MANAGEMENT PLAN

REMNANT TURPENTINE WOODLAND REHABILITATION

QUEEN ELIZABETH PARK, CONCORD

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For: **Concord Municipal Council**

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EXECUTIVE SUMMARY

The remnant Turpentine Woodland at Queen Elizabeth Park is in serious decline due largely to decades of mowing and compaction. Despite its degraded state it is the only remaining example on a shale soil of this once extensive woddland type. The long-term objective of the management plan, therefore, is to rehabilitate the remnant Turpentine Woodland vegetation community while retaining, where possible, a manageable passive recreation facility for the residents of Concord.

This report contains analyses of the degradation of the remnant, outlines rehabilitation strategies and specifies treatments. The plan examines the requirements of the tree stratum and the understorey separately - but recommends and outlines an integrated rehabilitation and management program . A database inventory of the condition and rehabilitation requirements of 200 major trees, prepared by David Forde (Treescan) has been supplied to Council.

The plan's primary findings are that the trees, while deteriorating, are in sufficiently good condition to justify rehabilitation treatments including pruning and rootzone decompaction - and that the removal of mowing and the regeneration of the native understorey is both a worthy objective in its own right as well as a key component of tree rehabilitation. Soil amendments are recommended only where they will not compromise the ultimate goal of natural regeneration of the remnant.

Due to the high level of deterioration of the understorey, regeneration may depend upon the ability of Council to heat treat the natural soil to stimulate any soil stored native seed. This is ideally acheived by burning debris piles. However, because the lighting of fires is controlled by the Clean Air Act, it is recommended that Council seek exemption from the Act in respect of the burns recommended.

Finally, it is important to note that the implementation of the plan should be carried out on an incremental basis for both ecological and logistic reasons. This will mean that some islands will be completed and will graduate to an ongoing maintenance regime before the construction of other islands commences. Both Council and the community must be aware of and support the preferred, staged nature of the project - to avoid any perception that the approach is disorganised or piecemeal.

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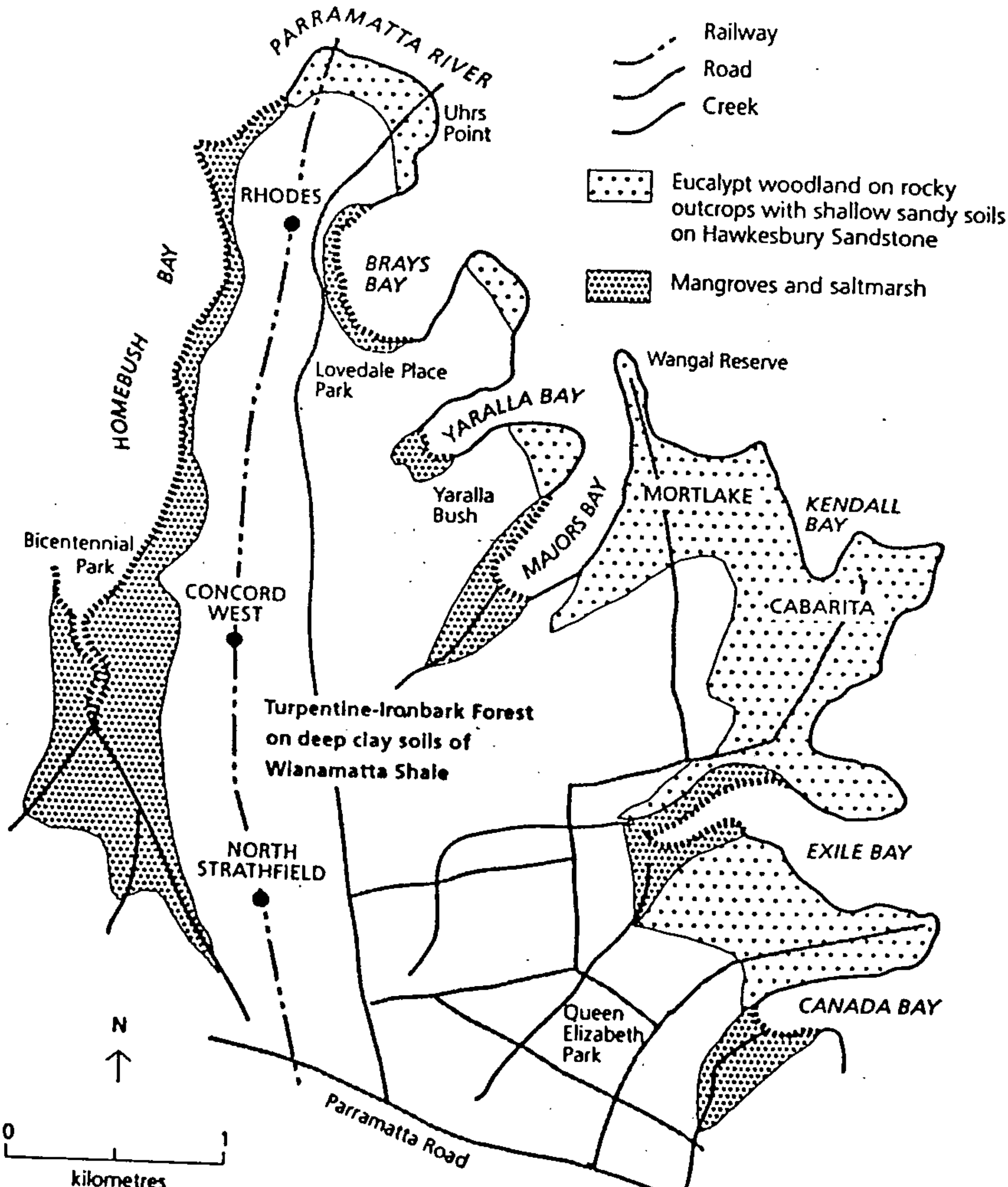

Figure 1. Vegetation patterns of Concord as they would have been in 1788 also showing location of Turpentine-Ironbark Forest and location of Queen Elizabeth Park. [Reproduced from Benson and Howell (1990) with permission of the authors.]

PART A : DISCUSSION

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1. INTRODUCTION

Queen Elizabeth Park, Concord, contains the only remnant Turpentine-Ironbark woodland on public land in the Municipality. Indeed, this vegetation type which once "extended from Glebe and Newtown westward to Auburn (Benson and Howell, 1990)" is now represented in Sydney by only three small remnants - one of which is the remnant at Queen Elizabeth Park, Concord.

The second small remnant exists on the privately owned Dame Eadith Walker property in Concord and the third, a larger remnant, survives at the Australian Navy property Newington at Silverwater. Queen Elizabeth Park however, is the only remnant representing the vegetation of this vegetation type on deep shale soils in the entire Sydney area (D. Benson, 1992, pers. comm.).

As most Municipalities and Shires within Australia can claim to retain and manage remnants of their native vegetation - the rehabilitation and ongoing management of the woodland remnant at Queen Elizabeth Park, especially considering its rarity in the entire district, could be considered a conservation imperative.

1.1 The brief

Crown dieback and tree loss has been occurring in the Turpentine Woodland at the park, since at least the 1970's and concern is growing that the remnant trees are now in serious decline.

In an attempt to turn around this degradation and to provide citizens with "living indicators of the original pattern of Concord's vegetation (Coupe,1983)" a plan of management for the remnant has been commissioned by Concord Municipal Council.

The brief for the plan of management requires the provision of two things:

1. a prescription for the rehabilitation treatment and future management of remnant trees; and

2. a design and specifications for the reconstruction and future management of an understorey to maximise existing tree survival and to enhance what remains of the local native vegetation system. [Treatments for specific sites are not the subject of this plan and, where required, must be subject to specific action prescription.]

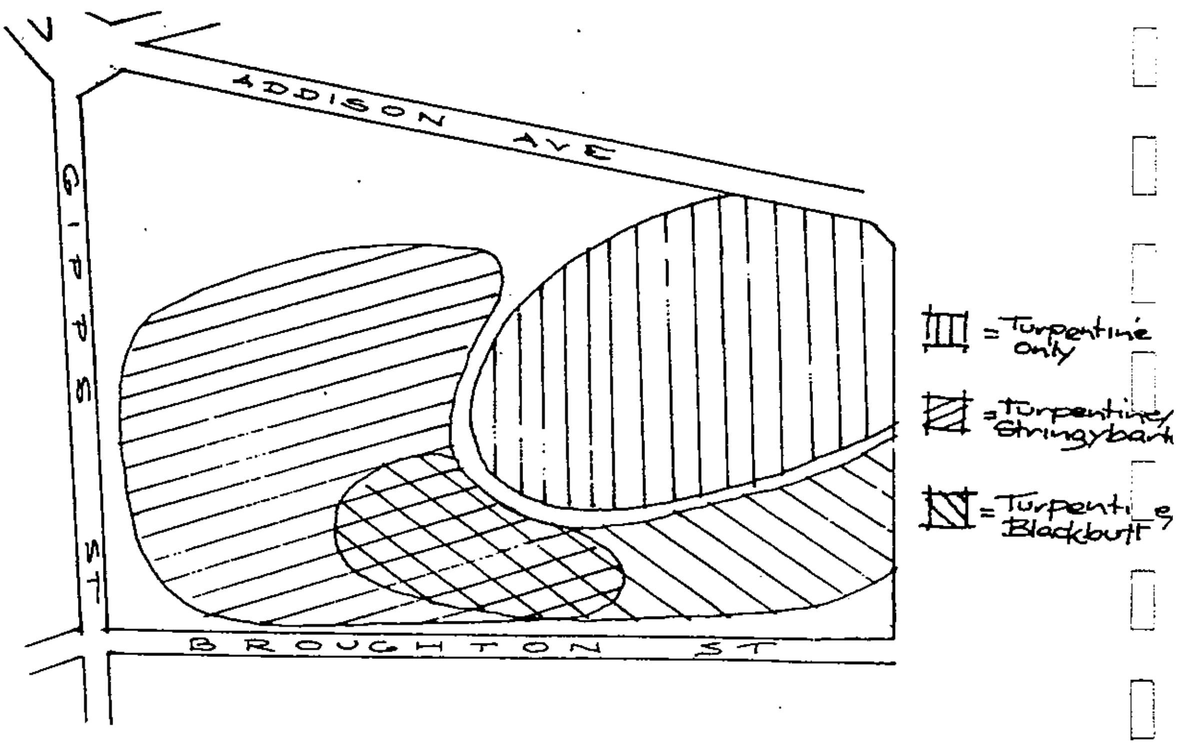
David Ford of Treescan was engaged to undertake the tree rehabilitation component of the plan and Tein McDonald was engaged to undertake the understorey rehabilitation component. This report is a compilation of the work of both consultants.

1.2 What was there in the past?

A surveyors report of 1857 described land on the eastern side of the present Concord Golf Course, 'good forest land.. on good black soil...wooded with gum, blackbutt stringybark, mahogany, apple, ironbark and she oak'(Benson and Howell, 1990)." In fact, these trees and others - including Turpentine (*Syncarpia glomulifera*) - made up what is often referred to as "Turpentine-Ironbark Forest that covered much of the inner western suburbs" (Benson and Howell, 1990)

While Turpentine-Ironbark Forest is a generic label for this forest type - a mosaic of vegetation associations reflecting slight changes in moisture, soil, fire history or available seed would have existed within the forest. At Queen Elizabeth Park, the process of mapping all remnant native trees has shown a pattern of distribution suggesting that the slightly elevated areas of the park were dominated by Red Mahogany and White Stringybark (*Eucalyptus resinifera* and *Eucalyptus globoidea*) - intergrading into Turpentines (*Syncarpia glomulifera*) in the areas of lower elevation.

Drawing 1 shows the approximate location of all remnant trees and islands of groundcovers and Figure 2 is diagrammatic representation of the possible distribution pattern of tree species in the remnant, extrapolated from present occurrence of individual remnant trees.



2. REMNANT TREE POPULATION

2.1 Indigenous tree species now present

The indigenous tree species on site - in order of highest to lowest occurrence - are:

Table 1: Trees present in the park

Scientific Name	Code	Common Name	Number present
Syncarpia glomulifera	(Sg)	Turpentine	179
Eucalyptus globoidea	(Eg)	White Stringybark	11
Eucalyptus resinifera	(Er)	Red Mahogany	6
Eucalyptus pilularis	(Epil)	Blackbutt	3
Eucalyptus robusta	(Erob)	Swamp Mahogany	1
Total			200

The dominance of Turpentine may be partly due to the pattern of logging in the past but is also a result of its superior powers of regeneration from seed and rootstocks. The alterations in forest conditions may have favoured Turpentine over other species resulting in its present abundance.

2.2 Present condition of the remnant tree population

In spite of the alterations to the forest over the past 200 years the tree population as a whole is in reasonable condition. However there are some sections where significant dieback of Turpentine is occurring, particularly in the north east areas, but scattered trees are dying throughout the park. Trees of some of the Eucalypt species are senescent and declining and overall there has been no regeneration to replace their few remnants. The changes wrought by the gradual transformation of the forest into parkland have acted against these under-represented Eucalypt species more than against the vigorous Turpentines.

The following Tables 1, 2 and 3 contain information extracted from the Remnant Tree Inventory which was taken in early 1992 and show that the tree population is aging with little sign of regeneration.

Table 2: Analysis of tree population by species and condition

Condition class code:

Gd: good. Avg: average. Ast: average & stressed.
Pr: poor. Dd: declining and/or dying.

Condition code:	Gd	Avg	Ast	Pr	Dd	Totals
Species						
Sg	69	73	12	19	6	179
Eg	5	3	0	3	0	11
Er	5	1	0	0	0	6
Epil	1	1	1	0	0	3
Erob	0	0	0	1	0	1
All trees	**80**	**78**	13	23	6	200

Total trees
in reasonable
condition (Gd+Avg) **158** or **79%**

The table shows that the majority of individual tree (except the single specimen of *E. robusta*) fall into the Good or Average categories which when combined comprise what could be termed reasonable condition. All species except Turpentine are in perilously low numbers. Turpentine numbers are about equal in both Good or Average categories but the numbers in the worse condition categories are substantial. Observations in the field suggest that these figures will show a continued decline over the coming years since it is evident that declining and dying trees greatly outnumber the planted or naturally occurring seedling or juvenile trees.

Table 3: Analysis of tree population by species and size

Size class code: Lg: large. Md: medium. Sm: small.

Size code:	Lg	Md	Sm
Species			
Sg	62	90	27
Eg	5	4	2
Er	6	0	0
Epil	3	0	0
Erob	1	0	0
Totals	77	94	29

The table shows that a majority of the trees of all species are large or medium in size and that small trees are a less significant proportion of the population. When the population is analysed for age (see Table 3 below) the figures show that most of the trees of all species are mature or overmature and few semimature trees are present. As previously noted all figures are particularly dire for the Eucalypt species present.

Table 4: Analysis of tree population by species and age

Age class code: O: overmature. M: mature. S: semimature

Age code:	O	M	S
Species			
Sg	3	150	26
Eg	1	7	3
Er	0	6	0
Epil	0	3	0
Erob	1	0	0
Totals	5	166	29

The figures in these tables demonstrate that the park trees are an aging and declining population; few young trees of any species are coming through to replace the older specimens in due course. The Turpentines are less badly affected than the Eucalypts because of their greater numbers and resilience so that there is still a little time available before the situation becomes critical. The other species will disappear in the next few years unless action is soon taken to ensure regeneration.

2.3 Causes of tree population decline

As demonstrated above one of the major problems in the park is the aging tree population. This is linked to the other main issues: changes to the original ecosystem, adverse soil conditions, physical damage, fungal decay and the lack of regeneration.

2.3.1 Aging trees.

Many trees in the park are reaching maturity and will begin to decline so that these problems are emerging:

* Trees are declining in vigour and becoming moribund, so that limb dieback and shedding is a continual hazard.

* Defence mechanisms set up by trees against pathogen invasion are becoming less effective so that pathogens are favoured.

* The maturity of the park's trees is resulting in many trees arriving simultaneously at the point of maximum maintenance requirements and maximum potential for decline.

* Trees which decline and die will cause a reduction in the population if no regeneration occurs.

2.3.2 Changes to the original ecosystem

The loss of understorey vegetation capable of enhancing infiltration of rainfall, aeration of the soil and nutrient recycling is a contributing factor in the decline of the trees. The roots of these plants opened the soil for air and water and some (particularly the peas, wattles and Casuarinas) were capable of fixing nitrogen for the use of other plants. Their death and decomposition was a vital link in mulching the soil surface and recycling nutrients. Beneficial soil organisms such as the symbiotic mycorrhyzal fungi (which extend the effectiveness of roots) and the decomposing bacteria were all part of this ecosystem and may now have disappeared.

The logging operations of the 19th century and the removal of dead trees over a long period have subtracted large quantities of the original biomass from the park. Timber which would have normally decomposed and recycled its nutrients within the ecosystem has been removed, causing an overall loss of nutrients. The proportion of organic matter in the soil has also been reduced: this affects the amount of humus and therefore the soil structure, its water holding capacity and food sources for soil organisms including earthworms (Buchanan 1989, p.42).

The park is located in a highly polluted area, the valley of the Parramatta River (Wright 1991). Increases in air pollution may have affected some of the trees but to differing degrees since the species have varying susceptibilities (Buchanan 1989, p.188). Little research has been done on this subject.

These changes all increase the stresses on the trees and therefore reduce their longevity, although the changes may be gradual and the resulting decline correspondingly slow.

2.3.3 Soil conditions.

The clay soils in the park are derived from the underlying Triassic Ashfield Shale, part of the Wianamatta Group (New South Wales Dept of Mines 1966). They are of reasonably good quality but gravelly, acid and prone to compaction. Clay soils are composed of very fine particles and are easily compacted especially when wet; moisture lubricates the particles and causes the aggregate-cementing agents to become more fluid allowing the particles to slip into positions that take up less space. Upon drying the soil shrinks and becomes impermeable. Mechanical relief of soil compaction is a difficult task if tree roots are present because of the risk of damage by machinery. Soils are easily recompacted.

Many years of heavy mower, vehicle and pedestrian usage has compacted large areas to the extent that roots have difficulty in penetrating the reduced pore spaces. Roots which cannot expand tend to die back. Water infiltration is reduced so that rain and irrigation water pools on the surface. The gas exchange function of the roots is reduced so that carbon dioxide builds up in the soil and roots are starved of oxygen.

The disappearance of the original understorey contributes to compaction since rain droplets falling on the unprotected soil of the extensive bare areas further compact the surface.

Apart from the physical soil problems there are also chemical deficiencies and imbalances. Soil pH in the park is generally very low (acidic) which although perhaps not greatly differing from natural levels may limit tree growth. In some areas there is evidence of salinity, possibly a legacy of previous marine conditions. Some of the minerals important for plant growth are lacking, especially Calcium, Phosphorus and Potassium although increases in soil organic matter resulting from regeneration plantings will improve nutrition in the long term.

2.3.4 Damaged and decayed trees.

There are many decayed trees in the park, chiefly the result of poor practices in the past, wounding by vehicles, mowing equipment damage or vandalism. Many trees have been lopped (presumably in an attempt to reduce or limit their height) leaving decaying stubs and weak suckering growth in the crowns. There are few trees in the park which have not received damage to their lower trunks or root flares from the passage of mowers. Many trees exhibit roots which have been killed by such damage; decline and destabilisation often results.

Once these wounds are inflicted older trees have greater difficulty in resisting the invasion of bacteria and fungi through the openings. Trees are well adapted to containing decay pathogens so that spread of disease is limited, but stressed or moribund trees are less able to combat invasions (Harris 1983 p.567). Once decay pathogens, bacterial and/or fungal, have become established the disease is difficult or impossible to treat successfully since the seat of the infection is deep in the heartwood where previously sound wood is being chemically altered.

Phytophthora cinnamomi root rot fungus produces similar symptoms of tree dieback to those to be seen in the north east of the park, particularly as the dieback appears to be spreading down the slope in the typical manner of this disease. Samples of roots and soil were taken from the perimeter of dieback areas and examined by Dr Brett Summerell of the Royal Botanic Gardens; no disease pathogens were found but continued monitoring might produce evidence of the disease. *P. cinnamomi* is favoured by the following conditions: this information is included for future reference if this disease is found to be present. These conditions should in any case be avoided.

* Saturation of the soil for short periods

* Poor internal soil drainage

* Soils of low fertility containing little organic matter

* Soil temperatures above 16 degrees Celsius (Marks et al, 1982, pp.6-10)

Specimens of fungal fruiting bodies found on the trunks or root flares of trees in the park during the Autumn fruiting season were identified by Dr Summerell as follows.

Table 5: Identified fungal fruiting bodies

Tree no	Fungus species	Consequence
155	Hirneola aericula-judae	Reduction of viability
148	Related to above	Reduction of viability
183	Ganoderma spp. possibly applanatum	Aggressive decay fungus

It is unfortunate that Tree 183 is a large *Eucalyptus globoidea* which is needed for seed collection. This severe bracket fungus disease cannot be treated and will rapidly decay the heartwood of the trunk.

Trees do not heal; new wood is laid over the decay site by the annual growth layers (very slowly in old trees) but the decay pathogens continue to break down the heartwood (Shigo 1986a p.502). Every time a tree has to contain an infection it not only uses scarce energy reserves but is forced to lose part of its energy storage. (Loss of energy storage also results after drastic pruning of old trees.) The best means of reducing the effect of decay pathogens is to raise the trees' vitality so that their natural mechanisms are capable of containing the infection. This is more difficult in senescent trees.

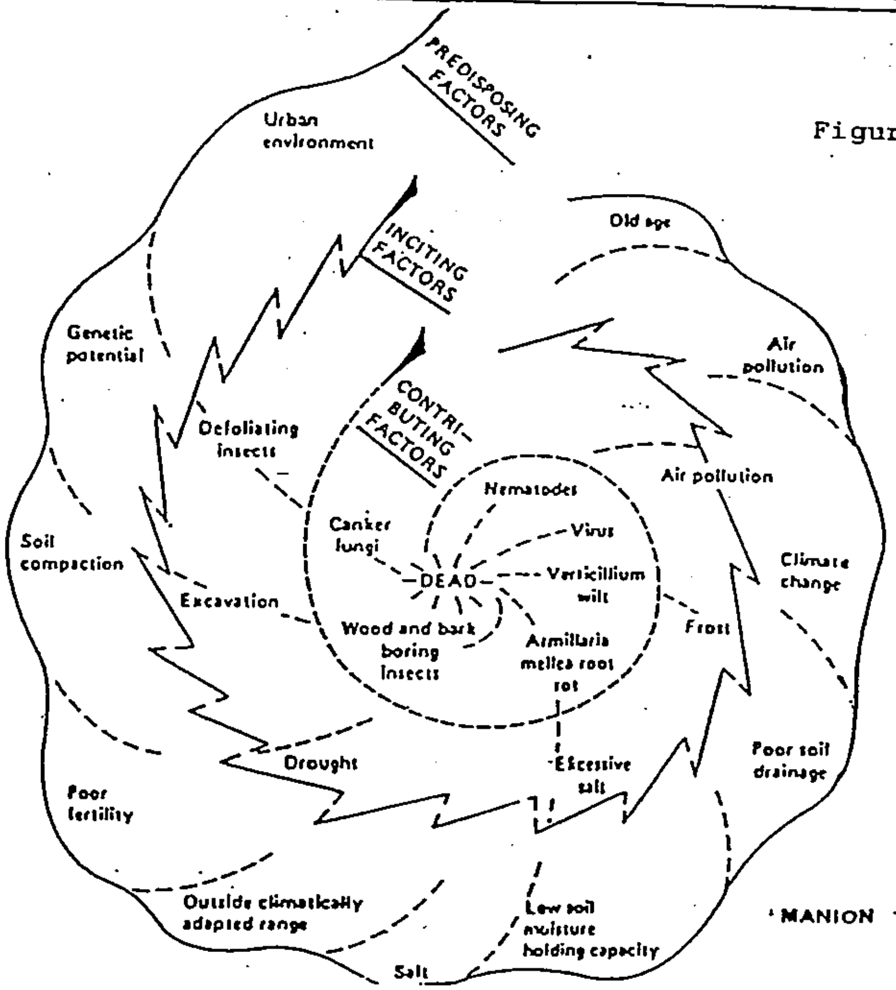
2.3.5 The decline spiral.

Many trees in the park are affected by some or all of the above problems acting in conjunction with each other. It is the combined effect of these adverse influences which can more easily overcome tree defences. Once trees are stressed it may only require a relatively minor event such as a period of drought to push them into an irrevocable decline.

For a clear idea of this concept refer to Figure 3 from Manion (1981). It can be seen that many factors are involved and most of them are present in the park trees.

THE SPIRAL OBSTACLE COURSE.
STRESS AND DECLINE IN TREES.

Figure 3



THE FACTORS ARE LIKE BARRIERS IN THE COURSE.

DURING THE LIFE OF ANY TREE, IT WILL CONTINUOUSLY AND REPEATEDLY ENCOUNTER AN ARRAY OF STRESS FACTORS.

THE PREDISPOSING FACTORS NUDGE THE TREE INWARD TO THE SECOND LEVEL OF THE SPIRAL.

THE INCITING FACTORS ACCENTUATE THE INWARD SPIRAL OF PREDISPOSED TR

THE CONTRIBUTING FACTORS OF THE INNER SPIRAL COMPETE FOR A NICHE TO THE WEAKENED AND DYING TREE.

2.3.6 Regeneration

Tree senescence and decline are part of a normal decay cycle which returns nutrients to the soil and makes conditions favourable for the following generations. This system has a missing link in the park however due to the lack of regeneration of young trees. The same soil compaction and mowing which is contributing to mature tree decline is also preventing seed germination and the growth of sapling trees.

It can be readily observed in the areas already set aside for replanting that seedlings are arising, either from the seed bank in the soil or from seed transported by natural means. These mulched and bollarded areas are evidently far more hospitable than the open ground where compacted soil prevents germination and any young plants are repeatedly mowed to ground level.

There are very few seedling or sapling indigenous trees in the entire park; all trees planted over the last decades have been either exotics or Australian natives from other areas. These species are of less importance and many are occupying space which could be better used for indigenous species regeneration.

2.4 <u>Measures for tree rehabilitation</u>

Queen Elizabeth Park undoubtedly contains some of the oldest trees in the Municipality (D. Benson, 1992, pers. comm). Many of these are under threat of decline or eventual death; the object of recommendations for rehabilitation is to increase their health and vigour as much as possible, thus lengthening their lifespan while making arrangements for the establishment of their successors.

The treatment of the aging trees is important. Aging in trees occurs as old wood is walled off and new cells are generated at a slower rate. Energy can only be stored (as starch) in living cells so that the tree declines as the volume of living cells decreases. The tree must grow new cells in new spatial locations every growing period; if it cannot do this it declines and dies. The aging process developed in the forest; if remnant trees are no longer part of the forest their aging process is affected by increases in the rapidity of aging (Shigo 1986 p.1).

A policy of favouring trees should be adopted, involving the increase of good health and vigour and the consequent disfavouring of disease and pest pathogens. This policy should include consideration of the following measures.

2.4.1 Soil treatment

Physical problems of the soil are the greatest single cause of tree decline in the park; see Section 2.3.3 above for a description of the soils and their problems.

The remedies are difficult in management terms since change in policies is required; this often entail changes in the function of sections of the park. Details of soil management measures can be found in Part B Section 1.2 below; the major issues are:

Exclusion of traffic
Use of rotating exclusion zones
Decompaction
Reduction of mowing
Changes to surface treatment
Soil analysis
Salinity
Irrigation

2.4.2 Pruning

Although some pruning has been done in the park there is a large backlog of work still to be performed. Many tree were the victims of lopping in past years and the damag from this has not yet been amended by removal of the resultant decaying stubs and suckering growth. Decaye stubs are a prime entry point for heartwood pathogens causing cavities and weakened trunks. Mature or declining trees require constant attention because they are shedding branches and dying back.

Details of pruning categories can be found in Part B, Section 1 below under the headings of:

Growth control
Thinning and lifting canopies
Damage control

2.4.3 Pests and diseases

Insect control is fortunately a relatively minor aspect of maintenance because most of the species in the park are not particularly subject to debilitating attack.

Diseases appear to be confined to fungal decay of heartwood by the entry of pathogens through wounds and stubs although undetected root diseases may be present.

Prevention through vigilance, constant monitoring and good practices is essential since many pests and diseases of large trees are difficult or impossible to treat. Favouring the trees and disfavouring the pathogens is the best line of defence against tree decline.

2.4.4 Reconstruction of indigenous understorey

The loss of understorey vegetation capable of increasing water infiltration and soil aeration is a contributing factor in tree decline; the reinstatement and management of an indigenous understorey will both enhance the survival of existing trees and provide a suitable environment for the future regeneration of trees from seed. The reconstruction and long-term management of an indigenous understorey is thus considered to be a fundamental step in the rehabilitation of the remnant tree population.

Due to the poor distribution and poor condition of many of the remnant trees, supplementary planting of the species in patterns imitating natural occurrence is needed. Propagation from a range of local seed sources is required in order to maintain any genetic adaptations to local conditions which may be critical for reproduction or development of the plants.

2.4.5 Temporary retention of declining trees

Use of local seed sources will involve the temporary retention of declining indigenous Eucalypts which are probably close to death and would otherwise be removed (for example Tree 183, see Section 2.3.4 above), so that their seed can be collected or be naturally dispersed.

Some degree of hazard to the public and staff may be involved in their retention; these declining trees are prone to dropping dead wood and sometimes live branches. However their value as sources of seed for the propagation of the next generation is very high and it is considered that the risk is worthwhile.

As a precaution exclusion zones should be provided at the radius of their driplines so that the traffic in their vicinity is reduced to the minimum. Explanatory signage (especially near trees already within regeneration areas) would help to alert the public to the reasons for their exclusion from the areas near these trees. The special maintenance requirements of such trees are constant monitoring and pruning as necessary.

An exclusion zone would take the form of bollards enclosing a mulched or planted area, in itself a deterrent to pedestrian traffic. This zone would also be beneficial to the tree by increasing the viability of the root system.

Examples of trees requiring this treatment are:

Tree 183

Tree 200

Tree 28

Tree 17

Tree 95

3. REMNANT UNDERSTOREY

3.1 Summary of understorey decline

Close inspection of the groundcover species reveals that a total of 20 native species still exist on site (See Section 3.2 below), some in large mown patches and other occurring very sparsely. While this number may appear impressive, the site is considered highly degraded as there is a total lack of shrub species and a very low number of species generally in comparison with what would have occurred on site in its previous healthy bushland condition.

The Central Mapping Authority 1951 air photo shows unmown low vegetation - apparently not shrubs - covering most of the open areas in marked contrast to closely mown grass in the south-west corner of the park. It is presumed that the site's history of both grazing and mowing is likely to have been sufficient to cause the disappearance of virtually all shrub species and groundcover species which are non-rhizomatous or rapid seeders.

In addition, the soil surface is compacted and in some places stripped of leaf litter and topsoil which might otherwise support biological activity and plant life.

3.2 Aims for rehabilitation of the understorey

The aim of an ecosystem restoration project is to reinstate a self-regenerating system representing the species, structure, function, and dynamics of the site's pre-existing indigenous vegetation (Newton, 1992). Depending on the degree of degradation, this aim can be approached by assisted natural regeneration techniques alone or by natural regeneration plus reconstruction (planting and other) techniques. The practice of Bush Regeneration encompasses both approaches while maintaining a focus "on reinstating ongoing natural regeneration processes (Australian Association of Bush Regenerators, 1992, pers. comm)".

In the case of Queen Elizabeth Park, the five native tree species and 20 native groundcover species surviving on site offer a very useful framework for the system's rehabilitation using assisted natural regeneration techniques.

Seed of other species may remain stored in the soil seed bank. The capacity of many of our native plant species to store seed in the ground for future regeneration is well documented(Carroll,1965;Purdie,1977;Drake,1979;Vlahos and Bell,1986;).

It is hoped that such stored seed may still be present at Queen Elizabeth Park and so heat treatment of the soil to stimulate any such seed to germinate is recommended and may be the most important part of the site's restoration treatment. Not only may any regenerating species will clarify which species previously existed on site and which require planting.

Any under-represented species which do not store their seed in the soil or which may be depleted are likely to require supplementary planting. This may especially include species from the plant families Fabaceae (which contain the peas and the wattles) and the family Epacridaceae (containing the "heaths") which are often under represented in degraded communities .

While insufficient evidence exists of the exact nature of the pre-existing vegetation, the absolute restoration of the pre-existing system may not be achieved. Nonetheless, it is likely that the long-term rehabilitation of a locally-indigenous and self-regenerating vegetation system will result if the project aims high and adopts the aspiration of restoration - a result which will enhance the natural legacy of the Concord area.

3.4 Remnant native groundcover species

Table 6: The observed native grass and forb species on site in descending order of occurrence

Scientific Name	Common Name
Microlaena stipoides	Weeping Grass
Dichondra repens	Kidney Weed
Carex sp	
Centella asiatica	
Danthonia tenuior	Wallaby Grass
Eragrostis brownii	Brown's Love Grass
Paspalidium distans	
Aristida vagans	
Eragrostis leptostachya	
Einadia trigonos ssp leiocarpa	
Poranthera microphylla	
Entolasia marginata	
Echinopogon caespitosus	Hedgehog Grass
Veronica plebeia	Veronica
Glycine sp	
Lagenifera stipitata	
Oxalis corniculata	Native Oxalis
Polymeria calycina	
Wahlenbergia sp	Native Bluebell
*Zornia dyctiocarpa**	

* This species is considered very rare in western Sydney, with only six records of occurrence (D. Benson, 1992, National Herbarium, pers comm.).

4. UNDERSTOREY REGENERATION AND RECONSTRUCTION PLAN

4.1 General model

Two major approaches are distinguished for the rehabilitation works : ASSISTED REGENERATION and RECONSTRUCTION. The former is to be applied where remnant regeneration potential exists and where little if any planting is required. The latter is applied where no remnant regeneration potential exists and reconstruction treatments are needed as a preliminary to the re-establishment of that potential.

Treatments directed towards the restoration of a functioning vegetation system are to be based on the following model but adapted for each location:

(a) bollarding of islands surrounding nominated high priority trees;

(b) exclusion of mowing from these areas;

(c) exclusion of any removal of twig, leaf- or fruit-fall from these areas;

(d) aeration and scarification of soils

(e) supervised heating the soil or burning of small fire piles throughout the exclusion zone as specified;

(f) subsequent selective weeding of these areas to maximise native regeneration.

(g) subsequent planting of listed species at specified densities - where necessary.

4.2 Staging of works

Plans 1 and 2 indicate short-term and longer-term exclusions. This staging is recommended due to the requirement for thorough weed control. The short-term areas have been selected because they have a higher number of native groundcovers and will respond more readily to weed control treatment. When these have consolidated to 100% native cover, an assessment can be made as to when the longer-term exclusions can be taken on.

The longer-term exclusions are distinguished by the fact that they have fewer natives and will require more commitment to planting, weed control and some mulching. This should not be taken on until the degree of familiarisation offered by work on the short-term exclusions is gained by the personnel carrying out the work.

4.3 Prioritisation of works

An hierarchy of three stages for understorey rehabilitation and replanting has been identified:

Priority

1. Sites where native groundcovers are associated with the target trees most in need of treatment.

2. Sites where no groundcover species exist under target trees but where the reconstruction or extension of islands are required.

3. Sites where connecting interplantings are required

Locations of such treatments are indicated in Plans 1 and 2 and an order of priorities is suggested based on the following criteria:

1. Rarity of the overstorey and understorey species on site and degree of threat of degradation of the species (whether tree or other).

2. Clusters of native species with potential to naturally regenerate and reintegrate with assistance.

3. The relative cost of treatment.

Sites where the vegetation has less potential to degrade quickly, sites where vegetation is better represented and sites where recovery requires extensive resources - fall into the less urgent classification.

Less-high priority areas are to be subject to less-intensive mowing achieved by the raising of the mowing height rather than the reduction in intensity of mowing.

Subsequent treatments of less-high priority areas are to follow the same procedure if the burning is found to offer significant advantage. If not - burning will be replaced by a greater emphasis on planting.

Treatments are of a medium to long-term nature and require a commitment throughout the stages until the goals are achieved.

4.3 Assisted natural regeneration works

Intervention which stimulate natural regeneration processes of existing species is to be considered more effective in the restoration of an indigenous vegetation system than planting (D.Benson,1992,pers comm.). This is based both on the assumption that any existing plants or stored seed represent genotypes that have proven ability to reproduce and survive on site and on the observation of the relative performances of planted specimins in comparison with naturally regenerated specimin. Planting, however, will be necessary on many sites b must be carried out within the context of long-term natural regeneration.

Regeneration interventions include the removal of mowing and trampling, skilled weed removal, and the application of heat treatment to the soil.

As well as native species, exotic species are likely to boom in response to any removal of mowing. The followi lawn and weed species are likely to develop in islan where mowing has been removed. Both groups of plants will require controlling to reduce their competition with the regenerating and planted natives.

Table 7: Lawn and weed species

Lawn grasses:	
Axonopus affinis	Carpet Grass
Paspalum dilatum	Paspalum
Pennisetum clandestinum	Kikuyu
Cynodon dactylon	Common Couch
	Queensland Blue Couch
	Mullumbimby Couch
Weeds:	
Conyza spp	Fleabanes
Hypochoeris radicata	Flatweed
Plantago lanceolatus	Plantain
Euphorbia peblus	Petty Spurge
Oxalis spp	Clovers
Bidens pilosa	Farmers Friends
Sida rhombifolia	Paddy's Lucerne
	Guilford Grass

Follow-up weeding will require the weeding personnel to be able to identify and protect any natives regeneratin from stored seed after fire, so the requirement fo skilled staff or bush regeneration contractors is essential at this stage. Weeding treatments should occur 1 month after the fire and at regular interval (initially at a fortnightly intervals) afterwards.

Although the exclusions will require intensive treatment initially, this will result in the consolidation of natives and therefore less ongoing maintenance in the medium and long-term. These areas will not be mown in the future and should require little maintenance if consolidated thoroughly in the first instance. The same resources that establish the short-term exclusions should cover the longer-term exclusions if the formula is followed in this way.

The use of selective herbicides for use on such species as annual grasses and Guilford grass should be investigated by the Parks Supervisor.

4.4 Reconstruction works

4.4.1 Selection of species for replanting

The planting of a very wide range of species on the basis that they occurred in the inner western suburbs and **may** have occurred on site is not recommended. This approach is likely to result in an excess of species which, on a small site will reduce the niches available for the regeneration of authentic species and will result in the establishment of an interesting "arboretum" rather than the reinforcement and extension of an authentic and self-regenerating remnant.

Rather, it is recommended that the planting focus be placed on reinstating seed sources and maintaining suitable niches to achieve the natural regeneration of **at least the known (or very likely) components** of the pre-existing system.

Therefore, it is recommended that planting of either groundcover, shrub or tree species be restricted to species that:

* Already exist on site.

* Are represented in the seed bank (indicated by fire trials).

* Occur ubiquitously and yet do not appear to restrict the development of other species.

* Occur in a remnant with similar remnant species particularly if nearby.

4.4.2 Missing species

There are likely to have been many more species on site than those which presently occur. Some of these may still be present in the seed bank and may be able to be induced to germinate by fire or heat treatment. Others may have to be planted. For this reason it is recommended that fire or heat pre-treatment must occur and that the sites be fallowed to allow natural regeneration to take place prior to any planting being undertaken.

Although it is unlikely all of the following were nati to the site, absent native species that are found locally and are considered by the author to have possible occurred on site include the following.

Table 8: Local native species absent from the park

Occurrence code:

* denotes listed as occurring locally in Benson 1982.
** denotes observed locally by D. Benson.
*** observed locally by T. McDonald.

Groundcover species

*Billardiera scandens**	Apple Dumpling
*Clematis aristata**	
*Geitonopleisium sp**	Scrambling Lily
*Eustrephus latifolius**	Wombat Berry
*Hardenbergia violacea**	
*Imperata cylindrica**	Bladey grass
*Lepidosperma sp****	
*Lomandra filiformis****	
*Lomandra longifolia**	
*Patersonia sp****	Flag Iris
Smilax glyciphylla	False Sarsaparilla
*Cheilanthes sp****	
Culcita dubia	Soft Bracken fern
*Dianella revoluta**	Flax Lily
*Dichelachne spp**	Plume Grasses
Imperata cylindrica	
*Kennedia rubicunda**	

Shrub species

*Acacia falcata**
*Acacia longifolia**
*Acacia parramattensis**
*Acacia suaveolens**
*Bursaria spinosa**
*Breynia oblongifolia**
*Daviesia ulicifolia**
*Dodonaea triquetra**
*Goodenia ovata**
*Helichrysum diosmifolium**
*Notelaea longifolia**
*Zieria smithii***

Unlikely native groundcover species include the persistent *Pratia sp* and *Commelina sp* as they do not exist on site except where introduced via container plantings.

Any planting must be from stock collected from Concord remnants and should contain groundcovers as well as shrub species. Should any species not be available in the first year, substitutes should not be used. The species should be propagated in advance for the following year's planting and from local indigenous stock. Direct seeding of on-site species may be carried out at a later stage of the project where such seed exists in large enough quantities and any other propagation needs have been met.

4.4.3 Tree species

All existing indigenous tree species are to be propagated from local stock and planting is to take place to supplement the existing remnant vegetation as specified. While other locally-occurring species are not represented on site, it is not recommended that these be introduced to the site.

4.4.4. Fallowing after heat treatment, mowing removal and weed control.

Fallowing is a technique which has been shown to have beneficial results elsewhere - particularly on other bush regeneration sites in Sydney (L. Brodie, National Trust, July, 1992, pers. comm.). It has also been used successfully on large-scale restoration projects after mining in the Northern Territory (Deiter Hinz, North Australian Land Reclamation Services, July, 1992, pers. comm.). This procedure allows the more accurate determination of which species are missing and the avoidance of overplanting with species which may inhibit the development of other species. It is a treatment that is time-costly rather than dollar-costly and acheives results which are more reliable. On a site like Queen Elizabeth Park, Concord, where there is little margin for error, fallowing is a highly desirable procedure.

4.5 Implementation

The implementation of the restoration treatments is recommended to be carried out in stages over a period of years. Transplanting and planting can be undertaken in priority 1 sites in Year 1 in weedy areas to be mulched heavily. However, where natural regeneration is the goal (on sites where heat treatment is being undertaken, all planting will be delayed until fallowing to determine natural regeneration potential has occurred.

Treatments in priority two and three areas will be carried out at a later stage and will be informed by the results of the treatment model applied to priority one sites. The maturation of the endpoint understorey is likely to take more than a decade. Results of the progress of the implementation should be reviewed at 5-year intervals.

4.6 Personnel

The personnel involved in the regeneration works shall e familiar with regeneration techniques or shall e supervised by a person familiar with regeneration techniques.

Options consist of:

(a) contract bush regeneration

(b) specialist staff

(c) volunteers under the supervision of either of t e above.

The preferred option is that which ensures:

* the appropriate level of technical expertise exists within the personnel and supervisor used, and

* follow-up throughout the year at the regular intervals specified weeding is applied.

Obviously the use of existing Parks staff or volunteers may be less expensive than contractors, but this advantage would be totally negated if the personne deployed did not have the required bushland weed contr expertise or were not able to carry out the regular follow up which is required. A suitable compromise may b the employment of an experienced Bush Regenerator t offer on-site training and occasional supervision to Councils field staff or volunteers.

The heat and /or burn treatments should be carried out by the local fire brigade or other trained and authorised personnel and burning should comply with the requirement of the Clean Air Act, administered by the Environmenta Protection Authority.

5. FUTURE MANAGEMENT

As the implementation of the plan would be carried out on an incremental basis, some islands will be completed and will graduate to an ongoing maintenance regime before the construction of other islands commence. Both Council and the community must be aware of and support the preferred, staged nature of the project - to avoid any perception that this is due to any design or implementation inadequacy.

The long-term objective of the project is to rehabilitate the remnant vegetation community while both minimizing the edge of islands for maintenance purposes and maintaining suitable shapes for picnic areas and pedestrian flows.

5.1 Maintenance

* All islands shall be kept in effectively weed-free condition by regular spot weeding runs.

* Mulch strips around islands shall be maintained at a depth of 5cm and shall be permanently kept in a weed free state by spray treatment within the mulch and at the mown edge.

* No spray shall be used within the islands once treatment is completed and 99% native cover is established within the islands.

* Mowing or brush-cutting near islands shall be carried out in such a way that the debris shall be directed away from the islands and so that no weed seed is distributed onto the islands.

5.2 Access

Unfenced paths may be constructed by Council through islands where these are deemed necessary by the Manager, Parks Department. However, these accessways should not detract from the requirements of reinstating the native vegetation systems.

Dogs must be prevented from entering islands by their owners.

5.3 Interpretation to community

The installation of interpretive signs, explaining that along-term programme of bush regeneration has commenced in the islands, is necessary to maintain public support for the bollarding of islands. At least one sign should explain the reasons for and objectives of the project.

5.4 Monitoring

Monitoring of the results of the initial heat treatments should be undertaken to ascertain their success a[illegible] applicability for subsequent stages of the project. [illegible] design might include the following features;

* the monitoring of 10 islands dominated by nati[illegible] groundcover and 3 islands dominated by non-native groundcover. In these islands numbers of native species in each island both before and at 6 month and 2 year intervals after the heat treatment should be recorded. I[illegible] possible, numbers of individuals of those species (or percentage cover for groundcovers) should also [illegible] recorded.

* In addition, similar monitoring should be carried out in an island where no burning takes place, in an islan[illegible] where no planting takess place and in an area where mowing is continued

* monitoring of the success of plantings should also b[illegible] undertaken. This should consist of records for islands where plantings are carried out. Counts of native species should be taken at 2 year intervals and any evidence o[illegible] natural regeneration from planted parents should be recorded in detail.

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PART B : SPECIFICATIONS

PART B: SPECIFICATIONS

1. SPECIFICATIONS FOR REHABILITATION OF REMNANT TREES

The philosophy of favouring trees over pathogens has been mentioned above and these measures will increase the vigour of the trees and help their defence mechanisms to overcome diseases.

1.1 Soil improvements

The following techniques are valuable in the improvement of physical soil problems.

* Exclusion of pedestrian and vehicular traffic from root zones, in some cases permanently where hazards exist or understorey regeneration is taking place, or on a rotation basis, so that root systems can regenerate in good soil conditions.

* Pedestrians should be confined as much as possible to pathways by the provision of shrub plantings at strategic points.

* Rotation of exclusion zones is a medium to long term method to reduce the effects of soil compaction and erosion thus allowing some degree of recovery for stressed trees. The rotation period is about three to five years depending on tree stress and response. Rotation is a useful measure where trees in good or average condition will not be otherwise protected by regeneration plantings.

* Decompaction of soil is required for good root propagation since compacted soil forms a barrier to root extension as well as inhibiting water infiltration and gas exchange. The process of mechanical decompaction within tree root zones can be damaging unless specialised equipment or techniques are used. Suitable equipment includes:

Terralift pneumatic decompactor which injects air at high pressure into the profile and creates a network of cracks to a maximum depth of about 900mm.

Toro *HydroJect* water injection aerator which uses high pressure water jets to bore numerous small holes into the soil to a depth of about 500mm.

A light and shallow scarification of the soil surface to a depth of about 50mm in order to break up the compacted crust.

For smaller areas simple hand forking to a depth of about 50mm would be very effective.

Mechanical decompaction should not be necessary where regeneration planting will take place since soil microorganisms and earthworms will successfully aerate the soil.

* Mowing should be reduced or eliminated in root zones s that decompacted soil is not soon recompacted.

* Changes to the soil surface treatment; elimination c the existing turfgrass and substitution of indigenou ground cover and understorey plants. The use of mulches in some root areas where understorey regeneratio planting is not planned would be beneficial, improvin conditions for tree roots, confining foot traffic to paths and reducing maintenance costs.

Areas within the shade of tree canopies where grass cove is difficult to sustain would be better mulched with organic materials such as the woodchip byproduct of tre removals. These mulched areas require maintenance t retain and replenish the material, but require less work and have a better appearance than inadequate grass cover. It can be seen in the recently replanted and mulche areas that water infiltration is far superior to that i nearby bare patches.

* Chemical deficiencies and imbalances are often easily amended once identified by soil analysis. Limited soil testing has been done as part of the investigations and the results show generally good soil chemistry with a few concerns which should be addressed.

One factor possibly responsible for tree deaths is salinity which has been identified in one area, Site S3. The park was originally the riparian zone of a mangrove creek so that salinity could be expected. Changes to the drainage patterns and general hydrology may be partly responsible for rising salinity in the soil profile. More testing is required to plot the pattern of salinity.

The acidic nature of the soils in some areas may be natural but also may be limiting tree growth and health. There is a reluctance to raise the pH levels in areas where regeneration is to take place because of the possibility of encouraging weed growth and retarding native understorey plants. It is intended in such areas to allow nutrient levels to rise with the increase in soil organic matter resulting from leaf litter bioaccumulation. However where trees are in a moribund or declining state and where no regeneration is contemplated some degree of intervention is recommended in the form of lime and fertiliser application to the soil surface.

Suitable areas are as follows:

Grid cells E6, D5, C4 contain a swathe of Turpentines (including the avenue) in average to good condition outside the regeneration zones. Soil improvement here would be beneficial and form a reference for future management practices.

Grid cells E9, D8, C8, and B9 contain trees which are stressed or declining and need urgent attention to delay further decline or deaths. Soil improvement may increase vigour and would serve as an experiment for future reference.

Grid cells C1 and C2 contain large Turpentines in good condition; soil improvement here would extend their longevity and delay decline.

* Careful monitoring and calibration of irrigation equipment so that soil moisture is kept at the optimum level. Drought is a major cause of stress for trees; if trees already in decline are subjected to additional stress factors the decline can easily be accelerated. Inadequate irrigation control can also create localised waterlogging which rapidly destroys root systems and causes destabilisation. Excess irrigation often causes soil compaction if droplet size is too large.

1.2 <u>Pruning</u>

Categories of pruning required in the park are:

* Growth control to reduce or redirect growth. Early pruning of young trees is vital to establish a straight leader and a strong scaffold of branches. In older trees such pruning reduces crown weight and wind loading, reduces hazards, weak interior growth and improves appearance. Branch pruning eliminates contact between trees and reduces competition and overcrowding. Pruning thus reduces the likelihood of damage in storms as well as the incidence of disease.

* Thinning and lifting canopies allows more light to penetrate under trees to improve grass or ground cover development and the growth of newly planted trees.

* Damage control, involving the rectifying of topping damage, removal of storm damage, removal of stubs, epicormic shoots, dead wood and decay, or bracing with cables or rods. Most damage control functions are integrated with other maintenance practices for prevention and good health as above.

Priorities should be set so that hazardous trees are the primary target; the removal of dead wood and the reduction of long branches should be attended to first. Once the trees are reasonably safe the aesthetic and sanitary pruning can be done.

These operations can be performed by Council staff if the necessary training has been done; the skill level required is high and contractors capable of this workmanship should be used if Council staff are not qualified.

1.3 Removals

The dying and dead trees should be promptly removed so that the reservoir of pathogens is decreased. The timber should be removed from the park. Stumps should be ground out; the chip should be removed and air dried before any reuse as mulch. The remaining dead material in the ground is possibly infected so the holes should be backfilled with well composted manure so that antagonistic Basidiomycete decay fungi are introduced to overwhelm any pathogenic diseases.

1.4 Protection from mowers

Impact from mowers and line trimmers is the greatest single cause of damage to the trunks and root flares. Many trees bear infected wounds and decayed roots from these impacts. The wounds cannot be treated; the damage has been done. The only way to reduce this major problem for the future must be the elimination of contact.

Every tree vulnerable to impact from such equipment should have the grass removed from the base of the trunk by the application of glyphosate to a radius of about 300mm. This will make close passes by equipment unnecessary. Operators should be warned of dire consequences for further transgressions.

1.5 Inventory

As part of the Plan of Management an inventory was taken of 200 remnant trees in the park. This is a vital part of the program since records can now be kept showing the state of improvement (or continued deterioration) of the trees. The information for Tables 1 to 4 above was extracted from the inventory records; comparisons could be made at intervals in a similar manner.

For this reason the inventory should be constantly amended as work on the trees proceeds. Details of work performed, costs, condition, etc can be entered and a schedule produced so that work is done on a logical and effective basis. When costs for the maintenance of a particular tree rise above its aesthetic or practical value it can be removed by a well informed decision.

2. SPECIFICATIONS FOR RECONSTRUCTION OF UNDERSTOREY

2.1. Creation, treatment and maintenance of islands

2.1.1. exclusion barriers

* Boundaries of the regeneration islands shall be identified using spray paint by a Bush Regenerator - and temporary barriers and explanatory signs shall be erected where appropriate

* Permanent exclusion barriers shall comply with the design policy of the Parks Department

* Temporary and permanent barriers shall contain a mulch strip below the barriers to act as a weed barrier between the mown area and the regeneration islands. Mulch strips around islands shall be maintained at a depth of 5cm and shall be permanently kept in a weed free state by either regular herbiciding or a combination of herbiciding and hand removal as appropriate. At no stage shall weed species be allowed to seed onto the site.

* All mowing or brush-cutting near islands shall be carried out in such a way that the debris shall be directed away from the islands and so that no weed seed is distributed onto the islands;

* No removal of naturally-falling tree debris shall be carried out by Parks staff after the creation of regeneration islands. It shall be retained to build up natural mulch in the islands and create niches for natural regeneration;

* All islands shall be kept in effectively weed-free condition by regular spot weeding runs;

* Herbicide spray shall not be used within the regeneration islands after the sites have reached the target native cover unless a herbicide selectively effective on weeds with underground storage organs is developed.

2.1.2 weed control

[to be carried out under the supervision of skilled Bush Regenerator]

* Primary weed clearing in the form of spot-spraying and hand weeding as appropriate shall be carried out around native species within the regeneration islands during the construction phase by a skilled weeder under the supervision of a Bush Regenerator.

* Follow-up Bush Regeneration weeding by personnel skilled in Bush Regeneration shall continue to be applied after the fire until 99% native cover is established on

site. Residual and recurring weed shall be removed prior to seeding. Guilford Grass may be considered a special case requiring individual assessment

* Such weeding shall occur within 1 month after the fire and at fortnightly intervals initially and after rain. At other times weeding can be carried out on a bi-monthly basis until the sites have consolidated to 99% native cover. Regular maintenance shall then be carried out to retain the condition of the site.

2.1.3. heat treatment

* after primary weed clearing, small fire piles shall be constructed and burnt at 3m centres in the regeneration islands except where weedy herbs are abundant.
The fires are to be not more than 50cm high and using fuel below 4 cm in diameter. Fuel dry weight should weigh at least 1.5 kg per sq metre.

* If pile burns cannot be arranged due to failure to gain an exemption from the Clean Air Act, heat treatment shall be applied to any bare soil and to sites where weed has been thoroughly killed

2.1.4. mulching

* after primary weed clearing, hardwood chip mulch shall be applied to a depth of 5 cm at all locations within the regeneration islands only where weed herbs are abundant;

* After primary weed clearing and heat treatments, natural mulch from Eucalypt and Turpentine shall be scattered through the treated islands to provide sparse protection to the regenerating seedlings and to improve soil conditions. Bare soil shall be visible over 50% of the area and at no location shall the cover exceed a depth of 1cm. Mulch shall be free of weed propagules.

2.2 <u>Reconstruction</u>

[to be carried out under the supervision of skilled Bush Regenerator]

* Boundaries of the islands shall be identified using spray paint in consultation with Parks Supervisor - and temporary barriers and explanatory signs shall be erected where appropriate.

* Temporary and permanent barriers shall contain a mulch strip below the barriers to act as a weed barrier between the mown area and the regeneration islands. Mulched edges of islands shall be kept free of all weed by ether regular herbiciding or a combination of herbiciding and hand removal as appropriate. At no stage shall weed species be allowed to seed onto the site.

APPENDIX 1.

List of Plates

1. Trees 11, 12 and 13. Two Turpentines with a Red Mahogany in the centre.

2. Tree 51, large Blackbutt with plantation area beyond.

3. Tree 51 showing possum damage to root flares.

4. Plantation area in grid cell D4, April 1992. Background: Tree 46 near seat, Tree 50 left.

5. Tree 199, Red Mahogany. Note old lopping wound in crown.

6. Tree 28, White Stringybark showing decline and epicormic shooting on trunk.

7. Tree 47 (left) Tree 50 (centre) and Tree 46 (right): Turpentines in good to average condition.

8. Turpentine dieback in grid cells C8 and B9 viewed from the south.

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8

SYDNEY ENVIRONMENTAL and SOIL LABORATORY

Sydney Environmental & Soil Laboratory Pty Ltd
Loch Maree House
237 Pennant Hills Road
Thornleigh NSW 2120
Australia
Telephone 02 980 6554
Facsimile 02 484 2427
A.C.N 002 825 569

RESULTS - Complete Chemical Analysis

Client:	TREESCAN Attn: Dave Ford
Sample:	Slightly saline Sample S3 500mm
Date:	4/6/92

Test:	**Results:**	**Comments**
Code	1100	
pH in water	4.1	severely acidic
pH in CaCl2	3.8	extreme pH
Salinity (mmhos/cm)	0.85	slightly saline

Soluble Cations	meq/100g	ppm	
Sodium	0.99	227.2	high
Potassium	0.01	3.1	
Calcium	0.04	8.0	
Magnesium	0.36	43.4	raised

This material appears to be affected by marine conditions with high sodium and magnesium levels in similar ratio to that found in seawater.
It is also possible that the severe pH is a result of draining marine soil thus leading to acid generation. I would predict that only trees adapted to this condition such as Casuarina littoralis would do well here as it will be impossible to lime down at this depth.

APPENDIX 4.

SYDNEY ENVIRONMENTAL and SOIL LABORATORY

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RESULTS - Complete Chemical Analysis

Client: TREESCAN
Attn: Dave Ford
Sample: Acidic Surface Samples
S2, S4, S5, S6
Date: 4/6/92

Test:	Results:	Comments
Code	1095	
pH in water	5.1	pH very low
pH in CaCl2	4.4	severely acid
Salinity (mmhos/cm)	0.14	no salt

Soluble Cations	meq/100g	ppm	
Sodium	0.08	19.3	
Potassium	0.03	12.5	
Calcium	0.00	0.0	V. low Ca
Magnesium	0.06	6.8	

Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC	
Sodium	0.20	44.9	2.4	OK
Potassium	0.26	101.4	4.9	low
Calcium	2.52	504.0	53.6	bit low
Magnesium	1.61	196.4	33.1	bit high

Sum of Exchangeable Cations	4.4	
Cation Exchange Capacity (CEC)	4.7	
Ca/Mg ratio	1.6	low

Nutrient	ppm	
Phosphorus	0	V. low
N as ammonium	36.9	
N as nitrate	22.1	N OK
Sulphate	28.8	OK
Iron	264.8	plenty

Summary and Recommendations

Much the same as the other area really even though initial pH work showed a greater difference. I suggest that 2 to/ha of lime would not be too much although you could reduce it to 1.5t/ha. The Native Plant Food at 50g/sqm will also be desireable I believe.

List of Plates

Royal Botanic Gardens Sydney

Identification of samples of fruiting bodies associated with trees.

David Ford.

21st May 1992.

Sample 1: Tree 155 Turpentine, Concord - *Hirneola aericula-judae*. This fungus is generally associated with dead wood. It is not pathogenic but its activity is likely to reduce the viability of the tree.

Sample 2: Tree 148 Turpentine, Concord - not possible to accurately identify from the sample but appears to be closely related to the fungus above, with the same consequences for the tree.

Sample 3: Tree 183 *E. globoidea*, Concord - *Ganoderma* spp. I could not identify this to species level, but it may possibly be *G. applanatum*, the cause of butt rot in many tree species. This fungus can be quite aggressively pathogenic. Other members of the genus are not as pathogenic but will reduce the vigour of the tree.

Sample 4: *Magnolia grandiflora*, Hunters Hill. - difficult to accurately identify, but probably a species of *Mycena*. *M. subgalariculata* is often found on living trees. The genus as a whole causes rot of timber and is likely to be a problem on a tree.

Sample 5: Stringbark, Springwood. - this one had me stumped (to coin a pun). It is definitely not *Armillaria*, and it is definitely causing a white rot disease but that is as far as I can go. It is certainly causing the degradation of the timber and is likely to cause a problem.

Brett Summerell

Dr Brett Summerell
Plant Pathologist
Royal Botanic Gardens

1:- Significant salt level ie S3 500.
2:- Acidic A horizons.
3:- Slightly acidic A horizons.
4:- Non saline B horizons.

Yours

Simon Leake