

prepared for



Urban Forest Canopy Technical Analysis

August, 2016

The logo for URBAN systems is contained within a white circular graphic. The word "URBAN" is written in a large, bold, red, sans-serif font, and the word "systems" is written in a smaller, red, sans-serif font directly below it.

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systems

REPORT TO:

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Contents

Introduction	1
Context and Objectives	1
Data and Analysis Methods	1
Tree Canopy Analysis	2
Forest Cover Results	2
Overall Tree Canopy Results	3
Tree Canopy in Relation to Land Use and Age of Development.....	6
Key Patterns.....	6
Closing Comments.....	9

Appendix A: Study Methods

Appendix B: Sample Sites

Introduction

Context and Objectives

The City of Abbotsford is concerned about its urban forest and recognizes that significant numbers of trees have been removed in recent years. City staff began work on a new tree bylaw, but wanted to be able to justify the need for strengthening the previous tree protection bylaw.

The purpose of this study was to provide information on the tree canopy and how it has changed over time. The objectives of the study were as follows:

- Calculate the City's overall tree canopy for two time periods including and excluding parks
- Analyze the tree canopy in relation to different land uses and ages of development, including changes in the tree canopy for each land use and age of development over the two time periods
- Analyze key patterns contributing to changes in the tree canopy

This technical study had a limited budget and did not have access to data such as full-featured LiDAR, so the methods were selected accordingly.

The tree canopy

is the layer of tree leaves, branches and stems that cover the ground when viewed from above.

Data and Analysis Methods

The data and analysis methods are described in detail in Appendix A. The following is a summary of the methods:

- Select 2005 and 2015 as the two time frames based on the quality of City air photos, and acquire digital GIS data for those time periods
- Identify 20 sample sites in collaboration with City staff to represent a range of land uses developed over a variety of decades
- Use a combination of image classification, GIS tools, and sample site digitizing to calculate and display the overall tree canopy for 2005 and 2015
- Verify the tree canopy data using another tool, iTree
- Calculate the tree canopy for the various land uses, and analyze changes in tree canopy in relation to land use and age of development

Tree Canopy Analysis

Forest Cover Results

The first analysis of Abbotsford's tree canopy identifies areas of contiguous forest that existed in 2005 and 2015 within the Urban Containment Boundary (UCB). In 2005 approximately 23% (1,514 ha) of the UCB was covered by significant patches of forest. By 2015 that number had dropped to 21.5% (1,406 ha). The forest cover decrease represents a reduction of approximately 7% over a 10-year period. Figure 1 summarizes the distribution of the forest across land use types (generalized zoning classes) in 2015:

Land Use Types	Area (ha)	Percent of Forest in this Zone
Residential – Rural and Suburban	538.5	38%
Parks, Open Space and Schools	296.1	21%
Residential – Urban (single detached lots)	266.1	19%
Residential – Medium Density	90.9	6%
Institutional	61.6	4%
Agriculture	55.2	4%
Industrial	42.8	3%
Commercial	35.9	3%
Comprehensive Development	18.5	1%
Grand Total	1,405.8	100%

Figure 1: 2015 Forest Area Distribution by Land Use

The neighbourhoods most affected by this reduction appear to be Aberdeen, McMillan, South Poplar, and Whatcom, as displayed in Figure 2 (areas in red represent forest removed between 2005 and 2015):

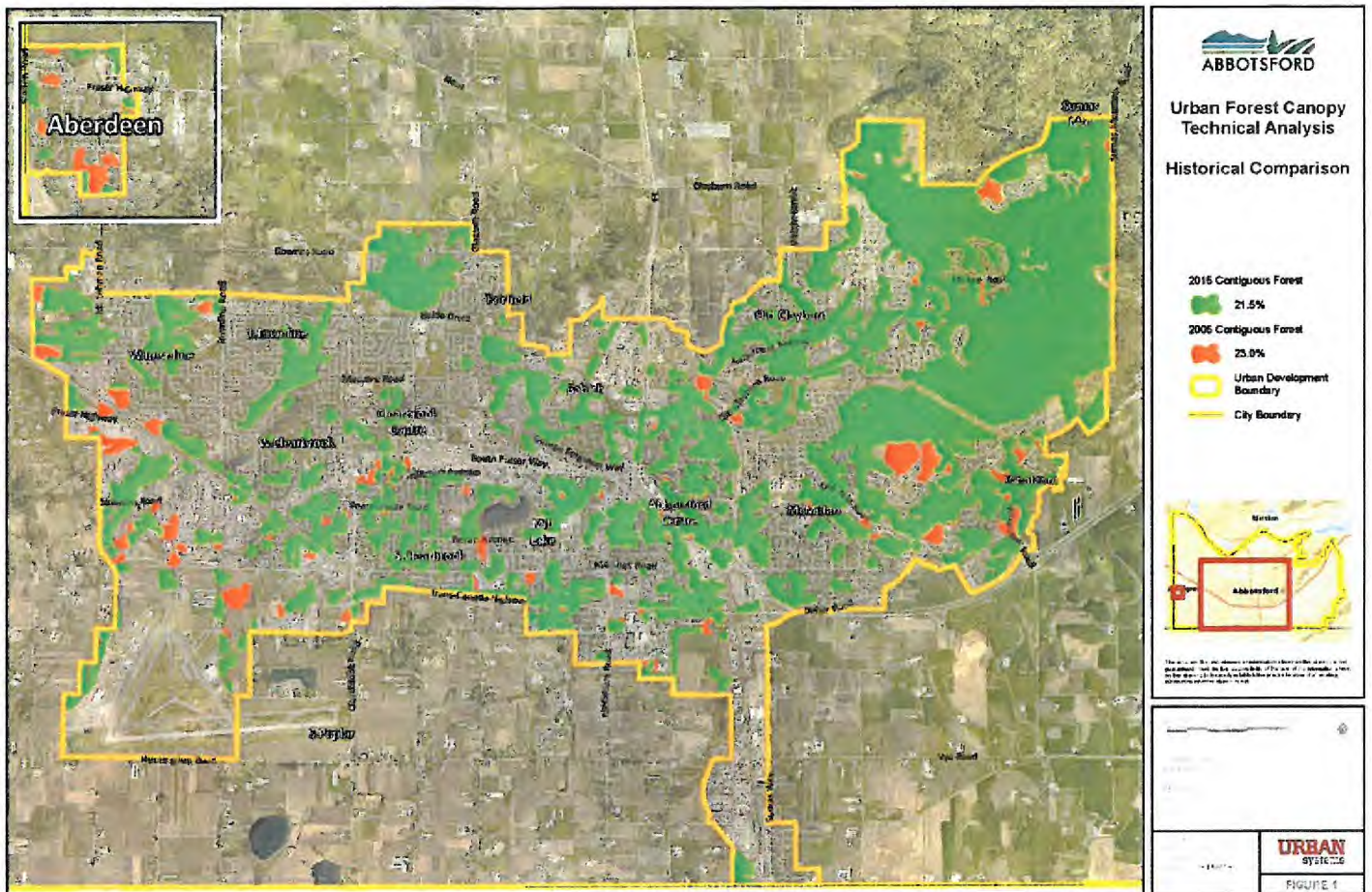
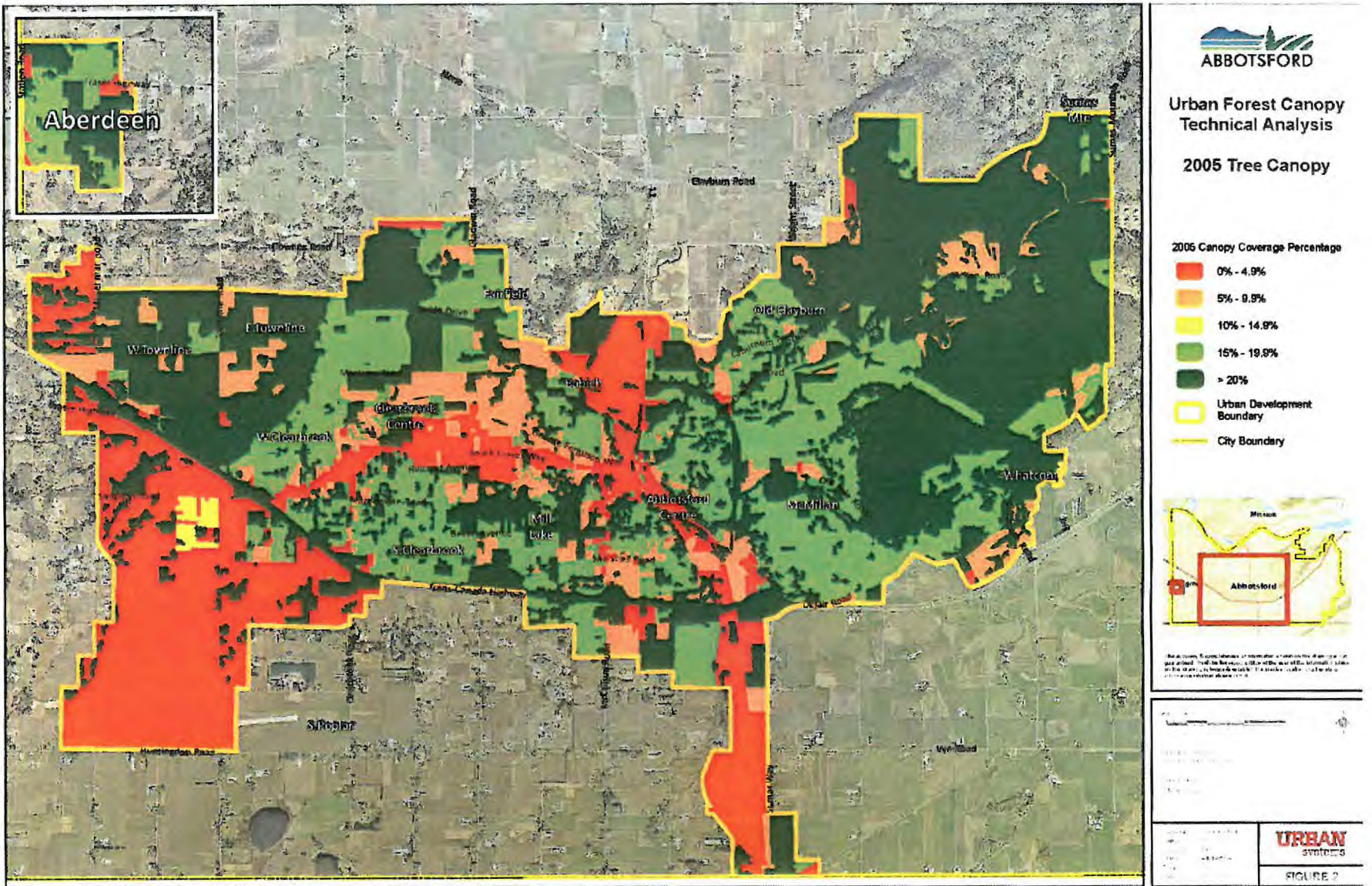


Figure 2: 2015 Forest Area Distribution 2005 and 2015

Overall Tree Canopy Results

The GIS analysis shows that the City's tree canopy within the UCB was around 33.2% (2,176 ha) in 2005, and 30.6% (2,009 ha) in 2015 (Figures 3 and 4). This is a decline of approximately 2.5%, otherwise stated as an 8% reduction of the 2005 canopy (a similar trend to the contiguous forest areas).

When Parks, Open Space and Schools are excluded, the tree canopy is lower, and the decline is slightly reduced. The 2005 tree canopy for the UCB minus Parks is 30.8% and for 2015 it is 28.1%.



Figures 3: 2005 Tree Canopy

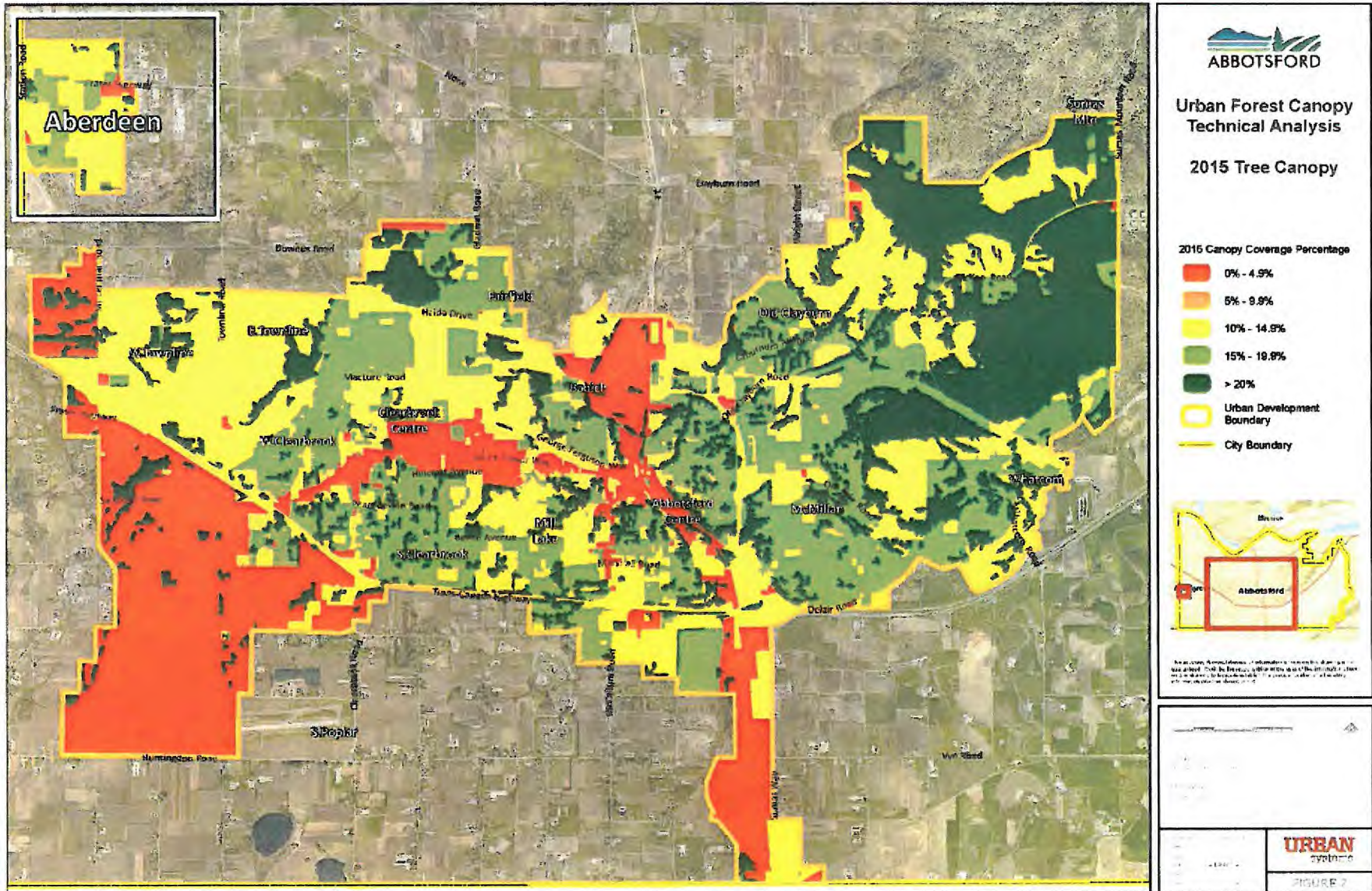


Figure 4: 2015 Tree Canopy



The iTree Canopy results closely mirror and confirm this trend. Using that method, the 2005 tree canopy for the UCB was 34.9%, and for it was 31.9%. This is a decline of approximately 3%.

Tree Canopy in Relation to Land Use and Age of Development

Tree canopy varies considerably in relation to land use. Figure 5 shows the average tree canopy in 2015 for selected land uses based on the 20 sample sites:

Land Use Types	Tree Canopy
Residential – rural, suburban and urban (11)	15.6%
Residential – Medium Density (2)	11.4%
Institutional (1 site)	14.9%
Commercial (3 sites)	6.1%
Industrial (3 sites)	2.3%

Figure 5: Tree Canopy by Land Use in 2015

Generally, older developments a higher tree canopy than newer projects. The following were some of the findings for 2015:

- Older residential neighbourhoods in Abbotsford had an average tree canopy of 18.3%, while newer neighbourhoods had an average tree canopy of 12.3%
- Older Industrial areas had an average tree canopy of 2.6%, with newer industrial areas averaging 1.5%.

Key Patterns

The sample site images in Appendix B illustrate the changes in the tree canopy. Examples for industrial and residential land are illustrated in Figures 6 and 7. In most of Abbotsford, tree canopy loss from 2005 to 2015 was caused by major clearing for land development.

Some of the trends related to tree canopy challenges in other communities include the following: infill of larger houses removing trees on smaller lots, lack of tree growth in new developments, and few trees in new developments, sometimes caused by zoning regulations. When housing affordability is a focus, lot sizes can be too small to accommodate trees in addition to utilities and usable outdoor space.



Figure 6: Industrial Land in Western Abbotsford 2005 (above) and 2015 (below)



Figure 7: Residential Land Development near Sumas Mountain 2005 (above) and 2015 (below)

Closing Comments

Assuming that the tree canopy trends for the previous 10 years in Abbotsford remain constant, the tree canopy in the UCB would be approximately 28% in 2025 and 25% in 2035. There are many measures that municipalities can use to protect and enhance the tree canopy, some of which are as follows:

- Raise awareness about the importance and benefits of the urban forest among City staff, Council, developers and the public, including information on the City's initiatives.
- Establish tree canopy targets, potentially for the city as a whole, for specific land uses, or for neighbourhoods.
- Update tree protection and other bylaws (e.g., OCP Development Permit Guidelines, Subdivision and Servicing, and Zoning) to incorporate more emphasis on the tree canopy.
- Integrate recommendations related to the urban forest into strategic plans such as the OCP and Sustainability Plans.
- Identify opportunities for protecting and planting trees on private property, and use programs and incentives to encourage this.
- Work with the agriculture community on opportunities to protect and enhance the tree canopy.
- Partner with private and government institutions to encourage more tree planting on their sites.
- Increase tree planting in existing and new parks, other City facilities, and road allowances.
- Consider requiring developers to contribute to the costs of boulevard tree planting.
- Adopt best management practices for tree planting and incorporate these into all relevant plans and policies.
- Adopt proper practices for tree maintenance and encourage private land owners to follow these practices as well.
- Monitor bylaws that require tree planting on private land.
- Support and expand stewardship programs to involve volunteers in planting and maintaining trees.

This document provides base data on Abbotsford's tree canopy. With the data already generated, additional types of analysis are possible.

Appendix A: Study Methods

The following GIS data was acquired from the City:

- Orthophotos for 2005 and 2015
- Zoning classifications for 2005 and 2015
- Urban Containment Boundary
- Neighbourhood Boundaries
- Municipal Boundary
- Legal Parcels
- Road centrelines with construction dates

Urban Systems generated the following data:

- 20 sample sites – identified and digitized in GIS to capture a variety of land uses developed in different decades
- 20 sample sites - digitized tree canopy for each site for 2005 and 2015
- Image classification – analyzed and classified air photos from 2005 and 2015 to identify larger contiguous patches of forest

The first step in the GIS analysis involved image classification tests to determine the classification tool that yielded the best results (using the ArcGIS 10.2.2 Toolbar – Image Classification). After initial trials with Interactive Supervised Classification combined with 39 training sites, it was determined the Maximum Likelihood Classification (MLC) with 39 training sites was the preferred method.

The results from the MLC process were then reclassified from 39 to 8 classes. This simplified results based on common characteristics. For example, several different sample sites were generated to represent the various roofing types found in the city. The image classification results for all types of roofs were then aggregated into a single reclassified value. Various forest sample results (deciduous vs coniferous) were reclassified into a single forest class, and so on.

The next step was to select the subset representing forest polygons and to clip the results to the Urban Containment Boundary (UCB). This made the dataset far more manageable. The next step was to convert the clipped UCB raster to polygons (needed for eventual overlay with other polygonal data like zoning). Polygons were then dissolved and forest patches less than 1,800 m² were removed to further improve manageability for quality control. Each of the remaining approximately 900 polygons were then visited and quality controlled for accurate classification. Contiguous forest areas missed by the image classification results were onscreen digitized, resulting in a final 721 polygons (most errors were due to shadows on the 2005 imagery).



The final 2005 contiguous forest polygons (over 1,800 m²) were then refined by on-screen digitizing using the 2015 orthophoto to remove or refine areas where deforestation had taken place for agriculture, commercial / industrial, or residential development purposes.

Concurrent to the image classification work, 20 sample sites were selected with input and review by City Staff. These sample sites attempt to represent various land uses, across development dates (older 1960s, 70s and 80s developments vs newer 1990 to present developments), across differing neighbourhoods. The 20 sample sites were weighted mostly towards residential development (13 sites), then commercial and Industrial development (3 sites each), with one representative Institutional site. Within the sample sites, onscreen digitizing was conducted to identify the tree canopy in 2005 and 2015. Google Street View was employed as an additional tool to identify whether vegetation was legitimate trees (more than 6 ft in height) vs. low shrubs or hedges.

The last GIS step was to integrate the results of the sample site digitizing and the image classification forest polygons. To achieve this, some work on the 2005 and 2015 zoning layers was required. For both years, the detailed zoning classes were generalized to the following categories:

- Agricultural
- Commercial
- Comprehensive Development
- Industrial
- Institutional
- Parks, Open Space and Schools
- Residential – Rural and Suburban
- Residential – Urban
- Residential – Medium Density

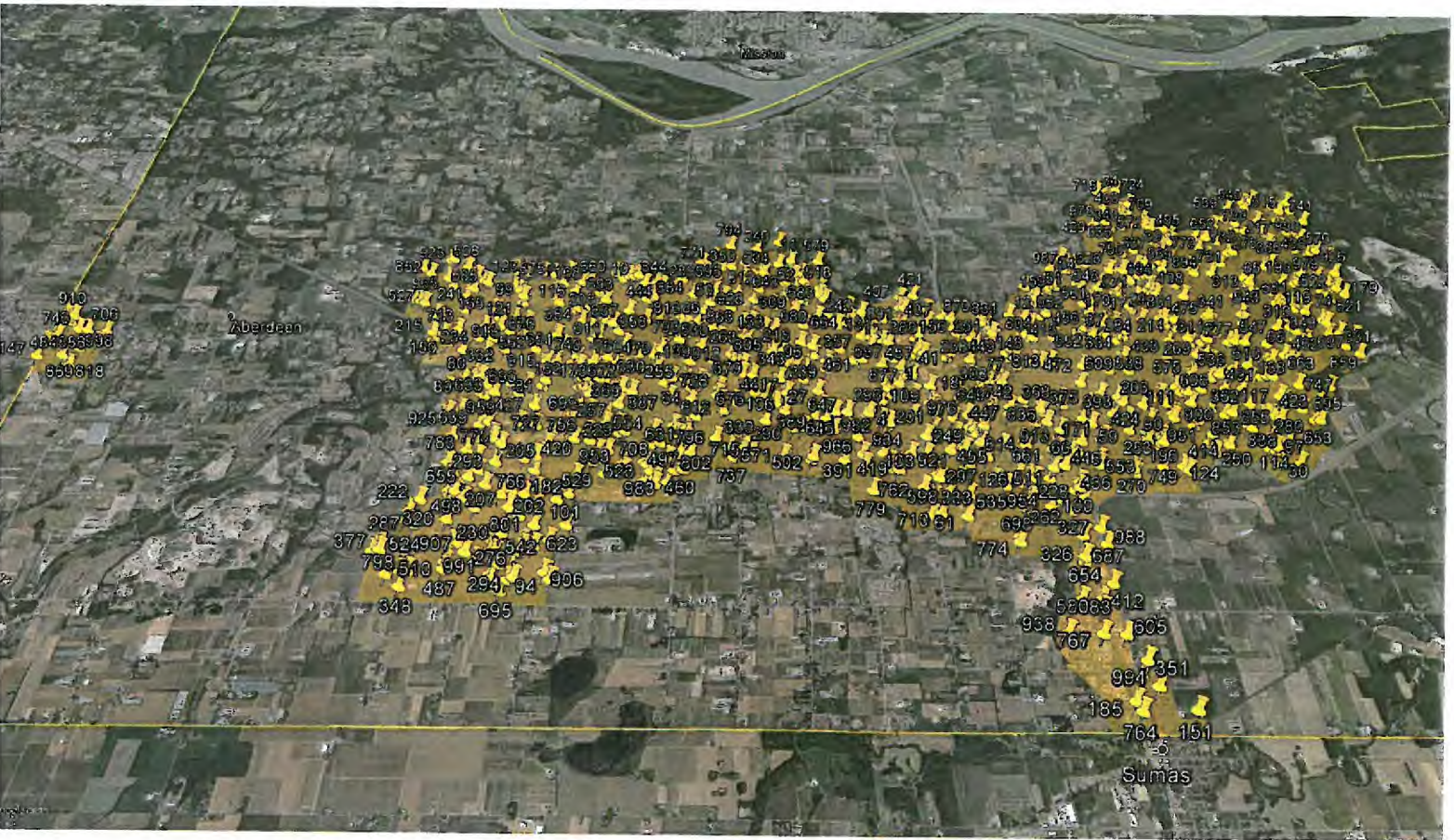
Average road construction dates by zoning polygon were then used to classify whether the development was older (pre-1990), or newer (\geq 1990). The image classification forest polygons were then overlaid in GIS with the age classified and generalized zoning polygons for the two time periods. Areas with 100% canopy cover (contiguous forest) were temporarily ignored, and average tree canopy numbers were generated from the sample site summary results for older and newer types of development. These averages were then applied to the remaining zoning classifications (net non-contiguous forest areas), by age class to complete the tree canopy analysis.

Assumptions for non-sample site land use types were as follows:

- Agriculture – industrial averages used as proxy
- Parks, Open Space and Schools – institutional averages used as proxy

Single resultant layers for 2005 and 2015 were then summarized to identify tree canopy percentages for the entire UCB, with and without parks.

To verify the results, iTree Canopy surveys (v6.1) were also run for 2005 and 2015, using the recommended 1,000 sample points, with the Urban Containment Boundary defining the project area.





Appendix B: Sample Sites

SITE
1

Industrial



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 1 - Industrial	Newer	2.5%	1.5%	-1.0%

SITE 2 Residential



2005

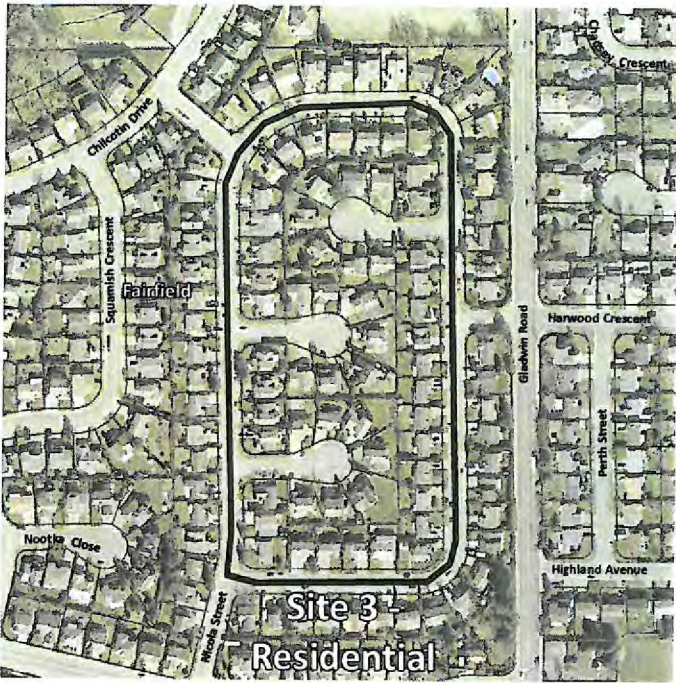


2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 2 - Residential	Older	8.1%	10.1%	2.1%

SITE 3

Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 3 - Residential	Older	12.9%	14.5%	1.5%

SITE 4
Industrial



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 4 - Industrial	Older	1.5%	1.4%	0.0%

SITE 5 Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 5 - Residential	Newer	7.4%	14.0%	6.6%

SITE 6 Residential



2005



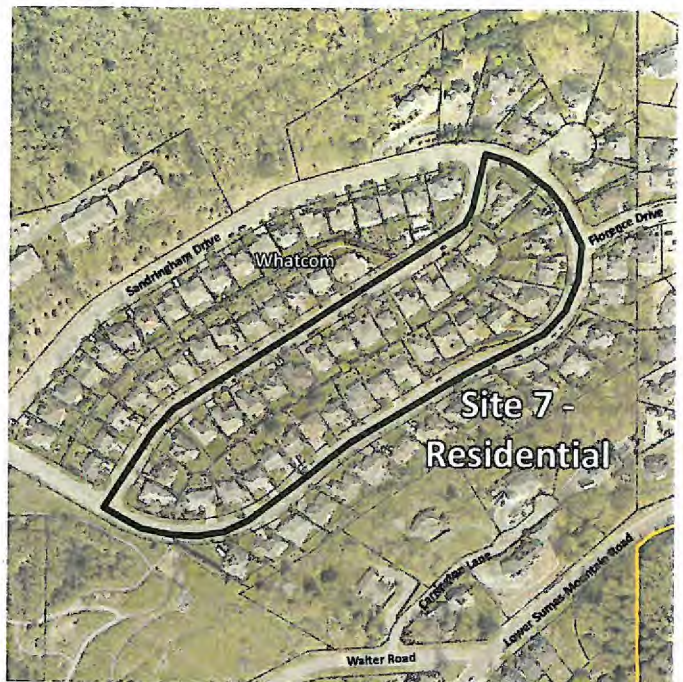
2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 6 - Residential	Newer	48.0%	10.8%	-37.1%

SITE 7 Residential



2005



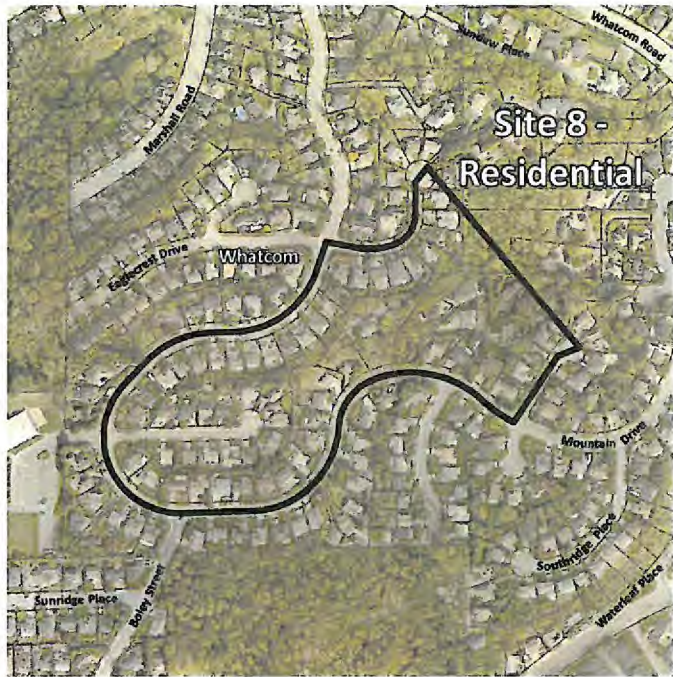
2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 7 - Residential	Newer	9.1%	15.3%	6.2%

SITE 8 Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 8 - Residential	Older	25.2%	28.6%	3.4%

SITE 9

Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 9 - Residential	Newer	9.6%	17.1%	7.5%

SITE 10
Residential



2005



2015

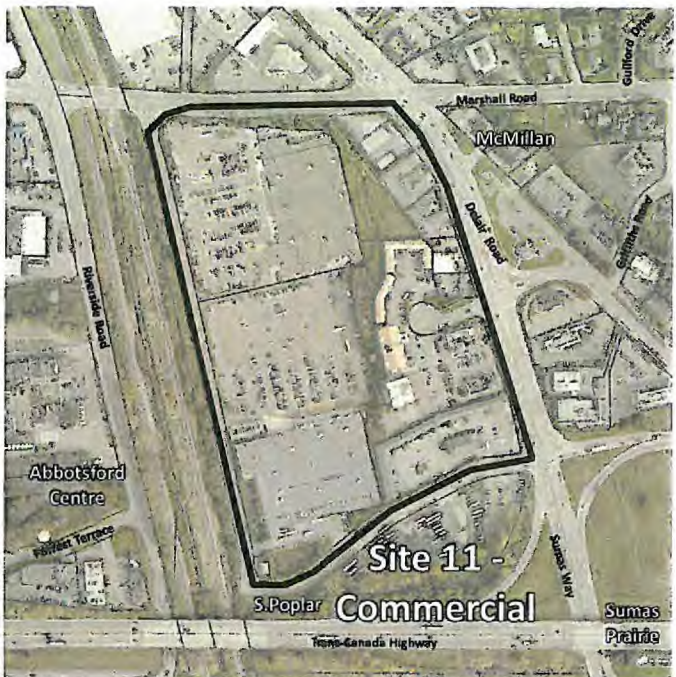
Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 10 - Residential	Older	15.9%	21.1%	5.2%

SITE 11

Commercial



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 11 - Commercial	Newer	6.9%	10.4%	3.6%

SITE 12 Commercial



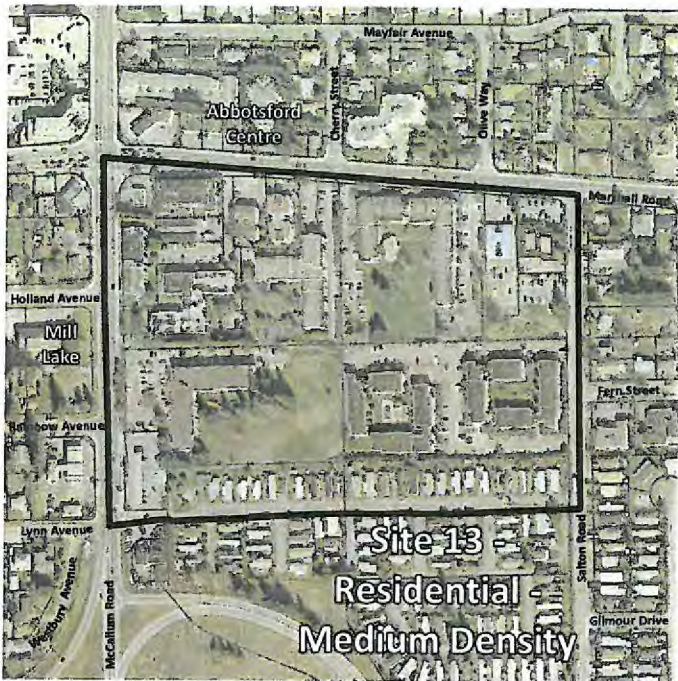
2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 12 - Commercial	Older	4.8%	4.8%	-0.1%

SITE 13 Residential | Medium Density



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 13 - Residential - Medium Density	Older	10.8%	14.5%	3.7%

SITE 14 Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 14 - Residential	Older	15.4%	20.6%	5.3%

SITE 15 Residential | Medium Density



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 15 - Residential - Medium Density	Older	6.9%	8.2%	1.3%

SITE 16 Commercial



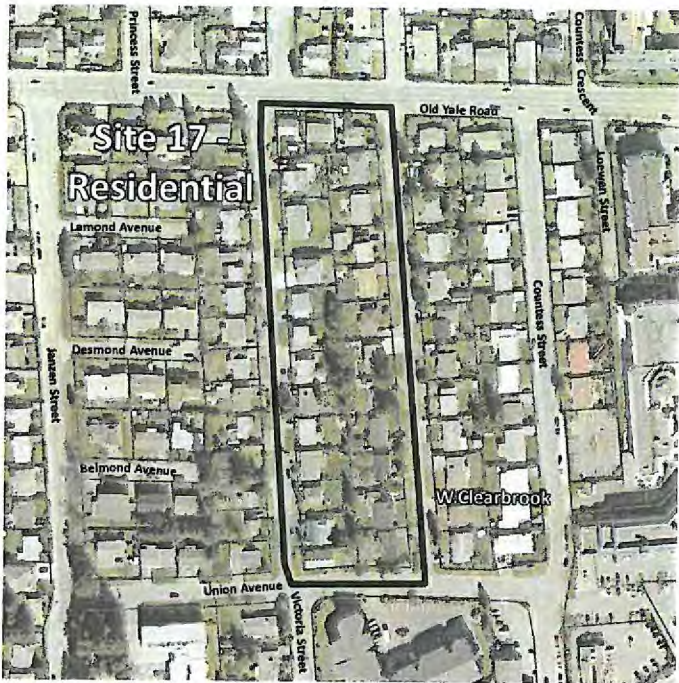
2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 16 - Commercial	Older	2.2%	3.2%	1.0%

SITE 17 Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 17 - Residential	Older	12.4%	15.1%	2.7%

SITE **18**
Industrial



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 18 - Industrial	Older	3.3%	3.8%	0.5%

SITE 19 Residential



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 19 - Residential	Newer	43.8%	4.3%	-39.4%

SITE 20 Institutional



2005



2015

Site Name / Zoning	Age Category	2005 Canopy Cover	2015 Canopy Cover	Change
Site 20 - Institutional	Newer	23.5%	14.9%	-8.6%