

INTEGRATING ESD – THE ENVIRONMENTAL LEGACY OF SYDNEY OLYMPIC PARK

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Executive Summary

A commitment to the environment was at the heart of all planning, construction and operation of facilities and venues for the Sydney 2000 Olympic and Paralympic Games. Post Games, this continued commitment to the principles of ecologically sustainable development will drive future development and activities at Sydney Olympic Park.

Sydney's successful bid to host the 2000 Summer Olympic and Paralympic Games was due in large part to the visionary commitment to deliver the Games with a heightened focus on ecologically sustainable development (ESD), superior to any major sporting event held anywhere in the world before.

The *Environmental Guidelines for the Summer Olympic Games (September 1993)*, developed by a range of environmental stakeholders, were offered to the International Olympic Committee (IOC) by the Sydney Bid Team in a spirit of goodwill to further the fundamental principles of the Olympic Charter. The environment has now been officially adopted as the third dimension of the Olympic Charter along with sport and culture.

The primary site for many of the Olympic venues and facilities was Sydney Olympic Park, Homebush Bay, a former dumping ground for domestic, commercial and industrial waste. The remediation and restoration of Homebush Bay, and the integration of ESD as an essential component of venue design, construction and operation represent the magnitude of the Olympic Coordination Authority (OCA)'s commitment to the environment.

OCA's approach to integrating ESD was achieved using a framework of planning instruments; OCA Act, State Environment Planning Policy (SEPP) 38, Sydney Regional Environmental Plan (SREP) 24 Homebush Bay Area, OCA's Environment Strategy, Environment Policy and Environmental Tender Specifications (ETS). The combined effect of this guiding framework was that the developments exemplified outstanding innovation, imagination and resourcefulness to the extent that in many instances OCA's environmental achievements dramatically exceeded the early expectations of most stakeholders.

OCA placed a high premium on the transparency of its decision-making processes and the effective communication of those processes to the broader community. In the lead up to (and immediately after) the Games, OCA initiated and actively participated in external reviews of its ongoing environmental performance at a local, national and international level. As part of this process the Earth Council conducted four periodic assessments of how OCA was meeting the commitments of the *Environmental Guidelines*. The fourth (and final) Earth Council Review was handed down in February 2001 with OCA receiving an outstanding 8.5/10 for overall environmental performance. Chairman of the Earth Council, Mr Maurice Strong described the Sydney Games as:

"the best ever and the greenest or most sustainable Games ever.... Without question Sydney 2000 has set the bar high..... I am confident that your example has set new standards that not only other Olympics, but also other events, construction, infrastructure, urban redevelopment and suburban development projects will need to follow".

The developments at Sydney Olympic Park and other Olympic venues have enabled Australian industries to showcase internationally the breadth of their environmental and technological innovation.

Post Games, there is still high international recognition of Sydney Olympic Park as being a benchmark for sustainability and a world class example of successful ESD integration. In June 2001 on World Environment Day, the United Nations Environment Program (UNEP) awarded both OCA and SOCOG its prestigious Global 500 Award for environmental excellence. This high profile international award recognised Sydney 2000's commitment to ecologically sustainable development, which set benchmarks in the areas of energy, water conservation, waste minimisation, pollution avoidance and protection of the natural environment.

The enabling legislation of OCA's successor, the Sydney Olympic Park Authority (established in July 2001) places a high premium on the Authority's commitment to the principles of ESD. The legislation identifies the *Environmental Guidelines* as a core document that must be considered by the Authority in all decisions relating to future planning, development and management strategies for Sydney Olympic Park and Millennium Parklands.

To deliver on this important challenge, the Sydney Olympic Park Authority is building on the environmental framework established by OCA which will include the following elements:

- Environment Policy/Strategy
- Revised Environmental Management System that will incorporate environmental tender specifications, environmental training
- Comprehensive environmental communication strategy; and
- Development of potential environmental education/research opportunities.

The new Authority will continue to promote and progress the understanding of the *Environmental Guidelines* in order that future environmental technologies and sustainable innovations are identified and supported and that Sydney Olympic Park remains at the forefront of environmentally sustainable management and development practices.

The environmental legacies evident at Sydney Olympic Park are a strong testament to the benefits of an integrated approach to ESD as a model for long term sustainable planning and management strategies. This holistic approach to ESD will continue under the new Authority and will ensure that future developments at Sydney Olympic Park strive to 'raise the bar' in terms of environmental innovation and sustainable management in all aspects of their design, construction and operation.

Introduction

The Sydney 2000 Summer Olympic and Paralympic Games were held at a number of venues located throughout the greater metropolitan region of Sydney including Sydney Olympic Park, Homebush Bay; Eastern Sydney and Western Sydney. Sydney Olympic Park, Homebush Bay is situated in the demographic and geographic heart of Sydney and was the major focus of the most concentrated array of environmental initiatives.

The Homebush Bay site is one of contrasts and a varied history. The site has considerable ecological value, providing ecologically sensitive habitats for a number of native and migratory birds and containing a regionally significant remnant eucalypt forest. However the site has also been utilised for urban developments and has been government brickworks and abattoir, as well as a naval armaments depot. In addition to those functions, parts of the site were used for domestic and industrial waste disposal for almost 50 years.

In the largest remediation project of its kind in the history of Australia the Homebush Bay site has been gradually transformed from a land use liability to an enduring community asset with much of its environmental value restored through the adoption of ESD practices. The end result has seen 9 million cubic metres of waste moved and safely confined on site in specially designed areas and the former rubbish tip transformed as part of Millennium Parklands.

Historical Overview: Environmental Planning and Management Systems

OCA was established in 1995 under the *Olympic Coordination Authority Act (1995)* from its predecessor organisation, the Homebush Bay Development Corporation. OCA was responsible for the design and construction of Olympic venues and facilities and ongoing site management during the Sydney 2000 Summer Olympic and Paralympic Games.

OCA's delivery of sporting venues and facilities was superimposed on a framework of NSW environmental legislation. This included the:

- Pollution Control Act (1970)
- Environmental Planning and Assessment Act (1979)
- State Environment Planning Policy (SEPP) 38 – Olympic Games and Related Projects
- Sydney Regional Environmental Plan (SREP) 24 – Homebush Bay Area
- Protection of the Environment Operations (POEO) Act (1997)

Overview of OCA's Environmental Framework

The *Environmental Guidelines for the Summer Olympic Games (September 1993)* provided the framework for OCA's commitment to ESD. In the development of Olympic venues and facilities, OCA continually strived to achieve environmental excellence and showcase the entire site as an example of world's best environmental practice. *The Environmental Guidelines* outlined ESD in terms of:

- Protecting biological diversity
- Energy conservation
- Water conservation
- Waste avoidance and minimisation
- Protecting significant natural and cultural environments

The challenge for OCA was to develop a process that effectively communicated the principles outlined in the *Environmental Guidelines* and maximised the opportunity for flexibility and imaginative design.

Under the overarching framework established by the *Environmental Guidelines* OCA produced the Homebush Bay Development Guideline series to provide guidance for developers, designers, land planners and managers in relation to environmental considerations. This five volume series included:

- Environment Strategy (Volume 1)
- Structure Plan (Volume 2)
- Masterplan (Volume 3)
- Transport Strategy (Volume 4)
- Landscape Strategy (Volume 5)

The series identified objectives relating to the implementation of ESD and was prepared in consultation with a variety of interested parties including representatives from State and Local Government, environment groups, academia, industry and community groups.

The Environment Strategy interprets the concept of ESD for Homebush Bay through objectives, outcomes and actions. The document establishes the principles for implementation of ESD under three key performance areas

- conservation of species
- conservation of resources
- pollution control

The Environment Strategy was not intended as a compliance document but rather as a guide towards achieving technologically outstanding and sustainable environmental outcomes. Its purpose was to encourage initiative and innovation and designers were required to report on the environmental performance of their proposals.

Parallel to the guidance provided by the Environment Strategy, was OCA's Environmental Tender Specification (ETS). The ETS again advocated environmental performance outcomes rather than prescriptive measures. This approach provided additional stimuli to tenderers to explore innovative ideas to achieve best practice in achieving ESD outcomes. The ETS required all respondents to calls for project delivery to outline their environmental initiatives and objectives in their environmental management plans.

OCA also developed an Environment Policy, a statement of OCA's intentions and principles in relation to environmental performance¹. This policy applied to all OCA activities.

OCA developed a comprehensive Environmental Management System (EMS) to verify the environmental performance of contractors and developers. OCA's EMS was implemented in 1997 and revised in 1999. The EMS complies with ISO 14001 and details the management approach adopted by OCA to ensure its environmental commitments are achieved. OCA's

¹ Sydney Olympic Park Authority is in the process of reviewing the existing environmental framework with a view to developing its own environmental processes that will reflect:

- environmental requirements as specified in the Sydney Olympic Park Authority Act 2001
- the Environmental Guidelines
- the changed operational nature of Sydney Olympic Park

Until this process has been completed, the previous OCA environmental framework continues to apply to all activities at Sydney Olympic Park.

EMS is a structured set of procedures, lists and actions that follows a project, from design through to construction and operation.

Compliance audits were undertaken to confirm that a project's EMP was implemented as designed and that regulatory requirements as well as compliance and non-compliance incidences were reported and handled correctly. Practical reinforcement of ESD for OCA's workforce (including all contractors) was achieved via a series of environmental training programs. This training enabled workers to make informed decisions relevant not only to Olympic projects but equally applicable to future developments. Over 13,000 workers were inducted using OCA's 'Working Greener' training package.

Public Communication

OCA's communication strategy aimed to present the concept of ESD in a manner that engendered the support and interest of local communities in the developments at Sydney Olympic Park and other Olympic sites. OCA utilised a number of public communication strategies to highlight its commitment to sustainable development including:

- Establishment of the Homebush Bay Visitors Centre in 1997. Since opening the Centre has provided information on the implementation of OCA's environmental initiatives to over 1,367,920 visitors (as at 13/9/2001).
- Production of Environment Fact Sheets containing specific information on ESD initiatives (energy, water, waste, remediation, biodiversity and heritage)
- Production of Development Fact Sheets providing technical details of environmental initiatives included as part of the development of the various venues and facilities.
- Publication of annual Environment Reports.
- Production of Quarterly Environmental Performance Report (QEPR)'s to the NSW Environment Protection Authority.
- An extensive web site which provides readily accessible information to national and international audiences (Website addresses are: www.oca.nsw.gov.au or www.sydneyolympicpark.nsw.gov.au)
- Production of several educational resources for primary and secondary schools
- Regular participation/presentations at national and international conferences on ESD
- World Environment Day activities highlighting the environmental legacies of the site
- Science Week displays – highlighting remediation strategies and the ecological significance of the site
- Training Programs/Seminars on ESD (internal and external)
- Olympic Neighbours Day
- "Trees for Homebush Bay" – a tree planting program involving students from local schools
- Hosting of several community forums to discuss remediation issues as part of the Enhanced Remediation Strategy.

Sydney Olympic Park Authority will continue to progress many of the above communication strategies and local community participation programs. The Authority is currently working in

partnership with the NSW Department of Education to develop curriculum for environmental education courses at primary and secondary school level.

Communication and Validation

OCA placed a high premium on the transparency of its decision-making processes and the effective communication of those processes to the broader community. This was an iterative process of continual improvement and represented an important and ongoing challenge for OCA. At a local, national and international level OCA initiated and actively participated in external reviews of its ongoing environmental performance. To compliment these activities OCA established internal mechanisms to verify its compliance with environmental commitments.

OCA's efforts to publicly communicate its environmental initiatives and programs at a local and international level were recognised when OCA was a finalist in the 1999 Banksia Award – Communications Category.

Local and National Reviews

At a local and national level, periodic reviews of OCA's environmental performance were conducted by Green Games Watch 2000 and Greenpeace. Green Games Watch 2000 was established by the NSW Government in 1995 and was jointly funded by OCA and the Commonwealth Government (via Environment Australia).

Green Games Watch 2000 provided input to OCA on the implementation of the environmental initiatives associated with the development of Olympic venues and facilities. This involved regular independent reviews of OCA's environmental performance that are publicly available. Greenpeace also produced regular reports on OCA's environmental performance.

In addition to the above reviews, OCA established and participated in a range of additional programs aimed at facilitating public scrutiny and verification:

- The Homebush Bay Environmental Reference Group (HBERG) was established in June 1998 as a component of the Enhanced Remediation Strategy and an important mechanism for consultation with the community on the long term remediation strategy for Sydney Olympic Park. HBERG's role was to provide feedback on issues related to the development and monitoring of the remediated lands. It also ensured that community, scientific and environment groups have a voice in the on-going management of the remediated areas².
- The Olympic Environment Forum (OEF) comprised representatives of OCA, Sydney Organising Committee of the Olympic Games (SOCOG), the NSW Environment Protection Authority (EPA), Greenpeace, Green Games Watch 2000 and Auburn Greenspace. The OEF met fortnightly to discuss progress on OCA works, SOCOG programs and general issues of environmental management relating the provision of facilities and events for the Games. These meetings also provided a forum for identifying and discussing emerging environmental issues³.

² The Homebush Bay Environmental Reference Group (HBERG) had its final meeting in June 2001. The Sydney Olympic Park Authority is committed to processes that facilitate effective community consultation and is considering the establishment of a forum similar to HBERG.

³ The OEF met for the last time in November 2000 and, drawing on the Games Time experiences, developed the *Sydney 2000 Olympic and Paralympic Games Environmental Benchmarks – Guidelines, Achievements and lessons for environmentally sustainable building and events*. The Benchmarks document was launched at Sydney Olympic Park on 23 March 2001 and provides a strong example of the benefits to be gained through the establishment of cooperative partnerships between Games organisers, government departments and environmental non-government organisations.

- OCA provided Quarterly Environmental Performance Report (QEPR)'s to the EPA from January 1998 to December 2000, which documented OCA's ongoing environmental performance⁴.
- OCA produced comprehensive annual Environment Reports, which provided information on OCA's environmental performance to the broader community in an easy to understand manner⁵.

International Reviews

OCA obtained an independent and international perspective on its ongoing environmental performance through the periodic reviews by the Earth Council, an international body, established after the Summit on Ecologically Sustainable Development in 1992 (often referred to as the 'Rio Summit').

The Earth Council conducted four reviews in the lead up to and immediately following the Sydney 2000 Games in order to assess how OCA was meeting the commitments set out in the *Environmental Guidelines* and how well OCA was fulfilling the environmental expectations of the international community.

Chairman of the Earth Council, Mr Maurice Strong, handed down the findings from the fourth (and final) Earth Council Review of OCA's environmental performance in February 2001. The findings of this Review were again very positive. The Earth Council awarded an environmental performance rating of 8.5 overall, which reflected the very high environmental standards achieved by OCA in the delivery of the infrastructure for the Games.

The Earth Council commended OCA's environmental planning and construction of facilities, energy conservation and generation, water conservation and reclamation, waste avoidance and minimisation, ecological studies and regeneration programs and transportation.

Mr Strong praised the integration of sustainable processes into the delivery of the Sydney 2000 Games and described the Sydney Games as:

"the best ever and the greenest or most sustainable Games ever.... Without question Sydney 2000 has set the bar high..... I am confident that your example has set new standards that not only other Olympics, but also other events, construction, infrastructure, urban redevelopment and suburban development projects will need to follow".

Environmental Legacies

OCA's Environment Strategy encouraged developers to take a holistic approach to developments that included design, operational management and maintenance issues, renewable energy, water conservation and where relevant, biodiversity. The extent to which individual developers embraced this approach and the emphasis on individual elements were not specified. Below is a brief summary of the key environmental legacies arising out of OCA's ESD commitments.

Remediation

The remediation of past domestic, commercial and industrial waste at Homebush Bay, including contaminated soil, was the largest project of its kind in Australia and is the greatest environmental legacy arising from the Sydney 2000 Games. Approximately 9

⁴ The final QEPR was provided to the EPA in March 2001.

⁵ Under the *Sydney Olympic Park Authority Act (2001)*, the Authority is required to produce annual reports on the State of the Environment at Sydney Olympic Park.

million cubic metres of landfill required treatment, with 160ha of the 760ha site found to require some form of remediation.

In brief summary, contaminated landfill was removed from areas of high environmental risk and contained in consolidated waste mounds with extensive leachate management systems. OCA developed landfill environmental management and monitoring plans (LEMMP)'s to ensure the integrity and long term management of the system⁶. The remediation of the Homebush Bay site represented an investment by the NSW Government of \$137 million.

In addition to the civil engineering remediation works, OCA established the Enhanced Remediation Strategy in March 1998. This strategy included the development of an 'Ecology Data Bank'; a computer based information system that can provide site managers with ready access to historic and contemporary information about the remediation and monitoring of the Homebush Bay site.

The Sydney Olympic Park Authority has now assumed responsibility for the ongoing management and maintenance of 11 separate landfill areas across the Homebush Bay site (including areas within Bicentennial Park).

Millennium Parklands

At approximately 430 hectares, Millennium Parklands will be Australia's largest metropolitan park; a magnificent and enduring environmental legacy for the people of Australia.

Millennium Parklands includes the natural landscape, wetlands, woodlands and remediated lands surrounding the urban core of Sydney Olympic Park, Newington Nature Reserve⁷ and Bicentennial Park. The Parklands contain a network of approximately 40km of pedestrian and cycle trails and has a varied landscape that includes ponds, water features and drainage systems.

In addition to its high aesthetic appeal and use for passive recreation, the Parklands also provide numerous other operational functions including: areas of ecologically sensitive flora, habitat for a diverse array of fauna, flood mitigation; stormwater collection and treatment; irrigation storage and consolidation and containment of domestic and industrial waste.

The recently completed freshwater wetlands area, adjacent to the Newington Nature Reserve, has been planted with a range of species which were grown from seedstock of plants within the Reserve, including Turpentine and Ironbark trees. Along Haslams Creek, several thousand mangrove seedlings and extensive plantings of three rare saltmarsh species have been re-introduced; all of which were grown on site at Homebush Bay.

Gabion baskets, as well as providing structural strength to landforms and creek banks, provide shelter sites for fauna such as frogs and lizards. Native grasses have generally been planted in mosaics rather than monocultures; for example, the waste-containment mound Woo-la-ra was planted with 48 different species.

Overall, more than 8 million hand-placed individual trees, shrubs, grasses, groundcovers and macrophytes of many species have been planted. Plantings of this scale, established on a completely bare canvas over a short time frame, cannot approach the structure, age, or

⁶ The second stage of a two-part process to destroy approximately 400 tonnes of soil contaminated with materials (ie: chlorophenols, chlorobenzenes) scheduled under the Environmentally Hazardous Chemicals Act is continuing in a secure area of the site. This is cutting edge remediation technology and is subject to stringent environmental licence conditions established by the NSW Environment Protection Authority. This process is anticipated to be complete by early 2002.

⁷ Millennium Parklands includes Newington Nature Reserve. The ownership of this Reserve remains vested in the NSW National Parks and Wildlife Service (NPWS).

species diversity found in natural ecosystems that have developed over millennia. Nevertheless, monitoring data clearly show that many species of native wildlife have adopted these new areas.

Over 150 native species of birds, 7 native species of frogs, and a number of native species of reptiles and fish have been recorded within the new landscapes since their construction. And, after more than five years of extensive site development, the Homebush Bay Green and Golden Bell Frog population remains one of the largest and viable within NSW.

Ecological Monitoring Programs

In recognition of the ecological significance of the site, OCA implemented monitoring and research programs for birds, saltmarsh, benthic invertebrates, mosquitos and the protected Green and Golden Bell Frog (*Litoria aurea*).

A number of these ecological monitoring programs are continuing under the Sydney Olympic Park Authority and will ensure that management practices encouraging the biodiversity of the site remain a priority for future site managers.

The conservation management of the endangered Green and Golden Bell Frog provides a strong example of OCA's (and now, the Sydney Olympic Park Authority's) efforts in this important area.

The current frog population is currently estimated to number approximately 1500 adults, about 600 of which inhabit the Brickpit. The other 900 frogs inhabit ponds and wetlands outside the Brickpit, all of which were created by OCA in order to ensure the continued viability of the frog population. Sub-populations of the frog that have developed in habitats created by OCA are currently large and continue to breed.

OCA's new frog habitat areas have been enthusiastically received by the scientific review committee (composed of four of the leading experts on the species), and are being utilised by the frogs. Indeed, Green and Golden Bell Frogs have been observed (during nocturnal monitoring) in or around almost all of the new ponds within a few weeks of their completion, and spawning has now occurred in several ponds.

In conjunction with road underpasses to enable movement between habitat areas, over 5 km of special "frog-fencing" has been installed around habitat areas, in order to deter frogs and other wildlife from crossing busy roads and to discourage people from wandering into some areas.

The conservation efforts of OCA in terms of frog habitat creation and the development and implementation of the Frog Management Plan for the Green and Golden Bell Frog were recognised in 2000 when OCA was awarded the prestigious national environmental 2000 Gold Banksia Award and the 2000 Banksia Award for Flora and Fauna.

Water Management - WRAMS

Water management has been a key component of ecologically sustainable development throughout the planning, development and operation of Sydney Olympic Park. The Water Reclamation and Management Scheme (WRAMS) is the main wastewater strategy for Sydney Olympic Park and is the largest scheme of its type in Australia.

A dual water reticulation network has been installed throughout the site, made up of separate potable and reclaimed water mains, to serve all new venues and Newington (village) housing. A water treatment plant has been installed to purify all reclaimed water, including stormwater collected at Homebush Bay and treated sewage.

Work commenced on the WRAMS project in 1999 and the system was commissioned and operational prior to the Sydney 2000 Olympic Games. WRAMS was connected to the residential suburb of Newington in April 2001.

WRAMS is designed to save up to 850 million litres of potable water annually and substantially reduce sewage discharge to Sydney's waterways. In the long term WRAMS will halve the use of potable water at Sydney Olympic Park and the neighbouring suburb of Newington. Reclaimed water is being used for irrigation and toilet flushing.

WRAMS is an excellent example of how environmental innovation has enabled significant conservation of water, our most precious resource. The environmental legacy value of WRAMS was recognised with the awarding of the prestigious 2001 Banksia Award (Infrastructure and Services category).

The WRAMS development at Sydney Olympic Park demonstrates that large scale and complex works can be delivered in an environmentally sensitive manner with community participation as a cornerstone.

As Australia's first large scale urban water recycling scheme, WRAMS provide information, under real usage conditions, to demonstrate the viability of urban water recycling and to encourage the improvement of water management in urban development locally, nationally and internationally.

Irrigation

Most of the irrigation needs for the Millennium Parklands are met by a water harvesting and reuse system, supported by WRAMS. A series of freshwater wetlands has been constructed as part of the remediation work of the Haslams Creek area. The freshwater wetlands collect the stormwater from Olympic Plaza, adjacent venues and areas, including Newington, in specially designed water storage ponds (the largest of which is located at the northern end of Olympic Boulevard).

The ponds are designed to catch the "first flush" of stormwater and allow the sediment to settle. Native freshwater plants absorb nutrients and lower the levels of suspended particles in stormwater. When integrated with the WRAMS program and other water pollution control measures, these ponds reduce sediment and nutrient loads by up to 90%. This water is then reused throughout the Parklands for irrigation. Drainage swales throughout Millennium Parklands control the stormwater collection and dispersion while solar powered pumps move the water through the reticulated irrigation system.

The water quality ponds also create important wetland habitats for birds and aquatic fauna, including the endangered Green and Golden Bell Frog.

ESD principles have also been incorporated into water saving landscaping practices. Engineered soils, permeable pavers and porous gravel - especially in pedestrian areas - provide for the best possible tree growth, as well as reducing stormwater run-off and the need for irrigation.

Low volume irrigation systems are in place across Homebush Bay. In some areas, more than one type of irrigation system is used in the same area to reduce water consumption. One example of these flexible watering practices is at the southern end of Olympic Boulevard, where one irrigation system waters the root zones of the Hoop Pines while the another waters the turf surrounding the trees.

Drought-tolerant Australian native plants have been used at all Olympic venues.

Specially designed roof rainwater collection systems have been installed in Stadium Australia to provide water for irrigation. At the Sydney Showground and Exhibition Complex

roof rainwater systems provide water for irrigation and toilet flushing. Such systems not only conserve water, they also reduce the pressure of stormwater run-off into waterways.

OCA has been recognised nationally for its integrated approach to water conservation and water management practices across Sydney Olympic Park. In 2001 OCA was awarded the Australian Water Association 2001 – Water Environment Merit Award for integrated water cycle at Sydney Olympic Park. In 2000 OCA won the State Government category RiverCare 2000 award for water management at Homebush Bay. OCA also won the Stormwater Industry Association Award 2000. In 1999 OCA was awarded the RiverCare 2000 award for stormwater management.

Energy Conservation Practices

OCA's commitment to energy conservation is evident in the broad array of built structures at Homebush Bay and other Olympic sites, encompassing a diverse variety of energy efficient building designs and technologies. The entire site serves as a physical demonstration of how a strong commitment to energy conservation has been realised in terms of its supply, management and use.

Photovoltaic Towers

The striking 30 metre high photovoltaic towers on Olympic Boulevard provide a dramatic example of sustainable energy and were seen by up to 280,000 people per day during Games Time. The photovoltaic collectors used on the towers were developed by the University of New South Wales (UNSW) and manufactured by BP Solar. UNSW is a world leader in solar technology and therefore the towers not only promoted the use of sustainable energy but also Australia's contribution and excellence in this area.

Each tower has a generating capacity of 23 Kilowatt hours (kWh) per day, equivalent to the amount of energy used to power a small house. The power is fed into the main grid during the day and drawn from the grid at night. When all 19 towers are operating they can produce approximately 160,000 kWh of energy each year, equivalent to their estimated annual energy consumption.

Olympic Park Station

Olympic Park Station and its connecting rail link located in the heart of Sydney Olympic Park were opened in 1998. The rail infrastructure reflected OCA's commitment to promote and maximise the use of public transport as the primary means of transport to the site. The station moved crowds of up to 50,000 passengers per hour in peak periods during the Games.

Sydney Showground Complex

The design and orientation of the Sydney Showground maximises natural light and ventilation and is another example of integrated energy efficient technology. Where artificial lighting is required, carefully positioned energy efficient lights are used in combination with light sensors, photosensitive switches, luminaries and reflectors, greatly reducing energy consumption.

Natural ventilation is the preferred mechanism for controlling the ambient air temperature inside the Pavilions and exhibition halls. Exhibition Halls (2, 3 and 4) are completely naturally ventilated via inlet louvres at the ground level, ventilation channels in the floor and outlets in the apex of the roof. All the exhibition halls have roof and wall insulation. Exhibition Hall 1 is the only hall to utilise air conditioning via a displacement system, which is designed to direct air only to the occupied zones (dramatically reducing the total volume of conditioned air). The use of these energy efficient technologies results in an estimated energy saving of

approximately 20% reducing carbon dioxide (CO₂) emissions by approximately 1750 tonnes per year.

Athletes Village - Newington

The Athlete's Village at Newington, developed by Mirvac Lend Lease Village Consortium (MLLVC), is one of the largest solar powered suburbs in the world (capacity to generate over one million kWh of power each year). All 665 dwellings built before the Olympic Games had roof mounted solar cells with power generated being fed into the grid. The photovoltaic panels generate approximately the same amount of energy over a year, as each permanent household consumes.

Design features of the permanent dwellings include:

- Orientation of houses and placement of windows to maximise solar penetration in winter and minimise in summer.
- Wall and ceiling insulation
- Cross ventilation and ventilated roof spaces for indoor thermal comfort
- Gas cooking appliances and gas boosted hot water systems (in each single lot dwelling)
- Installation of skylights to maximise natural light
- Vertical overhangs on windows facing east or west
- Vegetation positioned and selected to maximise solar penetration in winter while providing shade in summer

These features combined with the installation of '5-star' energy efficient devices, are estimated to halve the non-renewable energy consumption compared to standard project housing.

Sydney SuperDome

Sydney SuperDome achieved outstanding results in the application of the principles of ESD and was awarded the 1999 Banskia Environmental Foundation Award for Construction Practices. This facility was developed with a comprehensive and innovative approach to sustainability. During the demolition and construction phase a recycling rate of over 90% was achieved.

SuperDome installed A 70kW photovoltaic power plant capable of generating 87,000 Kwh per annum on the roof of the warm up court. The power plant feeds energy back into the grid and is the largest of its kind in Australia.

SuperDome purchases 100% of its power requirements from renewable energy sources through Energy Australia's 'Green Power Scheme', giving the SuperDome a near zero 'greenhouse effect' impact in terms of its energy generation. 'Green Power' is a scheme that guarantees that no less than 10% of power comes from pure energy sources such as solar, wind or biomass and 90% from hydroelectric.

Other sustainable strategies included:

- Roofing insulation developed from recycled materials such as telephone books
- A microclimate air conditioning system that delivers air as close to the patron as possible rather than air conditioning the entire seating bowl. The spill air from the bowl area is used to cool the public concourse areas and thermal mass storage,

night flush and demand controlled ventilation is used to minimise air conditioning energy usage.

- A building design that maximises the use of natural light. Where artificial light is needed high performance efficient lighting is used via a sophisticated remote controlled 'use specific' system.

These design initiatives combined with '5-star' energy efficient appliances are estimated to achieve a 65% reduction in energy expenditure.

Stadium Australia

The Stadium is a superb example of sustainable development. All materials were selected following a detailed life cycle assessment with an emphasis on low embodied energy. Part of the Stadium's energy requirements was provided by two gas cogeneration units which were estimated to save an estimated 500 tonnes of CO₂ emissions annually. Excess heat generated by the cogeneration process is used to heat water. The Stadium is another venue committed to sourcing 100% of its energy requirements through Energy Australia's 'Green Power' scheme.

Natural lighting is maximised by the use of translucent roofing, 'light scops' and light wells. Energy efficient light sensors are used for evening illumination or where the natural lighting does not meet requirements. The lighting system has reduced energy requirements by 20%.

Oversized lift shafts, stairwells and escalator voids provide a flow path for warm air while drawing cool air from the edge of the building. The use of air conditioning has been minimised with Levels 1 and 6 completely naturally ventilated. The lounge area located on Level 2 is cooled through passive ventilation and Level 4 is a mixture of passive and mechanical ventilation. The passive ventilation system has reduced the air conditioning demand by approximately 40%

Hotel

The hotel complex at Homebush Bay developed by MLLVC has established new ESD standards for high rise hotel accommodation. The hotel's management has formed an innovative partnership to promote the work of the World Wide Fund for Nature (WWF). The hotel also purchases 100% 'Green Power', saving an estimated 1200 tonnes of CO₂ emissions annually.

The hotel has one of Australia's largest solar hot water systems, consisting of more than 400m² of solar collectors.

Energy efficient design features include external shading of north, east and west orientated windows. The windows (manufactured from recycled glass) are linked to the air conditioning system that automatically shuts off when a window is opened. The use of energy and water efficient devices has been maximised wherever possible and will contribute to an estimated annual reduction in the hotel's energy saving of approximately 40% (compared with traditionally designed hotels).

Sydney Aquatic Centre

The Sydney Aquatic Centre maximises the use of natural light through its building design. A transparent strip in the roof directs natural lighting over the competition pool and reduces glare. The leisure area is predominantly lit in daytime through panels in the roof and by energy efficient lighting at night.

Ventilation of the facility is provided via an energy efficient microclimate air conditioning system that keeps warm air at pool level around the athletes and provides a cool envelope of

air around the spectators. The introduction of cool air through slots in the grandstand has reduced the volume of artificially cooled air by approximately 80%.

Waste Management and Minimisation

Waste management and minimisation was an important component of OCA's environment strategy. OCA developed highly innovative practices based on reducing and recycling waste, both during construction and the operation of venues and facilities. The 'reduce, reuse, recycle' or 3R philosophy was the basis of the waste management strategy implemented at Sydney Olympic Park. The waste management strategy specified that the creation of waste is best avoided or reduced at the point of generation; remaining waste should be re-used or recycled wherever possible; and disposal to landfill should be minimised as far practicable. OCA developed the Construction and Demolition Waste Guidelines which recommended the use of recycled materials and sought to reduce waste throughout construction. It also required designers and contractors to minimise the use of materials that create pollution in their manufacture, use or disposal. These requirements saw an overall construction waste recycling average of 60%. Average construction waste recycling rates for specific venues; the Sydney SuperDome, Showground and the Athletes' Village were 98%, 95% and 94% respectively. Wherever possible, recycled materials were incorporated into the roads, infrastructure, buildings and fittings of Olympic venues. Vast quantities of excavated rock and earth were crushed, stockpiled and recycled for use in developments that required fill. About 112,000 tonnes of sandstone from city sites have been used at the Homebush Bay site.

Nearly 220,000m³ (or 5,600 tonnes) of recycled crushed concrete have been used as road base. Approximately 40,000m³ of excavated soil was used to create embankments at the Athletic Centre. The Northern Water Feature at the end of Olympic Boulevard reused rocks from dismantled walls.

At the Lidcombe Media Village, timber, glass, bricks, concrete, steel and other materials have been recycled or reused, following demolition of some buildings. Recycled fly ash concrete was used during the construction of the water channel at the Penrith White Water Stadium.

Throughout the development of the Olympic venues and facilities, construction waste was minimised through careful ordering and agreements with manufacturers to minimise packaging. Mulch produced by processing vegetation wastes was used around new plants to help reduce water loss, and tree prunings were chipped and recycled. The recycling of building materials, paper, cardboard, PET, aluminium, glass and green waste introduced during construction will continue throughout the life of the venues at Sydney Olympic Park. Waste disposal bins and recycling facilities are widely available, colour-coded and signed to provide for prompt recycling of mixed recyclable, compostable materials and general waste.

The waste management strategy addresses waste created by operating venues, encouraging maximum recycling by both operators and the public. There is also a strategy to manage green wastes from landscape activities.

Sustainable Development – Relevance to Industry

The Sydney 2000 Olympic and Paralympic Games provided an ideal opportunity for Australian industry to showcase ESD best practice. Many of the tenderers went beyond the criteria of the *Environmental Guidelines*; with innovative and exciting solutions exceeding conventional construction practices. This response clearly demonstrates that OCA's framework for the integration of ESD successfully communicated to industry the premium placed on superior and sustainable environmental performance.

OCA's environmental framework, in particular the competitive ETS process – challenged industry to integrate ESD as a core component of the commercial investment in the project. OCA reiterated to proponents that the commitment to ESD must be demonstrated throughout the planning, development and operational phases. Tools such as life cycle analysis, OCA's required chain of custody processes for timber selection, and other materials selection based on energy efficiency and water conservation revealed a number of emerging environmental technologies that may not have been used were it not for OCA's environmental framework.

Post Games, there are significant commercial opportunities for planners, architects, developers and industry to further develop and market sustainable alternatives and surpass the environmental and technological benchmarks established at Sydney Olympic Park.

The 'human' environmental legacy from the Games is the knowledge of sustainable alternatives that the people involved in the delivery and/or operation of Games Time infrastructure can apply to future projects/developments. For example:

Sydney 2000 Workforce (OCA, SOCOG, ORTA, OSCC) applying ESD to future planning, system and project management, waste management and transportation management skills

State Planning and Regulatory Authorities

- Considering opportunities to apply the planning tools and experiences of Sydney 2000 to future developments.
- Developing a tailored version of the Environmental Guidelines.
- Developing flexible regulatory approaches to maximise sustainability at a reduced cost

Architects (Building and Landscape)

- Promoting the integration of sustainability as a competitive advantage for projects
- Researching building materials (eg: life cycle analysis, eco-ratings) to provide sustainable options that may deliver significant cost savings and performance over the life of new developments

Business/Industry groups

- Sourcing and marketing sustainable products to wider domestic and international markets
- Drawing on the Games Time experience as an example of why/how more sustainable products and services can be successfully used by other client groups

Environmental groups

- Providing advice to future developments which draw on the experiences of Sydney 2000
- Working cooperatively with the event organiser/developer to communicate the environmental technologies and broader environmental legacies to the community.
- Providing ongoing information to the community about emerging and innovative environmental technologies.

Site project managers and construction workers

- Knowledge of and familiarity with the use of alternative (and more sustainable) materials

- Recognition of the need to reduce construction and demolition waste on future work sites.

Future event sponsors and/or event suppliers

- sourcing and promoting more sustainable products/services for future events, capitalising on a competitive market advantage through promotion of sustainable business operations.
- working in partnership with future event organisers to promote messages of sustainability as a part of the corporate image of the sponsor/event organiser.

The extent to which innovative building design, materials selection and the protection of biodiversity becomes a core business component of future development is largely consumer driven. To that extent, it is beholden on all members of the community to question current building design, construction and operation practices and compare them with established and emerging sustainable alternatives.

Without legislative requirements and consumer pressure, the change to more sustainable development practices will be slow.

Conclusion

OCA worked diligently to achieve results that have surpassed the environmental accomplishments of not only previous Olympic Games, but also large-scale events or developments of any kind. These efforts were internationally recognised by the Earth Council who firmly endorsed OCA's environmental management and concluded that the Sydney 2000 Summer Olympic Games has set the environmental benchmark for future Games.

Arising from the Games Time experiences, the *Sydney 2000 Olympic and Paralympic Games Environmental Benchmarks – Guidelines, Achievements and lessons for environmentally sustainable building and events* was launched in March 2001. This document provides goals that can inspire planners, developers and the community and contains valuable examples to assess the environmental qualifications of projects.

In June 2001 on World Environment Day, the United Nations Environment Program (UNEP) awarded both OCA and SOCOG its prestigious Global 500 Award for environmental excellence. This high profile international award recognised Sydney 2000's commitment to ecologically sustainable development, which set benchmarks in the areas of energy, water conservation, waste minimisation, pollution avoidance and protection of the natural environment.

The Sydney Olympic Park Authority was established in July 2001 and is now the statutory authority responsible for Sydney Olympic Park and Millennium Parklands (including Bicentennial Park). The Sydney Olympic Park Authority Act (2001) requires consideration for the principles of ESD in carrying out any of the functions of the Authority and consideration of the *Environmental Guidelines for the Summer Olympic Games*.

Consistent with these commitments, the masterplanning process (currently underway) for future development at Sydney Olympic Park places a high premium on the Authority's commitment to the principles of ESD. To deliver on this important challenge, the Sydney Olympic Park Authority is building on the environmental framework established by OCA which will include the following elements;

- Environment Policy/Strategy;

- Revised Environmental Management System that will incorporate environmental tender specifications, environmental training;
- Comprehensive environmental communication strategy; and
- Development of potential environmental education/research opportunities.

The environmental legacies evident at Sydney Olympic Park are a strong testament to the benefits of an integrated approach to ESD as a model for long term sustainable planning and management strategies. This holistic approach to ESD will continue under the Sydney Olympic Park Authority and will ensure that future developments at Sydney Olympic Park continue to 'raise the bar' in terms of environmental innovation and sustainable management in all aspects of their design, construction and operation.

Appendix 1

EARTH COUNCIL REVIEW #4: SCORECARD

Fulfilment by OCA of Environmental Guidelines - January 2001

Note: The following table provides ratings of the actual performance of the OCA as of January 2001 on issues for which it was primarily responsible. Where the OCA was not responsible it is noted.

COMMITMENT	RATING (1 -10)	COMMENTS
A. Planning and Construction of Olympic Facilities		
1. Assess opportunities to adapt existing facilities; consider financial viability of new facilities	9	
2. Building and infrastructure design; consider environment	9	
3. Environmental/social assessment; community participation in planning process	8	
4. Planning to minimize impact on residents	9	
5. Protection of bushland, forest, wetlands, ecosystems	9	
6. Accordance with Environmental Planning and Assessment Act	10	
7. Preference for used industrial/commercial sites	9	
8. All sites accessible by public transport	10	
9. Scrutiny of companies tendering for construction	9	
10. Life cycle costing and impact assessment of building components	8	
B. Energy Conservation		
1. Ferry transport between Olympic Park and harbour zone	9	
2. Satellite parking at major bus and rail interchanges	9	
3. Cycle and pedestrian paths linked to public transport	8	
4. Passive solar building design	9	
5. Selection of materials for thermal performance	9	
6. Use of insulation and natural ventilation	9	
7. Widest possible use of renewable sources of energy	8	
8. High-efficiency lighting, with maximized natural light	9	
9. Use of energy-efficient appliances	9	
10. Use of recycled and recyclable building materials	9	
11. Building management/control systems to conserve	9	
12. Capacity to shut down ventilation during idle time	9	

COMMITMENT	RATING (1 -10)	COMMENTS
C. Water Conservation		
1. Encourage sound water management through public and industry education programs	9	
2. Water conservation and recycling practices	10	
3. Introduction of real cost pricing practices	-	Beyond scope of OCA
4. Recycling of treated storm water and sewage effluent	10	
5. Landscape design that decreases water requirements	9	
6. Water conservation and appropriate irrigation	9	
7. Selection of water-conserving appliances	9	
8. Building and infrastructure design to collect waste water for recycling	9	
9. Protecting recycled water quality by minimizing use of pesticides	9	
10. Use of appropriate pollutant removal prior to recycling of waste water	9	
D. Waste Avoidance and Minimization		
1. Application of best practice waste reduction to services, materials and appliances (with performance criteria)	9	
2. Co-operation with sponsors and contractors to develop purchasing and waste management policies	8	Yes, in regard to construction. SOCOG responsible during Games
3. Best practice recycling, composting, public education	8	
E. Air, Water and Soil Quality		
1. Selection of non-toxic materials/processes	8	
2. Improved procedures to minimize toxic fume emission and out-gassing	9	
3. Building techniques/design to minimize need for chemical pest control and aid integrated pest management	9	
4. Avoid CFC/HFC/HCFC in refrigeration and processes	7	Some HCFCs and HFCs in use.
5. Elimination of leaded fuels	10	
6. Minimizing and ideally avoiding chlorine-based products	8	
7. Controls to protect water quality of mangrove, estuarine and saltmarsh environments near Sydney Olympic Park from construction activity	9	
8. Comprehensive contamination testing of former industrial sites, with remediation and risk-reduction programs	9	

COMMITMENT	RATING (1 -10)	COMMENTS
F. Protecting Significant Natural/Cultural Environments		
1. Preservation and protection of integrity of natural ecosystems adjacent to Olympic sites	8	Crest of Bankstown Criterium Track a weak point
2. Assessment of habitat and species	9	
3. Low-impact and appropriate landscape programs	9	
4. Rehabilitation of wetlands	9	
5. Control of feral animals and weed invasion	9	
6. Buffer zones between venues and conservation areas	9	
7. Management for protection of natural ecosystems	9	
8. Use of low-wash ferry transport to protect mangrove	10	
G. Olympic Events		
1. Assist business to conform to Olympic requirements by establishment of a multi-sectoral panel	8	
2. Investigate opportunities to provide a database on new technologies suitable for use at the Olympic Games	8	OCA, SOCOG and Environment Australia published useful material but no database
H. Merchandising		
1. Merchandise tenderers required to provide information on life-cycle impacts	5	SOCOG responsibilities
2. Avoiding waste from non-durable goods and packaging	8	SOCOG responsibilities
3. Not using materials from threatened environments/species	9	SOCOG responsibilities
4. Maximum use of recyclable and recycled materials	7	SOCOG responsibilities
5. Promotional clothing made from natural fibres	3	SOCOG responsibilities
6. Embodying educational message in design and packaging of products	3	SOCOG responsibilities
I. Ticketing		
1. Tickets integrating event admission with public transport	9	ORTA/SOCOG responsibilities
2. Tickets printed on recycled and recyclable paper using non-toxic ink	8	SOCOG responsibilities
J. Catering		
1. Minimal packaging of foodstuffs subject to health standards	9	SOCOG responsibilities
2. Use of recyclable or reusable packaging	9	SOCOG responsibilities
3. Non-disposable cutlery and crockery wherever possible	9	SOCOG responsibilities

COMMITMENT	RATING (1 -10)	COMMENTS
K. Waste Management		
1. Minimizing waste and maximizing recycling	8	
2. Education of athletes, officials, media and spectators on correct waste disposal	8	
3. Recyclable packaging suitably identified to facilitate separation from other recyclables and assist collection	7	
4. Recycling bins at all venues, supported by education	8	
5. Electronic information transmission wherever possible, supported by effective paper recycling	9	
6. Special procedures for recycling/disposal of chemicals, film and other photographic materials	9	
L. Transport		
1. Implementation of transport strategies to ensure efficient movement	9	
2. Selection of transport systems which minimize energy use and pollution	8	Bus fleet heavily reliant on existing diesel fleet; status quo car fleet
3. Direct spectator access to major Olympic sites by public transport only	9	
4. Satellite car-parking established to facilitate transfer to public transport	9	
5. Special concession transport tickets available for spectators	10	
6. Public transit and admission tickets sold at same outlets	8	
M. Noise Control		
1. Adoption of noise abatement techniques	9	
N. Other Considerations		
1. Venue accessibility for disabled	9	
2. Crowd management training	9	
3. Adoption of equal opportunity principles	10	