CONTENTS

1 THE GOALS OF THE STREET TREE PLANTING GUIDELINES ARE:

1. To establish minimum expected standards, specifications, and work procedures.
2. To communicate these expectations to all persons and agencies engaged in the planting of street trees within Queenstown Lakes District.
3. To ensure high quality and consistent work practices that results in a healthy, sustainable and aesthetically pleasing urban forest.

1.1 INTRODUCTION

Queenstown Lakes District Council (QLDC) is responsible for the planting, maintenance and replacement of council reserve trees throughout the district. These public and often highly visible trees form an important element of QLDC's asset which is managed by the Property and Infrastructure Team.

Following consultation with QLDC regarding species choice, location and planting methodology, the majority of new street tree planting within new subdivisions are planted as an integral component of any new development, usually requiring the developer to adhere to a fixed maintenance period. Following the completion of this maintenance period, QLDC assess the condition and quality of the new planting and accepts responsibility for the trees and their ongoing maintenance.

This guideline has been produced to provide a minimum standard and direction for the planting of new trees specifically within council's road corridor. It is designed for new sub divisions, retrofitting into existing streets, car parks and all other suburban areas under the maintenance of QLDC.

The processes and expectations laid out in this document will provide clear guidance on planting the right tree, in the right environment and in the right place to provide a valuable tree asset that will enhance the local environment and benefit residents while requiring a minimal ongoing maintenance burden for QLDC and its rate payers.

QLDC is committed to protecting and enhancing the valuable tree asset that is within its area of responsibility. QLDC is also committed to future collaborative working with developers in order to ensure the sustainability of the tree asset for the benefit of future generations. QLDC recognise that amenity trees are planted on the basis of the multitude of social, cultural, economic and environmental benefits they provide for the community and are a significant element in meeting community driven expectations and outcomes.

1.2 BACKGROUND

The Queenstown Lakes District is recognised both nationally and internationally for its enviable environment that is further enhanced by the presence of many magnificent trees and hedgerows which during Spring provide a beautiful display of blossom and emerging new foliage, in Summer welcome shade, in Autumn a spectacular display of rustic colours and in Winter an intricate weave of bare colourful twigs.

Overall, the majority of the districts urban forest trees have attained maturity, with many trees entering senescence and nearing the end of their safe useful life. Therefore it is imperative that all new tree planting is appropriate to the location, successful and sustainable in order for successive tree generations to mature and continue the districts tree heritage into the future.

QLDC has inherited many tree related issues that cause conflict with existing services, residents and the surrounding built environment. Unsuitable species, poor planting location and the lack of available space for roots to extend resulting in hard surface defects as a result of natural root development and expansion (direct damage). This is a common problem throughout the Queenstown Lakes District and beyond.

1.3 STREET TREE PLANTING & CLIMATE CHANGE

How do street trees help combat climate change?

- Trees sequester carbon dioxide directly from the air and transform it into living matter - trunks, branches, roots, leaves, and flowers.
- Deciduous trees planted in strategic locations conserve energy by shading buildings during the summer months. This directly results in a reduced requirement for artificial cooling of buildings and corresponding reduced energy use which means reduced greenhouse gas emissions onsite and from power plants.
- An effective tree canopy in towns and cities helps reduce urban heat island effect, where heavy concentrations of buildings and asphalt adsorb heat and raise urban temperatures by as much as 10°. Lower temperatures mean less energy use for artificial cooling and reduced emissions.
- One large mature tree will sequester 8–10 tons of carbon dioxide from the atmosphere over its lifetime.

The overall effect of urban trees is to cool the local environment during the summer months. Deciduous trees provide summer shade that helps to filter some sunlight from reaching the surface below their canopies. When trees shade buildings, this can reduce summer demand for air conditioning, which in many towns and cities is powered by greenhouse-gas-emitting fossil fuels, such as natural gas or coal. Shade around air-conditioning units can also reduce energy use by partially pre-cooling air before it enters the building. During winter months, deciduous trees provide a spectacular display of autumn colours before they shed their leaves and allow sunlight to penetrate through the canopy, allowing buildings to benefit from the natural warmth of the winter sun.

Beyond their climate change mitigation role, trees also reduce pollution, slow down the water cycle and are important wildlife habitat.

2 TREE PLANTING GUIDANCE

2.1 SITE ASSESSMENT

All trees require fundamental environmental resources. Many sites considered for tree planting are unable to provide these resources, which can contribute to eventual tree decline and failure.

There are many factors to be considered when planting, particularly in the urban environment, therefore a process is necessary to methodically assess the many variables that will be encountered. This stage of planning is essential as these factors impact on soil water retention and movement, drainage, nutrient availability, the severity of soil compaction and root development. Tree roots require very specific conditions in order to thrive and support the tree both structurally and physiologically. Perhaps the most important factor is to ensure that the soil is not overly compacted which can severely inhibit the natural ingress of air allowing gaseous exchange to occur.

Natural factors to be assessed and considered can include:

- Heat and exposure - Increased temperature and sun scorch
- Low temperature, chilling and frost
- Drought
- Mineral deficiency
- Water logging
- Competition for light, water and nutrients
- Acid pH of soil and water
- Exposure to high winds and turbulence
- Soil compaction

Man-made factors to consider can include:

- Above ground factors - Proximity to buildings, utilities, distances to adjacent trees, visibility splays and distance back from kerb edge are significant factors that will determine the appropriate tree species for the location.
- Surrounding surfacing - Roads, pavement, car parking, driveways, new sub division/development site (usually a highly modified environment), berms, verges. The interaction of pavements and berms/verges is a common issue for tree root development.
- Underground factors – Utilities and services will require investigation to establish suitable placement of tree planting locations, or the services should be located away from planned tree planting locations in all new sub-

divisions. Development of the rooting environment will need to ascertain whether any utilities are potentially affected by the proposed tree planting. Mitigation and protection may be required, however, incorporation of services through tree pits is widely accepted where appropriate.

The existing soil should always be considered for use in the tree pit, though it may require soil improvements and/or decompaction, this will vary to individual site requirements and it is recommended that discussions take place with a professional arborist to establish a suitable outcome. The top soil is often removed as part of development. The underlying soil that's left should not normally be considered suitable for tree growth.

2.2 TREE SPECIES SELECTION

When choosing the species of tree to plant, it is recommended that guidance is sought from a suitably qualified professional arborist experienced in the local climatic conditions. Although it is desirable to plant large trees in the urban environment due to their eventual visual benefits to the streetscape, it is not always practical as a result of man-made restrictions such as overhead services and proximity to buildings and highways.

Therefore careful consideration needs to be taken before deciding on the eventual species of tree to be planted.

There are many variables to be considered when choosing a species for any particular site. These variables relate to both the trees to be planted and the conditions in which they are to grow. Design demands are often paramount, but cannot be considered in isolation from all the other factors involved in suitable species selection. All potential impacts on the likely success and longevity of any new planting should be considered.

Nursery catalogues are a useful source of information regarding a species or cultivar to be used. However, catalogues are primarily designed to sell trees and the information contained in them is often partial and incomplete, there are many publications available describing tree species and their characteristics. Local experience and knowledge of young tree performance is often as valuable, and there are occasions when specialist advice is needed.

Trees are adaptive and respond to the local environment in which they are growing, often producing modifications of form which do not match the nursery catalogue description. Site constraints are likely to affect the eventual form, development, speed of growth and eventual longevity of the young tree.

It is imperative that before any decision is made regarding species choice for planting within any QLDC reserve, an early consultation process is initiated with QLDC and the final decision on species choice is agreed with QLDC.

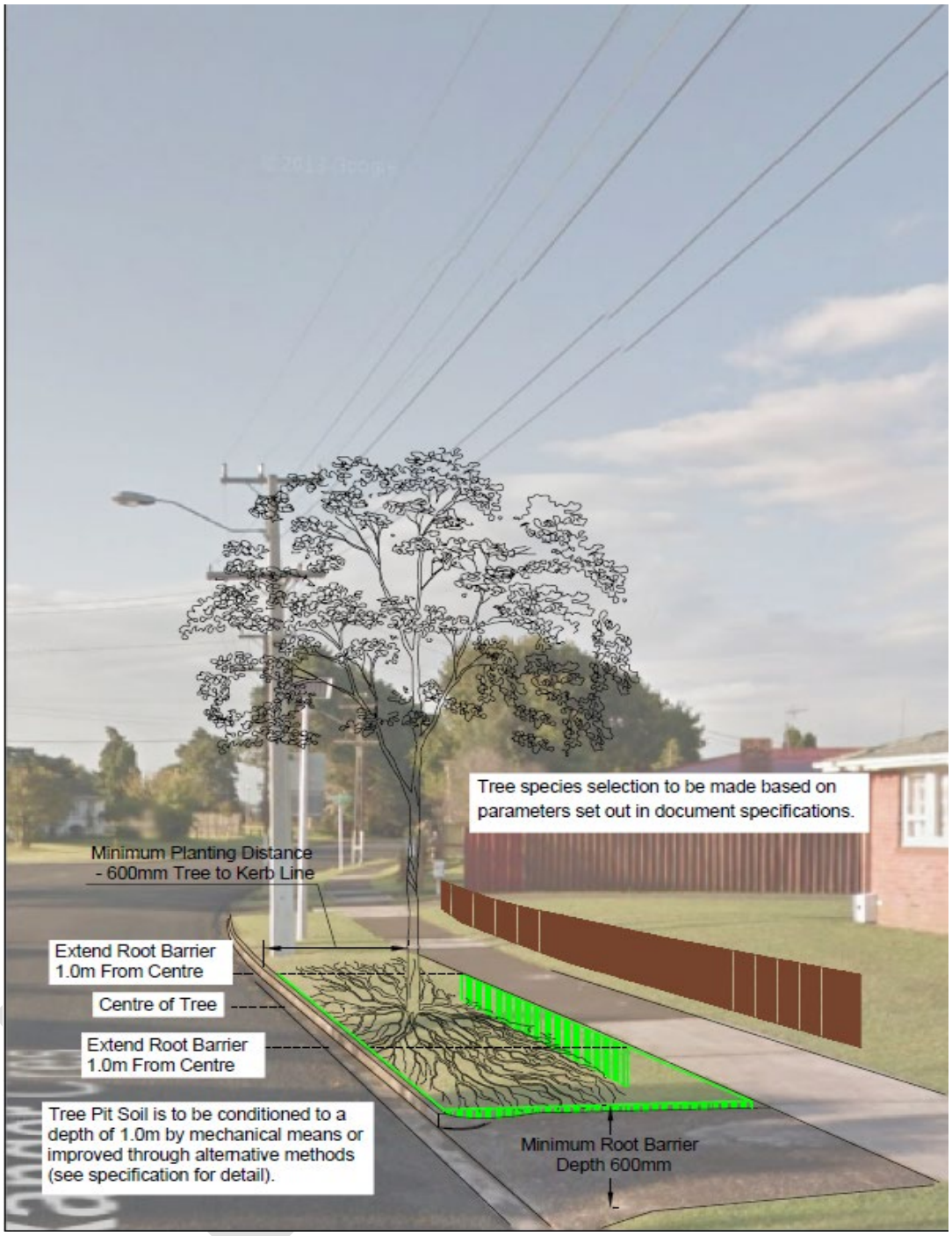
2.3 THE PARAMETERS FOR NEW STREET TREE PLANTING

The following parameters are set out to provide a guide to aid the correct selection of species for the location.

In all locations the following must be adhered to,

- No tree shall be planted closer than 600mm from the inside edge of the road kerb.
- No tree shall be planted to obscure visibility splays.
- No square tree pit opening shall be less than 1200x1200mm and when suitable no less than 1500x1500mm.
- Appropriate, vertically ribbed root barriers or root deflection systems shall be installed and be no less than 600mm deep. In a berm/verge situation the root barrier shall be installed at linear meter either side of the tree centre, longitudinally adjacent the footpath and road kerb. When a square tree pit opening is created the root barriers or deflection system shall be installed at the outer edge of the tree pit.
- Where practicable, the rooting environment shall be manipulated to provide no less than 8 cubic meters of good usable and uncompacted growing medium to encourage the tree to establish and develop to its full potential (Note: final tree pit sizes to be negotiated with QLDC dependant on site constraints and surrounding soil type). Where achievable the soil volume provision shall be greater than 8 cubic meters (advice from a suitably qualified professional arborist should be sought in the relevant amount of soil volume per tree species and the combination of trees per pit).
- In situations where established adjacent trees are already in situ, it is essential that no root damage occurs to any existing trees during planting and the ultimate dimensions of both trees should be considered.
- The distance to potential obstructions are required to be measured or calculated at the planning stage. Such restrictions can include overhead services, adjacent buildings, highways, road signage, lighting columns, power lines and street furniture.
- When new or renewal footpath construction is being undertaken the pavement layout should maximise the space available for the rooting environment of the tree. Flexible pavement options shall be incorporated to protect pavement deflection.
- Once the tree list has been selected for the planting location no other species list shall be used. As new varieties and cultivars are made available that are suitable to each of the species lists they will be populated into the appropriate list.

New street trees shall not be planted where the projected mature canopy spread is within 5 meters of any street light or overhead services.



Example of berm/verge tree selection and protection (Image created by Arborlab)

2.4 TREE STOCK SELECTION

Tree production is the first link in establishing healthy and sustainable street tree planting. Its importance is obvious, and planting projects have often failed through using poor quality trees. Healthy landscape trees are derived from high quality nursery stock. Ensuring that high quality trees are supplied for planting is essential to the successful long term sustainability of any street tree planting programme and an understanding of nursery production systems is therefore critical to enable differentiation between nursery trees of a high or low quality.

If plant quality is sacrificed for superficial looks, stock is sometimes forced to reach a saleable size in the shortest possible time, and while it might be large, it is not necessarily hardy or physiologically ready for planting.

Tree longevity in the landscape begins not at the planting site but at the nursery. The selection of physiologically healthy,

mechanically sound and resilient trees is fundamental. Poor production practices on the nursery can cause problems years or even decades after the tree has been growing in the landscape.

The production of young trees is a specialized and complex process, and expert advice is needed when evaluating nursery production systems and good practice. The choice of production system is the responsibility of the specifier and is inextricably linked to the individual site constraints.

2.5 TREE PIT FORMATION

2.5.1 Planting in 100% Engineered Environment – Footpaths, Car Parks, New Roads, Road Upgrades & Combined Tree Storm Water Applications

Based upon a basic conflict of principals between the compaction required for engineering and uncompacted soil environment requirements for root development, provision in areas where the compaction levels are likely to be high will require additional mitigation for the successful integration of trees into the engineered environment.

This Guideline sets a desired minimum requirement, where practicable, of 8m3 of good usable growing medium per tree in these environments (final tree pit sizes to be negotiated with QLDC dependant on site constraints and surrounding soil type).

Combining these factors is achievable through various methods. All of these methods have a higher installation cost associated with them when compared with traditional methods of planting, however it is essential to integrate both the trees requirements and those of the engineered environment to provide a long term benefit. If the rooting environment cannot be manipulated to provide a positive and sustainable rooting environment then no planting should be undertaken.

It is essential that all underground utilities and their locations are confirmed as they may need to be relocated during the installation phase of the tree planting (see drawing 1 below). Research shows that when an adequate soil volume is provided and the infrastructure is correctly built the root development will have very limited interactions with underground services.

Integration of soil into the engineered environment can currently be achieved via three main options, all have been tested worldwide:

- Soil cells
- Vault or rafting
- Structural Soils

Soil cells are the most widely available and a simple way of integration. There are several manufacturers with similar products.

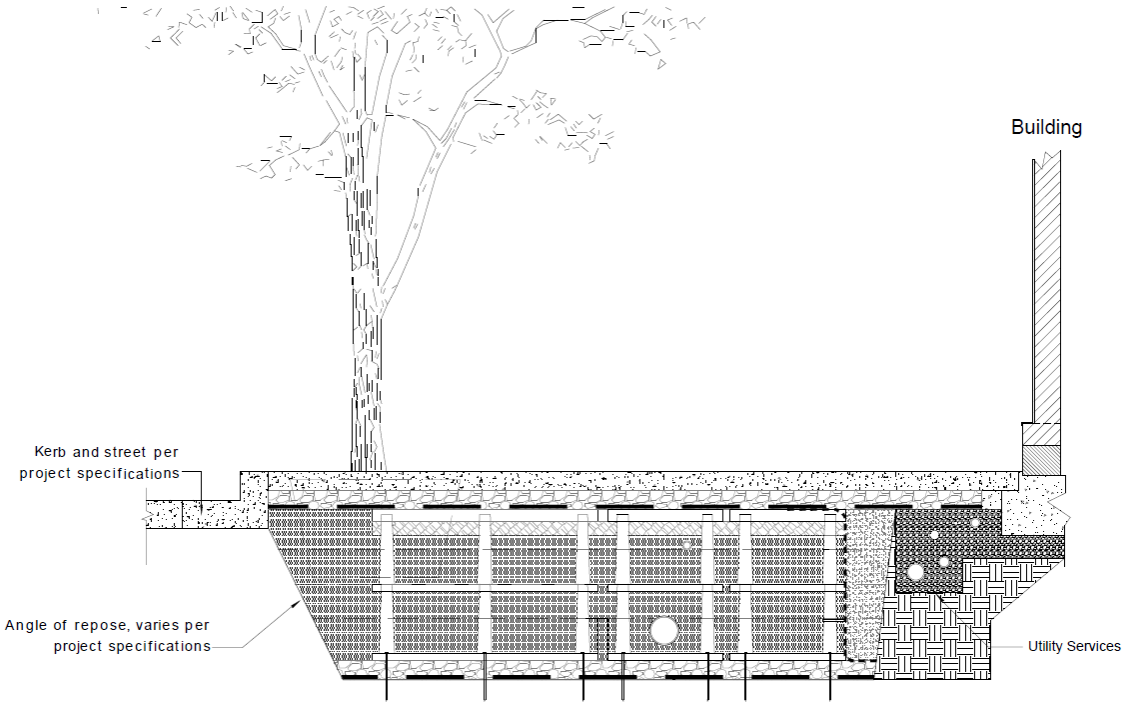
Vaults and rafts are widely used throughout North America (particularly Canada). They require pre cast or cast concrete, as a result they are normally purpose built due to the varying on site factors.

Structural soils blend an aggregate with a clay based soil that allows the blend to have a surface placed over it. More suited for pavements or foot traffic, this system is not suitable for heavier applications such as car parking.

The proposed soil to be integrated into either the soil cells or raft/vault system will require confirmation.

Combined tree and storm water applications are now often an additional benefit when planting trees in engineered tree pits. The emphasis of the soil being uncompacted allows the ingress of water into the proposed solution/pit for temporary holding.

The trees will utilise water runoff from the surrounding area, the soil will release the water at a slower rate post rainfall event and also potentially provide water cleansing affects. The method of integration of water into the engineered tree pit is required to be illustrated, clearly showing how water enters, exits and integrates to the storm water network. Dependant on the soil volume, soil type and potential expected outcomes for the project, the total storm water potential from the proposed engineered tree pit shall be estimated and form part of the information provided to QLDC.

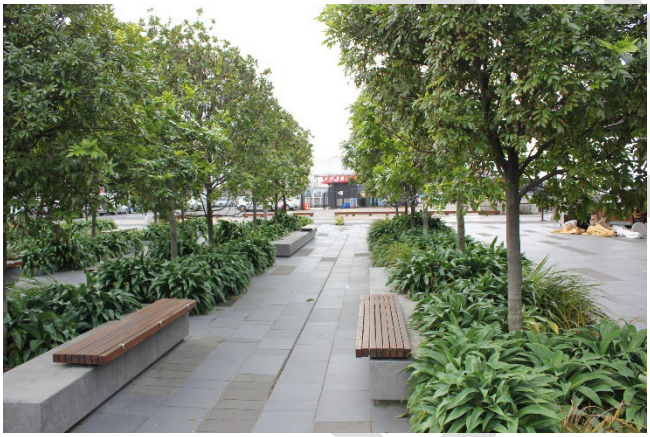


Drawing 1 - Example of engineered tree pit cross section (Image created by Arborlab, amended from DeepRoot drawing)

Integration of trees and infrastructure.

Example of soil cells being laid out into tree pit areas. Image courtesy of Paul Malcolm, MetroGreen.

Tree pits and car parking combined



Use of vertical / slot drainage to combine trees and storm water.

Good species selection in line with the proximity of the building. As the trees develop, some pruning required, for buildings and power line for proposed tram network.

2.5.2 Planting in Partially Engineered Environment – Berms/Verges with Areas of Soft Landscape, Central Median Areas of Roads

Many roads and streets throughout the Queenstown Lakes District have footpaths that have a concrete path, flanked with grass. It is common place for trees to be planted in these areas. The total width of the berm/verge including both areas of concrete and grass needs to be considered when proposals of new street planting is taken into account. There are various layouts of these across Queenstown with differing dimensions of pavement to berm ratios. Prevention of root damage to the surrounding footpath is required. This can be achieved in various ways such as position of planting, root barriers, soil amelioration and flexible pavement options.

The underlying soil type and geology is a critical factor. Soil in situ is likely to need some degree of amelioration. In areas the soil amelioration will require more detailed information. If the soil is not improved or at the very least broken up the roots are unable to penetrate. This leads to surface rooting causing issues with the surrounding infrastructure.

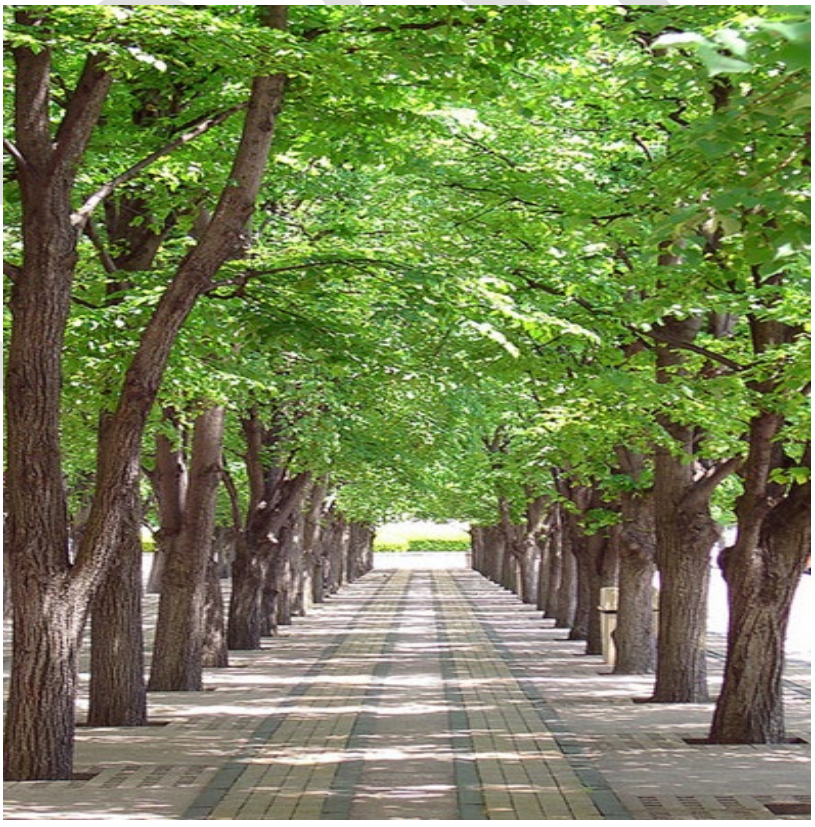
Root barriers will require 1 linear meter either side of the tree stem adjacent all footpaths, road kerbs and other likely areas potentially affected by the rooting matter within 3m of the stem of the tree. The root barriers shall have suitable vertical ribs, this will direct the roots down and prevent girdling that can have long term detrimental effects to the trees development to a depth of 600mm

Consideration to directing the rooting material of the tree under the pavement will provide additional rooting environment and therefore aid the trees development. Pile and beam footpath constructions or the use of soil cells under the pavement, along with the other amelioration techniques illustrated provide integration with minimised defects in the future (see drawing 2 & 3 below).

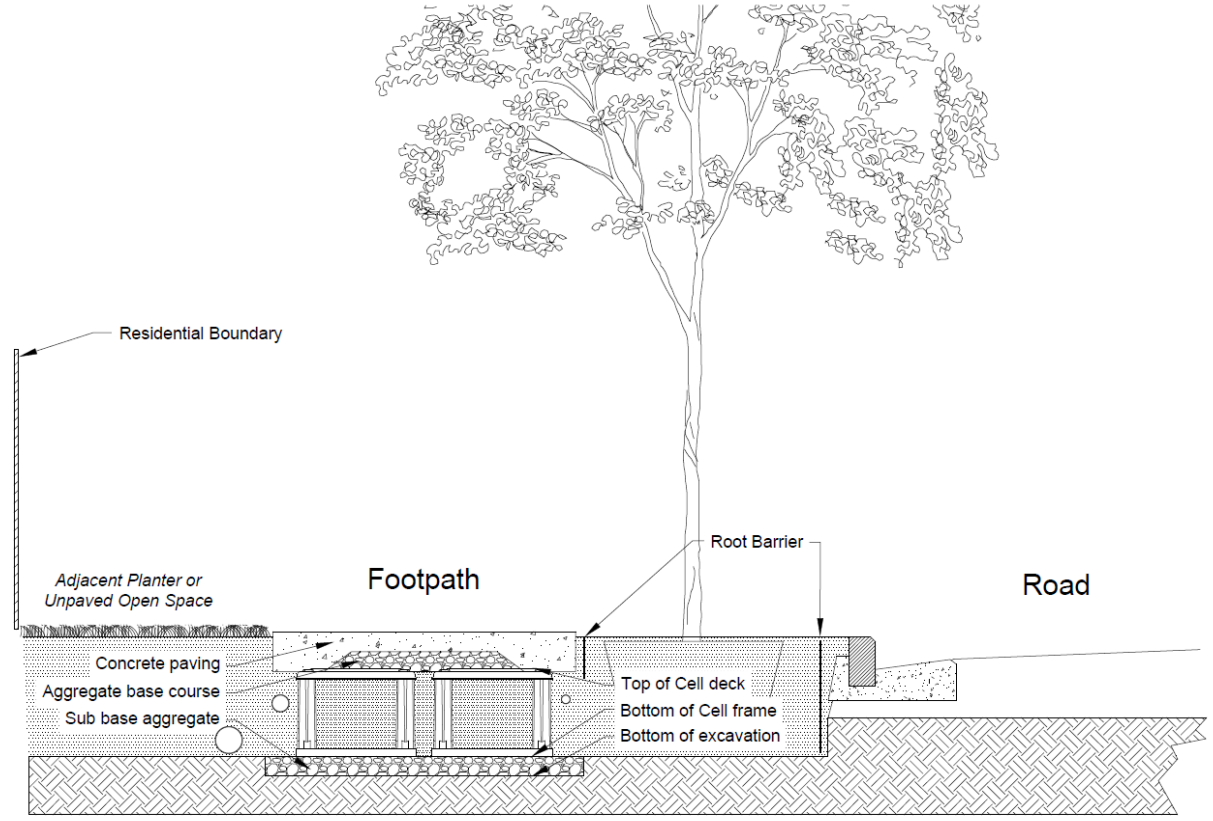
Flexible pavement options that allow movement of the pavement can also be considered e.g. http://www.tripstop.net/

Partially engineered check list

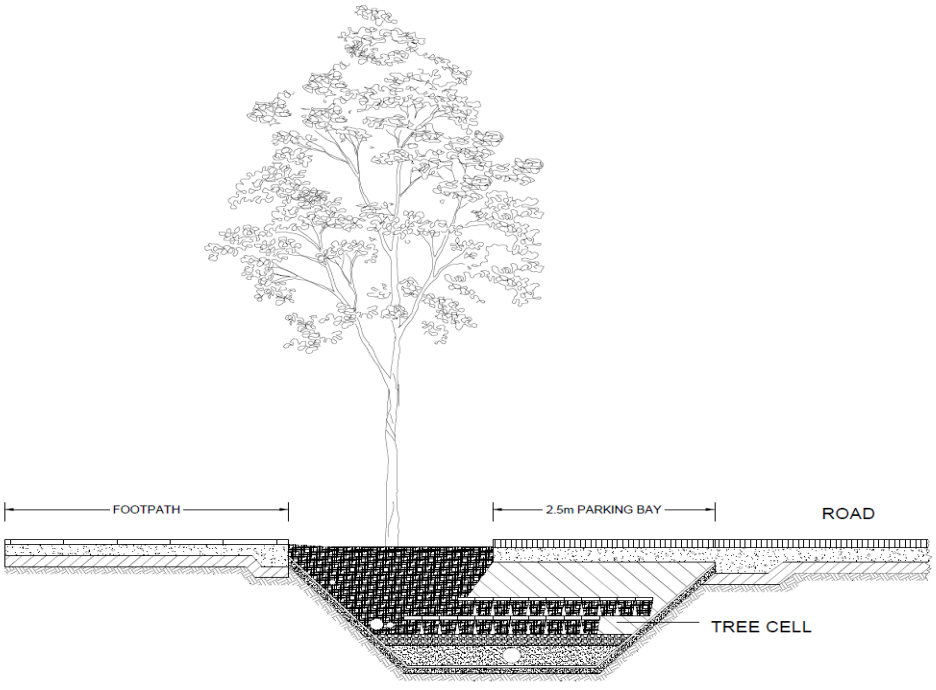
- Soil type ascertained
- Degree of soil amelioration required and proposed
- Root barriers and pavement construction methods proposed to integrate trees



Urban trees successfully growing within an engineered tree pit environment



Drawing 2 - Partially engineered example – Directing roots underneath pavements (Image created by Arborlab, amended from DeepRoot drawing)



Drawing 3 - Partially engineered example – Directing roots underneath parking bay (Image created by Arborlab, amended from MetroGreen drawing)

2.5.3 Planting in Areas of Soft Landscape Greater Than 3m Away From Kerbs, Pavements & Other Engineered Obstructions

In areas of soft landscape away from infrastructure the emphasis will require a suitable species to fit the location. A proposal of the planting specification and soil amelioration will need to be submitted to QLDC for approval.

Soft landscape check list

- Soil type ascertained
- Degree of soil amelioration required and proposed

2.6 PLANTING METHODOLOGY

A planting methodology shall be presented to QLDC for assessment which shall include such details as:

- Planting pit specification
- Soil type (existing and replacement soil)
- Irrigation specification details (if irrigation is to be installed prior to the formation of access driveways, this shall be installed at a depth of no less than 75cm to avoid damage)
- Tree support (normally 3 stakes supporting the new tree at a point no higher than 1/3rd of the trees height)
- Ground treatment around the base of the tree e.g. mulch, hard surfacing, grill

Only when QLDC is satisfied with the proposed planting methodology shall planting works proceed.

2.7 STREET TREE MAINTENANCE AND ASSOCIATED REQUIREMENTS

- Post-planting maintenance and management is important to ensure the establishment and sustainability of all new street tree planting. A full tree management programme with budgetary provision should be in place for all planting schemes. This management programme should be in place for a minimum period of three years (this maintenance period is usually stipulated as a condition of consent).
- The timing and frequency of any irrigation should take into account the prevailing weather conditions, soil moisture release characteristics, and the response of the tree species to water deficits. Regular monitoring must be undertaken to assess the effectiveness of any irrigation.
- *NOTE Nursery trees produced in ideal conditions can take time to adapt to localized planting conditions.*
- Any given volume of soil has the capacity to hold a given volume of water. The water holding capacity of the soil should be established and taken into account when assessing irrigation needs.
- In addition to water-holding capacity, the amount of water available to the tree should be established. Assessing all newly planted trees is impractical, but sample assessments should be made
- The frequency of irrigation is more important than the volume of water given at any one time. This should be accounted for in irrigation plans. Irrigation plans should also take into account the assessments made at the original site assessment and the subsequent species choice made.
- Formative pruning should be carried out as required throughout the early years of a tree's life in the landscape. Some of the nursery-prepared branching structure is temporary and formative pruning should continue until a permanent structurally sound scaffold system of branches typical of the species and appropriate to the site circumstances is produced.
- A formal assessment of young tree health and development should be carried out every six months. This assessment should include foliar appearance, leaf size and density, extension growth and incremental girth development. Continual assessment on an ad hoc basis should be carried out throughout the year.
- All stakes and ties should be checked at least every three months to ensure that the root system remains stable and firm in the ground, and that ties are still effective and not causing any damage to the tree. Any stakes and ties that are found to be not fit for purpose should be adjusted or replaced.
- All stakes and ties should be removed as soon as the developing root system is strong enough to support the tree.
- *NOTE Three full growing seasons are usually long enough for this to occur.*
- Where underground guying systems are used, the wires or straps should be cut as soon as the tree is self-supporting.
- The area around the base of the tree should be maintained in a weed-free condition. The use of herbicides should be avoided and wherever possible aged mulch should be used.

- All mulches should be replenished and hand-weeded as necessary and at least once annually. The mulched area should be enlarged, if practicable, as the tree develops.
- All grilles, grids, guards and other protective furniture should be checked at least annually. Such furniture should be removed as soon as it is no longer necessary to protect the tree, or where there is a risk of physical damage to the tree.
- The soil around newly planted trees should be regularly inspected for soil capping or compaction. Remedial action should be taken as necessary.
- *NOTE Inspections can be visual, but where conditions are extreme, on-site testing and amelioration might be necessary. This can include manually loosening the pit surface with hand tools or more extensive action using an air spade or equivalent. Mulching can prevent further compaction.*
- All trees should be checked on a regular basis for mammal, human and other external damage. Remedial action, where this is possible, should be implemented as soon as practicable following discovery.
- All trees should be checked on a regular basis for pests and diseases. Remedial action should be taken promptly on discovery, where necessary.
- Unless specific nutritional deficiencies are identified, no fertilizer should be applied to newly planted trees.

NOTE If visual inspection reveals symptoms of nutrient deficiency such as leaf scorching, pale foliage or necrotic spots, then further investigation will be necessary with remedial action taken. Remedial action may, in addition to fertilizer application, include pH testing, assessment of organic content and levels of compaction.

- Any tree that fails during the maintenance period shall be replaced with a new tree of the same species and specification.
- The details of all new street tree planting shall be recorded in such a way as this information may be transferred to Queenstown Lakes District Councils GIS software, the information required shall include:
  - Planting locations
  - Tree species planted and size
  - Photographs of the individual trees at the end of the three year maintenance period
  - All maintenance works undertaken during the three year maintenance period

2.8 WORLDWIDE CASE STUDIES

http://www.deeproot.com/silvapdfs/caseStudies/LidlCarPark.pdf

http://www.youtube.com/watch?v=8jcLtlbRuRs

http://www.youtube.com/watch?v=mLffDaa2Pak

http://www.youtube.com/watch?v=TlJDJXqwNyA

http://www.deeproot.com/silvapdfs/caseStudies/Charlotte%20Suspended%20Pavement.pdf

http://water.epa.gov/polwaste/green/upload/stormwater2streettrees.pdf

http://www.vtfpr.org/urban/documents/Main%20Streets%20to%20Green%20Streets.pdf

http://urbanforestry.frec.vt.edu/stormwater/Resources/TreesAndStructuralSoilsManual.pdf

http://vancouver.ca/files/cov/StreetTreeGuidelines.pdf

http://www.fao.org/uploads/media/Trees_for_parking_lots_and_paved_areas.pdf

2.9 ENGINEERED TREE PIT EXAMPLES

Soil cells
www.deeproot.com
www.metrogreen.co.nz

Vaults & rafts
http://www1.toronto.ca/city_of_toronto/parks_forestry__recreation/urban_forestry/files/pdf/TreePlantingSolutions_BestPracticesManual.pdf - Section 3.1

Structural Soils
http://www.hort.cornell.edu/uhi/outreach/pdfs/custructuralsoilwebpdf.pdf

2.10 INTERNET BASED INFORMATION

http://thefield.asla.org/2014/04/24/planting-trees-in-suspended-pavement/

http://thefield.asla.org/2014/05/06/rethinking-runoff-shrubs-stormwater/#more-2576

http://thefield.asla.org/2014/01/30/structural-soil-part-1/#more-2176

http://thefield.asla.org/2014/02/19/structural-soil-part-2/#more-2185

http://thefield.asla.org/2013/09/10/soak-it-up-design-competition/#more-1863

http://edmonstonmd.gov/files/Greening_DecaturSt_inclAddendum_v1.0.pdf

http://www.landscapeirrigation.com/ME2/Audiences/dirmod.asp?sid=&nm=&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=38FD064F957F4EFAA4BE57F5E7838420&AudID=AC361F5928F54864BFCBBD93E5B8624D