Arboricultural Impact Assessment Report

Site Address: Hornsby Ku-ring-gai Hospital
1 Derby Road
HORNSBY NSW 2077

Prepared For: **Health Infrastructure**
C/- TSA Management
Level 16, 207 Kent Street
Sydney NSW

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Executive Summary

The proposed development involves extension, to both the north and east, of an existing car parking area. The proposal is likely to require the removal of sixteen (16) trees. During the site inspection and assessment of the trees, ten (10) were found to have arboricultural reasons to support their removal. A further three (3) were identified as being excellent candidates for transplantation as they are palms. The location of two (2) trees was not noted on the supplied plans. The final tree, located within the road reserve, would be required to allow the proposed redevelopment.

Retention of the remaining seven (7) trees was considered viable and reasonable. An appropriate and detailed Tree Protection Plan and Tree Protection Plan (drawing) have been developed and are included in this document.

Brief

I have been asked to-
- Visit the site
- Identify the trees
- Determine the health and condition of the trees
- Examine the proposed plans
- Consider the impact of the proposed works on trees located within 10 metres of those works.
- Develop a Tree Protection Plan and Tree Protection Plan (drawing)
- Prepare an Arboricultural Impact Assessment Report for inclusion as a part of the DA documentation

Information Provided

The following plans and documents were reference in preparation of this report.

- Landscape Code for Development Applications, prepared by Hornsby Shire Council, dated 11 May 2005.
- Mental Health redevelopment- Hornsby Ku-ring-gai Hospital, Site Plan-Car Parking, Drawing No.: 50441, SD1.03-11C-2, Option 11C, Prepared by Hames Sharley, dated 5 April 2011.

Limits

Inspection date:

The site inspection was carried out on the 8/04/2011 and the site related observations contained in this report arise from the inspection on that date.

Definition of a Tree:
This report considerers trees that are covered by the Tree Preservation Order and relies on the definition and exemptions contained with the Tree Preservation Order in determining what a tree is and which trees are exempt. This report also considers all trees on the neighbouring

properties that are likely to be impacted by the proposed development regardless of the definition contained in the Tree Preservation Order

Method:

All trees were inspected from the ground and involved inspection of the external features only. Inspection of trees on the neighbouring property was from the property and or the public footpath. The inspection included the performance of a **V**isual **T**ree **A**ssessment (**VTA**)[1]. The inspection did not include any invasive, diagnostic or laboratory testing.

Identification:

Broad features visible at the time of inspection were used to identity the trees. Identification was not based upon a full taxonomical identification or comparison against a herbarium specimen. Wherever possible the selection of genus and probable species is provided.

Plans:

This report adopts the terms and nomenclature provided in the Australian Standard AS 4970-2009. To avoid confusion that this can cause the term Tree Protection Plan refers to the recommendations and processes required to protect the trees and the Tree Protection Plan (drawing), is a plan that may or may not have on it sections of or all of the Tree Protection Plan (other than a repetition of the drawing).

The trees that were not located on the survey plans provided are shown with their approximate centres marked on the Tree Protection Plan (drawing) (See Appendix 2).

Only the plans referred to above have been used in assessing the impact of the proposed DA on the trees. Where recommendations are made in this report including those recommendations contained in the Tree Protection Guidelines it is essential that these recommendations be able to be implemented. Any additional drawings, details or redesign that impact on the ability to do so may negate the conclusions made in this report

Observations

See Tree Schedule attached as Appendix 1.

[1] **VTA** – Visual Tree Assessment is a systematic inspection of a tree for indicators of structural defects that may pose a risk of failure. This is made from ground level, unless otherwise stated. Dr Clause Mattheck describes the method in *The Body Language of Trees*. It is the recognised assessment process and is supported by the International Society of Arboriculture as the standard visual assessment process. Invasive and other diagnostic fault detection procedures are generally only recommended when visual indicators of potential concern are observed.

Discussion

Roots on Development Sites

The critical issue when constructing adjacent to trees is the impact of construction activities on the roots. To understand this impact, it is important that we understand that there are two substantially different components to the root system.

- The structural roots are essentially underground branches. They are long lived. They provide physical support for the tree and act as the connection between the absorbing roots and the rest of the tree. These roots can be a little under a millimetre in diameter and can grow to be hundreds of millimetres in diameter over time. Their thick bark prevents them from drying out but as a result, they are not effective at absorbing water and nutrients from the soil.

- Absorbing roots are very small and the absorbing components usually microscopic. The absorbing roots are responsible for nearly the entire uptake of water and nutrients. They are highly ephemeral (come and go quickly), often lasting only two or three months but sometimes, in association with beneficial fungi, they can last a year or more.

  Absorbing roots are readily stimulated by water, soluble nutrients and soil temperatures over 16 degrees. (We can generally assume that soluble nutrients are always present in most soils at satisfactory levels particularly when organic material is present. This is one of the reasons that we encourage the use of mulch.)

The majority of roots occur in the first 600mm of soil depth. This is primarily because all plant tissue respires (burns oxygen) in order to function. Oxygen levels and root density deplete as soil depth increases. Absorbing roots and absorbing root organs are always at their highest density close to the surface. This zone is richer in oxygen, nutrients and beneficial micro- and macro-organisms.

The cutting of a structural root with a diameter of 25mm could conceivably result in the death of many thousands or even millions of root hairs, depending on the amount of root division.
The most important structural roots are those that grow directly from the trunk (first order lateral roots) and those roots that branch near the trunk and get rapidly thinner (zone of rapid taper). Damage to these roots is extremely undesirable.

In the construction process the most common risk of root severance occurs with excavation for the footings and or the slab, trenching for services and through grade changes (bulk earth works)

Because many roots are close to the surface, construction activity can indirectly impact on the health of roots through soil compaction. Even regular pedestrian activity has an affect on the roots close to the surface. By far the easiest and most efficient way of limiting construction damage is to limit activity in the area where roots are and to stimulate absorbing roots in the same area.

Tree Removal and Retention

The supplied plans indicate and intention to carry out alterations and additions to the existing car parking area located off Palmerston Road. These alterations and additions include extension of the car part to both the north and east. Extension to the north involves relocation of the existing crossover and layback and installation of an additional row of parking along the northern boundary of the area. Extensions to the east involve demolition of a number of covered walkways, seating areas and open lawn spaces in order to construct a parking area.

A total of twenty-three (23) trees were identified as falling within the zone of construction influence as defined by the Landscape Code for Development Applications, prepared by Hornsby Shire Council (adopted 11 May 2005). Of these, eight (8) have been proposed for removal by the client whilst a further six (6) have been identified as being appropriate to remove for arboricultural reasons. Two (2) trees identified as not appearing on the supplied plans but requiring removal in order to facilitate construction of the proposed works.

Relocation of the existing vehicle entry point from Palmerston Road involves the proposed removal of a Brush Box (*Lophostemon confertus*) street tree. The tree is one (1) of a group of four (4) located within this section of the road reserve. The presence of power lines along this side of the street has resulted in all of the trees within the group being severely lopped and pruned to provide clearances. This has resulted in all of the trees having highly asymmetrical canopies and high levels of epicormic growth.

Due to the position of the trees within the road reserve and within the property, relocation of the proposed vehicle entry point, without affecting a tree, is almost impossible. The only alternative would be to maintain the existing vehicle entry and incorporate it into the proposed design. Given that the subject tree is one of a grouping and has been negatively impacted by works associated with overhead power lines, the level of alteration required to accommodate its retention is not seen as appropriate. In this instance, removal of the tree to facilitate the proposed redevelopment is reasonable.

In order to enlarge the existing car parking area, Trees 6, 7, 8, 9 11 and 13 are proposed for removal. Trees 10 and 12 are indicated for retention. It is agreed that the overall health, structural condition and form of the trees nominated for removal is generally poor and that they have a generally limited viability and sustainability even within the existing environment. When these factors are taken into account, their removal to facilitate construction of the required car parking would not be considered unreasonable.

Tree 13, a Canary Island Date Palm (*Phoenix canariensis*) is one of a pair located at the rear of what is understood to be the Physiotherapy building. Estimations of the age of these two (2) palms when compared to the architectural style of the Physiotherapy building suggests that they are contemporaries and likely to have been part of the original landscaping for the building when it was constructed. As both an individual specimen, and even more so as a pair, these palms have a significant visual presence on the site. This factor could be successfully utilised in a new and more appropriate location. For this reason, it is suggested that transplantation of both palms be considered as opposed to the removal of a single specimen.

It appears from the proposed plans, that Trees 10 Bangalay (*Eucalyptus botryoides*) and Tree 12 Camphor Laurel (*Cinnamomum camphora*) are to be retained. Given the size and health of

these trees this is appropriate. Both trees will however become incorporated into the proposed new car parking area. At present, Tree 10 is located in a raised garden bed forming a barrier to vehicles between the exiting driveway and car parking. Tree 12 is currently located within an open grassed area behind the existing car parking area. Some concern is raised with regard to any intention to alter soil levels surrounding either or both of these trees. Demolition of the existing kerb and guttering at the base of Tree 10 will negatively impact on the tree. This work should be undertaken by hand in order to minimise the negative effects of such work.

As no detail as to either the current or proposed finished soil levels has been provided, only general statements about alterations to the soil levels surrounding trees to be retained can be made. In particular, it is noted that Tree 12 is at a higher level and the surrounding area. Excavation to reduce soil levels surrounding any tree will have a negative impact and could result in the tree becoming unstable. In this instance, concern is raised that the soil levels surrounding, in particular, Tree 12 should be maintained within the Minimum Tree Protection and ideally within the calculated Tree Protection Zone (refer to Tree Schedule- Appendix 1 of this report).

It is noted that the proposed works will significantly alter the effective catchment area of Tree 12. At present, this tree is growing within a grassed area where water absorption is inhibited only by the competition from the grass. Under the proposed plan, this tree will become enclosed by hard, impervious surfaces. As a minimum, the area ultimately allocated as a catchment area to this tree should be equal to the MTPZ as quoted in the Tree Schedule - Appendix 1 of this report.
Trees 14, 15 and 16 are located at the junction of two (2) covered walkways leading to the main building within the area. Supplied plans indicate that the proposed extension of the existing car park will come within very close proximity to this area. Given the poor form of the trees and their already inappropriate location given existing structures, let alone proposed construction works, removal of these trees is recommended.

Unfortunately, Trees 17 and 17a were not located on the supplied plans. Their positions, in relation to the proposed works, have had to be estimated. From those estimations, it would appear that both would be located within the footprint of the proposed works. As such, both would require removal in order to construct the proposed development in its present form. In the instance of both, this is considered reasonable from an arboricultural perspective. As for Tree 13 and its companion palm, transplantation of Tree 17a could also be considered. It appears to be a good specimen and of a considerable size allowing it to provide instant effect to a new location.

Trees 18, 19 and 20 are located within a small garden are at the rear of the existing lawn area. The garden is bounded on two sides by covered walkways and a seating area, with paving, has been installed within the garden. Given the confined area, the presence of a species such as Tree 19 Small-leaved Fig (*Ficus obliqua*) is considered to have a short term viability within the area. This is due to the fact that the species can attain heights of 15 or more metres and spreads of 20 or more metres. Additionally, a raised garden bed is not considered an appropriate location for such a species as the majority of *Ficus spp*. are recognised as having large, strong and vigorous root systems. These factors in combination will bring the tree into conflict with surrounding structures in the near future. Removal and replacement whilst the current works are being undertaken is seen as a more economically and environmentally sustainable option.

Tree 20 Wallangarra White Gum (*Eucalyptus scoparia*) is judged to have a short remaining life span. The appearance of significant amounts of epicormic growth within its canopy, the high number of branches that appear to have been removed as deadwood, the presence of a high proportion of deadwood still within the canopy and the visible signs of Winter Bronzing, a phenomenon caused by the presence of *Thaumasticoris sp.*, suggests that this tree is in an advanced state of decline. The species itself is noted to have an effective life span of approximately 40 years within the Sydney urban environment. This shortened life span is due largely to the inappropriate climatic, soil and environmental conditions with in Sydney when compared to the trees native Northern Tablelands district. For these reasons, removal of this tree at this time is recommended.

The Weeping Bottle Brush (*Callistemon viminalis*) located within the same garden area as Trees 19 and 20, is indicated on the supplied plans to be retained. Those same plans also indicate that a footpath or similar is to be constructed around the northern and eastern edge of the extended car park. This results in Tree 18 being located within the footprint of this footpath. Retention is therefore not possible if the development is approved in its current form. Considering the structural condition of this tree and the ease with which it could be replaced with a more sound specimen, retention is not seen as the most appropriate action. In this instance, removal would be appropriate and replacement with a higher quality specimen at the completion of works. This would provide for a better long term outcome for the site.

The tree identified as Tree 22 *Tibouchina spp*. is currently located within a lawn area immediately adjacent to a covered walkway. This 'tree' is in very poor condition from a health, structural and formative perspective. It has been lopped at approximately 1.6m with the resulting epicormic growth forming the entire canopy of the tree. This assessment, its overall small size and the ease with which it could be replaced lead to a recommendation to remove the tree as indicated by the proposed plans.

The final tree, Tree 21, inspected and assessed as part of this report, is located in a raised garden bed which will, by our estimations, be located along the eastern edge of the proposed new car parking area. This tree is of significant size and has a high visual prominence within the site. The supplied plans indicate this tree is to be retained and this would appear to be possible from the supplied detail.

As all of the trees, proposed for retention and located within existing car-parking areas, have already been under pruned to provide clearance to vehicles, further pruning at this time should not be necessary. Some minor under pruning of trees, not currently within car parking areas, may be required to allow for both construction works and use of the area. The necessity for, and scope of, these works will become clearer during construction. It is recommended that, prior to any pruning works being undertaken, that the Site Arborist be required to prepare a pruning specification in accordance with the provision of both AS 4373 Pruning of amenity trees, 2007 and AS 4970- Protection of trees on development sites, 2009.

Tree Protection

A Simple Solution

Over the last two decades, there has been an increasing awareness of the need to appropriately protect and care for trees on development sites. There have been conferences, workshops as well as a number of publications written. Most notably these include British Standard BS 5837: 2005, "Trees and Development" by Matheny N & Clark J and "Protection of Trees on Construction Site" by Hartley M. These publications all focus on minimising damage to the root system of the tree by establishing appropriate **T**ree **P**rotection **Z**ones **(TPZ).**

The British Standard provides Matheny and Clark as the source of the formula for calculating the radius of the tree protection zone. Interestingly Matheny and Clark site the British Standard as the source of the formula. Such a circular argument is of concern particularly when the Matheny and Clark include many examples of successful encroachment of their Tree Protection Zone in their text.

Matheny said, ***"It is not that common that we get that much space."*** and ***"With tolerant species we can squeeze that down by half or two thirds".*** (ISA Annual Conference 2007) Mathematically that suggests that the Tree Protection Zone could potentially contain as little as 12% of the root volume provided for using either formula.

Calculations and tables in the first two publications aim at providing a Tree Protection Zone sufficiently large enough to ensure that the health of the tree is not adversely impacted and achieves this without the need for arboricultural input other than ensuring that the maintenance of the protection zones. The British Standards or Trees and Development are ideal documents for application by anybody regardless of their understanding of plant physiology.

Matheny rightly states, ***"Because the tree is an individual the table is not enough. You need to consider all the factors."*** (ISA Annual Conference 2007) If we are to find benefit in the **TPZ** given in either the British Standard or Trees and Development it is that this is a **TPZ** that can be determined by <u>any person and without any arboricultural input</u> since it is a simple formula. Anyone able to measure the trunk diameter and follow the formula can calculate the **TPZ**.

A suitably experienced consulting arborist is often able to support a smaller **TPZ** when combined with appropriate arboricultural care and some provision is given in the British standard for this to take place. This makes no sense unless the formula for calculating the **TPZ** in the British Standard is prefaced with a note saying that this is the point at which arboricultural input is required. Regrettably, the Standard does not say this and as a result, it becomes an overly prescriptive.

An Arboricultural Solution

Land and development costs along with the environmental impact of urban sprawl make the sterilisation of large areas of land to form a **TPZ** undesirably burdensome. It is often far more cost effective to provide even the highest level of Arboricultural care possible to a tree to ensure that it thrives and prospers in the long term than to establish a **TPZ** that is unnecessarily large.

It makes logical sense to adopt a **M**inimum **TPZ** that is based on the size of a root plate required to transplant the same tree. Transplanting of large and even very old trees has been carried out with enough frequency and over such a long period that we have a good understanding how transplanted trees respond to root loss. A success rate of 97% can be expected when a transplant is properly undertaken with appropriate ongoing care.

Perhaps the 3% failure rate could be considered as unacceptable but it is likely that a percentage of these would have died within a few years in any case. Matheny again points out ***"Transplanting is a far greater impact – if we are going to transplant it we might as well keep it where it is and squeeze the protection zone."*** (ISA Annual Conference 2007) A transplanted tree will clearly undergo a greater degree of stress than a tree that is retained with an identical sized root plate that is appropriately protected and cared for.

The site constraints, more often than not, result in benefit from a **TPZ** that is smaller than that specified by the British Standard and Trees and Development. This simply means that there will be a requirement for appropriate levels of arboricultural care. This often gives rise to the question "What is the minimum area required by the tree?" There is unfortunately no absolute answer to this question but there are a number of important benchmarks to be considered.

- The protection should be large enough to allow the maintenance of the tree, with appropriate arboricultural input. In the past, this was called the **C**ritical **R**oot **Z**one **(CRZ)** and frequently relates to the size of the root plate that would be required to successfully transplant the tree. In most instances is an area with a radius of 5 times the trunk diameter. This document refers to this at the **M**inimum **T**ree **P**rotection **Z**one (**MTPZ).**

- Depending on the trees response to root damage, it is possible to come even closer to the tree particularly when construction impact is going to be limited to one side or better still to one quadrant of the Critical Root Zone **and** with the provision of additional distance around the remaining area of the root zone.

- The extent of any excavation should not result in the structural instability of the tree. A number of formula and test exist to determine the size of the **S**tructural **R**oot **Z**one (**SRZ**). There is however generally no need to consider the issue of structural stability if work is performed outside the **MTPZ**. In most circumstances, it is undesirable and often unwise to cut roots located in the Structural Root Zone.

There must be sufficient soil volume to allow the tree to grow to maturity with appropriate ongoing care. If the goal is to have minimal ongoing care this will clearly take a greater soil volume than a tree that will be extensively maintained (such as a tree growing in a rooftop planting).

AS 4970-2009

In August 2009, Standards Australia released AS 4970-2009 Protection of Trees on Development Sites. In its preface, this document acknowledges its reliance on the British Standard and Matheny and Clark. This standard requires a **TPZ** with a radius 12 times trunk diameter. As already discussed, there is no question that this will provide adequate protection

of the tree in almost all conceivable situations. It achieves this by enclosing and sterilising an enormous area.

The standard does acknowledge that it may be possible to encroach on this **TPZ** if the project arborist can demonstrate that the "trees will remain viable." As already stated, we can successfully transplant most trees in good health and vigour so the use of a reduced sized root plate remains demonstrated by several hundred years of successful tree transplanting. (Mathematically the standard sized root plate for a transplant has less than 20% of the root area of the **TPZ** specified in the AS 4970-2009.)

Of equal concern is the impact of the insistence of a **TPZ** with a radius of 12 times trunk diameter may have on tree retention and urban sprawl. Where there is a conflict between development and tree retention a decision will need to be made to refuse the development (potentially increasing urban sprawl) or to reduce the size of the **TPZ**.

If the development is acceptable then we need to answer the question "should we be removing trees that cannot be given a TPZ of the size recommended in AS 4970-2009?" The answer should be "No!" whenever there is adequate potential for retention of the tree to with appropriate arboricultural input. Unfortunately, this standard leaves us guessing on this issue.

Given that the standard has some significant issues and seeks to be "informative," it is hard to give it the credence that it deserves. The standard does outline some important process namely, considering tree retention as a design consideration, seeking sound arboricultural advice and ensuring appropriate monitoring of the trees. As far as practical, this document forms an important part of that process.

This report adopts the terms and nomenclature provided in the Australian Standard AS 4970-2009. This may be particularly true of the terms Tree Protection Plan (the recommendations and processes required to protect the trees and the Tree Protection Plan (drawing), which is a plan that may or may not have on it sections of the Tree Protection Plans

Methods of Tree Protection

It is important that we understand the processes and methods of tree protection. For that reason, a number of images have been included in Appendix 4 along with the information in this section to assist in ensuring that appropriate implementation of the tree protection.

Protect the roots

As already explained the purpose of establishing a Tree Protection Zone is more than concerned with protecting the trunk of the tree. A tree protections Zone's primary function is the protection of the roots of the tree.

The most appropriate method of protecting a tree is to establish an exclusion zone using some form of rigid temporary fence (a Tree Protection Zone or TPZ). Whilst it may seem easier to use flexible fabric barrier fence these products tend to fail over time and is easily pushed out of the way or damaged. In comparison, damaging rigid fence requires more of a hit, can damage machinery and involves the cost of repair or replacement of the damaged fence.

Sometimes however, it may become necessary to work within or to gain access through a Tree Protection Zone. To do this we need to develop a method to stop soil compaction and prevent direct physical damage to roots. A simple action such as walking on the same spot half a dozen times or more can lead to soil compaction. Pushing a full wheelbarrow will cause compaction on the first instance. It does not take long for that damage to accumulate and harm the roots of a tree.

There are a number of ways to protect roots against compaction and physical damage. We can divide these into two simple groups

- Systems that share the load and
- Systems that are fully load bearing.

Load-sharing surfaces are temporary and usually lightweight systems. Load-sharing surfaces sometimes can be as simple as mulch beneath plywood or planks or the use of scaffolding, to heavier duty systems such as the use of plastic or metal road plates or even rail decking. Photographs in appendix 4 show that these can be enough to protect a delicate egg from breaking.

Fully load-bearing structures include finished structures such as the slab of a building, a driveway or a pathway. Obviously each of these has a limit to the weight that it can bear and if this is exceeded the structure and things beneath it can be damaged. Load bearing systems can also include scaffolding and temporary bridging structures.

Protect the trunk

In most instances, enclosing of the Tree Protection Zone ensures that the trunk of a tree cannot be damaged. Sometimes however work needs to take place within the Tree Protection Zone and as a result, there is a risk of impact to the trunk. Damage to the trunk is extremely undesirable. Where it is possible to treat the wound, treatment is time critical and is very expensive. When treatment is not possible or is ineffective a trunk injury can lead to long-term structural and physiological problems.

Where possible operating machinery or performing activities that may result in impact to the trunk of the tree should avoided. Where this is not possible, it is important to protect the trunk. Strapping pieces of timber to the trunk of the tree has been the traditional method for achieving this task.

As any high school science student will recall Conservation of Momentum (as demonstrated by Newtons cradle) tells us that this force is basically transferred through the pieces of timber to the trunk of the tree often providing little to no protection and in some circumstances actually resulting in increased damage.

In response to the failure of timber to absorb impact, hessian or carpet underlay were used and whilst these improved the situation the timber still lacked the ability to absorb any of the energy. The use of fabric wraps also carried new problems; in particular, they often held moisture and this moist material was in constant contact with the trunk.

A more appropriate system needs a hard but flexible outer surface bonded to a soft impact absorbing material that has a low water holding capacity. This system is better at absorbing the energy of an impact … just think about a bicycle helmet. Just as with a bicycle helmet, if impact damages a board, it needs replacing and at the same time, the trunk of the tree needs inspecting.

Lastly, prevention is the best process. When machinery is operating in close proximity to the trunk of a tree, using an observer can greatly reduce the likelihood of impact. To be effective the observer should maintain direct visual contact with the tree and the machine and should have direct audio contact with the operator. (Two-way earmuff systems are useful for this task).

Protection of the canopy

The canopy of the tree is often the part of the tree that is least harmed in the construction process. Even so, there are two ways that the construction process can harm the canopy. The first is by direct impact between equipment and the branches of the tree and the second is from incorrect or excessive tree pruning.

Avoiding impact between machinery and branches simply requires care. When machinery needs to operate near branches an independent observer should be used. The observer should maintain direct visual contact with machine and the branches of the tree and should have direct audio contact with the operator.

All pruning work should be performed in accordance with the Australian Standard AS 4373-2007 “Pruning of Amenity Trees.” Any person who does not fully understand this standard or who has not had proper training to perform pruning should not attempt this work. The site arborist may provide instructions to workers on the site on making temporary cuts for later rectification by an arborist. These instructions should be carefully followed.

Tree Protection Plan (Recommendations)

Design Issues

#	Recommendation	Reason
1	Carry out demolition of the existing kerb and guttering, located within the Tree Protection Zone of Tree 10, by hand.	To minimise both damage to the tree and compaction of the soil surrounding the tree.
2	Soil levels at the base of any tree to be retained should not be altered.	To minimise damage to the root plate of trees to be retained.
3	Establish a 'tree protection' policy document including a Tree Protection Plan (Drawing) for inclusion as a part of the site induction process for all staff and contractors to undertake before commencing on site.	Ensuring all site staff and contractors understand the value and importance of protecting the tree reduces the likelihood of accidental damage.
4	All copies of the plans must include a copy of the Tree Protection Plan (Drawing) and a reference must be made on each and every plan or drawing to "check the Tree Protection Plan (drawing)"	Trades people often read plans rather than notes, including the Tree Management Plan (drawing) in the plan set will help the awareness of all trades people

Pre construction

5	In accordance with AS 4970-2009 (5.2) a copy of the Tree Protection Plan including the Tree Protection Plan (drawing) (Appendix 1) **must** be on site prior to any work commencing on the site.	To ensure that documentation is present and available as a reference for all site personnel.
6	TrunkGuard™ or a similar system of 100mm wide boards with thick polystyrene foam bonded to one side is to be installed around the entire trunk of each tree to be retained. This protection should extend as close as practicable to the first branching of the tree.	To provide protection for the trunk during adjacent demolition and construction works.
7	TrunkGuard™ or a similar system of 100mm wide boards with thick polystyrene foam bonded to one side is to be installed on lower level branches of each tree to be retained and in accordance with instruction from the Site Arborist.	To provide protection for the lower branches during adjacent demolition and construction works.
8	Correct and complete installation of Tree "Protection measures **are** to be certified by the project arborist" to the Principal Certifying Authority (PCA) AS 4970-2009 (5.3.2).	This is to ensure the tree protection is correct and completed in accordance with the Tree Protection Plan
9	An AQF Level 3 Arborist **must** perform the canopy pruning with all final cuts made in accordance with AS4373-2007. The arborist must **not** use climbing spikes.	To ensure the arborist makes correct cuts and that the tree is not unnecessarily damaged. It is preferable to use an AQF Level 5 arborist for this work.

During site works

10	In accordance with AS 4970-2009, (5.4.1) the project arborist **should** perform regular site inspections. Monthly inspections are appropriate.	To ensure a suitably qualified person has confirmed that the tree is in good health and the recommendations are being followed.
11	If at any stage an inspection reveals the Tree Protection Plan has not been complied with the project arborist **must** specify any required remedial works and the timeframe in which these works must be completed.	To ensure that all problems are appropriately rectified and that any remedial works required are carried out in a timely manner.
12	If at any stage an inspection reveals the Tree Protection Plan (recommendations) has not been complied with the project Arborist, site inspections thereafter **must** be carried out weekly	This is to provide additional supervision in order to avoid repeat problems and to ensure the correct and timely performance of remedial works.
13	Maintain natural ground level within the Tree Protection Zone. Do not trench, stockpile materials or change grades within this zone.	To prevent unnecessary or unauthorised damage to the trunk, roots and branches of the tree
14	The Tree Protection Zones **must** remain in force until construction work is completed.	To ensure that the tree is protected for the duration of the works that may impact on the tree.
15	Machinery access **is not** be permitted in the Tree Protection Zone to perform landscaping works	To avoid damage caused by machinery as a part of landscaping activities.
16	Should the need arise to modify the Tree Protection Zone, the project arborist **must** prepare an amended Tree Protection Plan and submit it to the Council's Tree Preservation Officer for approval **prior** to access or changes taking place.	To enable changes to occur if necessary but to ensure that those changes do not adversely affect the tree.
17	An independent observer **must** be present during the demolition of any structure within 3 metres of the Tree Protection Zone.	This is to reduce the likelihood of accidental impact to the tree. (Note: The use of the project arborist for this task is strongly recommended)
18	Prior to removing any exposed root, greater than 25mm in diameter, cleanly cut it to within 1 metre of the Tree Protection Zone.	This is to avoid tearing of roots.
19	Keep the cut ends of any root, cut as a part of condition 16, moist using a root oasis, a temporary hoarding or a root curtain.	To ensure that cut roots do not dry out.
20	The project arborist **must** be present for any open excavation on the boundary line adjacent to the Tree Protection Zone.	This is to ensure that site personnel follow items 16 and 17 correctly.

Post Construction

21	At practical completion, the project arborist **should** "assess tree condition and provide certification", to the PCA that the tree protection works have been in accordance with the Tree Protection Plan.	This is to provide a completion to the document trail for the certifier and or the certifying authority.
22	"Certification **should** include a statement on the condition of the retained trees, details of the deviations from the approved tree protection measures and their impacts on [the] trees" and provide specifications for any remedial or rectification works required.	This is to comply with AS 4970-2009 (5.5.2). It provides a documented record of the final condition of the tree. It audits and certifies the correction of any problems.
23	The project arborist **should** continue to perform quarterly inspects, maintenance and reporting for whichever is greater: • For 12 months after completion of construction activities or • For 12 month after achieving stable growth of the tree	To ensure the long tem recovery of the tree is certain.

Additional conditions

24	Irrigation of the Tree Protection Zone **must / should** be performed as follows • Less than 20mm of rain has fallen in the previous week from October to March or • Less than 10mm of rain has fallen in the previous week from April to September. Apply irrigation at 1 litre / square metre for every 2mm shortfall in the rainfall during the previous week.	This is to ensure healthy root growth and to ensure higher levels of readily available water to minimise stress. (Note: It may be easier to install a temporary irrigation system prior to installing any load sharing surface.)
25	An irrigation log **must / should** be maintained and kept on site and must record the weekly rainfall and the date and duration of any manual irrigation event.	To ensure appropriate records are available for monitoring and reporting.
26	Within 24 hours of observing a non-conformance, the Arborist **must** provide a written non-conformance report to the construction manager. The report must include what rectification and remedial action is required.	To ensure all relevant personnel are made aware of non-conformance and given the opportunity to rectify said.
27	Within 7 days of observing a non-conformance, the Site Arborist **must** supply a copy of any non-conformance report to the Council and the Principal Certifying Authority.	To ensure non-conformance is followed up and rectified by those responsible for activities on the subject site.

28	All holes for piers, fencing, and planting within the Tree Protection Zone **must** be potholed using an Air Knife, Air Laser or similar compressed air device.	To prevent excessive damage to the root plate of trees to be retained and minimise instances of trees being made unstable by inappropriate root severance.
29	Do not cut or damage any root greater than 25mm in diameter for the installation of a fence post, planting hole or pit. If a root of 25mm or greater is encountered the hole **must** be moved to allow for its retention	To prevent excessive damage to the root plate of trees to be retained and minimise instances of trees being made unstable by inappropriate root severance.
30	The Tree Protection Fences **must** remain in place until landscape works are to take place within the Tree Protection Zone.	To minimise damage to trees to be retained.
31	Provide notification to the Site Arborist, the Council and the PCA not less than 7 days before removing the Tree Protection Fences.	This allows a check to be undertaken to see whether trades remaining on site or landscaping works are likely to adversely impact on the trees

Should you require any further information, do not hesitate to call our office for assistance.

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Appendix 1

Tree

Schedule

Tree Schedule

Client Name: Health Infrastructure **Site Address:** Hornsby Ku-ring-gai Hospital, 1 Derby Road, Hornsby (NSW) 2077

No	Scientific Name	Health	Height (m)	Spread (m)	DBH (m)	TPZ (m)	MTPZ (m)	Retention Value	Comments	Recommendation
1	*Lophostemon confertus*	Fair	5	10 x 8	0.315	3.78	1.575	E	Within road reserve. Semi-mature. Severely lopped to clear overhead powerlines. Mature epicormic growth from lop wounds. 40% of canopy epicormic growth.	Retain & Protect.
2	*Lophostemon confertus*	Fair	8	8 x 9	0.405	4.86	2.025	L	Within road reserve. Semi-mature. Severely lopped to clear overhead powerlines. Mature epicormic growth from lop wounds. 30% of canopy epicormic growth.	Remove to facilitate proposed development.
3	*Lophostemon confertus*	Fair	8	8 x 11	0.34	4.08	1.7	H	Within road reserve. Semi-mature. Severely lopped to clear overhead powerlines. Mature epicormic growth from lop wounds. 40% of canopy epicormic growth.	Retain & Protect.
4	*Eucalyptus botryoides*	Good	20	14 x 16	0.52	6.24	2.6	E	Semi-mature. Asphalt car park 1.3m to E from base. Water hydrant 2m to N from base. Bus shelter 2.2m to W from base. Under pruned to clear car park, bus shelter & powerlines.	Retain & Protect.
5	*Eucalyptus botryoides*	Good	20	10 x 12	0.48	5.76	2.4	E	10% semi-mature epicormic growth. Asphalt carpark 1.3m to E. Sewer vent 2.6m to S. Existing driveway 5.2m to E. Bus shelter 2m to W. Under pruned to clear car park, bus shelter & powerlines.	Retain & Protect.
6	*Leptospermum patrsonii*	Fair	7	8 x 9	0.16 @ 0.9	1.92	0.8	L	Suppressed due to proximity to T7. 4 leaders @ 0.9m. Included main junction. 5^{o} phototropic lean to W. Water hydrant 2m to SW. Kerb & guttering 1.6m to N.	Remove to facilitate proposed development.

7	*Melaleuca styphelioides*	Good	9	10 x 9	0.3	3.60	1.5	M	Multiple leaders @ 1.8m. Main junction included. Asphalt car park 1.4m to S. Kerb & guttering of existing entry 1.2m to N.	Remove to facilitate proposed development
8	*Allocasuarina littoralis*	Poor	14	8 x 10	0.19 & 0.25	3.77	1.55	M	Dual leaders @ 0.8m. Included junction. Pruned on S side to clear car park. Kerb & guttering 0.6m to S & 0.5m to N. 15% deadwood.	Remove to facilitate proposed development.
9	*Allocasuarina littoralis*	Fair	14	9 x 7	0.375	4.50	1.875	M	Trifurcates @ 1.5m. Included main junction. Large area of insect damage to S leader @ 2m. Leader almost ring barked. Numerous inclusion though out canopy. Asphalt 0.5m to S. Kerb & guttering 0.5m to N.	Remove to facilitate proposed development.
10	*Eucalyptus botryoides*	Fair	18	16 x 14	0.67	8.04	3.35	H	5^{o} lean to NW. Insect damage on NW side. Extends from base to 1.6m. Exudation prolific. Evidence of branch failure in canopy. <5% deadwood. Asphalt 1.1 m to S. Kerb & guttering 1.5m to N.	Retain & Protect.
11	*Melaleuca leucadendra*	Good	10	9 x 8	0.41	4.92	2.05	M	Kerb & guttering 1.1m to N. Asphalt 0.8m to S.	Retain & Protect.
12	*Cinnamomum camphora*	Fair Exempt species	14	18 x 18	0.92	11.04	4.6	H	15% deadwood. Tip die back. 20% semi-mature & mature epicormic growth in canopy. Asphalt 2m to W. Dual @ 1.7m. Main junction occluded. Under pruned for clearance of car park, footpath & picnic tables below. Exempt species	Retain & Protect.
13	*Pheonix canariensis*	Good	14	8 x 8	0.725	8.7	3.625	H	One of a pair within immediate area. Appears contemporary to adjacent physiotherapy building (circa 1920's).	Transplant
14	*Alecryon spp.*	Fair	13	14 x 10	0.21 & 0.195	3.44	1.45	L	Dual @ base. Main junction occluded. Phototropic lean to W due to proximity of T15. Flush cuts. Heavily asymmetrical canopy, approximately ½, to	Remove

									N.	

15	*Acmena smithii*	Poor	12	12 x 7	0.475	5.7	2.375	N	15^{o} lean to NW. Dual @ 2m. Occluded main junction. Bracing within canopy between a 2nd order lateral and a 1st order lateral. Not under tension. Epicormic shoots on trunk. Covered pathway @ base. Has been lopped for clearance.	Remove.
16	*Acmena smithii*	Poor	12	6 x 4	0.205 & 0.19	3.35	1.4	N	Dual @ 0.2m . Occluded main junction. Leaders cross & contact @ 1m. Asymmetrical canopy due to proximity of T15 & covered walkway. 20% deadwood. Lopped for clearances.	Remove.
17	*Citharexylum spinosum*	Fair	18	10 x 12	0.44	5.28	2.2	M	In raised garden bed between pathways. Dual @ 2m. Small leader fused to dominant one @ 3m. Pruned for clearances of covered walkway & adjacent building.	Remove to facilitate proposed development.
17a	*Archontophoenix cunninghamiana*	Good	17	N/A	0.22	2.64	1.1	M	Base 0.3m from that of T17. Canopy wholly within that of T17.	Transplant
18	*Callistemon viminalis*	Fair	7	8 x 6	0.27	3.24	1.35	N	Dual @ 1.4m. Included main junction. 10% deadwood.	Remove to facilitate proposed development.
19	*Ficus obliqua*	Poor	9	8 x 9	0.2	2.40	1.00	L	20% deadwood. Pruned to clear walkway. On edge of path & paved seating area.	Remove as an inappropriate species for location.
20	*Eucalyptus scoparia*	Poor	16	12 x 14	0.52	6.24	2.6	N	Heavily underpuned. 40% canopy epicormic shoots from both trunk and 1st order laterals. Winter Bronzing (*Thaumasticoris sp.*) 30% deadwood. Tip die back.	Remove & replace.
21	*Liquidambar styraciflua*	Fair	15	17 x 14	0.705	8.46	3.525	H	5^{o} lean to NW. 20% epicormic shoots throughout canopy. Has been lopped.	Retain & Protect.
22	*Tibouchina spp.*	Poor	5	6 x 5	0.16 &	1.92	0.8	N	Has been severely lopped. Majority of canopy now mature epicormic growth. Similar in form to a	Remove.

					0.13				coppiced tree. Trifurcates @ base. 1 removed. Main junction included. 20% deadwood.	

Notes on Tree Schedule

Number (No)	N – Neighbours tree within proximity of the development
Scientific Name	Identification was performed using visual features visible from ground level at the time of inspection.
Health	**Good** – In good health with no significant faults or defects **Fair** – Some faults or health problems, not likely to cause short-term problems, generally able to be managed **Poor** – Significant health or structural defects with management likely to be inadequate or inappropriate
Height (m)*	Palm heights given for trunk only and does not include the height of the fronds.
Spread (m)*	The average diameter of the canopy unless the asymmetry of the canopy is noted or is critical to the design process.
DBH (cm)*	Trunk diameter - measured or approximated at 1.4m above ground as outlined in "Appendix A" AS 4970 – 2009
TPZ	The **T**ree **P**rotection **Z**one radius without requiring input from an arborist, as specified by AS 4970 – 2009
TPZM	The suggested minimum Tree Protection Zone radius determined following the process for reducing the TPZ outlined in AS 4970 – 2009. The TPZM usually requires moderate to extensive arboricultural input along with ongoing maintenance
Retention Value	**E = Essential** - Site suitability 40 plus years, good condition, able to be retained without design changes **H = High** - Site suitability 40 plus years fair condition or better able to be retained with minor design changes **M = Moderate** - Site suitability 20 - 40 years, or only retainable with moderate impact on the development of the site **L = Low** - Site suitability less than 20 years, or retention impacts significantly on development of the site **N = Nil** - Site suitability less than 5 years, or retention sterilises development of site **Note:** Site suitability considers health, life expectancy, risk of harm, desirability of species and impacts on current and proposed land use. Impact on development needs to be considered throughout the planning stage
Recommendations	Unless otherwise stated trees are to be retained

* All dimensions are approximate.

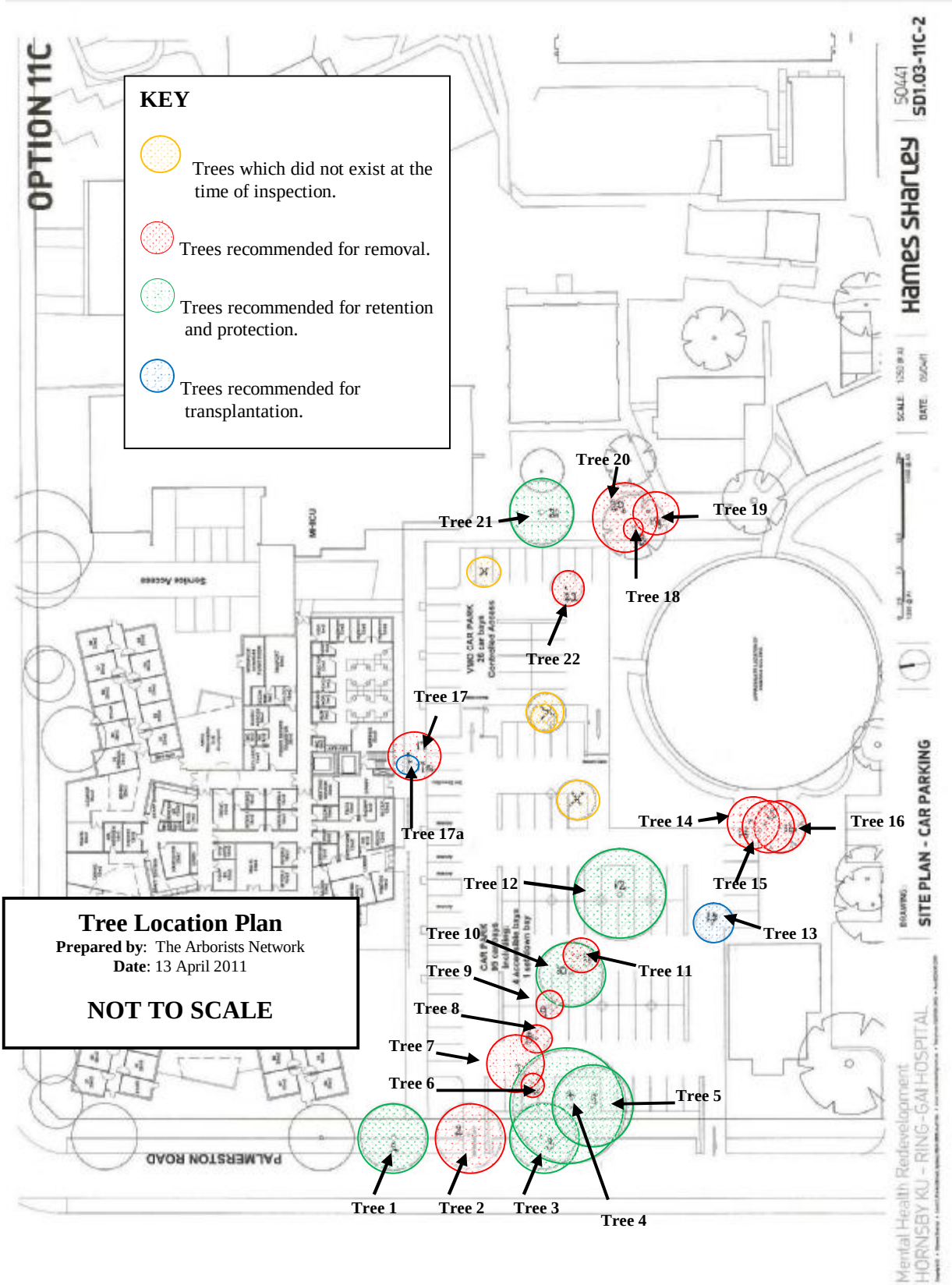
Appendix 2

Tree

Location

Plan

Tree Location Plan



Appendix 3

Generic

Tree

Protection

Guidelines

Generic Tree Protection Guildelines

1.0 Pre Construction:

1.1 Prior to the commencement of construction, the consulting Arborist will issue a report outlining the following:

1.2 The trees that have been protected, the maintenance activities (if any) for each tree that have already been performed, that the protective fence or fences have been installed in accordance with the Arborist's Report.

1.3 A statement that the physical protection (items 7 and 8 of the POTOCS standards) of the trees has been performed, to the above standards or if not, any non-conformances and why. e.g. the fence around trees is incomplete because of boundary fences.

1.4 All trees to be removed are to be marked with a single white line around the trunk. No tree shall be so marked until council consent for its removal has been given.

1.5 Prior to removal one of the following will confirm the tree is to be removed by marking the tree with a single horizontal yellow or orange line. One of the following persons, Surveyor, Landscape Architect, Arborist, Project Manager, and Tree Preservation Officer, should do this.

2.0 Tree Protection Zones:

2.1 The trees are to be protected by a 1.8 metre high fence to be constructed within 500mm of any construction activity and to include as much of the Primary Root Zone as possible.

2.2 Where the Tree Protection Zone occurs impart on the adjacent property, the fence will stop at the boundary lines.

2.3 Provision will be made to these protection zones for pedestrian access only.

3.0 Maintenance activities:

3.01 The following maintenance activities will be required for this site:
- Irrigation – by hand to comply with current specifications
- Soil Amelioration
- Mulching
- Crown cleaning in accordance with AS 4373-1996 - Pruning of Amenity Trees, removal of trees by sectional felling and stump grinding.
- Tree Removal

3.02 Timing: Maintenance activities are to be at the commencement of the construction process by qualified Arborists and then as required during the construction period.

3.1 Irrigation

3.11 Soil moisture during construction shall be maintained at not less than 60% of field capacity.

3.12 Irrigation is to be applied by hand. No construction activities are to take place within the Primary Root Zone until irrigation has been initiated and soil moisture reaches 70% of field capacity at a depth of 300mm.

3.13 On each visit, the consulting arborist shall check the soil moisture and manually check the irrigation system, when installed.

3.14 Soil moisture levels should be checked by physical touch or with a tensiometer.

3.2 Soil amelioration

3.21 An application of rooting hormones, humic acids, soil microflora and mycorrhizae may be applied by an arborist in accordance with the manufacturer's instructions.

3.22 Chemical fertilizers are to be used only after representative soil testing and based on the soil scientist's recommendations.

3.3 Mulching

3.31 The fenced area should be mulched with seed free mulch to a depth of at least 50mm.

3.4 Weed Control

3.41 Weed control shall be by hand pulling, wiping or spraying with a glyphosate based herbicide. Material likely to be root grafted to trees to be retained shall be removed manually.

3.42 Weed control shall not be performed by mechanical cultivation or by scraping or back burning.

3.5 Crown cleaning

3.51 Crown cleaning (AS4373-1996, Pruning of Amenity Trees) shall be performed in accordance with the standard, by an arborist and in compliance with the appropriate occupational health and safety regulations. All branches down to 50mm in size shall be inspected and appropriately treated.

3.52 Any concerns about health or safety that are observed by the arborist on the site will be reported in writing within 7 days to the superintendent/principal/client and/or head contractor.

3.53 The use of spurs on live trees and internodal cutting is strictly prohibited.

3.6 Tree Removal and Stump Grinding

3.61 Remove trees in a controlled or sectional felling to avoid any damage to the trees to be retained.

3.62 All shrubs, under-scrub and woody weeds that are to be removed shall be removed by hand as per 3.4 above.

3.63 No tree shall be removed unless it has been marked with a horizontal white and yellow/orange line around the trunk.

4.0 Fences:

4.1 The fencing of the Tree Protection zone as defined in section 8.0 of the POTOCS standards should be commenced prior to the commencement of ANY work, including demolition and land clearing by earth moving machinery but may be erected after tree maintenance activities.

4.2 The fence surrounding the Tree Protection Zone must be a rigid fence not less than 1.8m high.

5.0 Signs:

5.1 At least every 25 metres attached to all tree protection fence there shall be a sign, a minimum of 600mm x 600mm, bearing the following phrase in red letters on white background at least 50mm in height:

"TREE PROTECTION ZONE - KEEP OUT"

5.2 On the same sign above or on a separate sign attached adjacent, in red lettering on white background not less than 25mm in height is to be the following:

"PROHIBITED ACTIVITIES"

Followed by the list below in black letters not less than 15mm in height.

a) Entry of machinery or people.
b) Storage of building materials.
c) Parking of any kind.
d) Erection or placement of site facilities.
e) Removal or stockpiling of soil or site debris.
f) Disposal of liquid waste including paint and concrete wash.
g) Excavation or trenching of any kind (including irrigation or electrical connections).
h) Attaching any signs or any other objects to the tree.
i) Placing of waste disposal or skip bins.
j) Pruning and removal of branches, except by a qualified Arborist.

5.22 In letters not less than 25mm in height on the above sign should be the name of the supervising Arborist or arboricultural company or other appropriate contact and a contact phone number.

6.0 Root Cutting

6.1 All roots greater than 50mm in diameter that are required to be removed shall be cleanly cut and kept moist at all times and shall not be left exposed to the air for more than 10 to 15 minutes.

7.0 Maintenance Reports:

7.1 Weekly inspections and monthly reports should be made until the end of construction.
7.2 A consulting Arborist should be on site during any excavation work within the Critical Root Zone and will report on that work in the monthly report.
7.3 A site log shall be maintained and include the date of each inspection, the person who performed the inspection, the items inspected or tested, the maintenance activities performed, any repairs undertaken or required to be undertaken, and any substantial breaches or non-conformances.
7.4 The arborist performing the inspection should sign the entries in the logbook
7.5 The log shall be maintained on site or alternatively copies of the log entries for the month shall be submitted each month with the monthly report.
7.6 All maintenance shall continue for the 3 months after completion of construction

8.0 Non-Conformance Reports:

8.1 The following are non-conformances that need to be managed when they occur.
8.11 The removal or relocation closer to the tree of all or part of any protective fence prior to landscaping.
8.12 The performing of any activity noted as prohibited on protection zone signage
8.13 The failure to maintain adequate soil moisture or the failure in the operation of the irrigation system.
8.14 Mechanical damage to the trunk, stems, branches or retained roots.
8.15 The sudden and abnormal or premature shedding or decline of the tree.
8.2 Substantial breaches and non-conformances:
8.21 Any breach or non-conformance of the tree protection zone, by any party, shall be notified in writing within 2 working days of it being first observed.
8.22 Notification of any non-conformance should be made in writing to the site foreman, the consent authority and any independent certifier.

Appendix 4

Protection of Trees on Construction Sites

Establishing a Tree Protection Zone

Good Work	Poor Work
	
The fence should be rigid and hard to move.	Too easily damaged and collapses when hit
	
The TPZ is mulched where appropriate and weed free.	Put the fence where it should be! The TPZ is not for storage.
	
The purpose of the fence is to isolate the tree from the works and to protect the roots	Woven fencing seldom work particularly when it is used close to the work or when space is scarce

Load –Sharing Surfaces and root protection

Good Work	Poor Work
	
Like an egg tree roots are delicate	A single movement of a truck will cause irreparable damage
	
Load sharing should be appropriately designed for the load that it is to carry.	Without protection soil is compacted and roots are broken and damaged
	
The goal is to ensure that impact on the roots that are to remain is minimal.	This shows no regard for tree roots

Trunk protection using TrunkGuard

Good Work	Poor Work
	
Designed to absorb impact just like a bicycle helmet.	Trunk damage is usually irreparable and often causes long-term damage!
	
Flexible to fit the trunk	Even installation of a poorly designed system can injure tree!
	
Able withstand moderate construction impact (not that this should happen but unfortunately it does).	Serves little purpose at all!