

City of Guelph

One Canopy Tree Planting Strategy

January 2023

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Executive summary

Guelph needs to plant at least 3.6 million trees, covering an area of approximately 1,492 hectares, to achieve 40 per cent tree canopy cover by 2070.

The City of Guelph has adopted the goal of increasing the city's canopy cover to 40 per cent. Guelph's Official Plan requires doubling our current tree canopy in nine years. Area available on City-owned land suitable for planting trees and current planting efforts are not enough to achieve our targets. Increased planting efforts annually will require substantial investment, strategic planning, and collaboration with the community, residents, and private landowners.

In 2019, Guelph's tree canopy cover (herein after referred to as canopy) was reported to be healthy, diverse and cover 23.3 per cent of the land area of the city. Canopy cover in Guelph is used as an indicator of a sustainable, livable, green city and contributes to the social, environmental, and economic well-being of our city. For the purposes of this report, Urban Forest refers to all the trees and associated woody vegetation on both private and public lands in the City of Guelph. Canopy cover refers specifically to the land area covered by trees as viewed from above.

If action is not taken, there is a risk that Guelph's tree canopy cover will decline. A 2012 study found that on average, the tree canopy in urban areas within the United States decreases at a rate of approximately 0.2 per cent per year (Nowak & Greenfield, 2012). Growth of our city, increasing threats of climate change, pests and invasives, and decline in the quality and quantity of space suitable to plant trees will make it ever more difficult to grow trees in the city without a strategic approach for both replacing canopy losses and establishing new canopy.

Through the One Canopy Tree Planting Strategy (herein after referred to as the Strategy) we explored the current condition of the canopy, engaged with the community and stakeholders, evaluated opportunities and alternatives to achieve canopy target, and developed a strategy with an integrated action plan.

The objectives of the Strategy are:

- Increase canopy cover
- Advance environmental justice and equity
- Improve forest structure and function
- Increase quality of sites for optimal tree growth
- Increase resilience to climate change and other threats
- Increase coordination across City departments and external agencies
- Monitor and manage (use adaptive management to make evidence-based decisions)
- Engage, educate, and empower community members (celebrate successes)
- Invest in cost effective green infrastructure
- Prioritize tree planting based on benefit needs of the community

Key findings of Tree Planting Strategy

Key findings of the Strategy as they relate to the optimal levels of performance/service of the urban forest criteria were derived from our understanding of community needs and priorities from various engagement

activities, the Urban Forest Management Plan (UFMP) (City of Guelph, 2020) updated and the 2019 Urban Forest Study (Table 1).

Findings

- Guelph has enough land, suitable for tree planting, to support at least 40 per cent canopy cover target
- The current goal of 40 per cent canopy cover will not be achieved by 2031 with current planting efforts
- More than half of Guelph's land available for tree planting lies in private ownership –efforts on City land alone will not reach the target
- The current canopy cover is vulnerable to pests, disease, climate change, and development
- Incentives, outreach, education, partnerships, and support for the community are needed to increase tree planting across the city
- Increased funding is needed to support planting efforts to meet the canopy target
- Barriers, such as cost, conflicting priorities, and land maintenance burden, to planting and establishing trees exist
- Quality space for planting and growing trees is limited
- Increasing and diversifying canopy cover is key to providing optimal benefits
- The urban forest and associated tree canopy cover is a critical component of green infrastructure that has the potential to mitigate climate change and contribute to reducing carbon emissions
- Ecosystem benefits accrue as a result of tree planting in urban environments
- Guelph's canopy cover is not evenly or equitably distributed
- Preserving and creating new room for trees (amenity space) as the city grows will prove to be challenging as our community priorities compete for land

Strategic directions and recommendations

The direction of the Strategy was guided by the UFMP, Strategic Plan, and 2019 UFS. Recommendations of the Strategy were based on the relevant UFS recommendations and most recent community engagement for this project and include:

More canopy cover is required to achieve our targets

- Increase planting efforts on both public (City and other) and private lands

Plant strategically

- Use planting prioritization maps to inform tactical and operational planning for City tree planting programs
- Prioritize planting opportunities in and adjacent to the Natural Heritage System to enhance Natural Heritage System (NHS) function

We need spaces for trees to grow

- Identify and implement best practices in zoning and urban design that maximize quality growing space on public and private land.
- Use criteria in the Tree Technical Manual to evaluate and prioritize high quality planting sites in rights-of-way and other City lands

- Identify opportunities to increase hard surface planting in highly urbanized land use areas
- Identify options for improving the preservation of quality pervious growing space and soil resources in new residential and nonresidential development
- Ensure all future growing space designated for trees in new residential and non-residential development is high quality, including sufficient soil volume, quality, and crown space to support long-term growth

Plan for climate change

- Implement proactive maintenance and inspection programs to optimize the services delivered by street trees, including maintenance and watering of newly planted trees
- Use the results of the canopy cover and plantable space analyses to develop canopy cover targets for implementation at the project or site level and integrate targets into Guelph's policies, by-laws or built form guidelines or other guiding documents as appropriate
- Include consideration of current species abundance and leaf area as well as vulnerability to pests (and climate vulnerabilities) in species selection as part of a comprehensive planting strategy
- Increase structural diversity in the forest through strategic planting and species mixes to improve resilience to extreme weather events
- Identify populations of senescent street trees where underplanting would help maintain urban forest/tree canopy cover benefits and increase resilience to storm events
- Increase the rate of street tree planting to ensure a sustainable street tree population in the City (as determined by model - average trees required per year)
- Extend the time horizon for achieving 40 per cent canopy to 46 years (2070)

Collaboration is key to our success

- Fund and implement an outreach campaign with landowners and community organizations in Guelph to build partnerships and expand the tree canopy cover on private lands
- Increase outreach, education, incentives, and reduce barriers for tree planting on residential properties
- Examine opportunities for extending stormwater credit calculations based on per cent hard surface to include per cent relative tree canopy to incentivize tree planting on industrial, commercial, and institutional properties

We need to monitor and measure our progress

- Monitor forest and land cover change regularly using open-source tools developed by the USDA Forest Service (i-Tree) or other proven methods
- Monitor and measure tree planting across the city to better understand effectiveness of efforts

Financial implications

The initial investment for planting trees and the costs associated with maintaining older trees are outweighed by the benefits provided over a tree's lifetime, especially during the mature phase of life.

The cost to implement the One Canopy Tree Planting Strategy depends on factors such as the rate of tree loss, rate of tree replacement, and the timeframe over which the cost is spread. The estimated annual cost associated with achieving a 40 per cent tree canopy by 2070 is \$3.6 million, of which \$1.4 million is related to capital and \$2.2 million is for the associated operating impacts.

The City's current level of tree planting has an average capital cost of \$275 thousand per year for tree purchases. The Operating costs associated with this investment is \$412 thousand annually for the ongoing maintenance required to establish newly planted trees.

With the estimated annual cost requirement of \$3.6 million versus a current annual budget of \$687 thousand, an additional \$2.9 million annually will be required to meet the 40 per cent tree canopy cover.

The One Canopy Tree Planting Strategy will be considered with the other master plans and strategies and will be viewed with a corporate lens to incorporate the City's strategic goals. The plan will also be compared to our existing capital and operating plans considering current fiscal constraints and our capacity to deliver. The financial information included is intended to be a high-level estimate that will be refined as it is incorporated into the overall corporate plan and multi-year budget process.

Next steps

The Strategy implementation actions will be used to develop future operational plans, updated guideline lines, leverage existing funding, guide future investment, and support existing and new policies.

Introduction

Our past

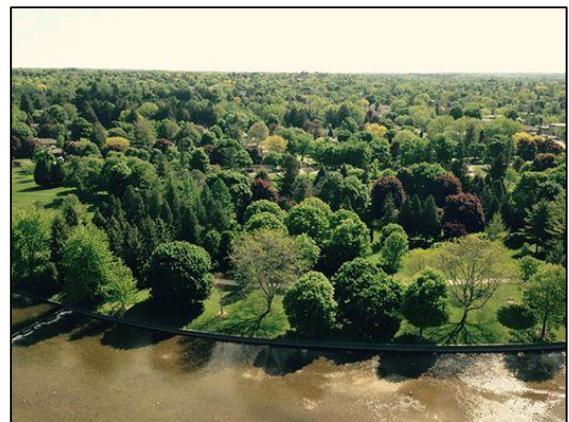
The forests in the area known as Guelph have changed through time immemorial. From herb-shrub tundra post glaciation to coniferous pine forests, shifting to hardwoods and eventually being cleared over the two centuries for logging and agriculture (LandOwner Resource Centre, 1997). When present day Guelph was founded in 1827 with the felling of a large maple tree, most of the forest present in the area would have been used for the lumber for construction or manufacturing potash with the land being eventually converted to agricultural use (LandOwner Resource Centre, 1997). However, Guelph's growth came at a cost. Forests and natural spaces would have been viewed as utilitarian and a hinderance to agriculture and development resulting in loss of trees and woodlands, and degradation and fragmentation of natural ecosystems.

Despite the losses, as Guelph became more urbanized, trees would eventually be incorporated into the landscape for newly developed homes and parks for landscaping and aesthetics, resulting in canopy cover gained through the conversion of agricultural land to residential or park lands. This gain can be seen in the contrast between Figures 1 and 2. Figure 1 looks west across the north end of the City, the centre of the photo showing the intersection of the Speed River and Woodlawn Road East. The inset highlights a section of the area currently known as Riverside Park surrounded by open fields, captured in image in Figure 2, seven decades later with extensive tree cover in mostly residential areas.

Figure 1: Archival image showing aerial view of north Guelph looking west, 1948, (Guelph Museums)



Figure 2: Image from 2018 showing view looking northeast across the Speed River



The concept of urban forestry and ecological restoration is not new. The concerns regarding degradation of landscapes across Ontario in the early 20th century and devastation of elm populations in the 60's evolved our understanding and appreciation for forests and trees beyond their beauty. Today we recognize the value of trees for the benefits they provide to the community's health and wellbeing, the environment, and the economy.

Our present

The importance of the tree canopy in Guelph was no clearer than when it was threatened most recently by the Emerald ash borer (EAB), with removal of close to 10,000 street and park ash trees. It is estimated that while 400,000 are still expected to die, these trees only represent three per cent of the leaf (meaning they are small trees) are in Guelph. The full impact of EAB on canopy loss is not known. Threats to the urban forest and the associated tree canopy cover will continue as Guelph is expected to grow and develop to support an expanding population and economy. Ironically, the urban forest is expected to help reduce the impacts of climate change while the trees that make up the urban forest are also threatened by climate change (e.g., changing weather patterns and temperature, increasing pest and disease infestations and drought).

Current planting programs, outreach, stewardships have been key to our successes to this point. However, our current efforts are not enough to achieve our canopy target within a reasonable timeframe.

While the City had been active in tree maintenance and planting in the past, the need for a sustainable future urban forest resulted in Guelph's first urban forest management plan, approved by Council in 2012, which ensured that we were future ready and catapulted us into a new era of urban forest management and stewardship.

The City now invests strategically in urban forest management, effectively improving the sustainability of our urban forest (**City of Guelph, 2020**).

Benefits of our urban forest

Trees do so much for us. They can mitigate climate change, store carbon, improve air quality, improve public health and mental wellbeing, increase real-estate values, reduce, stormwater run-off, and much more.

Guelph's urban forest is vital part of Guelph's green infrastructure with 23.3 per cent canopy cover including three million trees valued at \$803 million dollars. Our urban forest assets provide valuable benefits worth \$9.7 million of ecological services annually (Lallemand Inc. et al., 2019).

However, while Guelph's urban forest is mostly healthy, it is under threat and vulnerable to threats such as weather events, climate change, pests, and development. This is concerning if we are depending on our urban forest to protect us against the impacts of climate change and develop a sustainable, livable city. As we grow our City, and along with it our urban forest, we need to keep in mind that while a higher quantity of urban forest canopy cover is ideal, quality is as important. A healthier urban forest canopy is more resilient and sustainable in the long-term.

Our future

The City is committed to improving the City's livability, public health, the environment and preparing for the impacts of climate change by expanding the urban forest. This commitment extends beyond City owned and managed lands to private and other public lands. A livable City is one that includes a place where Urban forests create opportunities for recreation, aesthetics, and energy savings.

It was recently reported that Guelph's "urban greenness" (land area with presence and healthy vegetation) increased from 80 per cent in 2011 to 86 per cent in 2019 while other municipalities across Canada are experiencing decreases in greenness due to the urbanization process (Course et al., 2017). There is a complexity of factors related to this. However, the City's commitment to sustainable urban design in the last decade should be considered one of the most significant.

Examples of this include the development of new parks, landscaping requirements, street tree requirements and the protection of the natural heritage system. The links to human health and mental well-being are indisputable with studies linking lower risk of early death with living in greener neighbourhoods and increased ability to recover from stress (Burnup, 2020; Course et al., 2017).

Sustainable development and collaboration are likely the most critical factors in ensuring that generations now and in the future experience the full potential of benefits of the urban forest. Ironically, community priorities of the 2019 Community Plan ranked "Sustainable change and community growth" low compared to "Environment, water and waste". The two cannot be separated as without sustainable development, the environment is not protected.

This is exactly why the Strategy requires innovative and proactive approaches to achieving our canopy goals, our natural heritage and how important it is to protect it and understanding the consequences of losing our natural spaces and space for trees across the city.

Background

Guelph's tree canopy cover was estimated at 23.3 per cent of the City's total land area in 2019. The canopy cover is comprised of an estimated three million trees tree in parks, backyards, on boulevards, and elsewhere on both City and non-City lands, that are part of critical green infrastructure. Guelph's Official Plan sets a target of achieving 40 per cent canopy cover by 2031, which requires almost doubling the current canopy in less than nine years.

A realistic rate of canopy growth can be expected by implementing policy changes and programs that enhance the protection and growth of the trees.

The term urban forest generally (and for the purpose of this report) refers to all trees within the municipal boundary, regardless of land use type or ownership, including trees in private yards, street boulevards, parks, woodlands, wetlands, and fields. Tree canopy cover refers to the land area covered by tree canopy as viewed from above (2-dimensional). The two terms are often used interchangeably but for the purpose of this report, "urban forest" is used in a broad context of trees and forests in Guelph, and "tree canopy cover" is used in reference to the quantifiable area of tree canopy.

Purpose

The One Canopy Tree Planting Strategy is a roadmap to progress towards, and ultimately, achieve 40 per cent canopy cover. The Strategy was identified as a priority in the Council approved, second phase of the UFMP. It builds on the potential plantable spaces analysis completed as part of the 2019 Urban Forest Study and considers existing programs, partnerships, and funding sources, the

existing framework of urban forest and natural heritage policies, plans, guidelines and strategies, community priorities, gaps, and opportunities for tree planting efforts.

The Strategy builds on information from the Urban Forest Study to address how we'll meet Guelph's canopy targets by planting on public and private land, with the community and sharing ownership and responsibility of Strategy goals and outcomes.

For this Strategy "City land" refers to land owned and managed by the City. "Other public land" refers to land owned by Government agencies, and "private land" refers to all other land not considered City or public.

Goals

The City will:

- Enhance and expand the tree canopy
- Educate, engage, and empower stakeholders and the community
- Monitor the health and growth of the canopy cover and adapt as needed

Objectives

The Strategy goal should be measurable, specific, achievable, affordable, realistic, and timely. To achieve our goals, we must:

- Increase canopy cover
- Improve forest structure and function
- Increase quality of sites for optimal tree growth
- Improve maintenance of new trees for long-term survival
- Increase resilience to climate change and other threats
- Increase coordination across City departments and external agencies
- Monitor and manage (Use adaptive management to make evidence-based decisions)
- Engage, educate, and empower community members (celebrate successes)
- Invest in cost effective green infrastructure
- Advance environmental justice and equity
- Prioritize tree planting based on benefit needs of the community

We will work towards our goals by implementing the strategic directions and recommendations, leading by example, fostering collaboration, celebrating our urban forest and its stewards, learning from both our successes and failures, implementing cost effective strategies, and focusing on sustainable management and practices.

Approach and methodologies

The Strategy was completed as follows:

1. Develop project charter
2. Research and literature review
3. Review current state of Guelph's urban forest
4. Engagement
5. Canopy forecast modelling
6. Summarize gaps, challenges, and opportunities

7. Develop implementation actions

The project was started in December 2021 and was completed in May 2022, with updates in December 2022. The team was made up of City staff. Canopy forecast modelling was carried out by consultants Kuttner Forestry Consulting (KFC) and Diamond Head Consulting Ltd. (DHC).

Policy context

Provincial legislation

Examples of existing provincial legislation that contributes to the enhancement of canopy include:

- The Municipal Act
- Planning Act
- Provincial Policy Statement
- Endangered Species Act
- Ontario Heritage Act

Alignment with plans and strategies

The City has several strategies and plans that recommend tree planting and enhancing the canopy. The Strategy supports the City's Community Plan values (City of Guelph, 2021), Official Plan (February 2022 Consolidation), 2012 Urban Forest Management Plan (UFMP), 2020 UFMP Implementation update and second phase plan, Strategic Plan (2019 to 2023) and other climate and environmental initiatives.

Alignment with Strategic Plan

The City's Strategic Plan (City of Guelph, 2019) is a plan built on the community's vision for Guelph's future and aims to set out a climate adaptation plan which includes increasing the tree canopy and designing a sustainable City to ensure there is adaptable green infrastructure in development areas.

Figure 3: Plan hierarchy



The One Canopy Tree Planting Strategy aligns with the following Strategic Plan priorities and associated directions:

Sustaining our future

- Create and execute an ambitious and achievable climate adaptation plan
- Plan and design an increasingly sustainable city as Guelph grows
- Mitigate climate change by reducing Guelph's carbon footprint

Investing in and increasing Guelph's canopy cover will build a sustainable and resilient urban forest and prepare for the effects of climate change as Guelph continues to develop and grow. We expect to enhance and increase the area of new tree canopy cover across the City to meet our 40 per cent target within the next four to five decades to increase the benefits provided by trees and green infrastructure and to mitigate the impacts of climate change.

Powering our future

- Help businesses succeed and add value to the community

Powering our future strategic priority through ensuring policies and zoning by-laws support a healthy economy and are consistent with environmental priorities as the recommendations will lead to:

- Planting more trees in boulevards and in increasingly dense urban developments by implementation of green infrastructure technology through alternative design and low impact development standards
- Increased tree planting around and on commercial and service lands to reduce their environmental impact and increasing property values

Working together for our future

- Improve how the City communicates with residents and delivers services
- Develop a long-term financial and resource strategy that is achievable and affordable

Working together for our future strategic priority through exploring new funding options and partnerships to ease taxes for residents and businesses will lead to:

- Developing strategic partnerships with stakeholders to improve service delivery
- Improving how we deliver services and information to resident and property owners
- Build partnership and allow the City to help businesses achieve their sustainable goals

Building our future

- Maintain existing community assets and secure new ones

Building our future strategic priority through continuing working to develop new urban forest assets that respond to Guelph's growing and changing social, economic, and environmental needs. The urban forest is an asset with specific structural and functional value (i.e., goods and services) that provides social, economic, and environmental benefits. The urban forest is a key component of the City's natural heritage assets.

Navigating our future

- Improve local transportation and regional transit connectivity

Tree planting along walkways, cycle paths, multi-use paths and trails greatly improves the comfort and experience for users by providing shade and in some cases separation from vehicles.

Contrary to the previous statement, the recommendations contained in this report may contradict this pillar as trees often come in conflict with developing new, or improving existing transportation corridors (e.g., boulevards, medians, and rights-of-ways). This potential contradiction can be mitigated through the development and implementation of a “complete streets” strategy, which incorporates the needs of all roads users and includes street trees within standard road cross-sections.

Relationship to the Urban Forest Management Plan

The Strategy provides direction and actions to achieving 40 per cent canopy cover, specifically relating to tree planting efforts to increase and enhance canopy cover.

The Strategy supports the vision of the Urban Forest Management plan (UFMP) to foster the health and sustainability of its community by increasing its tree canopy cover, continually pursuing, and promoting the implementation of best practices for tree establishment that will provide a range of environmental, economic, and health benefits for residents, and habitat for a diversity of plant and animal species. By setting an example on its own lands and supporting expanded local stewardship, the City will enjoy and sustain its urban forest for the long-term.

The UFMP is a 20-year renewable roadmap for understanding and improving the management of Guelph’s urban forest. The plan is currently in the second phase of implementation (2019 – 2023).

Relationship to the Natural Heritage Action Plan

The Natural Heritage Action Plan (NHAP), approved 2018, is an implementation plan for protecting our natural resources as part of complete, healthy communities (City of Guelph, 2018a). The NHAP provides a framework of supporting actions to implement the City’s Official Plan policies specific to the natural heritage system and watershed planning. There are points of intersection between the One Canopy Tree Planting Strategy (and the UFMP) and NHAP with regards to enhancement, long-term monitoring, stewardship, and sustainability, such as, but are not limited to:

- Create a biodiversity strategy
- Develop a program to support native plant propagation and seed collection
- Complete an Ecological Restoration and Management Strategy
- Develop environmental educational programs
- Establish a community and neighbourhood-based adopt-a-space program

Relationship to Community Energy Initiative and Race to Zero campaign

The Strategy has a strong connection to the City’s energy initiatives with regards to the urban forest’s role in sequestering annual carbon emissions. The Community Energy Initiative (CEI) update, approved 2018, is Guelph’s commitment to use energy more wisely and fight climate change (City of Guelph, 2018b). The main

goal of the CEI is that Guelph will become a Net Zero Carbon community by 2050. Guelph also joined the United Nations Cities Race to Zero campaign in 2021. Guelph's target for the Cities Race to Zero is to reduce community per capita and corporate per capita GHG emissions by 63 per cent from 2018 levels by 2030 and achieve net zero GHG emissions by 2050.

Other local regulations

The City has several other plans and guidelines that support tree establishment, such as, but not limited to:

- Official Plan
- Community Plan
- Parks and Recreation Master Plan
- Urban Design Manual
- Brooklyn and College Hill Heritage Conservation District Plan and Guidelines
- Private Tree By-law
- Site Plan Guidelines
- Environmental Implementation Report Guidelines
- Tree Technical Manual

Current initiatives and programs

The City has many outreach and planting programs, or tree establishment initiatives currently underway by direction and support of the existing framework of regulatory and non-regulatory tools. Trees are currently planted in the City by municipal staff, contractors overseen by City staff, community groups such as "Trees for Guelph", volunteers (sometimes in collaboration with City staff) and private landowners. The current initiatives and programs should be leveraged and expanded to increase the number of trees planted annually.

Tree planting

Forestry operations

City Forestry crews plant up to 1,000 large caliper street and park trees annually. In 2022, due to increased capacity and resources, natural areas crews planted 7,600 smaller trees and shrubs in parks, open spaces, and natural areas.

Community tree planting events

The City along with volunteers, partners, community groups, and non-profit organizations host tree planting events, mostly in the spring and the fall. In 2022, 8,050 trees and shrubs were planted through the combined efforts of the City and others. These events take place in City parks and natural areas and school properties.

Stormwater subsidized tree planting program

The Stormwater subsidized tree planting program subsidizes the cost of tree planting and includes educational components. The City, partnered with Reep Green Solutions in 2021 to pilot the backyard tree planting program. In the first two years of the program, Reep planted 90 native trees. Also, participants attended a workshop, "Guelph's Tree Rebate Pilot: Planting and Caring for Trees in the City",

was hosted by Reep, online each year. The program was approved to continue in 2022 and 2023.

Grants

Trees for Guelph receives an annual grant from the City (and other funding sources) to plant trees on both City and private lands with hundreds of volunteers from school groups, residents and community groups contributing a significant percentage of the community tree plantings. Their program is the most significant connection with school aged children combining education and stewardship.

Memorial tree donation program

This program is currently paused and under review. The program allowed the community to memorialize someone by planting a tree in their name at one of our parks or greenspaces.

Partnerships and collaborations

Current City partners currently include Trees for Guelph (TFG), Forests Ontario, and Reep Green Solutions, Alectra, GRCA, University of Guelph (including the Arboretum), Ontario Public Interest Research Group (OPIRG), and local school boards.

The Forests Ontario Take Root program launching in 2023 could see up to 1000 trees planted in private yards across the city.

Outreach

City of Guelph website

The City's "Trees" website includes information about our programs, operations, and services. A website audit was completed in 2020.

City events

City staff continue to undertake activities such as presentations, workshops, tours and annual public works open houses.

Forestry in the Classroom

Forests Ontario facilitates the delivery of hands-on school age lessons on forestry topics by matching local schools and community groups with local forestry and natural resource practitioners. City forestry staff volunteer regularly as requested to share their knowledge.

Healthy Landscapes

The healthy landscapes program is an education-based program that provides residential property owners information about water conservation, tree planting, and landscaping. One of the program's focuses includes tree health and promotion of tree cover, and outreach on this and other core areas (e.g., native, non-invasive plant selection; best practices for landscape maintenance).

Development

Zoning

Zoning cannot regulate trees, although requirements for minimum landscaped open space and buffer strips provide space that can support trees in varying amounts.

Site plan guidelines

Guelph's Site Plan Approval Procedures and Guidelines inform the design of development proposals including a range of guidelines related to the enhancement of the urban forest such as screening, street tree planting along public roads, and parking lots. Landscape plans can be combined with vegetation compensation plans and may include mass or area plantings where appropriate.

One specific example being the requirement that trees along public roads are provided at a rate of one tree for every 8 meters of frontage to be considered for planting.

Urban design guidelines

Guelph's Urban Design Manual provide direction for the site organization and design of development related to the enhancement of the urban forest to ensure that trees are planted with a sufficient soil volume and in appropriate locations that support healthy tree growth to maturity, which contribute to maintaining and increasing Guelph's tree canopy cover. General standards speak to trees in surface parking areas and front yard plantings.

Tree Technical Manual

The City's Tree Technical Manual promotes best practice for tree planting (and management), provides standardization for tree replanted plans and report, and promotes effective, long-term retention, maintenance, and enhancement of the tree canopy. The manual establishes guidelines, standards and specifications for the preservation, protection, planting and maintenance of trees as they apply to development and construction in various contexts throughout the City, on both public and private lands.

City capital projects

Trees (replacement and/or new) are often planted as part Capital projects that develop, maintain, or improve a City asset, such as the construction or repair of parks, roads, or facilities on City-owned lands.

Private Tree By-law

The City's Private Tree By-law requires compensation for trees 10 centimetres diameter at breast height (DBH) and larger removed on properties 0.2 hectares or larger. In most cases, compensation is calculated using a method described in the Tree Technical Manual which adds up the total diameter of stems removed and replaces with the equivalent diameter. For example, if a 60 cm DBH tree is removed, then 10 trees (minimum diameter of 6 cm) would be required as compensation. This by-law is currently under review.

Resources (expenditures)

Having the right resources to carry out a tree planting program is essential. The City's current program is well resourced but at capacity. The program is not scalable with current resourcing to increase tree planting on City property nor to increase support for planting on private property. Additionally, the staff and other resources are not exclusively dedicated to tree planting but also to other initiatives of the UFMP such as hazard management, invasives management, inventory, tree maintenance, among many other tasks or projects.

Staff resources

Current staff resources include:

- Program Manager, Forestry and Sustainable Landscapes
- Lead Hands (Operations)
- Planting crews (Forestry)
- Planting crew (Natural Areas)
- Urban Forestry GIS Technologist
- Urban Forestry Field Technologist
- Stewardship coordinator (part-time)
- Natural Areas Technician and Technologist
- Administration staff

Equipment

Equipment available includes:

- Water trailers
- Mulch
- Dump trucks
- Mini excavator
- Hand tools

Trees and plant material

Street and park trees (large caliper trees) are sourced through multi-year contract with nurseries that can meet specifications (e.g., native, locally grown). Plant material for ecological restoration projects or those that required smaller, more cost-effective stock are sourced from a variety of native tree and plant nurseries. Demand for tree stock is increasing and municipalities and landscape contractors are competing annually to fulfill their orders. This has resulted in limited stock availability for small stock.

Contractors

The City uses third party planting contractors for capital projects such as new park development or roads projects. Contractors have not been used for large scale planting in natural areas in the past but will be considered for restoration plantings in natural areas to replace thousands of ash trees removed after they were killed by the emerald ash borer.

Funding and resource model (income)

City budgets

The current City budget supports a variety of urban forest management projects and initiatives, including street and park tree planting, naturalization and ecological restoration, recognizing that investing in the urban forest is investing in our future. Parks capital and operating budgets have been offset in past years using funds from grants, deferred development funds, and the Tree By-law compensation funds.

The backyard tree planting program is funded through Engineering capital budget as part of the stormwater rebate program. Engineering has limited capital budget for tree planting for infrastructure projects. Budgets usually only cover the cost of replacing removed trees, but not for new trees.

Private Tree By-law compensation

The City's Private Tree By-law requires compensation for the removal of trees by way of replacement trees on site or cash-in-lieu. Funds collected through this process is used by the City to plant compensation trees throughout the city. Average annual contributions based on funds collected between 2011 and 2021 are approximately \$100,000.

Tree fund donation program

The City's tree donation fund program supports City's tree planting program. Donations are received as minimum \$10, tax-deductible, one-time donations or re-occurring monthly donation. Donations can be dedicated as gifts with the option of sending an e-card. Donations over \$500 receive a certificate, suitable for framing.

Development

Subdivision deferred revenue and tree planting frontage fees from Committee of Adjustment developments and agreements contribute to a tree planting reserve fund.

Grants

Grant funding has supplemented capital funding to increase capacity for tree planting and increase support for community groups. Current and past grant opportunities include:

- Forests Ontario
- Tree Canada
- Canadian National Railway (CNR)
- Investing in Canada Infrastructure Program (ICIP)/government grants
- "TD Green Streets"

Community engagement

Community engagement was essential to understanding community needs and perceptions to set the direction of the Strategy.

A Communications and Engagement Plan was prepared to first ensure that residents, agencies, and developers are aware of and compelled to participate in engagement opportunities knowing the role private land will play in achieving canopy targets.

Key themes that came out of engagement included:

- Benefits (social, environmental, and economic)
- Canopy cover distribution
- Canopy cover quality
- Climate change
- Engagement, stewardship, and partnerships
- Incentives and funding
- Information and education
- Policy, standards, and guidelines
- Removing barriers (physical, financial, and social)

Key messages that came out of engagement included:

- Improve outreach and education
- Empower the community
- Improve tree establishment practices
- Prioritize space for trees
- Monitor tree planting efforts
- Prepare for climate change
- Review or develop new policies related to tree planting

Community feedback from the UFMP update in 2020 was also included.

What we did

Engagement for the One Canopy Tree Planting Strategy included two preliminary discussions, Indigenous sharing circle, letters to Indigenous Treaty partners, two public workshops, individual external and internal stakeholder meetings or consultation, as well as an online survey and interactive tools. Detailed summary engagement report is available on the project webpage:

haveyoursay.guelph.ca/one-canopy.

Preliminary engagement

Preliminary engagement for the Strategy included conversations with the Natural Heritage Advisory Committee on November 25, 2021, and with the City's Urban Forest Working Group on December 10, 2021, around project goals and objectives, framework, and scope.

Workshops

In February 2022, community engagement included two virtual workshops held on February 16th for special interest groups and the public, and 17th for businesses and associations. Workshop themes included:

- Benefits of trees
- Tree planting incentives
- Tree planting resource needs
- Ways the City can encourage tree planting
- Barriers of tree planting on private property
- Ways to increase tree canopy

Online and interactive tools

An online survey and interactive tools were also available for those members of the community that were unable to attend workshops and office hours. The survey and tools were available on the City's online community engagement site, Have Your Say Guelph, from February 1, 2022, to February 22, 2022. There were 254 participants who contributed through the engagement forum. The link for the online survey and tools were also emailed directly to over 100 key stakeholders including city council and executive team, City of Guelph staff, developers, consultants, green industry contractors, members of the building community, forestry and arboriculture professionals, landscapers, non-profit organizations, and environmental interest groups.

The purpose of the survey was to gain insight about the community's:

- Current planting efforts privately or with the City
- Role in planting efforts on public and private land
- Opinions on barriers to equitable canopy cover

Other engagement tools included mapping tools and ideas board where ideas could be shared about what the City can do to inspire and promote tree planting around Guelph, and a map where a virtual pin could be placed on a location where tree planting events have happened in the past, and what City lands the community would like to see tree planting events happen on in the future.

The City's interdepartmental Tree Team, comprised of City staff from various departments, met on March 8, 2022. The purpose of the meeting was to collect input regarding the challenges or opportunities related to increasing canopy cover from the perspective of their respective departments/fields.

The Grand River Conservation Authority (GRCA) was consulted in March 2022.

Indigenous relations

An Indigenous sharing circle took place on January 19, 2022. The focus of the sharing circle was to build relationships, talk about experiences and hopes for Guelph's future generations, centering the conversation on the lands and natural resources and the role of the City as a steward of the land.

Letters to Treaty partners were sent via email on March 2, 2022, to The Haudenosaunee Confederacy, Mississaugas of the Credit First Nation, and Six Nations of the Grand River Elected Council. The letter included information about the project and an invitation to engage with the City regarding any comments or concerns.

What we heard

The three most beneficial actions as ranked by UFMP survey respondents are:

- developing a city-wide tree planting strategy and planting more trees
- increasing the health and resilience of existing trees by implementing a proactive monitoring and maintenance program
- continuing to build community partnerships

Specifically, 86 per cent of respondents supported increasing tree canopy cover (and urban forest health) by developing a city-wide tree planting strategy and planting more trees.

The results of the One Canopy engagement suggests that overall, the respondents/participants are supportive of the goals and objectives of the One Canopy Tree Planting Strategy. Most recognize that there are challenges, mostly related to providing space to plant and grow trees on both City-owned and non-City-owned lands. Incentives, education, and resources were the most common opportunities identified to increase planting on non-City-owned lands, while resources and soil volumes/growing space were priority for City-owned lands.

Based on this and past engagement from various projects, there is no question that the community values green spaces, the environment, and the urban forest.

Benefits (social, environmental, and economic)

- Need for more outreach and education about the links between planting trees and carbon off-sets, and other benefits
- Top three benefits of trees in order of importance were improved physical health and emotional well-being, reducing air pollution, and maintaining our natural heritage (natural spaces)

Canopy cover distribution

- Monitoring and reporting on tree canopy should take place including tracking tree planting efforts
- Equitable distribution of canopy cover is important
- Increase planting density

Canopy cover quality

- Most people support the planting and use of a diversity of native tree species, whereas some felt that non-native, non-invasive species also have a place in the landscape
- Invasive species management is needed to protect our natural areas from ecological degradation
- Increasing the diversity of tree species planted in Guelph is important
- Many felt that more should be done for the long-term health of trees through improved maintenance programs and forest management practices on both City and private property

Climate

- Developing a tree planting strategy with an emphasis on climate change, particularly future climate appropriate species and carbon sequestration to align with future climate plans and/or strategies
- Address concerns about flooding and stormwater run-off that is the result of tree or canopy loss
- A species diverse canopy is key to being prepared for climate change
- Increasing canopy cover is needed to mitigate climate change

Engagement, stewardship, and partnerships

- The community would like increased engagement and partnerships, planting programs,
- Having access to more resources
- Empower and support community-led solutions for food insecurity, such as “food forests”
- Consult and engage Indigenous and cultural voices in urban forest management
- Recognize and celebrate community and business leaders and innovators and for projects that contribute to the City’s urban forest/sustainability goals.
- Develop a “Tree Stewards” program
- Community partnerships are essential to achieving our canopy goals

Incentives and funding

- Education programs focused on tree care and planting was ranked the highest of the programs and incentives that would convince someone to plant a tree if they had access to private property, ahead of (in order of ranking highest to lowest) neighbourhood planting events, a low-cost City subsidized non-profit organization tree planting service, and a one-time rebate or cost sharing for planting their own tree
- More financial incentives such as rebates and subsidies are needed to increase tree planting on private property
- Property owners are willing to pay between \$75 and \$500 to plant a large tree on their property versus receiving a small free tree

Information and education

- More educational materials, programs and information related to trees, with topics such as tree species, tree planting and care for property owners and students were requested
- The community would like information about tree planting events or other environmental initiatives on both City and non-City owned lands

Policy, standards, and guidelines

- City policies are needed to support the establishment of new canopy, not only replacement.
- Having an invasive species strategy would preserve and enhance the ecological health and resilience of the urban forest
- Explore alternative tree establishment methods and practices
- Exploring currently unavailable City spaces in parks, open spaces, and boulevards are ideal opportunities for increasing canopy cover
- Collaboration and cooperation are needed incorporate more trees into the landscape.
- City objectives and priorities should align to prioritize green infrastructure, green spaces, and sustainable development.

Removing barriers (physical, financial, and social)

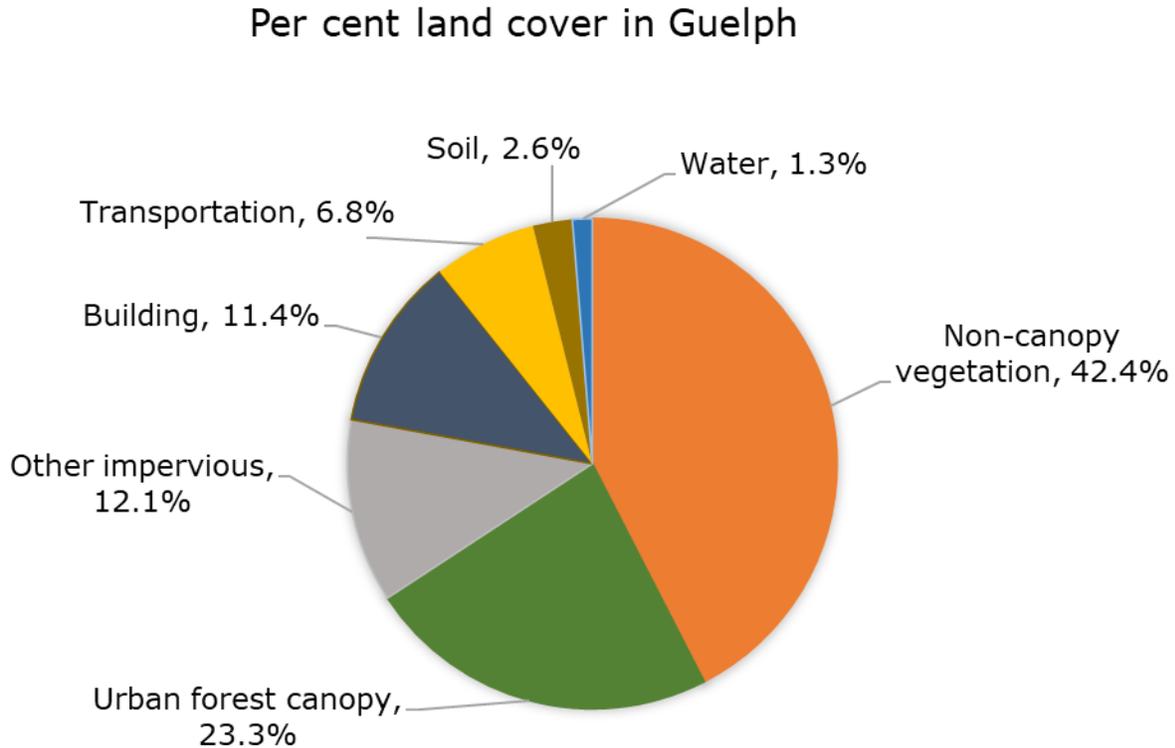
- Reduce or remove physical, economic, and social barriers of tree planting
- Prioritize space and soil volume/quality in development and construction for the installation and long-term retention of large shade trees

- There is concern that not enough space is designated for trees in landscapes such as streets, parks, or front yards
- Space and existing landscaping or tree cover were rated as the most significant barrier, other than financial, that prevents property owners from planting trees on their property
- Only 55 per cent of the survey participants are likely to plant a tree on their property in the next year and 64 per cent would be interested in the City planting a tree for free on City property in front of their home
- There was concern that lack of property ownership was a barrier to engagement and/or tree planting on private property
- Social or economic barriers may limit engagement in stewardship or tree planting

Canopy cover quantity and distribution

In 2019, City-wide canopy cover was measured at 23.3 per cent (Figure 4). 8.3 per cent of canopy cover is located on City-owned (and managed) land, 11.3 per cent is in private ownership, and 3.3 per cent in other public ownership. This is 37.6, 48.4, and 14 per cent of the total canopy respectively. The canopy cover estimate does not include the forest cover on the City-owned and managed "Arnell Springs" aquifer lands, or any other City-owned and managed land located outside of City limits.

Figure 4: Per cent land cover in Guelph (2019)



Canopy cover vs. leaf area

Canopy cover is used to understand the extent of forest cover as a percentage of land area, while leaf area gives us information about the ecosystem services a tree can deliver. Guelph used both in the UFS to describe the urban forest.

Canopy cover is a two-dimensional measurement of the horizontal surface area of the forest as seen from above. It is communicated as a percentage of total city land cover or as an area measurement but cannot with current technology capture accurate information such as forest health, age, or species. Canopy cover is achieved using land cover analysis. Figure 5 shows a sample of the imagery used to derive land cover in Guelph as well as a sample of the final mapping.

Figure 5: Sample of imagery and resulting land cover map



Leaf area is another way to describe the forest, which provides more information about forest structure beyond two dimensions. Leaf area describes the surface area of all the leaves found in every level of a tree crown. This makes it a much better measure to describe the value of a tree in terms of the potential ecosystem services a tree can deliver.

For example, the collective of sugar maple in Guelph store the most carbon, accounting for 13.4 per cent of carbon stored by the total of all trees that make up the urban forest, followed by eastern white cedar, which stores 8.8 per cent of total carbon.

Urban forest structure

Diversity

Increasing diversity in the urban forest will contribute to building resilience to climate change and other threats. The natural distribution of tree species is highly dependent on climate. Changes in climate affect the distribution of plant species (i.e., affect their ability to survive in their native range) and result in changes in forest composition. Changes in species composition may therefore affect several ecosystem properties (Natural Resources Canada, 2021).

The “30-20-10 Rule”, proposed by Santamour (1990), to guide the establishment of the urban forest, states that no tree family exceeds 30 per cent, no tree genus exceeds 20 per cent, and no tree species exceeds 10 per cent of the total urban forest inventory. The objective of this guideline is to promote urban forest diversity and resilience to pests, pathogens, and other stressors. Guelph’s TTM includes this rule as general guidance for tree establishment.

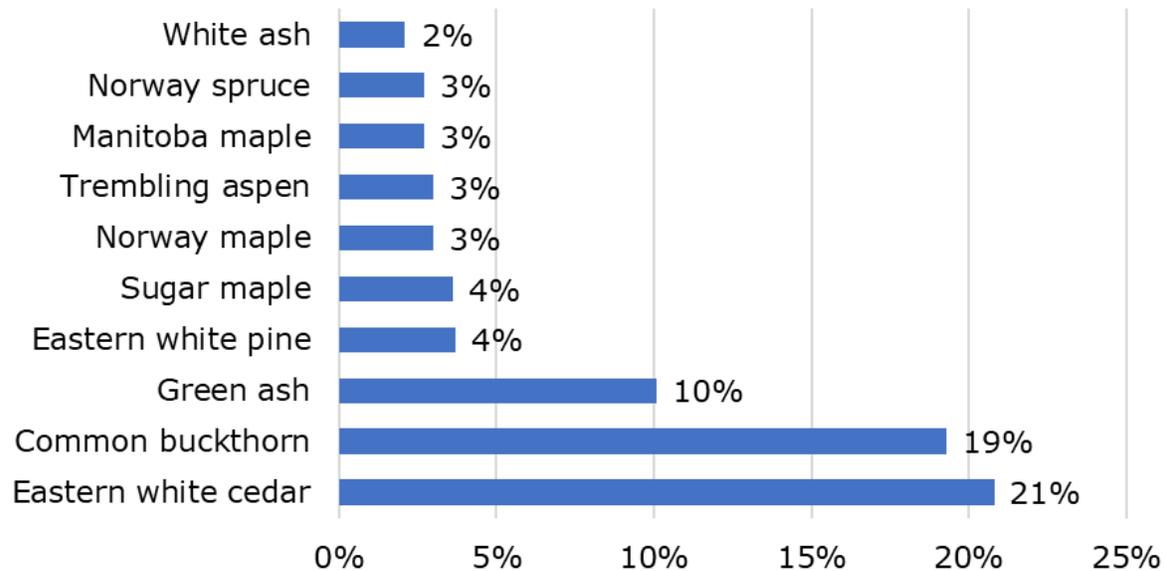
It’s important to note that this rule is more suited for the urban context such planning for subdivision street trees, it is not appropriate for natural areas or the NHS where tree diversity generally reflects natural conditions. In this context, ecological community “assemblages” are used to guide management actions including tree planting. The biodiversity targets for the NHS will be developed through a future biodiversity strategy as per the NHAP.

Species and age

Guelph is dominated by eastern white cedar, European buckthorn, and ash tree species. Most concerning is that the highly invasive buckthorn is the second most abundant tree. When ranked by leaf area eastern white cedar also dominated (16.6 per cent). Norway maple (9.1 per cent) was second followed by sugar maple (8.1 per cent).

Figure 6: Top ten trees in Guelph by population (number)

Top ten species by population



Managing invasive vegetation reduces competition and can allow natural regeneration to assist in our restoration efforts. However, unaided “naturalization” can lead to unhealthy ecosystems, dominated by invasive species. Diversifying the urban forest and implementing an invasive species management plan is required to build resilience to disturbances and overall health of the urban forest.

Functional diversity for climate resilience

Planting trees to target ecosystem provisions will mean using more drought and flood tolerant species. We may face important trade-offs, such as the use of non-native (non-invasive) tree species, when planning the future canopy composition for multiple functions, including future climate-tolerance.

Current plant lists encourage the use of native or non-native, non-invasive vegetation depending on the context. Ecological restoration planting projects are restricted to native plants only. Non-natives, non-invasive trees such as ginkgo biloba or linden are chosen for their urban tolerance. However, those only make up a small percentage of street or park plantings.

Functional diversity for optimal ecosystem services

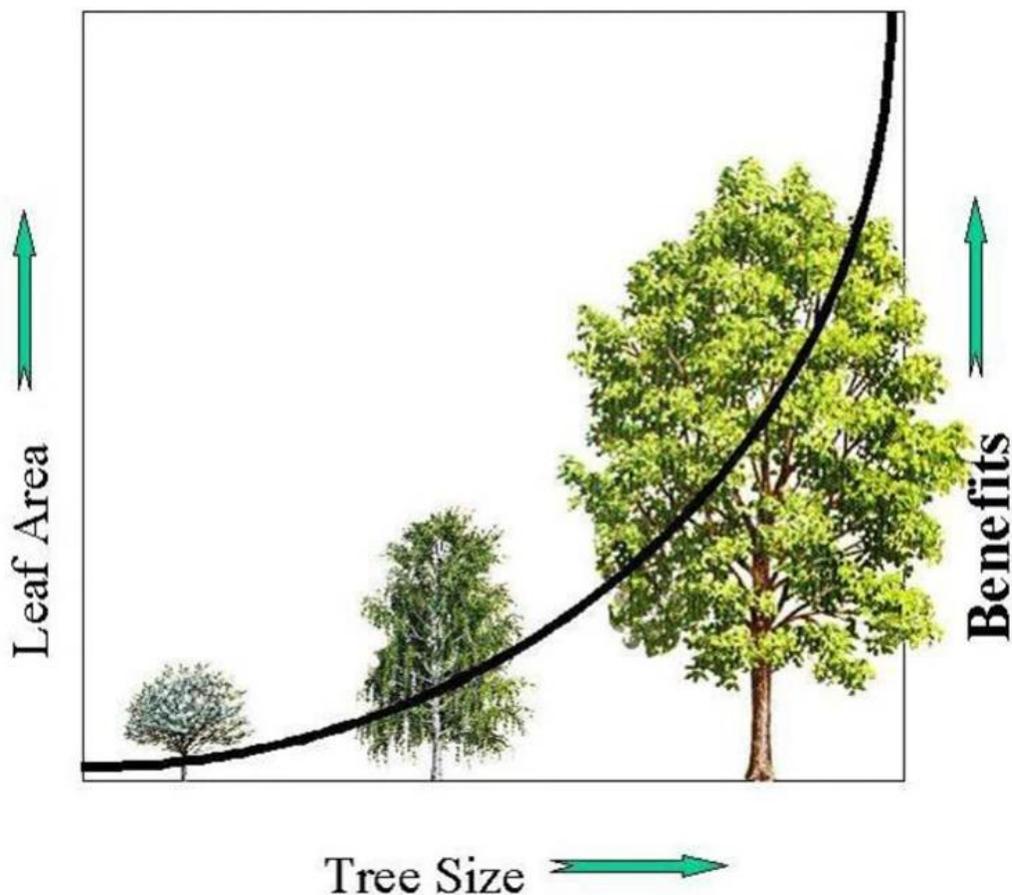
Guelph’s trees provide four key environmental services: energy savings, carbon sequestration, pollution removal, and reduce stormwater run-off. All parts of trees have a role in delivering ecosystem services. Wood tissue stores carbon, shade from leaves reduce energy costs and sequester atmospheric carbon.

Benefits of tree increase over time. However, larger, and older, healthy trees provide disproportionately more services than young trees. Trees with larger leaves (more leaf area) such as maples sequester more carbon than those with small

leaves such as honey locust. However, trees with smaller leaves often have higher tolerance to drought and urban conditions.

This emphasizes the importance of near-term planting with benefits being realized in decades to come. Specifically, front loading or jumpstarting tree planting in early years is beneficial. Especially since, the effects of climate change can increase in tree mortality from drought and insect outbreaks (Drever, 2021).

Figure 7: Example of the ecological benefits of trees increasing exponentially as leaf area increases (Kenney, 2000)



Sourcing tree and plant material

Tree size matters! More than 90 per cent of the trees planted by the City and through City-led events are smaller stock such as potted trees or whips because they are more cost effective and appropriate for restoration or naturalization projects. The trees are most mass planted in natural settings or planted as individual trees such as those in backyards tree planting program.

Large trees are costly, often experience transplanting shock, require more maintenance and less likely to thrive. Younger trees recover more easily after planting and typically grow a more vigorous root system. Studies have also shown that smaller caliper trees catch up to their larger counterparts at the 10-to-15-year range.

Canopy cover targets

The area of additional canopy required to reach 40 per cent canopy cover is 1,492 ha or 14,920,000 m² (City of Guelph, 2012).

The 40 per cent canopy target in the UFMP and Official plan was set based on a standard, developed by urban forest researchers, for the recommended canopy cover for urban municipalities, based on a select group of municipalities in the United States. It was done so without understanding the potential carrying capacity of land in Guelph nor, the effort it would require.

It is now recognized that targets cannot be broadly applied since each city is unique with regards to factors such as optimal service needs, natural ecology, growing/soil conditions, and land use planning policies. In addition, there are no benchmarks or tool kits available to set urban canopy targets (District of Oak Bay, 2017).

In addition, realizing such a goal assumes that there are enough actual plantable spaces, as well as adequate human and financial resources being allocated to support increased levels of tree planting and the associated long-term management of the expanding urban forest (City of Guelph, 2012).

“Furthermore, increases in canopy cover cannot simply be achieved by planting more trees. As this Plan illustrates, effective urban forest management requires an ongoing commitment to managing trees in all phases of their life cycle, as well as strategic planning to bolster the resilience of the overall urban forest against the numerous stressors it may be subjected to. The primary objective should not be to simply meet a canopy cover target but should be to steadily move the City forward with respect to the various strategic initiatives identified in this Plan in support of a truly sustainable urban forest” (City of Guelph, 2012).

Guelph’s canopy cover is in the range of other Southern Ontario municipalities that have completed canopy studies (Table 1). Some municipalities have lower or higher targets than 40 per cent based on the feasibility of achieving their targets as determined by canopy studies.

Table 1: Municipal comparison of current canopy, canopy targets, and timeframe

Municipality	Current canopy cover	Canopy cover target	Timeframe
City of Guelph (2022)	23	40%	9 years
Town of Oakville (Natural Resource Solutions & Dillon Consulting, 2012)	28	40%	50 years
City of Toronto (2013)	28	40%	50 years
City of London (2017)	24	34%	48 years
City of Hamilton	21	30%	n/a
Richmond (2018)	20	30%	26 years

Progressing towards the 40 per cent target will require policy adjustments, enhanced City realm planting program and an ambitious private realm planting program.

Contributing factors that limit progress include:

- Lack of site level canopy targets
- Limited planting in new developments above and beyond replacement/compensation trees
- Limited understanding of the contribution required to achieve canopy targets
- Lack of quality and quantity of growing space in developments, boulevards, and hardscapes

Land use and canopy cover

Land use is one of the most influential factors of the amount of canopy cover in cities. Land use describes how people use different areas of the City (e.g., residential, industrial).

Avoiding conversion of land use correlated with high canopy cover to that with low canopy cover must be a key objective of any sustainable development strategy. Once lands are converted the options for natural climate mitigation tools (such as trees) may be foregone and more expensive options may be required to meet carbon targets or compensation.

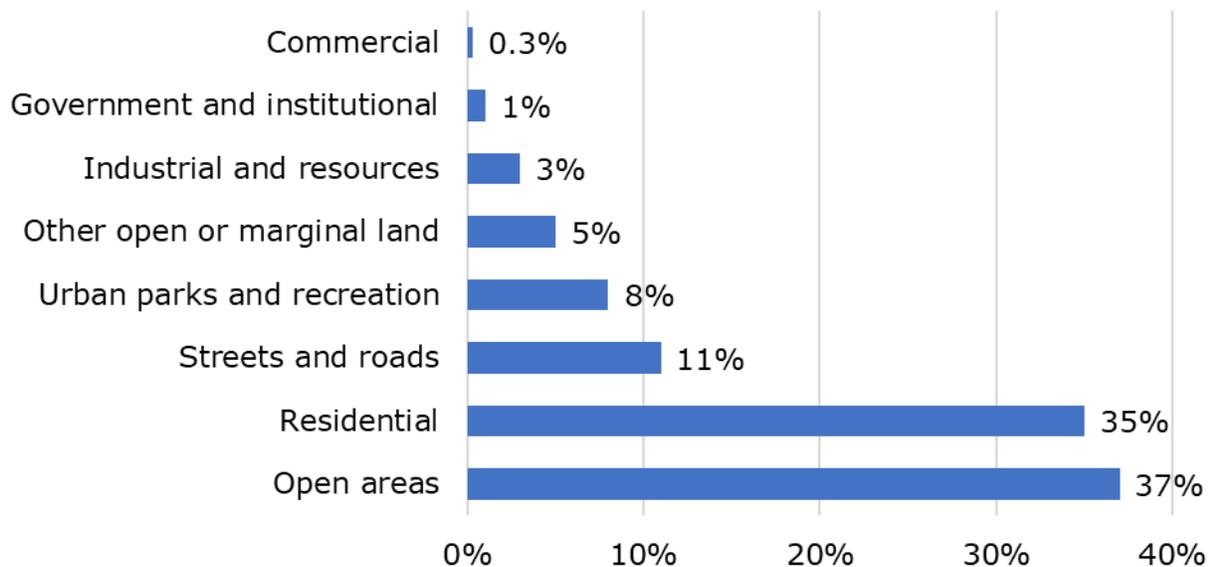
The distribution of canopy cover across Guelph is not equal and is most often related to the type of land use. The highest per centage, 42 per cent, of the canopy cover is located on vacant land, which includes open space and the natural areas. The lowest per centage is on commercial and industrial lands combined at 20 per cent. Prioritizing tree planting opportunities and canopy protection in areas with low

income and low canopy distribution can provide canopy health and economic benefits as well as access to green spaces for those that need it the most.

Figure 8 shows the distribution of canopy cover by land use across major city in Canada and in comparison, with slightly different land use categories, Figure 9 shows per centage canopy cover by land use for Guelph. Compared to canopy cover per centage in urban centres across Canada, Guelph’s residential canopy per centage is lower than the national average but above average for some land uses such as industrial, commercial, and institutional.

Figure 8: Tree canopy cover distribution by land use classes across Canada

Per cent relative canopy cover by land use in urban centres across Canada



For clarity, NHS and natural areas outside the NHS exist in all the land uses in Guelph. They are not exclusively in vacant land.

Figure 9: Tree canopy cover distribution by land use classes in Guelph

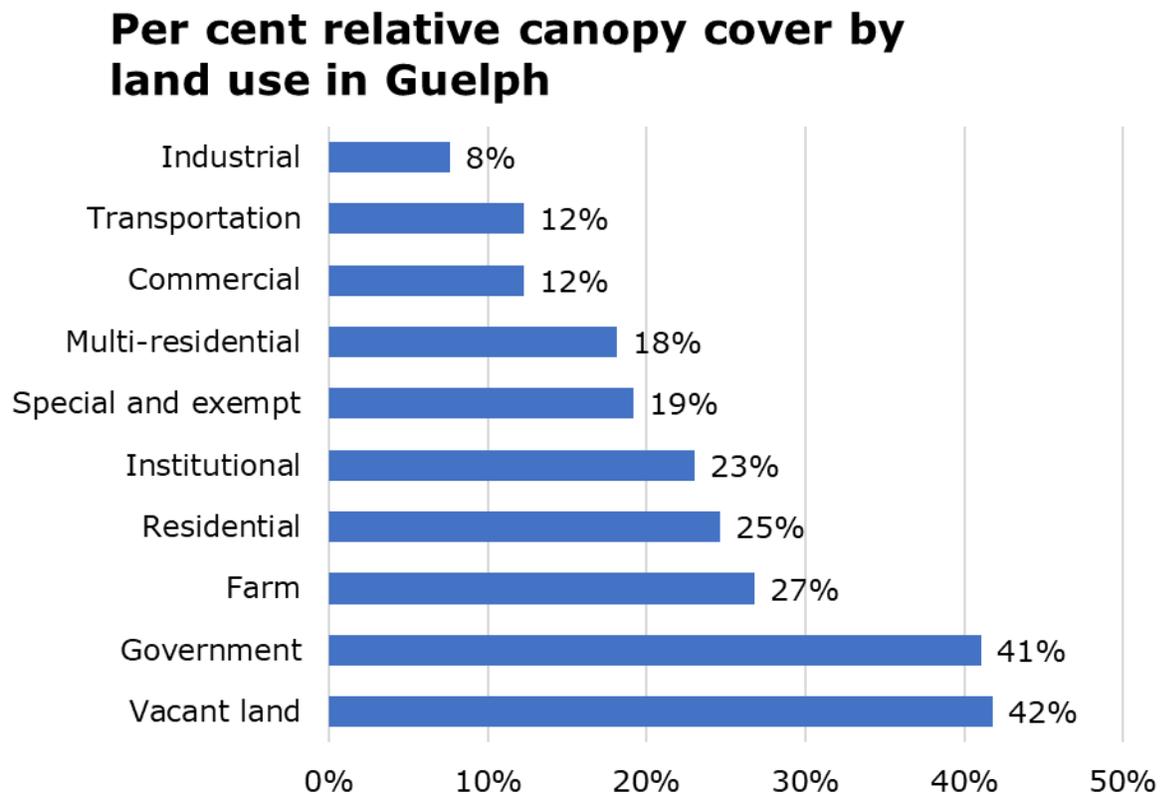


Figure 9 makes it clear that the distribution of tree canopy in the various land uses are not equal and so different tools must be employed to support opportunities. For example, in commercial lands, increasing plantable spaces using green infrastructure technology such as soil cells.

Maximum contribution of each land use or ownership type to the canopy cover goal will be used to develop canopy targets.

Some cities have set canopy cover targets by neighbourhood (Halifax) or land use (North Oakville, London, York Region) to support planners in understanding and enforcing optimal levels of greening to support a city-wide canopy cover goal (Table 2). North Oakville and Toronto require Canopy Cover Plans for development and site plan applications to demonstrate a proposed developments contribution to canopy cover targets.

Table 2: Canopy cover land use targets for North Oakville and London; Source: City of London, 2014; Natural Resource Solutions & Dillon Consulting, 2012

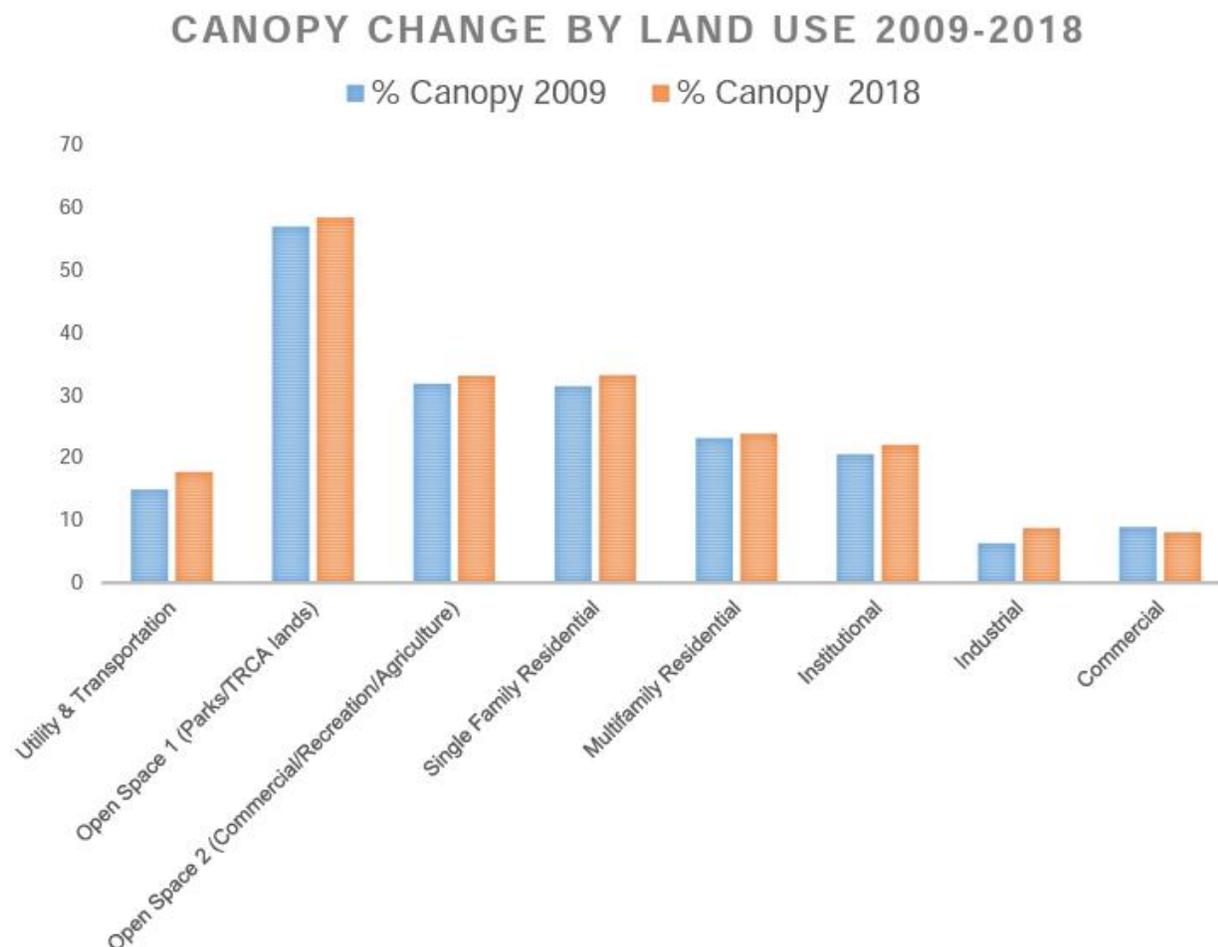
Land use	Canopy cover target (North Oakville)	Canopy cover target (London)
The NHS and Natural Lands North of 407	90%	60%
Agricultural Lands North of 407	0%	15%
Residential (all types)	20%	25-35%
Employment/Industrial	20%	15%
Parkland	50%	-
Arterial and Avenue Roads	34%	-
Cemetery	34%	-
Commercial/Mixed	15%	15%
Stormwater Management Facilities	15%	-
Transit Ways	34%	-
Public Use (schools)	20%	-
Transitional Area	15%	-
Institutional	25%	20%

Canopy change by land use

Canopy change usually occurs where natural cover, including forests, is lost to land conversion from natural or agricultural to urban land uses. With Guelph's intensification targets, we will likely see an increased loss of trees in residential areas and other built areas, but potentially increased canopy in stable lands protected by natural heritage system policies.

Canopy cover change by land use can be used to better understand the impacts of development and guide future policy and decision making regarding sustainable development. Guelph's 2019 canopy study did not measure canopy change over time. This will be completed as part of the future canopy study in 2029 and used to develop Guelph specific mortality rates. As an example, Toronto completed this type of assessment in 2018 (Figure 10) which determined that while canopy decreased on commercial lands, it increased on all other land uses.

Figure 10: Canopy change by land use; Sources: 2009 leaf-on point sample (Nowak et al., 2013) and 2018 leaf-on point sample, 2008 land use layer (KBM Resources Group et al., 2018)



Natural Heritage System and parks

Natural Heritage System

Canopy cover within the NHS is currently at 60 per cent. Canopy cover on lands designated as **NHS in the City's Official Plan are unique in that they are considered stable canopy with enhanced level of protection from loss due to development.** The NHS is protected in the Official plan under specific NHS policies and is distinct in that respect from those areas outside the NHS. Increasing canopy cover in the NHS was identified as a priority by stakeholders to support the ecological function of the NHS.

Parkland

Parks in Guelph currently contain 6.7 per cent of the overall canopy cover and 5.6 per cent of the land area available to plant trees. Guelph's Park Plan recommends increasing the canopy cover and naturalized spaces in parks and states that parks

provide a perfect opportunity to expand the urban forest for a climate resilient city. Parks are and have always been significant opportunities for community tree planting and naturalization. Through the Park Plan, the City will continue to support canopy goals and local stewardship while balancing the need for the recreation function of parks.

Canopy cover ecosystem services: natural climate solutions

Planting trees are one the least expensive ways to counter mitigate the effects of change and the impacts of extreme heat in the built environment. It is well known that there are direct relationships between tree canopy cover such as reduced heat related health impacts and electricity consumption.

Each year Guelph's trees provide annual ecosystem services worth \$5.6 million. This includes:

- Annual energy savings: 141,941 MBTUs (4,428 MWh) with a value of \$1,882,502
- Pollution removal: 156 tonnes with a value of \$2,051,438
- Avoided Runoff: 399,938 m³ with a value of \$929,742
- Gross Carbon Sequestration: 6,455 tonnes with a value of \$741,515

Additionally, the urban forest stores 196,894 tonnes of carbon with a value of \$22.6 million.

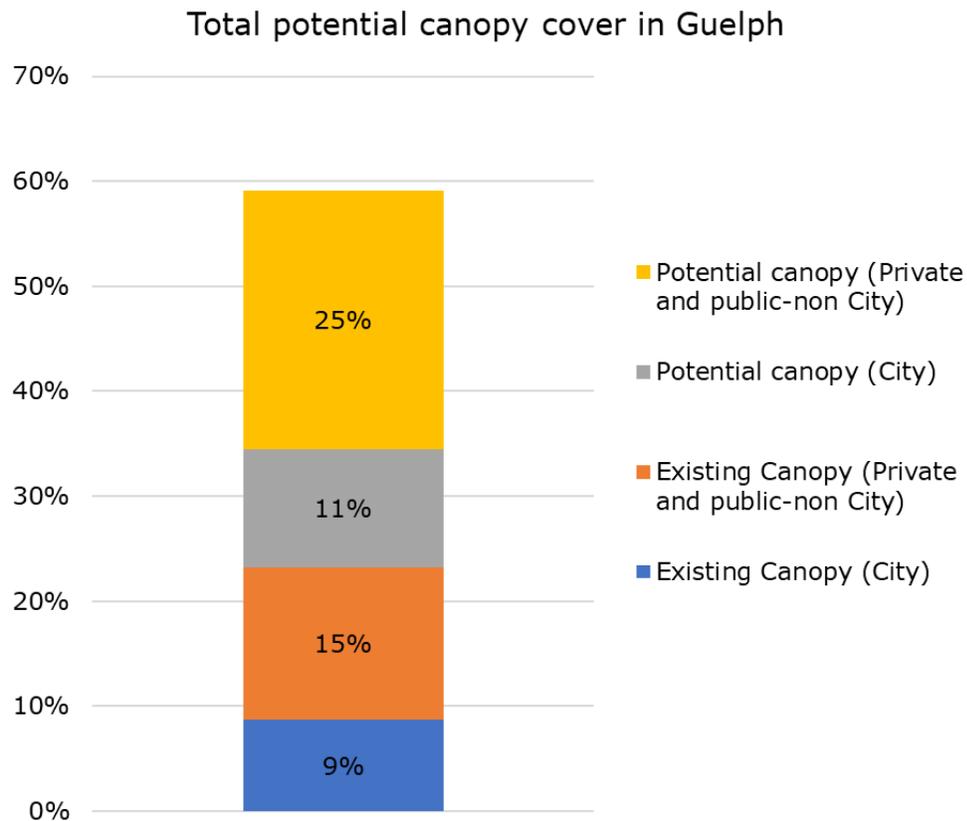
Maintaining and enhancing a healthy urban forest is a community-wide action to mitigate the effects of climate change and contributes to meeting the City's target to become a net-zero community by 2050. However, the ability of the canopy to act as a natural climate solution tool will depend on their growth and mortality under the stress of climate change, pests, and development. In Canada, the rate of projected climate change is expected to be 10 to 100 times faster than the ability of trees to migrate, resulting in impacts on forest health and productivity (Natural Resources Canada, 2021).

Carbon capture increases exponentially over time, indicating the importance of investments in near future planting for achieving long-term climate mitigation (Drever, 2021). Protection, improved management, restoration and avoided conversion of forests and urban forest canopy cover are key to scalable climate mitigation through carbon capture and provide other benefits (Drever, 2021).

Potential planting areas

There is approximately 2000 ha land that could potentially support tree growth. This land area could theoretically support a maximum of 59.1 per cent canopy cover (17 per cent more than our target) (Figure 11). 11.2 per cent of that land is owned by the City while the remaining 24.6 per cent is on private and other public lands. This means that the City can only contribute a maximum of 11.2 per cent of canopy towards the overall 40 per cent target.

Figure 11: Total potential canopy cover by land ownership

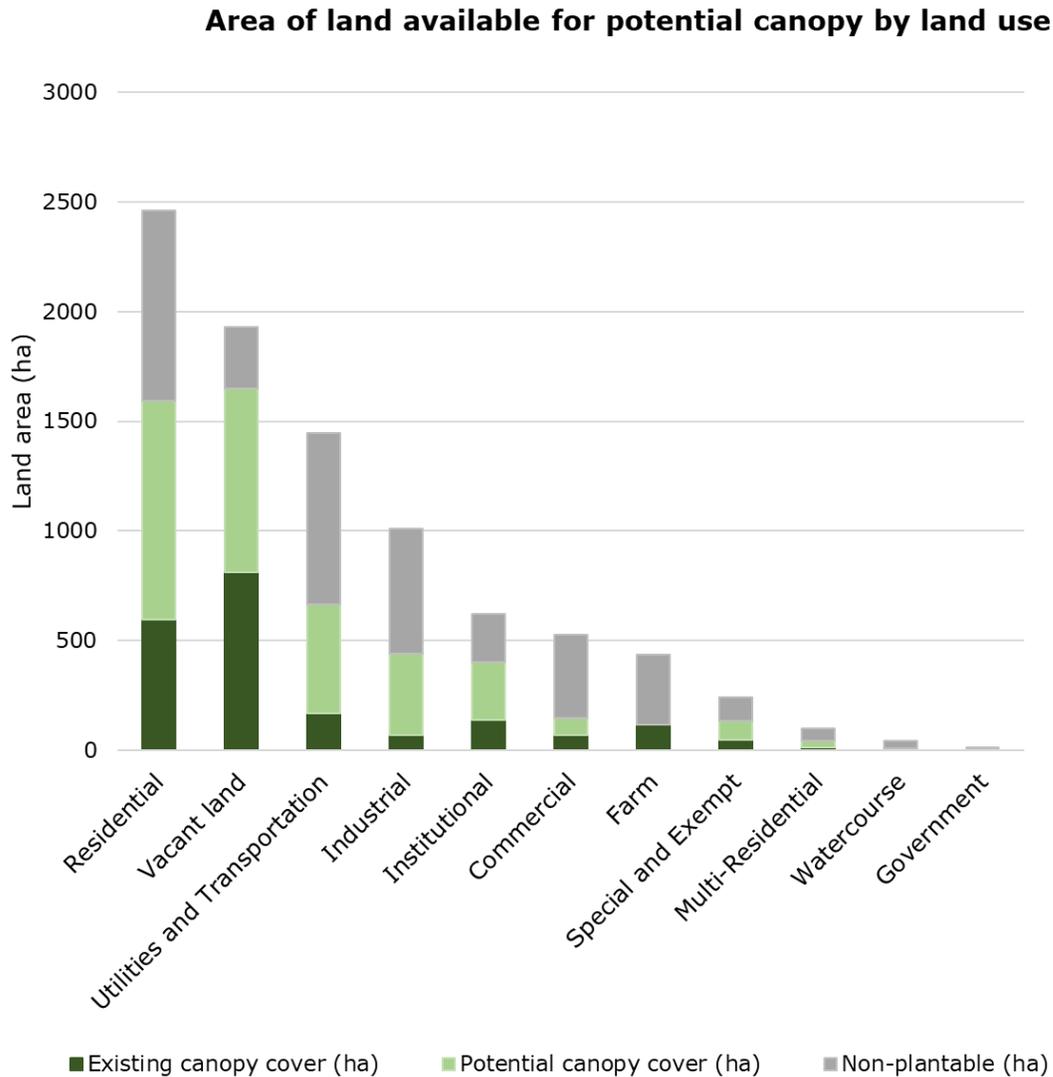


While 1,492 ha of land needed for tree planting to achieve the canopy target may seem like more than enough space, it is finite and represents a single point in time (2017).

Figure 12 below illustrates the land area currently covered by tree canopy, the potential area theoretically available for tree planting (additional canopy cover) and finally the non-plantable area of land – where planting is limited due to buildings, hard surfaces, conflicts with utilities, etc.

Once plantable land is converted to other land uses it will be lost unless we ensure that the land suitable for tree planting is conserved in addition to creating new spaces (e.g., parking lots, courtyards, amenity spaces, landscaped spaces).

Figure 12: Area of land available for potential canopy (tree planting) by land use



At a high level, it seems that achieving the 40 per cent canopy cover goal under optimal planting scenarios is theoretically feasible. However, it is not likely that tree planting can occur on all the potential planting area where other priorities such as open landscaped space in parks or meadow habitat. Land is valuable for many reasons. Preserving and creating new room for trees as the city grows will prove to be challenging as our community priorities compete for land.

Priority planting tool

Meeting community needs and optimizing benefits to the community through strategic tree planting is the foundation of the Strategy. Priority planting areas were determined in the 2019 UFS, using a Tree Planting Prioritization Tool or TPPT, developed by the Region of Peel, that prioritizes tree planting locations based on eight overall benefits that urban trees provide:

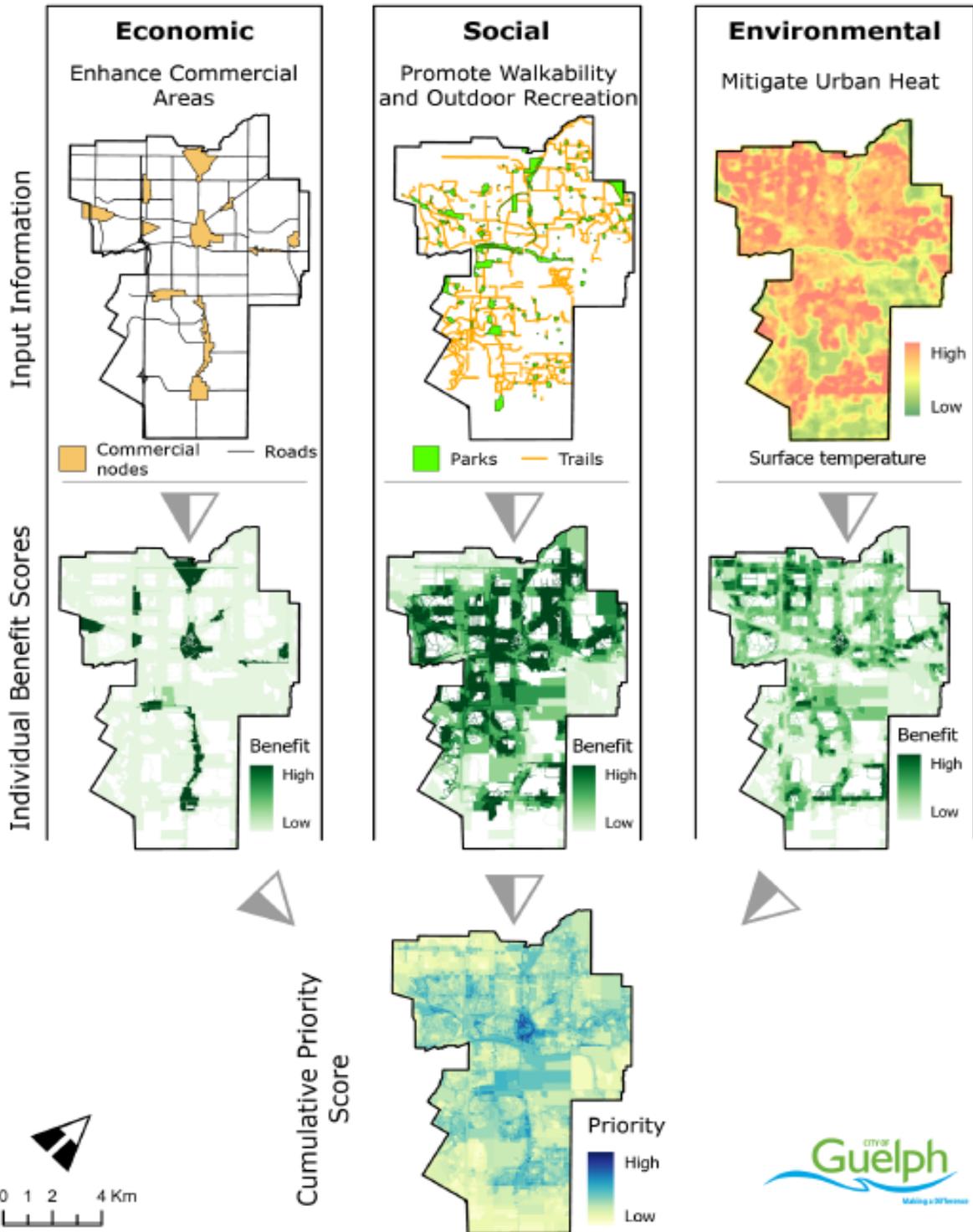
1. Mitigating air pollution
2. Mitigating urban heat island effect
3. Contributing to management of surface water quantity and quality
4. Maintaining and enhancing natural heritage
5. Enhancing economic value
6. Providing direct cost savings (reduced energy use)
7. Supporting improved physical health and emotional wellbeing
8. Strengthening communities and enhancing social equity

Each benefit as it related to the features in the spatial layers (e.g., sidewalk, park, commercial area) was modelled, scored and Figure 13 below illustrates how inputs to the tool overlaid using benefit scores resulting in the cumulative benefit score mapping.

The TPPT identifies areas in Guelph where tree planting would provide increased benefits for areas with low canopy, vulnerable populations, and other socio-economic factors.

Figure 13: Tree Planting Prioritization Tool cumulative priority benefits

Planting for Urban Forest Benefits



Equity (tree distribution and environmental inequality)

The benefits of trees are well understood. For this reason, cities attempt to incorporate trees into the urban landscape. However, these efforts are often restricted to City property and on private land depends on landowners' participation to plant and maintain trees. The leading factors associated with this are cost and risk.

The relationship to socioeconomic factors associated with increased canopy cover is complicated but research suggests that canopy cover often negatively correlated to socioeconomic factors such as income, level of education and minorities (Lockwood & Berland, 2019). Access to essential, heat-mitigating amenities, including trees or forests, should be provided to everyone, and not restricted only to those with means or affluence.

Canopy cover modelling

Urban forests are in decline, according one US study (Nowak & Greenfield, 2018). The loss of canopy coincided with increase of impervious cover resulting in loss of urban forest benefits of an estimated \$96 million per year. The factors of canopy gains and losses are highly variable. They include:

1. Natural tree growth (gain)
2. Naturally occurring regeneration (gain)
3. Intentional tree planting (gain)
4. Natural tree mortality (loss)
5. Intentional tree removal (loss)

Spatial (e.g., GIS) and aspatial (i.e., excel, i-Tree) canopy modelling tools can help us understand the impacts of natural and intentional events by "virtually" growing canopy cover under specific rates of gains and losses and calculate the ecosystem services of future forests based on anticipated health and structure.

Both tools were used for the Strategy. Aspatial modelling was used to determine if current tree planting efforts (number of trees planted per year) or an increase of 30 per cent would achieve 40 per cent canopy cover, and what actual amount of planting efforts is required to achieve our target within specific timeframes. Spatial modelling was used to determine the ecological services of the canopy at current planting effort, 30 per cent increase in current planting effort, and at the effort determined by the aspatial modelling to achieve 40 per cent.

Limitations of modelling

Models are one the most useful, and sometimes the only, tools for providing insights, informing real practices, and decision-making. However, because models cannot incorporate the true complexity of natural systems, they will always be subject to known uncertainties, approximations, and limitations. The limitations of the canopy cover modelling are discussed in detail below and within the reports (Appendix B).

Mortality rate

The most critical limitation for the modelling was the rate of tree loss/removal as related specifically to development. The 2.9 per cent rate used by the consultants,

while reflective of neighbouring municipalities (Oakville and Toronto), factor in local driving forces of development specific to urban policies and economics.

For that reason, City staff chose to model additional mortality scenarios using the DHC tool developed for Guelph:

- 1.4 per cent background (natural) mortality rate only
- 3.3 (the national average) per cent mortality rate (1.4 per cent background, plus 1.9 per cent development mortality) (Hilbert et al., 2019)

Results for City modelling is available in Appendix B.

Tree size input and output

The models were limited to one tree size input and out. The baseline minimum tree size required by City standards for compensation for one tree is a 60 mm caliper tree. Since we plant different stock sizes across the city in different contexts (i.e., five-gallon pot, whip, or bareroot) the estimated annual known combined planting efforts of 1500 large (60 mm caliper stock) and 10,000 small stock, with the smaller stock being the estimated at an equivalent number of 1500 large trees (6:1 ratio). This resulted in the total known number of trees planted in Guelph, in 2021, to be the estimated equivalent of 3000, 60 mm caliper trees.¹

The caveat here is that we don't know the actual effort of tree planting that occurs outside regulated development, City planting or City partner events. This information is required for more accurate canopy modelling.

Additionally, the output of the aspatial model planting effort (number of trees) is reported as 60 mm caliper stock. It makes sense that we would plant a variety of tree sizes and for that reason, the model numbers will be split and extrapolated to determine a cost effective and feasible annual planting ratio including variable tree stock sizes.

Canopy growth and planting efforts

To explore the planting efforts required to support a 40 per cent city-wide canopy cover, Diamond Head Consulting Ltd. ("DHC") was engaged to prepare a model for canopy growth for the City of Guelph, and then use the model to explore the City's canopy potential under nine modelling scenarios. These nine scenarios consist of three modelling horizons: 2031, 2050, and 2070, each of which is explored under a "Business as Usual" planting rate, a rate 30 per cent greater than the "Business as Usual" rate, and a rate that achieves 40 per cent canopy coverage city-wide by the relevant model horizon.

Model horizons align with the timing put forward through the City's Urban Forest Management Plan and Official Plan (i.e., 2031), the Community Energy Plan – "Net

¹ Since the completion of this modelling (based on 2021 planting data), the planting rate for small stock has increase from 10,000 to 15,605 in 2022 for a total estimated equivalent of 3,500.

Zero" (i.e., 2050), and the 2019 Urban Forest Study (i.e., 2070). In each case, modelling will use 2024 as the initialization year (i.e., "Year 0").

DHC has applied their proprietary canopy growth model, which has been leveraged as part of their work with numerous Canadian municipalities. The DHC Urban Forest Canopy Modelling Report of Findings and Summary of Methods can be found in Appendix B.

DHC's model results suggest that to achieve a city-wide 40 per cent canopy by 2031, 2050, and 2070, using only the default mortality of 4.3 per cent, annual planting rates would need to meet roughly 500,000, 50,000, and 25,000 trees (60 mm caliper), respectively. These would be supported by tree removal and replacement ratios of roughly 1:70, 1:7.3 and 1:3.1 respectively, and would each involve a net increase of city-wide tree density from approximately 33 trees per hectare (current) to 57 trees per hectare (all model scenarios) based on the average canopy size per tree assumed for areas outside the natural heritage system.

Model outcomes are generally optimized with longer-term model horizons, such as the 2050 and 2070 horizons explored in this study. Shorter model horizons, such as 2031 often result in particularly lofty planting targets as they effectively achieve desired canopy targets through new and immature tree canopy almost exclusively, having no time for simulated plantings to mature. The result of this tends to be overplanting in the short term, which results in a dramatic overshoot of the canopy target beyond the set horizon. This is the case with the 2031 scenario in this study which is planted to a 40 per cent city-wide canopy coverage.

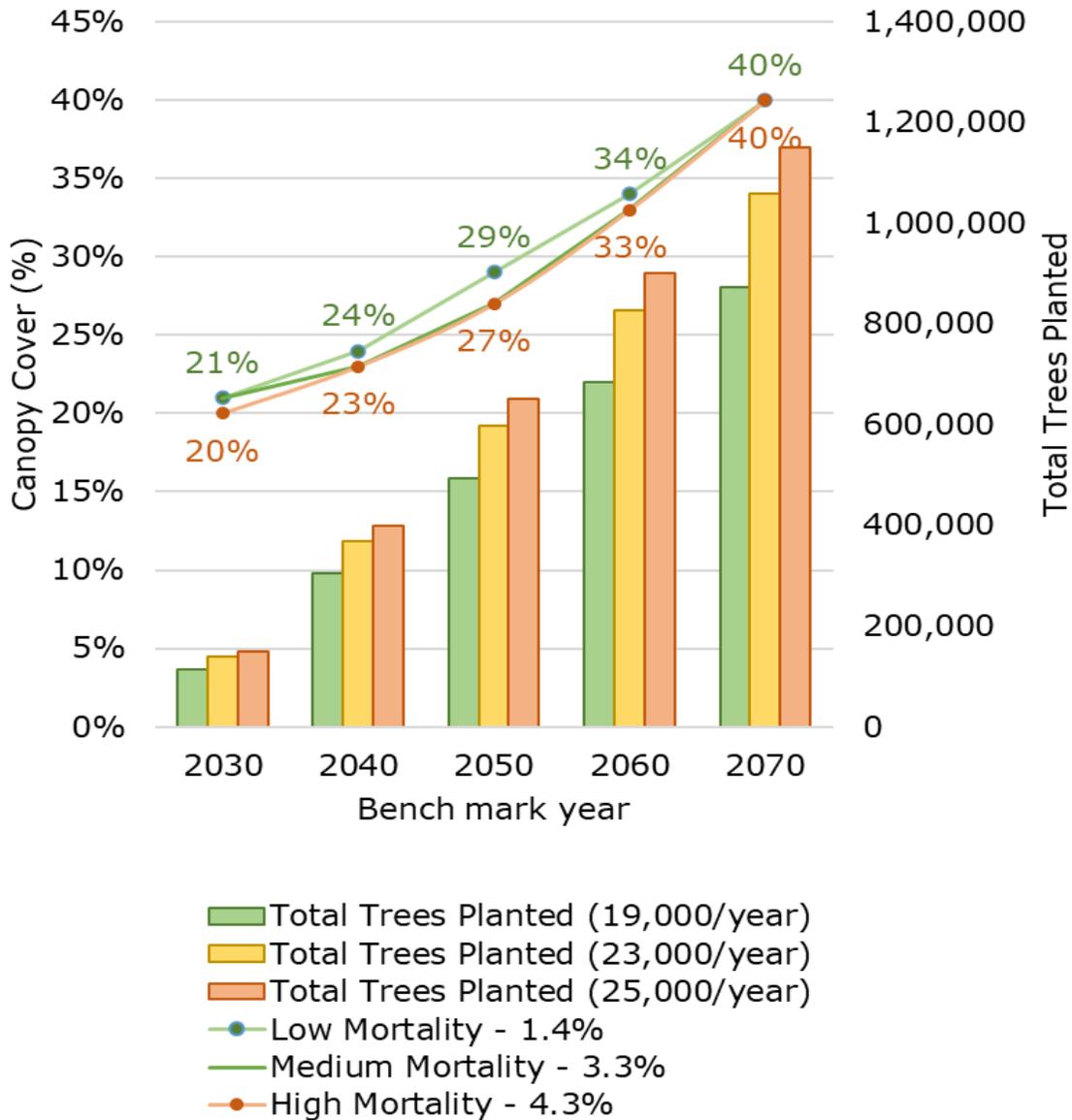
The further out horizons of 2050 and 2070 can be achieved through planting rates of 50,000 and 25,000 trees per year, respectively. These again necessitate maximizing planting within potential planting area on public and private lands, however the additional time afforded for trees to mature improves the curvature of the canopy projections.

Using DHC's model to explore alternatives

An estimated 19 to 25 thousand trees will need to be planted every year in Guelph to achieve 40 per cent canopy cover by 2070. This planting effort is based on a range of low, moderate, and high rates of mortality (natural and intentional combined). Figure 14 shows the resulting tree planting effort required to achieve our target under those mortality scenarios for the 2070 (46 year) timeframe.

Figure 14: Canopy modelling mortality scenarios for 40 per cent canopy cover target

Achieving 40% Canopy - Mortality Scenarios



Other timeframes of 2031 and 2050 were considered but the results of the modelling indicated the 40 per cent goal was achievable, however, not affordable, realistic, or affordable (i.e., high cost and effort).

It's important to note that the model used for this project defines "a tree" as a 60 mm caliper tree, and so the number of trees needed to achieve our target may seem small, but not all planting areas call for large caliper stock. Specifically, based on the proportion of single versus mass (group) tree plantings the City carries out, the number of trees required to fill an amount of area would increase approximately

30 per cent overall (e.g., at 3.3 per cent mortality the number of trees would increase from 23,000 to 80,000). However, it would cost us less because the cost of planting smaller trees is significantly less and requires much less effort.

Delivery of ecosystem services

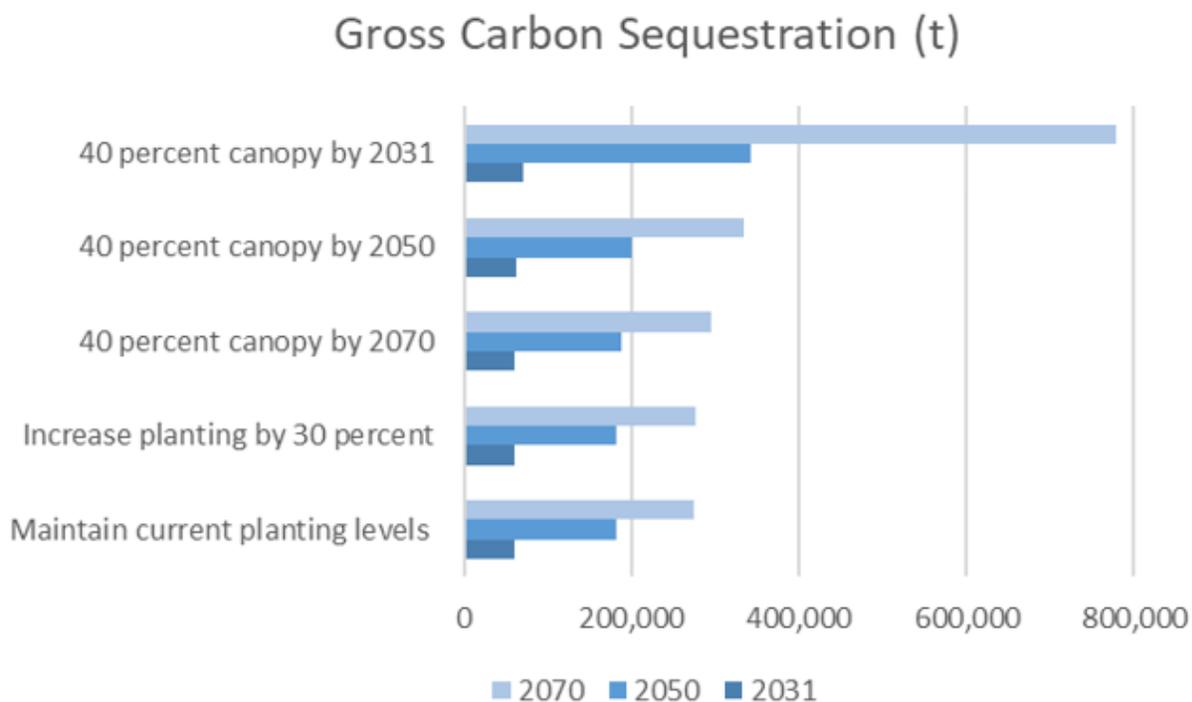
To model the ecosystem benefits of planting efforts and 40 per cent city-wide canopy cover, Kuttner Forestry Consulting was engaged to prepare models of canopy growth for the City of Guelph which explore the City's canopy potential under five modelling scenarios (Figure 15).

The study makes use of the i-Tree Eco v6 model and i-Tree Forecast to model outcomes over three-time horizons: 2024-2031; 2024-2050; and 2024-2070. Planting scenarios and associated rates were "business as usual"; increased "business as usual" planting rates by 30%; and the planting rates required to achieve 40% canopy cover over the three different time horizons according to a DHC's canopy growth model.

Carbon sequestered and pollutant removals attributable to tree planting were small as compared to the total carbon sequestration and pollutant removal potential at all but the most ambitious planting scenario (40% canopy cover by 2031). However, even small increases in carbon sequestered and pollutant removal are significant as to their impact on the environment and by extension, human health.

The carbon sequestration is directly linked to the expansion of the canopy (increase in leaf area, related to growth (age and size) of existing and annually planted trees).

Figure 15: Gross carbon sequestration for five planting levels in 2031, 2050, and 2070 associated with: maintaining current planting levels; increasing planting levels by 30 per cent; and planting levels required to achieve 40% canopy cover by 2031, 2050, and 2070



Modelling summary

The fundamental differences in DHC’s canopy modeling approach and the benefits modeling approach using i-Tree Forecast are numerous and **both models characterize the urban forest and canopy differently from the outset**, and as it develops over time. However, notwithstanding the assumptions and caveats to do with differences between the models used in this study, both models ultimately delivered complimentary results.

Both models implied that planting at current levels of effort will not sustain or grow Guelph’s canopy over time to reach the one Canopy goal of 40% canopy cover. And our i-Tree Forecast results showed that the environmental benefits of increased tree planting, at any level, has positive impacts. It is also clear that those same benefits accrue more rapidly and reach higher levels with large increases to current planting levels. The challenge remains to find means and resources to realize increases to tree planting rates, while at the same time finding the means and resources to engage in other activities that sustain, grow and benefit Guelph’s urban forest and canopy cover.

The complete summary of modelling results is available in Appendix B.

Monitoring, measuring, and adapting

Tree planting

The City and City partners track and report (quarterly and annually) the number of trees (and shrubs) planted by Forestry and sustainable landscapes and City partners (both on private and City lands). City and development (i.e., new subdivisions) related street and park tree plantings are tracked and inventoried in the City's GIS point based tree inventory.

The City has additional information regarding tree planting through site plans, development related landscape plans and vegetation compensation plans but does not currently record or track this information.

The City does not currently monitor the success of all compensation plantings, partner or City projects but plans to in the next few years as begin to rehabilitate the natural areas most impacted by ash and buckthorn removals. Monitoring landscaping and compensation plantings for developments in open spaces and the NHS is done as part of developer warranty requirements.

Canopy cover

The state of the canopy report and urban forest study was first done in 2019 and will be repeated every 10 years. The study used high quality satellite imagery and Light Detection and Ranging (LiDAR)² technology.

Measuring the canopy and monitoring changes gives us important information about how the canopy is changing and why. The next canopy study will include a canopy change analysis and will help us better understand both the positive and negative influences that impact the urban forest.

Gaps

While not unique to Guelph, challenges facing the growth and sustainability of Guelph's urban forest include pests, extreme weather events, development pressure and lack of resource knowledge. Guelph has made good progress, especially since the implementation of the UFMP, increasing planting initiatives. However, several gaps exist, such as:

- Lack of strategic planting plan with species and diversity targets
- Lack of site level canopy targets requirements for developments
- No consistent standard for integrating tree planting projects with capital road and infrastructure projects (e.g., road reconstruction, park renewal, cycle path construction, City facilities)
- No information about Guelph specific development related mortality rates
- Loss of existing plantable spaces through development
- Lack of new quality and quantity of growing space in both new developments, boulevards, and hardscapes

² LiDAR is a technology that uses lasers to collect geographic information, allowing for accurate horizontal and vertical measurements.

- Unknown amount of canopy loss through regulated and non-regulated activities
- Inadequate replacement rates (ineffective planting efforts)
- Lack of coordinated neighbourhood and community planting programs
- Limited residential tree subsidy or incentives program
- Current initiatives and programs have no targets and are not tracked effectively
- Unknown if zoning minimum open landscaped spaces can support adequate canopy cover for future development
- No dedicated budgets for trees in road and infrastructure projects
- Tree By-law compensation may not be effective for short term canopy loss
- Ad-hoc tree establishment of new canopy or reactive as replacements for removed trees
- City land suitable for tree planting not enough to reach 40 per cent target
- New or compensation tree planting for developments not tracked
- No information on new tree planting on private property (excluding development)

Barriers and challenges

Understanding the barriers and challenges of tree planting gives insight to the factors to help reduce or eliminate those barriers and/or challenges. The barriers and challenges identified through the Strategy include:

- Climate change
- Drought
- Invasives pests and vegetation
- Pests and disease
- Limited quality and quantity of locally appropriate tree stock
- Increased development pressure
- Reduced quality growing spaces for trees
- Increasing conflict with community priorities such as housing, infrastructure, transportation networks
- Lack of resources or support for private property owners, community groups, and organizations
- Costs related to maintenance and care of trees for property owners
- The community's level of willingness, resources, and support to care for trees
- Low engagement
- Conflicting infrastructure
- Grant opportunities lack year over year predictability and cannot be relied on for developing strategic planting plans.

Opportunities

There are many opportunities to support the objectives of the Strategy. The opportunities build on current or recommend developing new initiatives and programs such as workshops, partnerships, funding, or regulatory tools. More specifically:

- Working with other City divisions and key stakeholders on policies to improve tree planting and growing conditions in the City

- Promoting best planting, establishment, and new tree maintenance practice for all City projects
- Established City and community planting programs
- Implementing the tree planting prioritization tool
- New and existing partnerships with other agencies and organizations
- Expansion of tree planting funding model

The Strategy is only intended to outline a strategic approach with associated actions for establishing new trees to grow the urban forest/canopy cover. Opportunities for long-term maintenance and protection are part of the broader UFMP objectives and will be addressed through future maintenance and protection strategies.

Integrated approach

Increasing tree canopy cover in Guelph is a shared responsibility between the City, agencies, organizations, landowners, community groups. While the roles vary, only a collaborative effort will bring us to meeting our collective vision of a healthy, livable and climate resilient community.

An integrated approach to the strategies and actions in the Strategy includes non-regulatory and regulatory based tools that can be applied to both City and non-City lands. Non-regulatory approaches focus on education and outreach, collaboration with other government and non-government organizations, landowner incentives and staff training. Regulatory approaches focus on the creation of by-laws. (Sherman, 2015).

Non-regulatory tools

City tree planting

The City needs to increase current planting rates. The tree planting prioritization tool can be used to prepare strategic planting plans for cost effective establishment of trees in areas that would gain the most benefit.

Trees should be integrated as essential components of infrastructure projects through informed by guidelines and standards, such as the TTM or a future "Complete Streets Design Guide". Invasive vegetation, particularly buckthorn can be targeted for replacement with native tree populations through ecological restoration projects and implementing neighbourhood tree planting programs similar to the community gardens program is a great way to get the community involved.

Trees

Cost-effective planting strategies also require steady sources of new trees (Bourque, 2021). It is recommended that species lists are reviewed and updated regularly to reflect changing conditions and species appropriateness. Buying enough trees and the species of species we need is becoming more difficult. Partnering with growers and securing contracts for the supply of genetically appropriate, locally grown native trees is key to our success.

Partnerships

The City has dedicated community partners, volunteers, and tree champions who year after year have dedicated their efforts to create a greener and healthier Guelph. This continued relationship and connecting with new community members is the key to our success as we focus on growing the canopy on private lands in addition to City lands.

Partnerships and collaborations can provide funding sources, resources, and support planting on available City lands. Examples of partners that would benefit the One Canopy Strategy include:

- Rotary Club
- Forests Ontario
- Tree Canada
- Tree Mobile
- GRCA
- ICI and business owners
- Development Industry
- Guelph and District Home Builders' Association (GDHBA)

To illustrate the benefit of just one of these programs, the City's current investment in the Forests Ontario – Take Root program has the potential to add 1 per cent of overall tree canopy by planting 1000 trees annually on privately owned residential properties over 46 years. While this may not seem significant, this 1.1 per cent would cover 900,000 square metres (90 ha) of land – the equivalent of 118 full size soccer pitches.

Support for partnerships would likely have the most significant impact on canopy cover if supported on a long-term basis.

Private (and other public lands) tree planting

Private lands are the biggest opportunity for planting – more than any other land use. Fifty-six per cent, of the tree planting potential exists on private lands. To meet comprehensive planting goals, the Strategy requires the support of planting on private properties, such as residential, commercial, and institutional. Environmental benefits, beautification and public health improvements are known motivators for engaging in tree planting.

The City needs to invest in planting and stewardship on private land to enhance and expand our urban forest. Successful engagement in these kinds of neighborhood plantings requires an understanding of residents' decision making. The top reasons someone would plant a tree on their residential property in Guelph were to help the environment, to create shade and to make their yard beautiful. On the other hand, the top barriers in Guelph to planting trees on private property included space, not room because of other trees or landscaping, and small lot.

Outreach

Outreach can be as simple as increasing access to information about how to plant trees or planting events taking place in Guelph. Outreach for those in the community who are seemingly unengaged, can't afford, or don't typically

participate in tree planting could include providing access to information, resources, or stewardship opportunities.

Examples of outreach events that can raise awareness about the importance of tree planting include expert led tours, social media campaigns, community events, other City events/open houses. Outreach can include celebrating National Forest Week, Arbor Day, and Earth Day with activities such as events, contests, awards, etc.

Developing a call-to-action campaign for private property has the potential to encourage owners to plant trees on private property and increase participants in City planting events.

Engagement

Community engagement is essential in understanding the needs of the community as we continue to grow and care for our urban forest. The City should continue to engage for UFMP and tree planting initiatives with:

- General public, including youth
- Aboriginal groups
- Private landowners
- Contractors
- Municipal staff
- Businesses
- Development community
- Tree related professionals (e.g., Landscape Architect, Arborist, Forester, Ecologist)

Education

Education is a great way to provide people the understanding of the importance of trees and the urban forest. Education can encourage the community to plant and care for new trees.

The City should continue to support third party organizations such as Reep Green Solutions to deliver educational tree planting and care workshops, expand opportunities to deliver Forests Ontario school age workshops, build on TFG hands-on tree planting lessons with educational materials, and foster new partnerships with organizations that have existing workshops or ability to deliver educational materials. The City should host a workshop to promote best management practice (e.g., Tree Technical Manual).

The Healthy Landscapes program will continue to deliver tree planting best practice information, including tree planting species and spacing.

Other educational opportunities could include:

- Incentives, recognition, and rewards programs
- Private Tree By-law
- Tree Technical Manual
- Plant lists
- Invasive species management
- City of Guelph website
- City and partner campaigns
- Online tree benefits calculator

Incentives

Incentives for tree planting include recognition programs, grants, subsidies, and/or tax credits. Tree planting incentive programs that should be considered as part of the Strategy include, but are not limited to:

- Incentivized tree planting events to increase volunteers (e.g., workshop component, or plant one tree, take one home)
- Recognition programs, grants, subsidies, and/or tax credits
- Tree giveaways or reduced cost tree sales
- Grants made available neighbourhood planting or partnership grants using a tree reserve fund
- Industrial, commercial, and institutional (ICI) (corporate) tree planting program
- Recognition programs such as the proposed Adopt-a-space or Eco awards are great ways to celebrate individuals, business and organizations that are committed to our city's environment
- Subsidies and/or tax credits – small (e.g., stormwater rebate) and large-scale programs (e.g., Forests Ontario)

Regulatory tools

Regulatory tools such as guidelines, policies, and by-laws should be updated and aligned with the Strategic Plan. Specifically, reviewing existing guidelines and best management practices and align with Strategy/climate mitigation and adaptation strategies.

It is recommended that development guidelines should be updated to include canopy targets based on land use. The City should also review and update species list in TTM and other guidelines for species diversity and function to meet biodiversity targets as they apply to climate vulnerability.

Enhancing compensation requirements of the Private Tree By-law should be included in the upcoming review and consider incentivizing on site compensation planting.

Other regulatory tools for enhancing urban forest to consider include:

- Shade tree policy
- Invasive plant policy
- Soil management and conservation policies

Canopy cover targets

Guelph specific mortality rates (both intentional and natural) and canopy gains (natural regen, intentional planting, and natural growth) need to be established. This will be completed as part of the future canopy studies. The mortality rates will allow for more accurate modelling and help us better understand the impact of our planning policies on the canopy.

Developing canopy cover targets for land use is a complicated. Further canopy modelling based on more specific or targeted land use, such as parks or NHS, will help to guide future decisions for appropriate canopy targets.

Funding opportunities

Additional funding is required to implement the Strategy for trees, incentives, resources, tools, and such. There are several opportunities to develop an enhanced tree planting funding model.

City funding

City funding can be expanded through:

- Aligning the Private Tree By-law cash-in-lieu requirements with compensation calculations in the City's Tree Technical Manual
- Promoting the City's existing tree donation program
- Developing budget allotments for capital roads and infrastructure projects to ensure that new trees are included in these projects

Private property partnerships (leveraged funding)

The City alone does not have the funds, resources, or infrastructure to support the level of tree planting on private properties needed to achieve our canopy goals. Partnerships with organizations such as TFG and Forests Ontario leverage the City's funds/contributions to expand the tree canopy on private lands.

Grants

External funding can supplement both City funding and support projects on private lands. Most grants are available through application. Funds support projects that are related to community greening, ecological restoration, or reduction of greenhouse-gasses. Examples of funding grants include, but are not limited to:

- Tree Canada
- Federal grants (e.g., ICIP, 2 Billion Tree Fund)
- TD Green Streets
- Great Lakes Restoration Initiative

Monitoring and measuring success of the Strategy

The way in which we monitor our progress towards a sustainable urban forest is set out in the UFMP sustainability criteria and the optimal levels of service in three key areas: vegetation assets (i.e., quantity and quality), community framework (i.e., engagement, awareness, and collaboration), and management approaches (inventory, resources). This monitoring lets us know if we are effectively making progress towards our targets. These levels tell us amount and type of service that meets key objectives of the UFMP (driven by community priorities) and is sustainable, affordable, and realistic.

The current optimal canopy cover target for the City of Guelph is to achieve 75 to 100 per cent of the potential canopy (currently estimated to be 59 per cent of Guelph's land). However, it is unreasonable to expect that we can fill that space with trees. A more reasonable goal is 40 per cent of the land area which is still close to the optimal condition.

The City currently uses canopy cover percentage as the key performance indicator as a measure of the "Sustainability of the City's Urban Forest" for reporting Corporate strategic initiatives.

It's important to note that while measuring canopy cover is valuable, it is only one factor considered in the sustainability of the City's urban forest. The canopy cover measure does not speak to urban forest health, age, species, structure, ecological services, and other sustainability criteria. Canopy cover is however a simple, measurable, tangible and easily understood concept that provides the City an indicator that can be easily communicated to the community, and measured against comparator municipalities.

The City last reported on the level of service of the urban forest in 2020 (which included the measure of canopy cover), as part of the UFMP implementation report and update. Interim progress reports are provided to Council annually.

Comprehensive urban forest studies are carried out every 10 years. However, land cover analysis may be done every five years to measure only the canopy cover.

Success of the operation framework considered tangential to our plans include:

- Availability of stock from local growers
- Volunteerism and continued stewardship (Breger et al., 2019)
- Adequate funding

Implementation actions

The implementation plan summarizes the priority actions decided upon in the Strategy. The actions are split first by goals, then strategy and followed by actions. Additionally, each action is associated with the related objective (or desired outcome). All budget implications will begin to be incorporated into the 2024 budget process as well as the 10-year capital forecast. The Strategy has identified a key number of findings, gaps and opportunities that led to the actions developed for the next five years.

Enhance and expand canopy cover

Develop sustainable funding model

Table 3: Develop sustainable funding model

#	Action	Objective	Timeframe	Budget status
1	Undertake a comprehensive review of available and potential funding sources to develop 10-year forecast tree planting budgets in support the tree planting strategy	Invest in cost effective green infrastructure	Short-term	Presently supported in operating budget
2	Incorporate tree related costs into capital and infrastructure projects	Invest in cost effective green infrastructure	Short-term	Allocate through 10-year capital forecast

#	Action	Objective	Timeframe	Budget status
3	Continue to pursue funding for tree planting initiatives and projects (e.g., grants)	Invest in cost effective green infrastructure	Medium-term	Presently supported in operating budget

Develop a strategic planting plan (using TPPT)

Table 4: Develop a strategic planting plan (using TPPT)

#	Action	Objective	Timeframe	Budget status
4	Develop annual operating tree planting program for Parks (Forestry and natural areas) – above and beyond replacements	Increase canopy cover and prioritize tree planting based on benefit needs	Short-term	To be recommended in future capital and/or operating budget
5	Develop and implement annual planting plans targeting high quality sites (soil) and identify low quality sites for soil amendment program (capital project opportunity)	Increase quality of sites for optimal tree growth	Medium-term	Presently supported in operating budget
6	Develop a planting plan prioritizing vulnerable populations ³	Advance environmental justice and equity and prioritize tree planting based on benefit needs	Medium-term	Presently supported in operating budget

³ Vulnerable populations for this purpose a general term meaning with hospitals, schools, hospice facilities, low income, visible minorities.

#	Action	Objective	Timeframe	Budget status
7	Develop and implement annual planting plans with targets to plant species missing successional age classes and mature canopy focusing on species with low maintenance requirements	Improve forest structure and function and prioritize tree planting based on benefit needs	Medium-term	Presently supported in operating budget
8	Develop and implement annual planting plans targeting planting opportunities created through invasives management (ecological restoration/ERIC)	Increase resilience to climate change and other threats and prioritize tree planting based on benefit needs	Short-term	Presently supported in operating budget
9	Work with Engineering to identify opportunities to incorporate tree planting for capital roads and infrastructure projects (e.g., cycling infrastructure)	Increase coordination across City departments and external agencies and prioritize tree planting based on benefit needs	Medium-term	Presently supported in operating budget
10	Coordinate with Alectra Utilities to develop appropriate planting plans and list of trees within tree-height distance of power lines	Increase coordination across City departments and external agencies and prioritize tree planting based on benefit needs	Medium-term	Presently supported in operating budget

Leverage and develop new tree planting programs (non-regulatory tools)

Table 5: Leverage and develop new tree planting programs (non-regulatory tools)

#	Action	Objective	Timeframe	Budget status
11	Develop formal tree planting program	Increase canopy cover	Medium-term	Presently supported in operating budget
12	Increase capacity of City (staff) to coordinate and implement new tree planting programs	Increase canopy cover	Medium-term	To be recommended in future capital and/or operating budget
13	Explore tree sourcing options such as growing contracts and partnerships with other growers (e.g., Arboretum, Green Legacy)	Increase canopy cover	Short-term	Presently supported in operating budget
14	Leverage Urban Forest Stewardship Group and Urban Forest Working Group to support City and community initiatives	Increase coordination across City departments and external agencies	Short-term	Presently supported in operating budget

Leverage or develop new regulatory tools

Table 6: Leverage or develop new regulatory tools

#	Action	Objective	Timeframe	Budget status
15	Incorporate canopy targets into development/site plan guidelines and explore opportunities for tree planting of City property, especially Parks	Increase canopy cover and prioritize tree planting based on benefit needs	Long-term	Presently supported in operating budget

16	Improve planting standards on all development and capital roads and infrastructure projects through the continued implementation of the TTM	Increase canopy cover	Short-term	Presently supported in operating budget
17	Develop soil conservation and management guidelines	Increase quality of sites for optimal tree growth	Long-term	To be recommended in future capital and/or operating budget
18	Develop effective climate mitigation strategy including shade and urban heat island policies	Increase resilience to climate change and other threats	Long-term	To be recommended in future capital and/or operating budget
19	Review existing regulatory tools (guidelines) and align with Strategy/climate mitigation strategy (climate mitigation)	Increase resilience to climate change and other threats	Medium-term	Presently supported in operating budget
20	Review and update species list in TTM and other guidelines for species diversity and function to meet biodiversity targets as they apply to a climate vulnerability (climate adaptation)	Increase resilience to climate change and other threats	Long-term	Presently supported in operating budget
21	Review existing and develop regulatory tools (policies and guidelines) for species diversity and tree establishment requirements	Increase resilience to climate change and other threats	Long-term	Presently supported in operating budget

Educate, engage, and empower

Increase number of community participants in City tree planting events

Table 7: Increase number of community participants in City tree planting events

#	Action	Objective	Timeframe	Budget status
22	Increase number of annual City events	Increase canopy cover	Medium-term	To be recommended in future capital and/or operating budget
23	Increase outreach/advertising	Engage, educate, and empower community members (celebrate successes)	Medium-term	Presently supported in operating budget
24	Offer incentives to for participation	Engage, educate, and empower community members (celebrate successes)	Medium-term	Presently supported in operating budget

Increase number of community participants independent of the City (on private or other public lands)

Table 8: Increase number of community participants independent of the City (on private or public lands)

#	Action	Objective	Timeframe	Budget status
25	Develop urban forest grant and incentives program for private (residential and ICI) properties	Engage, educate, and empower community members (celebrate successes)	Medium-term	To be recommended in future capital and/or operating budget
26	Continue to fund stormwater tree rebate with third party organization to deliver workshops and plant native trees on residential properties and expand program to include ICI property	Engage, educate, and empower community members (celebrate successes)	Short-term	Presently supported in capital budget
27	Host tree giveaway events where residents can receive free or subsidized native trees (small stock sizes)	Engage, educate, and empower community members (celebrate successes)	Medium-term	To be recommended in future capital and/or operating budget
28	Develop and implement a Communications plan for targeted outreach (for private property owners in areas identified as high planting priority, to address perception barriers to planting on private property or on ROW in front of properties, in areas of low-income/low canopy equity and other objectives)	Engage, educate, and empower community members (celebrate successes)	Medium-term	Presently supported in operating budget

#	Action	Objective	Timeframe	Budget status
29	Develop public tree stewardship (watering) campaign with offer of watering tools (i.e., gator bags)	Engage, educate, and empower community members (celebrate successes)	Short-term	Presently supported in operating budget
30	Provide tree planting support to private property owners as well as ICI: workshops, website information, benefits tool calculator, links to programs, partners, and resources, etc.	Engage, educate, and empower community members (celebrate successes)	Short-term	To be recommended in future capital and/or operating budget
31	Provide resources/tools to community groups to water and mulch newly planted trees	Engage, educate, and empower community members (celebrate successes)	Short-term	To be recommended in future capital and/or operating budget

Increase collaboration

Table 9: Increase collaboration

#	Action	Objective	Timeframe	Budget status
32	Build on existing partnerships with school boards and pursue new partnerships (ICI), places of worship, businesses, etc. to support tree planting on their properties.	Increase coordination across City departments and external agencies	Medium-term	To be recommended in future capital and/or operating budget
33	Collaborate with GRCA around tree planting initiatives and identify opportunities for City or community planting events	Increase coordination across City departments and external agencies and prioritize tree planting based on benefit needs	Medium-term	Not required
34	Explore opportunities to partner or support tree planting or nature-based initiatives with organizations/agencies supporting vulnerable populations	Engage, educate, and empower community members (celebrate successes)	Medium-term	Not required
35	Partner with Indigenous community to integrate Indigenous Forest management principles into tree planting practices (e.g., species selection, species/cultural values)	Engage, educate, and empower community members (celebrate successes)	Medium-term	Not required

Monitor, measure, and report

Table 10: Monitor, measure, and report

#	Action	Objective	Timeframe	Budget status
36	Purchase leaf-on imagery and undertake spatial canopy cover analysis every five years	Monitor and manage (Use adaptive management to make evidence-based decisions)	Long-term	Presently supported in capital budget
37	Continue to undertake comprehensive urban forest study every 10 years (includes canopy cover analysis, ecosystem service and valuation modelling, and state of the urban forest report)	Monitor and manage (Use adaptive management to make evidence-based decisions)	Long-term	Presently supported in capital budget
38	Develop a protocol for tracking and documenting the number of new trees planted, including but not limited to development, capital projects and planting events on both City and non-City-owned lands	Monitor and manage (Use adaptive management to make evidence-based decisions)	Short-term	Presently supported in operating budget
39	Develop a protocol to monitor the quantity, quality, and survival of tree plantings	Monitor and manage (Use adaptive management to make evidence-based decisions)	Short-term	Presently supported in operating budget

#	Action	Objective	Timeframe	Budget status
40	Undertake canopy change assessment to determine Guelph specific development and natural mortality rates	Monitor and manage (Use adaptive management to make evidence-based decisions)	Long-term	Presently supported in capital budget
41	Update tree planting strategy with subsequent urban forest studies	Monitor and manage (Use adaptive management to make evidence-based decisions)	Long-term	Presently supported in operating budget
42	Continue to provide annual tree planting updates to Council and the community	Engage, educate, and empower community members (celebrate successes)	Short-term	Presently supported in capital budget

Financial implications

The City continues to make good progress towards our urban forest sustainability targets through investments (approved capital and operating budgets) made to date in the implementation of the UFMP. Other budgets or funding sources, such as grants and partnerships, have also been leveraged to invest in projects and initiatives. Limited resources are expected to present challenges in meeting the corporate and community targets.

In the first phase of UFMP implementation (2013- 2018), one of the principal drivers of the investment in the UFMP has been to manage the impacts of the emerald ash borer, which has been a very reactive program. Now in the second phase of the UFMP, as we turn to restoration and preparing our canopy for the future (among other priorities), we need to invest proactively for growth and resilience.

The initial investment for planting trees and the costs associated with maintaining older trees are outweighed by the benefits provided over a tree's lifetime, especially during the mature phase of life.

The average return on investment for trees can range from 1:1.37 to 1:3.09. York region reported a return of 1:23.6 (Bourque, 2021). That means that for every

dollar someone spends on planting or caring for a tree is guaranteed to provide some benefit whether the return is in energy savings, reducing the burden on the health care system or increase in property values.

The cost to implement the One Canopy Tree Planting Strategy depends on factors such as the rate of tree loss, rate of tree replacement, and the timeframe over which the cost is spread. The estimated annual cost associated with achieving a 40 per cent tree canopy by 2070 is \$3.6 million, of which \$1.4 million is related to capital and \$2.2 million is for the associated operating impacts.

The City's current level of tree planting has an average capital cost of \$275 thousand per year for tree purchases. The Operating costs associated with this investment is \$412 thousand annually for the ongoing maintenance required to establish newly planted trees.

With the estimated annual cost requirement of \$3.6 million versus a current annual budget of \$687 thousand, an additional \$2.9 million annually will be required to meet the 40 per cent tree canopy cover.

The One Canopy Tree Planting Strategy will be considered with the other master plans and strategies and will be viewed with a corporate lens to incorporate the City's strategic goals. The plan will also be compared to our existing capital and operating plans considering current fiscal constraints and our capacity to deliver. The financial information included is intended to be a high-level estimate that will be refined as it is incorporated into the overall corporate plan and multi-year budget process.

Conclusion

A successful tree planting strategy requires understanding the complexities of canopy cover distribution, community priorities, challenges, opportunities, gaps in current management and being able to leverage all the pieces towards a future goal.

To achieve the 40 per cent canopy target, an estimated 80,000 trees of varying sizes need to be planted every year across the city for the next 46 years. This significant undertaking will require a sustained commitment from the City and the community to work collaboratively. Aside from protecting and managing the existing canopy cover, the Strategy requires planting more trees on City, private and other public lands, and planting better, and allowing the time for trees to reach their potential.

There has been good progress to date in increasing tree planting, improving planting practices and management, increased stewardship, and unwavering support by the community for the UFMP and canopy initiatives. Through the implementation of the UFMP, we are actively working on closing the gaps by encouraging planting through other programs/projects, protecting more trees during construction, improving tree maintenance practices (decreasing tree mortality) and leveraging grants and partnerships with the community. The current progress and efforts, as good as they are, are not enough to get us to our canopy target.

It is not lost on us that the impact of the Strategy may only be realized by future generations. Investing and planning today in the growth of the urban forest will improve the benefits to the City only decades later but we are at a critical point of facing climate change and the exponential growth of our city. Inaction at this turning point, understanding what the significant role the urban forest play in our future, would be detrimental and recovery extremely difficult (and expensive).

The Strategy, along with the UFMP, will guide us towards our goal and ensure that we are making good progress. It will foster partnerships and collaboration. It will empower the community to contribute through simple but effective actions of tree planting. It will ensure that we consider the urban forest as an integral part of the landscape fabric that is intertwined with the way we live on, develop, and use land.

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Appendices

Appendix A. Definitions

The following definitions are drawn from City of Guelph (2012).

Canopy cover: A measurement of the areal extent of vegetation foliage, typically measured in percentage of total land area.

Diversity (species): Variation in the family, genus and species composition of trees in the urban forest. Species diversity encourages resilience to physiological stressors by reducing the number of pest or pathogen hosts or spreading them across a wider area at lower densities.

Diversity (structural): Variation in the age, size, structure, location, and other physical characteristics of urban forest trees. Structural diversity encourages a continuous urban forest canopy as larger and older trees are removed.

Plantable space: Potential plantable spaces are vegetated or exposed open spaces that could accommodate tree planting (i.e., plantable soil that is not filled with tree canopies or other overhead restriction). Actual plantable spaces are spaces meeting the above criteria that are in fact feasible for tree planting based on approved or anticipated land uses, including consideration of the need to balance treed and open spaces.

Potential canopy cover: A refined measurement of urban forest canopy which accounts for the subject area's carrying capacity for tree cover. It provides a useful baseline for assessment and enables more informed target and goal setting.

Urban forest: In this report, urban forest means all the trees in Guelph including those in the NHS. Various terms in the literature often used interchangeably include terms like urban forest canopy, canopy cover, forest cover and tree canopy. For consistency with past plans and reports, the term 'canopy cover' will be used in referring to the City's goal of increasing tree canopy cover to 40 per cent.

Urban forest canopy: A two-dimensional measurement of the horizontal surface area of the forest as seen from a "birds-eye" view. It is a popular metric because it is readily understood, but it does not capture other important aspects of the urban forest, such as species diversity, urban forest structure (i.e., size and age ranges) or condition, etc.

Appendix B. Canopy forecast modelling results

Table 11: Canopy forecast modelling results

Planting scenario	Mortality rate	Total annual planting rate	Projected total canopy cover	Canopy net change
2031 (7-year) "Business as Usual" (BAU)	1.4	6,874	21.7	-1.6
a 2031 (7-year) "30% increase BAU"	1.4	7,779	21.8	-1.5
2031 (7-year) "target" intensity	1.4	405,099	38.6	15.3
2050 (26-year) "Business as Usual"	1.4	6,874	24	0.7
a 2050 (26-year) "30% increase BAU"	1.4	7,779	24.4	1.1
2050 (26-year) "target" intensity	1.4	48,997	40	16.7
2070 (46-year) "Business as Usual"	1.4	6,874	27.4	4.1
a 2070 (46-year) "30% increase BAU"	1.4	7,779	28.3	5
2070 (46-year) "target" intensity	1.4	19,180	40	16.7
2031 (7-year) "Business as Usual"	3.3	6,874	20.4	-2.9
a 2031 (7-year) "30% increase BAU"	3.3	7,779	20.4	-2.9
2031 (7-year) "target" intensity	3.3	472,045	40	16.7
2050 (26-year) "Business as Usual"	3.3	6,874	20.4	-2.9
a 2050 (26-year) "30% increase BAU"	3.3	7,779	20.7	-2.6

Planting scenario	Mortality rate	Total annual planting rate	Projected total canopy cover	Canopy net change
2050 (26-year) "target" intensity	3.3	61,852	40	16.7
2070 (46-year) "Business as Usual"	3.3	6,874	22.8	-0.5
a 2070 (46-year) "30% increase BAU"	3.3	7,779	23.7	0.4
2070 (46-year) "target" intensity	3.3	23,702	40	16.7
2031 (7-year) "Business as Usual"	4.3	6,874	19.8	-3.5
a 2031 (7-year) "30% increase BAU"	4.3	7,779	19.8	-3.5
2031 (7-year) "target" intensity	4.3	486,894	40	16.7
2050 (26-year) "Business as Usual"	4.3	6,874	19	-4.3
a 2050 (26-year) "30% increase BAU"	4.3	7,770	19.4	-3.9
2050 (26-year) "target" intensity	4.3	61,852	40	16.7
2070 (46-year) "Business as Usual"	4.3	6,874	21.5	-1.8
a 2070 (46-year) "30% increase BAU"	4.3	7,779	22.4	-0.9
2070 (46-year) "target" intensity	4.3	25,191	40	16.7

Appendix C. UFMP-related sustainability criteria, optimal performance level, and key objectives

Table 12: UFMP-related sustainability criteria, optimal performance level, and key objectives

Sustainability criteria	Optimal performance level	Key objective
Relative canopy cover	The existing canopy cover equals 75-100 per cent of the potential	Achieve climate appropriate degree of tree cover, communitywide
Age distribution of trees in the community	25 per cent of the tree population is in each of four RDBH classes	At the neighbourhood level, citizens understand and collaborate with the City and / or non-government (NGO) partners in urban forest management plans
Species suitability	All trees are of species considered suitable for the area	Establish a tree population suitable for the urban environment and adapted to the local environment
Species distribution	No species represents more than 20 per cent of the entire tree population and at the neighbourhood level	Establish a genetically diverse tree population city-wide as well as at the neighbourhood level
Citizen involvement and neighbourhood action	Proactive outreach and coordination by City and non-government agency partners resulting in city-wide coverage and interaction including neighbourhood stewardship strategies	At the neighbourhood level, citizens understand and collaborate with the City and/or non-government (NGO) partners in urban forest management plans
Tree establishment planning and implementation	Tree planting plan is guided by municipality-wide goals	Urban forest renewal ensured through a comprehensive tree establishment program driven by goals such as canopy cover, species diversity, and species distribution

Sustainability criteria	Optimal performance level	Key objective
Tree habitat suitability	All trees planted in sites with adequate soil quality and quantity, and with sufficient growing space and overall site conditions to achieve their genetic potential and thus provide maximum ecosystem services	All publicly owned trees planted in habitats that will maximize current and future benefits provided to the site