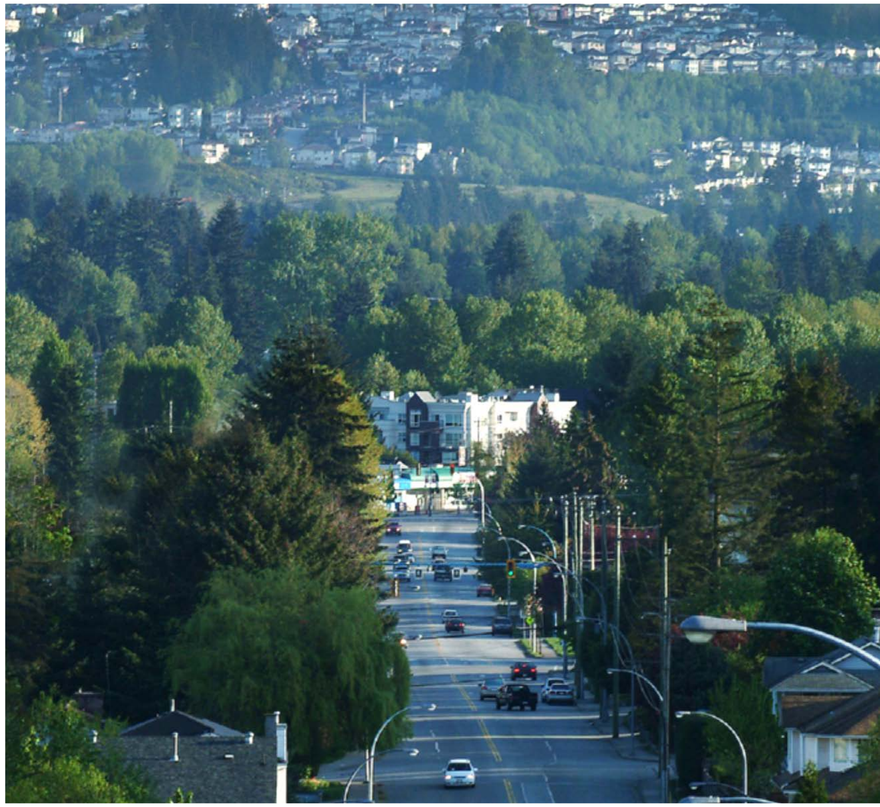
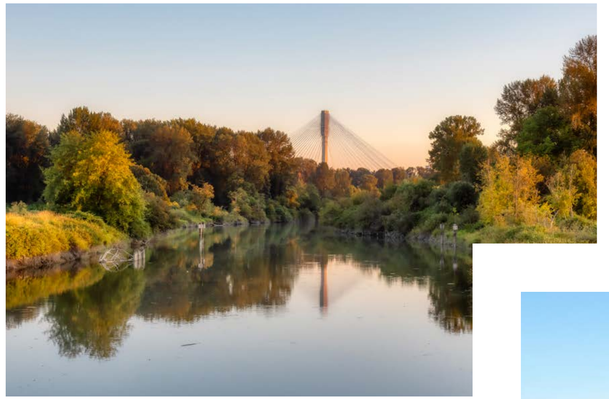
2021-2050

CITY OF PORT COQUITLAM

URBAN FOREST ROADMAP





This draft strategy benefited from significant teamwork and cooperation from the staff of Port Coquitlam's urban forestry team as well as input from the community and stakeholders.

DAVEY Resource Group

CITY OF PORT COQUITLAM

Prepared by Davey Resource Group (DRG) consulting team.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Port Coquitlam is centrally located within the Greater Vancouver region and is Canada's 88th-largest City by population. A diverse economy with expanding job opportunities coupled with its proximity to the densely populated Vancouver has brought continual growth in population. Today, Port Coquitlam is becoming more residential, home to 61,000 residents in just over 29 square kilometers. Port Coquitlam is mainly a commuter city as it is in close proximity to Vancouver, making its roads and highways an important resource to the community. While population growth increases diversity, creates new opportunities and provides a richer local culture, it also increases the demand for housing and the burden on City infrastructure, includes the urban forest.

To balance the sustainability of the urban forest with climate change and urban growth, a comprehensive plan is needed to maintain and enhance all the benefits it provides. Port Coquitlam's urban forest is simply defined as all of the trees, whether on public or private land, growing within City boundaries. Urban forests function as part of a City's green infrastructure that offer a broad range of benefits and services including storing greenhouse gas, intercepting stormwater runoff, improving air quality, and reducing energy consumption.

This is the City's first Urban Forest Roadmap (Roadmap). The plan sets out the steps required to achieve the goals for the urban forest for the next 30 years. The Roadmap includes actions in line with the City's urban forest vision of sustainability, as defined by the City staff, Council, and urban forestry stakeholders who helped shape this plan. This Roadmap:

- Provides a detailed overview of the current health and status of Port Coquitlam's urban forest and the ecosystem benefits it provides.
- Synthesizes the goals, visions, and responsibilities to form a clear directive for urban forest management.
- Introduces a management framework to evaluate the current standing and future progress on performance indicators and canopy targets.

1.BACKGROUND

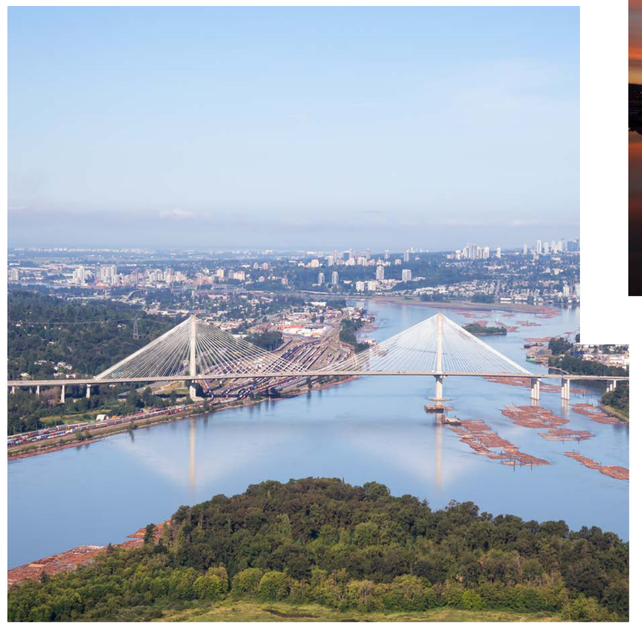
1.1 HISTORY

Port Coquitlam is centrally located within the Metro Vancouver Regional District, bordered by the Fraser River to the south and the Pitt River to the east. Its name refers to the Coast Salish language name for the local First Nation of 'kʷikʷəƛəm' meaning "red fish up the river". The initial establishment of the City by settlers was as a new freight terminus for CP Rail which led to a community forming around the station in 1911. Two years later, in 1913, Port Coquitlam was first incorporated as a municipality. While the City mostly developed for use as farmland, the latter half of the 1900s saw significant industrial and commercial development. The diverse economy and job opportunities coupled with its proximity to the densely populated Vancouver has brought continued growth in population. The City is increasing in residential density and today is home to 61,000 residents across just over 29 square kilometers.

Port Coquitlam is located within the Coastal Western Hemlock biogeoclimatic zone. The City has an oceanic climate with average summer temperature highs of 25°C that drops to -1°C lows on average in the winter months. Although the City typically receives about 1500 mm of precipitation during the year, precipitation peaks in the winter months and the summer months are often dry [1].

1.2 DEFINITION OF URBAN FOREST

Urban forests include all of the publicly owned and privately owned trees within an urban area. This includes individual trees and groups of trees located in natural areas, parks, backyards, on streets, and in commercial and industrial zones. Other elements such as plants, water, soil, micro-organisms, and wildlife are also part of this ecosystem.



1.3 PURPOSE OF THE ROADMAP

Trees play a vital role in the City of Port Coquitlam and provide numerous benefits to residents and visitors. By improving air quality, reducing energy consumption, managing stormwater, reducing erosion, providing habitat for wildlife, and promoting a connection with nature, the urban forest contributes to a healthier, more livable, and flourishing City.

The purpose of the Urban Forest Roadmap (Roadmap) is to create a tailored plan to assess the current standing of the urban forest, and to provide the management framework to maintain a healthy and desirable urban forest through coordinated, proactive, and sustainable practices.

1.4 VALUES STATEMENT

Port Coquitlam's urban forest is a shared, public resource that enhances the lives of residents and visitors by promoting healthy communities, creating biodiverse habitat, and providing environmental benefits. Urban forests also offer cultural and aesthetic value by creating beautiful, livable neighborhoods that provide opportunities for refuge, education, and recreation within the City. Urban trees are carefully selected, planted, protected, and maintained to enhance habitat, clean the air, capture carbon, manage stormwater, and maximize benefits to our City's environmental health and quality of life. The aim of the City's management objective is to make urban forestry inclusive of every resident by looking at planning initiatives through an equity lens.

The City is using measurable objectives to efficiently track forest growth and coordinate between public and private stakeholders to cooperatively work towards a greener future. The vision of urban forestry development for Port Coquitlam is its expansion and maintenance through increasing planting, adapting to climate change, and expanding green canopy cover as well as education on the benefits of having an expansive, resilient urban forest for future generations.

1.5 BENEFITS OF THE URBAN FOREST

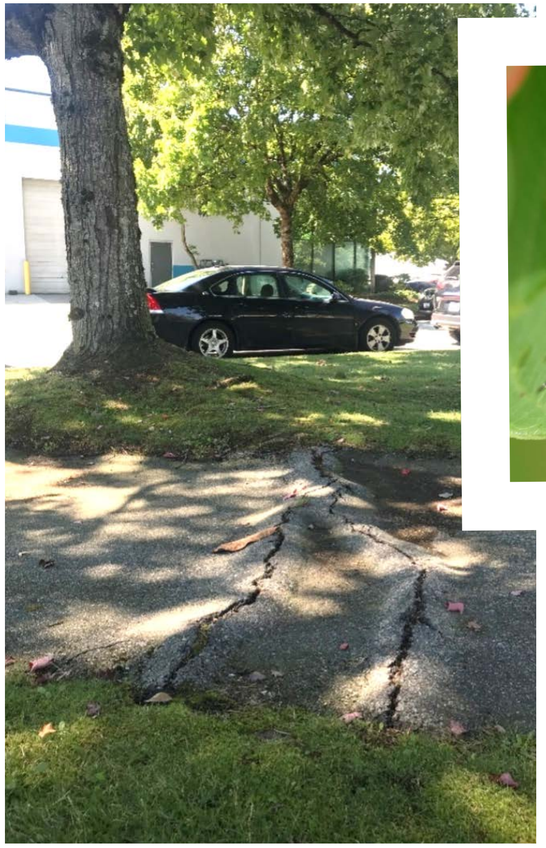
Urban forests continuously mitigate the adverse effects of urbanization and function to enhance the quality of life within the community. Trees not only improve air quality and provide cooling shade, but they also slow down stormwater runoff and remove pollutants, reducing sewer management and energy costs for municipalities. Unlike most other City infrastructure, trees appreciate in value over time through an accumulation of their ecological services, carbon storage, and energy savings. An urban forest with a healthy population of vigorous and mature growing trees maximizes the benefits available. However, it takes years for the benefits of trees to exceed the costs of planting and maintenance. For municipalities to extract the full potential of their trees, management strategies should consider species selection, suitable conditions, and regular maintenance to increase trees survival rates and lifespan.

1.6 THREATS TO THE URBAN FOREST

An urban forest is a dynamic and interactive ecosystem of working parts that include humans, trees, animals, insects, pests, and microorganisms. The urban ecosystem is at risk to the environmental impacts from a warming climate, as well as the new emergence of invasive pests that have no natural predators in an area. To stay healthy and vigorous, trees require routine maintenance in the form of regular inspections, watering, pruning, and/or fertilizing. Trees also require a certain level of soil quality and growing space. However, urban trees are often stressed by environmental factors such as soil compaction, lack of growing space, pollution, and mechanical injuries. Restricted growing spaces within boulevards and urban landscapes only amplify these adverse effects, presenting a greater need for intervention by City staff.

Port Coquitlam, being predominantly a commuter town for residents working in the greater Vancouver area, has been continuously expanding due to the demand of a competitive housing market. According to Statistics Canada, the City's population grew by 4.7% between 2011-2016 on par with the national 5.0% growth rate during that period [2]. With these demographic changes, pressure will be put on open spaces creating competition with the urban forest. Development and widening of roads and sidewalks will limit the availability of spaces where the City can plant trees which can grow to mature size. Management on this scale requires significant investment into this valuable resource; prompt action provides more time for the benefits of the urban forest to accumulate.

With a changing climate, Natural hazards like extreme rain, river flooding, wildfires, smoke events, extended summer heat waves and drought can disrupt the natural working order of urban ecosystems. Regional climate models have indicated that by 2050, the annual number of days with an average temperature over 22°C will double [3]. Stressors like heat and drought make plant and tree species more susceptible to disease and pests which capitalize on weakened defense systems of stressed trees. This is especially problematic in temperate oceanic climates such as that of Port Coquitlam, where extreme temperatures are historically less common. This warming climate can completely shift a forest species distribution making urban forest planning more difficult and time sensitive. Port Coquitlam City staff have observed an increase in tree mortality in recent years, likely because of heat and drought stress. In particular, Western Hemlock and Western Red Cedar have been noted as in-decline by City staff throughout the urban forest in Port Coquitlam. These recorded heat waves can be exacerbated in urban settings where a larger surface area of paved landscape acts to trap heat, holding the temperature into the evenings causing further stress to existing trees. This is known as the Urban Heat Island effect. These stressors reduce vigor and make trees more susceptible to pest infestation and diseases. As more exotic pests are imported into the country through global transportation, a strong monitoring system will be necessary to detect their presence and help prevent their establishment. Forest stressors will play a large role in urban forest management in the coming future due to forest pests and changing climate conditions.



1.7 PUBLIC OPINION ON THE URBAN FOREST

Strong public support is essential in developing a strong management strategy. Historically, residents in BC were in favor of reforestation efforts and tree planting as shown in a 1989 poll that found 82% of residents believed too few trees were being planted [4]. This is comparable across the country as another study found that residents of Fredericton, Halifax, and Winnipeg associate positive psychological, social, and ecological values with urban trees [5]. A recent community survey in Port Coquitlam (Let's Talk Trees) found that 88% of respondents were supportive of establishing a canopy cover target. Respondents were also generally in favor of increasing tree protection efforts and canopy cover across Port Coquitlam. Further studies conducted in the United States showed that public attitudes toward urban trees in general are positive. More than 90% of citizens surveyed appreciated urban trees. An even larger demographic was in support of urban trees believing that they offer shade, aesthetics, and increase property value on the condition that they be planted in their neighborhoods [6].

It is expected that as the climate crisis worsens, public support for urban forest growth will also increase. The United Nations has recognized that planting trees can help reduce CO2 in the atmosphere as well as improve local ecosystems with multiple benefits. Tree planting is only a single aspect of mitigating the impacts of climate change but is becoming increasingly more popular as it is a tangible effort that can be completed with public engagement and visible results. In general, there is a trend showing younger generations are becoming more environmentally conscious and will promote and support stronger tree protection programs and tree planting efforts.

The proportion of people living in urban areas continues to grow and cities consume vast amounts of energy and natural resources. Presently, 81.5% of Canadians live in cities [7]. As almost all cities across the country grow in population, the demand for space will increase, limiting resources available for trees and the urban forest. Urban forest protection appears to be supported by most research articles and surveys addressing the public opinion of tree protection and tree planting. It is anticipated that socio-demographic dynamics and changing values and perceptions of urban forests will be positive and support strong urban tree bylaws and dedicated forest management plans.

2.STATE OF THE URBAN FOREST

2.1 STREET AND PARK TREE INVENTORY

2.1.1 Inventory Background and Methodology

Creating and maintaining an up-to-date inventory of municipally owned trees is an important part of managing an urban forest. Unlike trees in natural forests, which are typically managed on a broader scale to assess attributes such as species composition, tree density, wildlife habitats and other ecological features, urban forests are primarily assessed and maintained on a tree-by-tree basis. A complete inventory of municipally owned and maintained trees provides a database consisting of descriptive information (e.g., tree location, diameter, health condition, etc.) for each individual tree as well as time sensitive information such as inspection dates, work history, and recent observations.

A tree inventory functions as a maintenance tool for municipalities to schedule pruning, watering, fertilization, and removal operations and allows City staff to monitor trees that have been assessed as potentially hazardous. A more comprehensive inventory enables municipalities to map and track canopy cover change, tree planting and mortality, and neighbourhood-specific metrics. For instance, neighbourhoods may vary in land use and tree age; a newly developed area with young trees shows promise for improving canopy cover as well as local air quality. Aging neighbourhoods with high tree mortality and commercial areas with a low density of trees may help prioritize future tree planting. A complete and comprehensive inventory provides a single database to organize and simplify maintenance and management of trees that require maintenance and monitoring for hazards. They provide the ability to map the spread of new pests and forecast patterns of decline with frequent updates, as well as to plan for maintenance schedules and removals. Furthermore, inventories are also helpful for facilitating communication with property owners and can serve as a community outreach and collaboration tool. Ultimately, tree inventories arm urban forest professionals with the knowledge to implement strategies, monitor metrics, and adjust policy to best serve their management goals. Future studies and inventories can assess and include natural areas into this plan, incorporating more managed green space.

Port Coquitlam has maintained a partial inventory of City-owned trees dating back to 1985. The extent of this original inventory is limited to tree plantings conducted by the City. It encompasses 2,500 park trees and 2,430 street trees, representing approximately 90% of landscaped park spaces based on aerial imagery assessments, and 25% of streets based on estimates of inventoried streets vs non-inventoried streets. Furthermore, this inventory's metrics has been limited to only the address, date of planting, maintenance records, and species of each tree. Key urban forest data metrics such as size, condition, pest/disease presence, risk assessment, or utility conflicts have so far not been included in the City's existing inventory data.

To provide more insight into the condition of the urban forest and create a stronger management tool, a more

thorough tree inventory was collected by Davey Resource Group in September 2021. This new inventory consists of 5,000 street and park trees growing within maintained areas. The metrics collected for each tree by DRG include species, diameter, condition, maintenance recommendation, address, and GIS location. This new inventory dataset now represents approximately 75% of the total street and park trees not already captured and encompasses almost all of the City-planted street trees. Approximately half of the remaining trees not yet surveyed are located in public parks and the other half are primarily resident-planted trees in City rights-of-way where sidewalks and other City boulevard assets are not present. Naturally grown trees in unmaintained lots and Parks were not included in either inventory dataset as such trees are best assessed and managed from a high-level perspective. Other trees that make up the urban forest include those planted or growing on private properties, which cannot be actively managed by City staff. However, insights from street and park tree inventory data can be applied through public outreach programs and policy initiatives to address common issues with private trees to obtain results across the urban forest.

2.1.1 Inventory Background and Methodology

Tree Condition

All inventoried street and park trees were ranked on their overall condition which was based off of a visual assessment of each tree's health and structure based on standard classifications of "Good", "Fair", "Poor", and "Dead" as set forth by the International Society of Arboriculture (ISA). Tree condition is a qualitative indication of how well trees are performing in their local growing environment given their susceptibility to pests, the expected maintenance needs and costs, risk level, and the projected trend in urban tree canopy cover. The majority (85%) of Port Coquitlam's municipally owned street and park trees included in our inventory were found to be in good condition, 13% in fair condition, and 2% in poor condition, dying, or dead.

The size class representing the smallest trees, measuring between 2 and 12 cm in diameter, has the lowest number of trees in good condition (77%) compared to the other size classes across which 86-87% of trees were found in good condition. This difference is most likely due to the higher mortality rate of newly planted and young trees. As trees establish themselves, they are susceptible to numerous environmental and biological stressors that can lead to decline. In Port Coquitlam, the decline of the smallest size class may be caused by the stress of the recent droughts and heat waves the City has experienced over the last few years.

These environmental factors do not have as large of an impact on mature trees that are well established and are able to utilize stores of energy and water to withstand climate events. Younger trees are more susceptible to mortality which can lead to climate change shifting the regeneration of native species/forest populations.

Above: Three Paperbark Maples in good, fair, and poor condition from left to right.

Species Diversity

The abundance and variety of species within an urban forests' tree population is an important parameter for its sustainability and ability to withstand threats from pests, diseases, and climate change. If certain tree species or family is overrepresented in an urban forest, this creates a greater opportunity for large-scale tree loss from single pest/disease outbreaks. The best practice guideline used to assess species diversity of urban tree populations is referred to as the "10-20-30 rule". This rule suggests that no species should represent more than 10% of all trees, no genus more than 20% and no family more than 30% [8].

Generally, Port Coquitlam has a diverse urban tree population with a total of 117 unique species identified. Only one species, Red Maple (Acer rubrum), surpasses the recommended species threshold at 13.4%. The two other species approaching the maximum are Norway Maple (Acer platanoides) at 8.6% and Douglas Fir (Pseudotsuga menziesii) at 8.4%. Only one genus, Maple (Acer), surpasses the recommended genus threshold at 29.6%. Only one family, Sapindaceae, which contains Maples and Horsechestnuts (Aesculus) reaches the maximum recommended family threshold at 30.1%.

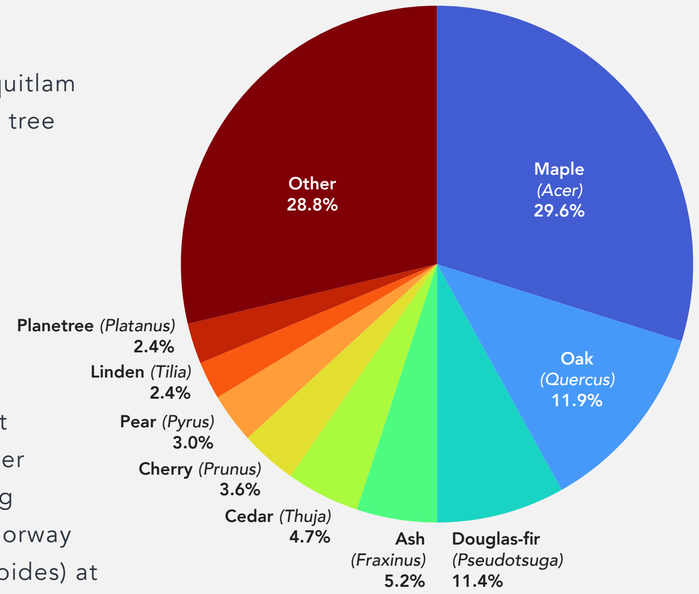
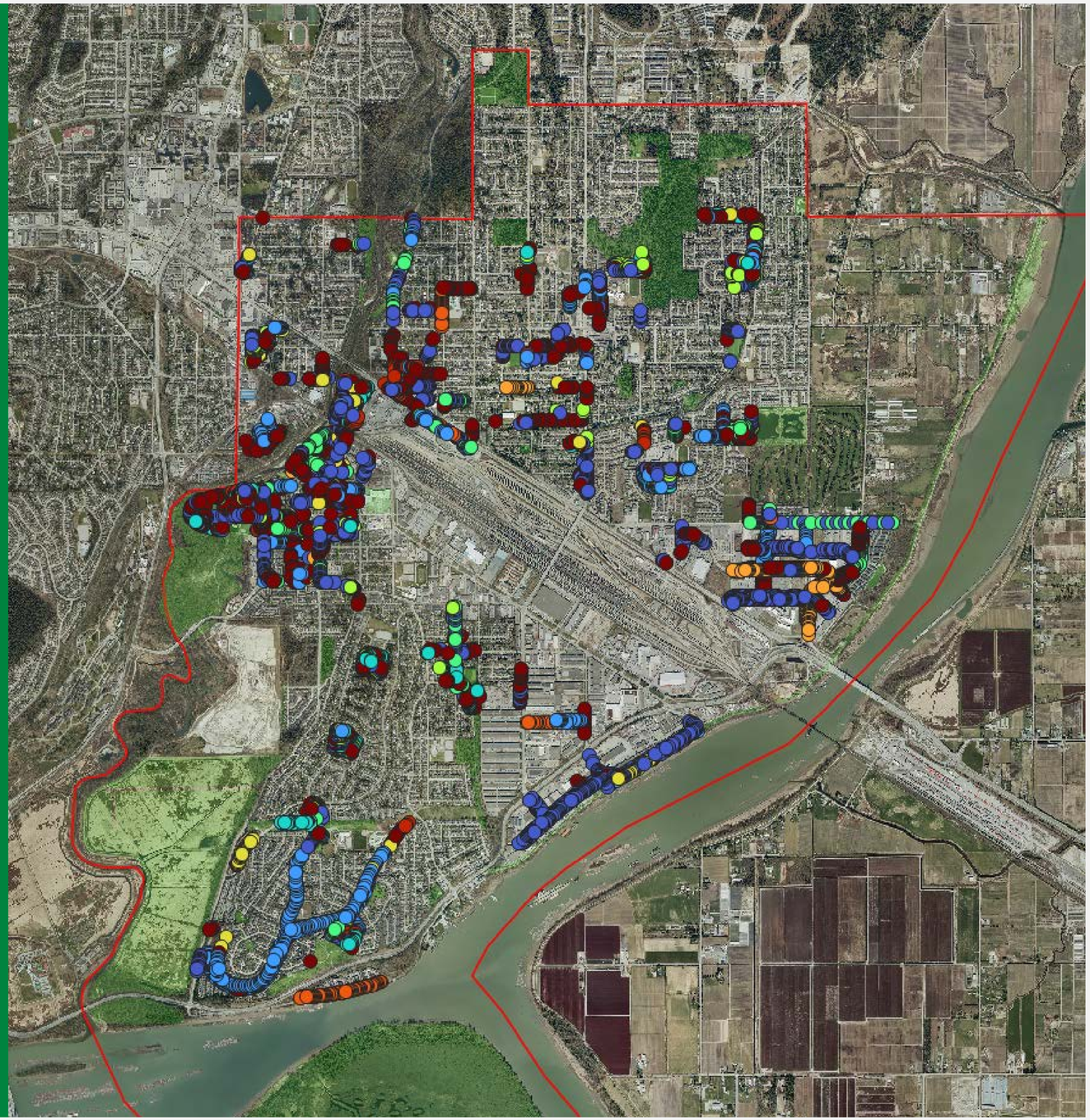


Figure 2.1.2a Breakdown of the 10 most common genera of trees collected in DRG's inventory during September

In order to maintain a healthy and diverse forest canopy, under-planted species that performed well in urban settings such as Bur Oak, Tulip tree, Pines, and Grand Fir could be emphasized in future planting opportunities. Although the foliage of many conifers restricts sightlines making them unsuitable as street trees, they can be incorporated into park and private tree plantings. These species are native to North America, the latter belonging to western forest ecosystems. They are considered adaptable to climate change, non-invasive, and grow well in the local climate of urban Port Coquitlam.

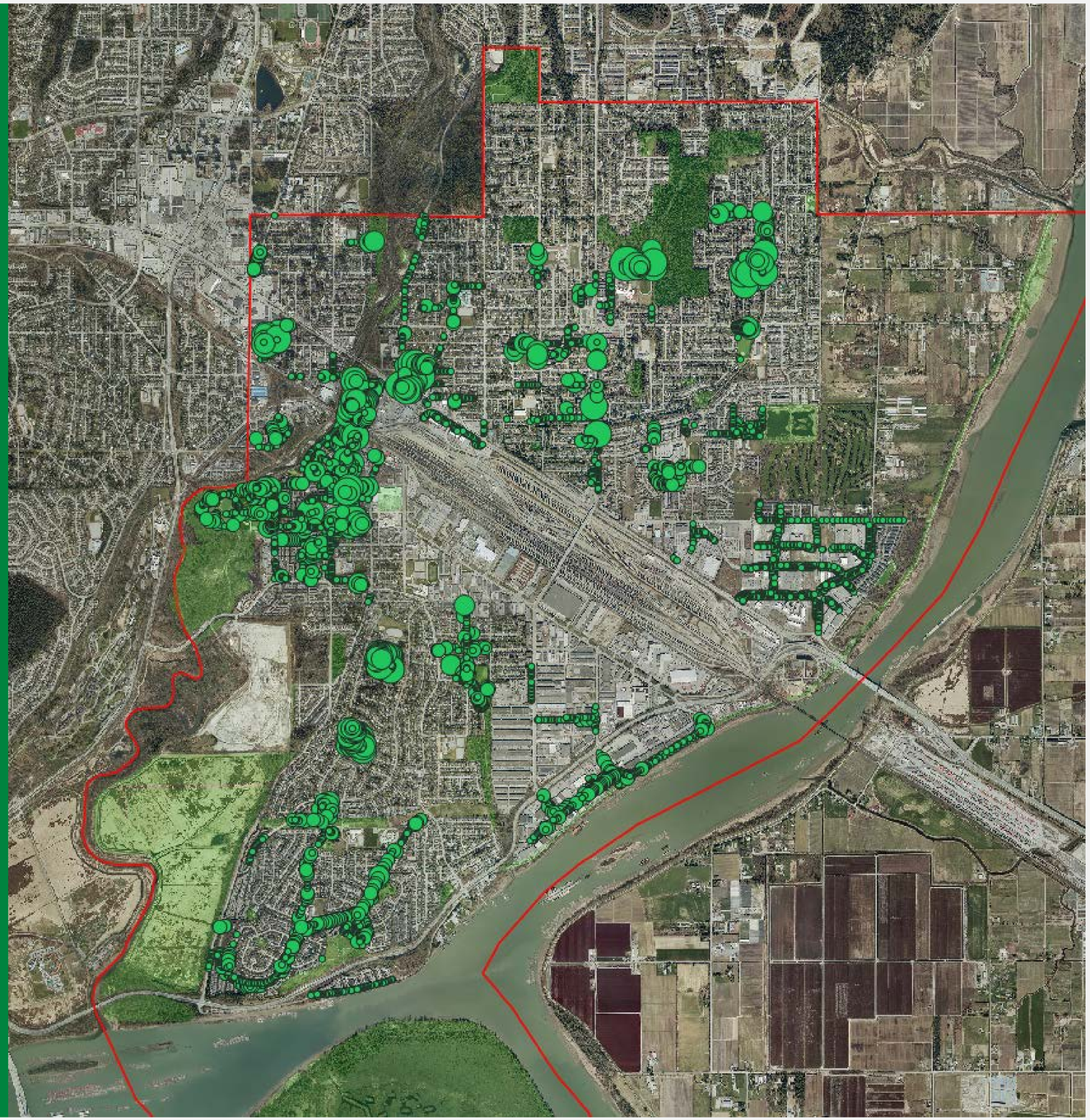


Top 10 Tree Types (by genus)

- **Maple** *(Acer)*
- **Oak** *(Quercus)*
- **Douglas-fir** *(Pseudotsuga)*
- **Ash** *(Fraxinus)*
- **Cedar** *(Thuja)*
- **Cherry** *(Prunus)*
- **Pear** *(Pyrus)*
- **Linden** *(Tilia)*
- **Planetree** *(Platanus)*
- **Other**

Figure 2.1.2b: Mapped locations of street and park trees collected in DRG's inventory during September 2021. The top 10 most common genera are featured.

Note the presence of monocultures (numerous trees of a similar species or genus) in many neighbourhoods. This may lead to local insecurities in canopy cover should these trees be impacted by a pest or disease.



Size Distribution

Having an urban forest with a range of trees at different sizes and ages ensures the benefits of trees are kept consistent over time. An ideal size class distribution, often utilized as a target by other municipalities such as Toronto, Ottawa, and Fredericton, follows a “reverse J” distribution [9]. This distribution has the smallest diameter trees (under 20 cm) as the largest proportion (40% of the population) and the largest diameter trees (greater than 60 cm) as the smallest proportion (10% of the population). While large, healthy trees provide the most urban forest benefits and best return on planting investment, a larger pool of small trees is required to eventually replace these mature trees. Additionally, the highest rates of mortality are often seen in the first few years of planting young and recently planted trees[10][11].

Within Port Coquitlam, 39% of inventoried trees are under 20 cm in diameter and 13% are over 60 cm in diameter. Overall, the population skews slightly mature but falls closely in line with the ideal size class distribution. The large number of mature trees is likely due to the extent of parks inventoried and the large size and species of trees they are capable of supporting. For Port Coquitlam to increase its canopy cover, this requires both maintaining their existing trees to meet their lifespan potential as well as increasing the number of new plantings each year.

Tree Diameter (cm)

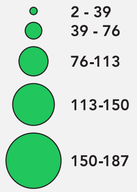


Figure 2.1.2b Size distribution of trees in DRG’s inventory taken in summer of 2021. Units are in centimeters of diameter at breast height (DBH) measured 1.4 m above ground.

Table 2.1.2 Summary of Port Coquitlam 2021 Tree Inventory surveyed by Davey Resource Group

TOTAL NUMBER OF TREES INVENTORIED	5,000 (2918 STREET TREES, 1997 PARK TREES, 85 STUMPS [TREES CUT AT GROUND LEVEL])
ESTIMATED TOTAL NUMBER OF STREET AND PARK TREES	7,000
ESTIMATED TOTAL NUMBER OF STREET AND PARK TREES REMAINING TO BE INVENTORIED	2000
TOP THREE SPECIES BY % OF OVERALL POPULATION	RED MAPLE (13%), NORWAY MAPLE (9%), DOUGLAS FIR (8%)
TOP THREE STREET TREE SPECIES BY % OF POPULATION	RED MAPLE (17%), NORWAY MAPLE (12%), PIN OAK (9%)
TOP THREE PARK TREE SPECIES BY % OF POPULATION	DOUGLAS FIR (19%), RED CEDAR (9%), RED MAPLE (9%)
PERCENTAGE OF TREES IN GOOD CONDITION	84.8%
PERCENTAGE OF TREES RECOMMENDED FOR MAINTENANCE PRUNING	11.6%

2.2 CANOPY COVER ANALYSIS

Canopy cover is the physical layer formed by the branches and crown of plants or trees that shade the ground beneath them and offer numerous ecological benefits. As canopy cover increases, so do the benefits that the urban forest provides. Because of this, many cities set canopy cover targets as a key goal within their Urban Forest Management Plans. Port Coquitlam's most recent canopy assessment utilized aerial imagery to obtain an estimate or the total canopy cover through the use of aerial imagery.

Table 2.2 Port Coquitlam's canopy coverage and proposed target compared to nearby municipalities

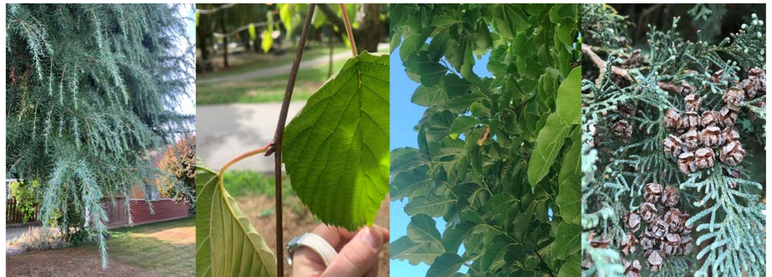
MUNICIPALITY	CANOPY COVER (%)	YEAR ASSESSED	TARGET CANOPY COVER
PORT COQUITLAM	23.0	2021	30% BY 2050 (PROPOSED)
NANAIMO	28	2010	32% BY 2020
NEW WESTMINSTER	18	2015	27% BY 2035
VANCOUVER	21	2018	22% BY 2050
VICTORIA	28	2019	NONE

2.2.1 Methodology

A study of the City's canopy cover was undertaken in 2017 using protocols based on the USA i-Tree methodology. Random plots of canopy coverage were sampled in the field across the entire City to determine an overall canopy percentage and later the same plots were assessed to observe changes in canopy coverage. The analysis found that between 2004 and 2016, the overall canopy cover declined slightly from 26.4% to 25.8%. A 2020 update to the report calculated the change in canopy cover level from 2004 to 2019 differentiated by zone but the overall coverage slightly increased to 26.4%. Apartment and commercial zoned areas saw the greatest losses in cover (10.3% and 4.0%, respectively), while parks saw the highest gain in canopy cover (3.6%) in these 15 years.

An additional assessment using remote sensing techniques to analyze the current health of the City's existing canopy and land use was also recently completed in 2021 by Davey Resource Group. This most recent estimate of canopy coverage was obtained through analysis of aerial imagery, wherein a computer program counted the total image area containing tree cover (pixels in colours determined to be trees and foliage) and compared it to the total urban area of Port Coquitlam. The figure obtained was 23.0% total canopy coverage. This differed from the previous study from 2019 which estimated a 26.4% canopy coverage. The study with the higher value used extrapolated data from ground-level canopy measurements at random sampling locations. The lower value was obtained using remote sensing data. Remote sensing allows for inaccessible areas such as private properties and buildings to be included in the total canopy coverage estimate while ground-level surveys may not accurately factor those areas into their estimates.

Utilizing leaf-on satellite and aerial imagery from 2019 and 2020, NDVI was established to assess canopy cover across an entire city. Our analysis identified the canopy cover of the overall City at 23.0%. This value was lower than the i-Tree study, which may be due to the weighting of the NDVI which accounts for vegetation density and foliage health that may not be captured in an i-Tree survey.



Normalized Difference Vegetation Index (NDVI) *is one of the most commonly used vegetation indices in remote sensing and can be used to easily assess canopy cover across an entire city. This technique uses satellite imagery to measure the reflective wavelengths of vegetation, or "greenness" to accurately estimate the condition of visible vegetation as well as to identify different types of land cover. The index can also account for vegetative density by measuring the amount of near-infrared light being returned in the imagery, which allows the final data values to be weighed based on the health and size of trees providing canopy cover.*

The imagery assessed using NDVI is limited to the leaves, branches, and stems of trees and other woody plants that cover the ground when viewed from above and does not account for understory vegetation or land cover beneath tree canopy. Since aerial imagery can only measure the top canopy layer, it does not provide a complete estimate of tree health as numerous below crown factors can affect tree health and structure.

2.2.2 Results of the Canopy Analysis

Canopy Health

The health and productivity of the urban forest depends on the interplay and connectivity between trees, plants, wildlife, and humans. A critical step in assessing the benefits of an urban forest is calculating the health of the trees in an urban setting. This Roadmap uses a combination of aerial imagery to assess overall forest conditions and cover and inventory data to provide a better understanding of tree health and maintenance requirements. Combining these two methods helps to overcome shortfalls and data gaps. An example in Port Coquitlam is the Brittle Cinder fungus *(Kretzschmaria deusta)* affecting Bigleaf Maple trees. The canopy of a tree infected with Brittle Cinder appears in good condition aboveground but can suffer critical, full tree failure due to root rot and destabilization. Port Coquitlam City staff have indicated that the presence of Brittle Cinder fungus has been observed on many Bigleaf Maple trees throughout the City's urban forest which has resulted in extensive hazardous tree removals. Additionally, forested areas within portions of the Hyde Creek Nature Reserve, and in Birchwood Park are growing in soil that is rapidly decomposing. The canopies in these areas may appear in good condition in aerial imagery, however due to soil decomposition many structural tree roots now exist above the surface of the soil, causing these trees to become unstable. The ability to observe tree diseases, trunk injuries, and numerous other factors in the field make tree inventories the most precise way to estimate tree health and maintenance needs.

The health analysis of Port Coquitlam's City-wide urban forest, based on imagery analysis, found that the majority of the canopy is in good or very good condition. This is comparable to the findings from the street and maintained park inventory. Both methods also found that only a small percentage of trees are in poor to dead condition.

Table 2.2.2a Port Coquitlam's current tree health data based on normalized difference vegetation index (NDVI) values from four band NAIP imagery data for the entire City including private and public land, as well as the inventory of street and park trees.

HEALTH RATING	HECTARES OF CANOPY COVER	PERCENTAGE OF CANOPY COVER	PERCENTAGE OF INVENTORIED TREES
1 - SHADOW/ NOT CLASSIFIED	5.50	0.85	0.00
2 - DEAD/DYING	5.61	0.87	0.49
3 - POOR	15.48	2.40	1.99
4 - FAIR	77.57	12.05	12.70
5 - GOOD	275.13	42.74	84.82
6 - VERY GOOD	264.39	41.08	
TOTAL	**643.67**	**100.00**	**100.00**

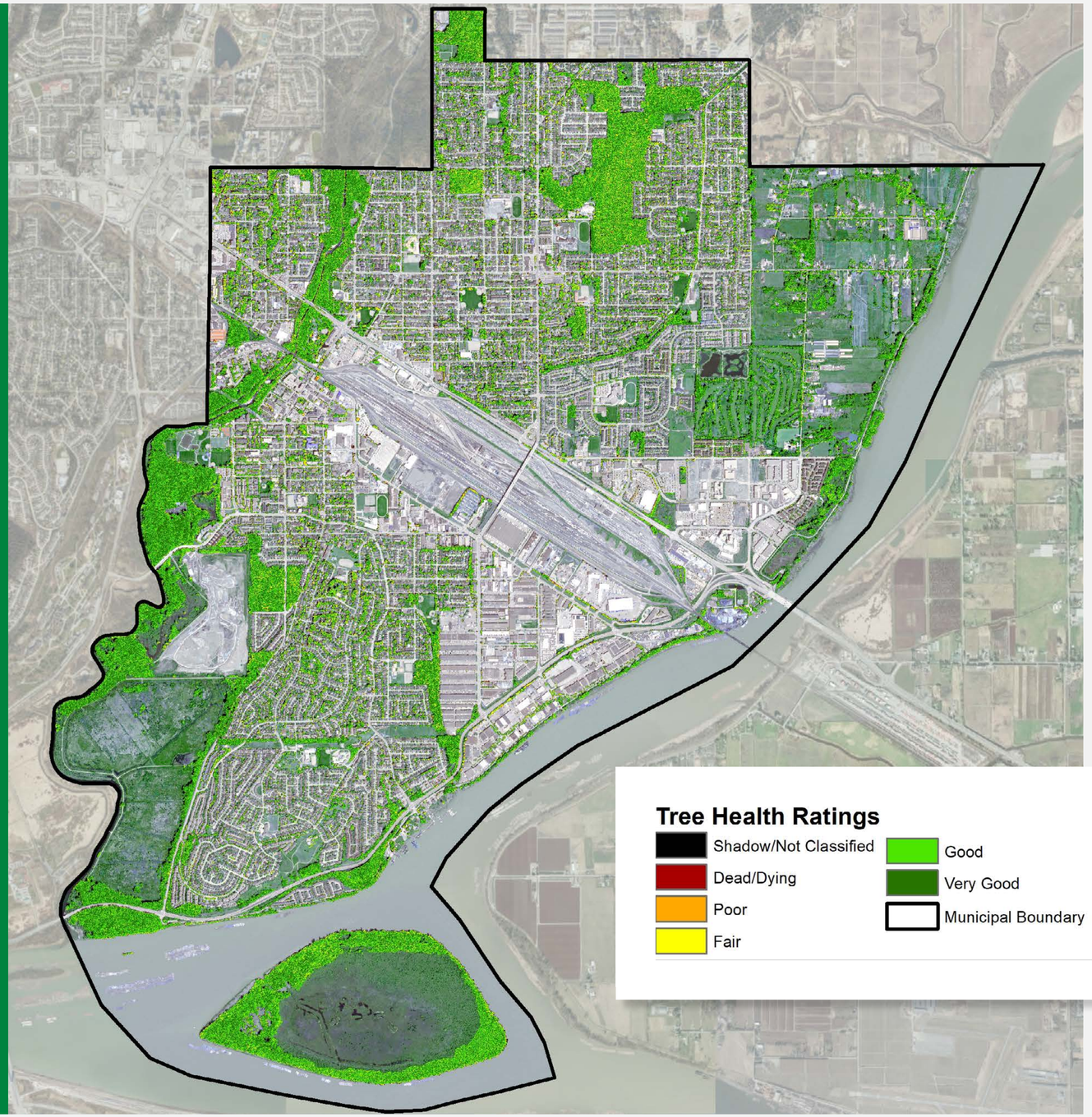


Figure 2.2.2a Estimated health of vegetation within the urban canopy in Port Coquitlam.

Port Coquitlam, BC
Fixed Tree Health Index

Ecosystem Benefit Analysis

Urban forests have quantifiable benefits based on the environmental functions that trees perform. Trees not only slow the flow of stormwater thereby reducing management costs for municipalities, but they also remove pollutants from the environment and sequester carbon in woody stems and roots. The value of these ecosystem functions is calculated in terms of both volume and cost savings. As urban forest cover increases, ecosystem benefits do as well. Specifically, the amount and distribution of leaf surface area is the source of the urban forest's ability to produce benefits for the community [12]. This can be increased and expanded by increasing suitable planting sites with adequate soil volume to accommodate tree growth.

Air Quality

Urban trees improve air quality in five fundamental ways:

- Absorption of gaseous pollutants such as ozone (O3), sulfur dioxide (SO2), and nitrogen dioxide (NO2)
- Reduction of emissions by reducing energy consumption
- Release of oxygen through photosynthesis
- Reduction of local air temperatures through transpiration and shading, thereby reducing ozone levels
- Interception of particulate matter such as dust, ash, and smoke

Air pollutants not only contribute to climate change; they also have direct impacts on human health particularly

by aggravating respiratory and cardiovascular diseases. i-Tree Canopy was used to calculate the urban forest's removal of air pollutants including carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), sulfur dioxide (SO2), and particulate matter less than 10 microns (PM10) (Table 2.2.2b).

Urban trees reduce atmospheric CO2 in two ways:

- Growth and the sequestration of CO2 in wood, leaves, and soil
- Reducing the demand for heating and cooling, thereby reducing the emissions associated with electric power generation and natural gas consumption

The total value of urban trees to Port Coquitlam is over $11.4 million in carbon storage. The City's current total tree canopy sequesters 1,860 tonnes of CO2 from the air, providing an annual value of $383,873. In 2020, the most recent data available, Port Coquitlam's CO2e emission totaled 310,800 tonnes CO2e community emissions which includes the private sector, industry (including CP rail & transit operations within the municipal boundary), homes, vehicular use within the municipal boundary and privately operated garbage collection. Of that, 2,477 tons CO2e are corporate emissions which includes all City operations (eg. municipal buildings, fleet vehicles, garbage collection, etc.). This means that 75% of the existing CO2 emitted from the City's corporate emissions can be sequestered and stored by trees each year. In Port Coquitlam, the largest producer of CO2 is transportation, as many people drive out of the City every day for employment. As the urban forest expands, the amount of benefits trees provide also increases. The urban forest sequestered most of the City's corporate emissions in 2021 and with additional planting across the City, an increase in the City's canopy could result in net zero CO2 emissions from the corporate sector.

Stormwater Runoff Reductions

Rainfall interception by trees reduces the amount of stormwater that enters collection and treatment facilities during large storm events. A healthy urban forest can reduce the amount of water runoff and pollutants in three primary ways:

- Leaves and branch surfaces intercept rainfall, thereby reducing runoff and flow rates
- Root growth and decomposition increase the capacity and rate of soil infiltration by rainfall and reduce overland flow
- Trees reduce soil erosion by diminishing the impact of raindrops on bare soil

Port Coquitlam's urban forest contributes to the avoidance of 2,830,000 gallons of stormwater runoff annually through the interception of rainfall on the leaves and bark of trees. As trees grow and the urban canopy expands over time, the value and contribution to the ecosystem continues to increase. Currently, the urban forest's stormwater mitigation is valued at $30,579 per year in savings. Port Coquitlam's 2017 Energy Action Plan estimated that the City spent $87,733 managing water/wastewater. Storm water management is a significant incentive to expand the urban forest as climate change forecasters have indicated that more severe weather patterns will emerge more frequently. As recently as 2021 extreme flooding in BC has resulted in mud slides, road washouts and flooding of entire cities. A healthy expansive urban forest can help mitigate these extreme weather incidents.

Altogether, the i-Tree Canopy analysis found that Port Coquitlam's tree canopy provides annual ecological benefits worth $423,488, equating to a value of $7.2 per capita.

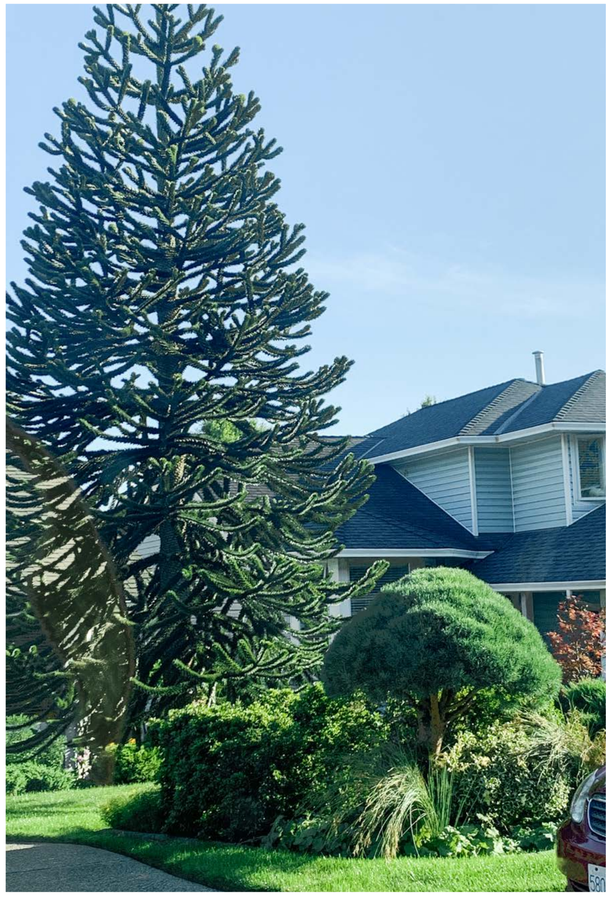
Table 2.2.2b Ecosystem benefits represented by the amount (units) of pollutants sequestered and stored, and the amount of stormwater runoff reduced by the entire urban forest including both private and public trees to Port Coquitlam.

AIR QUALITY	ANNUAL UNITS FILTERED (LBS)	ANNUAL VALUE ($CAD)
CO	1,123	$38
NO2	11,531	$72
O3	81,094	$4,889
SO2	4,387	$11
PM10	26,884	$4,026
ANNUAL CARBON	**UNITS (TONS)**	**VALUE**
TOTAL STORED	55,460	$11,434,060
ANNUAL SEQUESTRATION	1,860	$383,873
STORMWATER	**ANNUAL VOLUME (GALS)**	**ANNUAL VALUE**
AVOIDED RUNOFF	2,830,000	$30,579
ANNUAL VALUE		$423,488
TOTAL VALUE		**$11,857,548**

Energy Savings

Urban trees modify the local climate and conserve energy by filtering incoming sunlight, reducing radiation on impermeable surfaces, and lowering ambient temperatures. In Port Coquitlam, the warmest neighbourhoods are those with abundant concrete and fewer trees, such as the railyard and industrial areas. Older subdivisions with large mature trees tend to be cooler than comparable neighborhoods with fewer or smaller trees. This aligns with reduced canopy coverage in areas with increased impermeable surfaces. The "urban heat island" effect describes this increase in urban temperatures in relation to surrounding suburban and rural areas [13]. Heat islands are associated with a wider areal coverage of hardscape and impervious surfaces. Higher surface temperatures have a compounding effect of increasing energy usage for cooling and requiring more water usage for irrigation. Trees and other vegetation within an urbanized environment help reduce the heat island effect by lowering air temperatures 1 to 3°C compared with outside the green space [14].

Higher surface temperatures can have a negative impact on quality of life for urban residents, leading to less use of public spaces such as local parks and business districts that have fewer shade producing trees that result in reduced temperatures. Vegetation in abnormally warm areas may also become more easily stressed, which can increase their susceptibility to pests and diseases allowing them to sweep through a population and risk greater canopy loss. Tree spacing, crown spread, and vertical distribution of leaf area each influence the transport of warm air and pollutants along City streets and out of the street canyons. Trees reduce conductive heat loss from buildings by reducing air movement into buildings and against conductive surfaces (e.g. glass, metal siding). Trees act as windbreaks to reduce wind speed and air exchange into buildings, preventing the cooling effect on buildings, reducing annual heating costs of 10-20% [15].

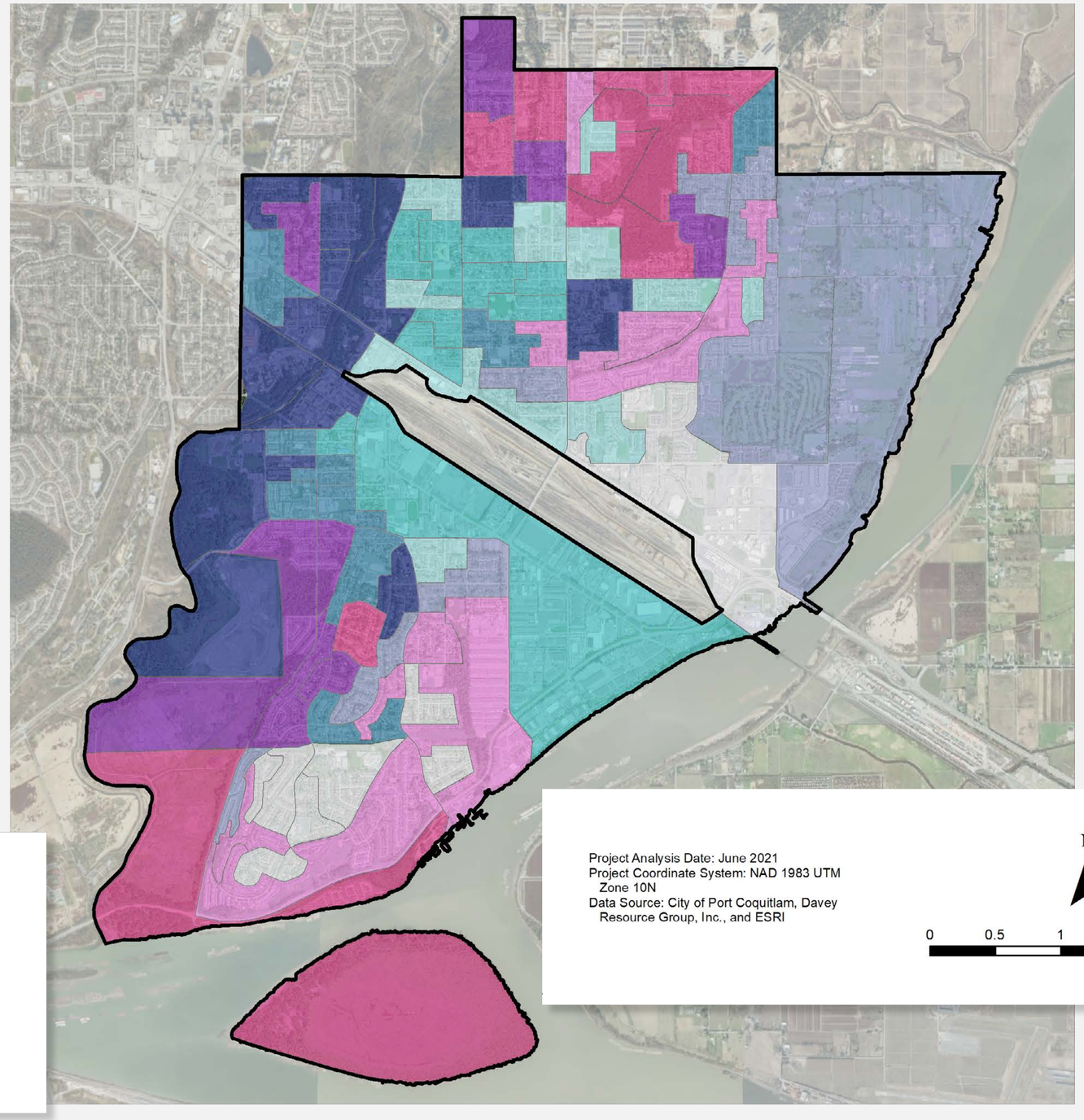


Aesthetic, Property Value, and Socioeconomic Benefits

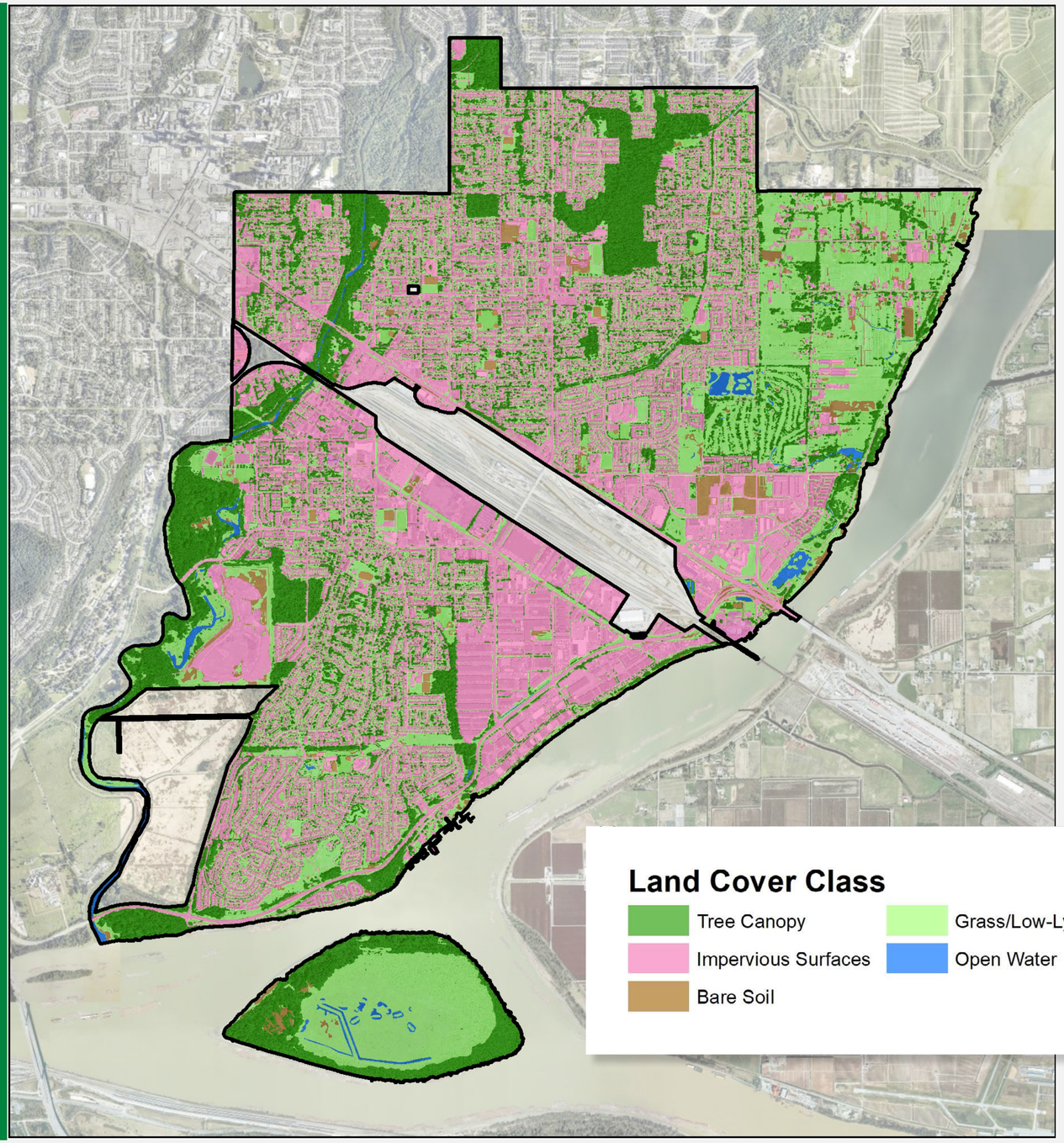
Trees provide beauty in the urban landscape, privacy and screening, improved human health, and a sense of comfort and place. There are many indicators that suggest trees and tree canopy cover contribute significantly to quality of life and community well-being, such as improving mood and mental health which have all been shown to reduce crime rates. The arboricultural industry uses various methods to try to capture the economic value of the aesthetic benefits of an urban forest through appraisal valuations that encompass a wide array of inputs.

Research shows that trees promote better business by encouraging more frequent and extended shopping and a willingness to pay more for goods and parking [16]. Through the use of hedonic regression analysis, it is possible to calculate the added value of trees in an urban environment by comparison of property values between areas of similar economic status. In residential areas, the values of these benefits are shown in the increased real estate value of houses featuring a mature, front yard tree [17] and that variations in tree cover and arrangement could increase land values by 30% compared to treeless land [18]. Comprehensive valuations of the urban forest should integrate hedonic analyses as well as cost-benefit estimates from ecosystem service calculations.

In addition to these benefits, trees have been shown to decrease poverty and reduce crime [19][20]. This can possibly be attributed to healthy vegetative areas signaling that they are better cared for and better protected [21]. However, urban tree cover is often inequitably distributed such that low-income neighborhoods and minority communities have less tree cover [22]. In Port Coquitlam, the lowest tree canopy areas appear to be focused on the north and south sides of the railroad tracks. These areas are associated with industry and businesses, as well as low-income households; property owners who do not occupy land may be less likely to invest in property maintenance, which may contribute to a low tree canopy cover in these neighbourhoods. These factors dictate the need for the City to focus their efforts into establishing new plantings and maintaining trees within these neighbourhoods. Planting equality needs to be addressed at a municipal level to ensure that both low- and high-income areas have equitable amounts of tree cover on City property. The City has the capability to require more trees be planted through the Subdivision Servicing Bylaw and permeable surface regulation. This would help force the incorporation of more plantable space into construction projects.



Port Coquitlam, BC Median Income and Canopy Percent



Land Cover

Using a remote land cover analysis tool provides insight into canopy growth opportunities. Including bare soil and pervious area land cover as potential tree planting sites, the maximum urban tree canopy in Port Coquitlam would cover 45.7% of the City. Therefore, the current canopy cover is only half (49%) of the potential canopy cover. The proposed 30% canopy cover target therefore is feasible given the amount of plantable land still available and is comparable to the canopy cover targets of other municipalities in the region (see section 4.3 for comparisons). There is also further potential to expand the plantable area by transforming impervious areas using methods such as installing planting mediums in fully paved parking lots.

Our analysis was able to calculate estimates of air quality and carbon capture provided by the urban forest canopy. An extensive assessment of benefits and investments should consider variability among tree species, growing condition, and maintenance practices throughout the City. The complexity of interactions between urban forests, their environment, and people makes quantifying their benefits difficult. A shortfall of i-Tree is that it does not account for the full range of tree benefits, including:

- *Psychological and physical wellness*
- *Reduction in crime and violence*
- *Increased in tourism revenue*
- *Critical wildlife habitat*
- *Socio-economic impacts*
- *Property value increase*

In summary, ***trees have high intrinsic values, even beyond what can be quantified.***

Port Coquitlam, BC

Land Cover Classification - No River & No Railyard & No KFN

CP Rail, Pitt River, Fraser River, Kwikwetlem First Nation land excluded from analysis

LAND COVER	AREA (HECTARES)	PERCENTAGE
TREE CANOPY	620.86	23.00
IMPERVIOUS SURFACES	1,072.54	39.74
PERVIOUS SURFACES	901.33	33.40
BARE SOIL	71.04	2.63
WATER	37.31	1.23
TOTAL AREA	**2,698.85**	**100**

Forest Fragmentation

Urban forests are typically fragmented and unevenly spread across an entire city. This increases the susceptibility to invasive species and alters the microclimate, resulting in the degradation of ecosystem health. A fragmentation class analysis was conducted to determine the distribution of the City's tree canopy. Generally, the health and diversity of the overall canopy can be improved by creating linkages between patch canopy areas to reduce forest fragmentation.

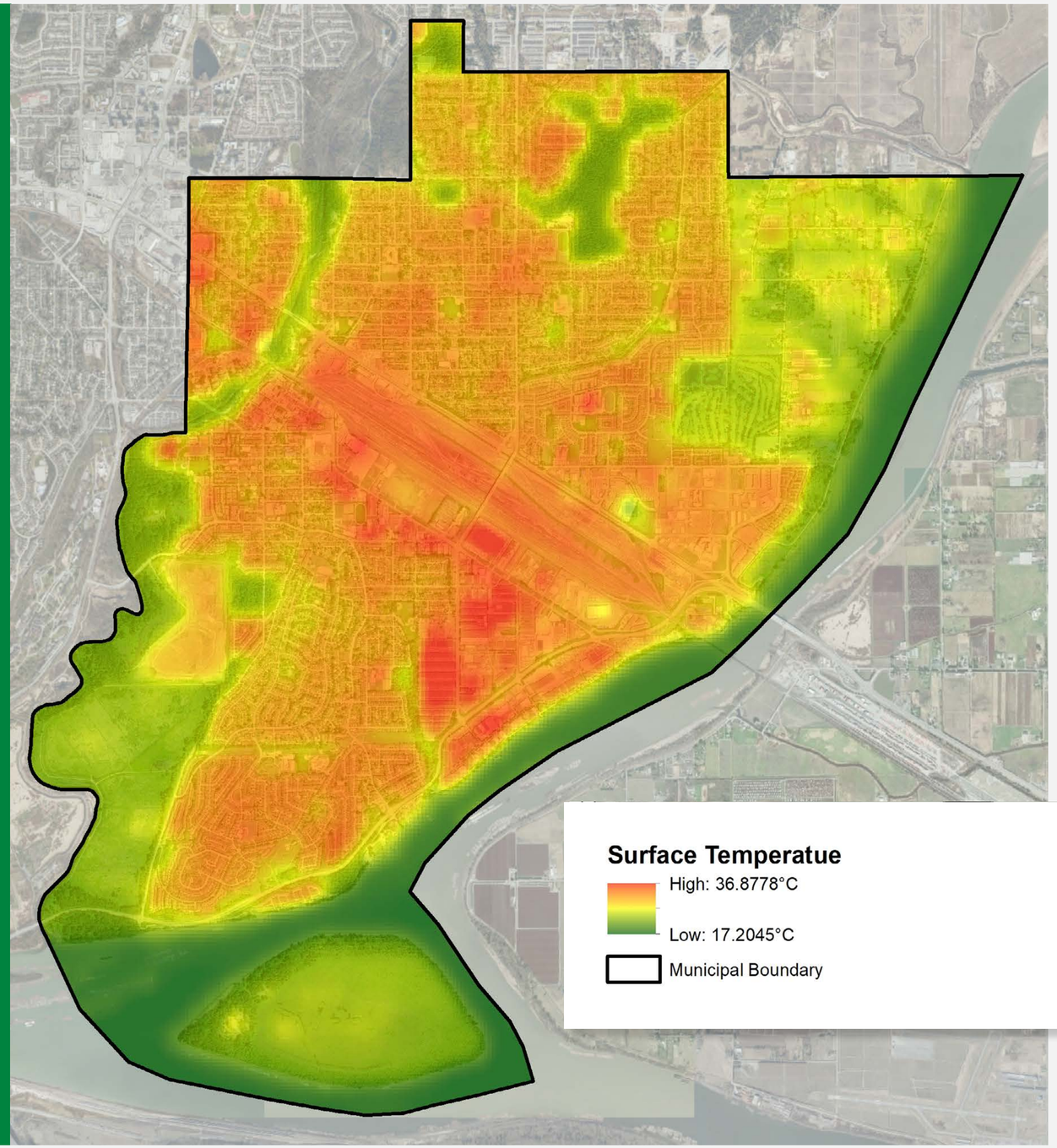
- **Patch canopy** refers to isolated clusters or single trees. These trees lack the protection of neighbouring trees and are exposed to micro stressors. Street trees are a good example of this. Patch canopy comprises half (51%) of Port Coquitlam's tree canopy.

- **Edge canopy** refers to the boundary between core forests and cleared land where a transition of plant and tree species creates a buffer to prevent wind damage, non-native species entry, and other disturbances. They tend to be a combination of fast-growing pioneer species. This category comprises 33% of the City's tree canopy.
- **Perforated canopy** refers to the boundary of core forests and small clearings or gaps. This occurs when a disturbance or abiotic factor kills off a group of trees or prevents them from growing. An example is a small blow down or a body of water or rock pile. This is the least common canopy category, representing only 5% of the City's canopy.
- **Core canopy** refers to unbroken forested areas. These areas are large enough to be self-sustaining forests and are mostly free of large openings. With regard to biodiversity, core canopy areas are associated with higher quality habitat and wildlife corridors. 11% of the City's canopy is categorized as core canopy.

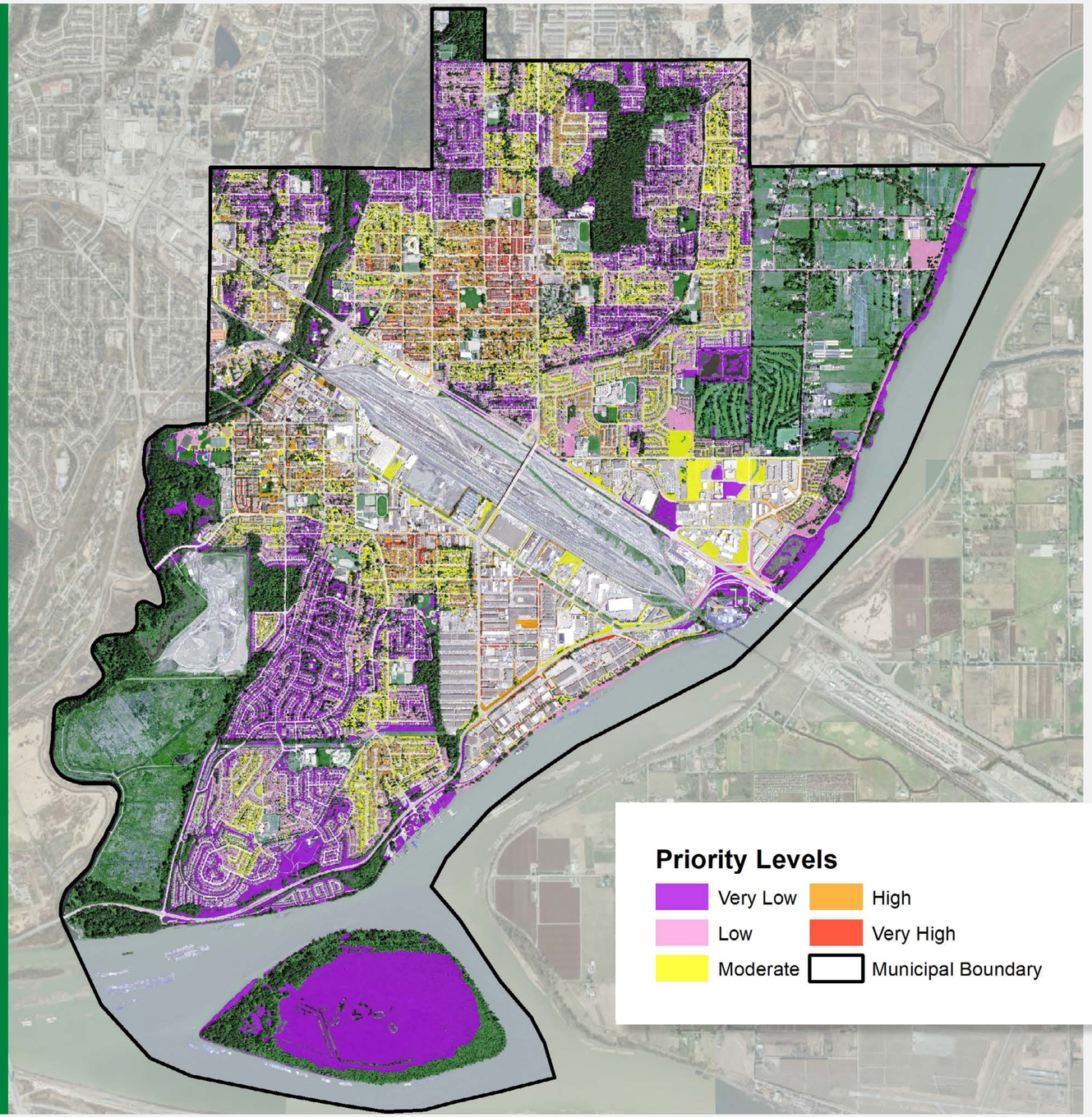
Analysis land cover utilization and forest fragmentation breakdowns r important when prioritizing when and where to plant trees. This is influenced by an array of factors and is balanced by the goal to achieve canopy cover targets, equitably distribute ecosystem benefits, and feasibility.

The factors considered in generating the priority planting maps are:

- Urban heat island
- Social equity (incorporates population density, median income, minority percent, and renter percent)
- Stormwater (incorporates distance to hardscape, distance to canopy, floodplain, soil erosion, and slope)



Port Coquitlam, BC
Land Surface Temperature



These planting prioritization factors were combined to assign all areas on a 5 point scale from very low to very high. While available planting sites may ultimately be planted over the next several decades, the trees that are planted in the next few years, should be planned for areas in most need, and where they will provide the most benefits and return on investment given a particular set of circumstances and desires to fulfill certain obligations to the community. The City can choose to target individual factors like heat islands for certain projects or select from the composite ranking to get the most return on investment across the board.

The highest priority planting areas in the City are located within the Glenwood and Central Port Coquitlam neighbourhoods. Glenwood is mostly comprised of condominiums and detached homes and is a middle-income family-oriented neighbourhood. Central is home to a variety of higher density residential townhomes, single family homes, and commercial buildings including the City's downtown. Most of the high and very high priority planting areas are located in residential areas with smaller lot homes where growth of new tree canopy will provide the greatest benefit to the residents. Prioritizing these areas provides trees and greenspace to high density blocks that otherwise have less space for private trees and yards.

Port Coquitlam, BC
Priority Planting - Composite

3.URBAN FOREST MANAGEMENT

3.1 POLICY CONTEXT

Canada has some of the most stringent forest policies and regulations in the world. These have helped protect and preserve old growth trees and species at risk in both an urban and natural setting at various levels of government. The policies that impact forests can have broad reaching implications that apply not only to the trees themselves, but also animal habitat, rare species, watercourses, and pests. Therefore, these regulatory policies can directly or indirectly play a role in guiding the management of both urban and natural forests.

The relevant federal laws include:

- Species at Risk Act
- Migratory Birds Convention Act
- Plant Protection Act

The relevant provincial laws include:

- Special Tree Protection Regulation
- Additionally, court rulings and past legal cases outline recommendations related to urban trees on private property.

The municipal regulations include:

- Port Coquitlam's Tree Bylaw (No. 4108)
- Subdivision Servicing Bylaw (No. 2241)
- Official Community Plan Bylaw (No. 3838)
- Zoning Bylaw (No. 3630)

Both federal and provincial acts help guide the establishment and creation of municipal bylaws that set the stage for urban forest management. For example, the Migratory Birds Convention Act prevents the removal of trees during the migratory season unless a nest search has been completed by a Qualified Environmental Professional.

Port Coquitlam has a newly updated tree bylaw as of 2019 that was amended in 2021 that has strengthened the management and protection of public and private trees across the City. One method that would help reach the proposed 30% canopy cover target would be to adopt new regulations that increase tree protection and canopy cover growth. Updating the Official Community Plan (OCP) and Subdivision Servicing Bylaw (No. 2241) presents opportunities to do this. Adopting the proposed 30% canopy cover target in the OCP directly referencing the Tree Bylaw with language that is consistent with the bylaw would bolster tree protection. Similarly, updating the Subdivision Servicing Bylaw to provide requirements for the planting and management of street trees during development and capital projects would play a large role in tree protection and canopy cover growth throughout the City. Implementation and enforcement of stringent tree protection guidelines and minimum standards for construction projects would help preserve existing mature trees. A landscape plan and follow-up inquiry for projects requiring replacement trees would ensure suitable planting locations and tree species are selected and that these regulations are being upheld. Overall, these changes would prioritize trees as City assets and ensure consistency through municipal documents.

Urban environments add additional stressors that can negatively impact tree growth and establishment. To best manage these impacts, some municipalities have adopted standard guidelines for planting in hard surfaces. These guidelines should follow industry standards which are aimed at selecting a suitable tree for the site and achieving the high soil volumes necessary for tree growth and survivability. One of the most persistent challenges in urban forestry is the ongoing battle between tree roots and pavement [24]. Boulevards and tree containers, for instance, limit the soil volume for roots to grow thus reducing water and nutrient availability and can conflict with underground utilities. The close proximity to hardscape can lead to soil compaction, root damage, girdling, and pavement lifting. Overall, these cause damage to trees and property as well as safety risks to the community. Mitigation and management options include the selection of hardy species, ground covers (grates) that can help accommodate tree growth, and appropriate soil mediums. Proper planning can help create connected planting sites that act as continuous channels that connect individual planting pits. This creates growing space and nutrient availability that can promote deep root growth alleviating sidewalk and pavement destruction caused by root growth. A variety of methods have been developed and implemented to increase tree survival in hard surfaces by using the best possible planting method for a given site.

Additionally, pest management activities are regulated at all three levels of government:

Federal Role

Health Canada's Pest Management Regulatory Agency (PMRA) regulates most acts and guidelines set out at a federal level affecting both the provincial and municipal regulations.

Provincial Role

Provinces and territories regulate registered pesticides including the sale, use, storage, transportation, and disposal, as long as the measures they adopt are consistent with any conditions imposed under the Pest Control Products Act or other federal legislation.

British Columbia's Weed Control Act regulates the use of pesticides and chemical control measures. It has designated a list of invasive plants as 'noxious weeds' (Appendix 1). Private property owners and government agencies are mandated by law to control these species on their property or jurisdiction.

Municipal Role

Port Coquitlam's 2011 Pesticide Use Control Bylaw (No. 3767) states that a person must not use or permit or cause to be used a pesticide for the purpose of maintaining outdoor trees, shrubs, flowers, other ornamental plants, or turf on private or City land. Exceptions to this bylaw are mainly the management of noxious weeds and pests. This limits homeowners from using most pesticides and herbicides for residential use. An Integrated Pest Management system (IPM) is normally implemented at this level of government with the focus of managing and maintaining local pest populations. Public education could be a successful and useful tool by creating online resources that teach and educate about new and emerging pests. Currently, the City does not operate on a pro-active pest management strategy.

Carbon Sequestration

In 2008, the B.C. government brought in its first carbon tax. Since then, the province has made it mandatory for all public sector agencies to purchase carbon offset credits. The goal of this program is to reduce the total greenhouse emissions in this sector by creating a financial incentive to do so. Port Coquitlam has adhered to this program and is updating its climate action plan to further its carbon neutrality. Port Coquitlam's urban forestry sector works in tandem with both the climate action plan and the environmental strategic plan to reduce CO2 emissions by sequestering carbon from the atmosphere. The total tree canopy of the City as of 2021 can filter 1,860 tons of CO2 from the air equaling almost 75% of the CO2 emitted by the City's corporate activities. With Port Coquitlam striving for carbon neutrality part of the carbon credits paid can potentially be used for additional planting and green infrastructure. Combining this with the goal of reaching 30% canopy cover City-wide will give Port Coquitlam the potential to be fully carbon neutral across the public sector in the future.

3.2 GOAL STATEMENTS

1. Increase canopy cover to maximize benefits
2. Protect existing canopy cover
3. Adapt to a changing climate
4. Integrate the urban forest into watershed and natural area management
5. Engage and partner with the community to build ownership of the urban forest

3.3 INDICATORS

The urban forest can be managed and evaluated using performance indicators to measure the levels of service, the operating costs, and the ecosystem benefits provided. These strategic indicators are structured around the five urban forestry goals and should guide future work to protect, enhance, and monitor the urban forest with support from the community.

The list of selected indicators was adapted from the Sustainable Urban Forest: A Step-by-Step Approach document authored by Davey Institute and the United States Department of Agriculture (USDA), Forest Service [25]. This framework uses a standard set of key objectives and performance indicators to assess the status of a municipality's urban forest as well as its management.

A snapshot of Port Coquitlam's standing with regards to a set of 18 performance indicators provides insight on the City's current strengths as well as areas in need of improvement. Each indicator is ranked on a 4-point scale from low to optimal with a description for each performance level . The performance on these indicators can be assessed every few years to track the progress of the Roadmap's implementation.

Table 3.2 Key objectives set to achieve the plan's goals. The City's current performance level for each indicator is ranked.

INDICATOR	KEY OBJECTIVE	LOW	FAIR	GOOD	OPTIMAL
RELATIVE TREE CANOPY COVER	Achieve desired degree of tree cover, based on potential or according to goals set for the entire municipality and for each neighborhood or land use.		●		
AGE DIVERSITY (SIZE CLASS DISTRIBUTION)	Provide for ideal uneven age distribution of all "intensively" (or individually) managed trees – municipality-wide as well as at neighborhood level.			●	
SPECIES DIVERSITY	Establish a genetically diverse tree population across the municipality as well as at the neighborhood level.	●			
PUBLICLY OWNED TREES (MANAGED "INTENSIVELY")	Current and detailed understanding of the condition and risk potential of all publicly owned trees that are managed intensively (or individually).			●	
PUBLICLY OWNED NATURAL AREAS (MANAGED "EXTENSIVELY")	Detailed understanding of the ecological structure and function of all publicly owned natural areas (such as woodlands, ravines, stream corridors, etc.), as well as usage patterns.	●			
MUNICIPAL AGENCY COOPERATION	All municipal departments and agencies cooperate to advance goals related to urban forest issues and opportunities.		●		
CITIZEN INVOLVEMENT AND NEIGHBORHOOD ACTION	At the neighborhood level, citizens participate and groups collaborate with the municipality and/ or its partnering NGOs in urban forest management activities to advance municipality-wide plans.		●		
CANOPY COVER ASSESSMENT GOALS	Urban forest policy and practice driven by accurate, high-resolution, and recent assessments of existing and potential canopy cover, with comprehensive goals municipality-wide and at neighborhood or smaller management level.			●	
ENVIRONMENTAL JUSTICE AND EQUITY	Ensure that the benefits of urban forests are made available to all, especially to those in greatest need of tree benefits.		●		

Table 3.2 Continued >

Table 3.2 Continued

INDICATOR	KEY OBJECTIVE	LOW	FAIR	GOOD	OPTIMAL
MUNICIPAL URBAN FOREST PROGRAM CAPACITY	Maintain sufficient well-trained personnel and equipment – whether in-house or through contracted or volunteer services – to implement municipality-wide Urban Forest Management Plans.		●		
TREE ESTABLISHMENT PLANNING AND IMPLEMENTATION	Comprehensive and effective tree planting and establishment program is driven by canopy cover goals and other considerations according to plan.		●		
GROWING SITE SUITABILITY	All publicly owned trees are selected for each site and planted in conditions that are modified as needed to ensure survival and maximize current and future tree benefits.		●		
TREE PROTECTION POLICY: DEVELOPMENT AND ENFORCEMENT	The benefits derived from trees on public and private land are ensured by the enforcement of municipality-wide policies, including tree care "best management practices".			●	
TREE PROTECTION POLICY: REPLACEMENT RATIO	Require replacement plantings for tree removals to offset loss of canopy cover.			●	
MAINTENANCE OF PUBLIC MANAGED TREES	All publicly owned, intensively (or individually) managed trees are well maintained for optimal health and condition in order to extend longevity and maximize current and future benefits.			●	
MANAGEMENT OF PUBLICLY OWNED NATURAL AREAS	The ecological integrity of all publicly owned natural areas is protected and enhanced – while accommodating public use where appropriate.		●		
NATIVE VEGETATION	Preservation and enhancement of local natural biodiversity.		●		
TREE PEST MANAGEMENT	Establish monitoring programs for existing and incoming forest pests as well as educational resources.	●			

4.PLAN IMPLEMENTATION

4.1 TREE PLANTING

A high-level analysis conducted by the City in 2020 estimated it would take 428 planted trees annually at $500 per tree (cost of tree, installation, and first year of maintenance) to gain the 3.6% of canopy cover needed to reach the proposed 30% canopy cover target. Based on new imaging data a more accurate estimate was completed for the City's canopy cover which found a total tree cover of 23.0%. This updated value means that the City's canopy cover needs to grow by 7.0% to reach the goal of 30% canopy cover over the next 30 years. The updated value nearly doubles the amount of area the canopy needs to expand by to achieve the proposed canopy cover target. This potential canopy cover area includes both private and City-owned property. Private land covers two thirds of the City's land mass but only represents 55% of the total canopy area. This means there is significant potential to increase canopy cover within private land. This will require further evaluation and implementation for future planting sites.

LAND OWNERSHIP	SHARE OF TOTAL AREA	SHARE OF TOTAL TREED AREA
PUBLIC LAND	34%	45%
PRIVATE LAND	66%	55%

Table 4.1 Distribution of public and private land ownership.

Cost estimates of tree planting were assessed using the values indicated in Port Coquitlam's 2020 Tree Canopy report. It is estimated that 770 trees would need to beplanted and maintained annually, at a cost of $385,000 a year over the next 30 years to reach the 30% canopy cover across the City. Currently only $33,400 is spent annually in dedicated tree planting by the City. This planting scenario is most likely an overestimation as 66% of the land mass is owned privately and contains over 55% of the tree area. It is more likely that only 50-60% of these trees would need to be planted on City property to reach the canopy goal. The planting could be spread between City and private property using community outreach programs and community education to emphasize the benefits of trees and tree planting. The City should also consider a tree planting discount for homeowners to incentivize planting on private property.

Research has identified four strategies municipalities and non-profit tree planting organizations can implement to direct the planting of trees to where they are needed most:

1. Target Planting Areas

Identifying where the shortcoming are and strategize a planting plan to focus on the areas in the most need of trees. In some cases, canvassers can go door-to-door in neighborhoods with low canopy cover advertising the benefits of trees to homeowners who can help water and maintain them. Canvassers should be selected with care, for instance by matching a canvasser's demographics to the local neighbourhood.

2. Build Strong Municipal and Non-Profit Partnerships

City planting programs have been the most successful when they involve local non-government groups, non-profit organizations, and local residents. These groups can help fill in gaps the municipality may have in implementing planting programs in "in-need" areas.

3. Reduce Property Owner Responsibility

Improving City maintenance of trees on public property is important in maintaining the health of the urban forest. For low canopy cover leighborhoods in particular, it's important to reduce the pressure on individual property owners to plant trees by planting on public lands adjacent to private property (e.g. boulevards). Among other factors, rental units are less likely to be occupied by property owners. Property owners who do not occupy land may be less likely to invest in property maintenance.

4. Prioritize Public Spaces

While most programs focus on getting trees onto residential properties, successful programs work on improving tree cover, not just in residential areas but also in public spaces. Planting trees in public spaces can provide neighborhood-wide health and environmental benefits.

4.2 INTEGRATED PEST MANAGEMENT

The goal of integrated pest management (IPM) is to proactively manage weeds, pests, and diseases while minimizing risk to the environment and human health. IPM uses the most economical and effective approaches by utilizing combinations of cultural, biological, genetic, and chemical control methods. The least environmentally harmful approaches are considered first, and chemical treatments are used as a final option. Within urban forest management, IPM does not exclude the use of forest pesticides but rather assesses the options available prior to the use of chemical treatments. A large emphasis of this system is to monitor the forest. This is implemented through collecting data and samples, public education, and proactive treatment.

Pest Management Control Measures

1.Non-chemical Control Measures

Forested areas have been managed for pests by planting tolerant species and increasing species diversity. These two approaches start in the planning phase of establishing an urban forest and can improve the baseline for effective pest control far into the future. Species diversity can also be increased in already treed areas to help ensure canopy cover in the face of a severe pest outbreak.

2.Tree Vigor

Selecting vigorous trees in good health can help prevent the spread of pests as the trees themselves have a natural ability to fight off numerous pests when in a healthy condition. Planting and sourcing healthy trees can also prevent the spread of existing pests.

3. Systematic Pruning

Pruning deadwood and diseased branches from trees can greatly increase the survivability of urban trees that no longer have to spend energy on fighting off an infection.

4. Rotation Planting

Rotation planting refers to the removal of diseased or infected trees and planting a different species in its place. Ideally, the species should be tolerant or resistant to the factors that caused the mortality of the previous species.

5.Alternative Pest Control Measures

Not all insects are harmful and require control measures. Insect species that prey on other insect populations is a natural form of control. Birds are one form of natural control. Some species will feed on large numbers of insects reducing the need for chemicals and other forms of management.

How to Burlap Band trees, controlling forest pests, City of Brantford 2021 https://www.brantford.ca/en/living-here/burlap-banding-step-by-step.aspx

6.Tree Banding

Tree trunk banding is an effective non-toxic control for some insect pests. As insects crawl on the tree, they become trapped in the banding until they can be removed. To increase the use of this technique, public awareness campaigns encourage homeowners to band their trees in response to certain insect outbreaks. Sticking agents are no longer recommended as it can cause harm to other animals that get stuck. For instance, burlap banding is recommended to manage LDD moth.

7.Monitoring Diseases and Insect Pests

Monitoring programs determine if insect populations or diseases are increasing, decreasing or remaining constant. This enables IPM to identify areas which have higher levels of infestation or infection and determine the appropriate control measures. In some cases the monitoring program acts as the control program. Pheromone or synthetic scent lures attached to sticky traps will attract and catch insect pests. In the case of wood borers, pheromone traps are used as the control method.

8.Chemical Control

Traditionally, pest control operations have relied upon chemical control measures. Chemical control remains a common practice for many cities when managing invasive or noxious plants or pests. The use of chemicals to control specific insect pests that pose significant economic and aesthetic losses to cities should continue to be explored and implemented as a secondary option.

9.Public Awareness

Public awareness is an important aspect of IPM as a large proportion of the monitoring of urban forests can be done by local residents.

Current City Practice

While urban forestry has staff dedicated to natural area work including trail maintenance and invasive species removal, there is no management strategy for pests in Port Coquitlam and management activities are performed on a reactive level without pre-planning in place. Noxious weeds and some highly invasive pests are managed by the provincial government in tandem with the Canadian Food Inspection Agency (CFIA) but limited monitoring or proactive work is currently being completed by the City. Port Coquitlam has a knotweed/hogweed control program with Himalayan Blackberry being managed around transportation corridors (trails, pathways & sidewalks) and is also targeted for volunteer invasive removal work parties. City crews also pull ivy off trees near City infrastructure as time allows but no invasive management plan is in place & less emphasis is put into managing other invasive species. 12 invasive plants are mapped in an internal mapping system; however, knotweed & hogweed are the most accurate and up to date as resources are limited. *We recommend expanding the urban forestry team to include a full-time pest management personnel.* This would be in combination with seasonal staff to help manage the state of forest pests and plants, as well as educate the public in pest awareness and ID. This personnel could establish educational material in response to incoming pests and weeds that could threaten the urban forest of Port Coquitlam.

Cost of Invasive Pest Management

Managing invasive pests in an urban forest is costly even if no pests arrive but managing and monitoring for pests is significantly more cost effective than the long-term cost of inaction. A 2009 report prepared for the Canadian Council of Forest Ministers concluded that Canada could have avoided a cost of $165 million annually by preventing the introduction and establishment of four high-profile invasive forest insects and diseases [26]. This appears to be the trend across the country as multiple cities failed to invest adequately in their urban forest. Cities like Regina recognize this and have invested $25,000 annually in public education of Dutch elm disease to help manage their urban forest. Port Coquitlam sits in a delicate position as its urban forest is susceptible to climate change impacts as well as invasive species due to its warm climate and species diversity. It is recommended that an investment be made into implementing an IPM strategy and hiring additional full-time staff to monitor and manage this system.

4.3 ACTIONS

Port Coquitlam's 18 indicators can be addressed through actionable items. The action table recommends quantifiable measures to help the City achieve its objectives, guided by the five overarching goals. The table describes the current performance level for each indicator, the status and management approach of other municipalities, and recommends suggestive actions with recommended timeframes to begin implementation upon Council direction to initiate or build upon existing City programs to improve Port Coquitlam's urban forest. Implementation may be impacted by other organizational priorities.

INDICATOR	SUPPORTING INFORMATION FOR THE CITY'S PERFORMANCE	COMPARISON TO OTHER MUNICIPALITIES	ACTION • Recommended timeframe to being implementation
RELATIVE TREE CANOPY COVER	Current canopy cover of 22.5% is 75% of 30% canopy cover goal, right at cusp between "fair" and "good". However, this goal is not explicitly included in other official planning documents.	Proposed canopy cover target is in line with regional municipalities (27% in New Westminster, 22% in Vancouver, 32% in Nanaimo) and similarly sized cities nationally (30% in Richmond Hill, 30% in St. Catharines).	Incorporate 30% canopy cover target into other municipal planning documents to achieve City-wide approach. • Immediate
AGE DIVERSITY (SIZE CLASS DISTRIBUTION)	The proportion of trees in the medium size class is lower than the target ideal (13.4% vs 20%). The other size classes are all slightly above their target proportions. A City-wide tree planting strategy, guided by the results of the canopy assessment, could be used to target and increase planting levels in alignment with the ideal size class targets in the long term.	Other municipalities typically acknowledge the need for age diversity (Vancouver, New Westminster, Regina, Toronto) and indicate which age class, if any, are underrepresented.	Develop an ongoing tree planting program to ensure an increased consistent supply of young trees. • 1-2 years Use the tree inventory data to track patterns of change in tree demographics. • 3-5 years
SPECIES DIVERSITY	One species (Red Maple), one genus (Maple), and one family (Sapindaceae) surpass the recommended threshold for species diversity. Street and park trees did not differ in species richness. The City has published a replacement tree list ranking adaptability to climate change and size at maturity for each species, but it does not promote or identify native species. Overall, there is no clear approach in City policy for species selection or achieving species diversity. Also, there is no long-term monitoring of species diversity or specific criteria targets for diversity. The proportion of trees in the medium size class is lower than the target ideal (13.4% vs 20%). The other size classes are all slightly above their target proportions. A City-wide tree planting strategy, guided by the results of the canopy assessment, could be used to target and increase planting levels in alignment with the ideal size class targets in the long term.	Other municipalities often do not provide specific criteria targets for species diversity, but instead simply acknowledge that some level of species diversity should be strived for, including generalized advocacy for native species (New Westminster, Toronto). Some municipalities also assess diversity on a neighbourhood scale (Vancouver, Regina). Other municipalities typically acknowledge the need for age diversity (Vancouver, New Westminster, Regina, Toronto) and indicate which age class, if any, are underrepresented.	Establish species selection guidelines for development projects that require a minimum diversity for new plantings. • 1-2 years Assess neighbourhood-specific species diversity to prioritize tree planting of underutilized species. • 1-2 years Develop an ongoing tree planting program to ensure an increased consistent supply of young trees. • 1-2 years Use the tree inventory data to track patterns of change in tree demographics. • 3-5 years
PUBLICLY OWNED TREES (MANAGED "INTENSIVELY")	Partial, but recent large-scale and detailed inventory encompassing approximately 75% of "intensively" managed trees. This accounts for most of the City-planted street and park trees. Includes condition rating and maintenance recommendations for each tree. The City does not track how many trees are removed internally (or through City-hired contractors each year). Tracking removed trees using the inventory would also identify and prioritize potential planting sites for replacement plantings.	Most other municipalities assessed do have a partial (Victoria, New Westminster, Vancouver) or functionally complete (Toronto) inventory. They include the standard metrics of collection including, species, size, condition, and location.	Maintain up-to-date inventory database by recording all pruning and removal work. • Immediate Complete inventory of all publicly-owned street and park trees. • 1 year Update the street and park tree inventory • Update full inventory at 5 years or cyclical 20% inventory per year

Table Continued >

INDICATOR	SUPPORTING INFORMATION FOR THE CITY'S PERFORMANCE	COMPARISON TO OTHER MUNICIPALITIES	ACTION • IMPLEMENTATION TIMEFRAME
PUBLICLY OWNED NATURAL AREAS (MANAGED "EXTENSIVELY")	The EnviroPlan (2011) discusses strategic directions for a healthy environment. Traboulay PoCo Trail guide highlights trail and connecting natural areas. The City lacks a survey document that tracks the level and type of public use in publicly owned natural areas (such as woodlands, ravines, stream corridors, etc.), as well as usage patterns. A natural area inventory and monitoring program could be coordinated with local conservation groups to collect comprehensive and detailed data for ecological structure and function. Encroachment of private property onto City property should be handled under trespass legislation, as this can reduce the area where trees can grow naturally.	Most Ontario municipalities partner with the local Conservation Authority to conduct natural area surveys and organize their function for public use.	Develop a document to identify natural areas and highlight their location, trails, public uses, and function. • 2-3 years Conduct ecological inventories to identify ecosystem health and trends. • 3-5 years Increase intercity cooperation to assess private property boundaries when reviewing building permits as well as reviewing new developments to retain plantable City land. • 1-2 years
MUNICIPAL AGENCY COOPERATION	Urban forestry works with bylaw enforcement to enforce the permitting systems and bylaws in place. Although informal collaboration between departments does occur, the City currently lacks formal policies that ensures cooperation among departments to promote tree preservation. A tree-focused working group should be assembled to regularly review City decisions that could impact trees. For example, trees are sparsely referenced in existing City documents (Corporate Strategic Plan, Hyde Creek Integrated Watershed Management Plans, Climate Action Plan, Environmental Strategic Plan, Official Community Plan, and Subdivision Servicing Bylaw).	New Westminster uses informal teams among departments and agencies to implement common goals on a project-specific basis. Guelph has formed a tree team of internal stakeholders as well as an urban forest working group of external stakeholders following the implementation of their Urban Forest Management Plan in 2013. The tree team is comprised of key staff from all departments involved in tree related issues to coordinate and problem-solve. The working group generates "great ideas and collaborations" and aims to foster new relationships with neighbouring regions. Both teams meet quarterly.	Establish a formal inter-departmental team to review and implement common goals on all municipal projects to ensure cooperation between departments. • 1-2 years Collaborate with adjacent departments to conduct a bylaw review to incorporate urban forestry goals and protection guidelines. • 1-2 years
CITIZEN INVOLVEMENT AND NEIGHBORHOOD ACTION	The City loosely collaborates with local non-government groups that educate and run community programs like gardening and walking groups. For example, the Burke Mountain Naturalists group operates across the TriCities. No extensive City-wide outreach programs with opportunities relating to tree or urban forest heath currently exist. However, there is strong public support for communicating with the public about planting, protecting, and managing trees (Let's Talk Trees 2017)	Vancouver has an Urban & Community forestry program that educates on and supports forest health. Richmond has a citizen-led Official Community Plan that educates and highlights street trees as community assets. Tree Canada's Greening Canada's School Grounds program strengthens the relationship between students and nature by creating green space to facilitate learning. The Delta School District is planting a cedar tree at every school and district site to show appreciation and respect for local First Nation culture through its Giving Tree Project.	Implement educational programs to engage local schools with education resources on trees, biodiversity, and invasive plants. • 1-2 years Facilitate community involvement opportunities for natural area projects (invasives removal and restoration). • 1-2 years

Table Continued >

INDICATOR	SUPPORTING INFORMATION FOR THE CITY'S PERFORMANCE	COMPARISON TO OTHER MUNICIPALITIES	ACTION • IMPLEMENTATION TIMEFRAME
CANOPY COVER ASSESSMENT GOALS	A complete, high-resolution Urban Tree Canopy (UTC) assessment is included as part of this Roadmap. The City-wide canopy cover goal is 30% by 2050. Canopy cover distribution is assessed in relation to land cover, surface temperature, socioeconomic factors, and priority planting sites.	Individual cities obtain and publish management plans utilizing their chosen methodologies. As detailed in section 2.2, certain biases are inherent in any methodology, and as such differing coverage estimates are best compared using similar methods.	Conduct and publish repeated UTC analyses at regular intervals to monitor forest cover and health trends. • Every 10 years Establish and implement specific canopy cover goals by land use cover. • 5 years
ENVIRONMENTAL JUSTICE AND EQUITY	Targeting planting sites for low canopy neighbourhoods is addressed in this current Roadmap. Corresponding planting priority areas have been identified to address surface heat temperatures, social equity, and stormwater drainage. Port Coquitlam lacks an implementation plan focusing on tree planting that could address this gap.	Toronto's Tree Planting Strategy is an implementation plan based off recommendations from their UFMS. For instance, they have implemented the Toronto Community House Corporation Planting and Stewardship Initiative to plant in low-income areas. Some cities do not address specific plans to prioritize in-need areas based off social equity (Victoria, New Westminster).	Implement priority planting program to target areas in need of canopy cover benefits. • 1-2 years
MUNICIPAL URBAN FOREST PROGRAM CAPACITY	The City's urban forest program includes a small team of trained and qualified staff. Additional tree maintenance professionals are contracted regularly to perform pruning and maintenance. Non-profit organizations have some collaboration with the City's department.	The size and budget of urban forestry staff vary across the country.	Increase involvement of local conservation and environmental groups to support services such as tree planting. • 2 years Expand the staff to include a dedicated forestry pest management position. • 1-3 years Expand temporary staff to assist in tree and trail maintenance, pest management, and tree planting. • 1-2 years Add specialized quipment to increase organizational capacity and decrease reliance on contracted services • 1-2 years
TREE ESTABLISHMENT PLANNING AND IMPLEMENTATION	Currently, approximately 200 trees are planted by the City per year. To reach the proposed 30% canopy cover target, the planting rate should be at approximately 770 trees per year across all sectors. There is no City-wide tree planting strategy. No current incentive for homeowners to plant trees on private property, however 60% of residents were in favor of this idea (Let's Talk Trees 2017). The City currently inventories new City-planted trees, however, no planting by developers or industry are inventoried. The City does not replace its own losses each year in addition to planting new trees.	Most cities have a dedicated fund for tree planting and City enhancement. North Vancouver has a Street Tree Planting Program, partially funded by BC Hydro and Tree Canada, that works to increase canopy cover via infill-planting in boulevards. To promote planting on private land, Nanaimo and Vancouver offer a tree voucher program for property owners, which has been highly popular. Toronto has partnered with a local non-profit to create the Backyard Tree Planting Program. This program provides subsidized tree planting services to property owners through either their full-service or do-it-yourself option. Toronto also partners with the local conservation authority to provide tree planting services to eligible industrial, commercial, and institutional landowners on a cost-shared basis.	Increase the level of tree planting throughout the City in line with the proposed 30% canopy cover target. • 1-2 years Track the number of trees planted by recording each tree in the inventory database. • Immediate Create a monitoring framework to track the number of trees planted by developers. • 1 year Manage fees to ensure that funds are being collected and allocated back to plantings properly • Immediate Offer a tree incentive program for residents. • 1-2 years Provide on-line, educational resources for residents on tree planting and care • 1-2 years Increase plantable area in heat island areas by removing hard scape • 1-2 years

Table Continued >

INDICATOR	SUPPORTING INFORMATION FOR THE CITY'S PERFORMANCE	COMPARISON TO OTHER MUNICIPALITIES	ACTION • IMPLEMENTATION TIMEFRAME
GROWING SITE SUITABILITY	The City lacks planting specifications for tree soil volume and growing space. Planting should be based on site characteristics, such as soil moisture content or slope. Appendix 3 includes recommended planting guidelines.	Most cities have planting guidelines regarding distances to utilities. Recently standards have been created by some cities for min soil volume per tree species, London (ON) has guidelines for how close a tree can be to a power line and how much open space is required for a new planting.	Establish minimum requirements for tree planting sites to be implemented in City and new development plantings focusing on site suitability and species selection. • 1-2 years
TREE PROTECTION POLICY: DEVELOPMENT AND ENFORCEMENT	The recently updated in 2019 and amended in 2021 private tree by-law regulates injury to and removal of all trees of a minimum size, in line with other nearby municipalities. All City trees are also protected. Penalties for offences are included in the bylaw. The penalties include fines and planting of replacement trees. Costs related to contracted tree plantings as well as for compensation in-lieu need to be updated annually and applied consistently across different types of development.	The City's bylaws are similar to, or stricter than, other nearby municipalities (such as New Westminster, Vancouver, and Coquitlam) which have similar bylaws in place to protect private and public trees. These bylaws often require an arborist report for construction plans and refer to protection standards for work close to trees. Guelph has a Tree Technical Manual which establishes guidelines, standards, and specifications for the preservation, protection and operational activities involving trees on public and private land.	Remove permit exemption for hedges by grouping hedges as a single tree. • 1-2 years Review suitability and enforcement of existing tree bylaws and protection standards to meet canopy cover goals. • Every 5 years Update City planning documents to be consistent with tree bylaw and Roadmap. • 1-2 years
TREE PROTECTION POLICY: REPLACEMENT RATIO	Current ratio is 1 tree if <60 cm DBH removed, 2 trees if over 60 cm DBH removed. No replacement trees required for injuries. Exemptions exist for the removal of hedges as well as for tree removals within 5 metres of a retained tree. When there is insufficient room for on-site planting, cash in lieu fees may be paid. Permit and cash in lieu fees contribute to the City's reserve fund for tree planting.	Some municipalities' ratios are proportional to the diameter of removed tree(s) (1-3 trees for Burnaby, 2-6 trees for Maple Ridge, 1 per 10cm DBH removed in Oakville). Toronto's ratio is relative to the removed tree's condition (1:1 to 3:1). Vancouver's ratio is 1:1 for large-growing species and 2:1 for smaller-growing trees. Coquitlam's ratio is a function of the lot size and the number of remaining trees.	Strengthen replacement ratio measures by removing the exemption for trees removed within 5 metres of a retained tree. • 1-2 years
MAINTENANCE OF PUBLIC MANAGED TREES	The City's pruning maintenance operates on a 5 to 7 year cycle. Young trees are structurally pruned. This is in line with recommended industry standards. For inventoried trees pruned by City staff, a description of the maintenance work is documented. Nevertheless, approximately 65% of maintenance calls are in response to residents' requests.	New Westminster structural prunes all immature trees and has a 7 year cycle goal for street tree pruning. Vancouver also does not provide its current cycle but has goals to shorten the cycle time and increase maintenance levels on younger trees. Similarly, Richmond Hill has a 10 year pruning cycle with plans to shorten this to 7-8 years.	Use the inventory data to schedule maintenance on an appropriate pruning cycle. • Annually on an appropriate cycle
MANAGEMENT OF PUBLICLY OWNED NATURAL AREAS	Significant effort by urban forestry staff is put toward trail maintenance and invasive species removal. However, this is a reactive measure rather than an action directed by a long-term strategic plan. The Hyde Creek Integrated Watershed Management Plan exists but is oriented to stormwater management. Creating a natural area management strategy for habitat restoration, hazard tree management, ecosystem mapping, and recreational use would guide future practices and facilitate resource planning. The management strategy should address flora and fauna (eg. protecting rare species, invasive species removal, habitat restoration, forest fragmentation) as well as public use, tree hazard, and fire.	New Westminster targeted natural area management strategies for managing invasives as well as a City-wide Biodiversity and Natural Areas Strategy underway. Surrey and Vancouver have natural area management plans. Surrey has individual strategy documents for 7 topics within natural area management as well as for 3 individual parks. These strategies are comprehensive and include operational recommendations and detailed issue analysis.	Map existing natural areas to identify neighbourhoods lacking equitable access to nature and wild spaces. • 3-5 years Develop a natural area management strategy that assesses forest health, biodiversity, emerging threats, area use objectives, management goals, and implementation steps. • 7-10 years

Table Continued >

INDICATOR	SUPPORTING INFORMATION FOR THE CITY'S PERFORMANCE	COMPARISON TO OTHER MUNICIPALITIES	ACTION • IMPLEMENTATION TIMEFRAME
NATIVE VEGETATION	No list of native trees provided by the City. The City encourages the use of native plants in place of invasive plants and maintains a list of invasives on its website. However, native trees are not identified in the City's Replacement Tree List. Six rare, native tree species also receive special protection under the tree bylaw.	New Westminster and Vancouver offer basic information on invasive plants and discourage their use in gardens. The latter also indicates which trees are native in their recommended replacement tree planting list. Toronto often requires native trees for replacement tree plantings and provides a brochure for native plant gardening.	Develop a priority planting list of commercially available native and climate adapted tree and plant species. The list is for use within natural and ravine area buffers to serve as a resource for private landowners and include guidance for landscaping when planting close to structures. A "no plant list" is recommended to correspond with the priority planting list of recommended species. This list will include invasive species and over represented species already planted. • 2-3 years
TREE PEST MANAGEMENT	No City-led forest pest monitoring is being done and pest management is done on a reactive level. There is no consolidated online resource for common tree pests on the City's website. The City has a webpage and brochure for the Chafer Beetle, a grass pest, but lacks comparable resources for tree pests. The Pesticide Use Control Bylaw bans the non-essential use of cosmetic pesticides for maintaining outdoor trees, shrubs, flowers, other ornamental plants or turf.	Pest management is partially done by the CFIA as well as the provincial and federal government for high risk pests. Cities with management plans typically have an additional pest monitoring system in place to identify existing or new threats (New Westminster, Vancouver (Stanley Park), Toronto). Some cities have a website dedicated to common tree pests (Toronto, Vancouver, Surrey). They provide tips for residents as well as links to the CFIA website.	Expand the staff to include a dedicated forestry pest management position. • 1-□ years Create and distribute resources to educate the public. • 2-3 years Create an Integrated Pest Management Strategy. • 2-4 years

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APPENDIX 1

PROVINCIAL NOXIOUS PLANT LIST		
BUR CHERVIL (ANTHRISCUS CAUCALIS)	GORSE (ULEX EUROPAEUS)	NUTSEDGE, YELLOW (CYPERUS ESCULENTUS)
CANADA THISTLE (CIRSIUM ARVENSE)	HOUND'S-TONGUE (CYNOGLOSSUM OFFICINALE)	PURPLE LOOSESTRIFE (LYTHRUM SALICARIA)
COMMON REED (PHRAGMITES AUSTRALIS SUBSP. AUSTRALIS)	JOINTED GOATGRASS (AEGILOPS CYLINDRICA)	RUSH SKELETONWEED (CHONDRILLA JUNCEA)
CORDGRASS, DENSE-FLOWERED (SPARTINA DENSIFLORA)	KNAPWEED, DIFFUSE (CENTAUREA DIFFUSA)	SCENTLESS CHAMOMILE (MATRICARIA MARITIMA)
CORDGRASS, ENGLISH (SPARTINA ANGLICA)	KNAPWEED, SPOTTED (CENTAUREA STOEBE)	SOW-THISTLE, ANNUAL (SONCHUS OLERACEUS)
CORDGRASS, SALTMEADOW (SPARTINA PATENS)	KNOTWEED, BOHEMIAN (FALLOPIA X BOHEMICA)	SOW-THISTLE, PERENNIAL (SONCHUS ARVENSIS)
CORDGRASS, SMOOTH (SPARTINA ALTERNIFLORA)	KNOTWEED, GIANT (FALLOPIA SACHALINENSIS)	TANSY RAGWORT (SENECIO JACOBAEA)
CRUPINA (CRUPINA VULGARIS)	KNOTWEED, HIMALAYAN (POLYGONUM POLYSTACHYUM)	TOADFLAX, COMMON / YELLOW (LINARIA VULGARIS)
DODDER (CUSCUTA SPP.)	KNOTWEED, JAPANESE (FALLOPIA JAPONICA)	TOADFLAX, DALMATIAN (LINARIA GENISTIFOLIA)
FLOWERING RUSH (BUTOMUS UMBELLATUS)	LEAFY SPURGE (EUPHORBIA ESULA)	VELVETLEAF (ABUTILON THEOPHRASTI)
GARLIC MUSTARD (ALLIARIA PETIOLATA)	MILK THISTLE (SILYBUM MARIANUM)	WILD OATS (AVENA FATUA)
GIANT HOGWEED (HERACLEUM MANTEGAZZIANUM)	NORTH AFRICA GRASS (VENTENATA DUBIA)	YELLOW FLAG IRIS (IRIS PSEUDACORUS)
GIANT MANNAGRASS/REED SWEETGRASS (GLYCERIA MAXIMA)	NUTSEDGE, PURPLE (CYPERUS ROTUNDUS)	YELLOW STARTHISTLE (CENTAUREA SOLSTITIALIS)

FOREST PESTS SPECIFIC TO PORT COQUITLAM

Defoliating moths, such as LDD moth (Lymantria dispar dispar) and winter moth (Operophtera brumata), threaten a broad range of hardwood tree hosts, particularly Apples (Malus). While LDD continues to be detected in the region, no established populations exist. During moth outbreaks, the feeding damage weakens the tree host, and renders it more vulnerable to other pests and diseases

In B.C., the LDD moth eradication strategy involves three main steps[1]:

1. Prevention — Preventing LDD moths from entering B.C. is always better than having to eradicate them once they are established
2. Monitoring — Pheromone traps are used to monitor and detect new introductions, and to monitor the success of treatments.
3. Treatment — Methods are designed to eradicate an introduced population quickly while it is still very small.

For treatment, there are multiple pesticide options available that are very effective for large outbreaks. For single trees, it is recommended that homeowners use burlap tree banding. This is a moderately effective treatment but requires regular checking and a fair bit of effort to maintain effectiveness. This option is the most environmentally conscious as no chemical are used for treatment and the effect on other unintended targets is minimal.

Japanese Beetle (Popillia japonica) is an invasive, regulated pest that feeds on the roots of turf grass and foliage of more than 300 plant species including both food and landscape plants. If this pest spreads, it could cause damage to B.C.'s agricultural sector, as well as food and ornamental gardens and turf in lawns, parks, sports fields and golf courses.

For treatment, the BC government works closely with the CFIA to conduct intensive trapping programs in and around the infected area of Vancouver. The CFIA has established a regulated area where the beetle is present. Within the regulated area, restrictions are in place for the movement of plant material, landscape waste, and soil to control the spread of Japanese beetle. If found, two treatments will be applied manually by trained and licensed pest management specialists and will be as unobtrusive as possible:

- A larvicide will be applied once per year to turf in the infested areas to kill Japanese beetle larvae.
- A foliar (leaf) application of the biological insecticide BeetleGONE!, Bacillus thuringiensis subsp. galleriae (Btg), will be applied to foliage during beetle flight in landscape beds where adult beetles are suspected. Depending on the weather and beetle development patterns, up to five applications may be required, generally at one-week intervals[2].

Hemlock Looper Moth (Lambdina fiscellaria) is a native defoliator of western hemlock, western redcedar, interior spruce and Douglas-fir. This insect periodically reaches outbreak levels, causing severe damage to forests in both Interior and coastal stands in British Columbia.

The Southern Interior Area manages western hemlock looper damage by monitoring populations in susceptible stands. When significant damage is predicted, plans are developed to reduce defoliation through targeted aerial spraying using the biological insecticide Bacillus thruringiensis var. kurstaki (Btk). This is not practical for an urban forest setting like Port Coquitlam due to the nature of urban forests with single trees spread around the city, but treatment on a tree-by-tree basis can utilized with a similar insecticide[3].

Asian Long-horned Beetle (ALHB, Anoplophora glabripennis) is an invasive insect that threatens many hardwood trees, particularly Maples (Acer). Currently B.C. does not have any ALHB infestations in the province as determined by the Invasive Species Council of B.C. However, it is a wood-boring insect that has the potential to be accidentally transported here in shipping containers, wooden packaging materials, and vehicles traveling from regions where it is established.

Western Spruce Budworm (Choristoneura freemani) is a native defoliating moth that can cause substantial damage during outbreak years. This moth has a wide range of coniferous hosts but is most threatening to Douglas fir (Pseudotsuga menziesii) and species of true fir (Abies). The feeding damage can kill the tops of trees, decrease tree vigor / growth, and in severe cases they cause tree death.

Vascular diseases including Kretzschmaria deusta, commonly known as "brittle cinder" or "burn crust" fungus, is an Ascomycete fungus that affects broadleaved trees. It is considered one of the most important root and butt decay pathogens in urban trees. It causes soft rot type II and has a broad host range. Within Metro Vancouver Regional Parks maple trees appear to be the primary host for the disease. There are no chemicals available to eliminate the brittle cinder fungus. Once the fungus is established, the tree will be lost in a relatively short period of time. The management tasks are focused on reducing the spread of the pathogen and minimizing the impact of the fungal infection. Regular monitoring of trees in high-risk areas where Bigleaf Maples are abundant, minimizing the access of vehicles, public and pets to affected areas, and removal of old fallen stems to avoid the spread of the fungal spores is recommended[4.

[1] "Lymantria (formerly referred to as Gypsy Moth) in British Columbia". https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/invasive-forest-pests/lymantria

[2] "Japanese beetle pest alert". https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/nursery-and-ornamentals/japanese-beetle

[3] "Western hemlock looper" https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/defoliators/western-hemlock-looper

[4] "Forest fungal pathogen management – best practices for Regional Parks". 2018. https://sustain.ubc.ca/sites/default/files/2018-32%20Forest%20Fungal%20Pathogen%20Management%20Best%20Practices%20for%20Regional%20Parks_Marin%20Bruzos.pdf

APPENDIX 2

RANKING SYSTEM OF THE KEY OBJECTIVES AND PERFORMANCE INDICATORS USED TO ASSESS THE STATUS OF A MUNICIPALITY'S URBAN FOREST AS WELL AS ITS MANAGEMENT.

INDICATOR	KEY OBJECTIVE	LOW	FAIR	GOOD	OPTIMAL
RELATIVE TREE CANOPY COVER	Achieve desired degree of tree cover, based on potential or according to goals set for entire municipality and for each neighborhood or land use.	The existing canopy cover for entire municipality is <50% of the desired canopy.	**The existing canopy is 50%-75% of desired.**	The existing canopy is >75%-100% of desired.	The existing canopy is >75%-100% of desired – at individual neighborhood level as well as overall municipality.
AGE DIVERSITY (SIZE CLASS DISTRIBUTION)	Provide for ideal uneven age distribution of all "intensively" (or individually) managed trees – municipality-wide as well as at neigh-borhood level.	Even-age distribution, or highly skewed toward a single age class (maturity stage) across the entire population.	Some uneven distribution, but most of the tree population falls into a single age class.	**Total tree population across the municipality approaches an ideal age distribution of 40% ju-venile (0-20cm), 30% small (21-41cm), 20% medium (42-61cm), and 10% large (>61cm).**	Total population approaches that ideal distribution municipality-wide as well as at the neighborhood level
SPECIES DIVERSITY	Establish a genetically diverse tree population across municipalities as well as at the neighborhood level.	**Five or fewer species dominate the entire tree population across municipalities.**	No single species represents more than 10% of total tree population; no genus more than 20%; and no family more than 30%.	No single species represents more than 5% of total tree population; no genus more than 10%; and no family more than 15%.	At least as diverse as "Good" rating (5/10/15) municipality-wide – and at least as diverse as "Fair" (10/20/30) at the neighborhood level.
PUBLICLY OWNED TREES (MANAGED "INTENSIVELY")	Current and detailed understanding of the condition and risk potential of all publicly owned trees that are managed intensively (or individually). Tree inventory used to guide management.	Condition of the urban forest is unknown.	Sample-based tree inventory indicating tree condition and risk level.	**Partial tree inventory that includes detailed tree condition ratings and is guiding management decisions.**	Complete tree inventory that is GIS-based and includes detailed tree conditions as well as risk ratings. Map of urban for-est integrated into municipality-wide GIS system.
PUBLICLY OWNED NATURAL AREAS (MANAGED "EXTENSIVELY")	Detailed understanding of the ecological structure and function of all publicly owned natural areas (such as woodlands, ravines, stream corridors, etc.), as well as usage pat-terns.	**No information about publicly owned natural areas.**	Publicly owned natural areas identified in a "natural areas survey" or similar document.	**Survey document also tracks the level and type of public use in publicly owned natural areas.**	In addition to usage patterns, ecological structure and func-tion of all publicly owned natural areas are also assessed and documented
MUNICIPAL AGENCY COOPERATION	All municipal departments and agencies cooperate to advance goals related to urban forest issues and opportunities.	**Municipal departments/agencies take actions impacting urban forest with no cross-departmental coordination or consideration of the urban forest resource.**	Municipal departments/ agencies recognize potential conflicts and reach out to urban forest managers on an ad hoc basis – and vice versa.	Informal teams among departments and agencies communicate regularly and collaborate on a project-specific basis.	Municipal policy implemented by formal interdepartmental or interagency working teams on all municipal projects.

Table Continued >

INDICATOR	KEY OBJECTIVE	LOW	FAIR	GOOD	OPTIMAL
CITIZEN INVOLVEMENT AND NEIGHBORHOOD ACTION	At the neighborhood level, citizens participate and groups collaborate with the municipality and/ or its partnering NGOs in urban forest management activities to advance municipality-wide plans.	Little or no citizen involvement or neighborhood action.	**Some neighborhood groups engaged in advancing urban forest goals, but with little or no overall coordination with or direction by mu-nicipality or its partnering NGOs.**	Many active neighborhood groups engaged across the community, with actions coordinated or led by municipality and/or its partnering NGOs.	Proactive outreach and coordination efforts by municipality and NGO partners resulting in widespread citizen involvement and collaboration among active neighborhood groups engaged in urban forest management.
CANOPY COVER ASSESSMENT GOALS	Urban forest policy and practice driven by accurate, high-resolution, and recent assessments of existing and potential canopy cover, with comprehensive goals municipality-wide and at neighborhood or smaller management level.	No assessment or goals.	Low-resolution and/or point-based sampling of canopy cover using aerial photographs or satellite imagery – and limited or no goal-setting.	**Complete, detailed, and spatially explicit, high-resolution Urban Tree Canopy (UTC) assess-ment based on enhanced data (such as LiDAR) – accompanied by comprehensive set of goals by land use and other parame-ters.**	As described for "Good" rating – and all utilized effectively to drive urban forest policy and practice municipality-wide and at neighborhood or smaller management level. [MS2]
ENVIRONMENTAL JUSTICE AND EQUITY	Ensure that the benefits of urban forests are made available to all, especially to those in greatest need of tree benefits.	Tree planting and outreach is not determined equitably by canopy cover or need for benefits.	**Planting and outreach includes attention to low cano-py neighborhoods or areas.**	Planting and outreach targets neighborhoods with low canopy and a high need for tree benefits.	Equitable planting and outreach at the neighborhood level is guided by strong citizen engagement in those low-canopy/ high-need areas.
MUNICIPAL URBAN FOREST PROGRAM CAPACITY	Maintain sufficient well-trained personnel and equipment – whether in-house or through contracted or volunteer services – to implement municipality-wide Urban Forest Management Plans	Team severely limited by lack of personnel and/or access to adequate equipment. Unable to perform adequate maintenance, let alone implement new goals.	**Team limited by lack of staff and/ or access to adequate equipment.**	Team able to implement many of the goals and objectives of the Urban Forest Management Plan	Team able to implement all of the goals and objectives of the Urban Forest Management Plan.
TREE ESTABLISHMENT PLANNING AND IMPLEMENTATION	Comprehensive and effective tree planting and establishment program is driven by canopy cover goals and other considerations according to plan.	Little or no tree planting; tree establishment is ad hoc.	**Some tree planting and establishment occurs, but with limited overall municipality-wide planning and post-planting care.**	Tree planting plan is guided by municipality-wide goals, with some post-planting establishment care.	Comprehensive tree establish-ment plan is guided by needs derived from canopy and other assessments, maintains species and age diversity, includes both planting and young tree care, and is sufficient to make progress toward canopy cover objectives.
GROWING SITE SUITABILITY	All publicly owned trees are selected for each site and planted in conditions that are modified as needed to ensure survival and maximize current and future tree benefits.	Trees selected and planted without consideration of site conditions.	**Appropriate tree species are considered in site selection.**	Municipality-wide guidelines in place for the improvement of planting site conditions and se-lection of suitable species.	All trees planted in sites with adequate soil quality and quantity, and with sufficient growing space and overall site condi-tions to achieve their genetic potential and thus provide maximum ecosystem services.

Table Continued >

INDICATOR	KEY OBJECTIVE	LOW	FAIR	GOOD	OPTIMAL
TREE PROTECTION POLICY DEVELOPMENT AND ENFORCEMENT	The benefits derived from trees on public and private land are ensured by the enforcement of municipality-wide policies, including tree care "best management practices".	No tree protection policy.	Policies in place to protect public trees and employ industry best management prac-tices, but inconsistently en-forced.	**Policies and practices in place to protect public and private trees, generally enforced.**	Integrated municipality-wide policies and practices to protect public and private trees, consistently enforced and supported by significant deter-rents.
MAINTENANCE OF PUBLIC MANAGED TREES	All publicly owned, intensively (or individually) managed trees are well maintained for optimal health and condition in order to extend longevity and maximize current and future benefits.	No maintenance of publicly owned trees, or on a reactive basis only.	Publicly owned trees receive only periodic inspection and maintenance.	**Publicly owned trees are inspected and proactively main-tained on a cyclical basis.**	All publicly owned, intensively managed trees are routinely and thoroughly maintained on an ongoing basis according to a comprehensive management plan.
MANAGEMENT OF PUBLICLY OWNED NATURAL AREAS	The ecological integrity of all publicly owned natural areas is protected and enhanced – while accommodating public use where appropriate.	No natural areas management plans or implementation in effect.	**Only reactive management efforts to facilitate public use (e.g., hazard abatement, trail maintenance).**	Management plan in place for each publicly owned natural area to facilitate appropriate public use.	Management plan for each publicly owned natural area focused on sustaining and, where pos-sible, improving overall ecological integrity (i.e., structure and function) – while facilitating appropriate public use.
NATIVE VEGETATION	Preservation and enhancement of local natural biodiversity.	No coordinated focus on native vegetation.	**Voluntary use of native species on publicly and privately-owned lands; invasive species are recognized.**	Use of native species is encour-aged on a project-appropriate basis in all areas; invasive species are recognized and discouraged on public and private lands.	Native species are widely used on a project-appropriate basis in all areas; invasive species are proactively managed for eradication to the full extent possi-ble.
REPLACEMENT RATIO	Require replacement plantings for tree removals to offset loss of canopy cover.	No replacement trees required.	Replacement trees required at a maximum 1:1 ratio. Minimum tree requirements sparse or unspecified.	**Replacement trees required at a minimum 1:1 ratio. Minimum tree requirements for planting size, size at maturity, and species recommended.**	Replacement tree ratio is a function of tree condition and the amount of diameter removed. Large-growing, long-lived, adaptable species recommended.
TREE PEST MANAGEMENT	Adequately manage new and existing pests and monitor levels.	**No pest management, monitoring or education is being done.**	**Pest management is done on a reactive base only, no monitoring is being done and no education is being done**	Pest management is being monitored and partially managed with some education.	Pest management is being monitored across the city and man-aged adequately combined with public and private education.

Table Continued >

APPENDIX 3

METHODOLOGY AND ACCURACY ASSESSMENT

DAVEY RESOURCE GROUP CLASSIFICATION METHODOLOGY

Davey Resource Group utilized an object-based image analysis (OBIA) semi-automated feature extraction method to process and analyze current high-resolution color infrared (CIR) aerial imagery and remotely-sensed data to identify tree canopy cover and land cover classifications. The use of imagery analysis is cost-effective and provides a highly accurate approach to assessing your community's existing tree canopy coverage. This supports responsible tree management, facilitates community forestry goal-setting, and improves urban resource planning for healthier and more sustainable urban environments.

Advanced image analysis methods were used to classify, or separate, the land cover layers from the overall imagery. The semi-automated extraction process was completed using Feature Analyst, an extension of ArcGIS®. Feature Analyst uses an object-oriented approach to cluster together objects with similar spectral (i.e., color) and spatial/contextual (e.g., texture, size, shape, pattern, and spatial association) characteristics. The land cover results of the extraction process was post-processed and clipped to each project boundary prior to the manual editing process in order to create smaller, manageable, and more efficient file sizes. Secondary source data, high-resolution aerial imagery provided by each UTC city, and custom ArcGIS® tools were used to aid in the final manual editing, quality checking, and quality assurance processes (QA/QC). The manual QA/QC process was implemented to identify, define, and correct any misclassifications or omission errors in the final land cover layer.

Classification Workflow

1. Prepare imagery for feature extraction (resampling, rectification, etc.), if needed.

2. Gather training set data for all desired land cover classes (canopy, impervious, grass, bare soil, shadows). Water samples are not always needed since hydrologic data are available for most areas. Training data for impervious features were not collected because the City maintained a completed impervious layer.

3. Extract canopy layer only; this decreases the amount of shadow removal from large tree canopy shadows. Fill small holes and smooth to remove rigid edges.

4. Edit and finalize canopy layer at 1:2000 scale. A point file is created to digitize-in small individual trees that will be missed during the extraction. These points are buffered to represent the tree canopy. This process is done to speed up editing time and improve accuracy by including smaller individual trees.

5. Extract remaining land cover classes using the canopy layer as a mask; this keeps canopy shadows that occur within groups of canopy while decreasing the amount of shadow along edges.

6. Edit the impervious layer to reflect actual impervious features, such as roads, buildings, parking lots, etc. to update features.

7. Using canopy and actual impervious surfaces as a mask; input the bare soils training data and extract them from the imagery. Quickly edit the layer to remove or add any features. Davey Resource Group tries to delete dry vegetation areas that are associated with lawns, grass/meadows, and agricultural fields.

8. Assemble any hydrological datasets, if provided. Add or remove any water features to create the hydrology class. Perform a feature extraction if no water feature datasets exist.

9. Use geoprocessing tools to clean, repair, and clip all edited land cover layers to remove any self-intersections or topology errors that sometimes occur during editing.

10. Input canopy, impervious, bare soil, and hydrology layers into Davey Resource Group's Five-Class Land Cover Model to complete the classification. This model generates the pervious (grass/low-lying vegetation) class by taking all other areas not previously classified and combining them.

11. Thoroughly inspect final land cover dataset for any classification errors and correct as needed.

12. Perform accuracy assessment. Repeat Step 11, if needed.

Automated Feature Extraction Files

The automated feature extraction (AFE) files allow other users to run the extraction process by replicating the methodology. Since Feature Analyst does not contain all geoprocessing operations that Davey Resource Group utilizes, the AFE only accounts for part of the extraction process. Using Feature Analyst, Davey Resource Group created the training set data, ran the extraction, and then smoothed the features to alleviate the blocky appearance. To complete the actual extraction process, Davey Resource Group uses additional geoprocessing tools within ArcGIS®. From the AFE file results, the following steps are taken to prepare the extracted data for manual editing.

1. Davey Resource Group fills all holes in the canopy that are less than 30 square meters. This eliminates small gaps that were created during the extraction process while still allowing for natural canopy gaps.

2. Davey Resource Group deletes all features that are less than 9 square meters for canopy (50 square meters for impervious surfaces). This process reduces the amount of small features that could result in incorrect classifications and also helps computer performance.

3. The Repair Geometry, Dissolve, and Multipart to Singlepart (in that order) geoprocessing tools are run to complete the extraction process.

4. The Multipart to Singlepart shapefile is given to GIS personnel for manual editing to add, remove, or reshape features.

Accuracy Assessment Protocol - Table 1

LAND COVER CLASSIFICATION	CODE VALUE
TREE CANOPY	1
IMPERVIOUS	2
PERVIOUS (GRASS/VEGETATION)	3
BARE SOIL	4
OPEN WATER	5

Determining the accuracy of spatial data is of high importance to Davey Resource Group and our clients. To achieve the best possible result, Davey Resource Group manually edits and conducts thorough QA/QC checks on all urban tree canopy and land cover layers. A QA/QC process will be completed using ArcGIS® to identify, clean, and correct any misclassification or topology errors in the final land cover dataset. The initial land cover layer extractions will be edited at a 1:2000 quality control scale in the urban areas and at a 1:2500 scale for rural areas utilizing the most current high-resolution aerial imagery to aid in the quality control process.

To test for accuracy, random plot locations are generated throughout the city area of interest and verified to ensure that the data meet the client standards. Each point will be compared with the most current NAIP high-resolution imagery (reference image) to determine the accuracy of the final land cover layer. Points will be classified as either correct or incorrect and recorded in a classification matrix. Accuracy will be assessed using four metrics: overall accuracy, kappa, quantity disagreement, and allocation disagreement. These metrics are calculated using a custom Excel® spreadsheet.

Land Cover Accuracy

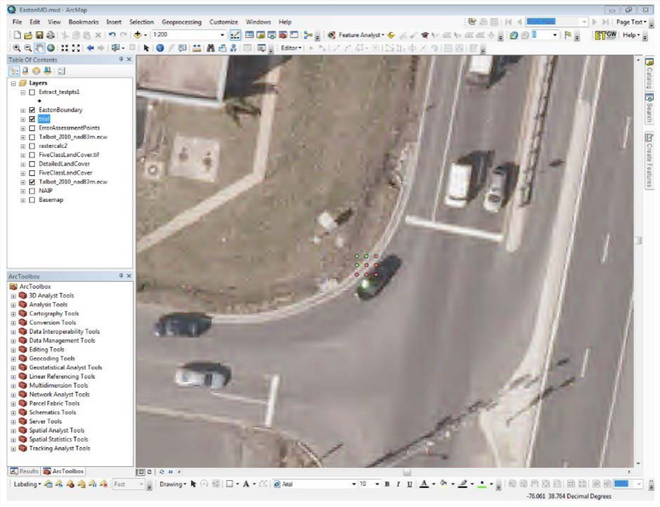
The following describes Davey Resource Group's accuracy assessment techniques and outlines procedural steps used to conduct the assessment.

1. Random Point Generation—Using ArcGIS, 1,000 random assessment points are generated.

2. Point Determination—Each point is carefully assessed by the GIS analyst for likeness with the aerial photography. To record findings, two new fields, CODE and TRUTH, are added to the accuracy assessment point shapefile. CODE is a numeric value (1–5) assigned to each land cover class (Table 1) and TRUTH is the actual land cover class as identified according to the reference image. If CODE and TRUTH are the same, then the point is counted as a correct classification. Likewise, if the CODE and TRUTH are not the same, then the point is classified as incorrect. In most cases, distinguishing if a point is correct or incorrect is straightforward. Points will rarely be misclassified by an egregious classification or editing error. Often incorrect points occur where one feature stops and the other begins.

3. Classification Matrix—During the accuracy assessment, if a point is considered incorrect, it is given the correct classification in the TRUTH column. Points are first assessed on the NAIP imagery for their correctness using a "blind" assessment—meaning that the analyst does not know the actual classification (the GIS analyst is strictly going off the NAIP imagery to determine cover class). Any incorrect classifications found during the "blind" assessment are scrutinized further using sub-meter imagery provided by the client to determine if the point was incorrectly classified due to the fuzziness of the NAIP imagery or an actual misclassification. After all random points are assessed and recorded; a classification (or confusion) matrix is created. The classification matrix for this project is presented in Table 2. The table allows for assessment of user's/producer's accuracy, overall accuracy, omission/commission errors, kappa statistics, allocation/quantity disagreement, and confidence intervals (Figure 1 and Table 3).

Figure 1



CONFIDENCE INTERVALS - Table 2

CLASS	HECTARES	PERCENTAGE	LOWER BOUND	UPPER BOUND
TREE CANOPY	643.6	18.7%	18.0%	19.3%
IMPERVIOUS	1,208.1	35.1%	34.2%	35.9%
GRASS/VEGETATION	1,025.2	29.7%	29.0%	30.5%
BARE SOILS	83.8	2.4%	2.2%	2.7%
WATER	485.8	14.1%	13.5%	14.7%
TOTAL	**3,446.5**	**100.00%**		

STATISTICAL METRICS SUMMARY	
OVERALL ACCURACY	95.60%
KAPPA COEFFICIENT	0.9395
ALLOCATION DISAGREEMENT	3%
QUANTITY DISAGREEMENT	1%

ACCURACY ASSESSMENT - Table 3

CLASS	USER'S ACCURACY	LOWER BOUND	UPPER BOUND	PRODUCER'S ACCURACY	LOWER BOUND	UPPER BOUND
TREE CANOPY	96.8%	95.5%	98.1%	94.7%	93.1%	96.4%
IMPERVIOUS SURFACES	96.2%	95.2%	97.2%	96.5%	95.5%	97.4%
GRASS & LOW-LYING VEGETATION	91.8%	90.2%	93.4%	94.7%	93.4%	96.0%
BARE SOILS	100.0%	100.0%	100.0%	79.2%	70.9%	87.5%
OPEN WATER	100.0%	100.0%	100.0%	99.3%	98.5%	100.0%

APPENDIX 4

GUIDELINES FOR CITY TREE PLANTING

SITE CONSIDERATIONS

- If no sidewalk exists, plant trees at least 3m behind the curb, preferably 4m if property lines allow.
- Plant per ESA (Electrical Safety Authority) Guidelines - only small trees under or within 4.5 m of high voltage overhead utility lines or poles. Medium or small trees are permitted from 4.5 m to 7.6 m from lines or poles. Large, medium, or small trees may be planted 7.6 m or farther from overhead lines or poles.
- No tree is to be planted closer than 3.6 m to the doors or 1.5 m from the sides of an above ground hydro vault (transformer).
- Trees may be planted at 0.5 m (measured horizontally) from buried street light cable, not closer than 0.9 m (measured horizontally) from other buried electric cables and not closer than 0.3 m (measured horizontally) from buried telephone and/or TV service cables where their location is known.
- No tree is to be closer than 2.0 m to a driveway or 0.5 m from a sidewalk going into a property
- No tree is to be closer than 6 m in line of sight to a stop sign or Railway Crossing Sign on a residential street only (i.e. not a collector or arterial road).
- No tree is to be closer than 15.0 m in line of sight to a stop sign or traffic signal light or Railway Crossing Sign on any collector or arterial road.
- No tree is to be closer than 3 m to the front and sides of a fire hydrant.
- No tree is to be closer than 0.3 m (measured horizontally) to a water main, or 0.7 m from a shutoff.
- No tree is to be closer than 0.2 m (measured horizontally) to a gas line.
- No tree may be closer than 2.0 m (measured horizontally) to a sanitary sewer.
- No tree may be closer than 3.0 m to another tree.
- No tree is to be closer than 4 m to a street light pole.

Tree planting locations will be determined on a site-specific basis. As a goal, no less than one tree should be planted for each lot. Larger lots and corner lots may have more than one tree.

Since large trees contribute more to the environment and the neighbourhood than small ones, the largest tree that is suitable for the location is to be planted, considering eventual size at maturity. Plantable space may include the boulevard in front of, or rear of, the sidewalk (where present). Tree locations may be staggered and/or grouped where appropriate to make the best use of available planting and growing space. All trees are to be planted on City property.

Prospective planting sites should be protected from soil compaction, prior to and after planting.

DESIGN AND SPECIES CONSIDERATIONS

Use of species with high adaptability to climate change is desirable.

Use of native species over non-native and invasive species is desirable. Native means naturally occurring (indigenous) to British Columbia and the region.

No more than five of any one species or variety is to be planted on one side of the street in a row. Trees should be matched one side of the street to the other (maximum of 10 matched trees) to provide a ‘closed canopy’ effect at maturity.

The planting should reflect the landscape character of plantings in adjacent neighbourhoods. It is not necessary and may not be desirable to match species in adjacent neighbourhoods, but consideration should be given to a neighbourhood identity with similar tree shape and size at maturity.

In order to integrate species diversity into each neighbourhood, the species mix shall provide no more than 10% of any one species City wide.

Trees with similar shape (eg. vase, oval, upright) are to be selected to provide a neighborhood landscape character.

Trees with large or messy fruit may be planted only in limited situations.

Trees with large thorns are not permitted and species such as poplar and willow are discouraged for street tree planting.

Coniferous needle-bearing trees will not be in boulevards, as they can cause sight line obstructions but may be planted rear of the sidewalk.

Plant according to current British Columbia Landscape Standards

To meet minimum soil volume requirements, at least 0.3 m3 of soil and preferably 0.6 m3 of soil per meter square of mature canopy area is recommended (Metro Vancouver, 2017). These soil volumes relate approximately to a surface area per tree, 8 m2 for a small tree and 35 m2 or more for a large tree (Table 1) assuming 1 m depth.

Table 1. Minimum recommended soil volume per tree, taken from Metro Vancouver 2017 “Tree Regulations Toolkit”

TREE SIZE	MINIMUM SOIL VOLUME (M3)	SHARED OR IRRIGATED SOIL VOLUME (M3)
SMALL TREE CANOPY SPREAD IS UP TO 6 M	8	6
MEDIUM TREE CANOPY SPREAD IS UP TO 10 M	10	15
LARGE TREE CANOPY SPREAD IS GREATER THAN 10 M	35	30

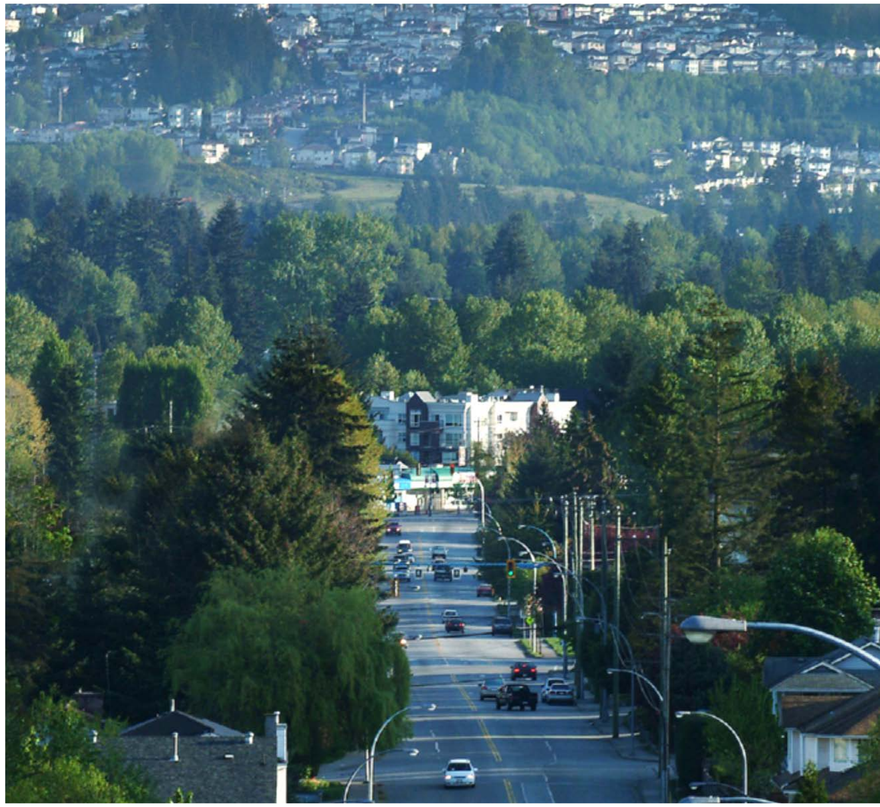
Balled and burlapped trees are preferred. Bare root trees are not acceptable. All synthetic twine should be removed and burlap should be pulled back. Trees must not show visible signs of damage

A tree should only be staked if it is unable to stand on its own, or when planted on boulevard. When staking, the stake should be placed on the windward side of the tree avoiding damage to the trunk and root ball. The tree should be tied to the stake, allowing for natural movement of the trunk. The stake should be fastened to the tree with a figure-eight loop tie of a soft elasticized material. The stake should be removed after one year or when the tree is established.

2021-2050

CITY OF PORT COQUITLAM

URBAN FOREST ROADMAP



Prepared by Davey Resource Group (DRG) consulting team.