# THE HAWKESBURY-NEPEAN REGION: HAS THE OPTIMUM POPULATION SIZE BEEN EXCEEDED?

Alan Jones and Ben Pearson

*The ecosystem of the Hawkesbury-Nepean River is under stress. Is population growth in the catchment area part of the cause? What would it cost to restore the system's health?*

## INTRODUCTION

After decades of dispute, there is now broad agreement in Australia that environmental degradation is widespread and that it is threatening our ecosystems, economy and quality of life.[1] There is less agreement, however, about the cause or causes of degradation with the role of population size being particularly contentious.[2]

Many people have considered Australia to be a huge, empty continent and have harboured a 'populate or perish' mentality. Population growth has been rapid by Western standards[3] and apparently widely accepted. Recently, however, the claimed benefits of population growth have been challenged by scientists, U. N. conferences and community groups.[4] Moreover, these challenges have focussed attention on excessive population size as a cause of environmental degradation. The question of the role of population in environmental degradation has had sufficient credibility for the Federal Government to include population as an intersectoral component of the environmentally sustainable development (ESD) process and to commission the House of Representatives Standing Committee for Long Term Strategies to inquire into Australia's population carrying capacity.

If we are to manage the environment we need to establish key ecological indicators of environmental degradation, indicators that are also strong determinants of quality of human life.[5] Aquatic ecosystems are prime candidates to be such indicators since they both fulfil many human needs and experience obvious degradation.[6] For example, eutrophic waterways look and smell foul and lose both anthropocentric and ecocentric values.

Public concern about the environment is particularly acute in regions where aquatic degradation is both severe and obvious. The Hawkesbury-Nepean River basin adjacent to Sydney is such a region. Alarm is being expressed publicly about, *inter alia*, the rapid rate of population increase here and the state of the Hawkesbury-Nepean waterway, an invaluable but deteriorating asset.

The main objective of this paper is to analyse environmental impacts in the Hawkesbury-Nepean River system, the role of population growth in these impacts, and the costs of modifying this role. Prior to this, brief comments are made on two questions: linkages between population size and environmental degradation; and the use of freshwater ecosystems as key indicators of environmental degradation.

## LINKAGES BETWEEN HUMAN POPULATION AND ENVIRONMENTAL DEGRADATION

Environmental degradation can have several causes. These include population size, per capita consumption, the quality of technology and the organisation of space and technology.[7] Impacts can thus increase or decrease independently of population size, a fact that greatly complicates attempts to isolate the effects of population size and to estimate carrying capacities or optimum sizes. These complications have caused some analysts to question the linkage between human numbers and environmental degradation and to reject the need to set population limits or optimum population targets.

But acceptance that linkages exist between population levels and environmental impact seems to be increasing.[8] For example, the authors of a recent state government discussion paper write that: 'In developing strategies to help protect waterways, it is necessary to look at the various uses that may be made of those waterways in the future and the environmental stress this may create. Without doubt, the most significant factor that will contribute to such stress is population growth.'[9]

**FRESHWATER ECOSYSTEMS: KEY INDICATORS OF ENVIRONMENTAL QUALITY**

Freshwater ecosystems are especially useful as indicators of environmental degradation over large spatial scales (catchments) because they integrate impacts associated with both the aquatic and terrestrial environments. There are numerous human uses of the aquatic environment (such as water supply, sewage disposal, transport, fishing, recreation, and sand mining), each of which imposes direct effects. In fact, humans have caused profound changes that have seriously degraded many of Australia's rivers and jeopardised their long-term ecological sustainability.[10]

Aquatic degradation is also partly due to terrestrial human activities, the effects of which occur indirectly via the strong links existing between waterways and their catchment.[11] These links occur because water drains through the catchment and into the waterway, carrying with it dissolved contaminants and sediment. Contaminants such as nutrients, metals and pesticides can also attach onto fine soil particles and enter the river via erosion. Once there, they may cause plant blooms or enter aquatic food webs with consequences for both the ecosystem and human health.[12] Of course, soil erosion itself causes aquatic impacts such as turbidity and sedimentation. For example, 30-fold increases in sediment yields to rivers can occur following clearing and cropping of small catchments.[13]

Aquatic degradation is often exacerbated by the limited ability of small waterways to dilute and assimilate contaminants. This makes them especially vulnerable to cultural eutrophication, a process whereby excessive plant growth (blooms) occurs as a result of nutrient oversupply. Algal blooms have become a major and increasing threat in many waterways, including the Hawkesbury-Nepean.[14] The impacts of eutrophication are often exacerbated by droughts and changes to natural flow patterns due to dams, weirs, extractive industry, the abstraction of water for human use, and irrigation.

This pressure on waterways combined with their sensitivity led researchers for the Ecologically Sustainable Development (ESD) working groups to conclude that: 'The quantity and quality of a region's water resource is an effective indicator of the level of sustainability of activities conducted within the region...'[15]

**HAWKESBURY-NEPEAN RIVER SYSTEM**
**Background, impacts and proposed developments**

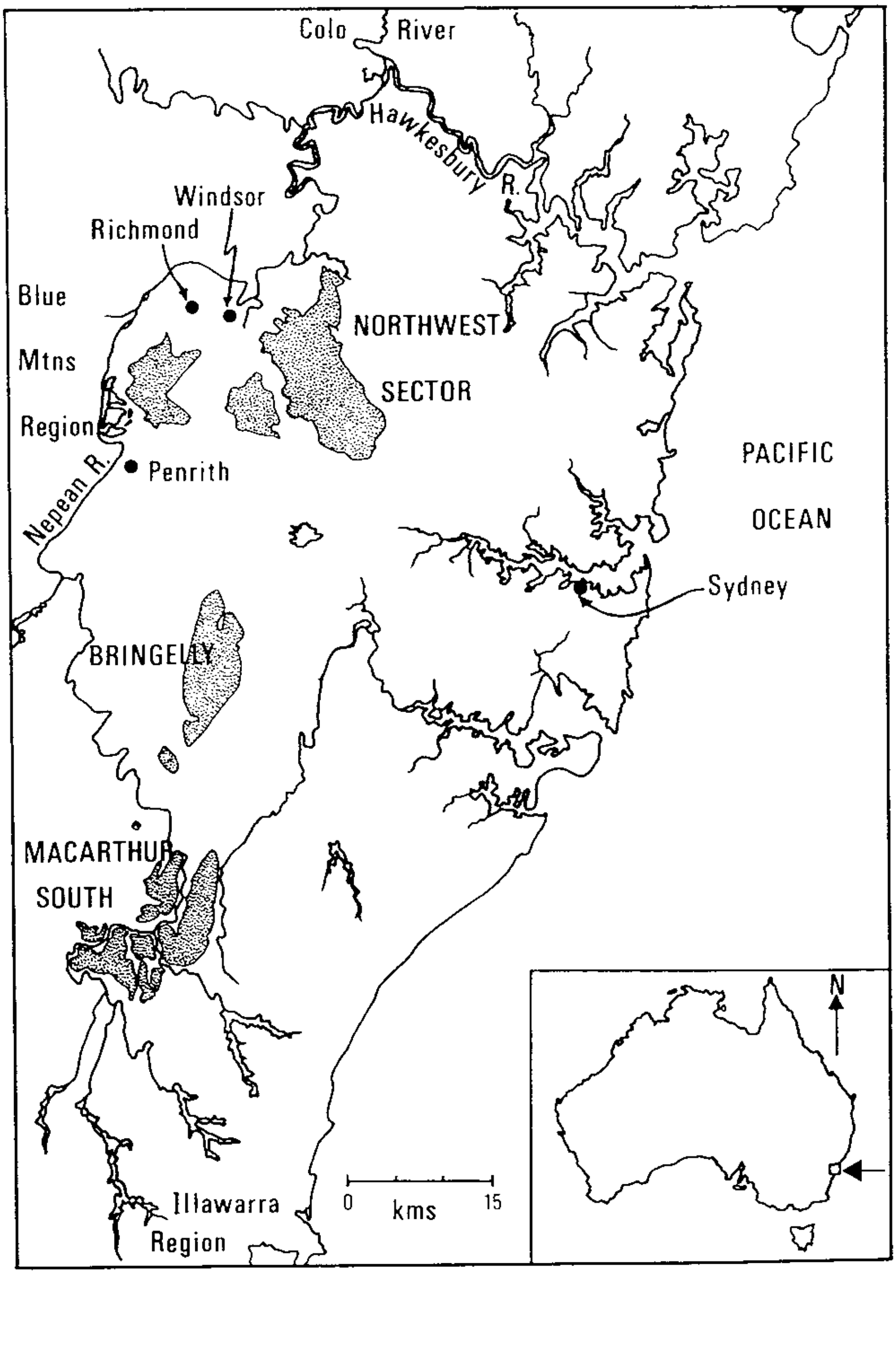
The Hawkesbury-Nepean River spans a distance of 530 kilometres from the northern Illawarra to the ocean at Broken Bay (see Figure 1). The catchment area covers about 21,730 sq. km. and land uses are: bushland (68 per cent), urban (5 per cent), agricultural (25 per cent) and industrial commercial (0.1 per cent).[16] Approximately 45 per cent of the total area is protected as it forms the catchments for dams. These Hawkesbury-Nepean dams provide 98 per cent of the water used in Sydney, Illawarra and the Blue Mountains. A recent population estimate for the Hawkesbury-Nepean region is 600,000 to 700,000 people.[17]

Human usage and modification of the catchment and waterway is varied and extensive. River flow is impeded by six dams and numerous compensation weirs making it the most heavily regulated river system in south-eastern Australia. Other factors modifying the flow include sewage effluent discharge, water abstractions and modified run-off resulting from urban development. About 100 sewage treatment plants are licensed to discharge about 185 megalitres of effluent per day (ML/day) to the river system.[18]

The river system is also heavily used for recreation, tourism and extractive industry. Approximately 20 million tonnes of gravel and 10 million tonnes of sand were removed from the river system between Penrith and Richmond between 1952 and 1972.[19] Fishing is also important, particularly in the estuary which is among the top 15 production areas in New South Wales (NSW). These uses combine to make this one of Australia's most important and valuable river systems.

It is not surprising that this river system is showing serious ecological stress. The combination of sewage discharge, reduced river flow (caused by river regulation and water abstraction), and urban/agricultural run-off has resulted in severe and increasing cultural eutrophication, bacterial contamination, toxic pollution and hypoxia.[20] For example, 41 algal blooms occurred in the river at Richmond between 1982 and 1988 compared with only 15 blooms in the previous nine years; 163 km of river upstream of the Colo-

**Figure 1:** Map of Hawkesbury-Nepean River system and region. Stippled areas indicate the sectors (Northwest Sector, Bringelly and Macarthur South) earmarked for urban development.



Hawkesbury junction were unsuitable for primary contact recreation (swimming and water skiing) because faecal coliform levels exceeded the guideline value of 150 units per 100 millilitres (mL); and levels of copper, selenium, cadmium and arsenic in oysters from the lower Hawkesbury River exceeded the recommended standards of the National Food Authority at two of the 14 sites tested. Further, it seems that pollution is injuring the Hawkesbury Bass.[21]

This situation has developed over many years and produced numerous statements of concern dating back to 1956. More recently, there have been dire media headlines[22] and sufficient public alarm to create over 30 local environmental groups which amalgamated to form CHANGE (Coalition of Hawkesbury And Nepean Groups for the Environment) in 1989. This public concern was shared by the then Minister for Conservation and Land Management, Garry West, who asserted in 1993 that: 'The previously clear, clean and productive river ... [which] supported a great range of life and activities, now shows signs of serious decline. There is increasing water quality, land and riverbank degradation and a dwindling river economy in significant parts of the catchment.'

This situation has provoked various official responses including research (especially water-quality modelling), planning (for example, regional environmental planning) and management (total catchment management committees). A broad conclusion from these responses is that large-scale development should be deferred due to uncertainty about the potential impact of development on water quality.[23]

Despite this, there are plans to increase the catchment's population by possibly 70 per cent by 2008. Three new sector corridors involving Macarthur South, Bringelly and the North-West sector (see Figure 1) have been earmarked for urban development with an anticipated 40,000 new housing lots released in the next five years.[24] If this growth is allowed to proceed, planners will face a challenge in accommodating it while at the same time meeting the objectives of ESD and the New South Wales State Rivers and Estuaries Policy. In particular, it will be important to maintain, or indeed restore, the range of environmental values already diminished. Of these, water quality is acknowledged to be paramount.[25]

**Water quality and projected costs of sewage treatment**

The best information relating to the river concerns water quality, especially nutrients. Approximately 673 tonnes of total phosphorus and 4,918 tonnes of total nitrogen are generated in the catchment each year of which about 13 per cent of the former and 22 per cent of the latter enter the waterway via sewage discharges. Most effluent (130 ML/day) is discharged from the 25 Sydney Water (Water Board) STPs which serve about 500,000 people. Already in the last three years, $300 million has been spent on the Board's sewerage system.[26] These effluent loads and treatment costs will increase with the planned population growth.

The dollar costs of various effluent-treatment options associated with this growth were recently analysed by the New South Wales Government Clean Waterways Programme.[27] The report recognised the pressing need to meet water quality standards and protect both recreational and ecosystem values. The information in the next two paragraphs is drawn from it.

For river-discharge options, meeting current licence standards for phosphorus concentrations in discharge effluent of one milligram per litre (1 mg/L) will cost $1.5 billion in 1994 dollars. However, despite the current improvements to effluent quality, water quality will continue to deteriorate as population increases. Moreover, stringent licence limits of 0.3 mg/L of phosphorus are anticipated, imposing a $2 billion cost. Even then algal bloom conditions would ultimately worsen because of population growth. Further reductions in phosphorus (to 0.05 mg/L) would keep the river largely free of sewage-induced algal blooms beyond 2025 but would cost $3 billion, produce much chemical sludge, and depend on technology that has not yet been implemented on a large scale.

Alternatives to river discharge are even more expensive. Re-use of effluent is ecologically attractive but would cost $2.5-3.5 billion for non-potable uses or $4-4.5 billion for potable uses. Diversion to the ocean ($3 billion) or zero river discharge via composting toilets and on-site discharge ($8,400 per property for installation and $700 per annum maintenance), or inland disposal ($19 billion) would all be very expensive, especially inland disposal. In addition, the above options (except composting toilets) incur an additional $2 billion costs for sewer reticulation and sewerage trunks to be borne initially by property developers and ultimately the consumer.

**Other costs associated with growth**

Environmental costs associated with population growth arise from the ecological principle of interrelatedness among ecosystem components; any action on some components will have unintended, often deleterious, effects on other components. Economists call these effects 'externalities' and ignore them. Dams, for example, have numerous side effects in addition to providing water, recreation or power. Apart from interfering with fish migrations, dams reduce the flow of water. Such 'environmental' flows are considered necessary for maintaining ecosystem health, reducing algal bloom conditions and, most probably, enhancing the catch of estuarine and near-shore fisheries.[28]

However, the deliberate increase of flows for environmental purposes imposes direct costs (for example, $45 million dollars' worth of water was used to flush away a Hawkesbury algal bloom in 1988),[29] and reduces the amount of water available for direct human use. Such increases would force a reduction in demand and/or increased reuse of water and/or the augmentation of supply by building more dams. None of these options is cost free; demand management would operate through increased prices, reuse involves new technology and infrastructure, and new dams are very expensive. For example, apart from capital and operating costs, the proposed Welcome Reef Dam will be prone to eutrophication, require expensive water treatment and will adversely affect several threatened species.[30]

A further cost of environmental degradation, often ignored, concerns the research needed to inform management. The shortfall in knowledge and understanding is freely acknowledged by the Sydney Water Board which is funding numerous studies. Further, the Hawkesbury-Nepean Catchment Management Trust is currently administering the 'Operation Healing' programme and organising research on fish habitats. Thus the taxpayer is subsidising growth in the catchment in a most tangible sense.

## DISCUSSION AND CONCLUSIONS

Freshwater ecosystems are key indicators of environmental impact. The river system draining the Hawkesbury-Nepean region is, by common consent, under severe anthropogenic stress. Algal blooms induced by nutrient pollution are the clearest evidence of environmental degradation but other problems exist. Evaluation of this degradation can be made against at least two criteria: the relevant objectives of management stated by Government; and public opinion concerning socially-acceptable change to the environment and quality of life and the costs associated with their maintenance.

Objectives of the national ESD process include the improvement of total quality of life, the maintenance of ecological processes and biodiversity, the provision of intergenerational equity and the employment of a precautionary approach. Objectives for the NSW State Rivers and Estuaries Policy are to slow, halt or reverse the degradation of rivers and estuaries, to ensure the long-term sustainability of their essential biophysical functions and to maintain their beneficial uses. Moreover, the guidelines for Sydney Water's Strategic Plan accord with the above.

These Government objectives and guidelines have been contravened, both on an episodic basis (as with algal blooms) and probably on a long-term, cumulative basis (as with water quality and sedimentation). Public opinion that quality of life is not acceptable because of environmental degradation, especially water pollution, has been forcefully and unequivocally expressed for many years. On top of this, the future will bring increased costs for water, waste treatment and housing, along with a much larger population. Not surprisingly, current residents are deeply opposed to further population growth and Sydney Water, which is obliged to meet water quality standards, is publicising the steep costs incurred by growth.

Consequently, on the basis of both management objectives and public opinion, the current situation is unacceptable. Moreover, under present technologies, consumption rates and social organisation, the human optimum population size has been well and truly exceeded; the values of the system are unacceptable and cannot be sustained. But what does optimum population size mean, how are it estimated and how will the mix of factors causing degradation change in the future?

The optimum population size is the maximum number who can use an area without a) an unacceptable alteration in the biophysical environment, b) an unacceptable decline in the quality of life and c) compromising the needs of future generations. Acceptability is a key criterion, one that depends substantially on value judgements. What is needed, then, is to assess the maximum population size that meets socio-economic standards concerning acceptable environmental quality. Ideally, judgements would be informed by sound scientific findings, cost-benefit or alternative-evaluation procedures and population/quality-of-life modelling.

While scientific understanding of the Hawkesbury-Nepean River is far from comprehensive, some cost-benefit analyses relating to population growth are available. Sydney Water have estimated waste treatment costs for different levels of benefit concerning the occurrence of algal blooms. While these estimates are limited to just one aspect of water quality (phosphorus), they are valuable because they are quantified in dollar terms, deal directly with quality of life issues in the waterway and provide an accessible, if limited, basis for decision-making. The estimates show that attempting to accommodate the planned population growth in the Hawkesbury-Nepean region will be massively expensive and probably in conflict with the affordable maintenance of a desirable quality of life. If these estimates are accepted, it would have been preferable for Sydney Water to have recommended a halt to population growth, at least until acceptable and efficacious methods of environmental management and rehabilitation are put in place. Although the 'no-growth' option was probably unavailable given the apparent official acceptance of Greater Sydney's growth,[31] it would have accorded with the precautionary and onus principles of management[32] which seem crucial for the region.

Even if the planned population increases do not occur, rehabilitating the present unacceptable environmental quality of the Hawkesbury-Nepean River will depend critically on a combination of willingness to reduce consumption and to pay for better technology and social organisation. Of course, a multitude of factors related to terrestrial issues will also require appropriate attention on an integrated catchment-management basis. It will be necessary to implement research into ecosystem processes and to monitor temporal trends, especially in selected aquatic indicators.

If population increases do occur, the urgency of these measures will increase. There are serious doubts that the problems associated with population growth in the Hawkesbury-Nepean region have acceptable and affordable solutions. The following statement was made in a politically-charged atmosphere. Nevertheless it reflects public opinion: 'While we may be able to put the pipes in the ground and build the treatment works I have no confidence yet that will result in a decent riverine environment. We cannot turn the river into a drain.'[33]

**References**


1. P. Keating, *Australia's Environment: A Natural Asset*, Australian Government Publishing Service (AGPS), Canberra, 1992, p. 45; *National Strategy For Ecologically Sustainable Development*, Commonwealth of Australia (ISBN 0 644 27253 8) 1992, p. 128
2. See National Population Council, *Population Issues and Australia's Future: Environment, Economy and Society*, AGPS, Canberra, 1992, p. 135
3. A. Borowski and Jing Shu, *Australia's Population Trends and Prospects 1991*, Bureau of Immigration Research, Commonwealth of Australia, 1992, p. 127
4. Australian Academy of Science Symposium, 'Population 2040: Australia's Choice', April, 1994; United Nations International Conference on Population and Development, Cairo, 1994; Australians for an Ecologically Sustainable Population; Coalition of Hawkesbury And Nepean Groups for the Environment.
5. D. Cocks, *Use With Care. Managing Australia's Natural Resources in the Twenty First Century*, NSW University Press, Kensington, 1992, p. 344
6. Australian and New Zealand Environment and Conservation Council (ANZECC), *Australian Water Quality Guidelines for Fresh and Marine Waters*, Canberra, 1992, p. 202; Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Towards Healthy Rivers*, Division of Water Resources Consultancy Report No. 92/44, 1992, p. 103
7. G. C. Daily and P. R. Ehrlich, 'Population, sustainability, and Earth's carrying capacity', *Bioscience*, vol. 42, no. 10, 1992, pp. 761-771; F. Crome, B. D. Foran and L. Moore, 'Population growth and biodiversity loss in Australia', Paper presented at the Australian Population Conference, ANU, September, 1994
8. See A.R. Jones, 'Freshwater ecosystems: valuable, vulnerable and threatened by human population increases', Paper presented at the Australian Academy of Science Symposium, April, 1994.
9. Water Board, *Choices for Clean Waterways: A discussion paper on planning wastewater services for the future*. New South Wales Government's Clean Waterways Programme, 1994, pp. 56, 7

[10] CSIRO, op. cit.; ANZECC, op. cit.; B.T. Hart, 'Ecological condition of Australia's rivers', *Search*, vol. 23, no. 1, 1992, pp. 33-37

[11] P. Cullen, 'Toxic algal blooms and the rhetoric of sustainability', *Australian Journal of Soil and Water Conservation*, vol. 4, no. 3, 1991, pp. 4-8

[12] CSIRO, op. cit..

[13] D.W. Connell, *Water Pollution. Causes and Effects in Australia and New Zealand*, 2nd Edition, University of Queensland Press, St Lucia, 1981, p. 203

[14] C. Heath and D. Cannon, 'Sydney and cyanobacteria - a commentary', In Proceedings of the Water Board Blue Green Algal Seminar 21-22 November, Water Board, 1990

[15] ESD Working Groups, Draft Intersectoral Report - Water Resources, 1991, p. 7

[16] P. Laut and S. Cuddy, 'Catchment regions in the Nepean-Hawkesbury basin', CSIRO Division of Water Resources, Australia, 1991

[17] Department of Planning NSW, personal communication, 1994

[18] B. Pearson, 'Rivers: ecological implications of Water Board activities. An initial report prepared for the Water Board as part of the Sydney Water Project.' Nature Conservation Council of NSW Inc., 1994, p. 194; J. H. Harris, 'Impoundments of coastal drainage of south-eastern Australia - a review of its relevance to fish migrations', *Australian Zoology*, vol. 21, 1984, pp. 235-250; 'An Inventory of Pollutant Sources in the Hawkesbury-Nepean River Catchment', Technical Report, NSW Environment Protection Authority (EPA)

[19] H. A. Scholer, 'Geomorphology of NSW coastal rivers', The University of NSW Water Research Laboratory, Manly Vale, Report No. 139

[20] B. Pearson, op. cit.

[21] Heath and Cannon, op. cit.; 'Hawkesbury-Nepean River System', June 1990 to December 1991 - Interim Water Quality Report, NSW EPA, 1993; 'Baseline Survey of Lower Hawkesbury', Draft, NSW EPA, 1991; W. Erskine, quoted in *Sydney Morning Herald*, 2 March 1994

[22] See J. Woodford, 'Progress leaves river on last legs', *Sydney Morning Herald*, 2 March 1994.

[23] Department of Planning, NSW, personal communication, 1994

[24] CHANGE, 'Hawkesbury Nepean River: A River in Crisis', Coalition of Hawkesbury And Nepean Groups for the Environment, 1993, p. 4; Department of Planning, Metro Plan for the Sydney Region, AGPS, Canberra, 1989; The *1993/94 - 1997/98 Program: Local Government Area Supplement, Sydney Residential Land - Urban Development Program*, Department of Planning, AGPS, Canberra, 1994

[25] *The NSW State Rivers and Estuaries Policy*, NSW Water Resources Council, NSW Government (ISBN 0 7305 7919 0), 1993, p. 40; *Hawkesbury-Nepean River: Sydney Regional Environmental Plan No. 20*, NSW Department of Planning, 1989, p. 60

[26] Water Board, 1994, op. cit.

[27] ibid.

[28] G. E. Petts, 'Long-term consequences of upstream impoundment', *Environmental Conservation*, vol. 4, 1980, pp. 325-333; NSW Water Resources Council, 1993, op. cit.; A.A. Aleem, 'Effects of river outflow management on marine life', *Marine Biology*, vol. 15, 1972, pp. 200-208

[29] *Our Water*, NSW Water Resources Council, 1993, p. 51

[30] 'Dams or Demand Management?', Graduate School of the Environment, Macquarie University Report No. 126, 1992, p. 40

[31] Department of Planning, Sydney's Future. A Discussion Paper on Planning the Greater Metropolitan Region, NSW Govt. (ISBN 0 7305 7166 1), 1993, p. 62

[32] M.D. Young, 'For Our Children's Children. Some practical implications of intergenerational equity, the precautionary principle, maintenance of natural capital, and the discount rate', Working Document 92/5, A.M.N.R.S. Program, Division of Wildlife Research, CSIRO, Canberra, 1993, p. 51

[33] Bob Wilson, Managing Director, Water Board, quoted in the *Sydney Morning Herald*, 22 June 1990