pond vegetation is also relevant in assessing the effectiveness of environmental allocations under the Environmental Flows Guidelines.

8. REVIEW OF THE PLAN

The Water Resource Management Plan has been established using the most up to date scientific information and the best available data on the ACT's water resources and their use. Allocations within the plan are the best estimate based on information available. However only limited information is available on water use as most use is unmetered and even water users can only estimate volumes used.

It is expected that, as future metering of water use provides better data, adjustments to allocations will be required in the short to medium term. Consequently this Plan, including all proposed allocations, will be reviewed within three years of the date of its approval by the Minister. The review will ensure that the Plan continues to be an accurate description of water resources of the ACT and their allocation to the environment and consumptive uses.

The review will take into account the results of all scientific research on environmental flows and stream management available at the time. The review will consider all data available on surface and groundwater in the ACT to ensure the Plan adequately describes the total water resource, its current usage, proposed allocations and actions for its management. The Act requires that any revised Plan will undergo the same public consideration and be subject to the same ministerial approval as this original plan.

Groundwater Recharge Results Obtained by the two Methods of Calculation

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Catchment		Water Balance Equation mm/y	Rainfall Recharge Equation mm/y
1	Michelago	37.67	34.16
2	Tharwa	30.69	28.49
3	Kambah	28.56	27.93
4	Uriarra	21.91	21.77
5	Woodstock	26.64	20.25
6	Guises	34.79	31.05
7	Naas	32.87	30.73
8	Gudgenby	34.86	32.93
9	Tennent	33.20	36.35
10	Corin	48.19	48.37
11	Bendora	54.63	56.63
12	Lower Cotter	32.88	39.06
13	Paddys	41.04	39.34
14	Tuggeranong	10.71	15.50
15	Upper Molonglo	24.17	26.47
16	Kowen	23.64	29.40
17	Fyshwick	23.75	28.21
19	Jerrabomberra	28.57	29.26
20	Lake Burley Griffin	18.64	16.30
21	Coppins	17.09	13.40
22	Woolshed	28.70	28.71
23	Sullivans	13.88	13.81
24	Woden	16.32	18.10
25	Weston	15.30	21.60
28	Lower Queanbeyan	22.83	25.00
30	Gungahlin	15.27	12.25
31	Lake Ginninderra	11.83	13.65
32	Parkwood	16.07	14.05
	Mean	26.60	26.89