Department of the Capital Territory

DRAFT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED EXTENSION
OF THE
NATIONAL BOTANIC GARDENS

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1 PURPOSE OF THE ENVIRONMENTAL IMPACT STATEMENT

1.1 Pursuant to paragraph 3.1.1 of the Environment Protection Administrative Procedures, the then Minister for Science and the Environment, Senator the Hon. J.J. Webster, on 18 October 1979, directed the preparation and submission of an Environmental Impact Statement in relation to a proposal by the Department of the Capital Territory to extend the area of the National Botanic Gardens by developing about 40 ha of land to the south of and contiguous with the existing Gardens on Black Mountain. (Appendix 1.)

1.2 The Department has investigated the environmental issues associated with the proposal and prepared this Statement to:

- demonstrate the need for an extension to the National Botanic Gardens;
- analyse two alternative sites for the proposed extension and evaluate the associated environmental issues; and
- provide the opportunity for public review and comment on the proposal.

2 SUMMARY

2.1 The National Botanic Gardens occupies approximately 44 ha on the north-eastern slopes of Black Mountain, less than 2 km from the Civic Centre of Canberra. (Map 1.) There is also a coastal annexe of 78 ha at Jervis Bay.

2.2 The functions of the Gardens are to collect, study and display a national collection of Australian native plants and related species for scientific study, conservation and public education and enjoyment.

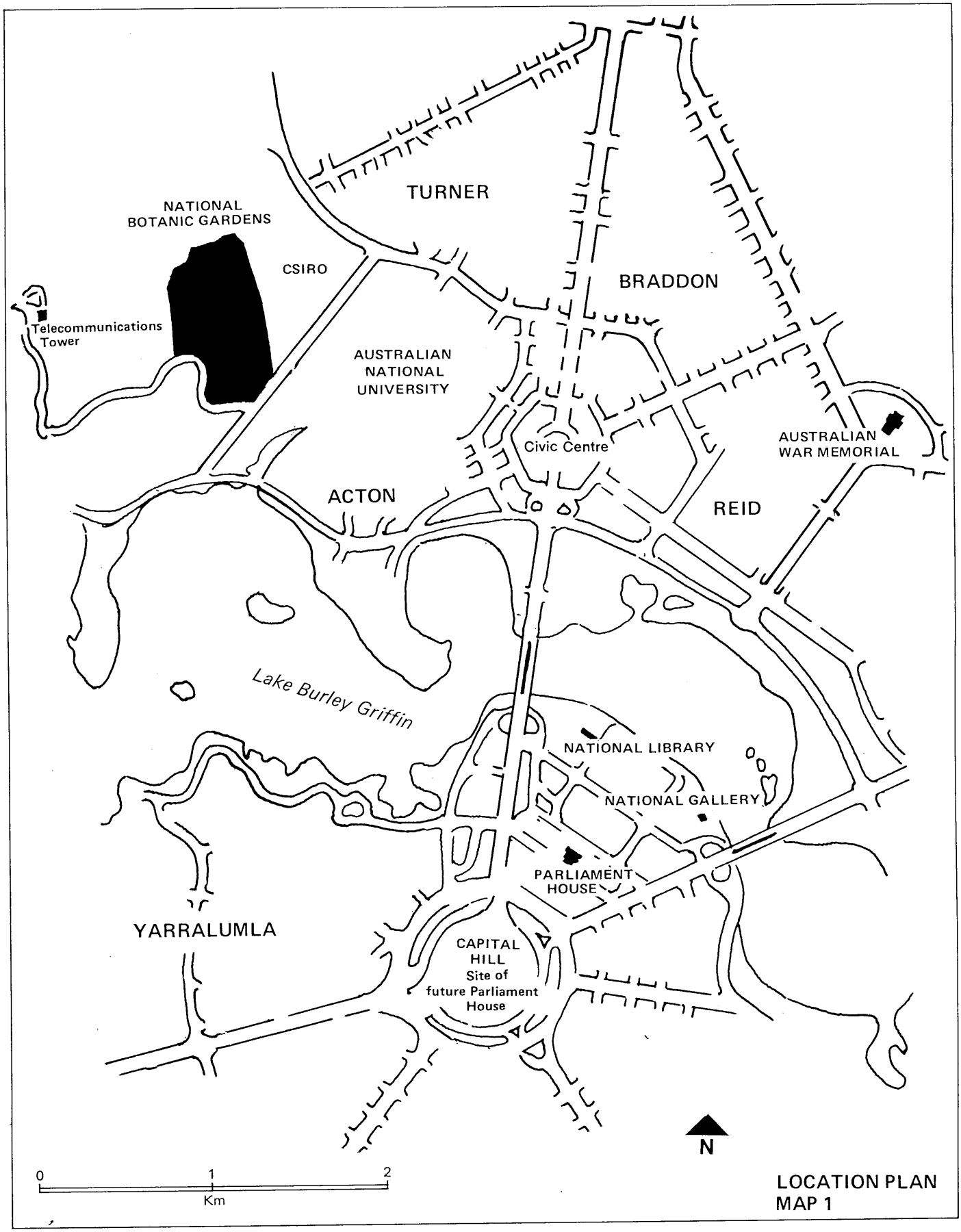
2.3 The present area was fenced for management protection purposes in 1960 and officially opened as the Canberra Botanic Gardens on 20 October 1970. An extension of the Gardens to accommodate additional plantings was foreshadowed at that time by the Hon. P. Nixon, then Minister for the Interior.

2.4 The existing site is almost at maximum capacity although only about half the number of species potentially suitable for cultivation in Canberra has been established.

2.5 Alternative ways of increasing representation of the Australian flora in the Gardens have been examined and their environmental effects assessed.

2.6 The preferred option is to utilise an additional 37 ha immediately south of the existing Gardens. This Draft Environmental Impact Statement examines the nature of the environmental modifications which would result from development of the proposed site and the potential benefits that could be achieved.

2.7 In addition, it is proposed to add about 3.5 ha to the north of the existing Gardens on the site of a former car dump, to provide additional facilities including a picnic area and public access to the upper part of the existing Gardens.



LOCATION PLAN
MAP 1

3 BACKGROUND TO THE PROPOSAL - HISTORY OF THE DEVELOPMENT OF THE NATIONAL BOTANIC GARDENS

3.1 In Walter Burley Griffin's successful design for the Australian national capital in 1911 he

> envisaged formal gardens between Regatta Point and Aspen Island, as they are now called. In the West Lake area he mapped out a large scale Continental Arboretum, an ambitious and novel concept in which he saw wide separate areas planted with species from Europe, Africa, Asia, North America and South America on the north side, while Australia and New Zealand would be represented on what is now the Weston Park on the southern shores of the lake ... and to complete the picture ... he nominated an area, where Stirling Park now stands, for the cultivation of specimens from the South Sea Islands.
>
> All the area now developed or being developed as Canberra's north-western suburbs was to be forest reserves; Black Mountain was a reservoir site and scenic lookout, to remain more or less in its native state. The Botanic Gardens were to extend from the lower slopes of Black Mountain to the lake's edge 'near the University'. (Canberra Botanic Gardens, Department of the Interior, 1970, p. 11.)

3.2 Little was achieved towards the formal establishment of either the Continental Arboretum or the Botanic Gardens during the next twenty years, although extensive tree-planting programs were implemented throughout the city and its surrounds.

3.3 In July 1933, the Advisory Council to the Minister for the Interior requested:

> ... that a start be made with laying out portion of the site set apart for Botanical Gardens and of planting same with native and exotic trees, shrubs and plants of economic and medicinal value as distinct from those grown for ornamental purposes only.

3.4 This request resulted in arrangements being made for Dr B.T. Dickson, Chief of the Council of Scientific and Industrial Research, to advise on preliminary investigations and layout of the Canberra Botanic Gardens. On 4 September 1935, Dr Dickson submitted his report to the Department of the Interior.

3.5 Dr Dickson stated that two important considerations were kept constantly in mind while he was preparing the report:

> In the first place botanical gardens cannot be created in a short time ... Consequently the most careful attention must be given to the choice of site and its suitability for the development of the main features of the gardens. Further if the establishment is once initiated it should be pursued consistently in order that the scheme may come to fruition in a reasonable period of years.

In the second place it is necessary to be quite clear on the point that botanical gardens cannot be successfully maintained, even if initially well-founded, in the absence of an adequate annual appropriation.

3.6 In supporting the general location originally suggested by Walter Burley Griffin, Dr Dickson noted that:

> It is not disguised that the land is gravelly and that the control of gullies which have developed down the slopes will constitute a difficult problem, though one not impossible of solution. Against this is to be set the scenic beauty of the site with the lake and the mountain forming the lower and upper boundaries.

3.7 On the question of size Dr Dickson stated:

> To enable the best development of any botanical gardens an area of some size is essential, particularly when the arboretum phase of the Gardens is given its proper proportion in the scheme as should be the case in Canberra. Further in order that the gardens shall be in keeping with the general scheme of layout for the capital, they should be spacious and susceptible of considerable subdivision.

3.8 The area Dr Dickson recommended (Map 2) was about 120 ha.

3.9 No development of any significance concerning the Botanic Gardens occurred until after the Second Warld War when the Superintendent of Parks and Gardens, then Mr Lindsay Pryor, took up the concept. By April 1949 the area recommended for the Gardens had been enlarged from that proposed by Dr Dickson by the addition of 'a natural preserve' between the Gardens proper and the summit of Black Mountain. (Map 2.) This enlarged area amounting to 230 ha was approved by the then Minister for the Interior, the Hon. P.A. McBride, on 16 October 1950 as the site of the Canberra Botanic Gardens and as a Natural Preserve.

3.10 Meanwhile, on 12 September 1949, the then Prime Minister, the Hon. J.B. Chifley, and the Director of the Royal Botanic Gardens, Kew, Sir Edward Salisbury, had carried out the first tree planting. The Canberra Times reported the event on 13 September 1949:

> The first tree planting in the botanic gardens area of Canberra was performed by the Prime Minister (Mr Chifley) in the presence of delegates to the British Commonwealth Specialist Conference in Agriculture. Mr Chifley planted a small gum tree and Sir Edward Salisbury, Director of the Royal Botanic Gardens at Kew, London, planted a small oak tree.[1] Six hundred acres of the south eastern slopes of Black Mountain and bounded by the CS & IR and the National University have been set aside for the botanical gardens. The timbered section near the top of Black Mountain, comprising approximately 300 acres, will be retained in its natural state for the development of native flora.

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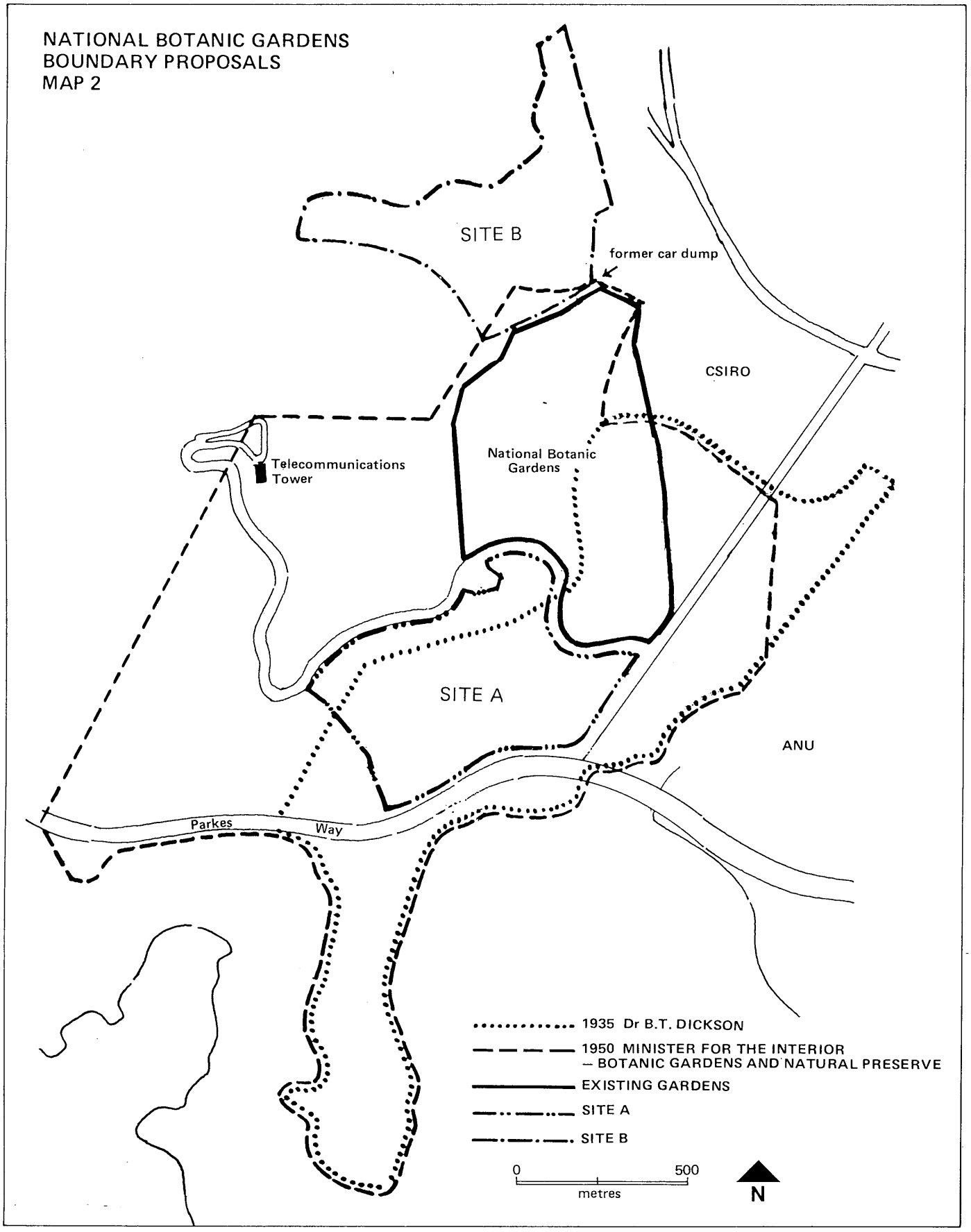
[1] An unsuccessful attempt to transplant this tree to Bowen Park was made in the late 1960s.


NATIONAL BOTANIC GARDENS
BOUNDARY PROPOSALS
MAP 2
SITE B
former car dump
CSIRO
Telecommunications
Tower
National Botanic
Gardens
SITE A
ANU
Parkes
Way
1935 Dr B.T. DICKSON
1950 MINISTER FOR THE INTERIOR
– BOTANIC GARDENS AND NATURAL PRESERVE
EXISTING GARDENS
SITE A
SITE B
0
500
metres
N

3.11 In 1951 the Jervis Bay Annexe was established on about 2 ha of land on the edge of Lake McKenzie. The purpose of this Annexe is to enable the National Botanic Gardens to cultivate frost-tender native plants under more favourable climatic conditions than those which prevail in Canberra.

3.12 An area of 44 ha within the area approved on Black Mountain was fenced in 1960 as an initial management unit.

3.13 In September 1966, the then Prime Minister, the Rt. Hon. H. Holt, approved the continued development of the Gardens and public access was permitted in 1967. The official opening was performed by the then Prime Minister, the Rt. Hon. J.G. Gorton, on 20 October 1970 to coincide with the Sixth International Congress of Park Administration.

3.14 In announcing the official opening the Hon. P. Nixon, then Minister for the Interior, indicated a plan to extend the Gardens by a further 40 ha once the present area was fully developed 'by about 1975'.

3.15 The Black Mountain Reserve was declared a public park on 23 July 1970 under the Public Parks Ordinance 1928. The Botanic Gardens area is included within the public park.

3.16 The Preliminary Development and Management Plan for the Black Mountain Nature Reserve (1974) recommended that '... the extension to the Botanic Gardens should be surveyed and excised from the existing reserve.' Two areas were referred to for the extension. The first was an extension of the Gardens to the north '... to include the old car dump which has been bulldozed over. This area is not recommended to be included within the reserve as it is better suited to management as a picnic and parking area by the Botanic Gardens.' An area to the south of the present Gardens site across Black Mountain Road was the second area suggested for extension. It was recognised that '... much of it has already been cleared in earlier days and the whole area is highly disturbed. It appears to be well suited to the Botanic Gardens and badly suited to the reserve.'

3.17 On 21 December 1978, the Minister for the Capital Territory, the Hon. R.J. Ellicott, announced that the Canberra Botanic Gardens had been renamed the 'National Botanic Gardens' in recognition of the nature of the plant collection. Mr Ellicott said it was necessary to consider enlarging the area substantially to provide for the increasing collection and an environmental impact study was being undertaken with this in view.

3.18 The National Botanic Gardens is now recognised as the country's centre of skill and information on growing Australian native plants and it will continue to play an increasing role in the study, cultivation and conservation of the Australian flora.

Present activities of the Gardens

3.19 In discussing the aims and objectives of botanical gardens Dr Dickson suggested:

> The modern tendency is for botanical gardens to become a combination of scientific and educational institution and public park, a fact well illustrated by the Royal Botanic Gardens at Kew, Le Jardin des

Plantes of Paris, Berlin Botanic Garden at Dahlem, the New York Botanical Garden at Bronx Park and the Botanic Garden of the Imperial University at Tokyo, Japan.

In view of the anticipated development of Canberra as the capital of the Commonwealth with a University and scientific institutions, the Botanical Gardens should be planned to serve as an additional scientific institution and as Canberra will increasingly become a mecca for visitors the conception of a public park with aesthetic landscape treatment should be a natural part of any scheme of development.

3.20 Dickson went on to recommend that:

The authorities would be well advised to plan the proposed gardens at Canberra so that they are developed with a balance between the scientific and the aesthetic, and certainly not to the neglect of the scientific phase.

3.21 The present aims of the National Botanic Gardens are to establish, maintain and display to the highest standard possible a national collection consisting predominantly of Australian native flora and related species for botanical and horticultural studies, conservation and public education and enjoyment.

3.22 The Canberra collection consists of living plants in the open ground at the Black Mountain site and a limited number of tropical and sub-tropical plants maintained under glasshouse conditions. Approximately 4000 species, or about half the number potentially capable of being cultivated in Canberra, are represented. A policy has been adopted to plant groups of individuals, rather than single specimens, wherever possible and the same species may occur in several places as plantings are arranged in taxonomic, ecological, geographic, educational and aesthetic groups.

3.23 Propagation of plants for the collection in the Gardens and for botanical and horticultural research is undertaken in the nursery. Plants produced are for use only at the National Botanic Gardens and its annexe at Jervis Bay. Several important collections of frost-tender plants are permanently held in glasshouses. In addition, some species which are difficult to propagate or cultivate are held in large containers as stock plants until numbers can be built up sufficient for establishment in the Gardens. Emphasis is being placed on bringing into cultivation a wide range of plant species endangered in their natural habitats.

3.24 A Herbarium with capacity for over 700 000 specimens has been established as an essential part of the National Botanic Gardens. About 100 000 specimens are currently held in the Herbarium. These have been assembled for botanical studies from field collections throughout Australia and many of these are vouchers for plants growing in the Gardens. A voucher specimen is one to which reference may be made in the future to verify the identity of the plant on which studies were made. Emphasis to date has been placed on the vascular flora although serious study and collection of the non-vascular flora has begun and investigations are being carried out determine the most suitable methods of cultivation of this somewhat neglected component of the Australian flora.

3.24 The Herbarium co-operates with other herbaria throughout the world and in 1978 more than 12 000 specimens were processed for loan or exchange. In addition to Botanic Gardens staff, the Herbarium is used by other botanists from Australia and overseas and has increasingly become a reference centre for students of the Australian flora.

3.25 The National Botanic Gardens works in close co-operation with other scientific institutions in Canberra including the Herbarium Australiense and other sections of the CSIRO Division of Plant Industry, the CSIRO Division of Forest Research, the Canberra College of Advanced Education, the Australian National University, the Australian National Parks and Wildlife Service and the Bureau of Flora and Fauna (Department of Science and the Environment).

3.26 The Australian Cultivar Registration Authority (ACRA) is based at the Gardens and many registered cultivars of Australian species are now planted for display and evaluation. The ACRA was set up in 1963 to register cultivars resulting from selection and breeding of Australian flora. It was transferred from Melbourne to the Gardens in 1973 and is recognised by the International Commission for the Nomenclature of Cultivated Plants of the International Union of Biological Sciences.

3.27 The National Botanic Gardens participates in an international seed exchange system between accredited botanical gardens throughout the world. During 1978-79 more than 6000 packets of seeds were supplied to other botanical gardens. The seeds of exotic plants received in exchange are evaluated by the Research Section of the City Parks Administration for use in the development and maintenance of the Canberra landscape.

3.28 An active botanical and horticultural research program has been developed to study taxonomy, ecology, morphology, nutrition, propagation, selection and domestication of Australian plants. This research has been described in papers published in scientific and technical journals.

3.29 The educational function of the Gardens is fulfilled by labelling plants; maintaining a display room with special botanical and horticultural displays which are changed quarterly; publishing the series Growing Native Plants which now includes ten volumes; providing ranger-led tours for school groups and others; conducting regular study groups for children from primary schools as part of the curriculum; and by constructing trails such as the Aboriginal Trail and the Nature Trail to illustrate special features and uses of Australian plants.

3.30 Native plant workshops for the general public were initiated in 1979 and over ninety people took part in a series of lectures and demonstrations on plant propagation towards the end of that year. These have been continued in 1980 and are designed to increase the knowledge of, and interest in, the cultivation of Australian native plants by home gardeners.

3.31 The Gardens is a major national tourist attraction and is open to the public from 9 am to 5 pm (6 pm on weekends during daylight saving) every day of the year except Christmas Day. More than 150 000 visitors were recorded during calendar year 1979. Horticultural advice on growing native plants is always available from trained staff at the inquiry desk in the display room. Two signposted walks (the white and the blue arrow walks) have been designed to lead the visitor through various parts of the Gardens such as the rainforest gully where many temperate and sub-tropical rainforest species have been

established. Special attention is being given to improve access and facilities for disabled people, the elderly and the very young throughout the Gardens and a special garden for disabled people is being planned for construction during the International Year of Disabled Persons in 1981.

3.32 Visitors may be taken by rangers on guided tours through the Gardens. Groups from educational institutions make up the bulk of these visitors. In the twelve-month period July 1978 - June 1979, 129 educational groups visited the Gardens, by arrangement, and most were conducted on tours led by the rangers and education officers.

3.33 In addition more than 1500 people including members of horticultural and bird-watching clubs, scientists with a professional interest in the Gardens and groups such as scouts were taken on guided tours.

Administration of the Gardens

3.34 The National Botanic Gardens is administered as a sub-section of the City Parks Administration, Department of the Capital Territory. The present staff complement consists of six professional botanists and horticulturists, twenty technical and overseer staff, four administrative and clerical officers and thirty-six industrial staff. Additional seasonal staff are engaged during summer to assist with maintenance during the peak growing season.

3.35 At this stage the Gardens is included within the Black Mountain Reserve public park and the provisions of the Public Parks Ordinance and Regulations apply. It may be appropriate in the future to consider a separate declaration for the National Botanic Gardens and specific legislation for the protection and maintenance of the living and herbarium collections and regulations of use of the area. Other ACT Ordinances relating to unleased land also apply.

3.36 The rangers within the Gardens are authorised officers under the following Ordinances: Dog Control Ordinance 1975, Timber Protection Ordinance 1919, Animals and Birds Protection Ordinance 1918, Careless Use of Fire Ordinance 1936, Protection of Lands Ordinance 1937, Public Parks Ordinance 1928, Trespass on Commonwealth Lands Ordinance 1932, Wildflowers and Native Plants Ordinance 1936 and Litter Ordinance 1977.

3.37 The botanic gardens located in Sydney, Melbourne, Perth and Adelaide have been proposed for listing in the Register of the National Estate maintained by the Australian Heritage Commission. It may be appropriate to consider the suitability of listing the National Botanic Gardens once the final boundaries are determined.

4 THE OPTIONS

4.1 The present area of the Gardens is almost fully occupied and contains about half the number of species it is believed can be grown successfully out of doors in Canberra. If no action is taken the collection could be maintained at its present level but would lack many species which are necessary to make the collection representative and seriously reduce its scientific and recreational potential.

4.2 The options available to cultivate the additional species potentially capable of being grown under Canberra outdoor conditions are:

(a) increase the density of planting on the existing site;

(b) reduce drastically the number of individuals of each species planted; and

(c) extend the area under cultivation.

4.3 Option (a): One of the management objectives of the Gardens has been to preserve as much as possible of the natural tree cover to maintain a wooded appearance to the footslopes of Black Mountain when viewed from the city. This has been achieved effectively as illustrated in photographs taken from vantage points in Canberra (Plates 1, 2 and 3). One of the consequences of this policy has been to restrict the density of planting to compensate for competition for light and water from the natural tree cover.

4.4 It is not feasible to increase the density of planting and maintain satisfactory growth without markedly reducing the existing tree cover. This would be contrary to the landscape policy of the National Capital Development Commission to maintain the presence of a tree canopy.

4.5 Option (b): Considerable effort and expense have been applied to the selection and design of plantings in the Gardens to serve the three main functions of education, recreation and scientific study.

4.6 The National Botanic Gardens as indicated in paragraph 3.22 has adopted a policy of group planting where possible to demonstrate the variability existing within families and genera and in some cases to establish a sequence of age classes. In the taxonomic groupings, related species have been planted together to illustrate affinities and differences between species and genera within one family. In other areas, plants occurring naturally in a geographic region have been established together to illustrate similarities in adaptive characteristics to particular ecological conditions. Species with a common function such as their value as traditional food and medicine have been planted together to assist in the educational program of the Gardens, while groups of plants with special landscape values arising from flower colour, form, texture or growth habit have also been established. Thus a single species with special scientific, educational and aesthetic interest may occur in a number of places in the Gardens.

4.7 Option (c): The most appropriate way to increase the number of species cultivated in Canberra is to increase the size of the Gardens. This can be achieved effectively either by:

(i) selecting an adjacent site, which could be integrated with the

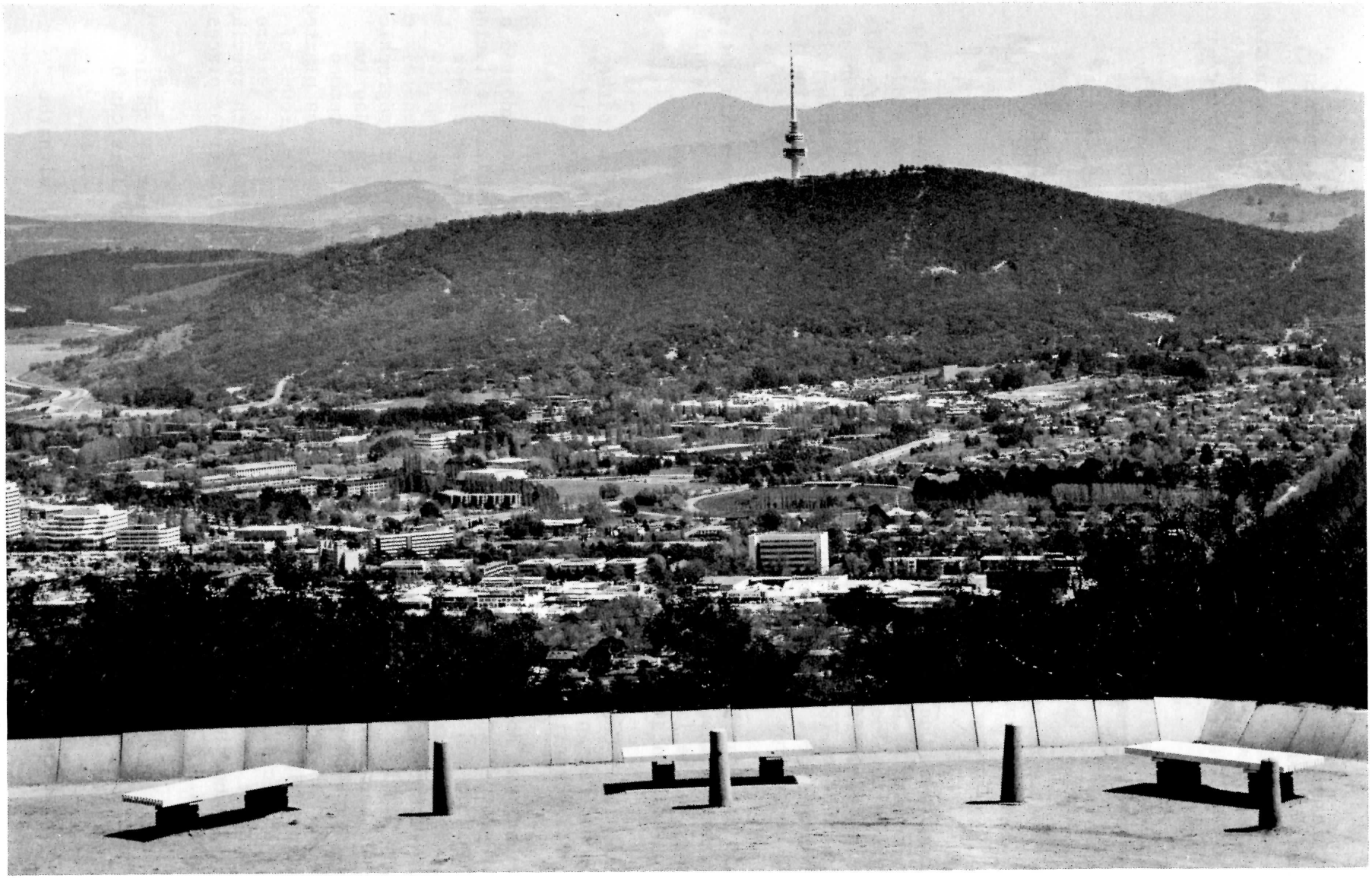


Plate 1: Black Mountain viewed from Mt Ainslie. The existing Gardens development on the lower slopes of Black Mountain is not obvious due to the careful retention of tree cover and sensitive siting of buildings and facilities.

existing Gardens thus utilising much of the existing infrastructure and resources, or by

(ii) selecting a site elsewhere in the Canberra region.

4.8 It is considered that the new area should be close to, and preferably adjoining, the existing Gardens to ensure the efficient use of equipment and staff. Failure to meet this criterion would require the duplication of both personnel and expensive equipment. Patrol and surveillance by rangers could be shared between contiguous sites, but the establishment of a new group would be required for an isolated site. Specialist labour for tasks such as plumbing and pest and weed control would be more efficiently utilised in a single garden complex than in isolated units. Managerial and professional staff would have direct access to all the Gardens if expansion was into an adjoining site, but if the new development was some distance from the existing offices much valuable time must be spent travelling. If the new site was separate, propagation material from the Gardens would need to be stored in holding areas at the site thus leading to a duplication of facilities.

4.9 The National Botanic Gardens is a major tourist attraction and it is appropriate that it is located in an area readily accessible to visitors and residents alike. It is also desirable from a tourist point of view that the Gardens not be dispersed. An expansion of the Gardens would improve its status as a tourist attraction and lead to an overall improvement in recreation facilities available to ACT residents and visitors.

4.10 For scientific reference purposes it is often desirable for plants to be grown where they can be readily compared with each other. If there is a significant geographical dislocation between examples of species, genera and families, then ease of comparison is lost and the usefulness of the Gardens as a scientific reference area is reduced.

4.11 After considering all reasonable options the preferred one is to extend the National Botanic Gardens into a suitable adjacent site.

4.12 There are several criteria which any extension to the existing Gardens must fulfil:

- For administrative efficiency the site should adjoin the existing Gardens, as discussed above, and be capable of development at reasonable cost.

- There should be a variety of landforms available to meet the environmental requirements of the large number of species to be grown in the area and to provide wide scope for landscaping and plant display.

- Soils should be medium to light and free draining so that water-logging problems do not occur under irrigation and after long periods of rain.

- Existing plant communities on the site should not contain any rare or endangered species not found elsewhere. It may be possible, however, to preserve representative stands of existing material within the Gardens.

- The site should not contain the habitats of rare or endangered fauna.

- The site must be capable of being provided with an adequate water supply.

- There must be good access for staff, students and other visitors. Ideally the site should be centrally located and not difficult for tourists to locate.

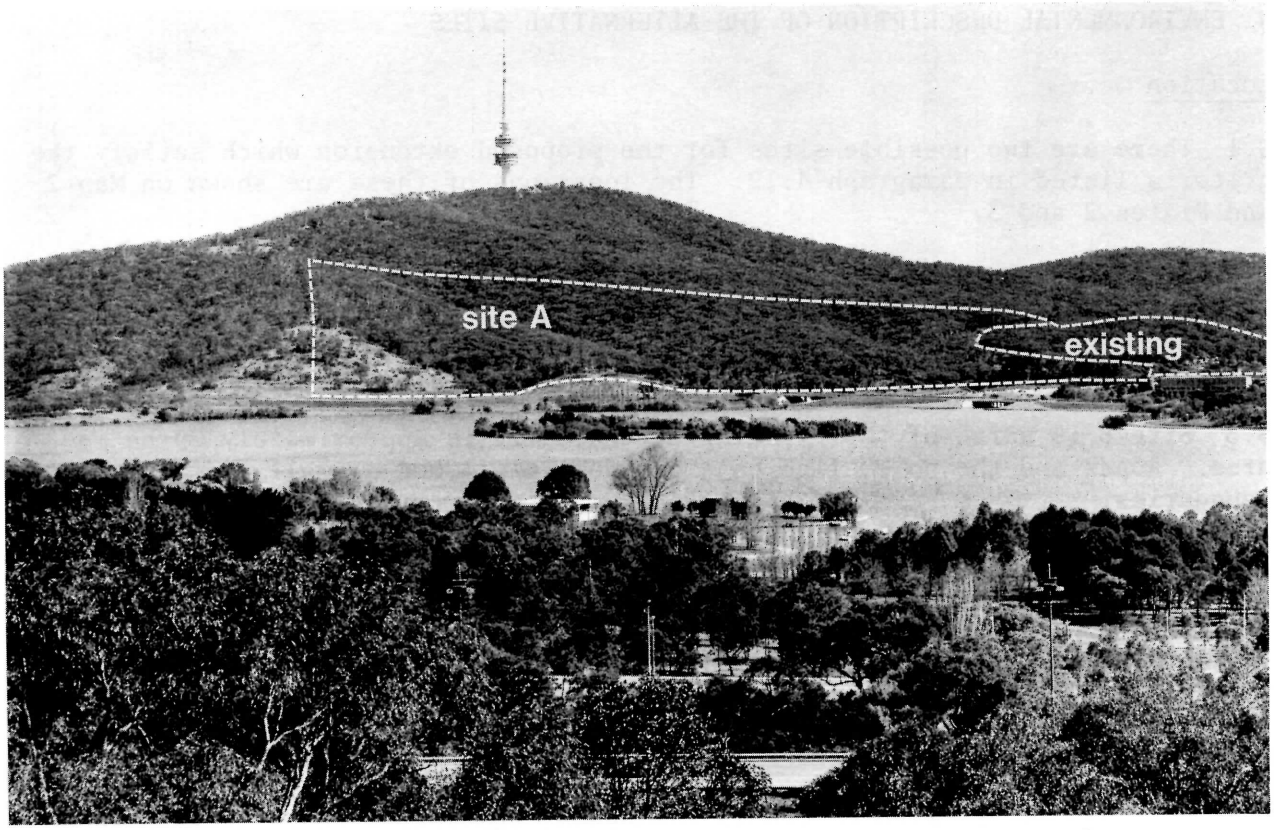


Plate 2: Site A viewed from Capital Hill. The wooded appearance of most of the site would be retained and tree cover restored on the bare areas.

Plate 3: Site B and the existing Gardens viewed from Capital Hill.

5 ENVIRONMENTAL DESCRIPTION OF THE ALTERNATIVE SITES

Location

5.1 There are two possible sites for the proposed extension which satisfy the criteria listed in paragraph 4.12. The locations of these are shown on Map 2 and Plates 2 and 3.

5.2 Site A is south of the existing Gardens between Clunies Ross St, Black Mountain Dr and Parkes Way. The western boundary follows the power line along a ridge to near the Sullivan Trig. point. The area of this site is approximately 37 ha.

5.3 Site B is north of the existing Gardens. It is approximately 29 ha in area. Roads and the power line easement define all but a small section of its boundaries.

Climate

5.4 The geographic position and altitude of Canberra result in a climate which differs in many respects from the climates of other large cities in Australia, most of which are located near the coast. The Canberra climate is continental, typified by hot summers and cold winters, but altitude has a moderating influence on summer temperatures and tends to lower those in winter.

5.5 Rainfall is distributed evenly throughout the year with an average annual recording of about 638 mm. Severe droughts have been recorded in the Canberra district since the early days of settlement, but usually the rainfall is fairly reliable.

5.6 The number of hours of sunshine received, particularly during winter, provides a good idea of the climate of a locality in mid-latitudes (Bureau of Meteorology, 1968). Winter sunshine is often a better indication of good weather than temperature readings because cold, sunny days are frequently more pleasant than cloudy ones. In winter Canberra receives five hours of sunshine per day - about an hour a day more than Melbourne and an hour less than Sydney. Fogs occur mainly in the May to July period with an average of about five days of fog each month.

5.7 There is a high frequency of north-west winds over most of the year, but Canberra is sheltered to some extent by mountains to the west. These winds are cold during winter. Easterly sea breezes in the late evenings in summer have a moderating influence on temperature. Winds are mostly light, the average annual wind speed being only half that in Melbourne and Sydney.

5.8 The climate of the existing Gardens and alternative sites is similar to that of the Canberra area generally with the exception that fewer frosts occur on the upper slopes. A frost is classified as severe when the air temperature falls below $0^{o}C$ and is usually destructive of plant cells. On average some thirty-nine of these frosts occur each year at the Canberra Forestry Station (altitude 580 m and situated across the lake from the Gardens). The reduction in the number of frosts on slightly higher ground, not subject to cold air drainage at night, is shown in ten years of records at Mt Stromlo (altitude 782 m) where an average of only sixteen severe frosts a year occur. Mt Stromlo is situated about 10 km south-west of Black Mountain. These records are con-

firmed by experience in the existing Gardens (altitude range 584 to 658 m) where some plant species which have grown well when planted on the upper slopes, have been killed by frost when planted in the lower parts.

5.9 The overall south-easterly aspect of the existing and proposed sites reduces the adverse effect on plants of dry westerly and north-westerly winds in summer.

5.10 The variable topography means that a wide range of microclimates exists on Black Mountain. This must be recognised when selecting planting sites, particularly for species marginally suited to the area.

Topography

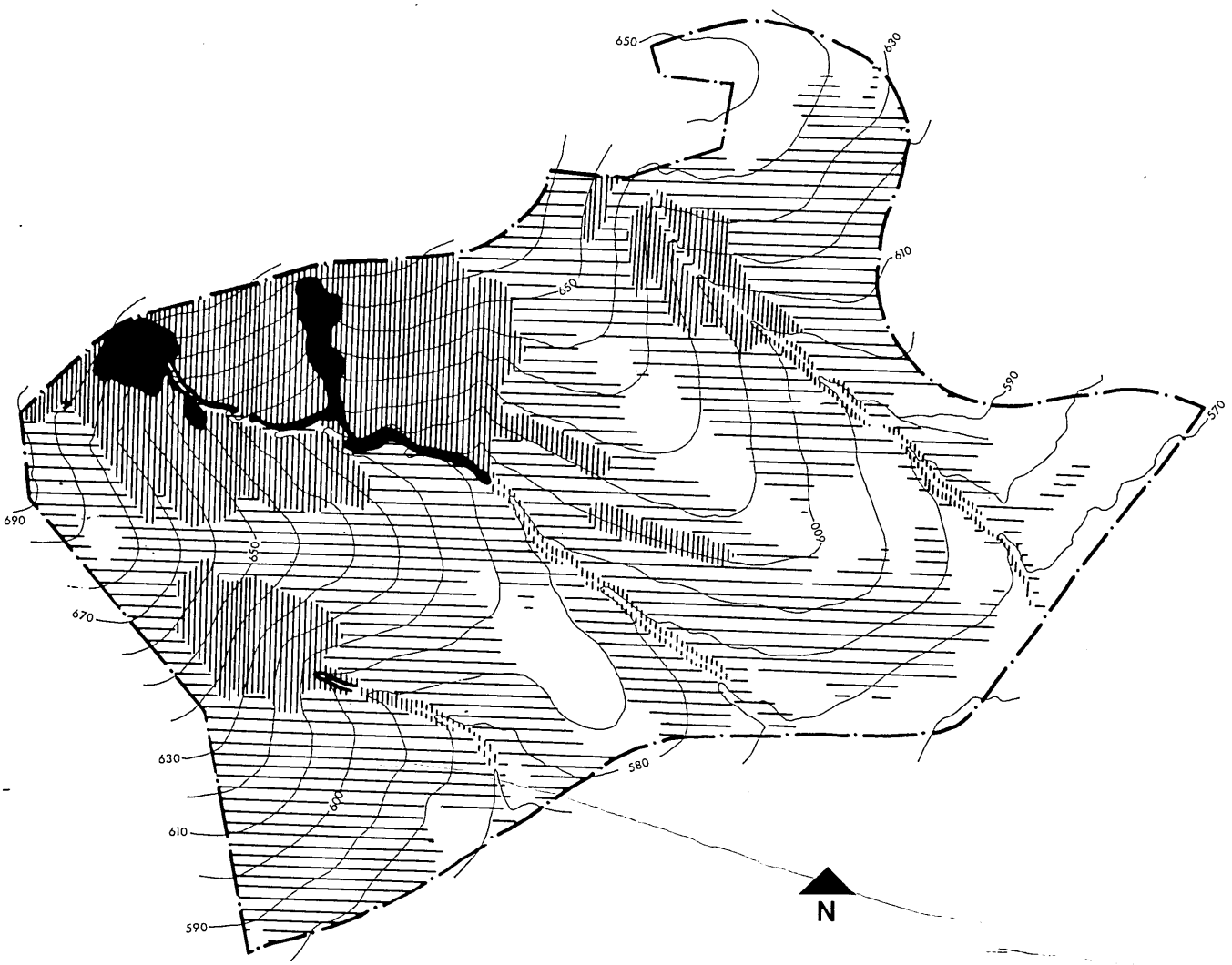
5.11 Black Mountain stands about 245 m above the surrounding Canberra plain. Steep slopes are common on all aspects close to the summit including the upper section of Site A where slopes on the gully sides exceed 60%. (Map 3.) Slopes of this degree are too steep for development without major modification and would be retained largely in their present state.

5.12 Site A contains three steep-sided gullies aligned north-west to south-east, and separated by flattened but inclined ridges. These ridges and gullies provide a wide range of planting habitats with differing degrees of exposure to wind and frost. One-fifth of this site (Table 1 and Map 3) has slopes of less than 20%. This includes the south-eastern section adjacent to Clunies Ross St and the area near the reservoir. A similar proportion of the site has slopes in excess of 40%.

5.13 Site B (Map 4) also contains a series of ridges and gullies but with greater variety of aspect north, south and east than Site A. It does not contain any slopes greater than 60% and a higher proportion, two-fifths, has slopes of less than 20%.

5.14 Different habitats in the ridge and valley systems on Black Mountain are influenced to a large extent by differences in incident solar energy. Jacobs (1955) used data collected at Mt Stromlo by Rimmer and Allen (1950) to calculate solar radiation received by slopes of various aspects and gradients. Variations of up to 300 cals/cm^2 on 20^o slopes and 400 cals/cm^2 on 30^o slopes were determined between north- and south-facing slopes. North aspects receive more radiation throughout the year than south aspects. The greatest differences between solar radiation received by contrasting slopes occur from April to September, and the smallest differences between October and March.

5.15 In a study of the influence of aspect on the composition and structure of dry sclerophyll forest on Black Mountain, Pook and Moore (1966) suggested that seasonal growth rates of plants on Black Mountain would differ because of differences in temperature and soil moisture on north and south aspects. Suitable temperatures for growth would occur earlier in the season on north aspects but soil moisture would become limiting sooner. Pook and Moore concluded that the length of the growing season on both aspects is virtually the same, but that maximum growth occurs at two different seasons.



0 – 20% slope

21 – 40% slope

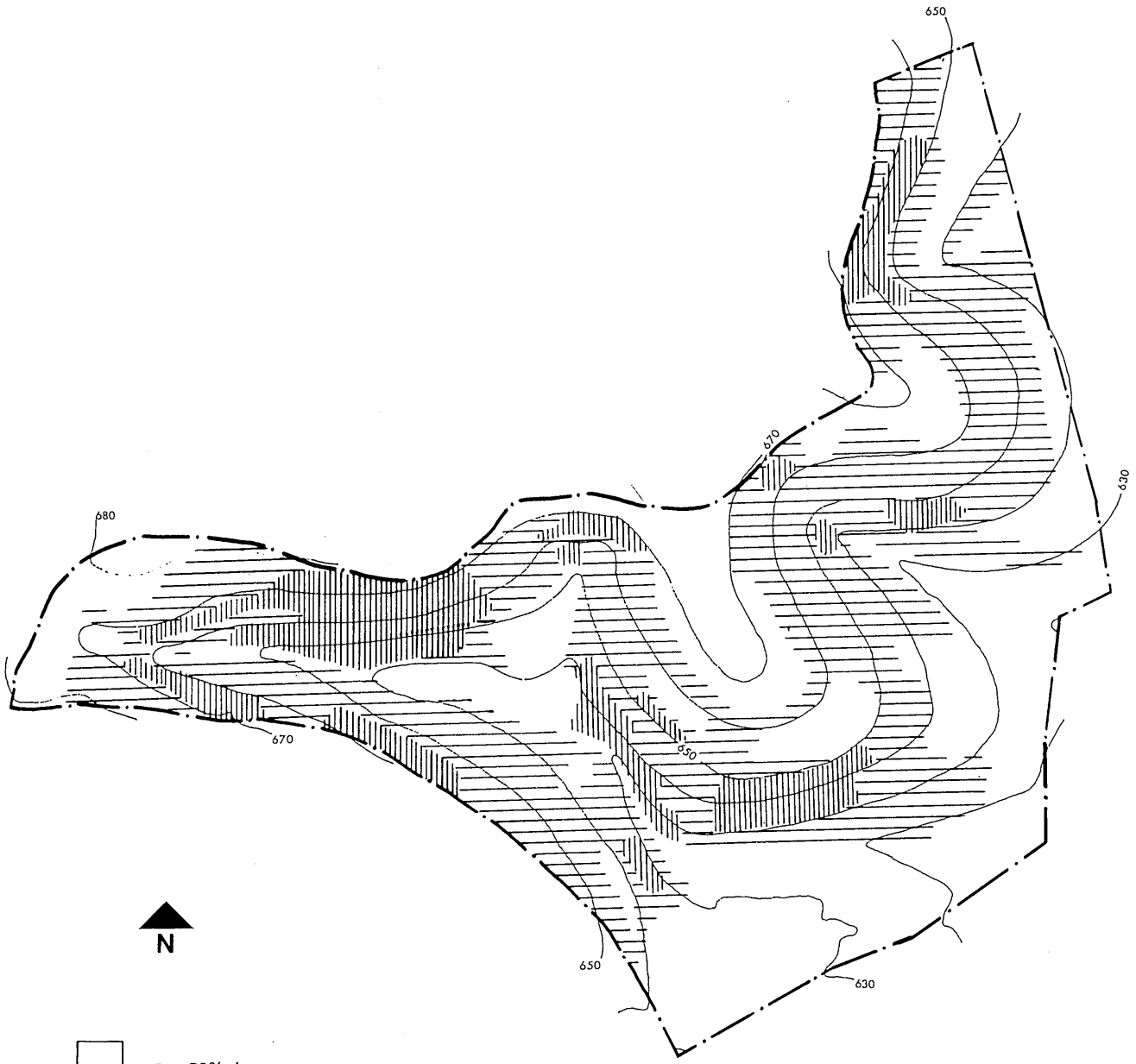
41 – 60% slope

> 60% slope

0 200

metres

SLOPE CLASSES – SITE A
MAP 3



SLOPE CLASSES — SITE B
MAP 4

5.16 While there is little opportunity to increase solar radiation in order to lengthen the growing season, supplementary watering as part of horticultural management may assist in reducing the limitation imposed by reduced soil moisture during summer, particularly on north aspects.

Table 1 Slope classes in Sites A and B and the existing area

	Percentage of each slope class			
Area	0-20	21-40	41-60	>60
A	21	56	21	2
B	40	44	16	-
Existing	77	21	2	Trace

Geology

5.17 Black Mountain is a horst bounded by faults on three sides leaving the older Black Mountain Sandstone raised above the surrounding younger rocks.

5.18 Almost the entire area of the present Gardens and Sites A and B are composed of Black Mountain Sandstone, a fine-grained quartzose sandstone with rare or thin shaly beds. This is Lower Ordovician in age.

5.19 There is a small area of State Circle Shale in the south-east corner of Site A. This is Lower Silurian in age.

Soils

5.20 The information contained in this section was drawn from the report on a soil survey investigation undertaken for the National Botanic Gardens by J.R. Sleeman and C.R. Watson, of CSIRO Soils Division. The report is reproduced in full as Appendix 2.

5.21 The investigation of the soils in Sites A and B was based on a series of auger inspections along selected topographic transects at sites shown on Figure 1 of Appendix 1. These were augmented by inspections of limited exposures in gully banks, and in excavations for roads and buildings in the existing Gardens and nearby areas of Black Mountain. These inspections tended to suggest that deep soils, with and without clay subsoils, are more common than indicated from the auger borings which were stopped by coarse gravel rather than basement rock.

Site A

5.22 This site consists of red/yellow earth and red earth/red podzolic soil, with associated lithosols and minor areas of siliceous sand. It has the highest percentage of steepest slopes (Table 1), more outcropping rock, surface layers that appear to be more gravelly and fewer soils with clay B horizons. In contrast to Site B the gullies here are filled with 5 m or more of gravelly colluvium.

Site B

5.23 This site consists of red earth/red podzolic soils with associated lithosols and red podzolic soils and minor areas of siliceous sand. Site B has a higher proportion of moderately steep slopes, more soils with impermeable clay B horizons and surface layers that appear to be slightly less gravelly.

Existing Gardens

5.24 Soils in the existing Gardens are red/yellow earths and red earth/red podzolic soils with associated lithosols and siliceous sands. In contrast to Sites A and B where steep and moderately steep slopes are common, the existing area is dominated by more gentle slopes on colluvium. The steeper sections of the existing area appear to have greater affinities with Site B.

5.25 In all three areas the upper layers, which are the most significant for plants and from an erosion point of view, are remarkably similar. They consist of 2-3 cm of leaves and twigs, over 1-2 cm of loam with fine sand, over 10-110 cm of fine sandy loam with variable quantities of angular sandstone gravel. These layers may overlay permeable, more clayey layers, impermeable clay layers or bedrock.

5.26 In their discussion, Sleeman and Watson wrote:

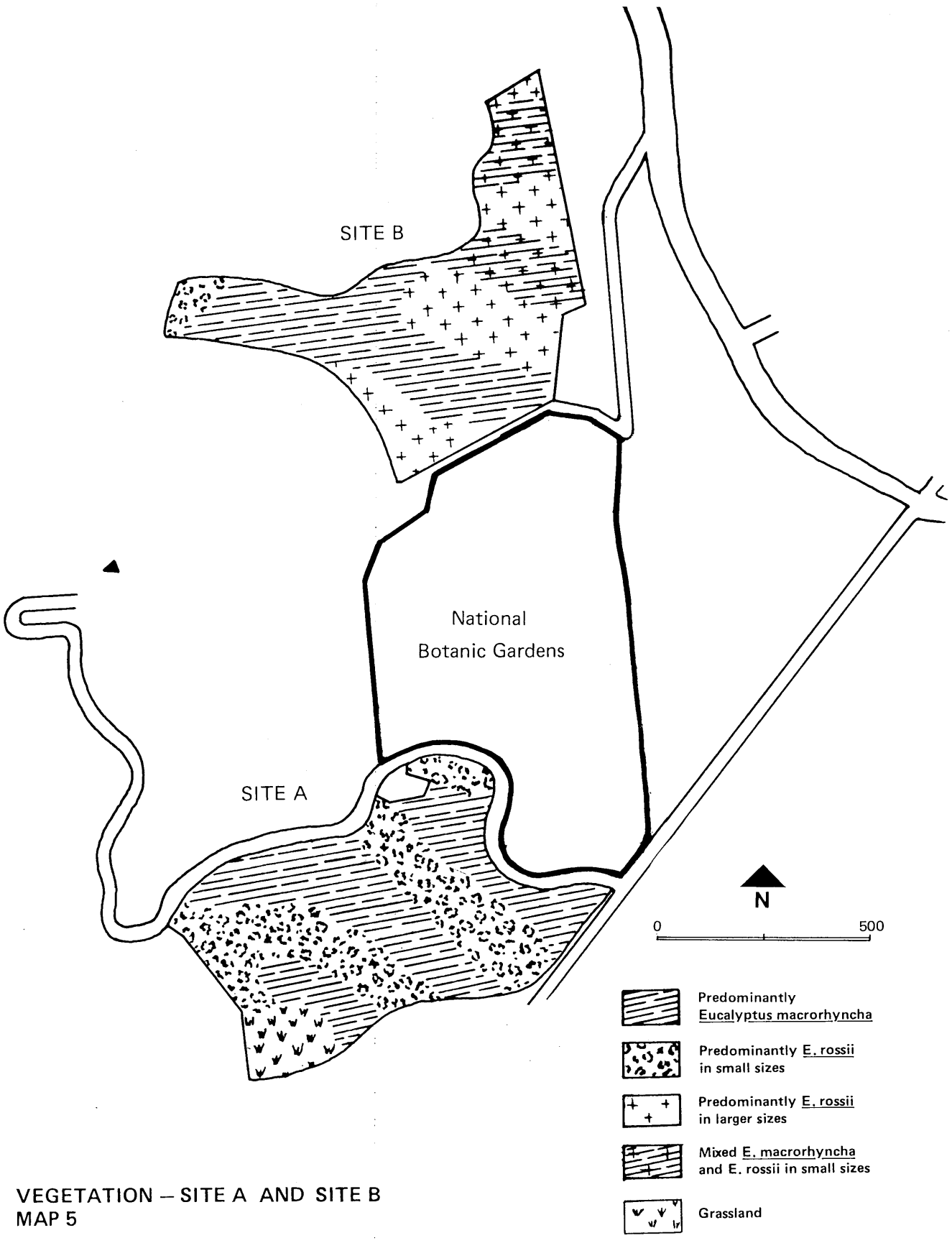
> Although slopes are such that rapid to very rapid surface run-off would be expected, with consequent removal of material, the coarse textured nature of the upper horizons leads to rapid water entry and prevents or limits run-off. Under conditions of heavy downpours or extended periods of rain the upper layers of soils with impermeable clay B horizons will be subjected to temporary waterlogging. This situation of minimal erosion loss can only be maintained under changed use patterns if surface conditions, litter and high permeability are maintained as far as possible.

Flora and vegetation

5.27 The vegetation of the Black Mountain Reserve has been described by Coyne (1969) and Elliott and Douglas (1974). Essentially it is an open forest (Specht, 1970) dominated by Eucalyptus macrorhyncha and E. rossii, with a tussock grass/shrub understorey.

5.28 The composition of the vegetation varies with aspect (Pook and Moore 1966). On the warmer, drier, north-facing slopes and ridge tops E. rossii is predominant, while in the understorey the tussock-grass Danthonia pallida and the shrubs Phyllanthus hirtellus and Dillwynia retorta are most frequent. On the cooler, moister, south-facing slopes E. macrorhyncha is predominant. Danthonia pallida and Poa sieberana and the shrubs Monotoca scoparia, Daviesia mimosoides and Acacia buxifolia are frequent. A few shrubs are common on both aspects, for example Brachyloma daphnoides, Grevillea aff. alpina, Hibbertia obtusifolia and Pultenaea procumbens.

5.29 Variations in vegetation patterns also occur as a result of fire and other disturbances. On part of Site A where destruction of the native vegetation has been almost complete Mediterranean weeds predominate, especially annual grasses. With disturbance of lesser impact the main effect is to increase some of the understorey shrub components in frequency of occurrence rather than number of species present.



VEGETATION – SITE A AND SITE B
MAP 5

Source: P.D. Coyne (1969)

5.30 Sites A and B both carry the open forest typical of Black Mountain, but differ according to the effects of past fires and human activity.

5.31 Site A has a dominant south-east aspect; hence Eucalyptus macrorhyncha and associated south-slope species tend to predominate through much of the site. The floristic list (Appendix 3) shows the other species present in this site.

5.32 A large part of the area has been disturbed by clearing for grazing. The southern corner is essentially a treeless, weedy grassland and the eastern corner (the site of the materials store used during construction of the Telecommunications Tower on Black Mountain and as a dump before that) has been cleared and disturbed. A large area on the adjacent slopes and also the north-east corner are semi-disturbed due to clearing and subsequent regeneration. The remainder of the site is covered by relatively undisturbed vegetation, except along an access track which follows a ridge. Within the relatively undisturbed open forest no recent fires have occurred (there is no charring of the tree trunks), resulting in a rather sparse shrub understorey.

5.33 Site B has a dominant easterly aspect, with Eucalyptus rossii and associated species predominant although the western arm of the site includes a deep gully with E. macrorhyncha. The north-slopes are dry, with smaller E. rossii than on Site A.

5.34 Only the site of the former car dump has been extensively disturbed. Charring of tree trunks indicates a relatively recent fire in this area, which correlates with the much denser shrub understorey than on Site A. However, this is not reflected in a significantly greater number of shrub species. (Appendix 2.)

Species composition

5.35 Appendix 2 presents data from a floristic survey of the two proposed sites carried out during September-October 1979. Due to the season of the survey some herbaceous perennials and the summer annual plants have not been recorded.

5.36 The survey was carried out selectively with due consideration given to variation in terrain, aspect and habitat to ensure a representative sample within the seasonal limits. It consisted of several excursions at intervals of about three weeks, the specimens being identified in the field and confirmed where necessary in the Herbarium.

5.37 The format of the list is based on that of M. Gray and H.S. McKee (1969) with some necessary nomenclatural changes. The abundance and distribution data is taken directly from that publication with kind permission of Mr Gray. Site A is richer in both native and exotic species, a reflection of greater diversity of habitat due to topography and disturbance.

5.38 Only two native species listed here are restricted and rare in the Black Mountain flora. Both of these, Parahebe perfoliata and Blechnum minus, are common in the wider ACT flora and are thriving within the National Botanic Gardens. A third species, Caladenia congesta, is recorded as not common in the Black Mountain flora and rare in the ACT flora. This species has been collected in the upper part of Site A where a large section would not be cultivated due

to the steepness of the terrain; preservation of this species within the Gardens would be ensured. Other species recorded as not common on Black Mountain are growing successfully within the National Botanic Gardens and are common in other areas of the ACT.

5.39 No published record of non-vascular plant distribution or abundance is available. However, the species recorded for the sites are relatively common in mountainous areas of the ACT. Many are also present in similar situations in the National Botanic Gardens.

Fauna and fauna habitat

Mammals

5.40 The information in this section is taken from a study, undertaken at the request of the National Botanic Gardens, by C.R. Tidemann, of the Zoology Department, Australian National University. The report is reproduced as Appendix 4. It is based on a survey made during 1974-75 by the author, a visit to the sites in November 1979, a review of relevant literature and discussions with Botanic Gardens personnel.

5.41 Nineteen species of native mammal and seven introduced species have been recorded in Sites A and B. Species recorded and their status within the sites are summarised in Table 2.

5.42 Movement of large terrestrial mammals such as kangaroos and spiny anteaters would be restricted upon development of either Sites A or B by fencing, thus denying them access to a small portion of their previously available habitat.

5.43 Some of the smaller terrestrial species, such as the two Antechinus and the two introduced rodents, Mus and Rattus, would be adversely affected to some extent by the removal of natural ground litter and fallen timber. However, the pattern of development in the existing Gardens allows the survival of these species albeit at reduced levels.

5.44 The arboreal mammals and the bats in the area would probably remain largely unaffected by any development. The planting of additional trees and shrubs may actually enhance the survival of some of these by providing additional food and shelter. The existing Gardens presently support most of the mammal species found in the adjoining Reserve excluding only the large mammals, such as kangaroos. Tidemann concludes that:

> The envisaged overall effects of the proposed extension in terms of habitat destruction and depletion of mammal fauna are fairly insignificant when viewed in a regional context. The Black Mountain Reserve contains large areas of habitat similar to that present in the study area and supports the associated mammal fauna. Similar faunal assemblages occur also on Mts Ainslie and Majura. No rare or endangered mammal species were found to occur in the study area, nor were any expected to occur there.

Table 2 Mammal species recorded from Sites A and B

Species	Status in Sites A and B
Native mammals	
Monotreme	
Spiny anteater (Tachyglossus aculeatus)	Uncommon
Marsupials	
Sugar glider (Petaurus breviceps)	Common
Brush-tailed possum (Trichosurus vulpecula)	Common
Ring-tailed possum (Pseodocheirus peregrinus)	Common
Yellow-footed marsupial mouse (Antechninus flavipes)	Common
Brown marsupial mouse (A. stuartii)	Uncommon
Wombat (Vombatus ursinus)	Rare, recorded from one sighting only
Eastern grey kangaroo (Macropus giganteus)	Uncommon
Bats	
Reddish flying fox (Pteropus scapulatus)	Uncommon migrant
Grey-headed flying fox (P. poliocephalus)	Uncommon migrant
Little flat bat (Tadarida planiceps)	Uncommon
White-striped bat (T. australis)	Rare
Yellow-bellied bat (Taphozous flaviventris)	Rare
Lesser long-eared bat (Nyctophilus goeffroyi)	Common
Gould's long-eared bat (N. gouldii)	Common
Gould's wattled bat (Chalinolobus gouldii)	Common
Chocolate wattled bat (C. morio)	Common
Little brown bat (Eptesicus vulturnus)	Common
King River little bat (E. regulus)	Common
Introduced mammals	
Feral cat (Felis catus)	Common
European fox (Vulpes vulpes)	Uncommon
European rabbit (Oryctolagus cuniculus)	Uncommon
European hare (Lepus europeaus)	Common
Black rat (Rattus rattus)	Uncommon
House mouse (Mus musculus)	Very common
Feral pig (Sus scrofa)	Rare vagrant, recorded from group of three only

Birds

5.45 The information contained in this section was obtained from a report undertaken for the National Botanic Gardens by Grahame Clark, of the Canberra Ornithologists Group (Appendix 5) and from Wilson (1980). The species list from the latter publication referring to the existing Gardens is included as Appendix 6.

5.46 The avifauna of Sites A and B is similar to that of the rest of the Black Mountain Reserve with some alterations due to the disturbance in Site A. The number of species within the Reserve (listed in Williams, 1976) is less than that in the existing Gardens due to the increase in food, nesting sites and shelter in the latter.

5.47 As the proposed extension (either Site A or Site B) would be developed under a similar management policy to that used in the existing Gardens a number of species would benefit due to the increase in seeds, fruit and insect food; the longer period in the year when suitable food is available; the larger number of nest sites for shrub-nesting species, and the greater diversity of habitats associated with the introduction of plants to the locality. The species which are considered to be in this category are listed in Appendix 5.

5.48 Clark considers there are only two bird species on Black Mountain which depend on unaltered ground layer habitat and thus would be affected by development of either of the two sites as part of the Gardens. They are the painted button-quail (Turnix varia) and the speckled warbler (Sericarnis sagittatus). If Site B is developed these birds would decrease in number. The development of Site A would have a lesser effect because of the smaller extent of suitable habitat for the two species.

5.49 If the techniques of tree surgery used in the existing Gardens are adopted in the extension then a considerable number of nesting hollows will be removed. This would reduce the nesting opportunities for parrots and certain other species such as white-throated tree creepers, maned duck and striated pardalote.

5.50 The increase in numbers of birds is likely to result in more predators, particularly the feral cat and the pied currawong (Strepera graculina). The pied currawong does, however, present an advantage so far as native birds are concerned in that it reduces the number of introduced birds such as the starling (Sturnus vulgaris) and the European blackbird (Turdus merula) in the Gardens.

5.51 The effects on birds of pesticides and herbicides are uncertain. Grahame Clark has observed during banding operations in the existing Gardens that the number of insect-eating birds declines after spraying. It is not known if this is due to removal of the food source as a result of the spraying or possibly a direct effect on the birds themselves. The effects do not seem to be long lasting.

5.52 Of the most common species in the area of the two sites, Clark considers that thirty-four will benefit from development as part of the Gardens; fifteen will either benefit or remain the same; two will be adversely affected, and then only if Site B is chosen. Appendix 5 lists the species in each category.

Reptiles and amphibians

5.53 The reptiles and amphibians in the two extension sites are similar to those on the remainder of Black Mountain. The following is a general discussion on these fauna in the Black Mountain Reserve taken from Coyne (1969) and Kukolic (1976). Table 3 shows the reptiles and amphibians found in the Reserve with their abundance. The nomenclature of this section follows that of Cogger (1975).

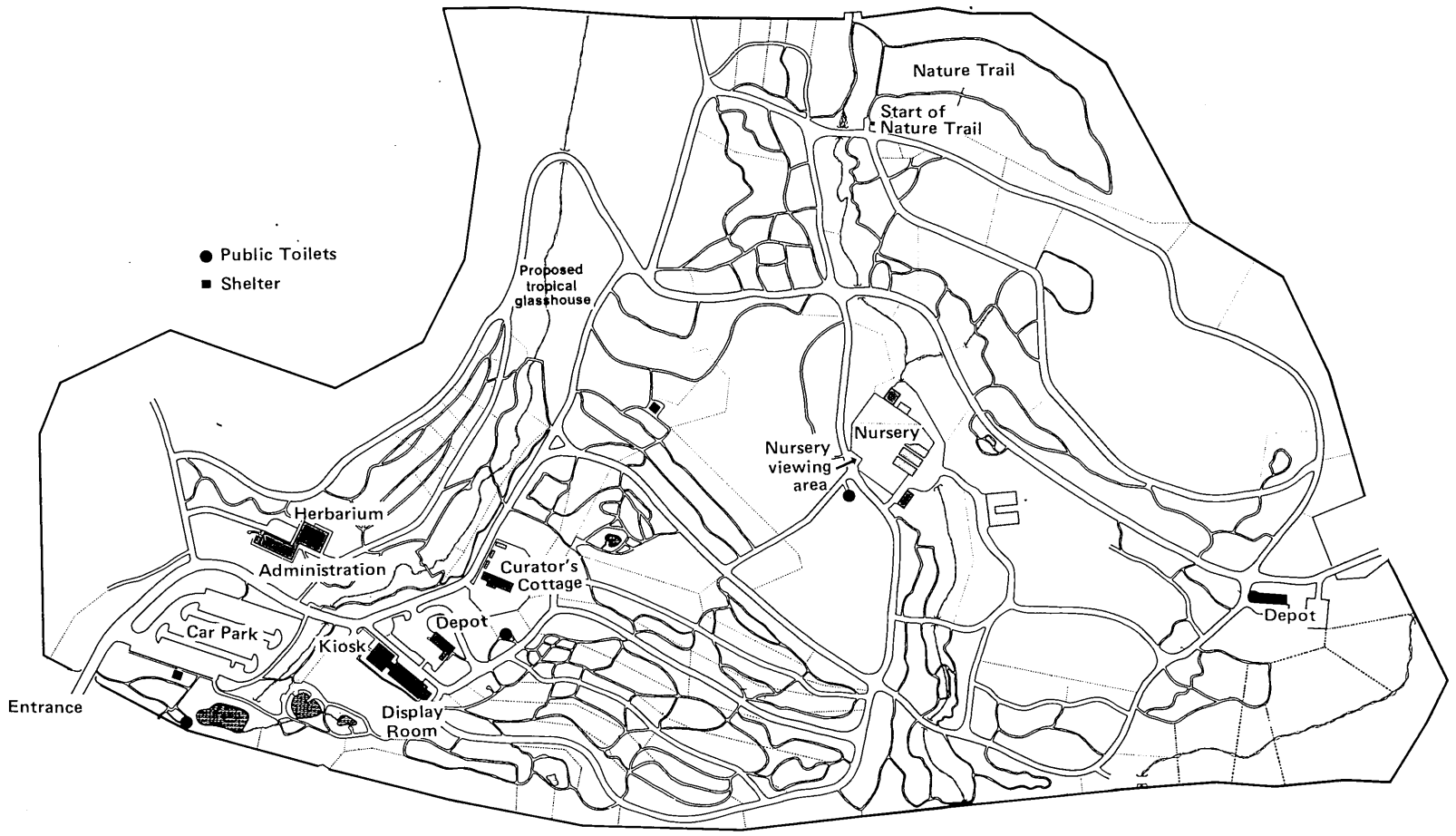
5.54 Skinks are the most abundant of the reptiles in both numbers and diversity, with the grass skink (Leiolopisma delicata) being both the most widespread and abundant.

5.55 Of the sixteen species of frogs known to occur in the ACT, thirteen are found in the existing National Botanic Gardens (Kukolic, 1979). It is expected that most of these also occur on Black Mountain although only those listed in Table 3 have been recorded; Pseudophryne bibronii is the most abundant and widespread frog.

Table 3 Reptiles and amphibians of the Black Mountain Reserve

Species	Status on Black Mountain Nature Reserve
Reptiles	
ELAPIDAE	
Red-bellied black snake, *Pseudechis porphyriacus*	Unknown
Common brown snake, *Pseudonaja textilis textilis*	Unknown
Black-headed snake, *Unechis gouldii*	Unknown
TYPHLOPIDAE	
Blind snake, *Typhlina nigrescens*	Moderately common
AGAMIDAE	
Bearded dragon, *Amphibolurus barbatus barbatus*	Moderately common
Tree dragon, *Amphibolurus muricatus*	Unknown
SCINCIDAE	
Common bluetongue, *Tiliqua scincoides scincoides*	Moderately common
Copper-tailed skink, *Ctenotus taeniolatus*	Common
Three-toed skink, *Hemiergis decresiensis*	Rare
Cunningham's skink, *Egernia cunninghami*	Unknown
Grass skinks, *Leiolopisma delicata*	Unknown
Leiolopisma guichenoti	Unknown
Morethia boulengeri	Moderately common
VARANIDAE	
Lace monitor, *Varanus varius varius*	Unknown
GEKKONIDAE	
Stone gecko, *Diplodactylus vittatus*	Unknown
Marbled gecko, *Phyllodactylus marmoratus*	Rare
PYGOPODIDAE	
Legless lizards, *Aprasia parapulchella*	Unknown
Delma impar	Rare
Burton's legless lizard, *Lialis burtonis*	Unknown
CHELIDAE	
Long-necked tortoise, *Chelodina longicollis*	Unknown
Amphibians	
HYLIDAE	
Whistling tree frog, *Litoria verreauxii*	Common
Eastern banjo frog, *Limnodynastes dumerillii dumerillii*	Moderately common
Spotted grass frog, *Limnodynastes tasmaniensis*	Common
Common eastern froglet, *Crinia signifera*	Common
Brown toadlet, *Pseudophryne bibronii*	Common

Source: Kukolic (1976).



NATIONAL BOTANIC GARDENS
MAP 6

6 THE EXTENSION PROPOSAL

6.1 Sites A and B have similar environmental characteristics and each would provide an area suitable for achieving the purpose of increasing the range of diversity of the Australian flora grown in the national collection.

6.2 The advantages of Site B are its gentle topography and sheltered nature. The site is less prominent than Site A and would allow more flexibility in development including increased density of planting and thinning of existing tree cover without being obvious from central Canberra. It is away from major traffic noise at present and gives a feeling of being well removed from the city and urban areas. Present access to this site is off Barry Dr and along a road at the rear of CSIRO and past an ACT Electricity Authority substation. Canberra residents would become familiar with this route, but it would be confusing to tourists. Development of the former car dump as a picnic and parking area would provide additional access to the existing Gardens, to Site B and to the Black Mountain Reserve. Access would need to be maintained to the former quarry now leased to the Australian National University. The main disadvantage of Site B, from a management point of view, is its distance from the administrative and works facilities which are concentrated in the south-eastern corner of the existing Gardens. (Map 6.)

6.3 Site B is about 2 km from the existing Gardens reservoir. Much of the site is too elevated to be adequately supplied without the construction of a second reservoir at a higher location on Black Mountain which would require road access, electricity and the installation of pipe-lines. To build the reservoir would require construction on a site about 30 m^2 and the digging of trenches to take 15 cm mains - one from the nearest or most suitable water supply and one leading to the Gardens. Landscaping of the reservoir and restoration work over the mains would be necessary.

6.4 Site A provides a wide range of planting micro environments and spectacular views across the city and Lake Burley Griffin (Plates 4 and 5) which would be attractive to visitors. The prominence of the site from vantage points such as Capital Hill (the site of the new Parliament House, arguably the nation's most important building) means that great care would be needed during development stages to maintain the wooded landscape appearance. The present water supply for the upper part of the Gardens is pumped to a small reservoir above the existing Black Mountain reservoir. The capacity of this small reservoir would have to be increased to meet the needs of the Site A extension. Alternatively, it may be possible to take water directly from the Black Mountain reservoir which is located on the same side of Black Mountain Rd as Site A. The selection of Site A would place the administration building, herbarium and display area in the centre of the Gardens.

6.5 The noise from traffic on Parkes Way could be an irritant in some parts of the Gardens although there are secluded gullies sheltered from surrounding activities. If Site A was developed the Gardens would be bisected by a road carrying significant traffic volumes including a high proportion of heavy vehicles. An underpass under this road would provide visitors and staff with ready access between Site A and the existing Gardens and avoid the need for them to cross the summit road.

6.6 There are no quantitative records of present human use patterns for either site. The CSIRO Division of Entomology has advised that there is no published

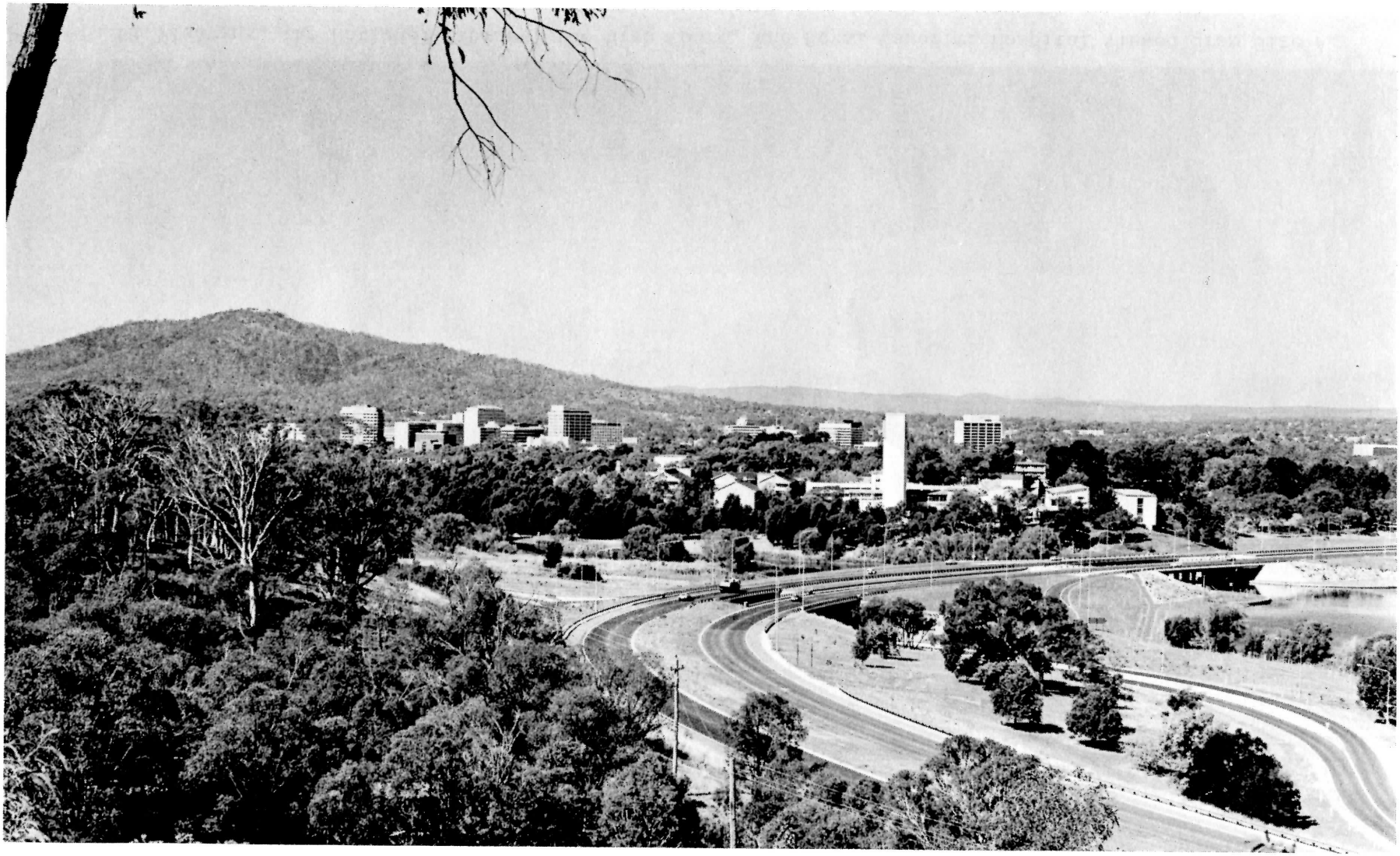


Plate 4: Mt Ainslie, Canberra Civic Centre, and the Australian National University viewed from Site A.

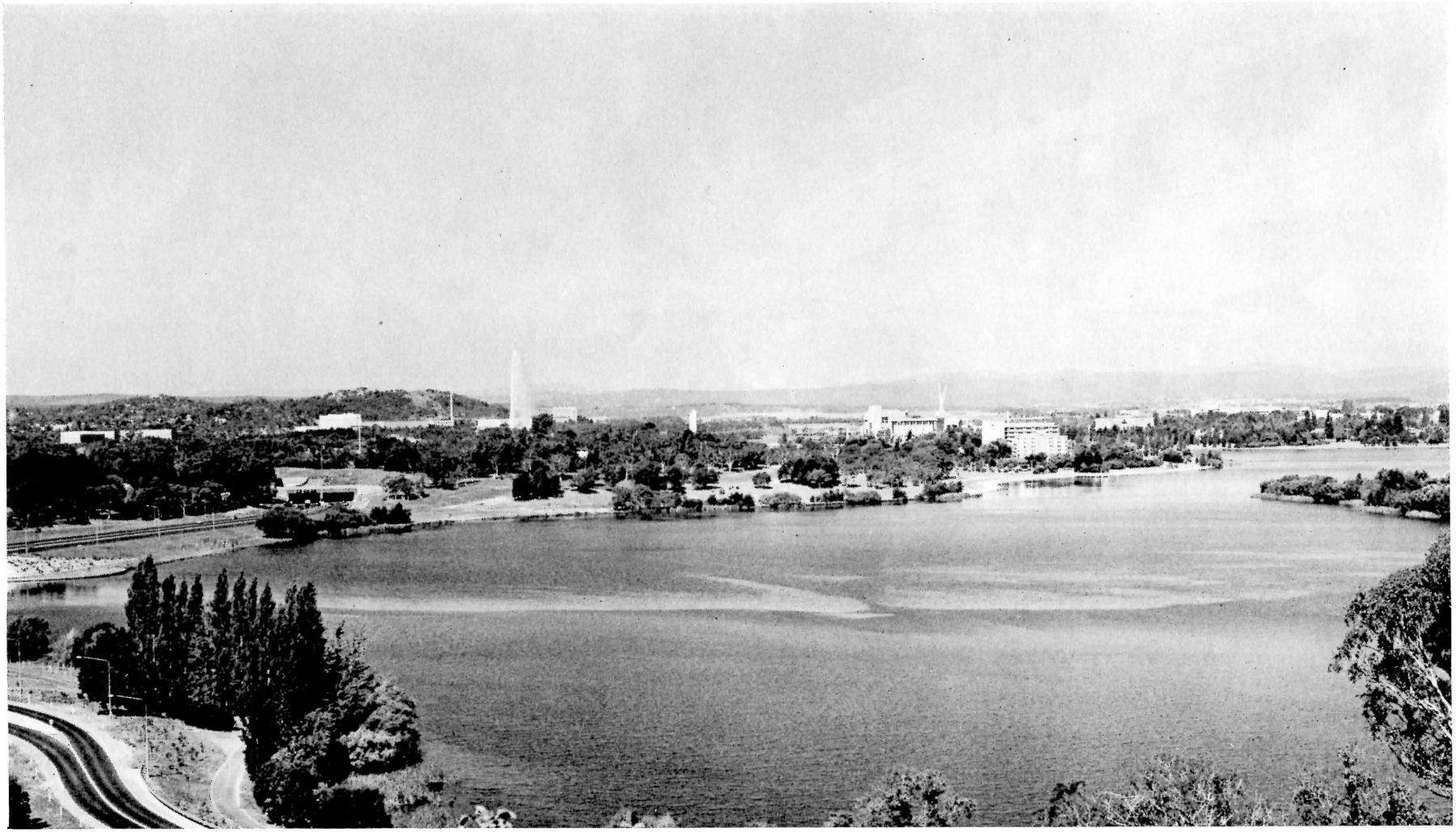


Plate 5: Mt Pleasant, the National Library, the High Court, and Royal Canberra Hospital viewed from Site A.

information on the status or distribution of the insect fauna occurring in the two alternative sites; however, various areas of the Reserve, and the rear part of the CSIRO site adjacent to the Reserve, have been sampled. Continued access to Site B has been requested and the point made that any major changes to the understorey of Site B could influence the results of insect trapping carried out at the rear of the CSIRO site outside the Reserve.

6.7 Occasional observations and indirect evidence from well-worn tracks suggest that parts of Site B are relatively well used by bushwalkers, joggers and as a path from Aranda to the CSIRO, ANU and Civic. Some residents of nearby O'Connor and Turner may use the area for passive recreation. CSIRO staff may also use the area at lunchtime for relaxation.

6.8 By contrast Site A shows little evidence of present use. Trailbike riding has occurred in the past but an active management program involving public education, restriction of access and ranger patrols has been implemented to reduce this activity. Site A is used by botany students from the Australian National University for ecological and floristics studies.

6.9 Each of the sites satisfies the criteria given in paragraph 4.12 for an extension to the Gardens. Site A, however, is located more favourably for management purposes, has been disturbed previously over a large portion of its area, has easier access for tourists, more appealing views and there are no water supply problems. Thus the preferred option is to extend the Gardens into Site A with access to the existing Gardens by way of an underpass.

6.10 In addition it is proposed to develop about 3.5 ha of the site of the former car dump to the north of the existing Gardens (Map 2) as a picnic facility and secondary access point for the Gardens.

7 ENVIRONMENTAL IMPACT OF THE PROPOSAL AND MEASURES TO AMELIORATE IT

Impact on the existing physical and biological environment

7.1 Development of Site A would result in replacement of the existing understorey in areas where garden development takes place; however, forest on the upper slope and selected stands of lower slope forest would be preserved. The extension would be developed progressively over about twenty years and changes overall would be gradual with no large-scale clearing occurring at any time. In view of the occurrence of the E. macrorhyncha - E. rossii alliance on the rest of Black Mountain and elsewhere in the ACT the loss of part of this alliance on Site A would not be of regional significance.

7.2 Roads and paths would be constructed along contours where possible and garden development carried out following the natural slope. The existing vegetation would be retained until new plantings were introduced, thus holding the surface soil and controlling erosion. As earthworks were initiated, drainage would be installed to protect potentially erodable ground from heavy run-off. Surface water would be quickly removed and fed into the drainage system.

7.3 Within the extension, flow patterns and water inputs would be altered. Irrigation would create a higher 'rainfall' at ground level although water demand would be increased as a result of intensive planting. Attempts would be made to keep water input in step with demand to avoid an increase in runoff.

7.4 There is a risk of fire running into both Sites A and B from other parts of Black Mountain Reserve to the west. People using Parkes Way and Black Mountain Rd which border Site A could also represent a fire hazard to the site. These risks would be recognised in the Fire Management Plan for the Black Mountain Reserve and specifically for the Gardens. The risk of serious fire should be reduced by having an irrigation system similar to that in the existing Gardens. It is considered that ground fires occurring in the area could be contained by the judicious use of the sprinkler system and manual control by fire teams within the Gardens. Crown fires could represent a risk to the protective tree canopy. Good access and an adequate internal road system with watering points should reduce this risk substantially. No wildfires have been known to occur in the existing Gardens since they were established and the Gardens does not represent a fire threat to the adjacent Reserve.

7.5 The proposed extension carries some risk of increased incidence of disease resulting from altered water regimes, or arrival of pests and diseases with the introduction of new plant material or from changes in species diversity and abundance. This risk is impossible to quantify; however, it must be recognised that similar risks are associated with the development of Canberra and the movement of people, vehicles, animals and plants as part of the day to day life of the community.

7.6 There is a known family group of kangaroos in the area and these could be excluded from the Gardens. The kangaroo population in the Black Mountain Reserve is at present understocked and this group should have no difficulty relocating elsewhere on the Mountain. The overall effects of the proposed extension in terms of habitat destruction and depletion of mammal fauna are limited when viewed in a regional context. The Black Mountain Reserve contains large areas of habitat similar to that present in the proposed site and supports the associated mammal fauna. Bird life in the area would benefit from garden development. Data from the existing Gardens show that in comparison with open

forest on the west of Black Mountain, garden development has increased the number of species present, swollen the numbers of individuals present in many species, led to greater nesting activity, and provided overwintering habitats for a large number of migrants that would otherwise leave the area. Appendix 6 provides a list of the bird species recorded in the existing Gardens. Support for the value of the existing Gardens as bird habitat is given by S. Wilson (1980):

> Birds also seem to have a marked preference for what ornithologists call 'edge country' where different kinds of habitat meet or merge. The special layout of the Gardens, designed to provide as many types of plant habitat as possible, coincidentally provides ample 'edge country'. Dry forest with both naturally occurring and introduced trees, open grassland, marshland, temperate zone rainforest and other terrains meet and overlap in this 44 ha.
>
> Shrub varieties of acacias, hakeas, melaleucas and callistemons are valuable nesting sites for many of the smaller kinds of birds.
>
> The National Botanic Gardens is dedicated to the study and conservation of the Australian flora. Birds are indispensable to the ecological balance of the many ecosystems incorporated in the Gardens and it is an indication of the Gardens success that so many native birds have identified with these habitats and settled there.

7.7 As pointed out by Clark (Appendix 5) the main problems associated with the extension of the Gardens with regard to the bird fauna are the probable reduction in nest sites and the alteration of ground layer habitat for two species in Site B. So far as is possible in keeping with tree health and safety, pruning regimes will be altered to leave nest sites in the extension.

7.8 Some reptiles and amphibians would remain in the Gardens while others would be disadvantaged by the changed environment and no longer persist. Experience in the existing Gardens is that additional moisture provided by irrigation and ornamental pools attracts frogs and some of their predators.

Visual impact of the proposal

7.9 Fencing would be visible along the southern and eastern boundaries and on the uphill side of Black Mountain Dr until plantings along the fence had been established. This would take about three years.

7.10 Earthworks associated with the installation of pipes and construction of roads and pathways in the forested areas would be hidden from distant view, but on the cleared slope, in the south-east corner, those works would be temporarily obvious but softened by landscaping and planting. Trenches for underground routing of pipes and cables would be filled as quickly as possible and the surface restored and mulched to minimise erosion and adverse effects. This is standard practice in the existing Gardens.

7.11 Depots and other buildings would be landscaped to blend with the environment. Buildings constructed in the existing Gardens have been designed to cause minimal visual intrusion and this aim has been achieved. (Plate 1.)

7.12 An area in the most easterly corner of the proposed extension could be reserved for parking for the Gardens and or the telecommunication facilities. Landscaping, as in the existing carpark, would be carried out to screen it from outside view. The underpass proposed to link the new site with the existing Gardens would be unobtrusive and would not represent an environmental hazard. By contrast it would enable safe movement for visitors and staff between the different sections of the Gardens.

7.13 As Site A became established it would take on a 'natural' appearance even though most of the plants would be species introduced from other parts of Australia. The form and appearance of most Australian plants are familiar enough to the visitor to give the impression of belonging to this environment. Suitable plants with desirable foliage texture and fast growth would be used to screen pathways and blend buildings into their surroundings. Once the extension was established, their presence would be unobtrusive to the casual distant observer and their close appearance would be in harmony with the existing environment.

7.14 Garden development would enhance the appearance of the lower edge of the forest and the slope above Black Mountain Peninsula as plantings in these areas would help to restore the canopy. This would help minimise the disturbance resulting from construction of Parkes Way.

Impact outside the Gardens

7.15 Chemicals are used in the Gardens for pest and weed control and as inorganic fertiliser. Care is taken in the selection and application of these materials and their effect on plants and animals in adjacent areas and particularly Lake Burley Griffin. About two litres of pesticide concentrates per year are used in the existing Gardens. The main pesticide used is Rogor 40[R1] which has a breakdown period of about five days.

7.16 The herbicides Triquat[R2] and Roundup[R3] are used in the Gardens for spot control of weed growth. They have been selected because of their effectiveness and characteristic of undergoing rapid breakdown on contact with soil.

7.17 The main fertiliser requirement of the Gardens is for the lawn areas, which are only 6% of the total Gardens area. The fertiliser, with an NPK ratio of 10:4:6, is applied at the rate of 30/g per m^2. General shrub beds are also fertilised with this twice annually at the low rate of 10/kg per hectare.

7.18 Sewage from the existing Gardens is fed into the Canberra sewerage network and a similar arrangement would apply in the new area. Waste paper and other garbage is collected in rubbish bins located around the Gardens and removed by a waste disposal firm.

7.19 Lawn clippings and tree prunings are used as mulch on the garden beds. Large material such as limbs, which cannot be chipped, is deposited at one of the dump sites around Canberra.

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[1]Rogor 40 is a trade name for dimethoate.

[2]Triquat is a trade name for a mixture of quaternary ammonium compounds.

[3]Roundup is a trade name for a mixture with glyphosate as the parent compound.

7.20 Gardening is a labour-intensive operation and the little noise it generates is largely absorbed by the vegetation. There is unlikely to be any significant increase in noise levels in the surrounding environment if Site A is developed. On the contrary, traffic noise from Black Mountain Dr and Parkes Way would have an impact on some areas in the proposed extension.

8 CONCLUSIONS

8.1 The development of Site A as an extension to the National Botanic Gardens would result in a major change to the understorey vegetation. However, its replacement by a wide range of other species would provide substantial additional opportunities for passive recreation, education and scientific study for Canberra residents and tourists, leading to a greater understanding and appreciation of the Australian flora.

8.2 The Department of the Capital Territory is confident the site could be developed without adverse effect on the landscape appearance of Black Mountain when viewed from vantage points in the city. This confidence is based on the extensive experience in developing the existing site over the past thirty years.

8.3 The reclamation of the former car dump on the northern boundary of the existing Gardens would improve a drastically disturbed and presently ugly site and provide additional access to the Gardens and the Black Mountain Reserve.

ACKNOWLEDGEMENTS

Mr J.R. Sleeman and Dr C.L. Watson, CSIRO Division of Soils, conducted the soils investigation of the alternative sites, and Mr M. Gray, CSIRO Division of Plant Industry, provided advice on the flora based on his earlier studies of the local area. Mr G. Clark prepared the information on birds and Mr C. Tidemann that on mammals in the two alternative sites.

This assistance is gratefully acknowledged without in any way committing these people to the concepts and views expressed in the proposal.

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COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION ADMINISTRATIVE PROCEDURES

PARAGRAPH 3.1.1

DIRECTION REQUIRING ENVIRONMENTAL IMPACT STATEMENT

Pursuant to paragraph 3.1.1 of the Environment Protection Administrative Procedures, I, JAMES JOSEPH WEBSTER, Minister for Science and the Environment, hereby direct the preparation or obtaining and submission to me, of an environmental impact statement in relation to the following action, namely:-

> the proposal by the Department of the Capital Territory to extend the area of the Canberra Botanic Gardens by developing approximately 40ha of land to the south of and contiguous with the existing Gardens on Black Mountain.

Dated this Eighteenth day of October 1979.

Minister for Science
and the Environment

THE SOILS OF PROPOSED BOTANIC GARDENS EXTENSIONS, A.C.T.

by

J.R. Sleeman and C.L. Watson

INTRODUCTION

This investigation was carried out in response to a request by the Director of the Botanic Gardens and covers the existing gardens and two adjoining areas, A & B, proposed for future expansion; area A consists of 37.0 hectares on the south side and area B of 28.9 hectares on the north side (Fig.1). The area is on the lower slopes of Black Mountain, and mainly includes steep terrain developed in Black Mountain Sandstone except for the south west corner of area A in State Circle Shale (Strusz and Henderson 1971); it carries a dry sclerophyll forest dominated by *E. macrorhynca - E. rossii* (Pryor 1954). The reconnaissance soil survey report by Grant (1976) indicates a dominance of rock outcrop in this area with associated duplex soils with yellow-brown clay subsoils and deep gravelly soils, whereas that by Walker (1978) indicates a dominance of massive earths and red and yellow podzolic soils.

The current investigation is based on a series of auger inspections along selected topographic transects and in selected sites shown in Fig.1, augmented by inspections of limited exposures in gully banks, and in excavations for roads and buildings. The latter tend to suggest that deep soils, with and without clay subsoils, are more common than indicated from the auger borings which were stopped by coarse gravel (recorded up to 15 cm in diameter) rather than basement rock. As observed in gully banks, gravelly, coarse textured layers may be 4 metres deep; in roadside cuttings on steep slopes similar layers may overlie clay horizons at depths up to 70 cm and in an excavation in gentle slopes they are 75 cm thick and overlie clay horizons that continue beyond a depth of 3 metres. Because there are no means for the extrapolation of this data

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over the area, the data from auger borings remain as the sole basis for the grouping into soil types and classification according to Stace *et al.* (1968) and Northcote (1971) as shown in Table 1. Neither horizon boundaries nor structure of the B horizon can be assessed from auger inspection; consequently classification classes remain imprecise.

SOILS

The upper two horizons are common to most soils in the area; an AO horizon some 2-3 cm thick, consisting of twigs and leaves and an A11 horizon some 1-2 cm thick with a loamy texture and an abrupt lower boundary.

Type A - Lithosol - Uc4.11, Uc4.13

Very dark greyish brown over dark brown loamy fine sand to fine sandy loam; massive or very weak, very fine angular blocky; soft to slightly hard; many to abundant angular sandstone fragments up to 15 cm across; not penetrable with an auger beyond some depth less than 45 cm.

This soil was recorded at sites 5, 14, 17 and 23 (Fig.1) on spur crests, mid-slopes and gently sloping colluvium (4-40% slopes).

Type B - Siliceous sand - Uc4.13, Gn1.44

Very dark greyish brown loamy fine sand over a brown fine sandy loam; massive; friable or soft; angular sandstone fragments 3-6 cm across, increasing from common to many with increasing depth; not penetrable with an auger beyond some depth between 60 and 120 cm.

This soil was recorded at sites 6, 13, and 24 (Fig.1), on mid-slopes and gently sloping colluvium (slopes of 7-21%).

Type C - Red/yellow earth - Dy2.21 (2.61), Db1.11 (1.51), Db1.21 (1.61) Dr2.11 (2.51)

A profile with a gradual increase in texture and amount of angular sandstone gravel with increasing depth; dark brown fine sandy loam; massive; friable; gravelly to moderately gravelly; passing to a brown to dark brown fine sandy clay loam; moderately to very gravelly; not penetrable with an auger beyond some depth less than 45 cm (type C1) and beyond some depth between 50 and 90 cm (type C2).

Type C1 was recorded at sites 3, 19 and 27 (Fig.1), on spur crests, and mid-slopes (slopes of 4-40%). Type C2 was recorded at sites 10, 16,25 and 28 (Fig.1), on mid-slopes and gently sloping colluvium (slopes of 7-51%).

Type D - Red earth/red podzolic soil - Gn2.14, Dy2.21 (2.61), Db1.21 (1.61), Dr2.11 (2.51), Dr2.21 (2.61)

A profile with a gradual increase in texture with increasing depth and with variable amounts of angular sandstone gravel; brown to dark brown fine sandy loam; massive; friable; passing to a yellowish red or red clay horizon; not penetrable with an auger beyond some depth between 50 and 115 cm. In type D1 the clay horizon is a light clay and the profile is moderately to very gravelly throughout. In type D2 the clay horizon is a medium or heavy clay that may be structured and the A horizon only is

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moderately to very gravelly.

Type D1 was recorded at sites 1, 9, 12 and 15 (Fig.1), on spur crests and mid-slopes (slopes of 11-38%). Type D2 was recorded at sites 2, 11, 20, 21, 22 and 26 (Fig.1), on spur crests, upper slopes, mid-slopes and lower slopes (slopes of 14-33%); the most common type on the State Circle Shales.

Type E - Red podzolic soil - Dy2.11 (2.51), Db1.21 (1.61), Dr2.21 (2.61)

Very dark greyish brown loamy fine sand; massive; soft; little to no gravel; over a brown to dark brown clay horizon (E1, a light clay and E2, a medium clay); little to no gravel; not penetrable with an auger beyond a depth of 40 cm at site 4 and beyond some depth between 65 and 85 cm at the other sites.

Type E1 was recorded at sites 4 and 8 (Fig.1), on a saddle and lower slopes (slopes of 4-34%). Type E2 was recorded at site 7 on colluvium/alluvium in a gully (slope 9%).

DISTRIBUTION OF THE SOILS

Because only a limited number of sites has been examined and there does not appear to be any relationship between soil type and topography (Table 1), possibly due to an inability to expose complete profiles in auger borings, it has not been possible to produce a soil map. However the following impressions of the relative importance of the various soil types in each area may prove helpful.

Area A

Dominantly types C2 and D1, with associated types A and D2, and minor type B. Area A has the highest percentage of steepest slopes (Table 2), more outcropping rock, surface layers that appear to be more gravelly and fewer soils with clay B horizons. In contrast to area B the gullies here are filled with 5 metres or more of gravelly colluvium.

Area B

Dominantly types D1 and D2 with associated types A and E1 and minor types E2 and B. Area B has a higher proportion of moderately steep slopes, more soils with impermeable clay B horizons and surface layers that appear to be slightly less gravelly.

Existing area

Dominantly types C2 and D2 with associated types A and B. In contrast to areas A and B which are dominated by steep and moderately steep sloes, the existing area is dominated by more gentle slopes on colluvium. The steeper sections of the existing area appear to have greater affinities with Area B.

DISCUSSION

Whilst the soils observed at the various inspection sites have been grouped on a morphological basis into 5 types, the upper layers which are most significant for plants and from an erosion point of view, are remarkably similar. They consist of an AO horizon (2-3 cm of leaves and

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twigs) over an A11 horizon (1-2 cm of loam with fine sand, consisting essentially of excrement of soil fauna and with an abrupt lower boundary) over 10-110 cm (most commonly 20-40 cm) of fine sandy loam with variable quantities of angular sandstone gravel (most commonly many fragments in the size range 3-5 cm). These layers may overlie permeable, more clayey layers, impermeable clay layers or bedrock. The only available analytical data for these soils are to be found in a report by Pook and Moore (1966) wherein they say the soils are moderately acid and report mean pH values of 4.9-5.0. A general idea of the properties of these soils may be gleaned from analytical data for similar soils in the A.C.T. One such soil is a red podzolic soil formed in metasediments of the Pittman Formation and described by Sleeman and Walker (1979 - Table 13). The A horizon of this soil is medium acid, has very low organic carbon, moderate to low total nitrogen, very low available phosphorus, low exchangeable calcium and potassium and an extremely low electrical conductivity; it has been classified as Dr2.41 according to Northcote (1971), Paleustult according to the USDA Soil Survey Staff (1975) and Ferric Acrisol according to FAO-Unesco (1974).

Although slopes are such that rapid to very rapid surface run-off would be expected, with consequent removal of material, the coarse textured nature of the upper horizons leads to rapid water entry and prevents or limits run-off. For this area Pook and Moore (1966) have noted that 'infiltration is rapid, and appreciable run-off occurs only during heavy downpours or extended periods of rain'. Under these conditions the upper layers of soils with impermeable clay B horizons will be subjected to temporary waterlogging.

Obviously, this situation of minimal erosion loss can only be maintained under changed use patterns if surface conditions, litter and high permeability are maintained as far as possible.

ACKNOWLEDGMENTS

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TABLE 1

Soil class and slope at inspection sites

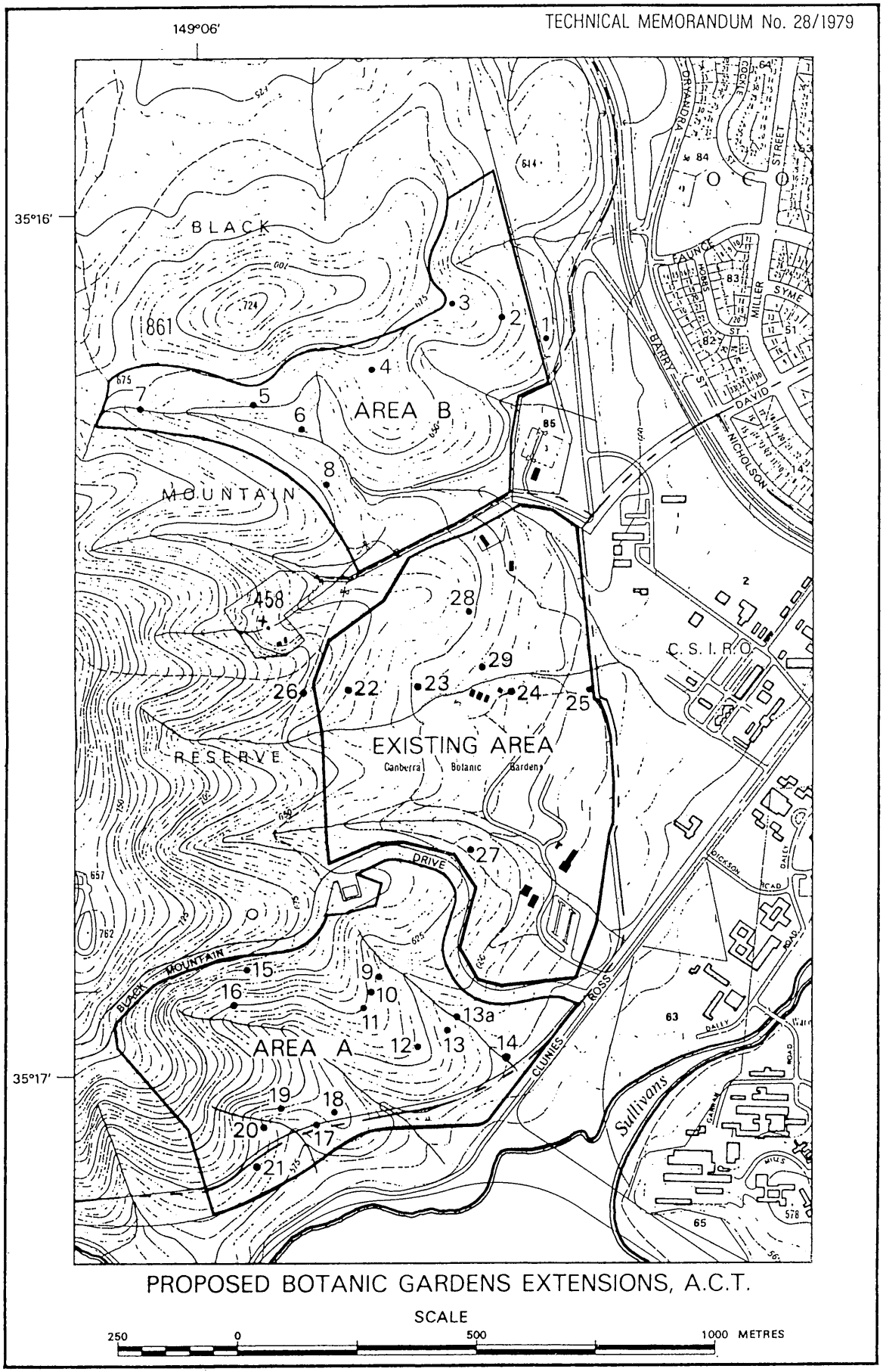
Area	Site No.	Soil type	Great soil group[1]	Principal profile form[2]	Slope %
B	1	D1	Red earth/red podzolic	Db1.21 or Db1.61	25
	2	D2	Red earth/red podzolic	Dr2.11 or Dr2.51	27
	3	C1	Red/yellow earth	Dy2.21 or Dy2.61	11
	4	E1	Red podzolic	Db1.21 or Db1.61	4
	5	A	Lithosol	Uc4.13	40
	6	B	Siliceous sand	Gn1.44	14
	7	E2	Red podzolic	Dy2.11 or Dy2.51	9
	8	E1	Red podzolic	Dr2.21 or Dr2.61	34
A	9	D1	Red earth/red podzolic	Gn2.14	38
	10	C2	Red/yellow earth	Dr2.11 or Dr2.51	23
	11	D2	Red earth/red podzolic	Dr2.21 or Dr2.61	14
	12	D1	Red earth/red podzolic	Db1.21 or Db1.61	11
	13	B	Siliceous sand	Uc4.13	21
	14	A	Lithosol	Uc4.13	4
	15	D1	Red earth/red podzolic	Dr2.21 or Dr2.61	36
	16	C2	Red/yellow earth	Db1.11 or Db1.51	51
	17	A	Lithosol	Uc4.11	27
	18	A	Lithosol	Uc4.11	
	19	C1	Red/yellow earth	Db1.21 or Db1.61	40
	20	D2	Red earth/red podzolic	Dy2.21 or Dy2.61	33
	21	D2	Red earth/red podzolic	Dy2.21 or Dy2.61	31
Existing	22	D2	Red earth/red podzolic	Dy2.21 or Dy2.61	25
	23	A	Lithosol	Uc4.13	9
	24	B	Siliceous sand	Uc4.13	7
	25	C2	Red/yellow earth	Db1.21 or Db1.61	7
	26	D2	Red earth/red podzolic	Db1.21 or Db1.61	19
	27	C1	Red/yellow earth	Db1.11 or Db1.51	30
	28	C1	Red/yellow earth	Db1.21 or Db1.61	25
	29	D2	Yellow podzolic		

[1] Stace *et al.* (1968) [2] Northcote (1971)

TABLE 2

Slope classes in areas A and B and the existing area

Area	Slope class (%)			
	0-20	21-40	41-60	>60
A	21	56	21	2
B	40	44	16	-
Existing	77	21	2	Trace



PROPOSED BOTANIC GARDENS EXTENSIONS, A.C.T.

SCALE

250 0 500 1000 METRES

Figure 1. Location of soil inspection sites

FLORISTICS OF SITES A AND B, BLACK MOUNTAIN

The symbols used in this list are as follows:

Distribution**		Abundance **		Observations	
w	widespread	c	common	+	present
s	sparse	fc	fairly common	-	not present
r	restricted	no	not common		
vr	very restricted	r	rare		
		o/c	once collected		

Species

* introduced plant
++ adventive in the area but native elsewhere in Australia.

** Source: Gray and McKee (1969)

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
1. CRYPTOGAMIA				
A. LICHENES				
LECIDEACEAE				
Lecidea sp. aff. L. coactata (Sm.) Nyl.	-	-	+	-
L. cinnabarina Somm.	-	-	-	+
Lecidea sp.	-	-	-	+
Rhizocarpon sp.	-	-	+	+
LECANORACEAE				
Lecanora atra (Huds.)	-	-	+	-
Lecanora sp.	-	-	+	+
HYPOGYMNIACEAE				
Hypogymnia billiardieri (Mont.) Filson	-	-	+	+
PARMELIACEAE				
Parmelia congensis J. Stein	-	-	+	+
P. cf. dissecta Nyl.	-	-	-	+
P. perlata (Huds.) Ach.	-	-	+	+
P. polyphylloides Muell. Arg.	-	-	+	+
P. reticulata Tayl.	-	-	-	+
P. rutidota Hook.f. et Tayl.	-	-	+	+
P. cf. subrudecta Nyl.	-	-	+	-
P. sp.	-	-	+	+
USNEACEAE				
Usnea inermis Motyka	-	-	-	+
U. scabrida Taylor	-	-	+	+

APPENDIX 3 (continued)

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
CLADONIACEAE				
Cladonia capitellata (Hook.f.) Hook.f.	-	-	+	+
C. chorophaea (Flk.) Spreng. complex	-	-	+	+
C. squamosula Muell.-Arg.	-	-	-	+
C. sydneyensis F. Wils.	-	-	+	-
Cladia aggregata (Sw.) Nyl.	-	-	+	+
Thysanothecium hyalinum (Tayl.) Nyl.	-	-	-	+
HETERODEACEAE				
Heterodea muelleri (Hampe) Nyl.	-	-	-	+
CANDELARIACEAE				
Candelaria concolor (Dicks.) Steim.	-	-	-	+
TELOSCHISTACEAE				
Teloschistes sieberanus (Laur.) Hilln.	-	-	-	+
T. spinosus (Hook. ex Tayl.) J. Murray	-	-	-	+
Caloplaca fulgens Koerb.	-	-	-	+
PHYSCIACEAE				
Physcia aipolia (Ehrh.) Hampe.	-	-	-	+
B. BRYOPHYTA				
a. MUSCI				
DITRICACEAE				
Ditrichum difficile (Dub.) Fleisch	-	-	+	+
DICRANACEAE				
Campylopus introflexus (Hedw.) Brid.	-	-	+	+
C. pallidus Hook.f. et Wils.	-	-	+	+
POTTIACEAE				
Triquetrella papillata (Hook.f. et Wils.) Broth.	-	-	+	+
FUNARIACEAE				
Funaria hygrometrica Hedw.	-	-	+	+
BRYACEAE				
Bryum ? billardieri Schwaegr.	-	-	-	+
Bryum sp.	-	-	-	+
AULACOMNIACEAE				
Leptotheca gaudichaudii Schwaegr.	-	-	+	+

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
BARTRAMIACEAE				
Breutelia affinis (Hook.) Mitt.	-	-	+	+
THUIDIACEAE				
Thuidium furfurosum (Hook.f. et Wils.) Reichdt.	-	-	+	+
Brachythecium salebrosum (Web. et Mohr.) B.S.G.	-	-	+	-
POLYTRICHACEAE				
Dawsonia longiseta Hpe.	-	-	-	+
Polytrichum juniperinum Willd. ex Hedw.	-	-	+	+
b. HEPATICAE				
LOPHOCOLEACEAE				
Lophocolea semiteres (Lehm.) Mitt.	-	-	+	+
C. PTERIDOPHYTA				
SINOPTERIDACEAE				
Cheilanthes tenuifolia (Burm.f.) Swartz	w	c	+	+
Pellaea falcata (R.Br.) Fee	r	nc	+	-
ASPLENIACEAE				
Asplenium flabellifolium Cav.	s	nc	+	-
BLECHNACEAE				
Blechnum minus (R.Br.) Ettingsh.	vr	o/c	+	-
2. PHANEROGAMIA				
A. GYMNOSPERMAE				
PINACEAE				
* Pinus radiata D. Don	vr	r	+	+
B. ANGIOSPERMAE				
a. MONOCOTYLEDONAE				
POACEAE				
Agrophyron scabrum (R.Br.) Beauv.	s	fc	-	+
* Aira caryophyllea L.	w	fc	+	-
Aristida vagans Cav.	s	lc	+	-
* Avena barbata Pott ex Link	r	lc	+	+
* Briza maxima L.	s	lc	+	+

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
POACEAE (continued)				
B. minor L.	w	fc	+	+
* Bromus diandrum Roth.	s	lc	+	+
* B. mollis L.	w	c	+	+
Danthonia caespitosa Gaudich.	w	c	+	+
D. carphoides F. Muell. ex Benth.	w	c	+	-
D. laevis J. Vickery	s	fc	+	-
D. pallida R.Br.	w	vc	+	+
Dichelachne rara (R.Br.) J. Vickery	s	lc	+	+
D. sciurea (R.Br.) Hook.f.	w	fc	-	+
Echinopogon caespitosus C.E. Hubbard	s	lc	+	+
Microlaena stypoides (Labill.) R.Br.	w	lc	+	+
Panicum effusum R.Br.	s	lc	+	+
* Paspalum dilatatum Poir	r	lc	+	-
* Phalaris canariensis L.	r	nc	+	+
* P. tuberosa L.	r	lc	+	+
Poa labillardieri Steud.	-	-	+	+
P. sieberana Spreng.	-	-	+	+
Stipa falcata Hughes	s	fc	+	+
Themeda australis (R.Br.) Staph.	w	lc	+	-
* Vulpia bromoides (L.) S.F. Gray	w	fc	+	+
CYPERACEAE				
Lepidosperma laterale R.Br.	s	lc	+	+
Schoenus apogon Roem et Schult.	w	lc	-	+
JUNCACEAE				
Juncus australis Hook.f.	w	fc	-	+
J. sarophorus L.A.S. Johnson	-	-	+	+
J. subsecundus N.A. Wakefield	s	lc	+	+
Luzula flaccida (Buchan) E. Edgar	w	c	+	+
L. meridionalis Nordensk.	-	-	+	-
LILIACEAE				
Bulbine bulbosa (R.Br.) Haw.	s	lc	+	-
Dianella revoluta R.Br.	s	lc	+	+
Stypandra glauca R.Br.	s	lc	+	+
Tricoryne elatior R.Br.	w	lc	+	-
XANTHORRHOEACEAE				
Lomandra filiformis (Thunb.) J. Britt. subsp. filiformis	s	lc	+	+
L. longifolia Labill.	w	lc	+	+
L. multiflora (R.Br.) J. Britt.	s	lc	+	-
ORCHIDACEAE				
Acianthus exsertus R.Br.	r	lc	-	+
Caladenia angustata Lindl.	w	c	+	+

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
ORCHIDACEAE (continued)				
Caladenia carnea R.Br.	w	c	+	+
C. congesta R.Br.	r	nc	+	-
C. praecox Nicholls	w	fc	+	+
Calochilus robertsonii Benth.	s	lc	+	+
Diuris maculata Sm. sens. lat.	w	c	+	+
D. sulphurea R.Br.	w	c	+	+
Glossodia major R.Br.	w	c	+	+
Microtis parviflora R.Br.	s	lc	+	-
Pterostylis longifolia R.Br.	r	lc	+	+
P. nutans R.Br.	r	lc	+	-
P. parviflora R.Br.	s	nc	-	+
Thelymitra ixioides Swartz var. truncata (R.S. Rodgers) W.H. Nicholls	s	fc	+	-
T. pauciflora R.Br.	w	fc	+	+
b. DICOTYLEDONAE				
PROTEACEAE				
Grevillea alpina Lindl.	w	c	+	+
++ G. rosmarinifolia cultivar	-	-	-	+
Hakea sericea Schrad.	r	lc	+	+
LORANTHACEAE				
Amyema pendulum (Sieb. ex Spreng.) Tiegh. subsp. pendulum (on Eucalyptus dives)	w	c	+	-
SANTALACEAE				
Exocarpus cupressiformis Labill.	w	c	+	+
POLYGONACEAE				
* Rumex acetosella L. sens. lat.	w	fc	+	+
* R. brownii Campd.	s	c	+	+
CHENOPODIACEAE				
Rhagodia nutans R.Br.	s	lc	+	-
CARYOPHYLLACEAE				
* Petrorhagia nanteulii (Burnat.) Ball et Heywood	s	lc	+	+
Stellaria pungens Brongn.	s	lc	+	+
LAURACEAE				
Cassytha pubescens R.Br.	w	fc	+	+
BRASSICACEAE				
* Hirschfeldia incana (L.) Lagreze-Foss	s	nc	+	-
* Sisymbrium officinale (L.) Scop.	r	lc	+	+

APPENDIX 3 (continued)

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
DROSERACEAE				
Drosera auriculata Bakh. ex Planch.	s	fc	+	+
D. peltata Sm. ex Willd.	s	lc	+	-
CRASSULACEAE				
Crassula sieberana (Schult et f. Schult.) Druce	w	c	+	+
PITTOSPORACEAE				
Billardiera procumbens (Hook.) E.M. Bennet	s	nc	+	-
B. scandens Sm.	s	fc	+	+
Bursaria lasiophylla E.M. Bennet var. lasiophylla	w	c	+	+
ROSACEAE				
Acaena anserinifolia (Forst. et Forst.f.) Druce	s	lc	+	-
A. ovina A. Cunn.	w	fc	+	-
* Cotoneaster cf. conspicua Marquand. (garden escape)	-	-	+	-
* C. franchetii Bois. (garden escape)	-	-	+	-
* Rosa rubiginosa L.	s	lc	+	-
MIMOSACEAE				
++ Acacia baileyana F. Muell.	s	lc	+	+
A. buxifolia A. Cunn.	w	lc	+	+
++ A. decurrens (Wendl.) Willd.	s	lc	+	+
A. genistifolia Link	w	lc	+	+
A. gunnii Benth.	s	lc	+	+
A. implexa Benth.	s	lc	-	+
A. lanigera A. Cunn.	r	nc	+	-
A. mearnsii D. Wild.	w	lc	+	+
++ A. rubida A. Cunn.	vr	r	+	-
FABACEAE				
Bossiaea buxifolia A. Cunn.	w	fc	+	+
Daviesia mimosoides R.Br.	w	c	+	+
Desmodium varians (Labill.) G. Don	s	nc	+	-
Dillwynia retorta (Wendl.) Druce var. phylicoides (A. Cunn.) J. Thompson	w	c	+	+
Glycine clandestina Wendl.	s	lc	+	-
G. tabacina (Labill.) Benth.	s	lc	+	-
Hardenbergia violacea (Schneev.) Stearn	s	lc	+	+
Hovea heterophylla A. Cunn. ex Hook.f.	s	nc	+	+
Indigofera australis Willd.	s	nc	+	+
* Medicago polymorpha L.	s	fc	+	+

APPENDIX 3 (continued)

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
FABACEAE (continued)				
Mirbelia oxylobioides F. Muell.	w	c	+	+
Pultenaea procumbens A. Cunn.	w	c	+	+
* Trifolium arvense L.	w	vc	+	+
* T. campestre Schreb.	w	c	+	-
GERANIACEAE				
Erodium crinitum Carolin	s	lc	+	-
* E. cicutarium (L.) L'Her.	w	lc	+	-
OXALIDACEAE				
Oxalis corniculata L.	w	c	+	+
EUPHORBIACEAE				
Phyllanthus hirtellus F. Muell. ex Muell. Arg.	s	lc	+	+
Poranthera microphylla Brongn.	s	lc	+	+
STACKHOUSIACEAE				
Stackhousia monogyna Labill.	s	nc	+	+
SAPINDACEAE				
Dodonaea viscosa Jacq. sens. lat.	s	fc	+	+
RHAMNACEAE				
Cryptandra amara Sm. var. longiflora F. Muell. ex Maiden et Betche	s	lc	-	+
Pomaderris affinis N.A. Wakefield	s	lc	-	+
DILLENIACEAE				
Hibbertia obtusifolia DC.	w	fc	+	+
H. stricta (DC.) F. Muell. sens. lat.	s	lc	+	+
HYPERIACEAE				
Hypericum gramineum Forst.f.	s	lc	+	-
THYMELAEACEAE				
Pimelea curvifolia R.Br.	s	lc	+	-
P. linifolia Sm.	s	lc	+	+
MYRTACEAE				
Eucalyptus dives Schau.	w	c	+	-
E. macrorhyncha F. Muell. ex Benth.	w	vc	+	+
E. mannifera Mudie subsp. maculosa (R.T. Bak.) L. Johnson	w	vc	+	+
E. melliodora A. Cunn. ex Schau.	w	fc	+	-
E. polyanthemos Schau.	s	lc	+	+

APPENDIX 3 (continued)

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
MYRTACEAE (continued)				
Eucalyptus rossii R.T. Bak. et H.G. Sm.	w	vc	+	+
Leptospermum multicaule	w	c	+	+
L. phylicoides (A. Cunn. ex Schau.) Cheel	w	c	+	+
HALORAGACEAE				
Gonocarpus tetragynus Labill.	r	lc	+	+
ARALIACEAE				
Astrotricha ledifolia DC.	r	nc	+	+
APIACEAE				
Hydrocotyle laxiflora DC.	w	c	+	-
EPACRIDACEAE				
Astroloma humifusum (Cav.) R.Br.	s	nc	-	+
Leucopogon sp. aff. L. fletcheri Maiden	r	lc	+	+
L. microphyllus R.Br. sens. lat.	s	lc	-	+
L. virgatus (Labill.) R.Br.	s	nc	+	+
Melichrus urceolatus R.Br.	s	fc	+	+
Monotoca scoparia R.Br.	s	fc	+	+
PRIMULACEAE				
* Anagallis arvensis L.	s	nc	+	+
GENTIANACEAE				
* Centaurium minus Gars.	w	lc	+	-
CONVOLVULACEAE				
Dichondra repens Forst et Forst.f.	w	fc	+	+
LAMIACEAE				
* Marrubium vulgare L.	r	lc	+	-
* Salvia verbenacea L.	s	lc	+	-
SCROPHULARIACEAE				
* Linaria pelisserana (L.) Mill.	s	lc	+	-
Parahebe perfoliata (R.Br.) B. Briggs et Ehrend	r	r	+	-
* Verbascum thaspus L.	s	lc	+	-
OROBANCHACEAE				
* Orobanche minor Sm.	r	lc	+	+
PLANTAGINACEAE				
* Plantago lanceolata L.	w	fc	+	+

APPENDIX 3 (continued)

Species	Distribution in Black Mountain area	Abundance in Black Mountain area	Observation in sites A	B
RUBIACEAE				
Galium gaudichaudii DC.	s	lc	+	+
Pomax umbellata (Sol. ex Gaertn.) Miq.	s	mc	-	+
CAPRIFOLIACEAE				
* Lonicera japonica Thunb.	vr	lc	+	-
CAMPANULACEAE				
Wahlenbergia granticola Carolin	-	-	+	-
GOODENIACEAE				
Goodenia hederacea Sm. subsp. boormanii (Krause) Carolin	s	c	+	+
STYLIDIACEAE				
Stylidium graminifolium Swartz ex Willd.	s	c	+	+
ASTERACEAE				
Brachycome aculeata (Labill.) Less.	r	lc	+	-
* Carduus pycnocephalus L.	r	lc	+	-
Cassinia longifolia R.Br.	s	lc	+	-
C. quinquefaria R.Br.	w	c	+	+
* Chondrilla juncea L.	w	fc	+	+
* Cirsium vulgare (Saui) Ten.	s	lc	-	+
* Conyza bonariensis (L.) Cronq.	s	lc	+	+
* C. floribunda H.B.K.	s	lc	+	+
Cymbonotus preissianus Steetz	w	lc	+	-
Gnaphalium gymnocephalum DC.	s	lc	+	-
G. sphaericum Willd.	s	fc	+	+
Helichrysum apiculatum (Labill.) D. Don sens. lat.	w	fc	+	+
H. collinum DC.	r	lc	+	+
H. semipapposum	w	fc	+	+
H. viscosum Sieb. ex Spreng.	s	lc	+	+

APPENDIX 4

ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED EXTENSION TO THE NATIONAL BOTANIC GARDENS, CANBERRA, ACT

MAMMALS

C.R. Tidemann *

Study area

Sites A and B (as per proposal map; site A bounded by Parkes Way and Black Mountain Dr; site B bounded by Black Mountain Reserve management roads and power line).

Introduction

This section presents the results of the mammal study. It is based on a survey made during 1974-75 by C.R. Tidemann, a brief site visit in November 1979, a review of relevant literature and discussion with various personnel connected with the National Botanic Gardens.

Objectives

To determine the effects of the proposed extension to the National Botanic Gardens on mammal fauna in the study area, with emphasis on its regional context and any rare or endangered species.

Study components

(a) to assess the habitat modification and mammal species affected by the proposed extension to the National Botanic Gardens with particular reference to any rare or endangered species;

(b) to assess disturbance to mammal fauna by the proposed development;

(c) to assess the regional significance of loss of habitat and any special features; and

(d) to compile a list of the mammal species known to occur in the study area(s).

Methods

(a) Habitat assessment - Faunal habitats were assessed on the basis of vegetation structure and quality and by secondary reference to floristics. For most species of mammals it is vegetation structure rather than species composition which affects habitat suitability.

(b) Fauna assessment - The mammal fauna list was compiled from several different sources of information:

(i) a survey of the mammal fauna of the Black Mountain Reserve, which was carried out by the author in 1974-75. This study involved several consecutive periods of trapping for small mammals and night-time spotlighting at five sites within the Black Mountain Reserve;

* Zoology Department, Australian National University, Canberra.

(ii) reference to an unpublished report of a similar study made by the Conservation and Agriculture Section, Department of the Capital Territory, in 1976 (Kukolic 1976, unpublished);

(iii) consultation with various personnel connected with the National Botanic Gardens: Mr Chris Green (ranger), Mr Andy McWhirter (ranger), Mr Kurt Thaler (ranger), Mr John Jervis (ranger), Mr John Wrigley (curator), Miss Kay Loxton (research assistant).

A brief visit was made to inspect sites A and B in November 1979 to assess the current status of these areas.

Results

(a) Habitat type and condition Sites A and B support similar stands of eucalypt forest, with dominants being E. macrorhyncha, E. rossii and E. mannifera. Disturbed, or partially cleared, areas occur at both sites supporting stands of various weed species. Habitat quality appears to be similar at both sites, and is typical of this forest association which occurs widely on Black Mountain.

(b) Mammal species known to occur in the study area Nineteen species of native mammal and seven introduced species have been recorded in the study area. Of these, only one wombat has been sighted and recorded, and the two flying foxes, Pteropus spp. and feral pig, Sus scrofa, are uncommon vagrants. However, others of those listed are common resident species in the study area.

Species recorded and their status are summarised in Table 1.

TABLE 1 Mammals recorded from Sites A and B

Species	Status
(a) Native mammals	
Monotreme	
Spiny anteater (Tachyglossus aculeatus)	Uncommon
Marsupials	
Sugar glider (Petaurus breviceps)	Common
Brush-tailed possum (Trichosurus vulpecula)	Common
Ring-tailed possum (pseudocheirus peregrinus)	Common
Yellow-footed marsupial mouse (Antechinus flavipes)	Common
Brown marsupial mouse (A. stuartii)	Uncommon
Wombat (Vombatus ursinus)	Rare, recorded from one sighting only
Eastern grey kangaroo (Macropus giganteus)	Uncommon
Bats	
Reddish flying fox (Pteropus scapulatus)	Uncommon migrant
Grey-headed flying fox (P. poliocephalus)	Uncommon migrant
Little flat bat (Tadarida planiceps)	Uncommon
White-striped bat (T. australis)	Rare
Yellow-bellied bat (Taphozous flaviventris)	Rare
Lesser long-eared bat (Nyctophilus goeffroyi)	Common

Species	Status
Gould's long-eared bat (N. gouldii)	Common
Gould's Wattled bat (Chalinolobus gouldii)	Common
Chocolate Wattled bat (C. morio)	Common
Little brown bat (Eptesicus vulturnus)	Common
King River little bat (E. regulus)	Common
(b) Introduced mammals	
Feral cat (Felis catus)	Common
European fox (Vulpes vulpes)	Uncommon
European rabbit (Oryctolagus cuniculus)	Common
European hare (Lepus europeaus)	Common
Black rat (Rattus rattus)	Uncommon
House mouse (Mus musculus)	Very common
Feral pig (Sus scrofa)	Rare vagrant, recorded from group of three only

It seems likely that the swamp wallaby, Wallabina bicolour, once occurred in the study area as it is still present in similar habitat in the Ainslie-Majura Reserve, but it does not appear to be on Black Mountain now. The common marsupial mouse, Sminthopsis mumina, probably exists in low numbers, but has not been recorded on any survey.

The one wombat recorded in the Reserve (A. McWhirter, personal communication) may have been a deliberate release, or a vagrant from elsewhere; suitable habitat for this species does not occur on Black Mountain.

Habitat modification as a result of the proposal, and its effect on mammal fauna

The effects of development of Site A or B along similar lines to that of the existing Gardens will result in the partial destruction of forest, excluding those areas which are too steep for development. Movements of large terrestrial mammals such as kangaroos and spiny anteaters will be restricted or prevented by the fencing of the newly developed area, thus denying them access to a small portion of habitat previously available.

Some of the smaller terrestrial species, such as the two Antechinus and the two introduced rodents, Mus and Rattus, will probably be adversely affected to some extent by the removal of natural ground litter and fallen timber, but the general pattern of development employed in the existing Gardens does allow the survival of these species, albeit at reduced levels.

The arboreal mammals and the bats will probably remain largely unaffected by development. The planting of additional flowering and fruiting trees and shrubs may actually enhance the survival of some of these species. The existing Gardens presently support most of the mammal species found in the adjoining Reserve (Tidemann, 1979) excluding only the large mammals, such as kangaroos.

The envisaged overall effects in terms of habitat destruction and depletion of mammal fauna are fairly insignificant when viewed in a regional context. The Black Mountain Reserve contains large areas of habitat similar to that present in the study area and supports the associated mammal fauna. Similar faunal assemblages occur also on Mounts Ainslie and Majura.

Rare or endangered species

No rare or endangered mammal species were found to occur in the study area, nor are any expected to occur there.

Summary

Nineteen species of native mammal and seven introduced species have been recorded from the study area. Some of these were recorded from one or a few individuals and others were uncommon migratory animals. The majority are fairly common resident species. No rare or endangered species occur in the study area or are expected to occur there.

Some habitat destruction will result from the proposed development, but it is expected to be insignificant when viewed in a regional context.

Fencing of the study area will impede movement by larger mammals, but will probably not have much effect on other species. The introduction of flowering and fruiting trees, and the provision of permanent water sources, may actually enhance the survival of some of the possums and flying foxes.

References

Kukolic K., Report of a Survey of the Ainslie and Black Mountain Reserves, Conservation and Agriculture Branch, Department of the Capital Territory, 1976 (unpub.).

Tidemann C.T., 'Mammals in the Gardens', in National Botanic Gardens, AGPS, Canberra, 1980.

APPENDIX 5

ENVIRONMENTAL IMPACT ASSESSMENT FOR PROPOSED EXTENSION TO THE NATIONAL BOTANIC GARDENS, CANBERRA, ACT

BIRDS *

Grahame Clark

Introduction

This report is based on considerable banding and census work carried out over a period of ten years within the existing boundaries of the National Botanic Gardens, but only a few visits to the two proposed extension sites, A and B. From these few visits it appears that the bird life is similar in broad outline to that on the rest of the Black Mountain Reserve. Therefore certain patterns of avifauna and movement can be interpolated. However the first site (A) is the less typical since it appears to have been more affected by human interference.

Beneficial effects

If the boundaries of the Gardens are extended and development is undertaken to the standard of the rest of the Gardens the following effects beneficial to certain species of birds will follow:

. a greater density of food-bearing plants (nectar and seed-bearing) will result in an increase in the amount of available food;

. a greater variety of food-bearing plants will result in an increased period of food availability;

. the cultivation and watering of areas will provide a greater density of insect food;

. dense growth of vegetation will provide extra nesting sites for species that nest in undergrowth; and

. the increased variety of habitats will provide a greater 'ecotone' effect.

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* The common names used for species in this report are those recommended by the Royal Australian Ornithologists Union for the Birds of Australia, Emu, Vol. 78, supplement (1978). Acknowledgment is due to various members of the Canberra Ornithologists Group for their advice and knowledge of the avifauna of the area.

The species which will increase in numbers because of these effects will be:

Common bronzewing (Phaps chalcoptera)
Gang-gang cockatoo (Callocephalon fimbriatum)
Australian king-parrot (Alisterus scapularis)
Crimson rosella (Platycercus elegans)
Eastern rosella (Platycercus eximius)
Fan-tailed cuckoo (Cuculus pyrrhophanus)
Shining bronze-cuckoo (Chrysococcyx lucidus lucidus)
Kookaburra (Dacelo gigas)
Sacred kingfisher (Halycon sancta)
Common blackbird (Turdus merula)
Rose robin (Petroica rosea)
Golden whistler (Pachycephala pectoralis)
Rufous whistler (Pachycephala rufiventris)
Leaden flycatcher (Myiagra rubecula)
Grey fantail (Rhipidura fuliginosa)
Superb fairy-wren (Malurus cyaneus)
White-browed scrub-wren (Sericornis frontalis)
White-throated gerygone (Gerygone olivacea)
Brown thornbill (Acanthiza pusilla)
Red wattlebird (Anthochaera carunculata)
Noisy friarbird (Philemon coriculatus)
Yellow-faced honeyeater (Lichenostomus chrysops)
White-eared honeyeater (Lichenostomus leucotis)
Yellow-tufted honeyeater (Lichenostomus melanops)
Crescent honeyeater (Phylidonyris pyrrhoptera)
New Holland honeyeater (Phylidonyris novaehollandiae)
Eastern spinebill (Acanthorhynchus tenuirostris)
Silvereye (Zosterops lateralis)
House sparrow (Passer domesticus)
Red-browed firetail (Emblema temporalis)
Double-barred finch (Poephila bichenovii)
Olive-backed oriole (Oridus sagittatus)
Australian magpie (Gymnorhina tibicen)
Pied currawong (Strepera graculina)

Adverse effects

The adverse effects of the expansion are in four main areas:

- destruction of habitat;
- elimination of nesting holes;
- concentration of predators; and
- use of pesticides/herbicides.

Destruction of habitat

There are only two species on Black Mountain which depend on unaltered ground-layer habitat. They are the painted button-quail (Turnix vario) and the speckled warbler (Sericornis sagittatus). If Site B is developed these birds will decrease in number. The development of Site A will have a lesser effect because it has a smaller amount of suitable habitat for the two species.

Elimination of nesting holes

The elimination of nesting holes will pose a serious problem. If the present method of dealing with all hollow limbs in the Botanic Gardens is used in the extension then a considerable number of nesting hollows will be removed. This will seriously reduce the nesting of all parrots and certain other species (e.g. white-throated tree creepers, maned duck, striated pardalote).

Concentration of predators

The increase in the number of birds will cause a concentration of predators particularly the feral cat (Felis catus) and the pied currawong (Strepera graculina). A management policy might be necessary to keep these two under control. The latter is only a serious problem during the breeding season when the conditions provided in the Gardens allow a much greater density of breeding pairs than is normal and hence a high predation rate on nestlings of other species. Feral cats will always be a problem unless numbers are kept low.

Use of pesticides/herbicides

The use of these is always contentious. Observations during banding operations in the Gardens suggest that the numbers of insect-eating birds decline after consistent spraying. Whether this is due to direct effects or to elimination of food (or even the observer's imagination) is not certain. The effects do not seem to be long lasting. This problem would merit further objective study should the opportunity arise.

Unknown effects

There are some species of birds which, while they would not be adversely affected by the extension, may not benefit either. Without further detailed study it is impossible to say. The following lists such species which occur on Black Mountain:

Australian hobby (Falco longipennis)
Collared sparrow hawk (Accipiter cirrhocephalus)
Tawny frogmouth (Podargus strigoides)
Dollar bird (Eurystomus orientalis)
Black-faced cuckoo-shrike (Coracina novaehollandiae)
Eastern yellow robin (Eopsaltria australis)
Weebill (Smicrornis brevirostris)
Striated thornbill (Acanthiza lineata)
Grey strike-thrush (Colluricincla harmonica)
White-throated treecreeper (Climacteris leucophaea)
Brown headed honeyeater (Melithreptus brevirostris)
White-naped honeyeater (Melithreptus lunatus)
Spotted pardalote (Pardalotus punctatus)
Striated pardalote (Pardalotus striatus)
White-winged chough (Corcorax melanorhamphus)
Grey currawong (Strepera versicolor)
Australian raven (Corvus coronoides)

Summary

The main problem associated with the extension of the National Botanic Gardens is one of nest sites. If the present techniques of tree surgery are continued then a great number of nest sites will be eliminated. The problem of predators may also require a management policy in order to lessen its impact. As far as habitat alteration is concerned the effects will be minimal. Of the fifty or so most common species, thirty-four species will benefit, fifteen will either benefit or remain the same (data is insufficient to say), and two will be adversely affected, and then only if Site B is chosen.

Bird species (common and scientific names) recorded at the National Botanic Gardens

Names

The English names used in this list of species are those recommended by the Royal Australasian Ornithologists Union. The scientific names are those given in the Checklist, part 1 (non-passerines) and the interim Checklist, part 2 (passerines), published by the Royal Australasian Ornithologists Union.

Breeding

Species known to have bred in the Gardens are indicated by an asterisk.

Abundance

A relative indication of numbers present in the Gardens is given by terms ranging from 'extremely rare' for species recorded only once, through 'very rare', 'rare', 'irregular sightings', 'occasional', 'uncommon', 'fairly common', 'common' to 'very common'. These are indicators only and are not precise.

Seasonal presence of species in the Gardens

This is indicated by the following terms:

Nomadic — tends to wander and can occur at any season.

Migrant — moves seasonally. Normally all birds of the species move. Most migrant species occur in the ACT over the warmer months. Those few which migrate here over winter are indicated.

Altitudinal migrant — a species normally found in the nearby high country over summer and which appears near Canberra in winter.

Partial migrant — where most of the birds of a species move from the area seasonally. Some individuals remain where suitable food is available, for example, in the Gardens.

Passage migrant — where the species moves through the area in spring and summer on migration but does not stay to breed.

Resident — to be found in the Gardens or nearby at all seasons of the year and not subject to nomadic or migratory movement as a species.

Species	Status
White-faced heron *(Ardea novaehollandiae)*	Occasional; resident
Rufous night-heron *(Nycticorax caledonicus)*	Very rare; nomadic
Black duck *(Anas superciliosa)*	Fairly common*
Black-shouldered kite *(Elanus notatus)*	Rare; resident
Brown goshawk *(Accipiter fasciatus)*	Occasional; resident
Collared sparrowhawk *(Accipiter cirrocephalus)*	Uncommon; resident*
Peregrine falcon *(Falco peregrinus)*	Very rare; resident
Australian hobby *(Falco longipennis)*	Occasional; resident
Brown falcon *(Falco berigora)*	Occasional; resident
Australian kestrel *(Falco cenchroides)*	The most common hawk; resident*
Painted button-quail *(Turnix varia)*	Rare; resident*
Feral pigeon *(Columba livia)*	Common; resident
Spotted turtle-dove *(Streptopelia chinensis)*	Very rare; aviary escapees?
Common bronzewing *(Phaps chalcoptera)*	Fairly common; resident*
Gang-gang cockatoo *(Callocephalon fimbriatum)*	Common in winter; occasional in summer*
Galah *(Cacatua roseicapilla)*	Occasional; resident*
Sulphur-crested cockatoo *(Cacatua galerita)*	Rare; resident
Musk lorikeet *(Glossopsitta concinna)*	Very rare; nomadic
Little lorikeet *(Glossopsitta pusilla)*	Occasional; nomadic
Australian king-parrot *(Alisterus scapularis)*	Uncommon; chiefly in winter, nomadic
Crimson rosella *(Platycercus elegans)*	Common; resident*
Eastern rosella *(Platycercus eximius)*	Common; resident*
Red-rumped parrot *(Psephotus haematonotus)*	Occasional; resident
Pallid cuckoo *(Cuculus pallidus)*	In small numbers; migrant*
Brush cuckoo *(Cuculus variolosus)*	Rare; migrant*
Fan-tailed cuckoo *(Cuculus pyrrhophanus)*	Fairly common; partial migrant*
Horsfields' bronze-cuckoo *(Chrysococcyx basalis)*	In small numbers; migrant*
Shining bronze-cuckoo *(Chrysococcyx lucidus)*	Fairly common; migrant*
Southern boobook owl *(Ninox novaeseelandiae)*	Uncommon; resident?*
Barn owl *(Tyto alba)*	Uncommon; resident?
Tawny frogmouth *(Podargus strigoides)*	Regular in small numbers; resident?*
White-throated needletail *(Hirundapus caudacutus)*	Irregular sightings; nomadic migrant
Laughing kookaburra *(Dacelo novaeguineae)*	Common; resident*
Sacred kingfisher *(Halcyon sancta)*	In small numbers; migrant*
Dollarbird *(Eurystomus orientalis)*	In small numbers; migrant*
Welcome swallow *(Hirundo neoxena)*	Occasional; partial migrant
Tree martin *(Cecropsis nigricans)*	In small numbers; migrant*
Richard's pipit *(Anthus novaeseelandiae)*	Very rare, seen in the grassy areas; resident
Black-faced cuckoo-shrike *(Coracina novaehollandiae)*	Common; partial migrant*.
White-winged triller *(Lalage sueurii)*	Irregular sightings; migrant
White's thrush *(Zoothera dauma)*	Very rare; winter only, altitudinal migrant
Blackbird *(Turdus merula)*	Common; resident*

Species	Status
Rose robin *(Petroica rosea)*	Rare; passage migrant autumn and spring?
Pink robin *(Petroica rodinogaster)*	Very rare; migrant, winter only
Flame robin *(Petroica phoenicea)*	In small numbers autumn to spring; altitudinal migrant*
Scarlet robin *(Petroica multicolor)*	Fairly common; resident*
Red-capped robin *(Petroica goodenovii)*	Very rare; nomadic
Hooded robin *(Melanodryas cucullata)*	Now very rare*
Eastern yellow robin *(Eopsaltria australis)*	Common; resident*
Jacky winter *(Microeca leucophaea)*	Very rare; resident*
Crested shrike-tit *(Falcunculus frontatus)*	Rare; resident*
Olive whistler *(Pachycephala olivacea)*	Very rare; winter only, altitudinal migrant
Golden whistler *(Pachycephala pectoralis)*	Common except in summer; altitudinal migrant*
Rufous whistler *(Pachycephala rufiventris)*	Common early spring to late autumn; rare in winter*
Grey shrike-thrush *(Colluricincla harmonica)*	Common; resident*
Leaden flycatcher *(Myiagra rubecula)*	Common; migrant*
Satin flycatcher *(Myiagra cyanoleuca)*	Very rare; passage migrant
Restless flycatcher *(Myiagra inquieta)*	Very rare; resident*
Rufous fantail *(Rhipidura rufifrons)*	Uncommon; passage migrant
Grey fantail *(Rhipidura fuliginosa)*	Common; partial migrant*
Willie wagtail *(Rhipidura leucophrys)*	In small numbers; partial migrant?*
Spotted quail-thrush *(Cinclosoma punctatum)*	Very rare; altitudinal migrant
Clamorous reed warbler *(Acrocephalus stentoreus)*	Rare; near water features; migrant
Superb fairy-wren *(Malurus cyaneus)*	Very common; resident*
White-browed scrubwren *(Sericornis frontalis)*	Fairly common; resident*
Speckled warbler *(Sericornis sagittatus)*	Fairly common; resident*
Weebill *(Smicrornis brevirostris)*	Very common; resident*
Western gerygone *(Gerygone fusca)*	Rare; migrant*
White-throated gerygone *(Gerygone olivacea)*	Common; migrant*
Brown thornbill *(Acanthiza pusilla)*	Very common; resident*
Buff-rumped thornbill *(Acanthiza reguloides)*	Uncommon; resident*
Yellow-rumped thornbill *(Acanthiza chrysorrhoa)*	Uncommon; resident*
Yellow thornbill *(Acanthiza nana)*	Uncommon; resident
Striated thornbill *(Acanthiza lineata)*	Very common; resident*
Southern whiteface *(Aphelocephala leucopsis)*	Very rare; resident
Varied sittella *(Daphoenositta chrysoptera)*	Fairly common; resident*
White-throated treecreeper *(Climacteris leucophaea)*	Common; resident*
Red wattlebird *(Anthochaera carunculata)*	Common, particularly in winter; resident*
Little wattlebird *(Anthochaera chrysoptera)*	Extremely rare
Noisy friarbird *(Philemon corniculatus)*	Very common; migrant*
Little friarbird *(Philemon citreogularis)*	Very rare; migrant
Regent honeyeater *(Xanthomyza phrygia)*	Uncommon; nomadic*
Yellow-faced honeyeater *(Lichenostomus chrysops)*	Extremely common especially in spring; partial migrant*
White-eared honeyeater *(Lichenostomus leucotis)*	Common in winter; altitudinal migrant
Yellow-tufted honeyeater *(Lichenostomus melanops)*	Irregular sightings in winter; nomadic
Fuscous honeyeater *(Lichenostomus fusca)*	Small numbers in winter; very common in spring; migratory in Canberra area
White-plumed honeyeater *(Lichenostomus penicillata)*	Fairly common; resident
Brown-headed honeyeater *(Melithreptus brevirostris)*	Fairly common; resident
White-naped honeyeater *(Melithreptus lunatus)*	Very common in early spring; partial migrant*
Crescent honeyeater *(Phylidonyris pyrrhoptera)*	Common in winter; altitudinal migrant*
New Holland honeyeater *(Phylidonyris novaehollandiae)*	Very common particularly in winter; resident*
Eastern spinebill *(Acanthorhynchus tenuirostris)*	Extremely common particularly in winter; resident*
Scarlet honeyeater *(Myzomela sanguinolenta)*	Extremely rare; migrant
White-fronted chat *(Ephthianura albifrons)*	Very rare; near water features
Mistletoebird *(Dicaeum hirundinaceum)*	Uncommon; resident*
Spotted pardalote *(Pardalotus punctatus)*	Very common especially in winter; resident*
Striated pardalote *(Pardalotus striatus)*	Fairly common; resident*
Silvereye *(Zosterops lateralis)*	Very common; large numbers in winter; resident*
European goldfinch *(Carduelis carduelis)*	Occasional; resident*
House sparrow *(Passer domesticus)*	Common near the buildings; resident*
Red-browed firetail *(Emblema temporalis)*	Common; resident*
Double-barred finch *(Poephila bichenovii)*	Common; resident*
Common starling *(Sturnus vulgaris)*	Occasional in the grassy areas; resident
Olive-backed oriole *(Oriolus sagittatus)*	Fairly common; migrant*
Satin bowerbird *(Ptilonorhynchus violaceus)*	Very rare; resident*
White-winged chough *(Corcorax melanorhamphos)*	Common; resident*
Australian magpie-lark *(Grallina cyanoleuca)*	Common; resident*
White-browed woodswallow *(Artamus superciliosus)*	Very rare; migrant*

Species	Status
Dusky woodswallow *(Artamus cyanopterus)*	Uncommon; migrant*
Grey butcherbird *(Cracticus torquatus)*	Very rare; resident
Australian magpie *(Gymnorhina tibicen)*	Very common; resident*
Pied currawong *(Strepera graculina)*	Very common in winter, occasional in summer; resident*
Grey currawong *(Strepera versicolor)*	Uncommon; resident*
Australian raven *(Corvus coronoides)*	Common; resident*
Little raven *(Corvus mellori)*	Very rare; passage migrant

Source: Wilson, S., 'Birds in the Gardens' in National Botanic Gardens, AGPS, Canberra, 1980.