Urban Tree Canopy
Assessment



Nanaimo, British Columbia
May | 2026

CITY OF NANAIMO
THE HARBOUR CITY

PlanIT Geo
developers of TreePlotter



Nanaimo, British Columbia

Urban Tree Canopy Assessment

"As nature's largest and longest-lived creations, trees play an extraordinarily important role in our cities; they are living landmarks that define space, cool the air, soothe our psyches, and connect us to nature and our past."

-Jill Jonnes, *Urban Forests: A Natural History of Trees and People in the American Cityscape*

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Assessment Overview

Introduction

Urban tree canopy (UTC) in Nanaimo, British Columbia, is shaped by the region's coastal climate, land use patterns, and community values. Ongoing tree planting efforts and the natural growth of established trees help strengthen the city's urban forest. At the same time, development pressures, storm impacts, shifting climate conditions, and threats from pests and disease create challenges to maintaining a healthy canopy. Because many of these changes happen gradually and are difficult to detect from the ground, regular tree canopy assessments are essential for tracking and sustaining Nanaimo's urban forest.

As of 2025, Nanaimo has trees covering 39% of the city (across all lands, including private and public), showing its strong connection to nature. Forested areas of mostly Douglas fir and other native species define much of the city's landscape, weaving through neighbourhoods, parks, and trails. These trees shade streets, filter air pollutants, store carbon, and support the wildlife that gives Nanaimo's neighborhoods much of their character.

Nanaimo's commitment to urban forestry is demonstrated through real policy and funding:

- **Tree Protection Bylaw (Bylaw 7126, updated 2021):** Regulates the removal of protected trees on private property, especially mature trees and those within environmentally sensitive areas.
- **Development Permit Areas:** The City's Official Community Plan (OCP) identifies areas along water bodies and steep hills as needing protection. It focuses on keeping trees and managing natural resources.
- **Urban Forest Management Strategy (2010, with ongoing updates):** Establishes goals for canopy expansion, biodiversity, and community engagement.
- **Street Tree and Public Planting Programs:** Nanaimo maintains an inventory of street trees and provides guidelines for planting and maintenance.
- **Community Tree Planting and Stewardship:** The City collaborates with local partners and volunteers to support work parties to plant trees and remove invasive species.
- **Climate Action Integration:** The City's 2022 Climate Action Plan emphasizes the importance of urban forests for tackling climate issues, capturing carbon, and reducing heat. It also connects trees with managing stormwater and supporting biodiversity.

Nanaimo connects its urban tree management efforts with provincial and regional plans, including the BC Climate Action Charter and waterway protection rules. This helps ensure that environmental protection and green spaces are integral to city planning. That coordinated approach is producing tanglible results across the city.

As of 2025, Nanaimo's urban tree canopy has climbed to 39%, up from 33% in 2016.

Weather events have influenced how Nanaimo manages its urban forest. The 2018 windstorm led to the loss of many mature trees, while recent drought years (2015, 2021, 2023) have caused stress to both urban and natural forests. To lessen the impact of future events, Nanaimo plants a diversity of species and engages in proactive maintenance. These practices ensure a more resilient urban forest.

Through updated data collection and canopy assessments, Nanaimo tracks tree distribution, identifies areas for restoration, and prioritizes planting where environmental and social benefits are greatest. This approach, along with solid policies and community involvement, positions Nanaimo as a leader in urban forestry. The city is dedicated to creating a healthy, diverse, and climate-resilient tree canopy for future generations.

Connection to Nanaimo's City Plan

This assessment will assist the City in achieving the desired outcomes and green goals identified in *City Plan: Nanaimo ReImagined* related to the city's urban tree canopy, natural areas, and greenways. These outcomes include an increased number and improved quality of trees; enhanced community understanding of the benefits provided by tree canopies; adapting natural and constructed infrastructure to climate change and increasing community resilience; and the continuation of Nanaimo’s treed character and interconnected recreational networks.

The *Integrated Action Plan (IAP)*, a supporting documents to *City Plan: Nanaimo ReImagined*, calls for an updated Urban Tree Canopy Management Strategy, to be informed by this comprehensive tree canopy assessment. The IAP also calls for an updated tree protection bylaw and development guidelines to align urban tree management with City Plan objectives.

Additionally, this tree canopy assessment will support the City in continuing to refine and enforce tree removal and protection regulations, updating tree planting standards to prioritize climate-resilient and drought-tolerant species, and increase plantings in public spaces, including parks, greenways, and along streets where appropriate.

Nanaimo's urban tree canopy provides critical ecological, social, and aesthetic benefits, including wildlife habitat, improved air and water quality, climate moderation through shade, and overall community livability. A resilient and healthy urban forest depends on the protection, maintenance, and management of existing trees, as well as the ongoing planting and establishment of new trees on both public and private lands.

Together, these actions will strengthen Nanaimo's urban forest, support climate adaptation, and ensure the long-term sustainability of the City's natural and green infrastructure.

Methods Overview

This assessment used Pleiades High-Resolution (PHR) satellite imagery and applied machine learning methods to categorize land cover in Nanaimo for 2025. The assessment included the following land cover types: tree canopy, shrubs, other vegetation, bare earth, impervious surfaces, and water. Additionally, the analysis identified potential planting sites suitable for future tree planting and areas unsuitable for planting. Areas unsuitable for planting included recreational fields and golf courses, utility lines and corridors, cemeteries, wetlands, and waste management areas. **Following the Canadian Forest Service standards, this assessment focuses on tree canopy as a percentage of land, excluding water.**

This assessment enables Nanaimo's stakeholders to develop new programs and priorities for protecting and expanding the urban forest. **The key outcomes of this urban tree canopy assessment include:**

- **Measure how much tree canopy and other types of land cover there are and where they are located**
- **Quantify the ecosystem services provided by the tree canopy to the community**
- **Identify areas where tree canopy can be expanded (Possible Planting Area analysis)**
- **Determine priority areas for tree preservation and planting based on socioeconomic, environmental, and climate-related factors**
- **Conduct a LiDAR-enabled analysis to identify the tallest trees in Nanaimo**
- **Develop canopy change scenarios to model how Nanaimo's tree canopy may change in the future, supporting data-driven canopy goal setting and long-term planning**

For more information about the methodology used to complete this assessment, see Appendix B.

Study Area

The study area covers the City of Nanaimo's administrative boundary as of September 2025. The city includes a mix of privately owned, government-owned, and Crown-owned land, reflecting the variety of land management and ownership. Areas north and west of the urban core are more rural with larger lots, open space, and natural areas, including forests, wetlands, and coastal ecosystems. The eastern part of the city is adjacent to Nanaimo Harbour and the Northumberland Channel, with large wetland areas home to a variety of plants and animals. These areas are important for maintaining a healthy, strong coast.

This assessment collects data on tree canopy, tree canopy change, and other environmental factors to give useful information to the City of Nanaimo and its partners. With this snapshot of Nanaimo's urban tree canopy, the city can support informed decision-making, policy development, and long-term planning for its trees. This information is categorized by different geographic areas:

- **Nanaimo City Boundary**
- **Riparian Areas**
- **City-owned Properties and Road Dedication Areas**
- **Schools**
- **Statistics Canada Dissemination Areas**



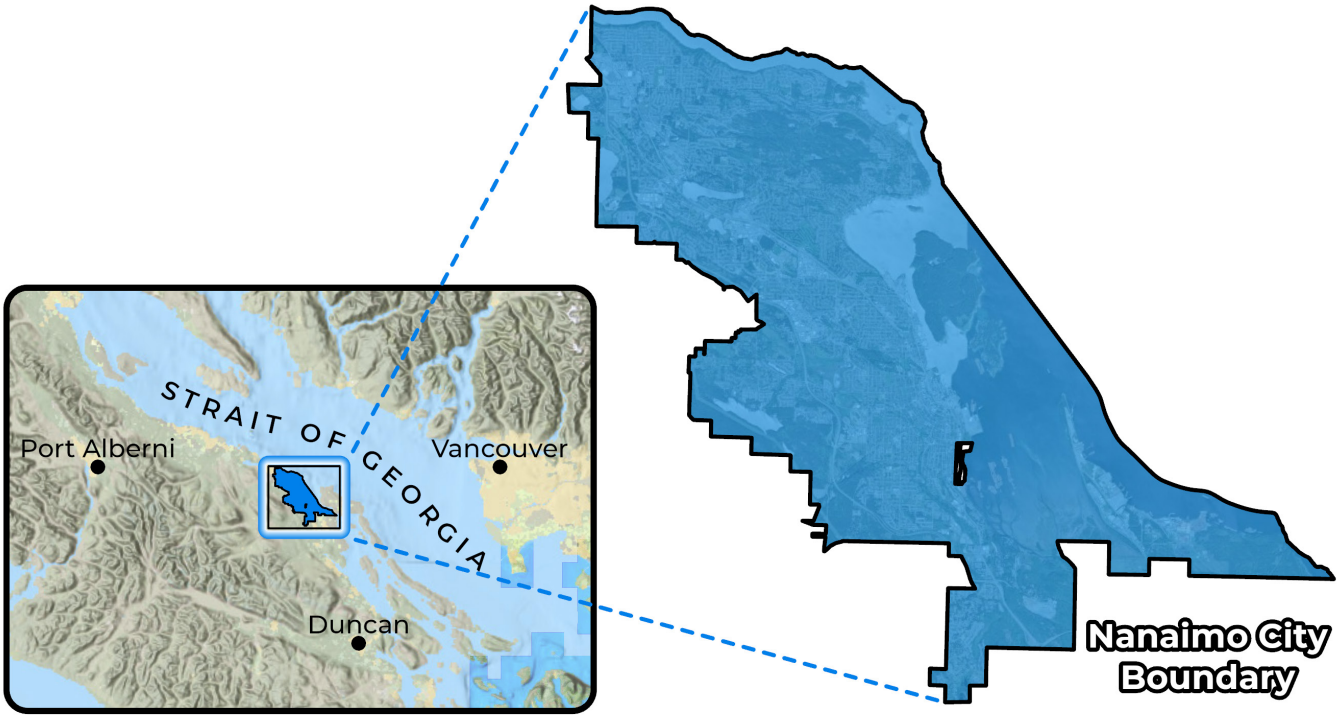


Figure 1. Located directly west of the City of Vancouver across the Strait of Georgia, the City of Nanaimo spans approximately 98 square kilometers (about 9,808 hectares) in the southeastern quarter of Vancouver Island, British Columbia.

Assessment Overview

In 2025, within Nanaimo's city limits and excluding bodies of water, 39% of the land was covered with urban tree canopy (37% UTC when excluding Saysutshun, a Class A Provincial Park), and 11% was available for potential planting. Half of the city was deemed unsuitable for planting unless significant land changes were made. There are 120 hectares of potential planting area located across Nanaimo's city-owned properties (10% of the city-wide distribution of vegetated land with potential to plant trees).

The City of Nanaimo has 1,055 hectares of city-owned and operated parks, ranging from forested natural areas with trail systems, such as Bowen Park, to more recreation- and sports-focused parks, such as Beban Park. Local government–owned property plays a large role in supporting the city's urban forest. **Although making up only 13% of the total city-wide area, city-owned properties contain 19% of Nanaimo's urban forest, with an average canopy cover of 65%.** Having many trees in parks and public spaces is important because they provide benefits for everyone, such as habitat for wildlife and shade for recreational areas. These spaces are precious to the city, and need to be maintained so future residents can also enjoy them.

This assessment also identified Nanaimo's tallest trees, supporting public interest, storytelling, and future heritage or notable tree programs. A detailed analysis of tree canopy changes and growth projections illustrates how Nanaimo's canopy may change under various environmental pressures and development threats. This information serves as a useful tool for guiding policy, investment, and community actions.

Project Methodology

Data Sources

Land cover, urban tree canopy, and possible planting areas were mapped using the sources and methods described below. These data sets provide the foundation for the metrics reported at the selected geographic assessment scales.

This assessment used high-resolution (50-centimeter) multispectral Pleiades satellite imagery collected in 2025, along with high-resolution LiDAR point cloud data provided by the City of Nanaimo, to support detailed analysis of canopy height and structure across the study area.

Mapping Land Cover and Identifying Trees

The land cover data set is the most important part of a tree canopy assessment. For this assessment, EarthDefine provided a six-class land-cover dataset. This dataset was produced using machine-learning and LiDAR data to extract tree canopy cover and other land cover types from the 2025 satellite imagery. The classification distinguishes trees from shrubs based on their appearance and characteristics. Trees usually have darker and denser leaves, taller canopies over 3 metres, and a more regular shape. On the other hand, shrubs tend to be lighter in colour, shorter, and irregularly shaped, often blending in with other plants around them. These six classes are shown in Figure 2 on the following page.



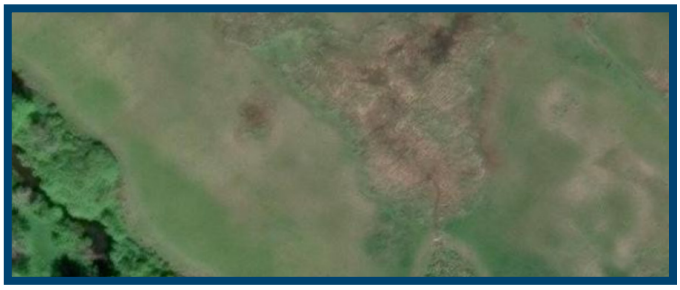
Land Cover Classes & Examples



Tree Canopy:
Leaves, branches, and stems generally greater than 10-15’ tall.



Shrubs:
Woody plants with multiple stems arising from the base, generally less than 10' tall.



Other Vegetation:
Healthy grasses, herbaceous plants, open pastures and turf grass.



Bare Soil and Dry Vegetation:
Exposed earth, sand, or dead/dormant grasses.



Impervious Surfaces:
Roads, sidewalks, parking lots, buildings, and other paved areas.



Water:
Rivers, lakes, ponds, reservoirs, and wetlands.

Figure 2. This study identified six (6) unique land cover classes within the 2025 assessment imagery: tree canopy, shrubs, other vegetation, bare soil and dry vegetation, impervious surfaces, and water. Images sourced from satellite imagery of Nanaimo.

Identifying Tree Canopy Change

This assessment looked at how the tree canopy has changed over time using high-resolution (50-centimetre) Pleiades satellite imagery from 2016. It highlights how environmental conditions and people have influenced the landscape over the 9-year study period. The City of Nanaimo supplied 2016 LiDAR data, which was used to refine the classification process and improve accuracy. Tree canopy change was identified by comparing imagery captured from multiple years (2016 and 2025).

Unless otherwise noted, tree canopy change is expressed as percent net change throughout the report, which is calculated by dividing the UTC change hectares by the total land area (e.g. +88 hectares ÷ 556 land hectares = +1.6%). It tells you how much the canopy has changed relative to the entire land area.

Identifying Planting Opportunities and Limitations

Plantable spaces in Nanaimo are located in vegetated areas without tree cover, except for areas with shrubs. Most of the shrub cover in the city is found in areas where forests are regrowing or expanding, or near rivers and streams. These areas are often dominated by native shrub species like salal, Oregon grape, and red huckleberry, which thrive in the city's moist coastal climate and acidic soils. In many of Nanaimo's upland and coastal sites, these shrubs play an important ecological role like stabilizing soils, supporting wildlife habitat, and contributing to forest recovery. **For the purposes of this analysis, shrub areas are considered unsuitable for tree planting, as many represent natural regeneration or sensitive ecosystems.** Further ground-truthing may identify some shrub-dominated sites as suitable for planting trees on a case-by-case basis.

All types of non-tree vegetation, such as grass, pasture, and other low plants, were initially seen as suitable sites for possible tree planting. However, these areas were refined by overlaying manually delineated unsuitable zones, which include recreational fields, cemeteries, utility corridors, wetlands, estuarine zones, and golf course fairways. In addition, the City of Nanaimo provided internal infrastructure data identifying areas to be excluded from planting, including water, storm, and sanitary mains; natural gas and transmission lines; and stormwater detention areas. This approach ensured that modeled planting opportunities reflect both ecological feasibility and real-world constraints.

In total, 1,079 hectares were identified as suitable for potential tree planting, while 4,938 hectares were classified as unsuitable. Over half of the unsuitable area, approximately 3,050 hectares, consists of impervious surfaces such as roads, buildings, and other paved infrastructure, which limit opportunities for canopy expansion.

It is important to note that the classification of possible planting area is intended as a general planning guide, not a prescriptive directive for tree placement.

Unsuitable for Tree Planting Example:



Figure 3. Vegetated areas where tree plantings would be feasible but undesirable due to their current usage (left) were delineated in the data as “Unsuitable” (right). This example shows several recreation and baseball fields, as well as mapped underground utilities.



State of the Canopy and Key Findings

Nanaimo's Land Cover

The results of this study can be used to design a strategic approach to identifying existing canopy and future planting areas. The land cover data presented below depicts Nanaimo's current city limits.

Figure 4 illustrates the distribution of land cover within the City of Nanaimo, including water bodies. Tree canopy covers approximately 31% of the city's area, representing the largest land cover class. Impervious surfaces account for about 25%, followed by water areas at 20%. Water hectares are elevated because the city boundary extends into the Strait of Georgia. Non-canopy vegetation, such as grass and open groundcover, comprises around 12%, while soil, bare earth, and dry vegetation account for 8%, and shrubs make up roughly 4% of the total area.

Land Cover Classes Distribution Pie Chart:

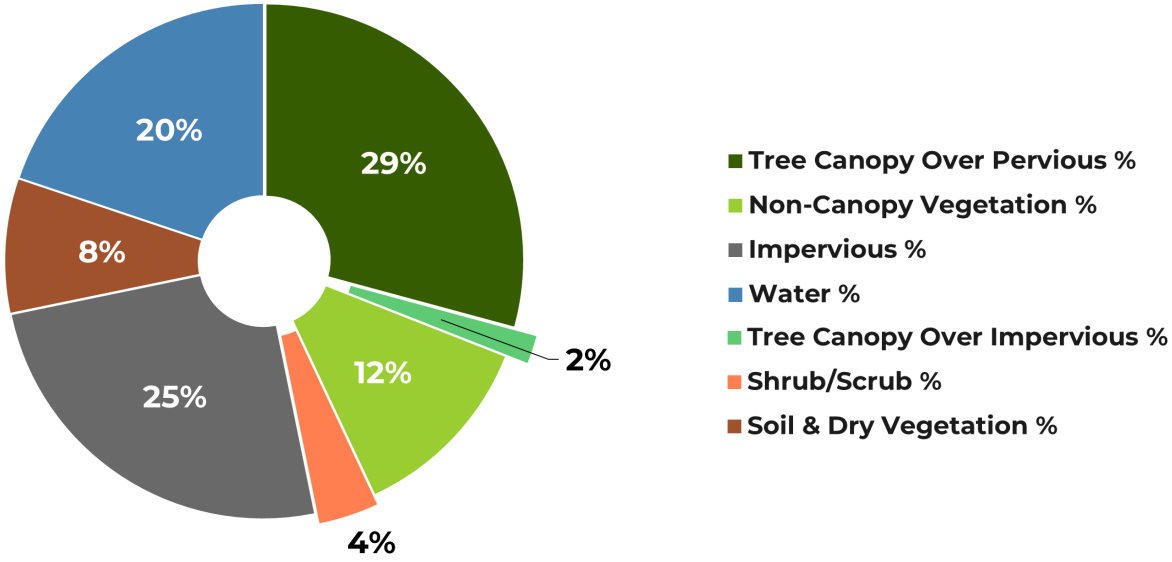


Figure 4. Pie chart showing the distribution of land cover classes throughout Nanaimo's total area, including public and private lands (percentages based on the total area including water bodies).

This analysis may differ from other assessments or land cover studies in the City of Nanaimo because urban tree canopy estimates are sensitive to methodological choices, including the imagery and algorithms used for canopy detection, minimum height thresholds for what qualifies as tree canopy, the study area boundary applied, and how land cover classifications such as open water are treated. While this page and the following page present raw land cover metrics that retain water bodies in the total area, all subsequent urban tree canopy percentages in this report exclude water from the total land area calculation, consistent with standard urban forestry practice. These differences do not reflect errors in any single study, but rather the expected variation between assessments using different parameters and data sources.

Land Cover Classes Distribution Map:

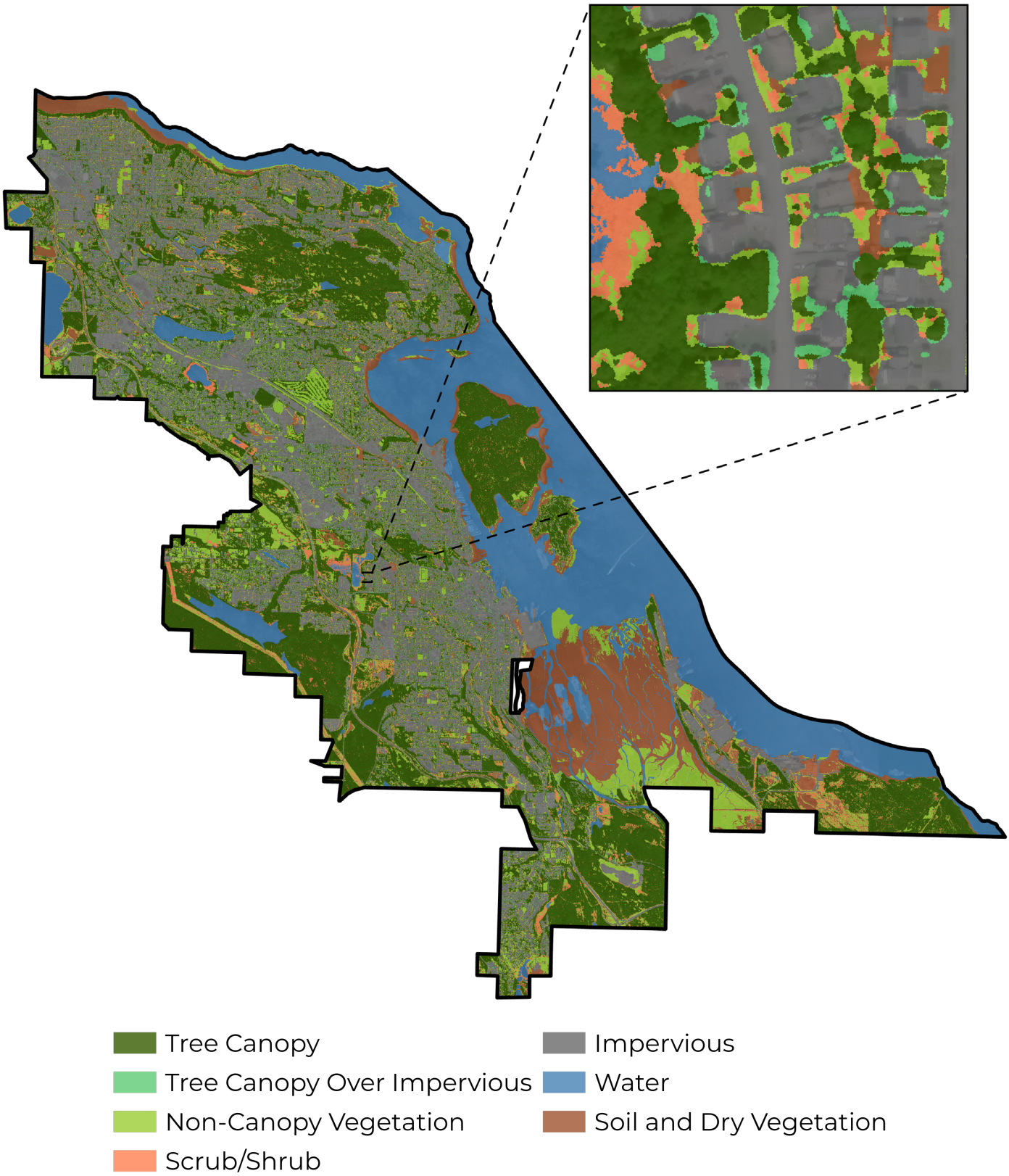


Figure 5. Map of land cover classification results in Nanaimo.

Existing and Potential Tree Canopy in Nanaimo

In accordance with Canadian Forest Service standards, this assessment presents urban tree canopy as a percentage of land area only, excluding water bodies. **As such, approximately 2,426 hectares of water within the city boundary were removed from the UTC analysis. As of summer 2025, 3,792 hectares of the city were covered by tree canopy, representing 39% of Nanaimo's 9,808 land hectares.** An additional 1,079 hectares (11%) were classified as other vegetation suitable for future tree planting.

The remaining 4,938 hectares (50%) were determined to be unsuitable for new tree planting due to existing land uses or site constraints. Within this category, impervious surfaces, such as roads and buildings, accounted for 62% (3,050 hectares), while bare earth, often associated with areas under construction or recently disturbed, accounted for 21% (1,031 hectares). The remaining 857 hectares (17%) included golf course fairways, recreational fields, utility corridors, and other land uses where tree planting is not feasible.

The data show that Nanaimo has limited available area to plant trees, with only about 11% of the city's land suitable for establishing additional canopy. As a result, the preservation and management of existing forested areas, particularly those dominated by mature Douglas fir and mixed coastal species, will be critical to sustaining overall canopy cover. Where planting opportunities do exist, the species choice matters as much as the location. Nanaimo's soils vary considerably across the city, from the acidic, moisture-retaining soils near riparian areas to the shallower, drier conditions found in downtown corridors and newer developments. A tree planted in the wrong soil type, or one that cannot tolerate the extended summer dry periods that are characteristic of the region, will struggle to establish and may not survive its first decade. Careful planting and regular maintenance during the first five years are crucial to make sure the trees survive and provide long-lasting environmental and social benefits.

The city's recommended species list should be reviewed regularly against current climate projections and known pest risks. Species that have historically performed well in the Pacific Northwest may face increasing stress if summers grow hotter and drier. Introducing a wider mix of species, including those adapted to slightly warmer, drier conditions, will help ensure that the trees planted today remain healthy and thriving when they reach maturity in 20 to 30 years.

Urban Tree Canopy (UTC) Potential Classes Distribution:

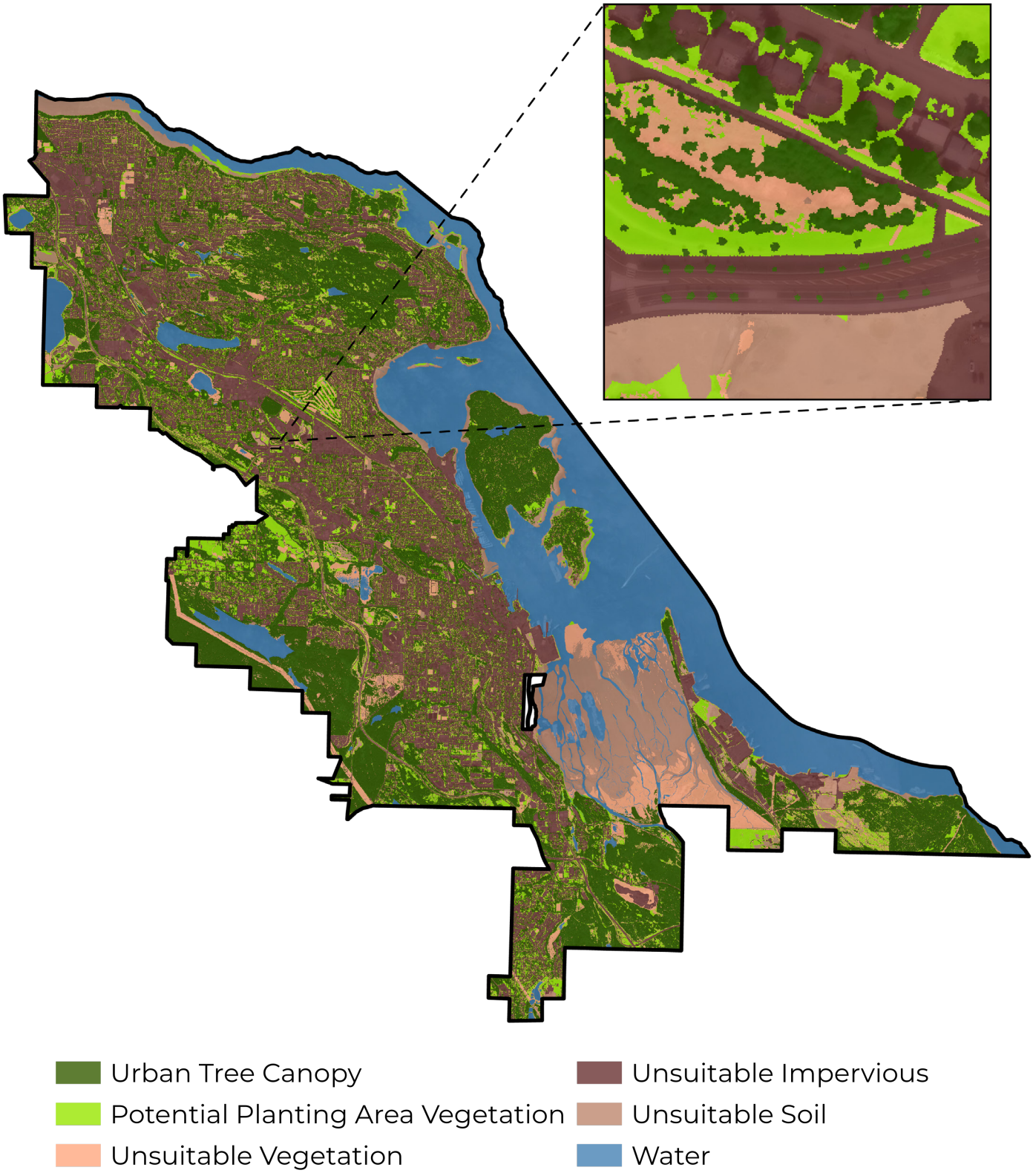


Figure 6. Map of tree canopy, possible planting area, and area unsuitable (impervious, soil, vegetation) for tree canopy throughout Nanaimo.

Urban Tree Canopy (UTC) Potential Classes Distribution:

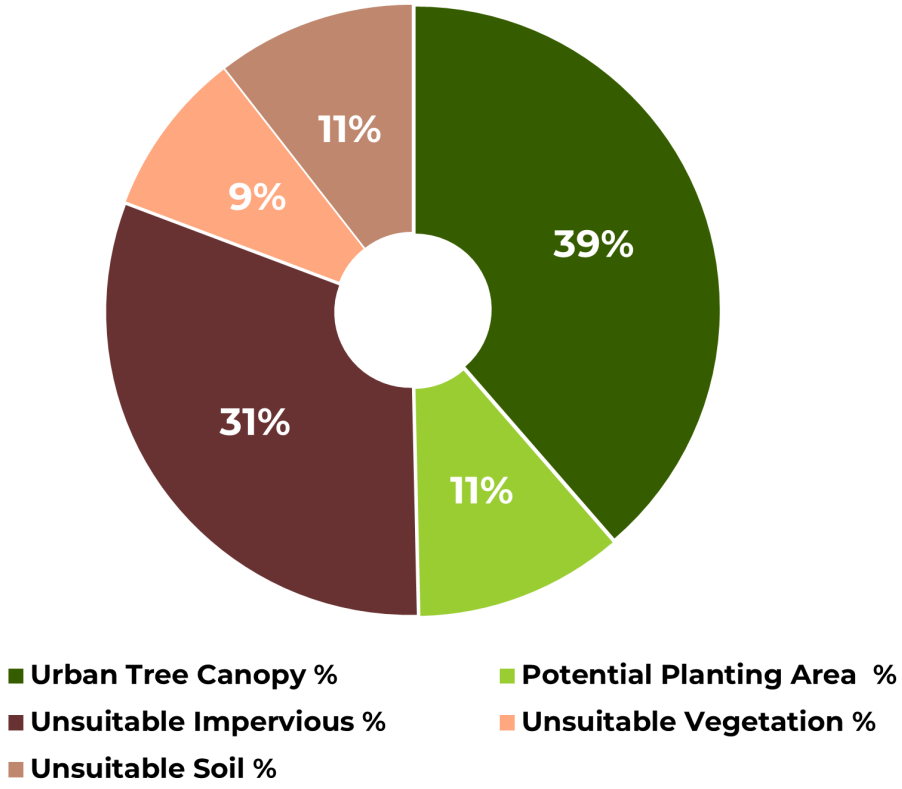


Figure 7. Pie chart showing the distribution of tree canopy, possible planting area, and area unsuitable (impervious, soil, vegetation) for tree canopy throughout Nanaimo's total area, including public and private lands. Percentages exclude water.

Tree Canopy and Impervious Surfaces

Nanaimo's urban tree canopy covers about 3,792 hectares. It has been divided into categories based on whether the trees hang over surfaces that can absorb water (pervious) or surfaces that cannot (impervious). Canopy overhanging impervious areas provides ecological value by reducing heat through shading, improving air quality, and intercepting stormwater runoff. **Only 7% of Nanaimo's paved surfaces are currently shaded by trees. That means more than 3,000 hectares of roads, parking lots, and sidewalks absorb full sun throughout the day, raising street temperatures.** Expanding canopy over those surfaces is one of the highest-impact ways the city can reduce urban heat.

There is a notable disparity in canopy distribution across the city. **The urban core and downtown areas have some of the lowest canopy cover, with expansive impervious surfaces frequently exceeding 80% of total land cover.** In contrast, neighbourhoods that are more residential and located on the outskirts of the city have noticeably greater tree cover and bigger areas of forest. Although tree planting opportunities in the downtown area are limited, targeted planting in available road-dedication areas or boulevard strips could create high-impact benefits, such as enhancing shade, cooling paved areas, and improving pedestrian comfort.

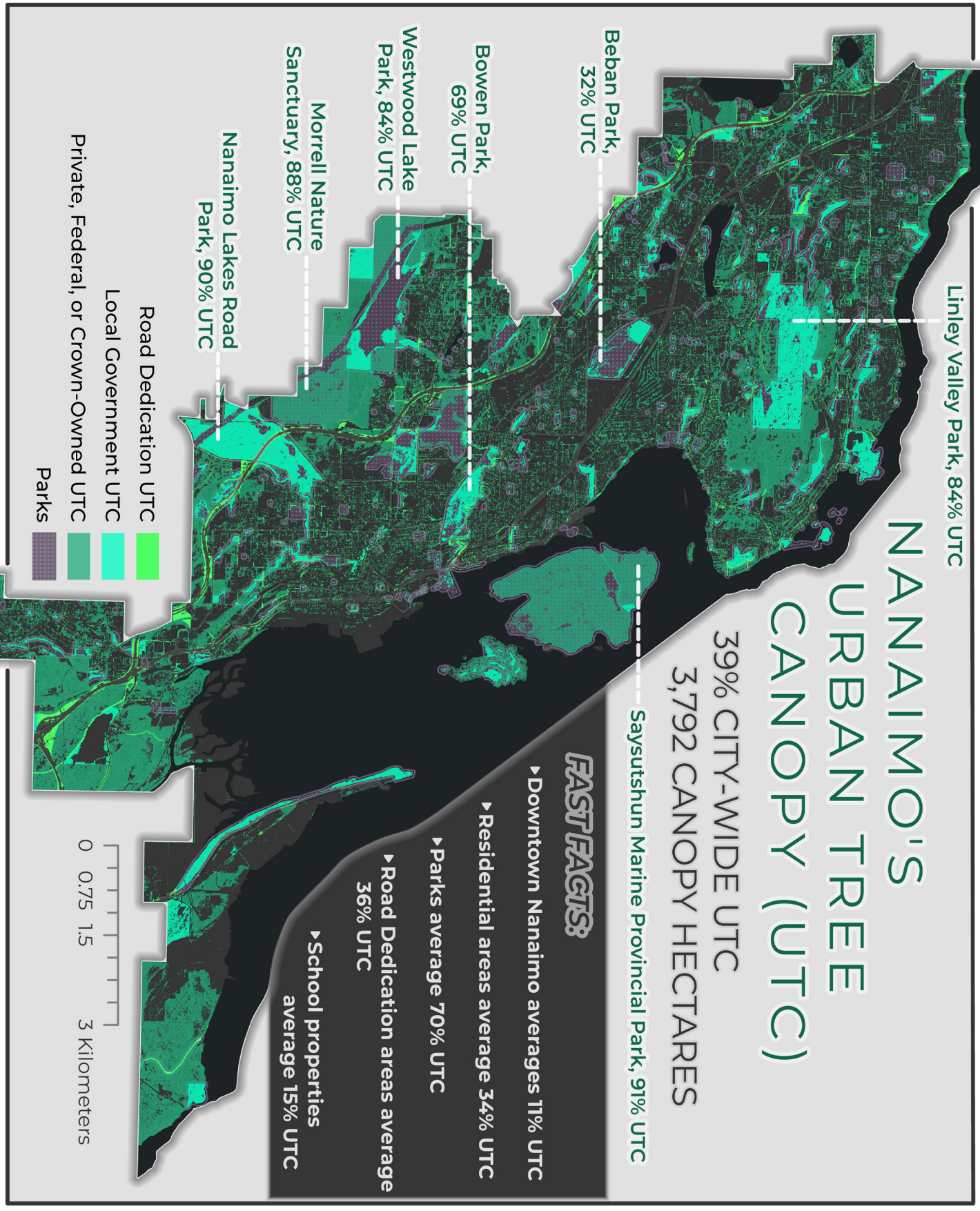


Figure 8. Overview of Nanaimo's urban tree canopy.

Tree Canopy Change in Nanaimo

Over the nine-year study period, Nanaimo experienced a net increase in urban tree canopy cover. Between 2016 and 2025, canopy coverage within the city boundary grew by approximately 515 hectares, representing a +5.3% absolute gain. Put another way, the city added roughly 16% more canopy than it had in 2016. This assessment provides a clear picture of the conditions based on images taken at each time period in 2016 and 2025. **Taking a closer look at canopy dynamics over the nine-year period, Nanaimo lost a total of 269 hectares of tree canopy between 2016 and 2025 while gaining about 785 hectares, meaning growth outpaced loss by nearly three to one. Three-thousand-and-six hectares of canopy remained stable between 2016 and 2025.**

The primary causes of canopy loss can be grouped into the following major categories of loss:

- **Urban Development and Construction:** Over the nine-year period, approximately 60 hectares of canopy were cleared for development, an area roughly equivalent to 84 soccer fields. Tree canopy removal is often associated with the construction of new housing, commercial projects, and road expansions, particularly in growing neighbourhoods on the city's northern and western edges. While Nanaimo's Tree Protection Bylaw (Bylaw 7126) helps regulate removals, continued urban growth presents an ongoing challenge to maintaining canopy cover.
- **Windstorms and Drought Stress:** Extreme weather events, including the 2018 windstorm and multi-year droughts (2015, 2021, and 2023), have contributed to canopy reduction by uprooting mature trees, intensifying pest activity, and reducing tree resilience. Drought stress weakens roots and reduces canopy density, especially in urban areas without irrigation. This makes trees more vulnerable to dying from other problems, such as disease and decay.
- **Natural Tree Mortality and Maintenance Removals:** Each year, roughly 0.72% of Nanaimo's tree canopy is lost due to natural causes (see Page 33 for more information), including old trees reaching the end of their lives, pest damage, and removals by city crews or property owners for safety reasons. While some of these reductions are offset by planting new trees, maintaining a stable canopy is important. This requires actively replacing trees and using a variety of species.



In contrast, canopy growth can be attributed to several factors, including the natural expansion of existing trees, new tree plantings, and natural regeneration through seed dispersal:

- **Favourable Growing Conditions and Natural Expansion:** Nanaimo's mild coastal climate and abundant rainfall create ideal conditions for tree growth. Analysis shows that the existing tree canopy expanded at an average rate of 2% annually between 2016 and 2025. Much of this growth comes from the natural crown expansion of mature trees within residential areas and forested tracts where trees remain undisturbed.
- **Natural Regeneration and Seed Dispersal:** Natural regeneration contributes about 0.8% (see Page 33 for more information) to canopy growth per year, driven by new trees growing in the lower layers of the forest and by seed dispersal in early-successional or semi-managed landscapes. Native species such as Douglas fir, bigleaf maple, and red alder readily establish in open or disturbed sites, supporting long-term forest renewal and biodiversity.
- **City-Led Tree Planting and Stewardship:** The City of Nanaimo and its partners continue to advance organized tree planting and stewardship programs. Each year, the City plants approximately 150 large-statured tree species, focusing on city-owned property and road dedication areas. In addition, the City subsidizes the purchase of over 1,000 retail nursery sized trees per year, for planting on private property within the City. The program funding is collected through development, permits, and tree-cutting related fines.

Between 2016 and 2025, the City of Nanaimo gained 515 hectares (+5.3%) of tree canopy.



Tree Canopy Loss Example:

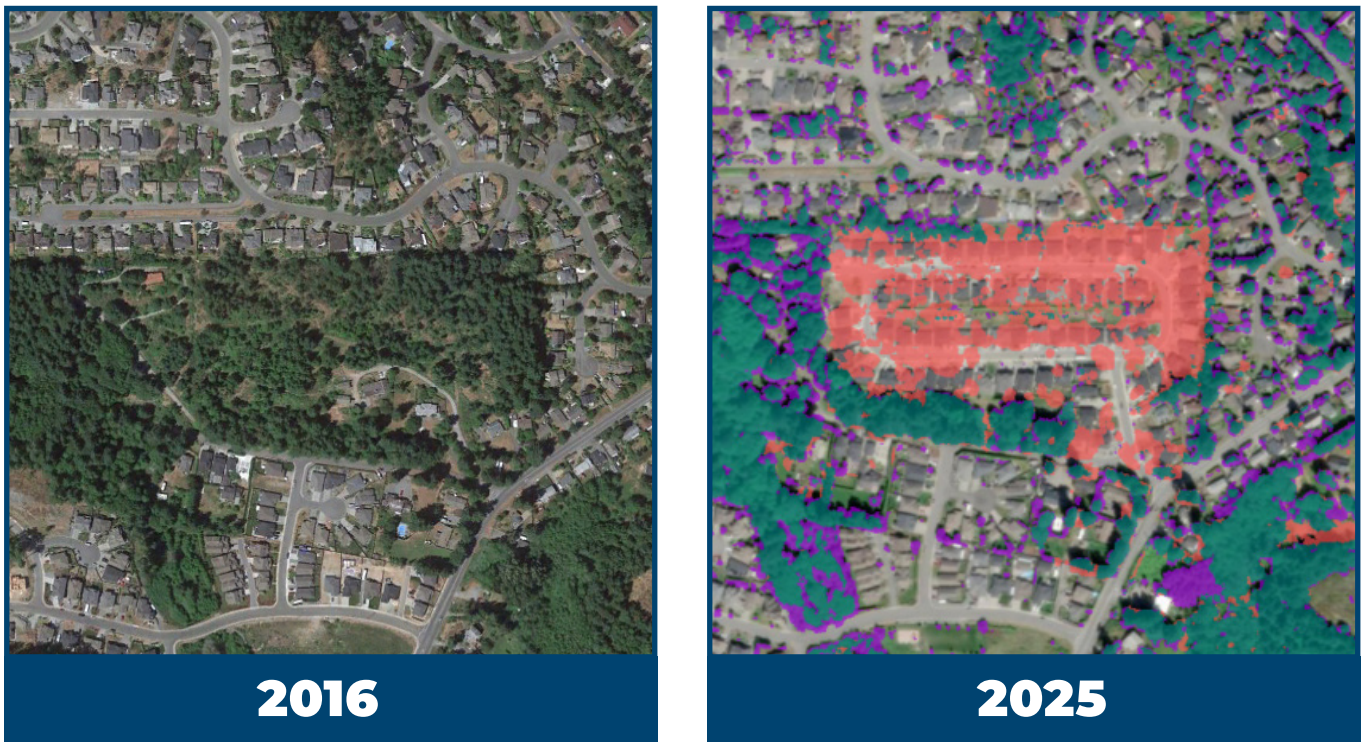
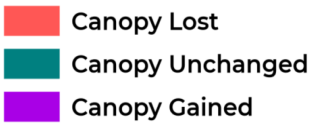


Figure 9. The neighbourhood development on Golden Oak Crescent caused a loss of canopy from 2016 (left) to 2025 (right).



Tree Canopy Gain Example:

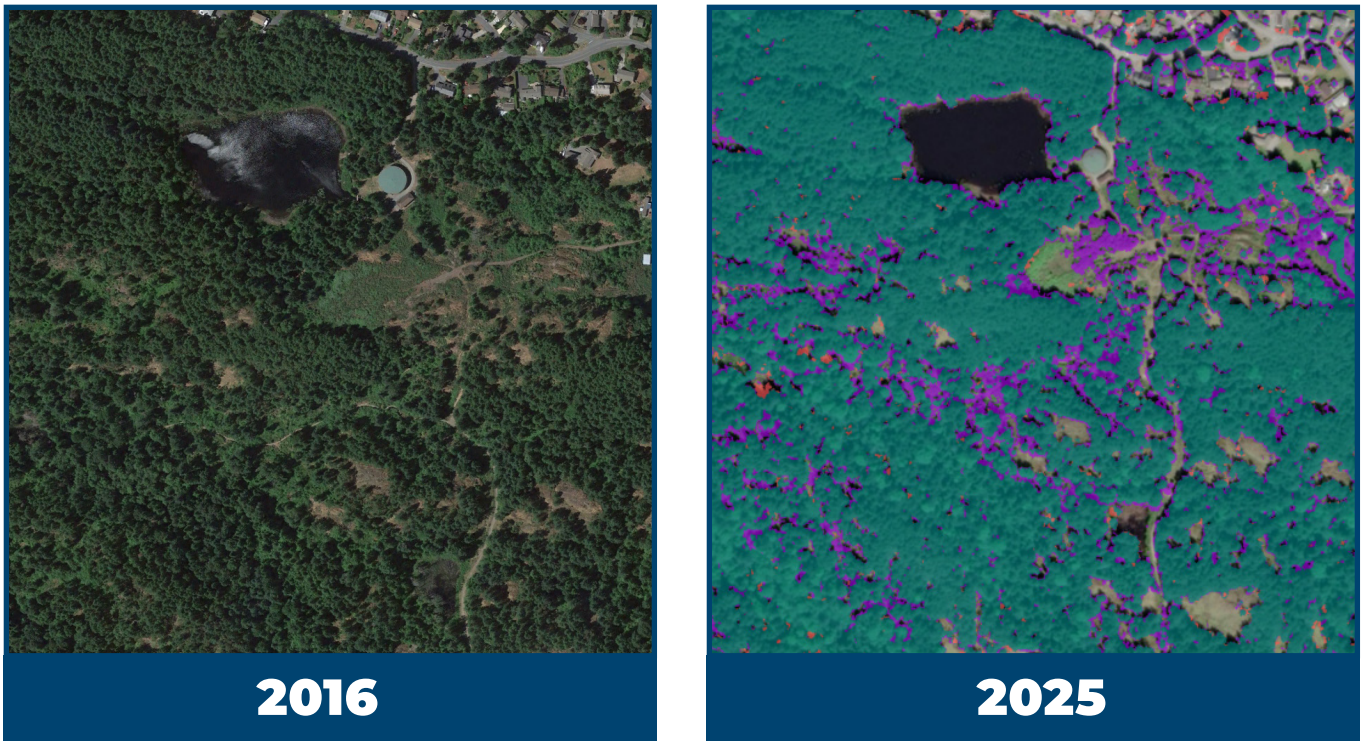


Figure 10. Maturing trees that closed gaps in tree canopy and natural regeneration added canopy in Linley Valley Park and the surrounding areas, from 2016 (left) to 2025 (right).

Tree Canopy Cover in Nanaimo's Riparian Areas

Riparian areas are the strips of land and vegetation found alongside rivers, streams, lakes, wetlands, and other watercourses, and they play a critical role in maintaining healthy ecosystems. These areas provide food and habitat for fish (including salmon and other freshwater species) and must remain largely undisturbed to keep the surrounding waterway ecosystem functioning properly. Riparian areas also protect nearby properties from flooding and prevent land loss caused by erosion and channel instability, making them important for both nature and people.

Because of this, the City of Nanaimo has regulated activity in and around these areas since 1997 through Development Permit Areas (DPAs) and its Zoning Bylaw. Depending on the size and condition of a watercourse, setback distances (buffer zones where construction and land disturbance are restricted) range from 7.5 metres for minor, isolated streams to 30 metres for larger rivers with significant riparian vegetation. These setbacks are measured from key reference points such as the top of the riverbank or the wetland boundary, and any development proposed within them requires a Development Permit to ensure there is no net loss of habitat. **Taken together, these protections reflect the vital role of riparian areas in habitat preservation, flood control, and erosion management in Nanaimo.**

Protected riparian areas are vital for the environment of Nanaimo and the surrounding region, as well as for the water quality of streams and the larger bodies of water they connect to. Trees play a crucial role in these zones, providing numerous benefits that support the case for protecting these spaces. **Across the city, 572 hectares are designated as riparian areas, with 345 hectares of tree cover, averaging 60% coverage.** Additionally, an estimated 61 hectares in these areas can be planted with more trees. These new plantings would help connect tree cover, better manage stormwater, provide habitat for wildlife, and offer shade to streams to keep water temperatures stable. To support this work, the City of Nanaimo has secured two grants totaling $40,000 for community groups, with a significant portion directed toward tree plantings in these riparian areas.



Nanaimo Watercourse Setback Distances Diagram:

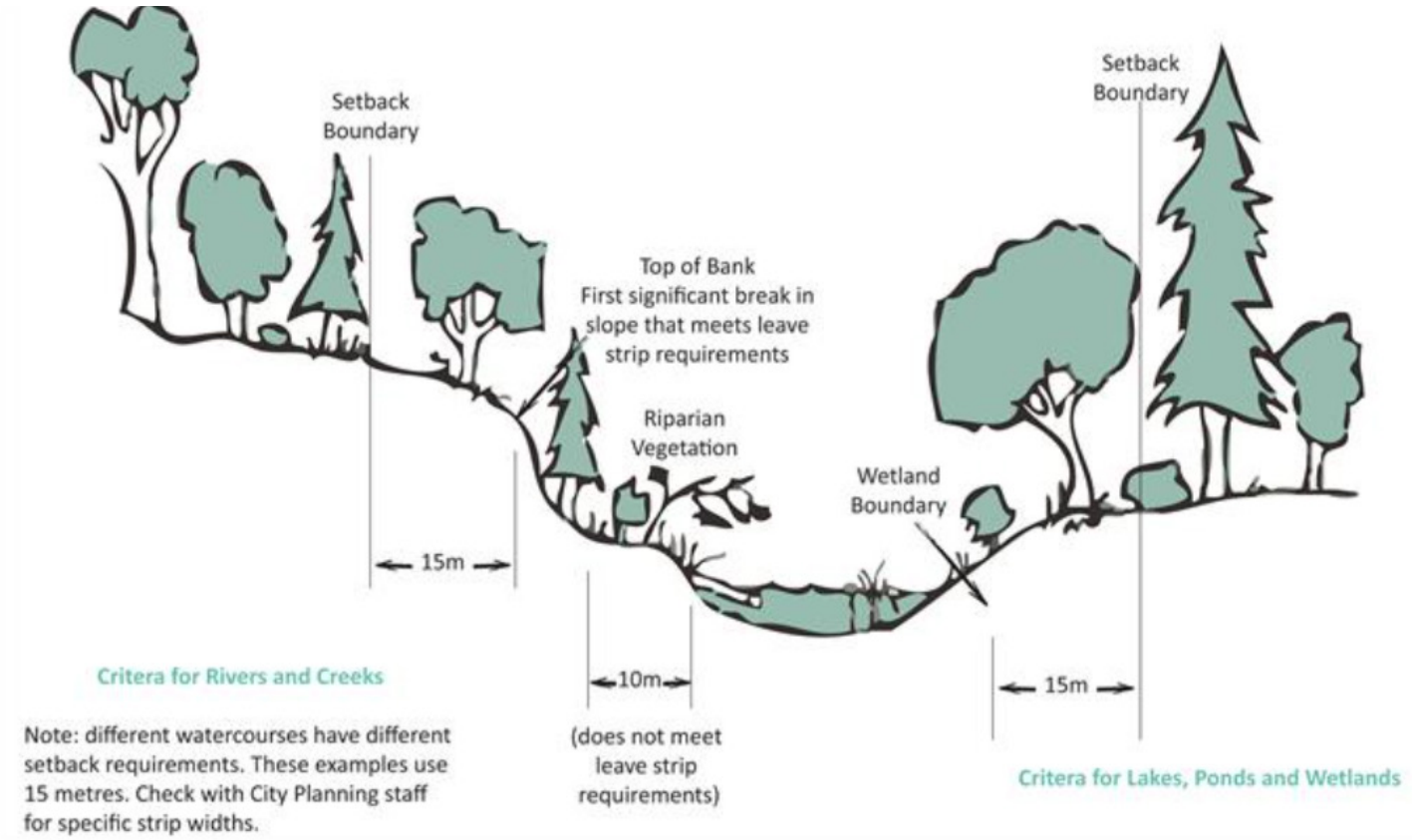


Figure 11. How setback distances are measured from watercourses and wetlands. Setbacks are measured from the Top of Bank (rivers and creeks) or Wetland Boundary (lakes and ponds), Source: City of Nanaimo, Watercourse Protection.



Tree Canopy Distribution within Riparian (Watercourse Setback) Areas Map:

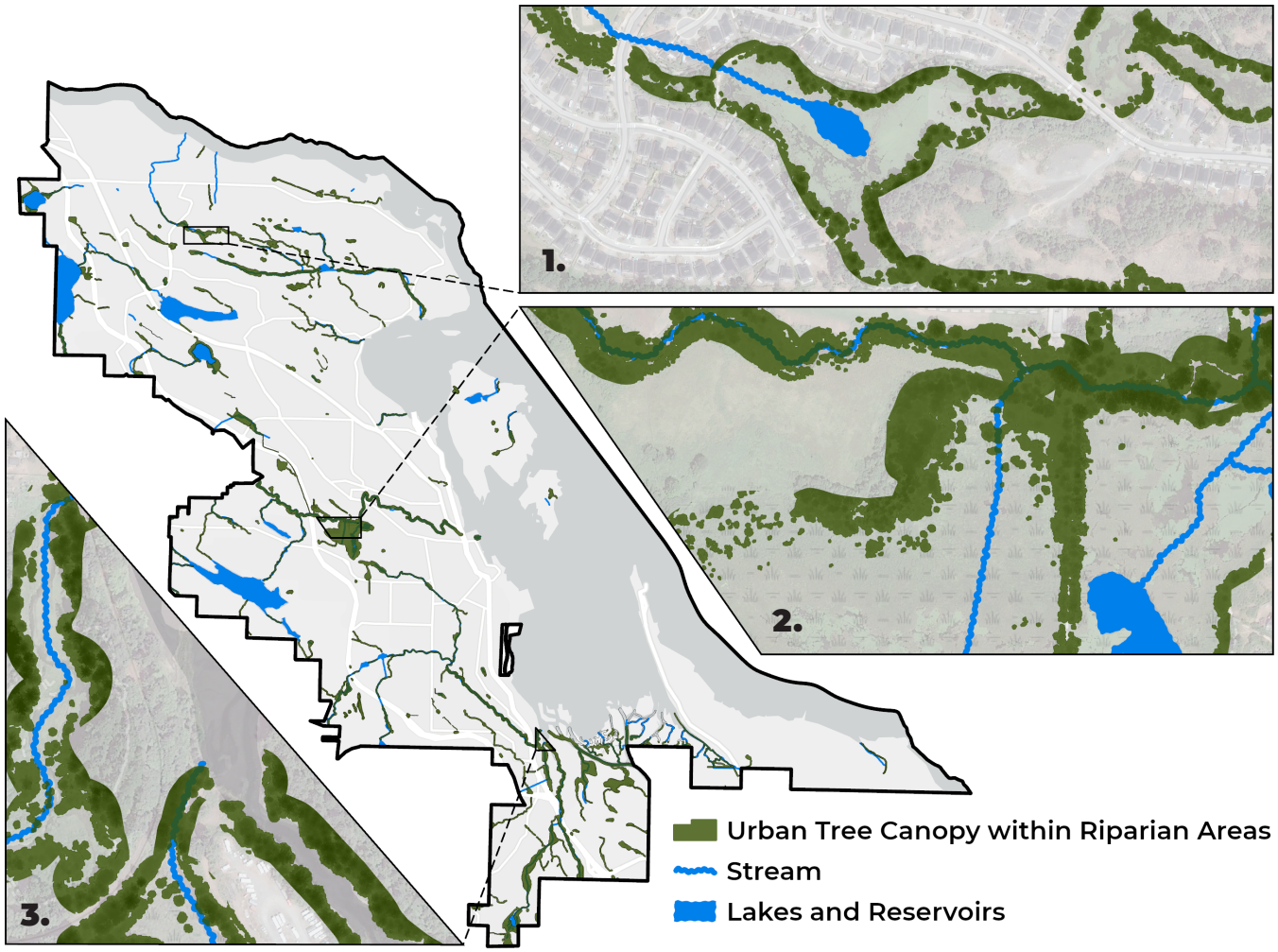


Figure 12. Map displaying urban tree canopy (dark green) within Nanaimo's watercourse setback areas, shown alongside streams and lakes/reservoirs (blue). Inset maps highlight riparian areas across three contrasting land use contexts: a residential neighbourhood (1), a large open space (2), and a coastal estuary (3), illustrating the city-wide extent and diversity of these ecologically significant buffers.

Tree Canopy Change in Nanaimo's Riparian Areas

During the 9-year study period in Nanaimo, the riparian areas saw a 51-hectare increase in tree canopy, representing an 8.9% growth. Most of this increased canopy came from existing trees growing larger and filling gaps. However, there were also some areas where new trees naturally regenerated that weren't present in 2016.

Tree Canopy Cover by City-Owned Property

City properties play a key role in Nanaimo's urban forest, serving as spaces for residents to gather and as connections between tree-covered areas on private and public lands. Most city properties are parks, but they also include recreational trails, riverbank areas, and sites for local government buildings. **These city-owned lands make up 19% of the city's urban forest and are valuable because many families and children visit them daily.** Additionally, Nanaimo manages 1,400 hectares of land along streets including boulevards, medians, and pavement, that contain trees providing essential shade for sidewalks. These areas are collectively referred to as "road dedication areas".

City-owned properties, excluding road dedication areas, have an average urban tree canopy of 65%. In contrast, private properties, mostly residential, have an average of 40%, while federal and Provincial-owned areas have about 54%. Some examples of city properties with both high UTC percentages and hectares include Nanaimo Lakes Road Park (92% UTC), Linley Valley Park (90% UTC), and Linley Valley Cottle Lake Park (88% UTC). **Although many city properties have many trees, canopy levels vary widely across different types of public land, and some areas have little or no tree cover.** Overall, 106 hectares of city-owned land are available for planting trees, representing 11% of the city's total area suitable for planting.

Road dedication areas, which are the green strips between roads and sidewalks, currently have 297 hectares of tree cover and an average of 21% tree canopy coverage. **Considering the space taken up by utilities, there are 108 hectares of lawn in these areas where adding more trees could greatly enhance shaded sidewalks.** Planting more trees here can help connect the tree cover between homes and nearby parks, allowing residents to enjoy uninterrupted shade while walking. That said, expanding tree cover in these areas requires careful planning, as trees near roads, sidewalks, and underground utilities can cause conflicts with infrastructure. It will be important to balance community preferences with operational constraints, as well as accounting for ongoing maintenance costs such as irrigation, root pruning, and canopy management.

Maintaining the tree canopy on city-owned properties and expanding it near streets and sidewalks is important for long-term growth. However, private and residential properties also need to contribute. **In fact, 55% of the city-wide tree canopy and 73% of the city's potential planting area are on private land, which means residents must take care of their trees and replace them when they die.** The City of Nanaimo helps support tree growth on public land by planting 150 trees each year in road dedication areas and parks. Additionally, they offer a tree voucher program that subsidizes the sale of a least 1,000 nursery trees to residents, encouraging them to plant on their own properties. Supporting the city's tree canopy is a community effort.

Tree Canopy Change by City-Owned Property

Overall, city-owned properties and road areas gained a total of 137 hectares of tree cover between 2016 and 2025. City properties increased by 4.7%, **while road dedication areas saw a 6.1% increase.** This growth can be attributed to favourable weather conditions and successful city tree-planting programs.

Notable city-owned locations include Third Street Park, which added over 6 hectares of tree cover (a 26.2% increase). The northern part of Linley Valley Cottle Lake Park added nearly 3 hectares (12.7% growth), and the Harmac Arboretum also gained 3 hectares (11.2% growth).

For comparison, tree cover also grew on federal and Provincial lands (2.2% increase) and private properties (6.3% increase).

Nanaimo's city-owned properties are essential for maintaining large, mostly undisturbed forested areas that contribute significantly to the city's overall tree canopy. Tree canopy expanded by 137 hectares on these city-owned lands from 2016 to 2025.



Tree Canopy Potential by Ownership Class:

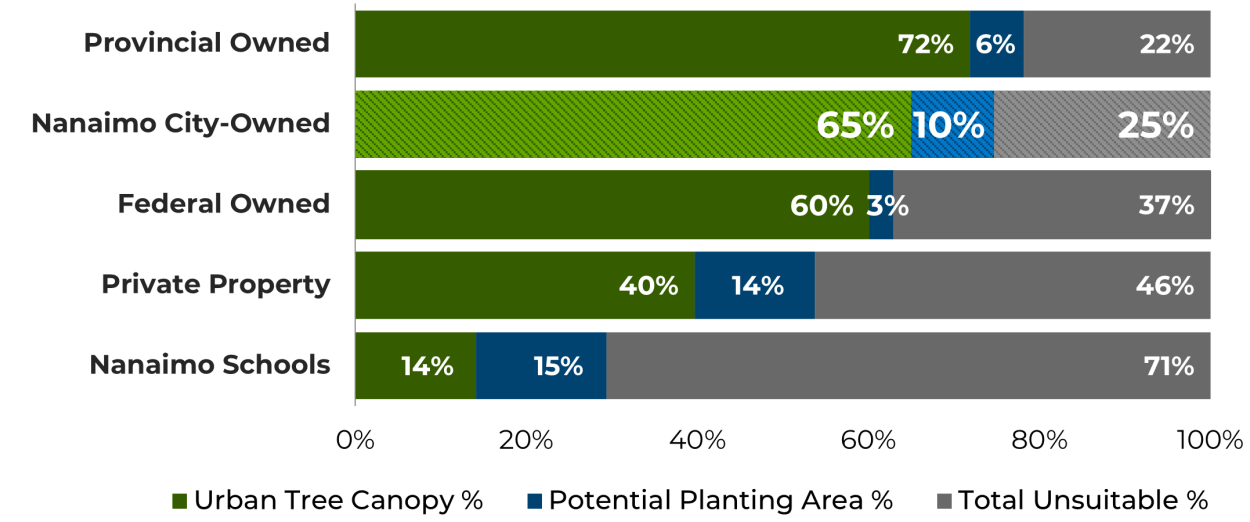


Figure 13. Bar chart displaying urban tree canopy, possible planting area, and unsuitable area percentages by five ownership types in Nanaimo.

City-Owned Parcels Urban Tree Canopy, Possible Planting Area, and Tree Canopy Change Percent Ranges:

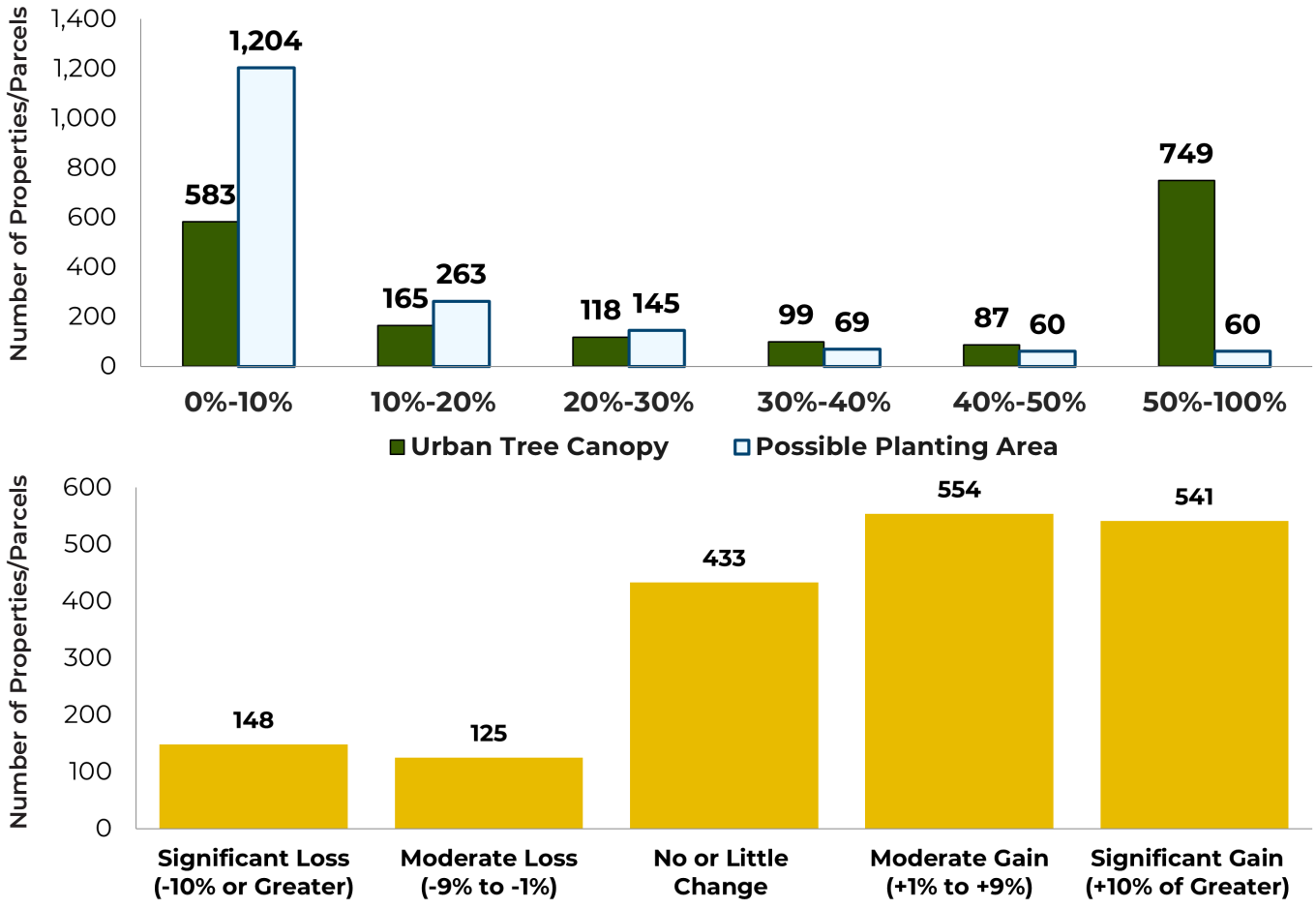


Figure 14. Bar charts displaying the distribution of city-owned property parcels within urban tree canopy and potential planting area (top chart) and urban tree canopy change (2016-2025; bottom chart) percent ranges. The y-axis represents the number of properties.

Tree Canopy Cover by Schools

School properties serve a dual role in Nanaimo: they are both community greenspaces and one of the primary ways children encounter nature in an urban environment. Collectively, schools occupy 92 hectares of land across the city, of which 13 hectares are covered by urban tree canopy. That coverage is uneven, ranging from 3% to 43% across individual properties, with a citywide school average of 15% UTC.

A handful of schools have managed meaningful canopy cover despite competing demands on their land. Uplands Park Elementary (43% UTC), Frank J. Ney Elementary (36% UTC), and Cilaire Elementary (29% UTC) each exceed a quarter canopy coverage while still accommodating recreation fields and parking. Uplands Park stands out because although it is the third-largest school by area, it holds 3 hectares of canopy, representing 21% of the total canopy distributed across all school properties. **At the other end of the spectrum, 13 schools fall below 10% canopy coverage, with Chase River Elementary (3% UTC), Georgia Avenue Elementary (5% UTC), and Wellington Secondary (5% UTC) at the bottom.**

The low canopy numbers at many schools are compounded by high impervious surface coverage. **On average, 46% of school property is pavement, parking lots, or buildings, surfaces that absorb and retain heat especially where unshaded.** Across all schools, roughly 14 hectares of land are available for new tree planting. Schools with the most planting potential relative to their size include École Quarterway Elementary, Rutherford Elementary, and Rock City Elementary.

Tree Canopy Change by Schools

School properties in Nanaimo collectively gained a total of 3 hectares of tree cover, reflecting a 3.5% increase, over the 9-year study period. **Every school in the city saw some degree of growth in tree canopy, ranging from a 1% increase to an 8% increase.**

The strongest performers were École Pauline Haarer Elementary (8.2% increase), Randerson Ridge Elementary (6.9% increase), and Frank J. Ney Elementary (6.8% increase). In absolute terms, Nanaimo District Secondary added the most ground. As the largest school property by area, it gained 0.3 hectares, translating to a 2.3% increase.

School Tree Canopy and Possible Planting Area Map:

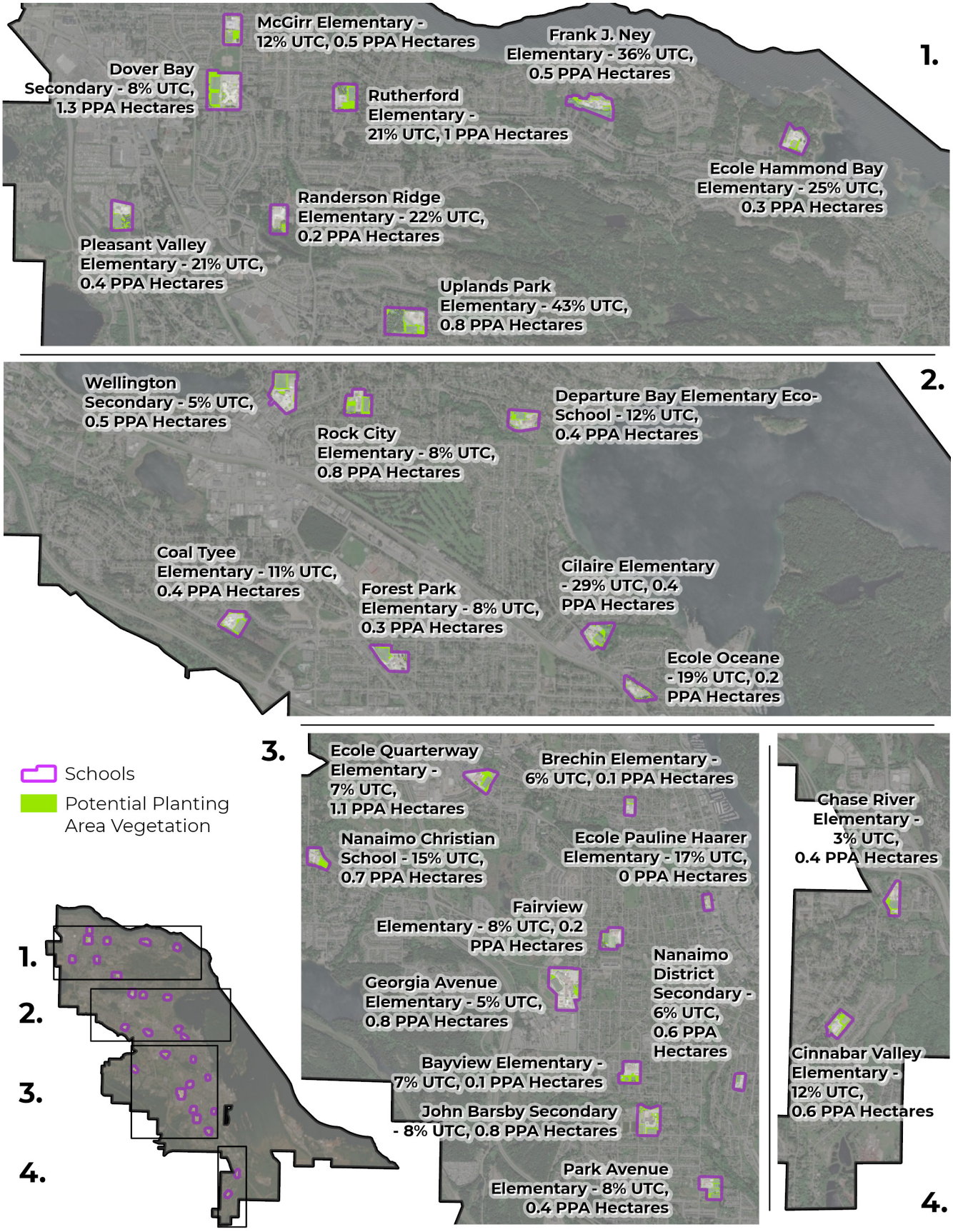


Figure 15. Map of schools in Nanaimo, labeled with their respective urban tree canopy percentages and possible planting area in hectares.

Tree Planting Prioritization by Dissemination Area

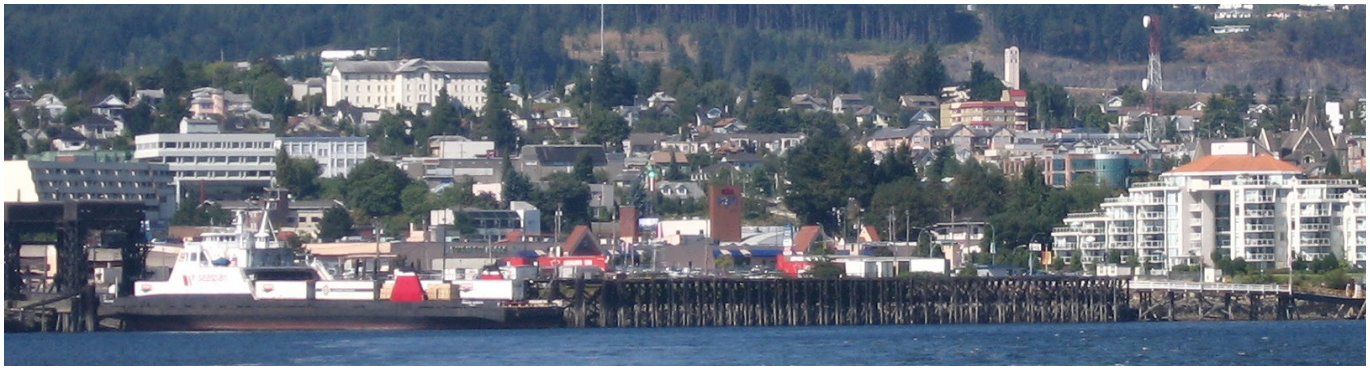
Prioritization Analysis Overview

A dissemination area (DA) is a small, relatively stable census geography made up of one or more adjacent dissemination blocks, with an average population of about 400–700 residents. DAs are designed to have broadly similar population sizes and are the smallest standard areas for which full census data are released across Canada.

Tree canopy across Nanaimo's dissemination areas ranged from 7% to 76%. Of the 151 DAs in the study area, 30 had tree canopy cover above the citywide average of 39%. **Thirty-nine DAs had less than 20% urban tree canopy, and these lower-canopy areas are mostly scattered along the denser urban corridor that runs diagonally from the northwest portion of the city toward the downtown core.** Ten DAs had between 20% and 37% of their area designated as plantable space, and these areas together comprise 19% of the city's total plantable area. However, available space isn't enough on its own to decide where to plant new trees. Social factors, environmental impacts, and equity must also be considered when choosing where to add more tree cover.

Increased tree canopy cover can provide a wide array of benefits to a local community. To locate specific areas in need, seven variables representing a range of socio-economic, demographic, and climatic factors were analyzed at the dissemination area level. The five socio-economic variables were derived from the most recent Statistics Canada census release and the urban heat island variable was derived from Landsat temperature bands captured on August 4, 2025.

Each variable was normalized and assigned equal weight, and the final score for each dissemination area was calculated by summing the normalized values for that area. Rankings range from high priority (dark blue) to low priority (light yellow) and are calculated for each criterion and overall to highlight where multiple needs overlap.



Planting Prioritization by Census Block Groups

Tree Canopy Percent by Dissemination Area Map:

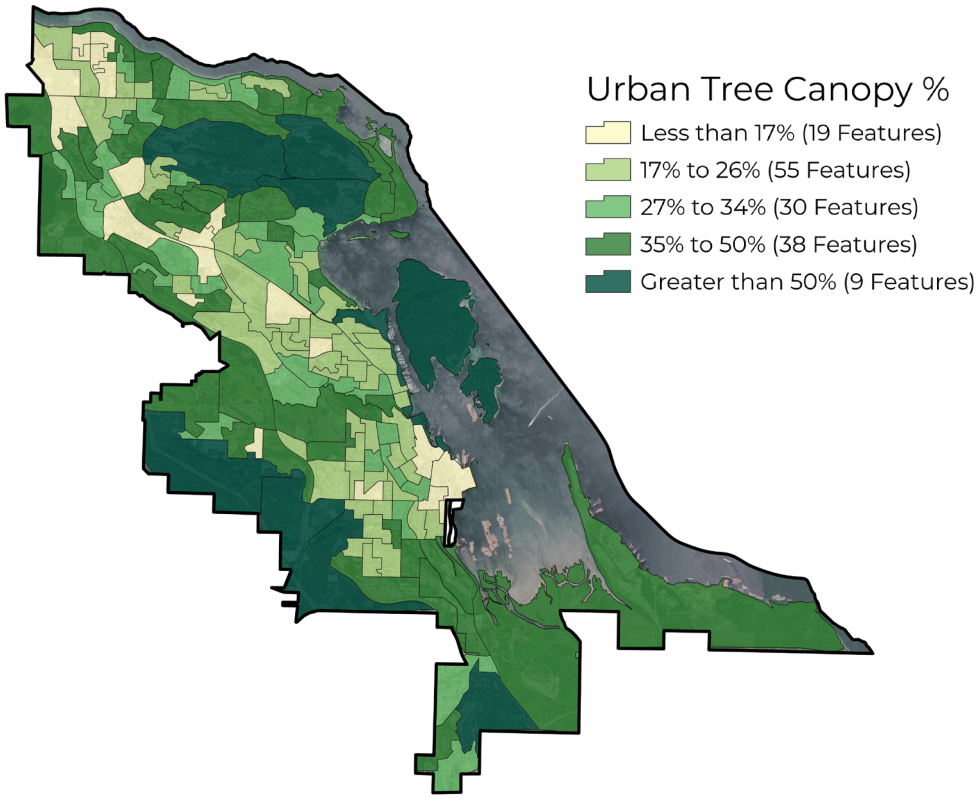


Figure 16. Map displaying the average tree canopy percent by dissemination area. Darker features have higher tree canopy percent.

Possible Planting Area Percent by Dissemination Area Map:

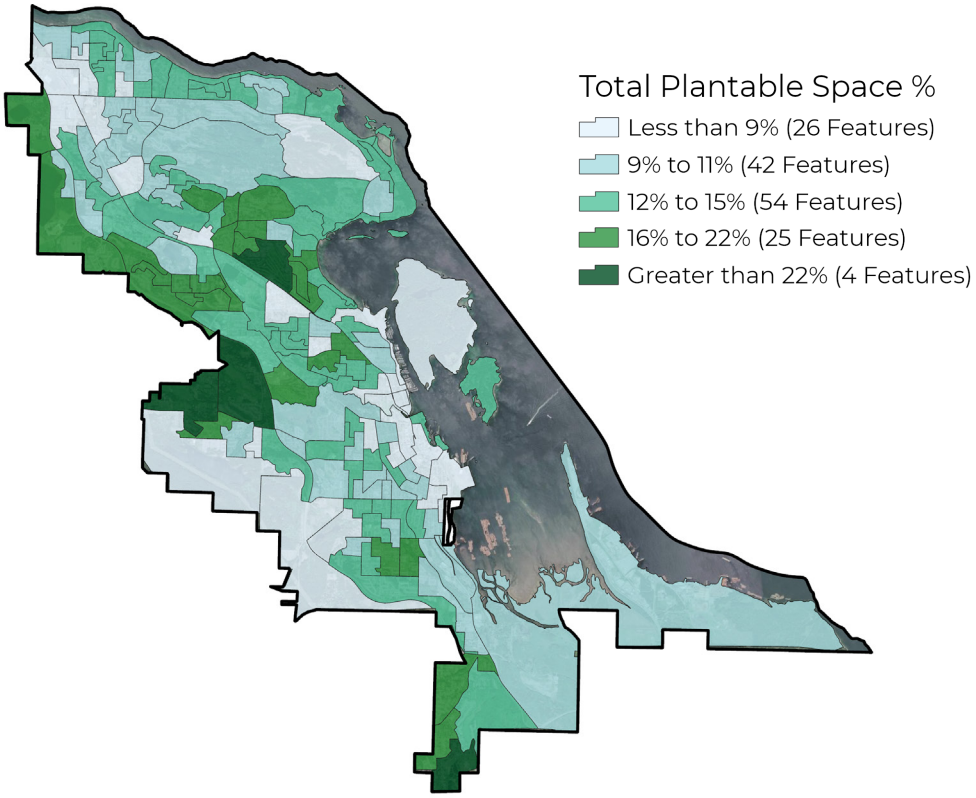


Figure 17. Map displaying the average possible planting area percent by dissemination area. Darker features have higher planting area percent.

Prioritization Variables Considered



Low Existing Tree Canopy:
Dissemination areas with lower tree canopy cover percentages and higher non-canopy land are prioritized for planting to increase overall canopy.



Possible Urban Tree Canopy:
Dissemination areas with greater plantable area are prioritized for expanding urban tree canopy.



Prevalence of Low Income (LIM-AT):
Dissemination areas with higher percentages of residents living in low income based on the Low-income Measure, After Tax (LIM-AT) are prioritized for planting to enhance benefits for economically disadvantaged households.



Unemployment Rate:
Dissemination areas with higher unemployment rates are prioritized for planting opportunities.



Vulnerable Population (Dependency Ratio):
Dissemination areas with larger ratios of residents aged 0–14 and 65+ relative to the working-age population (15–64) are prioritized for planting to support vulnerable populations.



Median After-tax Household Income:
Dissemination areas with lower median after-tax household incomes are prioritized for planting to address environmental inequality.



Educational Attainment:
Dissemination areas with lower percentages of adults with a high school diploma or equivalency certificate are prioritized for planting to improve outcomes.



Urban Heat Island:
Dissemination areas with higher surface temperatures are prioritized for planting to mitigate the effects of urban heat.



Stormwater Mitigation Potential:
Dissemination areas with larger percentages of plantable space within 30 metres of impervious surfaces and water bodies are prioritized for planting to improve stormwater management.

Overall Prioritization Ranking by Dissemination Areas Map:

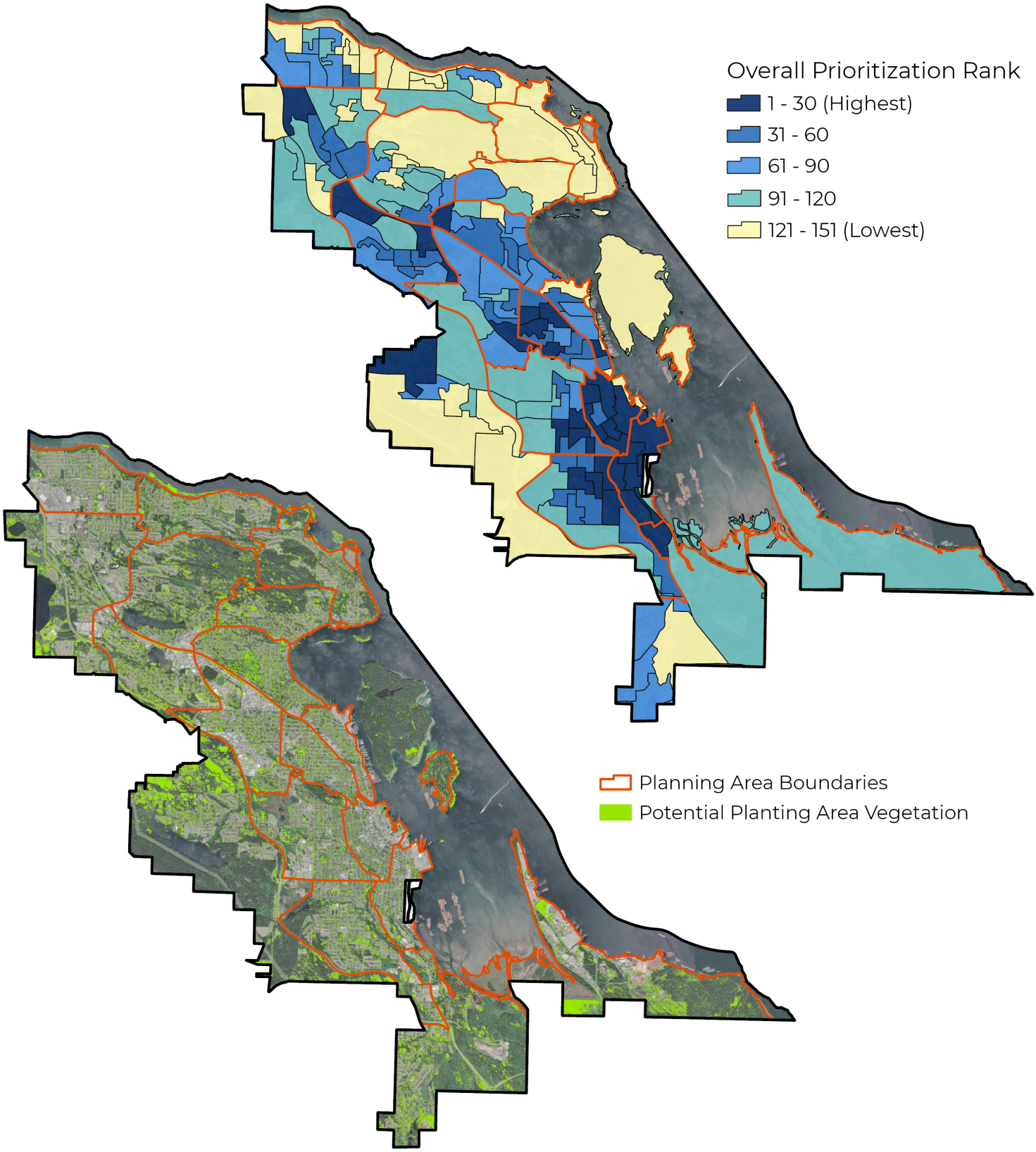


Figure 18. Overall prioritization rankings for Nanaimo's dissemination areas (top map). Dark blue indicates higher priority for tree plantings while the yellow indicates the lowest priority areas. The bottom map shows the distribution of areas identified as potential plantable space.

Ecosystem Benefits

The Value of Nanaimo's Urban Forest

The i-Tree tools were utilized to assess the benefits and functions of green infrastructure within the city limits of Nanaimo, based on the latest available research. Trees and shrubs produce oxygen, help reduce pollution by lowering air temperatures, and improve public health by decreasing harmful air pollutants that can lead to illness and death. Additionally, tree canopy coverage has been shown to mitigate stormwater runoff, reducing flood risk, stabilizing soil, minimizing sedimentation in streams, and providing cooling benefits.

Trees play a crucial role in sequestering carbon from the atmosphere through photosynthesis and storing it long-term in their biomass. **Nanaimo's current tree canopy contributes an estimated $13.7 million annually in avoided infrastructure costs and an additional $367 million in stored carbon. The ~31,500 tons of carbon sequestered annually by Nanaimo's trees is about equal to a loaded BC Ferry!**

Diagram of Urban Forest Benefits:

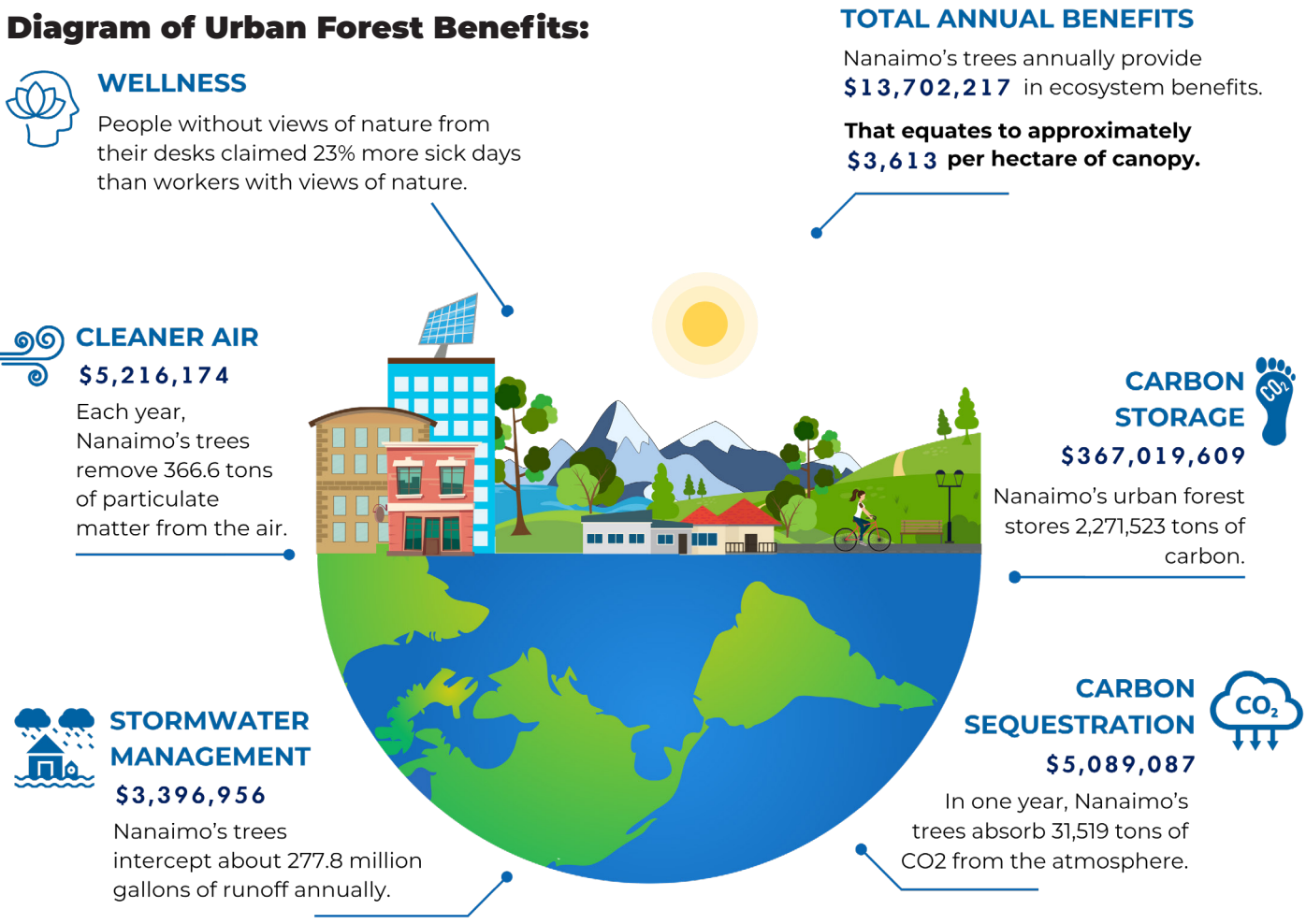


Figure 19. Ecosystem service benefits of Nanaimo's canopy cover. Data sourced from i-Tree, the US Forest Service, the Arbor Day Foundation, and the U.S. Environmental Protection Agency. Monetary values are represented as $ CAD.

Nanaimo's Tallest Trees

Impressive Tree Specimens in the City

Nanaimo's urban forest is defined not only by its overall canopy cover but also by its exceptional individual trees. Inside Westwood Ravine Park, a Douglas fir rises ~63 metres into the sky, as tall as The Pacifica condominium complex in downtown. It is the tallest tree in any Nanaimo park, but it is far from the only remarkable specimen in the city. To highlight these notable trees, an analysis was conducted to identify the tallest ones using detailed height data from a 2025 LiDAR survey, along with a refined tree canopy layer created for this study. The analysis first excluded any trees under 30 metres in height to focus on the city's most prominent specimens and then removed obvious non-tree artifacts such as tall construction equipment. After filtering the approximate 165,000 trees that are between 30 and 55 metres tall, **532 trees remained, representing Nanaimo's tallest canopy cohort.**

The results show that roughly half of these tallest trees are concentrated in Saysutshun Marine Provincial Park, Westwood Lake & Ravine Parks, and Nanaimo Lakes Road Park, highlighting pockets of structurally impressive and likely older forest. This information directly supports the City's goals for heritage tree programming, public outreach, and preservation planning, offering tree "fun facts" and mapping for community engagement while also highlighting large undeveloped parcels with significant trees. By showing where tall trees are located on both public and private lands, this analysis raises awareness of important old-growth and notable urban trees. It can also guide future efforts to protect these trees, manage development, and encourage responsible caring for the environment.



In Nanaimo's parks, a total of 251 park parcels feature at least one tree exceeding 30 metres. Notably, 16 parks have at least one tree that stands taller than 55 metres, with the eight tallest park trees represented in Table 1. While many of the city's tallest trees are found in untouched forest areas, there are also some impressive specimens in smaller urban parks. For instance:

- **At Mansfield Park,** a 41-metre Douglas fir grows directly beside the playground, large enough that its canopy shades the swings on a summer afternoon.
- **Comox Park contains** a 35-metre Douglas fir visible from the park entrance, its upper branches reaching above the rooftops of the surrounding neighbourhood.
- **In Nob Hill Park,** the walking path dips beneath the canopy of a Douglas fir that stands 33 metres tall, its canopy stretching across the trail like a natural archway.

Douglas fir trees have been a prominent feature of Vancouver Island's landscape for more than 10,000 years. They are known for their impressive lifespan, often living up to 500 years, and can grow taller than 90 metres. Given their long-standing presence in the region, it's not surprising that a significant number of the tallest trees in Nanaimo are Douglas firs, even in urban settings.

Table 1. Each value represents the tallest tree recorded within the park boundary. Parks are ranked by their maximum tree height.

Park	Approximate Tallest Tree Height (m)
Westwood Ravine Park	63
Saysutshun Marine Provincial Park	61
Colliery Dam Park	61
Westwood Lake Park	60
Sealand Park	60
Dunster Park	59
Nanaimo Lakes Road Park	59
Ryan Road Park	59



Westwood Ravine Park has a Douglas Fir of a height equal to The Pacifica condominium complex downtown, rising approximately 63 metres into the sky.

Nanaimo's Tallest Trees Map:

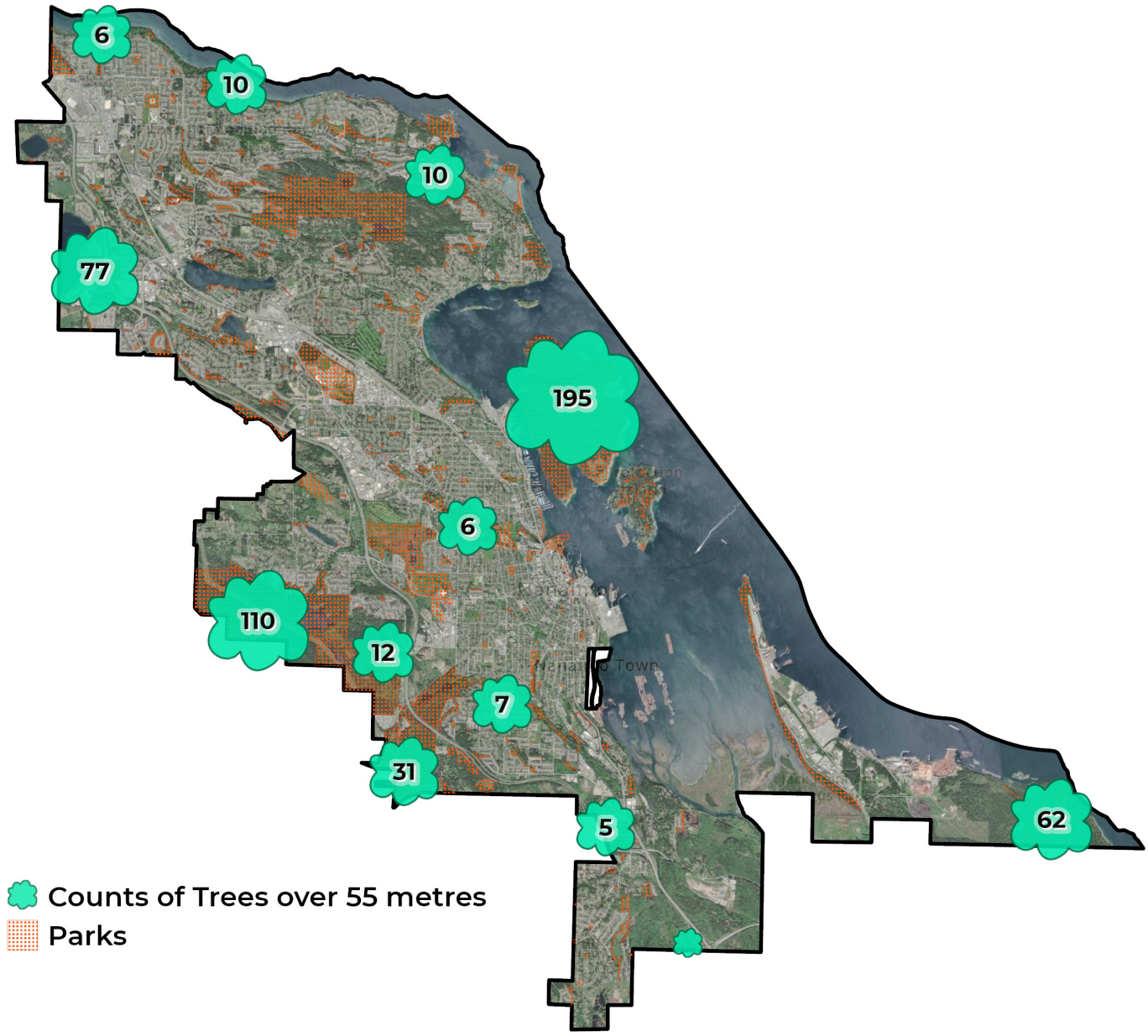


Figure 20. Distribution and counts of trees over 55 metres tall in Nanaimo. Larger teal icons represents higher density of tall trees.



The Future of Nanaimo's Tree Canopy

Tree Canopy Projection Scenarios Overview

Nanaimo's tree canopy grew steadily between 2016 and 2025, with new plantings and natural expansion outpacing losses from development and climate events. Whether that trend holds over the next two decades depends on how well the city manages a set of growing threats. To explore the range of possible outcomes, this study modeled three scenarios for Nanaimo's canopy through 2046.

1. **Business-as-usual:** This means no major problems affecting the trees.
2. **Moderate threats:** This includes some risks, like pests or diseases.
3. **Substantial threats:** This scenario considers more serious problems that could harm trees, like severe drought.

According to research from the University of Maryland, Nanaimo's climate could change significantly by 2080. It might feel similar to the climate of Three Rivers, California, today. Under a high-emissions scenario, the study predicts that by then Nanaimo could be about 6.4 degrees Celsius warmer in the summer and 16% drier. In the winter, it might be about 4.5 degrees Celsius warmer and 4.8% wetter. For trees adapted to the cool, moist Pacific Northwest, sustained summer heat and drought are serious stressors.

Nanaimo's Potential Extreme-Case Climate Scenario in 60 Years:

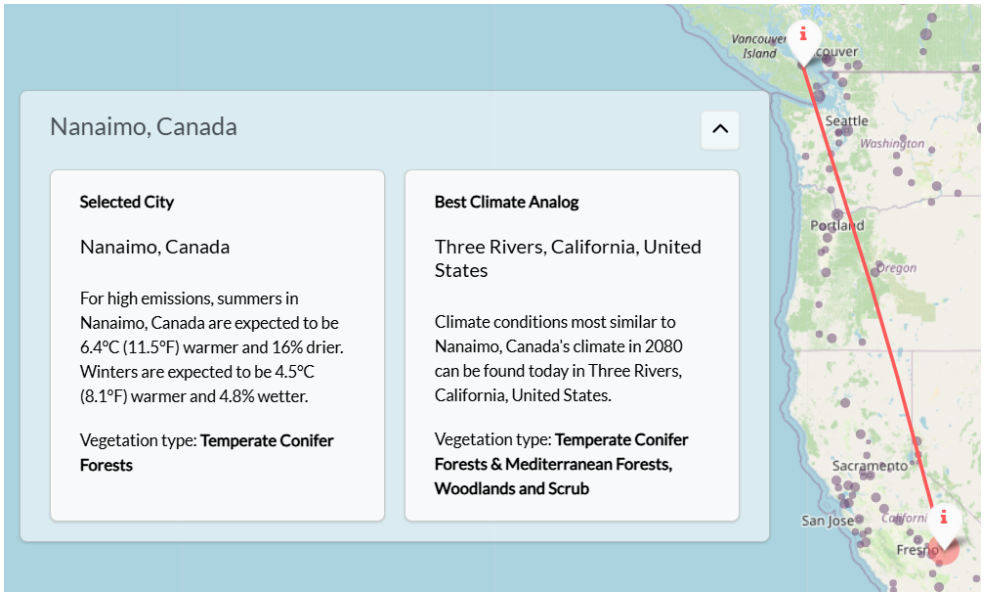


Figure 21. By 2080, Nanaimo's climate, under a worst-case-scenario, could be similar to today's climate in Three Rivers, California, Source: University of Maryland, What Will My City Feel Like in 60 Years?

Canopy Projection Model Inputs

The growth and decline rates for trees in this model were calculated from actual changes in tree canopy between 2016 and 2025 in Nanaimo. This involved looking at factors like how many trees die each year, how many are removed for development, how fast they grow each year, and how many new trees naturally sprout (see Figure 21). The city-wide scenarios also estimated how much tree cover would be lost due to large-scale development outlined in the Community Plan.

In the moderate and substantial threat scenarios, the basic rates of tree death and growth were used, but they included planned changes over 20 years that would lead to higher death rates and lower growth rates. Some examples of these changes include pest invasions, such as the western spruce budworm (Choristoneura freemani), which feeds on the leaves of Douglas fir and other conifer trees. Another concern is the emerald ash borer (Agrilus planipennis), an invasive insect that poses a threat to urban ash trees. Additionally, the spongy moth (Lymantria dispar dispar) can defoliate many types of broadleaf and conifer trees. The model also projects longer droughts if the city gets warmer and drier during the summer months.

The City of Nanaimo plants 150 trees each year on city-owned land and road dedication areas. Nanaimo's Parks and Recreation Department also subsidizes the sale of at least 1,000 nursery trees to residents, who then plant them on their own property (as reflected in the city-wide scenarios). See Appendix C for a complete list of variables.

Canopy Projection Model Growth and Decline Variables:

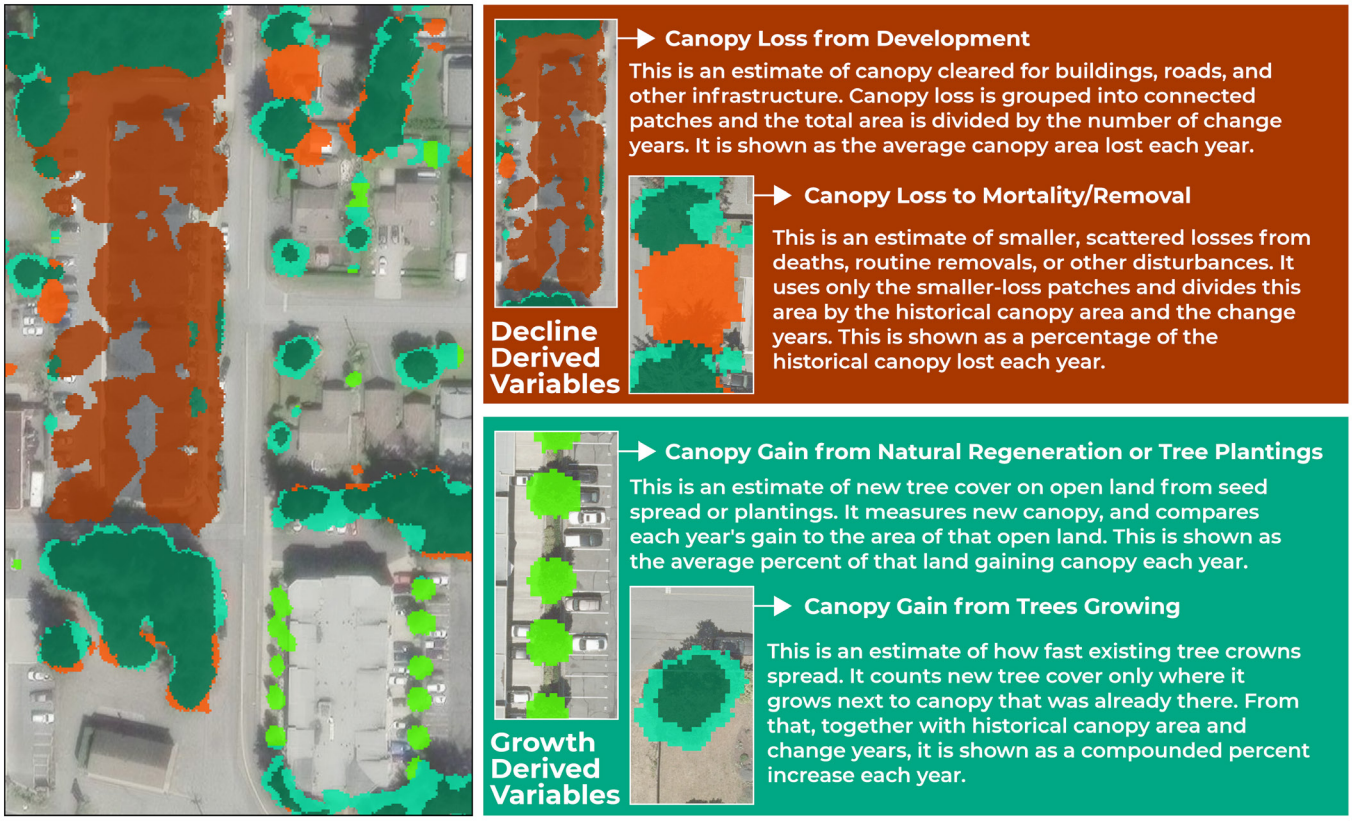


Figure 22. Growth and decline variables derived from canopy change data in Nanaimo.

Canopy Projection Model Findings

Under a business-as-usual scenario with no major threats, Nanaimo is on track to grow its urban tree canopy from 38.7% today to 46.3% by 2046, a net gain of 746 hectares and a potential . Despite this, the city needs to remain alert to emerging risks. If moderate threats, such as pest encroachment or disease, take hold, that net gain could shrink significantly. Under a substantial threats scenario, involving more serious stressors like severe drought or widespread pest damage, the city could actually lose canopy by 2046. These outcomes are a reminder that future tree canopy growth is not guaranteed. If climate change accelerates or new threats emerge, the city may need to increase the number of trees planted each year or expand the number of trees distributed through its voucher program to stay on a positive trajectory.

With the help of favourable conditions in the Pacific Northwest, Nanaimo has made meaningful progress in expanding its urban tree canopy. The city's ongoing tree planting efforts and voucher program reflect a genuine commitment to a greener future. Although overall tree canopy has grown, there is a significant difference in canopy cover across the city. The downtown core and many roadways have much lower canopy cover, so people who live and visit these areas don't experience as many tree benefits as those who live in well-treed parts of town. Unlike naturally forested areas that have grown without much help, these more developed spaces need intentional planting to have enough tree cover. Continuing to plant 150 trees per year on city-owned land and in road-dedication areas will remain crucial to expanding the tree canopy where it's lacking. To get the most benefits from that investment, it's important to choose places where trees can grow over hard surfaces like roads and rooftops. This way, the canopy can provide the most shade and help cool those areas in the summer.

Table 2. Tree growth projections for the City of Nanaimo based on minimal or no threats, moderate threats, and substantial threats. The first set of three scenarios assesses the entire City of Nanaimo, and the second set assesses city-owned property only.

	Scenario	UTC % in 2026*		Net Tree Canopy Change		UTC in 2046	
		%	Hectares	%	Hectares	%	Hectares
150 Trees Per Year City-wide	No Threats + Comp Plan	**38.7%**	**3,792**	**7.6%**	**746**	**46.3%**	**4,538**
	Moderate Threats + Comp Plan	**38.7%**	**3,792**	**1.4%**	**135**	**40.0%**	**3,927**
	Substantial Threats + Comp Plan	**38.7%**	**3,792**	**-1.2%**	**-112**	**37.5%**	**3,680**
150 Trees Per Year City-Owned Property	No Threats	**61.3%**	**727**	**10.9%**	**130**	**72.2%**	**857**
	Moderate Threats	**61.3%**	**727**	**1.5%**	**18**	**62.8%**	**745**
	Substantial Threats	**61.3%**	**727**	**-2.3%**	**-27**	**58.9%**	**700**

Conclusions and Recommendations

Conclusion

The City of Nanaimo values its natural resources and is committed to maintaining a healthy, sustainable urban environment. Regular assessments of the city's tree canopy are key to ensuring the long-term health of its urban forest. Maintaining and expanding canopy cover can be achieved through careful planning, investment, and the ongoing care of trees.

To preserve and enhance Nanaimo's tree canopy, the city should continue conducting tree canopy assessments at regular intervals. As the city population continues to grow, this data will inform urban forest policies and management practices, prioritizing canopy health and growth. The urban forest provides a range of environmental, social, and economic benefits, fostering greater community pride and engagement with citywide initiatives. Continuing assessments will help identify areas where canopy cover should be preserved, opportunities to expand it, and where targeted investments can produce the greatest benefits.

Realizing these benefits requires a long-term commitment to capital planning that accounts for the full cost of urban forestry, from planting and establishment to ongoing maintenance such as pruning, irrigation, and infrastructure conflict mitigation. While these initial investments can be significant, proactive planning helps distribute costs over time and reduces the risk of reactive, more expensive interventions down the road. Embedding urban forest funding into the city's long-term financial planning will be essential to sustaining Nanaimo's urban forest.

Recommendations

1. **Promote a Resilient, Climate-Ready Urban Forest**
   The findings from this assessment provide important information to help build a stronger urban forest in Nanaimo. This data can support budget requests at the municipal and provincial levels, and strengthen grant applications for additional programs. From 2016 to 2025, Nanaimo saw meaningful growth in tree canopy. However, trees are not evenly spread across the city, and development continues to put pressure on existing canopy. It is important to keep planting trees where they are most needed and to protect existing trees so future generations can enjoy them.

   Urban forests help solve local problems. Trees cool the air, provide shade on sidewalks, and lower air conditioning costs when planted near homes and buildings. Well-placed trees also improve air quality and help reduce the urban heat island effect, which is caused by paved surfaces that absorb and retain heat.

To keep Nanaimo's urban forest healthy and strong over the long term:

- **Plant a diversity of species.** Douglas fir is the dominant native tree in Nanaimo and is essential to the city's character. However, planting a wide variety of species makes the urban forest more resilient to pests, disease, and a changing climate.
- **Prioritize large shade trees.** Planting large-statured trees in available spaces along sidewalks and in public areas is one of the most effective ways to maximize limited planting space.
- **Protect what's already there.** With only 11% of Nanaimo's land available for new planting, preserving mature trees, especially in forested parks and residential areas, is just as important as planting new ones.

2. **Expand Canopy Where It's Needed Most**

Not all parts of Nanaimo have the same level of tree cover. The tree planting prioritization analysis in this assessment identified specific dissemination areas (small neighbourhoods of roughly 400–700 residents) that are most in need of investment. These high-priority neighbourhoods tend to share a combination of challenges:

- **Low existing tree canopy cover**
- **High amounts of pavement and impervious surfaces**
- **Lower household incomes and higher rates of unemployment**
- **Higher surface temperatures due to the urban heat island effect**
- **Higher proportions of vulnerable residents, including children and seniors**

These are the areas where trees would make the biggest difference, like providing shade, cooling streets, improving air quality, and making neighbourhoods more livable. Targeting the city's 150 trees per year and voucher program trees toward these priority areas would help ensure that the benefits of Nanaimo's urban forest are shared more equally across the community.

3. **Strengthen the Heritage Tree Program and Public Awareness**

Nanaimo is home to some remarkable trees. Using detailed height data from the 2025 LiDAR survey, this assessment identified 337 trees over 30 metres tall within city limits. The tallest trees are mostly concentrated in Linley Valley Cottle Lake Park, Westwood Lake Park, and Morrell Nature Sanctuary, but impressive specimens can also be found in smaller neighbourhood parks.

The city can build on this data to:

- **Expand the heritage tree program** by formally recognizing and protecting Nanaimo's tallest and oldest trees on both public and private land.
- **Create public engagement opportunities,** such as self-guided tree tours, interpretive signage in parks, or an interactive online map highlighting notable trees.

- **Use tall tree locations to guide development decisions,** flagging areas with significant trees for early consideration in land-use planning.

Sharing the stories of Nanaimo's most remarkable trees helps build community pride and strengthens public support for urban forest programs.

4. **Stay Alert to Urban Forest Threats and Adapt Plans if Needed**

This assessment modeled three scenarios for Nanaimo's tree canopy over the next 20 years. Under a no-threats scenario, the city is on track to grow its canopy from 39% today to 46% by 2046. However, this growth is not guaranteed. In moderate or severe threat scenarios involving pests, disease, or severe drought, canopy gains could shrink significantly or even reverse.

Threats to watch for include:

- **Invasive pests,** such as the western spruce budworm, emerald ash borer, and spongy moth, which can damage or kill large numbers of trees
- **Drought and heat stress,** which weakens trees and makes them more vulnerable to disease and other problems. This is a growing concern as Nanaimo's summers may become hotter and drier
- **Windstorms,** like the damaging 2018 storm that caused the loss of many mature trees across the city

The city should monitor for early signs of these threats and be prepared to adjust its urban forestry programs in response. If conditions worsen, increasing (and diversifying) the number of trees planted each year or expanding the nursery tree voucher program would help offset losses and keep the canopy on a positive path.

5. **Invest in a Complementary Operational Forest Inventory**

Nanaimo already has great tools for understanding its urban forest including a street and park stem inventory, now paired with this canopy assessment. What's missing is the same level of detail for the city's forested areas: the ravines, naturalized blocks, and densely canopied parks that make up the largest share of total canopy. Right now, the City has little ground-level information about species, condition, or structure in these areas. An operational forest inventory would fill that gap, moving beyond canopy counts to the kind of information needed to actually manage what's there. Specifically, it would:

- **Provide data to calculate forest volume and a yield curve to estimate site productivity**
- **Summarize species composition, stand age, and overall health indices**
- **Identify forested areas at-risk to pest invasions and diseases such as laminated root rot**

6. **Integrate This Data into Existing GIS Systems to Maximize Its Value**
The land cover, canopy change, tallest trees, and prioritization data from this assessment become even more powerful when combined with other city datasets. Integrating this information into Nanaimo's existing Geographic Information System (GIS) infrastructure would make it easier for city staff across departments to use the data in everyday planning and decision-making. **The city's GIS department manages a robust library of spatial data that can be used to support urban forestry and other environmental initiatives and improvements.**

Some examples of how this could work:

- **Shade analysis of walking routes.** By combining the canopy overhang data with the city's sidewalk and trail network, staff could identify which popular walking routes have little or no shade and prioritize those corridors for new tree planting. This kind of analysis directly supports the goal of targeting trees to maximize canopy over impervious surfaces.
- **Development review.** Overlaying tree canopy and tallest trees data with development permit applications would help planners identify where tree loss is likely and ensure protection or replacement planting is directed to high-priority areas.
- **Stormwater management.** Combining canopy data with stormwater infrastructure maps could help identify where strategic tree planting would most reduce runoff and protect water quality.
- **Park maintenance planning.** LiDAR height data can help park crews identify the tallest and potentially most vulnerable trees for proactive inspection and care.
- **Integrate complementary GIS data sources.** Caslys Consulting Ltd.'s 2025 Land Cover Classification should be used as a complementary dataset to help city teams across departments connect tree canopy goals with broader city priorities such as stormwater, walkability, and development planning.

Making this data widely accessible within the city's GIS environment ensures it is used not just for this report, but as a living resource that supports smarter, greener decision-making for years to come.



Appendices

A. Glossary and Key Terms

Land Hectares: Total land area, in hectares, of the assessment boundary (excludes water).

Non-Canopy Vegetation: Areas of grass and open space where tree canopy does not exist.

Possible Planting Area: Areas of grass and open space where tree canopy does not exist, and it is biophysically possible to plant trees.

Shrub: Areas of shrub or other leafy and woody vegetation (smaller than 2-metres tall) that are not classified as tree canopy.

Soil/Dry Vegetation: Areas of bare soil and/or dried, dead vegetation.

Total Hectares: Total area, in hectares, of the assessment boundary (includes water).

Unsuitable Impervious: Areas of impervious surfaces that are not suitable for tree planting. These include buildings and roads and all other types of impervious surfaces.

Unsuitable Planting Area: Areas where it is not feasible to plant trees due to existing land uses.

Unsuitable Soil: Areas of soil/dry vegetation considered unsuitable for tree planting. Irrigation and other modifiers may be required to keep a tree alive in these areas.

Unsuitable Vegetation: Areas of non-canopy vegetation that are not suitable for tree planting due to their land use.

Urban Tree Canopy (UTC): The “layer of leaves, branches and stems that cover the ground” (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of the urban forest. Tree canopy was generally taller than 3 metres.

Water: Areas of open, surface water not including swimming pools.

B. Expanded Urban Tree Canopy Assessment Methodology

1. **Data Acquisition and Preparation:** PlanIT Geo used EarthDefine Land Cover data (derived from 50-centimeter, 4-band satellite imagery and LiDAR supplied by the City) to map tree canopy for 2016 and all land cover classes for 2025.

2. **Land Cover Classification:** Training labels for seven land cover classes: tree canopy (including overhanging impervious surfaces), shrub vegetation, herbaceous/grass, bare soil/dry vegetation, impervious surfaces, open water, and tree canopy over impervious, were developed using 4-band satellite imagery and LiDAR. Identical Deep Convolutional Neural Network (DCNN) workflows were applied to both the 2016 and 2025 imagery for consistency, with hyperparameter-optimized models performing semantic segmentation. Post-classification refinements included knowledge-based rules (e.g., masking water bodies using NDWI) and manual QA/QC.

3. **Possible Planting Areas Delineation:** All areas lacking tree canopy were further classified as either suitable or unsuitable for planting. Unsuitable areas for canopy expansion (e.g., golf courses, sports fields, utility corridors, wetlands) were excluded by manually digitizing these features. These areas, while vegetated and potentially suitable for tree planting from a biophysical perspective, are considered unsuitable due to land use constraints. The original seven-class land cover data was then converted into Urban Tree Canopy potential classes, resulting in the following final classifications: Urban Tree Canopy, Possible Planting Area, Unsuitable Impervious, Unsuitable Vegetation, Unsuitable Soil, and Water. This refined classification provides a detailed spatial framework for prioritizing tree planting efforts.

4. **Historical Canopy Change Analysis:** The 2016 and 2025 tree canopy classifications were compared using GIS overlay analysis to quantify changes in canopy extent over the 9-year period. This approach enabled the identification of areas where tree canopy was lost, gained, or remained stable, providing essential baseline data for evaluating the effectiveness of urban forestry initiatives. It should be noted that the 2016 historical tree canopy data is a single-class dataset; therefore, land cover change analysis was limited to the tree canopy class only. This methodology enables precise tracking of canopy changes since 2016 while maintaining methodological consistency across time periods, ensuring comparable results for long-term urban forest management planning.

5. **Multi-Scale Spatial Analysis:** Land cover metrics (area and percent cover) were calculated for the entire Area of Interest (Nanaimo City Limits) and for each assessment geography. Raster and vector outputs supported both fine-grained analysis and regional planning.

C. Expanded Planting Scenario Methodology

These projections show how urban tree canopy could change over 20 years if the City keeps planting at a steady "business as usual" rate, while accounting for growth, loss, development, and natural regrowth. They are planning tools, not a single guaranteed future. Model inputs came from the tree canopy assessment (e.g., total land area, existing canopy, and plantable area), client feedback, and growth and decline rates derived from the tree canopy change assessment.

There are two geographic scopes. The city-wide model uses the full municipal land base. Those runs also include canopy loss from large projects reflected in the Comprehensive Plan, which projects a loss of 230 hectares of tree canopy phased over 20 years, and a tree voucher program (1,000 trees per year planted on land not owned by the city). These small nursery trees are treated as adding little or no canopy for the first several years after planting and use a higher early loss rate than standard planted trees. The city-owned model uses the smaller area for that ownership class only. Comprehensive-plan loss and the voucher program are omitted there because, in this work, they apply outside city-owned property.

Across both geographies, three threat levels use the same base canopy loss and growth from the change assessment. No threats use the base rates derived directly from the tree canopy change data. Moderate and substantial threats add stress over time: from set years onward, annual loss from tree mortality rises, and annual growth on existing canopy is reduced, to stand in for pressures such as pests, drought, or storm damage. The substantial scenario uses stronger adjustments than the moderate one, and the loss rate outweighs the growth rate towards the end of the 20 year horizon.

What the model does each year is the same structure for every run:

- **Update the canopy carried forward from prior years using the base (and, where applicable, threat-adjusted) mortality and growth, plus routine development-related canopy loss, and in city-wide runs only, the scheduled comprehensive-plan loss.**
- **Add new city planting at a fixed annual count, split among small, medium, and large mature sizes. New trees start with a small canopy and expand along a smooth S-shaped curve toward full mature spread; mortality applies separately to newly planted trees.**
- **Add a small amount of natural regeneration on a portion of plantable area, then recompute total canopy and UTC percent for that year.**

Our urban forests are more complex than any spreadsheet or script can capture. The model does not predict every local event, the exact timing of every project, or future policy shifts. The moderate and substantial threat levels are illustrative brackets for stress, not precise forecasts of specific hazards. Results should be read as structured "what-if" comparisons under stated assumptions, not as certainties.

Table 3. Core input variables for the tree canopy growth scenarios.

Input Variable	Value	
Mortality & Loss		
Annual New Tree Mortality*	5.00%	
Annual Loss to Mortality	0.72%	
Annual Canopy Loss to Development	6.58 Ha	
Growth & Regeneration		
Natural Regeneration Rate	0.77%	
Annual Canopy Growth Rate	2.04%	
Land Susceptible to Natural Regeneration	0.50%	
Planting Parameters		
Starting Canopy Radius*	0.4 m	
Years to Maturity	30 years	
Total Potential Plantable Area	1,079 Ha	
Tree Planting Distribution (150 Caliper Trees per Year)		
Tree Stature	*Mature Canopy Radius (m)*	*% of Population**
Small	2.0	10%
Medium	4.0	60%
Large	8.0	30%
Nursery Trees from Voucher Program (City-wide Scenarios Only)		
Annual Small Trees Planted per Year*	1,000	
Nursery Tree Annual Mortality	30%	
Nursery Tree Years Until Canopy	7	
Nursery Tree Mix*	40% small, 40% medium, 20% large	

**These variables were determined in consultation with the City of Nanaimo staff.*

D. Accuracy Assessment

Classification accuracy serves two primary purposes. Firstly, accuracy assessments provide information to technicians producing the classification about where processes need to be improved and where they are effective. Secondly, accuracy measures provide information about how to use the classification and how well land cover classes are expected to estimate actual land cover on the ground. Even with high-resolution imagery, slight differences in classification methodology and image quality can significantly impact overall map area estimations. The classification accuracy error matrix illustrated in Table A1 contains confidence intervals reporting the high and low values that could be expected to compare the classification data and the actual on-ground land cover in 2025. This accuracy assessment was completed using high-resolution satellite imagery, with computer and manual verification. This study did not include field verification.

The internal accuracy assessment was completed in these steps:

1. **Each sample point was then referenced using the Pleiades imagery and assigned one of the five generalized land cover classes ("Ref_ID") mentioned above.**
2. **If the technician could not discern the reference value from the imagery, the point was dropped from the accuracy analysis. In this case, no points were dropped.**
3. **An automated script was then used to assign values from the classification raster to each point ("Eval_ID"). The classification supervisor provides unbiased feedback to quality control technicians regarding the types of corrections required. Misclassified points (where reference ID does not equal evaluation ID) and corresponding land cover are inspected for necessary corrections to the land cover.**
4. **Accuracy is re-evaluated (repeat steps 3 & 4) until an acceptable classification accuracy is achieved.**

Statistical relationships between the reference pixels (representing the actual conditions on the ground) and the intersecting classified pixels are used to understand how closely the entire classified map represents Nanaimo's landscape. The error matrix in Table A1 represents the intersection of reference pixels manually identified by a human observer (columns) and the classification category of pixels in the classified image (rows). The blue boxes along the diagonals of the matrix represent agreement between the two-pixel maps. Off-diagonal values represent the number of pixels manually referenced to the column class classified as another category in the classification image.

Overall accuracy is computed by dividing the total number of correct pixels by the total number of pixels reported in the matrix (245 + 112 + 199 + 191 + 53 = 678/800 = 98%), and the matrix can be used to calculate per class accuracy percentages. For example, technicians manually identified 241 points in the reference map as tree-canopy, and 242 of those pixels were classified as tree canopy in the classification map.

This relationship is called the “Producer’s Accuracy” and is calculated by dividing the agreement pixel total (diagonal) by the reference pixel total (column total). Therefore, the Producer’s Accuracy for tree canopy is calculated as “241/242 = 0.996”, meaning that one can expect that ~100% of all 2025 tree canopy in the Nanaimo study area was classified as tree canopy in the 2025 classification map.

Conversely, the “User’s Accuracy” is calculated by dividing the number of agreement pixels by the number of classified pixels in the row category. For example, 241 classification pixels intersecting reference pixels were classified as tree canopy, and 245 pixels was identified as canopy in the reference map. Therefore, the User’s Accuracy for tree canopy is calculated as “241/245 =.98”, meaning that ~98% of the pixels classified as tree canopy in the classification were actual tree canopy. It is important to recognize the Producer’s and User’s accuracy percent values based on a sample of the existing ground cover, represented by the reference pixels at each sample point. Interpretation of the sample error matrix results indicates this assessment accurately mapped land cover and, more importantly, tree canopy in Nanaimo in 2025.

Table 4. Accuracy assessment for Nanaimo's 2025 land cover raster.

Classification Data	Reference Data: Tree Canopy	Vegetation	Impervious	Soil / Dry Veg.	Water	Total Reference Pixels
Tree Canopy	241	3	1	0	0	245
Vegetation	1	101	10	0	0	112
Impervious	0	4	199	0	0	203
Soil / Dry Veg.	0	0	0	168	13	181
Water	0	0	0	0	59	59
Total	242	108	210	168	72	800

Overall Accuracy = 96%

Producer's Accuracy	
Tree Canopy	100%
Veg. / Open Space	94%
Impervious	95%
Bare Ground / Soil	100%
Water	82%

User's Accuracy	
Tree Canopy	98%
Veg. / Open Space	90%
Impervious	98%
Bare Ground / Soil	93%
Water	100%

The Pleiades High Resolution satellite imagery was acquired on July 23rd, 2025, during a period of notably low water conditions in the bay receiving the Nanaimo River Estuary. As a result, areas ordinarily submerged appeared as exposed bare earth and sand in the imagery and were classified accordingly. While this may suggest lower accuracy in the water classification, it is in fact an accurate reflection of the actual conditions present on that date.

May | 2026

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Nanaimo, British Columbia

CITY OF NANAIMO
THE HARBOUR CITY

PlanIT Geo
developers of TreePlotter