Diamond Head Consulting Ltd.
Preliminary Tree Assessment

For:

South False Creek Seawall – Creekside Drive and Island Park Walk
Vancouver, BC

September 18, 2015

Attention: Allan Moors
Landscape Designer
Active Transportation Branch
Engineering Services

Submitted by:

DIAMOND HEAD
CONSULTING LTD.

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The following Diamond Head Consulting staff performed the site visit and prepared the report. All general and professional liability insurance and individual accreditations have been provided below for reference.

Max Rathburn
Certified Arborist
Qualified Tree Risk Assessor

Trevor Cox, RPP, MCIP
Certified Arborist
Qualified Tree Risk Assessor

This report summarizes the planned management of trees on the site. If there are any questions or concerns as to the contents of this report, please contact us at any time.

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Insurance Information

WCB:	# 657906 AQ (003)
General Liability:	Northbridge General Insurance Corporation - Policy #CBC1935506, $5,000,000 (Mar 2014 to Mar 2016)
Errors & Omissions:	Lloyds Underwriters – Policy #1010346D, $1,000,000 (June 2011 to June 2016)

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1.0 Executive Summary

The City of Vancouver has requested a review of trees located in two areas in South False Creek. The majority of the trees at these locations are young to mature cherry trees that have been planted with a lack or nutrient and soil moisture holding capacity to support their current and future growth. Therefore the trees have a limited life span at the site and will require renovations surrounding each tree to refurbish their soil conditions. It is our opinion that they are not worth working around given that they would be unduly damaged during this process and they are already stressed. If cherries are to be replanted at the site – then there are many new cultivars that will not be prone to the bacterial blight and have rooting structures that will not be prone to lifting sidewalks or paths adjacent to them. The replacements, with appropriate soil volume, will provide the amenity to the City for a much longer time frame than what the original trees would be providing.

2.0 Introduction

Diamond Head Consulting Ltd. (DHC) was asked to complete an assessment of the trees on and adjacent to the following proposed development:

Civic address:	**South False Creek Seawall Vancouver**
Project No.:	unknown
Client name:	City of Vancouver
Date of Last site visit:	September 4 2015

Trees within the two subject areas have been assessed and inventoried including: species, diameter at breast height (dbh) measured to the nearest 1 cm at 1.4 m above tree base (multi stem trees may be measured below the main stem union, estimated height and general health and defects. Critical root zones were calculated for each of the trees with the potential for development impacts. Tree hazards were assessed according to International Society of Arboriculture and WCB standards. Suitability for tree retention was evaluated based on the health of the trees and their location in relation to the proposed Seawall works.

2.1 Limits of Assignment

- Our investigation is based solely on our visual inspections of the trees done on August 24th 2015.
- Our inspection was conducted from ground level. We did not conduct soil tests or below grade root examination to assess the condition of the root system of the trees.
- Only the trees specified in the scope of work were assessed and assessments were performed within the limitations specified.
- This report does not provide any estimates to implement the proposed recommendations provided in this report.

- This report is valid for six months from the date of submission. Additional site visits and report revisions are required after this point to ensure accuracy of the report for the District's development permit application process.
- We have been provided with a tree location Survey (PDF) by The City of Vancouver City Engineering Services for use in this study.

2.2 Purpose and Use of Report

- Provide documentation pertaining to the overall health and structural condition of the subject trees for use in the planning of the proposed Seawall improvements.

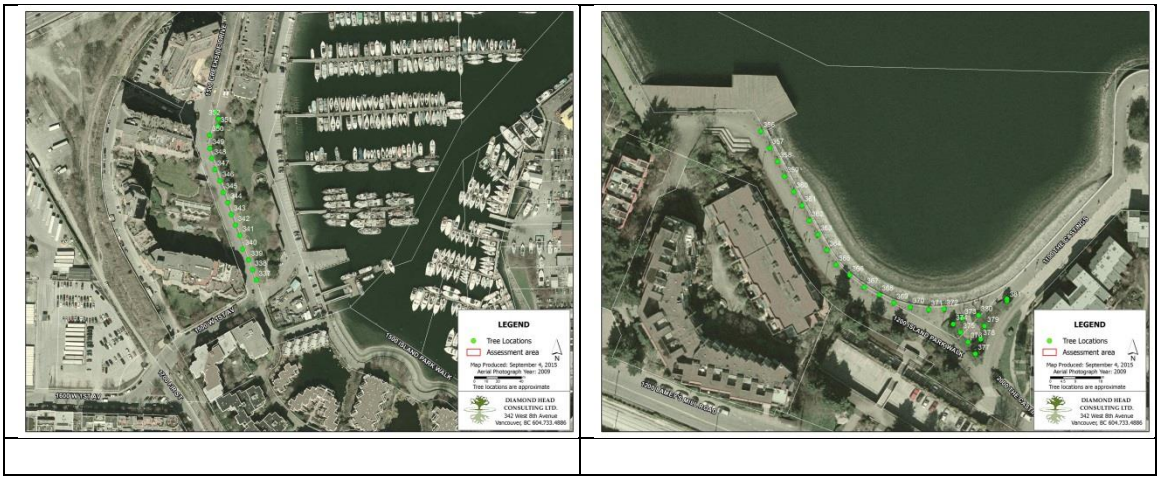


Figure 1. Location of the two study areas – Seawall pedestrian / bike path

3.0 Observations and Discussion

3.1 Tree assessment summary

Diamond Head Consulting Ltd was asked by The City of Vancouver to provide an arborist report discussing the current health and structural condition of the trees within two areas of the South False Creek Seawall. The two areas for this study include Creekside Drive (trees fronting the south side of the road) and trees along the Seawall at Island Park Walk (including a small Park).

The vast majority of the subjects trees located in both areas are Ukon Cherry (*Prunus serrulata 'Ukon')* The Ukon Cherry is a late flowering tree, with yellowish colored blossoms. In addition there are fewer more recently planted Snow Goose Cherry trees *(Prunus serrulata 'Snow goose')*, these trees were most likely planted as replacement trees for the Ukon Cherry trees that were removed (reasons unknown), as they are thought to be more disease resistant than many other cherry tree varieties.

Creekside Drive:
There are 17 trees growing along the south side of Creekside Drive that are included within the scope of this study. These trees appear to have minor infections of bacterial blight, and are in overall fair health and structural condition. The trees are growing adjacent to the curb and the root zones are covered by hardscape. The majority of these trees could be transplanted if there are found to be in conflict with the proposed plans.

Island Park Walk:
The trees included within the scope of this study are, 17 trees growing in this section of the Seawall path and 9 trees that are growing within a small park adjacent the Seawall. The trees along the Seawall appear to have severe infections of bacterial blight and bacterial canker, as well as infestations of Cherry Bark Tortrix are present. These trees are in overall very poor health and structural condition. In addition the trees are located in a harsh growing environment along the seaside with hardscape covering the root zones.

The trees growing in the small adjacent park are in fair overall health condition and the tree's root zones are recommended to be accommodated in any future planning if these trees are to be retained.

3.2 Long Term Planning Considerations

Diamond Head Consulting Ltd (DHC) was asked to provide input on a long term strategy for the trees in question along the South False Creek Seawall. In order to help address some of the longer term strategies for these trees, there needs to be a framework to help guide this discussion. The Urban Forest Management Plan for the City of Vancouver is not a public document at this time but likely contains content that would help guide this process. It likely provides a vision for the City's Urban Forest and provides a number of objectives or goals to help fulfill the vision. In an online presentation called the 'Draft Urban Forestry Strategy'[1] there are a number of principles that are listed under three main objectives that are to help stop a declining tree canopy cover across the city. These are listed as:

1. Protect – by ensuring that the existing canopy is protected
2. Plant – by installing the right tree in the right place
3. Manage – by ensuring resiliency to disease and climate change

With the main goal being to protect and enhance the urban forest on private and public land, the city should be trying to maximizing its plantings to achieve canopy gain on city streetscapes and parks (public spaces) without compromising other values. The intent being to look for opportunities to plant the largest tree whenever possible (with the soil to support it). Obviously budgets play a role in a long term planting strategy and the lowest possible cost in achieving this canopy should help lead in the general direction to the maximum value. However, as the City continues to densify and the competing values for space both above and below ground intensify, eventually there will be a need to look at retrofitting streetscapes to provide better growing mediums for trees. This work is costly and entails much more planning and cost, but it coincides with other long term planning for storm water management goals including

[1] http://vancouver.ca/files/cov/Urban-Forest-Strategy-Draft.pdf

permeability standards for urban landscapes. A major consideration in the update to the South Creek Seawall project, and its decision as to whether the cherry and pine trees along the seawall should be retained, relocated, removed or enhanced should be the longevity and size of canopy of each tree. The cherry trees at the site are considered a small tree that are not in the best health (limited longevity) and do not provide the same environmental benefits when comparing them to larger trees.

Soil Volume

There are many environmental variables which contribute to the early mortality of urban trees and the problems of soil compaction, poor drainage and aeration, high soil pH, road salt and limited rooting space are common to numerous sites and can have severe consequences on tree growth. It is suspected that many of these issues would be contributing to the decline of the trees at the site. There are tree species considerations that can help reduce the problems listed above. However, there is one problem that we cannot select for and that is the lack of rooting space. It is suspected that there is very limited soil volume available to the trees along the seawall and would have a maximum of about $6m^3$ of soil placed (3m long x 2m wide x 1m deep) with each tree given the date at which they were planted. The area between trees being filled with either subsoils from landscape works done in the area or gravels to meet the compaction requirements for the seawall. The following table provides the soil volume required to support a mature tree based off of its diameter:

TREE SOIL VOLUME REQUIREMENT STANDARDS

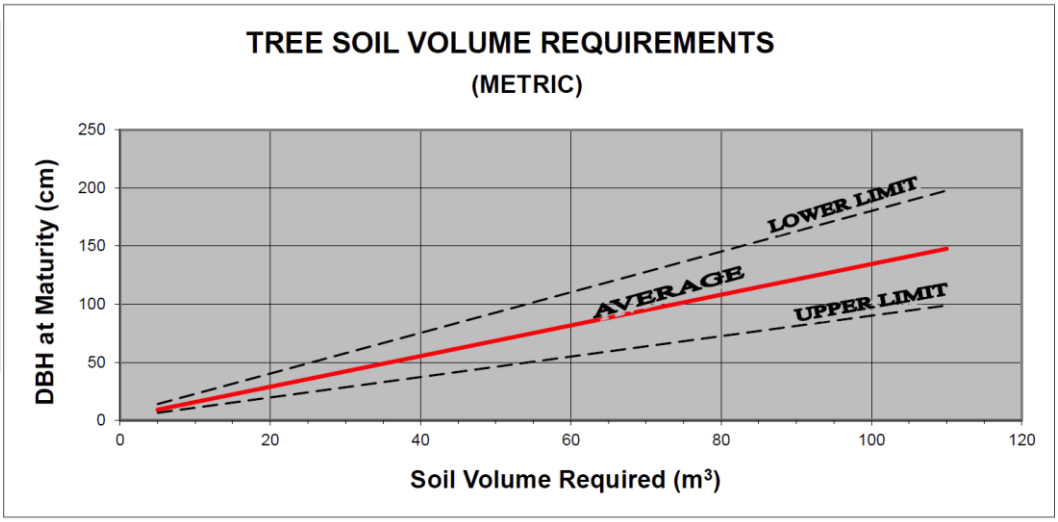


Figure 1. Recommended Tree Soil Volume Requirements by Size of Tree.[2]
Upper Limit Area (the area between the average line and the upper limit line): Values in this area should be used in the case of poor soil conditions such as compacted and/or graded soils (ie. street medians and roadside plantings). The soil volume selected should reflect the severity of compaction and grading at the planting site.

2 Information is based on data collected and published in the Journal of Arboriculture 18(2): March 1992.

Lower Limit Area (the area between the average line and the lower limit line): Values in this area may only be used in ideal soil conditions (ie. native, undisturbed soils). The soil volume selected should reflect the amount of construction activity at the planting site.

Considering that the majority of the cherry trees at maturity would be about 60cm in diameter, a suitable soil volume for these trees would be about 45m3 (10m long x 3m wide x 1.5m deep). This is significantly higher than what is found at the site and would help **explain why so many of the trees are in decline**. To ensure the trees remain healthy and provide the benefits that they were intended to provide at the site, the city would need to consider renovating the existing site to ensure that the trees had sufficient soil volume. This would entail creating soil pits adjacent to the trees.

There has been a lot of recent research that has been correlating the early death of trees in urban landscapes to the lack of soil volume. In addition, the soil resource provides the reservoir of soil moisture and nutrients for the trees during times of drought and lack of litter inputs. This is a very important factor when trying to ensure your asset will be able to survive the effects of climate change and resiliency to disease. This is another major consideration for determining whether to relocate, remove and replant trees or look at re-furbish the existing soils.

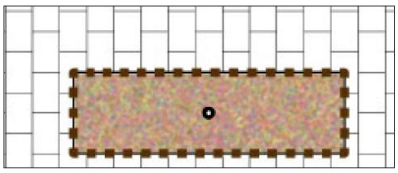
When considering the possibility of re-furbishing the tree pits with new soil, the amount of work to uncover the root balls of the existing trees, and install new soil adjacent to it would end up damaging much of the rooting structure on these already stressed trees. It would require a qualified person to either expose the roots or have an arborist supervising the work to ensure the trees were not unduly harmed. When considering the cost associated with trying to work around these trees (poor health) and the ability to choose a cultivar of cherry that is more resistant to disease and that would have a longer life span at the site, it is recommended that the City look at replacing all the trees rather than work around them.

Design Methods: How to Achieve Soil Volume

The following illustrations from Casey Trees (Tree Space Design Report, 2008) provide suitable options for consideration in renovating the soil adjacent to the trees so that the appropriate amount of soil is provided for each tree.

Open Soil Area

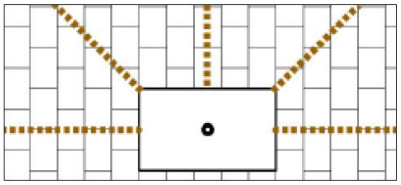
An unpaved area of soil surrounding a tree, which contains existing, new or amended soil. An open soil area may be planted or covered with mulch. Open soil areas reduce impervious surface and stormwater runoff.



Open soil areas can be continuous or separated by pavement. Open soil areas can be planted with groundcover, ornamental plants or grass or covered with mulch as shown in the images above.

Root Paths

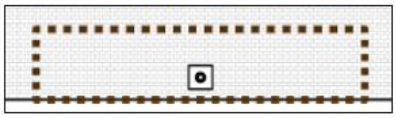
Constructed paths that use aeration or drainage strips to give roots a way to grow out of the tree space and under pavement in order to access better planting soils. Root paths can connect tree spaces and adjacent green spaces.



Root paths under construction, shown in ground trench (above left) and extending out from a tree space (middle, photos courtesy of James Urban). Root paths run under the pavement to connect tree spaces to landscape areas (above right).

Covered Soil Area

An area of soil that is under pavement and specially designed to accomodate tree root growth. Design methods include structural soil, sidewalk support and soil cells.

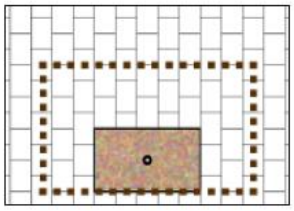


A variety of **pavements**, both solid and permeable, can be used to create a covered tree space. Pavers, such as granite cobbles and permeable paver blocks (shown above left and middle), placed with gaps between the stones allow water to flow to the soil below. Grates can be used as a soil covering when they are not immediately adjacent to the tree.

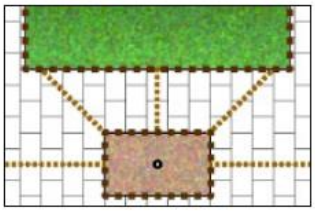
Combinations of Design Methods

Design methods can be combined in several ways to achieve greater soil volumes. Open soil areas can be used in combination with covered soil areas, and root paths can connect soil areas to green spaces. Creatively combining design methods is a way to work around utilities and other streetscape elements.

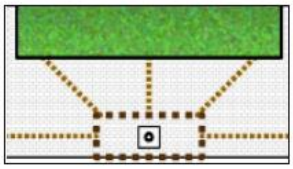
Open & Covered Soil Area



Open Soil Area Connected to Green Space



Covered Soil Area Connected to Green Space



Siting Considerations:

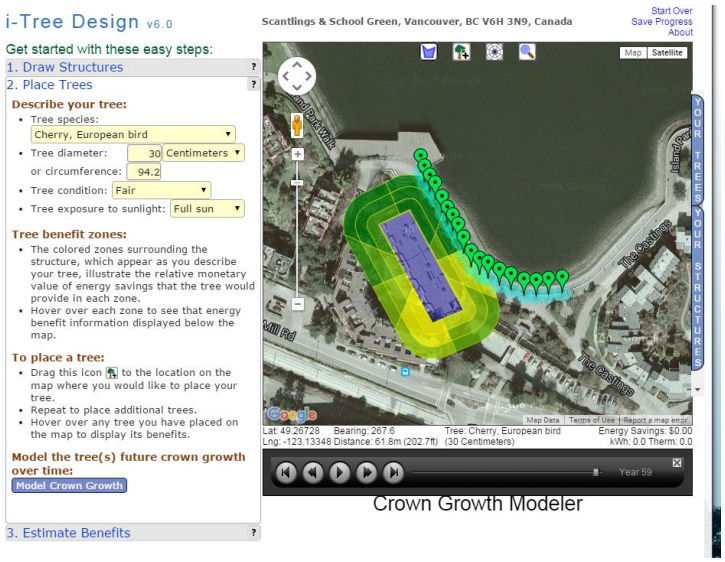
Beyond the species of tree that is to be considered for the site there are a number of other considerations that should be made in relation to the site.

1. Those trees that are within the **riparian** strip of the ocean. Riparian buffers are important for good water quality and the vegetation adjacent to it is a major source of energy and nutrients for the life within them. Consideration should be given to maximizing the tree canopy where it is within 30 meters of the ocean.

2. There are likely areas where the trees located along the walkways may be blocking **views.** Identification of those corridors and consideration to their importance is warranted if changes to the species composition and planting scheme are made.
3. The placement of trees can have significant impact on the **heating and cooling** on adjacent buildings (The examples below illustrate this).
4. The evenly spaced row of flowering cherry trees provides a different **experience** than having a number of larger widely spaced and larger canopy trees.

Tree Species Considerations:

A common characteristic of cherry trees is that they prefer to have their structural roots above the existing grade. This causes problems with trying to have walkways or sidewalks immediately adjacent to them as the roots will cause pavers and asphalt to lift and the roots by the tree will be above the ground causing potential trip issues. This issue becomes a longer term maintenance issue but also warrants consideration at the planning stages in relation to the traffic and proposed surface adjacent to the trees.



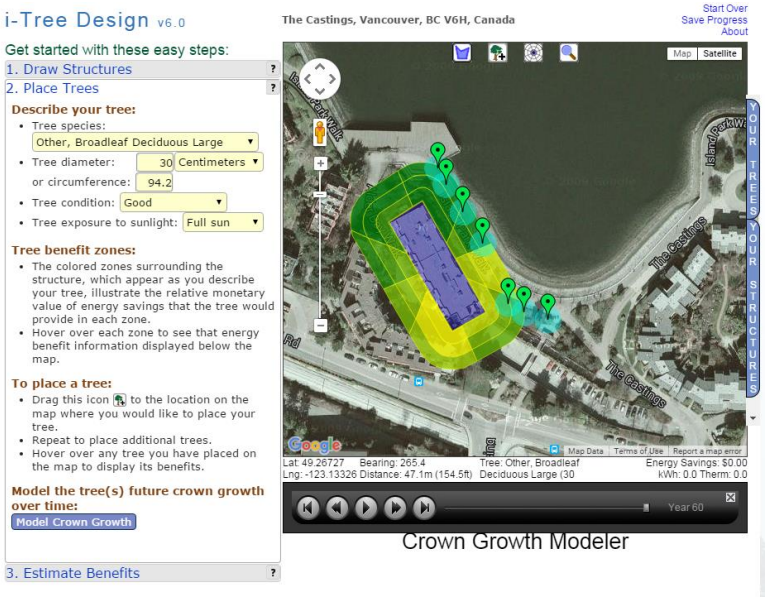
Crown Growth Modeler

A broader diversity of trees is needed in our urban landscapes to guard against the possibility of large-scale devastation by both native and introduced insect and disease pests. Urban foresters and municipal arborists should use the following guidelines for tree diversity within their areas of jurisdiction: (1) plant no more than 10% of any species, (2) no more than 20 % of any genus, and (3) no more than 30 % of any family. **The current tree species composition of the City Vancouver's street and park inventory has the *Prunus* genus at 28% of the inventory.** This is well beyond the recommended 20%. When considering the possibility of replacing old or dying tree stock at these two sites in South False Creek, the importance of diversifying the tree species composition City wide should play a significant role in the decision about what should be done.

The following illustrations from I-Tree Design show two examples of trees located along the Island Park Walk. The first (to the right) shows the walkway planted with European bird cherry at 30cm in diameter (other cherry tree cultivars are not available). There are 21 trees located in the positions they are currently in. The shading around the building shows the areas that are appropriate to plant trees to have cooling (green) and thermal input (yellow) on the building. The apartment building is highlighted to show the cooling and heating benefits of trees. In this current situation the trees are in fair to poor health and lack the adequate soil volume to support them for not more than 20 years into the future. The appropriate soil volume for these trees would be $45m^3$ for 21 trees – which would be $945m^3$ if they were to be installed with appropriate soil at the time of planting. For ease of comparison we have input that the trees will

remain at a fair condition for the next 30 years so that we can see the environmental benefits they provide in relation to another large broadleaf tree.

In the example to the right from I-Tree Design, seven large broadleaf trees at 30cm in diameter have been placed in the appropriate places to facilitate shading and cooling for the nearby building and provide cover adjacent to the riparian area. These trees would eventually reach about 90cm in diameter at maturity and therefore would require about 70m^3 of soil for each tree. This equates to a total of 490m^3 of soil for the seven trees.



Crown Growth Modeler

The following table provides a comparison of some of the environmental benefits of the two examples illustrated above in the I-Tree Design.

I-Tree Design Comparison of Cherry Trees Vs Large Broadleaf Trees over 30 years					
	Stormwater	Energy Reduction	Air Quality	Carbon Dioxide Removed	Overall Benefits Over 30 years
21 Cherry trees	27,377 litres of stormwater/Year 821,308 litres over 30 years	9,183 Kilowatt-hours -235.3 therms of heating fuel (requires heating due to shading)	~$700 of ozone, ~$10 of NO2 Removed ~$120 Particulate matter removed	1,704 Kilograms	$3,723
7 Large broadleaf trees	76,004 litres of stormwater/Year 2,280,131 litres over 30 years	6,054.9 Kilowatt-hours 146.4 therms of heating fuel reduction	~$570 of ozone, ~$10 of NO2 Removed ~$140 Particulate matter removed	1,432 Kilograms	$18,388

With the information provided above a case has been illustrated where the City would be better off in considering a different planting scheme at the site that provided sufficient soil volume for a large, tree. Doing so will allow the City to meet a number of the standard best practices found in urban forest management:

1. Maximize gains in tree canopy cover given the available soil volume
2. Increase tree species diversity and resilience to disease, pests and climate change
3. Reduce the long term costs associated with tree management (right tree, right place)

There is a sizable difference in the measured environment benefits with the two examples above and that the cost to renovate the existing soil conditions would be cheaper with a change

to different tree species that have a large canopy that will be performing well in the next 70-100 years as opposed to the Cherry trees remaining in place that are in serious decline. An investment in renovating the soil beside a number of the declining cherry trees would not be able to realize the long term benefits in relation to replacing these trees with a larger tree because their lifespan is expected to be only another 20 years, given their health right now.

Tree Replacement

There are a number of cherry trees that have been planted relatively recently given their size. These trees are easily removed and can be transferred to a staging area or another planting site. The cost to move these trees and stage them would depend on the ultimate size of the tree and whether they were being replanted right away or being staged at a nursery or city property until they were planted.

The following table illustrates the approximate costs for this work and shows that in most cases if you are not re-planting the tree right away it does not make economic sense to store the tree. Alternately, the City could end up providing these trees to the Tree Keeper program rather than spend the money to remove them.

	Cost
Remove tree by hand <10cm dbh for transplant	~$350
Cost of storage (mulch and no watering)	~100
Cost to replant	~$200
Cost of a new 7cm caliper tree and install	~$500
Remove the tree by cutting it down (root ball left in place for civil works).	~$50

The compounding issue with transplanting a tree is that it does not guarantee survival. However, given the size of the trees and if this work was done in the fall then there would be a good chance at survival (~90%).

The discussion provided helps identify a number of considerations for the removal, replacement or enhancement of the existing trees at the site. Other considerations not discussed like the aesthetics of any proposed combination of plantings, the history associated with the existing landscape and the surrounding infrastructure and recreation needs will need to be factored in to determine the right combination of retention, removal and replacement.

3.4 Tree Inventory

The following is an inventory of assessed trees, each of which was marked with a numbered tag. Tree species, characteristics, comments, recommendations and required root protection zones have been suggested (Table 1). Their locations are illustrated on the accompanying map.

Overall Health and Structure Rating

Excellent = Tree of possible specimen quality, unique species or size with no discernible defects. Or a heritage tree.
Normal = These trees are in fair to good condition, considering its growing environment and species.
Poor = These trees have low vigour, with noted health and/or structural defects. This tree is starting to decline from its typical species growth habits.
Very poor = These trees are in serious decline from its typical growth habits, with multiple very definable health and/or structural defects.
Dead/Dying = These trees were found to be dead, and/or have severe defects and are in severe decline.
High Risk = These trees have been deemed hazardous by a Certified Tree Risk Assessor utilizing CTRA methods. They have a probability of failure of 3 or higher with a total overall risk rating of 8 (Moderate 3) or above.

2.3 Photographs

Photo 1 and 2. Showing the subject trees along Creekside Drive.

Photo 3. Showing the subject trees along the Seawall at Island Park Walk.

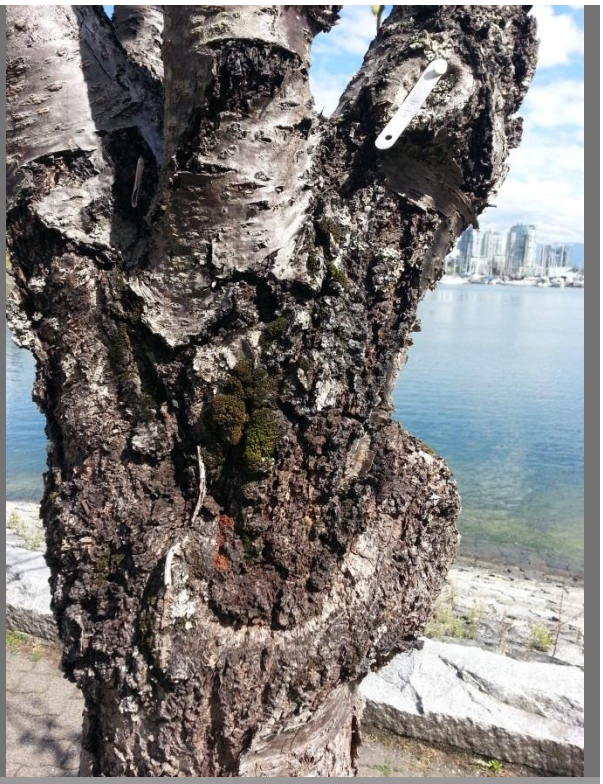


Photo 4. These trees are infected with bacterial canker.

Tree Inventory Table

Table 1. Tree Inventory Creekside Drive.

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
337	Ukon Cherry	*Prunus serrulata 'Ukon'*	26	5	Normal	Unsuitable	This tree is manifesting minor symptoms of bacterial blight, and there is evidence of minor Chery Bark Tortrix infestations.		1.6
338	Ukon Cherry	*Prunus serrulata 'Ukon'*	26	5	Normal	Unsuitable	This tree is manifesting minor symptoms of bacterial blight, and there is evidence of minor Chery Bark Tortrix infestations.		1.6
339	Ukon Cherry	*Prunus serrulata 'Ukon'*	12	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight. Slight lean to north.	Transplanting would need to accommodate trees lean when replanted.	0.7
340	Snow goose Cherry	*Prunus serrulata 'Snow goose'*	8	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		0.5
341	Ukon Cherry	*Prunus serrulata 'Ukon'*	11	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		0.7

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
342	Ukon Cherry	*Prunus serrulata 'Ukon'*	14	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		0.8
343	Ukon Cherry	*Prunus serrulata 'Ukon'*	18	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		1.1
344	Ukon Cherry	*Prunus serrulata 'Ukon'*	21	5	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		1.3
345	Ukon Cherry	*Prunus serrulata 'Ukon'*	14	3	Poor	Unsuitable	This tree is manifesting minor symptoms of bacterial blight. Previously broken stems.	The tree's crown has been permanently damaged.	0.8
346	Ukon Cherry	*Prunus serrulata 'Ukon'*	15	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		0.9
347	Ukon Cherry	*Prunus serrulata 'Ukon'*	23	5	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		1.4
348	Ukon Cherry	*Prunus serrulata 'Ukon'*	18	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		1.1
349	Ukon Cherry	*Prunus serrulata 'Ukon'*	15	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		0.9

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
350	Ukon Cherry	*Prunus serrulata 'Ukon'*	18	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		1.1
351	Ukon Cherry	*Prunus serrulata 'Ukon'*	13	4	Normal	Suitable	This tree is manifesting minor symptoms of bacterial blight.		0.8
352	Ukon Cherry	*Prunus serrulata 'Ukon'*	31	5	Normal	Unsuitable	This tree is manifesting minor symptoms of bacterial blight. Asphalt at base	This tree is too large to transplant.	1.9
353	Snow goose Cherry	*Prunus serrulata 'Snow goose'*	17	3	Normal	Suitable	Full Crown, with healthy foliage.		1

Table 2. Tree Inventory Island Park Walk

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
356	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6
357	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6
358	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
359	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4
360	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4
361	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
362	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4
363	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6
364	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
365	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4
366	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4
367	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
368	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.4
369	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6
370	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
371	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6
372	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Very Poor	Unsuitable	These trees are manifesting symptoms of bacterial blight and bacterial canker. There is evidence of Cherry Bark Tortrix infestation. This tree is in health decline and over 35% of the crown is dead.	Replacement of this tree with a healthy specimen would be appropriate.	1.6
373	Ukon Cherry	*Prunus serrulata 'Ukon'*	35	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	2.1
374	Lodgepole pine	*Pinus contorta*	20	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	1.4

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
375	Ukon Cherry	*Prunus serrulata 'Ukon'*	24	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	1.5
376	Ukon Cherry	*Prunus serrulata 'Ukon'*	25	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	1.6
377	Lodgepole pine	*Pinus contorta*	35	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	2.1
378	Ukon Cherry	*Prunus serrulata 'Ukon'*	20	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	1.4
379	Ukon Cherry	*Prunus serrulata 'Ukon'*	35	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	2.1
380	Ukon Cherry	*Prunus serrulata 'Ukon'*	28	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	2

Tag #	Common Name	Botanical Name	DBH (cm)	Height	Overall Condition	Transplant Suitability	Comments	Tree Retention Comments	Root Protection Zone (m)
381	Lodgepole pine	*Pinus contorta*	40	5	Normal	Unsuitable	Located in small park in a more suitable growing environment than the Seawall trees.	Impacts to be determined after plans are reviewed.	2.4

Discussion

We have provided general comments regarding the health and structural condition of the subject trees. Once we are provided with plans for the Seawall upgrades we can comment of the retention viably of the trees based on the proposed construction impacts. In addition we can provide detailed tree retention recommendations that include Tree Protection Setbacks and low impact methods of construction if required.

4.0 Construction Guidelines

The following are recommendations for risk mitigation and proper tree protection during the construction phase of the project.

Tree Retention Zones

Ten times the diameter or greater was used to determine the optimal tree protection zone (TPZ) depending on the species of tree and specific site conditions. The TPZ is the area around the tree in which no grading or construction activity may occur without project arborist approval, and is required for the tree to retain good health and vigor.

The following are tree preservation guidelines and standards for the TPZs:

- No soil disturbance or stripping;
- The natural grade shall be maintained within the protection zone;
- No storage, dumping of materials, parking, underground utilities or fires;
- Any plan affecting trees should be reviewed by a consultant including demolition, erosion control, improvement, utility, drainage, grading, landscape, and irrigation;
- Special foundations, footings and paving designs are required if within the tree protection zone;
- Utilities should be routed around the TPZ;
- Excavation within the tree protection zone should be supervised by a consulting arborist;
- Surface drainage should not be altered so as to direct water into or out of the TPZ; and
- Site drainage improvements should be designed to maintain the natural water table levels within the TPZ.

Respecting these guidelines will prevent changes to the soil and rooting conditions, wounding of the trees and contamination due to spills and waste. Any plans for work or activities within the RPZ that are contrary to these guidelines should be discussed with the project arborist so that mitigation measures can be implemented.

Tree Protection Fences

Prior to any construction activity on site, tree protection fences must be constructed at the specified distance from the tree trunks. The protection barrier or temporary fencing must be at least 1.2 m in height and constructed of 2 by 4 lumber with orange plastic mesh screening. This must be constructed prior to tree removal, excavation or construction and remain intact throughout the entire period of construction. Further standards for fencing construction can be found at:

http://vancouver.ca/your-government/protection-of-trees-bylaw.aspx

Unsurveyed Trees

Trees that are identified by DHC on the Tree Retention Plan, and within this report as unsurveyed trees have been hand plotted for approximate location only. Their location and ownership cannot be confirmed without being surveyed. The property owner or project developer must ensure that all relevant on and off site trees are surveyed by a legally registered surveyor, whether they are identified by DHC or not.

Regulation of Soil Moisture and Drainage

The excavation and construction activities adjacent to the RPZs can influence the moisture availability to the subject trees. This is due to a reduction in the total rooting mass, changes in drainage conditions and changes in exposure including reflected heat from adjacent hard surfaces. To mitigate these concerns the following guidelines should be followed:

- Soil moisture conditions within the tree protection zones should be monitored during hot and dry weather. When soil moisture conditions are dry, supplemental irrigation should be provided. Irrigation should wet the soil to the depth of the root system (approximately 30 cm deep).
- Any planned changes to the surface grades within the RPZ, including the placement of mulch, should be designed so that the water will flow away from the tree trunks.
- Excavation adjacent to trees can alter the soils hydrological processes by draining the water faster than it had naturally. It is recommended that when excavating within 6 m of any tree, the site be irrigated more frequently to account for this.

Tree Pruning

All heavy machinery (excavators, cranes, dump trucks, etc.) working within five meters of tree crowns should be made aware of their proximity to the tree. If there is to be a sustained period of machinery working within five meters of the tree crowns, a line with colored flags should be suspended at the height of the crowns along the length of the protected tree area. If there are concerns regarding the clearance required for machinery and workers within the tree protection zone, or just outside of it, the project arborist should be consulted so that a pruning prescription

can be developed or a zone surrounding the crowns can be established. Any wounds incurred to the subject trees during construction should be reported to the project arborist immediately.

Fertilization

Fertilization and root zone enhancements may be recommended by the project arborist in any phase of the project if they deem it necessary to provide the best chance of tree survival.

Paving Within and Adjacent to Tree Protection Zones

If the development plans propose the construction of paved areas and/or retaining walls close to the proposed tree protection zones measures should be taken to minimize impacts. Construction of these features would raise concerns regarding proper aeration, drainage, irrigation and opportunities for adequate root growth. The following design and construction guidelines are recommended be followed to minimize the long-term impacts to trees if any paving or retaining walls are necessary:

- Any excavation activities near the TPZ (tree protection zone) should be monitored by a Certified Arborist. Excavation should remove and disturb as little of the rooting zone as possible and all roots greater than 2 cm in diameter should be hand pruned.
- The natural grade of the rooting zone should be maintained. Any retaining walls should be designed at heights that will maintain the existing grade to within 20 cm of its current level. If the grade is altered, it should be raised not reduced in height.
- The long-term health of the tree is directly dependent on the volume of available, below ground growing space. If the RPZ must be compromised, the planned distance of structures from the trunks of the subject trees should not be closer than 50% of the RPZ on more than two sides of the tree.
- Compaction of sub grade materials can cause the trees to develop shallow rooting systems. This can contribute to long-term damage to pavement surfaces as the roots grow. Minimizing the compaction of sub grade materials using structural soils and increasing the strength of the pavement reduces the reliance on sub grade for strength.
- If it is not possible to minimize the compaction of sub grade materials, subsurface barriers should be considered to help direct roots downward into the soil and prevent them from growing directly under the paved surfaces.

Plantings Within the TPZs

If there are plans to landscape the ground within the TPZ, measures should be taken to minimize impacts. It is not recommended that the existing grass layer be stripped, as this will damage the surface roots. The grass layer should be covered with mulch at the start of the project, which will gradually kill the grass while moderating soil moisture and temperatures. Topsoil should be mixed with the mulch prior to planting of shrubs; however the depth of this new topsoil layer should not exceed 20 cm. Planting should take place within the newly placed topsoil mixture and should not disturb the original rooting zone of the trees. Two meters around the base of each tree should be left unplanted and covered in mulch.

Monitoring During Construction

Ongoing monitoring should be provided for the duration of the project. Site visits should be more frequent during activities that are higher risk, including the first stages of construction when excavation occurs adjacent to the trees. Site visits will ensure contractors are respecting the recommended tree protection measures and will allow the arborist to identify any new concerns that may arise.

During each site visit the following measures will be assessed and reported on:

- The integrity of the Tree Protection Zone and fencing;
- Changes to TPZ limits including: overall maintenance, parking on roots, and storing or dumping of materials within TPZ. If failure to maintain and respect TPZ is observed, suggestions will be made to ensure tree protection measures are upheld;
- Review and confirmation of recommended tree maintenance including root pruning, irrigation, mulching and branch pruning;
- Health and condition of each tree;
- Damage to trees that may have resulted from construction activities will be noted, as will the health of branches, trunks and roots of protected trees. Recommendations for remediation will follow;
- Changes to soil moisture levels and drainage patterns; and
- Factors that may be detrimentally impact the trees.

All findings and recommendations will be documented in a summary report. All concerns will be highlighted along with recommended mitigation measures.

5.0 Limitations

1. Except as expressly set out in this report and in these Assumptions and Limiting Conditions, Diamond Head Consulting Ltd. ("**Diamond Head**") makes no guarantee, representation or warranty (express or implied) with regard to: this report; the findings, conclusions and recommendations contained herein; or the work referred to herein.

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3. The findings, conclusions and recommendations made in this report reflect Diamond Head's best professional judgment in light of the information available at the time of preparation. This report has been prepared in a manner consistent with the level of care and skill normally exercised by arborists currently practicing under similar conditions in a similar geographic area and for specific application to the trees subject to this report as at the date of this report. Except as expressly stated in this report, the findings, conclusions and recommendations set out in this report are valid for the day on which the assessment leading to such findings, conclusions and recommendations was conducted. If generally accepted assessment techniques or prevailing professional standards and best practices change at a future date, modifications to the findings, conclusions, and recommendations in this report may be necessary. Diamond Head expressly excludes any duty to provide any such modification if generally accepted assessment techniques and prevailing professional standards and best practices change.

4. Conditions affecting the trees subject to this report (the "**Conditions**", including without limitation structural defects, scars, decay, fungal fruiting bodies, evidence of insect attack, discoloured foliage, condition of root structures, the degree and direction of lean, the general condition of the tree(s) and the surrounding site, and the proximity of property and people) other than those expressly addressed in this report may exist. Unless otherwise stated: information contained in this report covers only those Conditions and trees at the time of inspection; and the inspection is limited to visual examination of such Conditions and trees without dissection, excavation, probing or coring. While every effort has been made to ensure that the trees recommended for retention are both healthy and safe, no guarantees, representations or warranties are made (express or implied) that those trees will remain standing or will not fail. The Client acknowledges that it is both professionally and practically impossible to predict with absolute certainty the behaviour of any single tree, or groups of trees, in all given circumstances. Inevitably, a standing tree will always pose some risk. Most trees have the potential for failure and this risk can only be eliminated if the risk is removed. If Conditions change or if additional information becomes available at a future date, modifications to the findings, conclusions, and recommendations in this report may be necessary. Diamond Head expressly excludes any duty to provide any such modification of Conditions change or additional information becomes available.

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6. Diamond Head shall not be required to give testimony or to attend court by reason of this report unless subsequent contractual arrangements are made, including payment of an additional fee for such services as described in the fee schedule and contract of engagement.

7. In preparing this report, Diamond Head has relied in good faith on information provided by certain persons, Government Bodies, government registries and agents and representatives of each of the foregoing, and Diamond Head assumes that such information is true, correct and accurate in all material respects. Diamond Head accepts no responsibility for any deficiency, misinterpretations or fraudulent acts of or information provided by such persons, bodies, registries, agents and representatives.

8. Sketches, diagrams, graphs, and photographs in this report, being intended as visual aids, are not necessarily to scale and should not be construed as engineering or architectural reports or surveys.

9. Loss or alteration of any part of this report invalidates the entire report.

6.0 Appendix 1 – Tree Transplanting Specifications

Transplantation Methods:

- There are two methods of digging trees for transplantation;
  1) Tree Spade, this is a mechanical shovel like tool that consists of a number of large metal blades that encircle the tree, digging into the ground and then lifting the entire tree, including its roots and soil, out of the ground. The advantage to method is it is often cheaper and faster than using hand methods. The disadvantage is a smaller root ball is dug and larger roots can be damaged. This method is mostly used for trees less than 30cm in diameter.
  2) Hand dig ball and burlap: this method consists of digging the out the trees root ball by using hand methods such as shovels and picks, then wrapping the trees root ball with burlap and drum laced using standard nursery lacing techniques and materials as per current BCSLA/BCLNA standards to hold the root ball together for transport. Transportation of the tree is undertaken by craning the tree on to the deck of a flatbed truck/trailer, and planted into the new site via crane.

Recommend method:

- Given the large size of the subject trees and the shape of its crown, I would recommend using the Hand dig ball and burlap method, as the success rate of this method is higher for lager sized trees. Note Tree Spade method may be used if the spade is large enough although the success rate of trees surviving may be lower than the hand dug method.
- The recommended root ball size for these trees is 1.2 – 2.5m diameter. Note the actual root ball size may vary depending on soil conditions, and possible underground

obstructions. The experience of a qualified tree moving contractor will be relied upon to make sure the proper root ball is formed.

Timing of Transplants:

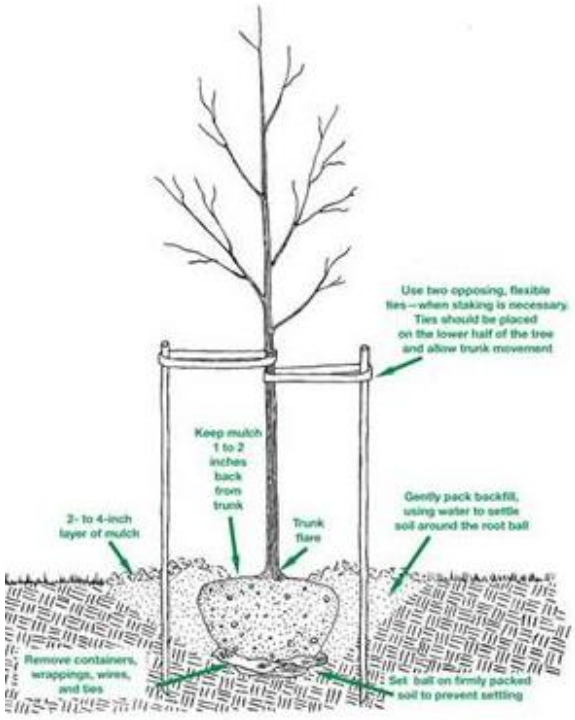
- The digging and moving of the subject trees is limited to be undertaken in the months of September to April. No tree transplanting is desirable in the months of July through August.
- The cutting of the root balls is to be undertaken no more than 2 days prior to moving the trees, and the root ball will be protected from desiccation by watering and shading with burlap or similar materials.

TABLE 1. **ROOT BALL SIZE GUIDELINES**

Calliper of Tree (measured in cm at a height of 20 cm)	Approximate Diameter of Root Ball (measured in m)
Up to 10 cm	1.2 m
10 to 12.5 cm	1.5 m
12.5 to 15 cm	1.8 m
15 to 17.5cm	2.0 m
17.5 to 20 cm	2.1 m
20 to 25 cm	2.3 m
25 to 30 cm	2.5 m

Planting and After Care:

The planting site should be fully prepared before digging and transporting is commenced so that the trees can be planted immediately, and they are not left exposed for any extended period. For example, for best efficacy and reduced mortality, the trees should be planted on the same day they are dug and/or no later than the second day after they were dug, and subject to appropriate care for the tree in the interim (i.e. protect from desiccation).



The planting hole should be dug to approximately 1.5 times the root ball diameter in size and to the same depth of the root ball of the subject tree. The correct finished planting height of the root ball is vital to tree survivorship. During re-planting, the height of the root ball should be set such that the root collar is level with the surrounding finished soil level, including

provision for expected settlement of the root ball, settlement of the growing medium or differential settlement of both.

The root ball must have all tie wires, lacing and/or burlap removed from the top one-third to one-half of the root ball after placement, and before backfilling. Backfill process should be undertaken to meet current BCSLA/BCLNA standards; including watering in and compacting the backfill to suitable levels to hold the tree in place without over-compacting it such that root growth into the backfill is not inhibited.
Guying or staking of the subject trees after transplanting should be undertaken as per BCSLA/BCLNA specifications, with Contractor designed systems that are suitable to the subject tree and the planting site conditions, while avoiding the creation of trip hazards. Special measures may be implemented to reduce risks associated with guying or staking to meet BCSLA/BCLNA standards.