GREENSCENENZ

ENHANCING AND PROTECTING
LIVING ENVIRONMENTS

Arboricultural Assessment

Monterey cypress (*Hesperocyparis macrocarpa)*
1817 Great North Road Avondale

Version 1
December 2020

Table of Contents

Appendices

Acronyms

Acronym/Term	Description
PRZ	Protected Root Zone
TPZ	Tree Protection Zone
SRZ	Structural Root Zone
CR	Crown Radius
DBH	Diameter at Breast Height
TPM	Tree Protection Methodology
VTA	Visual Tree Assessment
AC	Auckland Council
AUP-OP	Auckland Unitary Plan Operative in part 2016
RC	Resource Consent
TOA	Tree Owner Approval
LOA	Land Owner Approval
RMA	Resource Management Act 1991
SEA	Significant Ecological Area
RPMP	Regional Pest Management Plan 2019-2029
DOC	Department of Conservation

1 Introduction

1.1 Scope

GreensceneNZ Ltd has been engaged by Auckland Council to provide an arboricultural assessment of a notable Monterey cypress (Hesperocyparis macrocarpa) colloquially referred to as 'macrocarpa' located at 1817 Great North Road, Avondale. This report provides an assessment of arboricultural health, ecosystem services, landscape values and comment on the tolerance to construction of the notable macrocarpa. The key matters addressed in this report are as follows:

- Identify and describe the existing tree and natural environment; extent of the root plate (drawing showing the tree, the site, and the extent of the root plate).
- Estimate of how close works could go (also shown on the drawing)
- Assessment of shading of the tree on the site
- Visual Tree Assessment
- Ecosystem services

1.2 Tree Location

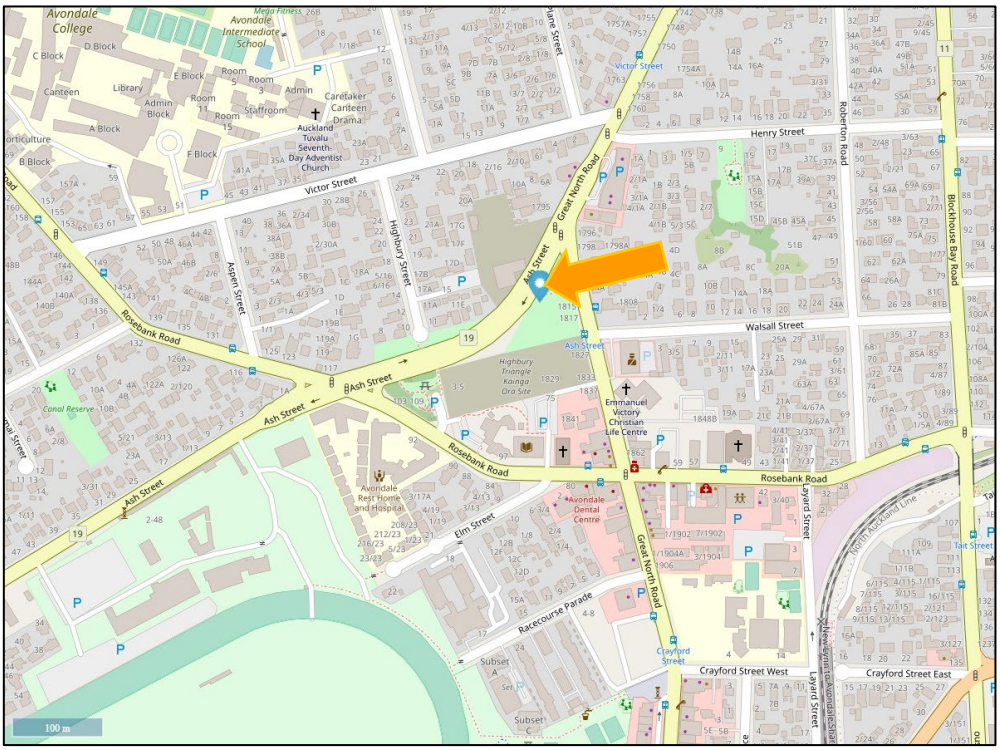


Figure 1: Location of the scheduled macrocarpa to the north of Avondale CBD within the road reserve of Ash Street (State Highway 19) between New Lynn in the south and Point Chevalier to the North.

The notable macrocarpa is located on the boundary between 1817 Great North Road and the Ash Street (State Highway 19) road reserve, *see figure 1*. Historically the scheduled tree appears to be a remnant of two to three macrocarpa planted along the existing property boundary before the creation of the road reserve, *see photograph 1*. This early aerial image of the macrocarpa indicates its urban residential and market garden location. Pre-1940, Avondale's growing settlement was known for its orchards, market gardens, brick works, tanneries, and horse racing course. It is possible that the macrocarpa trees were planted in this location to reduce the wind loading to the benefit of neighbouring horticulture businesses. Currently the macrocarpa is surrounded by mature Norfolk Island pines, swamp cypress, Notable cottonwood poplar trees, *see photograph 2.* In the late 1970s the construction of the Ash Street road connection resulted in the removal of the second macrocarpa to the west shown in *photograph 1*.

Photograph 1: 1940 aerial photograph showing the location of the scheduled macrocarpa on the boundary of 1817 Great North Road, Avondale before the construction of the Ash Street extension (Retrolens)

Photograph 2: 2020 aerial photograph of the scheduled macrocarpa on the boundary between Ash Street (State Highway 19) and 1817 Great North Road

1.3 Macrocarpa species characteristics

The botanical name *Cupressus macrocarpa* was updated to *Hesperocyparis macrocarpa* in 2013 to reflect the difference between the Western Hemisphere and Eastern Hemisphere clades of cypress trees. The *macrocarpa* botanical family tree is as follows:

Kingdom: Plantae

Division: Pinophyta

Class: Pinopsida

Order: Pinales

Family: Cupressaceae

Genus: Hesperocyparis

Species: H. macrocarpa

Binominal name: Hesperocyparis macrocarpa

Synonyms: Callitropsis macrocarpa, Cupressus macrocarpa, Neocupressus macrocarpa

Common names. Macrocarpa, Monterey cypress

The Monterey cypress (H. macrocarpa) has an extremely restricted natural distribution limited to thirty hectares of Pacific coast between Cypress Point and Point Lobos in the Monterey area of California. It is thought that the early seed collector Karl Hartweg first discovered and recorded the tree in 1846. Although in 1838 it had been grown from an unknown seed source by the Horticultural Society at Kew, United Kingdom. Macrocarpa were first recorded as being in New Zealand as early as 1864 and between 1869 and 1876 at least 6 kg of macrocarpa seed were obtained from Californian suppliers and distributed to growers in both islands for forestry plantations.[1] There are records of Macrocarpa trees planted at Mount Eden in 1866 and it is now highly domesticated throughout New Zealand. The growth rate of macrocarpa in New Zealand is well researched as it is an important plantation tree, NZ Farm Forestry states:

[1] J.T. Miller And F.B. Knowles 1996 Fri Bulletin No. 124 Introduced Forest Trees In New Zealand: Recognition, Role, And Seed Source 9. The Cypresses Cupressus Spp. Chamaecyparis Spp. Issn 0111-8129 Odc 17 4. 7 Cupressus (931) :232

'Macrocarpa can grow at 80 to 150 cm a year with a diameter growth of >2 cm. At age 10 trees may be 8 m to 12 m tall with a mean diameter at breast height of 15 to 25 cm. Stands on reasonable sites will put on volume of 20 m3/ha/annum or more, and trees with a mean diameter at breast height of 60 cm (30m tall) may be produced within 35 to 40 years.'[2]

Eckenwalder 1993 describes macrocarpa as trees to 25 m; crown generally broadly spreading, especially on exposed headlands, fairly sparse, often composed of few major limbs from near ground, more upright in sheltered locations. Bark rough, fibrous. Branchlets decussate, 1.5 to 2 mm diameter leaves without gland or sometimes with inconspicuous, shallow, pitlike, abaxial gland that does not produce drop of resin, not glaucous. Pollen cones 4 to 6 × 2.5 to 3 mm; pollen sacs 6 to10. Seed cones oblong, 2.5 to 4 cm, greyish brown, not glaucous; scales 4 to 6 pairs, smooth, umbo nearly flat at maturity. Seeds mostly 5 to 6 mm, dark brown, not glaucous.[3]

The largest macrocarpa in New Zealand was identified and measured in 2012, is in Awhitu, South of Auckland, it has a DBH of 4.63m with a height of 23.8m with an approximate planting date of 1878.[4] It is apparent from global heritage tree measurements that macrocarpa growth height tends to reach cessation at maturity (around 40 years in New Zealand) while trunk girth continues to grow beyond the mature life stage to over-mature and veteran life stage phase.[5]

Mature trunks tend have fluted stems with significant rib formations and large buttress roots. Statistical studies conclude that the frequency of decay related failure is deemed very low to medium, while the frequency of 'weak fork' or included bark fork failure can be high in macrocarpa trees. They are susceptible to Coryneum canker caused by Seiridium cardiale fungi which can cause severe crown dieback, however failure of stems are likely to be due

2 Nzfarm Website Https://Www.Nzffa.Org.Nz/Farm-Forestry-Model/Species-Selection-Pool/Species/Cypress/Macrocarpa/#:~:Text=Macrocarpa%20can%20grow%20at%2080,Diameter%20growth%20of%20%3e2%20cm.
3 Eckenwalder, James E. 1993. Cupressus. Flora of North America Editorial Committee (eds.): Flora of North America North of Mexico, Vol. 2. Oxford University Press.
4 www.register.notabletrees.org.nz/tree/view/963
5 LEATHART S 1991 Whence our trees. Foulsham London ISBN 0-572-01675-2

to decay by other secondary fungi. It has also been discovered that there is a high incidence of wind damage following the exposure of the inner crown by pruning works.[6]

[6] Dr. D LONSDALE 1999 Principles of tree hazard assessment and management Forestry Commission London:TSO

2 Macrocarpa data

2.1 Tree metrics

The macrocarpa metric data are the quantitative measurements recording the biological size of the tree they were recorded on 24th November 2020, the weather was overcast with occasional rain.

Feature	Size
Diameter at breast height (1.4m)	2.52m
Diameter of root flare	2.95m
Tree Height	26m to 27.5m (Measured by Lecia Disto 810 with height tracking at three suitable vantage points)
Canopy height	20m
Height of canopy above ground	5.0m (estimated)
Height of first significant branch union	7.0m (estimated)
Crown spread North	12.5m
Crown spread North East	10.5m
Crown spread East	11.5m
Crown spread South East	11.9m
Crown spread South	12.8m
Crown spread South West	12.9m
Crown spread West	10.8m
Crown Spread North West	10.9m
Average crown spread	11.75m

Average crown span	23.5m
Structural Root Zone Radius	5.21m
Tree Protection Zone Radius (BS5837:2012)	15.0m
Potential Root Zone Radius	30.24m
Quantity of scaffold stems from 3m height	8 (see photograph 7)
Live crown size	467m^2

2.2 Tree info

The macrocarpa tree info is the secondary qualitative analysis of the tree data combined with observations and research.

Feature	Assessment
Life Stage	Over-mature
Age	120 years plus
Occurrence of species	Common in New Zealand
BS5837:2012 Quality Category	B12
Physiological Condition	Fair
Structural Condition	Fair
Visual Tree Assessment Observations	Co-dominant stems; broken branches; above average deadwood; chlorotic leaves; poor branch unions.
Size of tree	Large
Amenity visibility distance	Visible from 2km (estimated)
Importance of position	Major significance with over 20k vehicle per day

Presence of other trees	Within a small park and group of 10+ trees
Role in location or setting – Visual and spatial quality. Would its removal detract?	Major significance (see photographs 5 to 7)
Useful life expectancy – will it be there for the next generation?	10 to 50 Years (estimate)
Form	Fair - typical form for over mature macrocarpa with flat top spreading canopy.
Scientific value	Minor significance.
Historic value	Minor significance, perhaps some unconfirmed local value due to age of tree.
Cultural value	Minor significance
Functional value	Very significant, see eco benefits section.
Ecological value	Minor significance
Stand landscape value – screen/buffer/part of a green network	Major significance
Evidence of ancientness	Large girth; changes in crown architecture; crown retrenchment; shallow hollowing between buttress roots.
Lifetime (approx. 120 years) CO_2 equivalent of carbon[3] (i-tree)	36893kg
Annual carbon sequestered (i-tree)	298Kg
Annual air pollutants removed (i-tree)	3kg
Annual stormwater runoff prevention (i-tree)	$17m^3$

3 Macrocarpa assessment

3.1 Amenity landscape Assessment

The amenity landscape assessment utilizes the Standard Tree Evaluation Method (Ron Flook 1996)[7]. The age of the tree is inferred from the 1940 aerial whereby it appears the tree has reached maturity at approximately 40 years of age.

3.1.1 Stature

'The use of tree volume, as a measure of tree size gives a realistic appraisal of the tree in the landscape' McGarry and Moore 1988.

Figure 2 Large canopy area and volume.

The macrocarpa tree has a large live crown size of 467m^2 as viewed from the eastern aspect from Great North Road with a calculated crown volume of 5898m^3 which is calculated using the cylinder formulae:

$$\pi \text{ X } average\ crown\ radius\ 2 \text{ X } canopy\ height$$

[7] R. FLOOK 1996 A Standard Tree Evaluation Method STEM RNZIH ISBN: 0-473-04039-5

The result gives cylinder volume based on the pink line shown in *figure 2*. For a more accurate estimation, the canopy volume figure is reduced by 32% in line with the 68% to 32% ratio of the crown area to pink rectangle. It is assumed that from all cardinal point aspects that the crown area populates 68% of the pink rectangle. The macrocarpa has a large dense live crown volume of 5898m^3 giving the tree a significant stature.

3.1.2 Visibility

The macrocarpa is a large stature landmark tree contributing to the green corridor adjacent to State Highway 9, *see photographs 3, 4 & 5.*

Photograph 3, 4 & 5: Role in location and green corridor values as seen from SH9 from the East and West views and the view from Great North Road. (Google Street View 2020)

It has a dense year-round foliage cover and is located in a visually prominent position in the landscape. It exhibits good form consistent with similar over-mature macrocarpa with a habit typical of the species. It contributes to the amenity and visual character of the area by creating a sense of place and local identity as proven by the 'save this tree' signs. It is also a landmark, visible from many local dwellings particularly on the hill to the East of the tree. The average daily traffic count of 35,000 (*mobileroad.org*) vehicles passing the tree is high. Therefore, the macrocarpa has a significant visibility in the landscape and is a prominent feature in the local urban environment.

3.1.3 Proximity to other trees

The macrocarpa stands in a group of ten plus trees including mature Norfolk Island pines, swamp cypress and notable cottonwood poplar trees, *see appendix 1.*

3.1.4 Role in setting

The macrocarpa contributes to the local setting by providing a significant component of the green corridor and urban ngahere (forest). Currently the Avondale area has been assessed as low canopy cover (10% to 15%) with very few large trees, thus increasing the valuable role of the macrocarpa in the setting, *see figure 3.* The macrocarpa has a historic connection with the European settlers of the Avondale or Whau area where planting exotic trees was commonplace for functional wind reduction and shading. It now provides a green barrier between the State Highway and the local urban area to its south and is likely to contribute to the local property values. Anecdotally various realtors have photographed the macrocarpa in the background of sales marketing material, perhaps helping to infer a green environment through hedonic and biophilic economic value responses[8] which in turn increase sales and property values, *see figure 4.*

[8] House, E., C. O'Connor, K. Wolf, J. Israel, & T. Reynolds. 2016. Outside our Doors: the benefits of cities where people and nature thrive. Seattle, WA: The Nature Conservancy, Washington State Chapter, 30 pp.https://www.nature.org/content/dam/tnc/nature/en/documents/Outside_Our_Doors_report.pdf

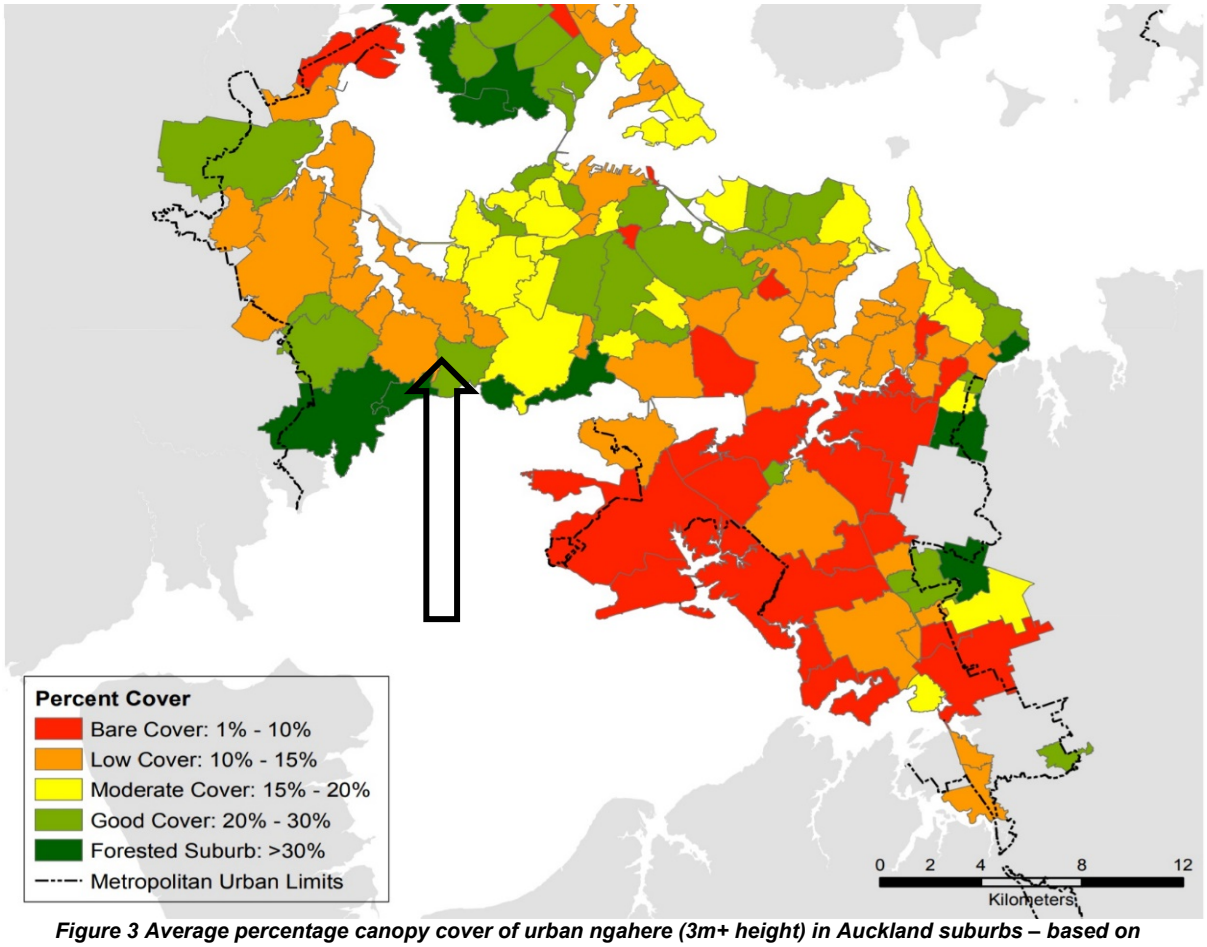


Figure 3 Average percentage canopy cover of urban ngahere (3m+ height) in Auckland suburbs – based on analysis of the 2013 LiDAR survey. Auckland Urban Ngahere Strategy Auckland Council.[9]

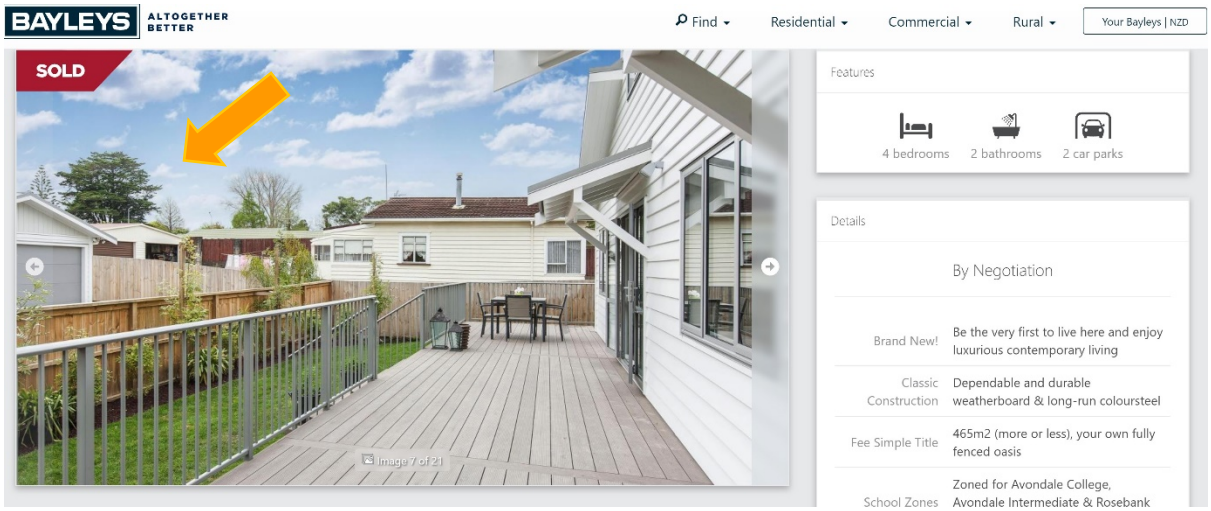


Figure 4 The macrocarpa indirectly adds value to neighbouring properties through hedonic and biophilic response values invoking connection to greenspace. (Image courtesy of Baileys)

[9] https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/Documents/urban-ngahere-forest-strategy.pdf

3.2 Shade Assessment

Shade has been plotted using the guidelines set out in the British Standard BS 5837:2012 adapted for New Zealand sun paths and angles with the addition of seasonal variation, as outlined in *figure 5 & 6.*

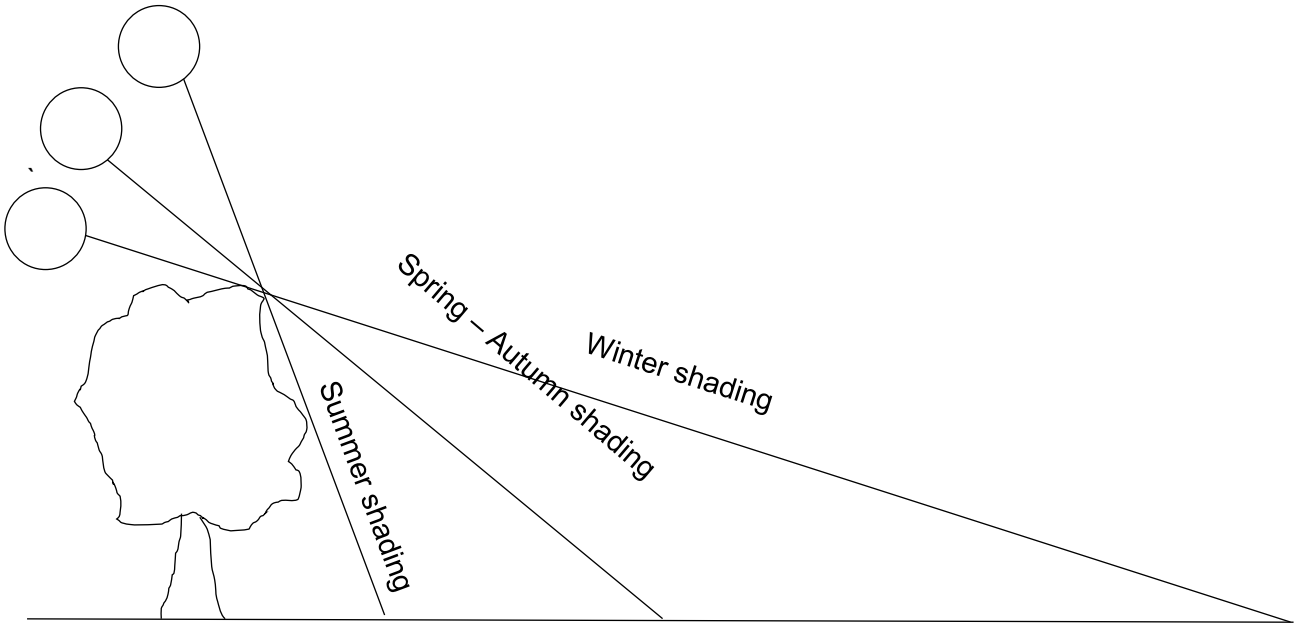


Figure 5: Season shading differences.

Figure 6: Seasonal shading paths with times marked to represent the centre of the shade from the macrocarpa.

The summer shade from the macrocarpa is slight due to the high angle of the summer sun. While during spring, autumn, and winter the lower sun has a much larger shade impact over 1817 Great North Road to the south. Tree shade can be a dis-benefit due to the loss of potential daytime sunlight to help heat north facing properties, but only when not overcast during the winter, autumn, and spring months. Another dis-benefit is the lack of suitable levels of liveable natural light within adjacent buildings due to the proximity of large trees. However, if there is a proposed adjacent construction then natural light solar light tubes should be designed into the new building, therefore providing adequate light without losing trees. Shade should not be viewed as negative impact as there are many climatic benefits all year round including reduced air conditioning costs, urban heat island effect and lower soil temperatures which benefit microbial biodiversity an important component of tree health.

3.3 Visual Tree Assessment

3.3.1 Roots

The macrocarpa has no exposed roots for visual inspection. However, there is a relatively large sweeping buttress roots which infer a strengthening of the shallow spreading root zone typical of this species. The largest buttress root is located to the West, here it is expected that the largest structural root mass is located.

Photograph 6: Trunk with fluted and ribbing morphology, indicating a transfer of load from stems through the trunk to the root zone.

3.3.2 Trunk

Typical of the macrocarpa species the trunk is fluted with many ribs which are an indication of a transfer of loading and strengthening as the tree has developed, *see photograph 6*.

3.3.3 Stems

There are eight stems (300mm to 700mm estimated diameter) furcating from the trunk at a height of between 3 to 4m from ground level, *see photograph 7.*

Photograph 7: Eight scaffold stems (300mm to 700mm estimated diameter) from 3m height.

The multi-stemmed nature of the tree is usually formed following destruction of the terminal shoot. The terminal leader could have been cut, damaged by frost, pests or wind loading within the formative years of the macrocarpa life. With resources being channelled into more than one main stem or sink then multi-stemmed trees may be able to display greater photosynthetic surface area. There is one dominant main stem extending the full height of the tree which is slightly inclined into the property of 1817 Great North Road. The largest dominant stem appears to have an indented cortical/bark strip approximately 5m in length from the main stem union to the first significant branch union. On both sides of the strip are two raised and ribbed masses, indicating a positive reactionary wood growth around a section of decay. It should be noted that this stem also has been subjected

to branch loss at the top of the canopy. Therefore, it would be prudent to investigate this decay further, a destructive test using a resistograph should ascertain the extent of canker and defensive compartmentalisation without compromising the tree further.

Aside from the vertical strip of decay, there is evidence of pruning works which indicates historic dieback or storm damage. A climbing inspection of the tree using a 360 camera shows that the internal canopy branch unions are of a good form, *see photograph 8.*

Photograph 8: Although appearing superficial this section of decay could be an indication of canker.

3.3.4 Branches

The lower branches have been pruned creating a significant loss of the lower canopy. The loss of lower branches can change the dynamic positive damping effect on the stems during wind loading increasing the likelihood of further storm damage. In the mid canopy there are numerous pruning wounds, some of which do not show callousing, indicating a poor response and a possible lack of overall tree vigour, *see photograph 10*. It is assumed that the significant amount of pruning was carried out to remove branch failures and reduce the hazard exposed by this tree to occupiers within the road reserve. Within the centre mid canopy ther branch unions appear to be structurally sound, *see photograph 9*. In the upper canopy there are 20mm to 50mm diameter branches exhibiting dieback, however this is a relatively small portion of

the overall canopy. The lateral flat-topped branches show a typical form for a macrocarpa of this life stage. The top tier of branches has failed entirely and are either dead or moribund, *see canopy section 3.3.5.*

Photograph 9: Climbing inspection of mid canopy indicates fair to good form of branch unions.

Photograph 10: Non calloused pruning wounds in the mid canopy and slight dieback of upper canopy.

3.3.5 Canopy

On visual investigation of the tree from the ground and considering the age of the tree it is reasonable to conclude that the tree has started to retrench its canopy as it passes from the over-mature life stage to the veteran life stage. To confirm this conclusion, we would expect to see crown retrenchment, the onset of hollowing, saprotrophic fungi associations which are typical of the tree veteranisation phase. However, on closer inspection of the top tier of the canopy using a drone these signs of veteranisation are not present.

The collapsed top tier of the canopy still has signs of growth on the branch ends of the partially attached but broken branches. The now dead branches still have their attached leaves, indicating that the upper tier canopy did not retrench and did not dieback but suffered a catastrophic event likely due to a storm, *see photographs 10 & 11.* The timing of the top tier collapse is between October 2017 and September 2018 according to the historic google street view images, *see figure 7.* During this period there were some major storms in the Avondale area with most damage to local trees occurring during the 12th April 2018 storm. The direction of failure of the branches within the collapsed canopy indicates a wind loading from the North West direction. The collapse may have gone unnoticed as the canopy would have retained its green look for some time.

Figure 7: Google street view images from October 2017 (left) followed by upper canopy collapse before September 2018 (right).

Photograph 10: Collapsed upper tier of canopy, possibly due to extreme wind loading from a North Westerly direction as indicated by the orange arrow.

Photograph 11: Moribund but green branches which have partially ripped out, dead and still attached leaf material indicates that the tree has not retrenched or died back gradually.

It should be noted that the sudden collapse of the upper tier canopy may not be entirely caused by wind loading, it could also have been made weaker by pests and diseases pre-storm. It would be prudent to sample the live but collapsed branches in the upper canopy to ascertain if there are any significant issues. The lower mid canopy branches have already been sampled and sent to through to MPI for fungal analysis, it is likely to take around three weeks to get the results from this sample (mid December 2020).

3.3.6 Pests and diseases

Macrocarpa are highly susceptible to Seiridium canker which has caused extensive shelterbelt damage throughout New Zealand. The typical symptoms of resin bleeds from active legions have not been found on this tree, however the lens shaped, and sunken cortex/bark has been noted on the main stem, *see section 3.3.3*. The vertical lens of bark decay is surrounded by what appears to be healthy tissue in the form or reactionary wood.

As mentioned above a sample of mid canopy material has been sent to MPI for analysis. If there is evidence of canker causing fungi, it will not be enough to give the tree a short-term prognosis of decline followed by death in this case. The canker can rapidly affect all macrocarpa trees, but in large trees the decline may take many years for the cumulative effects of multiple cankers to take hold. [10]

3.4 Quality Assessment

The purpose of categorizing trees on site is to identify the quality and value of existing trees. This is to allow for informed decisions to be made on which trees should be removed or retained in the event of development on site. The macrocarpa has been categorized according to British Standard BS 5837:2012 as category B a tree of moderate quality which has suffered damage or is in decline.

[10] Sinclair W.A; Lyon H.H (2005) Diseases of Trees and Shrubs, Second Edition; Cornell University Press. Ithaca and London.

3.5 Eco-Benefits Assessment

i-tree Eco is a software application designed for urban forest assessment. It uses field data from complete inventories or randomly located plots, along with hourly air pollution and meteorological data. It quantifies the structure and environmental effects of urban forests (or trees) and calculates their value to communities. i-tree Eco is also a suitable tool for calculating tree carbon content, providing climate change mitigation and provision of ecosystem services.

Over the lifetime of the macrocarpa it has sequestered an estimated 37 tonnes of carbon and provided significant reductions in local storm water runoff of an estimated 17 cubic meters a year. The air pollution benefit has been calculated at 3kg per year however it is possible that this figure is higher due to the near location of the busy State Highway. The macrocarpa will provide a high leaf surface area for the deposition of particulate matter which will be reducing the pollution levels to the South of the tree.

3.6 Tree Protection Assessment

The best human interaction for any mature tree tends to be no human interaction at all. However, it is important to manage the hazards posed by the macrocarpa and consider how this tree can interact with a future urban environment.

The tree protection zone for this tree is calculated at a 15m radius, which is the maximum recommended radius stated in the *BS5837:2012 Trees in relation to design, demolition, and construction* guidelines. However, this generic approach requires a modification to include root constraints, existing impacts and species tolerances. As this is a large tree it is worth considering a larger root zone around the standard 15m radius to 30m where if any construction were to occur then supervised root pruning should be carried out, *see tree location plan appendix 1*. It is possible that over 120 years that various outlier roots have extended further in one particular direction as the root system does not generally show the symmetry seen in the branch system.

The development of all roots is influenced by the availability of water, nutrients, oxygen, and soil penetrability. As far as these conditions allow, the root system tends to develop sufficient volume and area to provide physical stability. The uptake of water and mineral nutrients by the root system takes place via the fine non-woody roots (typically less than 0.5 mm diameter) and associated beneficial fungi (mycorrhizae). Their survival and functioning, which are essential for the health of the tree as a whole, depend on the maintenance of favourable soil conditions. All parts of the root system, but especially the fine roots, are vulnerable to damage. Once roots are damaged, water and nutrient uptake is restricted until new ones have grown. Mature trees recover extremely slowly, if at all, from damage to their woody roots as they do not have the adaptability of their younger life stages.

Historically the macrocarpa has grown in a relatively open space up until the late 1970s when the new Ash Street road connection was built. It is possible that there was some regrading of the land and some roots would have been severed to the North of the tree during construction, however the tree has obviously adapted to this impact over the last fifty years.

According to the recent topographical plan (Anchor Consulting) completed for LOT 1 DP 514556 a storm water pipe passes through the TPZ and the SRZ to the East of the tree. Identification of the SRZ provides an indicative area within which most structural roots responsible for anchorage and stability are likely to be encountered. It is assumed that this storm water pipe was an open trench excavation which would have impacted the tree at the time and possibly resulted in significant root loss. There is a discrepancy in the location of the storm water pipe as the Auckland GIS plan places the storm water pipe to the West of the macrocarpa while the recent topographical plan locates it to the East, *see figure 8.*

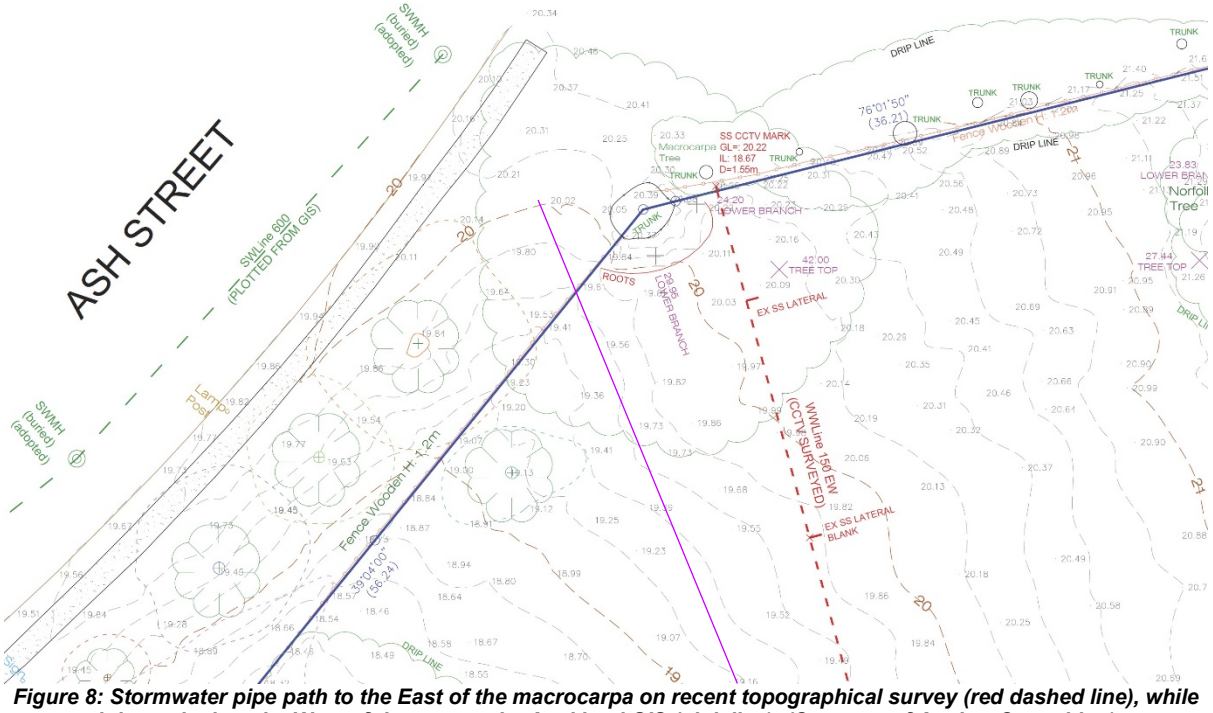


Figure 8: Stormwater pipe path to the East of the macrocarpa on recent topographical survey (red dashed line), while it is marked on the West of the tree on the Auckland GIS (pink line). (Courtesy of Anchor Consulting)

As with any old or late life stage tree they often do not have the ability to rapidly adapt to changes in their environment, therefore it is important not to affect the root zone suddenly or significantly. Also as indicated by the use of macrocarpa for the prevention of farm hillslope erosion their shallow spreading roots stabilise the ground. Therefore, it is fair to assume that any linear incursion into the shallow TPZ could likely result in unintended windthrow, especially as either the West or East side has already been historically cut for the storm water pipe. A reduction in the root volume would also increase the trees susceptibility to drought by removing a vital mass of fine roots and mycorrhizal associations. If canker is found to be present on this tree, then drought conditions will also speed up the process of infection throughout the tree.

The macrocarpa will have little tolerance to construction however it may be possible to construct within the TPZ if exploratory holes were dug and piles were constructed with no root loss over 10mm diameter, however it is important that ground water gradients remain the same and there is no future compaction of the TPZ even by foot traffic. Any construction or changes within the SRZ of the macrocarpa could possibly be catastrophic for the survival of this tree.

In terms of canopy management, it is recommended that only dead detached branch hangers are removed. The removal of macrocarpa deadwood for disease sanitisation work can be troublesome as they tend retain small amounts of live tissue making deadwood difficult to identify. Pruning back to live tissue will increase the chance of infection and speed up the effects of canker if present on the tree.

With the exception of the removal of deadwood, all pruning should be avoided because it;

- Results in immediate vascular dysfunction of conductive xylem;
- Disrupts tree growth regulating pathways;
- Alters, or delays, the accumulation, distribution and gradients of non-structural carbohydrates;
- Affects the composition and relative stability of non-structural carbohydrates;
- Reduces the assimilation of key essential nutrients, such as nitrogen; and
- Results in the proportionate decline of root mass.

4 Conclusions

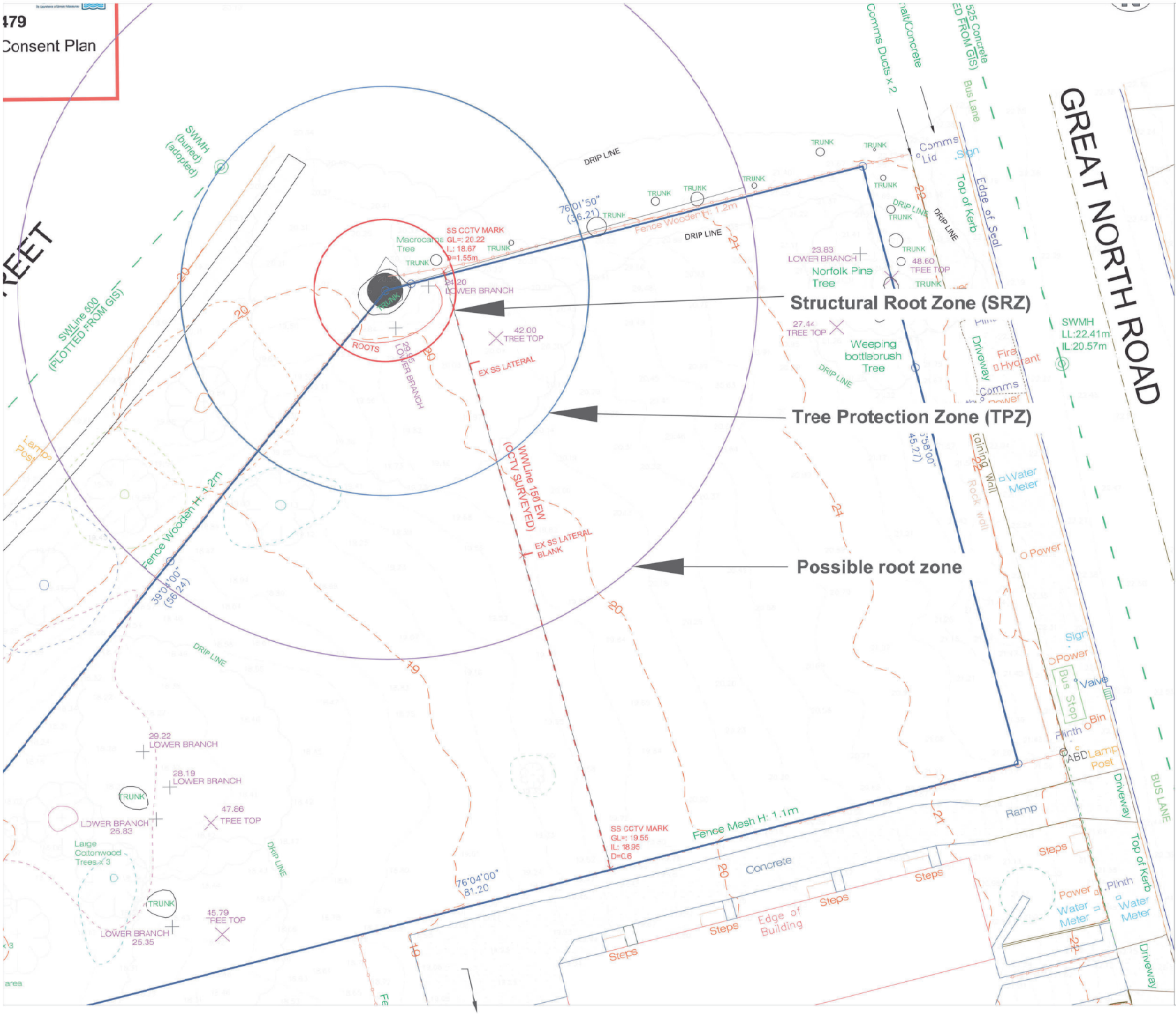
The macrocarpa is significant tree with high landscape and eco benefit values. It has suffered numerous recent pruning works and storm damage which has reduced its large dense canopy volume, thus reducing its overall value. Due to its late life stage and recent branch losses the macrocarpa is in a delicate balance whereby it requires as many of its resources as possible to recover. Therefore, it would be irresponsible to remove these resources by carrying out branch or root removal in the future. Instead works should be carried out to improve the condition of its root zone.

That said, a common-sense balanced approach should be taken when retaining and managing large trees in the urban environment. If construction were required within the TPZ it should be less than 10% of the TPZ and minor (no more than 10mm diameter root loss) or ideally re-designed and avoided entirely, but in combination with improving the trees health. It could be possible to perhaps invigorate the tree by retaining roots and rebuilding with structural soils capable of retaining moisture and hard surfacing. While pushing technical arboriculture this would have no guarantee of success for such and old established tree and could be prohibitively costly.

At this stage it is recommended that there is further investigation into the extent of the stem canker and interpret the results from the MPI investigation due in mid-December 2020.

Appendix 1

Tree location Plan



Tree Locaton Plan (Based on Anchor Consulting Tooographical plan of LOT 1 DP 514556

PROJECT NAME 1817 Great North Road		PROJECT #
PROJECT ADDRESS Avondale	DATE 02/01/2020 SCALE @ A3 1:400	MAP #
MAP NAME Tree Locaton & Protection Plan	DRAWN GSMZ CHECKED	REV
FILE:		

Key

Structural Root Zone Radius 5.21m
No incursion into the SRZ

BS5837 CategoryB TPZ 15m radius
Minor less than 10% and minor pruningnor ore than 10mm diameter roots

Ideal TPZ based on 12 x DBH = 30m
Excavation in this area should be supervised, ground protection should be used in this area also.

GREENSCENENZ
ENHANCING AND PROTECTING LIVING ENVIRONMENTS