

AUSTRALIAN CAPITAL TERRITORY

1997 STATE OF THE ENVIRONMENT REPORT

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INTRODUCTION

The Australian Capital Territory (ACT) is of total area about 2,358 square kilometres, and only about 14% is classified urban; 54% is within conservation reserves. The ACT is the only State or Territory of Australia without a marine coastline. The ACT was planned as a distinctive area of Australia to provide the location of the seat of Federal Government, subsequent to Federation.

Canberra, as the principal urban area, was established to produce government and a national image: it was consciously planned and created. It did not emerge ad hoc as a significant regional centre like other cities. Its function as the national capital has consequently excluded many of the industries which would typically occur in a city the size of Canberra today.

As Canberra has expanded beyond the initial concept articulated in Walter Burley and Marion Griffin's plan, an important feature of its planning has been the 'neighbourhood' concept for residential areas. The open space system which is such a feature of the Griffins' plan continued, through the 'Y' Plan, to influence the planning of the residential areas.

The related notions of Canberra as the 'bush capital' and as a 'garden city' are reflected in the lower than average population densities.

The dispersed pattern of development adopted in the 1970s provided for relatively self-contained new towns, with major employment and retail centres and separate, localised, industrial centres.

Canberra is thus made up of the districts of Canberra Central, Woden Valley/Weston Creek, Tuggeranong, Belconnen and Gungahlin, together with the smaller settlements of Tharwa, Hall and Oaks Estate. Reference to Canberra is reference to these five districts.

Today, four of Canberra's five districts have their own town centres. The construction of Gungahlin town centre has been delayed, in view of the existence of an endangered species on the intended location. Surrounding the existing town centres are residential areas, many with their own suburban shopping centres. Canberra's industrial estates of Fyshwick, Hume and Mitchell are separate from the residential areas and town centres.

The Territory Plan has stated the need for a wider range of housing types than the 'standard' three-bedroom, detached brick veneer house. Public housing, once offered to attract workers to Canberra, no longer plays the major part in the market: the amount of public housing fell from approximately 70% of the total housing available in 1959 to some 12% in March 1995.

LAND

INTRODUCTION

Major landscape features of the ACT are its rugged, timbered mountains in the south and west, and plains and hill country in the north.

The total area of the ACT is 2,358 km². About 60% is hilly or mountainous. The highest peak is Mt Bimberi (1910 m) in the south. The Molonglo River traverses the northern plains and hill country which contain most of the urban areas which represent about 14% of the Territory's area.

The Murrumbidgee escarpment cuts across the Territory from south-east to north-west. To the east of it lie pastoral areas in the south and the urban area in the north. To the south-west, are two belts of mountainous terrain, separated by the Cotter River valley. Much of the south-western area is within Namadgi National Park.

LAND QUALITY

Assessment

It is not possible to make a comprehensive assessment of Land quality in the ACT because the data required are not accessible, or because the data are limited in coverage or do not exist.

The exception is that of sites contaminated as a result of former sheep dips. Mapped sites have been investigated and action taken on those sites needing remediation.

Implications

Without fundamental data on soils and about soil degradation, the potential extent and hazard of further degradation cannot be ascertained. It is reasonable to predict from research in similar landscapes in adjacent areas, that the ACT may be confronted with a dryland salinity problem. Until the basic survey is undertaken, it will not be possible to be more specific.

Recommendations/Objectives to be achieved

Recommendations from ACTSER'95 in relation to Land Quality still basically apply, although the Government has announced funding for a new accelerated data capture project for 1997-98. In order for an assessment of Land Quality, the Government should ensure that:

- data on soil types, land quality and capability that were collected as part of the Decade of Landcare are analysed and mapped to meet the objectives of the data capture project;
- all areas of the ACT are digitally mapped for erosion and soil salinity and critical areas of concern identified;
- results of the ACT Forests' soil survey and research on soil type/structure, aspect and land forms including the presence of erosion and erosion hazard are made available to this office in digital form;
- monitoring and digital mapping of groundwater be undertaken as an early indication of dryland salinity; and

- greater coordination and support for community monitoring of land quality be engendered to streamline data collection and transfer to relevant bodies, as well as to improve analysis of data, with a profile/directory of community-based environmental groups and their monitoring activities in ACT catchments accessible on the Environment ACT Homepage.

Background

The integrity of the soil resource is essential to the health of the Land, enabling it to sustainably support a range of important landuses such as agriculture, urban development, waste disposal or transport infrastructure. For this reason, land quality, or the extent to which the soil resource is free from depletion or degradation, is of concern to many communities.

Ideally, land quality would be assessed in this report on the basis of fundamental soil properties which reflect the condition of the soil, and the actual and likely extent of degradation such as soil erosion and dryland salinity. Factors such as the occurrence of known contaminated sites, or the detrimental effects of landfill are also considered.

Declines in land quality can often be remediated once the problem and its causes have been identified. This may mean applying lime or fertilisers, restricting areas to stock access, revegetating some agricultural catchments, imposing erosion control measures in urban development areas, changing to a more appropriate landuse, or simply not using some areas of land identified as having a high risk of developing dryland salinity.

Although they are difficult to map, soil properties such as the nutrient status and structural condition are important. Declining amounts of soil nutrients after continued harvesting can cause serious declines in the production of basic resources such as food if they are not replaced. Similarly, the ability of plants to grow is much reduced in soils compacted by traffic, farm and construction machinery. There are also impacts on soil biota, and the way in which soils transfer water - leading to increased amounts of runoff following rainfall. Land reshaping for urban development is an important cause of a decline in land quality in urban areas.

Areas affected by soil degradation often have a very low productive capacity, and for that reason soil degradation is of great concern in agricultural communities. However, it also affects urban communities directly. There are recorded instances in NSW and Western Australia of the concrete in mortar joints and brick foundations crumbling due to dryland salinity. Other outcomes of dryland salinity can include damage to roads due to the effects of the salt and waterlogging on the road base.

Erosion can be of equal concern to urban areas due to the threat to road infrastructure. Further problems arise from rivers and lakes silting up as a result of sediment washed off construction sites and streambanks, and the generation of dust from soils which have had their surface structure destroyed.

The extent to which this occurs is reflected by the higher turbidity levels in streams draining areas currently being developed. Impact of this nature has been minimised in the ACT through the erosion and sediment control plans under the *Water Pollution Control Act 1994*, to be repealed when the *Environment Protection Bill 1997* is enacted.

LANDUSE & LAND CAPABILITY

Assessment

The Territory Plan provides for land use across the ACT. Although land capability studies (geotechnical reports) are prepared for urban development areas, comprehensive capability information for the majority of the ACT is not available. Therefore, it is only possible to comment on the change and rate of change of landuse.

Landuse in the ACT has remained virtually unchanged since the last Report ,in 1995. This is due to a combination of factors, including the relatively small increase in the rate of population growth and continuation of an economic downturn in the ACT. Much of this growth has been accommodated by urban infill and consolidation of new urban areas such as Gunghalin and Dunlop, for which infrastructure had been developed in the previous reporting period. Overall, there has been an increase in the total amount of urban area in the ACT by less than 0.08%, all of which was in the Ginninderra Creek catchment.

In addition, 567 hectares of lowland native grassland have been placed into the Canberra Nature Park reserve system.

Implications

It is unfortunate that comprehensive land capability information for the ACT is not available. Such information would reassure the community that only sustainable landuses are being conducted and appropriately located in the Territory.

As an awareness that using land for disposal of solid waste is not sustainable at historical rates, and, with encouragement from Government, the community has been increasing the level of recycling and re-use in the community.

Recommendations/Objectives to be achieved

The Government

- is urged to adopt and fund the draft Nature Conservation Strategy, in particular the ecological survey work, to ensure that future areas of urban development or infill do not place land of high conservation status at risk;
- should undertake capability studies of recent and future urban areas to ensure that rising groundwater levels do not impose a risk of salinity; and
- ensure the data capture project analyses and maps data in soil capability that were collected as part of the Decade of Landcare in the late 1980s early 1990s.

Background

If we were managing our resources sustainably, land would be used for purposes to which it is most suited. However, in practice, an area of land is generally capable of supporting more than one particular use and it is recognised amongst land management professionals that there are limitations to some landuses on some areas of land. These limitations can be climatic and/or inherent in the soil and/or induced by past land management practices and other components of land. Land used within its capability and managed appropriately would not be expected to experience any deleterious environmental problems. There is a need to take account of any induced/external impacts affecting the assessed land capability.

Landuses in an area should change if they are not environmentally and economically sustainable, and they will be replaced by other landuses. However, it is possible for land to be used in

a way which is not environmentally sustainable and for this use to continue for some time before difficulties with soil degradation or decline in productivity become apparent. This may also be caused by off-site impacts adversely affecting the water table by raising levels and other externalities such as terms of trade particularly relating to the 23% of rural lands in the ACT.

The ACT is unique in Australia as a Territory identified and planned for a specific purpose - of being Australia's capital, indeed Australia's *Bush Capital*, with limitations about the types of industry that can establish, and provision for swathes of bush, or green, between the town centres that make up Canberra. Of the sixteen Territory Plan land uses, we have condensed them into four main uses - urban, rural, forestry and conservation. While more than 50% has been reserved for conservation purposes, the main change in landuse continues to cater for urban expansion. In Canberra, that expansion has typically been into the lowlands and lowland grasslands. A significant concern is that lands reserved for urbanisation are suited for that purpose, and that existing or proposed urban areas are not located on lands with a high risk of becoming saline, being flooded frequently and that they are not lands of high conservation status or are contaminated to the extent that they pose a risk to health or the environment.

Further issues relate to the disposal of solid waste into landfill: in terms of the physical space used for this purpose, and the possibility of contamination of soil and groundwaters by leachates if leakage occurs.

There is also a wide range of interdependent properties and processes which are affected by landuse changes through both biotic and abiotic pathways.

VEGETATION MANAGEMENT

Assessment

Draft management plans are in place for all of the conservation areas within the ACT. Management plans are also in draft form for all other land managed by ACT Government including the draft Bushfire (fuel) Management Plans. However, it is not possible to make a comprehensive and detailed assessment of vegetation management in the Territory. This is because the data required are not accessible, or because the data are limited in coverage, or quality, or do not exist. However, there is much more to maintenance of vegetation than species retention. Cover, even seasonally determined, is not an adequate substitute for a knowledge of the ecosystem services (such a system provides certain resources to the biota, but in turn the biota also provide services to the system in modifying habitat for other organisms or mitigating physical processes such as rainfall and radiation). Cover, even seasonally determined, is not an adequate substitute for a knowledge of the ecosystem services provided by particular species or guilds. For example, there can be a sequence of replacement events in which cover may be retained, but ecosystem services curtailed.

Implications

The lack of basic vegetation cover data at the appropriate seasons, as well as the poor quality of existing baseline vegetation mapping in the Territory, mean that the status of vegetation cover and management in the ACT cannot be definitively determined. The NDVI Greenness Index has allowed the impact of the low rainfall this previous winter on vegetation growth to be assessed – demonstrating landholders' claims that it has been a poor season.

Areas outside the reserve system have been less impacted by changed landuse in this reporting period due to a slower rate of urban expansion. However, areas such as woodland and grassland are still vulnerable.

Recommendations/Objectives to be achieved

That the Government make available

- remotely sensed imagery for the ACT - groundtruthed and analysed for NDVI - in the year before each State of the Environment Report is due;
- a compiled and technically documented baseline vegetation map (including pastures and crops) of the ACT before the next State of the Environment Report is due.

Background

High quality vegetation cover data is of fundamental importance to the health of the Land. Vegetation cover is more than just native vegetation (which includes woodlands, shrubs and grasslands), it also includes any land based crops.

In an agricultural context, the issue is one of managing vegetation cover so that it is maintained for the entire year – including the dry period in late autumn. This serves to reduce the amount of erosion by wind and water, and improves the hydrological functioning of a catchment, thereby working towards preventing and/or ameliorating dryland salinity. Further benefits arise including those to native flora and fauna and the physico-chemical properties of the soil.

In urban areas, improved vegetation management can reduce the impact of urbanisation on the rest of the catchment. The benefits are much the same as in agricultural lands. It is simply the scale and the degree of modification that is different. Chemical sprays and fertiliser inputs need monitoring to gauge their impact on the environment generally and vegetation in particular.

LANDUSE AND LANDUSE CHANGE

Conservation of native ecological communities is the main landuse in the ACT, comprising 124542 hectares or 53% of the total area of the ACT. Rural landuses, predominantly grazing, covers 23% of ACT lands, and urban settlements 14%. The remainder is managed by ACT Forests.

There has been little change to landuse since the last ACT State of the Environment Report in 1995. Increases in the amount of land used for urban settlement were only slight, reflecting a decline in the rate of growth of the population of the ACT.

The change that did occur tended to be concentrated in Ginninderra Creek catchment, with increases in urban area as a result of the Gungahlin and Dunlop developments. A small area of land was also converted from rural (planned for urban development) to conservation, with the discovery of the legless lizard in the Gungahlin area.

The Territory has benefited significantly from early and comprehensive land-use planning including designation of significant ecological areas as conservation areas and protection of water supply catchments. Reserves include Namadgi National Park, Jerrabomberra Wetlands, Canberra Nature Park, the Murrumbidgee River Corridor, Molonglo Gorge Nature Reserve, Lower Molonglo River Corridor, Mulligan's Flat Nature Reserve and Tidbinbilla Nature Reserve.

Sheep and cattle grazing occupy by far the greatest proportion of the 23% (65671 ha) of the ACT's land devoted to pastoral, agricultural and other 'rural' activities. There are also significant areas used for horse agistment, usually on land near urban areas. Irrigated cropping takes up less than 100 ha and

orchards and vineyards less than 25 ha. Agriculture and horticulture in the Territory make only a small contribution to Canberra's needs for fresh produce.

Most rural areas are leased (82%). Although not yet implemented, the Rural Lease and Rural Rental policies aim to promote effective stewardship of the land under care of ACT landholders. Lease terms will vary from up to 21 years (short term) to 50 years (long term). Leases west of the Murrumbidgee River will be long term, and those to the east, short term. Planning authorities consider short-term leases a land bank for future urban land uses (Gungahlin and Symonston rural leases lie outside this policy).

Urban areas, located mainly in the north of the Territory in the Jerrabomberra, Upper Molonglo, Murrumbidgee, Ginninderra and Lower Molonglo catchments, account for about 14% of ACT land. The city of Canberra abuts rural land and, in parts, conservation areas. The former has provided the land needed for urban development as the city has grown, while the latter provides residents with easy access to outdoor activities.

There are about 21600 ha (approximately 7% of the ACT's land area) of plantation forest in the ACT. Most of the area is managed for the production of softwood timber from *Pinus radiata*. The established pine forests, such as Kowen, Stromlo, Uriarra and Pierces Creek, are in the northern part of the Territory. After harvesting, 500–1000 ha of land are planted with new pine forest each year. No native forests or woodlands have been cleared for plantation since the mid 1970s. Any new plantations will be developed on areas already cleared of native vegetation.

WATER

INTRODUCTION

The ACT lies within the upper Murrumbidgee River catchment, in the Murray-Darling Basin. The Murrumbidgee flows through the Territory from the south, and its tributary, the Molonglo, from the east. Other tributaries of the Murrumbidgee include the Cotter, Paddys, Naas and Gudgenby Rivers. Other important watercourses are Ginninderra, Sullivans and Jerrabomberra creeks.

All these catchments lie either wholly or partially within the Territory, with Lake Burley Griffin as the 'sink' for six of them. The Queanbeyan River lies outside the ACT, but it has a significant impact on water quality in the ACT.

Canberra is noted for its urban lakes, which are key aesthetic and recreational features of the urban landscape and also play an important role in the management of stormwater and urban run-off. The largest of these, Lake Burley Griffin, was created in 1964 by the construction of Scrivener Dam across the Molonglo River. Lake Ginninderra and Lake Tuggeranong were created in 1974 and 1987 respectively by damming Ginninderra and Tuggeranong Creeks.

Rivers and Lakes in the ACT are managed for any of four main purposes. These are:

1. Conservation of aquatic habitats, migratory routes or landscape qualities;
2. Water supply;
3. Catchment drainage (eg of stormflow, or urban run-off); and
4. Recreation.

When the ACT was gazetted, the borders were planned so that the Territory would incorporate sufficient area for an adequate water catchment for the new city that was to arise on the plains. The new Territory was granted rights to the NSW catchment of the Queanbeyan Rivers for the purposes of water supply. These rights have been utilised by the construction of Googong Dam.

Water Resource Use

Water quality in the ACT is of a generally high standard in relation to the intended uses, although there is occasional cause for concern about the use of ACT's waters for recreational purposes. Lake Tuggeranong was closed for several days during the reporting period. In the case of faecal coliforms, although direct comparison with the guidelines is difficult, there may be cause for concern at many water quality monitoring sites, presumably as a result of activities in the streams and their catchments. The situation should be monitored closely for pathogens typically associated with faecal coliforms to ensure ongoing safety for recreational use of the waters.

There is no cause for concern in relation to drinking water quality due to the high standard of treatment of waters before reticulation. Surveys of resident satisfaction with their water supply confirm this.

There is currently sufficient water supply capacity to guarantee water to the ACT community for some years into the future. Trends are towards decreased water consumption. Treated effluent is being re-used for playing fields and golf courses at Duntroon, Southwell Park, Belconnen and Lower Molonglo Water Quality Control Centre, the new visitors centre at Mt Stromlo, and recently

for the grounds of Condamine Court at Northbourne Avenue, as part of a redevelopment project of ACT Housing. ACTEW continues to develop technology to reduce water consumption.

A comprehensive assessment of the water resource is not possible as there are very few data available on groundwater and groundwater quality. Groundwater is a major component of the water cycle and thus should be considered in any assessment of our water resources. There is anecdotal evidence of a growth in the number of bores being sunk in the ACT, but with no system of registration, there is no way of confirming that this is the case, and no way of assessing the pressures that such bores would be placing on the resource.

The lack of accessible and up-to-date groundwater information is problematic in that both groundwater levels and groundwater quality do impact on the land resource as well as on the in-stream water resource. Drawdown in groundwater reserves due to unregulated use could potentially result in severe depletion of groundwater in some parts of the ACT. This would render the resource unavailable to future uses for some time. Paradoxically, there is also a risk of dryland salinisation developing in other parts of the ACT, but the likely hazard cannot be determined due to the lack of groundwater monitoring.

Recommendations/Objectives to be achieved

Progress has been slow on the previous recommendations for identifying the groundwater resource and quality. Those recommendations stand, and are becoming urgent as the resource is being further exploited. The Government is urged to fund a program to monitor and map the groundwater resource.

To ensure data on drinking water storage in subsequent SoE Reports is available, it is recommended that relevant agencies ensure that quarterly returns on actual storage levels for the two storage catchment areas, as well as an explanation of performance, be made available for the Office of the Commissioner for the Environment, commencing in October 1997. Levels recorded during those quarterly returns should be both the lowest level, the median and the 90 and 10 percentiles.

The next SoE Report will include indicators to record volumes in ML/annum of effluent re-used, and to plot this on a timeline graph in subsequent reports, thus providing for monitoring of growth in the re-use of water. It is thus recommended that relevant agencies ensure that quarterly returns on volumes of effluent reused be made available for the office of the Commissioner for the Environment, as well as an explanation, commencing in March 1998.

Aquatic Ecology

On the basis of available data, it is possible to assess only the status of aquatic invertebrates in streams of the ACT, which is reasonably good, with many streams indicating a high score when the Australian River Assessment System (AusRivAS) was used. Streamflows during this reporting period were generally lower than average, due to the low rainfall conditions, and this resulted in stream invertebrate scores being somewhat lower than otherwise expected, although still of a high standard.

Many of the water quality data measured routinely by the ACT Government suggest that water quality in the ACT is generally of a good standard for aquatic biota, with some exceptions where high turbidity levels exist in streams, possibly due to streambank erosion, gully erosion in the catchment and in streams draining areas being developed for urban settlement.

There are no systematic and comprehensive data on the condition and extent of riparian vegetation or of channel morphology, and only limited data exist on biota other than aquatic invertebrates. One

frog, one fish and one crustacean have been declared vulnerable, and two fish have been declared endangered.

Potential pressures include the extent of invasion by exotic species such as willows, carp and weatherloach. Data on these species are neither systematic nor comprehensive.

Recommendations/Objectives to be achieved

Determination of appropriate environmental flows for selected ACT streams is a matter of some importance. Mechanisms for identifying those flows need to be addressed by Government. The ACT has committed to a COAG agreement of 1994, that water entitlements for the environment will be in place by the end of 1998. This is drawn to the attention of relevant agencies.

Riparian vegetation, condition and extent should be digitally mapped. Survey and mapping of the condition of riverbanks and the level of protection afforded, such as fencing out livestock should be undertaken.

ALGAE & BLUE-GREEN ALGAE

Median values for chlorophyll a levels varied from 1.3 ug/L at site number 901 (Gudgenby river at Tennant) to 23 ug/L at site number 204 (Murrumbidgee river at Halls Crossing). The latter site is located some kilometres downstream of the Lower Molonglo Water Quality Control Centre.

DISCHARGES INTO STREAMS

The main source of waters discharged legally into ACT streams is wastewater, derived from treated sewage generated in the ACT urban area. Sewage from all of the 115 085 sewered properties is treated at the Lower Molonglo Water Quality Control Centre (LMWQCC) before being discharged into the Molonglo River close to where it flows into the Murrumbidgee River.

The total volume of water discharged from the LMWQCC has been slightly lower in 1995 and 1996 than in years prior to 1994.

In 1996/97, no serious spills/incidents were reported to the EPS. The LMWQCC can be bypassed when too much water flows through the sewage system for the treatment works to handle. This can occur when conditions of high rainfall onto ground that is already wet from rains in the preceding days and weeks coincides with peak periods of water use - usually in the mornings and late afternoons. The problem is exacerbated by the addition of water to the sewage system from illegal connections, which should have been made to the stormwater system.

There were no bypasses of the LMWQCC in 1996/97 and this is attributed to the construction of a new storage pond in 1995. (Bypasses can happen when heavy rainstorms generate large volumes of stormwater which feed illegally into the sewage handling system. Untreated waste water then passes past the treatment plant into the River system without treatment.)

Stormwater is generally fed into the ACT streams and lakes via stormwater drains. It is estimated by the Department of Urban Services that 95% of properties in the ACT are connected to the system for disposal of stormwater. It is not easy to identify how much of the flow into our lakes is due to the urban area, but the streamflow data give some insight into what the total flow was in relation to flow out of rural catchments for the reporting period.

ACTEW has been innovative and experimental in dealing with sewage and sewage issues, and is currently alternative means to dispose of greywater, for example.

DISSOLVED OXYGEN

ACT waterways are in reasonably good condition as indicated by concentrations of dissolved oxygen at monitoring sites. There were no instances in which dissolved oxygen levels fell to below the 4mg/L guideline. There are, however, some obvious problems, with the lowest levels of dissolved oxygen recorded for the Molonglo River downstream of Queanbeyan. This is a result of the high level of organic material discharged into the river.

There are some potential sources of stress on dissolved oxygen levels in ACT waterways. These include the discharge of effluent and stormwater into rivers and the trapping effects of willows in some stream reaches. The impacts of these on stream health require further investigation. Levels of dissolved oxygen below Scrivener Dam are particularly low because of low oxygen levels in water releases from the dam.

DRINKING WATER QUALITY

Water is supplied for drinking within the ACT and Queanbeyan by ACTEW Corporation. The quality was generally of a high standard during the reporting period.

Overall, less than 6% of samples failed to meet the guidelines during the 1996/97 reporting period, mainly due to aesthetic factors such as colour, turbidity and pH. There were no failures due to bacteriological contamination during the reporting period.

FAECAL COLIFORMS

Median values for the number of colony forming units (cfu) per 100mL ranged from 4 cfu/100mL at Lake Tuggeranong (site number 249), to 780 fu/100mL at site number 301 (Ginninderra Creek at Parkwood).

GROUNDWATER QUALITY

Groundwater quality in the ACT is generally of a high standard, and would generally be considered drinkable (meeting guidelines for drinking water quality), if not particularly pleasant. There are, however, several sites of concern in the ACT

A plume of contaminated water surrounds the Pialligo landfill site, which was filled with Canberra's municipal garbage in the 1960s and 1970s. Investigations showed that leached water from the Pialligo landfill was very saline (from the breakdown of domestic refuse) and also contained organic pollutants and heavy metals. The plume extended from the site into permeable sand and fractured rock aquifers to a distance of about 400 m to the west and north.

Intermittent monitoring of the groundwater by the Department of Urban Services over the last few years has shown that the plume of contamination extends further than it did in 1977. However, concentrations of pollutants in some monitoring bores, including those within the landfill, have decreased since 1977.

Other pollution plumes identified in 1984 are located at Hume (phenol and tannin contamination of groundwaters), at Civic, Braddon and Mitchell (hydrocarbon plumes), and a plume associated with west Belconnen Landfill.

Analysis of groundwater quality data from the West Belconnen site identified a plume of contaminated water below the fill site. Contaminants include excessive levels of nitrogen, faecal coliforms and phenols. Further investigations suggested that the plume is migrating off-site through groundwaters and has the potential to discharge to nearby streams.

RAW WATER TREATMENT

Raw water used for water supply to the ACT and Queanbeyan is of a relatively high standard. Water from the Cotter system is disinfected by chlorination. Because these waters are particularly soft, lime is also added. That only chlorination is needed to meet health standards, reflects the relatively undisturbed nature of the catchments from which water is drawn.

In contrast, water from the Googong Dam must be subjected to the full chemical and filtration treatment prior to disinfection to make it safe for human consumption. This is because of the extent of catchment modification, such as clearing for agriculture and ongoing agricultural use.

TOTAL NITROGEN

Rivers flowing through the ACT generally had low levels of nitrogen during the 1996/97 reporting period. Median values at most sites were between 0.06 and 3 mg/L, with a maximum value of 7.5 mg/L recorded at Halls Crossing on the Murrumbidgee River.

In contrast, nitrogen levels were much higher at sites below where effluent is discharged into the Molonglo from the Lower Molonglo Water Quality Control Centre (sewage treatment works). Nitrogen levels at these sites have been as high as 23 mg/L, although median concentrations of nitrogen were in the range 6 to 10 mg/L.

There is a high nitrogen concentration in the Murrumbidgee River downstream of the ACT, but the concentration decreases with distance downstream, as the ecosystem operates to return nitrogen levels towards the natural balance. This transfer is apparent in the decline in median total nitrogen concentration from 5.9 mg/L at Hall to 1.0 mg/L at Station 108 in the centre of Burrinjuck Dam. The reduction in median nitrogen concentration reflects the transfer of nitrogen by organisms from the water to the atmosphere.

The nitrogen concentration in Burrinjuck Reservoir below the last sampling station probably continues to decline towards a typical level of 0.3 to 0.5 mg/L in the Burrinjuck outflow. The nitrogen concentration in the river downstream of Burrinjuck Reservoir is, then, similar to the concentration in the river upstream of the ACT.

The strategy in the ACT has been to ensure phosphorus concentrations are low, and to maintain nitrogen at a level which will discourage nitrogen fixing blue-green algae. There is currently a national debate on the removal of nitrogen from discharging effluent, but there is currently no evidence to suggest that elevated nitrogen levels are of concern for inland waters.

TOTAL PHOSPHORUS

Levels of phosphorus in ACT streams are low. Almost all values are below the maximum desirable limit of 0.1 mg/L. The only exceedances in the 1996/97 reporting period were at the Lower Molonglo Water Quality Control Centre (ie the sewage treatment works) at station 401 and at Flints Crossing on Paddy's River (station 834).

As would be expected, sites above Canberra had a slightly lower median phosphorus concentration (0.01 mg/L) while sites below Canberra had a slightly higher concentration (0.02 to 0.04 mg/L). The highest median concentration was 0.08 mg/L in the Molonglo River downstream of LMWQCC (station 401) - but even this was still below the maximum desirable limit.

The 90 percentile high concentration of total phosphorus in the Murrumbidgee River and Burrinjuck Reservoir was in the range of 0.04 to 0.09 mg/L. These results suggest that diffuse sources from urban and rural runoff are major phosphorus sources in the catchment, and point sources, such as the LMWQCC, are not the dominant contributors of phosphorus.

In practice, more than 98% of phosphorus is removed from wastewater during treatment at the LMWQCC plant serving Canberra. Hence treated effluent from the ACT accounts for less than 15% of the total phosphorus loading on Burrinjuck Reservoir in a median flow year. The balance comes from wastewater treatment plants in the NSW portion of the catchment, urban runoff and rural runoff.

The median concentration at all Burrinjuck sites was in the range 0.02 mg/L to 0.04 mg/L, with the lower values being in the deeper part of the Lake and the higher values being at Station 102 which, not surprisingly, also had the highest algal levels, as discussed later.

The median concentration of phosphorus at the urban lakes was 0.03 to 0.04 mg/L in Lake Ginninderra; 0.04 to 0.08 mg/L in Lake Burley Griffin and 0.08 mg/L in Lake Tuggeranong. The 90 percentile phosphorus concentrations in the urban lakes were generally 0.05 to 0.18 mg/L.

The urban lakes in Canberra play an important role in capturing and storing phosphorus from urban runoff. Hence higher phosphorus levels are measured in streams leading to the lakes, and in the urban lakes, than in rivers downstream of them.

Total phosphorus is often used as an indicator of the potential for algal growth in fresh water ecosystems; the measured levels in the rivers and Lake Burrinjuck indicate a moderate and occasionally high potential for algal growth, but not unacceptable conditions for a river system such as the Murrumbidgee River. There are higher concentrations in the urban lakes as a result of urban runoff; and this makes the lakes susceptible to water quality problems if not carefully managed.

TOTAL SUSPENDED SOLIDS

Measurements of total suspended solids (TSS) indicate that in streams monitored by the ACT, almost all were within an acceptable range during the 1996/97 reporting period.

Desirable values for TSS are less than 25 mg/L for aquatic habitats of the ACT. The median concentration at all river sites was in the range 3 to 22 mg/L. Lake Ginninderra had a higher median value, a reflection of the continuing development of urban land in the area.

Results for total suspended solids prior to 1992, where available, tended to be higher than in more recent years. This was particularly the case in Burrinjuck Dam, Lake Ginninderra and Lake Burley Griffin.

TURBIDITY

Rivers flowing through the ACT generally had low levels of turbidity for much of the 1996/97 reporting period. Although almost all of the 24 stations recorded exceedances of the guideline at some

stage during 1996/97, this tended to occur only once to several times at any one station. This is typical of most large Australian rivers flowing through agricultural plains during periods of low flow.

Median values at most sites were up to 30 NTU, although all sites reported median values of less than 10 NTU during 1996/97.

At times, high turbidity levels occur at all sites. The urban lakes have higher turbidity levels most of the time, with Lake Tuggeranong and Lake Ginninderra having the highest median turbidity, of about 30 to 40 NTU respectively. This is typical of construction activities in an urbanising area.

STREAM SALINITY

Measurements of salinity, as electrical conductivity, indicate that salinity levels in streams monitored by the ACT are all within the acceptable limits for drinking water (for humans) of 800uS/cm. At the "worst" station, 90% of the measurements of electrical conductivity were below 600uS/cm.

Median values for electrical conductivity were all less than 260 uS/cm except for two stations: Ginninderra Creek at Parkwood (number 301) and at the Lower Molonglo Water Quality Control Centre (number 401). Median values for these two stations were 390 and 405 uS/cm respectively in the 1996/97 reporting period.

There was an increase in electrical conductivity at the Molonglo site (number 401) during the last ten years, and this is a result of the lower rainfall received more recently, and due to the role of the Lower Molonglo Water Quality Control Centre in sustaining river flows during drier periods.

For the remaining stations, values for electrical conductivity during 1996/97 did not differ substantially from the longer term (five yearly and ten yearly) data, suggesting no apparent longer terms trends in stream salinity at these monitoring stations.

WATER RECYCLING

There have been several initiatives by the ACT Government to further enhance the volumes of treated sewage water re-used. These include:

1. An upgrading of the Duntroon Playing Fields to allow for the eventual irrigation of all fields, including the golf course, with treated effluent. At the time of publication, the first stage, viz installation of the irrigation system and associated works, was completed. The second stage is to connect the system to the sewage treatment plant at Fyshwick and it is scheduled to be completed in 1997/98.
2. CRANOS (Compact Reduced Air demand Nitrifying/denitrifying Odour controlling unit with low Solids production) is a new technology for treating effluent at the domestic and commercial scale. Ten domestic units have been trialed during the reporting period to determine the safety of these units or possible wider application in the ACT urban area as well as surrounds.

Treated effluent is being used at Southwell Park, Belconnen, the Lower Molonglo Water Quality Control Centre, the visitors centre at Mt Stromlo and the grounds of Condamine Court on Northbourne Avenue.

WATER SUPPLY

There is an adequate water supply to meet the current needs for water to the ACT and Queanbeyan consumers. Increased community awareness of the need to conserve water and the slowdown in the growth of population has meant that the current water supply system will be able to cope with the community demands.

The amount of water stored in dams supplying water to the ACT and Queanbeyan was more than 85% of the total available storage capacity throughout the period 1996/1997. In fact, in the winter and early spring months of 1996, the dams were at 100% of capacity.

The combined storage capacity of the existing reservoirs used by Queanbeyan and the ACT is sufficient to provide water for a population of 400,000, based on average daily water use during the early 1980's which included a major drought. The present population supplied is about 330,000, so it would appear that the capacity will be adequate on present rates of consumption for the next 10 to 15 years.

The amount of water stored has declined in the few months at the end of the reporting period because of the low rainfall conditions over the autumn and early winter months of 1997. Significantly less than normal rainfall and available meteorological evidence indicate that we are about to experience a strong El Nino event in the coming months. A strategy to conserve and use water more efficiently may need to be implemented to ensure that there is a sufficient water supply to meet the needs of the communities through the expected El Nino event.

The communities of the ACT and Queanbeyan did not experience restrictions on the amount of water used during the reporting period.

WATER USE

Water consumption per person during the last six years has been the lowest recorded since the late 1960's. In 1996, water consumption in the ACT and Queanbeyan in 1996 was 61812.6 million litres, which is equivalent to an average daily consumption of 424 litres of water per person.

The effect of decreasing use of water by individuals is the accompanying decrease in the total amount of water used by the ACT and Queanbeyan, despite an increase in the total population. This means that the need for a new dam to supply water to the ACT and Queanbeyan can be postponed for some years.

Small increases and decreases in water consumption from year to year tend to reflect changes in the amount and seasonality of rainfall. About 55% of water used in the ACT is typically used on domestic gardens, and enough rainfall at the right time reduces the amount of watering needed. So water consumption in the ACT is lower in years of high rainfall, such as in 1983 in 1992.

The total volume of sewage re-used is low compared to discharges from the Lower Molonglo Water Quality Control Centre. It is expected that re-use volumes will increase as the re-use technology develops.

It is expected that it will be possible in the next report to report the total volume of water recycled or re-used annually by each sector.

BIODIVERSITY

INTRODUCTION

The ACT covers about 2,358 sq. km.(235,800 ha) of which 54% (approximately 127,00 ha) is within conservation reserves, and 8% (15,700 ha) under ACT Forests.

Conservation areas cover most of the south of the Territory and extend the protection of the Kosciuszko National Park along the border of Yarrowlunla Shire.

Although some 14% of the ACT has been developed for the national capital, Canberra, the urban space has significant conservation and other open areas that make a considerable contribution to the richness of the biodiversity in the Territory.

Two IBRA bioregions are represented in the ACT. Most of the Territory is within the South-Eastern Highlands bioregion, and the remainder is within the Australian Alps (AA) region (Thackway and Cresswell 1995).

The South-Eastern Highlands bioregion is characterised by wet and dry sclerophyll forests, woodland, minor cool temperate rainforest and minor grassland and herbaceous communities. The Australian Alps (AA) region (conserved within Namadgi National Park) is dominated by alpine herbfields, and other treeless communities, Snow Gum woodlands and montane forests dominated by Alpine Ash.

With more than half the Territory under conservation management, it can be expected that both the biodiversity in the area, and the supporting data, should be considerably richer than that in some of the surrounding Shires that have historically had landuses that are less sympathetic to the conservation of natural resources.

Native species and their Ecosystems

Assessment

Conservation of species diversity is considered to be reasonably good in the ACT, because of the large proportion of the ACT protected within reserves rather than any comprehensive knowledgeable assessment based on available data. Data on species diversity is limited.

The alpine ecological communities in the ACT are considered to be in good condition, and under minimal threat of degradation or fragmentation. Aquatic ecosystems in the alpine region are also well protected, although there is some concern as to the potential impact of trout.

In contrast, only about 10% of the ACT sector of the South Eastern Highlands (SEH) biogeographic region can be considered adequately protected, namely the Forest ecosystems (within Namadgi National Park, Tidbinbilla Nature Reserve and Canberra Nature Park) and the riparian (riverside) ecosystems (within the Murrumbidgee River Corridor).

Two of the other, less well protected ecosystems within the SEH region — Natural Temperate Grasslands and Yellow Box - Red Gum Grassy Woodland — are poorly represented within the reserve system and have been declared endangered. Present management based on information from research is adequate for the grasslands, but not adequately based for the woodlands. Yellow Box - Red Gum Grassy Woodland occupies about 10% of the ACT's total woodland area.

The SEH (lowland) wetlands in the ACT clearly benefit from the protection afforded by linked wetlands in the alpine region, but little is systematically recorded of the conservation status of the lowland wetlands and their associated aquatic ecosystems.

Riparian communities are partially protected now, but the reported loss of some species such as casuarinas and the spread of willows suggest significant deterioration since non-indigenous settlement (primarily because of clearing of stream banks, grazing and pine plantations), with consequent impacts on aquatic ecosystems.

Although broad knowledge of abundance and distribution of local vertebrate species is reasonable, it has not improved significantly since ACTSER 94 with the noteworthy exception of two reptiles declared threatened (Striped Legless Lizard, *Delma impa*, and the Eastern Lined Earless Dragon *Tympanocryptis lineata pinguicolla*).

Knowledge of local invertebrates is insufficient for any complacency about long-term sustainability. The ACT Flora and Fauna Committee has declared nine animal species (four birds, one lizard, one frog, one fish, one crustacean and one insect) as vulnerable, and six animal species (one mammal, one bird, two fish, one lizard and one moth) and four plant species as endangered.

Implications

Lack of knowledge about what exists currently means that loss of biodiversity may occur without our knowing about it.

Lack of knowledge about how local ecological communities function means that current management practices may be protecting them only in the short term rather than in the long term.

Recommendations/Objectives to be achieved

The release of a draft Nature Conservation Strategy for public comment is commended, and when finalised and adopted, the Government is urged to provide sufficient resources for its implementation.

The Flora and Fauna Committee should continue to be serviced sufficiently for it to fulfill its terms of reference.

While it is noted that some Commonwealth funding has been secured to support the monitoring of the ecological dynamics of grasslands, more resources are needed for research on, and the monitoring of, biodiversity and functioning of other ecological communities in the ACT.

In particular, mapping and inventory research is needed to establish more objective data for the abundance and distribution of invertebrates and non-avian vertebrates, as a baseline against which to measure any future change.

Background

Fundamental to the concept of biological diversity (biodiversity) is the number and variety of individual species and of the ecological circumstances in which they live. Changes in the number and/or abundance of species, and changes to different ecosystems, are the most obvious factors that warn of possible changes in biodiversity.

Biogeographic regions are recognised by the major ecosystems that occur in a landscape which in turn reflect patterns of geology, landforms, soil, climate, and land use. Within these biogeographic regions, ecological communities can be distinguished by dominant vegetation types and physical features. The

major ecological communities in the area covered by this report are in woodlands, grasslands, riparian (riverside) zones, wetlands, montane (alpine) areas and forests. (Where urban areas have developed, the original ecological communities have obviously been largely destroyed, although some pockets of natural areas remain and a few mainly vertebrate species have benefited.)

Of the 80 biogeographic regions into which Australia is divided, two are represented in the ACT. These are the

Australian Alps — including alpine herbfields and other treeless communities, Snow Gum (*Eucalyptus pauciflora*) sub-alpine woodlands and montane forests. About 20% of the ACT falls into this region, essentially encompassing the upper Cotter River and its catchment, and the

South Eastern Highlands — predominantly wet and dry sclerophyll forests, but including some cool temperate rainforest and grasslands, wetlands, and other herbaceous communities. The majority of the ACT below the Cotter falls into this region.

The long-term survival of biodiversity — i.e. native species and ecological communities — depends on effective protection and management which are based on reliable data. High quality research and monitoring, supported by appropriate legislation to enable resource allocation for the preparation and implementation of protection and recovery plans, is fundamental to the conservation of biodiversity.

Threats and Reasons for Change

Assessment

From a reconstruction of vegetation types that would have existed in the ACT c.1750 (by CSIRO Wildlife and Ecology Division), it is apparent that woodlands and grasslands and their species have suffered most from urban development. That pressure has slowed dramatically in the last few years, and in particular, in the reporting period. In fact, the area of land to go under new houses during the reporting period was virtually balanced by the area of grassland and woodland that was protected. However, because of the fragmentation of remnant native grasslands, urban development now constitutes a serious threat to their existence, regardless of how slow the urban spread might be.

The spread of environmental weeds and other exotic species (including feral animals), (particularly in the peri-urban areas) is also a serious threat to biodiversity; however, although a Weeds Strategy is in place, data are not adequate to quantify the extent of the threat.

Other sources of threats to biodiversity relate to what might be thought of as people engaging in recreational activities and lifestyle pursuits (bushwalking, camping, 4WD and off-road driving). This is a possible area for research or further investigation.

Implications

As long as adequate funds are provided for implementation of Action Plans for the management of remnant native grasslands and woodlands, there is not a lot more that could be done in relation to conservation of these communities.

Without adequate mapping of the weed infestation, it will be difficult to assess the scope of the programs to be undertaken, and to assess whether any progress is being made towards control.

Recommendations/Objectives to be achieved

It is recommended that -

- the extent and type of weed infestation be digitally mapped for use as a reference point for action plans to implement the Weeds Strategy; and for use (and update) by Landcare Groups in the management of weeds; and
- the location and date of community group weed eradication activities be recorded and accessible on the Environment ACT World-Wide Web page.

Background

The size of the urban area has changed from 10,563 ha in 1953 to 23,991 ha in 1997.

Environmental weeds are plants that invade, or could invade, natural ecosystems, usually with adverse effects on the survival and regeneration of local native plants and animals. Many, but not all, weeds are exotic species. Weeds usually have characteristics, such as prolific seeding or fewer predators, that make them able to outcompete indigenous plants. As weeds take over an area, local native biodiversity often decreases markedly. In aquatic ecosystems, weeds may alter stream flow patterns and even stop flow altogether. Weeds can also affect local animal species by changing the availability of food, nesting sites or cover (as protection from predators).

Exotic bird species include the Starling (*Sturnus vulgaris*), Common Myna (*Acridotheres tristis*), Blackbird (*Turdus merula*), Mallard (*Anas platyrhynchos*), House Sparrow (*Passer domesticus*) and Feral Pigeon (*Columba livia*), all of which are pests, and the European Goldfinch (*Carduelis carduelis*), Greenfinch (*Carduelis chloris*) and Skylark (*Alauda arvensis*) which appear to have little impact. However exotic birds compete for food and breeding habitat with native species. Starlings and Common Mynas, for example, compete with native species, such as parrots, for nesting hollows. Although most exotic species tend to remain within urban areas of the ACT, and so have limited impacts on native species outside these areas, the Blackbird has been observed in remote and heavily forested areas, where it may displace the native White's Thrush (*Zoothera dauma*).

About 25 exotic mammal species are found in the ACT (excluding those in zoos). Many of these pose significant threats to native animal and/or native plant communities. For example, feral pigs destroy pasture and damage sensitive plant communities through their feeding and other behaviour. Cats, both feral or domestic, prey on a wide range of native animals and there is scientific and community concern that they may be having a significant impact on the sizes and long-term sustainability of many populations. Several exotic mammal species also pose actual or potential threats to native animals.

Some exotic mammal species are widespread and abundant throughout the ACT (eg rabbits and foxes) while others are widespread only in limited habitats (eg feral pigs in forests and pastoral areas, brown hares in lowland areas and pine plantations, black rats in lowland areas). Other species have more limited populations (eg feral goats in Namadgi and Tidbinbilla, feral dogs in the southern half of the ACT).

Conservation Action

Assessment

A Draft Nature Conservation Strategy has been released for public comment. Its finalisation and adoption by the Government followed by implementation is awaited.

The work of the Flora and Fauna Committee has continued to be supported. In response to declarations, six Draft Action Plans for ecological communities or for species declared vulnerable or endangered have been prepared (due for release 1 October 1997), namely:

Natural Temperate Grassland

Striped Legless Lizard (*Delma impar*)

Eastern Lined Earless Dragon (*Tympanocryptis lineata pinguicolla*)

A leek orchid (*Prasophyllum petilum*)

A subalpine herb (*Gentiana baeuerlenii*)

Northern Corroboree Frog (*Pseudophryne pengilleyi*)

National Recovery Plans are available for the following species declared endangered/threatened in the ACT:

Button Wrinklewort (*Rutidosis leptorrhynchoides*)

Trout Cod (*Maccullochella macquariensis*)

Swift Parrot (*Lathamus discolor*)

Conservation of the ecological communities that are not particularly well protected (i.e. Native Grassland and Yellow Box - Red Gum Woodland) is being addressed through the preparation of further Action Plans. Wetland and riparian communities need further study, so the beginning of a survey program for wetlands (funded from the 1997-98 budget) is welcomed.

Draft Management Plans (DMPs) for most of the ACT's Nature Reserves and other protected areas have already been released, others are due and some are being finalised; Murrumbidgee River Corridor (Management Plan due September 1997), Canberra Nature Park (DMP released late 1996), Tidbinbilla Nature Reserve (DMP released May 1997), Lower Molonglo River Corridor (DMP due September 1997), Namadgi National Park (revised DMP due May 1998), Government Horse Holding Paddocks (Management Plan due March 1998), Googong Foreshores (DMP due May 1998).

Implications

Clearly there are not enough human and financial resources to do immediately all that needs to be done in terms of conservation research and action. However, what is being done is following a reasonable and logical path. Nevertheless, a greater effort is needed overall. For example, until Draft Action or Management Plans are finalised, the requirement for resources may not be known and the implementation of essential conservation efforts may be hampered.

Recommendations/Objectives to be achieved

Overall a greater effort is needed to maximise the effectiveness of conservation management.

Draft Management and Action Plans should be finalised as quickly as possible to ensure adequate and effective distribution of resources.

Background

Effective protection and management of threatened species and ecological communities, especially those that are threatened, is essential to their long-term survival. Appropriate conservation legislation, together with the preparation and implementation of protection and recovery plans, is fundamental to threatened species management. Fortunately such legislation is in place. What is needed are the resources to prepare the necessary action plans and to implement them. All of them need to be set with a general strategy for Nature Conservation (as required by the legislation).

SPECIES DIVERSITY

Conservation of species diversity is considered to be reasonably good in the ACT because of the large proportion of the ACT protected within reserves, although there is no comprehensive data base or long-term monitoring to support this view objectively. Overall, data on species diversity are limited.

Plants

There is a detailed list of Plants of the ACT.

Invertebrates

Very little is known of the ACT's invertebrate animals, partly because of a lack of research and partly because of the potential number and diversity of the organisms to be studied.

Insects are probably the best known of the invertebrate classes. More than 200 species are known from ACT records in the Australian National Insect Collection Specimen Database. These are mainly butterflies, mantids, beetles, flies, moths, dragonflies and termites. It is unlikely that any of these species are restricted to the ACT.

Vertebrates

There is some data on the ACT distribution and abundance of vertebrates —fish, amphibians, reptiles, birds and mammals. In the case of birds, these data are collected by members of Canberra Ornithological group and can be considered very reliable. In the case of other (i.e. non-avian) vertebrates, reliability varies from group to group and species to species, as resources for intensive surveys have generally not been available. Overall, therefore, the data are insufficiently detailed to identify any changes in the abundance or distribution of individual species that may have occurred since the ACTSER 1994 and 1995 reporting periods.

ECOSYSTEM DIVERSITY

The ACT's range of vegetation is shown in the regional vegetation map as summarised below.

Australian Capital Territory		
	Area (ha)	%
Non forest system	73 564	31
Moist forest	71 950	30
Dry forest	30 281	13
Urban	17 891	8
Woodland	15 670	7
Exotic forest	14 573	6
Subalpine woodland	6 040	3
Frost hollow	2 265	1
Plateau complex	1 553	1
Water body	1 247	1
Rocky outcrop	847	0
Severely disturbed forest	33	0

Source: NPWS Broadscale Eastern Bushlands Database

Numbers/Percentages are rounded to nearest whole.

Absolute figures may not be 100% accurate due to mapping techniques.

Of the two biogeographic regions in the ACT, only one — the Australian Alps region, comprising about 20% of the ACT — is well conserved, being fully contained within the boundaries of Namadgi National Park. The alpine ecological communities are considered to be in good condition, with appropriate management and research (to the extent that resources allow) and under minimal threat of fragmentation. Aquatic ecosystems in the alpine region are also well protected, although there is some concern as to the potential impact of any introduction of trout.

In contrast, only about 10% of the ACT sector of the South Eastern Highlands (SEH) biogeographic region (about 80% of the ACT) can be considered sufficiently protected, namely the forest ecosystems (within Namadgi National Park, Tidbinbilla Nature Reserve and Canberra Nature Park) and the riparian (riverine) ecosystems (within the Murrumbidgee River Corridor).

The SEH (lowland) wetlands in the ACT clearly benefit from the protection afforded the linked wetlands in the alpine region, but little is known of the conservation status of the lowland wetlands and their associated aquatic ecosystems. The ACT's riparian (riverside) ecosystems have important functions as wildlife corridors (for example, the Murrumbidgee River Corridor is important in honeyeater migrations) and in the maintenance of catchment processes, but there has been no comprehensive study. Riparian communities are somewhat protected now, but the loss of vegetation such as Casuarinas and the invasion by Willows suggest significant deterioration since settlement (primarily because of clearing of stream banks, grazing and pine plantations), again with consequent impacts on aquatic ecosystems.

Two of the ecosystems within the SEH region — Natural Temperate Grasslands and Yellow Box - Red Gum Grassy Woodland — are poorly represented and have been declared endangered. Present research-based management is adequate for the grasslands, but inadequate for the woodlands. A survey of ACT woodland in 1996-97 provided valuable new data.

Descriptions and more detail on some of these ecosystems are available in ACTSER 94 and ACTSER 95. In the reporting period, significant data are available only for grasslands and woodlands, with some data for wetlands.

Grasslands

Natural temperate grassland occurs at 38 locations in the ACT, within which there are 67 sites differentiated by land use, land management and/or floristic associations. (Five floristic associations have been recognised in ACT grasslands.) There are about 1450 ha of grassland, with some 850 ha (41 sites in 27 locations) having moderate to high botanical significance. In 1996, natural temperate grassland was declared an endangered community in the ACT under the *Nature Conservation Act 1980*.

Five species associated with natural temperate grasslands and grassy woodlands have been declared endangered in the ACT (see *Managing Threatened Species and Managing Ecological Communities*). Experimental work has shown that invertebrate groups are not a reliable index of biodiversity in grassland sites. Studies assessing how groups of invertebrates respond to floristic diversity are currently being developed.

Woodlands

From the 1996/97 survey of remnant woodland patches, an assessment of natural qualities (in a five level rating system) was used to assess natural qualities. The highest qualities are associated with an area of some 1600 ha, the next highest with more than 18,600 ha and the middle rating with about 8,600 ha. The remaining 2,900 ha of woodlands were considered of low quality, with some mature

trees still standing but little of the original vegetation community remaining. One type of woodland, Yellow Box - Red Gum Grassy Woodland, occupies about 10% of the total woodland area and was declared as an endangered community in 1997 (see Managing Ecological Communities).

Wetlands

The ACT has a diverse range of aquatic habitats ranging from small sub-alpine bogs to the larger riverine systems such as the Murrumbidgee River. Most of the ACT's significant wetlands (Big Creamy Flats, Cotter Flats, Ginini and Cheyenne Flats, Nursery Swamp, Rock Flats, Rotten Swamp, Scabby Range Lake, Snowy Flats, Upper Cotter River, and Upper Naas Creek) occur in the Australian Alps Bioregion although three (Bendora Reservoir, Jerrabomberra Wetlands and Horse Park Wetland) occur in the South Eastern Highlands Bioregion. Most of the high altitude wetlands occur above 1000 m altitude (highest is Snowy Flats at 1610 m) in the Cotter catchment (between the Brindabella Range in the west, the Bimberi and Scabby Ranges in the south and the Cotter/Gudgenby divide in the east) and the Gudgenby River catchment, and are protected in reserves (mainly Namadgi National Park). Sub-alpine and montane vegetation communities in wet areas often constitute *Sphagnum* bog (generally acidic with a low nutrient content, dominated by hummock-forming mosses) or *Carex* fen (swamp, lacking hummock-forming mosses, comprising mainly grass-like plants, such as sedges or rushes) interspersed with patches of wet heath and wet herbfield. As representatives of sub-alpine ecosystems, these wetland sites are considered of 'National Significance' as well as regional or local significance.

Sub-alpine vegetation is sensitive to disturbance from feral animals such as pigs, which may disturb large areas of herbfield in their search for food such as insect larvae and tubers and also facilitate the entry of exotic plant species into the area. Recreational walkers may also pose direct and indirect threats to high altitude wetlands, several of which provide habitat for rare species. For example, Big Creamy Flats, one of the biggest areas of wet heath and wet herbfield in the ACT, has several rare plant species occurring in the area (*Olearia rhizomata* ms, a perennial daisy; *Viola improcera*, a small herb; *Carex capillacea*, a small sedge, *Oreobolus oxycarpus* Austral Moonwort; *Botrychium australe*; and Snow Coprosma *Coprosma nivalis*). Cotter Flat provides habitat for the rare Broad-toothed Rat *Mastacomys fuscus*, as well as for the Orange-groined Toadlet *Uperoleia laevigata*, the Whistling Tree Frog *Litoria verreauxii* and the Two-spined blackfish *Gadopsis bispinosus*.

The lowland wetlands are also important ecologically. Bendora Dam contains threatened fish and frog fauna, with only a single introduced fish species. Jerrabomberra Wetlands supports 77 species of waterbird (including breeding populations of 16 species and significant numbers of Latham's Snipe *Gallinago hardwickii* which is protected under international treaties), and is an important refuge for waterbirds when prolonged dry periods occur in the region, as well as being the only known site for the locally rare plant *Schoenoplectus mucronatus* in the ACT. Horse Park Wetland is an important ACT and regional example of a relatively intact, permanent, lowland freshwater marsh with significant European and aboriginal cultural values: it is possibly the most important site for Latham's Snipe in the ACT. Horse Park Wetland has no formal protection in the reserve system, unlike the other significant lowland wetlands (eg Jerrabomberra Wetlands Nature Reserve and Murrumbidgee River Corridor Nature Reserve). There has been no systematic survey of the distribution and importance of the smaller lowland wetlands, which are probably at highest risk as they lie outside the reserve system.

Details of the natural qualities and ecological (including species-specific) importance of individual wetlands have been summarised by Lintermans and Ingerwersen (1996) in the ACT chapter of *A Directory of Important Wetlands in Australia*.

CHANGED FIRE REGIMES

The vegetation communities and associated wildlife of the ACT, as of the Region, have developed as assemblages of species subject to modification by fire events. For thousands of years, there has been a human component in the occurrence of fire, with selective and opportunistic burning by Aboriginal people having been followed by frequent extensive burning by graziers. Dating of tree rings and fire scars in the ACT indicate that the frequency of ignition has increased since European settlement: changes in landuse have also affected the occurrence and behaviour of 'natural' fires started by lightning strikes.

Proximity of urban areas to grasslands, forests and other bushfire-prone areas, and the increasing use of the ACT's natural areas for outdoor recreation and nature based tourism (see Recreation in the ACT) has increased the risk of fires occurring and affecting the biodiversity of natural areas, both in the short-term and long-term.

Fire suppression in the ACT is primarily covered by the *Bushfire Act 1936* (covers fires on both urban and non-urban land) and the *ACT Fire Brigade Act 1957* (cover urban fires only), although other legislation (e.g. related to pollution, conservation or planning) is also relevant. The agencies responsible for managing fire management in most ACT land are ACT Parks and Conservation, Canberra Urban Parks and ACT Forests. Amendments to the Bushfire Act made in 1996 require the production of fuel management plans for areas of Government land that are bushfire-prone. Accordingly, a Draft Bushfire (Fuel) Management Plan was released by Environment ACT in August 1997. This Draft Plan details fire histories, fire management objectives and proposed actions for the ACT's various reserves, forests, urban areas and unleased rural land (but not leased land). It also provides extensive background information on habitat-management considerations for wildlife and ecological communities (including species-specific data).

Major fires occurred in the ACT in the summers of 1939, 1952, 1979, 1983 and 1985. Reserves and forests have suffered most in the past twenty years. The fire in January 1983 burned about 36,000 ha of the then Gudgenby Nature Reserve (now part of Namadgi National Park). From 1977 to 1996, 25 fires were recorded as either starting in or spreading to Kowen Forest, with most the result of arson or escapes from the adjacent Field Firing range. However, no large areas have been burnt: the spread of the major March 1985 fire was limited by the fuel reduction by a previous fire and a hazard reduction burn. Although many fires in the Kowen forest area have been recorded as starting from trains (including 12 from one train in 1991), these have not had significant impact on the forest's fire history as most have spread into NSW rather than back into the ACT.

The ACT Parks and Conservation Service's management of the Jervis Bay Territory provides a rare example of an imposed fire regime having been developed and successfully applied to conserve biodiversity. The fire regime, introduced in 1977, was designed as a vegetation management strategy, to maintain the range of communities in a mosaic of differing age classes.

In 1996, the Australian Alps Liaison Committee (including ACT, NSW and Victoria) established a Fire Monitoring Project, to monitor the fire ecology of less well understood species and to assess changes in vegetation structure and composition. The project involves regular monitoring at 40 sites throughout the Australian Alps National Parks: seven of these sites are in Namadgi National Park and will provide valuable data for future SERs.

At the level of individual species, some rare plant species may be threatened because of inappropriate fire regimes. In the ACT, Small Purple Pea (*Swainsona recta*) and Button Wrinklewort (*Rutidosia leptorrhyncoides*), perennial herbs found in natural temperate grasslands (see Managing Threatened

Species in the ACT), appear to be overwhelmed by other species under the prevailing fire regime. A greater frequency of fires would suit these species better, by reducing competition. However, this approach to effective species management conflicts with the need to reduce fire frequencies in areas close to urban development (because of potential risks to life and property, air pollution and aesthetic factors).

PESTICIDE POLLUTION

To control Pest Animals in the ACT and Pest Plants in the ACT, many chemical control agents are used.

An investigation into the use of chemicals for pest control in the ACT was carried out in 1997 by the Office of the Commissioner for the Environment, although the report of this investigation has not yet been released.

Within the ACT Government, pesticides are used by Cityscape Services (for areas controlled by Canberra Urban Parks i.e. about 5000 ha of urban open space, parks and roadsides) ACT Parks and Conservation Service (nature reserves, rural roadsides, horse trails, travelling stock reserves, agisted land), ACT Forests (plantation forests) and Totalcare Industries (contractual competitor with Cityscape Services). In addition, pest control is carried out by other areas of Government, often devolved to local levels (e.g. responsibility for pest control in and around schools has been devolved to individual school principals, although in practice Cityscape continue to provide most services). One outcome of the change to a purchaser-provider model of pest control is the lack of *centralised* knowledge and decision-making on individual pesticides (e.g. effectiveness, direct and indirect toxicity, or residual life in the environment).

Pesticide chemicals are registered by the National Registration Authority for use in the ACT. Many of these chemicals are halogenated organic compounds (contain, chlorine, bromine or fluorine).

Examples of the pest control chemicals used in the ACT are:

- 2,4-D amine (Amicide) for many pest plants (weeds) including Paterson's Curse, Thistle species and Bathurst Burr
- metasulfuron methyl (Brush-Off) for many weeds including Broom, Sweet Briar, Cotoneaster, Firethorn, Hawthorn and Blackberry
- dicamba+MCPA (Buckshot) for weeds such as horehound and Thistle species
- glyphosate (Roundup) for a range of woody and succulent weeds
- flupropanate (Frenock) for Serrated Tussock
- chlorpyrifos (Deter) for termites and ants
- chlorpyrifos, xylene and 1,1,1-trichloroethane (Dursban) for termites, ants, cockroaches and spiders
- permethrin (Coopex Dust) for silverfish, ants
- dimethoate (Rogor) for sap-sucking insects
- brodifacoum (Talon G) for rats and mice
- wafarin (Wafarin) for feral pigs.

The Commissioner's investigation found that, except for Cityscape Services and ACT Forests, pest control operators in the ACT could not supply any data on the quantities of chemicals used for pest control. This means it is impossible to establish a baseline usage in order to identify changes in use over a significant timeframe of, say, five years.

Generally, practices in chemical application and monitoring are inconsistent. A Pest Management Manual has been produced by Canberra Urban Parks, but is not in use by all ACT operators. There are no significant monitoring programs in place to determine the long-term impact of the control activities on target species, and (because of the enormity of the task) only incomplete evaluation of the impact of control chemicals on non-target species and communities. There is therefore immense reliance on data provided by the manufacturers of the pesticides, who must conduct tests that satisfy the requirements of the World Health Organisation and the relevant Environment Protection Agencies.

The Commissioner's investigation found that the chemical pest control programs were not leading to eradication of pests, nor were they necessarily as cost-effective in the long-term as they were considered to be in the short-term. More importantly, there was significant evidence from the community consultation that best practices in pesticide application were not always followed.

The extent of pesticide pollution (i.e. pesticides passing into the ecosystem and having the potential to affect non-target species) in the ACT is therefore not known at present, and the ecological implications of the current practices of chemical pest control can therefore not be predicted. However, it is fairly certain that if pesticides are used too randomly and/or frequently, some target pest species may develop partial or full resistance to those chemicals, giving pest managers fewer options in the future and increasing the overall pressures of pesticide pollution on the environment.

In the report on his investigation into chemical pesticide use, the Commissioner is likely to recommend that a much more rigorous approach be taken to defining and enforcing legislation, establishing useage protocols and developing effective monitoring programs for pesticide use in the ACT.

Integrated Pest Management (IPM) which uses a broad and synergistic range of mechanical, cultural and biological methods is advocated by the ACT Parks and Conservation Service, and is the favoured way to reduce the need for chemicals in pest control. However, as more effort is needed to establish effective IPM programs, there needs to be greater emphasis on the benefits of IPM and adequate resources available to pest control managers to devote to IPM strategies.

PEST ANIMALS

Several introduced vertebrate species are significant pests in the ACT (see Species Diversity in the ACT). These include mammals (e.g. feral cats, feral pigs, foxes), fish (e.g. Carp, Oriental Weatherloach, Redfin) and birds (e.g. Common Myna, Common Starling). However, the ACT's relative geographical isolation from other urban centres has meant that some animal pests established in other major cities are not present here. Controlling the introduction of potential pest species into the ACT is therefore seen as an important aspect of future pest management, especially in terms of aquarium escapees which could find their way into the high country or Murray-Darling river systems.

In recent years there have been several significant pest animal control achievements in areas managed for nature conservation in the ACT:

- cattle and horses have been eradicated, and pigs and goats are under sustained long-term control, in Namadgi National Park
- rabbits are under sustained long-term control in Tidbinbilla Nature Reserve.

Conversely, exotic bird species such as Common Starling, Common Myna and Common Blackbird have well-established populations with little prospect of acceptable control measures becoming available.

The predator-prey relationship between exotic pests can be important in regulating impacts on populations of native animals: the most prominent example is the effect of rabbit control on fox and feral cat populations, which appear to turn to native species when rabbits are in short supply. Research is being carried out in the ACT to develop approaches to the most effective timing of control strategies for rabbits and their predators.

Rabbit calicivirus was officially released in the ACT in October 1996, having been assessed nationally as being of no threat to native species. Its potential success as a biological control organism may have implications for both its exotic predators and its native ones (e.g. Wedge-tailed Eagle).

Although all feral pest populations require intense management, introduced aquatic species are particularly difficult to control once established in the wild. In the ACT, Carp (*Cyprinus carpio*), Oriental Weatherloach (*Misgurnus anguillicaudatus*) and Redfin (*Perca fluviatilis*) are well established pests in aquatic ecosystems.

Carp are a major environmental problem throughout Australia's inland waters, having become the dominant species throughout most of their widespread distribution range. Oriental Weatherloach, a small exotic aquarium species probably originally released into the wild by a 'kindhearted' aquarist, has spread since the 1980s from a known small population in Ginninderra Creek throughout the Region. They are now found in the Murrumbidgee, Cotter and Paddy Rivers as well as in Ginninderra and Tuggeranong Creeks.

Redfin provides an example of how, apart from direct impacts, exotic pest animals can also harbour and transmit diseases and parasites. In the 1980s, Epizootic Haemopoietic Necrosis Virus (EHNV) was isolated in Australian fish populations, particularly in Redfin. Although EHNV is thought to have been naturally present in Australia, it previously had no vector to facilitate its wide dispersal. However, with the spread of susceptible Redfin populations over eastern Australia, the transmission of EHNV is now common (in live fish illegally used as bait, on fishing lines and tackle, or on boats) and it is widespread in the Canberra region. In laboratory trials, the disease has devastating effects on native fish species such as Macquarie Perch (*Macquaria australasica*) and Mountain Galaxias (*Galaxias olidus*), so EHNV could become a significant problem in future.

In the ACT only one native animal species is considered as requiring management. Eastern Grey Kangaroos (*Macropus giganteus*) are so widespread and abundant in the ACT that they sometimes come into conflict with human activities (e.g. through collisions with motor vehicles or by causing soil erosion or significant crop pasture or fencing damage) and must be considered under animal pest management strategies. In mid-1995 an ACT Kangaroo Advisory Committee (KAC) was established to ensure that kangaroo management was based on sound scientific principles. The KAC has reported on kangaroo management on rural lands (ACT KAC 1996a), in captivity (ACT KAC 1996b) and on public lands (ACT KAC 1997). A range of management strategies has been recommended, including reducing kangaroo habitat by re-establishing native forest on reserve lands previously cleared for grazing, better monitoring of kangaroo numbers and movements at the public land - rural land interface, and using shooting as the most humane method where culling of large numbers of kangaroos is deemed necessary.

PEST PLANTS

Pest plants (weeds) are a major problem on ACT land. They are prevalent throughout the ACT occurring in conservation areas, farm land, forests, parkland, some urban gardens, along waterways and on road verges. Up to 40% of plant species growing wild in the ACT are exotic: of the 532 naturalised exotic species recorded, at least one third are, or could become, serious pests in the ACT's natural ecosystems (i.e. environmental weeds). Fortunately, the ACT has not been affected by the aquatic plant species that are some of Australia's worst environmental weeds.

In recent years there have been several significant pest plant control achievements in areas managed for nature conservation in (or around) the ACT:

- several weed species are under control at Googong Foreshores, including Sweet Briar *Rosa rubiginosa*, Willow *Salix* spp. and Hawthorn *Crataegus monogyna*
- Blackberries are under sustained long-term control in Tidbinbilla Nature Reserve
- a small outbreak of the noxious Alligator Weed (*Alternanthera philoxeroides*) was detected in Lake Ginninderra and destroyed.

Conversely, some pest plant species are now well-established with little prospect of effective control being possible in the short- to medium-term: these include introduced species associated with the landscaping of urban development, plantation species, horticultural escapees (e.g. *Cotoneaster* and *Pyrocantha* spp.) and native species not indigenous to the ACT (e.g. Cootamundra Wattle *Acacia baileyana* now naturalised in Canberra Nature Park). Willows (*Salix* spp) constitute a specific threat to some of the ACT's riverine environments because of their ability to reproduce both vegetatively and by seed. They also have vigorous growth rates. More recent studies have highlighted the threat from seedling reproduction. Male and female willows of many species and varieties have been introduced into Australia and, under the right conditions, prolific seedling establishment has occurred in many areas, including the ACT, increasing the willows' spread, abundance and ecological damage significantly (see Willows (Cremer 1997 in the full report).

A comprehensive survey of environmental weeds across the whole ACT was carried out in 1995 by Berry and Mulvaney, while a more detailed localised weeds survey was undertaken in the Paddys River Catchment. Both surveys highlighted the wide distribution of exotic species. The Paddys River survey identified weeds and their location specifically for the application of a strategic control program. Currently, a survey of roadside vegetation, including weeds, is being finalised.

The proliferation of weeds in the ACT has been of increasing concern to both the Government and the community. Individual and agency responsibility for weed management has not always been recognised or met; control programs have not been co-ordinated; and legislation has not offered direction or an enforceable deterrent to inappropriate land management. The former weed control program, while substantial, had not given a suitable return on investment and effort put into it. Furthermore, the continuing introduction and use of invasive species has the potential to worsen the current situation.

Past weed control programs in the ACT were undertaken by land management agencies and individual land managers according to local priorities and resources. The result has been a diffuse effort which often failed to recognise the influence of weed problems on neighbouring land to the success of the program.

In an attempt to provide a more rigorous and co-ordinated weed management program, with the understanding and support of both the urban and rural communities, the ACT Government, in consultation with the community, developed a Weeds Strategy which was launched in September

1996. The Strategy outlines a ten-year program for a coordinated Territory-wide approach to weed control within a regional context, focussing on:

- preventing the introduction and establishment of new weed species
- reducing the impact of existing weed problems
- coordinated action on weed management (on the basis that it is more likely that a problem will be brought under control when all stakeholders focus their efforts and resources on a particular weed problem in a particular area).

The Weeds Strategy, as the result of extensive consultation and the consideration of a wide range of options, provides a mechanism for government and the community to work in partnership within available resources and priorities. The Strategy involves gathering information to determine weed control priorities, ensuring resources are applied effectively in a co-ordinated manner, and monitoring the results.

Extensive community consultation during the development of the ACT Weeds Strategy identified the following species as requiring management priority:

Sweet Briar *Rosa rubiginosa*
Blackberry *Rubus fruticosus*
St Johns Wort *Hypericum perforatum*
Thistles (various spp.)
Pine (wildings) *Pinus radiatus*
Willow *Salix spp.*
Serrated Tussock *Nassella trichotoma*
Cotoneaster *Cotoneaster spp.*
Firethorn *Pyrocantha spp*

Other recognised priorities are:

Privet *Ligustrum spp*
Honeysuckle *Lonicera japonica*
Ivy *Hedera helix*
False Acacia *Robinia pseudoacacia*
Mont Pellier Broom *Genista monspessulana*
Kangaroo Thorn *Acacia paradoxa*
Hawthorn *Crataegus monogyna*
Gorse *Ulex europaeus*
White Poplar *Populus alba*
Common Alder *Alnus glutinosa*

The Weeds Strategy indicates that the ACT Parks and Conservation Service will maintain a database of ACT weed species and locations, and will provide weed mapping guidelines to community groups and others willing to undertake small or large scale surveys. Government Agencies will identify and map weeds species occurring on land they manage. Data held by the ACT Parks and Conservation Service will be available to community groups, rural lessees and other government agencies. ACT Government land management agencies will monitor the long term progress of weed control programs, and provide information to the ACT Landcare Sub-Committee. The ACT Landcare Sub-Committee will report to Government each year on progress in weed control, and will make the results of monitoring weed control programs available to the community. The ACT Parks and

Conservation Service will provide advice and guidance for private land managers wishing to implement and monitor programs on their land.

Stakeholder interest in weeds extends beyond the ACT border. Liaison with Councils and Shires, other government agencies and the community surrounding the ACT, is an important aspect of successful weed control on either side of the ACT border. Active participation is achieved through the Upper Murrumbidgee Catchment Co-ordinating Committee, the Southern Tablelands and South East Region Pest Plant Committee, and in co-operation with Shires and Councils. Under the Weeds Strategy, the ACT Government will invite input from the broader region into weed control program priorities, will maintain ACT representation on regional bodies involved in natural resource management, and will collaborate with other regional stakeholders on the use of regional resources (e.g. equipment, technology, expertise).

In particular, roadsides and rivers are corridors for weed spread across the ACT/NSW border, and require co-ordinated action. Roadside management of weeds in the ACT has been neglected through unresolved management responsibility, and the Weeds Strategy identifies this as an aspect where close co-operation with neighbouring landholders is to be strengthened. Management of road verges varies in different areas of the region, but is well advanced in a few cases. There is clearly a regional responsibility to ensure that the same standards are applied to roadside weed management both in the ACT and in adjoining areas.

RECREATION

Outdoor and nature based recreation have a continuing impact on the ACT's biodiversity, as Canberra's urban population make use of the various urban parks and nature reserves for a variety of recreational pursuits. These recreational activities may impact on the biodiversity qualities of the ACT's natural area in many ways.

Erosion, the spread of weeds and increased fire risks are particular problems associated with nature based recreation in the ACT. In sensitive habitats, such as the high alpine ecosystems, off-road vehicles may cause significant impacts, while just one or two hikers can cause significant damage to Sphagnum Bogs and the species they harbour, such as Corroboree Frogs. Even in much hardier habitats, repeated traffic by walkers or mountain bikes can cause significant track erosion (for example, deep erosion gullies on Mount Ainslie have been attributed to mountain bike use).

The introduction of 'user-pays' approaches (e.g. to Tidbinbilla Nature Reserve in July 1997) may put greater pressure on to the 'free' natural areas, such as the Murrumbidgee River Corridor and Namadgi National Park, so monitoring of visitation and environmental impacts of visitors in these areas is essential. More visitor management and appropriate interpretation may be required.

The development of recreation-associated infrastructure — such as the requested extension of the Corin Forest recreation area — also has the potential to impact on local biodiversity. Again the collection of baseline data and of monitoring is essential.

The ACT Government has sought to harness the growth in nature based recreation to maximise both sustainability and economic growth by developing its *Nature Based Tourism Strategy for the ACT*. This Strategy envisions nature based tourism in the ACT as “an industry which is sustainable, shaped by the ACT's unique character, offers a variety of satisfying opportunities for ACT residents and visitors to understand and appreciate the Territory's natural and cultural values, and which leads the way in the region and more broadly across Australia.”

The Strategy provides a framework for the planning, development and marketing of this industry, by integrating conservation, economic and social goals for growth. For example, the Strategy explains that simply using the natural attractions to encourage visitors to 'stay another day' can significantly increase the ACT's economic yield per visitor through accommodation, food, drink and other services (e.g. for each 1% of ACT visitors who stay one extra day, say to visit Tidbinbilla, the Territory earns about \$1.85 million per year). The focus of the Strategy is on yield — increasing the economic and other benefits for the Territory — rather than simply increasing visitation.

Even without significant promotion, visitation to natural areas within the Territory is steadily increasing. This presents a potential increase in pressures on biodiversity from visitor and industry impacts, including an increased risk of fire (see Changed Fire Regimes-ACT). The Strategy aims to encourage the further development of a sustainable industry for the Territory, and includes consideration of key management issues, including integrating tourism and land management, infrastructure development and the respective roles for industry and the government. The Strategy also establishes ten guiding principles to inform and guide further initiatives, including ensuring that the ACT's natural and cultural values are protected and appreciated by the community and industry and ensuring that benefits are returned to the resource.

The Strategy sets a mixture of short, medium and long term goals for the development of nature based tourism in the ACT. As a first priority, the ACT Government will:

- finalise management plans for all parks and reserves
- undertake a public education / promotion campaign on the existing planning and land management systems
- improve tourist signage
- extend current research and data collection on park and other natural area users
- increase marketing and promotion of higher yield nature based tourism products
- investigate further nature based tourism development opportunities
- further investigate the scope for user charges
- with the industry and other stakeholders, develop and implement an appropriate licensing and accreditation system for nature based tourism operators.

NATIVE VEGETATION CLEARING

Up to 31% of lands in the ACT have been mapped as areas which have been cleared or which are native grasslands.

Much of the remnant native vegetation is in the 55% of the ACT that is in some sort of reserve system.

Recent estimates by the CSIRO of the original (pre-European) vegetation cover, indicate that the vegetation systems most affected by clearing are the woodlands and dry forest systems. Up to 76% of the pre-European woodland cover has been cleared.

The techniques used cannot ascertain the extent to which grassland systems have been modified. However, given the extent of urban development and agricultural land use in the ACT, it is clear that many areas of grassland would have experienced some level of disturbance.

Under the current clearing, tenure and land use pattern, substantial opportunities exist for wildlife corridors.

Clearing during the reporting period was minimal, as there was minimal change in land use. More land was conserved than converted from planned urban (i.e. rural) to actual urban development. The conserved land was grasslands.

MANAGING THREATENED SPECIES

Under the *Nature Conservation Act 1980*, Action Plans are required to be prepared for all species and communities declared endangered or vulnerable (see also Species Diversity in the ACT, Ecosystem Diversity in the ACT and Managing Threatened Communities in the ACT).

Five species associated with natural temperate grasslands and grassy woodlands (see Ecosystem Diversity in the ACT and Managing Threatened Communities in the ACT) have been declared endangered (Button Wrinklewort *Rutidosia leptorrhynchoidea*, Small Purple Pea *Swainsona recta*, a leek orchid *Prasophyllum petilum*, Eastern Lined Earless Dragon *Tympanocryptis lineata pinguicollis*, Regent Honeyeater *Xanthomyza phrygia* and Golden Sun Moth *Synemon plana*) or vulnerable (Hooded Robin *Melanodryas cucullata*, Swift Parrot *Lathamus discolor*, Superb Parrot *Polytelis swainsonii*, Brown Treecreeper *Climacteris picumnus*, Striped Legless Lizard *Delma impar* and Perunga Grasshopper *Perunga ochracea*).

Other species declared endangered in the ACT are *Gentiana bauerlenii* (a subalpine herb), Macquarie Perch (*Macquaria australasica*), Trout Cod (*Maccullochella macquariensis*) and Brush-tailed Rock-wallaby (*Petrogale penicillata*).

Other species declared vulnerable are Corroboree Frog (*Pseudophryne corroboree*), Two-spined Blackfish (*Gadopsis bispinosus*) and Murray River Crayfish (*Euastacus armatus*).

Two bird species, Powerful Owl (*Ninox strenua*) and White-bellied Sea-eagle (*Haliaeetus leucogaster*) have been determined as rare by the Flora and Fauna Committee.

Draft Action Plans, which identify research, monitoring and management requirements and protection mechanisms appropriate to the conservation values for each site, have been prepared for:

- No. 1 - Natural Temperate Grassland
- No. 2 - Striped Legless Lizard (*Delma impar*)
- No. 3 - Eastern Lined Earless Dragon (*Tympanocryptis lineata pinguicollis*)
- No. 4 - A leek orchid (*Prasophyllum petilum*)
- No. 5 - A subalpine herb (*Gentiana bauerlenii*)
- No. 6 - Northern Corroboree Frog (*Pseudophryne pengillyi*)

National Recovery Plans have been produced for the following species declared endangered/threatened in the ACT:

- Button Wrinklewort (*Rutidosia leptorrhynchoidea*)
- Trout Cod (*Maccullochella macquariensis*)
- Swift Parrot (*Lathamus discolor*)

In 1995, 170 hectares of natural temperate grassland was included in the Gungahlin Grassland Reserve, which protects a significant population of the Striped Legless Lizard and a small population of the Golden Sun Moth (see Managing Threatened Communities in the ACT)

MANAGING ECOLOGICAL COMMUNITIES

Under the *Nature Conservation Act 1980*, Action Plans are required to be prepared for all species and communities declared endangered or vulnerable.

In 1996, natural temperate grassland and Yellow Box - Red Gum Grassy Woodland were declared endangered communities in the ACT under the *Nature Conservation Act 1980*.

Grasslands

Draft Action Plans for natural temperate grasslands and for several of the associated threatened species are being prepared (see *Managing Threatened Species in the ACT*). These plans identify research, monitoring and management requirements and protection mechanisms appropriate to the conservation values for each site.

In 1995, 170 hectares of natural temperate grassland was included in the Gungahlin Grassland Reserve, which also protects a significant population of the Striped Legless Lizard and a small population of the Golden Sun Moth.

In May 1997 the ACT Government announced that, in West Belconnen, an area of grassland with high conservation values previously identified for residential development would be retained as a nature reserve (comprising some 30 hectares of high conservation value grassland among 100 hectares of pasture and grassy woodland).

Apart from one significant grassland area in Gungahlin, committed to development in 1992 before its values were recognised, no natural temperate grassland has been lost since ACTSER 95. To retain other grassland sites (low to moderate botanical significance) in Gungahlin areas that are planned for development, incorporation into road reserves, easements and urban parks (as landscape features, research resources or buffers) is being considered.

Although management prescriptions to retain conservation values have been developed for all urban natural temperate grasslands, a recent review of compliance indicated a need for better implementation of the prescriptions. In cooperation with each agency/landholder Environment ACT is developing conservation management actions appropriate to each grassland site. Response to seasonal conditions and management or other disturbance mechanisms is measured in terms of changes in exotic and native plant species richness and cover in the long-term floristic monitoring program. Short-term responses are less important than medium to long-term trends in abundance and diversity.

Woodlands

A survey of ACT woodland in 1996-97 has provided valuable new data. The highest natural qualities were associated with an area of 1600 ha. Yellow Box Red Gum Grassy Woodland, which occupies 10% of the ACT's total woodland area, was declared an endangered ecological community in the ACT in 1997 — an Action Plan is being prepared.

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Bushfire control officers in land management agencies and the Bushfire Brigade keep records of fires. The Draft Bushfire (Fuel) Management Plan (1997) details fire histories for the ACT's various reserves, forests, urban areas and unleased rural land.

Cremer, Laurie - Problem Willows in the Australian Capital Region - written for this Report, 1997

CSIRO Wildlife and Ecology Scientists have developed a procedure for modelling spatial vegetation patterns within a Geographic Information System. They have used the procedure to "predict" what vegetation patterns might have existed before European settlement. More information is in the full report.

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ATMOSPHERE

RAINFALL AND ITS VARIABILITY

Rainfall in the most recent three years is reviewed here; the climatological context for rainfall in the ACT is discussed below. It is informative to consider these rainfall statistics in the context of statistics for a range of climatic parameters in the ACT. Both Canberra and Hall were drier than average in 1994, with only 60% of normal annual rainfall (annual rainfall totals are compared with the long-term mean in the table below). Conditions in 1995 were wetter, with 27% above average rainfall. In 1996 rainfall was slightly above normal in Canberra (6%), and 19% above average in Hall. The pattern of rainfall through 1996 differs between the two stations, despite their relative proximity: the wettest month at both was January the wet February at Hall was not reflected at Canberra, where the next wettest months were July and September. Eight months had above-average rainfall at both Canberra and Hall in 1996. The driest month at both stations was April.

Annual rainfall in the Australian Capital Territory, 1994-1996

	<i>Canberra</i>			<i>Hall</i>		
	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>
Annual total (mm)	383	801	673	421	867	840
Anomaly (mm)	-249	+169	+41	-284	+193	+136
Anomaly (%)	-39	+27	+6	-40	+27	+19
Mean (mm)		632			704	

The long-term perspective : Canberra

As is typical of the region, Canberra has experienced large fluctuations in annual rainfall, including several extended periods of above- and below-average rainfall since 1940. In addition the variability of rainfall has altered through time, being greater in the early part of the record and lower since about 1980; this is shown in the graphs of annual rainfall below. These provide a long-term perspective on rainfall variability over time in the eastern part of the ACT, highlighting periods of wetter and drier than normal conditions over the last 57 years.

- In the 1940s rainfall was below normal, as it was for several years around 1980 and in a number of other years scattered through the record (e.g. in the 1960s). Several wetter than normal years around 1950 and 1960 produced a generally wetter period then; the same is true of the mid 1970s.
- Since the early 1980s rainfall has tended to be slightly above average, with the notable exception of 1994 when below-average rainfall was associated with a prolonged El Niño event.
- The wettest year on record was 1950 (1063 mm); the driest was the El Niño year of 1982 (262 mm).

- Annual rainfall totals (in mm) are shown for the full length of the station record (1940-1996). The long-term mean rainfall provides a reference for comparison of individual annual totals.
- Deviations from mean annual rainfall (lower graph) are calculated as the difference between the rainfall for each year and the mean for all years (in mm).

A four-year running mean indicates the underlying pattern of interannual variability.

The seasonal view : Canberra

As has occurred throughout the region, rainfall at Canberra has undergone marked fluctuations in seasonality since 1940. On average the driest month is October and the wettest June, with a range of just over 25 mm.

- From the start of the record until 1960 the driest months were in winter-spring (June-September); the driest season then moved to autumn-winter (April-August), with the driest conditions in June-July. Since about 1980 the driest part of the year has been around June.
- The wettest months since about 1975 have been in summer, in November and January, with December somewhat drier.
- Between 1955 and 1980 June and July were markedly drier than average, while October was wetter; the seasonal signal in rainfall was stronger during that period. Over the length of the record June rainfall has decreased slightly, and July rainfall increased.
- Coherent patterns of variation through time are evident in this type of plot; e.g. some months wetter early this century, then becoming drier. Another common example is of a shift in the timing of the wettest or driest part of the year, which can have important consequences for agriculture.
- The data have been smoothed using a non-linear 61-month filter; this means that variations at shorter time scales than ± 5 years are smoothed over, revealing lower-frequency patterns of change in seasonality.

This seasonal view of Canberra rainfall is compared with that at other places in the region in a regional overview of long-term fluctuations in rainfall seasonality.

Underlying trends : Canberra

The underlying trends in the record of rainfall at Canberra help to clarify patterns in the apparently random interannual fluctuations. It should be remembered that particularly high or low values at the start or end of a record can have a disproportionate effect on the shape of the curves.

- Canberra rainfall shows a rise from the start of the record to about 1960, followed by a slight decline and subsequent rise in the lowest-frequency component.
- The medium-term component has become less significant since the mid-1980s, and the shorter-term component has also lost amplitude. This is consistent with a decline in interannual variability, which was at its greatest through the years before 1960.
- Between 1960 and the early 1980s the medium- and shorter-term signals were fluctuating in phase with one another, giving a discernible pattern to the variability. The very dry year of 1982 is a

good example; then both shorter and medium-term components reached a low point, superimposed on a relatively low point in the low-frequency component.

- The graph in the CD shows the underlying characteristics or trends in the monthly rainfall (y axis, in mm) over time. Three different smoothers have been used: a low-frequency one (~40 years), that shows the lowest variability; a medium-frequency one (~20 years) that shows moderate variability; and a higher-frequency one (~10 years) showing the greatest variability.
- When looked at together, these filtered rainfall series reveal interesting characteristics of the behaviour of rainfall over time. Long-term trends are evident, as are periods when rainfall variability was generally greater or less, and periods when fluctuations of different frequencies were dominant.

TEMPERATURE AND ITS VARIABILITY

Temperature in the most recent three years is reviewed here; the climatological context for temperature in the ACT is discussed below. It is informative to consider these temperature statistics in the context of statistics for a range of climatic parameters in the ACT.

Annual temperature statistics are compared with the long-term mean in the table below. Canberra was slightly warmer than average in 1994, with an overall mean temperature of 13.2°C (an anomaly of 2%). This was primarily due to above-average maximum temperatures; night-time minimum temperatures were slightly below normal. This pattern of higher daytime temperatures (more sunshine) and colder nights (more loss of heat from the surface) is consistent with reduced cloud cover during the relatively dry year of 1994. Conditions in 1995 were slightly cooler, although still above average in the mean. In this case maximum temperatures were below average and minimum temperatures warmer than usual, probably due to increased cloud cover. In 1996 annual mean, maximum and minimum temperatures were all slightly below average. The pattern of mean temperature and temperature anomalies through 1996 is illustrated in a series of monthly temperature graphs for 1996. In total six summer and early autumn months were cooler than average (January-April, November, December), and the winter and spring months were warmer than normal. Negative anomalies were largest in February, around -2.5°C.

Annual temperature statistics in the Australian Capital Territory, 1994-1996

	<i>Mean</i>			<i>Maximum</i>			<i>Minimum</i>		
	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1994</i>	<i>1995</i>	<i>1996</i>
Annual Mean (°C)	13.2	13.0	12.7	20.4	19.0	19.1	6.0	6.9	6.2
Anomaly (°C)	+0.3	+0.1	-0.2	+1.0	-0.4	-0.3	-0.4	+0.6	-0.1
Anomaly (%)	+2	+0.6	-2	+5	-2	-2	-6	+9	-2
Long-term Mean (°C)	12.9			19.4			6.4		

The long-term perspective : Canberra

There are some interesting overall trends in annual temperature at Canberra over the 57-year record there, including a slightly cooler period in the 1950s and 1960s followed by warmer conditions. The graphs below show annual mean temperatures (the average of the monthly mean temperatures for all months in the year), annual mean maximum temperatures (the average of all the maximum temperatures), and annual mean minimum temperatures, all as deviations from the appropriate long-term average.

- The 1940s ended with below-average annual mean temperatures. Conditions remained cooler than average until the late 1960s, when temperatures returned to oscillating more closely about the long-term average.
- The period around 1980 was particularly warm, and there were several warmer than average years around 1990. Most recently, conditions have been closer to normal.
- The cooler conditions in the 1950s and 1960s were due more to a fall in minimum temperatures than to a decline in maximum temperatures, although these also tended to be slightly below average during this period. The coldest years were also those when both maximum and minimum temperatures were lower, probably indicating a predominance of weather systems bringing cold air to the area.
- The warmer spells of years around 1980 and 1990 had quite different patterns of minimum and maximum temperature: during the early 1980s warm period both maximum and minimum temperatures tended to be above average; whereas around 1990 higher minimum temperatures dominated, while maximum temperatures oscillated around normal. An increase in minimum temperatures suggests an increase in cloud cover at night, trapping outgoing heat emitted from the earth's surface.
- Annual average maximum (top) and minimum (bottom) temperatures have tended to fluctuate together at Canberra, with no obvious trends over the length of the record. Minimum temperatures may have been slightly less variable between 1960 and 1970.
- There are also no obvious trends or changes in the temperature range (middle: the difference between maximum and minimum temperatures).

AIR QUALITY CONTROLS

Currently, there are few legislative air quality controls in place in the ACT other than the *Air Pollution Act 1984*, which sets some emissions standards for commercial premises, and regulates burning materials in the open, emissions from domestic solid fuel appliances and the lead content of leaded petrol.

Under the Act, the concentration of specific pollutants in emitted air are limited and certain measures are required to be taken to limit fugitive emissions.

The Environment Protection Act, 1997, allows for licensing of premises that emit to the air.

In addition, when the National Environment Protection Measures (NEPMs) are in place, it will be mandatory for a jurisdiction to report exceedances of ambient air quality goals to the National Environment Protection Council. The National Pollutant Inventory, when it is implemented, will set emission limits for listed pollutants and provide criteria for 'scheduling' emission sources. The ACT is likely to contain few such scheduled sources - probably only the major incinerators and wood-processing facilities.

As with other jurisdictions, the ACT is subject to certain national or international controls relating to emissions. For example, national maximum emissions limits for motor vehicles are set by Australian Design Rules. On 1 January, 1997, ADR37/01 came into force, which further reduces CO, NO_x and HC exhaust emission limits for all models produced after this date. There is a two-year phase-in period.

The ACT Government Analytical Laboratory is responsible for Air Quality monitoring in the ACT, all of which takes place in Canberra.

OZONE DEPLETION & UV

The latest results indicate that ozone depletion continues at all latitudes, but especially over Antarctica. Consequently, there is, on average, more UV-B radiation arriving at the Earth's surface. However, local factors can influence enormously the precise quantity of irradiation at any moment.

For each 1% reduction in total ozone, there is approximately a 2% increase in UV-B reaching ground level. The precise increase in morbidity (incidence of disease) and mortality associated with the greater exposure to UV is hard to estimate. Although there is no doubt about the importance of UV-irradiation as a cause of skin cancer, many other carcinogenic factors also exist and the interactions between them are complex.

The effects of increased irradiation on native flora and fauna have been little studied. It is known that increased UV can damage plant leaves, reduce photosynthesis and thereby diminish yields in crop plants. Sensitivity varies between species.

GREENHOUSE GAS EMISSIONS

Australia has a high level of greenhouse gas emissions per capita compared with many other developed countries. The ACT follows the national pattern. The high dependence on motor vehicle transport, and the relatively large average distances travelled for commuting, combined with our use of electricity (much of it from coal-fired power stations), and the generally high standard of living and consumption, mean that the Territory is a large greenhouse emitter *per capita* - although, of course, only a very small contributor to the world's total.

The latest inventory (1997) shows that electricity consumption is the sector responsible for the greatest proportion of our greenhouse emissions - about 50%. Transport follows, accounting for just over a quarter. On the plus side, the ACT has no major industrial sources, and also acts as a sink for about 392 000 tonnes of carbon annually, through forest growth. (This quantity represents a little more than 10% of our emitted total.)

Compared with the last inventory, in 1990, emissions in all sectors have increased with the exception of waste.

CONSUMPTION OF ODSs

Commonwealth legislation prohibits the import of CFCs to Australia, with the exception of those specified for essential uses. The existing stock of CFCs within the country is falling and replacement substances are being used.

As a result, consumption of CFCs and most other ODSs within the ACT is falling. Methyl bromide remains legal in the Territory and is still used in small quantities for some fumigation requirements.

Figures on the amount and type of ODSs brought into the ACT are included in the NSW total and are not available separately. Even if they were, they would not necessarily give an exact picture of the pressure, as controlled handling by licensed operators ensures that the bulk of ODSs 'used' or stored are not discharged to air - apart from in the operation of aircraft fire extinguishers.

AIR EMISSIONS

Emissions of CO, HC (hydrocarbons), NO_x and SO₂ were estimated for the ACT in 1985, broken down by source into several different categories. (The inventory did not include emissions outside the ACT that occurred as a result of consumption within the Territory or transport to it.) More recent, comparable, data were not available for this Report.

The 1985 Inventory showed that motor vehicles were by far the greatest single source of non-greenhouse air emissions. It is considered likely that this remains the case today, with solid fuel heating a significant second source of particles, CO and HC in parts of the city in the cooler months.

Projections estimate that the total vehicle/kilometres travelled (VKT) in Canberra will continue to increase; despite the improvement in emission rates from new cars, this growth is expected to increase air emissions.

AIRBORNE LEAD

In general, the concentration of airborne lead has continued to fall as more and more vehicles use unleaded petrol. (Unleaded petrol has been available since 1986 for new vehicles.) The current price differential of at least 2 cents per litre between leaded and unleaded petrol is also aimed at encouraging greater use of unleaded petrol.

In addition, since December 1995, the lead content of the leaded petrol sold in Canberra has been fixed at a concentration of 0.2g/L, whereas before then the ACT's leaded petrol was the same as rural NSW petrol, with a lead value of 0.84g/L. (These figures come from Australia.)

All ambient air measurements show that the concentration of airborne lead is well below the NHMRC guideline for lead of 1.5 µg/m³ air - the highest readings generally only reaching 0.25 µg/m³.

There is a slight seasonal variation in lead concentration visible in the results for 1995, with a rise in winter months. (A similar small increase was recorded in Civic in winter 1996.) This is under investigation but could be due to the greater number of people using cars to commute in winter compared with warmer months. If so, as time passes and the number of older vehicles continues to fall, then this slight seasonality should disappear.

Lead in Blood

In 1993 the NHMRC published its concern over exposure to lead, especially in young children, and recommended a blood level of less than 10 µg/dL for all Australians. The Australian Institute of Health and Welfare conducted a national survey of lead in children in 1995, testing blood lead levels in a representative sample of 1575 children aged 1-4 years.

Airborne lead is currently measured at Civic, Woden and Monash by the ACT Government Analytical Laboratory. During part of 1995, lead was also recorded at Belconnen and Gowrie.

CARBON MONOXIDE (CO)

The concentration of carbon monoxide (CO) is measured continuously but averaged over 8-hour periods. In Civic during the reporting period, the highest 8-hour CO values have continued to breach the NHMRC guideline for the protection of human health (a concentration of 9 ppm).

These exceedances are mainly in the evening/night, particularly 5pm-12am on Thursdays and Fridays, when the CO concentration may reach 11ppm. This can be clearly related to increased traffic flows from the commuter rush-hour, late night shopping and nightlife peak times. Winter-time also contributes to the problem through the increased use of solid-fuel heating and because overnight inversion layers can lead to pollutant trapping.

Monash also shows clear time-related and seasonal peaks - winter nights again being the worse - although its concentrations are generally lower than Civic and no breaches have been recorded. However, for some nights, the concentration can remain just short of the guideline for periods of several hours. The results reflect the increased use of solid-fuel heating and the high incidence of overnight inversions in the Tuggeranong Valley.

Exceedances have occurred in Civic for several years, but there appears to be no clear and significant long-term trend in either direction in average concentrations or numbers of exceedances. However, given the increase in size of the fleet and the rate of usage and possible increased contribution from domestic woodburning, the ACT government may need to seek strategies for CO containment.

NITROGEN DIOXIDE

The hourly nitrogen dioxide concentrations measured at all monitoring sites in Canberra are consistently below the NHMRC guideline of 0.16 ppm. There is a slight tendency for higher values to occur at the Civic site, which suggests that motor vehicles are our major source.

As nitrogen dioxide is a precursor gas for photochemical smog, these results should be considered in conjunction with the levels of lower atmosphere ozone

There is no clear seasonal or long-term trend.

LOWER ATMOSPHERE OZONE

During the reporting period, one-hour average concentrations of ozone at all sites were consistently below the revised NHMRC guideline for the protection of human health. (In the latter half of 1995, the NHMRC revised its one-hour average ozone guideline downward from 0.12 ppm to 0.10 ppm.)

The hourly averages show a slight tendency to be higher in summer, probably as a result of the greater amount of sunlight and the consequent photochemical reactions that form ozone. There are isolated occasions when the hourly values recorded are significantly above the long-term average - at Monash, on one occasion, even breaching the 0.1 ppm guideline. Further investigation of this is underway.

Recent medical research demonstrates that there are effects of ozone exposure over longer time periods and there has been an international move to consider the introduction of four-hourly guidelines/standards. Results of monitoring in the ACT show that four-hourly average ozone concentrations at all sites are consistently below the new NHMRC guideline of 0.08 ppm.

VISIBLE HAZE & PARTICLES

Haze: Nephelometry results for Civic show a clear diurnal and seasonal cycle, with haze being greatest at night in the late autumn/early winter (May, June, July). This is probably related to two factors: the higher incidence of inversions at that time and the greater use of wood-burning stoves and open-fire places, which are sources of fine particles.

Nephelometry readings were much higher in 1996 than 1995 - as with most other parameters - for reasons that are still under investigation and may possibly reflect meteorological conditions.

There is no specific guideline for haze.

TSP: The yearly average concentration of total suspended particles (expressed as μg particles per m^3 of air) was below the NHMRC guideline of $90 \mu\text{g}/\text{m}^3$ throughout the reporting period. The highest daily readings reached close to or beyond $100 \mu\text{g}/\text{m}^3$ in April 1995, but otherwise remained in the vicinity of $50 \mu\text{g}/\text{m}^3$. There is no NHMRC guideline for daily exposure, but the USEPA guideline for the largest daily reading in a month is $260 \mu\text{g}/\text{m}^3$.

The long-term record for Civic suggests a downward trend in average annual TSP values in the last 16 years. This may be connected with improvements in motor vehicle design and performance, a decrease in backyard burning, or even changed building site practices affecting wind-blown dust.

PM10: PM10 (particles with a diameter smaller than $10 \mu\text{m}$) represents a sub-set of TSP. PM10 were measured at Civic and Gowrie in the reporting period. There is no NHMRC guideline for PM10, but the proposed NEPM standard is currently set at $50 \mu\text{g}/\text{m}^3$. The monitoring revealed several breaches of this standard.

In 1996, Environment Australia commissioned ANSTO and CSIRO to conduct a study (the Australian Aerosol Pilot Study) to characterise particle pollution in six urban areas of Australia, of which one was Monash in Canberra. The study examined the relative abundance of particles by weight (concentrating mainly on the range of 0.1 to $10 \mu\text{m}$ in diameter), and analysed the relative proportions of inorganic and carbon-containing particles. Preliminary results suggest that measurements of PM10 alone will not be an adequate indicator for estimating the concentrations of the smallest particles that are most likely to have adverse health effects.

TSPs are sampled every six days, whereas nephelometry measurements are continuous.

Research is suggesting that measurement of particles by different size categories is more useful than knowing the amount of total particles in air. The most important categories for human health are considered to be particles less than $10 \mu\text{m}$ in diameter (PM10) and particularly those less than $2.5 \mu\text{m}$ (PM2.5).

HUMAN SETTLEMENT

HUMAN POPULATION

Australian Bureau of Statistics (ABS) figures indicate that the population of the ACT grew from 304,600 in June 1995 to 308,000 in June 1996, an increase of 1.1%.

The birth rates declined during the same period, and the number of deaths increased slightly.

Birth and Death Rates, ACT and Australia - 1991 and 1996				
Number of births/deaths	ACT June 1991	Australia June 1991	ACT June 1996	Australia June 1996
Live births	4936	261,158	4903	252,176
Crude birth rates	17.5	14.8	15.7	13.7
Deaths	1228	119,571	1368	126,241

Source: ABS (Note: Crude birth rates are expressed as per '000 Estimated Resident Population)

While the birth rate for the ACT has fallen from 1991 to 1996, it remains higher than the rate for the whole of Australia. In 1995, in the ACT, the median age of mothers giving birth to their first child was 27.8 years. (Source: ABS Catalogue 3301.0) (Note: These data were only available for 4 States, and no comparable data are available for 1996). There are data, however, for the 'first nuptial birth of this marriage' - the median age in this category for the ACT was 28.6 years, for Australia the figure was 28.7 years.

What they indicate is that the median age for first nuptial birth is slightly lower for the ACT than for the rest of Australia).

Net migration figures were also negative, and the figures escalated more in 1996-97.

Net migration in the ACT	
Year	Net migration
June 1992	+1700
June 1993	+1600
June 1994	-100
June 1995	-177
June 1996	-462
June 1997	-1300

(Source: ACT Government, Office of Financial Management)

POPULATION CHARACTERISTICS

The population characteristics for the ACT show an age structure which is still relatively young (more than 1 in 5 persons in the ACT is under 15 years); a mix of people from non-English speaking backgrounds which is high for the designated area; a large indigenous population (in absolute numbers); and a higher ratio of females to males, compared with most LGAs in the Region.

Although the population is relatively young now, with no/minimal growth it does indicate a much older population in 20-30 years. The large proportion of young people under the age of 15 years (22.6%) together with the proportion of the population 65 years and over (7.1%) suggests a significant proportion of the population (30%) for whom government services may need to be targeted.

Population Characteristics for the ACT							
Number of males	Number of females	Persons	% pop'n under 15 years	% pop'n 65 years and over	% pop'n indigenous origin	% pop'n overseas born	% pop'n speaking other language
147,831	151,412	299,243	22.6	7.1	1.0	22.3	12.8

Source: ABS

Source: ABS Catalogue 2015.8

ACT Population 15 years+, by registered marital status, June 1996					
	Married	Separated	Divorced	Widowed	Never Married
Male	58,619	3,412	6,008	1,680	43,485
Female	59,076	4,421	9,368	7,539	37,913
Total	117,695	7,833	15,376	9,219	81,398

INCOME

Estimates of average weekly earnings (below) are derived by dividing estimates of weekly total earnings by estimates of employment including part-time and casual employment. Reports are issued quarterly.

Weekly Income, ACT						
Average Weekly Total Earnings (for quarter to May, 1996, \$)			Average Weekly Total Earnings (for quarter to May, 1997, \$)			Annual growth rate
Males	Females	Persons	Males	Females	Persons	(%)
753.50	536.40	642.10	767.30	566.10	670.50	4.4

Source: ABS Catalogue No. 6302.0.

The implications to be drawn from these data are that there is potentially greater capacity to tax for provision of services in the ACT than in most other places in the region. However, another view is that the ACT has the purchasing power to pay for generally good services from which the surrounding region benefits.

EMPLOYMENT

In June 1997, the ACT unemployment rate was 7.1% in trend terms, which remained stable compared with the previous month. This figure is below that for Australia (8.7%) which also remained stable.

Teenage unemployment has increased, with the proportion looking for full-time work increasing from 26.3% in May to 42.5% in June 1997. This is below the May 1996 figure of 43.9%, but substantially above the national average of 28.4% in June 1997. In spite of a rise in employment in the ACT during June 1997, there remains concern about opportunities within the region for youth employment (reflected in the out-migration figures).

The workforce participation rate for the ACT in June 1997 was 73.3% in trend terms, compared with the figure for Australia of 63.1%.

Better analysis is needed to determine the extent of underemployment, about which there is some concern, particularly about the extent to which the method of measurement of employment statistics

disguises the true situation, and the implications for reduced income for individuals, reduced investment in the economy and increased demand upon support services. The need for improved analysis of employment trends extends to concern about involuntary over-employment, both for the health of individuals, and to enable a better spread of employment opportunity.

In the ACT, the number of individuals employed by the Commonwealth Public Service fell from 54,800 to 50,600 in the year February 1996 to February 1997. Similarly, the number of individuals employed by the ACT Government fell from 19,800 to 16,800 (*Source: ABS Catalogue 6248.0*). The Public Service and Merit Protection Commission reports that in the period June 1996 to March 1997, 3,069 persons were retrenched from the Australian Public Service. In the year to June 1997, there were 1290 appointments to the Australian Public Service.

The average weekly number of job advertisements in the ACT remained relatively flat during June 1997, decreasing by one advertisement in trend terms over the month (or 0.3%). The level of job advertisements was slightly above that of a year ago in trend terms.

Nationally, job advertisements recorded a significant increase in trend terms during June 1997 (1.4%), and by 7.0% during the year.

While workforce participation rates (including unemployment) are recorded under the 'Condition' indicator, 'Employment', it is worth noting, here, that the current continuing increase in the ACT unemployment rate is attributed to falling numbers of people in part-time employment. This may lead to a further reduction in employment opportunities, for those seeking full-time work but willing to work part-time. There are also indications of a trend towards increased numbers of discouraged workers (ie those who have given up looking for work).

INCOME EQUITY

The Smith Family reports that it is currently assisting 20,000 individuals with emergency welfare assistance, an increase of 20% over the same period last year. The organisation has identified a change in the degree of need being experienced by individuals: it is no longer characterised by the need for one-off payments for food or assistance with electricity accounts, etc, but is now characterised by deeper and more serious financial crises such as those linked to unemployment and the incapacity to maintain loan repayments which were manageable prior to job loss.

The Salvation Army confirms the trend in the increased proportion of individuals seeking assistance, noting a 22% increase in requests for assistance. The Salvation Army averaged 694 individuals assisted per month in the 1996-97 financial year.

The Society of St Vincent de Paul reports a slight drop in requests for assistance from 1995/96 to 1996/97, but an overall increase in the total amount of assistance given for the same period, from \$738,213 to \$758,923. Requests for assistance in payment of electricity accounts in the operational region (includes Yass and Queanbeyan) increased by 44% in the period. While figures for Canberra are less easy to disaggregate, requests for assistance with fares, accommodation and heating in the same period rose by 40%.

In relation to Social Security benefits in the ACT, the numbers of clients in receipt of Youth Training Allowance fell between June 1996 and June 1997. Numbers of clients in receipt of pensions for Wives/Carers and for the "Widow B" Pension also fell. Similarly, the number of clients in receipt of Sickness Benefit and Special Benefit also fell. Clients in receipt of Mature Age Allowance (both for Clients and Partners) fell significantly. Numbers of clients in receipt of Age Pensions, Disability

Support and Sole Parent Benefits rose. These changes may be due to changes in Government policy or entitlement rules. Other figures are not comparable due to new or changed payment arrangements.

HOUSING

In the ACT, the proportion of family income required to meet average loan repayments at June 1997 was 14.2%, compared with 16.7% for the same period in 1996. For Australia, the proportion required as at June 1997 was 23.6%, compared with 28% for the same period in 1996. *Source: Real Estate Institute of Australia, home loan affordability data.*

Housing activity indicators showed a decline in the June 1997 quarter. Between the March and June quarters, the number of plans lodged decreased by 4 per cent, the number of commencements decreased by 43 per cent to 322 and the number of dwellings under construction decreased by 15 per cent to 710. For the same period, the number of completions increased by 47 per cent and the number of completed not occupied dwellings increased marginally by 3 per cent. The total number of commencements decreased to 1,430 in 1996-97 after a record high 4,100 commencements in 1993-94, 2,850 commencements in 1994-95 and 2,130 commencements in 1995-96.

Housing affordability is increasing, but the median house price is also dropping, indicating that generally speaking, the market is not holding value, or that smaller houses are being built.

The median house price has fallen steadily from \$160,400 in January 1995 to \$147,500 in June 1997. The fall in median price for town houses has been slightly less over the same period, from \$131,300 to \$119,300.

Median rental per week for a 3 bedroom house has fallen only marginally over the period January 1995 to June 1997, from \$173 to \$171; and for the same period, for a 2-bedroom unit, the median cost of rental has increased from \$153 to \$154.

Thus, while houses are becoming more affordable to purchase, people in the rental market face a situation which is *prima facie* inequitable, and this must be a cause of concern for those on low incomes.

Other trends indicate a decrease in public housing stock as a proportion of total housing stock. In 1991, the proportion of public housing stock in the ACT was 12.6%; in 1997 it is below 11%.

COMMUNITY & CULTURAL FACILITIES

A total of 1271 community and cultural facilities was registered in an audit by ACT Government Planning and Land Management. These include:

- welfare/community service facilities
- accommodation facilities for older people and low cost/student accommodation
- restricted accommodation
- health facilities
- education facilities
- arts/cultural facilities
- public facilities
- indoor sport/recreation facilities
- outdoor sport/recreation facilities.

Of these, 1089 were privately owned and/or managed. Seventy-three are under direct management by the ACT Government. For 109 of the facilities, there was insufficient information to determine ownership/management. In 1995-96, the total expenditure on planned and urgent maintenance for community facilities which are the responsibility of the ACT Government was \$430,000. The 1996-97 budget allocation for facilities maintenance remained the same as for the previous year.

All of the community facilities for which the ACT Government has maintenance responsibility have access for people with disabilities.

SENSE OF COMMUNITY

In a series of Focus Groups conducted with Canberra residents from May 1996 to February 1997, participants placed a high value on

- a 'sense on belonging';
- people caring for each other;
- willingness to participate for community benefit;
- feeling safe; and
- having pride in the community.

On the first two points, it was felt that the ACT community performs below average, while on the remaining points, it was felt that the community performs well.

Participants assigned a lower value to:

- community sharing;
- shared values;
- community-driven government;
- willingness to listen to others;
- a productive community;
- people-friendly facilities and events; and
- access to information and knowledge.

Of these, they considered that the ACT community performs above average on only the last three points listed.

There are 1539 community organisations and 474 Government agencies providing a community service currently listed on the data base of the Community Information and Referral Service.

ACT community members are somewhat self-contained while at the same time seeking a sense of community as a desired community character. They enjoy participation in sporting and other community events at a rate which is generally higher than that of other Australians. There is a wide range of community organisations operating within the community.

Canberra Festival commissioned research to discover who attends Canberra Festival events and overall levels of satisfaction with those events. Almost 73% of people attending Festival events in 1996 came in family groups and 68% of respondents said they intended to visit more than one event. Thirteen per cent of visitors were from interstate or overseas. In the program survey of people attending, 91% of respondents agreed that the events were exciting, good value and that they had good access.

The ABS 'Participation in Sport and Physical Activities' 1995-96 survey shows that the ACT participation rate in organised sport is the highest in Australia for children 5 - 14 years (74.6%) and

the second highest for people over 15 years (36.9%). ACT participation rates are above the national average for all age groups, for both males and females.

CULTURE

Expenditure on arts and cultural development refers to Government expenditure and does not include any figure for sums contributed voluntarily by patrons or self-funded cultural pursuits.

Expenditure on arts and cultural development in the ACT totals \$3.2m over 3 years in the current period, although it has not been possible to obtain a breakdown of this budget or how it has changed in recent years.

Daily (Monday to Friday) newspaper circulation of the "Canberra Times" has dropped from an average 42,604 in June 1996 to 41,624 in June 1997. Saturday circulations have experienced a similar drop from 72,321 to 71,893. Sunday circulations have also fallen from 40,028 to 38,913.

The number of library loans per capita for the 1996/97 period is 8.11.

Of community concern is the need for library branches to maintain flexible hours and for the Library Service to keep pace with current materials and services. There must be considerable pressure within current budget constraints to maintain these expectations.

Trend data should be developed to monitor changes in the area of culture as part of an ongoing process.

EDUCATION

Data show a higher proportion of males than females in all areas of pre-school, primary, secondary and in part-time attendance at TAFE. There are higher proportions of females to males reported in full-time TAFE, and in full-time and part-time University attendance. There is a higher proportion of female to male overseas students reported.

A total of twelve schools have closed in the ACT in the period 1989-1997. These include 7 Primary schools and 5 High schools. Eight new Primary Schools and 2 new High schools have opened during this period (note, one of these, Gold Creek, will include both Primary and Secondary components from 1998).

There has been a 1% drop in enrolments in Government schools and a 1% increase in the number of enrolments in non-government schools in the period 1996 - 1997. There has, however, been a net loss of 164 students from the system. The increase in non-government enrolments may be attributable to policy changes e.g. in assistance to non-government schools.

In 1997, there were 46 literacy programs (reading recovery) operating at Government primary schools. As part of their curriculum, secondary schools offer learning assistance which may include literacy skills. There is general acceptance that the ACT is ahead of the national average on literacy rates. However, the recently completed National Study on Adult Literacy, noting that 50% of the population performs at the lowest two levels of measures for literacy must be cause for concern.

In February 1997, 3,013 students from language backgrounds other than English were identified as requiring involvement in an ESL (English as a Second Language) program. Approximately 87 full-time equivalent teachers were employed to teach these students, either directly in Introductory

English Centres and local schools or through the Language for Understanding Across the Curriculum program. These figures do not include adults requiring involvement in an ESL program.

The number of University students is falling in real terms due to a drop in enrolments by overseas students. Access to tertiary education is becoming more difficult and costly. There must be some concern about the quality of education during this time of upheaval and change, and concern is often expressed about the employment prospects for graduates.

In 1997, the Australian National University had a total of 777 international fee-paying students, no increase over the previous year. In the same period, the number of Australian students paying Graduate Tuition Fees increased from 484 to 534. The university of Canberra reports a drop in the number of full fee-paying overseas students from 612 in 1996 to 601 in 1997. In the same period, the number of Australian students paying Graduate Tuition Fees rose from 233 to 397.

SAFETY

'Perceptions' of crime were measured as part of a survey of the total population of the ACT in 1995 and published in the Final Report of the ACT Safety Committee, November 1996.

The results of the study indicate that there is an overestimation of the risk of crime in the ACT relative to the crime rate (using victim-based statistics). The rates have actually decreased in the ACT for murder, unlawful entry and for motor-vehicle theft. The statistics are not easy to interpret. They do not reveal 'thwarted' attempts at break and entry, (because of security locks, automatic external lighting, Neighbourhood Watch, etc) in houses, or thwarted attempts at motor-vehicle theft. Canberra and the ACT give the image of safe places to live, and this image should be maintained by good security in all activities of the population. However, we should not encourage unwarranted fear, mistrust and stereotyping of individuals and also unwarranted expenditure on security and/or fortress living. At the same time, it must be said that 46.3% of the population do not perceive problems in relation to crime.

However, there is an upward trend in the number of armed and unarmed robberies in the ACT, which is consistent with the national trend.

In general, more property crimes are committed by males than females. However, the most recent figures (1995-96) reported show a sharp increase in the number of females being arrested for property crimes. The Institute of Criminology notes that this trend concurs with their recent studies indicating that of the four major groups (Adult Male, Adult Female, Juvenile Male, Juvenile Female). In the Institute study, the sharpest increase in involvement in crime is among juvenile females. The Institute notes, too, that women are more likely to be involved in credit card fraud, which is on the increase, and can possibly be attributed to current economic circumstances.

There is some fluctuation in arrest rates, generally trending down to 1994-95 and increasing again the following year. This may be due to a number of factors: a change in policy/policing activity; an increase in the number of juvenile arrests; a change in legislation; or a change in emphasis on community policing.

HEALTH

Life expectancy is defined by the ABS as the average number of additional years a person of a given age and sex might expect to live if the age-specific death rates of the given period continued throughout his or her lifetime.

ABS collects data State by State on 'selected causes of death' which are reported periodically.

Data on diagnoses of mental disorders and respiratory diseases are maintained by the ACT Department of Health and Community Care.

The data indicate that life expectancy for females remains markedly above that for males, and in the ACT, life expectancy for both males and females is better than the national average.

Diseases of the circulatory system, cancers and heart disease are the greatest reported causes of death in the ACT, with higher death rates for males than females in each category.

For future State of the Environment reports, it may be useful to address as an indicator 'years of potential life lost'.

While the data for ACT hospitals show an overall decrease in the number of patients on waiting lists, and significant reduction in some specialty areas, other areas have experienced increases. There is no available breakdown of statistics to indicate the which of the patients on the waiting lists were presenting for elective or non-elective treatment, although this remains a key issue of public debate.

STORMWATER AND SANITATION

Data on stormwater are kept by the ACT Department of Urban Services. ACTEW maintains data on the sewerage system.

The Department of Urban Services estimates that 95% of properties in the ACT are connected to the system for disposal of stormwater.

The ACTEW 1996/97 Annual Report lists 115,083 sewered properties (including both private dwellings and businesses).

In 1996-97, 9 serious spills/incidents were reported to the Environment Protection Authority. These involved overflows from sewers 300mm in diameter or above, and overflows from pump stations.

Figures on the quality of treated sewage discharge to streams are not provided, although it is known that discharge is monitored. There remain some localised causes for concern (e.g. occasional leakages from the Queanbeyan sewerage works and from the old sewerage works at Weston). There are also occasional incidents after major storms.

It is noted that ACTEW is innovative and experimental in dealing with sewage and sewerage issues and should be encouraged to continue along these lines. In fact, all development authorities should be urged to keep pace with Australian best practice in disposal of sewage and waste water (for example the Rouse Hill development which employs a dual pipe system for waste water and espouses a policy of no increase in quantity and no decrease in quality of stormwater runoff).

TRANSPORT INFRASTRUCTURE

Road length in the ACT in 1995 was 5,590 lane km, comprising 60 lane km of national highways, 40 lane km rural arterials, 750 lane km urban arterial roads, 550 rural local roads and 4,190 urban local roads. (*Source: AUSTRROADS Roadfacts 1996*).

The Infrastructure Management Section, Department of Urban Services reports that \$14.6m was spent in 1996-97 on roads maintenance, with a further \$2.7m spent on street lighting maintenance.

Programs of traffic calming have been introduced in some suburbs. Some maintenance methods have been controversial for safety reasons.

The 1991 ACT Cycling Strategy Plan provides an estimate of the length of cycleways at the time as approximately 820km of paths, comprising 240 km of paths >1.8m wide and 580 km of paths <1.8m.wide . The Urban Structure Planning Unit of the ACT Department of Urban Services in 1997 confirms that while some additional links may have been provided in the interim, the 1991 estimate remains reasonably accurate.

To make use of this infrastructure, there needs to be appropriate bike storage facilities (for example, in town centres).

TRANSPORT MODES

In June 1997, there were 1169 new motor vehicle registrations in the ACT, a 4.5 per cent increase over the previous month. The total number of new motor vehicle registrations in the ACT for June 1997 was 20.5 per cent above the level recorded in June 1996. Nationally, the number of new vehicle registrations increased by 1.1 per cent during the month, and is 10.1 per cent above the level a year ago.

In 1995, the total number of motor vehicles registered in the ACT was 178,770, or 640 vehicles per 1,000 population.

An ABS study, April 1996, reported that the ACT had the highest proportion of unleaded vehicles (62%), while the national figure was 54.4%.

ACTION has 354 buses operating, including 21 'special needs' buses.

Aerial has 223 taxis operating - 4 of these cars have been converted to 'maxi-taxis'.

Three Countrylink trains operate daily return trips Canberra-Sydney.

In terms of interstate bus travel, the following are the major operators:- Murrays operates an average of 22 interstate buses per day through Canberra, Greyhound Pioneer operate on average 16-20 buses per day, and Countrylink operates 4 interstate buses per day.

In 1995-96, the Federal Aircraft Corporation reported that there were 1,777,802 domestic passenger movements through the Canberra Airport. There were 35,518 public transport aircraft movements and 73,278 general aviation aircraft movements throughout the year.

One of the characteristics of Canberra is its system of peripheral freeways, which has alleviated the worst of congestion and pollution problems experienced by other Australian capital cities.

However, Canberra has a high level of car usage and is highly car-dependent (In an ABS study in April 1996, the most reported distance travelled annually was between 20,000 and 30,000 kilometres - the ACT reported the highest number of households travelling this distance (24%)). This has both environmental implications and implications for the affordability of transport.

In terms of public transport, in April 1996, a higher proportion of ACT residents used bus transport to get to work (13%) than did residents in other States and Territories (e.g. for South Australia, the figure was 9%, nationally, the figure was 7.1%) However, a mismatch of government parking/pricing policies has failed to encourage more passengers to use ACT intertown buses. Without adherence to the so-called 'self-containment' policy (to concentrate employment in town

centres) many travellers report scattered travel patterns requiring the use of a car. The ABS Transport Study in April 1996 revealed that for those ACT households not using some form of public transport to get to work, the principal reasons were:

- service takes too long (47%)
- vehicle is needed before/after work or study (26%)
- vehicle is needed during work hours (23%)
- infrequency of service (23%)
- comfort/privacy (22%)
- reliability of service (16%)
- fares cost too much (15%).

(Note: More than one answer may have been specified.)

Public transport in the ACT has experienced declining service, patronage and revenue. There is considerable scope for changing the way in which the current bus fleet is used. There should be ongoing attempts to reduce the use of private cars and promote the use, through economic instruments, of a mass transit system by the majority of the population.

The majority of people in Australia (about 64%) travel to work or study as a single driver in a car. In the ACT, 76.4% nominated travel as a driver in a car/truck or van as the principal mode of travel to work. This compares with 77.6% for Australia. In the ACT, a larger proportion of residents (13%) use the bus system than for residents in other States or Territories. However, with the exception of Tasmania and the Northern Territory, a small proportion of residents in other States (or 8.5% nationally) use trains to travel to work - a mode of travel not available in the ACT.

WASTE MANAGEMENT

SOLID WASTE

The majority of solid waste is disposed of by burying in the two operating landfills in the ACT at West Belconnen, opened in 1976, and Mugga Lane, opened in 1978. Household garbage that is not recyclable is collected weekly in 140 litre wheeled bins and disposed of at either of the landfills by contractors.

Overall, tonnage of waste to landfill has significantly decreased. There were increases from the year 1995-96 to 1996-97 in household waste, commercial/industrial waste, tyres, special waste and asbestos, and decreases in tonnage for builders' spoil, clean fill, garden waste and private delivery. Some of these decreases may be related to the introduction of tip fees.

The ACT Government released the "No Waste by 2010 Waste Management Strategy" for Canberra in December 1996. The Strategy set the goal of achieving a waste free society by 2010, and the ACT Government is the first government in the world to set such an ambitious goal. A priority action within the No Waste Strategy was to develop a waste inventory, surveying solids being recycled and disposed of in Canberra, Queanbeyan and surrounding areas. The survey includes estimates of quantities, composition and sources. The survey will assist the establishment of performance benchmarks.

Measured waste to landfill in the ACT				
Waste type	1993/94	1994/95	1995/96	1996/97
ACT Household	44 150	39 590	39,668	41,671
Queanbeyan Household	9 860	9 480	8,789	9,025
Builders' Spoil	127 750	70 600	66,358	58,249
Clean Fill	90 770	4 360	3,406	2,499
Commercial	64 180	69 030	69,958	70,727
Garden Waste (charged)	12 530	8 070	7,745	6,587
Tyres	360	470	551	711
Asbestos	1 010	680	831	942
Sullage	3 340	1 380	1,998	1,548
Special Wastes	1 610	3 760	1,684	1,973
Private delivered (estimated)	60 240	64 640	51,072	44,050
Total	415 800	272 060	252,068	237,981

All trucks collecting domestic household waste are weighed on entry to the landfills. This part is relatively short. A simple statement of the units in which the indicator is measured, details of sampling strategies. Spatial and temporal information should be given as appropriate - eg measured weekly in two locations in the ACT. Because of the proposed CD format, it will be necessary to carefully delineate the area over which this particular indicator value is relevant.

MATERIALS RECYCLING AND RE-USE

During 1996/97, BFI collected 25,113 tonnes of recyclables from Canberra and the local region. Of this material, 2,703 tonnes or 10.7% was disposed of as waste at ACT landfill. The waste component was predominantly glass fines, non-recyclable glass products such as pyrex, pane glass, etc and other plastic products which are not part of the collection service.

ACT Recycling/Resource Recovery results (tonnes)		
Product	1995-96	1996-97
Glass	7,795	7,756
Paper	37,124	37,466
PET	429	472
HDPE	439	393
Liquid-paperboard	251	229
Aluminium cans	200	189
Steel cans	826	877
Garden waste	65,190	85,640
Demolition waste	55,389	82,848
Metals ferrous	5,541	5,514
Cooking oil and fat	754	687
Clothing	1,585	1,181
Revolve	7,000	4,451
Motor oil	1,935	2,669
Total	184,458	230,372

The figures indicate overall increases in the total amount of material recycled, with the most significant increases being in the amounts of garden waste, demolition waste and motor oil being recycled. Revolve's tonnage of recycled material significantly decreased over this period.

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CONTAMINATED SITES

Previous land uses in the ACT have led to contamination of the landscape at a number of places. The Contaminated Sites Unit reports that over 100 former dip sites and landfills have so far been identified. It was not possible to obtain a map showing the location of these sites. Contamination at several sites has resulted in groundwater contamination.

Canberra lies within a well-known wool-producing region, and much of the city and its suburbs is built on once pastoral land. Thus, there are higher than normal amounts of arsenic and/or DDT in soil around sites where sheep were once dipped—for parasite control—in commercial preparations containing these substances. Not all of these sites were identified prior to residential development of this land. The Bureau has now determined that houses have been built on or near five such sites. The

sites are being investigated and the residents of those houses counselled. The Government has offered to buy five properties where sample results were significantly over the health investigation level for arsenic.

The Environment and Land Bureau has reviewed its records to identify land previously used for sheep dips, industrial land fill, hydrocarbon storage, and other activities likely to have had unfavourable impacts on the environment.

NOISE

A total of 255 noise complaints was received by the Pollution Control Authority in 1996-97. During the period, 13 Noise Direction Notices were issued. No prosecutions were undertaken for non-compliance. During 1996-97, 16 exemptions were granted under the Act with one subsequently revoked and re-issued to allow for a changed condition.

Environment ACT reports that only a small number of complaints was received concerning traffic noise. Due to a current difficulty in applying the Australian Standard for traffic noise, these incidents barely register on the scale. The problem is being discussed by an intergovernmental group.

The number of aircraft noise complaints from November 1996 (when Airservices Australia commenced taking complaints) to August 1997 for the ACT and surrounding Region totals 88.

HERITAGE

There are currently 27 places listed on the ACT Heritage Places Register, with 52 listed on the Interim Register and 7 currently listed for public comment.

These are as follows:

ACT Heritage Listing			
Place Name	Register No	Interim Register	Public Comment
Aboriginal Chart Quarry, District of Gungahlin		14/12/96	
Aboriginal Digging Stick, Namadgi National Park (NNP)			*(23/8/97)
Aboriginal Place PII12	6		
Aboriginal Place PII13	7		
Aboriginal Rock Art Sites NNP District of Rendezvous Creek		4/9/96	
Acton Peninsula, Acton		16/12/96	
Ainslie Primary & Public Schools, Ainslie			(1/3/96)
Albert Hall, Yarralumla		28/2/97	
Alt Crescent, Ainslie	27		
Anzac Park & Memorials, Reid		27/6/97	
The Apostolic Nunciature			(4/9/96)
Barton Housing Precinct	12		
Bendora Hut, NNP, District of Cotter River		28/2/97	
Blandfordia 5 Housing Precinct, Griffith/Forrest/Red Hill		14/6/96	
Braddon Housing Precinct	13		
Brassey House, Barton		14/6/96	
Brayshaw's Homestead, NNP		27/6/97	
Brumby Yard 3, NNP		27/6/97	
Brumby Yard 4, NNP		27/6/97	
Brumby Yard 7, NNP		27/6/97	
Brumby Yard 8, NNP		27/6/97	
Brumby Yard 9, NNP		27/6/97	
Brumby Yard 10, NNP		27/6/97	
Brumby Yard 11, NNP		27/6/97	
Calthorpe's House, Red Hill	11		
City Hill	2		
Civic Square Precinct, City		27/6/97	
Corroboree Park Precinct, Ainslie	25		
Crinigan's Hut, Amaroo	14		
Cuppacumbalong Woolshed Complex, District of Paddy's River		4/9/96	
Deasland Homestead & Dairy	3		

Demanding Hut, NNP, District of Mount Clear		28/2/96	
Duntroon Dairy, Campbell		4/9/96	
Duntroon Woolshed, Pialligo		4/9/96	
Evans Crescent Housing Group			(1/3/96)
Forrest Fire Station Precinct	15		
Forrest Housing Precinct	24		
Frank & Jack's Hut, NNP, District of Rendezvous Creek		28/2/97	
Free Serbian Orthodox Church, Forrest		14/2/96	
Ginninderra Blacksmith's Workshop	4		
Ginninderra Police Station & Grounds	5		
Ginninderra Village Precinct, Nicholls		27/6/96	
Goldenholm Dairy, Fyshwick	26		
Gungahleen (formerly Stone Hut School), Lyneham		4/9/96	
Horse Gully Hut, NNP, District of Mount Clear		28/2/97	
Hospital Creek Hut, NNP, District of Rendezvous Creek		28/2/97	
"Huntly", District of Stromlo		14/6/96	
Hotel Acton			(23/8/97)
Kingston/Griffith Housing Precinct, Kingston		16/2/96	
Kingston Power House Precinct		(20/2/96)	
Lennox House Complex		16/2/96	
Manning Clark's House, Forrest	16		
Manuka Swimming Pool, Griffith		4/9/96	
Max & Bet Oldfield's Hut, NNP, District of Mount Clear		28/2/97	
Melbourne & Sydney Buildings, City		14/6/96	
Mount Franklin Chalet & Precinct, NNP		27/6/97	
Mugga Mugga, Symonston	17		
National Rose Gardens, Parkes	18		
National Film & Sound Archive, Acton		27/6/97	
Northbourne Housing Group, Dickson		27/6/97	
Northbourne Oval, Braddon		27/6/97	
Pryor's Hut, NNP, District of Cotter River		28/2/97	
Red Hill Precinct, Red Hill		26/8/94	

Reid Housing Precinct	23		
Reid Uniting Church		16/2/97	
Rose Cottage, Gilmore	22		
Rowley's Rendezvous Creek Hut, NNP, District of Rendezvous Creek		28/2/97	
Salvation Army Hall		27/6/97	
St John the Baptist Church & Churchyard, Reid	19		
St John's Schoolhouse, Reid		27/6/97	
Surveyor's Hut	8		
Tennent Homestead, NNP, District of Tennent		28/2/97	
Tharwa Bridge, Tharwa		16/2/96	
Theodore Aboriginal Artefact Grinding Site	20		
"The Valley"	9		
Tocumwal Housing Precinct, O'Connor		4/9/96	
Tuggeranong Boundary Marker Complex, Greenway		14/6/96	
Tuggeranong Homestead & Environs, Richardson		1/12/93	
Tuggeranong Schoolhouse, Chisholm	21		
Wakefield Gardens Precinct, Ainslie		27/6/96	
Waterhole Hut, NNP, District of Mount Clear		28/2/97	
Westerman's Homestead, NNP		27/6/97	
Woolshed Creek Fossil Site & Narrabundah Ashstone Locality	10		
Yarralumla Brick Works, Yarralumla			(23/8/97)
York Park Oak Plantation, Barton		27/6/97	

* Brackets indicate date not a gazettal date