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Introduction

The process of evaluating tree health and condition involves gathering information in the field, determining the significance of that information and producing a report of the findings. As many reports are the product of periodic ongoing monitoring of a developing situation, over time, some repetition in explanatory information is inevitable.

In producing and explaining the findings, each report is intended to be readily understood and able to stand alone, with no further reference being required by the reader.

Each report contains the following sections;

- **Overview** Describes the events that precipitated the initial evaluation and identifies the subject, owner and location.
- **Tree Inspection** Containing an explanation of the field work techniques and an outline of methods and instruments used in analysis.
- **Observations** Gives site and tree specific information and commentary.
- **Conclusions** An interpretation of the field work observations, testing and analysis, with recommendations for treatment.

Overview

Since 1997 the trees within the Native Growth Protection Areas that are integral to the Chestnut trails community have been subject to periodic evaluation. A proposal for services was provided to carry out the 2011 inspection using the following criteria.

- To inspect the trees within the Native Growth Protection Areas that borders the community at Chestnut Trails in the city of Bothell; part of an ongoing inspection cycle.
- To evaluate the health and structural condition of the trees relative to disease, decay or defect and to determine the risk of tree failure.
- To test the trees as necessary with the Resistograph to determine the nature and extent of any defect or decay.
- To provide a report with recommendations for action to reduce the likelihood of failure.

Tree Inspection

To develop an accurate picture of tree health and condition, information must be gathered about the multiple, changeable, factors which influence tree vitality and stability. Vital, healthy tree growth is the result of a complex association of internal and external influences and to consider each tree as an isolated entity is to fall short in understanding the whole picture. As a practical matter, information must be gathered and structured in the best way to communicate the results of the observations and to impart any recommendations for treatment.

Individual tree inspection begins at ground level; tree genus and species is determined and soil quality, rooting conditions, soil level, irrigation and drainage characteristics are observed. Soil is a living micro-system that relies on an active working relationship between structural and living organic components. In an urban setting the structural condition of the soil is most commonly adversely

affected. Alterations to physical soil structure will have an effect the functions of the living soil components.

The quality of the soil may be assessed in its ability to contain and disperse available moisture and the level of soil compaction may be tested to evaluate the aeration capacity of the soil. Some soil types are easily compacted and although they are high in nutrient quantity, little of that nutrient quality is available to the growing tree. Compact soils also cause problems by restricting the trees ability to discharge the gasses produced as part of the growth cycle.

The visible parts of the tree, the trunk, branches and leaves live in balance

with the unseen roots. Damage to the soil leads to inhibited root growth and causes a lack of vitality and decline within the tree as a whole. Soil compaction is commonly the result of short term heavy or any long term traffic in the root zone. The effects of soil compaction may not become apparent in the tree for decades following the initial compaction event.

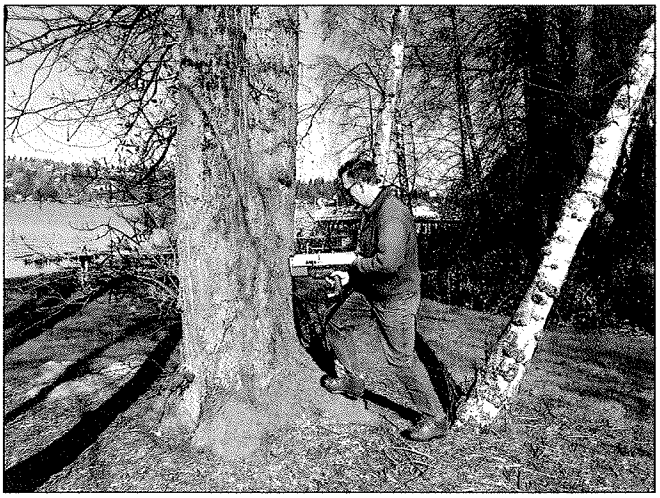
If signs of stress are present, a soil test may be made to assess the fertility of the soil. Testing establishes the presence and degree of vital nutrients and micro-flora. Vital soil is essential to vital tree growth, the presence of nutrients and organisms within the soil mean that growth can continue. An imbalance of nutrients can cause poor vitality; often exhibited by leaf discoloration, distortion or lack of annual growth. Poor nutrition will slow growth and can diminish the trees natural defense mechanisms and expose the tree to disease.

In nature, few tree species grow alone; the forest is their natural and protected setting. Whether native or introduced, regardless of a trees' origin, trees in a landscape setting demand special attention. Although bound by the

genetic code of its predecessors each tree is also the product of its local environment in terms of health and stability.

Looking at the overall picture, the health and condition of the soil, turf and other plants and trees can reveal the cause of disease, or indicate potential problems. The presence of certain species of fungus can indicate decay. Certain decay fungi may destroy support tissues and leave conductive tissues unharmed. The tree may appear healthy and continue to grow until the internal decay outpaces the new outer growth.

A root crown examination may be necessary if root decay is suspected. By removing the soil at the base of the tree, the location, health and condition of the absorbing and support roots can be determined.

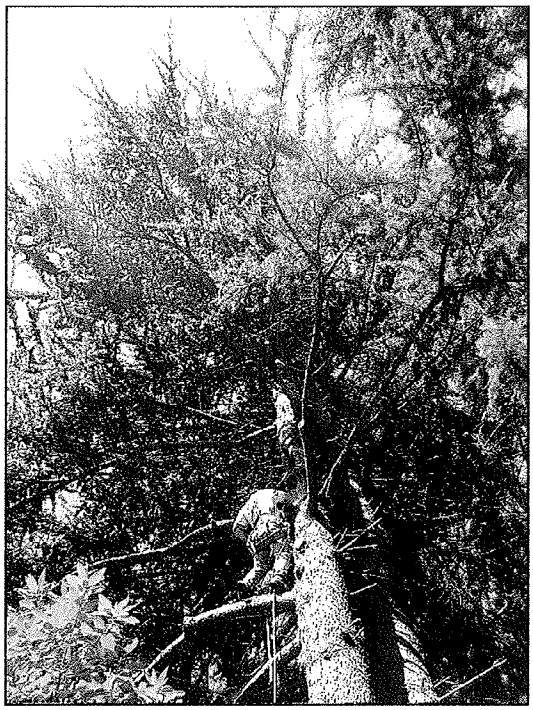


In the primary examination of the root crown and trunk a mallet is used to test for loose bark. Bark lifting can indicate dead or hollow areas and give signs of the presence of decay in the root crown zone and at the base of the trunk. The mallet may be used to "sound" for decay but has limited reliability. If decay is suspected the tree will be tested using the Resistograph. Where Resistograph tests were made a more detailed explanation and an interpretation with illustrations is given later in the text.

The type of decay and its effect on the stability of the wood depends on the species of fungus involved. Soil and root tissue samples may be taken to determine the cause of disease by laboratory testing.

The inspection continues with an evaluation of the tree crown, first by eye or with the use of binoculars then, if necessary, by climbing into the canopy of the tree. The color, size and condition of the leaves, trunk, branches and twigs are assessed.

The form and formation of all the trees components give information about health, vitality and structural strength. The crown density, the number of leaves on each stem, and past and current growth extension, indicate current health and



reveal previous problems. Changes in growth rate in past growth may indicate prior disease or injury.

An evaluation of the general growth habit will reveal any problems related to vigor, or the genetic component of tree growth. Previous treatments such as pruning or cabling are observed, the quality of the work, and its effect on the tree. Any growth abnormalities are noted: weak limbs, discolored or missing bark, cracks or cavities in branches or trunks. Indications of disease are observed within the canopy of the tree, disease may be indicated by leaf blight, stem canker, fungal growth or insect and bird activity.

Trees produce adaptive growth to compensate for the stress related to growth and injury. The shape and formation of limbs and trunks can reveal the ability of the tree to compensate for weakness or indicate internal problems that may lead to limb or trunk breakage. The interpretation of these changes in form is part of a growing body of knowledge pioneered in Europe and adopted across the globe. The knowledge is not new but the application of that knowledge in risk assessment is in the forefront of progress in understanding how trees compensate for stress. Research into stress-loading of trees and materials testing of wood structure has led to the development of systems of structural evaluation based on the principals of bio-engineering.

Observations

Since the inception of the Tree Inspection program at Chestnut Trails the primary goal has been the reduction of risk associated with the potential failure of trees within the Native Growth Protection Areas. These areas have a history of failure and that failure has been documented in prior reports. To best assess the risk the following criteria were outlined in the original report and used in subsequent evaluations:

- De- lineation of the area into usage zones.
- Identification of site disease.
- Inspection of individual trees for hazard.
- Resistograph testing for decay.
- Identification of current management issues.
- Identification of ongoing management concerns.

When tree risk is assessed one of the elements that must be considered is the *target.* A target is considered as something that would be adversely affected if a tree were to fail. The rating placed on a target relates directly to its occupancy. A dwelling is given a higher rating that a little used pathway. Similarly a tree in the center of a stand away from paths and dwellings may have no target; such a tree would have a low hazard rating.

These criteria were developed with the recognition that the greatest hazard is posed by a newly exposed, diseased tree with decay that is located in close proximity to a residence that is occupied for a large part of the day and night. The initial reports identified failure risk areas and adjacent residences. The NGPA's were also surveyed for the presence of Laminated Root Rot which was determined to be the primary pathogenic contributor to whole tree failure.

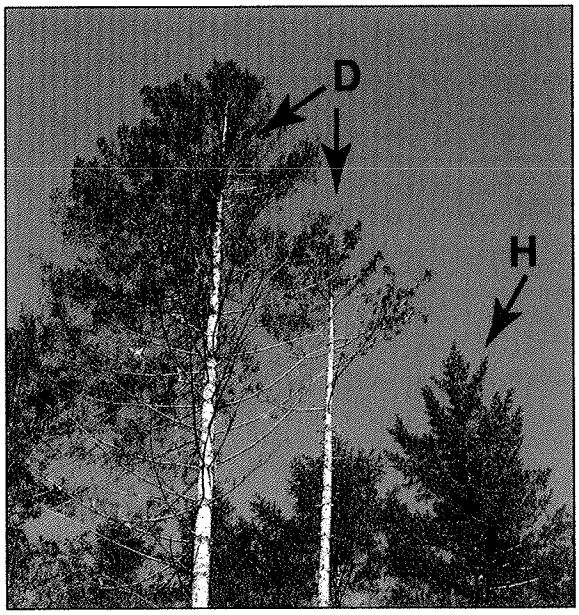
Laminated Root Rot also known as Yellow Ring Rot affects conifers in Japan, Manchuria, and Western North America; from Southern Oregon, to British Columbia. In North America two distinct forms exist; in Washington State one form occurs through the Eastern Cascades and Eastern Washington. The second form is found here in Western Washington. Different species are affected by the different strains. The eastern form primarily affects Western Redcedar

(*Thuja plicata*) and the western form affects the Douglas fir (*Pseudotsuga menziesii*).

The disease occurs mainly in forests that are managed for timber production but is often found in settings such as Chestnut Trails where stands of trees remain, following the clearing of a wooded area. Trees susceptible to the disease in Western Washington include; Mountain Hemlock (*Tsuga mertensiana*), Douglas fir (*Pseudotsuga menziesii*), Grand Fir (*Abies grandis*), Pacific Silver Fir (*Abies amabilis*), and White Fir (*Abies concolor*).

Symptoms and Diagnosis

Trees may be infected at a young age but the disease is seldom noticed until the trees are at least ten years old. Most destruction occurs in trees between 25 and 125 years old. The majority of the trees are blown down while still alive. Failure is due to root decay caused by the fungus, *Phellinus weirii*, which digests the woody support roots while absorbing root activity continues. New growth continues while older root and trunk tissues are decayed. The typical pattern of decay, shown in the photograph above, leaves only stubs of support roots showing following failure.



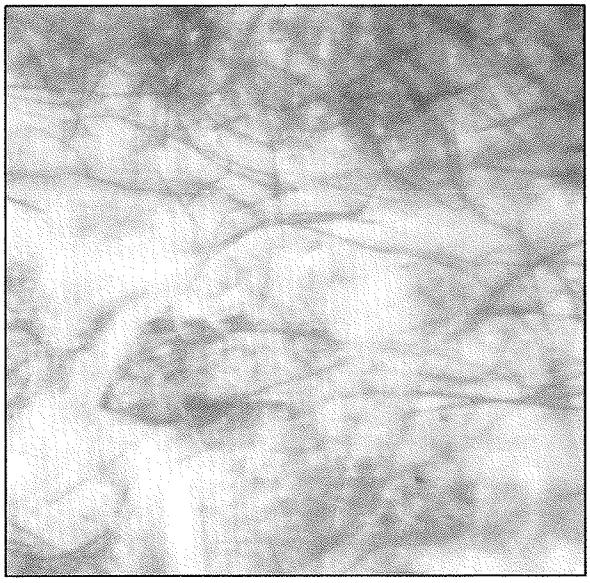
Laminated Root Rot spreads on site by growing through the soil via root contacts. Diseased trees

and the stumps of fallen trees should be considered infection sites and the fungus is capable of surviving on decaying stumps for over 50 years. An area of fifty feet around a diseased stump is a potential infection zone; all susceptible trees that fall within this area may be infected.

The above ground symptoms of the disease are often subtle. The growth within the upper canopy of some trees is reduced; this can cause a "rounding of the crown" shown as **D** in the previous photograph. Conifers typically have a dominant central leader shown as **H.** When the disease slows growth the leader is first affected, the surrounding limbs continue to grow forming the rounded crowns as shown above. A disease center may be indicated by a group of trees with rounded crowns surrounded by trees with strong central leaders.

The base of some trunks may be decayed at the root crown level close to the ground. This decay can be detected in standing trees with the use of the Resistograph.

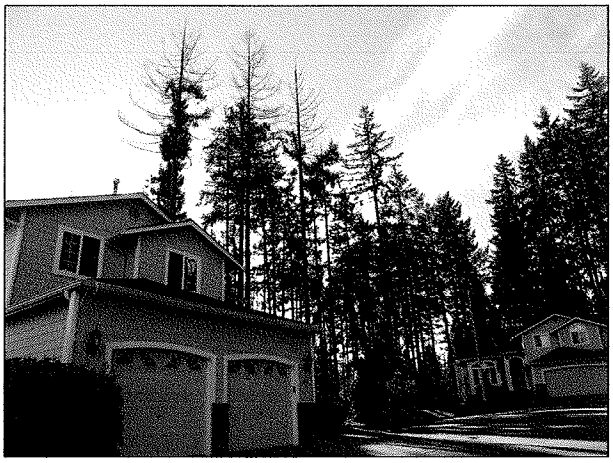
The symptoms described above may also be attributed to a number of other forms of disease and further examination is necessary to determine that *Phellinus weirii* is at work.



Positive diagnosis of Laminated Root Rot is made through the microscopic examination of root tissues. Shown at right, the hair-like growth

is known as setal hyphae and is a fungal structure which shows that *Phellinus weirii* is present. Extensive de-lamination of wood tissues and decay are to be expected where setae are present.

The risk of whole tree failure increases significantly where Laminated Root Rot exists. Furthermore the risk of additional failure increases with incidence of failure. As individual trees fall the remaining trees become exposed. The new exposure can cause additional failure in both diseased trees and healthy trees with poor structural form.



To better understand the implications of the site disease on the stand as a whole, the disease sites were located on the plans. All susceptible trees with increased risk of failure were identified by plotting their location in relation to the known disease sites. An additional disease sites was identified and is shown as D5 on the updated site plan.

A new development since the last inspection is crown die-back in a number of trees on site. Illustrated in the photograph above the die-back has affected trees in several locations with the largest concentration occurring in the area shown as Z3 on the sketch. This form of die-back indicates root related issues but is not typical of Laminated Root Rot. Several trees in this area are standing dead; the decline and death of these trees has occurred since the last inspection in 2006.

Also of concern is a single tree in area Z1. This tree, shown on the sketch plan as T1 is located next to a disease center and is dying back. The tree was tested with the Resistograph to ascertain whether decay is present at the base of the tree. Following resonance testing a second tree shown in area Z4 was also tested.

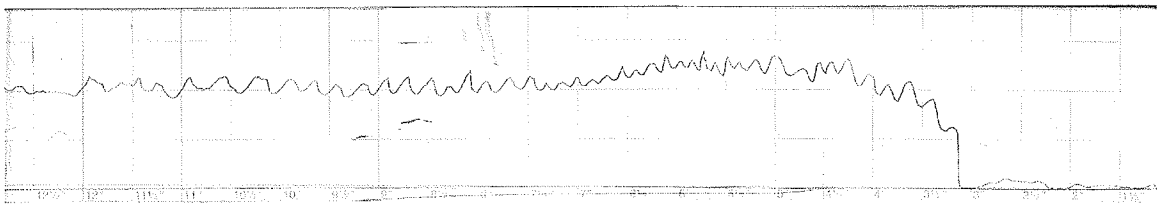
The Resistograph is an instrument, or rather a family of instruments, for detecting decay and defects in trees and timber. The instrument measures the

resistance to a needle inserted into the wood under constant drive. In the M300 model, the constant drive is provided by either a crank and fly wheel or a battery driven electric motor, while the F400 relies on a battery driven motor alone. The M300 tests to a depth of 12" and the F400 to 16"in depth.

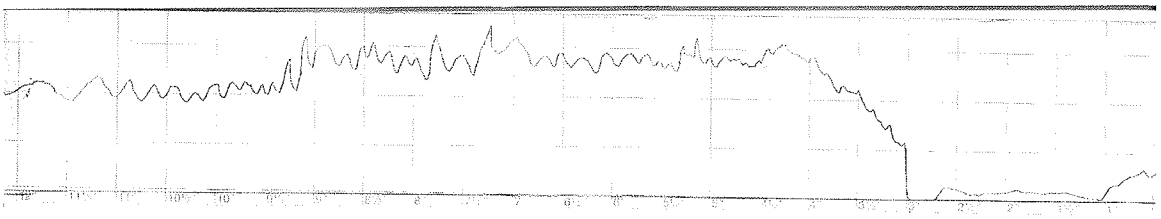
The resistance to the needle tip is transferred through an "intelligent" satellite gearbox to a pointer on the top of the instrument that maps the result on a waterproof wax paper printout. Drilling resistance correlates to the physical properties of the wood. Defects such as cracks areas of decay, hollows and to a certain extent tree ring structures can be detected and mapped. The resistance is mapped on a 1:1 scale on the wax paper, giving a clear graphical representation of the mechanical properties of the wood. The Resistograph utilizes a 3mm needle tip and a 1.5mm flexible needle that tends to "squeeze" between the fibres of the wood causing very little wounding.

The Resistograph charts are shown below and should be read from right to left; areas of lower strength are shown by a lower reading on the scale.

The tree shown as T1 on the sketch shows a test within the normal range with no significant loss of resistance with depth.



The tree shown as T2 shows good resistance to 9.5" in depth followed by areas of reduced resistance.



Conclusions and Recommendations

Trees of immediate concern are those that are showing symptoms of root disease, have active decay and are located in close proximity to homes, There are currently eleven of these trees on site, located in area Z3 and shown on the updated sketch plan. Where trees represent a high risk of failure and associated hazard they have been marked with florescent paint as shown in the photograph, top right.

Of secondary concern are trees that are currently showing some initial indicators of decline. The photograph at left shows a Douglas fir that is exhibiting the initial stages of decline as shown by the death of the leading shoot (shown with the red arrow). This die-back is typically related to root distress and may be caused by a pathogen or by changes in water availability caused by weather pattern shifts and drainage alterations. No other symptoms of pathogenic disease were found in proximity to these trees.

Where there is a likelihood of failure there is the possibility of injury and damage and the associated exposure to litigation. Trees, although generally long lived, are organic structures with a finite life cycle, which includes senescence and decline. They are also shedding organisms that periodically cast off parts to manage disease and to provide for growth. Each of these elements involves a

degree of risk. Much of the risk can be managed by cultural techniques such as pruning or additional structural support. To remove *all risk* associated with trees would call for the removal of all trees. As a solution, wholesale tree removal is neither prudent nor practical. To live with trees is to assume some level of risk. The degree of risk that is acceptable must be determined by the owner or manager of the property on which the tree resides. The goal here is to provide a conservative assessment of the current condition of trees with an assessment of the associated risk and recommendations for action where appropriate.

Tree Inspection should not be considered as a one time event. Trees are dynamic organisms growing, aging and responding to multiple internal and external influences over time. In order to fully appreciate the effects of change over time, continued monitoring through periodic inspection is necessary.

Monitoring by inspection is particularly important in the case of Chestnut Trails. The site has a history of failure and a number of trees are showing symptoms which may indicate early stage decline. These indications may also represent temporary set backs due to local environmental alterations and these trees may well recover and continue growing for many years to come. Continued monitoring will help assess the significance of the symptoms over time. The next inspection should be scheduled in 2012.

I hope the preceding information is clear. Please let me know if there are further questions.

Yours sincerely,

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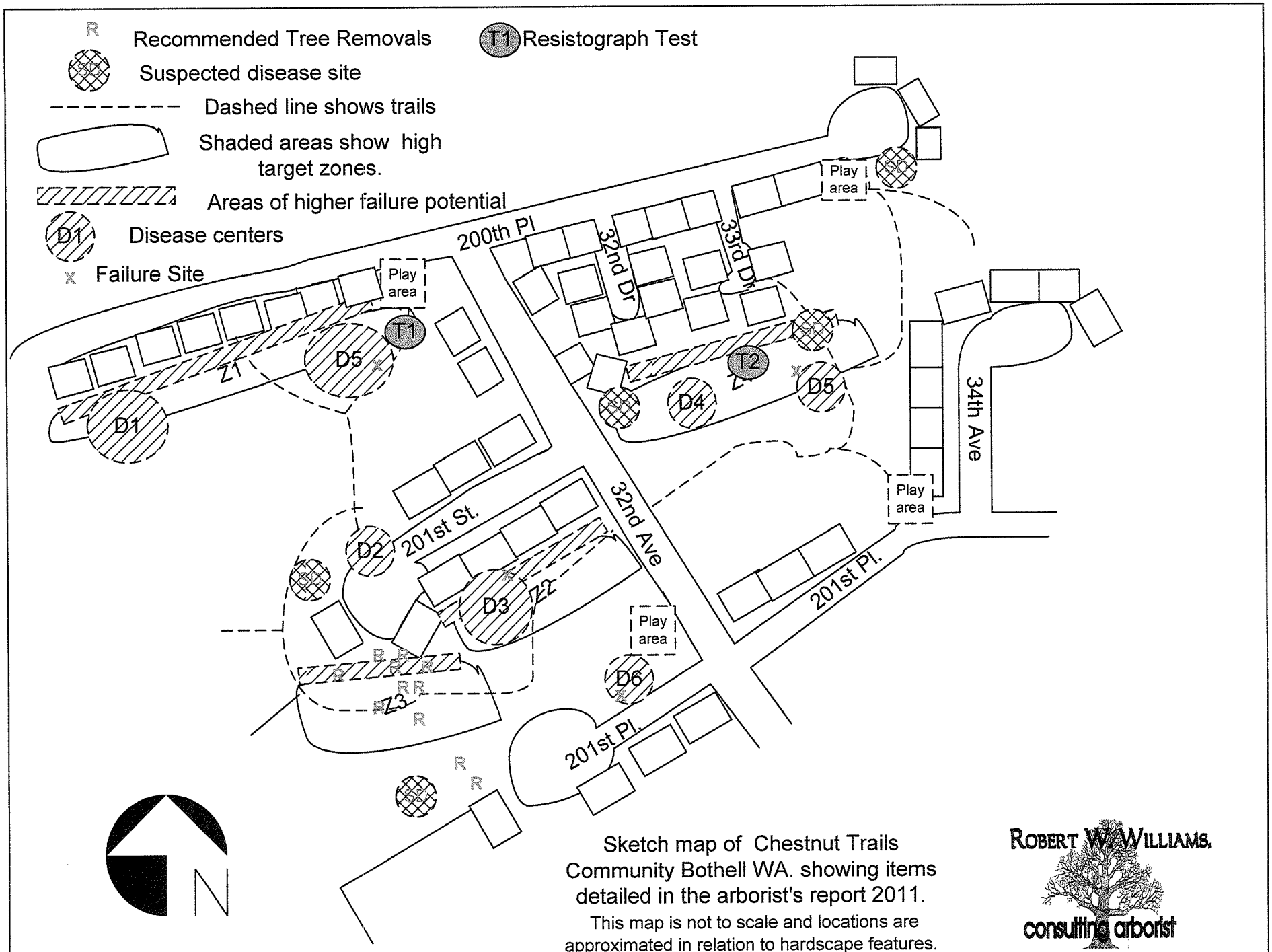
Certified Arborist #0176A
Certified Tree Risk Assessor #362



Sketch map of Chestnut Trails Community Bothell WA. showing items detailed in the arborist's report 2011.

This map is not to scale and locations are approximated in relation to hardscape features.

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