

Township of Woolwich

Cost and Labour Efficiency of Different Planting Methods

Version 1 - November, 2022.



The largest roadside tree program in Ontario, since 1890!

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Table of Contents

Experts	2
Contributors	2
Authors	2
Planting Methods Comparison - Executive Summary	5
Planting Methods and Tree Sizes	7
Method 1. Caliper Trees in Wire Basket or Large Containers	7
Method 2. 5G to 7G Containers	9
Method 3. 2G/3G Containers (Floradale Road)	10
Method 4. Plugs/Bare Root Seedlings	12
Survivorship And Tree Growth	16
Cost and Labor Comparison	19
References	21
Appendix 1 – Township Road Maps	22
Appendix 2 – Proposed 2023 Road Installations	23

Table of Tables

<i>Table 1 Itemized cost comparison</i>	19
<i>Table 2 Labor Requirements and Crew Output</i>	19

Table of Figures

<i>Figure 1 Total Project Cost Comparison of Four Different Planting Methods</i>	6
<i>Figure 2 Project Duration in Years of Four Different Planting Methods</i>	6
<i>Figure 3 Left hand image. Installing Calliper Tree in Wire Basket into hand dug hole. May 2021</i>	8
<i>Figure 4 Right hand image. 25G container stock. Johnson’s Nursery</i>	8
<i>Figure 5 Installing 7G tree. (Tree Atlanta Tree Planting)</i>	9
<i>Figure 6 Installing 2 Gallon and 3 Gallon Trees Along Floradale Road, Elmira, ON. October 2022</i>	10
<i>Figure 7 3G container tree with machine dug hole, and hand backfilled tree. Elmira Nature Reserve, June 2021.</i> ...	11
<i>Figure 8 Left Hand Photo. Pottiputki tree planting device</i>	12
<i>Figure 9 Right Hand Photo. Transplant shovel and forestry planting bag</i>	12
<i>Figure 10 TFW Planting Crew showing all required equipment and materials. Elmira, ON. November 2022</i>	13
<i>Figure 11 Stripping vegetation using brush trimmer. Elmira ON. November 2022</i>	14
<i>Figure 12 Planting plug using Pottiputki. Elmira, ON. November 2022</i>	14
<i>Figure 13 Installing coco fibre mat. Elmira ON. November 2022</i>	15
<i>Figure 14 Installing fiberglass stake and tree shelter. Elmira, ON. November 2022</i>	15
<i>Figure 15 American sycamore seedlings after 6 months growth. Elmira Nature Reserve, October 2022.</i>	17
<i>Figure 16 Tree heights after 5 years of bare root versus container stock</i>	18
<i>Figure 17 Installation Cost / Tree</i>	20
<i>Figure 18 Estimated trees planted annually</i>	20

Planting Methods Comparison - Executive Summary

Trees for Woolwich plans to plant 21,570 trees along the Township's 335km of rural roads¹ (Cowan, 2022). These trees will form a highly visible "park" which will be enjoyed by residents daily, provide stormwater management and a habitat corridor network throughout the township.

Despite the many benefits, there are, however significant risks both technically and politically – it is no accident that the last significant roadside tree program in Ontario ended in the 1880s (Schwan, 2022). TFW completed four pilot installations during 2022 to quantify some of these risks, and test different installation methods.

Pilot projects were completed on Lerch Road (59 trees), Kramp Road (120 trees), Floradale Road (205 trees) and a Regional Road (89 trees) with a total of 473 trees planted. These installations provided data on installation costs, labor, and watering requirements. We can now better evaluate the effectiveness of four different installation methods. We also conducted a literature review to predict both survivorship and size of trees after 5 years, and determine the most cost-effective approach.

TFW recommendation is that we use Plug/Seedlings size trees for all locations, using only early spring and late fall planting windows to minimize or eliminate watering. Survival for Plug/Seedlings is predicted to be 70% to 85% (ArborGen, 2022) which is the same as 2G/3G and 7G container trees, and better than caliper size trees currently being installed by the Region and Township of Woolwich (reference). The project budget for Plug/Seedlings is estimated at \$306,000 compared to \$8,500,000 for caliper trees.

TFW proposes to install approximately 3000 trees in spring, and 3000 trees in fall of 2023. This would correspond to approximately 70km of road. A proposed list of road segments to be planted is found in Appendix 2 – Proposed 2023 Road Installations

¹ There are 335km of rural roads within the township – 215 operated by Township of Woolwich, and 120km operated by Regional Municipality of Waterloo.

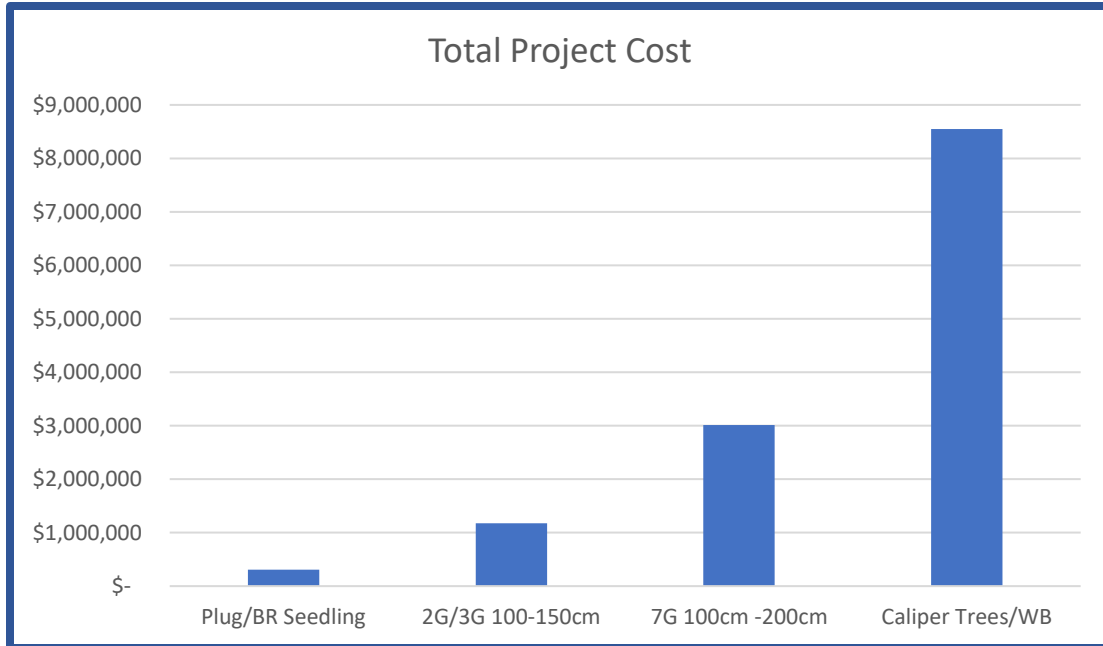


Figure 1 Total Project Cost Comparison of Four Different Planting Methods

Time to complete the project, using a fixed crew size of 3, and 8 crew weeks/season is 3.1 years, compared to 2G/3G project duration of 22 years, and caliper tree project duration of 78 years.

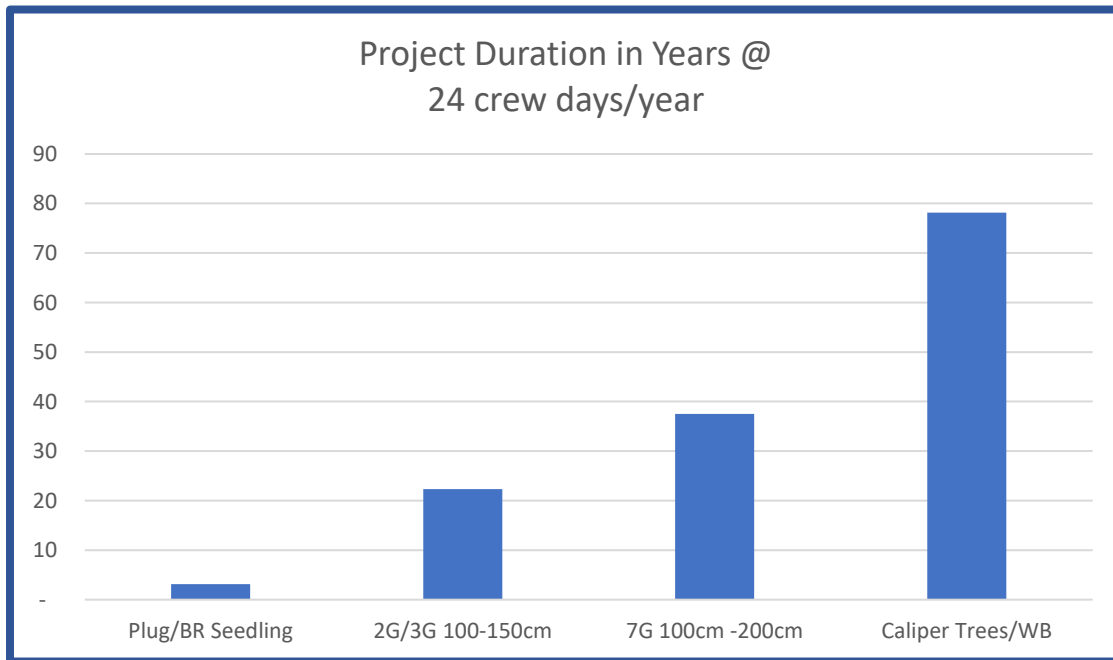


Figure 2 Project Duration in Years of Four Different Planting Methods

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Planting Methods and Tree Sizes

Method 1. Caliper Trees in Wire Basket or Large Containers

The traditional approach to planting roadside trees in rural settings is based on urban tree standards (Township of Woolwich, 2022). Specific rural tree planting specifications do not exist or are identical to urban tree specifications (Region reference)(Township of Woolwich, 2022). However, soil conditions in rural areas are significantly different than urban roadsides, typically with uncompacted soil and little or no imported soil. TFW hypothesis is that rural roadside conditions are more similar to reforestation conditions, and less similar to urban boulevard planting.

Urban tree specifications typically require 40mm to 60mm trees and a metal or wood support stake. This size of trees requires a planting hole 1200-1500mm in diameter and comes in either Wire Basket (WB) weighing 100 to 200kg, or 10 Gallon to 20 Gallon Container (10G to 20G) weighing 40 to 80kg. Typically, this size hole would be machine dug, and manually placed and backfilled. However, for rural roadside trees machine access is often either not possible or effective, meaning that many of the holes would have to be hand dug.

Caliper trees have an installation cost of \$350 to \$450 (reference), and require 8 to 12 watering events in the first 2 years after installation(Kuzek, 2022) and 40 to 60 litres per watering (North Dakota State University, 2021). Failure rate of caliper trees is higher than the other methods, primarily due to failure to water, and increased watering requirements



Figure 3 Left hand image. Installing Calliper Tree in Wire Basket into hand dug hole. May 2021

Figure 4 Right hand image. 25G container stock. Johnson's Nursery

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Method 2. 5G to 7G Containers



Figure 5 Installing 7G tree. (Tree Atlanta Tree Planting)

5G to 7G container tree requirements are similar to Wire Basket trees discussed above. Hand digging holes and handling the containers is much more feasible, and watering requirements are reduced as there is less root volume to keep moist. These size trees typically require watering 5-7 times per year, and need 20 litres per watering (Kuzek, 2022).

Method 3. 2G/3G Containers (Floradale Road)



Figure 6 Installing 2 Gallon and 3 Gallon Trees Along Floradale Road, Elmira, ON. October 2022

TFW installation team planted 205 trees along Floradale Road in October 2022. The trees were planted over 5 working days using a crew of 2.5 on average. Our peak installation rate was 40 trees per day. The equipment required included:

- 6m trailer
- 2 totes
- Brush trimmer and soil cultivator
- Tree shelters
- 4 seater UTV, used to carry trees, mulch, and water tote
- Heavy duty pickup truck, to carry 1000kg of water and tow trailer

While we achieved a maximum Installation rate peaked 40 trees/day, we believe that further optimization could result in improving the rate to 45 trees/day.

These size trees typically require watering 4-5 times per year, and need 10 litres per watering (Kuzek, 2022)



Figure 7 3G container tree with machine dug hole, and hand backfilled tree. Elmira Nature Reserve, June 2021.

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Method 4. Plugs/Bare Root Seedlings

TFW installation team planted and installed, staked and placed shelters on 90 trees in 3.0 hours in November 2022. Because we only had one day to optimize production, we believe that further improvements are possible to a rate of 300 trees/day with a 3-person crew.

Depending on soil conditions and plug type, we used either a Pottiputki or transplant shovel. Trees and hardware were stored in a forestry planting bag.



Figure 8 Left Hand Photo. Pottiputki tree planting device



Figure 9 Right Hand Photo. Transplant shovel and forestry planting bag

We soaked the plugs before installation, and carried the plugs in a waterproof bag with wet mulch. Because of cooler fall temperatures, and reduced evapotranspiration, no watering is planned for fall or spring. One or two watering may be required based on soil conditions in the 2 years after planting.

Equipment requirements are significantly reduced compared to all other methods. Seedlings, shovels, coco disk mats, shelters, and stakes all fit into a pickup truck. No trailer, excavation equipment or UTV is required.



Figure 10 TFW Planting Crew showing all required equipment and materials. Elmira, ON. November 2022

Plug planting requires 4 steps (Figure 11 to Figure 14): stripping vegetation using a brush trimmer, planting the plug using a Pottiputki or transplant shovel, installing coco fiber matt, and stake and tree shelter.

Trees will typically not be watered at time of planting (early spring or late fall). Plug/bare root size trees in forestry plantings do not receive watering, as they are used where access with water and equipment is not possible. Survivorship is increased however if the site encounters a hot dry spell. We therefore are planning 2 watering events per tree, during the worst conditions over the 2 years after planting.



Figure 11 Stripping vegetation using brush trimmer. Elmira ON. November 2022



Figure 12 Planting plug using Pottiputki. Elmira, ON. November 2022

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Figure 13 Installing coco fibre mat. Elmira ON. November 2022



Figure 14 Installing fiberglass stake and tree shelter. Elmira, ON. November 2022

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Survivorship And Tree Growth

Our estimates for survival and growth are based on both a literature survey, and current TFW members' experience in planting and caring for more than 10,000 trees of all four sizes. We were unable to find a direct survivorship comparison for our tree planting sizes, in conditions similar to rural roadside trees. Therefore, we will be relying on studies with analogous conditions, forestry advisors to TFW, and our own experience with each tree size.

Anecdotally, our experience with the three smallest sizes of trees has been similar, with survival rates between 50% and 90%, and averaging approximately 75%. Survival of the largest tree size, Caliper Tree/Wire Basket, has been lower than 75%, watering requirements have been much higher, and purchase and installation costs much higher. This corresponds to the consensus in arboriculture research, that survival and tree health is inversely related to tree planting size (Gilman & Miesbauer, 2013)(Watson, 2005)

TFW planted all 4 sizes of trees at the Elmira Nature Reserve. The larger caliper trees survival was approximately 90%, but at a high cost for transplanting, and heavy labor cost for watering. On the other hand, seedlings planted at a cost of less than \$3 / each have a similar survival rate, and in some cases have grown from a 40 cm tall "stick" with no branches, to more than 2m in one season, without any supplemental water (see Figure 15).



Figure 15 American sycamore seedlings after 6 months growth. Elmira Nature Reserve, October 2022.

Forestry professionals assert that vegetation management (herbicide) is the differentiating factor between successful and unsuccessful plantings (Nicholson, 2006), not size. In which case planting the minimum possible size tree, and spraying, would optimize project resources. Survival rates in some contexts can be increased by up to 50%, and growth rates increased by 80% for many North American hardwoods by introducing 3 years of weed control. Because of restrictions on the use of pesticides in Ontario, we are controlling weeds immediately around each tree using coco fibre mats.

The most direct comparison we are aware of between container planted stock and plug/seedlings is by North Carolina Cooperative Extension. They found a survivorship of 43% for bareroot, and 73% for 1G container stock (Hall, 2011). Sizes of trees after 5 years were almost identical (see Figure 16).

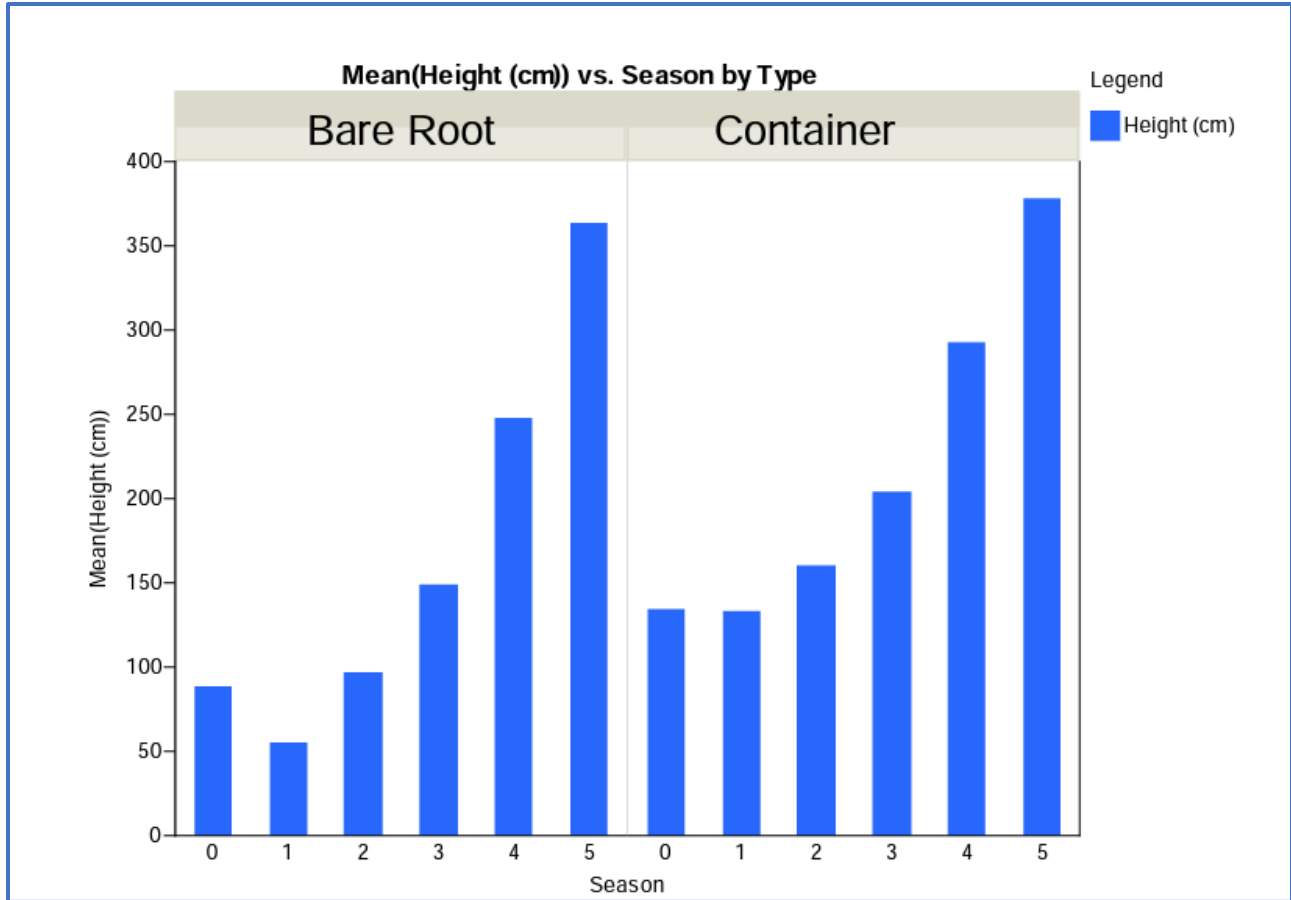


Figure 16 Tree heights after 5 years of bare root versus container stock.

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Cost and Labor Comparison

Based on our experience with the four different approaches, we have assembled materials and labor estimates for each. The crew output/year assumes funding for 24 crew-days for a 3-person crew. The number of watering events for each method varies from 2 for Plug/BR to 10 for Caliper Trees.

Table 1 Itemized cost comparison

Roadside Tree Cost Comparison				
Reference Site	Regional Road	Floradale Rd North	Lerch Rd	Region of Waterloo
Description	Plug/BR Seedling	2G/3G 100-150cm	7G 100cm - 200cm	Caliper Trees/WB
Tree	\$ 2.75	\$ 19.50	\$ 68.00	\$ 205.00
Tree Tube. 3' Plantra	\$ 2.75	\$ 2.75	\$ 2.75	\$ 2.75
Stakes	\$ 1.07	\$ 1.07	\$ 1.07	\$ 8.00
Tie Wraps	\$ 0.30	\$ 0.30	\$ 0.30	\$ 0.30
Install labor@\$28/hr	\$ 2.24	\$ 16.00	\$ 26.88	\$ 56.00
Water costs @28/hr	\$ 2.37	\$ 6.72	\$ 10.08	\$ 50.40
Shipping (prorated)	\$ 1.10	\$ 2.10	\$ 15.00	\$ 30.00
Contingency (8%)	\$ 1.04	\$ 3.84	\$ 9.92	\$ 27.36
Total	\$ 14	\$ 52	\$ 134	\$ 380

Table 2 Labor Requirements and Crew Output

Performance Standards				
Description	Plug/BR Seedling	2G/3G 100-150cm	7G 100cm - 200cm	Caliper Trees/WB
Trees/3man crew/day	300	42	25	12
Watering Events. 2 yrs	2	4	6	10
Trees Planted / Season	7,200	1,008	600	288
Total Cost of Project	\$ 306,490	\$ 1,176,300	\$ 3,015,000	\$ 8,545,725
Project Duration Years	3	22	38	78
(Assuming 24 crew-days and 3-person crew)				

From these performance standards we derive the average cost per tree, and the number of trees that can be planted per year. Plug/Bare Root approach has a significant cost advantage over the other methods. In addition, it could be completed during the “working life” of the current TFW and Township staff, allowing greater project control, and ensuring that the project will not be forgotten or shelved.

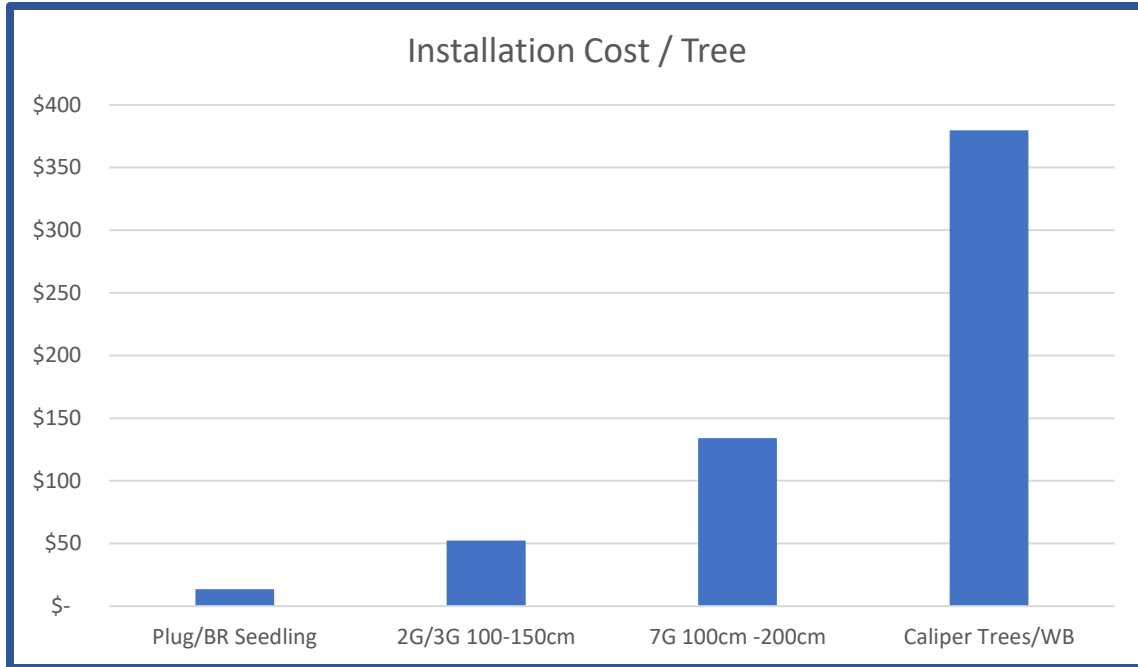


Figure 17 Installation Cost / Tree

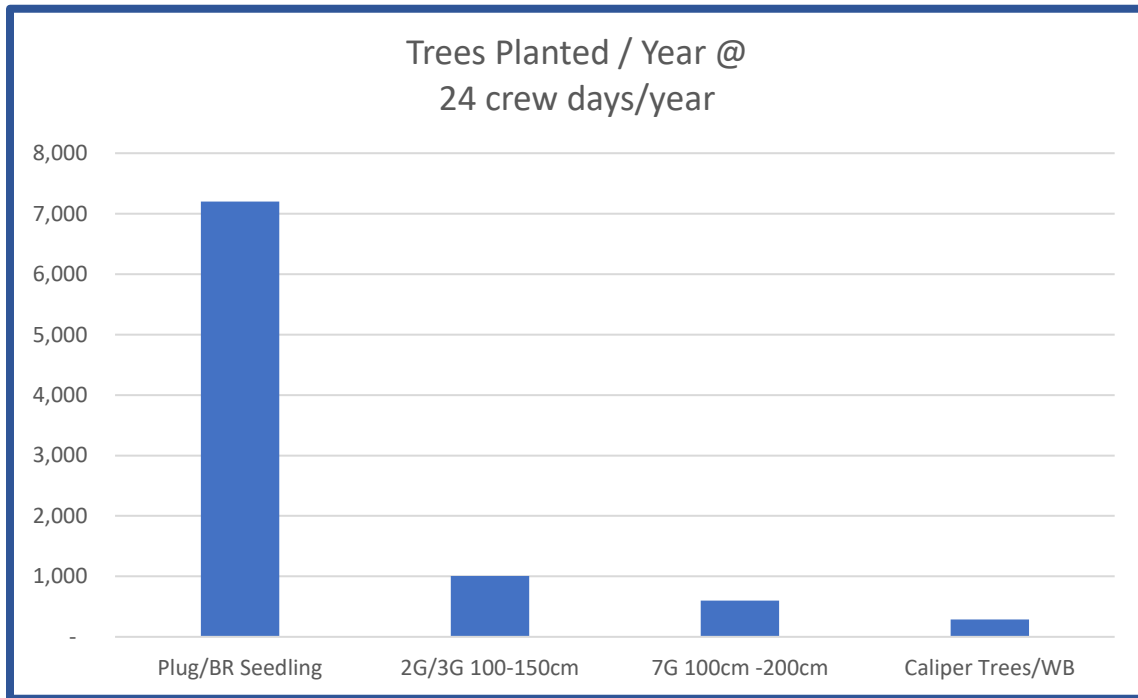


Figure 18 Estimated trees planted annually

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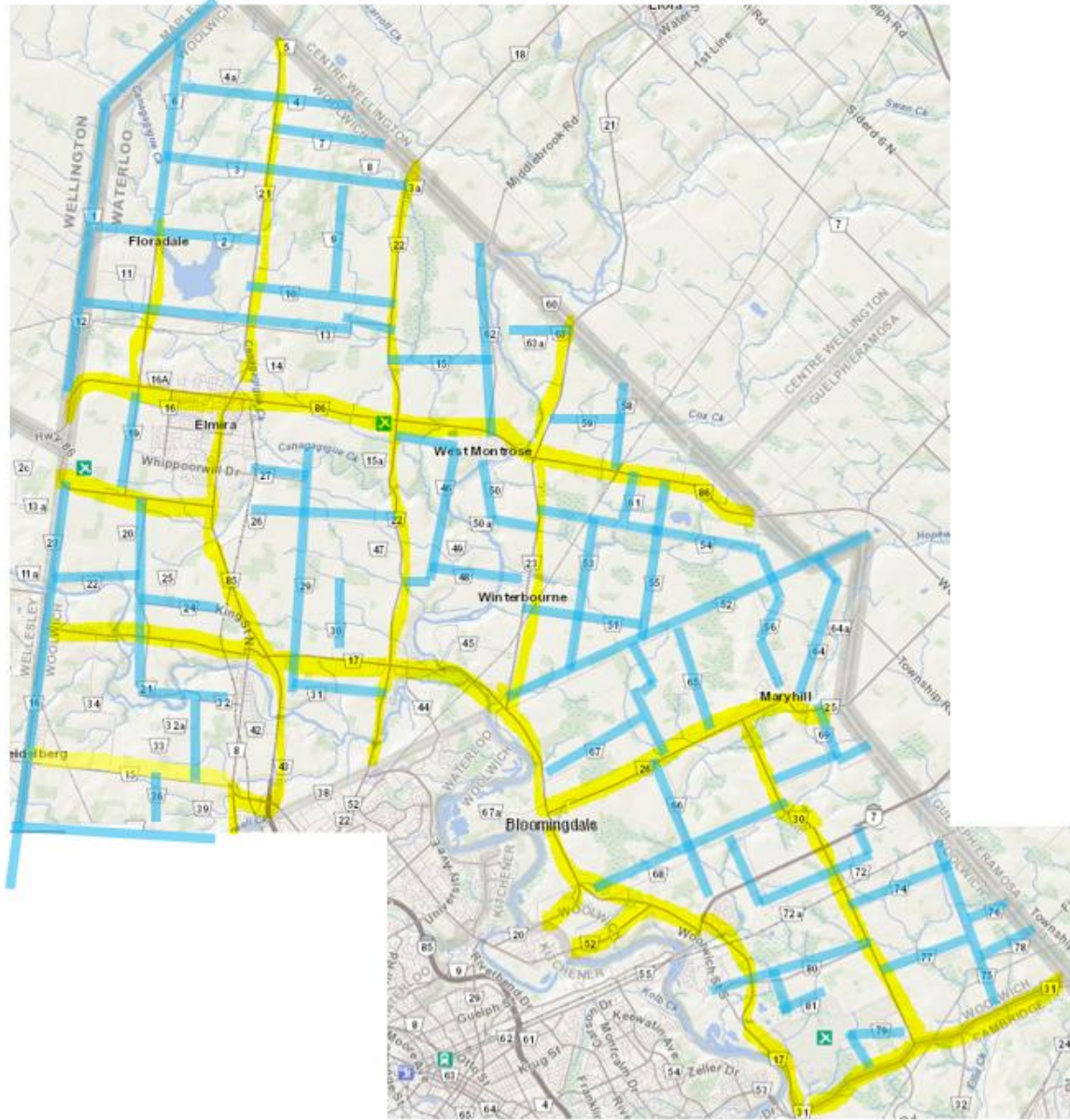
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Appendix 1 – Township Road Maps

Regional – 120 km approx. ignoring built up areas

Township – 215 km approx. ignoring built up areas



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Appendix 2 – Proposed 2023 Road Installations