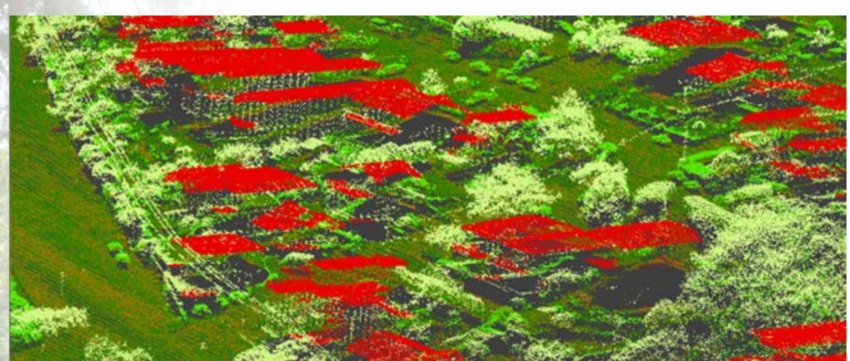
3 Status and Trends

This section describes the current state of Richmond's urban forest and how it is changing. Several methods were used to analyze past and present urban forest status including LiDAR, historical aerial photos, vegetation maps, and the City's tree and habitat inventory data.

LiDAR is flown with a laser sensor shooting pulses down to the ground surface to create a 3D model of the ground below. The City collected LiDAR data in August 2017 to measure the extent of Richmond's tree canopy and permeability.

The points can then be classified into different features like trees, buildings, roads, powerlines and so on. Some of the products of the LiDAR used in this section include canopy mapping, impermeable area mapping, and tree heights. LiDAR collected in the future will enable detailed canopy change monitoring. The City will conduct flights every few years to monitor the change.

Example image of a LiDAR point cloud (in three dimensions, showing raw data that will be processed to generate a map of tree canopy.



3.1 Tree Canopy

Tree canopy is a common metric used to describe the extent of a city's urban forest and a tool to monitor its change over time. To visualize it, imagine looking down from an aerial view at the green layer of tree crowns (leaves and branches) below.

City-Wide Tree Canopy

Canopy cover across the city was 12% based on 2017 LiDAR capture. This estimate includes public and private properties, as well as land areas in the Agricultural Land Reserve and Vancouver International Airport.

While there isn't a precise means to estimate Richmond's pre-contact forest cover, historical vegetation mapping suggests that roughly 1,600 ha (~12%) of Richmond supported deciduous-coniferous forest, with additional cover in forested bog areas. The remainder of the approximately 11,200 ha (~88%) of the city supported grass or shrub cover.

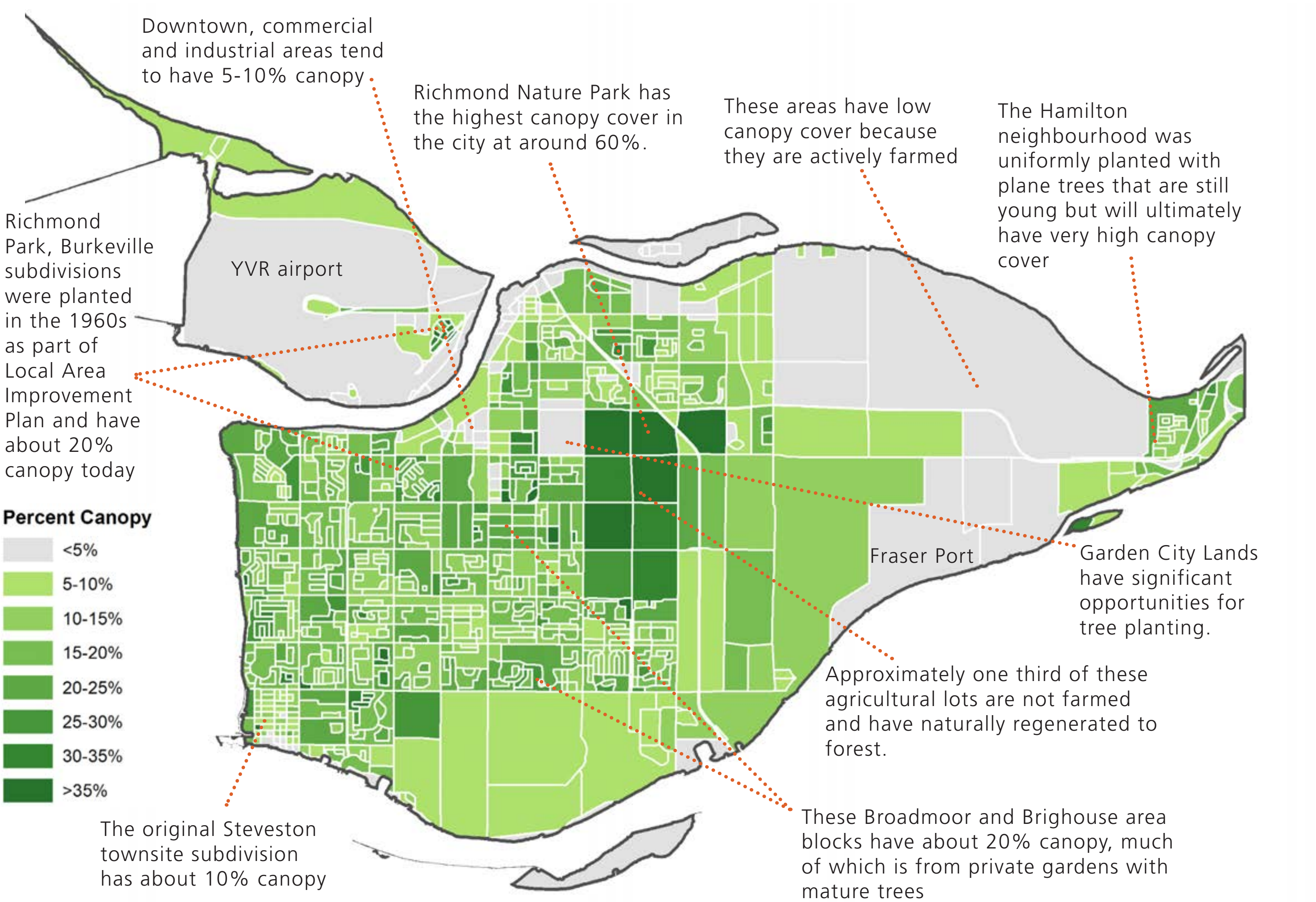
The map below summarizes the tree canopy by census dissemination blocks. Canopy cover is concentrated in Richmond's residential neighbourhoods, parks, natural areas and fallow farmland that has regenerated to forest.

Public Tree Canopy

Tree canopy over public land averages 20%. Within parks canopy cover is higher, averaging 24%, while on street boulevards canopy cover is lower, averaging 15%.

This Strategy sets a target to increase canopy cover over the **public realm** from 20% to 30% by 2045. This target is aspirational yet realistic in that it aims to plant out two-thirds of the potential sites in the City presently (factoring in that utility conflicts will eliminate up to one third of potential planting sites).

Map of Richmond's City-Wide Tree Canopy



Regional Canopy Change

Changes in canopy cover globally are tracked by University of Maryland scientists using satellite imagery. The Global Forest Cover Change dataset maps forest loss between 2000 and 2017 (Hansen et al. 2013).

While this dataset cannot detect isolated individual tree loss, it is good for showing large-scale changes across the landscape. Province-wide, the area of canopy loss exceeds the area of canopy gain in more than 90% of BC municipalities.

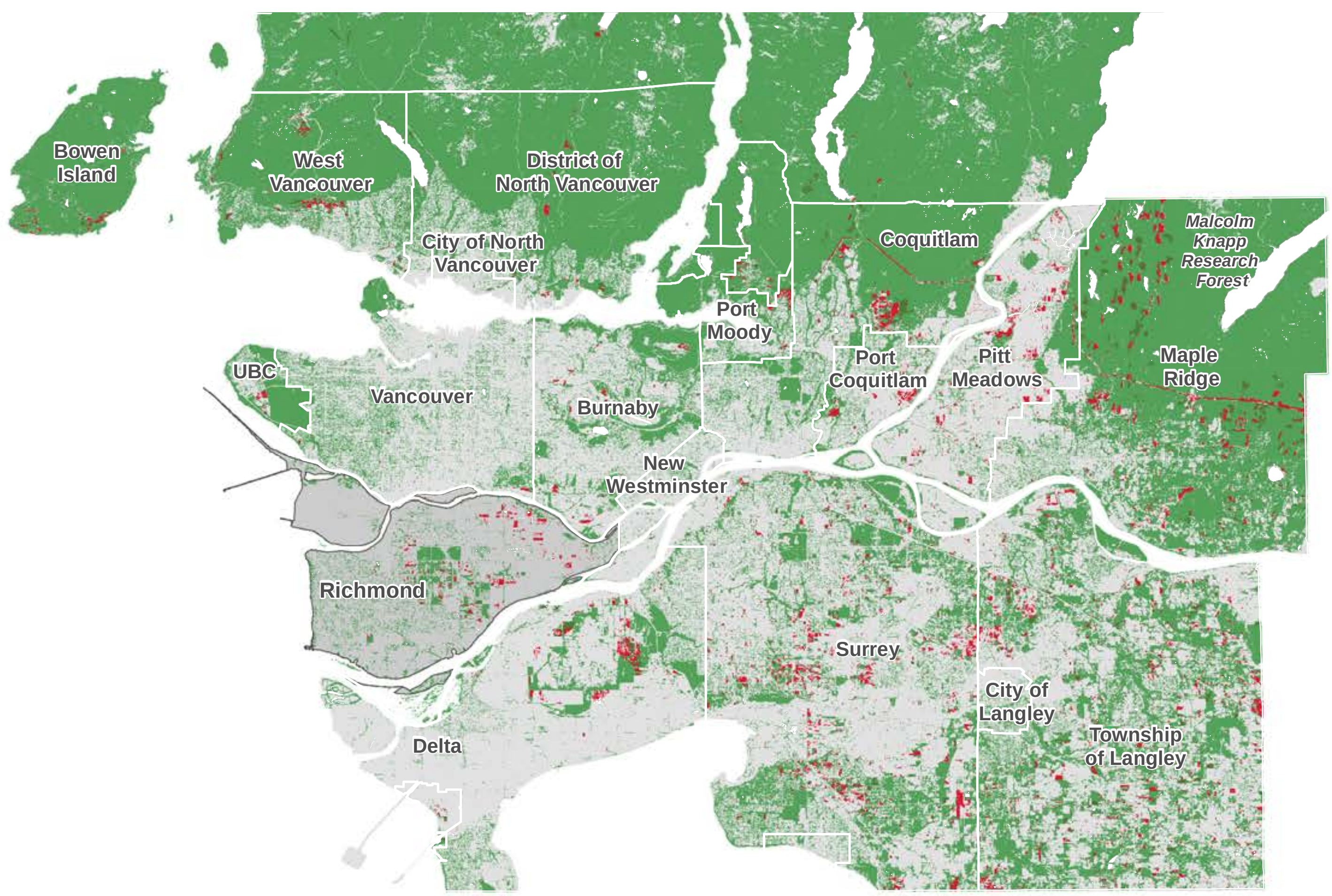
In the map below, the green canopy for the region is sourced from Metro Vancouver's land cover classification data. The red areas showing loss are sourced from the Global Forest Cover Change data.

Richmond's Canopy Change

In Richmond, the areas showing red are mostly associated with agricultural use and cropping changes rather than actual tree loss. While some urban losses are visible – for example commercial and town home developments in City centre – in general the tree canopy has been relatively stable since 2000. Canopy changes not detectable in this dataset are typically planting and removal of individual or small groups of trees. Canopy losses in Richmond have primarily occurred on private land.

In Richmond, large areas are under the jurisdiction of the federal or provincial governments, including YVR Vancouver International Airport and Fraser Port, or are within the Agricultural Land Reserve. While some of these land uses preclude tree planting, the City can work with these agencies and landowners to plant suitable trees on adjacent city roads and properties where possible.

Map of regional canopy and canopy loss



3.2 Richmond's Native Forests and Bogs

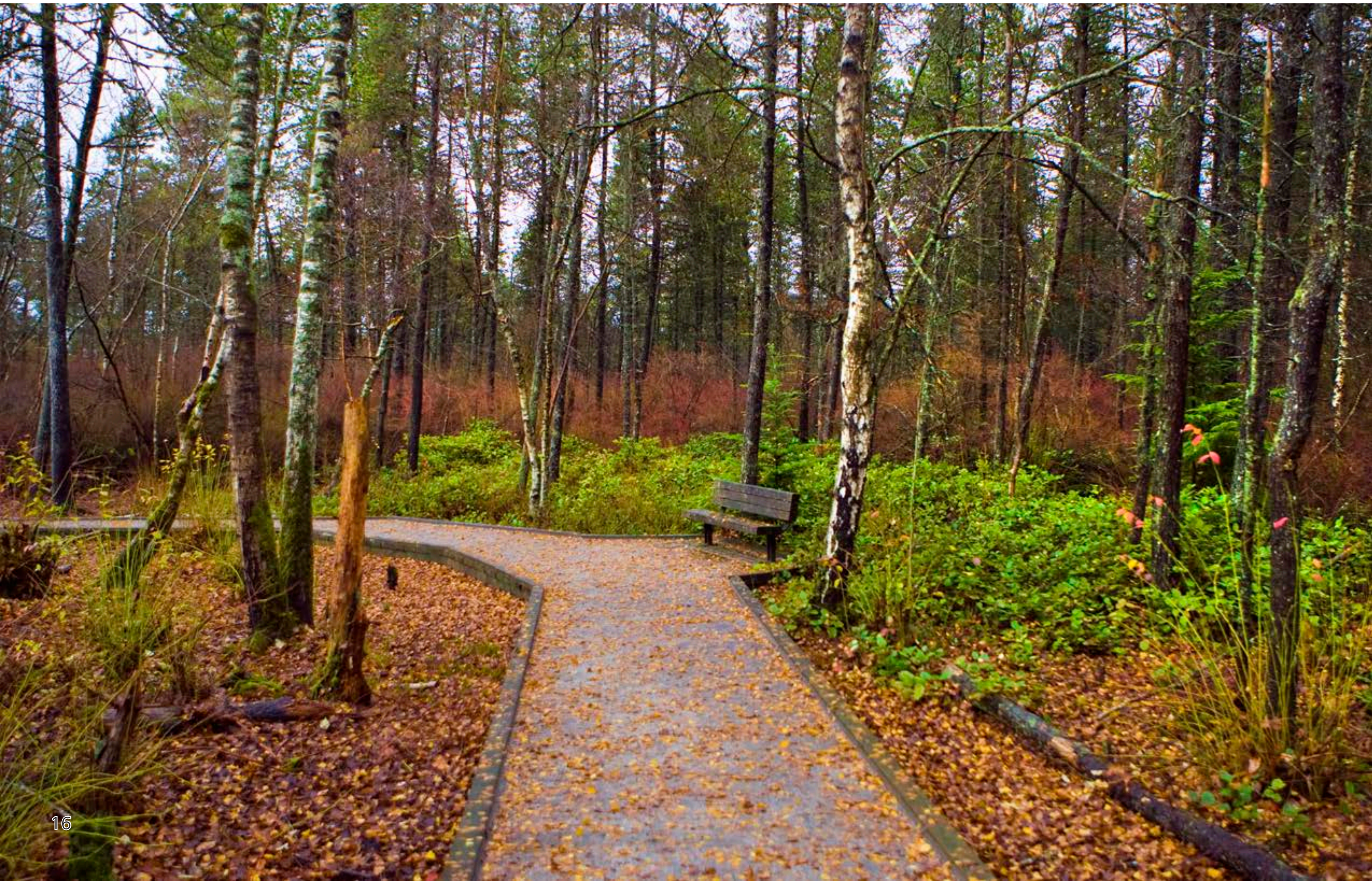
Richmond's natural areas today bear little resemblance to vegetation surveyed pre-1880s (see the map on page 17). Agriculture, urbanization, hydrological changes and peat mining have permanently impacted the landscape and altered ecosystems.

The 2002 habitat inventory identified 568 ha of bog and upland forest in Richmond that provides habitat for small mammals and birds such as woodpeckers, great blue heron, red-tailed hawks and barn owls. Approximately 120 ha of this native forest habitat is protected in Richmond's park system and most of the remainder is within the Environmentally Sensitive Areas (ESAs) Development Permit Area that applies to private land.

Present day bog habitats are dominated by paper and European birch or lodgepole pine. Dryland and riparian forest habitats include birch woodlands, black cottonwood and alder forests at the river's edge, and scattered stands of non-native trees like black locust, oak and maple. Understory vegetation in natural areas typically consists of a mix of native species, like salal, blueberry, ferns, and non-native species such as Himalayan blackberry.

Even though they have been affected by human settlement, Richmond's native forests and other ESAs provide essential habitat for urban biodiversity and critical ecosystem services. Bog habitats store carbon in the underlying organic soils. Native forests provide habitat for native bees and honeybees that pollinate hundreds of hectares of blueberries. Riparian forests help to moderate water temperatures by casting shade over aquatic habitats.

Enhancement and restoration in parks and ESAs are likely to improve the quality of Richmond's native forests over time. However, climate change and urban development will also place pressure on these natural areas and increase the risk of disturbance events like wildfire. The City monitors the health of and changes in natural areas with tools such as LiDAR.



The map below shows vegetation surveyed between 1858 and 1880. The 2002 habitat inventory is overlaid on the map to show the current extent of native vegetation relative to the past.

Richmond's largest remnant habitat areas are currently found along shorelines, in riparian areas, parks and greenways. Smaller habitat patches are found embedded within the matrix of urban and agricultural land uses.

Map of 1880s and 2002 habitats

Map legend

2002 Habitat Inventory

GRASS AND GRASSLIKE PLANTS

- br s ct — **Tidal marsh:** bulrush(br), sedge(s), cattails(ct).
- g — **Prairie*:** grass(g).
- g W hh ca — **Prairie grass with shrubs:** grass(g), willow(W), hardhack(hh), crabapple(ca).

SHRUBS

- ca — **Crabapple**(ca).
- W — **Willow**(W).
- W ca hh r — **Mixed shrubs:** Willow(W), crabapple(ca), hardhack(hh), rose(r).

SHRUBS/MOSS

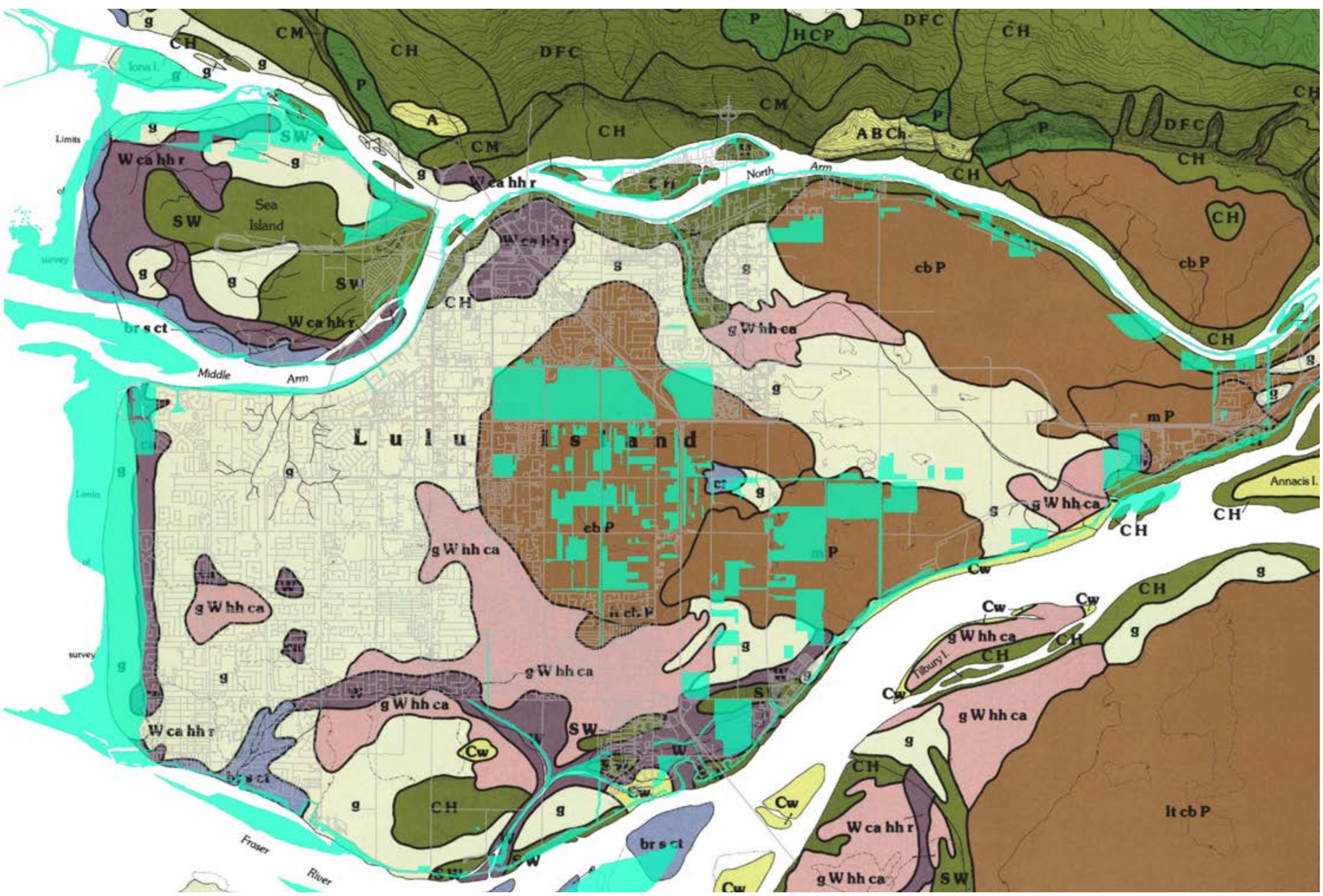
- lt cb P — **Labrador tea:** Labrador tea(lt), cranberry(cb), salal, pine(P).
- cb P — **Cranberry marsh*:** cranberry(cb), pine(P).
- m P — **Moss with scrub pine:** sphagnum (m), scattered pine (P), hemlock, spruce.

WOODLAND

- Cw — **Mixed Woodland:** Cottonwood(Cw), alder, willow, crabapple.

CONIFEROUS FOREST

- C H — **Mixed wet:** Cedar(C), hemlock(H), spruce, alder, [cottonwood], willow, yew, [crabapple], ferns.
- S W — **Spruce:** Spruce(S), willow(W), alder, crabapple, vine maple, briars.



Historic vegetation map (North et al. 1979)

3.3 Soils and Permeability

Soil and water are essential for healthy tree growth. In urban areas, soils are often removed and replaced with much smaller amounts of topsoil or paved with impervious surfaces that water cannot pass through. These conditions impact tree health and resilience by restricting the volume of soil for roots to grow in and the amount of water available to trees.

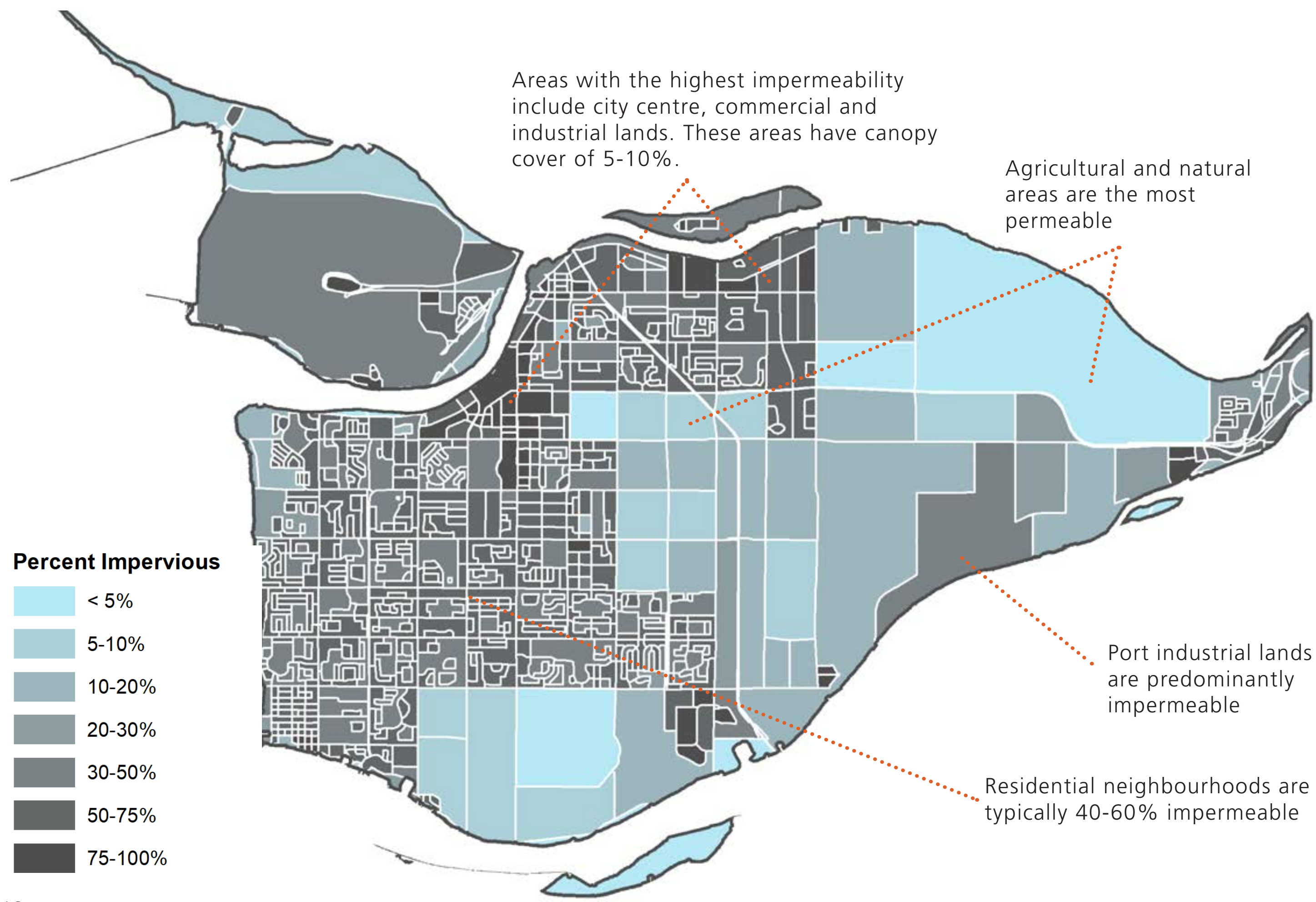
Richmond's native soils are typically silt loam to silty clay loam textures originating from marine and fresh water sediments. Where peat bogs occur, the soils are organic. Richmond also has introduced soils in urban areas. Richmond's soils are poorly drained and have high water tables in most months but drought conditions can occur in summer. Richmond's high water table restricts the depth of rooting for trees and vegetation. This is a unique and challenging situation for tree planting.

The map below summarizes impermeability by city section. Other than on agricultural land, Richmond's urban forest canopy tends to decrease with increasing impermeability. Once impermeability exceeds about 50%, canopy cover becomes more limited.

Urban Tree Planting Challenges

The urban parts of the city have much higher impermeability than agricultural areas because of the coverage of roads and buildings. Impermeability in urban areas is likely to increase as neighbourhoods densify with larger building coverage and parking to accommodate more people. Areas with more buildings, asphalt and concrete surfaces also tend to be hotter because they absorb more heat. To sustain a public urban forest canopy in areas with high impermeability, planting sites need special improvements like structural soil or soil cells that allow for adequate soil and rainwater storage for tree roots under paved areas.

Map of Richmond's impermeable cover



3.4 City Trees: the Urban Forest Today and Tomorrow

This section reports on several metrics useful for describing the status of the City tree population and its future trends. The City recently collected an inventory of its trees on streets and in developed parks (i.e., outside natural areas) so they can be mapped to monitor tree health and assist in scheduled maintenance. More than 56,000 trees have been inventoried and numerous additional tree stands are found in our parks.

Tree Diversity

The diversity of an urban tree population is a useful indicator of vulnerability. In general, the more homogenous a population is in terms of species or genetic diversity, the more vulnerable it will be to pest and disease attack and impacts of climate change. Similarly, a population that lacks age and life-expectancy diversity will go through cycles of mass removals. When trying to reduce vulnerability and grow a resilient tree population, several types of diversity are important to consider.

Tree type and dominance

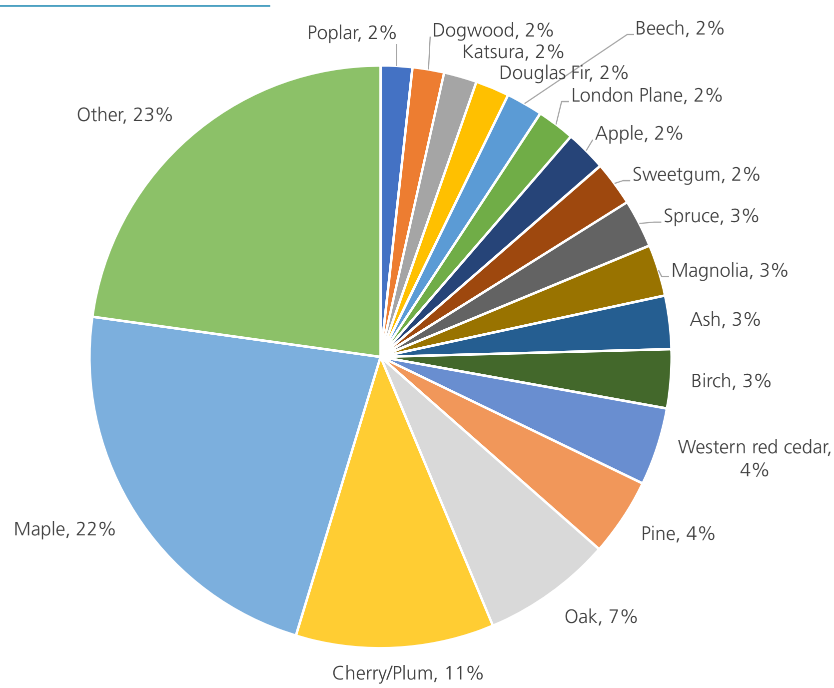
The pie graph shows the most common trees planted in Richmond. The 10-20-30 rule-of-thumb recommends that populations have no more than 10% of any species, no more than 20% of any genus and no more than 30% of any family (Santamour, 1990). However, recent guidelines for a sustainable urban forest suggest that 5-10-15 diversity rule should be targeted city-wide (Leff, 2016). Richmond's tree inventory has a very high proportion of maple (22%) relative to other types of trees, and cherry/plum is also prominent (11%).

To understand which types of trees are dominant in terms of size, the relative *basal area* (cross-sectional area of all the trees stems) and *leaf area* (square metres of leaf surface) are useful measures. The genera that are both common in number and large in size are providing most of the ecosystem services in Richmond's streets and parks (excluding natural areas).

The maple genus is by far the most common and largest contributor to leaf and basal area on public land. Cherry/plum and oak are also large contributors relative to other genera.

With 40% of Richmond's tree population comprised of only three genera (maples, cherry/plum and oak), Richmond's tree canopy is vulnerable to disease or disturbance affecting these trees. **Diversifying the types of trees used in the City is necessary to reduce vulnerability in the tree population and a priority for future tree planting plans.** Diversity can be increased by using alternative species in new planting locations and by strategically replacing species in some locations when trees reach the end of their lives.

Richmond's Most Common Street and Park Trees



Age and size distribution

Age and size diversity are important for maintaining a relatively stable urban forest population over time. Using size as a proxy for age, the 40:30:20:10 guideline (Richards, 1989) recommends a breakdown by tree age class shown on the graphic below.

Richmond has a good proportion of young trees to support future canopy growth. However, there are fewer mature and old trees than are recommended by the guidelines due to Richmond's young urban forest. The size distribution of the City tree population reflects both the City's increased planting efforts over the last 20 years and the removal of some older trees due to hazard and development. **Retention of existing large trees on City property should be prioritized whenever possible.**

Genetic and structural diversity

Genetic diversity between individuals is important for adaptation to pests, disease and future climate. While we do not have an easy way to measure genetic diversity among urban trees, we can assume that urban forests are less genetically diverse than native forests because of clonal nursery cultivation. This creates vulnerability if genetically identical individuals are all susceptible to a pest or disease. **Increasing the genetic diversity of nursery stock should be prioritized.**

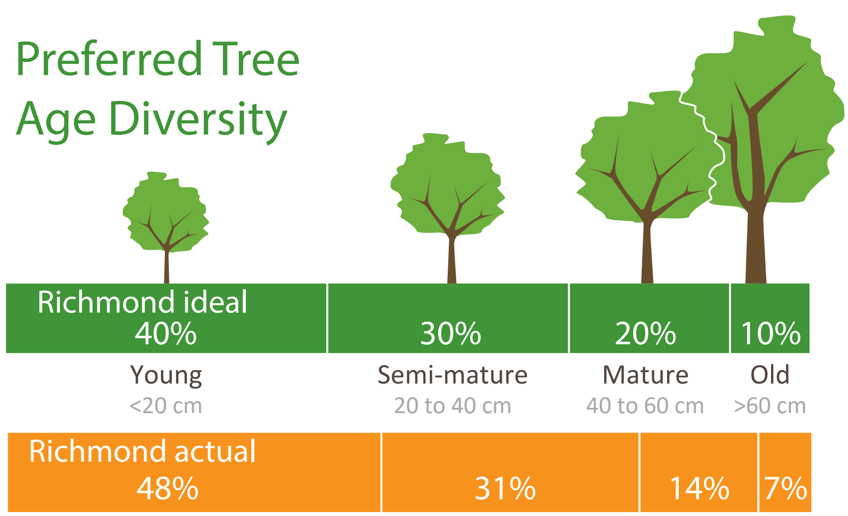
Structural diversity is especially important for habitat and includes having a variety of tree sizes, layers, ages, decay classes, woody debris and understory plants. Most streets and developed parks have low structural diversity compared to native forests. Often risk to people or property means that it is not suitable to have decaying trees, debris or understory in urban areas. **Structural diversity should be enhanced in natural parks or locations where there are few people or targets, to improve the habitat value of an area and ultimately the resilience of Richmond's biodiversity.**

Tree Health and Planting Rates

Richmond's public urban forest is generally in good health based on the inventory data collected to date which shows a relatively low incidence of pests and diseases. Birch bronze borer is killing birch across the region and drought is impacting some trees but overall population mortality rates are relatively low.

The most common reasons for removing trees on public land are in response to storm damage, end-of-life decline, disease or conflicts with development such as road widening and upgrades, driveways or new utilities or facilities. **The City removes approximately 300 trees per year and is planting about 850 new and replacement shade trees[1] per year as well as mass plantings for forest restoration in parks.** However, this number can vary substantially from year to year depending on weather events and construction projects.

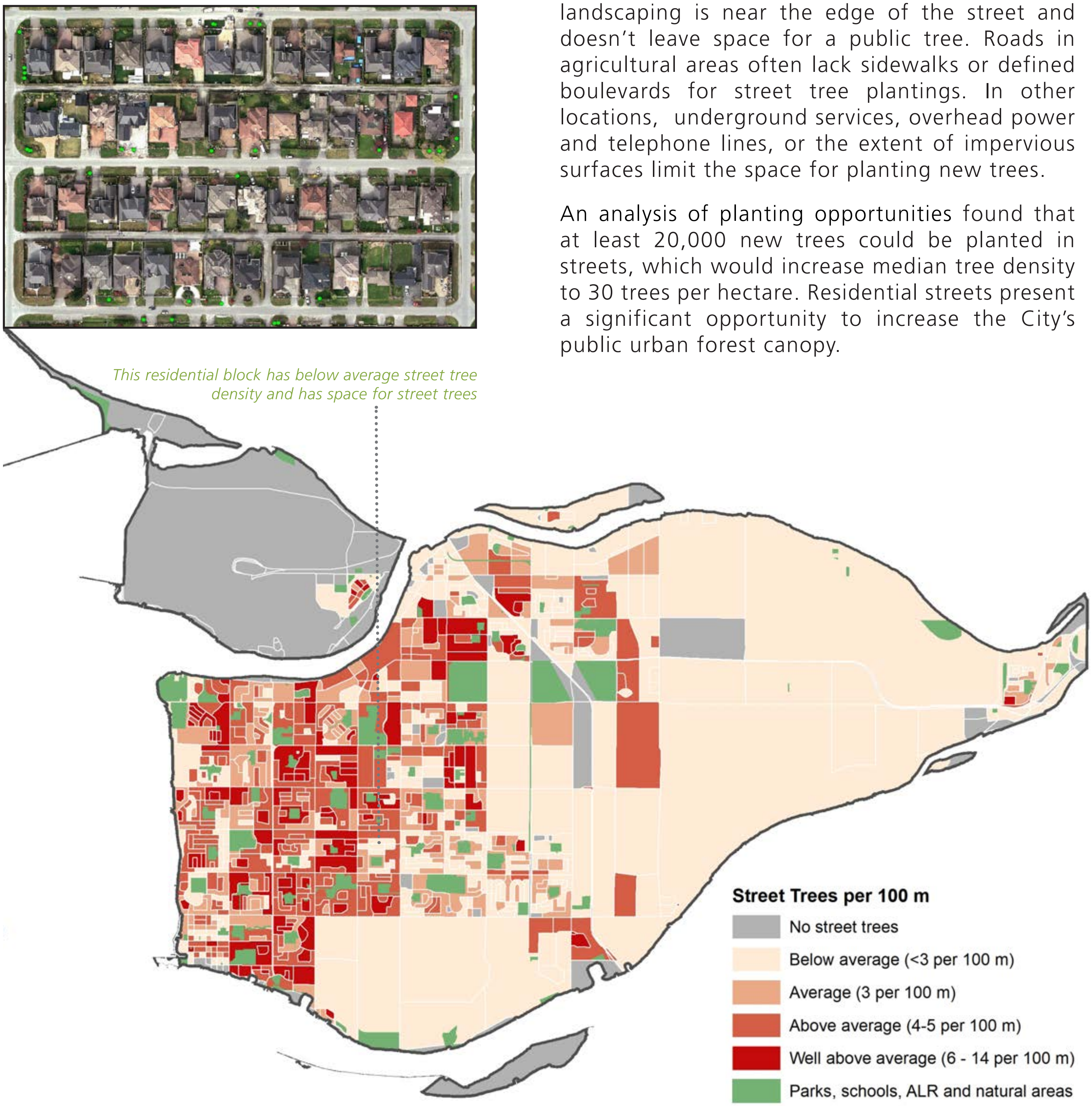
1 Shade trees are young trees installed at a larger size (e.g., > 3 m height height or > 4 cm caliper) and are typically what are planted into streets or landscaped parks. Shade trees tend to account for the largest proportion of City planting and maintenance budgets.



City Tree Distribution

Richmond's 56,000 inventoried trees and uninventoried natural area trees are distributed across streets and parks, and are most abundant in residential rather than agricultural parts of the city.

Map of street tree density by block



Street Tree Density

Richmond has approximately 1 City street tree for every 6 people. In terms of planting density, Richmond's streets are planted at an average density of 3 trees per 100 m, or 19 trees per ha. For comparison, Vancouver has approximately 1 street tree for every 4 people and an average of 6 street trees per 100 m, or 49 street trees per ha.

Street trees (within the City's rights-of-way) are absent in some locations because private landscaping is near the edge of the street and doesn't leave space for a public tree. Roads in agricultural areas often lack sidewalks or defined boulevards for street tree plantings. In other locations, underground services, overhead power and telephone lines, or the extent of impervious surfaces limit the space for planting new trees.

An analysis of planting opportunities found that at least 20,000 new trees could be planted in streets, which would increase median tree density to 30 trees per hectare. Residential streets present a significant opportunity to increase the City's public urban forest canopy.

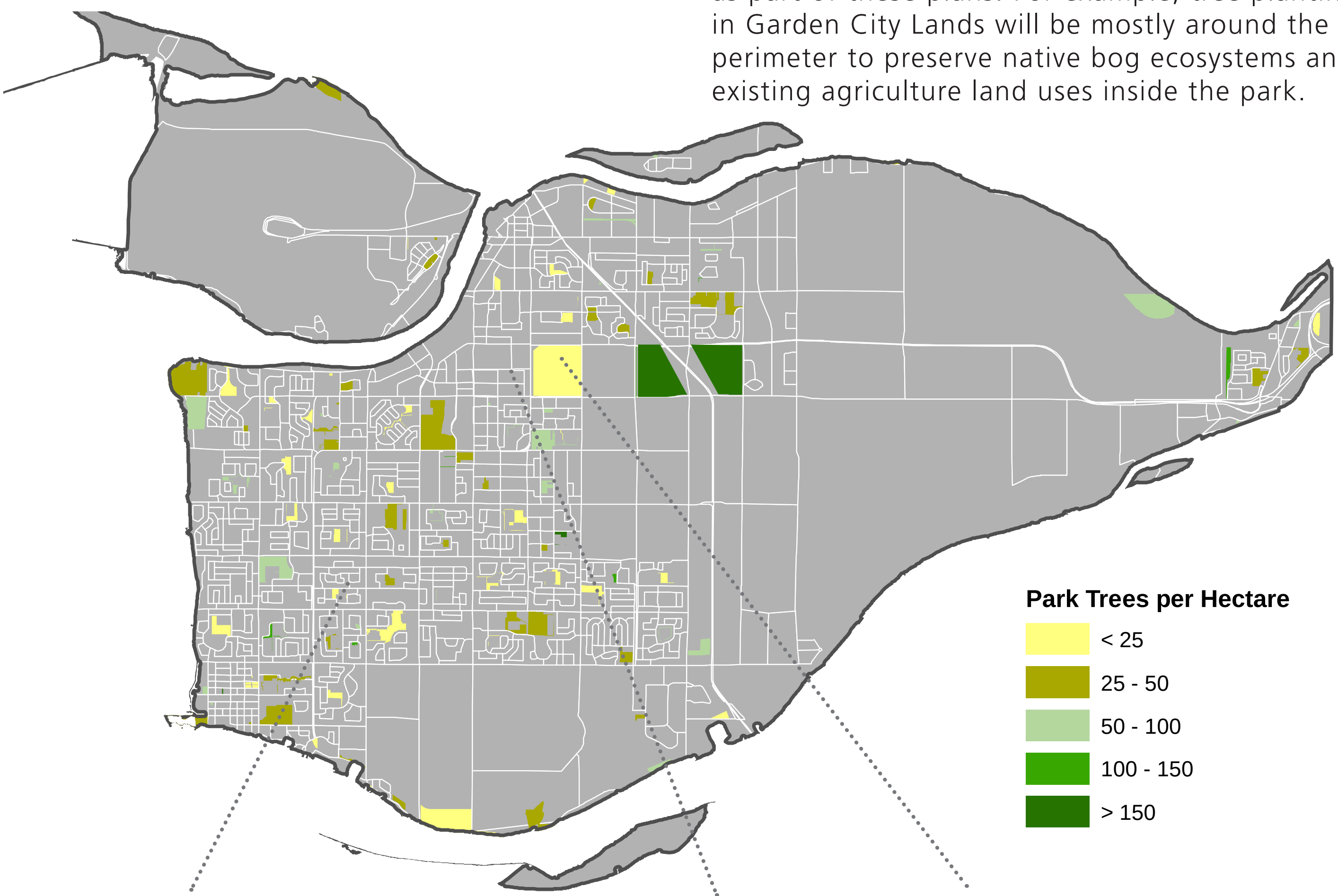
Park Tree Density

Tree density in parks is largely determined by park use. For example, parks with extensive sports fields support a relatively low density of trees. By contrast, natural area parks often have very high tree density.

Park tree density is highest in Richmond Nature Park, and lowest in the Garden City Lands.

It is recommended that City parks with available open space be considered for tree planting as a high priority. Across all parks, the median tree density is 37 trees per hectare. Most Richmond parks have space for additional trees. An analysis of planting opportunities found that at least 10,000 new shade trees could be planted in parks, which would increase median tree density to 55 trees per hectare. Planting in parks will help to move canopy cover from 20% towards the 30% target for Richmond's public realm. Other park uses will need to be considered as part of these plans. For example, tree planting in Garden City Lands will be mostly around the perimeter to preserve native bog ecosystems and existing agriculture land uses inside the park.

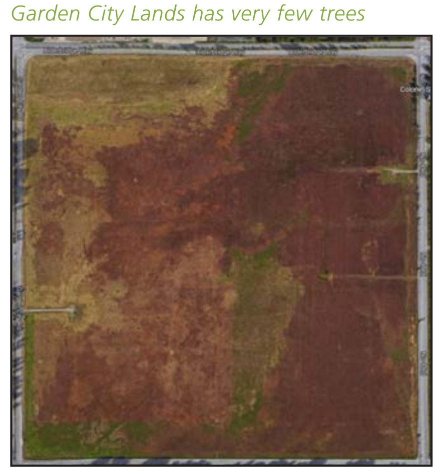
Map of number of trees by park



The median tree density in parks is 37 trees/ha

Richmond Nature Park is almost entirely forested

Garden City Lands has very few trees



City Planting Opportunities

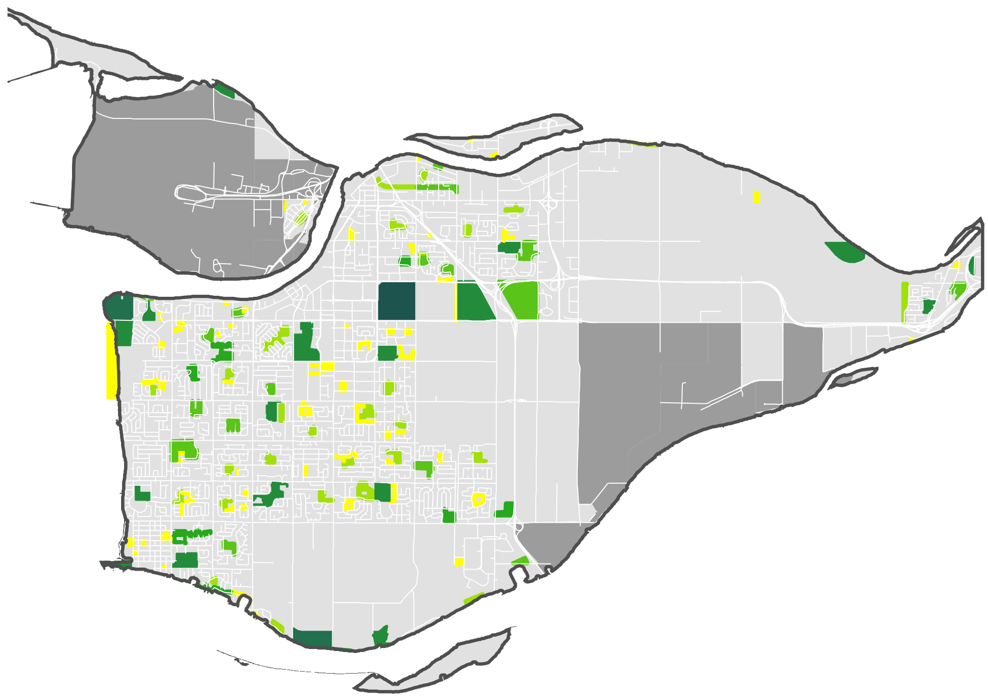
Richmond's plantable spots have been estimated by identifying the permeable spaces on public land that could potentially support shade trees.

Roads have approximately 20,000 potential shade tree planting spots. The map below shows where these opportunities are concentrated in the roads around each block. Many opportunities are on the public right-of-way attached to private residential landscapes.

This analysis does not account for utility conflicts. It is expected that further analysis of constraints will reduce the total opportunities by up to one-third, therefore the annual planting target aims to plant out approximately 20,000 of these sites over the next 25 years. As well, forest restoration or new parkland planting may provide mass planting opportunities that have not been captured by this analysis.

In parks and schools, approximately 10,000 potential shade tree planting spots have been identified outside active uses (e.g., sports fields). The map below shows the number of opportunities in each park.

Map of tree planting opportunities by park



Map of street tree planting opportunities