Urban Forest Management Plan

Volume 1. Documentation

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Summary

The residents of Spruce Grove deeply appreciate their natural environment and value the forests that form an integral part of the City's fabric. One of the City's Key Initiatives, "Clean and Green", specifically identifies the urban forest as a priority area and provides a number of objectives, action plans, timelines and measures of success for ensuring the sustainability of urban forests.

The City of Spruce Grove contracted Timberline Forest Inventory Consultants to prepare a Forest Management Plan to assist in obtaining the objectives relating to the Forest Management and Natural Areas development priorities. A forest management plan is a living document that is meant to guide the long-term process of forest management. This plan is the beginning of that process. It describes:

- Detailed information on the status and distribution of forest stands within the four City forests.
- Methods used to collect and summarize data.
- Short-term (one to five-year) recommendations and a benchmark against which future changes to the forest resource can be compared.
- Recommendations for mitigating problems revealed by the forest assessment.
- Tentative recommendations for longer-term policy and planning work.
- Information needs to review existing long-term strategic goals and develop new ones.

To better understand the City's forests, background information on the environments within which the forests occur is provided. Discussions of regional climate, surficial geology and soils, hydrology and hydrogeology, and vegetation set the big-picture context. An overview of the four City forests (area and volume of standing timber) is also provided as background.

The Forest Management Plan is provided as two volumes. Volume 1 contains all of the written material pertaining to background information, environmental setting, general forest stand characteristics, methods used to complete the forest assessment, analysis and mapping, detailed descriptions of each forest, short and longer term plans, references and appendices containing assessment criteria and tabular summaries. The characteristics and management strategies for each of the four forests are discussed in separate sections.

Volume 2 contains the maps referred to in Volume 1; this arrangement is intended to make it easier to view the text and map information at the same time.

The method used to complete the Forest Management Plan involved the review of existing information, stratification of 1999 1:10,000 scale black and white aerial photographs to identify forest inventory units, fieldwork to collect detailed inventory information within map units, assignment of forest and ecological attributes to map units, data analysis, GIS data capture, and final reporting.

Clearing for agriculture and to a lesser extent urban development has left all four forests as islands in a sea of urban development and cultivated land. The total areas for Heritage Grove, Atim Creek, Cooke Lands, and GroveCo 60 are 58.0, 53.6, 5.7 and 6.4 hectares respectively. Heritage Grove and Atim Creek account for about ninety percent of the total forested area. Both areas are supplied by carbonate-rich groundwater and contain a high diversity of forest cover types. There are significant areas of organic soils that have developed under wet conditions in the past; some of these previously wet areas have dried and black spruce forests have been replaced

by deciduous forests. Fire and logging have played a major role in forest development in these two forests. In Heritage Grove, City expansion has reduced the size of the forest somewhat over the last 80 years. Comparatively, Cooke Lands and GroveCo 60 contain entirely upland forest types and mineral soils that receive local groundwater water input from precipitation or surface run-off from adjacent areas. These forests have mainly been influenced by fire.

The short-term (one year) plan for Heritage Grove identifies tamarack and black spruce mortality, high to extreme fire hazard, hazardous trees, invasive species, and groundwater as the top priorities. Recommendations include determining the causes of tamarack mortality, incorporating fire management planning to reduce fuel loading, removal of hazardous trees, the control of noxious weeds or invasive tree species, and taking local groundwater conditions into account if further developments adjacent to the forest are planned.

The short-term plan for Atim Creek identifies flooding, fire hazard, sensitive sites, invasive species, and groundwater as the top priorities. Recommendations include reduction of flooding causes, fire management planning, protection of sensitive sites, monitoring invasive species, and monitoring local groundwater conditions prior to development.

Short-term plans for GroveCo 60 and Cooke Lands forest areas were not developed because no urgent issues were identified for these areas. Five-year plans make general references to dealing with local hydrology issues through appropriate planning and engineering, fire hazards, invasive species, and trail development. Recommendations include ground water planning, fire management planning, invasive species monitoring, and improving existing trail systems and planning new ones.

Long-term strategies will depend on both community objectives and input, and future environmental conditions. Flexibility is required to adapt to continuous and inevitable changes in the forest and in the surrounding urban and natural environment. Local and regional groundwaterGround water and fire protection will continue to be a concern in all Spruce Grove forests; however, Heritage Grove should receive the highest priority. Additional sources of funding and partnerships that support urban forestry and management activities should be considered.

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 Background and policy context

Nearly 80 percent of Canadians live in cities, and the urban forest, both planted and natural, represents the main source of contact that many have with the natural environment. A recent poll indicated that 84 percent of Ontario urbanites surveyed viewed the trees and natural areas in their neighbourhoods as extremely important[1]. The numerous benefits of urban forests (pollutant filters, shade, windbreaks, stormwater control, noise attenuation, recreational areas, wildlife habitat, increased property values[2], psychological well-being) are well recognized.

The residents of Spruce Grove deeply appreciate their natural environment and value the forests that form an integral part of the City's fabric. Educational signboards throughout Heritage Grove and a well-maintained system of pathways that are used by a large number of City residents attest to the value that the City places on natural areas.

One of the City's eight Key Initiatives[3], "Clean and Green", specifically identifies the urban forest as a priority area and provides a number of objectives, action plans, timelines and measures of success for ensuring the sustainability of urban forests (Table 1).

Table 1. "Clean and Green" urban forest objectives and action plan 2002-2005

Priority Area	Objective	Preliminary Action Plan	Timeline	Measure of Success
Trees	• Ensure that tree growth is maintained and fostered	Review type/size standards and multi-year planting objectives	May 2003	• City program achieves vision for the City
Forest Management	• Develop and maintain/expand forests • Ensure long-term existence of urban forest	• Initiate tree replacement plan • Fire Plan booklet (tree pruning and brush cleaning to reduce fire hazard) • Education plan to promote fire safety in schools • Identify high risk fire areas • Identify and establish priority areas for replanting and succession planting • Promote Arbor Day activities for school tree plantings • Protect existing and future forest areas	• Sept. 2003 • Apr. 2003 • Sept. 2003 • Jul. 2002 • Apr. 2003 • Apr. 2003 • Jul. 2002	• Healthy thriving forest areas • Established program • Identified areas • Arbor Day established • Existence of protected area
Natural Areas Development	• Develop and maintain/expand natural habitats	• Establish a detailed inventory of different habitat types • Identify natural areas through environmental analysis	• Dec. 2003	• Long-term management plan for natural areas in place

[1] Source: Tree Canada website: http://www.treecanada.ca/programs/urbanforestry

[2] Tax roll data provided by Paul Hanlan, City of Spruce Grove Planning Department was analyzed and showed that land values for residential lots immediately adjacent the north side of Heritage Grove (west of Calahoo Road) were about 10% higher on a square foot basis than values across the street from Heritage Grove.

[3] These key initiatives provide the strategic direction for the City from 2002-2005. Source: City of Spruce Grove 2001. The Key to the Future: Key Initiatives 2002-2005.

These priorities and objectives are aligned well with current approaches to urban forestry that emphasize the importance of co-ordinating administrative components, the physical area of urbanization, and the role that urban forests play within the community. The City's priorities and criteria for success are well matched to management of the urban forest under the encompassing definition proposed by Wassanaer et al. (2000) as "*a single consolidated forest composed of flora and fauna within the urbanized area that facilitates the social, economic and ecological well-being of the community*".

Spruce Grove's urban forest policy appears to be both progressive and proactive relative to most other municipalities. A survey of Internet sites revealed very few references to forest management planning for urban forestry that considered management of both naturally occurring forests and planted trees, and Kenney and Idziak (2000) reported that only one third of communities with less than 100,000 people had any strategic forest management plan at all. Spruce Grove residents believe that the Heritage Grove forest is in decline as evidenced by the lack of new tree growth and the replacement of spruce forests with poplar, and are concerned about the potential consequences over the long term. In response, Spruce Grove policymakers have identified the need for a Forest Management Plan as an important element of urban forest management.

The City of Spruce Grove contracted Timberline Forest Inventory Consultants to prepare a Forest Management Plan to assist in attaining the objectives relating to the Forest Management and Natural Areas development priorities. The establishment of relevant and attainable planning objectives is linked to the definition of what a forest management plan is.

Conventional forest management plans identify goals that define what the future desired state of the forest is to be, recognize various resource values, uses, and activities, identify sustainable timber harvest levels, and provide the context for long-term, mid-term and short-term goals; note that part of the focus is on fibre production. Urban forest management planning shares the same basic framework, but the focus is on maintaining or enhancing the existing forest resource; timber harvest for economic gain is an unlikely objective. Kenney and Idziak (2000) state that comprehensive urban forest management plans should include:

- An up-to-date computerized inventory of the forest resource;
- A strategic plan, which would include an outline of the vision or objectives for the urban forest, an overview of the extent and condition of the resource, and a broad outline of the methods to be used to achieve the objectives;
- A five-year management plan to implement the longer-term goals;
- An annual operating plan to implement specific activities; and
- An arboriculture plan to track planted trees.

A forest management plan is a living document that is meant to guide the long-term process of forest management, and this plan is the beginning of that process. The long- and short-term goals and objectives are dependent on both community needs and biological realities, and will undoubtedly change with time as the community grows and as environmental conditions both within and beyond the control of the City inevitably change.

The City has requested that Timberline include most of the elements identified by Kenney and Idziak (2000) in the forest management plan, with an emphasis on documenting the forest resource, identifying current and potential problems with stand health, fire, succession, and regeneration, and presenting short and mid-term alternatives. Four forested areas are considered in this management plan, and include Heritage Grove, Atim Creek, GroveCo 60, and the Cooke Lands Forest Reserve. The locations of these forests are shown below in Figure 1.

An arboriculture plan that addresses the maintenance and enhancement of street tree populations is not included as part of this plan, but should be integrated where possible as both are important elements of an overall urban forestry strategy.

1.2 Objectives

The objectives of this plan are to:

1. Provide detailed information on the status and distribution of forest stands within the four City forests shown in Figure 1. This information will provide the basis for short-term (one-to five-year) recommendations and a benchmark against which future changes to the forest resource can be compared. It will also provide the City with information needed to review existing long-term strategic goals and develop new ones.

2. Provide recommendations for mitigating problems revealed by the forest inventory that is part of objective 1.

3. Provide tentative recommendations for longer-term policy and planning work.

4. Discuss possible funding sources that might be available to municipalities and community groups for forestry activities both within and adjacent to the four identified forests.

1.3 Document organization

This Forest Management Plan is provided as two volumes. Volume 1 contains nine sections and two appendices. Section 1 (this section) describes background information and objectives. Section 2 provides an overview of the environmental setting within which all four of the forests occur, and summarizes general forest stand characteristics. Section 3 discusses the methods used to complete the inventory, volume analyses, and mapping themes. Sections 4 through 7 provide detailed resource information and one to five year suggested plans for Heritage Grove, Atim Creek, GroveCo60 and Cooke Lands Forest Reserve, respectively. Section 8 provides a set of tentative longer-term forest management recommendations based on the City's preliminary action plan items in Table 1, information revealed by the forest inventory, and other information. It also includes a summary of potential funding sources and a brief review of "carbon credits". Section 9 lists the references cited in preparing the forest management plan. Appendix A includes tables summarizing the criteria used to assess fire, blowdown, decay and breakage, and snag habitat potential. Appendix B contains tabular summaries of information for each map unit in each of the four forests.

Volume 2 contains the maps referenced in Volume 1; this arrangement will allow the reader to more easily view both the maps and the relevant parts of the report at the same time.

A compact disc containing all of the photos taken during field surveys in 2004 has also been provided as part of the deliverables for this project; these photos may provide a useful historic record in future.

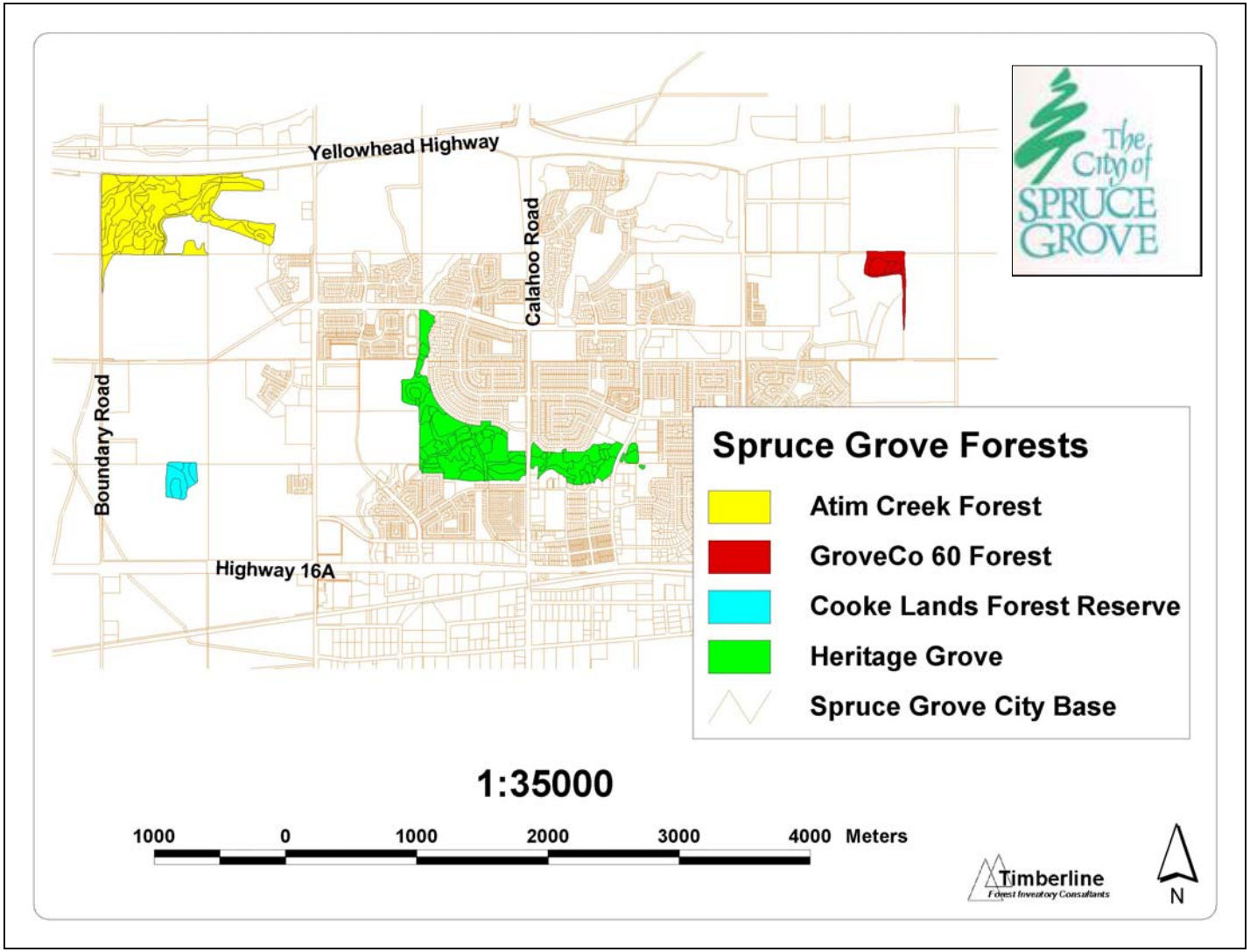

Figure 1. Location of the four forests covered by this forest management plan

2 Biophysical Setting and Summary of Forest Characteristics

2.1 Biophysical Setting

2.1.1 Regional climate

Alberta is an ecologically diverse province, and includes six major climatically and ecologically distinct Natural Regions which may be further subdivided into 21 Natural Subregions. The City of Spruce Grove occurs entirely within the Parkland Natural Region and the Central Parkland Natural Subregion. This subregion is transitional between the boreal forests to the north and the grasslands to the south. Climate data for the nearest weather station at Stony Plain based on 1971-2000 climate normals[4] is presented in Table 2, along with average climatic data for the Central Parkland subregion and the Boreal Dry Mixedwood subregion lying immediately to the north and west[5] of the Central Parkland. The data indicate that the Stony Plain area has a greater climatic affinity to the Central Parkland subregion than to the Boreal Dry Mixedwood subregion. Vujnovic 1998 (cited in Vujnovic et al. 2000) indicates that the Stony Plain- Spruce Grove area falls within the wettest part of the Central Parkland subregion, a trend that is supported by the comparative average annual precipitation values provided in Table 2.

Table 2. Climate data for Stony Plain, the Central Parkland Natural Subregion, and the Boreal Dry Mixedwood Subregion

Climatic parameter	Stony Plain	Central Parkland subregion	Boreal Dry Mixedwood subregion
Average annual temperature:	3.4°C	2.3 °C	-1 °C
Average annual precipitation	536mm	441mm	459mm
Growing degree days>5 °C[6]	1477	1412	1299
Frost-free period	134 days	102 days	98 days

2.1.2 Vegetation

Much of the native vegetation has been removed by cultivation; several hundred thousand hectares around Edmonton was already cleared by the 1920's (Bowser et al 1962). In the Rumsey area of central Alberta near Red Deer, a mosaic of dry grassy uplands and moist depressions occupied by aspen groves or willow are characteristic of the Central Parkland there; to the north and west, as precipitation increases, closed aspen and balsam poplar forests tend to become more common. White spruce stands occur in moister locations where intense fires are less likely to occur. Wetlands are typically cattail, sedge or bulrush marshes and the conifer-dominated wetlands that occur in Wagner Natural Area, Heritage Grove, and Atim Creek forest are uncommon in the Central Parkland subregion.

[4] Source: http://www.climate.weatheroffice.ec.gc.ca/climate_normals
[5] Source: Alberta Sustainable Resource Development, unpublished climate summaries for the Central Parkland Natural Subregion and Boreal Dry Mixedwood ecoregions based on 1961-1990 climate normals.
[6] Growing degree days are a measure of the amount of energy available for plant growth. Higher values indicate that more energy is available. In Alberta, these values range from a low of about 300 in the Alpine subregion to a high of 1690 in the Dry Mixedgrass subregion of southeastern Alberta.

Two previous vegetation studies provide more detailed information on understory vegetation composition than is provided in this forest management plan. Williams (Williams/Ecomark, in Durrance and Associates 2003) summarizes understory and overstory plants encountered during a one-day survey of Atim Creek forest and indicates potential rare and uncommon plant species that may be found in the general area. Map units developed by Williams for the Atim Creek area are more general than those presented in Volume 2 of this management plan; however, the two sets of map units are compatible enough that the vegetation descriptions and photographs provided by Williams will provide a reasonable indication of major plant species distribution patterns. Cosco (1990) provides a detailed landscape unit map of Heritage Grove with map units very similar to those provided in this forest management plan and associated detailed vegetation descriptions and photographs.

2.1.3 Surficial Geology and Soils

Gently undulating lacustrine (lake-deposited) and fluvial (stream-deposited) materials are typical of the Spruce Grove area (Shetsen, 1990, in Vujnovic et al., 2000). The east end of Atim Creek forest is underlain by coarse-textured fluvial materials; there, a conspicuous feature is an esker, a relatively sharp-crested coarse-textured landform laid down either underneath glacial ice or on its surface by fast-flowing glacial meltwaters. Refer to Section 5.3 for more discussion of this feature.

Bowser et al (1962) mapped the soils of the Spruce Grove city area as a complex of silty loam- to loam-textured Orthic Dark Grey Luvisols[7] (Mico series, Winterburn series) and silty loam to loam textured Eluviated or Black Chernozems (Malmo series and Ponoka series). The Heritage Grove and much of the Atim Creek Forest were mapped by Bowser et al. (1962) as Organic soils composed of sedge and moss peats (Figure 2). Mineral soils associated with Heritage Grove, Atim Creek, and Cooke Lands Reserve appear to best fit the Mico series, while soils in GroveCo 60 appear to best fit the Ponoka Meadow series, typically having a thick black upper horizon and mottling indicating imperfect to poor drainage in the lower horizons.

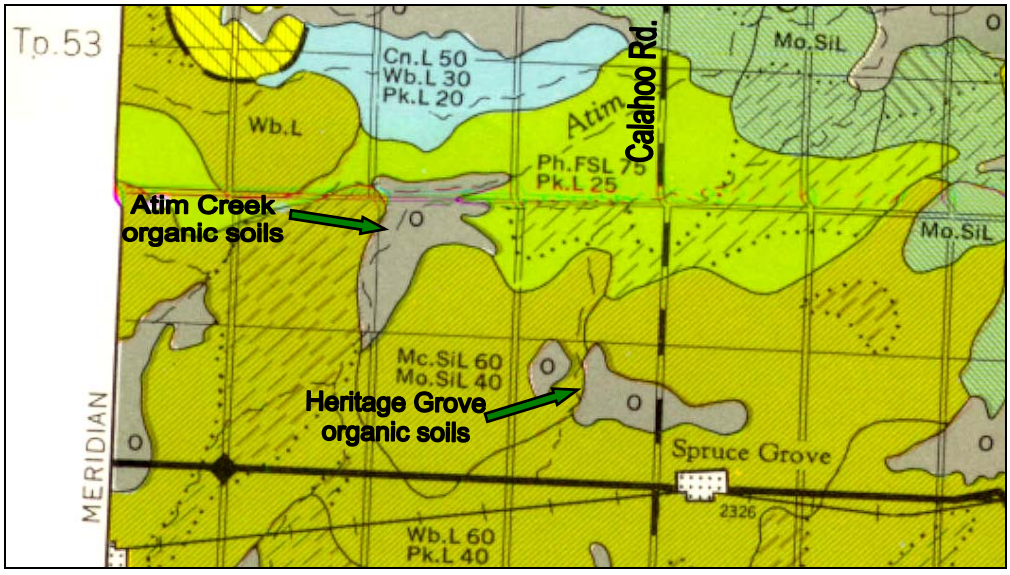

Figure 2. Soils in the vicinity of Spruce Grove as mapped by Bowser et al. (1962)

[7] Soils taxonomy and nomenclature follows the Canadian System of Soil Classification (Canadian Soil Classification Working Group 1998) and was determined by matching the profile descriptions provided in Bowser et al 1962 to the best fit in the 1998 taxonomy.

2.1.4 Hydrology and Hydrogeology

Heritage Grove is drained on the west side by Dog Creek, and there is a slight northerly gradient to the area. Atim Creek provides drainage for Atim Creek forest; the Yellowhead Highway and a beaver-dammed culvert have impeded drainage, and local flooding south of the highway has occurred. GroveCo 60 lies in a depression and receives local groundwater and surface lateral flows from the surrounding cultivated fields. Cooke Lands Forest Reserve receives seasonal flows from an ephemeral creek running from cultivated fields into the southeast corner of the stand.

Groundwater flow patterns have had a pronounced effect on the development and history of the Heritage Grove and Atim Creek forests. The Atim Creek study (Alberta Environment Planning Division 1978, plate 8) indicates that the Wagner and Heritage Grove areas are in a groundwater discharge zone; the recharge area is to the south and west of Stony Plain (Figure 3). Sections 4.5 and 5.5 provide more detailed discussions of groundwater effects and their relationship to stand history and current distribution of stand types and organic soils for Heritage Grove and Atim Creek forest, respectively.

2.2 Summary of General Forest Characteristics

Table 3 summarizes total area and volume statistics for all four Spruce Grove forests. Heritage Grove and Atim Creek forests account for about 90 percent of the total forested area and 85 percent of the total standing volume of trees. The average estimated volume per hectare is an indication of relative productivity, assuming a more or less equal age distribution and stand density. By this criterion, GroveCo 60 currently appears to be the most productive and Atim Creek forest the least productive. The "mean annual volume increment estimate" provides an idea of the amount of wood added due to annual tree growth; it is calculated by taking the total estimated standing volume for each map unit, dividing by the age of the forest in that map unit, and summing the resultant mean annual increment value for each map unit across the entire forest. Sections 4 through 7 provide more in-depth analyses of forest cover characteristics for each forest.

Table 3. Summary of stand area and stand volume characteristics for all four Spruce Grove forests

	Heritage Grove	*Atim Creek*	*Cooke Lands Forest Reserve*	*Groveco 60*	*All forests*
Total area (ha)	58.0	53.6	5.7	6.4	123.7
Total forested area (ha)	50.2	43.9	5.7	6.4	106.2
Total non-forested area (ha)	7.8	9.7	0	0	17.5
Total estimated standing volume (m3)	9040	6379	814	1791	18024
Total estimated conifer volume (m3)	5860	2098	341	905	9204
Total estimated deciduous volume (m3)	3180	4281	473	886	8820
Average estimated volume (m3) per hectare, total forest area	156	119	144	281	146
Mean annual volume increment estimate, total forest area (m3/year)	125	112	11	22	270

Standing, conifer,and deciduous volume estimates are derived from timber cruise data collected during field surveys in support of this management plan in 2004. For stands where this information was not collected, 1985 Phase 3 Forest Inventory stand volume tables were used.

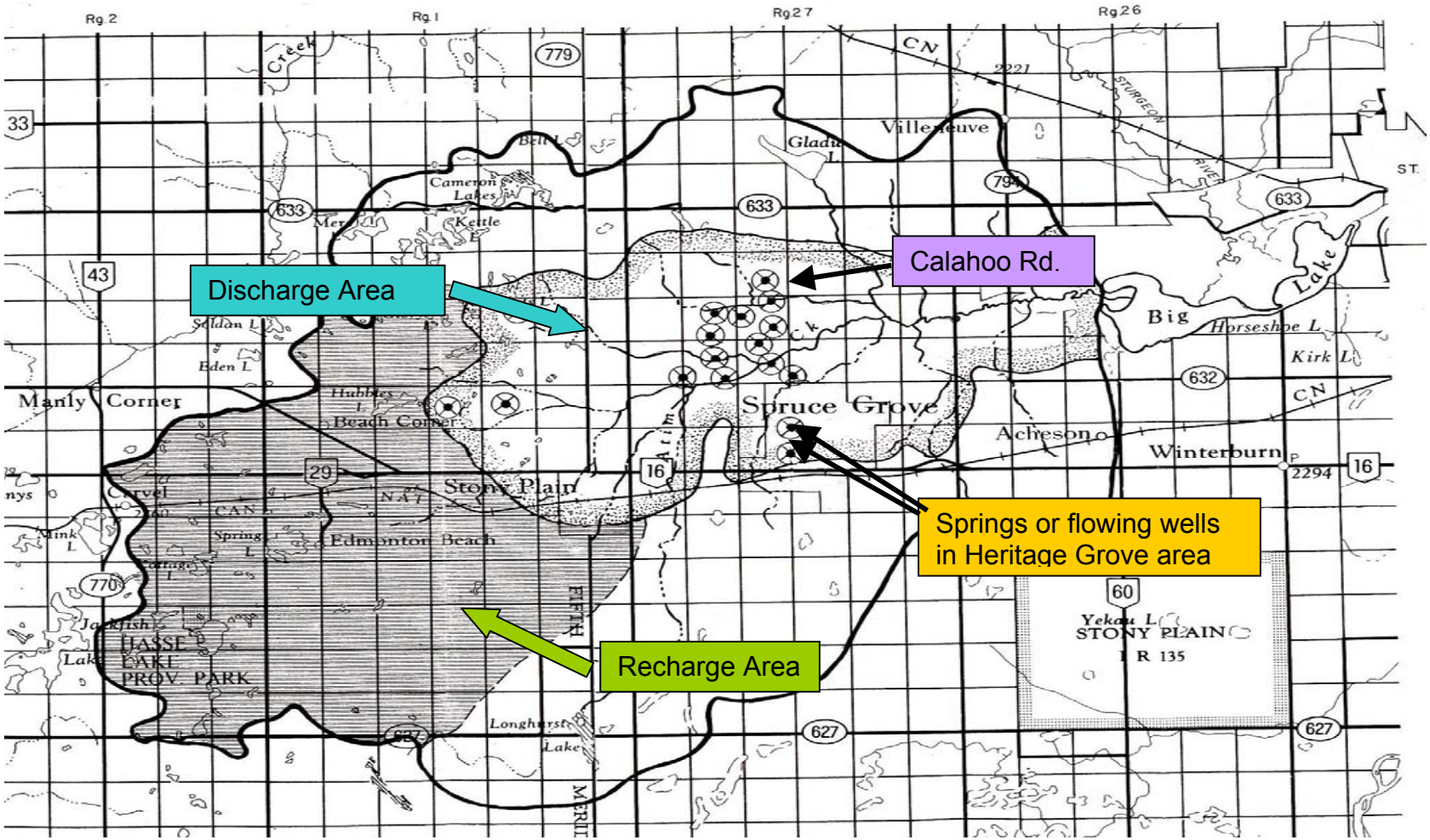

Figure 3. Local groundwater flow patterns, Stony Plain-Spruce Grove area

(Source: Plate 8, Atim Creek Study, Alberta Environment Planning Division 1978)

3 Methods

The process used to complete this forest management plan involved review of existing information, initial stratification of 1999 1:10,000 scale black and white airphotos to identify forest inventory map units, fieldwork to collect detailed inventory information within map units, assignment of forest and ecological attributes to map units, data analysis, GIS data capture, report preparation, and review of the results by Spruce Grove planning staff.

3.1 Forest Inventory

3.1.1 Pre-field stratification and fieldwork planning

The detailed inventory required for this forest management plan required large-scale recent photographic coverage. The most recent large-scale available airphoto coverage was 1999 1:10,000 black and white panchromatic. Interpretation was done using an Abrams stereoscope; criteria used to produce an initial stratification of vegetation cover into map units included tone and texture characteristics related to tree height and stand composition for forested stands and vegetation type or disturbance category for non-forested stands. In addition, map units were recognized by photo-interpretable characteristics such as hydrologic features and topographic location.

Both the initial stratification and existing information, primarily Cosco (1990) and Williams (Williams/Ecomark, in Durrance and Associates 2003) were used to plan fieldwork. Plots were located to sample map units that were considered representative of common and recurring forest cover types; map units that were located in unusual areas (e.g., the sandy esker at the eastern end of Atim Creek forest and discussed below in Section 5.3) were also sampled.

3.1.2 Field sampling

Field sampling involved five field days and 11 person-days in total. One reconnaissance trip was made on July 15, 2004 to gain an initial understanding of local variations in the Heritage Grove, GroveCo 60, Cooke Lands Forest Reserve and Atim Creek forests; Paul Hanlan, Pat Wankiewicz, and Paul Feser of the City of Spruce Grove accompanied John Cosco and Dave Downing of Timberline on part of this trip, and extensive field notes were gathered that were subsequently used for inventory refinement and identification of areas requiring short-term management.

Two other field visits were made at which site, soil, vegetation and tree growth (mensuration) information was collected at a total of 27 plots. Eleven plots were sampled within Atim Creek forest (August 15 2004), ten within Heritage Grove (August 25-26, 2004), three within GroveCo 60 (August 16 2004), and three within the Cooke Lands Forest Reserve (August 16 2004). Surveyors were Dave Downing (all forests: site, soil and understory vegetation data collection), Vic Tran (Atim Creek, GroveCo 60, Cooke Lands: tree measurements), John Cosco (Heritage Grove: tree measurements), and Bryce Maynes (Atim Creek: tree measurements).

Plot locations were determined using a “stratified random” approach. The map unit to be sampled was selected based on preliminary strata and existing information as discussed above. Within the map unit, the plot was located at random to reduce the possibility of bias in volume estimates.

At each plot, a soil pit was dug to at least 60 cm and three to four layers were generally differentiated based on texture, structure and color differences. The presence of free carbonates was tested by dropping a 10 percent hydrochloric acid solution on soil samples taken from various levels in the soil profile. Observations of depth to water table, effective rooting depth, depth to mottles and gleying (indicative of imperfect to poor drainage) and stoniness were also made.

A list of the vascular species occurring within a 10m by 10m area around plot centre was compiled; relative abundance values for each species were recorded as one of five abundance classes determined by ocular estimates of foliar cover. In addition, the tree canopy structure and composition was assessed at the site. Site attributes (slope, aspect, slope position, landform type, and parent material type) were noted. Tree measurements were taken within a fixed-radius plot; to reduce bias, the radius was selected by the person doing the tree measurements before arriving at the plot. Within each fixed-radius plot, the diameter at 1.3m and health status of all living dominant and co-dominant trees greater than 9.1cm diameter at 1.3m was collected, and representative trees were sub-sampled to determine heights and ages. Ages were collected with an increment corer and field-counted. Understory species less than 9.1cm diameter at 1.3m were tallied.

The vegetation, site, tree growth, and soil information were then all considered together to develop a qualified judgement of the moisture and nutrient status of each plot and the map unit it represented. Each plot was assigned to one of four subjectively determined moisture classes – moist (average moisture), very moist, wet, and very wet (the latter with standing water at or above the soil surface) and one of two subjectively determined nutrient classes (average and rich).

Finally, at each plot four digital photographs were taken in each of the four cardinal directions and a geographic positioning satellite (GPS) reading was taken at plot centre with a handheld receiver. Generally, locational readings were reported as accurate to within 15m of actual location. This photographic and locational information may be useful to monitor stand changes over time.

3.1.3 Post-field interpretation

Plot data were used in combination with stereo photo interpretation to assign Alberta Vegetation Inventory (AVI) forest cover labels, general soil types (mineral or organic soils), and moisture and nutrient ratings to each map unit. This information was subsequently used to assign additional attributes such as map unit forest cover type, age class, volume statistics, fire hazard rating and decay and breakage hazard to each map unit. All attributes are presented in Tables B-1 (Heritage Grove), B-2 (Atim Creek), B-3 (GroveCo 60) and B-4 (Cooke Lands Forest Reserve) in Appendix B of this volume. AVI standards are fully presented in the *Alberta Vegetation Inventory Standards Manual, Contract Version 2.1* (Alberta Forestry, Lands and Wildlife 1992).

AVI labels recorded in the abovementioned tables are provided for both the overstory, or main tree canopy, and the understory. A typical AVI label and the meaning of the information in it is as follows:

m-40-23-Sw7Pb3-1918-G

- "m" = moisture regime (m=mesic (average), d=dry, w=wet).
- "40" = percent estimated crown closure.
- "23"= height of main canopy (or understory) in metres.
- Sw7 = 70 percent of the stand composition by crown closure is white spruce (Sw); other species codes are Pb (balsam poplar), Lt (tamarack), Sb (black spruce), Bw (white birch) and Aw (trembling aspen). SC and SO stand for closed and open shrub types. CIP and CP stand for cultivated areas.
- Pb3 = 30 percent of the stand is balsam poplar.
- 1918 = stand origin. If reported to the nearest year, the stand age was determined from a sample. If to the nearest decade, stand age was estimated from known ages in surrounding stands.
- G= subjective measure of site quality based on height-age relationships.

AVI labels are too numerous and complex to represent in a comprehensible manner on a map, therefore, the labels were simplified to a general forest cover type for each map unit based on the following rules:

- If deciduous species accounted for 80 percent or more of the overstory, the stand was considered to be deciduous and was named according to the leading and secondary species (e.g. if the AVI label read "Pb7Aw3" for composition, the stand would be called "Balsam poplar- aspen" for mapping purposes).

- If coniferous species accounted for 80 percent or more of the overstory, the stand was considered to be coniferous and was named according to the leading and secondary species (e.g. if the AVI label read "Sb7Lt3" for composition, the stand would be called "Black spruce-tamarack" for mapping purposes). Although tamarack is a deciduous conifer (it loses its needles in the fall), it was considered for the purposes of this planning exercise to be coniferous.

- If neither coniferous nor deciduous species were clearly dominant, the stand was considered to be "mixedwood" and was named according to the leading, secondary and occasionally tertiary species. For example, if the AVI label read Sw4Pb4Aw2, the stand would be named "White spruce-balsam poplar".

3.2 Volume estimates

Volume estimates were completed for each forested map unit in all forests. Two methods were used to estimate deciduous, coniferous and total volumes:

1. If the map unit had been field visited and mensuration data collected within a fixed radius, this information was considered to represent the stand. Individual tree volumes were calculated using a "13/7" utilization standard, meaning that a minimum diameter at base of 13cm and 7cm as a minimum top was used; this was done to ensure comparability with "Phase III" estimated volumes (see point 2 below). Individual tree volume

calculations used published coefficients (Huang 1994) appropriate to the Central Parkland Natural Subregion. Individual tree volumes were then expanded to a per-hectare value using an appropriate conversion from the fixed-radius plot value, and total map unit volumes for conifer, deciduous and total volume were calculated by multiplying the per hectare volume by the area of the map unit.

2. If the map unit had not been field visited, then Phase III Forest Inventory[8] Volume Tables appropriate to the Central Parkland (Zone 4) were used Each AVI label was converted to the closest matching Phase III label, and volume data were obtained from the appropriate row of the table for a "13/7" utilization standard. Total map unit volumes for conifer, deciduous and total volume were calculated by multiplying the per hectare volume by the area of the map unit.

The total map unit volume information reported in Tables B-1 through B-4 in Appendix B of this volume is derived from field plot data where this information was collected, otherwise, Phase III volume table information was used.

3.3 GIS data capture and thematic map preparation

Map units were digitized and registered to a Spruce Grove city base provided by the City of Spruce Grove. Themes were developed for each map unit as follows:

1. *General forest cover type*: as described in Section 3.1.3
2. *Age class*: AVI stand label information was used to generalize age classes into one of four classes: less than 10 years, 10-60 years, 61-100 years, and >100 years.
3. *Spring/fall and fall and summer fire hazard*: Development of this rating was adapted from *FireSmart – Protecting Your Community from Wildfire* (Partners in Protection, 2003) and is provided in Appendix A, Table A-1.
4. *Blowdown hazard*: Development of this rating was based on soil type, general forest cover type, moisture status, and inferred depth to water table. Ratings are provided in Appendix A, Table A-2.
    - Note that blowdown can be affected by removal of adjacent trees. For example, a tall white spruce stand might be relatively resistant to blowdown if it is protected from direct winds by a surrounding belt of deciduous trees, but if these are removed, the consequent direct exposure of white spruce to winds can result in extensive blowdown. Whte spruce tends to have a shallow, broad root system.
5. *Decay and breakage hazard*: Development of this rating was based on general forest cover type and age class. Balsam poplar and aspen are susceptible to rot and stem decay at relatively young ages. Ratings are provided in Appendix A, Table A-3.
6. *Wildlife Snag Habitat Potential*: Although wildlife habitat value within Spruce Grove forests might be limited by the isolated nature of these areas and surrounding urban development, snags can provide important habitat for species with a smaller local range, such as songbirds, woodpeckers, squirrels,and bats. Snag habitat ratings are similar to those developed for decay and breakage; older balsam poplar trees tend to rot from the centre out and can provide good habitat. Ratings are provided in Appendix A, Table A-4.
7. *Special features*: Special features are defined as those believed to be locally or regionally uncommon. These are discussed in Sections 4.3, 5.3, 6.3, and 7.3.

[8] Phase III was an earlier version of forest inventory that was largely replaced by Alberta Vegetation Inventory in the early 1990's.

4 Heritage Grove

4.1 Forest Cover

Heritage Grove occupies an area of 58 ha of which approximately 50 ha is forested and 8 ha is non-forested; 69 map units were identified based on photo-interpretable forest cover attributes (species composition, canopy cover, height, age). To produce readable maps, each map unit has been assigned to one of 11 general forest cover types or four non-forested types (Figure HG-2, Volume 2), and to one of three broad age classes (Figure HG-3, Volume 2). The type of soil (organic or mineral) with which each type and age class is associated is also shown in Figures HG-2 and HG-3 because this association is of interest both from the natural feature and management perspectives.

Table 4 summarizes area and volume statistics for Heritage Grove. Figure 5 shows that the dominant forest cover types in Heritage Grove are balsam poplar, white spruce, black spruce and black spruce-tamarack, accounting for 57 percent of the total area. "Wet" forest cover types (white spruce-tamarack, black and white spruce, black spruce, black spruce-tamarack, and the birch stand on the 1998 burn) cover 34 percent of the total area. "Drier" forest cover types (balsam poplar, aspen, other birch stands, balsam poplar-white spruce, white spruce-aspen, and white spruce) cover 52 percent of the total area. Non-forest cover types account for the remaining 14 percent. Stands from 61 to 100 years of age occupy about 60 percent of Heritage Grove and this area is equally divided between "wet" and "drier" forest types. Most stands from 10-60 years old are drier, mainly deciduous stands, and only six percent of the total area is occupied by wet forest types in the 10-60 year age class (Figure 6).

Forty percent of Heritage Grove is underlain by mineral soils and 60 percent by organic soils. Organic soils are those in which the organic component (undecomposed to decomposed organic matter generally deposited in wet environments) accounts for more than about 20 percent of the soil profile by volume. Mineral soils are those in which the mineral fraction (a combination of sands, silts and clays) is prevalent. "Wet" forest types are always associated with organic soils in Heritage Grove and "drier" stands are usually associated with mineral soils, but it is interesting to note that drier deciduous and coniferous stands occupy organic soils on 20 percent of the area (Figure 6). The importance of this association will be discussed in connection with stand history in Section 4.5.

4.2 Site nutrient and moisture status

Figure HG-4 in Volume 2 shows the distribution of site nutrient and moisture conditions throughout Heritage Grove. Mineral soils are typically calcareous fine-textured silty clay loams with dark gray to black humic "A" horizons. Calcareous fibric or mesic-textured layers greater than 50cm thick are typical of organic soils in Heritage Grove. All sites were judged to be nutrient-rich[9].

[9] This conclusion was reached through observations of both soil characteristics (calcareous reactions in many places, well-developed dark humus layers) and plant species occurrence. Species such as red-osier dogwood (*Cornus stolonifera)*, bracted honeysuckle (*Lonicera involucrata*), wild red raspberry (*Rubus idaeus)*, cow parsnip (*Heracleum maximum*), and stinging nettle (*Urtica dioica*) are typically associated with nutrient-rich sites, and high species diversity (more than about 20 vascular plant species in a 100m2 plot) is another indicator of site richness on sites that have not recently been disturbed.

Black spruce, black spruce-tamarack, white spruce-tamarack and mixed black and white spruce stands are associated with wet to very wet sites. Moist to very moist sites support balsam poplar, aspen, and mixedwood stands.

At the time of sampling in late August 2004, organic soils associated with deciduous stands were moist to the touch but no free water was expressed when samples were squeezed, even from samples taken at depths of nearly a metre. Organic soils associated with black spruce, black spruce-tamarack, or black and white spruce stands typically exhibited slow seepage below 40cm and free water was expressed from samples taken below about 20cm.

Many organic soils including those associated with "drier" forest stands had lenses of layered whitish-gray calcareous deposits within the organic matrix that reacted very strongly with dilute hydrochloric acid, indicating the presence of free carbonates. Close inspection of these deposits revealed the occasional presence of gastropod shells. This evidence, together with similar observations made in the Wagner Natural Area (Vujnovic et al., 2000), indicates that at one time the Heritage Grove area was probably partly occupied by marl ponds. The Atim Creek Study (Alberta Environment Planning Division, 1978) indicates that flowing wells or springs have been noted in and near Heritage Grove (refer to Figure 3 above), and water flow patterns are evident from oblique air photographs taken in the 1920's and small-scale vertical air photographs taken in September 1950 and May 1962 (refer to Figures HG-12 through HG-15 in Volume 2).

4.3 Special features

There are four special features of note in the Heritage Grove forest. These include two recent burns (1989 and 1998), an uncommon and possibly rare community type, and several stands with an unusual forest type-soil combination (Figure HG-5, Volume 2).

In the last two decades, two significant fires have occurred in Heritage Grove. The 1989 burn covers about 0.3 ha in what was formerly a black spruce stand and was described by Cosco (1990) in a previous inventory of the Heritage Grove area. Figure 4 shows a comparison of this burn in 1990, when fireweed dominated the site, and in 2004, when succession to tall shrubs has occurred. The 1998 burn, which also occurred in a dense black spruce stand, is three times larger than the 1989 burn. Early successional trends in this burn (birch and willow dominant, with only a few black spruce seedlings) and heavy shrub growth in the 1989 burn indicate that black spruce will likely not dominate either site for at least the next several decades.

Vujnovic et al. (2000) discuss two black spruce-tamarack (*Picea mariana – Larix laricina*) communities and one tamarack-black spruce community in the Wagner Natural Area several kilometres to the east. Although black spruce-tamarack communities are fairly common in the adjacent Dry Boreal Mixedwood natural subregion, they are unusual in the Central Parkland subregion within which both Heritage Grove and Wagner Natural Area occur. The set of species reported for these communities in the Wagner Natural Area is quite different from those noted in the Heritage Grove, and tamarack communities similar to those found in Heritage Grove have not been identified in recent rare plant community tracking publications (Allen 2003). The Alberta Natural Heritage Information Centre has been contacted about these communities, and Timberline has recommended that government experts visit them.

The final special feature is the occurrence of deciduous and mixedwood forest stands on deep calcareous organic materials. This soil-vegetation association is very uncommon and its occurrence in both Wagner Natural Area (Vujnovic et al. 2000) and Heritage Grove might point to similar successional trends; apparently, the nutrient status of organic soils is sufficient to

support the growth of aspen, balsam poplar, and large white spruce while water tables are not high enough to adversely affect poplar or white spruce root systems.

4.4 Stand Health Assessment 2004

Most stands in Heritage Grove exhibit a normal state of health given stand age and composition; it is a normal and natural successional process for deciduous trees to self-thin during the early stages of stand development when significant mortality occurs due to intense competition for light, water and nutrients. In later successional stages, stem disease and rot, top dieback and branch or trunk breakage is also normal. These trends also occur in coniferous stands, but because conifers are typically longer-lived than deciduous species, they take longer to appear. There are, however, a few areas where natural mortality or dieback is occurring, and a potentially more serious problem exists east of Calahoo Road within stands that include tamarack (*Larix laricina)*.

Figure HG-6 in Volume 2 shows the distribution of mainly healthy stands and those with potential health problems. Map units 1 and 3 (Figure HG-1, Volume 2) are deciduous, and the mortality noted is due to self-thinning because of competition for light, water and nutrients as the stands mature. Map units 2, 9, 61 and 65 in Figure HG-1 contain populations of aspen and balsam poplar where many of the trees have dead tops. This tendency may be due to a combination of winter dessication and spring frost due to unusually mild winters in the last two decades (Hogg et al., 2000).

Black spruce mortality appears to be related to local increases in the water table and consequent flooding of root systems due to blockage of natural drainage by trails or roads. Map units 43 and 44 in Figure HG-1 (Volume 2), just west of Calahoo Road, and some areas within map unit 55 appear to be affected by drainage obstructions. It is also possible that some salt damage might have occurred to trees immediately adjacent to Calahoo Road.

Mortality in tamarack is clearly evident along the east and west sides of Calahoo Road and along the trail system east of Calahoo Road (map units 43, 44, 45,50, and 70 in Figure HG-1 (Volume 2)). Dead tamaracks in various stages of decomposition showed no evidence of insect attack (no sub-bark galleries, weeping entry points, or sawdust at the base of trunks), and tamaracks that were dying showed no evidence of stem damage or leaf injury. Tamarack mortality due to insects or disease is uncommon; larch sawfly is the cause of significant mortality[10]. It is possible that hydrological or chemical factors are contributing to tamarack mortality; even white spruce adjacent the apartment complex west of Calahoo Road are showing signs of stress such as heavy cone loads, and this species is typically quite resistant to environmental stresses. Local flooding could interact with pathogens such as Armillaria root rot (*Armillaria mellea*) to cause mortality[11].

This situation is potentially serious and needs to be monitored; it is recommended that a pathology expert be contacted by spring 2005 to investigate the possible causes of tamarack mortality and if possible suggest corrective measures. If the decision is made to replant tamarack that have died, it is important to ensure that they receive full light, as tamarack is very intolerant of shade (Krajina et al., 1982).

[10] Source: USDA Forest Service, web link
http://www.na.fs.fed.us/spfo/pubs/silvics_manual/Volume_1/larix/laricina.htm
[11] Ibid.

Burn about a year after 1989 fire

Same location in 2004 – note shrub growth and lack of regenerating conifers. The ellipses circle the same trees in both photos

Figure 4. Heritage Grove 1989 burn a year after fire and in 2004

Table 4. Summary of general forest cover types in Heritage Grove

Heritage Grove Mapped Forest Cover Type	Area (ha)	Estimated coniferous volume (m3)	Estimated deciduous volume (m3)	Estimated total volume (m3)	Area (ha) in each stand age class (years) by cover type				Area (ha) of soil type	
					<10 years	*10-60 years*	*61-100 years*	*Not applicable*	*Mineral*	*Organic*
Balsam poplar	10.6	399	1620	2019		5.3	5.4		7.1	3.5
Aspen	3.9	108	580	688		3.9			3.9	
Birch	2.4	35	76	112	0.9	1.5				2.4
Mixed shrub	2.4					0.3		2.1		2.4
Balsam poplar - White spruce	2.3	190	384	574		0.2	2.1		1.6	0.7
White spruce - Aspen	2.6	364	234	598			2.6		1.8	0.7
White spruce	8.6	2352	175	2527			8.6		3.4	5.3
White spruce - Tamarack	0.7	106	5	112			0.7			0.7
Black and white spruce	1.0	123	20	143			1.0			1.0
Black spruce	8.2	726	2	728		1.6	6.6			8.2
Black spruce - Tamarack	6.6	741	34	775		0.4	6.2			6.6
Tamarack	3.3	715	50	765			3.3			3.3
Wet meadow	0.7							0.7		0.7
Field	3.3							3.3	3.3	
Trail	1.5							1.5	1.5	
Total area or volume	**58.0**	**5860**	**3180**	**9040**	**0.9**	**13.0**	**36.5**	**7.6**	**22.5**	**35.5**

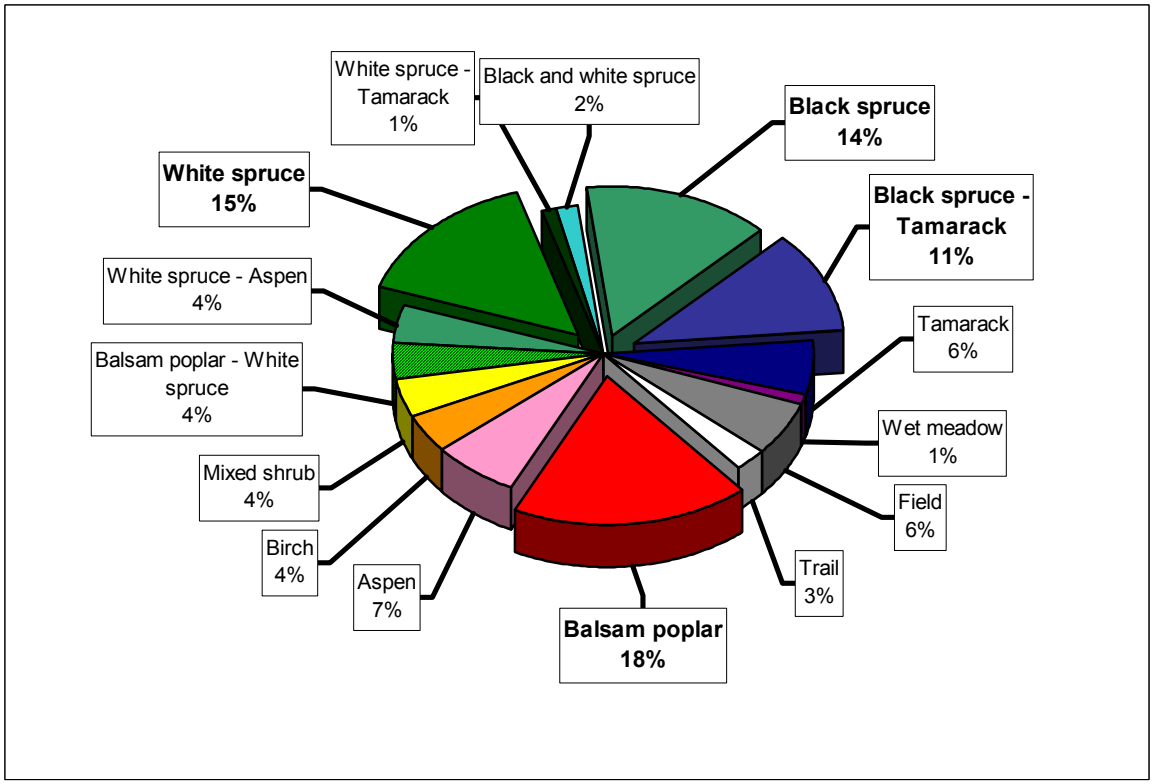

Figure 5. General forest cover type proportions within Heritage Grove

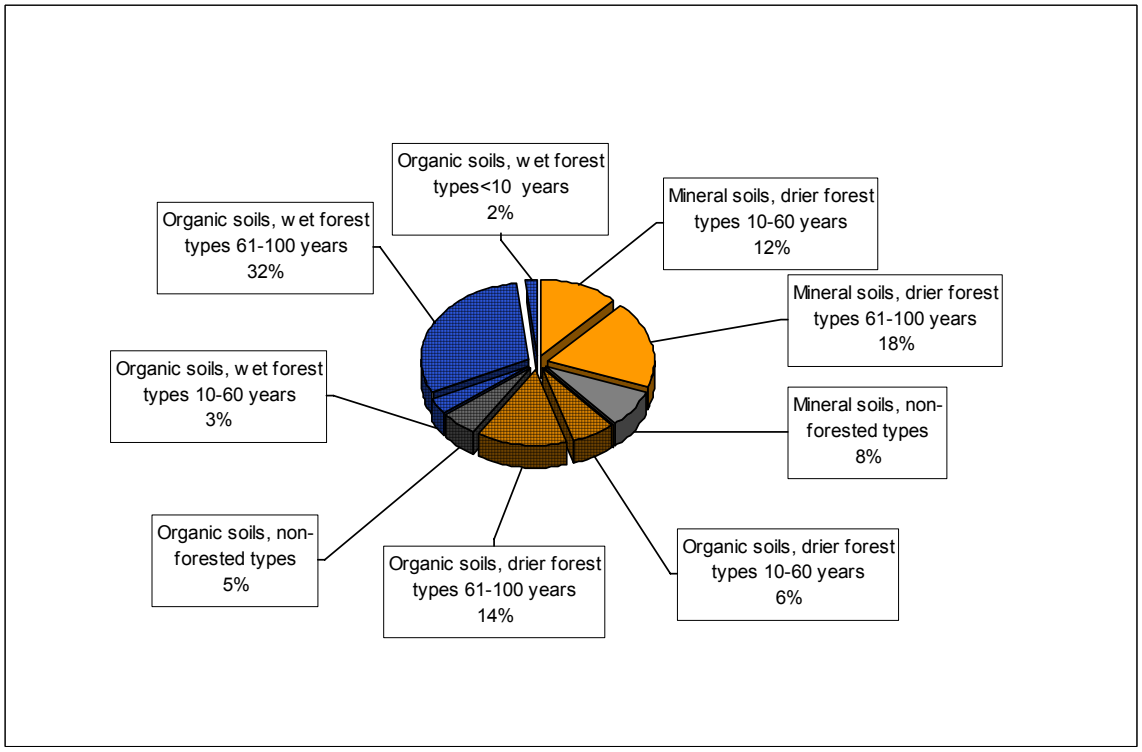

Figure 6. Stand age distribution by forest cover type and soil type within Heritage Grove

4.5 Stand history and future trends

Over the last fifty years, urban growth has occurred all around Heritage Grove, but there have been relatively minor reductions to the actual area forested, as shown in the sequence of air photographs in Figures HG-12 through HG-15 in Volume 2. Figure HG-12 is an oblique photograph taken during the 1920's and shows that even then most of the surrounding forest had been cleared for cropland; the closed nature of forests at the northern limits of the Central Mixedwood natural subregion is evident from the remnant stands. Some stands within Heritage Grove appear to be quite short, indicating that they were in an early successional stage. Figures HG-13 through HG-15 have the current forest inventory and Spruce Grove city base overlaid on the airphoto base to highlight changes in both forest cover and land use. In Figure HG-13, taken in September 1950, note the whitish flow pattern just west of Calahoo Road which may indicate the presence of a flowing spring. In Figure HG-14, taken in May of 1962, note the light-colored forest in the southwest part of Heritage Grove; this is indicative of local logging of spruce in these stands, and evidence of partial logging, probably of white spruce, was noted in many stands throughout Heritage Grove during field surveys. Note also the darker north-south fingers just north of the mobile home park west of Calahoo Road, indicating that perhaps groundwater was close to the surface at that time, at least in spring. Figure HG-15 was taken in September 1999 and represents the approximate current distribution of forests in Heritage Grove.

The discussions of stand types in Section 4.1 and of organic soils in Sections 4.2 and 4.3, taken together with the abovementioned photographic evidence and stand age history leads to several conclusions:

- Heritage Grove and the other forests within Spruce Grove change continuously. Heritage Grove has been influenced by stand-affecting events such as fire and logging over the last 60 to 100 years, and two fires within the last fifteen years that have burned rapidly and completely through small areas are indicative of potential fire intensity. Post-fire and post-logging stand growth and some conversion of forested lands to agriculture have resulted in changes to both the total area forested and its composition.
- Heritage Grove, like the Wagner Natural Area, is influenced by groundwater flow. A detailed hydrogeological study done for the Wagner Natural Area (Spencer Environmental, 1990) indicates that the source of groundwater for springs in the Wagner area is a buried layer of glacial sands capped by several metres of relatively impermeable fine-textured glaciolacustrine deposits. As groundwater flows through the sands and upward to the surface, it dissolves large quantities of calcium carbonates; the presence of calcium and other dissolved elements in sample wells indicates that the source of water for the Wagner Natural Area and very likely for Heritage Grove as well is from shallow subsurface flows and not overland flow. The Atim Creek study (Alberta Environment Planning Division 1978, plate 8) indicates that the Wagner and Heritage Grove areas are in a groundwater discharge zone; the recharge area is to the south and west of Stony Plain. Therefore, although urban development may have an effect on the hydrology of Heritage Grove, it seems probable that groundwater supply from the recharge area is a controlling influence over much of the forest, as indicated by the development of organic soils and marl deposits. Locally, however, deep ditching has probably contributed to drying of adjacent areas and flooding within the ditch (e.g., map unit 39, Figure HG-1, Volume 2).
- The fact that deciduous and mixedwood communities are occurring on relatively dry and deep organic deposits indicates that stand-replacing events such as fire have occurred in the last 10-100 years and have replaced the previous stand types, which were probably black spruce dominated stands with a well-developed moss layer. The current stands are

composed of fast-growing early successional species that could not possibly have generated the depths or types of organic matter that are found underneath them. Moreover, the City has developed lands immediately adjacent the forest over the past 25 years, but the changes to groundwater appear to have occurred prior to that based on stand history, so that urban development is an improbable cause of site drying and stand conversion. Ditching (as mentioned above), trail construction and adjacent urban developments might contribute to some local drying or flooding events.

- It is likely that these deciduous and mixedwood – organic soils combinations are quite unstable and will be burned completely in the next severe fire. It is unlikely that they will return to black spruce-dominated stands unless there is a marked increase in groundwater flow. Were this to occur, it is likely that measures would need to be taken to prevent flooding of residences and other structures, and therefore the groundwater regime that promoted the development of "wet" forests in the past is unlikely to return.
- If current drying trends continue, and if fires occur, it is likely that more "wet" forests will be replaced by deciduous dominated types; revegetation of the 1989 and 1998 burns provides evidence to support this. The extent of black spruce and black spruce-tamarack stands will decrease, although it may take many decades for total conversion to deciduous stands to occur.
- Heritage Grove has a history of tree harvesting for lumber or firewood that has affected its current composition. Stands that were predominantly conifer have regenerated to poplar and/or birch with scattered spruce understories. This is particularly evident in the southwestern portion of Heritage Grove (map units 20, 22, 26, 27, 28, Figure HG-1, Volume 2).

It may be desirable to plant large white spruce seedlings obtained from local populations to replace black spruce if a mixture of deciduous, mixedwood, and coniferous stands is to be the desired future forest.

4.6 Fire hazard potential

Figure HG-7 and HG-8 in Volume 2 show the potential spring/fall and summer fire hazard potential in Heritage Grove. Refer to Section 3.3 above for a discussion of the assessment method; note that stands rated as "extreme" hazards in spring are typically coniferous stands that are immediately adjacent to developed lots. Although map unit 44 (Figure HG-1, Volume 2) is a less flammable mixed balsam poplar-white spruce stand, it has been rated as an extreme fire hazard in spring because the adjacent stands in map units 36 and 43 are highly flammable and if ignited could create enough heat to burn through map unit 44. An apartment complex is only a few metres north of map unit 44.

The deep organic soils that occur throughout Heritage Grove, and particularly those that have little free water in the organic soil profile, pose a significant fire hazard. Smouldering ground fires commonly occur in organic soil horizons following the passage of surface and crown fires including lightning and person caused fires (Frandsen 1997, cited in Hale 2004). Ignition is initiated by a source of heat such as a flame or glowing ember, and occurs when the heat evolved from combustion is sufficient to overcome heat losses. High amounts of inorganic materials in the soil (more than 80 percent) or high moisture conditions reduce the likelihood of ignition. Once ignition occurs, the smouldering front begins to burn downward and laterally, if conditions are favourable for sustained smouldering. As smouldering progresses, it creates a bowl shaped depression. Lateral spread becomes the dominant form of spread once downward spread reaches mineral soil or an organic soil moisture content above the smouldering moisture limit

(Hungerford et al.1995, cited in Hale 2004); as the amount of heat generated and the duration of burning increase, organic matter with progressively higher moisture content will burn.

Fires that start in organic materials in Heritage Grove may burn unnoticed for a long period of time, even through the winter. A lightning strike, lit cigarette or informal campfire may be all that is needed to start a fire in these materials. Dry, windy conditions in the spring may result in a ground fire if the fire front in the burning organic material reaches the surface at the right time and place.

4.7 Decay and Breakage Hazard and Blowdown Hazard

Figures HG-9 and HG-10 (Volume 2) show the distribution of stands prone to decay and breakage (mainly balsam poplar stands greater than 60 years old) and blowdown (mainly wet coniferous stands with water tables close to the surface). The criteria for determining decay and breakage and blowdown hazards are outlined in Section 3.3 (methods). Map unit 37 is included as both a high decay and breakage and blowdown risk because of the large number of standing dead snags following the 1998 fire.

4.8 Wildlife Snag Habitat Potential

Stands that are judged to have moderate to high snag habitat potential are typically those with high decay and breakage hazard ratings; in Heritage Grove, these stands include balsam poplar stands greater than 60 years of age and black spruce stands visited during plot surveys that showed extensive evidence of decay and breakage (Figure HG-11, Volume 2). The criteria for determining snag habitat potential are outlined in Section 3.3 (methods). Map unit 37 (Figure HG-1, Volume 2) is not classed as good snag habitat because most of the standing dead trees following the 1998 burn are too small to provide habitat for cavity dwelling birds and mammals.

4.9 Heritage Grove One- and Five-Year Management Plans

Table 5 presents the one-year suggested operational plan for 2005 through 2006; Table 6 presents the five-year plan (2005-2010). Both the one and five year plans reference the inventory information and conclusions presented in Sections 4.1 through 4.8. The one-year plan makes specific reference to map units in which some action is suggested; the five-year plan makes more general references to monitoring the results of the first year of plan implementation and suggests some forest management strategies that could be of interest to the community. The recommendations made by Cosco (1990) were used as information for the one- and five-year plans.

With respect to invasive and exotic species, Freedman and Willison (1996) have identified *Sorbus aucuparia* (European mountain ash) as an invasive alien that can establish vigorous, self-maintaining populations. If the long-term goal is to maintain natural vegetation, invasive species such as European mountain ash should be monitored and controlled.

Table 5. One-year Heritage Grove operating plan (2005-2006)

Map unit (refer to Figure HG-1 in Volume 2)	**Issue**	**Recommended action**
Units 39,40,43,45,50,70	• Tamarack *(Larix laricina)* mortality • Black spruce mortality	• Contact forest pest and disease expert to determine causal factors for tamarack mortality and possible corrective actions. Remove hazardous trees. • Mitigate local flooding (e.g. along Calahoo Road in map units 40 and 43), near Kinsmen Centre (map unit 55) to deal with black spruce mortality. Remove hazardous trees.
All forested units bordering occupied lots particularly on north side of Grove	• High to extreme fire hazard potential in some units • Organic soils that may	• Have fire department review and possibly incorporate FireSmart recommendations e.g. reduction of fuel loading, removal of hazardous trees), and consider training in appropriate wildland firefighting techniques. • Provide education to homeowners immediately adjacent to Heritage Grove forest • Conduct regular patrols in spring, particularly in early May
Units 1,2,3,4,61,64,65,66	• Blowdown and decay and breakage potential (refer to hazard areas on maps). Hazardous trees pose a health and safety risk, and in places, an aesthetic concern.	• Remove hazardous trees (within 5m of trails or falling distance from structures) level with ground surface. In units 61, 64, 65,66, dead tops could be removed and the boles left standing for a few years; they may regenerate new foliage. • Remove black spruce and larch trees that have died due to flooding or other causes. • Retain snags in the forest interior (more than 5m from trails or within falling distance from structures) as these can be valuable wildlife habitat. • Consider planting tall nursery stock (1.5- 2m white spruce) in units 61,64,65,66 and making improvements to the park area. This area may provide excellent opportunities for managed forest themes that meet a particular public interest – see 5 year plan. • Conduct regular patrols, especially after windstorm or heavy snowfall events, to monitor trails for blowdown and breakage hazards. • Minimize damage to trees during regular maintenance; damage provides a point of disease entry and can cause reduced growth or mortality through direct damage.

Table 5. One-year Heritage Grove operating plan (2005-2006)

Map unit (refer to Figure HG-1 in Volume 2)	**Issue**	**Recommended action**
Throughout Heritage Grove	• Invasive species (introduced), particularly noxious weeds such as tansy (*Tanacetum vulgare*) are controlled under the provincial Weed Control Act and invasive trees such as European mountain ash (*Sorbus aucuparia*) may become more prevalent with time and compete with native communities.	• Control noxious weed infestations by hand-pulling populations e.g. along drainage ditch beside trail in unit 21. (Refer to Section 31 of the Alberta Weed Control Act, RSA 2000, C W-5). • Mechanically remove invasive tree species and treat the stumps with glyphosate to reduce suckering, and/or inject the trunks with glyphosate ("hack-and-squirt") to kill the shoot and root systems. The reasons for undertaking this activity should be presented to the community along with the probable consequences of inaction (partial stand replacement by non-native tree species accompanied by probable changes in understory composition and wildlife habitat).
Throughout Heritage Grove	• Education	• Refurbish and revise signs to incorporate new information.
All Spruce Grove forests	• Obtain grants	• Apply to Tree Canada Foundation for a grant prior to January 31 2005 to assist with education (possibly updated signage based on the inventory in this report) and tree health assessment
Throughout Heritage Grove	• Groundwater	• Ensure that future development does not lead to a significant change in groundwater tables e.g., increases due to either stormwater retention or decreases due to a reduction in infiltration rates in the immediate local recharge area • Groundwater management issues may involve a larger area, as previous studies have shown that the recharge area for groundwater resources is southwest of the City.

Table 6. Heritage Grove five-year plan 2005-2010

Map unit (refer to Figure HG-1 in Volume 2)	**Issue**	**Recommended action**
1. Tamarack and black spruce-tamarack stands throughout Heritage Grove	• Mortality	• If tamarack mortality continues and the cause can be corrected, consider replacing dead tamaracks with large nursery stock tamarack in well-lit sites. In shady locations and/or if the cause of mortality is not determined, consider some infill planting with large nursery-stock white spruce (black spruce in wet areas). • Groundwater management issues may involve a larger area, as previous studies have shown that the recharge area for groundwater resources is southwest of the City.
2. Whole forest	• Maintenance	• Five-year monitoring of forest health (survey from existing trail systems), record any changes by map unit, and undertake mitigation as needed. • If the preference is to replant dead trees with live ones, white spruce or black spruce (wetter sites) are the best choices as they grow on a wide range of sites and are more shade-tolerant than species such as aspen and balsam poplar. • Single-tree events are less importance than stand-replacing events, and responses should be dealt with accordingly • Monitor invasive species populations to determine population numbers and trends (increases or decreases, and where these are happening)
3. All Spruce Grove forests	• Grants and memberships	• Become active members of the FireSmart association and the Tree Canada Foundation to share ideas on fire management and community forestry, respectively. • Schoolyard naturalization could be considered; grants are available.
4. East end of Heritage Grove by Brookwood School (units 61, 64, 65, 66)	• Community forestry	• The Brookwood School location is easily accessible to all users and has available parking close by; it may provide a good opportunity for community organizations to plant trees. • Schoolyard naturalization could be considered

Table 6. Heritage Grove five-year plan 2005-2010

Map unit (refer to Figure HG-1 in Volume 2)	**Issue**	**Recommended action**
5. All Spruce Grove forests	• Groundwater	• Continued monitoring of developments immediately adjacent to the forests and in the groundwater recharge areas to the south .
6. Whole forest	• Community involvement: o is community feedback being sought? o Are communities kept informed about tree maintenance? o Are communities provided with the opportunity to take an active role in urban forest planning?	• Develop a venue for community review of forest management activities. • Provide opportunities for community organizations to plant trees and assist with habitat surveys, patrols, education, and maintenance

5 Atim Creek

5.1 Forest Cover

Atim Creek forest occupies an area of 53.6 ha of which approximately 44 ha is forested and 9.6 ha is non-forested; 41 map units were identified based on photo-interpretable forest cover attributes (species composition, canopy cover, height, age). To produce readable maps, each map unit has been assigned to one of 10 general forest cover types or four non-forested types (Figure AC-2, Volume2), and to one of three broad age classes (Figure AC-3, Volume 2). The type of soil (organic or mineral) with which each type and age class is associated is also shown in Figures AC-2 and AC-3 because this association is of interest both from the natural feature and management perspectives.

Table 7 summarizes area and volume statistics for Atim Creek. The dominant forest cover types in Atim Creek are balsam poplar, white spruce, balsam poplar-aspen and aspen, accounting for 56 percent of the total area (Figure 7). "Wet" forest cover types (white spruce-tamarack, black and white spruce, and black spruce-tamarack) cover 16 percent of the total area. "Drier" forest cover types (balsam poplar, balsam poplar-aspen, aspen, birch stands, white spruce-balsam poplar, and white spruce) cover 66 percent of the total area. Non-forest cover types account for the remaining 18 percent. Stands from 10 to 60 years of age occupy nearly 60 percent of Atim Creek, and "drier" forest types are prevalent in this age class. All stands from 61-100 years of age are drier deciduous or mixed conifer-deciduous stands, and only one stand exceeds 100 years of age as of 2004 (Figure 6). About thirty percent of the deciduous stands have a patchy understory of regenerating white spruce.

Approximately equal proportions of mineral and organic soils underlie Atim Creek forest; the organic soils are dominant in the western half of the area. Organic soils are those in which the organic component (undecomposed to decomposed organic matter generally deposited in wet environments) accounts for more than about 20 percent of the soil profile by volume. Mineral soils are those in which the mineral fraction (a combination of sands, silts and clays) is prevalent. "Wet" forest types are always associated with organic soils in Atim Creek and "drier" stands are usually associated with mineral soils. Drier deciduous, coniferous and mixed conifer-deciduous stands occupy organic soils on about 30 percent of the area (Figure 8).

5.2 Site nutrient and moisture status

Figure AC-4 in Volume 2 shows the distribution of site nutrient and moisture conditions throughout Atim Creek forest. In the western portion of the forest, mineral soils are loam to silty clay loam textured with about 15 cm of dark gray to black humus-enriched loams at the surface. Calcareous fibric or mesic-textured peaty organic layers greater than 50cm thick are typical of the organic soils that occur in a southwest-northeast belt through the central and western portions of Atim Creek. These organic deposits thin out to the east, and along the truck trail and on the esker (refer to Section 5.3 below), sandy loam to loamy sand textured mineral soils with thin (5-10cm) humus-enriched loams occur. Atim Creek is not as nutrient-rich as Heritage Grove, and the eastern third of the area is judged to have average moisture and nutrient conditions as indicated by soil and vegetation characteristics. The western two-thirds is judged to be well supplied with nutrients. Above the main slope break east of Atim Creek, sites are moist to very moist; below the break, seepage and flooding occurs in the creek valley and sites are wet or flooded.

Table 7. Summary of general forest cover types in Atim Creek forest

Atim Creek Mapped Forest Cover Type	Area (ha)	Estimated coniferous volume (m3)	Estimated deciduous volume (m3)	Estimated total volume (m3)	Area (ha) in each stand age class (years) by cover type				Area (ha) of soil type	
					10-60 years	*61-100 years*	*>100 years*	*Not applicable*	*Mineral*	*Organic*
Balsam poplar	10.4	301	1887	2188	8.3	2.0			2.7	7.7
Balsam poplar - Aspen	6.4	278	711	990	4.8	1.6			6.4	
Aspen	5.5	122	672	794	4.5	1.0			5.5	
Birch	1.2	15	28	43	0.4	0.7				1.2
Mixed shrub	4.3							4.3		4.3
White spruce - Balsam poplar	4.5	486	424	910		4.5			2.8	1.7
White spruce	7.5	716	413	1130	4.6	1.8	1.1		2.9	4.6
White spruce-Black spruce	0.9	14	1	15	0.9				0.9	
White spruce -Tamarack-Poplar	3.9	99	118	216	3.9					3.9
Black spruce - Tamarack	3.5	59	25	84	3.5					3.5
Tamarack	0.2	8	3	11	0.2					0.2
Field	4.2							4.2	4.2	
Wet meadow	0.4							0.4		0.4
Water	0.7							0.7		
Total area or volume	**53.6**	**2097.6**	**4281.8**	**6379.4**	**31.2**	**11.6**	**1.1**	**9.7**	**25.3**	**27.5**

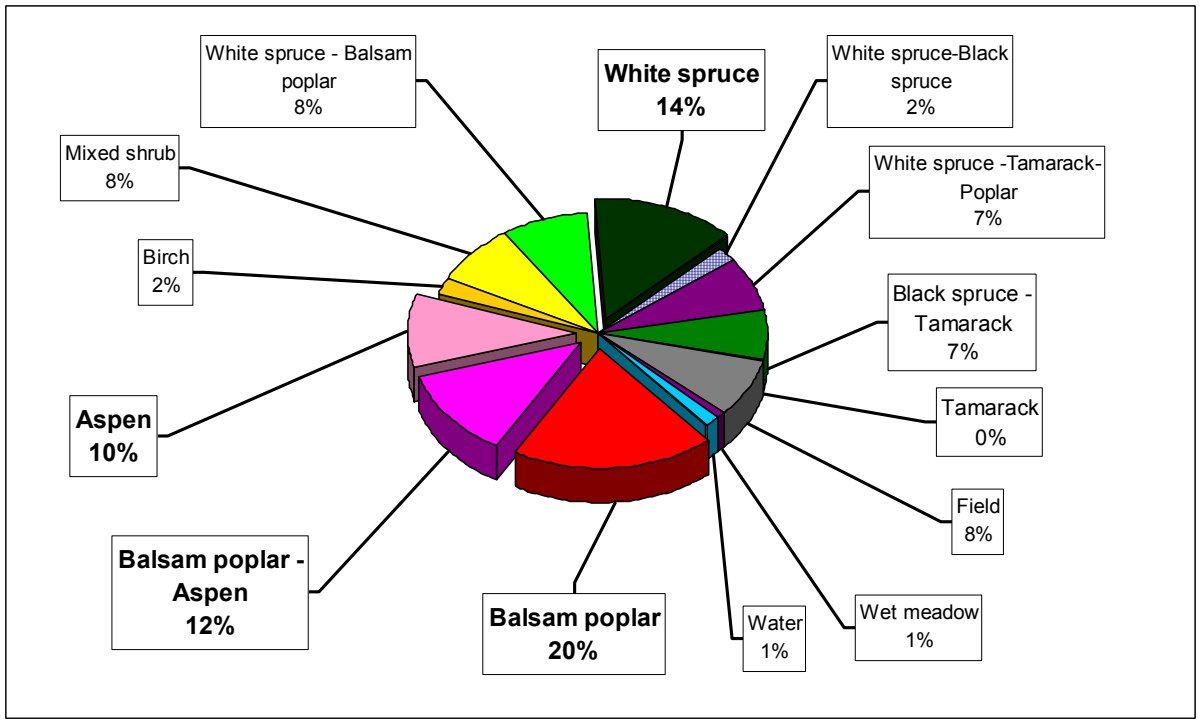

Figure 7. General forest cover type proportions within Atim Creek forest

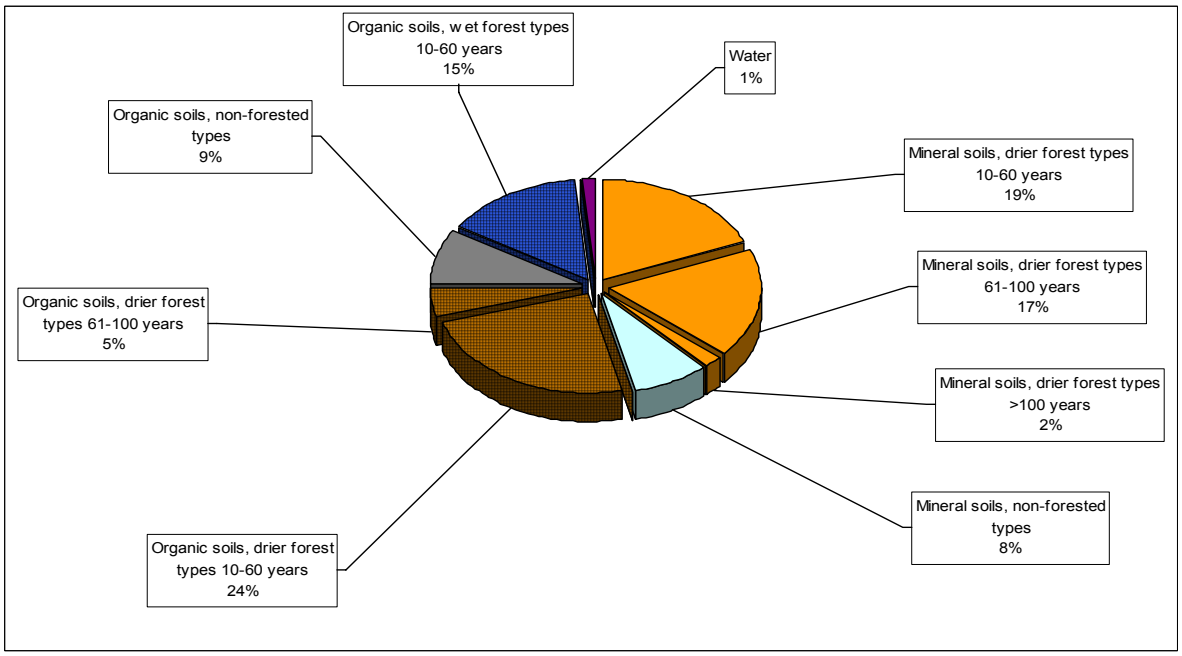

Figure 8. Stand age distribution by forest cover and soil type within Atim Creek forest

Black spruce-tamarack and mixed shrub stands are associated with wet to very wet sites. Moist to very moist sites support other forest types.

At the time of sampling in early August 2004, organic soils associated with deciduous, mixedwood conifer-deciduous, and white spruce stands were moist to the touch but no free water was expressed when samples were squeezed, even from samples taken at depths of nearly a metre. Organic soils associated with black spruce-tamarack stands had free water that could be expressed by squeezing samples taken below about 20cm.

Some organic soils had lenses of layered whitish-gray calcareous deposits within the organic matrix that reacted very strongly with dilute hydrochloric acid, indicating the presence of free carbonates. Gastropod shells were present but uncommon in these deposits. This observation is similar to that made in Heritage Grove, but because the marl deposits are evidently not as extensive, marl ponds may not have occurred at Atim Creek to the same degree that they did in Heritage Grove. It is likely that some marl deposition is occurring in the flooded area (map unit 3, Figure AC-1, Volume 2) and in the pond (map unit 14, Figure AC-1, Volume 2).

5.3 Special features

There are five special features of note in the Atim Creek forest. These include a sandy esker landform, an unusual forest cover-soil combination, a small seepage slope, two unusual forest types, and a flooded area caused by beaver damming of Atim Creek at the culvert adjacent to Yellowhead Highway (Figure AC-5, Volume 2).

The sandy esker landform appears to be the westernmost limb of an alluvial-aeolian sandy deposit (laid down by a combination of running water and wind) shown in Plate III of the Edmonton Sheet soil survey (Bowser et al., 1962). It is characterized by non-calcareous loamy sands and fine sands to at least 1m, a relatively sharp crest, and side slopes of about 20 percent; the crest is about 10m above the surrounding area. This landform is locally unique; the south side has been cultivated for at least 50 years but the steeper north-facing slope is young aspen forest with sparse shrub cover across much of the slope. There is a small wetland at the east end, and at the base of the slope, local seepage creates moist, somewhat richer conditions.

The small seepage slope (map unit 15, Figure AC-1, Volume 2) is an area of very open forest that is vegetated primarily by herbaceous species. This area was not visited during field surveys; a previous environmental survey (J. Williams/Ecomark, in Durrance and Associates 2003) suggests that this area may provide habitat for uncommon or rare species.

Vujnovic et al. (2000) discuss two black spruce-tamarack (*Picea mariana – Larix laricina*) communities and one tamarack-black spruce community in the Wagner Natural Area several kilometres to the east. Although black spruce-tamarack communities are fairly common in the adjacent Dry Boreal Mixedwood natural subregion, they are unusual in the Central Parkland subregion within which both Atim Creek and Wagner Natural Area occur. Map units 5 and 10 (Figure AC-1, Volume 2) have similar compositions to those noted by Vujnovic et al. (2000) and have a different understory composition than black spruce-tamarack forests in Heritage Grove. The white spruce-tamarack-poplar stand (map unit 36, Figure AC-1, Volume 2) is a unique feature of the Spruce Grove forests and might also be provincially uncommon.

The flooded area is noted as special because it and the associated water body to the north are the only extensive areas of open water and marsh vegetation in the four surveyed forests (there is one local area in Heritage Grove. The area may provide feeding areas for moose, aquatic habitats for various species; abundant snags are present because of flood-caused tree mortality.

5.4 Stand Health Assessment 2004

Most stands in Atim Creek forest exhibit normal states of health given stand age and composition; it is a normal and natural successional process for deciduous trees to self-thin during the early stages of stand development when significant mortality occurs due to intense competition for light, water and nutrients. In later successional stages, stem disease and rot, top dieback and branch or trunk breakage is also normal. These trends also occur in coniferous stands, but because conifers are typically longer-lived than deciduous species, they take longer to appear.

Figure AC-6 (Volume 2) shows those areas that have a higher incidence of disease or other damage. Map unit 1 in Figure AC-1 (Volume 2) is a balsam poplar stand where many of the trees have dead tops. This could be due to a combination of winter desiccation and spring frost due to unusually mild winters in the last two decades (Hogg et al., 2000). Map unit 4 in Figure AC-1 has reached a mature seral stage where most of the balsam poplars have stem rot or bole breakage; this is also a normal successional trend. Map unit 13 is immediately adjacent to the flooded area, and trees around the perimeter of this stand are dying probably because the rooting zone is flooded.

5.5 Stand history and future trends

Atim Creek forest appears to have stayed much the same in extent from the earliest photo records available (mid-1920's); the cleared field north of the esker was smaller in 1920 than in 1962 or present day (1999), and clearing for the Yellowhead Highway has removed portions of the northernmost stands since 1962. Stand age and composition has changed significantly, however. For example, in the 1920's photograph, the esker appears to have been forested with a mixture of white spruce and deciduous trees, but in the 1962 photo, a very young stand of aspen has developed. This stand was approximately ten years old in 1962 based on field aging of the trees in 2004. Figures AC-12, AC-13, and AC-14 in Volume 2 show these changes between the mid 1920's (Figure AC-12), May of 1962 (Figure AC-13), and present day (1999) (Figure AC-14).

The discussions of stand types in Section 4.1 and of organic soils in Sections 4.2 and 4.3, taken together with the abovementioned photographic evidence and stand age history leads to several of the same conclusions that were reached for Heritage Grove:

- Atim Creek forest has changed significantly over the last 80 years. There have been stand-affecting events such as fire and logging over the last 60 to 100 years. During field surveys, there was abundant evidence of white spruce harvesting (stumps, young successional stands of aspen with white spruce understories).
- Atim Creek is influenced by groundwater flow, although probably to a lesser extent than Heritage Grove or Wagner Natural Area. It is reasonable to conclude from the subregional groundwater studies (Spencer Environmental 1990; Alberta Environment Planning Division 1978) that all three areas receive groundwater inputs from a recharge area to the southwest of Stony Plain. Refer to the discussion in Section 4.5 above for further details.
- As similarly noted in Heritage Grove, the occurrence of deciduous and mixedwood communities on relatively dry and deep organic deposits indicates that stand-affecting events such as fire and logging have occurred in the last 10-100 years and have replaced the previous stand types, which were probably black spruce dominated stands with a well-developed moss layer. The current stands are composed of fast-growing early successional species that could not possibly have generated the depths or types of organic matter that are found underneath them. Spruce Grove's urban development has only

recently expanded to near the boundaries of Atim Creek forest, and current urban development is therefore very unlikely to have contributed to site drying and stand conversion.

- It is likely that these deciduous and mixedwood – organic soils combinations are quite unstable and will be burned completely in the next severe fire. It is unlikely that they will return to black spruce-dominated stands unless there is a marked increase in groundwater flow.
- Flooding is a relatively recent development and is probably related to the construction of the Yellowhead Highway and blockage of the natural flow regime by beavers damming the culvert.
- Grazing has had an influence on local areas within Atim Creek forest mainly along the creek and in deciduous stands on either side of the trail on the east side; heavy grazing and soil compaction were noted in map unit 35 (Figure AC-1, Volume 2) and local damage to riparian areas was noted during field surveys for this management plan and by Williams in May 2003 (Williams/Ecomark, in Durrance and Associates 2003).

It may in future be desirable to plant large white spruce seedlings or taller nursery stock obtained from local populations to replace black spruce if a mixture of deciduous, mixedwood, and coniferous stands is to be the desired future forest. In wet areas requiring reforestation, black spruce would be a good choice as well.

5.6 Fire hazard potential

Figure AC-7 and AC-8 in Volume 2 show the potential spring/fall and summer fire hazard potential in Atim Creek forest. Refer to Section 3.3 above for a discussion of the assessment method.

The deep organic soils that occur through the central portion of Atim Creek forest, and particularly those that have little free water in the organic soil profile, pose a significant fire hazard. The discussion of burning characteristics and multi-season hazards provided above in Section 4.6 is relevant to Atim Creek as well.

5.7 Decay and Breakage Hazard and Blowdown Hazard

Figures AC-9 and AC-10 in Volume 2 show the distribution of stands prone to decay and breakage (mainly balsam poplar stands greater than 60 years old, flooded areas with abundant standing snags, and other areas with snags) and blowdown (mainly wet coniferous stands with water tables close to the surface and the flooded area adjacent to the pond). The criteria for determining decay and breakage and blowdown hazards are outlined in Section 3.3 (methods).

5.8 Wildlife Snag Habitat Potential

Stands that are judged to have moderate to high snag habitat potential are typically those with high decay and breakage hazard ratings; in Atim Creek, these stands include balsam poplar stands greater than 60 years of age and black spruce stands visited during plot surveys that showed extensive evidence of decay and breakage. The flooded area (Map unit 3, Figure AC-1, Volume 2) provides good snag habitat for wildlife species that can swim or fly to the snags. The criteria for determining snag habitat potential are outlined in Section 3.3 (methods).

5.9 Atim Creek Forest One- and Five-Year Management Plans

Table 8 presents the one-year suggested operational plan for 2005 through 2006; Table 9 presents the five-year plan (2005-2010). Both the one and five year plans reference the inventory information and conclusions presented in Sections 5.1 through 5.8. The one-year plan makes specific reference to map units in which some action is suggested; the five-year plan makes more general references to monitoring the results of the first year of plan implementation and suggests some forest management strategies that could be of interest to the community.

Table 8. One-year Atim Creek Forest operating plan (2005-2006)

Map unit (refer to map in map folio)	**Issue**	**Recommended action**
Units 13, 27, 28	• Flooding	• If spruce mortality due to flooding caused by beaver blocking the culvert running under Highway 16 is seen to be a problem, consider installing perforated culvert extensions to enhance water flow • Monitor beaver activity and control if it poses a hazard to highway stability or adversely influences the flow regime in Atim Creek
Entire Atim Creek forest	• Planning future development to control fire hazard risk	• This area is not currently in proximity to residences; ensure that if construction does occur, relevant FireSmart recommendations are followed regarding distance to dwellings, dwelling construction standards etc. • It may be necessary to reduce fine fuels in pasture lands next to developed areas if pasture grasses and forbs are tall enough (>20cm) to carry fire; a ploughed buffer strip 3-6m wide may be adequate.
Forested areas on esker formation	• Maintenance of natural features, construction issues	• Zone this area as environmental reserve; steep slopes on the north side of the esker may be subject to accelerated erosion if trees are removed
Forested areas on organic soils and below the Atim Ck. slope break	• Maintenance of natural features, drainage, construction issues	• Map units 34, 22, 24, 31, 35, and 45 are deciduous forest on mineral soils and pose fewer potential construction issues than most other units that are underlain wholly or partly by organic soils that range from very moist to wet. Construction issues may include erosion, flooding, and the stockpiling and distribution of large quantities of organic materials. • Detailed soil surveys to determine the exact extent of organic soils (including type, thickness, and moisture evaluations) are recommended to support the establishment of appropriate environmental reserve boundaries.

Table 8. One-year Atim Creek Forest operating plan (2005-2006)

Map unit (refer to map in map folio)	**Issue**	**Recommended action**
Entire Atim Creek forest	• Invasive species (introduced), particularly noxious weeds such as tansy (*Tanacetum vulgare*) are controlled under the provincial Weed Control Act and invasive trees such as European mountain ash (*Sorbus aucuparia*) may become more prevalent with time and compete with native communities.	• Monitor for invasive species and control as needed.
Entire Atim Creek forest	• Education, trail development	• Over the next year, there are probably few educational opportunities as the area is not immediately adjacent to residential development at this time • Trail planning, if undertaken in 2005-2006, should consider the distribution of organic or wet mineral soils; these areas will require trail surface preparation such as gravelling or boardwalks. Areas known to be preferred wildlife habitat (e.g. calving, feeding) should be avoided.
Throughout Atim Creek and adjacent developments	• Groundwater	• Ensure at the planning stages that future subdivision development does not lead to a significant change in groundwater tables e.g., increases due to either stormwater retention or decreases due to a reduction in infiltration rates in the immediate local recharge area • Groundwater management issues may involve a larger area, as previous studies have shown that the recharge area for groundwater resources is southwest of the City.

Table 9. Atim Creek 5- year plan

Map unit (refer to map in map folio)	**Issue**	**Recommended action**
Entire forest (see list items 2 through 6 in Heritage Grove 5-year plan)	As for Heritage Grove items 2 through 6 in five year plan	As for Heritage Grove items 2 through 6 in 5-year plan.

6 GroveCo 60

6.1 Forest Cover

GroveCo 60 forest occupies an area of 6.4 ha, all of which is occupied by either balsam poplar or white spruce stands. Table 10 summarizes area and volume statistics for GroveCo; Figure 9 and Figure 10 show cover type and age proportion characteristics, respectively. The white spruce map units in GroveCo 60 are the oldest and tallest of any stands in the four forests and are also the most productive. Figures GC-2 and GC-3 in Volume 2 show the spatial distribution of the general forest cover types and age classes in GroveCo.

Table 10. Summary of general forest cover types in GroveCo 60

GroveCo 60 Mapped Forest Cover Type	Area (ha)	Estimated coniferous volume (m3)	Estimated deciduous volume (m3)	Estimated total volume (m3)	Area (ha) in each stand age class (years) by cover type	
					61-100 years	*>100 years*
Balsam poplar	4.0	56	826	882	4.0	0.0
White spruce	2.4	849	59	909	0.0	2.4
Total area or volume	**6.4**	**905**	**886**	**1791**	**4.0**	**2.4**

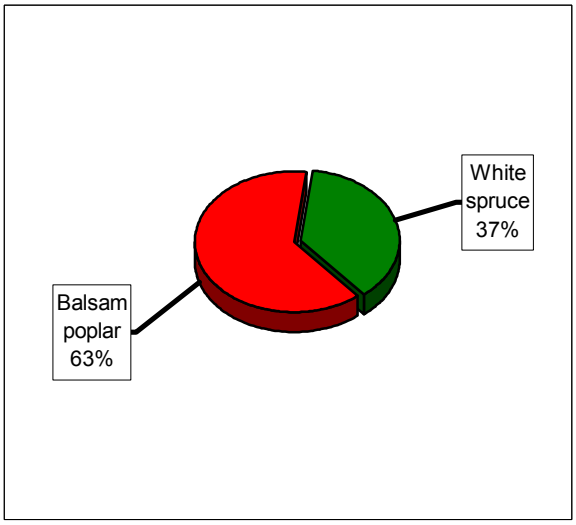

Figure 9. General forest cover type proportions in GroveCo 60

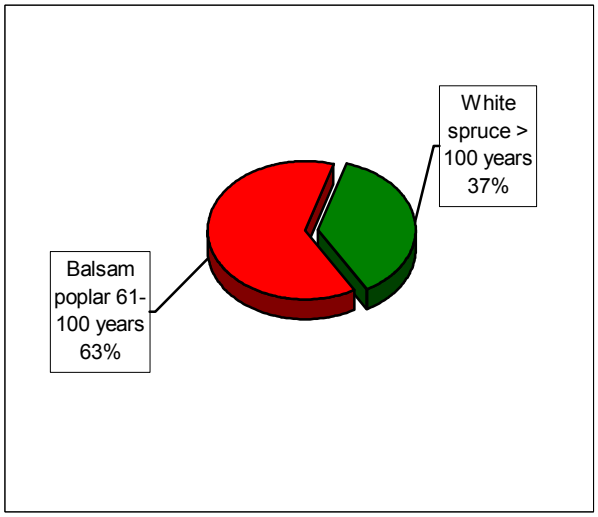

Figure 10. Age classes in GroveCo 60

6.2 Site nutrient and moisture status

Figure GC-4 in Volume 2 shows the distribution of site nutrient and moisture conditions throughout GroveCo 60. All sites are judged to be rich and moist to very moist; high species diversity, dense tall shrub cover, indicator species such as cow parsnip (*Heracleum maximum*), red-osier dogwood (*Cornus stolonifera*), and deep, humus-rich silt loam soils all supported this

conclusion. GroveCo 60 is in a local depression and likely receives surface flows and local groundwater inputs from the surrounding higher terrain, particularly to the west.

6.3 Special features

The special features in GroveCo 60 are the central stands of tall white spruce, which are both the oldest and tallest stands in all four forests (Figure GC-5, Volume 2). One of the larger trees was measured at 34.9m tall and 65cm diameter at 1.3m above ground surface; trees this large are usually found growing beside major rivers on rich, moist sites.

6.4 Stand Health Assessment 2004

All stands in GroveCo 60 exhibit normal states of health given stand age and composition (Figure GC-6, Volume 2). It is expected that the balsam poplar stands will thin out as stem disease and rot take their toll; over time, the seed rain from adjacent white spruce stands will contribute to the development of a white spruce understory where shrub competition is not too great. The white spruce stands may live for several hundred years in the absence of fire or severe disease or insect infestations, and if the moisture and nutrient supply that the stand receives is not adversely affected by climate change or adjacent urban developments. Lazaro (1990) summarizes the effects of urbanization as follows:

> *"As the land surface is developed for urban use, a region is transformed from the natural state to a totally manmade state. New structures add large amounts of impervious areas to the watershed, which in general increase slopes and considerably diminish the water storage capacity. As the area covered by structures approaches 100 percent, the amount of vegetation, natural surface and infiltration will all approach zero…. Saturation and consequent surface runoff occur relatively rapidly in the urban watershed, since storage and infiltration have been reduced to practically zero. Incoming rainwater quickly fills any depressions and becomes readily available for surface runoff. Subsurface runoff is virtually nonexistent."*

6.5 Stand history and future trends

GroveCo 60 appears to have become established well before most settlement occurred, but is probably a remnant stand. It will likely undergo the successional changes outlined above in Section 6.4 if care is taken to preserve the environmental conditions that support the stand at present.

6.6 Fire hazard potential

Figure GC-7 and GC-8 in Volume 2 show the potential spring/fall and summer fire hazard potential in GroveCo 60. Refer to Section 3.3 above for a discussion of the assessment method.

At this time, the risk of fire spreading from this stand would be partly dependent on the surrounding cultivated lands and the height and density of crop or pasture plants; it is well known from recent events in southern Alberta that grass fires can cause extensive damage, and grass fires could spread from ignition points within GroveCo 60.

6.7 Decay and Breakage Hazard and Blowdown Hazard

Figure GC-9 in Volume 2 show the distribution of stands prone to decay and breakage. All stands within GroveCo 60 are rated as moderate to high hazard because of the prevalence of older balsam poplar. Blowdown hazard throughout GroveCo 60 is rated as low (Figure GC-10, Volume 2). The criteria for determining decay and breakage and blowdown hazards are outlined in Section 3.3 (methods).

6.8 Wildlife Snag Habitat Potential

All stands within GroveCo 60 are considered to have good snag habitat potential because of the prevalence of large old balsam poplar and the presence of standing dead snags throughout (Figure GC-11, Volume 2). The criteria for determining snag habitat potential are outlined in Section 3.3 (methods)

6.9 GroveCo 60 Five-Year Management Plan

There is nothing that urgently needs to be done in GroveCo 60 over the next year; Table 11 presents the five-year suggested operational plan for 2005 through 2010. The five-year plan makes general references to planning considerations; those dealing with surface and shallow groundwater flow should be evaluated further by urban hydrologists or civil engineers when development proposals are examined to ensure that water flow from the adjacent upland areas is neither decreased nor increased in quantity.

Table 11. GroveCo 60 five-year operating plan (2005-2010)

Map unit (refer to map in map folio)	**Issue**	**Recommended action**
Entire forest	• Development planning – groundwater issues	• Review GroveCo 60 master plan as developed by Butler Krebes and Associates (2003) and incorporate their concepts for green area retention adjacent the forested area to ensure that local groundwater flow regimes are minimally impacted. • Apply similar green area considerations to the east and north of the forested area. • Ensure at the planning stages that sufficient infiltration can occur to maintain the current patterns of water flow to the site • Ensure at the planning stage that the area is not regarded as a stornwater retention zone.
Entire forest	• Development planning – fire issues	• This area is not currently in proximity to residences; ensure that if construction does occur, relevant FireSmart recommendations are followed regarding distance to dwellings, dwelling construction standards etc. • It may be necessary to reduce fine fuels in pasture lands next to developed areas if pasture grasses and forbs are tall enough (>20cm) to carry fire; a ploughed buffer strip 3-6m wide may be adequate.
Entire forest	• Education	• The public may be interested to know that the white spruce growth in this area rivals that of Edmonton's river valley.

Table 11. GroveCo 60 five-year operating plan (2005-2010)

Map unit (refer to map in map folio)	**Issue**	**Recommended action**
Entire forest	• Invasive species (introduced), particularly noxious weeds such as tansy (*Tanacetum vulgare*) are controlled under the provincial Weed Act and invasive trees such as mountain ash (*Sorbus aucuparia*) may become more prevalent with time and compete with native communities.	• Monitor for invasive species and control as needed.
Entire forest	• Clean up and improve trail surfaces on existing trail systems within GroveCo. Some yard wastes (concrete) have been dumped along the truck trail that goes partway into the stand. The south trail entrance appears to be a popular informal campfire spot and is difficult to monitor from the adjacent subdivisions because of a small hill.	• Apply gravel to trail surfaces and consider relandscaping to improve visibility and reduce the attractiveness of the site for informal gatherings. • Take care not to damage trees or create local flooding if trail improvements involve the use of heavy equipment or extensive fill placement.

7 Cooke Lands Forest Reserve

7.1 Forest Cover

Cooke Lands Forest Reserve ("the Reserve") is the smallest of all four forests, with an area of 5.7ha. Mixedwood aspen-white spruce and white spruce-balsam poplar stands and aspen-balsam poplar stands are the cover types within this forest. Table 12 summarizes area and volume statistics for the Reserve; Figure 11 and Figure 12 show cover type and age proportion characteristics. Figures CR-2 and CR-3 in Volume 2 show the distribution of stand types and ages in the Reserve.

Table 12. Summary of general forest types in Cooke Lands Forest Reserve

Cooke Lands Reserve Mapped Forest Cover Type	Area (ha)	Estimated coniferous volume (m3)	Estimated deciduous volume (m3)	Estimated total volume (m3)	Area (ha) in each stand age class (years) by cover type	
					10-60 years	*61-100 years*
Aspen- white spruce	2.9	51	278	329		2.9
Aspen-balsam poplar	1.7	85	146	231	1	1
White spruce-balsam poplar	1.1	205	48	253		1
Total area or volume	**5.7**	**341**	**472**	**813**	**0.8**	**4.9**

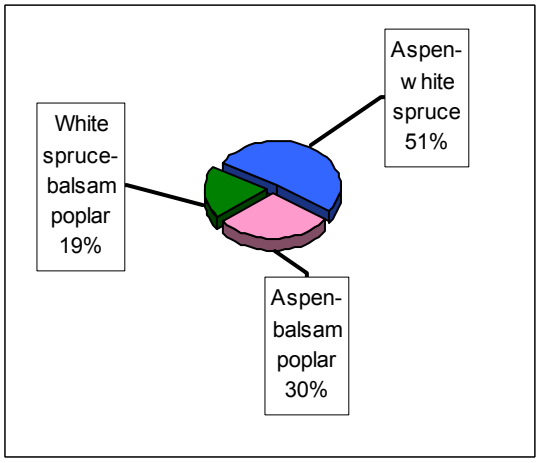

Figure 11. General forest cover type proportions in Cooke Lands Forest Reserve

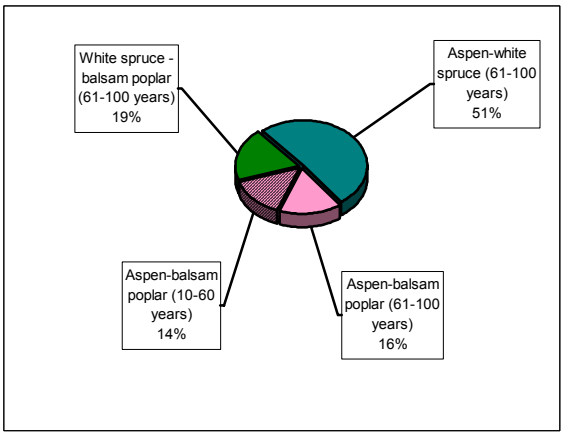

Figure 12. Age classes and cover types in Cooke Lands Forest Reserve

7.2 Site nutrient and moisture status

Figure CR-4 in Volume 2 shows the distribution of site nutrient and moisture conditions throughout the Reserve. The aspen-white spruce stands are judged to be average in terms of both moisture and nutrients, while the white spruce-balsam poplar and aspen-balsam poplar stands are

judged to be rich and very moist. These latter stands are in slightly lower areas and receive some surface flow.

7.3 Special features

There appear to be no locally or regionally significant features within the Reserve. It is nevertheless worthy of preservation. It is a healthy and relatively undisturbed forest that provides habitats for a variety of plants, animals, invertebrates, and micro-organisms. It also adds variety to the local landscape and will be a valuable part of any urban development in the area.

7.4 Stand Health Assessment 2004

All stands in the Reserve exhibit normal states of health given stand age and composition (Figure CR-5, Volume 2). It is expected that the aspen- balsam poplar stands will thin out as stem disease and rot take their toll over time.

7.5 Stand history and future trends

The Reserve has probably been used as a local source of white spruce for building products and fuel and is a remnant stand. Barring stand-replacing fires, severe insect or disease infestations, major climate changes or changes to surface water flow regimes due to urbanization, all stands will eventually be dominated by white spruce.

7.6 Fire hazard potential

Figure CR-6 and CR-7 in Volume 2 show the potential spring/fall and summer fire hazard potential in the Reserve. Refer to Section 3.3 above for a discussion of the assessment method.

At this time, the risk of fire spreading from this stand would be partly dependent on the surrounding cultivated lands and the height and density of adjacent crop or pasture plants; it is well known from recent times in southern Alberta that grass fires can cause serious damage, and grass fires could spread from ignition points within the Reserve.

7.7 Decay and Breakage Hazard and Blowdown Hazard

Figure CR-8 in Volume 2 show the distribution of stands prone to decay and breakage. All stands within the Reserve are rated as moderate to high hazard because of the prevalence of older balsam poplar. Blowdown hazard throughout the Reserve is rated as low (Figure CR-9, Volume 2). The criteria for determining decay and breakage and blowdown hazards are outlined in Section 3.3 (methods).

7.8 Wildlife Snag Habitat Potential

All stands within Cooke Lands Forest Reserve are considered to have fair to good snag habitat potential because of the prevalence of large old balsam poplar particularly in map unit 4 (Figure CR-1, Volume 2). Figure CR-10 (Volume 2) shows the distribution of snag habitat in the Reserve. The criteria for determining snag habitat potential are outlined in Section 3.3 (methods).

7.9 Cooke Lands Forest Reserve Five-Year Management Plan

As for GroveCo 60, there is nothing that needs to be done in the Reserve over the next year; Table 13 presents the five-year suggested operational plan for 2005 through 2010. The five-year plan makes general references to planning considerations; those dealing with surface and shallow groundwater flow should be evaluated further by urban hydrologists or civil engineers when development proposals are examined to ensure that water flow from the adjacent upland areas is neither decreased nor increased in quantity.

Table 13. Five year management plan, Cooke Lands Forest Reserve

Map unit (refer to map in map folio)	**Issue**	**Recommended action**
Entire forest	• Development planning – groundwater issues	• Retain a buffer area adjacent the Reserve so that local groundwater flow regimes are minimally impacted. • Ensure at the planning stages that sufficient infiltration can occur to maintain the current patterns of water flow to the site • Ensure at the planning stage that the area is not regarded as a stornwater retention zone; the small creek flowing into the Reserve could be seen as a convenient channel.
Entire forest	• Development planning – fire issues	• This area is not currently in proximity to residences; ensure that if construction does occur, relevant FireSmart recommendations are followed regarding distance to dwellings, dwelling construction standards etc. • It may be necessary to reduce fine fuels in pasture lands next to developed areas if pasture grasses and forbs are tall enough (>20cm) to carry fire; a ploughed buffer strip 3-6m wide may be adequate.
Entire forest	• Education	• The public may be interested to know that remnant forests of this type, even though small, do provide valuable wildlife habitat. • A primitive trail system could be developed and possibly accessed from the nearby church parking lot if the church is supportive.
Entire forest	• Invasive species (introduced), particularly noxious weeds such as tansy (*Tanacetum vulgare*) are controlled under the provincial Weed Act and invasive trees such as mountain ash (*Sorbus aucuparia*) may become more prevalent with time and compete with native communities.	• Monitor for invasive species and control as needed.

8 Long-term directions

Long-term directions for Spruce Grove urban forests will depend on community input and future environmental conditions, and flexibility is needed to adapt to continuous and inevitable changes in the forest and in the surrounding urban and natural environment. It is evident from the forest history of both Heritage Grove and Atim Creek forests that black spruce-dominated forests are being replaced over time by deciduous forests, probably due to a decrease in near-surface groundwater flow. This is not a situation that can be easily remedied, and it is quite likely that spruce forests will continue to be replaced by deciduous forests over time if groundwater quantities continue to decrease. If it is the communities' wish that spruce forests be maintained, then a reasonable response would be to reforest burns or other disturbances with white spruce seedlings or black spruce in wet areas, both of which are shade-tolerant and adapted to a wide range of environmental conditions. White spruce underplantings in deciduous forests could also be undertaken to promote the development of mixedwood forests over several decades.

Local surface flow and groundwater concerns are also of prime importance in GroveCo 60 and Cooke Lands Reserve; although these areas are apparently not as dependent on subregional groundwater discharge as parts of Heritage Grove and Atim Creek, they are dependent upon the maintenance of current local water tables. Urban development planning should ensure that water supplies to these forests are neither increased nor decreased.

Fire protection will continue to be a concern in all four Spruce Grove forests. Heritage Grove should receive the highest priority in this regard because of the proximity of urban development to the forest. There is time to plan adequate buffers and fire control strategies for Atim Creek, GroveCo 60 and Cooke Lands Reserve because urban development has not yet reached the perimeters of these forests.

In support of management activities, it may be worthwhile to consider sources of funding that support urban forestry. In this regard, Timberline was asked to investigate possible funding sources, including "carbon credits". It may also be worthwhile to consider partnerships with other municipalities and organizations that have urban forestry as a common interest.

8.1 Funding opportunities

Tree Canada Foundation supports the Green Streets Canada program. This program offers communities an opportunity to expand and enhance municipal tree programs by providing, on a competitive basis, additional funding with which to undertake a tree inventory, plant trees of all sizes, maintain trees and provide educational opportunities for its citizens. The City of Spruce Grove would be a good candidate for such funding, and would qualify for funding up to $5000. The next deadline for grant application is January 31 2005, and municipalities may qualify once for funding. Funding opportunities that might be pursued within the first year of this plan might include such activities as investigation of tamarack mortality near Calahoo Road, reforestation near Brookwood School in the east part of Heritage Grove, development of an improved trail system through GroveCo 60, and educational signage.

Several agencies provide funds for schoolyard naturalization, including Shell Environment Fund, TD Friends of the Environment Foundation, Toyota Evergreen Learning Grounds, Tree Canada Foundation (Greening Canada's School Grounds) and Alberta Ecotrust Foundation. Local businesses may see the value in contributing funds or in-kind support to such activities.

In connection with the Kyoto Accord and the reduction of greenhouse gases, afforestation has been seen as one way to "sequester" carbon and the concept of carbon credits for municipalities and industry is being reviewed. According to Lois Macklin[12], the carbon credits program is in the preliminary development stages but existing forests would not qualify for carbon credits. Evaluation of allowable credits will involve going beyond business as usual – for example, undertaking a tree-planting program. Under these criteria, the estimated annual capture of between 200 and 300 tonnes of carbon by Spruce Grove forests (mean annual increment values in Table 3) would not qualify for carbon credits.

8.2 Partnerships

It may be useful for Spruce Grove to consider partnerships with other agencies that have an urban forestry interest. Tree Canada Foundation has a broad membership base and the City of Spruce Grove would be a welcome addition to their organization given the City's well-defined urban forestry focus. The FireSmart organization (Partners in Protection) has several municipalities as members, and Spruce Grove may benefit from the knowledge accrued through several recent years by members and contribute to the knowledge base. A representative of Partners in Protection indicated that Spruce Grove would be welcome to attend their general meetings.[13]

8.3 Other urban forestry possibilities

Antonelli et al. (2004) discuss programs that have worked well in Calgary, including a community tree planting program, a planting incentive program (15 to 50 trees provided at subsidized cost), an arbor day program and a birthplace forest program (choosing new trees to celebrate babies). Such programs may be of interest to Spruce Grove residents.

[12] Senior Advisor, Biological Sinks program, Alberta Environment
[13] John McLevin, Wildfire Prevention Officer, Alberta Sustainable Resource Development, Edmonton.

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Appendix A. Criteria used to assign fire hazard, blowdown, decay and breakage, and wildlife habitat ratings

Table A-1. Criteria for determining fire hazard potential

Forest type	Canopy	Season	Moisture	Soil type	Rating *
Conifer	Open	Spring/fall	Dry to very moist	Mineral	High
Conifer	Open	Spring/fall	Wet	Mineral	Moderate
Conifer	Open	Spring/fall	Dry to very moist	Organic	High
Conifer	Open	Spring/fall	Wet	Organic	Moderate
Conifer	Open	Summer	Dry to very moist	Mineral	High
Conifer	Open	Summer	Wet	Mineral	Moderate
Conifer	Open	Summer	Dry to very moist	Organic	High
Conifer	Open	Summer	Wet	Organic	Moderate
Conifer	Closed	Spring/fall	Dry to very moist	Mineral	High
Conifer	Closed	Spring/fall	Wet	Mineral	High
Conifer	Closed	Spring/fall	Dry to very moist	Organic	High
Conifer	Closed	Spring/fall	Wet	Organic	High
Conifer	Closed	Summer	Dry to very moist	Mineral	High
Conifer	Closed	Summer	Wet	Mineral	High
Conifer	Closed	Summer	Dry to very moist	Organic	High
Conifer	Closed	Summer	Wet	Organic	High
Mixed conifer and deciduous	Open	Spring/fall	Dry to very moist	Mineral	High
Mixed conifer and deciduous	Open	Spring/fall	Wet	Mineral	Moderate
Mixed conifer and deciduous	Open	Spring/fall	Dry to very moist	Organic	High
Mixed conifer and deciduous	Open	Spring/fall	Wet	Organic	Moderate
Mixed conifer and deciduous	Open	Summer	Dry to very moist	Mineral	Moderate
Mixed conifer and deciduous	Open	Summer	Wet	Mineral	Moderate
Mixed conifer and deciduous	Open	Summer	Dry to very moist	Organic	Moderate
Mixed conifer and deciduous	Open	Summer	Wet	Organic	Moderate
Mixed conifer and deciduous	Closed	Spring/fall	Dry to very moist	Mineral	High
Mixed conifer and deciduous	Closed	Spring/fall	Wet	Mineral	Moderate
Mixed conifer and deciduous	Closed	Spring/fall	Dry to very moist	Organic	High
Mixed conifer and deciduous	Closed	Spring/fall	Wet	Organic	High
Mixed conifer and deciduous	Closed	Summer	Dry to very moist	Mineral	Moderate
Mixed conifer and deciduous	Closed	Summer	Wet	Mineral	Low
Mixed conifer and deciduous	Closed	Summer	Dry to very moist	Organic	Moderate
Mixed conifer and deciduous	Closed	Summer	Wet	Organic	Low
Deciduous (including shrublands)	Open	Spring/fall	Dry to very moist	Mineral	Moderate
Deciduous (including shrublands)	Open	Spring/fall	Wet	Mineral	Moderate
Deciduous (including shrublands)	Open	Spring/fall	Dry to very moist	Organic	High
Deciduous (including shrublands)	Open	Spring/fall	Wet	Organic	Moderate
Deciduous (including shrublands)	Open	Summer	Dry to very moist	Mineral	Low
Deciduous (including shrublands)	Open	Summer	Wet	Mineral	Low
Deciduous (including shrublands)	Open	Summer	Dry to very moist	Organic	Low
Deciduous (including shrublands)	Open	Summer	Wet	Organic	Low
Deciduous (including shrublands)	Closed	Spring/fall	Dry to very moist	Mineral	High
Deciduous (including shrublands)	Closed	Spring/fall	Wet	Mineral	Moderate
Deciduous (including shrublands)	Closed	Spring/fall	Dry to very moist	Organic	High
Deciduous (including shrublands)	Closed	Spring/fall	Wet	Organic	Moderate
Deciduous (including shrublands)	Closed	Summer	Dry to very moist	Mineral	Low
Deciduous (including shrublands)	Closed	Summer	Wet	Mineral	Low
Deciduous (including shrublands)	Closed	Summer	Dry to very moist	Organic	Low
Deciduous (including shrublands)	Closed	Summer	Wet	Organic	Low

Table A-1. Criteria for determining fire hazard potential

Forest type	Canopy	Season	Moisture	Soil type	Rating *
Cultivated areas					Low
Wetlands and flooded areas					Low

* stands immediately adjacent to occupied lots are rated one class higher unless they are maintained fields or flooded areas

Basic source of information: Canadian Fire Behaviour fuel type descriptions and FireSmart area evaluation tables.

Table A-2. Blowdown hazard

Forest type	Canopy	Soil	Moisture	Inferred water table	Class
Deciduous	Open	Mineral	dry-very moist	Deep	Low
Deciduous	Open	Mineral	Wet	Shallow	Low
Deciduous	Open	Mineral	Very wet	At or above surface	Moderate
Deciduous	Open	Organic	dry-very moist	Deep	Low
Deciduous	Open	Organic	Wet	Shallow	Low
Deciduous	Open	Organic	Very wet	At or above surface	Moderate
Deciduous	Closed	Mineral	dry-very moist	Deep	Low
Deciduous	Closed	Mineral	Wet	Shallow	Low
Deciduous	Closed	Mineral	Very wet	At or above surface	Moderate
Deciduous	Closed	Organic	dry-very moist	Deep	Low
Deciduous	Closed	Organic	Wet	Shallow	Moderate
Deciduous	Closed	Organic	Very wet	At or above surface	High
Mixed conifer and deciduous	Open	Mineral	dry-very moist	Deep	Low
Mixed conifer and deciduous	Open	Mineral	Wet	Shallow	Low
Mixed conifer and deciduous	Open	Mineral	Very wet	At or above surface	Moderate
Mixed conifer and deciduous	Open	Organic	dry-very moist	Deep	Low
Mixed conifer and deciduous	Open	Organic	Wet	Shallow	Low
Mixed conifer and deciduous	Open	Organic	Very wet	At or above surface	Moderate
Mixed conifer and deciduous	Closed	Mineral	dry-very moist	Deep	Low
Mixed conifer and deciduous	Closed	Mineral	Wet	Shallow	Low
Mixed conifer and deciduous	Closed	Mineral	Very wet	At or above surface	Moderate
Mixed conifer and deciduous	Closed	Organic	dry-very moist	Deep	Low
Mixed conifer and deciduous	Closed	Organic	Wet	Shallow	Moderate
Mixed conifer and deciduous	Closed	Organic	Very wet	At or above surface	High
Coniferous	Open	Mineral	dry-very moist	Deep	Low
Coniferous	Open	Mineral	Wet	Shallow	Moderate
Coniferous	Open	Mineral	Very wet	At or above surface	Moderate
Coniferous	Open	Organic	dry-very moist	Deep	Low
Coniferous	Open	Organic	Wet	Shallow	Moderate
Coniferous	Open	Organic	Very wet	At or above surface	High
Coniferous	Closed	Mineral	dry-very moist	Deep	Low
Coniferous	Closed	Mineral	Wet	Shallow	Moderate
Coniferous	Closed	Mineral	Very wet	At or above surface	High
Coniferous	Closed	Organic	dry-very moist	Deep	Moderate
Coniferous	Closed	Organic	Wet	Shallow	High
Coniferous	Closed	Organic	Very wet	At or above surface	High

Rationale: Open-grown stands should have some wind resistance vs. closed stands where rooting is probably less extensive. Shallow water tables = shallow rooting. Organic soils don't provide as much strength as mineral soils.

Table A-3.Decay and bole breakage hazard rating

Stand type	Age class	Rating*
Aspen	0-60	Low
Aspen	61-100	Moderate
Aspen	>100	High
Coniferous	0-60	Low
Coniferous	61-100	Low
Coniferous	>100	Moderate
Mixed conifer and deciduous	0-60	Low
Mixed conifer and deciduous	61-100	Moderate
Mixed conifer and deciduous	>100	Moderate
Balsam Poplar	0-60	Moderate
Balsam Poplar	61-100	High
Balsam Poplar	>100	Very high

*High potential for decay and breakage in and adjacent to flooded areas. A map unit was also ranked high if significant disease or damage agents causing whole-tree mortality were noted during field surveys.

Table A-4. Wildlife snag habitat potential

Stand type	Age class	Rating*
Aspen	0-60	Low
Aspen	61-100	Moderate
Aspen	>100	High
Coniferous	0-60	Low
Coniferous	61-100	Moderate
Coniferous	>100	Moderate
Mixed conifer and deciduous	0-60	Low
Mixed conifer and deciduous	61-100	Moderate
Mixed conifer and deciduous	>100	Moderate
Balsam Poplar	0-60	Moderate
Balsam Poplar	61-100	High
Balsam Poplar	>100	Very high

* *High potential for snags in and adjacent to flooded areas. A map unit was also ranked high if significant disease or damage agents causing whole-tree mortality were noted during field surveys.

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Appendix B. Detailed map unit characteristics

Volumes expressed as cubic metres of wood.

Table B-1. Heritage Grove map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
1	2.3	High	Low	Low	Low	Poor	>10% dead	rich/very moist	mineral	No	Aspen	10-60	NA
2	0.6	High	Low	Low	High	Good	Top dieback	rich/very moist	mineral	Yes	Balsam poplar - White spruce	61-100	NA
3	0.2	Moderate	Low	Low	High	Good	>10% dead	rich/moist	mineral	Yes	Balsam poplar	61-100	NA
4	0.5	Moderate	Low	Low	High	Good	Healthy	rich/moist	mineral	Yes	Balsam poplar	61-100	NA
5	0.1	Moderate	Low	Low	Moderate	Fair	Healthy	rich/moist	mineral	Yes	Balsam poplar	10-60	NA
6	1.8	High	Moderate	Low	Moderate	Fair	Healthy	rich/moist	mineral	No	White spruce - Aspen	61-100	NA
7	1.4	Extreme	High	Low	Moderate	Fair	Healthy	rich/moist	mineral	Yes	White spruce	61-100	NA
8	0.6	High	High	Low	Moderate	Fair	Healthy	rich/moist	mineral	Yes	White spruce	61-100	NA
9	1.6	High	Low	Low	Low	Poor	Top dieback	rich/moist	mineral	No	Aspen	10-60	NA
10	0.7	High	Moderate	Moderate	Moderate	Fair	Healthy	rich/very moist	organic	No	White spruce - Aspen	61-100	Unusual forest cover/soil combination
11	0.3	High	Low	Low	Low	Poor	Healthy	rich/very moist	organic	No	Mixed shrub	Not applicable	NA
12	2.3	High	High	Moderate	Moderate	Fair	Healthy	rich/very moist	organic	Yes	White spruce	61-100	
13	1.0	High	Low	Low	High	Good	Not ground checked	rich/very moist	organic	No	Balsam poplar	61-100	Unusual forest cover/soil combination
14	1.0	Moderate	Moderate	Moderate	Low	Poor	Healthy	rich/wet	organic	No	Black and white spruce	61-100	NA
15	0.4	High	Moderate	Low	Low	Poor	Healthy	rich/very moist	organic	Yes	Black spruce - Tamarack	61-100	NA
16	0.2	High	Moderate	Moderate	High	Good	Healthy	rich/moist	organic	Yes	Balsam poplar - White spruce	61-100	Unusual forest cover/soil combination
17	0.4	High	High	Moderate	Moderate	Fair	Healthy	rich/moist	organic	Yes	White spruce	61-100	
18	0.4	Moderate	Moderate	Moderate	Low	Poor	Healthy	rich/wet	organic	Yes	Black spruce - Tamarack	10-60	NA
19	0.6	Moderate	Low	Low	Moderate	Fair	Healthy	rich/very moist	mineral	Yes	Balsam poplar	10-60	NA
20	2.5	Moderate	Low	Low	High	Good	Healthy	rich/very moist	mineral	Yes	Balsam poplar	61-100	NA
21	1.5	Low	Low	Low	Low	Poor	Not applicable			Not applicable	Trail	Not applicable	NA
22	1.0	High	High	Low	Moderate	Fair	Healthy	rich/very moist	mineral	Yes	White spruce	61-100	NA

Table B-1. Heritage Grove map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
23	0.5	High	High	Moderate	Moderate	Fair	Healthy	rich/very moist	organic	Yes	White spruce	61-100	NA
24	0.6	High	Moderate	Low	Moderate	Fair	Healthy	rich/very moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
25	0.5	High	Low	Low	Moderate	Fair	Healthy	rich/very moist	organic	Yes	Birch	10-60	Unusual forest cover/soil combination
26	1.0	High	Moderate	Low	Moderate	Fair	Not ground checked	rich/very moist	organic	Yes	White spruce	61-100	
27	0.5	High	High	Low	Moderate	Fair	Not ground checked	rich/moist	mineral	Yes	White spruce	61-100	NA
28	1.5	Moderate	Low	Low	Moderate	Fair	Healthy	rich/very moist	mineral	Yes	Balsam poplar	10-60	NA
29	0.1	Low	Low	Low	Low	Poor	Not applicable	rich/moist	mineral	Not applicable	Field	Not applicable	NA
30	0.2	Moderate	Low	Low	Low	Poor	Not applicable	rich/wet	organic	Yes	Mixed shrub	Not applicable	NA
31	1.0	High	Moderate	Moderate	Low	Poor	Healthy	rich/very moist	organic	Yes	Tamarack	61-100	Uncommon stand type
32	0.4	High	Low	Moderate	Moderate	Fair	Healthy	rich/very moist	organic	Yes	Birch	10-60	NA
33	0.9	High	Low	Low	Moderate	Fair	Healthy	rich/moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
34	0.5	Extreme	High	High	Low	Poor	Healthy	rich/wet	organic	No	Black spruce - Tamarack	61-100	NA
35	0.1	Low	Low	Low	Low	Poor	Not applicable	rich/very wet	organic	Yes	Wet meadow	Not applicable	NA
36	2.9	Extreme	High	High	Low	Poor	Healthy	rich/very wet	organic	Yes	Black spruce	61-100	NA
37	0.9	High	Low	High	High	Poor	Healthy	rich/wet	organic	Yes	Birch	<10	Burn (1998)
38	3.1	Low	Low	Low	Low	Poor	Not applicable	rich/moist	mineral	Not applicable	Field	Not applicable	NA
39	0.4	Low	Low	Low	Low	Poor	Not applicable	rich/very wet	organic	Yes	Wet meadow	Not applicable	NA
40	1.7	High	High	High	Low	Poor	Healthy	rich/wet	organic	Yes	Black spruce - Tamarack	61-100	NA
41	1.6	Extreme	High	High	Low	Poor	Healthy	rich/very wet	organic	Yes	Black spruce	10-60	NA
42	0.2	High	Moderate	Moderate	Low	Poor	Healthy	rich/wet	organic	Yes	Black spruce	61-100	NA
43	0.6	Extreme	High	High	Low	Poor	>10% dead	rich/wet	organic	Yes	Black spruce - Tamarack	61-100	NA

Table B-1. Heritage Grove map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
44	0.5	Extreme	Moderate	Low	High	Good	>10% dead	rich/very moist	organic	Yes	Balsam poplar - White spruce	61-100	NA
45	2.4	High	Moderate	High	Low	Poor	>10% dead	rich/wet	organic	Yes	Black spruce - Tamarack	61-100	Uncommon stand type
46	0.2	Low	Low	Low	Low	Poor	Not applicable	rich/very wet	organic	Yes	Wet meadow	Not applicable	NA
47	0.1	High	Low	Low	High	Good	Healthy	rich/very moist	organic	Yes	Balsam poplar	61-100	Unusual forest cover/soil combination
48	0.2	Moderate	Low	Low	Low	Poor	Not applicable	rich/wet	organic	No	Mixed shrub	Not applicable	NA
49	1.1	Extreme	High	Moderate	Moderate	Fair	Healthy	rich/very moist	organic	No	White spruce	61-100	
50	2.3	High	Moderate	Low	Low	Poor	>10% dead	rich/very moist	organic	Yes	Tamarack	61-100	Uncommon stand type
51	2.0	High	Moderate	High	High	Good	Healthy	rich/wet	organic	Yes	Black spruce	61-100	NA
52	0.2	High	Low	Low	Moderate	Fair	Not ground checked	rich/very moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
53	0.7	High	Low	Low	Low	Poor	Not applicable	rich/very moist	organic	Yes	Mixed shrub	Not applicable	NA
54	0.3	Moderate	Low	Low	Moderate	Fair	Healthy	rich/very moist	mineral	No	Balsam poplar	10-60	NA
55	1.6	Extreme	High	High	Low	Poor	>10% dead	rich/wet	organic	Yes	Black spruce	61-100	NA
56	0.2	High	Low	Low	Low	Poor	Not applicable	rich/very moist	organic	Yes	Mixed shrub	Not applicable	NA
57	0.3	High	Low	Low	Low	Poor	Healthy	rich/very moist	organic	Yes	Mixed shrub	10-60	Burn (1989)
58	0.4	Moderate	Low	Low	Moderate	Fair	Not ground checked	rich/very moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
59	0.9	Moderate	Low	Low	High	Good	Not ground checked	rich/very moist	mineral	No	Balsam poplar	61-100	NA
61	0.2	Moderate	Moderate	Low	Moderate	Fair	Top dieback	rich/moist	mineral	No	Balsam poplar - White spruce	10-60	NA
64	0.5	Moderate	Low	Low	Moderate	Fair	Healthy	rich/moist	mineral	No	Balsam poplar	10-60	NA
65	0.8	Moderate	Low	Low	High	Good	Top dieback	rich/moist	mineral	No	Balsam poplar - White spruce	61-100	NA
66	0.1	Moderate	Low	Low	Moderate	Fair	Healthy	rich/moist	mineral	No	Balsam poplar	10-60	NA
67	0.5	High	Low	Low	Moderate	Fair	Healthy	rich/very	organic	Yes	Birch	10-60	Unusual forest cover/soil

Table B-1. Heritage Grove map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
								moist					combination
68	0.2	High	Low	Low	Moderate	Fair	Not ground checked	rich/very moist	organic	No	Balsam poplar	10-60	Unusual forest cover/soil combination
69	0.5	High	Moderate	High	Low	Poor	Not ground checked	rich/very wet	organic	No	Black spruce - Tamarack	61-100	NA
70	0.7	High	Low	High	Moderate	Fair	>10% dead	rich/wet	organic	Yes	White spruce - Tamarack	61-100	NA
71	0.4	High	Low	Low	Low	Poor	Not applicable	rich/wet	organic	Yes	Mixed shrub	Not applicable	NA
72	0.2	High	Low	Low	High	Good	Not ground checked	rich/very moist	organic	Yes	Balsam poplar	61-100	Unusual forest cover/soil combination

Table B-1 (continued). Heritage Grove detailed forest cover label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
1	m-55-14-Aw10-1961-G	m-20-7-Aw10-1995-G	Yes	Plot	C2Aw	23	101	124		130	0	297	297	field plot	5.0
2	m-55-19-Pb10-1934-G		Yes	Casual	C3PbSw	69	180	249			38	100	139	Phase III volume tables	2.4
3	m-20-20-Pb10-1920-M		Yes	Casual	A3Pb	77	48	125			14	9	23	Phase III volume tables	0.3
4	m-40-19-Pb10-1920-M		Yes	Casual	B3Pb	47	129	176			23	63	86	Phase III volume tables	1.0
5	m-75-20-Pb10-1944-G		Yes	Casual	D3Pb	47	215	262			6	26	31	Phase III volume tables	0.4
6	m-50-21-Sw5Aw3Pb2-1920-G		Yes	Casual	B3SwAwPb	144	73	217			260	132	392	Phase III volume tables	4.7
7	m-65-20-Sw10-1920-G		Yes	Casual	C3Sw	255	48	303			352	66	418	Phase III volume tables	5.0
8	m-20-22-Sw10-1920-G	m-HG-G	Yes	Casual	A3Sw	121	20	141			73	12	85	Phase III volume tables	1.0
9	m-65-19-Aw8Pb1Sw1-1950-G	m-40-7-Sw6Aw2Pb2-1972-G	Yes	Casual	C3Aw(Sw)	69	180	249			108	283	391	Phase III volume tables	4.4
10	m-50-20-Aw4Sw4Pb2-1920-M		Yes	Casual	C3AwSw(Pb)	140	137	277			104	102	206	Phase III volume tables	2.5
11	w-75-10-SC8-F		Yes	Casual											
12	m-70-26-Sw10-1920-G		Yes	Plot	C4Sw	256	33	289	390		888	0	888	field plot	10.6
13	m-20-20-Pb10-1920-G	m-8-SC7-G			A3Pb	77	48	125			74	46	120	Phase III volume tables	1.4
14	m-20-25Sw7Sb3-1920-G	m-30-11-Bw10-1940-G	Yes	Casual	A4SwSb	121	20	141			123	20	143	Phase III volume tables	1.7
15	w-20-14-Sb7Lt2Sw1-1920-G	w-7-SC5-G	Yes	Casual	A2SbLt	36	13	49			15	5	20	Phase III volume tables	0.2
16	m-70-23-Sw8Pb2-1920-G	m-30-12-Pb5Bw3Sw2-1960-G	Yes	Casual	C3SwPb	255	48	303			46	9	55	Phase III volume tables	0.7

Table B-1 (continued). Heritage Grove detailed forest cover label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
17	m70-26-Sw10-1920-G		Yes	Casual	C4Sw	256	33	289			96	12	108	Phase III volume tables	1.3
18	w-40-14-Sb7Lt2Sw1-1945-G		Yes	Casual	B2SbLt	109	7	116			43	3	46	Phase III volume tables	0.8
19	m-70-20-Pb9Sw1-1945-G		Yes	Casual	C2Pb	23	101	124			14	62	76	Phase III volume tables	1.8
20	m-55-24-Pb10-1905-G		Yes	Plot	C3Pb	69	180	249	0	216	0	544	544	field plot	5.5
21	CIP trail System		Yes	Casual											
22	m-65-28-Sw10-1920-G		Yes	Plot	C4Sw	256	33	289	394		375	0	375	field plot	4.5
23	m-70-28-Sw10-1920-G		Yes	Casual	C4Sw	256	33	289			129	17	146	Phase III volume tables	1.7
24	m-70-23-Pb10-1945-G		Yes	Casual	C3Pb	69	180	249			39	101	140	Phase III volume tables	2.4
25	m-40-15-Bw10-1980-G	m-11-SC6-G	Yes	Casual	B2Bw	19	48	67			10	25	35	Phase III volume tables	1.4
26	m-10-24-Sw10-1920-G	m-9-SC6-G			A3Sw	121	20	141			121	20	141	Phase III volume tables	1.7
27	m-55-28-Sw9Aw1-1920-G				C4Sw	256	33	289			116	15	131	Phase III volume tables	1.6
28	m-65-24-Pb10-1945-G		Yes	Casual	C3Pb	69	180	249			102	266	368	Phase III volume tables	5.3
29	CP														
30	w-4-SC4-F	w-HG-F													
31	w-55-21-Lt9Sw1-1909-G		Yes	Casual	C3Lt	170	18	188			167	18	184	Phase III volume tables	1.9
32	m-40-14-Bw9Pb1-1980-G	m-11-SC6-G	Yes	Casual	B2Bw	19	48	67			8	20	28	Phase III volume tables	1.1
33	m40-21-Pb9Bw1-1945-G	m-10-SC6-G	Yes	Casual	B3Pb	47	129	176			43	118	161	Phase III volume tables	2.7
34	w70-15-Sb8Lt2-1920-G		Yes	Casual	D2SbLt	185	9	194			87	4	91	Phase III volume	1.5

Table B-1 (continued). Heritage Grove detailed forest cover label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
														tables	
35	w-HG-U														
36	w-60-12-Sb9Lt1-1915-G		Yes	Plot	C1Sb	65	2	67	89		256	0	256	field plot	2.9
37	m-10-1-Bw10-1998-G	m-HF-G	Yes	Casual	A1Bw	8	6	14			7	6	13	Phase III volume tables	2.2
38	CP														
39	w-HG-U														
40	w-55-11-Sb8Lt2-1920-G	w-20-6-Sb8Lt1Bw1-1974-G	Yes	Plot	C1SbLt	32	4	36			55	7	62	Phase III volume tables	0.7
41	w-75-12-Sb9Bw1-1950-G		Yes	Casual	D1Sb	86	14	100	81		129	0	129	field plot	1.5
42	w-20-15-Sb9Sw1-1920-G	w-9-SC7-G	Yes	Casual	A2Sb	36	13	49			6	2	8	Phase III volume tables	0.1
43	60-14-Sb8Lt2-1915-G		Yes	Casual	C2SbLt	170	18	188			104	11	115	Phase III volume tables	2.1
44	m-60-22-Pb7Sw3-1920-G		Yes	Casual	C3PbSw	69	180	249			36	95	131	Phase III volume tables	1.6
45	m-50-18-Lt8Sb2-1920-G	m-2-SC5-G	Yes	Plot	B2LtSb	109	7	116	157		380		380	field plot	8.6
46	w-HG-U			Casual											
47	m-40-19-Pb10-1940-G	m-9-SC6-G	Yes	Casual	B3Pb	47	129	176			7	19	26	Phase III volume tables	0.4
48	w-8-SC8-F														
49	m-40-25-Sw9Pb1-1920-G	m-9-SC4-G	Yes	Casual	B4Sw	183	30	213			202	33	235	Phase III volume tables	2.8
50	w-40-18-Lt9Sb1-1920-G	w-7-SC5-G	Yes	Plot	B2Lt	109	7	116	233	14	548	32	580	field plot	6.9
51	w-30-15-Sb9Lt1-1905-G	w-3-SC6-G	Yes	Plot	B2Sb	109	7	116	58		119	0	119	field plot	1.4
52	m-80-17-Pb10-1960-G				D2Pb	2	104	106			0	18	19	Phase III volume tables	0.4
53	w-6-SC7-U														
54	m-80-17-Pb10-		Yes	Casual	D2Pb	2	104	106			1	28	29	Phase III	0.7

Table B-1 (continued). Heritage Grove detailed forest cover label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
	1960-G													volume tables	
55	w-65-14-Sb10-1937-G		Yes	Plot	C2Sb	170	18	188	137		216	0	216	field plot	3.2
56	m-8-SC7-M														
57	m-2-SC8-G-BU5-1990		Yes	Casual											
58	m-20-18-Pb10-1940-G	m-9-SC7-G			A2Pb	16	34	50			6	13	19	Phase III volume tables	0.3
59	m-75-21-Pb10-1920-G				D3Pb	47	215	262			41	189	231	Phase III volume tables	3.9
61	m-60-19-Pb10-1960-G		Yes	Casual	C3PbSw	69	180	249			10	27	38	Phase III volume tables	0.9
64	m-50-18-Pb10-1960-G		Yes	Casual	B2Pb	19	48	67			9	22	31	Phase III volume tables	0.3
65	m-60-23-Pb10-1920-G		Yes	Casual	C3PbSw	69	180	249			59	153	211	Phase III volume tables	2.5
66	m-70-18-Pb10-1960-G		Yes	Casual	C2Pb	23	101	124			3	11	14	Phase III volume tables	0.3
67	m-40-15-Bw10-1980-G	m-11-SC6-G	Yes	Casual	B2Bw	19	48	67			10	26	37	Phase III volume tables	1.5
68	w-75-22-Pb10-1945-G				D3Pb	47	215	262			9	42	51	Phase III volume tables	0.8
69	w-40-14-Sb8Lt2-1915-G				B2SbLt	109	7	116			56	4	59	Phase III volume tables	0.7
70	m-50-24-Sw6Lt2Pb2-1920-G		Yes	Casual	B3SwLtPb	158	8	166			106	5	112	Phase III volume tables	1.3
71	w-6-SC8-G														
72	m-75-21-Pb10-1940-G				D3Pb	47	215	262			9	42	51	Phase III volume tables	0.6

***volume in cubic metres**

Table B-2. Atim Creek Forest map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
1	1.6	Moderate	Low	Low	High	Good	Top dieback	Rich/moist	mineral	Yes	Balsam poplar	61-100	NA
2	0.5	High	Moderate	Low	High	Good	Healthy	Rich/moist	mineral	Yes	White spruce - Balsam poplar	61-100	NA
3	2.9	Low	Low	Low	High	Good	Healthy	Rich/very wet	organic	Yes	Mixed shrub	Not applicable	Flooded
4	1.1	High	High	Moderate	Moderate	Fair	Top dieback	Rich/very moist	mineral	Yes	White spruce	>100	NA
5	1.5	Moderate	Low	High	Low	Poor	Healthy	Rich/wet	organic	Yes	Black spruce - Tamarack	10-60	NA
6	0.9	Moderate	Low	Low	Moderate	Fair	Healthy	Rich/very moist	mineral	Yes	Balsam poplar - Aspen	10-60	NA
7	1.5	High	High	Low	Low	Poor	Healthy	Rich/very moist	organic	Yes	White spruce	10-60	NA
8	1.5	Moderate	Low	Low	Low	Poor	Healthy	Rich/very moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
9	0.7	Moderate	Low	High	High	Good	Healthy	Rich/wet	organic	Yes	Birch	61-100	NA
10	2.1	High	High	High	Low	Poor	Healthy	Rich/wet	organic	Yes	Black spruce - Tamarack	10-60	Uncommon type
12	0.4	Low	Low	High	High	Good	Not ground checked	Rich/very wet	organic	Yes	Birch	10-60	Flooded
13	0.8	High	Moderate	High	High	Good	>10% dead	Rich/wet	mineral	Yes	White spruce - Balsam poplar	61-100	NA
14	0.7	Low	Low	Low	Low	Good	Not applicable	Water	Water	Not applicable	Water	Not applicable	NA
15	0.4	Low	Low	Low	Moderate	Fair	Not applicable	Rich/wet	organic	Yes	Wet meadow	Not applicable	Seepage
16	1.1	High	High	Moderate	Moderate	Fair	Not ground checked	Rich/very moist	mineral	Yes	White spruce	61-100	NA
17	0.6	Moderate	Low	Low	Moderate	Fair	Not ground checked	Rich/very moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
19	0.4	Moderate	Low	Low	Moderate	Fair	Healthy	Rich/very moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
20	1.1	High	High	Low	Low	Poor	Healthy	Average/very moist	organic	Yes	White spruce	10-60	NA
21	0.9	High	High	Low	Low	Poor	Healthy	Average/very moist	mineral	Yes	White spruce-Black spruce	10-60	NA
22	0.7	Moderate	Low	Low	Moderate	Fair	Healthy	Rich/moist	mineral	Yes	Balsam poplar - Aspen	10-60	NA

Table B-2. Atim Creek Forest map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
24	0.4	Moderate	Low	Low	High	Good	Healthy	Average/moist	mineral	Yes	Balsam poplar	61-100	NA
25	2.0	High	Low	Low	Low	Poor	Healthy	Rich/very moist	organic	Yes	White spruce	10-60	NA
26	5.2	Moderate	Low	Low	Moderate	Fair	Healthy	Rich/moist	organic	Yes	Balsam poplar	10-60	Unusual forest cover/soil combination
27	1.7	High	Moderate	Low	Moderate	Fair	Healthy	Rich/very moist	organic	Yes	White spruce - Balsam poplar	61-100	NA
28	0.7	High	High	Low	Moderate	Fair	Healthy	Rich/very moist	mineral	Yes	White spruce	61-100	NA
31	0.7	Moderate	Low	Low	Moderate	Fair	Healthy	Average/moist	mineral	Yes	Balsam poplar	10-60	NA
32	1.7	Low	Low	Low	Low	Poor	Not applicable	Average/moist	mineral	Yes	Field	Not applicable	NA
33	0.8	Moderate	Low	Low	Low	Poor	Healthy	Average/moist	mineral	Yes	Aspen	10-60	NA
34	1.6	Moderate	Low	Low	Low	Poor	Not ground checked	Average/moist	mineral	No	Aspen	10-60	NA
35	1.6	Moderate	Low	Low	High	Good	Healthy	Average/moist	mineral	Yes	Balsam poplar - Aspen	61-100	NA
36	3.9	High	Moderate	Low	Low	Poor	Healthy	Rich/very moist	organic	Yes	White spruce - Tamarack-Poplar	10-60	Uncommon type
38	1.0	Moderate	Low	Low	Moderate	Fair	Healthy	Average/moist	mineral	Yes	Aspen	61-100	NA
39	2.0	Moderate	Low	Low	Moderate	Fair	Healthy	Average/moist	mineral	No	Balsam poplar - Aspen	10-60	Sandy esker
40	1.1	Moderate	Low	Low	Low	Poor	Healthy	Average/moist	mineral	No	Aspen	10-60	Sandy esker
42	1.1	Moderate	Low	Low	Low	Poor	Not ground checked	Average/moist	mineral	No	Aspen	10-60	Sandy esker
43	1.3	Moderate	Low	Low	Low	Poor	Not applicable	Rich/wet	organic	No	Mixed shrub	Not applicable	NA
44	2.5	Low	Low	Low	Low	Poor	Not applicable	Average/moist	mineral	Yes	Field	Not applicable	NA
45	1.2	Moderate	Low	Low	Moderate	Fair	Healthy	Rich/moist	mineral	Yes	Balsam poplar - Aspen	10-60	NA
46	0.2	Moderate	Low	High	Low	Poor	Not ground checked	Rich/wet	organic	Yes	Tamarack	10-60	NA
47	1.4	Moderate	Low	Low	High	Good	Not ground checked	Average/moist	mineral	Yes	White spruce - Balsam poplar	61-100	NA
48	0.1	Moderate	Low	Low	Low	Poor	Not applicable	Rich/wet	organic	No	Mixed shrub	Not applicable	Sandy esker

Table B-2 (continued). Atim Creek Forest detailed forest label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
1	m-15-23-Pb10-1943-G	m-45-19-Pb10-1948-G	Yes	Plot	A3Pb	77	48	125		318	0	515	515	field plot	8.4
2	m-30-21-Sw8Pb2-1940-G	m-25-11-Sw6Pb4-1970-G	Yes	Casual	B3SwPb	144	73	217			77	39	116	Phase III volume tables	1.8
3	w-2-Sc8-G		Yes	Casual											
4	m-35-30-Sw9Pb1-1869-G	m-25-15-Pb5Sw5-1928-F	Yes	Plot	B4Sw	183	30	213	356	316	398	353	751	field plot	5.6
5	w-15-14-Lt8Sb2-1960-G	w-50-10-Sb6Bw4-1960-G		Casual	A2LtSb	36	13	49			54	19	73	Phase III volume tables	1.7
6	m-45-18-Pb7Aw2Sw1-1960-G	m-15-12-Sw6Pb4-1960-G		Casual	B2PbAw	19	48	67			17	43	60	Phase III volume tables	1.4
7	m-10-13-Sw9Pb1-1960-G	m-HG-G	Yes	Plot	A2Sw	44	15	59	116	4	5	5	11	field plot	0.2
8	m-60-18-Pb9Sw1-1960-G		Yes	Casual	C2Pb	23	101	124			35	155	190	Phase III volume tables	4.3
9	m-20-17-Bw6Sw4-1940-G	m-HG-G	Yes	Casual	A2BwSw	16	34	50			12	25	37	Phase III volume tables	0.6
10	m-55-12-Sb6Lt3Bw1-1960-G		Yes	Plot	C2SbLt	170	18	188	65	3	5	5	11	field plot	0.2
12	w-6-8-Bw8Pb1Sw1-1960-M	w-3-Sc8-M			A1BwPb	8	6	14			3	2	6	Phase III volume tables	0.1
13	m-35-19-Sw7Pb3-1923-G	m-30-12-Sw7Pb3-1930-G	Yes	Plot	B3SwPb	144	73	217	120	212	98	174	271	field plot	3.4
14	NWF														
15	M-HG10-G														
16	m-30-19-Sw9Pb1-1920-G	25-8-Sw6Sb2Bw2-1960-M			B3Sw	191	24	215			203	26	229	Phase III volume tables	2.7
17	m-15-18-Pb9Sw1-1960-G	m-HG-G			A2Pb	16	34	50			10	21	31	Phase III volume tables	0.7
19	m-10-18-Pb9Sw1-1960-G	m-25-14-Pb9Sw1-1960-G		Casual	A2Pb	16	34	50			6	12	18	Phase III volume tables	0.4
20	m-20-12-Sw8Lt1Pb1-1966-G	m-5-Sc7-G	Yes	Plot	A2Sw(Lt)	44	15	59			49	17	66	Phase III volume tables	1.7

Table B-2 (continued). Atim Creek Forest detailed forest label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
21	m-6-12-Sw8Pb2-1960-G	m-55-9-Sb8-1960-G	Yes	Casual	A1Sw(Pb)	15	1	16			14	1	15	Phase III volume tables	0.3
22	m-10-9-Pb8Aw2-1980-G	m-5-Sc7-G	Yes	Casual	A2PbAw	16	34	50			11	24	36	Phase III volume tables	1.5
24	m-40-20-Pb7Sw2Aw1-1910-G	m-10-12-Sw6Pb4-1960-G	Yes	Casual	B3Pb(Sw)	47	129	176			19	52	71	Phase III volume tables	0.8
25	m-6-12-Sw8Pb2-1960-G	m-HG-G		Casual	A1Sw(Pb)	15	1	16			30	2	32	Phase III volume tables	0.7
26	m-40-18-Pb9Sw1-1960-G	m-10-10-Sw9Pb1-1960-G	Yes	Plot	B2Pb	19	48	67	42	207	216	1064	1280	field plot	29.1
27	m-10-19-Sw7Pb3-1920-G	25-9-Sw7Pb2Bw1-1960-G			A3SwPb	104	51	155			176	86	262	Phase III volume tables	3.1
28	m-30-19-Sw10-1920-G	m-40-12-Sw10-1960-G			A2Sw	44	15	59			31	11	42	Phase III volume tables	0.5
31	m-60-18-Pb9Sw1-1960-G	10-10-Sw9Pb1-1960-G		Casual	C2Pb	23	101	124			15	67	82	Phase III volume tables	1.9
32	m-HG-CL														
33	m-65-17-Aw10-1960-G			Casual	C2Aw	23	101	124			18	79	97	Phase III volume tables	2.2
34	m-70-16-Aw10-1960-G				C2Aw	23	101	124			36	158	195	Phase III volume tables	4.4
35	m-35-23-Pb8Aw2-1915-G	15-10-Sw6Pb2Bw2-1969-G	Yes	Plot	B3PbAw	47	129	176	12	239	20	393	413	field plot	4.6
36	m-20-16-Lt6Sw4-1973-G	m-55-11-Pb4Wb3Sb3-1980-G	Yes	Plot	C2LtSw	152	18	170	25	30	99	118	216	field plot	7.0
38	m-55-23-Aw10-1910-G	m-10-12-Sw10-1960-G		Casual	C3Aw	69	180	249			66	172	238	Phase III volume tables	2.5
39	m-40-15-Aw8Pb2-1960-G	m-20-10-Sw6Aw3Pb1-1969-G	Yes	Plot	B2AwPb	19	48	67	19	106	211	211	422	field plot	9.6
40	m-65-15-Aw10-1963-G		Yes	Plot	C2Aw	23	101	124		137	0	151	151	field plot	3.7
42	m-80-15-Aw10-1960-G				D2Aw	2	105	107			2	111	113	Phase III volume tables	2.6

Table B-2 (continued). Atim Creek Forest detailed forest label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
43	w-2-Sc6-G	WHG-G													
44	CP														
45	m-25-18-Pb6Aw4-1960-G	20-12-Sw8Pb2-1960-G		Casual	A2PbAw	16	34	50			19	40	59	Phase III volume tables	1.3
46	m-15-14-Lt8Sb2-1960-G	m-50-10-Sb6Wb4-1960-G			A2Lt(Sb)	36	13	49			8	3	11	Phase III volume tables	0.2
47	m-40-23-Pb4Sw3Aw3-1910-G	m-20-10-Sw7Bw2Pb1-1960-G			B3PbSwAw	96	89	185			135	125	260	Phase III volume tables	2.8
48	w-2-Sc6-G	WHG-G													

***Volume in cubic metres**

Table B-3. GroveCo 60 map unit theme summary,

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
1	0.5	Moderate	Low	Low	High	Good	Healthy	Rich/moist	mineral	No	Balsam poplar	61-100	
2	3.1	Moderate	Low	Low	High	Good	Healthy	Rich/very moist	mineral	No	Balsam poplar	61-100	
3	1.5	High	Moderate	Low	Moderate	Good	Healthy	Rich/moist	mineral	No	White spruce	>100	Very tall white spruce
4	0.4	Moderate	Low	Low	Moderate	Good	Healthy	Rich/very moist	mineral	No	White spruce	>100	Very tall white spruce
5	0.4	High	Moderate	Low	Moderate	Good	Healthy	Rich/very moist	mineral	No	White spruce	>100	Very tall white spruce
6	0.5	Moderate	Low	Low	High	Good	Healthy	Rich/very moist	mineral	No	Balsam poplar	61-100	

Table B-3(continued). GroveCo 60 detailed forest label and volume* calculation information *

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
1	m-30-23-Pb9Aw1-1940-G	m-30-12-Aw7Pb3-1970-G	Yes	Casual	B3Pb	47	129	176			23	64	88	Phase III volume tables	1.4
2	m-65-24-Pb10-1939-G		Yes	Plot	C4Pb	67	133	200		222	0	677	677	field plots	10.4
3	m-50-29-Sw9Pb1-1896-G	m-15-19-Sw9Pb1-1940-G	Yes	Plot	C3Sw	255	48	303	376		562	0	562	field plots	5.2
4	m-6-28-Sw10-1890-G	m-55-19-Pb9Sw10-G	Yes	Casual	C3PbSw	140	137	277			61	59	120	Phase III volume tables	1.1
5	m-40-28-Sw8Pb2-1901-G	m-15-18-Sw9Pb1-1940-G	Yes	Plot	B4Sw(Pb)	183	30	213	515		227	0	227	field plots	2.2
6	m-55-19-Pb10-1940-G	m-40-10-Aw7Pb3-1940-G	Yes	Casual	C3Pb	69	180	249			32	85	117	Phase III volume tables	1.8

*** volume in cubic metres**

Table B-4. Cooke Lands Forest Reserve map unit theme summary

Map unit number	Area (ha)	Spring and fall fire hazard	Summer fire hazard	Blowdown hazard	Decay and breakage hazard	Wildlife snag habitat potential	Tree health	Moisture and nutrient	Soil type	Calcium and free carbonates	General forest cover	Stand age class (years)	Special features
1	1.1	Moderate	Moderate	Low	Healthy	Moderate	Fair	Rich/very moist	mineral	No	White spruce - Balsam poplar	61-100	
2	2.4	Moderate	Moderate	Low	Healthy	Moderate	Fair	Average/moist	mineral	No	Aspen - White spruce	61-100	
3	0.5	Moderate	Low	Low	Healthy	Moderate	Fair	Average/moist	mineral	No	Aspen - White spruce	61-100	
4	0.9	Moderate	Low	Low	Healthy	High	Good	Rich/very moist	mineral	No	Aspen - Balsam poplar	61-100	
5	0.8	Moderate	Low	Low	Healthy	Moderate	Fair	Rich/very moist	mineral	No	Aspen - Balsam poplar	10-60	

Table B-4(continued). Cooke Lands Forest Reserve detailed forest label and volume* calculation information

Map unit number	AVI overstory label	AVI understory label	Visited 2004	Observation type	Equivalent Phase III label for volume table use	Volume/ha (coniferous) based on Phase III tables	Volume/ha (deciduous) based on Phase III tables	Total map unit volume based on Phase III tables	Volume/ha (coniferous) based on field plot data	Volume/ha (deciduous) based on field plot data	Total map unit volume (coniferous)	Total map unit volume (deciduous)	Total map unit volume	Source of volume data	Mean annual increment (m3) for map unit
1	m-40-23-Sw7Pb3-1918-G	m-15-12-Sw10-1961-G	Yes	Plot	B3SwPb	144	73	217	191	45	205	48	253	field plots	2.9
2	m-45-16-Aw8Sw2-1937-M	m-25-12-Aw8Sw2-1965-M	Yes	Plot	B2AwSw	22	37	59		97	0	231	231	field plots	3.5
3	m-35-22-Aw5Sw3Pb2-1910-G	m-20-12-Aw8Sw1Pb1-1960-G	Yes	Casual	B3AwSwPb	96	89	185			51	47	97	Phase III volume tables	1.0
4	m-55-18-Aw7Pb3-1930-M	m-20-12-Aw9Bw-1960-M	Yes	Casual	C2AwPb	23	100	123			22	94	115	Phase III volume tables	1.6
5	m-25-22-Pb4Aw3Sw3-1944-G	m-20-16-Sw6Bw2Aw2-1950-G	Yes	Observation	B3PbAwSw	47	129	176	84	70	64	53	116	field plots	1.9

*** volume in cubic metres**