Integrated Pest Management Strategy for Sydney Olympic Venues

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1 Introduction

Integrated Pest Management is an approach to pest management that considers the biological and ecological requirements for pest populations to proliferate. There are numerous definitions for IPM which vary according to the perspective of the person defining the concept. Integrated Pest Management can be generally defined as:

> *A pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below threshold levels* (Gips, 1990)

Integrated pest management programs also emphasise that chemical pesticides must be viewed as the last option for control within a management program rather than the first.

The relevant aspects of Olympic Guidelines that relate to pest management clearly indicate the commitment by Olympic organisers to minimise or eliminate the use of chemical pesticides at Olympic venues. This intention reflects a growing recognition that chemical pesticides can cause harm to the environment and impact on human health.

The *Environmental Guidelines* indicate a specific requirement to establish integrated pest management (IPM) as the preferred method of pest control for Olympics venues. This direction provides significant opportunities for developing innovative pest management strategies for a diverse range of urban environments. The successful adoption of IPM at Olympic venues will provide a benchmark for the future of urban IPM in Australia.

The range of pest problems in Olympic venues, which encompass both indoor and outdoor spaces, are likely to be diverse and of varying intensity depending on the venue, its maintenance regime, use pattern and physical surrounds. The opportunity for venue design elements, which minimise the development of pest infestations is appropriate in purpose built venues. Existing facilities have limited options for 'designing out' pests, however if they are to be modified prior to the Olympics, this may provide an opportunity to incorporate design elements and strategies to minimise pests.

2 Scope of these guidelines

A major challenge for Sydney Olympic authorities, tendering organisations and contractors is to develop and maintain facilities in an ecologically sustainable manner. The objectives for these guidelines is therefore to provide a starting point for contractors, specifiers, designers, building managers and users of Olympic facilities to address pest management as an integral part of sustainable facility design, construction, maintenance and use.

Green Games Watch 2000 is a coalition of major environment groups working towards achieving an environmentally responsible Sydney Olympic Games. In commissioning this document, Green Games Watch 2000 requested guidelines which would:

- raise awareness of Olympic authorities, developers, sponsors, merchandisers and service providers of their broader responsibilities in relation to non-chemical pest control;
- assist with the implementation of commitments to non-chemical control of pests in indoor and outdoor Olympic environments; and,
- be consistent with the commitments outlined in the *Environmental Guidelines for the Summer Olympics Games* and *Homebush Bay Development Guidelines: Environment Strategy* and *Homebush Bay Development Guidelines: Landscape Strategy*.

It is beyond the scope of these guidelines to anticipate all the pest management problems that may occur in Olympic venues. These guidelines attempt to provide practical guidance on the framework of, and requirements for, an integrated pest management strategy which emphasises non-chemical options to

accommodate the wide range of pest management situations at Olympic venues.

The guidelines also aim to raise the awareness of sponsors, merchandisers and service providers to their broader responsibilities in relation to requirements for non-chemical and integrated pest management as specified in the *Environmental Guidelines* for the Olympics. Useful resources on integrated pest management, in addition to cited literature, have been included to further guide the reader.

2.1 Olympics indoor venues

2.1.1 Venues to be used for indoor sports during the Sydney Olympics include:

Aquatic Centre, Homebush Bay [Swimming, Diving, Synchronised Swimming, Water Polo];
Convention Centre, Darling Harbour [Weightlifting];
Entertainment Centre, Darling Harbour [Basket ball];
Exhibition Halls, Darling Harbour [Boxing, Fencing, Judo, Taekwondo, Table Tennis];
Multi-useArena, Homebush Bay [Gymnastics];
Velodrome, The Crest, Bankstown [Cycling];
Sydney Showground Pavilions, Homebush Bay [Handball, Volleyball, Badminton; Basketball, Rhythmic Gymnastics];

State Sports Centre, Homebush Bay [Fencing, Wrestling] (OCA, 1996)

Other significant indoor venues include:

Athletes' Village, Newington (adjacent to Homebush Bay);
Lidcombe Hospital [Media Village];
Multi-storey carpark, Homebush Bay
Underground Railway Station, Homebush Bay; (OCA, 1996)

as well as offices, including demountable temporary offices, shops, cafes, amenities, changing rooms, training rooms and other enclosed areas in otherwise outdoor sports venues.

2.2 Olympics outdoor venues

2.2.1 Venues to be used for outdoor sports during the Sydney Olympics include:

Rushcutters Bay, Rushcutters Bay Park & Yarranabbe Park [Yachting]
Regatta Centre, Penrith Lakes [Canoeing, Rowing, White Water Rafting and kayaking]
Equestrian Centre, Horsley Park [Equestrian]
Eastern Suburbs, including Centennial Park, Moore Park and Queens Park [Road Cycling];
North Sydney to Botanic Gardens to Centennial Park to Rozelle Hospital to Iron Cove foreshore to Canada Bay to
Homebush Bay [Marathon];
Sydney Harbour, Opera House, Botanic Gardens and Domain [Triathlon];
Bondi Beach [Beach Volleyball];
Hindmarsh Stadium in Adelaide, Brisbane Football Stadium, Sydney Football Stadium & others;
Main Stadium, Homebush Bay [Football, Athletics];
Bicentennial Park, Olympic Park [Modern Pentathlon];
Shooting Centre, Cecil Park [Shooting];
Softball Centre, Blacktown [Softball, Baseball];
Fairfield City Farm [Mountain Bikes];
State Hockey Centre, Homebush Bay [Hockey];
Archery Centre, Homebush Bay [Archery];
Tennis Centre, Homebush Bay [Tennis]

Other significant outdoor venues include: Millennium Park [environmentally sensitive recreation area]

2.3 Methodology

To assess the current status of integrated pest management strategies and how they may best apply to the Olympics, literature from technical texts and reputable websites in the field were consulted. Representatives from pest control organisations, leaders in the field of applied urban integrated pest management in Australia, were also consulted.

Interviews were held with property management personnel at existing venues where Olympic events will be held to determine current pest management practices. A phone survey of Olympic sponsors was undertaken to ascertain if there are any requirements for integrated pest management in existing company environment policies.

A review of OCA's draft *Integrated Pest Management Manual* provided a basis for developing a priority list of actions for the implementation of a comprehensive integrated pest management strategy for the Olympics.

3 Recommendations & actions for implementation of an Olympics IPM strategy

The development and implementation of an integrated pest management strategy for the broad range of venues and conditions associated with the Olympics, and their uses post Olympic events, requires significant planning, co-ordination, research and the allocation of resources to ensure commitments made in the *Environmental Guidelines for the Summer Olympic Games* are realised.

In order to implement an effective IPM strategy, it is ideal that pest management be considered during the early stages of the planning process, where there are opportunities to design structures or landscapes (or retro-fit existing ones) that minimise pest susceptibility and reduce the need for chemical pesticides. Pest management must also be considered alongside other initiatives to improve and protect air, water and soil quality and in efforts to minimise the chemical load in general. Pest management is a significant factor for consideration in the maintenance of good indoor air quality and in providing ecologically sustainable outdoor spaces for the community. Decision making processes concerning pest management should be based on ESD principles and involve the community where appropriate.

To follow are recommendations for consideration in the development of a comprehensive Olympic IPM strategy and a priority list of actions for implementation. The priority list of actions were largely derived from OCA's Draft *Integrated Pest Management Manual*, with modifications to broaden the scope of actions to include the broad range of pests that may be encountered at Olympic venues.

3.1 Recommendations

That consideration of integrated pest management strategies constitutes a design input for the construction of new Olympic venues and existing venues that are to be refurbished prior to the Olympics.

The *Environmental Guidelines* are committed to "the use of building techniques and interior design that minimise the need for chemical pest control and maximise opportunities for integrated pest management".

IPM should ideally be considered in the designing of structures or landscapes to essentially 'build out' favourable environments for pests to proliferate in. For venues that are already built there are limited options. However, this does not negate the possibility of retro-fitting or modifying existing structures to reduce their susceptibility to pest infestations.

That integrated pest management consultants develop integrated pest management strategies for the full spectrum of potential pest management situations at Olympics venues.

It is beyond the scope of these guidelines to provide detailed IPM strategies for all potential pests at Olympic venues. In order to develop detailed IPM strategies for Olympics venues, site inspections by trained IPM consultants need to be carried out and appropriate strategies devised to meet *Environmental Guidelines* requirements.

That non-chemical controls are given the highest priority within the Olympics integrated pest management strategy.

Official environmental guideline documents for the Sydney Olympics require the implementation of integrated pest management strategies which emphasise non-chemical controls. Integrated pest management strategies do not necessarily negate the use of chemical controls, but often incorporate them as a last resort. In order to give non-chemical controls the highest priority in the Olympics IPM strategy, these requirements need to be made explicit in tender documents and briefs issued by OCA, SOCOG and other organisations responsible for the delivery and operation of Olympic venues.

That pest control companies must bid for contracts on the basis that chemical pesticides are the last option for pest management in Olympics facilities and demonstrate that they can provide integrated pest management strategies and services.

To ensure that pest control companies are able to provide IPM services, with an emphasis on non-chemical control methods to meet *Environmental Guidelines* requirements, OCA and SOCOG should clearly specify these requirements in tender documents and contracts.

That a 'Code of Practice for the Safe Use of Pesticides' forms the basis on which chemical pesticides are chosen and used within the Olympics integrated pest management strategy.

The decision to choose and use a chemical pesticide should not be based solely on the acute toxicity of the active constituent of a pesticide formulation. Where it is deemed appropriate within the context of the Olympic IPM strategy that a chemical pesticide be used, the least hazardous chemical formulation and application method suitable for the situation should be chosen. A 'Code of Practice for the Safe Use of Pesticides' could form the basis of information on which decisions about chemical formulations and applications methods are chosen. (See Appendix A)

That in existing venues to be utilised for Olympic events, SOCOG undertakes negotiations with venue property managers well in advance of the event dates to establish the requirement for integrated pest management.

Certain Olympic events will take place in existing venues where pest control programs are already established. A survey of current pest control practices would reveal if programs meet the requirements specified in the environmental guideline documents. Where programs do not comply with guideline requirements, SOCOG should ensure appropriate changes are implemented in advance of the Olympic events to be held at the existing venue.

That integrated pest management strategies are adopted at Olympic venues throughout the duration of the Games and become part of the operating manuals for all post-Olympics facilities - public, commercial and residential.

Post-Olympics building management of the Athletes Village, in particular, may be left to the discretion of individual occupants. Occupants need to be made aware that innovative pest management strategies may have been implemented. Operating manuals, written in plain language and written for the non-expert, should therefore be provided for the residential components of the development, for use by Athletes' Village occupants, both during and after the 2000 Olympics. Similar operating manuals, tailored to the needs of building services professionals, and protocols for commercial and public buildings should include information on integrated pest management programs.

That OCA and SOCOG ensure Olympic sponsors and merchandisers are aware of the environmental standards, and requirements for integrated pest management which minimise the use of chemical pesticides, in the manufacture, use and disposal of products and services.

The Olympic guideline requirements to implement IPM and reduce chemical pesticides also extend to those organisations that are sponsors and merchandisers to the Olympics. The SOCOG consumer products environment policy encompasses '…The extent to which it [the product] affects the environment during manufacture, use and disposal…' . This is of particular relevance to industries which currently utilise significant quantities of chemical pesticides in the development of their products which should be taken into account in a life-cycle assessment of the overall impacts of a particular product or service.

3.2 Priority list of actions for implementation

- Survey and record all significant, actual or potential, pest problems at all Olympic venues to identify and evaluate their risks.
- Develop integrated pest management strategies for all significant, actual or potential, pest problems that

occur at all Olympic venues.

- Develop an Integrated Pest Management Policy and Implementation Procedures to promote the exclusion of pests from Olympic venues through non-chemical means.
- Educate and inform all officers, lessees, venue operators and contractors of their pest control obligations as specified in the Environmental Guidelines.
- Ensure the Integrated Pest Management Policy is incorporated into contracts and tender documents for Olympic venue construction, fit-out, use and management.
- Implement procedures to ensure procurement of pest management services and pesticides is consistent with the Integrated Pest Management Policy.
- Investigate non-chemical options for managing pests and initiate trials for broad scale application in Olympic venues.
- Develop a policy to guide chemical control-agent selection and use.
- Develop educational signage and operational manuals to inform all stakeholders about Olympic integrated pest management programs.

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4 Olympics environmental guidelines & pest management requirements

The three environmental guideline documents of most relevance to Sydney Olympic developments and pest management are:

- the Sydney Olympics 2000 Bid's (1993) *Environmental Guidelines for the Summer Olympic Games*;
- the Olympic Co-ordination Authority's (OCA, 1995) Homebush Bay Development Guidelines: Environment Strategy; and,
- the Olympic Co-ordination Authority's (OCA, 1995) *Homebush Bay Development Guidelines: Landscape Strategy*.

4.1 Environmental Guidelines for the Summer Olympic Games

The purpose of the *Environmental Guidelines for the Summer Olympic Games* is to outline the environmental issues the bid organisation considered relevant to the summer Olympic Games and the associated environmental guidelines developed to address these issues (Sydney Olympic 2000 Bid, 1993). The document specifies criteria for sustainable development and outlines how compliance with these criteria shall be demonstrated in Olympics facilities.

In terms of meeting the requirements of the *Environmental Guidelines* for pest control, there is a point of confusion that requires clarification for the purposes of these guidelines. On the one hand the *Environmental Guidelines* require implementation of non-chemical pest control at Olympic sites. In other aspects, however, there are requirements to minimise the use of pesticides and maximise opportunities for integrated pest management.

The basis on which these Guidelines have been developed is for the implementation of integrated pest management with the emphasis on non-chemical controls, leaving chemical pesticides as the last option in any pest management program for the Olympics. Although highly desirable, it is unlikely that totally non-chemical measures will be adequate to manage the range of pest problems that may occur at Olympic facilities given the short time frame in the lead up to the Olympics.

The *Environmental Guidelines* refer to six specific aspects that commit to various elements relating to pesticides and non-chemical pest management.

4.1.1 Water conservation

- Protecting the usability of recycled water by minimising the use of pesticides in landscape maintenance.

4.1.2 Improving air, water, and soil quality

- Improved fit-out and management procedures at Olympic sites to minimise toxic fume emission and out-gassing from paints, carpets, glues and pest control practices;
- The use of building techniques and interior design that minimise the need for chemical pest control and maximise opportunities for integrated pest management;
- Minimising and ideally avoiding the use of chlorine based products (organochlorines) such as PCBs, PVCs and chlorine bleached paper.

4.1.3 Protecting significant natural and cultural environments

- Implementation of non-chemical pest control at Olympic sites; and
- Control of feral animals and weed invasion.

4.2 Homebush Bay Development Guidelines: Environment Strategy

The purpose of the *Homebush Bay Development Guidelines: Environment Strategy* is to interpret the concept of ecologically sustainable development (ESD) for Homebush Bay (OCA, 1995). The document specifies environmental outcomes and associated processes and actions to achieve these outcomes.

The requirements of the *Homebush Bay Development Guidelines: Environment Strategy* have less direct relevance to pest management than the *Environmental Guidelines*. Specific outcomes of key performance areas that broadly encompass pest management activities are:

4.2.1 People and their environment

- That after redevelopment, Homebush Bay offers a high quality of life to those who live or work at the site, and a highly desirable recreation destination.
- In planning open spaces odours and hazards to personal safety should be avoided wherever possible.

4.2.2 Pollution control

- That development at Homebush Bay results in improvement in the quality and quantity of water entering Homebush Bay and the Parramatta River from the site.
- Operators/lessees must provide as part of DAs environmental management plans that demonstrate measures being taken to protect the site. These may cover: chemical herbicides and insecticides, fertilisers, plant species that minimise the need for insecticides, storage of chemicals and paints.

4.2.3 Implementation of ESD

- Decision making processes should effectively integrate both long and short-term economic, environmental, social and equity considerations.
- Decisions and actions should provide for broad community involvement on issues that affect them.

4.3 Homebush Bay Development Guidelines: Landscape Strategy

The purpose of the *Homebush Bay Development Guidelines: Landscape Strategy* is to establish principles for landscape design and management. The guiding principles in the *Environment Strategy* are incorporated into the landscape strategies which include elements such as site development, ESD, species selection and conservation (OCA, 1995).

The *Landscape Strategy* refers to the following actions that are relevant to pest management activities:

4.3.1 Landscape design principles

- Establish a register of landscape assets and constraints as a design aid for use by developers and consultants including significant ecological zones, existing tree surveys, conservation areas.
- Ecologically sustainable landscape design and development.
- Development of rehabilitation program of the conservation areas including Plans of Management and strategies for on-going weeding, planting, clearing of buffer areas.
- Landscape design proposals should incorporate use of ecologically sustainable treatments and materials within the bounds of safety, economy and life cycle such as: use of plants suited to site conditions to minimise irrigation, fertiliser and pesticide use.

4.3.2 Landscape management and maintenance

- The OCA requires a standard operational manual that will be prepared by consultants for each landscape package. This will provide for maintenance within contracts and on-going maintenance requirements.
- The OCA will develop detailed guidelines in the form of performance indicators for the maintenance requirements of the various landscape precincts and zones. Consultants will be required to show how these have been met.
- Best practice outcomes will be considered and particular areas nominated for monitoring. The areas should include but not be limited to horticultural practices.

4.3.3 Landscape Principles for the 3 key areas

- Develop management plans for the protection of conservation areas that will cover items such as total catchment management, including pollution and weed encroachment.
- Develop an education program to promote better understanding of the conservation areas at Homebush Bay and their functional requirements.

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5 Why reduce chemical pesticides?

The emergence of DDT before World War II changed the nature of pest control from one of an essentially integrated nature to an industry that relied almost entirely on synthetic chemical pesticides. The dependence on pesticides for the majority of pest control activities still exists today. The effectiveness of DDT, and the generations of pesticides that followed, has greatly limited research and development of other less-toxic methods of pest control, particularly biological controls.

The effectiveness of many chemical pesticides has been reduced through over use and the subsequent development of pest resistance, pest resurgence and secondary pest outbreaks due to the destruction of natural predators. For pest managers who rely solely on chemical pesticides, the issue of pest resistance, resurgence, and the detrimental impacts on natural predators, as well as the spiralling costs of modern chemical pesticides, are significant limitations to the chemical management of pests. From a broader environmental perspective, the development of resistance to chemical pesticides has led to the development and reliance on new chemicals, perpetuating the 'chemical treadmill' associated with chemically managing pests.

Pollak (1993) reports, that the production of chemicals, of which pesticides are a significant component, has increased at an exponential rate since World War II. It has been estimated that between 50,000 – 100,000 chemicals are now in common use. The earth's 'natural' toxic compounds have been present in the biosphere for thousands of years. The addition of a significant number of synthetic, 'unnaturally' occurring chemicals has tipped the scales, so that the level of synthetic chemical mixtures are now at an all time high.

Rachel Carson in her revolutionary book, *Silent Spring*, raised concerns about the impacts of synthetic pesticides over thirty years before many had anticipated the magnitude of the problems evident today. The following quote captures the essence of the growing concern over pesticides: "For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals from the moment of conception until death. The public must decide whether it wishes to continue on the present road, and it can do so only when in full possession of the facts".

The recent publication of *Our Stolen Future: how man-made chemicals are threatening our fertility, intelligence and survival* (Colburn *et al,* 1996) has provided another pivotal point in the growing awareness about the impacts of pesticides on human health and the environment. The authors link declining male sperm count and the sharp rise in hormone-related cancers in women in recent decades to the exposure to endocrine disrupting chemicals, including some commonly used pesticides. The authors warn: 'Never assume a pesticide is safe. Anything designed to disrupt living organisms-plant or animal- may also prove harmful to humans or other animals in unexpected ways'.

The legacy of pesticide manufacture, use and disposal, is the contamination left behind in the air, soil, water and organisms that have been exposed during the life-cycle of a pesticide. Chemical contamination, including pesticide contamination, is an issue of direct relevance to Olympic authorities who must address serious soil and water contamination at Homebush Bay. If the Olympics are to leave behind a positive environmental legacy, authorities have a significant opportunity to break the dependence on chemical pesticides by adopting integrated pest management strategies for Olympic venues.

5.1 Human health impacts

Exposure to pesticide formulations, either through the course of work with pesticides, or due to unintentional exposures through residues in food or environmental contamination, can cause a range of adverse human health impacts. From the scientific literature it is evident that a great deal more is known about the short term (or acute) toxic impacts of pesticides than the long-term (or chronic) impacts of exposure to pesticide formulations. There are also concerns about the delayed toxic effects of exposures to pesticides and the development of diseases such as cancer and neurological damage which may not become evident until many years after initial exposure.

There is substantial variation in the impact of a toxic substance from individual to individual and from developmental stage to developmental stage in the same individual. On the whole, children, the sick, elderly or pregnant women are more vulnerable to the impacts of pesticides. The extrapolation of toxicity data from animal tests to humans is, however, usually based on the healthy adult male model and may therefore not adequately estimate the real hazards to more vulnerable members of the community.

Rogers (1997) indicates that chronic pesticide exposures, meaning low-level exposures over a long period of time, are perhaps the least understood area and are of greatest concern with respect to environmental and community exposure to pesticides. The relationship between chronic pesticide exposure and diseases such as chronic fatigue syndrome and multiple chemical sensitivity is currently gaining a great deal of public and medical attention.

In the urban environment, the use of pesticides plays a significant role in human exposures and environmental contamination. While there are standards set for managing pesticide residues in food products, such as maximum residue limits (MRL) and average daily intakes (ADI), there are no such standards to protect the community from pesticide residues in their homes or public places.

5.2 Environmental impacts

Improvements in analytical methods and testing procedures have made the monitoring of pesticides in the environment a more accessible and precise process. As a result, it has been increasingly shown that pesticide residues are present in the environment to a greater extent than perhaps anticipated. Pesticide residues are now routinely found in waterways, soils, sediments, air, wildlife and food products.

Community concern over the impact of pesticides on the environment is increasing, as is witnessed by the growing demand for pesticide free produce and the call for stricter controls on the use of pesticides internationally and within Australia. Political and community attention is now focussed on certain agricultural industries that intensively use pesticides, such as the cotton and horticulture industries.

Researchers in environmental toxicology note that while acute toxicity of pesticides is readily measured in experimental studies, increasing research attention is being directed towards the long term impacts on the environment brought about by chronic exposure to and build-up of pesticides (Aquatech, 1997).

5.3 Measuring the toxicity of pesticides

The most common method of measuring the acute toxicity of a pesticide is by giving test animals known doses of a poison and observing the results. This is the method by which the lethal dose, referred to as the LD_{50}, of a compound is established. The '50' refers to the dose of a given substance that kills 50% of the test organisms exposed during the experimental process. These measures are used to predict the toxicity of pesticides to people and other non-target organisms. The higher the LD_{50} the less acutely poisonous a compound is. The LD_{50} is usually expressed in milligrams of poison per kilogram of body weight, or mg/kg.

Toxicity ratings for pesticides can be grouped according to the following doses:
[From Rogers (1997)]

Rating	Dose
Practically non-toxic	>15 g/kg
Slightly toxic	5-15 g/kg
Moderately toxic	0.5-5 g/kg
Very toxic	50-500 mg/kg
Extremely toxic	5-50 mg/kg
Supertoxic	<5 mg/kg

5.3.1 Limitations to toxicity measures

It is unwise to base decisions about pesticides solely on their LD50 rating. While the LD50 is an important measure, it does have some severe limitations as a measure of the real risks associated with pesticide formulations and their use. Chronic, or long-term effects associated with low-level exposures, are not indicated by the LD50 (Olkowski *et al*, 1991). Another risk not reflected in the LD50 is the potential for synergism between mixtures of chemicals. Synergism is defined by Pollak (1993) as the condition in which the combined action of a mixture of chemicals is greater than the sum of their separate individual actions; that is, the resulting toxicity of two or more chemical formulations may be multiplicative rather than just additive.

The majority of toxicity data used for the registration of pesticides in Australia is supplied by the manufacturer of the pesticide product. Little independent testing is done in Australia for health or environmental effects of pesticides (Rogers,1997).

6 Integrated pest management

Integrated Pest Management is an approach to pest management that considers the biological and ecological requirements for pest populations to proliferate. There are numerous definitions for IPM which vary according to the perspective of the person defining the concept. Integrated Pest Management can be generally defined as:

> *A pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilises all suitable techniques and methods in as compatible a manner as possible and maintains the pest populations at levels below threshold levels* (Gips, 1990)

Integrated pest management programs also emphasise that chemical pesticides must be viewed as the last option for control within a management program rather than the first.

The development of integrated pest management occurred in the 1950s as researchers began to question the over-reliance on chemical controls and emerging pesticide resistance problems. The development of pesticide resistance, coupled with modern advances in techniques of population assessment of both pests and natural enemies, were the origins of IPM.The principles of IPM were developed within an agricultural framework and it is a more recent development that these principles have been applied to horticultural and urban pest management situations.

In implementing an integrated management program, the emphasis is on 'managing' pests rather than relying on chemicals to totally 'control' any undesirable organisms. Potential pest problems need to be anticipated and appropriate multi-faceted strategies developed before an organism reaches numbers where it becomes a pest. This approach to pest management requires a new definition for the concept of 'pest' and the notion of 'controlling' pests

6.1 What is a pest?

The concept of 'pest' is a human construction and makes sense only in terms of the relationship between the 'pest' and people. The perception and the definition of 'pest' that is subsequently adopted will therefore determine the approach to managing it. Any definition of a pest is by nature subjective, and based on human needs and values which change from situation to situation.

A working definition of 'pest' for the purposes of these Guidelines is - *an organism that, at a given place and time, is undesirable.* Undesirability may encompass a direct threat to health or property, or may be related to issues of comfort and aesthetics (Hadlington & Gerozisis, 1995).

6.2 Pest types

Given the diverse range of venues for the Olympics it should be anticipated that a diverse range of pest management situations have the potential to arise. In developing a comprehensive pest management policy for the Olympics, it is therefore essential to consider the full range of pest problems and develop a flexible IPM policy, based on sound integrated principles, which can accommodate the full-range of situations.

The range of pests likely to be encountered in urban/horticultural environments fall into the following major categories:

- Structural pests: organisms that cause economic and structural damage to buildings, usually timber and fabric. For example termites, wood-boring beetles, fungal decay and mortar bees.
- Nuisance pests: organisms that may cause an annoyance such as irritation, unsightly markings, odorous residues, noise, minor damage or be unsightly. For example, crickets, book lice, stored product pests.
- Public health pests: organisms which have the potential to transmit disease or cause allergic reactions in sensitive individuals. For example, mosquitoes, flies, rats cockroaches, rodents, bees and wasps.
- Landscape pests: organisms that are pests primarily of plant species such as aphids, snails, mites and caterpillars, and weed species of plants.

- Vertebrate pests: organisms such as rabbits, foxes, and feral cats that attack native wildlife and the natural environment.

NB: The above categories of pest types are not mutually exclusive. For example, a pest may be both a nuisance pest and also pose a risk to public health. The distinction between the categories is determined by the situation in which the pest occurs and the observer.

6.3 Establishing pest thresholds

[The following information on establishing pest thresholds was adapted from the University of Florida, Institute of Food and Agricultural Sciences (1998)].

An essential component of any IPM program is the establishment of pest thresholds to facilitate decision - making. Pest management decisions are influenced by the health or safety dangers created by the pest, by legal restrictions on pest infestations, and by levels of pest tolerance in various situations. A pest management decision may also depend on the costs involved to manage a pest weighed against the benefits received. On the basis of any of these factors, a threshold for action can usually be established to determine what type of management is needed and when it should begin.

Threshold levels differ depending on the circumstances. For example, in the case of agriculture, thresholds may be set according to the level of economic damage that is tolerable; while in the case of disease, thresholds based on medical criteria are generally used. For the food service industry thresholds may be set according to requirements for the protection of public health and for aesthetic damage established in regulations (Olkowski *et al*, 1993).

Personal tolerance to pests is also a significant determining factor in setting thresholds. For Olympic athletes, officials and visiting spectators, standards or familiarity with a given pest will greatly influence the status given to that organism. The wide range of Olympic venues and their varying purposes will also influence pest thresholds.

6.3.1 Health and safety thresholds

Health or safety threats commonly require fast, extensive, and sometimes costly pest management measures. A multitude of pests have the potential for causing injuries to people (eg. mosquitoes, biting bugs, fleas, spiders, bees, wasps) or transmitting diseases to people or animals (eg. rats and mice, cockroaches, fleas, flies, mosquitoes). Other pests, such as termites, and wood-boring beetles, can cause damage that make buildings structurally unsafe or reduce their economic value.

Decisions to manage pests are based on knowledge of the potential harm they can cause. If serious injury or damage may result, the management threshold must be very low. For instance, one rat chewing on electrical wiring can cause a serious fire that has significant health and safety consequences.

6.3.2 Legal thresholds

Public safety codes often require management of pests in public buildings, commercial housing, food service facilities, and other public structures. Building and safety standards address the management of structural pests as well as the repair of damage caused by them. These legal thresholds dictate when pest management methods must be used, even though in some cases management methods cannot be economically justified, or the pests may not be causing a hazard to public health or safety.

6.3.3 Pest acceptance thresholds

People have different degrees of acceptance of pests that they are willing to tolerate in and around their homes and public spaces. Pest acceptance thresholds may be high because of social or cultural factors or because of concerns about the costs or hazards of pest management methods used. A pest acceptance threshold can be extremely low due to a person's fear of the pest. Acceptance thresholds may sometimes be modified if you can provide factual information about specific pests, the potential for pest damage, and methods of pest management.

6.3.4 Economic thresholds

In certain instances, the cost of management measures may need to be justified. Economic thresholds may apply if there are no health and safety, legal, or tolerance thresholds that need to be considered. An economic threshold is a level of pest abundance at which the potential loss caused by pest damage is expected to be greater than the cost of managing the pest.

6.4 What is a pesticide?

According to the NSW *Pesticides Act* 1978, the term 'pesticide' is all-encompassing and is used to describe any agent that is intended to control a pest. There are many types of pesticides from various sources with differing effects on the target pests. For example, an insecticide is designed to kill insects while a rodenticide is designed to kill rodents, a fungicide kills fungi and a herbicide is for weeds.

Pesticides may be sourced from botanical origins [eg Pyrethrum extracted from the Chrysanthemum daisy] or microbial origins [such as the micro-organism *Bacillus thuringiensis*]. A pesticide could also be based on an inorganic source such as a mineral or element like copper or arsenic.

The majority of pesticides in use today however are synthetically derived substances. The major categories of modern synthetic pesticides include: organochlorines, organophosphates, carbamates and synthetic pyrethroids.

7 Critical elements of an integrated pest management strategy

An IPM strategy is based on a number of inter-related elements that all need to be considered in the development of a pest management program. The following critical elements have been adapted from Gips (1990), and indicate the components of importance for consideration in the development of an Olympics integrated pest management strategy:

- **People:** qualified and trained integrated pest managers are required to assess complex factors and appropriate management action;
- **Knowledge and information:** an understanding of the biology and ecology of pests and their natural enemies, along with their inter-relationships with the surrounding ecosystem, is required in order to devise an effective program and to make sound management decisions;
- **Monitoring and sampling:** each management situation is unique and the pest manager must monitor to observe changes and take action accordingly. Monitoring and sampling will vary depending on the situation;
- **Decision-making**: threshold pest levels need to be established which indicate the level of damage/pest density etc at which point control methods must be put into action; and
- **IPM methods**: there are a number of techniques or tactics that can be used to manipulate pest populations. These include but are not limited to, cultural, biological, host resistance, physical and chemical controls.

7.1 Integrated pest management methods

7.1.1 Cultural controls

Cultural controls are modifications of management practices that make the environment less favourable for the pest's reproduction and survival. For example, the prompt cleaning of food spillages and the maintenance of high levels of hygiene in kitchens will discourage the development of cockroach or ant populations by limiting food and moisture supplies; and the manipulation or removal of pest habitats, such as tree stumps in which termites may establish colonies; will reduce pest breeding sites.

7.1.2 Biological controls

Biological controls involve the use of natural enemies to manipulate the pest organism. The main approaches to biological control include:

- existing, naturally occurring biological control, based on the understanding of the natural suppressive factors operating in each organism in the ecosystem;
- classic biological control involves the deliberate introduction and establishment of natural enemies;
- augmentation and enhancement of natural enemies involves the provision of food sources and habitat for natural enemies that helps to favour their populations;
- host resistance involves the selective breeding and genetic manipulation of the host plant or animal so that it is resistant to pest attack;
- autocidal control, where the pest contributes to the reduction of its own population. For example, the release of laboratory propagated sterile males into the environment to breed with females.

7.1.3 Physical/mechanical controls

Physical/mechanical controls are the direct or indirect measures that destroy pests outright such as temperature manipulations, steam sterilisation of soil, steam heat to kill insect pests and weeds, and oxygen removal. Mechanical controls include fly swatters and hands.

7.1.4 Chemical controls

Chemical controls involve the use of chemical pesticides, either naturally occurring or synthetically derived, that kill or control weeds, micro-organisms, vertebrates and insects.

8

Integrated pest management strategies

8.1 Integrated management of cockroaches

Cockroaches are considered a public health and nuisance pest because of their potential to spread disease, trigger allergies and cause annoyance.

8.1.1 Cockroach habits and ecology

There are over 400 species of cockroach in Australia with five or six species considered as pests. Cockroaches are gregarious by nature and are attracted by the pheromones excreted in faeces and regurgitations. Cockroaches are thigmotactic, meaning they prefer to be in constant physical contact with surfaces, hence their liking for cracks and crevices. Being nocturnal, they forage at night for water and food and will eat almost any organic material.

The pest status of cockroaches comes from their potential to transmit diseases such as the Salmonella food poisoning bacteria, gastroenteritis and Staphylococcus bacteria. Contamination of food and utensils occurs from constant contact with excreta, regurgitations, egg cases and moulted skins. They are also known to cause allergic (often asthmatic) reactions in certain people exposed to large infestations (Verkerk, 1990).

Common pest species of cockroach are classified into two groups:

- *Blattella germanica* [German cockroach]

Found almost exclusively in indoor areas and prefer warm, humid, confined conditions such as cracks and crevices in kitchens, bathrooms and laundries.

- *Periplaneta* species

Periplaneta americana [American cockroach]
Periplaneta fuliginosa [Smokey-brown]
Periplaneta australasiae [Australian cockroach]

Generally found outdoors; however wall cavities, roof and subfloor voids and drains also provide habitats. They are active throughout the warmer months and numbers diminish dramatically during the colder periods.

8.1.2 Conventional control methods

Conventional management of cockroaches generally involves the broad application of a range of different residual insecticides to interior and exterior areas. Poor control following the use of insecticides can occur due to operator error, absorption of insecticide into surfaces, premature breakdown of chemicals, repellency and resistance.

Regular use of certain groups of insecticide may lead to insecticidal resistance. The widespread use of surface spray and aerosol treatments can lead to a proportion of treated cockroach populations receiving sub-lethal doses which then act as dispersal or flushing agents, promoting the development of pesticide resistance and poor control of infestations.

8.1.3 Integrated strategy for cockroach management

[The following strategy has been developed and tested by Systems Pest Management Pty Ltd, Sydney]

For new structures it is possible to consider cockroaches and their desired habitats at the design stage of any construction to incorporate features which minimise the opportunity for their development. This is also useful in existing structures where renovations and maintenance procedures are to be carried out. If an IPM program is to be undertaken in an existing facility, maintenance procedures need to be identified by the IPM consultant in order that appropriate maintenance can be carried out.

Inspection
A detailed inspection of the potentially infested area is required to determine the extent and severity of the infestation and to reveal factors that may contribute to the development of infestations. Based on a knowledge of pest biology and ecology, indicators of a significant cockroach infestation include: presence of adults, nymphs, moulted skins, egg cases, droppings [poppy-seed like] and regurgitation marks [small brown deposits stuck to surfaces].

Common harbourage areas for cockroaches include: cracks and crevices, gaps beneath and around sink units, drawers, refrigerator motors, refrigerator door seals and hinges, cupboard hinges, cane baskets, stored papers and books and electrical appliances; and wall and ceiling voids and drains for the larger species.

Monitoring & sampling
Non-insecticidal sticky traps provide an attractive harbourage and have a sticky base and attractant (food attractant or pheromone) for capturing cockroaches. They are effective monitoring and sampling devices and provide a visual opportunity to confirm the species of cockroach infestation as well as an indication of the population density. They also provide effective monitoring devices to determine the efficacy of various treatment strategies.

Sticky traps are effective for the control of low level infestations as part of an overall IPM strategy because the traps effectively capture female cockroaches which lay their egg cases onto the sticky trap. Traps should be placed as near as possible to potential harbourage areas and be checked and changed regularly as part of the program.

Decision-making for management strategy
Threshold pest levels need to be established which indicate the level of damage/pest density at which point control methods must be put into action. For example, if dealing with a commercial kitchen, finding more than five cockroaches on a monitoring sticky trap and cockroach droppings and regurgitation marks inside food storage cupboards may warrant a call to the pest manager for further inspection and potential localised treatment. Thresholds need to be established on an individual basis according to the situation.

Integrated pest management methods:

- Remove large, accessible pockets of cockroaches, egg cases, dropping and moulted skins by means of a powerful vacuum cleaner with appropriate nozzle.
- Heat flush cockroaches from harbourage areas, identified during the inspection, with a heat gun (eg a paint stripper) which emits hot air between 500 to 600 degress celcius. [Great care should be taken to avoid prolonged exposure of heat to plastics and other materials which may otherwise ignite or be damaged]. As cockroaches begin to emerge and scatter, apply direct heat to them for several seconds to kill them, or remove with a vacuum cleaner.
- If the cockroach infestation is significant, a liquid insecticidal (or physical) barrier may need to be placed around the area of treatment to contain the flushed cockroaches and reduce the risk of spreading the infestation into other areas. Low risk chemicals, such as pyrethrum or Permethrin wettable powder, or double-sided sticky tape are useful.
- Extra non-chemical sticky traps should be placed during and after a cockroach treatment.
- Apply insecticidal cockroach bait to breeding and harbourage areas. The bait contains a food source that is highly attractive to cockroaches as well as a stomach poison such as borax or Hydramethylnon.
- Abrasive dusts such as Dryacide (amorphous silica dust) can be applied to areas where there is a high risk of re-infestation such as around warm electrical appliances. Dryacide differs from conventional insecticides in its mode of action. It is a physical cockroach control agent that works by absorbing and abrading the waxy cuticle of the cockroaches thus dehydrating them. It is very repellent to cockroaches and treated areas remain less attractive to re-infestation.

Recommendations to be carried out following treatment

It is essential that the pest manager identifies procedures to be carried out post treatment. Attention to these recommendations will significantly reduce the possibility of re-infestation.

Recommendations may include:

- Thorough clean-up of treatment area;
- Regular checking of sticky traps;
- Sealing cracks and crevices and other harbourage areas;
- Attention to hygiene;
- Food storage practices;
- Storage of other materials;
- Reducing moisture sources; and
- Education of staff and facility users about the pest management program.

8.2 Integrated management of mosquitoes

Mosquitoes are considered a public health and nuisance pest because of their ability to spread disease and cause discomfort.

8.2.1 Mosquito habits and ecology

Mosquitoes are one of the most serious pests that have a direct impact on humans. Mosquitoes seriously affect the lives of vast numbers of people world-wide by transmitting microbial organisms that can cause disease and death, especially in tropical areas.

Mosquitoes are vectors (carriers) of arboviruses, the most important of the mosquito-borne pathogens in Australia. Of the arboviruses of greatest concern, the Dengue viruses can cause a moderately severe short-term illness with potential for a severe and potentially fatal haemorragic manifestation, Murray Valley Encephalitis (MVE) and Kunjin (KUN) viruses may cause a potentially fatal brain infection and neurological disability in those that survive, while the Ross River (RR) and Barmah Forest (BF) viruses can be responsible for a debilitating polyarrthritis that may last months to years. Mosquitoes can also transmit devastating human disease agents including malaria, yellow fever, dengue and filariasis (Russell, 1997).

There are over 3000 species of mosquitoes worldwide. All mosquitoes develop in water that is still or very slow-moving. Each genus of mosquito differs from others primarily in the type of aquatic habitat (fresh-water or saltwater) in which it develops (Olkowski *et al*, 1991).

Conventional treatment for mosquitoes often involves the broad-scale application of residual pesticides to breeding areas, often with significant impacts on other organisms.

8.2.2 Mosquitoes at Homebush Bay

Homebush Bay is an important breeding place where pest populations of mosquitoes are impacting on residential areas to the north and east in particular. The most important 'breeding grounds' are currently in the saline wetlands of the Newington RANAD and Bicentennial Park. Twenty seven species of mosquito have been identified, most of which are not important vectors of disease-causing organisms. The freshwater wetlands of Homebush Bay produce pest mosquitoes from various natural and constructed habitats; there are no known significant habitats outside the area that would provide pest levels of mosquitoes inside the area (Russell, 1997)

Within the Homebush area, the most productive sites have been the marshland (Cumbungi swamp) in the southeast quarter of Newington, and ponds throughout the site, including a number of the ‘frog ponds’, The important species are saltmarsh mosquitoes *Aedes vigilax* and *Culex sitiens* and the freshwater wetland species *Culex annulirostris* and *Coquillettidia linealis*. Of these, *Aedes vigilax* is the important pest species

and would be responsible for the day-biting that is a problem for most visitors. The other three species are primarily evening and night biters and, with *Aedes vigilax* as well, would present the major problem after sunset (Russell, 1997).

8.2.3 Integrated strategy for mosquito management

The main elements to be considered in the IPM strategy for mosquitoes are:

- Monitor the size of mosquito populations by using light traps, resting stations and biting counts;
- Field surveys to determine which species are biting and, based on an identification of the species, where and when they are breeding. This information is necessary before control measures can be applied to those sites where mosquitoes are present and causing a nuisance. Biting counts must be taken after dark when female mosquitoes are flying and looking for blood meals. The count is made by exposing some portion of the body, usually a forearm or lower leg, for a specified time, usually 2 to 15 minutes, and capturing the insects as they feed;
- Action levels need to be established. The action level represents the level at which action is implemented before the injury level is reached, or the level at which pests become intolerable. A typical injury level for initiation of treatments might be 5 bites /15 minutes;
- Educate members of the community about the role they can play in reducing larval sources and protecting themselves from mosquito attack;
- Eliminate larval sources by reintroducing tidal flushing to the wetlands or by stocking bodies of water with native (and preferably locally indigenous) predatory fish;
- Application of low-hazard larvicides when and where necessary and appropriate to control mosquito larvae. (eg Vetobac is a larvacide containing Bacillus thuringensis var israelensis and is considered to be a relatively low hazard product to non-target organisms);
- Application of growth regulators may also need to be considered where necessary. Growth regulators prevent the larvae completing development to the adult form and therefore disrupts the breeding cycle;
- Direct physical controls such as the use of insect screens and nets are an important means of protection for the community from mosquitoes;
- Direct biological controls such as predatory mosquito eating fish are an appropriate and available biological control agent. While the 'mosquito fish' Gambusia holbrooki is present in some of the freshwater habitats, native species are preferable. However, none are currently used in NSW specifically for mosquito control; and,
- Broad-scale insecticidal application to a mosquito infested area should only be considered in full consultation with experts and the community in the vicinity of the area to be potentially treated and after a through risk assessment of the likely impacts on non-target organisms. This is not a preferred treatment option.

8.3 Integrated management of termites

Termites are considered a structural pest of timbers and, indirectly, a public health pest if structural damage to a building makes it unsafe for habitation.

8.3.1 Termite habits and ecology

Termites are social insects with similar organisation to that of ants, bees and wasps. Commonly referred to as 'white ants' , termites are in fact not related to ants - their closest relative in evolutionary terms is the cockroach. Termites live in colonies that consist of several castes- worker, soldier, king and queen, who all perform their own duties. All activities of individuals are directed towards the survival of the colony. A complex system of chemical (hormonal) communication throughout the colony is controlled by the queen at the epicentre of the colony.

Colonies nest in a variety of places which are characteristic of particular termite species. Nests may be ground mounds, arboreal structures on the outside of trees, or subterranean colonies in the soil. Termites feed on wood and wood containing derivatives such as cardboard, paper and composite wood containing products.

There are over 300 species of termite present in Australia of which up to 30 species are capable of causing economic damage to structures. The termite genus *Coptotermes* is responsible for more damage than all other termite genera combined. This termite species is the main timber pest of buildings in the Sydney region. Termites may pose a public health threat if structures have been damaged to the point were they present a danger to inhabitants.

Termites provide major ecological benefits by recycling woody tissue and trace elements, thereby increasing soil organic content, soil aeration, drainage and mixing, They are also a food source for other animals such as the echidna and Tawny Frogmouth (Verkerk, 1990).

Common pest genera of termite in NSW include:

Coptotermes species
Schedorhinotermes species
Nasutitermes species
Microcerotermes species
Heterotermes species

8.3.2 Conventional control methods

The traditional approach to treating termites, developed in the 1900s in Australia, involved the use of inorganic dusts such as Arsenic Trioxide to control colony nest sites and this method is still used today. The use of synthetic liquid termiticides expanded rapidly from the 1940s with the introduction of the controversial cyclodienes: (Heptachlor, Chlordane, Dieldrin and Aldrin) which were applied as chemical barrier treatments. The cyclodienes were withdrawn in 1995 for this purpose due to their detrimental impacts on health and accumulation in the environment. They have been replaced with the organophosphate pesticide Chlorpyrifos and synthetic pyrethroids such as Bifenthrin and Permethrin.

Termiticides are applied as chemical soil barrier treatments that are intended to provide a protective chemical barrier between the structure and the soil. These chemical barriers must be continually renewed to provide on-going protection. New termiticides and application methods are currently being researched, such as chemically impregnated plastic or fibrous blankets and pipe reticulation systems, which work on the same principle of providing a chemical barrier between the structure and the soil.

In terms of the effectiveness of chemical barrier treatments to control termites, Verkerk (1990) states 'Despite the bombardment of buildings and soil around Australia with millions of litres of persistent chemicals for more than forty years, human intervention seems to have little effect on the amount of damage caused to buildings by termites. In fact many support the common perception that in the absence of sound quantitative data, that numbers of so-called 'destructive termite species' actually appear to be increasing rather than declining'.

In Australia, the protection of buildings from termite attack and methods of treatment are guided by the following Australian Standards:

- AS 3660.1-1995 [Amendment 1, 1996] Protection of buildings from subterranean termites Part 1; New Buildings. This Standard is called up in the Building Code of Australia.

- AS 3660 -1993 Protection of buildings from subterranean termites - prevention, detection and treatment of infestation.

- AS 3660.3 Termite management Part 3; assessment criteria for termite management systems.
  [In public review phase at time of writing]

8.3.3 Integrated strategy for termite management

New structures

One approach to termite management which negates the use of chemical pesticides is to 'build out' termites at the design stage of any structure. Verkerk's (1990*) Building out termites: an Australian manual for environmentally responsible control* provides practical guidance on Minimum Termite Risk (MTR) design and construction techniques for Australian conditions.

For buildings under construction, Verkerk lists the following general building factors as important considerations at the design stage for implementation of MTR principles. Generally, all building components and the design need to be analysed from the perspective of potential termite susceptibility.

Minimum termite risk (MTR) elements to be considered in the construction of new buildings include:

- Site selection
- Building material selection
- Construction site practices
- Subfloor clearances
- Foundation types
- Continuous physical shielding systems
- Ground & surface water drainage
- Subfloor ventilation & incident light
- Exterior perimeter soil and paving levels
- Substructures abutting main building
- Removal of termite attractants from subfloor and adjacent areas
- Maintenance of complete subfloor inspection access
- Storage and utilisation of subfloor areas
- Construction & waterproofing of wet areas
- Wall framing
- Service pipes, electrical wiring and other connections
- Concrete composition, expansion joints, dimensions, reinforcement, curing, slab-edge design

Physical termite barriers

In conjunction with MTR building principles, there are now protective methods such as stainless steel mesh and crushed granite that provide a physical barrier against termites. The Australian Standard 3660 - 1993 provides details about installing physical barriers (Hadlington & Marsden, 1998).

Existing structures

For existing structures, the potential for incorporating MTR principles, or physical barriers, is limited to renovations and extensions. Modifications to existing structures to reduce termite susceptibility are possible, but the process is not ideal and may be costly.

A Sydney-based company, Systems Pest Management Pty Ltd provided the following integrated termite management program, based on the work of Verkerk (1990):

- Timber pest inspection

A detailed inspection of all accessible timbers is required on a regular basis. Inspections are usually undertaken yearly, but if the structure is considered highly susceptible to termites more frequent inspections may be recommended. If no termite infestation is detected there is no requirement for treatment. The pest management consultant should provide recommendations for modifications to reduce susceptibility.

- Monitoring

Monitoring procedures can be put in place to give early warning of termite infestation. Monitoring may also be useful if there are active termites in order to determine the direction and source of the termites. Various monitoring systems are being trialed and developed. Systems Pest Management has developed the 'bait box' luring system. The monitoring devices work on the principle of luring termites to a cellulose bait-containing material which can then be baited with a poison to indirectly destroy a colony nest.

- Decision-making for management strategy

During an inspection, an evaluation of the overall susceptibility of the structure can be made. Based on this information, and an understanding of the termite activity in the area, decisions can be made as to the frequency of inspection and level of modification required to reduce susceptibility. If an active infestation is discovered, localised treatment options can be considered.

Integrated termite treatment methods:

- The first priority is to locate the source of the infestation at the colony nest. If the nest can be located, it should be physically removed. If removal is not an option, localised treatment with a low-hazard pesticide (such as the synthetic pyrethroid, Permethrin) may be required.
- If the termite colony nest cannot be located, localised treatment of active termite workings is carried out with arsenic trioxide dust. While arsenic is considered a highly toxic substance, it is possible to use it in such as way that presents minimal risks compared with the hazards of high volume volatile liquid chemicals.
- Localised treatments are generally re-inspected after a period of 4-6 weeks to determine their efficacy. It may be necessary to repeat the treatment at this stage, and a further re-inspection would be required.
- Recommendations are made for structural modifications to reduce the chance of re-infestation and reduce overall susceptibility. Modifications may include improvements to inspection access, subfloor ventilation and removing timber from direct ground contact.
- A program of inspections is devised based on the level of susceptibility of the structure and intensity of current/previous infestation.
- In a small percentage of active infestations, where damage or economic thresholds are low, it may be considered appropriate to carry out a broad-scale chemical barrier treatment with one of the currently registered termiticides such as Chlorpyrifos (an organophosphate insecticide) or Bifenthrin (a synthetic pyrethroid). This would be considered a last option and the occupants of the facility to be treated would be provided with the relevant safety information to minimise the impacts of exposure to chemical residues. The public should be notified if a public facility has been treated so they can make informed choices about whether they wish to enter treated facilities.

8.4 Integrated management of landscape pests

Planting and managing vegetation is a significant part of the Olympics and may require the management of landscape pests. These include organisms that attack vegetation such as insects and other plant species

which are considered weeds.

In addition to requirements for integrated pest management in the *Environmental Guidelines*, the *Homebush Bay Development Guidelines: Landscape Strategy* identifies significant landscape design principles when it states that:

"Landscape design proposals should incorporate the use of ecologically sustainable treatments and materials within the bounds of safety, economy and life cycle such as: use of plants suited to site conditions to minimise irrigation, fertiliser and pesticide use".

8.4.1 Integrated vegetation management & the Olympics

The OCA's draft *Integrated Pest Management Manual* addresses Olympic guideline and strategy requirements and provides a thorough approach to integrated landscape pest management with an emphasis on non-chemical methods of pest and disease control. The opportunities for designing and developing landscapes to allow for the integration of natural pest control and protection of the biodiversity of Olympic venues is also recognised in the Manual. The Manual states: "The implementation of this strategy [integrated pest management] is likely to be the largest of its kind in public parkland areas within Australia".

OCA's draft Manual details Horticultural Hygiene Procedures to minimise the introduction of pests and diseases into Olympic venues. The Pesticide Use and Handling Procedures provided in the manual covers the majority of important issues associated with pesticides, however, the Code of Practice for the Safe Use of Pesticides included in these guidelines (Appendix 1) includes some further details which should be considered in the decision-making process for least hazardous pesticide selection and use.

The OCA Manual identifies the following points as critical to the implementation of integrated vegetation management at Olympic venues:

- Landscape plantings to be designed, developed and managed to allow for the integration of natural pest control and to enhance the total biodiversity of Olympic venues;
- Plantings which allow for dense areas of vegetation, composed of a variety of plant species, with a heavy emphasis on the use of locally occurring species to attract native insectivorous birds and native predatory species of invertebrates;
- External factors that impact on the optimum health of plants are to be avoided (eg: damage from soil compaction by vehicles and machinery, root damage to plants by excavation, water stress, poor soil aeration, vandalism of trees, and drift from dust);
- Inclusion of OCA's Tree Protection Policy in tenders and other documents for any work which may impact on vegetation around venues;
- Use of best horticultural practice to maintain healthy plants resistant to pest and disease infestation;
- Plant hygiene procedures to be incorporated into all contract documents to promote quality assurance by landscape maintenance contractors;
- Investigate and trial alternative non-chemical methods for the control of pests and diseases for application a larger scale;
- OCA to develop a policy regarding the selection and use of control agents at Olympic venues;
- When a pesticide is deemed necessary, the least toxic effective pesticide is to be used;
- The use of pesticides is to be carried out in accordance with the Pesticide Use and Handling Procedures; and
- Raise public awareness through interpretive signage about the significance of integrated pest management for environmentally responsible pest and disease control at Olympic venues.

8.4.2 Integrated strategy for weed management

There is a recognised correlation between disturbed soil and the appearance of weeds as part of the natural process of vegetation succession in response to changes in the soil micro-habitat. In order to minimise weeds and to prevent their return in the long-term, any action to control weeds must include strategies to modify the soil so it becomes unfavourable for future weed growth.

Olkowski *et al* (1991), indicate that habitat modification is a key element in a long-term, integrated approach to managing weeds. The following components should be considered:

- Establishing realistic tolerance levels for weeds based on knowledge of what weeds are present, how aggressively they are growing, where the weeds are growing and how much damage they are likely to cause other plants;

- Modifying the habitat to minimise conditions that produce weeds above the set tolerance levels. That is indirect weed suppression utilising design/redesign, habitat modification (eg. limiting water, mulching to limit light, manipulating soil fertility) and horticultural controls (eg. complementary & competitive plantings) which all reduce life supports for weeds; and

- Focusing direct suppression efforts on weed populations that threaten to exceed tolerance levels.

8.4.3 Plantings for Biodiversity

Plantings for Biodiversity prepared by Ecohort on behalf of Green Games Watch 2000, identifies techniques for consideration in relation to establishing native habitat and corridor areas with an emphasis on physical procedures to reduce reliance on chemicals.

It details techniques for the implementation of vegetation management strategies to minimise chemical inputs such as: site preparation (weed removal, hand chipping & grading, ripping & hoeing, fencing & vermin control); planting methods (hand & mechanical planting, mulching); and, maintenance procedures (watering, fertiliser use, tree guarding, weed control).

8.5 Integrated management of vertebrate pests

Managing vertebrate pests on Olympic sites is required in order to protect native flora and fauna and their habitats. The *Endangered Species Protection Act 1992* is the primary Commonwealth instrument to protect and encourage the recovery of endangered or vulnerable plants, animals and ecological communities. The Act lists key threatening processes which impinge upon those species and communities and includes predation by the European red fox and feral cats, competition and land degradation by rabbits.

Certain vertebrate pests (ie. European rabbits, hares, feral pigs, wild dogs) are declared noxious in NSW under the *Rural Lands Protection Act 1989* and the occupier of the land is responsible for control of those pests if found on site. Vertebrate pests such as feral cats & dogs, European rabbits, hares and foxes are highly likely to be found on Olympic sites.

Other vertebrate pests such as rats and mice are also likely to be found, but would usually be managed as part of pest control programs carried out by urban pest control operators. There are also concerns regarding the introduction of vertebrates that may subsequently become pests in the post-Olympics use of facilities; in particular, where cats, dogs and other vertebrates may be introduced to the site by occupiers of the village.

An important issue in the management of vertebrate pests is the consideration of animal welfare. In essence, practices should be adopted that minimise the suffering of target and non-target animals, consistent with effective control. Further details should be obtained from the NSW Government Animal Ethics Committee.

8.5.1 Integrated management of vertebrate pests

In the past, control of vertebrate pests has centred on their 'eradication' which has largely been an unsuccessful approach. The emphasis has now shifted to sustained management programs that aim to

minimise the damage caused by those pests. This approach requires quantification of the linkages between pest density and the costs and benefits of control (Bureau of Resource Sciences, 1993).

The Bureau of Resource Sciences (BRS) has developed a national program for the management of vertebrate pests that is detailed in its publication *Managing vertebrate pests: principles and strategies*. The program aims to produce 'best possible' management plans for Australia's major vertebrate pests to be implemented by State pest management agencies. The plans are based on current scientific understanding of the ecology and population dynamics of pest species and the most recent developments in pest control technology.

NSW Agriculture plays a supervisory role in the management of vertebrate pests in NSW and in 1996 produced its *Vertebrate Pest Control Manual* which serves as a field guide. NSW Agriculture also administers the *Rural Lands Protection Act 1989*, but the Rural Lands Protection Boards are responsible for the application of the Act for vertebrate pest management. The Rural Lands Protection Boards are also developing district-wide vertebrate management programs in conjunction with local councils. For example, a rabbit control program for the Sydney Basin will soon be implemented with the co-operation of local councils. The National Parks and Wildlife Service (NPWS) is the responsible agency for the management of vertebrate pests in national parks

The BRS has released a series of detailed guidelines that address each vertebrate pest and its management options. There are now detailed management guidelines for the control of rabbits, foxes, feral pigs, goats, horses, and rodents. For further details on those management programs the reader is directed to those specific publications.

The basis of the separate guidelines is a strategic process that can be generally applied to the management of all vertebrate pests. The separate components for planning and evaluating include:

- Problem definition: define the problem in terms that measure the harmful impact; assess available information and/or collect the data needed to evaluate the problem; and identify the scope of the problem.
- Definition of objectives, performance criteria and criteria for failure: the process includes determining outcomes and a time frame for achieving it; setting performance indicators; and establishing criteria for failure.
- Identification and evaluation of management options: strategic options for managing vertebrate pests include: eradication, one-off control, sustained control, sporadic control, commercial harvesting and hunting and no control.
- Implementation & monitoring of program and evaluation against objectives: the aim is to evaluate and, where practicable, improve the efficiency of control operations; the management objectives should be evaluated based on previously established performance criteria.

9 Integrated pest management and the Sydney Olympics

Guidance on integrated pest management for Olympics venues should not be overly prescriptive, but rather provide a framework for decision-making by setting benchmarks and desired outcomes. This approach is appropriate because of the diverse range of venues, and the opportunities for innovation in pest management strategies that may arise in the lead up to the Olympics.

Pest problems in the wide range of Olympic venues, which encompass both indoor and outdoor spaces, are likely to be diverse and of varying intensity depending on the venue, its maintenance regime, use pattern and physical surrounds. The opportunity for venue design elements, which minimise the development of pest infestations, is appropriate in venues being purpose built. Existing facilities have limited options for 'designing out' pests. However if they are to be modified prior to the Olympics, there may be an opportunities to incorporate design elements to minimise pests.

It is not possible within the scope of these guidelines to anticipate all the potential pest problems that may occur at Olympic venues. However, it is possible to summarise the potential pest problems and strategic approach to integrated pest management for Olympic venues (Table 1). The task of identifying pests, and subsequently developing a specific IPM strategy, requires full site inspections of each venue by entomologists and IPM consultants to determine the current pest status and the habitats favouring pest development.

For the purpose of these guidelines, potential pest species have been determined based on the typical pest species encountered throughout the Sydney region[1], and via consultation with building managers at selected existing facilities to be used as Olympic venues. The IPM strategies included have been researched from literature and through consultation with integrated pest management consultants at Systems Pest Management Pty Ltd, Sydney.

Table 1: Strategic Approach To Integrated Pest Management At Olympic Venues

Potential pest problem	Strategic approach to integrated pest management
Structural pests: [e.g., termites, wood boring beetles, fungal decay, mortar bees]	**New structures:** • Inspect building location for presence of structural pests • Minimum termite risk (MTR) design strategies (eg. construction methods & material choice; concrete slab design; ventilation; inspection access; drainage; physical barriers (eg. crushed granite, stainless steel mesh) • **Existing structures:** • Regular property inspection & structural pest susceptibility analysis • Modification & maintenance procedures to reduce susceptibility (eg. reducing moisture sources; timbers out of direct ground contact; improving inspection access; replacement with pest-resistant building materials) • Localised treatment of active infestations with low-hazard techniques & materials in accordance with the Code of Practice for the Safe Use of Pesticides (eg. localised luring & baiting; direct nest destruction)

[1] The Olympics will take place over the season of spring, during which time temperatures in the Sydney region are generally cooler than the hotter summer months when many pest species are at their greatest abundance. So the timing of the Olympics generally favours lower abundance of many pest species. However, it is important to note that the venues will also be used intensively post-Olympics in all seasons.

Nuisance pests: [e.g., ants, cockroaches, rodents (rats and mice), crickets, book lice, cicadas, bees, wasps, silver fish, cloth moths, carpet beetle]	**New structures:** • Construction & interior design elements to reduce breeding, harbourage and access points (eg. minimise cracks & crevices and entry points; reduce potential moisture sources; location of electrical equipment; insect screens; storage practices, ventilation) • Low-hazard cleaning & maintenance regimes • Staff/occupant education programs • Pest management protocols in operating venue manuals • **Existing structures:** • Regular inspections • Establish pest sightings register • Low -hazard cleaning & maintenance regimes • Modifications to reduce pest breeding & harbourage areas (eg storage practices, crack & crevice sealing, ventilation) • Localised treatments for active infestations utilising physical & cultural controls; biological controls; localised application of low-hazard pesticides in accordance with the Code of Practice for the Safe Use of Pesticides. • Staff/occupant education programs • Pest management protocols in operating venue manuals
Public health pests: [e.g., cockroaches, mosquitoes, houseflies , fleas, lice, spiders, mites, ticks, European wasps, bedbugs and rodents (mice and rats)]	**New structures/outdoor areas:** • Design elements to reduce breeding, harbourage and access points (eg. minimise cracks & crevices & entry points; reducing potential moisture sources; placement of electrical equipment; insect screens, landscape design) • Low-hazard cleaning & maintenance regimes • Staff/occupant/community education programs • Pest management protocols in venue operating manuals • **Existing structures:** • Regular inspection • Establish sightings protocol and register • Low -hazard cleaning & maintenance regimes • Modifications to reduce pest breeding areas • Localised treatments for active infestations utilising physical & cultural controls; biological controls; localised application of low-hazard pesticides as required in accordance with the Code of Practice for the Safe Use of Pesticides. • Staff/occupant/community education programs • Pest management protocols in venue operating manuals

Landscape pests: [e.g., aphids, scale, bugs, psyllids, beetles, weevils, leaf hopper, thrips, leaf minor, leaf spots, rusts, wilt and weeds]	**As per OCA's draft Integrated Pest Management Manual:** • Biorational controls (eg. biological, physical, cultural) • Horticultural hygiene procedures • Least hazardous pesticide selection • Staff/community education programs • Pest management protocols in venue operating manuals
Vertebrate pests: [e.g., feral cats, dogs, foxes, European rabbits, hares]	**A strategic process that can be generally applied to the management of all vertebrate pests (Bureau of Resource Sciences, 1993):** • Problem definition • Definition of objectives, performance criteria and criteria for failure • Identification and evaluation of management options • Implementation & monitoring of program and evaluation against objectives • Staff/occupant/community education programs • Pest management protocols in venue operating manuals

9.1 Olympic Co-ordination Authority's: *Draft Integrated Pest Management Manual*

The Draft Integrated Pest Management Manual: a guide to the management and control of pests at Olympic venues (OCA, undated) primarily covers the integrated management of landscape pests. The Manual states "The Integrated Pest Management Strategy principally addresses these issues in relation to pest and disease control of plant material at all Olympic venues. The same principles can, however, be applied to the control of any detrimental organism at all Olympic venues (p1)".

The Manual identifies important actions for the development and implementation of integrated pest management for landscape pests, but is limited at this stage in not providing a comprehensive program for the management of other likely pest management situations such as structural or vertebrate pests. Horticultural Hygiene Procedures and Pesticide Use and Handling Procedures have been included in the draft Manual.

9.2 Pest management practices at existing venues

Some Olympic events will take place in existing venues that have not been purpose-built for the Olympics. In implementing the Olympics integrated pest management strategy it will be necessary to determine current pest management procedures at these venues to assess whether they are in accord with the requirements of the *Environmental Guidelines*. Olympic organisers will need to decide how they will manage pest control at existing venues if they do not meet the Guideline requirements.

In preparing this document, discussions were held with two venues that will host Olympic events - Sydney Convention & Exhibition Centre, Darling Harbour and Sydney Entertainment Centre.

9.2.1 Sydney Entertainment Centre

The Building Services Manager reported that contact with SOCOG regarding a range of issues to do with hosting an Olympic event had taken place, but they have not yet been informed of the *Environmental*

Guidelines requirements for integrated pest management.

The current pest management regime for the Centre has been in place for approximately seven years under the direction of the current Building Services Manager. The program consists of monthly building inspections and localised treatments as required. The pest control company also provides details on hygiene and maintenance issues which require attention. The pest problems usually encountered at the site include rodents and cockroaches, but outbreaks are infrequent.

Treatments for rodents involve the use of traps and chemical baits, which are placed out in tamper-proof containers. Cockroach treatments are carried out with spot Pyrethrum application. McDonalds, Pizza Hut and candy bars are located within the Centre complex. McDonalds[2] carry out their own pest management procedures while Pizza Hut and candy bars are managed by the Centre pest control contractors. No material safety data sheets (MSDS) were available at the time for the pesticides used in the Centre, although they will be requested in the future. There have not been any reports of adverse reactions to the pest control program at the Centre.

9.2.2 Sydney Convention & Exhibition Centre, Darling Harbour

Pest control for these premises includes the convention and exhibition centres as well as four cafes and the Cockle Bay Bar. Consultation with the Building Services Manager and representative from the pest control company currently carrying out pest management, indicated that requirements for IPM and non-chemical pest control as specified in the *Environmental Guidelines* have not yet been conveyed to them.

The current pest control service involves two visits a month and spot treatments as required. The main pest problems include rodents, cockroaches and spiders. A sightings register has been established to identify 'hot spots' of pest activity and staff are encouraged to record pest sightings.

Spot treatments for cockroaches involve the use of synthetic pyrethroids such as Permethrin, cockroach baiting gels, non-chemical sticky traps and space sprays such as Pestigas (a pyrethrin based insecticide). Rodent treatments involve the use of chemical baits, which are placed in tamper proof bait stations, and glue traps. Proofing work, that is physically excluding rodents, is also carried out by Wizard Pest Control.

Wizard Pest Control endeavours to keep chemical insecticides to a minimum and material safety data sheets are available for all the chemical products they do use on site.

9.3 Olympic sponsors & merchandisers

All sponsorship contracts require the sponsor to be aware of the environmental commitments, and SOCOG will expect all sponsors to respond to the requirements of the *Environmental Guidelines*. Merchandisers are subject to SOCOG's consumer products environment policy which encompasses '…the extent to which it [the product] affects the environment during manufacture, use and disposal…' (Myer,1997).

A phone survey of a selection of Olympic sponsors was conducted to ascertain if any requirements for least hazardous pest management have been included in company environment policies. While some sponsors do have environment policies, none of the organisations surveyed have included specific requirements for reducing pesticides or adopting integrated pest management strategies.

In relation to the requirement to minimise the use of chemical pesticides for the Olympics, it would be appropriate for SOCOG to include in its evaluation of the life-cycle of products the extent to which pesticides may have been used in the development of a product. For example, there are valid concerns raised about the environmental impacts of pesticides used to grow cotton both in Australia and in other countries. This has direct implications for the manufacture of cotton clothing and other cotton-containing items bearing the Olympic symbols.

[2] As McDonalds are an Olympic sponsor, it would be appropriate for SOCOG to review their current pest management practices to determine if they comply with *Environmental Guidelines* requirements.

The use of pesticides to grow food products is also an issue of concern. Myer (1997) notes that in terms of green marketing, McDonalds could consider the use of organically grown food products.

The use of pesticides also needs to be considered as a component in 'Green Office' programs in relation to indoor air quality.

10 Case studies

10.1 Royal Botanic Gardens Kew, London.

[adapted from Royal Botanic Gardens Kew website at http://www.rbgkew.org.uk/]

The Royal Botanic Gardens Kew (RBG Kew) is committed to an ecological approach to managing pests in its horticultural activities through the use of an Integrated Pest Management (IPM) strategy. An IPM policy has been devised which is actively promoted to visitors through signage and information sheets.

The aim of the IPM program is to provide stable, long-term pest control through a combination of biological, cultural and chemical methods. The objective is to manage pests by suppressing populations to low and tolerable levels. Control is to be achieved wherever possible by using cultural and biological methods as the primary approach.

A chemical approach is tolerated where it will control the pest or disease outbreak but have a limited effect on any bio-control agents (ie through selectivity). The final outcome should either leave control balanced in favour of the natural enemy or be conducive to the rapid reintroduction of beneficial organisms.

An eradication program with chemicals cannot be used except in quarantine situations or where plant hygiene in relation to virus or disease vectors is of uppermost importance.

Only chemical pesticides cleared under the *Control of Pesticides Regulations (1986)* and of minimal impact to beneficial organisms are permitted for use. They are applied in accordance with a Code of Practice and Conditions of Approval in order to minimise risk of exposure to employees and visitors.

10.2 Green Pest Control in Southwark's Parks, London

[Adapted from Davis, M. (1996) Green Pest Control in Southwark's Parks, *Pesticides News*, 31]

Southwark Council, a borough of London, has made a commitment to a pesticide strategy which aims to reduce or eliminate the use of pesticides from its parks and gardens. The program, which commenced in 1996, was established in collaboration with the Pesticides Trust[3] who provided expert independent advice to Council. Initially the policy focussed on tightening contract specifications in order to allow greater control over contractors use of pesticides. With tighter controls Council found it became easier to monitor use, certification of applicators and equipment.

Alternative ways of specifying weed control were then investigated, as herbicides constituted the greatest use of pesticides in the parks. All scheduled use of pesticides was then removed from contracts, which effectively meant the contractor had to bid for the contract on the understanding that work was to be carried out without using pesticides. This provided a measure of quality control of the contractor.

To help in advancing the process, demonstrations of alternative control products such as the Waipuna[4] hot water weed control system were carried out. Training was identified as a requirement and Council officers

[3] The Pesticides Trust is an environmental charity, and includes in its memberships a wide range of interests: environmental, food and consumer, farming and growing, conservation, wildlife, medical, health and safety and development organisations. The Pesticides Trust is not indiscriminately opposed to pesticides, but aims to create awareness among those who make decisions over the use and regulation of pesticides.

[4] The Waipuna system is a chemical-free and commercially viable vegetation management system based on steam which penetrates and breaks down the cell structure of the plant. The machine is designed to operate in an urban environment and control growth at, or around, kerb and channel, footpath edges, driveways, boundaries etc. According to Waipuna Pty Ltd, the system is specifically suited for use in roads, parks, golf courses, schools, industrial sites. The system has been used throughout Australia and New Zealand (Waipuna, 1996). Contact: Waipuna Australia Pty Ltd. Suite 102, 17 Heatherdale Road, Ringwood, Victoria 3136. Ph (03) 9874 5100

were sent on courses to improve their pest management skills. With continued public and political support the Council believes the strategy will continue to be effective and that it will expand into neighbouring authorities as well.

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12 Further resources

Internet resources

Error! Reference source not found..

Urban integrated pest management

This site is maintained by the University of Florida, Institute of Food and Agricultural Sciences. The site contains sections on structural pests, biting and stinging insects, fabric & wood destroying pests, insects around food, occasional invaders, lawn insects and landscape pests.

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National Integrated Pest Management Network

The National Integrated Pest Management Network (NIPMN) is the result of a public-private partnership dedicated to making the latest and most accurate information on pest management available on the World Wide Web. The members of NIPMN include universities, government agencies, and industry and have agreed to a set of standards which ensure science-based, unbiased pest management information.

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The Association of Applied Insect Ecologists (AAIE)

The AAIE was established in 1967 to allow practitioners of Integrated Pest Management (IPM) to exchange philosophical ideas and technical information. Today, AAIE's 300-plus members lead the development, adoption and implementation of IPM.

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The Pesticides Trust

The Pesticides Trust aims to create awareness among those who make decisions over the use and regulation of pesticides, and among workers and consumers of the problems associated with pesticides; to provide a forum for discussion of the issues and to help co-ordinate action to tackle problems; to provide information about pesticides; to promote the implementation of ecologically sound, less pesticide-dependent methods of pest control.

Further reading

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Organisations

Urban Feral Animal Group
PO Box B127 Boronia Park, NSW 2111
or contact your local Council or NSW National parks & Wildlife Service, Pest Species Officer
ph: 9412 1811

13 Appendix 1: Code of practice for the safe use of pesticides

[Adapted with permission from Koehler, P. & Short, D. (1998) Department of Entomology & Nematology, Co-operative Extension Service, Institute of Food and Agricultural Sciences , University of Florida, Gainsville].

Objective
The objective of the Code is to provide guidance on decision-making about pesticides and to promote the safe use, storage and disposal of pesticides within the context of the Olympics integrated pest management strategy. Pesticides include insecticides, herbicides, fungicides and other pest controlling agents.

Background
In NSW pesticides are controlled under the *NSW Pesticides Act 1978* which is administered by the NSW Environment Protection Authority. The Pesticides Act works in conjunction with the *Commonwealth Agricultural & Veterinary Chemicals Act 1988*. In NSW the sale, supply, possession, use or disposal of pesticide is prohibited unless it is registered and carried out in accordance with conditions of registration or carried out in accordance with a permit, order or certificate. It is an offence under the Pesticides Act to fail to read or observe label instructions or to cause risk to persons or property in using a pesticide (Environmental Defenders Office, 1992).

Code of practice
When applying any pesticide, you assume the legal responsibility for using it strictly in accordance with label instructions. You must always protect people who live or work in the treated area so they are not exposed to harmful residues. Avoid using pesticides or application methods that might injure non-target animals or plants or damage property. Pesticide use should not endanger the environment or cause contamination of groundwater, soils, air, or human and animal foods. In addition, you must use pesticides in ways that avoid excessive exposure to any part of your own body.

Information summarised in the code includes: precautions that must be observed when handling pesticide containers; guidelines for mixing pesticides; steps that must be taken to properly apply pesticides; ways to safely store pesticides; and, information on pesticide disposal.

Liquids
Pesticide liquids are mixtures of powdered or liquid active ingredients combined with liquid carriers such as water or petroleum products. Pesticides may dissolve in the carrier to form a solution or may remain suspended in the liquid to form an emulsion or suspension. Suspensions and emulsions require constant agitation to maintain a uniform spray
mixture.

Liquid pesticides are applied as spot treatments, crack and crevice treatments, fogs or mists in confined areas, or general sprays to large areas. The common ways to apply liquid sprays are with aerosol dispensers, hand-held compressed air sprayers, backpack sprayers, or larger motorised spray units.

When liquid sprays are applied, a residue of pesticide active ingredient remains on the treated surfaces and helps to manage pests over a period of time, the length of which depends on the type of pesticide used, the type of formulation, the concentration of active ingredient applied, the type of surface treated, and environmental influences such as temperature, humidity, or sunlight.

Undiluted pesticides contain concentrated amounts of active ingredient that may cause serious injury if inhaled, splashed or blown into the eyes, or spilled on the skin or clothing. Some concentrated pesticides may be flammable.

Applying liquid sprays in certain areas may be extremely hazardous. For example, electric outlets, motors,

or exposed wiring pose a potential threat of electrical shock to persons applying water-based pesticide sprays. Pilot lights and gas flames from heaters and appliances may ignite flammable petroleum-based pesticides. Sparks from electric motors and switches and glowing heating elements may also ignite flammable materials. Pesticide vapours or fumes in confined areas may injure people if ventilation is inadequate.

Gases
Gases that kill pests are known as fumigants. They are used to manage certain stored-product insects, drywood termites, wood-destroying beetles, soil-infesting nematodes, soil pathogens, and some rodents. Specially trained pest control operators are required for fumigation procedures.

Dusts
Dust formulations are finely ground dry powders that contain toxic materials. These are sometimes used to manage certain insects. Most dusts are blown into inaccessible places where pests hide. Dusts do not penetrate surfaces and they usually break down slowly. Therefore, the active ingredient in dust formulations remains on the treated surface and is active against pests for a long period of time if the treated area stays dry. Because they do not penetrate, dusts are more effective than liquids on absorptive surfaces such as concrete.

Dusts may be applied in cracks and crevices, under cabinets or appliances, and in other areas inaccessible to children and pets. This formulation leaves visible residues on treated surfaces, which often limits its use to areas such as warehouses, attics, crawl spaces, and wall voids.

Dusts usually provide better coverage than sprays in inaccessible or hard-to-reach places. In wall voids, they can be dispersed with compressed air to better reach all surfaces. During manufacture, dusts are sometimes given an electrical charge or they are combined with an electrically charged powder to make them cling to surfaces better. Bulb applicators, shaker cans, aerosol cans, and compressed air dusters are used to apply dust formulations.

When using dusts, prevent their drift into the airspace of rooms or work areas. Apply dusts only according to the instructions on the pesticide label. Wear approved respiratory protection to avoid inhaling dust particles.

Desiccants are dusts or sorptive powders (eg Dryacide) used to manage certain insect pests found in buildings. The powder abrades or adsorbs the waxy coating that protects insects from losing body water. Desiccants often last longer than other forms of insecticides. However, insects must move through the material or dust and pick some up on their bodies for it to be effective. Desiccants should be blown into wall voids, attics, and crawl spaces and also into other areas where insects hide. Some desiccants are repelling, which helps keep insects from treated areas. Avoid breathing dusts during application by wearing respiratory protection.

Granules
Granular formulations are sometimes used to manage ants, snails, slugs, and occasionally other soil-inhabiting organisms. Usually granules are combined with a food substance or attractant to encourage target pests to feed on them. Do not apply granules in areas where children or pets may come in contact with them.

Poisoned baits
Poisoned bait may be used to manage specific types of insects. Most baits are a combination of a pesticide and a food material and are usually placed in a bait station or broadcast over the soil around the outside of a structure.

Choose bait types and bait station styles on the basis of (1) the type of pest being managed, (2) the past history of bait use, and (3) the conditions where baiting will take place. For example, when baiting for ants, select a bait that foraging workers will carry back to the nest to feed to the colony's reproductives and brood; the toxic substance must be slow-acting so that foraging workers are not killed before they reach the nest. Bait used to manage flies, on the other hand, must be fast-acting in order to stop continued annoyance and

prevent further egg laying.

Place or apply insect baits in areas of greatest activity or in areas that cannot be sprayed or dusted. To treat ants, place the bait along trails, near nest entrances, around the foundation of the building, and under sinks and other out-of-the-way locations inside the building. Apply cockroach bait under appliances, under sinks, behind furniture, and in hidden areas where these insects have been observed or are suspected to occur. Place bait at wall intersections, as cockroaches tend to travel along edges. For cockroach species that occur outdoors, place baits in or around woodpiles, in water meter boxes and other protected locations where these insects are usually found.

How pesticides can injure people

Poisonous chemicals such as pesticides injure or kill people by interfering with the normal functioning of internal body organs and systems. The nature and extent of injury depends on the toxicity of the chemical as well as the dose (amount of material) that enters the body. A person's health and size may also influence the severity of injury.

The ingredients of some pesticides are very potent and are capable of causing poisoning at doses as small as a few drops. Other less-toxic pesticides might require a great deal to be consumed before signs of illness appear. Regardless of the specific potential hazard, anyone working with pesticides should avoid exposure by using suitable protective clothing and application techniques. Anyone living or working in pesticide-treated areas must also be protected from exposure levels that will result in injury.

Poisoning symptoms

Symptoms are abnormal conditions, feelings, or signs that indicate the presence of an injury, disease, or disorder. When a person is exposed to a large enough dose of pesticide to cause injury or poisoning, some type of symptoms will usually appear. These may show up immediately or after several days; sometimes they may not appear for several months or years. It may be difficult to associate the illness or injury with its cause if there has been a lapse of time between exposure and observable effect.

The effect of an exposure can be localised (such as eye or skin irritation) or generalised (when the pesticide is absorbed into the blood and distributed to other parts of the body). A pesticide can affect several different internal systems at the same time. If the person experiences an injury but recovers quickly, or gets worse and dies within a short time, it is known as an acute illness or injury. If the resulting effects last for a long time, and perhaps are irreversible, it is known as chronic. Examples of chronic conditions usually associated with high or prolonged levels of exposure to certain pesticides include, among others, infertility, birth defects, and cancer.

Some pesticide poisoning symptoms are similar to symptoms produced by many other chemicals or conditions. The type of symptoms may vary between chemical classes of pesticides and may also be different among pesticides within the same chemical class. The presence and severity of symptoms usually are proportional to the amount of pesticide (the dosage) entering the tissues of the exposed person. Symptoms may include a skin rash, headache, or irritation of the eyes, nose, or throat. These symptoms disappear within a short period of time and sometimes are difficult to distinguish from symptoms associated with an allergy, cold, or the flu.

Other symptoms, which might be caused by higher levels of pesticide exposure, include any of the following: blurred vision, dizziness, heavy sweating, weakness, nausea, stomach pain, vomiting, diarrhoea, extreme thirst, and blistered skin. Poisoning can also result in apprehension, restlessness, anxiety, unusual behaviour, shaking, convulsions, or unconsciousness of the victim. Although these symptoms can indicate pesticide poisoning, they also may be signs of other physical disorders or diseases. Whenever the possibility of poisoning exists, consult a physician and be sure to have readily available a copy of the pesticide label or the name of the pesticide, the manufacturer, and the EPA registration number. Diagnosis of a pesticide related injury usually requires; careful medical examinations, laboratory tests, observation, and familiarity with a person's medical history.

Individuals commonly vary in their sensitivity to pesticides. Some people show no reaction to a dose that can cause severe illness in others. A person's age and body size may influence their response to a given dose; thus infants and young children are normally affected by smaller doses than adults. Also, adult women may be affected by smaller doses of some pesticides than adult men. The unborn child carried by a pregnant woman may be highly sensitive to exposure to some pesticides by the prospective mother.

Pesticides that are applied in strict accordance with their label instructions and with adherence to application rates, re-entry intervals, protective equipment requirements, aeration periods, and other listed procedures generally do not leave unsafe levels of pesticide residues. Accidents during application may result in a

higher, and sometimes unsafe, exposure. An improper application caused by not following label instructions may also result in injury.

Protecting people

Always apply pesticides in strict accordance with label instructions. Never use a pesticide in a building or other area unless people living or working there can be protected from exposure. This often requires that inhabitants leave the area before an application begins and that they remain away for a specified period of time after the application has been completed. To reduce personal exposure, remove or cover food and utensils before pesticide applications are made. Protect linen, bedding and similar items, open windows and doors in order to increase ventilation after an application has been made. Vacuum carpets and clean floors after a treatment, and keep children and pets away from these areas.

Insecticides may be needed to manage pests in places where food is stored, prepared, or eaten. If so, special precautions must be taken. For instance, never treat food preparation surfaces with dusts or liquid sprays and do not allow residues to drift onto food or utensils. If fogs are used, all food preparation surfaces must be thoroughly cleaned after application.

Never make an application near air ducts or ventilation systems unless the system can be shut down for a period of time. Do not apply pesticides inside heating or cooling ducts.

Infants, children, the elderly, & people with medical conditions

Sometimes the use of pesticides must be restricted or avoided to protect people living in the targeted area. Rely on non-chemical management methods as much as possible, and use a pesticide only where absolutely necessary. When pesticides are needed, choose the safest formulation available such as a bait or a liquid spray having low volatility and follow all label instructions and precautions. Be extremely careful when using pesticides in areas occupied by infants, children, the elderly, or a person who is sick. These areas include hospitals, nursing homes, schools, and certain households.

Infants are more vulnerable to pesticide exposure than larger children or adults. This is because of their smaller size and undeveloped immune system which is responsible for detoxifying hazardous chemicals. Do not apply a pesticide to any item used for infant care, and avoid spraying or dusting carpets, clothing, blankets, towels, or any fabrics that infants or others may contact. When a pesticide is needed in areas where an infant may spend part of the day, use a formulation that will break down completely before the infant returns.

Children under the age of six are active and curious and it is difficult to keep them away from places where a pesticide has been used for management of household pests. Young children are highly mobile and active exploring and put many objects (including their hands) into their mouths. They also frequently crawl on floors and climb on other surfaces. Therefore, never apply a pesticide to play equipment, toys, or any surfaces normally contacted by the youngsters. On carpets, use pesticides that break down rapidly. In all cases, use pesticides having low toxicity and low volatility. If you use bait stations or traps, secure them in a place well out of reach and out of
sight.

Elderly people may be susceptible to respiratory illnesses and other physical disorders that may result in them having a low tolerance to many airborne dusts and chemicals, including certain pesticides. In some instances, their bodies may be unable to properly degrade or eliminate foreign or toxic materials, such as pesticides. Therefore, use extreme caution when making pesticide applications in rooms where elderly people sleep or spend long periods of time and whenever possible, avoid treating these places. In other areas, use a pesticide with low toxicity and low volatility and spot treat as much as possible to reduce potential hazards. Select alternate methods of management whenever possible, and always augment pesticide use with other pest management techniques so that the amount of pesticide used can be minimised.

People who are acutely ill or suffer from conditions such as diabetes, alcoholism or have allergies or respiratory disorders including asthma and emphysema may be more sensitive to pesticides in their

environment. Medications used to treat illnesses may influence the effects of pesticide exposure. Provide persons who are ill or using medications with the name of the pesticide you plan to use and ask them to contact their physician for advice.

Applicator safety
Safety risks for applicators working in buildings or enclosed areas are compounded by hazards such as electrical equipment, possibility of explosions, and confined work areas. Learn to recognise hazards in the application site that could cause injury. Avoid pesticide exposure by wearing required or recommended protective equipment. Carefully maintain, clean, and store protective equipment in order to keep it in good condition and to ensure that it provides optimum protection.

Fire, explosion, & electrical hazards
Fires, explosions, and electrical hazards can occur in residential, industrial, and institutional settings and other confined areas. Before using a pesticide, examine the intended application site for hazards. For example, never apply a pesticide dissolved in oil or petroleum solvent in an enclosed area if there is any source of spark or flame such as functioning electrical motors, wall switches, appliances, or pilot lights. Before making an application, shut off electric and gas services to the treatment area. Avoid the use of aerosols in wall voids near hot water pipes since heat from these pipes can ignite solvents and cause a fire. Do not use dust in an enclosed area if there is an ignition source. Any airborne dust at the right concentration can explode. Boric acid dust is capable of extinguishing a pilot light, which could create an explosion hazard due to escaping gas (most new gas appliances are equipped with safety shut-off devices or igniters in place of pilot lights).

Do not use a water-based spray around electric appliances, outlets, or switches unless the power has been shut off. Water conducts electricity, so you are at risk of electrocution if the spray touches a live power source.

Working in confined areas
Confined areas present special hazards to persons making a pesticide application. Confined areas may be attics, crawl spaces beneath buildings, storage areas, closets, small rooms, and other places that have poor ventilation. Hazards include inhaling the pesticide being applied and coming in contact with treated surfaces. Cramped areas also may be uncomfortably hot due to poor air circulation. High temperatures may increase the applicator's exposure potential, because sweating accelerates the rate of skin absorption of some pesticides.

Exposure hazards should be reduced when working in confined areas by wearing personal safety equipment. Whenever possible, increase ventilation in the treatment area by opening windows or using a fan to bring in fresh air. Always begin the application from a point furthest from the exit and never walk or crawl through freshly applied pesticide.

To avoid breathing fumes, wear an approved respirator for the pesticides being applied. Be sure it is in good working condition, fits well and thoroughly forms a good seal well around your face.

Prevent skin or eye contact with spray residues or vapour. When making an application, always wear a longsleeved shirt and full-length pants, coveralls, or lightweight spray suit. Protect your hands with waterproof gloves and use a face shield or goggles to prevent spray or dust from getting into your eyes. Read the pesticide label carefully for the minimum protective clothing requirements.

Protecting pets & domestic animals
Pets housed in or near residences or other buildings that are to be treated can often include several types of mammals, birds, reptiles, amphibians, and fish. Associated with pets and domestic animals is their food and water supplies, bedding, pens, equipment, and toys.

Most animals are susceptible to injury by pesticides. Some types of pesticides are applied at low doses. Fish and birds are among the most susceptible. Cats are very sensitive because they are metabolically unable to

detoxify many types of pesticides. Young animals as well as older or sick animals may be affected by lower pesticide doses than adult or healthy animals. Cats and dogs often lie and sleep on the ground and other surfaces that may have been treated and then they may groom and clean themselves by licking. This process can increase their potential for exposure even when small amounts of pesticide have been used.

In order to provide protection for pets and domestic animals, remove them from the area before making a pesticide application. Keep animals away until the spray dries and the area is well ventilated. Do not apply pesticides on or near animal food or water or dishes in which are used in feeding. If the animals are returned to the treated area, flea collars should be removed and any ectoparasite systemic medications should be discontinued.

Protect pests in aquariums. First turn off aerators or unplug them so airborne pesticide is not bubbled into the water. Second, cover the tank with newspaper or plastic bags to prevent sprayed pesticide from drifting into the water. Third, place any food or drugs used to treat the pets in plastic bags so they do not become contaminated with insecticide. Protect birds or other animals in cages by asking the owner to remove the pet from the premises or carrying the cage to an untreated bedroom. Keep the animal out of sprayed rooms until the treatment is dry.

Pesticide drift

If pesticides are not carefully applied, they may drift beyond the treatment site and become deposited as unacceptable residues on surfaces not intended to be treated. These residues can possibly endanger non-target organisms. Residues from improper application or improper rinsing of equipment may also result in contamination of surface or groundwater.

Preventing drift or unwanted exposure

Do not use dust formulations in outdoor locations since they easily drift to areas not to be treated. To prevent drift when applying liquid sprays, use low pressures and large nozzle orifices. This reduces formation of small droplets that are subject to drift. Never make an outdoor application of a liquid spray when the wind is blowing faster than 8 kilometres per hour. If there is a slight wind, select a formulation or adjuvant that reduces drift. Be especially careful if you are spraying near fruit trees or vegetable gardens, flowers, clothing being air dried outside, cars, windows, and dark surfaces that may spot. Special care should be practised around pet or livestock food and water containers, fish ponds, bird baths, swimming pools, saunas, spas, or outdoor furniture. Avoid outdoor applications that may drift to children's play areas, sandboxes, swing sets, or lawns and shrubbery that children contact.

Do not apply a pesticide in outdoor locations where residues can be carried into a stream, pond, or other water source. Never drain or wash application equipment where runoff will enter sewers, sinks, sumps, or drain tile systems.

When making a liquid or dust application inside a structure, keep the spray or dust away from air ducts, fans, or blowers in order to prevent the material from being blown into non-target areas.

Characteristics of treated surfaces

Treatment sites may have surfaces whose characteristics must be evaluated before applying a pesticide. Depending on the type of surface, a pesticide can be absorbed and rendered ineffective, or the surface may be stained or etched. Concrete, for example, is porous and tends to absorb liquid sprays, reducing the amount of residue on the surface that is available to manage target pests.

Floor coverings such as linoleum, tile, and carpeting can be stained or etched by some pesticides or solvents. Certain wallpapers and carpets contain dyes that may run, dissolve, fade or change colours if exposed to components of some pesticides. Paint and other finishes used on walls or woodwork may also react with spray chemicals to produce spotting or discolouration. Fabrics of all types, and the dyes used to make their patterns and colour, may also react, affecting future wear or causing a stain or change in colour. A soiled fabric may react differently to a clean one. Fabrics also can absorb a liquid pesticide, reducing pest management effectiveness.

Dust formulations can leave an unsightly residue if applied to surfaces of furniture, woodwork, fabrics, and other items in the treatment area.

Preventing problems

Stains or colour changes may be caused by an excessive dose or by certain application techniques. The formulation type being used may affect staining or spotting. A soiled or greasy surface may increase staining, spotting, or absorption. Paint that has been recently applied and not fully dried or cured has more of a tendency to spot.

Whenever possible, first apply a pesticide to an inconspicuous area, such as a closet, and allow the pesticide to dry for several hours to observe the reaction. Care should be taken when treating upholstery, furniture, drapes, or lower wall surfaces with a pesticide (lower wall surfaces are more likely to be soiled, which may enhance staining or bind the pesticide to make it less effective). Read and follow label directions and precautions carefully to avoid: staining, spotting, visible residues, and pesticide deactivation. Thoroughly clean the application equipment before adding a pesticide to prevent a possible reaction between the pesticide and leftover contaminants in the equipment. These contaminants may cause stains or other adverse effects.

When two or more pesticides are mixed, additional problems associated with pesticide in compatibility may appear. Check the compatibility of pesticide mixtures before application by mixing a small quantity to determine whether separation or discolouration occurs.

Odour problems

Many pesticides have odours that can be detected during and after application. Odours are usually strongest when pesticides are first applied. In confined areas, odours may become overpowering and objectionable; they can cause nausea or headache, initiate asthma or other breathing difficulties, or may trigger other medical or anxiety-related symptoms.

An odour may be a chemical characteristic of the pesticide or its solvent, or it may be a substance added to the pesticide as a warning agent to reduce chances of injury. Reduce problems associated with odours by (1) using only the application rate stated on the pesticide label, (2) applying the pesticide in localised areas or as a spot treatment whenever possible, (3) using a low-odour formulation if available and if appropriate, (4) increasing ventilation to the application area by opening windows and doors or using fans, and (5) applying the pesticide during periods when the building is not occupied.

An odour may also be caused by a reaction between the pesticide and surfaces that have been treated. Before applying any pesticide in a confined area, read the pesticide label to determine if any of the chemicals in the formulation will react with treated surfaces to produce an odour.