CITY OF WOODINVILLE

TREE BOARD PACKET

December 10, 2014

CITY HALL COUNCIL CHAMBERS
17301 133RD AVENUE NE
WOODINVILLE, WASHINGTON 98072

CITY OF WOODINVILLE
TREE BOARD AGENDA
SPECIAL MEETING WEDNESDAY, DECEMBER 10, 2014 5:30 PM

• Thomas L Quigley • Michael Munniks • Ron Smith • Steve Yabroff • Stephanie Young

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5:30 **CALL TO ORDER**

5:31 **ROLL CALL**

5:33 **APPROVE AGENDA IN CONTENT & ORDER**

5:35 **PUBLIC COMMENTS**

BUSINESS AND DISCUSSION ITEMS

5:40 **1. Approval of Draft Minutes - November 12, 2014**

5:45 **2. Study Session – Review of Tree Code**

6:20 **PUBLIC COMMENTS**

6:25 **DIRECTOR'S REPORT**

6:30 **ADJOURNMENT**

(Note: The agenda may be rearranged or changed at the beginning of the meeting, with a consensus of Tree Board members present.)

Issue Date: December 4, 2014
Staff Contact: Jenny Ngo, Sr. Planner

Faxed to:	**News Media**
E-mailed to:	**Tree Board**
Publish:	**Not published**
Post:	**1) In-House, 2) Post Office & 3) Website**

CITY OF WOODINVILLE, CITY COUNCIL CHAMBERS
17301 133RD AVE. NE, WOODINVILLE, WA 98072

NEXT REGULAR MEETING JANUARY 28, 2014, 5:30 PM

AGENDA ITEM 1

City of Woodinville, Washington

TREE BOARD REGULAR MEETING MINUTES OF November 12, 2014

Woodinville City Hall City Council Chambers, 17301 133rd Avenue NE, Woodinville, WA

CALL TO ORDER	The regular meeting for the Woodinville Tree Board was called to order at 5:32 p.m. by Chair Quigley.
ROLL CALL	Tree Board Present: Tom Quigley, Stephanie Young, Steve Yabroff, and Ron Smith Absent: Michael Munniks City Staff Present: Jenny Ngo, Senior Planner **MAIN MOTION: to excuse Board Member** There was a motion to excuse Board member Munniks from the meeting. **Motion by: Board Member Young** **Second by: Board Member Yabroff** **Action for the Main Motion: PASSED 4 - 0** **Vote: Ayes: 4.** **Nayes: 0.** **Abstain: 0.**
APPROVAL OF AGENDA ORDER AND CONTENT	Agenda item 3 added to discuss the topic of arborist review for tree removal in existing groves. Motion to approve agenda with additional item 3 passed.
PUBLIC COMMENTS	None.
BUSINESS AND DISCUSSION ITEMS *Approval of 9/24/14 Regular Tree Board Minutes as presented*	1a. Approval of September 24, 2014 Tree Board Meeting Minutes as presented. **MAIN MOTION: to approve the regular meeting minutes of September 24, 2014, as presented.** **Motion by: Board Member Yabroff** **Second by: Board Member Young** **Action for the Main Motion: PASSED 4 - 0** **Vote: Ayes: 4.** **Nayes: 0.** **Abstain: 0.**

Approval of 6/25/14 Regular Tree Board Minute as presented	1b. Approval of June 25, 2014 Tree Board Meeting Minutes as presented. **MAIN MOTION: to approve the regular meeting minutes of 6/25/14, as presented.** **Motion by: Board Member Yabroff** **Second by: Board Member Young** **Action for the Main Motion: PASSED 4 - 0** **Vote: Ayes: 4.** **Nayes: 0.** **Abstain: 0.**
Discussion and Review of Draft Tree Code	2. Discussion & Review of Draft Tree Code The Tree Board discussed the draft of the tree code from WMC 21.15.010 through WMC 21.15.080. Jenny Ngo provided a summary of major changes to the tree code, including changes to overall organization, language revisions and omissions, general intent and structure of the proposed draft. Tree Board Members discussed the purpose and intent of the tree code. Board Members noted that they were unfamiliar with how the City's goal of 40 percent tree canopy was developed. Board Members requested information on how the goal was developed and on the results of a prior tree canopy study completed by UW. Board Members emphasized the importance of ensuring that the goal is realistic and supported by data. Some Board Members stated concerns with overplanting based on the tree density requirements. Sites without enough tree credits may encourage property owners to plant more trees closely together in lieu of payment to the Tree Fund. The trees, once mature, may obstruct sunlight or become nuisances. Board Members discussed including a provision that permits tree removal or pruning once the trees are mature in these instances. Tree Board Members emphasized creating a code that is simple for property owners to use and for staff to implement. Board Members stated that the code was heading towards the right direction but would like to see further simplification where possible. Board Members stated that they had some difficulty determining if tree density requirements were appropriate for specific zones without evaluating the density and dimensional requirements required by the zoning code. The Tree Board directed staff to provide different scenarios of tree credits based on zoning code requirements, such as impervious surface and setbacks. Steve Yabroff and Board Members discussed how to address tree removal in existing tree groves and mature landscape. Board Member Yabroff stated that the Tree Board should consider language requiring a certified arborist to inspect and evaluate viability of trees once a grove is removed or impacted by construction. One example mentioned is the Woodinville-Duvall Road project, where trees within groves were removed in the right-of-way and on private property for the widening project. Board Members

	expressed concerns regarding the vulnerability of these tree groves once a portion of the trees is removed. Board Members directed staff to develop potential code language options for addressing whole or partial removal of tree groves within the draft code. **MAIN MOTION: To extend the meeting 15 minutes to finish discussion of the draft tree code.** **Motion by: Board Member Yabroff** **Second by: Board Member Young** **Action for the Main Motion: PASSED 4 - 0** **Vote: Ayes: 4.** **Nayes: 0.** **Abstain: 0.**
PUBLIC COMMENTS	None.
DIRECTOR'S REPORT	None
ADJOURNMENT	Chair Quigley called the meeting adjourned. The meeting was adjourned at 6:45 p.m.

Respectfully submitted,

Sandy Guinn
Sr. Administrative Assistant

INTENTIONALLY
BLANK

AGENDA ITEM 2

CITY OF WOODINVILLE, WA

REPORT TO THE TREE BOARD

17301 133rd Avenue NE, Woodinville, WA 98072
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To:	Tree Board	**Date:** December 10, 2014
From:	Dave Kuhl, Development Services Director	
By:	Jenny Ngo, AICP, Senior Planner	
Subject:	Review of Tree Code	

ISSUE: Shall the Tree Board discuss proposed revisions to the Tree Code?

STAFF RECOMMENDATION: To review and provide feedback on the proposed changes.

POLICY DECISION: The Tree Board provides an advisory role to the City Council on matters of trees and urban forestry.

BACKGROUND:
During the November 12, 2014, Tree Board Meeting, Board Members discussed sections of the preliminary draft of the tree code from WMC 21.15.010 through WMC 21.15.080. Sections WMC 21.15.090 through WMC 21.15.130 were not reviewed during that session.

During the course of the discussion, Board Members requested that staff provide additional information on two items:

- Results from the UW Tree Canopy Assessment. The study examined tree canopy coverage within the City boundaries area through grid indexing of aerial imagery. An aerial photograph of the City was divided into small sections or cells. A visual analysis was conducted for each cell to establish a tree canopy percentage. The study determined that the tree canopy in Woodinville is estimated to be 36 percent in 2007.
- Examples of lots and tree density requirements based on the minimum zoning requirements. The zoning code provides requirements related to dimensions and densities of lots within individual zoning districts, including impervious surface, setbacks, building coverage, and other standards. Tree Board Members requested diagrams that could show these requirements on a standard size lot, as well as estimates on how many tree credits could be supported.

DISCUSSION:
The draft tree code included in this report has not changed since the last meeting. Starting with Section WMC 21.15.090, continue discussion on the draft tree code regulations. Please refer to staff comments at the end of each section for discussion points and questions.

RECOMMENDED ACTION:
DISCUSS AND MAKE RECOMMENDATIONS

Attachment 1: November 2014 Draft Tree Code
Attachment 2: Tree Permit Flow Chart
Attachment 3: UW Tree Canopy Assessment
Attachment 4: Residential Zone Examples: Dimensional and Tree Canopy Requirements

Attachment 1 Proposed Code Changes to Chapter 21.15
DEVELOPMENT STANDARDS – TREE REQUIREMENTS

Sections:

21.15.010 – Purpose and Intent
21.15.020 – Applicability
21.15.030 – Exemptions
21.15.040 – City Tree Fund Established
21.15.050 – Hazard Rating and Nuisance Trees
21.15.060 – Tree Removal Permits
21.15.070 – Tree Permit Submittal Requirements
21.15.080 – Tree Replacement Requirements - Minimum Tree Density
21.15.090 – Supplemental Tree Planting Requirements
21.15.100 – Alternative Compliance.
21.15.110 – Tree Maintenance
21.15.120 –Tree Protection During Construction
21.15.130 – Enforcement and Penalties

21.15.010 – Purpose and Intent

(1) Trees are integral to Woodinville's community character and protect public health, safety, and general welfare. Protecting, enhancing, and maintaining healthy trees, groves of trees and vegetation are key community values. The City's goal is to achieve an overall tree canopy coverage of 40 percent for the community. The many benefits of healthy trees and vegetation contribute to Woodinville's quality of life by:
  (a) Minimizing the adverse impacts of land disturbing activities and impervious surfaces such as runoff, soil erosion, land instability, sedimentation, and pollution of waterways;
  (b) Improving the air quality by absorbing air pollutants and carbon dioxide, and generating oxygen;
  (c) Providing cost-effective protection from severe weather conditions with cooling effects in the summer months and insulating effects in winter;
  (d) Providing visual relief and screening buffers;
  (e) Providing habitat, cover, food supply, and corridors for a diversity of fish and wildlife; and
  (f) Providing economic benefit by enhancing local property values and contributing to the region's natural beauty, aesthetic character, and livability of the community.

(2) The purpose of this chapter is to establish processes and standards to provide for the retention, protection, preservation, replacement, proper maintenance, and use of significant trees and woodlands located in the City of Woodinville. The intent of this chapter is to:
  (a) Maintain and enhance canopy coverage provided by native trees for their benefits;
  (b) Preserve and enhance the City of Woodinville's environmental, economic, and community character with mature landscapes;
  (c) Promote site development practices that work to avoid removal, destruction, or disturbance of significant trees, groves of trees, and the City's natural vegetation;
  (d) Mitigate the consequences of required tree removal in land development through on- and off-site native tree replacement with the goals of halting loss and enhancing Woodinville's tree canopy to achieve an overall healthy tree canopy cover of 40 percent City-wide over time;
  (e) Implement the goals and objectives of the City's Comprehensive Plan;

(f) Implement the goals and objectives of the State Environmental Policy Act (SEPA).

Staff Comment: This section was slightly modified to reduce some of the repetition in the original code. Are these goals still accurate? Is 40 percent an appropriate goal?

21.15.020 – Applicability

(1) No property owner or their representative shall remove, destroy, or disturb trees located within the jurisdictional boundaries of the city except as provided in accordance with this chapter.

(2) Removal of trees not exempted by WMC 21.15.030 shall require a tree removal permit. Tree removal permits shall be processed as described in WMC 21.15.060.

Staff Comment: This section was re-written and simplified. Previous versions indicated that the code applies only in certain situations. As proposed, the language states that *all* tree removal should be consistent with this chapter (including tree permits, protection and maintenance), unless it is exempt below. This will allow for any unusual circumstances that may not be anticipated presently, and would otherwise not require compliance with the code.

21.15.030 – Exemptions

(1) The following activities are exempt from the provisions of this chapter:

(a) Any tree on private, developed property that poses an imminent threat to life or property, due to a storm event such as a windstorm or ice storm, may be removed without first obtaining a permit. The party removing the tree will contact the City within seven days of removal to provide documentation of threat for approval of exemption. If the City Tree Official determines that the emergency tree removal was not warranted, he or she may require that the party obtain a permit and/or require that replacement trees and vegetation be replanted as mitigation, in accordance with WMC 21.15.130.

(2) Trees may be removed by the City or utility provider in situations involving immediate danger to life or property, or interruption of services provided by a utility.

(3) Commercial Nurseries or Tree Farms. A nursery or tree farm owner may remove trees that are being grown to be sold as Christmas or landscape trees.

(4) Removal of trees with a diameter-at-breast-height of less than two inches.

(5) Removal of nonsignificant trees with a diameter-at-breast-height of less than six inches within a 12-month period, and which have up to a combined diameter-at-breast height of 40 inches or 10 tree credits.

(6) Trees within the public right-of-way and trees removed as part of a City construction project that is subject to the requirements of Chapter 2.24 WMC.

Staff Comment: This section uses most of the same language as the previous version. Note that in (4), the "less than 2 inches" language retained (proposed for elimination in the previous draft) as it conflicts with (5).

(5) was moved to this section from the Applicability section in the previous draft. The intent of this is to create all exemptions in the same place, and to put limits on the number of nonsignificant trees that can be removed. The language for the dead tree exemption is incorporated into the section below. The significant tree criteria remains at 6 inches in this draft – is there a willingness by the Tree Board to move to 9 inches instead? Additionally, is the threshold under (5) appropriate? In the case of trees in critical areas or subdivision tracts, should special attention be paid to these exemptions?

Is requiring a permit and replanting a priority for hazardous, nuisance or dead trees? If this is unnecessary, consider creating (7) stating "Hazardous, nuisance and dead trees, as defined in WMC 21.15.040. The party removing the tree shall contact the City within seven days of removal and provide documentation. If the City Tree Official determines that tree removal was not warranted, the Official may require the party obtain a permit and/or plant supplemental trees in accordance with WMC 21.15.080." so that these trees are completely exempted.

21.15.040 – City Tree Fund Established

(1) Fund established. A City Tree Fund is established for the collection of any funds used for the purpose and intent set forth by this chapter.

(2) Funding sources. The following funding sources may be allocated to the City Tree Fund: payments received in lieu of supplemental plantings pursuant to WMC 21.15.090; any civil penalties collected pursuant to this chapter; agreed-upon restoration payments or settlements in lieu of penalties; sale of trees or wood from City property; donations and grants for tree purposes; sale of seedlings by the City; and other monies allocated by City Council.

(3) Funding purposes. The Tree Board shall provide recommendations to City Council for approval on how the funds will be allocated. Prioritization will be based on the Urban Forestry Plan. The City shall use money received pursuant to this section for the following purposes:

(a) Acquiring, maintaining and preserving wooded areas within the City;
(b) Planting and maintain trees within the City;
(c) Identification and maintenance of heritage trees;
(d) Establishment of a holding public tree nursery;
(e) Urban forestry education; or
(f) Other purposes relating to trees as determined by City Council.

Staff Comment: This section was slightly modified from the original. Are there other funding purposes or sources to consider?

21.15.050 – Hazard, Nuisance and Dead Trees

(1) General Requirements. A hazard, nuisance, or dead tree shall be designated through an arborist report prepared by a qualified tree professional consistent with WMC 21.15.070(2)(b). The arborist report shall provide information on how the tree meets the following criteria if tree removal is based on nuisance or hazard. If the condition is obvious as identified by a layperson through a cursory visual inspection, the City Tree Official may waive the requirements for an arborist report.

(2) Hazard trees. A tree may be designated as a hazard tree if *all of the following criteria* are met:

(a)The tree has a combination of structural defects and/or disease that makes it subject to a high probability of failure
(b) Is in the proximity to moderate-high frequency of persons or property; and
(c) The hazard condition of the tree cannot be lessened with reasonable and proper arboricultural practices nor can the persons or property be removed.

(3) Nuisance trees. A tree may be designated as a nuisance tree if it meets *one of the following criteria*, and the tree cannot be corrected by reasonable practice including, but not limited to, pruning of the crown or roots of the tree, bracing or cabling, and small modifications of the site:

(a) The tree is causing obvious, physical damage to private or public structures, including but not limited to: sidewalk, curb, road, driveway, parking lot, building foundation or roof;
(b) The tree has been damaged by past maintenance practices that cannot be corrected with proper arboricultural practices;
(c) The tree is predisposed to fungus diseases, or is a chronic diseased tree, that would require annual spraying
(d) The grove of trees on the property excessively obstruct sunlight or present a security concern; or
(e) There is overcrowding or overplanting.

(3) Dead trees. The tree is determined to be diseased, dead, or dying, and may or may not pose a potential safety hazard.

> Staff Comment: This section uses most of the same language as is in the June 2014 draft code. Dead, nuisance and hazardous trees are placed in one location since they are treated similarly throughout the code. The language related to tree removal is placed in the staff comment section in WMC 21.15.030.
>
> An additional nuisance qualification was added under (3)(d) to address tree plantings that obstruct sunlight or are a safety concern – note that this is for the entire grove, rather than an individual tree.

21.15.060 – Tree Removal Permits

(1) Tree removal within properties zoned as single-family residential (R-1 through R-8) and not exempted under WMC 21.15.030 shall be subject to a tree permit and required to meet minimum tree density regulations in WMC 21.15.090. The following sets forth Tree Permit I through IV required for development activities or removal requests. For tree removal in critical areas, requirements are listed in subsection (3).

(a) Tree Permit I – Tree Removal No Construction. Required for tree removal on a property on which no development activity is proposed or in progress. Removal of trees is limited to the following:
(i) In the R-1 zone, five healthy trees per 12-month period
(ii) In the R-4 zone, three healthy trees per 12-month period
(iii) In the R-6 through R-8 zones, two healthy trees per 12-month period
(iv) A property owner may remove twice the maximum number of healthy significant trees if he/she agrees not to remove additional healthy trees for a 24-month period.
(v) No limit on the number of hazardous, nuisance or dead trees
(vi) Any tree removal in residential subdivisions, tracts or easements under common ownership shall comply with WMC 21.15.050(4).

(b) Tree Permit II – Minor Construction. Required for any project where:
(i) The total square footage of the proposed improvements is 25 percent or less than the total square footage or assessed value of the existing structures on the subject property, and the project includes site disturbance, impacts to the dripline of existing trees, or tree removal; or
(ii) Tree removal on a property on which no development activity is proposed or in progress which does not qualify for Tree Permit I

(c) Tree Permit III – Major Construction. Required for any project where:
(i) Construction includes one to two dwelling units on an individual lot, or

(ii) The total square footage of the proposed improvements exceeds 25 percent of the total square footage of assessed value of the existing improvements on the subject property, or

(iii) A grading permit is required.

(iv) Exceptions for previously approved development. Any subdivision or short subdivision that is subject to tree permit approved prior to March 17, 2009 shall not be subject to tree retention and plan requirements in this section, except that any modifications that results in removal of additional existing trees shall be subject to the requirements of this chapter.

(d) Tree Permit IV – Land Division. Required for any new residential subdivision or short subdivision.

(2) Tree removal within properties zoned as non-residential zones and not exempted under WMC 21.15.030 shall be subject to the following requirements:

(a) Tree Permit I – Tree Removal No Construction. Applies to tree removal on a property on which no development activity is proposed or in progress. Removal of trees is subject to the following requirements:

(i) Removal of up to ten percent of tree credits per 12-month period

(ii) No limit on the number of hazardous, nuisance or dead trees

(b) All other development, redevelopment or additions shall meet the minimum landscape requirements for replanting pursuant to Chapter 21.16 WMC.

(3) Trees located in critical areas or critical area buffers. Any tree trimming or removal in areas designated as critical areas and/or buffers as defined in Chapter 21.24 WMC shall submit a Tree Permit I. If more than two trees are removed, the City Tree Official may require submittal of a critical areas alteration pursuant to Chapter 21.24 WMC.

(a) Priority action. If a tree is proposed for removal, the priority action for the tree is to create a "snag" or wildlife tree. If creating a snag or wildlife tree is not feasible, then the felled tree shall be left in place.

(b) Supplemental planting requirements. When tree removal is proposed in critical areas or its buffers, the following provisions shall be met:

(i) If less than 10 trees are removed, supplemental trees shall be planted consistent with WMC 21.15.070 and WMC 21.15.090; or a qualified tree professional may determine to the satisfaction of the City Tree Official that equal or better habitat function and values can be achieved with the priority action and the following:

(A) A lesser number of tree credits are planted, using native species or the same species as the removed trees;

(B) Understory plantings are installed;

(C) A coverage analysis is submitted stating that the replanted trees will have equal or better coverage than the trees removed within five years; and

(D) A replanting plan is submitted.

(ii) If more than 10 trees are removed, supplemental trees shall be planted consistent with WMC 21.15.070 and WMC 21.15.090.

(4) Tree permit requirements. Tree permits I through IV shall comply with the submittal requirements listed in WMC 21.15.070. Tree permits shall be processed as a Type I project permit pursuant to Chapters 17.07 through 17.09 WMC. Appeals shall be processed consistent with Chapter 17.17 WMC.

(5) If proposed development activities qualify for more than one tree permit, the tree permit with the most stringent requirements shall comply. The City Tree Official shall have the authority to determine which permit requirements apply and may require a combination of requirements based on the nature of the proposed development.

(6) Trees located in residential subdivisions or tracts under common ownership. Removal of any tree under common ownership shall require a Tree Plan I and shall meet tree density requirements pursuant to WMC 21.15.070. The applicant shall obtain signatures from a majority of owners who hold ownership or interest in the tree, or approval from the subdivision homeowner's association after notification is made to all affected owners and no objections are received.

Staff Comment: This section is a combination of several different sections, including WMC 21.15.060(2), (3), (5) and (6). Tree permits are established so that applicants are made aware that a permit is required for these activities (not clear with "tree plan"). Each section is broken down into the different requirements of when a permit would be triggered. This section continues with the separation between residential and non-residential zones, and some language is included for flexibility with minor tree removal in non-residential zones.

Should there be a provision for property owners that want to remove more than permitted per year, beyond twice the tree credits per 24-month period? An example of this language would be under (1)(b), where they would fall into the requirements for a Tree Permit II.

Should there be special requirements for removing trees in shared tracts or in critical areas?

If a property owner removes some trees from the site without undergoing redevelopment, what sort of permit requirements and replanting ratios apply? If they propose a new addition, would they be subject to bringing the entire project up to landscaping standards? What is the best way to accommodate the range of lot sizes in the commercial and industrial districts?

WMC 21.15.070 – Tree Permit Submittal Requirements

(1) Tree removal permits required by WMC 21.15.050 and WMC 21.15.060 shall be submitted with the following materials outlined in Table 1.

WMC 21.15.070(1) Table 1 – Tree Permit Submittal Requirements.

Requirements	Tree Permit I	Tree Permit II	Tree Permit III	Tree Permit IV
Tree Permit Application	X	X	X	X
Arborist Report, prepared by a qualified tree professional		X	X	X
Tree Inventory	For affected trees only: 1) Size in DBH 2) Species	1) Size in DBH; 2) Species; 3) General Health; 4) Retention Status	1) Size in DBH; 2) Measured Driplines; 3) Critical Root Zone 4) Species; 5) General Health; 6) Retention Status	1) Size in DBH; 2) Measured Driplines; 3) Critical Root Zone; 4) Species; 5) General Health; 6) Retention Status
Tree Retention Plan	1) Location of structures 2) Size, location and species for impacted trees only	1) Location of structures 2) Size, location and species for impacted trees only	(i) Location of property lines, disturbance activities, and all existing and proposed structures	(i) Location of property lines, disturbance activities, and all existing and proposed structures

	3) Identify trees for removal	3) Identify trees for removal	(ii) Size, location, driplines, and species of all trees (iii) Limits of disturbance (iv) Identification of trees to be retained (v) Location of protection measures consistent with WMC 21.16.110, including standard details, and any protection instructions	(ii) Size, location, driplines, and species of all trees (iii) Limits of disturbance (iv) Identification of trees to be retained (v) Location of protection measures consistent with WMC 21.16.110, including standard details, and any protection instructions
Replanting Plan	X	X	X	X
Tree Density Requirements (WMC 21.15.090)	Property must meet the lesser of: 1) 2 trees planted per each tree removal, or 2) minimum tree density in WMC 21.15.090(1)	Property must meet the lesser of: 1) minimum tree density in WMC 21.15.090(1), 2) 50 percent greater than tree credits currently on site, or 3) 10 credits per acre if the site has zero credits	Property must meet minimum tree density in WMC 21.15.090(1)	Property must meet minimum tree density in WMC 21.15.090(1)
Preservation and Maintenance Agreement				X

(2) Submittal Materials.

(a) Tree permit application. A city-designated tree permit application shall be completed and signed.

(b) Arborist report. Arborist reports prepared by a qualified tree professional shall contain the following information, unless waived by the City Tree Official. In cases where the City Tree Official does not agree with the arborist report, the Official may seek a third party review, to be reimbursed by the applicant according to the City's current fee schedule.

(i) Description of each tree's health and viability. If a tree is not viable for retention, justification for removal based on health, risk of failure or suitability of species shall be provided. The impact of tree removal on nearby remaining trees shall be included.

(ii) Location of the limits of disturbance around all trees potentially impacted by site disturbance and special instructions for working within the protection area (hand-digging, tunneling, root pruning, maximum grade changes, etc.)

(iii) Existing and proposed tree credits on site, including a calculation of tree density credit requirements.

(iv) Suggested location and species of supplemental trees, maintenance, and planting specifications consistent with WMC 21.15.120.

(v) Recommendations on tree protection measures consistent with WMC 21.16.110 and correspond to the tree Protection Plan in subsection (f).

(c) Tree inventory. A tree Inventory shall be submitted as a part of the Arborist Report, when required. The tree inventory shall include the information listed in Table 1 above and shall correspond to the required site plan. The report shall include an indication for each tree, of whether it is proposed to be retained or removed, based on health, risk of failure and suitability of species; (b) limits of disturbance around viable trees;

(d) Tree retention plan. The tree retention plan must show the approximate trunk location and measured driplines tree retention plan shall include the information listed in Table 1 above and any additional information from arborist report. The plan may be combined with demolition, grading, or drainage plans.

(e) Replanting plan. A replanting plan shall be submitted if new trees are required pursuant to WMC 21.15.090. A replanting plan shall include the location of all trees and include a planting schedule that indicates species, quantity, size, and tree density calculations.

(e) Preservation and Maintenance Agreement. The applicant shall submit a preservation and maintenance agreement pursuant to WMC 21.15.100, for approval prior to occupancy, recording, or final inspection.

Staff Comment: This section is intended to be a simplified version of the requirement table. The same requirements are included. The table and information below clears up what is a submittal requirement, since the previous version is unclear about that (e.g., Tree Location is not a submittal requirement but a detail to be shown on the plans). This section moves the maximum tree removal requirements to the previous section.

Are there submittal materials missing from the list? Are the explanations of each item clear?

*Tree density requirements were changed for Tree Permit I (tree removal with no construction) to two trees per each tree removal or meeting minimum density requirements. It will be simpler for homeowners to plant a number of trees per each tree removal rather than go through the density calculations. What are some concerns or considerations?

21.15.080 – Tree Replacement Requirements - Minimum Tree Density

(1) Any tree removal subject to a tree permit shall be required to meet minimum tree density pursuant to WMC 21.15.070(2). The minimum tree density is calculated as the credits required per acre multiplied by the lot size in acres. For the purposes of calculating required minimum tree density, City right-of-way and areas to be dedicated as City right-of-way shall be excluded from the lot area used for calculation of minimum tree density. The following minimum tree credits are required based on zones:

(a) R-1 zone: 60 tree credits per acre

(b) R-4 zone: 40 tree credits per acre

(c) R-6 through R-8 zone: 30 tree credits per acre

(d) All other zones: 20 tree credits per acre or applicable landscape requirements pursuant to WMC 21.15.060.

(2) For Tree Permit I, the property owner may select the lesser of: 1) plant two trees per each tree removed; or 2) the minimum tree density.

(3) For Tree Permit II, the property owner may select the lesser of: 1) the minimum tree density; 2) 50 percent greater of the tree credits currently on-site; or 3) 10 tree credits per acre if the site has zero credits.

(4) The applicant shall demonstrate compliance with the minimum tree density through a tree credit calculation. The tree credit calculation is the sum of all retained existing trees and any supplemental tree plantings pursuant to this section. If a site falls below the minimum tree density with existing trees, supplemental planting shall be required. The tree credit value that corresponds with diameter-at-breast-height shall be found in the table below:

WMC 21.15.090(3) Table 1 – Tree Credit Calculation

Diameter-at-Breast-Height		Total Credit
Minimum	Maximum	
1.0	3.0	0.5
3.1	6.0	0.75
6.1	10	1.0
10.1	15.0	2.0
15.1	23.0	4.0
23.1	36.0	6.0
36.1	50.0	11.0
50.1 and above		20.0

(a) Diameter-at-breast-height of the tree shall be measured in inches. Existing trees are measured four-and-a-half feet off the ground; new plantings are measured six inches off the ground. The measured diameter-at-breast-height shall be its size at the time of measurement.

(b) Existing trees transplanted to an area on the same site may count toward the required density if approved by the City Tree Official based on transplant specifications provided by a qualified tree professional that will ensure a good probability for survival.

(5) For residential subdivisions with Native Growth Protection Easements (NGPEs), the tree credits within the NGPE may be counted where the homeowner's association or owner of the NGPE has determined the number of tree credits that exist within the NGPE. The remaining tree credits required for the entire subdivision to meet the minimum tree density will be equally divided among the total number of lots. Where the tree credits in the NGPE have not been determined, the minimum tree density shall apply to each lot within the subdivision.

Staff Comment: This section combines and consolidates language in several areas so that minimum tree density and tree credit calculations are easier to follow. There are some changes to the thresholds.

A section was created for non single-family residential zones consistent with WMC 21.15.060 above. Should this be included and are the thresholds adequate?

*Subsection 2 and 3 were modified to update language used in WMC 21.15.070 Table 1.

21.15.090 – Supplemental Tree Planting Requirements

(1) For sites and activities requiring a minimum tree density and where the existing retained trees do not meet the minimum requirement, supplemental trees shall be planted to achieve the required minimum tree density. Tree density credits for supplemental trees shall be calculated pursuant to WMC 21.15.090.

(2) Tree species. The tree species chosen for the supplemental plantings shall either be trees of the same mix of species as the removed trees or mix of species listed in the Woodinville

Plant Species List. Trees shall conform to American Association of Nurserymen (AAN) grades and standards as published in the American Standard for Nursery Stock Manual. Trees should be selected and sited to produce a hardy and drought-resistant landscape area.

(3) Tree size. The required minimum size for any supplemental tree is a diameter-breast-height of two-inches or greater. Multiple-stemmed trees may be permitted as an option to single-stemmed trees, provided that such multiple-stemmed trees are at least 10 feet in height and that they are approved by the City Tree Official prior to installation.

(4) Tree location. In designing a development and in meeting the required minimum tree density, the trees shall be planted in the following order of priority:

(a) In preserved groves, critical areas or its buffers.

(b) Adjacent to stormwater facilities, as approved by the Public Works Director pursuant to Chapter 14.09 WMC.

(c) Entrance landscaping, traffic islands, and other common areas in residential subdivisions that have enough area to support mature trees of the planted species

(d) Site perimeter and/or required landscaped setbacks.

(e) Individual building lots.

(f) Off-site, when room is not available on-site to ensure long-term health and viability for the trees. Trees shall be planted at another location within the same City-designated neighborhood and as approved by the City Tree Official.

(g) Payment to the City Tree Fund. If trees cannot be planted in accordance with (a) through (g), the applicant may satisfy the requirements by paying into the City Tree Fund the current market value of the supplemental trees plus an additional 50 percent for maintenance.

(5) Installation. All required trees shall be installed according to sound horticultural practices in a manner designed to encourage quick establishment and healthy plant growth.

(a) Timing. All trees shall be installed prior to the issuance of a certificate of occupancy or plat recording, except in the following instances where deferred installation is secured with a performance bond pursuant to Chapters 15.42 or 20.06 WMC prior to issuance of certificate of occupancy or plat recording:

(i) Installation is deferred during the summer months up to six months at the next planting season to increase survival rates of planted trees; or

(ii) Installation is deferred due to diseased soil or other pest infestation that will result in a low likelihood of survival, as determined by a qualified tree professional who is ISA certified in risk assessment. Installations may be delayed and not planted for a period of time at the discretion of the City Tree Official. Alternative compliance may be required and replacement trees planted at another site.

(b) Placement. All required trees shall be installed in the ground and not in aboveground containers. When an applicant proposes to place trees above a subterranean structure, the applicant shall: (a) provide site-specific documentation prepared by a qualified expert establishing that the design will adequately support the long-term viability of the trees; and (b) enter into an agreement with the City indemnifying the City from any damage resulting from development activity on the subject property which is related to the physical condition of the property. The applicant shall record this agreement with the County Recorder's Office.

(c) Grading. Berms shall not exceed a slope of two horizontal feet to one vertical foot (2:1).

(d) Soil specification. Soils in planting areas shall have adequate porosity to allow root growth. Soils which have been compacted to a density greater than one and three-tenths grams per cubic centimeters shall be loosened to increase aeration to a

minimum depth of 24 inches or to the depth of the largest plant root ball, whichever is greater. Imported topsoils shall be tilled into existing soils to prevent a distinct soil interface from forming. After soil preparation is completed, motorized vehicles shall be kept off to prevent excessive compaction and underground pipe damage. The organic content of soils in any planting area shall be as necessary to provide adequate nutrient and moisture-retention levels for the establishment of plantings.

(e) Fertilization. Fertilization of trees planted shall be by special approval of the City Tree Official only.

(f) Irrigation. For any required tree planting, irrigation shall be in place. Irrigation shall be designed to conserve water by using best management techniques available, including, but not be limited to: drip irrigation; moisture sensors; automatic controllers; spacing designed to minimize overspray; and separate zones for turf and shrubs to meet watering needs of different sections.

(i) A permanent built-in irrigation system with an automatic controller designed and certified by a licensed landscape architect. This option is required for Tree Permit IV.

(ii) A temporary irrigation system designed and certified by a licensed landscape architect, which provides sufficient water to ensure that the plants will become established.

(iii) Irrigation by hand, applicable only for Tree Permits I or II. An inspection shall be completed by City staff one year after the certificate of occupancy to ensure that the trees have become established.

(iii) Exceptions to the irrigation requirement may be approved by the City Tree Official for less water-intensive strategies such planting native vegetation that does not require supplemental irrigation, low impact development, established indigenous plant material, or where natural appearance is acceptable or desirable to the City. However, those exceptions will require temporary irrigation until established.

(g) Drainage. All planted areas shall have adequate drainage, either through natural percolation or through an installed drainage system. A percolation rate of one-half inch of water per hour is acceptable.

(h) Mulch. Required plantings shall be covered with two inches or more of organic mulch to minimize evaporation and runoff. Mulch shall consist of materials such as yard waste, sawdust, bark or wood chips, and/or organic compost. All mulches shall be kept at least six inches away from the trunks of shrubs and trees.

(i) Protection. All required trees must be protected from potential damage by adjacent uses and development, including parking and storage areas. Protective devices such as bollards, wheel stops, trunk guards, root guards, etc., shall be required as needed to protect required trees.

Staff Comment: This section combines several standards together, including the supplemental tree planting requirements in WMC 21.15.070(e), the alternative compliance in WMC 21.15.040, and installation requirements in WMC 21.15.090.

Are the planting requirements sufficient? What should be added or removed?

*Changes were made to subsection 6 to provide a better provision for alternative compliance. The Tree Official may reduce the density requirements if the purpose and intent are met. A 25% reduction was included to serve as an example. Should this code section be included, and if so what is an appropriate percentage?

WMC 21.15.100 – Alternative Compliance

(1) Additional density credits. The applicant may earn additional tree density credits through alternate measures or procedures that will be equal to or better to the provisions in this chapter. If the City Tree Official determines that the proposal meets the purpose and intent of the code through alternative compliance, the Official may modify the tree density requirements.

(2) Criteria. The City Tree Official shall review each alternative compliance request based on the following criteria:

(a) The alternative is designed to ensure the long-term health and maturity of the tree;

(b) The alternative will provide increased environmental benefits including natural function and values beyond the standard requirements;

(c) If applicable, the alternative will enhance or improve critical areas or NGPE areas.

(d) The alternative will not increase soil erosion, slope instability, nor create drainage issues; and

(e) The alternative provides equivalent or greater compliance with the tree code.

(3) The following activities or strategies may qualify for alternative compliance:

(a) Retention of specimen or heritage trees and groves of trees may earn up to an additional 10 percent of the tree credits for the subject tree or grove.

(b) Use of low impact development (LID) designed to the satisfaction of the City Tree Official and Public Works Director may earn up to an additional one tree credit per 1,000 square feet of designated LID area.

(3) Infrastructure installation or modifications such installation of root protection barriers, planter strips wider than eight feet, and other similar measures to ensure long-term tree health may earn up to 25 percent per affected tree.

(4) Planting 15 square feet of understory landscaping within the canopy area of each supplemental tree may earn up to 25 percent of the tree credits for the subject tree. Understory landscaping must include shrubs planted at least 24 inches on center and groundcovers planted 18 inches in center.

Staff Comment: *This section is new and addresses previous discussions on how to incentivize certain actions or strategies that would not otherwise be covered in other sections.

Is this section something that should be included in the tree code? What other alternative strategies should be included? Are the incentives reasonable?

21.15.110 – Tree Maintenance

(1) The following maintenance requirements apply to all trees planted consistent with this chapter:

(a) Responsibility for Regular Maintenance. The applicant, landowner, or successors in interest shall be responsible for the regular maintenance of required trees. Trees that are dead and removed shall be replaced in-kind by the property owner. The timing of the replacement planting shall be determined by the City Tree Official and a qualified tree professional.

(b) Maintenance Duration. Maintenance shall be ensured in the following manner except as set forth in subsections (1)(c) and (d) of this section:

(i) All required trees shall be maintained throughout the life of the development.

(ii) Any existing tree, tree designated for preservation, or planted tree shall be maintained for a period of five years following issuance of the certificate of occupancy or plat recording for the individual lot or development. A

maintenance guarantee pursuant to Chapter 15.42 or 20.06 WMC shall be secured to ensure the maintenance.

(c) Non-native Invasive and Noxious Plants. It is the responsibility of the property owner to remove non-native invasive plants and noxious plants from the vicinity of any tree or other vegetation. Removal must be performed in a manner that will not harm the tree or other vegetation that the City has required to be planted or protected.

(d) Pesticides, Herbicides, and Fertilizer. The use of pesticides, herbicides, or fertilizer shall be by special approval of the City Tree Official only.

(2) Tree Permits and Utility Plans. Tree permits and utility plans shall be coordinated. In general, the placement of trees should adjust to the location of required utility routes both above and below ground. Location of trees shall be based on the plant's mature size both above and below ground.

(3) Tree Pruning. Topping or pruning to the extent that would constitute tree removal as defined in Chapter 21.06 WMC is not allowed. If a required tree smaller than six inches in diameter-at-breast-height is topped, it must be replaced pursuant to the standards in WMC 21.15.120. If a tree six inches or larger in diameter-at-breast-height is topped, the property owner may be subject to enforcement actions pursuant to WMC 21.15.130. Trees may be windowed or limbed up using best management practices. This method of tree pruning shall maintain the health of the tree.

(4) Table 21.15.110 – Pruning Techniques. The following techniques for healthy pruning shall be used. No permit is required for pruning; however, all pruning should be done under the direction of a qualified tree professional.

Table 21.15.110(4) Table 1 – Pruning Techniques

Healthy Pruning Techniques	Improper Pruning Techniques
Crown Cleaning – removing dead, dying, diseased, crowded, weakly attached, or low-vigor branches, in a manner that should not reduce the canopy.	**Topping –** the cutting of a trunk or main branch to the point where there is no branch large enough and vigorous enough to become the new leader.
Crown Thinning – selective removal of branches throughout the crown of the tree to improve interior light and air. Remaining branches should be well-distributed and balanced.	**Stripping –** removing the branches from the inner section of the trunk or branch. Can cause structural imbalances and potential failure.
Crown Raising – removal of the lower branches of the tree to provide height clearance, typically 8 feet for pedestrians and 16 feet for vehicles.	**Imbalance –** removing portions of the tree and creating an imbalance in the structure of the tree. Can cause cracking damage from the wind through twisting; or weak new growth.
Windowing – removing several branches symmetrically within an area of the tree's crown to enhance views.	**Excessive Pruning –** removing portions of the tree to a point where it can kill the tree. Can invite decay and disease.

Staff Comment: *Minor modifications were made to clean up this section.

21.15.120 – Tree Protection During Construction

(1) These standards must be adhered to through the duration of site work and included on demolition, grading, and building plans as necessary. Prior to development activity or initiating tree removal on the site, vegetated areas, groves and individual trees to be preserved shall be protected from potentially damaging activities. A meeting on-site between the City Tree Official or designee and the contractor shall be held to determine that these standards have been met, prior to site disturbance.

(2) Tree protection measures shall include, but are not limited to, the following:

(a) Protective Barrier. Prior to any site disturbance, a temporary protective barrier shall be erected to establish the limits of disturbance that extends five feet beyond the dripline of all retained trees. No construction activities, storage, parking, or construction vehicle access is allowed in this area.

(i) The protective barrier shall be constructed of chainlink and at least four feet in height. Signage shall be installed no further than 15 feet apart on the protective barrier. The protection barrier shall follow the fencing standard detail established by the City.

(ii) The protective barrier shall be maintained until completion of the project and is authorized by City Tree Official.

(b) Toxic Materials. Measures shall be in place for the proper disposal of toxic materials such as polluted runoff, concrete washout or other chemicals.

(c) Excavation near trees. Excavation or compaction of earth or other potentially damaging activities is prohibited within the protective barrier. The City Tree Official may allow such activities approved by and under the supervision of a qualified tree professional retained by the applicant.

(i) If equipment is authorized to operate within the critical root zone, the areas adjoining the critical root zone of a tree shall be covered with mulch to a depth of at least six inches, or with plywood, metal or similar material in order to protect roots from damage caused by heavy equipment.

(ii) Minimize root damage by excavating a two-foot-deep trench, at edge of critical root zone, to cleanly sever the roots of trees to be retained.

(iii) Corrective pruning performed on protected trees in order to avoid damage from machinery or building activity.

(iv) Maintenance of trees throughout construction period by watering.

(d) Grade. The grade shall not be elevated or reduced within the critical root zone of trees to be preserved without the City Tree Official's authorization based on recommendations from a qualified tree professional. The following activities may occur:

(i) Coverage of up to one-half of the area of the tree's critical root zone with light soils (no clay) to the minimum depth necessary to carry out grading or landscaping plans, if it will not imperil the survival of the tree. Aeration devices may be required to ensure the tree's survival.

(ii) If the grade adjacent to a preserved tree is raised such that it could slough or erode into the tree's critical root zone, it shall be permanently stabilized to prevent suffocation of the roots.

(iii) The applicant shall not install an impervious surface within the critical root zone of any tree to be retained without the authorization of the City Tree Official. Alternatives to installing impervious surface within the critical root zone shall be considered.

(iv) Utility trenches should be located outside of the critical root zone of trees. If utilities must be placed within the critical root zone, the applicant's qualified tree professional shall establish to the satisfaction of the City Tree Official that the design will adequately support the long-term viability of the trees.

(v) Trees and other vegetation to be retained shall be protected from erosion and sedimentation. Clearing operations shall be expose the smallest practical area of soil to erosion for the least possible time. To control erosion, it is encouraged that shrubs, groundcover, and stumps be maintained on the individual lots, where feasible.

(e) Directional Felling. Directional felling of trees shall be used to avoid damage to trees designated for retention. Any trees designated for preservation, per the approved tree plan, that are significantly damaged or destroyed during felling of trees approved for removal shall be replaced per WMC 21.15.070.

(f) Additional Requirements. The City Tree Official may require additional tree protection measures that are consistent with accepted urban forestry industry practices.

Staff Comment: This section includes some minor changes. Language was condensed where repetition and wordiness occurred. Full editing of this section has not been completed.

Are there other protection measures that are missing? Are there ones that are unnecessary?

21.15.130 – Enforcement and Penalties

(1) Authority. It shall be the duty of the City Tree Official, or designee, to administer the provisions of this chapter. The City Tree Official shall have authority to enforce and carry out the provisions of this chapter. Enforcement shall be conducted in accordance with the administrative code enforcement procedures and special enforcement provisions related to tree conservation set forth below. To the extent there is a conflict between the provisions of this section and Chapter 1.06 WMC, this section shall control.

(2) Voluntary Compliance. Voluntary compliance is the preferred method of enforcement. The following remedies should only be pursued when a violator is not voluntarily complying with the restoration requirements, when other requirements are stipulated by the Code Enforcement Officer or City Tree Official, or when the violator did knowingly act in a manner contrary to the requirements of this code.

(3) Cease and Desist. The City Tree Official may issue a notice to cease and desist using the procedure set forth in WMC if the City Tree Official finds that a violation of this code has occurred. Continued illegal tree activity following issuance of a cease and desist from the City for the tree activity shall result in fines of $1,000 per day of continued activity.

(4) Stop Work Order. If a violation of this chapter or an approved tree plan occurs on property on which work is taking place pursuant to a City of Woodinville development or building permit, the City Tree Official may suspend work as appropriate through issuance of a stop work order. The City Tree Official shall remove the stop work order when the City Tree Official determines that the violation has been corrected or when an agreement has been reached with the violator regarding rectification of the violation. Any stop work order issued under this section may be appealed using the procedures set forth in Chapter 2.30 WMC.

(5) Notification of Violation. The City's Code Enforcement Officer shall notify a person who violates this chapter; such notification shall also include a statement of the restoration action required to be taken to correct the violation as determined by the City Tree Official.

(6) Civil Penalty. A person who fails to comply with the requirements of this chapter or the terms of a permit issued hereunder, who undertakes an activity regulated by this chapter without obtaining a permit, or fails to comply with a cease and desist or stop work order issued under this chapter shall also be subject to a civil penalty as set forth in Table 21.15.130. Each unlawfully removed or damaged tree shall constitute a separate violation.

(a) Any person who aids or abets in the violation shall be considered to have committed a violation for purposes of the civil penalty.

(b) The amount of the penalty shall be assessed in accordance with Table 21.15.130. The City Tree Official may elect not to seek penalties if he or she determines that the circumstances do not warrant imposition of civil penalties in addition to restoration.

(c) Table 21.15.130 – Penalties.

Table 21.15.130(6) Table 1 – Penalties

Types of Violations	Allowable Fines per Violation
1. Removal of tree(s) approved to be removed, but prior to final tree plan approval or issuance of a City tree removal permit	$1,000 per tree
2. Removal or damage of tree(s) that are or would be shown to be retained on an approved tree plan or any other violation of approved tree protection plan	$1,000 per tree
3. Removal of tree(s) without applying for or obtaining a required City permit	$1,000 per tree

(8) Tree Restoration.

(a) Violators of this chapter or of a permit issued thereunder shall be responsible for restoring unlawfully damaged areas in conformance with the requirements of this chapter. Information shall be submitted on repair of any environmental and property damage and restoration of the site results in a site condition that, to the greatest extent practical, equals the site condition that would have existed in the absence of the violation(s).

(b) In cases where the violator intentionally or knowingly violated this chapter or committed previous violations of this chapter, restoration costs shall be paid at the discretion of the City Tree Official. Restoration costs may be based on the City-appraised tree value of the subject trees, utilizing the industry standard trunk formula method in the current edition of "Guide for Plant Appraisal." If diameter of removed tree is unknown, determination of the diameter size shall be made by the City Tree Official by comparing size of stump and species to similar trees in similar growing conditions. The amount of costs above the approved restoration plan will be paid into the City tree fund.

(c) Restoration Plan Standards. The restoration plan shall be in accordance to the following standards:

(i) The number of trees required to be planted is equal to the number of tree credits of illegally removed trees according to Table 21.15.070.

(ii) The minimum size for a tree planted for restoration shall be as required under WMC 21.15.070(2).

(iii) In the event the violators cannot restore the unlawfully removed or damaged trees due to current or future development activity or other site conditions as determined by the City Tree Official, the violators shall make payment to the City tree fund. Unless otherwise determined to base the restoration costs on appraised value, the amount paid will be the City's unit cost for a restoration tree multiplied by the number of outstanding tree credits plus 50 percent for maintenance. The City's unit cost is based on the current market cost of purchase, installation and five-year maintenance for a minimum-sized tree for restoration.

(iv) The restoration plan shall include a maintenance plan and an agreement or security to ensure survival and maintenance of restoration trees for a three-year period unless the violation was on a site with an approved tree plan, in which case the maintenance period is five years.

(9) Failure to Restore or Pay Fines.

(a) Prohibition of Further Approvals. The City shall not approve any application for a subdivision, short subdivision, or any other development permit or approval or issue a certificate of occupancy for property on which a violation of this chapter has occurred until the violation is cured by restoration or other means accepted by the City Tree Official and by payment of any penalty imposed for the violation.

Staff Comment: This section includes some minor changes. Language was condensed where repetition and wordiness occurred.

DEFINITIONS

WMC 21.06.063 Broadleaf tree
Broadleaf tree: a tree characterized by leaves that are broad in width and may include both deciduous and evergreen species.

WMC 21.06.101 City Tree Official
City Tree Official: the Development Services Director or his/her designees responsible for implementing the Community Urban Forestry Plan and Regulations. The City Tree Official shall use the expertise of a certified arborist, under contract by the City, for technical advice on decisions related to the community urban forest.

21.06.139 Critical root zone.
Critical root zone: the area surrounding a tree at a distance from the trunk, which is equal to one foot for every inch of tree diameter-at-breast-height or otherwise determined by a qualified tree professional.

21.06.140 Crown.
Crown: the area of a tree containing leaf- or needle-bearing branches.

21.06.143 Deciduous.
Deciduous: a plant species with foliage that is shed annually.

21.06.168 Diameter-at-breast-height.
Diameter-at-breast-height: the diameter measurement in inches of the outside bark of a tree trunk, measured at four-and-a-half feet above the ground line. New plantings are to be measured at six inches above the ground level.

21.06.174 Dripline.
Dripline: the distance from the tree trunk, that is equal to the furthest extent of the tree's crown.

21.06.220 Evergreen.
Evergreen: a plant species with foliage that persists and remains green year-round.

WMC 21.06.309 Heritage tree
Heritage tree: a tree or stand of trees that is particularly desirable because it has valued, unique characteristics that set them apart from other similar trees. Valued, unique characteristics include uncommon genus, species, form, size, location, historic significance or other desirable feature(s).

WMC 21.06.359 Limit of disturbance, tree.
Limit of disturbance, tree: the boundary between the area of minimum protection around a tree and the allowable site disturbance as determined by a qualified tree professional.

21.06.406 Native growth protection area (NGPA).
Native growth protection area (NGPA): an area where native vegetation is preserved for the purpose of preventing harm to property and the environment, including, but not limited to, controlling surface water runoff and erosion, maintaining slope stability, buffering and protecting plants and animal habitat.

21.06.408 Naturalized species.
Naturalized species: nonnative species of vegetation that are adaptable to the climatic conditions of the coastal region of the Pacific Northwest.

21.06.486 Qualified tree professional.
Qualified tree professional: an individual with relevant education and training in arboriculture or urban forestry. The individual must be an arborist certified by the International Society of Arboriculture or a registered consulting arborist from the American Society of Consulting Arborists. For Forest Management Plans, the qualified tree professional must have the ability to assess wooded sites and prescribe measures for forest health and safety. A qualified tree professional that makes determinations on hazard or nuisance trees is required to have certification as a tree risk assessor.

WMC 21.06.599 Significant tree
Significant tree: an existing healthy tree which has a minimum diameter-at-breast-height of six inches, as measured according to the most current published edition of the International Society of Arboriculture's "Guide for Plant Appraisal."

WMC 21.06.xxx Snag or wildlife tree.
Snag or wildlife tree. The remaining trunk of a tree that was intentionally reduced in height and usually stripped of its live branches.

WMC 21.06.617 Specimen tree.
Specimen tree: a viable tree that is considered in very good to excellent health and free of major defects, as determined by the City's Tree Official

WMC 21.06.680 Tree removal
Tree removal: the removal of a tree, through either direct or indirect actions, including but not limited to: (1) clearing, damaging or poisoning resulting in an unhealthy or dead tree; (2) removal of at least half of the live crown; or (3) damage to roots or trunk that is likely to destroy the tree's structural integrity

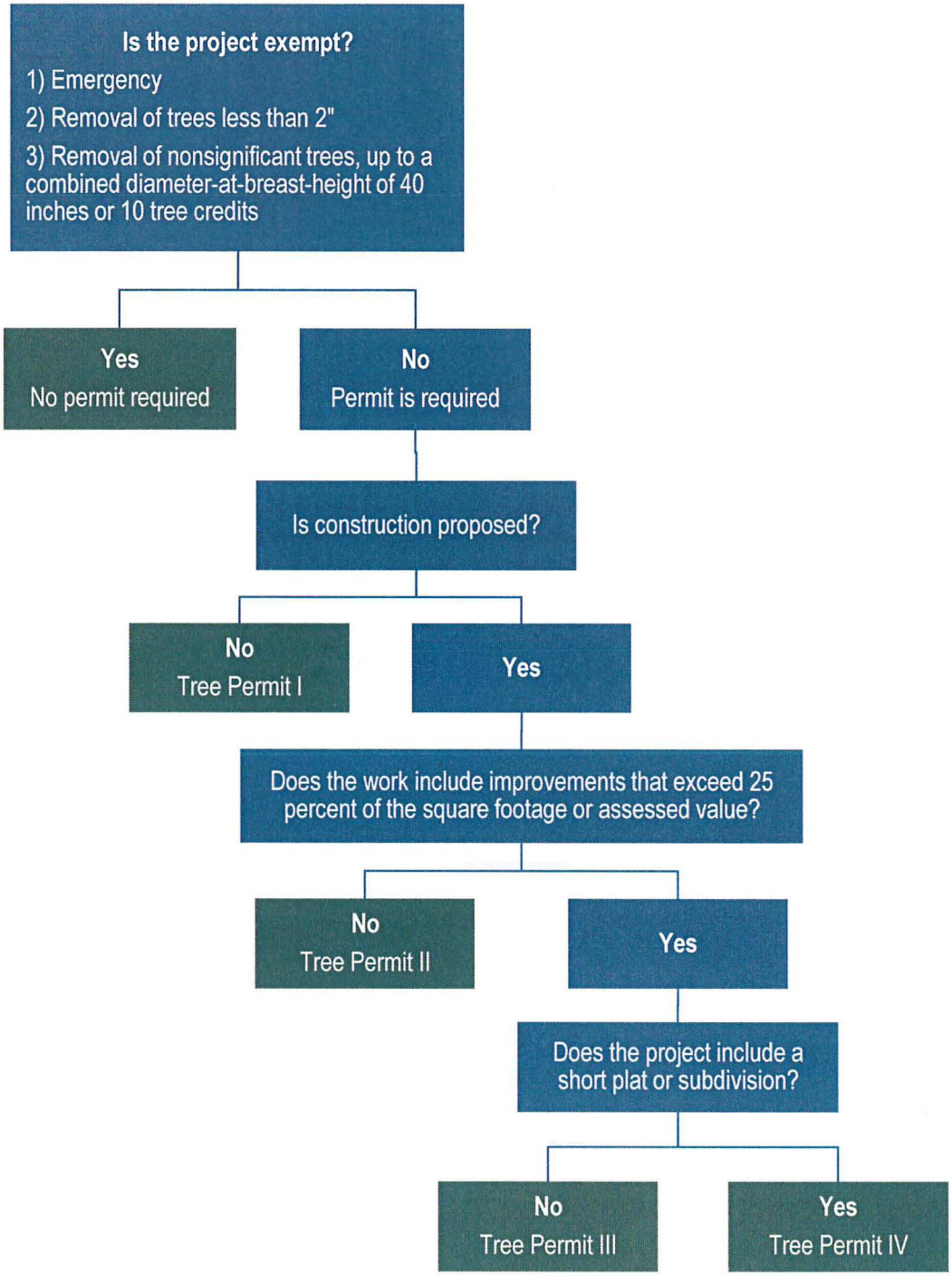
WMC 21.06.xxx Tree grove

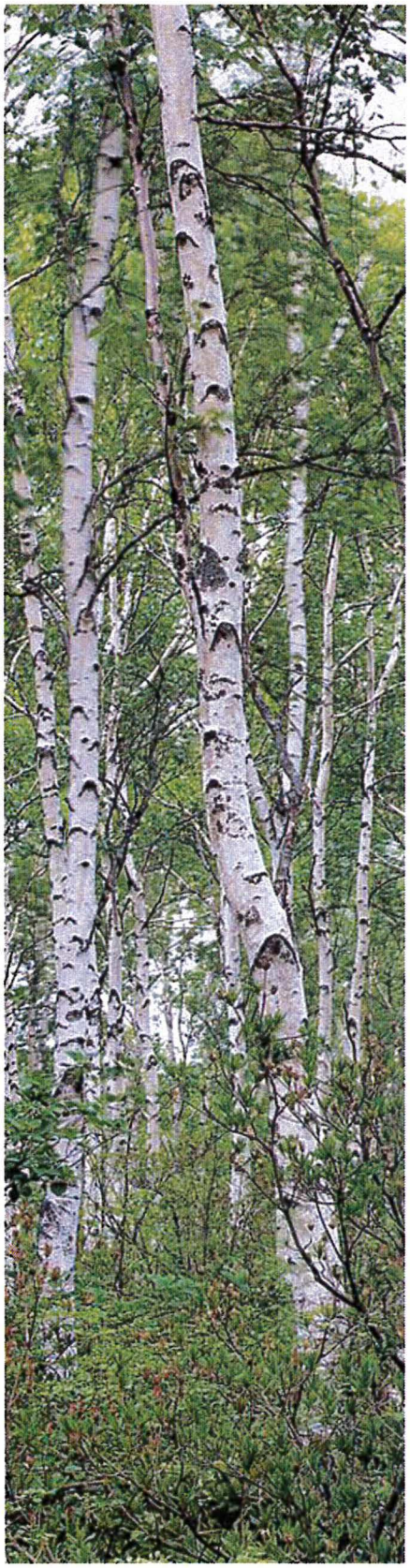
21.06.695 Viable tree.

Viable tree: a significant tree that a qualified tree professional has determined to be in good health, with a low risk of failure due to structural defects, is relatively windfirm if isolated or remains as part of a grove, and is a species that is suitable for its location

Staff Comment: A new definition for tree grove, snag or wildlife tree was included.

Attachment 2. Flow chart outlining new permit requirements.





City of Woodinville Tree Canopy Assessment

University of Washington Extension
Geographic Information Systems
Certificate Program, 2008-2009

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1. ABSTRACT

This GIS project is an assessment of the total percentage of urban tree cover within the city limits of Woodinville, Washington. It was conducted from January to June 2009 through the University of Washington Extension, Geographic Information Systems certificate program, in cooperation with the City of Woodinville and the Woodinville Tree Board. This project specifically addresses urban tree coverage through aerial photography over a roughly 6 square mile area.

In order to determine a tree cover percentage for the city, a vectorized raster layer was developed by digitizing a 2007 aerial photograph of Woodinville. Digitizing was accomplished by overlaying a grid of uniform square cells onto the photograph. Within each cell, tree cover percentage was evaluated and assigned a numerical value between 0 and 100, in increments of 5. The resulting vectorized raster layer calculated tree coverage within the city limits boundary at 36%.

To further analyze tree coverage for specific areas of the city, the primary resultant grid was subdivided into smaller assessment grids. The subdivided grids included eleven well-defined neighborhoods and four re-combined zoning districts. A grid analyzing tree type for the entire city was also produced. The project deliverables included maps, charts, tables, and a written report. Also included is specific methodology for re-creating each of these grids (and additional custom grids) for the purposes of analyzing either tree coverage or tree type.

2. INTRODUCTION

It is generally understood and appreciated that trees within our communities provide both beauty and function. In fact, urban forests, and the chain of life that they support, are a vital component of any community. The necessity to protect, manage, and improve urban forests where possible has become an important function in effective community and city planning. The Washington State Legislature in 2008 affirmed this position through their "Evergreen Communities Act" (HB 2844). One of the statements in this act reads, "The legislature finds that the preservation and enhancement of city trees and urban and community forests are one of the most cost-effective ways to protect and improve water quality, air quality, human well-being, and our quality of life."

With this in mind, the city of Woodinville is making significant efforts to responsibly address urban forests and tree canopy cover in their city planning. They have already met the standards to become a certified Tree City USA organization and have designated a Tree Board to oversee a specific Work Plan for 2008-2009. This plan recognizes that Woodinville is losing its tree canopy cover at a substantial rate due to urban development and illegal tree cutting. From these activities the city is concerned that tree canopy loss

will contribute to the degrading of all normally functioning ecosystems, of which the trees are a vital component.

As one of the first steps to remedying this situation, the Woodinville Tree Board's work plan calls for a GIS analysis project of the tree canopy cover. The analysis is based on an aerial photograph of the city taken on April 3, 2007. This analysis project effectively assesses current conditions of the tree cover, and provides a basis for next planning steps.

3. PROJECT PLANNING

A. ORGANIZATION

The project was organized around five planning phases. The phases were chronologically ordered according to logical progression. Each member participated in all phases, roughly within the parameters of their respective roles. For each month of the project a status report was generated to keep the project on track and document all project activities. The monthly reports also served as a feedback mechanism for class instructors who advised during the project. The five phases were as follows:

1. Research and investigate other tree canopy assessment projects and studies to review various methodologies and procedures used in similar circumstances.
2. Consult with remote imaging specialists as well as the Washington State Department of Natural Resources. Attend sessions of the DNR Technical Advisory Committee formed to address the Evergreen Communities Act.
3. Experiment with and evaluate different digitizing techniques for use with aerial photography. Select best digitizing process.
4. Conduct digitizing of the aerial photo, followed by quality control measures and analysis of the data.
5. Produce final deliverables package including maps, tables, charts and a written report documenting all methodology and procedures.

Phase three was particularly highlighted in the plan, as it was recognized to be the greatest challenge and vital to the success of the project. All digitizing methods considered needed to meet certain minimum requirements. These included:

- All digitizing needed to be accomplished within the time period of approximately 6 weeks.
- The task of manual digitizing within that time frame, had to be achievable by the limited number of 3 project members.
- Digitizing needed to be highly detailed and accurate.
- Digitized tree cover needed to be comprehensive over the entire city, not merely a sampling of selected areas.
- Methodology of digitizing needed to have the ability to be easily replicated for future use.

B. REVIEW OF LITERATURE

In order to select an effective method of digitizing that met all these requirements, the first phase of the project involved researching and investigating other projects and studies regarding tree canopy assessments. It was important to determine what approach others had used in their assessments, whether those approaches could be replicated, and explore all options and variables involved. While many studies and projects were investigated, two in particular seemed most relevant.

The first, a project conducted by a Washington DC based not-for-profit called Casey Trees, was outlined in a 2006 report. Their website describes this program as a group dedicated to restoring, enhancing, and protecting the tree canopy in the greater Washington DC area. One of the comprehensive plans for their assessment project was to determine the extent of the District's tree canopy at a sufficient level of detail to establish tree canopy goals for neighborhoods across the city. While this project encompassed assessments of many different ecological aspects including stormwater runoff and "green roofs," the measuring of the tree canopy was a major component. This was accomplished both by individual street tree survey inventories and high resolution satellite data.

Another study consulted for this project was from 2006, and was titled, "A method for locating potential tree-planting sites in urban areas: A case study of Los Angeles, USA." Conducted by researchers at UC Davis and the Center for Urban Forest Research, this study developed criteria to identify locations for possible tree planting. Within a GIS software environment, a computer program was developed to search, test, and locate potential tree planting sites around the Los Angeles area. The computer program made its assessment by "planting" virtual trees in suitable areas. Land cover data in the base map used for locating potential tree-planting sites was derived from remote sensing data. Specifically, the imagery used for the LA study was collected by Quickbird satellite at various times from 2002-2005. Although this was not a tree canopy assessment per se, it was an assessment of ground cover over an urban environment and included many elements also present in the Woodinville project.

To further gather background and investigative information, project members attended two meetings of the Washington State Department of Natural Resources, Technical Advisory Committee. This committee of forestry, planning, and GIS professionals was formed to address requirements of the Washington state legislature's 2008 Evergreen Communities Act. It was hoped that the methodology selected for the City of Woodinville tree assessment could parallel that used by the Washington State DNR for consistency with already established state-wide procedures. However, the ultimate recommendation of the committee was for the use of remote imaging or satellite data, which was not an option in the Woodinville project.

Despite this recommendation, the information gathered from these meetings, and those of the Casey Trees and Los Angeles studies, among others, was useful. It helped to distinguish between two related, yet quite different approaches to urban tree management: street tree inventories and tree canopy coverage assessments. Since the

Woodinville project was not an inventory of trees, but rather an assessment of overall tree coverage, a method of digitizing needed to be found that could mimic the results of satellite data which seemed best suited for use in coverage assessments. Moreover, if the end results of the assessment using another methodology could rival that of satellite data, it should lend the kind of validity to the outcome inherent to remote image sensing.

The final aspect of information gathering involved direct consultation with several experts and professionals in the fields of forestry, remote image sensing, urban planning, photogrammetry, and of course, Geographic Information Systems. These experts provided valuable insights into the various methodologies, techniques, and processes used in projects of this type. Their advice and recommendations were used to evaluate the best approach to the project, considering overall resources and requirements. While these sources did indicate that the prevailing methodology used in tree canopy assessments was high resolution satellite data, their information left open the possibility of achieving somewhat similar results with other methods.

C. PROPOSED METHODS

Following the review of literature and information obtained, there were six different analysis methods which were considered. The first was the windshield survey. A windshield survey involves making a cursory examination of the study area based on pre-defined criteria. Often, as the name implies, it is done quickly, from the seat of a moving car – however, a windshield survey can also be done with great care. For a tree canopy assessment, a team of analysts would likely drive around the city with a GPS and estimate the boundaries of large continuously forested areas. The benefits of such a scenario are clear – a pair of volunteers could complete an initial assessment over the course of a weekend. Unfortunately, a windshield survey would severely underestimate the canopy because it is unable to take into account inaccessible private lands, and unsuited to the survey of sparsely forested suburban areas. Because this analysis method did not meet the city's expectations of accuracy and thoroughness, it was very early abandoned.

Another analysis method considered was the inventory survey. There are two types of inventory survey: the sample and the complete. A sample inventory survey is an ideal companion to a windshield survey. After plotting forested areas, the analysis team would enter the area and inventory the properties of a representative sample of individual trees, including estimated height, diameter at breast height (DBH), and taxonomy. A complete inventory would assess the properties of every individual tree. In regards to city tree planning and protection, a complete inventory would be the perfect ideal – each tree could be separately tracked and judged. However, such an ideal is unrealistic. A complete inventory would take uncountable man-hours, and would likely be unsustainable. The sample inventory has its own merits, but in the end is just as rough as a windshield survey.

The third analysis method considered is by far the most commonly used for this type of project – remote sensing. Remote sensing involves the use of satellite images as the basis

for analysis. Because all object classes have a unique spectral signature (the amount of energy they reflect at given frequencies), it is possible to program a computer to analyze a satellite image. With time and patience, one could theoretically train the analysis computer to find individual trees by species, if the data was spatially and spectrally rich enough. The primary drawback to remote sensing analysis is upfront cost. Images with the spatial and spectral resolution required for accurate analysis are enormously expensive, often costing thousands of dollars per hectare. The cost of image processing software and personnel training can also be formidable. Of course all remote image analysis requires extensive ground-truthing to verify its results. The main benefit, though, is that once the results have been ground-truthed, they are scientifically repeatable and mathematically defendable. Remote sensing is by far the least subjective analysis method available, but it can be difficult for a small municipality to justify the cost.

Satellite imaging is not the only form of remote sensing. Aerial photo analysis, also known as photogrammetry, is also considered a part of remote sensing. Features identified in an aerial photo can be drawn in a map, and then analyzed independently of the photo.

The fourth method of analysis considered involved sketch digitizing. Through the use of a Wacom digital pen tablet and the free ArcSketch extension, continuous stands and individual trees were traced directly over the aerial photo, creating polygons which could later be analyzed. The primary drawbacks of this method were based on the fact that the project required the team to divide the work of digitizing evenly among the members. Not every team member had a pen tablet, and although the sketching could be done with a mouse, there would be an obvious quality difference among the results. The steadiness of each individual's hand would also be a factor leading to diverse results. Although all survey methods involve some level of subjectivity, the sketch method was the only one that involved physical subjectivity.

A fifth method, similar to sketch digitizing was dubbed "mixed type" digitizing. In an attempt to standardize the drawing of features over the aerial photo, it was decided to use a point to denote individual trees, and regular polygons to denote continuous stands. The points would later be buffered with a circular polygon which approximated the tree's canopy breadth. After all the trees were drawn, they could then be analyzed. One benefit of this method was that it could be expanded very easily. For example, a street tree inventory could be tied to the appropriate polygons. Although this concept had many merits, it required too much time to be spent at the individual tree level. The project's limited resources required some method of automating either the analysis, or the digitization, or both.

The sixth and final analysis method considered was grid indexing. Grid indexing is often used as a sample or ground-truthing technique. A grid of evenly sized cells, much like a sheet of graph paper, is overlaid onto the aerial photo. From there, sample areas can be picked using a 'dartboard' method, or some sort of predefined counting algorithm. A similar type of analysis is actually practiced in remote sensing – each pixel of the image is analyzed independently, and the resulting raster grid is then analyzed as a whole. Our

idea was to create a grid which covered the city in appropriately sized cells and then assign an analysis value to each cell. The results would be more subjective than a traditional remote sensing analysis, because the analysis relied on human interpretation, but it avoided the flaws of the other manual methods, which involved looking at each tree individually. Additionally, the creation of the grid itself could be automated, saving critical time.

Of all the methods available, grid indexing seemed to offer the most efficient use of time and resources. First of all, it utilized the already available and highly detailed aerial photo, which was a valuable central resource in several city projects. Also, the drawing of the grid could be automated, which minimized the subjectivity of feature creation. And finally, the individual cell analysis could be done quickly by multiple independent analysts, taking advantage of limited time and resources. As it turned out, the final grid could also be used creatively for interesting products and results.

Although the resultant grid was composed of vector polygons, the effect of the polygonal topology simulated a raster. This allowed the final product to be easily converted back and forth from a raster to a vector, and allowed a variety of different analyses to be run.

4. METHODOLOGY

A: PROCESS

The first step in the project work phase was to create the digitization grid. This was accomplished using a developer sample code called DS Map Book. DS Map Book acts as an extension to ArcGIS, and its primary purpose is to create an index map for a multiple-page map set. The resulting grid, heretofore referred to as the 'index grid', is effectively a large group of square polygons, each having a unique identifier. The city boundary (including the UGA) was used to constrain the extent of the grid, which created just enough grid cells to fill the city area. The calculated dimensions of the grid cells were $1/8^{th}$ inch by $1/8^{th}$ inch on the screen at a scale of 1:5000. At the digitizing scale of 1:500, this represented an area nearly an inch square on the screen. The actual real life area of each grid cell was 2712.67 square feet, with a side length of 52.08 feet.

Once the index grid had been created, three additional fields were added to the database. The first was called 'TC_Percent', which was the field reserved for the tree cover percentage. In this case, percentage refers to the ratio times 100, making it a more obvious human number. It was decided that tree cover would be estimated in multiples of five, because less discrete numbers would have been impossible to validate, and multiples of ten would have ignored the natural fractions of ¼ and ¾. The second added field was 'TC_Type', the tree cover type. The three possible values were 'C' denoting coniferous, 'D' denoting deciduous, and 'M' denoting mixed type. It is important to note that these values represented existence, not a majority type. If a single branch from a deciduous tree extended into a cell dominated by coniferous trees, the cell was labeled as having mixed

type. The third field was called 'TC_Flag', and was used exclusively by the digitizing team to mark cells that demanded extra attention. For further information on the fields and attributes of the index grid, please see the Appendix.

Aerial Photo Preparation

As a rule, aerial photographs tend to be very dark, and have strong shadows. In order to make the process of digitization easier, a graphics program called Adobe Photoshop was used to color-correct the images. Photoshop is an industry benchmark for graphics and photography, and its ability to deal with the geographically rectified images (geotiffs) used in ArcGIS can be expanded with a software plug-in called Geographic Imager from Avenza Systems.

The first step was an Auto Levels filter, which creates a binned histogram based on the lightest and darkest values in the image, and then equalizes the intermediate values. This filter makes the colors of the image look more natural. The next step was to readjust the Levels for each color channel – red, green, and blue. This partially undoes the effects of the previous step as it denormalizes each channel in order to enhance it. The values of the red and blue were decreased by 0.90 and 0.95, respectively, and the green value was increased by 1.10. These values were chosen on the fly for their result: an unnatural image in which plants stood out. In order to reduce the shadows, a third adjustment was made – the contrast was increased by 30% and the brightness was increased by 20%. The final result was a set of image tiles which the team determined was easier to analyze. It is important to remember that the adjusted aerial photos were only a step in the digitization process, and should not be considered part of the final deliverables.

Digitization Process

In order to maximize the efficiency of the time spent on the digitization, the cells of the index grid were divided equally among the three team members. Each member would digitize their own cells individually, and then the tables would be recombined before quality control proceeded. Before beginning, two steps were taken to ensure that each digitizer was being as objective as possible. The first step was a digitizing test. A random string of 25 cells was chosen from a suburban area of the city, and each team member evaluated the cells separately. When the results were compared, it was found that there was a high degree of similarity and agreement between digitizers. The second step was to draw up a series of standard guides illustrating some common situations (**see Figure 1**).

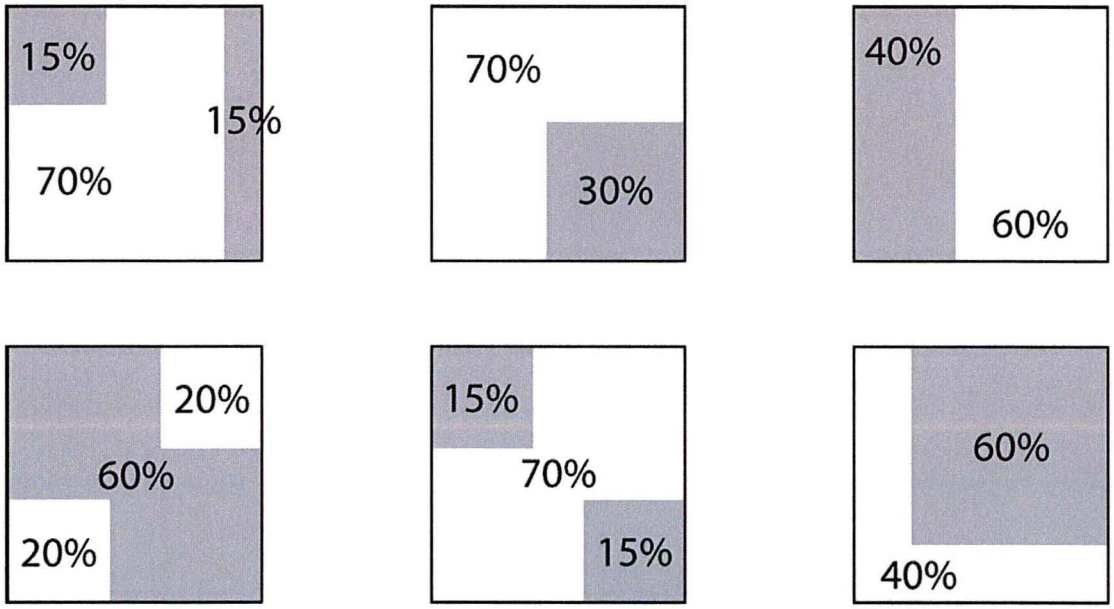


Figure 1 – These boxes represent various combinations of area percentages which were likely to be encountered during the digitization process.

Based on the 6-inch pixel resolution of the aerial photo, and the level of detail the team thought the photo warranted, it was decided to do the analysis at a 1:500 scale. The actual work of digitizing was more tedious than difficult. When a cell is selected in ArcMap, a tiny cross appears in the center, making it easy to estimate percentages from a four-quarter perspective. Other techniques, such as combination and subtraction, helped to mentally reorganize the trees in a cell, making it easier to name a percentage. The task is well-suited to those with excellent spatial cognition skills (someone who is good at estimating distances). Of course, as with all endeavors, the process became easier over time. Although digitizing speed is relative to the density of trees in the focus area, a fair estimate is 250 cells per hour. Using that value, it was estimated that approximately 260 hours were spent on the digitization – a significant proportion of the overall time spent on the project.

Once the digitization was completed, the three parts of the index grid were recombined. At that point, the quality control phase of the project could begin.

B: QUALITY CONTROL

Following the digitizing phase of the project, all combined data was subjected to a number of methods of quality control. The first method employed was to conduct data integrity checks within the attribute table. Search commands combed the tree cover

percentage column to discover any numerical values that were not listed in increments of five. Any errors discovered were reevaluated within the appropriate grid cell and assigned the correct percentage value. A similar check was made within the tree type column, to discover any values that were not labeled correctly. Attributes falling outside the appropriate designations were also reevaluated and reassigned. This quality control method was best suited to weeding out typographical errors.

The second quality control measure taken was to conduct ground-truthing within the project boundary area. Using the aerial photo and overlay grid displayed on a laptop computer, the project team drove to a number of selected sites with the intention of visually inspecting and comparing actual tree cover with the corresponding grid cells and underlying aerial photo. A Garmin Nuvi 650 was used to determine correct geographical location in the field. All sites observed confirmed correct assessments of tree percentage and type, i.e. that trees had been correctly differentiated from bushes, scrub, and open fields. This quality control method was most important as a validation of our photographic interpretation skills.

As stated previously, the index grid included a method of flagging questionable cells. The third quality control measure involved clearing those flags. This practice was largely an effort of teamwork, and the results were the products of consensual agreement. After the ground-truthing expedition, most of the tree vs. non-tree questions were decidedly easier to answer.

The fourth quality control measure was another database search. This time, the team searched for cells with 0% tree coverage adjacent to cells with 100% tree coverage. It was surmised that such an occurrence would be unlikely in nature, and was most likely an additional typographic error. As we found out, though, such an occurrence is rather common within the city. This is easily explained by the interaction between the regularity of the digitizing grid and the regularity of the street grid – a large number of cell boundaries coincided with abrupt roadway edges. However, a few actual errors were found, and all the cells in the surrounding area were reevaluated.

The fifth quality control measure instituted was a random sampling of the entire index grid. The selection of cells to be error-checked was determined by the use of a so-called 'dartboard method', in which cells were chosen pseudo-randomly from the entire grid. In order to increase the apparent randomness while insuring equal coverage over the entire city, the grid was sampled at the neighborhood level. The city of Woodinville is divided into eleven separate neighborhoods, each of which covers a geographically or municipally distinctive area. Our goal with the dartboard selection was to make sure that each part of each neighborhood was adequately represented in the sample. In total, 127 cells were sampled (**see Plate 1**). Because of the neighborhood sampling, the sample density was higher at the nexuses of multiple neighborhoods. Using the following standardized equation, the team was able to determine the sampling size error.

$$\text{Sampling Error} = \sqrt{\frac{p(100-p)}{n}}$$

p = sample percentage
n = sample size

Based on a population size of 65,250 and a sample size of 127, the calculated sampling error was +/- 3.8%. Once the sample cells had been chosen, they were evaluated for correctness by group consensus, and the evaluation was compared to the original results, with consistent success.

The sixth and final quality control measure was an evaluative comparison between photo data and analysis data. After the data had been completely classified and a preliminary thematic map had been prepared, it became immediately clear that the digitization had been highly accurate due to the direct comparison of vectorized raster cells to tree coverage in the photo. The spatial distribution of tree coverage between the preliminary map and the aerial photo was highly correlated. In many parts of the city, roadcuts and power line right-of-ways can be seen on the preliminary data map. This assured the project team that the digitization was complete, and that analysis could begin.

C: ANALYSIS

After the quality control phase of the methodology had been completed, the analysis phase began. Due to the nature of the project, tree cover analysis is a percentage based on area. The first step in the analysis process was to decide which area was to be analyzed. Because of the simplicity and adaptability of this project, any area can be used, as long as the correct files are available.

For the purposes of this project, three area categories were chosen – neighborhoods, zones, and jurisdictions. Jurisdictional and neighborhood boundaries were already available in the Woodinville GIS library. Although zone boundaries were not available, the process of extracting zones from the parcel database was a fairly straightforward process of selecting records based on the value in the zoning field.

To keep the process simple, the analysis team decided to analyze zones by type, rather than by unique value. Therefore the various residential zones were combined into one main zone. Industrial zones and commercial zones were also separately recombined, and parks and public lands were merged into a single zone. Although tree cover analysis can be done at a parcel level, experience shows that large continuous areas lend themselves to more accurate analysis.

Once an analysis area had been chosen, the next step was to clip the index grid to the area of interest. This was done by using the Clip tool within ArcGIS. The clipping process removes cells outside the selected area, and reshapes the cells along the area's border. Any area which can be defined by a closed polygon can be used as the clipping path. Because the clip operation creates a new file, this can be done over and over again without changing the original index grid. The results of the clip were used in the next step, which was to calculate the areas of each cell. Before the clip operation, the cell area had been held constant. After the clip, cells along the border of the polygon were reshaped, and their areas must be accurately calculated. ArcGIS contains a function which accomplishes this. It creates a new copy of the file that has a new field, which is the area of the cell in square feet. Once the areas have been calculated, the clip file can be either saved or deleted.

The final step in calculating the tree cover was to add a field to the table to hold the tree cover area results. Once the field has been created, it must be populated with the formula to calculate its value.

The value is the area of the cell multiplied by the percentage of tree cover in the cell. This gives the area of tree coverage in square feet for each cell. Once this is done, the processes for extracting the total areas and tree cover percentages for the entire area of interest is a simple process which can be done in a matter of seconds. **Table 1** shows the results for each of the chosen analysis areas, both by area and by percentage. For more detailed technical information about the analysis process, please refer to the appendix.

Area Name	Total Area	Tree Coverage Area	Percent
Neighborhood East Wellington	22595046.24	9874834.75	43.70
Neighborhood Lower Westridge	13440621.88	8460282.84	62.95
Neighborhood North Industrial	12726961.76	1584062.78	12.45
Neighborhood Reinwood Leota	12876935.00	7336954.78	56.98
Neighborhood Tourist District	5447911.55	954606.34	17.52
Neighborhood Town Center	13753251.62	2636505.94	19.17
Neighborhood Upper Westridge	11678804.53	4110140.68	35.19
Neighborhood Valley Industrial	9051928.95	744799.52	8.23
Neighborhood West Wellington	14815643.99	9414035.95	63.54
Neighborhood Wedge	11273959.66	4252840.74	37.72
Neighborhood Woodinville Heights	6516589.44	3219802.24	49.41
Zoning Business	14323446.02	1598005.53	11.16
Zoning Industrial	23428703.38	3008791.64	12.84
Zoning Public	9271102.40	3687777.35	39.78
Zoning Residential	89704631.95	44670911.10	49.80
Zoning UGA	15663767.39	1869562.57	11.94
Overview with UGA	173928017.17	59333245.74	34.11
Overview without UGA	157945745.79	57353116.04	36.31

Table 1 – Spreadsheet showing final area statistics in square feet, and corresponding percentage.

Although the tree cover statistics themselves can be very useful, the data becomes more vivid and explicable when it is thematically mapped. Thematic mapping involves classifying the data, in this case tree cover percentage or type, by some category or value. The artistic methods of the output maps are based largely on the classification scheme used. With regard to tree cover percentage, there are 21 unique values available (0-100, in multiples of 5), so creating more than 21 classes would be extraneous.

Of the many possible ways to classify the data, the project team chose a simple 3-class scheme corresponding to the graduated categories high, medium, and low. There are a number of automated methods for choosing which values correspond to which class, but the data histogram showing value frequency (**see Figure 2**) suggested that a manual method would be simplest. The classification scheme for this project used the values from 0-15% for low, 20-90% for medium, and 95-100% for high.

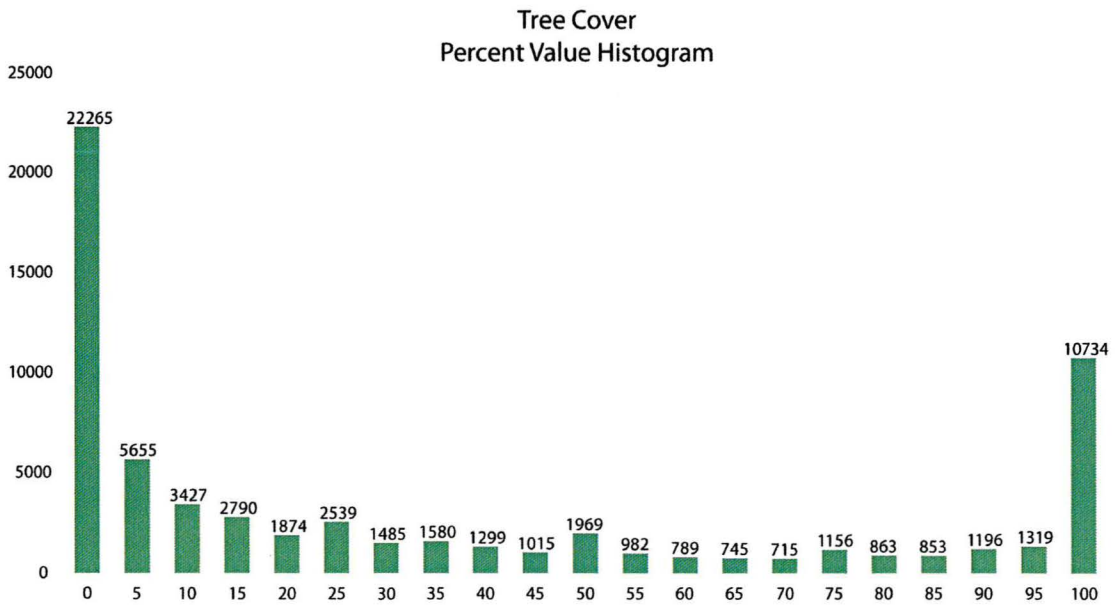


Figure 2 – Histogram showing counts of unique tree cover percent values. Note that counts for 0% and 100% comprise half the total cells. Also notice spikes at natural divisions, 25%, 50% and 75%.

As unbalanced as it seems, this scheme gives the most area to the under-represented medium values while still maintaining reasonable definitions for high and low. The colors used for tree cover value representation were chosen from ColorBrewer, a website devoted to appropriate and visually appealing color management. The team felt that the yellow-green sequential color pattern gave an environmentally appropriate feel to the map.

The tree cover type, or composition, data was also divided into three classes, because there were only 3 unique values available, for coniferous, deciduous, and mixed type. Although it gives a sense of urgency, ColorBrewer's yellow-orange-red sequential pattern was used because it was one of the only color schemes that contained great enough difference between categories, yet was visually distinct from the colors selected for the tree cover percentage maps. Even using such a broad color combination it is still somewhat difficult to differentiate between color shades in the map. **(see Plate 8)**. Because of the haphazard and intermixed nature of the data, the tree cover type statistics are easier to see in tables and charts. Both bar graphs **(Figure 3)** and pie charts **(Figure 4)** were produced in MS-Excel, expressly for this purpose.

5. GIS PRODUCTS

The following pages contain the project's charts and graphs as well as a sampling of the color plate maps that were produced as project deliverables. The maps were formatted within a standardized City of Woodinville template frame complete with legend. Each map's title in the lower left corner corresponds to the naming conventions applied in the ArcGIS data sets. Additional map layers such as streets, railroads, and bodies of water were added for reference purposes, but do not pertain to the data created during digitization of the aerial photo. As explained by the histogram, the classification and color scheme for tree cover percentage in all maps used the values from 0-15% for low (yellow), 20-90% for medium (light green), and 95-100% for high (dark green). The projected coordinate system used in all maps was Washington State Plane North.

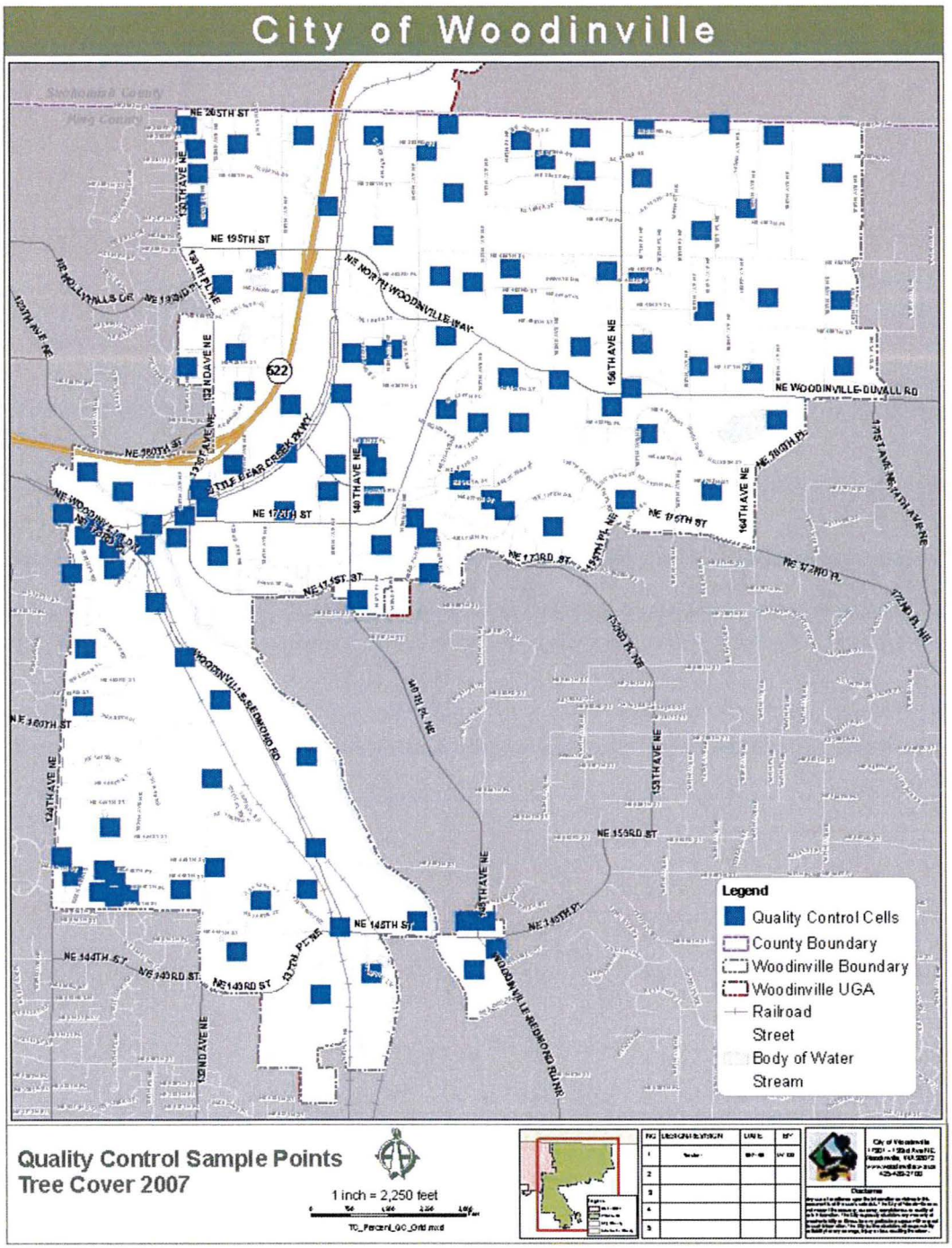


Plate 1 – City of Woodinville quality control sample points. Blue squares indicate cells randomly selected for tree cover percentage confirmation using dart board method.

Plate 2 – City of Woodinville tree canopy overview, including urban growth area. Dark green indicates areas of largely continuous tree cover. Tree cover: 34%

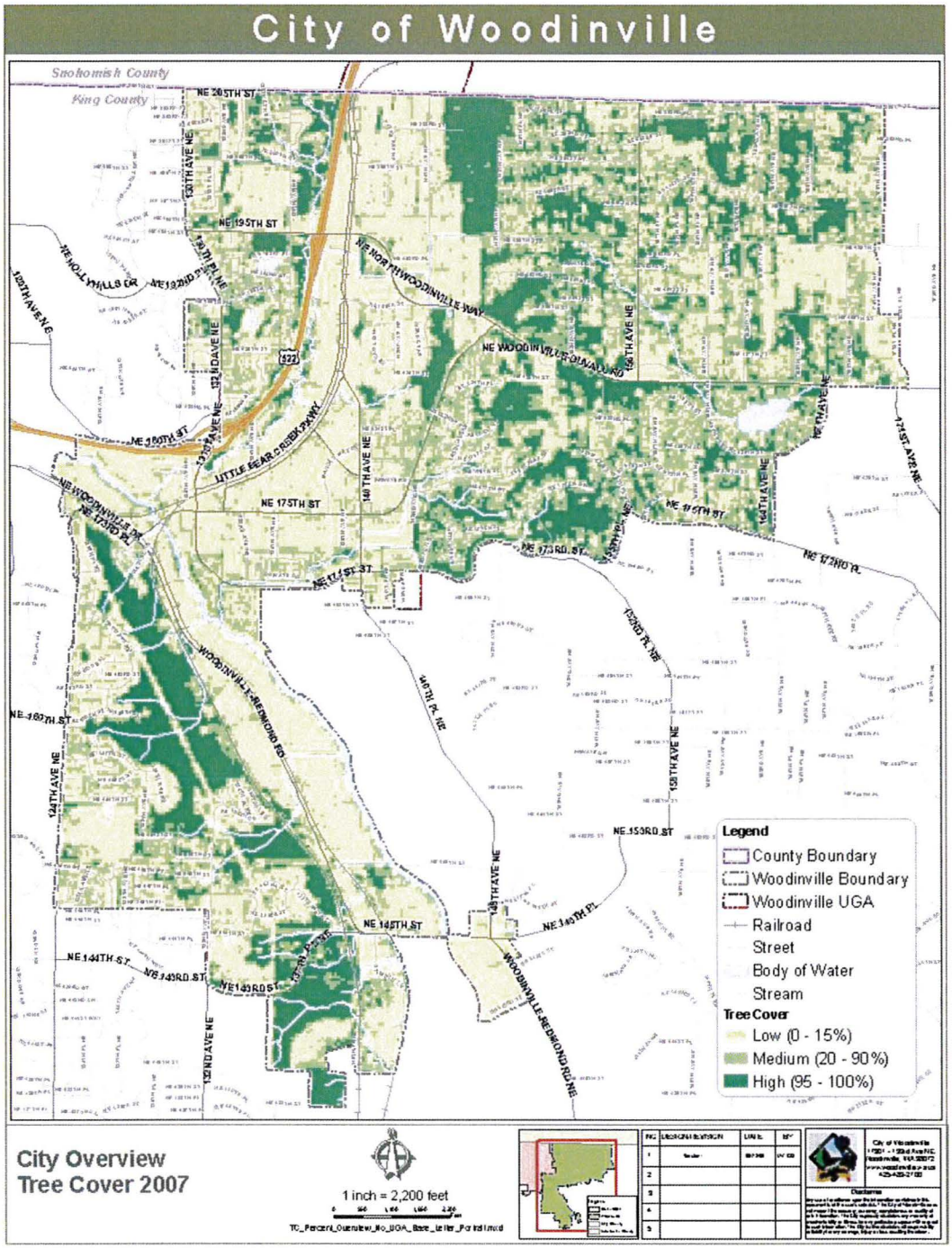


Plate 3 – City of Woodinville tree canopy overview. This view omits the urban growth area. Dark green again indicates areas of largely continuous tree cover. Tree cover: 36%

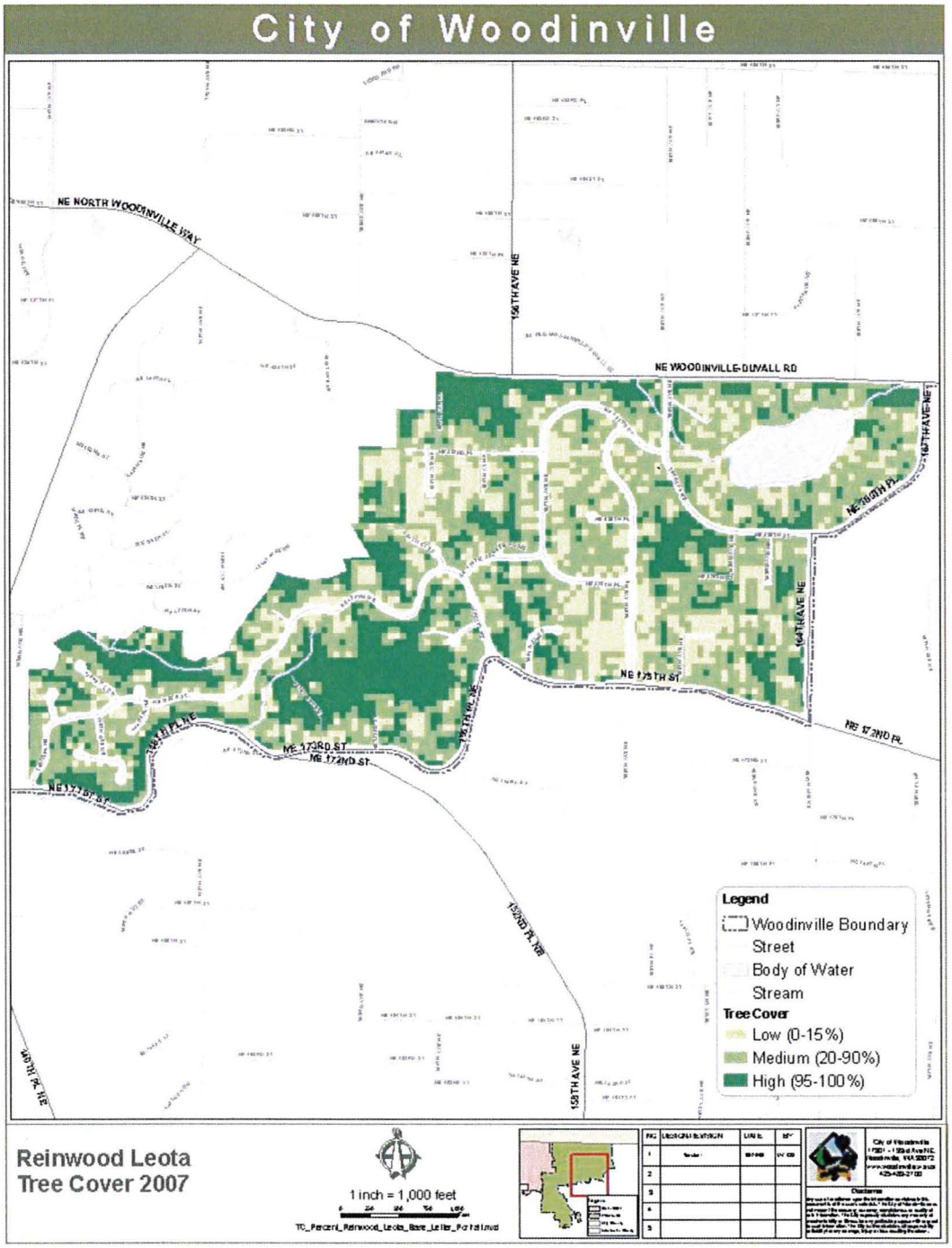


Plate 4 – City of Woodinville, Reinwood Leota residential neighborhood. Note that the area does not include the street right-of-ways. Tree cover: 57%

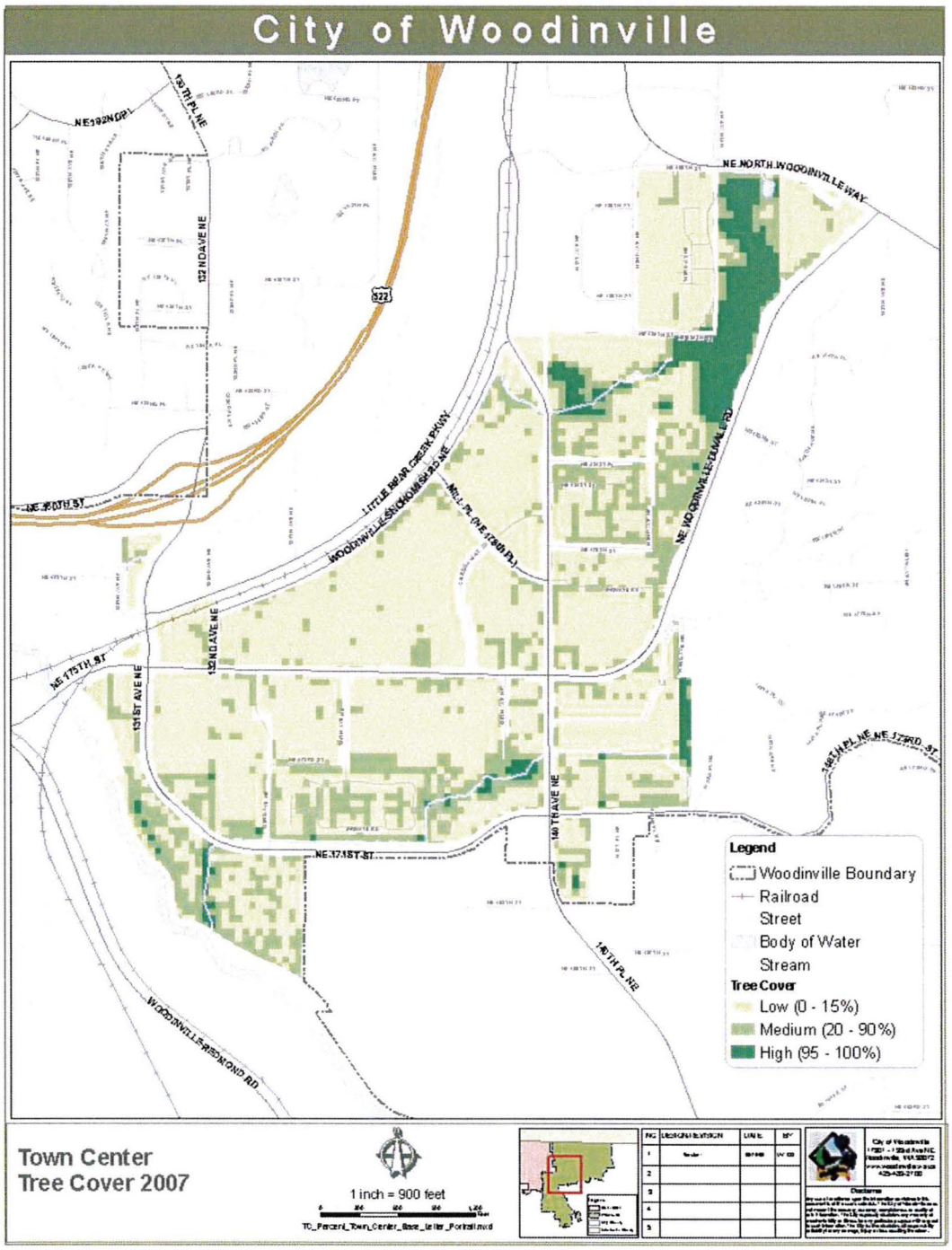


Plate 5 – City of Woodinville, Town Center neighborhood. This downtown largely commercial district contains sparse tree cover. Tree cover: 19%

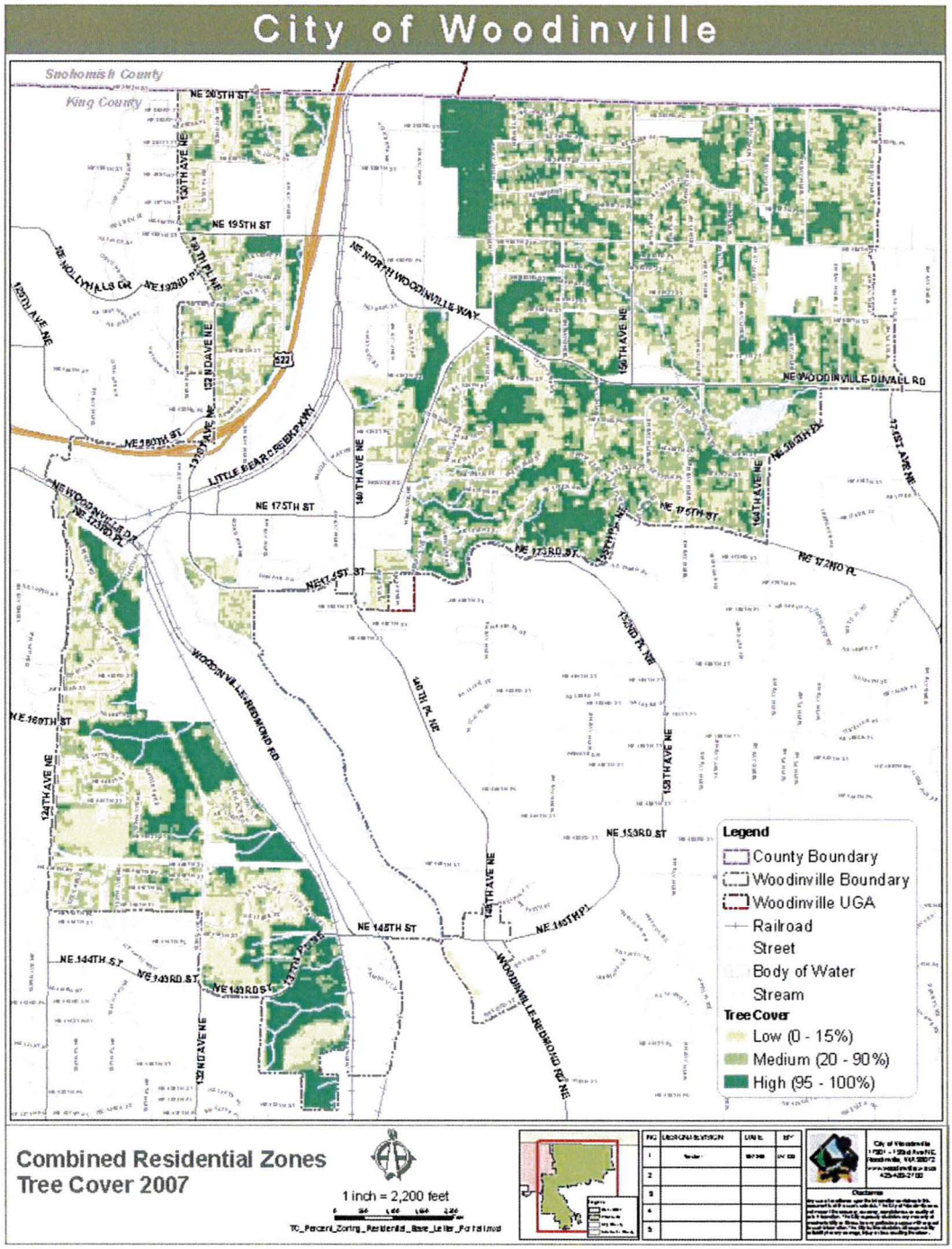


Plate 6 – City of Woodinville, combined residential zones. This map implies that a majority of the city's tree cover is contained within private land. Tree cover: 50%

Plate 7 – City of Woodinville, Industrial Zones. This area has a very low percentage of trees, many of which are used as property boundary markers or landscape within large paved areas. Tree cover: 13%

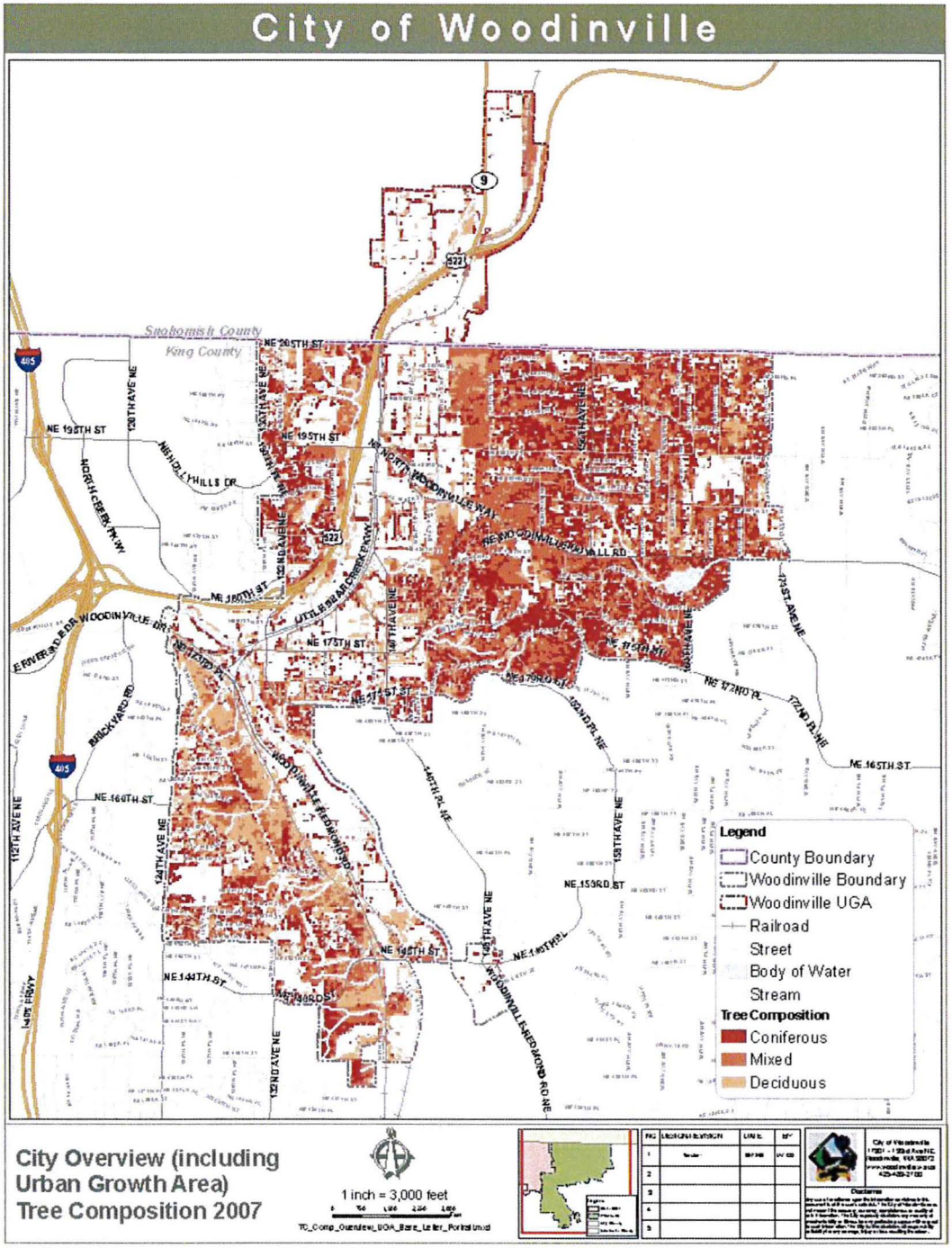


Plate 8 – City of Woodinville tree composition map, including urban growth area. Red color ramp indicates areas of coniferous, deciduous and mixed tree type.

	Coniferous	Deciduous	Mixed	Null
Without UGA	14210	11244	15710	18015
With UGA	14615	12056	16346	22232

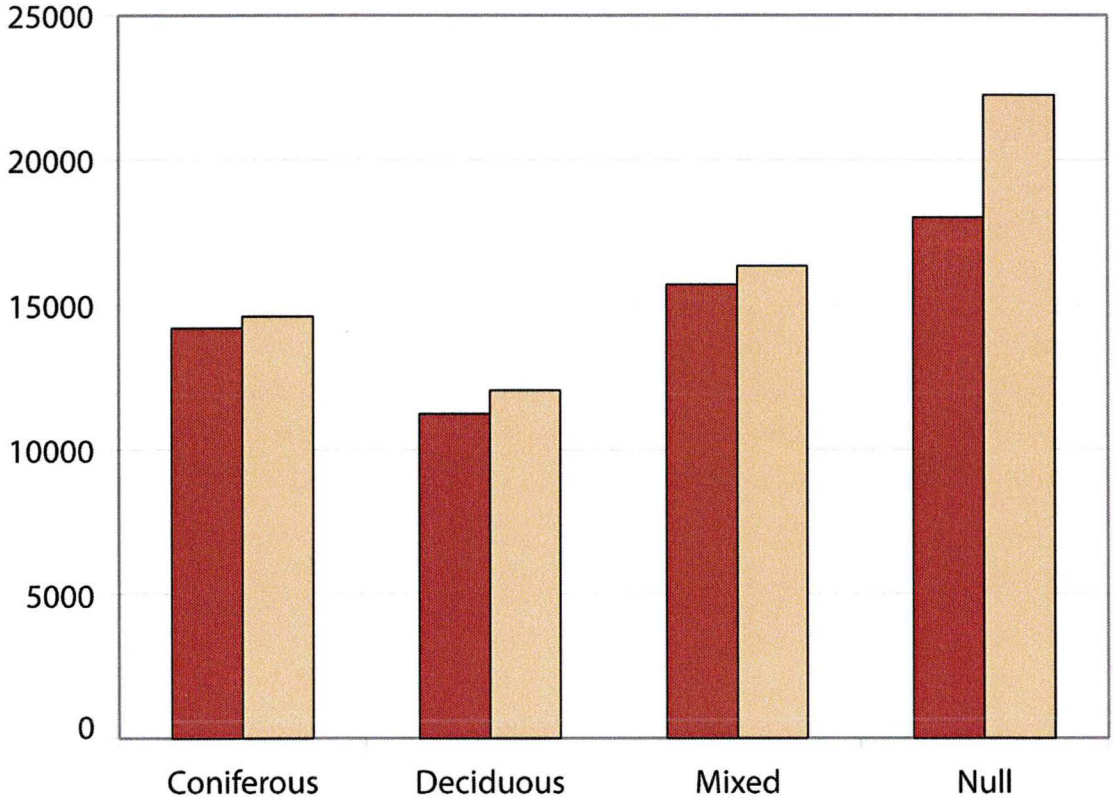


Figure 3 – Bar graph showing number of cells marked as Coniferous-only, Deciduous-only, and Mixed. Includes with UGA and without UGA. Number of Null cells (no tree cover) shown for comparison.

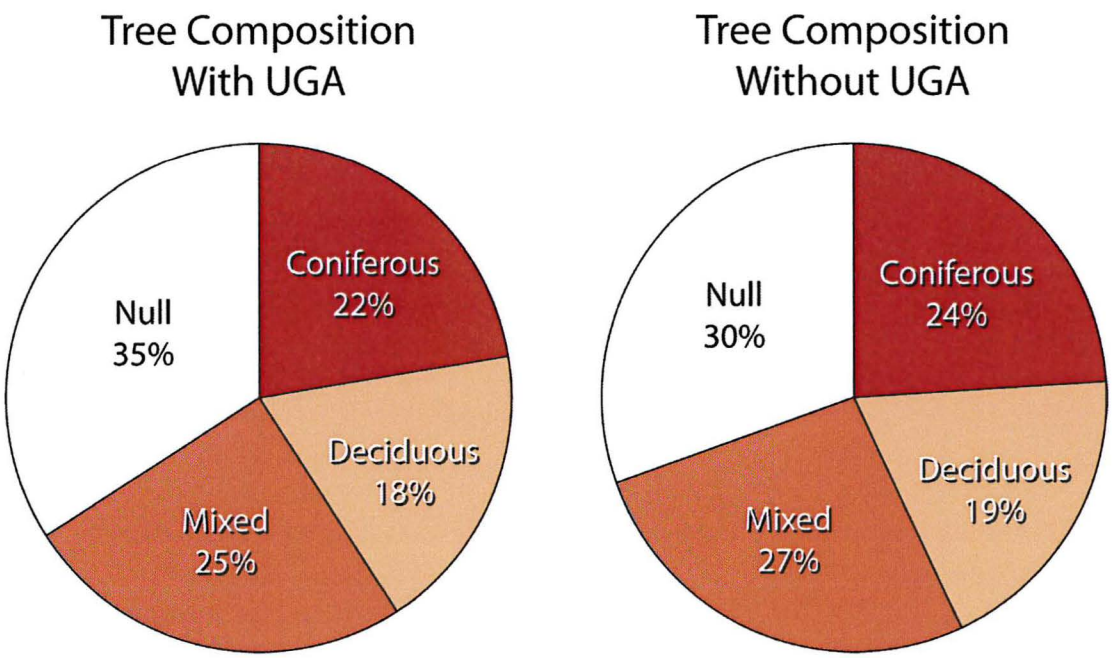


Figure 4 – Pie chart showing percentage of cells marked as Coniferous-only, Deciduous-only, and Mixed. Includes with UGA and without UGA. Percentage of Null cells (no tree cover) shown for comparison.

6. SUMMARY and EVALUATION

This GIS project revolved around one central research goal, to determine the percentage of tree cover within the city limits of Woodinville. This was based on an aerial photograph taken on April 3, 2007. Although two years had elapsed between the time of the photograph and this project, it was deemed to be recent enough to be able to capture an accurate tree cover percentage for the entire city.

The need for this assessment was driven by the fact that the city recognized that its overall tree cover was incrementally being diminished. Ongoing construction and development within the city limits, as well as illegal tree cutting, was gradually and inexorably reducing the amount of natural and original tree cover. If the trend of rapid tree loss continued, the results could be long term damage to the comprehensive and

interconnected ecosystems of the city. To repair such damage would be costly, difficult, and time consuming. Therefore the city had a strong desire to preserve, manage, and improve all their valuable natural resources, including tree cover. This project was one of the efforts that resulted from that position.

Unlike most projects of this type, satellite or remote imaging data was not utilized. Since this was an academic project, no funds were available to secure the most advanced, high resolution satellite data. Also, satellite imagery is typically captured over wide areas or "swaths" with the focus being primarily on overall landforms or large forested areas. Except for high resolution, most satellite data is not as effective in producing fine, detailed images of ground cover, including individual urban trees. When satellite imagery is used for urban tree cover analysis, additional effort and expense is necessary to fine-tune the images for clarity and accuracy. The aerial photograph used in this project permitted analysis to be accomplished without the need for purchasing expensive satellite data, and even more importantly, allowed precise and detailed analysis of trees within the confines of an urban environment, without extensive fine tuning of the image.

By not utilizing satellite imagery, the challenge for this project remained to select a methodology for effectively and comprehensively digitizing the aerial photograph. Several methods were considered, including windshield surveys, tree inventory surveys, sketch digitizing, and mixed type digitizing. All these methods were rejected for various reasons, as none of them adequately met the digitizing requirements for this project.

As a result, a unique approach was devised, termed "grid indexing." This method prescribes the overlay of a predefined square grid pattern onto the aerial photo within a GIS mapping software environment. The resulting layered combination allows percentages of tree cover to be assigned through visual inspection of the photograph within a raster-like cell structure. The grid indexing method perfectly met the digitizing requirements for this study, could be accomplished at virtually no cost, and produced a highly detailed and accurate vectorized raster data layer of 65,250 cells that could be easily analyzed at multiple levels. The grid allowed easy identification of areas of tree cover as well as individual trees no more than a few feet high. Even though the aerial photo was taken in early April before most deciduous trees set their leaves, even small trees with bare branches could be correctly identified.

The data images produced from the digitizing showed a direct correspondence with the tree cover displayed in the photograph. To achieve the most effective display of the data, tree cover amounts as determined by cell value were grouped into low, medium, and high categories. A yellow-green color gradient was used to portray these values, with white being used for cells that contained no tree cover at all.

Following digitizing and display of the data, the results were analyzed and calculations performed on the dataset which yielded a score of 34% tree cover for the entire city of Woodinville. This direct result was significant, as it was the primary purpose of the entire project and answered the central question posed by the city.

Other analyses included similar calculations for each separate neighborhood area within Woodinville, as well as four combined zoned areas: residential, business, industrial, and schools & parks. For each defined neighborhood or zone, a percentage of tree cover was calculated.

The final calculation performed on the data was for tree composition. Each cell that contained tree cover was coded according to the type of trees it contained: coniferous only, deciduous only, or a mix of both. Of those three groups, the largest category, mixed, comprised 25% of all cells that contained tree cover. This was followed by coniferous-only at 22% and deciduous-only at 18%.

Post analysis evaluations of this project argue that the methods employed and results achieved were significant because the project utilized a grid system to effectively analyze and digitize tree cover over an entire city without the need for any satellite data. This was due to the unique approach of dramatically enlarging the application of DS Mapbook. In other applications using DS Mapbook, grid indexing is typically only used as a utility to sample very small city block-sized areas, but in this project that methodology was expanded significantly to cover approximately six square miles. That fact alone makes the relatively simple technique of grid indexing to calculate tree cover percentages a valuable and useful tool with much merit. It is highly recommended for any community, organization or business which desires an economical, yet highly effective and reliable method to calculate tree cover, or assess any kind of ground cover that is recognizable using aerial photography. In an academic or classroom setting it is an excellent method for students or volunteers to assess aerial photos and gain experience with GIS software, photogrammetry analysis, database management, and statistical calculation. When used by communities, it serves as an effective tool to help balance the ongoing expansion and change of new development and construction with responsible urban forest and ecosystem management.

7. APPENDIX

Attribute Table Field Guide
This guide is a reference documentation of the fields present in the attribute table. Most of the information available here can also be found by using ArcCatalog or ArcMap.

FID
FID field is a non-unique object identifier. The integrity of this field is maintained internally by ArcGIS, and it will be renumbered if any table records are added or dropped. This field should not be modified.

Type: Object ID

Shape
Shape field is a description of the object's geometry. In the index grid, the value in this field will be "Polygon"; in the centroid grid, the value will be 'Point'. The integrity of this field is maintained internally by ArcGIS, and it will be automatically updated if the geometry type is modified. This field should not be modified.

Type: Geometry

GRID_ID
GRID ID field contains a unique object identifier. The object identification is a concatenation of the ROW_NUM and COL_NUM fields, with the ROW_NUM value transformed into a two character string. This field was created by DS Map Book, and can be useful for maintaining the integrity of the attribute table. This field can be deleted at the end user's discretion, but should only be modified or recalculated from a clean copy.

Type: String
Length: 50

ROW_NUM
ROW NUM field contains an object identifier that is unique to each row of the grid. It is recalculated as a two character string and then concatenated with the COL_NUM to create the GRID_ID. This field was created by DS Map Book, and can be useful for maintaining the integrity of the attribute table, and for doing analysis at a row level. This field can be deleted at the end user's discretion, but should only be modified or recalculated from a clean copy.

Type: Long
Precision: 9

COL_NUM
COL NUM field contains an object identifier that is unique to each column of the grid. It is concatenated with the ROW_NUM to create the GRID_ID. This field was created by DS Map Book, and can be useful for maintaining the integrity of the attribute table, and for doing analysis at a column level. This field can be deleted at the end user's discretion, but should only be modified or recalculated from a clean copy.

Type: Long
Precision: 9

PLOTSCALE
PLOTSCALE field is an unused reference created by DS Map Book. It should only have a single value, 5000 (which is an artifact of the grid creation). This field can be deleted at the end user's discretion, and can easily be rebuilt or recalculated.

Type: Double
Precision: 18
Scale: 11

TC_Percent
TC Percent field was created manually and contains a tree cover value estimated by the project team. The value is a percent, meaning that its mathematical value for use in calculations is $x/100$. The value has a range between 0 and 100, and only contains multiples of five. The values in this field represent the bulk of the work done by the project team. This field should only be modified or recalculated from a clean copy.

Type: Short
Precision: 4

TC_Tr_Type
TC Tr Type field was created manually and contains a tree cover descriptor estimated by the project team. The only allowed values are 'C' (coniferous), 'D' (deciduous), 'M' (mixed), and null. The values in this field represent the bulk of the work done by the project team. This field should only be modified or recalculated from a clean copy.

Type: String
Length: 25

TC_Flag
TC Flag field was created manually and used internally by the project team to mark cells of interest. It should not contain any values, and can be deleted at the end user's discretion.

Type: String
Length: 10

F_AREA
F AREA field was created and calculated by the ArcGIS "Calculate Areas" tool. In a raw, unclipped version of the grid, all the values should be identical. Otherwise, the values on the borders of the grid will have variable areas. The value in this field represents the area of the grid cell, in square feet. This field can easily be rebuilt or recalculated.

Type: Double
Precision: 0
Scale: 0

TC_Sqft
TC Sqft field was created manually and calculated by formula. The formula can be expressed using SQL by the following equation:

```
[TC_Sqft] = [F_Area] * [TC_Percent] / 100
```

This can be restated as "the cell's area multiplied by the tree cover percentage, divided by 100". As stated above, the value in TC_Percent is a percentage expression, which must be divided by 100 to be used in an equation. The value in this field represents the area of the grid cell covered by trees, in square feet. This field can easily be rebuilt or recalculated.

Type: Double
Precision: 0
Scale: 0

PROCESS METHOD of GRID ANALYSIS

There are four simple steps which must be followed to produce statistically analyzable grids from the index grid. A number of sample analysis grids have already been produced by the project team, using a number of common analysis areas, such as neighborhoods and zones. By following the steps within this section, it will be possible for the end user to not only recreate these sample grids, but construct new grids as well.

The first step in the process is to clip the index grid to a boundary. Any polygon can be used, even a simple rectangle. The City of Woodinville already has a number of simple polygons that can be used for this purpose, including city and neighborhood boundaries. In order to use the city's zoning information, it is necessary to do some preliminary extraction work, but once that has been done, the clip process is fairly straight forward. Some suggestions for further analysis: delineated wetlands, stream buffers, and very large parcels. To perform this step, use the Clip tool in ArcToolbox, which can be found by the following path: `Analysis Tools > Extract > Clip`. The input feature will be the index grid, and the clip feature will be the chosen boundary polygon. This tool requires the designation of an output file, which will be used for the next step.

The second step of the process is to calculate the areas of the clipped grid cells. This is a fairly simple action, best accomplished by using the Calculate Areas tool in ArcToolbox. The tool can be found by the following path `Spatial Statistics Tools > Utilities > Calculate Areas`. The input feature will be the clipped grid, and an output feature designation is required. The resulting areas will be in a new field called F_AREA, which is populated by data of type 'double'. The area values represent square feet.

The third step of the process is to create a new field which will hold the tree cover areas. This step can be completed in a variety of different ways. It is possible to add a new field to the table using ArcCatalog or ArcMap. There is also a tool within ArcToolbox which can be found by the following path: `Data Management Tools > Fields > Add Field`. The ArcToolbox method may be preferable if this process is to be automated using a script or model. In this project the team created the field with a data type of 'double' in order to match the F_AREA field. The name of this field in the

sample grids is TC_Sqft, since it will eventually contain the square footage of tree cover in the cell.

The fourth step of the process is to populate the new field with tree cover area values. This can be accomplished using the field calculator in ArcMap or ArcCatalog, or with the ArcToolbox tool which can be found at the following path: `Data Management Tools > Fields > Calculate Field`. The intended result is to multiply the value from F_AREA by the value in TC_Percent, and then divide by 100. The syntax for declaring this equation varies based on the method used to enter it. The correct syntax when using the field calculator is:

```
[TC_Sqft] = [F_AREA] * [TC_Percent] / 100
```

This will give the value in square feet of the estimated tree cover for each cell.

The fifth and final step of this process is to extract the statistics. There are a number of different ways to do this, but the simplest way is to right-click on the TC_Sqft field in the attribute table view and choose 'Statistics'. It is simple to extract means, sums, and standard deviations from the resulting dialog box, which can then be used in a spreadsheet or report. To derive total tree cover percentages, compare the summary from TC_Sqft to the summary for F_AREA. For a summary of the statistics produced by the project team using the sample grids, see **Table 1**.

8. REFERENCES

Miles G. Logsdon, PhD – University of Washington professor, specialist in remote sensing applications. http://boto.ocean.washington.edu/staff_pages/miles/

Duncan Munro – Seattle Public Utilities, specialist in remote sensing applications. http://gis.esri.com/library/userconf/proc05/papers/pap2024.pdf

L. Monica Moskal, PhD – University of Washington professor, specialist in remote sensing applications. http://faculty.washington.edu/lmmoskal/

Washington State Department of Natural Resources – Technical Advisory Committee. http://www.dnr.wa.gov/researchscience/topics/urbanforestry/pages/rp_urban_eca.aspx http://www.dnr.wa.gov/ResearchScience/Topics/UrbanForestry/Pages/rp_urban_eca_tac.aspx

Washington State Evergreen Communities Act – HB 2844 http://www.cted.wa.gov/site/1126/default.aspx http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2844&year=2007

Casey Trees – Urban Tree Canopy Goals, APA National Conference, April 18, 2007. http://www.caseytrees.org

"A method for locating potential tree-planting sites in urban areas: a case study of Los Angeles, USA." By Chunxia Wu, Qingfu Xiao, and E. Gregory McPherson http://www.treesearch.fs.fed.us/pubs/30226

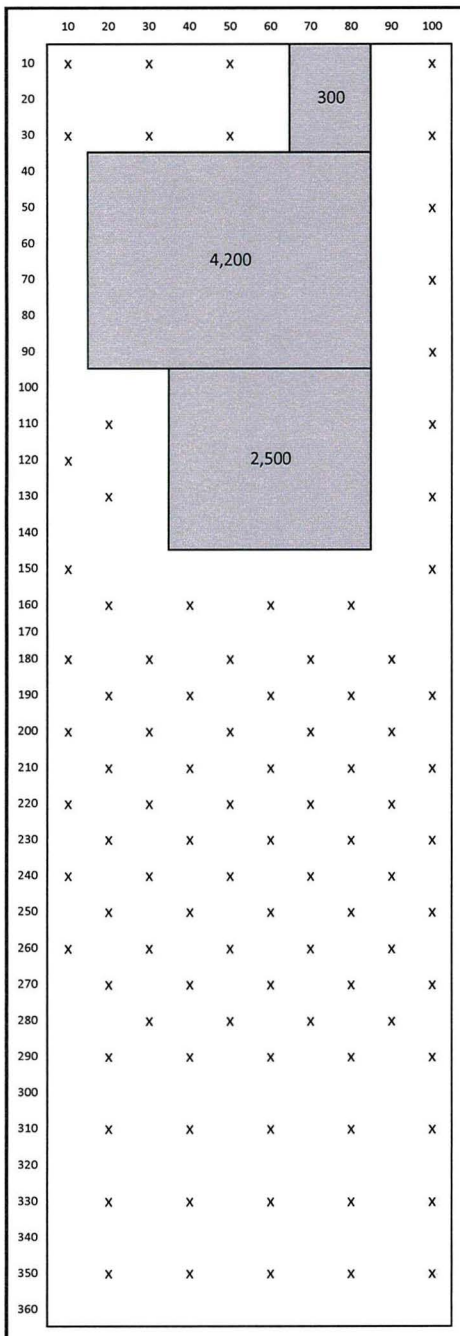
ESRI – ArcGIS – http://www.esri.com/software/arcgis/arcview/index.html

DS Mapbook – http://edndoc.esri.com/arcobjects/9.2/cpp_vb6_vba_vcpp_doc/com_samples_docs/cartography/map_production/dsmapbook/9d2dafa6-fcae-4e3d-bd27-1f242b216452.htm

ColorBrewer – http://www.personal.psu.edu/cab38/ColorBrewer/ColorBrewer_intro.html

Avenza Geographic Imager – http://www.avenza.com/geographicimager

Adobe Photoshop – http://www.adobe.com/products/photoshop/photoshop/



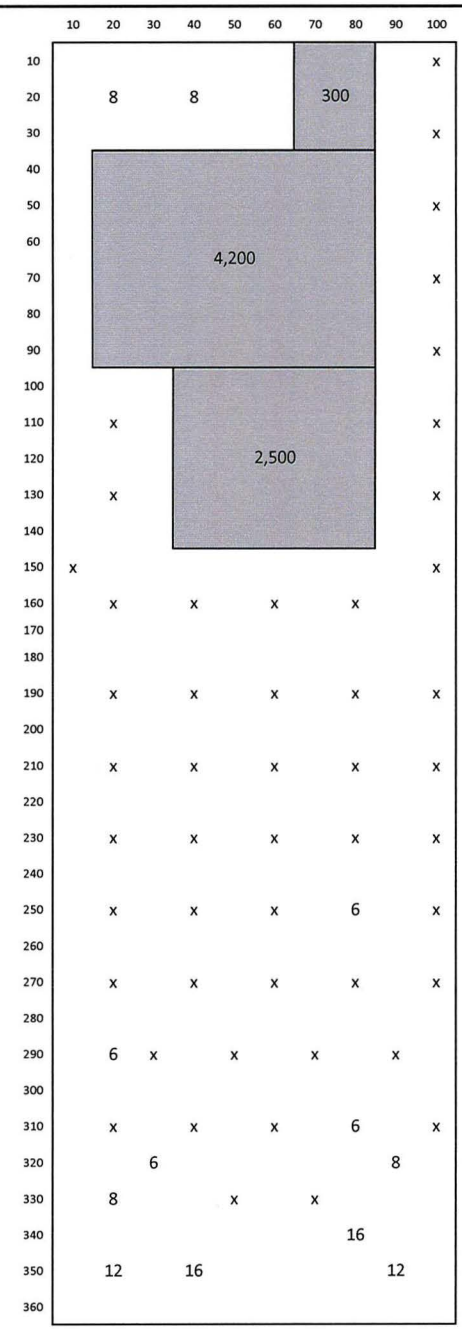
R-1

Impervious Surface:	20% 7,000 sf
Interior setback:	10 feet
Street setback:	10 feet
Minimum lot width:	100 feet
Tree credits required:	48 trees
	60/acre

RESULT

Trees: New 2" caliper	
Spacing: At least 15 on-center	
Total trees:	66 trees
Credits required	48 credits
Proposed:	48 credits (66 new)

x = new 2"



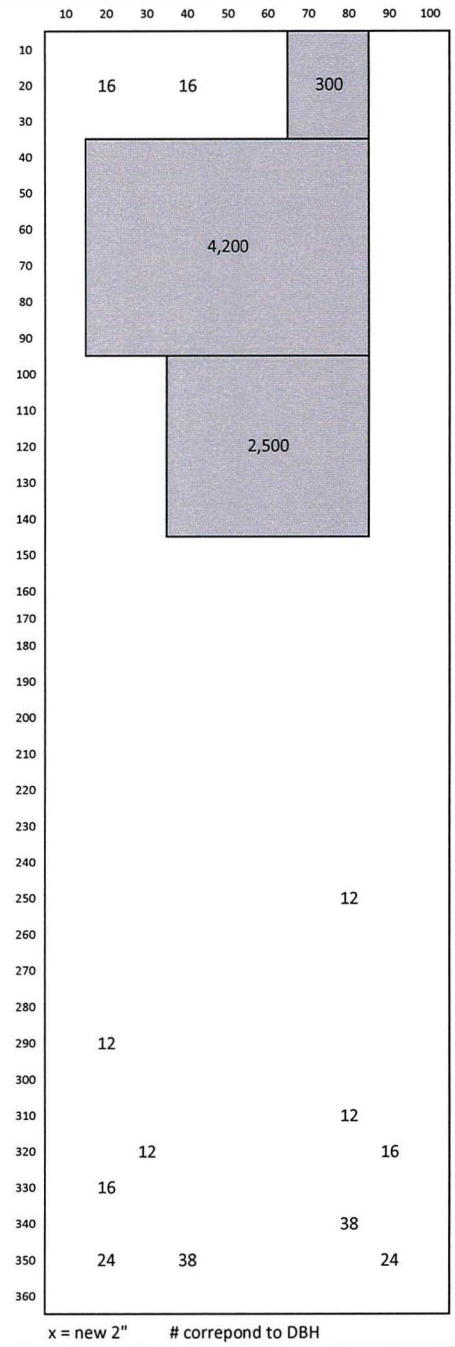
R-1

Impervious Surface:	20% 7,000 sf
Interior setback:	10 feet
Street setback:	10 feet
Minimum lot width:	100 feet
Tree credits required:	48 trees
	60/acre

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	43 trees
Credits required	48 credits
Proposed:	20 credits (12 existing)
	23 credits (46 new)

x = new 2" # correpond to DBH

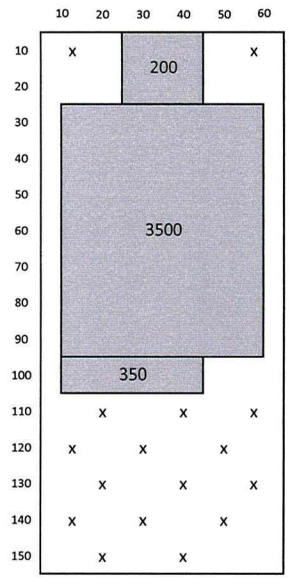


R-1

Impervious Surface:	20% 7,000 sf
Interior setback:	10 feet
Street setback:	10 feet
Minimum lot width:	100 feet
Tree credits required:	48 trees
	60/acre

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	12 trees
Credits required	48 credits
Proposed:	58 (12 existing)

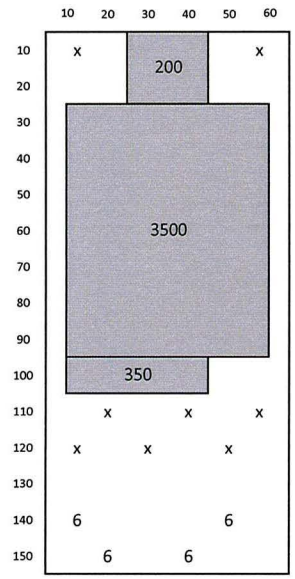


R-4 (9,000 sf)

Impervious Surface:	45% 4,050 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	60 feet
Tree credits required:	8 credits (12 if 60/acre)

RESULT

Trees:	New plantings
Spacing:	At least 15 on-center
Total trees:	16 trees planted
Credits required	8 credits
Proposed:	8 credits (16 new)

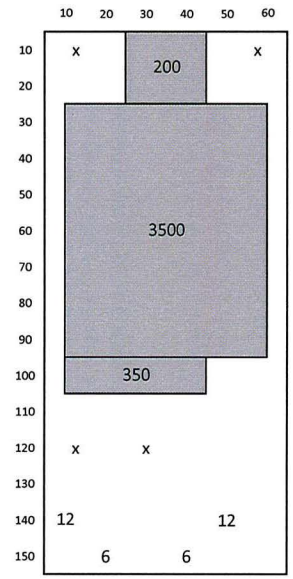


R-4 (9,000 sf)

Impervious Surface:	45% 4,050 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	60 feet
Tree credits required:	8 credits (12 if 60/acre)

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	12 trees
Credits required:	8 credits
Proposed:	4 credits (4 existing) 4 credits (8 new)

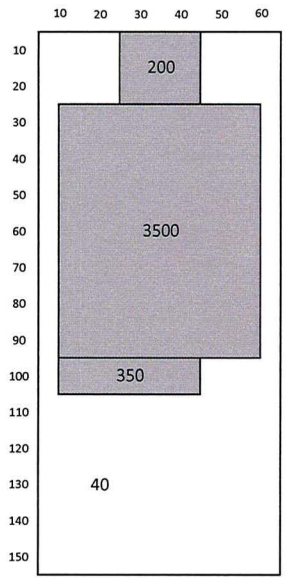


R-4 (9,000 sf)

Impervious Surface:	45% 4,050 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	60 feet
Tree credits required:	8 credits (12 if 60/acre)

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	8 trees
Credits required	8 credits
Proposed:	4 credits (4 existing) 4 credits (4 new)

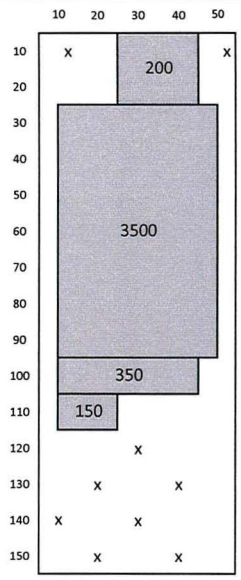


R-4 (9,000 sf)

Impervious Surface:	45% 4,050 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	60 feet
Tree credits required:	8 credits (12 if 60/acre)

RESULT

Trees:	Existing trees
Spacing:	At least 15 on-center
Total trees:	1 trees
Credits required	8 credits
Proposed:	11 credits (1 existing)

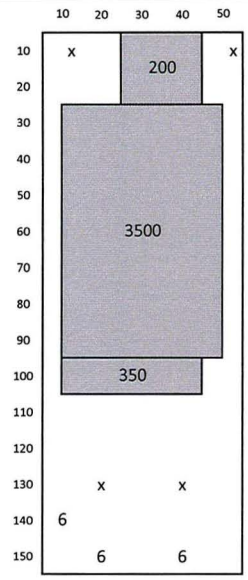


R-6 (6,000 sf)

Impervious Surface:	70% 4,200 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	50 feet
Tree credits required:	3.9 credits (7.8 if 60/acre)

RESULT

Trees:	New plantings
Spacing:	At least 15 on-center
Total trees:	8 trees planted
Credits required	3.9 credits
Proposed:	4 credits (8 new)

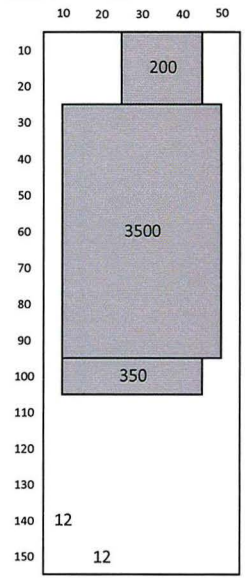


R-6 (6,000 sf)

Impervious Surface:	70% 4,200 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	50 feet
Tree credits required:	3.9 credits (7.8 if 60/acre)

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	7 trees
Credits required	3.9 credits
Proposed:	2.25 credits (3 existing) 2 credits (4 new)

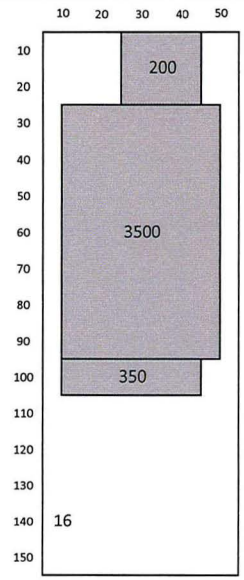


R-6 (6,000 sf)

Impervious Surface:	70% 4,200 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	50 feet
Tree credits required:	3.9 credits (7.8 if 60/acre)

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	2 trees
Credits required	4 credits
Proposed:	4 credits (2 existing)

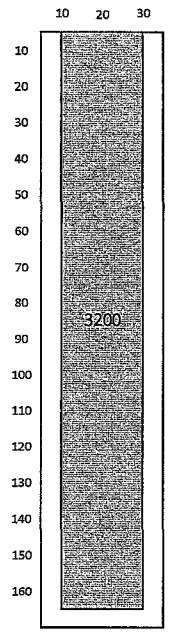


R-6 (6,000 sf)

Impervious Surface:	70% 4,200 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	50 feet
Tree credits required:	3.9 credits (7.8 if 60/acre)

RESULT

Trees:	Existing trees
Spacing:	At least 15 on-center
Total trees:	1 trees
Credits required	3.9 credits
Proposed:	4 credits (1 existing)



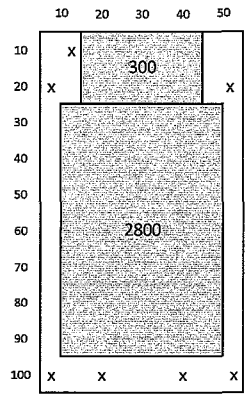
Impervious surface is 3,200 sf max in this scenario

R-8 (5,000 sf)

Impervious Surface:	75% 3,750 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	30 feet
Tree credits required:	3.5 credits (6.9 if 60/acre)

RESULT

Trees:	None
Spacing:	At least 15 on-center
Total trees:	0
Credits require	3.5 credits
Proposed:	0 credits



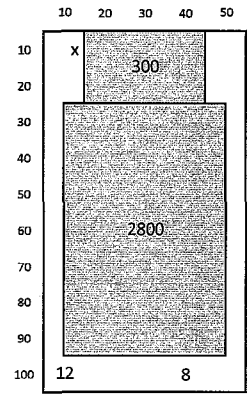
Impevious surface is 3,100 sf max in this scenario

R-8 (5,000 sf)

Impervious Surface:	75% 3,750 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	30 feet
Tree credits required:	3.5 credits (6.9 if 60/acre)

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	7 trees
Credits required:	3.5 credits
Proposed:	4 credits (4 existing) 4 credits (8 new)



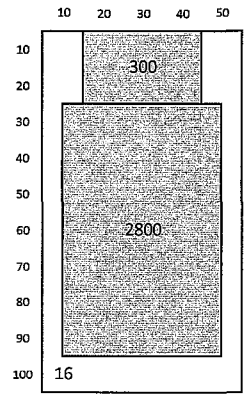
Impevious surface is 3,100 sf max in this scenario

R-8 (5,000 sf)

Impervious Surface:	75% 3,750 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	30 feet
Tree credits required:	3.5 credits (6.9 if 60/acre)

RESULT

Trees:	New and existing trees
Spacing:	At least 15 on-center
Total trees:	3 trees
Credits required:	3.5 credits
Proposed:	3 credits (2 existing) .5 credits (1 new)



Impevious surface is 3,100 sf max in this scenario

R-8 (5,000 sf)

Impervious Surface:	75% 3,750 sf
Interior setback:	5 feet
Street setback:	10 feet
Minimum lot width:	30 feet
Tree credits required:	3.5 credits (6.9 if 60/acre)

RESULT

Trees:	Existing trees
Spacing:	At least 15 on-center
Total trees:	1 tree
Credits required:	3.5 credits
Proposed:	4 credits (1 existing)

INTENTIONALLY
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CITY OF WOODINVILLE
TREE BOARD MEETING

PUBLIC COMMENT SIGN IN SHEET

DATE & TIME: **Wednesday, December 10, 2014 5:30 PM**

WELCOME to the Tree Board meeting! Public Comments provide an opportunity for the public to address the Tree Board. If you wish to speak, please indicate in the appropriate box when you sign in.

When you are recognized by the Tree Board Chair:

1. Please give your name and address.
2. Please limit your comments to five minutes per individual, and seven minutes if representing a group.

Thank you for your participation.

PRINT NAME	ADDRESS/PHONE (Optional)	REPRESENTING SELF/BUSINESS	DO YOU WISH TO SPEAK?