

URBAN TREE CANOPY ASSESSMENT METHODOLOGY

Davey Resource Group Classification Methodology for Urban Tree Canopy

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

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

ual editing, quality checking, and quality assurance processes (QA/QC). The manual QA/QC process was implemented to identify, define, and correct any misclassifications or omission errors in the final land cover layer.

CLASSIFICATION WORKFLOW

1. Prepare imagery for feature extraction (re-sampling, rectification, etc.), if needed.
2. Gather training set data for all desired land cover classes (canopy, impervious, grass, bare soil, shadows). Water samples are not always needed since hydrologic data are available for most areas. Training data for impervious features were not collected because the City maintained a completed impervious layer.
3. Extract canopy layer only; this decreases the amount of shadow removal from large tree canopy shadows. Fill small holes and smooth to remove rigid edges.
4. Edit and finalize canopy layer at 1:2000 scale. A point file is created to digitize-in small individual trees that will be missed during the extraction. These points are buffered to represent the tree canopy. This process is done to speed up editing time and improve accuracy by including smaller individual trees.

5. Extract remaining land cover classes using the canopy layer as a mask; this keeps canopy shadows that occur within groups of canopy while decreasing the amount of shadow along edges.
6. Edit the impervious layer to reflect actual impervious features, such as roads, buildings, parking lots, etc. to update features.
7. Using canopy and actual impervious surfaces as a mask; input the bare soils training data and extract them from the imagery. Quickly edit the layer to remove or add any features. Davey Resource Group tries to delete dry vegetation areas that are associated with lawns, grass/meadows, and agricultural fields.
8. Assemble any hydrological datasets, if provided. Add or remove any water features to create the hydrology class. Perform a feature extraction if no water feature datasets exist.
9. Use geoprocessing tools to clean, repair, and clip all edited land cover layers to remove any self-intersections or topology errors that sometimes occur during editing.
10. Input canopy, impervious, bare soil, and hydrology layers into Davey Resource Group's Five-Class Land Cover Model to complete the classification. This model generates the pervious (grass/low-lying vegetation) class by taking all other areas not previously classified and combining them.
11. Thoroughly inspect final land cover dataset for any classification errors and correct as needed.
12. Perform accuracy assessment. Repeat Step 11, if needed.

AUTOMATED FEATURE EXTRACTION FILES

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

1. Davey Resource Group fills all holes in the canopy that are less than 30 square meters. This eliminates small gaps that were created during the extraction process while still allowing for natural canopy gaps.
2. Davey Resource Group deletes all features that are less than 9 square meters for canopy (50 square meters for impervious surfaces). This process reduces the amount of small features that could result in incorrect classifications and also helps computer performance.
3. The Repair Geometry, Dissolve, and Multipart to Singlepart (in that order) geoprocessing tools are run to complete the extraction process.
4. The Multipart to Singlepart shapefile is given to GIS personnel for manual editing to add, remove, or reshape features.

Urban Tree Canopy Accuracy Assessment Protocol

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

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

Table 1. Land Cover Classification Code Values

Land Cover Classification	Code Value
Tree Canopy	1
Impervious	2
Pervious (Grass/Vegetation)	3
Bare Soil	4
Open Water	5

LAND COVER ACCURACY

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

1. *Random Point Generation*—Using ArcGIS, 1000 random assessment points are generated.
2. *Point Determination*—Each point is carefully assessed by the GIS analyst for likeness with the aerial photography. To record findings, two new fields, CODE and TRUTH, are added to the accuracy assessment point shapefile. CODE is a numeric value (1–5) assigned to each land cover class (Table 1) and TRUTH is the actual land cover class as identified according to the reference image. If CODE and TRUTH are the same, then the point is counted as a correct classification. Likewise, if the CODE and TRUTH are not the same, then the point is classified as incorrect. In most cases, distinguishing if a point is correct or incorrect is straightforward. Points will rarely be misclassified by an egregious classification or editing error. Often incorrect points occur where one feature stops and the other begins.
3. *Classification Matrix*—During the accuracy assessment, if a point is considered incorrect, it is given the correct classification in the TRUTH column. Points are first assessed on the NAIP imagery for their correctness using a “blind” assessment—meaning that the analyst does not know the actual classification (the GIS analyst is strictly going off the NAIP imagery to determine cover class). Any incorrect classifications found during the “blind” assessment are scrutinized further using sub-meter imagery provided by the client to determine if the point was incorrectly classified due to the fuzziness of the NAIP

Table 2. Classification Matrix

Reference Data	Classes	Tree Canopy	Impervious Surfaces	Grass & Low-Lying Vegetation	Bare Soils	Open Water	Row Total	Producer's Accuracy	Errors of Omission
	Tree Canopy	153	10	2	0	0	165	92.73%	7.27%
	Impervious	7	752	5	3	0	767	98.04%	1.96%
	Grass/Vegetation	0	8	37	0	0	45	82.22%	17.78%
	Bare Soils	0	0	0	6	0	6	100.00%	0.00%
	Water	0	0	0	0	17	17	100.00%	0.00%
	Column Total	160	770	44	9	17	1000		
	User's Accuracy	95.63%	97.66%	84.09%	66.67%	100.00%		Overall Accuracy	96.50%
	Errors of Commission	4.38%	2.34%	15.91%	33.33%	0.00%		Kappa Coefficient	0.9081

imagery or an actual misclassification. After all random points are assessed and recorded; a classification (or confusion) matrix is created. The classification matrix for this project is presented in **Table 2**. The table allows for assessment of user's/producer's accuracy, overall accuracy, omission/commission errors, kappa statistics, allocation/quantity disagreement, and confidence intervals (**Table 3**).

- Following are descriptions of each statistic as well as the results from some of the accuracy assessment tests.

Overall Accuracy – Percentage of correctly classified pixels; for example, the sum of the diagonals divided by the total points $((153+752+37+6+17)/1000 = 96.50\%)$.

User's Accuracy – Probability that a pixel classified on the map actually represents that category on the ground (correct land cover classifications divided by the column total $[153/160 = 95.63\%]$).

Producer's Accuracy – Probability of a reference pixel being correctly classified (correct land cover classifications divided by the row total $[153/165 = 92.73\%]$).

Kappa Coefficient – A statistical metric used to assess the accuracy of classification data. It has been generally accepted as a better determinant of accuracy partly because it accounts for random chance agreement. A value of 0.80 or greater is regarded as “very good” agreement between the land cover classification and reference image.

Errors of Commission – A pixel reports the presence of a feature (such as trees) that, in reality, is absent (no trees are actually present). This is termed as a false positive. In the matrix below, we can determine that 4.38% of the area classified as canopy is most likely not canopy.

Errors of Omission – A pixel reports the absence of a feature (such as trees) when, in reality, they are actually there. In the matrix below, we can conclude that 7.27% of all canopy classified is actually classified as another land cover class.

Allocation Disagreement – The amount of difference between the reference image and the classified land cover map that is due to less than optimal match in the spatial allocation (or position) of the classes.

Quantity Disagreement – The amount of difference between the reference image and the classified land cover map that is due to less than perfect match in the proportions (or area) of the classes.

Confidence Intervals – A confidence interval is a type of interval estimate of a population parameter and is used to indicate the reliability of an estimate. Confidence intervals consist of a range of values (interval) that act as good estimates of the unknown population parameter based on the observed probability of successes and failures. Since all assessments have innate error, defining a lower and upper bound estimate is essential.

Table 3. Accuracy of Results

Confidence Intervals

Class	Acreage	Percentage	Lower Bound	Upper Bound
Tree Canopy	394.6	14.6%	13.9%	15.3%
Impervious Surfaces	2,098.5	77.6%	76.8%	78.4%
Grass & Low-Lying Vegetation	139.9	5.2%	4.7%	5.6%
Bare Soils	12.2	0.5%	0.3%	0.6%
Open Water	58.0	2.1%	1.9%	2.4%
Total	2703.2	100.00%		

Accuracy Assessment

Class	User's Accuracy	Lower Bound	Upper Bound	Producer's Accuracy	Lower Bound	Upper Bound
Tree Canopy	95.6%	94.0%	97.2%	92.7%	90.7%	94.7%
Impervious Surfaces	97.7%	97.1%	98.2%	98.0%	97.5%	98.5%
Grass & Low-Lying Vegetation	84.1%	78.6%	89.6%	82.2%	76.5%	87.9%
Bare Soils	66.7%	51.0%	82.4%	100.0%	100.0%	100.0%
Open Water	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Statistical Metrics Summary

Overall Accuracy =	96.5%
Kappa Coefficient =	0.9081
Allocation Disagreement =	5%
Quantity Disagreement =	1%

Urban Tree Canopy Ecosystem Benefits Calculations

AIR QUALITY

The i-Tree Canopy v6.1 Model was used to quantify the value of ecosystem services for air quality. i-Tree Canopy was designed to give users the ability to estimate tree canopy and other land cover types within any selected geography. The model uses the estimated canopy percentage and reports air pollutant removal rates and monetary values for carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), sulfur dioxide (SO₂), and particulate matter (PM) (Hirabayashi 2014).

Within the i-Tree Canopy application, the U.S. EPA's BenMAP Model estimates the incidence of adverse health effects and monetary values resulting from changes in air pollutants (Hirabayashi 2014; US EPA 2012). Different pollutant removal values were used for urban and rural areas. In i-Tree Canopy, the air pollutant amount removed annually by trees and the associated monetary value can be calculated with tree cover in areas of interest using BenMAP multipliers for each county in the United States.

To calculate ecosystem services for the study area, canopy percentage metrics from UTC land cover data performed during the assessment were transferred to i-Tree Canopy. Those canopy percentages were matched by placing random points within the i-Tree Canopy application. Benefit values were reported for each of the five listed air pollutants.

CARBON STORAGE AND SEQUESTRATION

The i-Tree Canopy v6.1 Model was used to quantify the value of ecosystem services for carbon storage and sequestration. i-Tree Canopy

was designed to give users the ability to estimate tree canopy and other land cover types within any selected geography. The model uses the estimated canopy percentage and reports carbon storage and sequestration rates and monetary values. Methods on deriving storage and sequestration can be found in Nowak et al. 2013.

To calculate ecosystem services for the study area, canopy percentage metrics from UTC land cover data performed during the assessment were transferred to i-Tree Canopy. Those canopy percentages were matched by placing random points within the i-Tree Canopy application. Benefit values were reported for carbon storage and sequestration.

STORMWATER

The i-Tree Hydro v6.0 Model was used to quantify the value of ecosystem services for stormwater runoff. i-Tree Hydro was designed for users interested in analysis of vegetation and impervious cover effects on urban hydrology. This most recent version (v6.0) allows users to report hydrologic data on the city level rather than just a watershed scale giving users more flexibility. For more information about the model, please consult the i-Tree Hydro v6.0 manual (<http://www.itreetools.org>).

To calculate ecosystem services for the study area (City of Somerville), land cover percentages derived for the project area were used as inputs into the model. Precipitation data from 2005-2012 was modeled within the i-Tree Hydro to best represent the average conditions over an eight year time period. Model simulations were run under a Base Case as well as an Alternate Case. The Alternative Case set tree canopy equal to 0% and assumed that impervious and vegetation cover would increase based on the removal of tree canopy. Impervious surface was increased 0.7% based on a percentage of the amount of impervious surface under tree canopy and the rest was added to the vegetation cover class. This process was completed to assess the

runoff reduction volume associated with tree canopy since i-Tree Hydro does not directly report the volume of runoff reduced by tree canopy. The volume (in cubic meters) was converted to gallons to retrieve the overall volume of runoff avoided by having the current tree canopy.

Through model simulation, it was determined that tree canopy decreases the runoff volume in the project area by 4,361,443 gallons per year using precipitation data from 2005-2012. This equates to approximately 11,052 gallons per acre of tree canopy (4,361,443 gals/11,052 acres).

To place a monetary value on storm water reduction, the cost to treat a gallon of storm/waste water was taken from McPherson et al. 1999. This value was \$0.04 per gallon. Tree canopy was estimated to contribute roughly \$174,458 to avoided runoff annually to the project area.

Zoning Classifications

To assess tree canopy coverage in different zoning types, the eighteen zoning types in the 2019 Somerville Zoning Ordinance (<https://www.somervillezoning.com/>) were condensed into six broader categories as shown in **Table 4**.

Table 4. Zoning Classifications

Zoning Classification from Zoning Code	Zoning Classification for Urban Forest Management Plan
Assembly Square	Other Special Districts
Civic	Civic Special Districts
Commercial Business	Commercial Districts
Commercial Core 3	Commercial Districts
Commercial Core 4	Commercial Districts
Commercial Core 5	Commercial Districts
Commercial Industry	Commercial Districts
Fabrication	Commercial Districts
High Rise	Mid & High-Rise Districts
Mid Rise 3	Mid & High-Rise Districts
Mid Rise 4	Mid & High-Rise Districts
Mid Rise 5	Mid & High-Rise Districts
Mid Rise 6	Mid & High-Rise Districts
Neighborhood Residential	Residential Districts
not applicable	Rights-Of-Way (ROW)
Powderhouse School	Other Special Districts
Tufts University	Other Special Districts
Urban Residential	Residential Districts

Prioritized Planting Locations based on Tree Canopy Data

The following methodology was used to identify and prioritize planting locations throughout the City of Somerville as part of the Tree Planting Plan (*Section 3.1*).

PRIORITIZED PLANTING - PLANTING LOCATION

A geographic information system (GIS) based planting prioritization scheme was created as part of the urban tree canopy analysis. The planting location polygons (representations) were created by taking all grass/open space and bare ground areas and combining them into one dataset. Non-feasible planting areas such as agricultural fields, recreational fields, and major utility corridors were removed from consideration. The remaining planting space was then converted to multipart features creating separate, distinct polygons for each location. Using zonal statistics, the priority grid raster was used to calculate an average value for each planting location polygon. The averages were binned into five (5) classes (Very Low, Low, Moderate, High, and Very High) with the higher numbers indicating higher priority for planting.

HOW SITES WERE PRIORITIZED

To identify and prioritize planting potential, the analysis assessed a number of environmental and demographic data, including proximity to hardscape, canopy fragmentation, floodplain proximity, soil permeability, slope, soil erosion factor (K-factor), urban heat island index, and proximity to bus routes and bike lanes (**Table 5**). In addition, planting potential was prioritized in Environmental Justice areas (which include parameters of income, minority populations and English language isolation) and where there are vulnerable populations (elderly housing, schools, child care and medical centers) (**Table 5**). Each factor was assessed using data from various sources and analyzed using separate grid maps. Values between zero and four (with zero having the lowest priority) were assigned to each grid assessed. The grids were overlaid and the values were averaged to determine the priority levels at an area on the map. A priority level ranging from Very Low to Very High was assigned to each area on the map based on the calculated average of all grid maps. Once the process of identifying priority was completed, the development of planting strategies followed. All potential planting sites were not treated equally as some sites were considered to be more suitable than others. Through prioritization, sites were ranked based on a number of factors pertaining to storm water

Table 5: Priority Ranking Variables

Dataset	Source	Weight
Urban Heat Island Index	Urban Tree Canopy Assessment	0.20
Proximity to Hardscape	Urban Tree Canopy Assessment	0.15
Floodplain Proximity	National Hydrologic Dataset	0.10
Soil Permeability	Natural Resource Conservation Service	0.10
Slope	National Elevation Dataset	0.10
Soil Erosion (K-factor)	Natural Resource Conservation Service	0.05
Canopy Fragmentation	Urban Tree Canopy Assessment	0.15
Equity	Massachusetts GIS Dataset	0.05
Vulnerable Population	Somerville GIS Dataset	0.05
Bus Routes and Bike Lanes	Somerville GIS Dataset	0.05

reduction and a relative urban heat island index. While available planting sites may ultimately be planted over the next several decades, the trees that are planted in the next several years should be planned for areas in most need, and where they will provide the most benefits and return on investment.

References

- Hirabayashi, S. 2014. i-Tree Canopy Air Pollutant Removal and Monetary Value Model Descriptions. https://www.itreetools.org/documents/560/i-Tree_Canopy_Air_Pollutant_Removal_and_Monetary_Value_Model_Descriptions.pdf [Accessed 11 February 2019]
- i-Tree Canopy v6.1. i-Tree Software Suite. [Accessed 11 February 2019] <http://www.itreetools.org/canopy>
- i-Tree Hydro v6.0. i-Tree Software Suite. <http://www.itreetools.org/hydro/index.php>. [Accessed 11 February 2019]
- McPherson, E.G., Simpson, J.R., Peper, P.J., Xiao, Q. 1999. Tree Guidelines for San Joaquin Valley Communities. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research.
- Nowak, D.J., Greenfield, E.J., Hoehn, R.E., Lapoint, E. 2013. Carbon storage and sequestration by trees in urban and community areas of the United States. *Environmental Pollution* 178: 229-236.
- U.S. Environmental Protection Agency (US EPA). 2012. Environmental Benefits Mapping and Analysis Program (BenMAP). <http://www.epa.gov/air/benmap> [Accessed 11 February 2019]
- U.S. Forest Service. 2012. STRATUM Climate Zones. <http://www.fs.fed.us/psw/programs/uesd/uep/stratum.shtml>. [Accessed 11 February 2019]

I-TREE STREETS INPUTS AND REPORTS

i-Tree Streets Inputs

The i-Tree Streets model (<https://www.itreetools.org/tools/i-tree-streets>) uses specific inputs to calculate the ecosystem service benefits of trees. If no community-specific information is available, then the model uses a set of standard values based on the region the city is located. The following default regional economic inputs were used to run Somerville's i-Tree Streets model:

Benefit Prices	
Electricity (\$/Kwh)	0.1401
Natural Gas (\$/Therm)	1.408
CO2 (\$/lb)	0.0033
PM10 (\$/lb)	8.31
NO2 (\$/lb)	4.59
SO2 (\$/lb)	3.48
VOC (\$/lb)	2.31
Stormwater Interception (\$/gallon)	0.008
Average Home Resales Value (\$)	291,000.00

i-Tree Streets Reports

The following i-Tree Streets reports were generated as part of Somerville's inventory analysis.

Annual Benefits of Public Trees by Species (\$/tree)

7/29/2020

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error
maple, Norway	53.40	1.49	9.46	10.09	48.49	122.94	(N/A)
pear, callery	36.47	1.21	7.39	8.77	88.80	142.64	(N/A)
maple, red	31.41	0.61	5.09	7.23	46.37	90.70	(N/A)
honeylocust	72.06	1.42	12.49	14.25	65.78	166.01	(N/A)
linden, littleleaf	49.69	0.94	8.27	9.76	30.54	99.19	(N/A)
ash, green	62.87	1.21	11.01	12.58	48.10	135.77	(N/A)
zelkova, Japanese	56.03	1.10	9.01	9.92	77.02	153.08	(N/A)
planetree, London	53.25	1.05	8.48	10.48	44.35	117.62	(N/A)
plum	18.38	0.42	2.86	2.52	11.07	35.25	(N/A)
Japanese tree lilac	10.19	0.20	1.53	1.26	9.25	22.41	(N/A)
cherry, kwanzan	15.64	0.33	2.41	2.06	10.46	30.91	(N/A)
oak, northern red	66.14	1.65	11.66	16.29	46.90	142.64	(N/A)
elm, hybrid	14.96	0.35	2.34	3.20	57.90	78.74	(N/A)
sweetgum	27.27	0.49	3.22	4.81	34.80	70.58	(N/A)
ash, white	48.91	0.93	8.47	9.97	44.71	112.99	(N/A)
oak, pin	34.95	1.01	6.17	8.92	50.42	101.47	(N/A)
Vacant (Do Not Plant)	2.22	0.03	0.38	0.19	4.29	7.11	(N/A)
maple, hedge	19.94	0.46	3.24	3.18	19.81	46.63	(N/A)
elm, american	42.95	1.23	8.46	11.89	74.31	138.84	(N/A)
goldenrain tree	9.59	0.18	1.43	1.18	9.12	21.50	(N/A)
Japanese pagodatree	40.31	0.77	6.65	9.12	46.04	102.89	(N/A)
ginkgo	6.96	0.13	1.07	0.99	10.84	19.99	(N/A)
maple, silver	82.49	1.85	15.86	24.96	44.34	169.50	(N/A)
elm, Siberian	25.83	0.70	4.79	6.77	65.40	103.50	(N/A)
hornbeam, European	14.55	0.29	2.14	3.42	47.09	67.49	(N/A)
maple, freeman	45.69	0.95	7.75	10.36	41.60	106.34	(N/A)
maple, amur	28.22	0.62	4.56	4.30	25.22	62.91	(N/A)
apple	17.90	0.31	2.87	2.73	13.71	37.53	(N/A)
serviceberry	17.35	0.36	2.65	2.24	10.74	33.33	(N/A)
elm, Chinese	15.75	0.38	2.50	3.49	59.73	81.85	(N/A)
cherry, higan	4.13	0.07	0.58	0.48	8.02	13.28	(N/A)
basswood, American	48.92	1.12	8.53	12.32	59.50	130.38	(N/A)
linden, silver	4.93	0.13	0.80	1.18	28.73	35.78	(N/A)
oak, swamp white	14.87	0.34	2.17	2.98	39.43	59.78	(N/A)
sycamore, American	81.81	1.80	13.73	18.94	57.66	173.95	(N/A)
tree-of-heaven	81.75	1.62	15.64	21.87	85.88	206.76	(N/A)
maple, sugar	62.03	1.46	10.46	15.97	54.67	144.60	(N/A)
oak, scarlet	61.77	2.04	11.84	17.84	65.67	159.15	(N/A)
maackia, amur	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)
hornbeam, American	27.03	0.51	4.11	6.09	46.80	84.53	(N/A)
chokecherry, common	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
cherry, yoshino flower	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
serviceberry, downy	12.57	0.25	1.90	1.57	9.74	26.03	(N/A)
serviceberry, Alleghen	2.42	0.04	0.34	0.29	7.50	10.59	(N/A)
oak, shingle	49.05	1.39	8.43	11.31	59.29	129.47	(N/A)
parrotia, persian	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
maple, sycamore	27.11	0.70	4.57	4.72	26.56	63.65	(N/A)
serviceberry, eastern	19.19	0.40	2.93	2.47	11.11	36.09	(N/A)
cedar, northern white	11.04	0.31	2.47	2.05	13.48	29.34	(N/A)
maple: Shangtung	2.22	0.03	0.38	0.19	4.29	7.11	(N/A)
maple, Japanese	16.03	0.34	2.54	2.41	16.53	37.86	(N/A)
katsura tree	21.93	0.41	3.79	5.15	46.35	77.64	(N/A)
hophornbeam, eastern	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)

Annual Benefits of Public Trees by Species (\$/tree)

7/29/2020

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error
tupelo, black	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)
coffeetree, Kentucky	27.24	0.49	3.73	3.45	55.45	90.35	(N/A)
plum, cherry	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
catalpa, northern	64.00	1.18	11.44	16.55	43.04	136.20	(N/A)
unknown tree	13.12	0.25	2.25	4.93	36.11	56.65	(N/A)
pine, eastern white	54.93	0.97	10.69	16.02	18.49	101.10	(N/A)
mulberry, white	28.01	0.54	4.45	6.21	46.63	85.84	(N/A)
baldcypress	19.15	0.27	1.98	1.24	48.86	71.50	(N/A)
elm, slippery	61.31	1.79	12.40	17.26	85.35	178.09	(N/A)
maple, trident	1.22	0.03	0.18	0.26	6.20	7.88	(N/A)
beech, American	111.66	2.34	23.86	38.00	94.02	269.88	(N/A)
oak, English	44.02	0.83	6.55	8.05	39.02	98.47	(N/A)
boxelder	32.20	0.69	5.16	4.83	27.72	70.61	(N/A)
maple, miyabei	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
hardy rubber tree	12.31	0.16	1.09	0.47	44.18	58.22	(N/A)
tulip tree	32.83	0.50	3.77	2.76	58.22	98.07	(N/A)
spruce, Norway	59.35	1.04	11.61	17.12	16.78	105.90	(N/A)
cherry, black	34.39	0.98	5.52	5.31	15.21	61.41	(N/A)
birch, paper	58.24	1.19	9.48	10.04	79.51	158.47	(N/A)
cherry, sargent	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
spruce, Colorado	22.51	0.41	3.95	6.76	24.77	58.41	(N/A)
hawthorn	18.17	0.39	2.77	2.38	10.93	34.64	(N/A)
hackberry, northern	12.31	0.16	1.09	0.47	44.18	58.22	(N/A)
snowbell, Japanese	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)
rose-of-sharon	6.59	0.12	0.96	0.79	8.51	16.97	(N/A)
yew	8.74	0.19	1.46	2.88	42.25	55.52	(N/A)
magnolia, Chinese ; m	8.16	0.15	1.21	0.98	8.82	19.31	(N/A)
juniper spp.	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
viburnum: spp.	4.15	0.09	0.83	0.57	8.39	14.02	(N/A)
birch, river	12.31	0.16	1.09	0.47	44.18	58.22	(N/A)
spruce, white	35.77	0.69	6.72	10.07	24.40	77.65	(N/A)
elm, rock	85.94	2.06	15.34	19.07	94.25	216.67	(N/A)
oak, white	43.35	1.21	7.33	9.96	56.56	118.40	(N/A)
hawthorn: cockspur	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
ash: European	38.43	1.17	9.05	7.61	27.78	84.06	(N/A)
spruce	7.13	0.13	0.98	2.60	23.75	34.60	(N/A)
hemlock, eastern	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
pear, common	19.06	0.62	3.51	4.17	64.49	91.86	(N/A)
maple	16.71	0.36	2.67	2.54	16.96	39.24	(N/A)
dogwood, flowering	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
beech, European	71.88	1.77	12.34	14.50	86.09	186.57	(N/A)
horsechestnut	72.69	2.83	12.60	19.90	82.71	190.73	(N/A)
pine: Japanese red	38.43	1.17	9.05	7.61	27.78	84.06	(N/A)
larch, European	97.63	2.06	18.95	25.98	108.40	253.01	(N/A)
cedar, atlantic white	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
sourwood	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
oak, sawtooth	6.70	0.10	0.89	0.96	31.51	40.16	(N/A)
unknown shrub	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
cherry, cornelian	12.85	0.24	1.94	1.56	9.76	26.36	(N/A)
ash	15.33	0.24	2.29	2.96	35.97	56.78	(N/A)
fringetree, White	27.00	0.45	4.29	3.99	17.97	53.70	(N/A)
hawthorn, Washington	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
Paradise apple	2.42	0.04	0.34	0.29	7.50	10.59	(N/A)
dogwood	12.85	0.24	1.94	1.56	9.76	26.36	(N/A)

Annual Benefits of Public Trees by Species (\$/tree)

7/29/2020

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error
oak	14.24	0.32	2.03	2.81	39.48	58.88	(N/A)
magnolia: cucumbertre	108.34	3.78	32.46	25.48	7.60	177.67	(N/A)
peach	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
mountainash: spp.	15.54	0.43	3.50	3.14	21.12	43.74	(N/A)
corktree, amur	63.59	1.25	10.80	14.07	45.17	134.88	(N/A)
magnolia, sweetbay	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
mulberry: spp.	60.11	1.62	14.83	13.26	27.75	117.57	(N/A)
birch, European white	63.59	1.25	10.80	14.07	45.17	134.88	(N/A)
magnolia, star	25.52	0.55	3.92	3.37	12.46	45.83	(N/A)
redbud, eastern	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
Citywide Total	43.43	1.00	7.54	8.91	50.40	111.29	(N/A)

Somerville

5/23/2019

Stored CO2 Benefits of All Trees by Species

Species			Standard Error	% of Total		
	Total stored CO2 (lbs)	Total (\$)		Tree Numbers	% of Total \$	Avg. \$/tree
maple, Norway	5,248,484.07	17,320.00	(N/A)	14.13	26.75	13.02
pear, callery	1,945,443.88	6,419.96	(N/A)	13.70	9.92	4.98
maple, red	1,124,177.06	3,709.78	(N/A)	11.35	5.73	3.47
honeylocust	2,525,343.15	8,333.63	(N/A)	9.64	12.87	9.19
linden, littleleaf	1,980,023.71	6,534.08	(N/A)	7.03	10.09	9.87
ash, green	1,128,673.21	3,724.62	(N/A)	6.95	5.75	5.70
zelkova, Japanese	667,851.04	2,203.91	(N/A)	5.11	3.40	4.58
planetree, London	660,535.55	2,179.77	(N/A)	4.46	3.37	5.19
plum	361,627.12	1,193.37	(N/A)	3.45	1.84	3.67
Japanese tree lilac	47,736.00	157.53	(N/A)	2.51	0.24	0.67
cherry, kwanzan	137,174.39	452.68	(N/A)	2.16	0.70	2.23
oak, northern red	870,975.13	2,874.22	(N/A)	1.48	4.44	20.68
elm, hybrid	38,486.35	127.00	(N/A)	1.46	0.20	0.93
sweetgum	67,960.01	224.27	(N/A)	1.34	0.35	1.78
ash, white	185,155.77	611.01	(N/A)	1.30	0.94	5.01
oak, pin	322,169.00	1,063.16	(N/A)	1.10	1.64	10.22
maple, hedge	66,986.51	221.06	(N/A)	0.85	0.34	2.76
elm, american	325,120.86	1,072.90	(N/A)	0.80	1.66	14.31
goldenrain tree	10,884.73	35.92	(N/A)	0.68	0.06	0.56
Japanese pagodatree	74,432.48	245.63	(N/A)	0.55	0.38	4.72
ginkgo	5,961.40	19.67	(N/A)	0.52	0.03	0.40
maple, silver	613,624.40	2,024.96	(N/A)	0.49	3.13	44.02
elm, Siberian	87,263.43	287.97	(N/A)	0.49	0.44	6.26
hornbeam, European	11,282.16	37.23	(N/A)	0.45	0.06	0.89
maple, freeman	106,706.79	352.13	(N/A)	0.44	0.54	8.59
maple, amur	32,806.99	108.26	(N/A)	0.34	0.17	3.38
apple	21,210.94	70.00	(N/A)	0.33	0.11	2.26
serviceberry	16,801.47	55.44	(N/A)	0.31	0.09	1.91
elm, Chinese	7,773.81	25.65	(N/A)	0.30	0.04	0.92
cherry, higan	605.41	2.00	(N/A)	0.30	0.00	0.07
basswood, American	103,239.73	340.69	(N/A)	0.28	0.53	13.10
linden, silver	6,587.41	21.74	(N/A)	0.27	0.03	0.87
oak, swamp white	5,728.28	18.90	(N/A)	0.24	0.03	0.82
sycamore, American	105,470.45	348.05	(N/A)	0.24	0.54	15.13
tree-of-heaven	118,269.07	390.29	(N/A)	0.24	0.60	16.97
maple, sugar	129,920.76	428.74	(N/A)	0.22	0.66	20.42
oak, scarlet	138,435.39	456.84	(N/A)	0.18	0.71	26.87
maackia, amur	184.40	0.61	(N/A)	0.13	0.00	0.05
hornbeam, American	6,614.65	21.83	(N/A)	0.12	0.03	1.98

chokecherry, common	108.34	0.36	(N/A)	0.12	0.00	0.03
cherry, yoshino flowering	98.49	0.33	(N/A)	0.11	0.00	0.03
serviceberry, downy	3,046.53	10.05	(N/A)	0.11	0.02	1.01
serviceberry, Allegheny	137.84	0.45	(N/A)	0.11	0.00	0.05
oak, shingle	27,723.08	91.49	(N/A)	0.11	0.14	9.15
parrotia, persian	88.64	0.29	(N/A)	0.10	0.00	0.03
maple, sycamore	13,980.69	46.14	(N/A)	0.10	0.07	5.13
serviceberry, eastern	4,985.97	16.45	(N/A)	0.08	0.03	2.06
cedar, northern white	2,970.36	9.80	(N/A)	0.08	0.02	1.23
maple: Shangtung	21.18	0.07	(N/A)	0.07	0.00	0.01
maple, Japanese	3,570.93	11.78	(N/A)	0.07	0.02	1.68
katsura tree	7,491.19	24.72	(N/A)	0.07	0.04	3.53
hophornbeam, eastern	107.57	0.35	(N/A)	0.07	0.00	0.05
tupelo, black	92.20	0.30	(N/A)	0.06	0.00	0.05
coffeetree, Kentucky	2,243.12	7.40	(N/A)	0.06	0.01	1.23
plum, cherry	59.09	0.20	(N/A)	0.06	0.00	0.03
catalpa, northern	25,896.83	85.46	(N/A)	0.06	0.13	14.24
unknown tree	1,785.29	5.89	(N/A)	0.06	0.01	0.98
pine, eastern white	13,417.37	44.28	(N/A)	0.06	0.07	7.38
mulberry, white	4,775.34	15.76	(N/A)	0.06	0.02	2.63
baldcypress	182.62	0.60	(N/A)	0.06	0.00	0.10
elm, slippery	38,272.48	126.30	(N/A)	0.06	0.20	21.05
maple, trident	84.19	0.28	(N/A)	0.05	0.00	0.06
beech, American	56,112.32	185.17	(N/A)	0.05	0.29	37.03
oak, English	5,123.13	16.91	(N/A)	0.05	0.03	3.38
boxelder	5,503.26	18.16	(N/A)	0.05	0.03	3.63
maple, miyabei	49.24	0.16	(N/A)	0.05	0.00	0.03
hardy rubber tree	15.15	0.05	(N/A)	0.04	0.00	0.01
tulip tree	334.94	1.11	(N/A)	0.04	0.00	0.28
spruce, Norway	9,644.46	31.83	(N/A)	0.04	0.05	7.96
cherry, black	16,071.04	53.03	(N/A)	0.04	0.08	13.26
birch, paper	4,842.15	15.98	(N/A)	0.04	0.02	3.99
cherry, sargent	39.40	0.13	(N/A)	0.04	0.00	0.03
spruce, Colorado	1,078.89	3.56	(N/A)	0.03	0.01	1.19
hawthorn	2,153.50	7.11	(N/A)	0.03	0.01	2.37
hackberry, northern	11.36	0.04	(N/A)	0.03	0.00	0.01
snowbell, Japanese	46.10	0.15	(N/A)	0.03	0.00	0.05
rose-of-sharon	194.36	0.64	(N/A)	0.03	0.00	0.21
yew	363.12	1.20	(N/A)	0.03	0.00	0.40
magnolia, Chinese ; magnoli	184.51	0.61	(N/A)	0.02	0.00	0.30
juniper spp.	143.37	0.47	(N/A)	0.02	0.00	0.24
viburnum: spp.	74.71	0.25	(N/A)	0.02	0.00	0.12
birch, river	7.57	0.02	(N/A)	0.02	0.00	0.01
spruce, white	1,768.57	5.84	(N/A)	0.02	0.01	2.92
elm, rock	8,992.92	29.68	(N/A)	0.02	0.05	14.84
oak, white	4,520.48	14.92	(N/A)	0.02	0.02	7.46
hawthorn: cockspur	143.37	0.47	(N/A)	0.02	0.00	0.24

ash: European	3,724.82	12.29	(N/A)	0.02	0.02	6.15
spruce	106.98	0.35	(N/A)	0.02	0.00	0.18
hemlock, eastern	143.37	0.47	(N/A)	0.02	0.00	0.24
pear, common	1,085.70	3.58	(N/A)	0.02	0.01	1.79
maple	1,117.49	3.69	(N/A)	0.02	0.01	1.84
dogwood, flowering	9.85	0.03	(N/A)	0.01	0.00	0.03
beech, European	2,729.87	9.01	(N/A)	0.01	0.01	9.01
horsechestnut	0.00	0.00	(N/A)	0.01	0.00	0.00
pine: Japanese red	1,862.41	6.15	(N/A)	0.01	0.01	6.15
larch, European	5,203.13	17.17	(N/A)	0.01	0.03	17.17
cedar, atlantic white	71.69	0.24	(N/A)	0.01	0.00	0.24
sourwood	71.69	0.24	(N/A)	0.01	0.00	0.24
oak, sawtooth	10.83	0.04	(N/A)	0.01	0.00	0.04
unknown shrub	71.69	0.24	(N/A)	0.01	0.00	0.24
cherry, cornelian	174.67	0.58	(N/A)	0.01	0.00	0.58
ash	89.37	0.29	(N/A)	0.01	0.00	0.29
fringetree, White	907.91	3.00	(N/A)	0.01	0.00	3.00
hawthorn, Washington	9.85	0.03	(N/A)	0.01	0.00	0.03
Paradise apple	13.78	0.05	(N/A)	0.01	0.00	0.05
dogwood	174.67	0.58	(N/A)	0.01	0.00	0.58
oak	171.55	0.57	(N/A)	0.01	0.00	0.57
magnolia: cucumbertree	14,495.33	47.83	(N/A)	0.01	0.07	47.83
peach	9.85	0.03	(N/A)	0.01	0.00	0.03
mountainash: spp.	477.75	1.58	(N/A)	0.01	0.00	1.58
corktree, amur	2,398.14	7.91	(N/A)	0.01	0.01	7.91
magnolia, sweetbay	9.85	0.03	(N/A)	0.01	0.00	0.03
mulberry: spp.	4,499.23	14.85	(N/A)	0.01	0.02	14.85
birch, European white	2,398.14	7.91	(N/A)	0.01	0.01	7.91
magnolia, star	1,071.83	3.54	(N/A)	0.01	0.01	3.54
redbud, eastern	9.85	0.03	(N/A)	0.01	0.00	0.03
Citywide total	19,619,708.03	64,745.04	(N/A)	100.00	100.00	6.88

Stored CO2 Benefits of All Trees by Zone

Zone	Total stored CO2		Standard Error	% of Total		Avg. \$/tree
	(lbs)	Total (\$)		Tree Numbers	% of Total \$	
Somerville, MA	19,619,708.03	64,745.04	(N/A)	100.00	100.00	6.88
Citywide total	19,619,708.03	64,745.04	(N/A)	100.00	100.00	6.88

Somerville

Replacement Value of Public Trees

7/29/2020

Species	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total Standard Error	% of Total
maple, Norway	538	7,780	562,687	1,580,961	969,318	628,216	181,925	52,425	20,675	4,004,524 (±0)	17.05
honeylocust	2,366	62,041	279,937	1,770,127	1,030,586	144,607	0	21,550	0	3,311,213 (±0)	14.10
linden, littleleaf	2,318	46,397	117,152	1,068,245	1,210,440	529,661	235,407	24,596	0	3,234,216 (±0)	13.77
maple, red	13,643	173,704	581,241	1,040,618	370,660	90,760	12,180	0	0	2,282,806 (±0)	9.72
ash, green	0	5,518	304,752	1,112,913	411,092	117,941	0	0	0	1,952,217 (±0)	8.31
pear, callery	5,394	110,823	498,887	762,933	158,060	6,493	0	0	0	1,542,589 (±0)	6.57
planetree, London	1,386	32,652	189,264	780,015	440,278	56,370	26,328	0	0	1,526,292 (±0)	6.50
zelkova, Japanese	6,595	67,539	152,865	570,242	574,089	14,330	0	0	0	1,385,661 (±0)	5.90
oak, northern red	1,804	15,549	27,749	117,796	344,999	348,431	168,021	30,690	34,310	1,089,348 (±0)	4.64
sweetgum	1,456	26,181	73,778	156,668	26,062	0	0	0	0	284,146 (±0)	1.21
maple, silver	328	908	11,116	13,148	11,954	43,826	86,984	56,877	27,715	252,856 (±0)	1.08
plum	15,428	36,997	77,460	67,142	24,240	3,787	0	0	0	225,055 (±0)	0.96
oak, pin	4,843	13,184	11,824	29,276	50,473	68,174	26,644	0	0	204,418 (±0)	0.87
ash, white	0	8,466	41,279	75,908	23,244	7,575	13,322	0	13,858	183,651 (±0)	0.78
elm, american	4,274	6,973	16,568	26,296	11,290	6,493	9,404	44,467	53,121	178,886 (±0)	0.76
cherry, kwanzan	7,816	34,335	51,180	50,991	0	0	0	0	0	144,321 (±0)	0.61
sycamore, American	0	370	3,296	30,696	67,456	9,628	13,994	18,503	0	143,942 (±0)	0.61
oak, scarlet	381	1,186	2,092	11,290	21,949	61,687	44,913	0	0	143,499 (±0)	0.61
Japanese pagodatree	897	1,625	22,052	82,789	26,062	0	0	0	0	133,424 (±0)	0.57
basswood, American	254	1,186	7,137	31,214	7,747	43,607	37,170	0	0	128,314 (±0)	0.55
maple, hedge	3,907	6,314	59,068	11,954	0	12,763	0	0	0	94,006 (±0)	0.40
Japanese tree lilac	17,783	33,837	34,605	0	0	0	0	0	0	86,225 (±0)	0.37
elm, hybrid	9,504	26,703	22,728	11,921	0	0	0	0	0	70,856 (±0)	0.30
maple, sugar	0	187	5,240	8,941	23,244	32,464	0	0	0	70,075 (±0)	0.30
maple, freeman	0	4,328	16,922	23,316	7,969	6,493	5,485	0	0	64,514 (±0)	0.27
beech, American	0	0	0	3,514	0	17,726	32,579	0	0	53,819 (±0)	0.23
tree-of-heaven	386	702	1,072	3,005	13,849	13,431	4,813	6,316	0	43,574 (±0)	0.19
maple, amur	298	2,163	30,026	7,969	0	0	0	0	0	40,456 (±0)	0.17
oak, shingle	0	0	5,661	34,534	0	0	0	0	0	40,195 (±0)	0.17
pine, eastern white	0	0	1,870	8,493	16,449	11,195	0	0	0	38,007 (±0)	0.16
spruce, Norway	0	0	0	11,290	7,747	18,081	0	0	0	37,118 (±0)	0.16
apple	1,697	2,365	18,589	10,543	0	0	0	0	0	33,194 (±0)	0.14
elm, Siberian	467	9,506	2,055	3,974	0	3,358	4,813	0	7,040	31,213 (±0)	0.13
ginkgo	3,427	7,792	11,162	6,311	0	0	0	0	0	28,692 (±0)	0.12
goldenrain tree	4,318	14,303	9,845	0	0	0	0	0	0	28,466 (±0)	0.12
serviceberry	745	3,837	21,289	0	0	0	0	0	0	25,871 (±0)	0.11
hornbeam, European	1,257	11,093	13,290	0	0	0	0	0	0	25,641 (±0)	0.11

Species	DBH Class (in)									Total	Standard Error	% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42			
elm, slippery	0	1,263	0	4,313	8,310	0	0	10,793	0	24,679 (±0)	0.11	
catalpa, northern	0	0	2,549	0	7,969	0	9,404	0	0	19,922 (±0)	0.08	
elm, Chinese	0	12,167	2,811	4,313	0	0	0	0	0	19,290 (±0)	0.08	
hornbeam, American	149	488	13,660	0	0	0	0	0	0	14,297 (±0)	0.06	
oak, swamp white	469	7,919	5,661	0	0	0	0	0	0	14,049 (±0)	0.06	
linden, silver	3,083	1,430	0	0	7,747	0	0	0	0	12,260 (±0)	0.05	
katsura tree	505	0	0	821	9,628	0	0	0	0	10,954 (±0)	0.05	
maple, sycamore	0	2,218	1,163	3,044	3,422	0	0	0	0	9,847 (±0)	0.04	
oak, English	0	0	9,845	0	0	0	0	0	0	9,845 (±0)	0.04	
oak, white	0	0	2,536	6,977	0	0	0	0	0	9,514 (±0)	0.04	
elm, rock	0	0	0	3,044	5,866	0	0	0	0	8,910 (±0)	0.04	
cherry, black	0	0	991	2,104	5,645	0	0	0	0	8,740 (±0)	0.04	
serviceberry, eastern	0	1,849	6,522	0	0	0	0	0	0	8,371 (±0)	0.04	
cedar, northern white	359	1,012	2,953	3,985	0	0	0	0	0	8,309 (±0)	0.04	
magnolia: cucumbertree	0	0	0	0	0	0	8,163	0	0	8,163 (±0)	0.03	
coffertree, Kentucky	512	628	0	6,311	0	0	0	0	0	7,451 (±0)	0.03	
cherry, higan	5,967	641	0	0	0	0	0	0	0	6,608 (±0)	0.03	
Vacant (Do Not Plant)	6,600	0	0	0	0	0	0	0	0	6,600 (±0)	0.03	
horsechestnut	0	0	0	0	0	6,493	0	0	0	6,493 (±0)	0.03	
corktree, amur	0	0	0	6,311	0	0	0	0	0	6,311 (±0)	0.03	
beech, European	0	0	0	6,311	0	0	0	0	0	6,311 (±0)	0.03	
ash: European	0	0	0	6,088	0	0	0	0	0	6,088 (±0)	0.03	
larch, European	0	0	0	0	5,866	0	0	0	0	5,866 (±0)	0.02	
maple, Japanese	359	419	5,045	0	0	0	0	0	0	5,823 (±0)	0.02	
birch, paper	232	0	1,204	4,207	0	0	0	0	0	5,643 (±0)	0.02	
spruce, white	0	0	1,477	3,985	0	0	0	0	0	5,461 (±0)	0.02	
serviceberry, downy	447	1,221	3,569	0	0	0	0	0	0	5,236 (±0)	0.02	
spruce, Colorado	0	0	5,060	0	0	0	0	0	0	5,060 (±0)	0.02	
pine: Japanese red	0	0	0	4,313	0	0	0	0	0	4,313 (±0)	0.02	
boxelder	0	0	4,248	0	0	0	0	0	0	4,248 (±0)	0.02	
mulberry: spp.	0	0	0	0	3,422	0	0	0	0	3,422 (±0)	0.01	
mulberry, white	467	0	1,832	678	0	0	0	0	0	2,977 (±0)	0.01	
yew	0	1,186	1,477	0	0	0	0	0	0	2,663 (±0)	0.01	
chokecherry, common	2,553	0	0	0	0	0	0	0	0	2,553 (±0)	0.01	
cherry, yoshino flowering	2,253	0	0	0	0	0	0	0	0	2,253 (±0)	0.01	
parrotia, persian	2,089	0	0	0	0	0	0	0	0	2,089 (±0)	0.01	
maackia, amur	2,037	0	0	0	0	0	0	0	0	2,037 (±0)	0.01	
hawthorn	134	0	1,842	0	0	0	0	0	0	1,976 (±0)	0.01	
fringetree, White	0	0	1,870	0	0	0	0	0	0	1,870 (±0)	0.01	
serviceberry, Allegheny	1,697	0	0	0	0	0	0	0	0	1,697 (±0)	0.01	
plum, cherry	1,642	0	0	0	0	0	0	0	0	1,642 (±0)	0.01	
baldeypress	381	1,186	0	0	0	0	0	0	0	1,567 (±0)	0.01	

Species	DBH Class (in)									Total	Standard Error	% of Total
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	>42			
magnolia, star	0	0	1,477	0	0	0	0	0	0	1,477 (±0)	0.01	
tulip tree	0	1,412	0	0	0	0	0	0	0	1,412 (±0)	0.01	
maple: Shangtung	1,334	0	0	0	0	0	0	0	0	1,334 (±0)	0.01	
pear, common	0	321	850	0	0	0	0	0	0	1,170 (±0)	0.00	
maple, miyabei	1,161	0	0	0	0	0	0	0	0	1,161 (±0)	0.00	
maple, trident	953	0	0	0	0	0	0	0	0	953 (±0)	0.00	
hophornbeam, eastern	911	0	0	0	0	0	0	0	0	911 (±0)	0.00	
juniper spp.	0	893	0	0	0	0	0	0	0	893 (±0)	0.00	
tupelo, black	850	0	0	0	0	0	0	0	0	850 (±0)	0.00	
spruce	0	837	0	0	0	0	0	0	0	837 (±0)	0.00	
hardy rubber tree	783	0	0	0	0	0	0	0	0	783 (±0)	0.00	
hemlock, eastern	0	739	0	0	0	0	0	0	0	739 (±0)	0.00	
hawthorn: cockspur	0	739	0	0	0	0	0	0	0	739 (±0)	0.00	
magnolia, Chinese : magi	170	558	0	0	0	0	0	0	0	728 (±0)	0.00	
unknown tree	0	198	179	0	351	0	0	0	0	727 (±0)	0.00	
rose-of-sharon	396	321	0	0	0	0	0	0	0	717 (±0)	0.00	
cherry, sargent	706	0	0	0	0	0	0	0	0	706 (±0)	0.00	
mountainash: spp.	0	0	679	0	0	0	0	0	0	679 (±0)	0.00	
birch, European white	0	0	0	678	0	0	0	0	0	678 (±0)	0.00	
hackberry, northern	634	0	0	0	0	0	0	0	0	634 (±0)	0.00	
cedar, atlantic white	0	593	0	0	0	0	0	0	0	593 (±0)	0.00	
unknown shrub	0	524	0	0	0	0	0	0	0	524 (±0)	0.00	
viburnum: spp.	134	370	0	0	0	0	0	0	0	504 (±0)	0.00	
cherry, cornelian	0	443	0	0	0	0	0	0	0	443 (±0)	0.00	
snowbell, Japanese	384	0	0	0	0	0	0	0	0	384 (±0)	0.00	
birch, river	381	0	0	0	0	0	0	0	0	381 (±0)	0.00	
sourwood	0	370	0	0	0	0	0	0	0	370 (±0)	0.00	
maple	66	0	194	0	0	0	0	0	0	260 (±0)	0.00	
dogwood, flowering	232	0	0	0	0	0	0	0	0	232 (±0)	0.00	
magnolia, sweetbay	232	0	0	0	0	0	0	0	0	232 (±0)	0.00	
peach	232	0	0	0	0	0	0	0	0	232 (±0)	0.00	
hawthorn, Washington	191	0	0	0	0	0	0	0	0	191 (±0)	0.00	
redbud, eastern	164	0	0	0	0	0	0	0	0	164 (±0)	0.00	
Paradise apple	164	0	0	0	0	0	0	0	0	164 (±0)	0.00	
oak, sawtooth	149	0	0	0	0	0	0	0	0	149 (±0)	0.00	
dogwood	0	74	0	0	0	0	0	0	0	74 (±0)	0.00	
oak	0	70	0	0	0	0	0	0	0	70 (±0)	0.00	
ash	0	66	0	0	0	0	0	0	0	66 (±0)	0.00	
Citywide Total	155,673	818,699	3,365,430	9,592,518	5,907,482	2,303,588	921,550	266,216	156,719	23,487,874 (±0)	100.00	

TREE INVENTORY DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

Davey Resource Group (DRG) collected tree inventory data using Rover mobile mapping software. Rover is a GIS field data collection system built by DRG.

The software both collects data and processes data validations. Rover spatially joins features such as points, lines or polygons with GIS layers in order to derive data. The tool’s GPS capabilities allow it to merge nearby camera hardware with the tablet computer to attach photos to features and render data on top of Google Terrain Maps, Google Hybrid Maps and Open Street Maps (when Internet connection is available).

Rover’s online and offline functionality gives field technicians the ability to directly distribute information to clients. Data uploads or electronic forms are transmitted to clients in real-time. The knowledge and professional judgment of DRG’s arborists ensure the high quality of inventory data.

Data fields are defined in the glossary of the management plan. At each site, the following data fields were collected:

- address
- ash treatment candidate
- condition wood
- condition canopy
- gridling root
- grow space size – width
- grow space size – length
- grow space type
- further inspection
- hardscape damage
- location
- overhead utilities
- ownership
- park name
- primary maintenance need
- mapping coordinates
- maintain ground
- new sidewalk
- notes
- risk assessment
- risk rating
- species
- stems
- tree size*
- visible root flare

* measured in inches in diameter at 4.5 feet above ground (or diameter at breast height [DBH])

Tree Inventory Input Fields and Definitions

The data fields definitions that were collected for each tree, stump, and planting site during the inventory are defined as follows:

- **Mapping coordinate.** X and Y coordinate locations.
- **Location.** The tree's location in relation to public ROW and/or public space.
- **Address.** The location of each street tree and planting site so that they can easily be identified for future maintenance work. Street trees and planting sites will be located using an address number, street name, side of address, and on street.
- **Species.** Trees were identified by genus and species, with the exception of genera such as *Amelanchier*, *Crataegus*, *Malus*, or *Prunus* where field identification of species is often not practical.
- **Diameter.** Diameter is measured in inches to the nearest tenth at 4-1/2 feet above the ground, or diameter-breast-height (DBH). If a tree was marked as a multi-stem the largest leader was measured. In some cases where the tree forked before 4.5 ft, DBH was measured at the narrowest point of the trunk.
- **Multi-stem.** Trees were identified if they have multiple stems or are a single stem. Typically if the tree splits lower than 1.5ft from the ground, then it would be marked as a multi-stemmed tree. In these cases the DBH of the largest stem was recorded.
- **Condition - canopy.** In general, the health and structure of each tree was recorded in one of the following categories based on visible twig and foliage conditions at the time of the inventory and adapted from the rating system established by the International Society of Arboriculture:
 - *Good—80% condition rating*
 - *Fair—60% condition rating*
 - *Poor—40% condition rating*
 - *Dead—0% condition rating*
- **Condition - wood.** In general, the health and structure of each tree was recorded in one of the following categories based on visible root, trunk, and scaffold branch conditions at the time of the inventory and adapted from the rating system established by the International Society of Arboriculture:
 - *Good—80% condition rating*
 - *Fair—60% condition rating*
 - *Poor—40% condition rating*
 - *Dead—0% condition rating*
- **Growing Space Type.** Growing space locations are categorized as:
 - **Island**—*Sites surrounded by pavement or hardscape (e.g., parking lot, cul-de-sac).*
 - **Median**—*Sites located between opposing lanes of traffic.*
 - **Natural Area**—*Sites developed through natural growth instead of design or planning.*
 - **Open/Restricted**—*Open sites with restricted growing space on 2 or 3 sides.*
 - **Open/Unrestricted**—*Open sites with unrestricted growing space on at least 3 sides.*
 - **Raised Planter**—*Sites located in an above-grade or elevated planter.*
 - **Tree Lawn/Parkway**—*Sites located between the street curb and the public sidewalk.*

- **Unmaintained Area**—Sites located in areas that do not appear to be regularly maintained.
- **Well/Pit**—Sites at grade level and completely surrounded by sidewalk.
- **Growing Space Size - Width.** The minimum dimension of the Growing Space Type recorded in feet. In areas where the width or length would not restrict the growth of the tree, 99' was used as a default number.
- **Growing Space Size - Length.** The maximum dimension of the Growing Space Type recorded in feet. In areas where the width or length would not restrict the growth of the tree, 99' was used as a default number.
- **Maintain Ground.** Sites that require ground maintenance (e.g. weeding).
- **New Sidewalk**—Sidewalks that appear new is noted.
- **Visible Root Flare**—Root flares that are visible is noted.
- **Girdling Roots**—Girdling roots that are visible is noted.
- **Sidewalk Deflection**—Where trees are present, cracking or lifting of sidewalk pavement one inch or more is noted.
- **Primary Maintenance Need.** The following primary maintenance needs were determined based on ANSI A300 standard specifications:
 - **Removal**—Trees designated for removal have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have a large percentage of dead crown. All trees with safety risks that could be seen as potential threats to persons or property and seen as potential liabilities to the client would be in this category. This category includes large dead and dying trees that are high-liability risks as well as those that pose minimal liability to persons or property (such as trees in poor locations or undesirable species).
 - **Tree Clean**—These trees require selective removal of dead, diseased, dying, and/or broken wood to minimize potential risk. Priority of work should be dependent upon the Risk associated with the individual trees.
 - **Young Tree Train**—These are young trees that must be pruned to correct or eliminate weak, interfering, or objectionable branches in order to minimize future maintenance requirements. Generally, these trees may be up to 20 feet in height and can be worked with a pole pruner by a person standing on the ground.
 - **Stump Removal**—This category indicates a stump that should be removed. Lacking specific information on stump removal required by local code requirements per the client.
 - **Plant Tree**—During the inventory, vacant planting sites will be identified by street, address, and site number. The size of the site is designated as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growing space available and the presence of overhead wires. Lacking local code definitions, planting sites are determined based on standard specifications set forth in accepted technical journals and by the arboriculture industry.
- **Ash Treatment Candidate.** Condition of ash trees were judged as suitable for possible treatment against Emerald Ash Borer (EAB).
- **Overhead Utilities.** The inventory indicates whether overhead conductors or other utilities are present at the tree site that could result in conflicts with the tree.

- **Risk Assessment.** A Level 2 qualitative risk assessment was performed based on the ANSI A300 (Part 9) and the companion publication *Best Management Practices: Tree Risk Assessment*, published by the International Society of Arboriculture (2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.

– **Likelihood of Failure**—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.

- » **Improbable**—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
- » **Possible**—Failure could occur, but it is unlikely during normal weather conditions within the specified time period.
- » **Probable**—Failure may be expected under normal weather conditions within the specified time period.
- » **Imminent**—Failure has started or is most likely to occur in the near future, even if there is no significant wind or increased load. The tree may require immediate action.

– **Likelihood of Impacting a Target**—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls toward the target.

- » **Very low**—The chance of the failed tree or branch impacting the target is remote.
 - Rarely used sites
 - Examples include rarely used trails or trailheads
 - Instances where target areas provide protection
- » **Low**—It is not likely that the failed tree or branch will impact the target.
 - Occasional use area fully exposed to tree
 - Frequently used area partially exposed to tree
 - Constant use area that is well protected
- » **Medium**—The failed tree or branch may or may not impact the target.
 - Frequently used areas that is partially exposed to tree on one side
 - Constantly occupied area partially protected from tree
- » **High**—The failed tree or branch will most likely impact the target.
 - Fixed target is fully exposed to tree or tree part

– **Categorizing Likelihood of Tree Failure Impacting a Target**—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

– **Consequence of Failure**—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.

- » **Negligible**—Consequences involve low value damage and do not involve personal injury
 - small branch striking a fence
 - medium-sized branch striking a shrub bed
 - large tree part striking structure and causing monetary damage
 - disruption of power to landscape lights
- » **Minor**—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.
 - small branch striking a house roof from a high height
 - medium-sized branch striking a deck from a moderate height
 - a large tree part striking a structure, causing moderate monetary damage
 - short-term disruption of power at service drop to house
 - temporary disruption of traffic on neighborhood street

» **Significant**—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.

- a medium-sized part striking a vehicle from a moderate or high height
- a large tree part striking a structure resulting in high monetary damage
- disruption of distribution primary or secondary voltage power lines, including individual services and street-lighting circuits
- disruption of traffic on a secondary street

» **Severe**—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.

- injury to a person that may result in hospitalization
- a medium-sized part striking an occupied vehicle
- a large tree part striking an occupied house
- serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Trees have the potential to fail in more than way and can affect multiple targets.

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

- » **None**—Used for planting and stump sites only.
- » **Low**—The Low Risk category applies when consequences are “negligible” and likelihood is “unlikely”; or consequences are “minor” and likelihood is “somewhat likely”. Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.
- » **Moderate**—The Moderate Risk category applies when consequences are “minor” and likelihood is “very likely” or “likely”; or likelihood is “somewhat likely” and consequences are “significant” or “severe.” In populations of trees, Moderate Risk

trees represent a lower priority than High or Extreme Risk trees.

- » **High**—The High Risk category applies when consequences are “significant” and likelihood is “very likely” or “likely”, or consequences are “severe” and likelihood is “likely”. In population of trees, the priority of High Risk trees is second only to Extreme Risk trees.
- » **Extreme**—The Extreme Risk category applies in situations where tree failure is imminent and there is a high likelihood of impacting the target, and the consequences of the failure are “severe”. In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

- **Notes.** Additional information regarding disease, insect, mechanical damage, etc. are included in this field.

Maintenance needs are based on *ANSI A300 (Part 1)* (ANSI 2008). Risk assessment and risk rating are based on *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture [ISA] 2011).

The data collected were provided to the City of Somerville in an electronic ESRI® shapefile, and Microsoft Excel™ spreadsheet.

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
Shapefiles Keith Johnson, City of Somerville GIS Coordinator, Capital Projects and Planning/Engineering Dept.	2018-2019	NAD 1983 StatePlane Massachusetts Mainland; Feet
6in Aerial Imagery City of Somerville GIS	2017	NAD 1983 StatePlane Massachusetts Mainland; Feet

Site Location Methods**EQUIPMENT AND BASE MAPS**

Inventory arborists use FZ-G1 Panasonic Toughpad® unit(s) and internal GPS receiver(s).

Base map layers were loaded onto these unit(s) to help locate sites during the inventory. The table below lists the base map layers, utilized along with source and format information for each layer.

STREET RIGHT-OF-WAY (ROW) SITE LOCATION

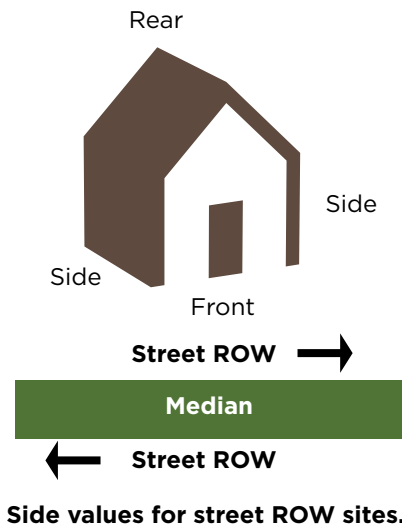
Individual street ROW sites (trees, stumps, or planting sites) were located using a methodology that identifies sites by *address number*, *street name*, or *side*. This methodology was developed by DRG to help ensure consistent assignment of location.

ADDRESS NUMBER AND STREET NAME

The *address number* was recorded based on visual observation by the arborist at the time of the inventory (the address number was posted on a building at the inventoried site). Where there was no posted address number on a building, or where the site was located by a vacant lot with no GIS parcel addressing data available, the arborist used his/her best judgment to assign an address number based on opposite or adjacent addresses. An “X” was then added to the number in the database to indicate that it was assigned (for example, “37X Choice Avenue”).

Sites in medians or islands were assigned an address number using the address on the right side of the street in the direction of collection closest to the site. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was assigned its own address.

The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.



SIDE VALUE

Each site was assigned a *side value*. Side values include: *front*, *side*, *median* (includes islands), or *rear* based on the site's location in relation to the lot's street frontage. The *front side* is the side that faces the address street. *Side* is the name of the street the arborist walks towards or away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

PARK AND/OR PUBLIC SPACE SITE LOCATION

Park and/or public space site locations were collected using the same methodology as street ROW site.

SITE LOCATION EXAMPLES



The tree trimming crew in the truck traveling westbound on E. Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address/Street Name: 226 E. Mac Arthur Street

Side: Side

On Street: Davis Street

The tree site circled in red signifies the crew's target site. Because the tree is located on the side of the lot, the *on street* is Davis Street, even though it is addressed as 226 East Mac Arthur Street.



Location information collected for inventoried trees at Corner Lots A and B.

Corner Lot A

Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Front
On Street:	Hoover St.

Corner Lot B

Address/Street Name:	226 E Mac Arthur St.
Side:	Side
On Street:	Davis St.
Address/Street Name:	226 E Mac Arthur St.
Side:	Front
On Street:	E Mac Arthur St.
Address/Street Name:	226 E Mac Arthur St.
Side:	Front
On Street:	E Mac Arthur St.

List of Parks/Public Areas Collected in Somerville

- ALBION PLGD
- ALEWIFE BROOK RESERVATION*
- ALLEN ST PLGD & COMM GARDEN
- ARGENZIANO SCHOOL PLGD
- ASSEMBLY SQUARE BLOCK 2A PLAZA**
- AVON COMMUNITY GARDEN**
- BAILEY PARK
- BIKEWAY COMMUNITY GARDEN*
- BLESSING OF THE BAY*
- BROWN SCHOOL PLGD
- CENTRAL HILL PARK
- CHUCKIE HARRIS PARK
- CITY HALL
- COMMUNITY PATH*
- CONCORD SQUARE
- CONWAY FIELD
- CONWAY PARK
- CORBETT-MCKENNA PARK
- CREMIN PLGD
- CUMMINGS SCHOOLYARD
- DAVIS SQUARE PLAZA (STATUE PARK)
- DEPARTMENT OF PUBLIC WORKS
- DICKERMAN PLGD
- DILBOY FIELDS & STADIUM*
- DRAW 7 PARK*
- DURELL POCKET PARK & COMM GARDEN
- EAST LIBRARY
- EAST SOMERVILLE SCHOOLYARD
- EDGERLY EDUCATION CENTER SCHOOLYARD
- EDWARD LEATHERS PARK
- FIRE STATION
- FLORENCE PLAYGROUND
- FOSS PARK*
- GILMAN SQUARE
- GLEN PARK & CAPUANO/JAMES MCCARTHY FIELD
- GRIMMONS PARK
- HARRIS PLGD
- HEALEY COMMUNITY SCHOOLYARD
- HENERY HANSEN PARK
- HODGKINS-CURTIN PARK
- HOYT-SULLIVAN PLGD
- KENNEDY SCHOOLYARD
- KENNEY PARK
- LEXINGTON PARK
- LINCOLN PARK
- MARSHALL STREET PLGD
- MAXPAC SQUARE AND DOG PARK**
- MILK ROW CEMETERY
- MORSE-KELLEY PLGD
- MYSTIC HOUSING DEVELOPMENT***
- NATHAN TUFTS/POWDERHOUSE PARK
- NORTH STREET VETERANS PLGD
- NUNZIATO FIELD
- OSGOOD PARK
- PALMACCI PLGD
- PAUL REVERE PARK
- PERKINS PLGD
- PERRY PARK
- POLICE & FIRE STATION
- POWDERHOUSE ROTARY
- PROSPECT HILL PARK
- QUINCY ST PARK
- SEVEN HILLS PARK
- SOMERVILLE COMM GROWING CENTER
- SOMERVILLE HIGH SCHOOL
- SOMERVILLE JUNCTION PARK
- SOMERVILLE LIBRARY
- SOUTH STREET FARM
- STONE PLACE PARK
- SYLVESTER BAXTER RIVERFRONT PARK*
- SYMPHONY PARK
- TRUM FIELD
- TRUM PLGD
- TUFTS PLAYING FIELD & COMM GARDEN***
- UNION SQUARE PLAZA
- VETERANS MEMORIAL CEMETARY
- VETERANS MEMORIAL RINK
- WALNUT STREET PARK
- WEST BRANCH LIBRARY
- WEST SOMERVILLE NEIGHBORHOOD SCHOOLYARD
- WINTER HILL SCHOOLYARD
- WOODSTOCK PLGD
- ZERO NEW WASHINGTON PARK

*Designates State-owned property

**Designates Privately-owned public space

***Designates Privately-owned property

References

- American National Standards Institute (ANSI). 2008. *ANSI A300 (Part 1)–2008, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices (Pruning)*. Londonderry: Tree Care Industry Association, Inc.
- . 2011. *ANSI A300 (Part 9)–2011, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management Standard Practices (Tree Risk Assessment a. Tree Structure Assessment)*. Londonderry: Tree Care Industry Association, Inc.
- Smiley, E.T., Matheny, N., Lilly, S. 2011. *Best Management Practices: Tree Risk Assessment*. International Society of Arboriculture [ISA].

SUGGESTED TREE SPECIES

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 6 on the USDA Plant Hardiness Zone Map.

Hardy Trees and Shrubs (Dirr 2010), *Landscape Plants of the Southeast* (Halfacre & Shawcroft 1999), and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1998) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade.

DECIDUOUS TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
<i>Acer rubrum</i> ^{d,n}	red maple	Red Sunset*
<i>Acer saccharum</i> ⁿ	sugar maple	'Legacy'
<i>Aesculus flava</i> ^{n*}	yellow buckeye	
<i>Betula alleghaniensis</i> ^{n*}	yellow birch	
<i>Betula lenta</i> ^{n*}	sweet birch	
<i>Betula nigra</i> ^{a,n}	river birch	Heritage*
<i>Carpinus betulus</i>	European hornbeam	'Franz Fontaine'
<i>Carya illinoensis</i> ^{d,n*}	pecan	
<i>Carya laciniosa</i> ^{d,n*}	shellbark hickory	
<i>Carya ovata</i> ^{d,n*}	shagbark hickory	
<i>Castanea mollissima</i> *	Chinese chestnut	
<i>Celtis laevigata</i> ^{a,s,n}	sugar hackberry	
<i>Celtis occidentalis</i> ^{d,n}	common hackberry	'Prairie Pride'
<i>Cercidiphyllum japonicum</i>	katsuratree	'Aureum'
<i>Diospyros virginiana</i> ^{d,s,n*}	common persimmon	
<i>Fagus grandifolia</i> ^{a,n*}	American beech	
<i>Fagus sylvatica</i> *	European beech	(Numerous exist)
<i>Ginkgo biloba</i> ^{d,s}	ginkgo	(Choose male trees only)
<i>Gleditsia triacanthos inermis</i> ^{d,s,n}	thornless honeylocust	'Shademaster'
<i>Gymnocladus dioica</i> ^{d,s,n}	Kentucky coffeetree	Prairie Titan*
<i>Juglans nigra</i> ^{d,s,n*}	black walnut	
<i>Larix decidua</i> ^{a,s*}	European larch	
<i>Liquidambar styraciflua</i> ^{s,n}	American sweetgum	'Rotundiloba'
<i>Liriodendron tulipifera</i> ^{n*}	tuliptree	'Fastigiatum'
<i>Magnolia acuminata</i> ^{n*}	cucumbertree magnolia	(Numerous exist)
<i>Magnolia macrophylla</i> ^{n*}	bigleaf magnolia	

DECIDUOUS TREES continued

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
<i>Metasequoia glyptostroboides</i> ^a	dawn redwood	'Emerald Feathers'
<i>Nyssa sylvatica</i> ^{d,s,n}	black tupelo	
<i>Platanus occidentalis</i> ^{n*}	American sycamore	
<i>Platanus × acerifolia</i>	London planetree	'Yarwood'
<i>Quercus alba</i> ^{s,n}	white oak	
<i>Quercus bicolor</i> ^{s,n}	swamp white oak	
<i>Quercus coccinea</i> ^{d,n}	scarlet oak	
<i>Quercus imbricaria</i> ⁿ	shingle oak	
<i>Quercus lyrata</i> ^{d,n}	overcup oak	
<i>Quercus macrocarpa</i> ^{d,s,n}	bur oak	
<i>Quercus montana</i> ^{d,n}	chestnut oak	
<i>Quercus muehlenbergii</i> ⁿ	chinkapin oak	
<i>Quercus palustris</i> ^{d,s,n}	pin oak	
<i>Quercus phellos</i> ^{d,s,n}	willow oak	
<i>Quercus robur</i> ^s	English oak	Heritage [*]
<i>Quercus rubra</i> ^{d,s,n}	northern red oak	'Splendens'
<i>Quercus shumardii</i> ^{d,n}	Shumard oak	
<i>Styphnolobium japonicum</i> ^s	Japanese pagodatree	'Regent'
<i>Taxodium distichum</i> ^{s,n}	common baldcypress	'Shawnee Brave'
<i>Tilia americana</i> ⁿ	American linden	'Redmond'
<i>Tilia cordata</i> ^a	littleleaf linden	'Greenspire'
<i>Tilia × euchlora</i>	Crimean linden	
<i>Tilia tomentosa</i> ^a	silver linden	'Sterling'
<i>Ulmus americana</i> ^{a,d,n}	American elm	'Jefferson'
<i>Ulmus parvifolia</i> ^d	Chinese elm	Allée [*]
<i>Zelkova serrata</i>	Japanese zelkova	'Green Vase'

DECIDUOUS TREES continued

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
<i>Aesculus × carnea</i>	red horsechestnut	
<i>Alnus cordata</i>	Italian alder	
<i>Asimina triloba</i> ^{n*}	pawpaw	
<i>Cladrastis kentukea</i> ⁿ	American yellowwood	'Rosea'
<i>Corylus colurna</i> ^d	Turkish filbert	
<i>Eucommia ulmoides</i>	hardy rubber tree	
<i>Koelreuteria paniculata</i> ^{d,s}	goldenraintree	
<i>Ostrya virginiana</i> ⁿ	American hophornbeam	
<i>Parrotia persica</i>	Persian parrotia	'Vanessa'
<i>Pistacia chinensis</i>	Chinese pistache	
<i>Prunus maackii</i>	amur chokecherry	'Amber Beauty'
<i>Prunus sargentii</i>	Sargent cherry	
<i>Pterocarya fraxinifolia</i> [*]	Caucasian wingnut	
<i>Quercus acutissima</i>	sawtooth oak	
<i>Quercus cerris</i>	European turkey oak	
<i>Sassafras albidum</i> ^{d,n*}	sassafras	

DECIDUOUS TREES continued

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
<i>Acer buergerianum</i>	trident maple	Streetwise®
<i>Acer campestre</i> ^s	hedge maple	Queen Elizabeth™
<i>Acer cappadocicum</i>	coliseum maple	'Aureum'
<i>Acer ginnala</i>	amur maple	Red Rhapsody™
<i>Acer griseum</i>	paperbark maple	
<i>Acer nigrum</i> ⁿ	black maple	
<i>Acer pensylvanicum</i> ^{n*}	striped maple	
<i>Acer triflorum</i>	three-flower maple	
<i>Aesculus pavia</i> ^{s,n*}	red buckeye	
<i>Amelanchier arborea</i> ⁿ	downy serviceberry	(Numerous exist)
<i>Amelanchier laevis</i> ⁿ	Allegheny serviceberry	
<i>Carpinus caroliniana</i> ^{n*}	American hornbeam	
<i>Cercis canadensis</i> ^{d,n}	eastern redbud	'Forest Pansy'
<i>Cornus alternifolia</i> ⁿ	pagoda dogwood	
<i>Cornus kousa</i>	Kousa dogwood	(Numerous exist)
<i>Cornus mas</i>	corneliancherry dogwood	'Spring Sun'
<i>Corylus avellana</i>	European filbert	'Contorta'
<i>Cotinus coggygria</i> [*]	common smoketree	'Flame'
<i>Cotinus obovata</i> ^{n*}	American smoketree	
<i>Crataegus phaenopyrum</i> ^{d,n*}	Washington hawthorn	Princeton Sentry™
<i>Crataegus viridis</i> ^{d,n}	green hawthorn	'Winter King'
<i>Franklinia alatamaha</i> ^{n*}	Franklinia	
<i>Halesia tetraptera</i> ^{n*}	Carolina silverbell	'Arnold Pink'
<i>Laburnum × watereri</i>	goldenchain tree	
<i>Maackia amurensis</i>	amur maackia	
<i>Magnolia × soulangiana</i> [*]	saucer magnolia	'Alexandrina'
<i>Magnolia stellata</i> [*]	star magnolia	'Centennial'
<i>Magnolia tripetala</i> [*]	umbrella magnolia	
<i>Magnolia virginiana</i> ^{s,n*}	sweetbay magnolia	Moonglow®

DECIDUOUS TREES continued

Small Trees: 15 to 30 Feet in Height at Maturity (continued)

Scientific Name	Common Name	Cultivar
<i>Malus spp.</i>	flowering crabapple	(Disease resistant only)
<i>Oxydendrum arboreum</i> ⁿ	sourwood	'Mt. Charm'
<i>Prunus subhirtella</i>	Higan cherry	'Pendula'
<i>Prunus virginiana</i> ⁿ	common chokecherry	'Schubert'
<i>Staphylea trifolia</i> ^{n*}	American bladdernut	
<i>Stewartia ovata</i> ⁿ	mountain stewartia	
<i>Styrax japonicus</i> *	Japanese snowbell	'Emerald Pagoda'
<i>Syringa reticulata</i> ^s	Japanese tree lilac	'Ivory Silk'

^a denotes species that are recommended for improving air quality (Bell and Wheeler 2006).

^d denotes species that are drought tolerant (Clatterbuck 2012).

^s denotes species that are tolerant to salt spray, saline soils, or both (Appleton et al. 2015).

ⁿ denotes species that are native to the eastern United States (USDA PLANTS database 2020).

* denotes species that are not recommended for use as street trees.

CONIFEROUS AND EVERGREEN TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
<i>Abies balsamea</i> ⁿ	balsam fir	
<i>Abies concolor</i> ⁿ	white fir	'Violacea'
<i>Cedrus libani</i>	cedar-of-Lebanon	
<i>Chamaecyparis nootkatensis</i>	Nootka falsecypress	'Pendula'
<i>Cryptomeria japonica</i> ^s	Japanese cryptomeria	'Sekkan-sugi'
× <i>Cupressocyparis leylandii</i>	Leyland cypress	
<i>Ilex opaca</i> ^{d,s,n}	American holly	
<i>Picea omorika</i>	Serbian spruce	
<i>Picea orientalis</i>	Oriental spruce	
<i>Pinus densiflora</i>	Japanese red pine	
<i>Pinus strobus</i> ^{d,n}	eastern white pine	
<i>Pinus sylvestris</i>	Scotch pine	
<i>Pinus taeda</i> ^{d,n}	loblolly pine	
<i>Pinus virginiana</i> ^{d,n}	Virginia pine	
<i>Pseudotsuga menziesii</i> ⁿ	Douglas-fir	
<i>Thuja plicata</i>	western arborvitae	(Numerous exist)

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
<i>Chamaecyparis thyoides</i> ⁿ	atlantic whitecedar	(Numerous exist)
<i>Juniperus virginiana</i> ^{d,s,n}	eastern redcedar	
<i>Pinus bungeana</i>	lacebark pine	
<i>Pinus flexilis</i>	limber pine	
<i>Pinus parviflora</i>	Japanese white pine	
<i>Thuja occidentalis</i> ⁿ	eastern arborvitae	(Numerous exist, many are shrubs)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
<i>Ilex × attenuata</i> ^d	Foster's holly	
<i>Pinus aristata</i>	bristlecone pine	
<i>Pinus mugo</i> ^{d,s}	mugo pine	

^d denotes species that are drought tolerant (Clatterbuck 2012).

^s denotes species that are tolerant to salt spray, saline soils, or both (Appleton et al. 2015).

ⁿ denotes species that are native to the eastern United States (USDA PLANTS database 2021).

ZONE 7 TREES

With climate shifts due to climate change, there may be opportunities to plant a variety of species that were previously unsuited to Somerville's climate.

Trees Suitable for Zone 7

Scientific Name	Common Name	Cultivar	Mature Height
<i>Acer nigrum</i> ⁿ	black maple		>45 feet
<i>Cedrus deodara</i> [*]	deodar cedar		>45 feet
<i>Ilex</i> x ^d	Nellie R. Stevens holly	'Nelly R. Stevens'	15-30 feet
<i>Juglans regia</i> [*]	English walnut		>45 feet
<i>Lagerstroemia fauriei</i>	Japanese crapemyrtle		31-45 feet
<i>Lagerstroemia indica</i>	common crapemyrtle	(Numerous exist)	15-30 feet
<i>Magnolia grandiflora</i> ^{s,n*}	southern magnolia		>45 feet
<i>Pinus echinata</i> ^d	shortleaf pine		>45 feet
<i>Pinus elliotii</i> ⁿ	slash pine		>45 feet
<i>Quercus hemisphaerica</i> ⁿ	Darlington oak		>45 feet
<i>Quercus pagoda</i> ⁿ	cherrybark oak		>45 feet
<i>Quercus michauxii</i> ⁿ	swamp chestnut oak		>45 feet
<i>Quercus buckleyi</i>	Texas red oak		>45 feet
<i>Quercus velutina</i> ^{d,n}	black oak		>45 feet
<i>Sorbus alnifolia</i>	Korean mountainash	'Redbird'	31-45 feet
<i>Stewartia koreana</i>	Korean stewartia		15-30 feet

^d denotes species that are drought tolerant (Clatterbuck 2012).

^s denotes species that are tolerant to salt spray, saline soils, or both (Appleton et al. 2015).

ⁿ denotes species that are native to the eastern United States (USDA PLANTS database 2020).

^{*} denotes species that are not recommended for use as street trees.

References

- Appleton, Bonnie, et al. *Trees and Shrubs That Tolerate Saline Soils and Salt Spray Drift*. Virginia Polytechnic Institute and State University, 2015, pp. 6–9.
- Bell, R., and J. Wheeler. 2006. “Talking Trees, An Urban Forestry Toolkit for Local Governments.” *ICLEI Local Governments for Sustainability*.
- Clatterbuck, Wayne K. 2012. *SP570 Drought-Tolerant Trees*. Tennessee Urban Forestry Council.
- Dirr, Michael. 2010. *Dirr’s Hardy Trees and Shrubs: an Illustrated Encyclopedia*. Timber Press.
- Dirr, Michael A. 1998. *Manual of Woody Landscape Plants, 5th Edition*. Stipes.
- Halfacre, R. Gordon., and Anne R. Shawcroft. *Landscape Plants of the Southeast*. Sparks Press, 1999.
- United States Department of Agriculture (USDA). 2021. PLANTS Database. Website: <https://plants.sc.egov.usda.gov/home>. Accessed May 5, 2021.

TREE PLANTING

Tree Planting Overview

Planting trees is a valuable goal as long as tree species are carefully selected and correctly planted. When trees are planted, they are planted selectively and with purpose. Without proactive planning and follow-up tree care, a newly planted tree may become a future problem instead of a benefit to the community.

When planting trees, it is important to be cognizant of the following:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations (i.e., confined spaces, overhead wires, and/or soil type).
- Select the species or cultivar best suited for the site conditions.
- Examine trees before buying them, and buy for quality.
- Properly prepare the tree planting site prior to planting.
- Ensure that the tree is planted at the correct depth.
- Only apply soil amendments (fertilizer, compost) if necessary.
- After planting, use mulch or ground cover, but be sure not to cover the root flare of the tree.
- Water the tree regularly, at least until it is established.
- Long-term tree care includes watering during drought periods, adding mulch, and selective pruning.

For additional details see *Section 3.1 Tree Planting Plan*.

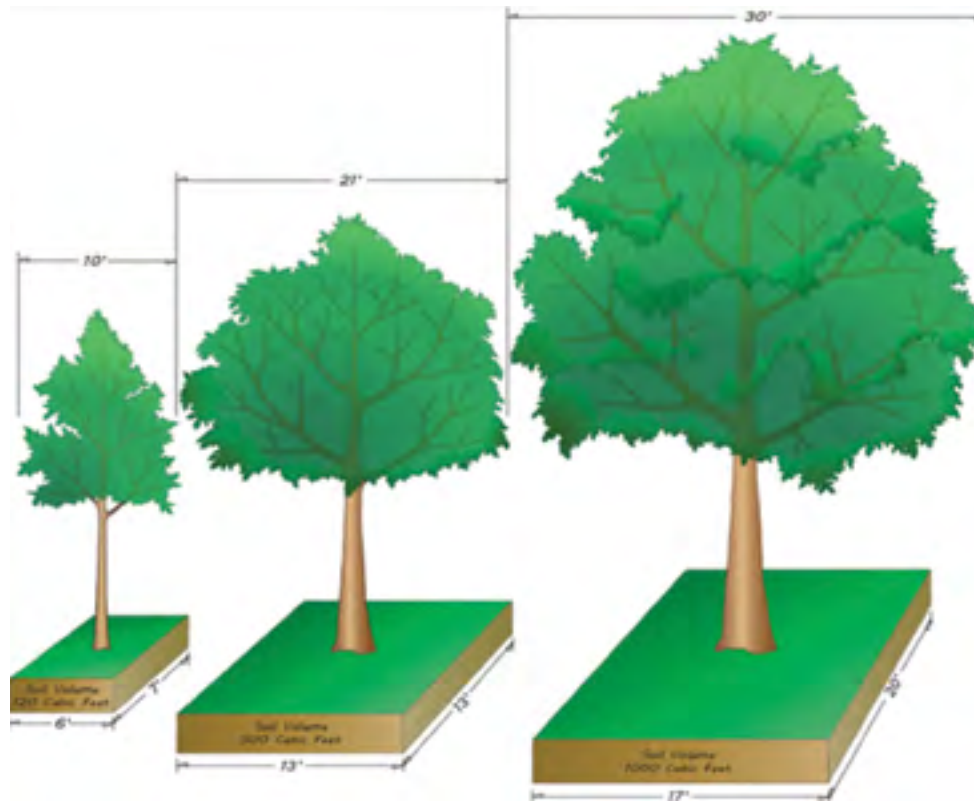
Tree Size and Soil Availability

The goal of tree planting is to have a vigorous, healthy tree that lives to the limits of its natural longevity. That can be difficult to achieve in an urban growing environment because irrigation is limited and the soils are typically poor quality. However, proper planning, species selection, tree planting techniques, and follow-up tree maintenance will improve the chance of tree planting success.

The ability for a tree to grow to its full potential is highly dependent on soil conditions. A tree's root system is typically quite shallow, with the majority of roots in the top two feet of soil, and the roots usually spread outwards up to three times the width of the tree canopy. Thus, the ultimate size a tree will grow is highly dependent on the volume of soil it has available. The quality of that soil is also very important.

City of Somerville Technical Specifications for Tree Planting

The following technical specifications are included in the City of Somerville Tree Planting contracts. They detail the requirements that contractors must follow to ensure that tree planting is performed correctly.



Minimum recommended requirements for tree sites is based on tree size/dimensions. This illustration is based on the work of Casey Trees (2008).



CITY OF SOMERVILLE

2021 TREE PLANTING AND RELATED SERVICES

TECHNICAL SPECIFICATIONS

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. The scope of work includes all labor, materials, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of all the planting work as shown on the drawings and as specified herein. The scope of work includes, but is not limited to, the following:
 - 1. Submitting samples of materials and analyses for approval.
 - 2. Securing necessary permits and approvals.
 - 3. Site preparations, which may include any or all of the following: sawcutting asphalt, concrete, or brick and removing material, removing dead or dying trees (maximum caliper size of 9 inches), removing cobbles from around the edge of tree wells and disposing of the material, installing edging material to stabilize brick sidewalks, removing and disposing of tree grate.
 - 4. Locating, purchasing, delivering and installing all specified trees.
 - 5. Back filling with suitable material within tree planting area.
 - 6. Furnishing and installing all necessary planting operations, including: staking, guying, watering, fertilizing, mulching, weeding, pruning, drip bag installation, etc.
 - 7. Establishing finished grades.
 - 8. Cleaning site at end of planting operations, and properly disposing of all excess and surplus material.
 - 9. Providing a two year warranty and maintenance period for all trees.
 - 10. Maintaining, protecting, composting, mulching, weeding, pruning damaged or broken limbs, and replacing dead trees during the warranty period.
- B. Planting will take place throughout the City at various locations along streets and in other City-owned City-leased land. Planting on private property within 20 feet of Right-of-Way may be required as well.
- C. The City anticipates the planting work will take place during the Spring and Fall planting seasons. Occasional plantings may take place outside of this time.
 - 1. Spring Planting Season: April 1st – June 15th
 - 2. Fall Planting Season: September 15th – November 30th
- D. The City of Somerville reserves the right to work with its own work force or other Contractor(s) as necessary.
- E. Approved plant locations shall be marked by City staff prior to planting. The City does not guarantee the locations of existing pipes or underground conduits. The Contractor will have planting locations

checked by Dig-Safe for utility conflicts before any excavation or pavement removal is started. In the case of conflicts, the Contractor will inform the City Urban Forester immediately to arrange an alternative planting location. The Contractor shall use due caution when excavating in the vicinity of sprinkler systems, driveways, walks, steps, walls, heating cables, and/or heating pipes, and will be required to repair any damages caused at the Contractor's expense.

- F. The tree planting will be performed by the requirements of the Contract Documents and will be directed by the City Urban Forester. The Urban Forester will instruct the Contractor if changes need to be made due to any omission, contractual or otherwise, being noticed during the planting operation.
- G. All work shall be done in a safe and workman-like manner, in compliance with the rules and regulations of the Massachusetts Occupational Safety & Health Administration (OSHA) and all other City and State agencies and authorities having jurisdiction of the types of work included in this Contract.
- H. A Massachusetts Certified Arborist (MCA) or International Society of Arboriculture Certified Arborist (ISA) will carry out the planting of City of Somerville Public Shade Trees. These persons will be at the work site for all planting operations. Names and certification numbers of MCA, ISA, or equivalent arborists will be submitted and approved by the City Urban Forester before any planting occurs.
- I. Powers and Duties of the City Urban Forester
 - 1. For the purposes of the contract, the City of Somerville is acting through its City Urban Forester who is a Certified Arborist and who, in combination with the Tree Warden, by delegation and local ordinance, has control over and is responsible for the care and removal of all trees on City streets, playgrounds, schools, recreation lands and conservation land. The City's Tree Warden, in accordance with the Massachusetts General Laws, Chapter 87 entitled "Shade Trees", has authority over, control and supervision of all trees which now or which may hereafter exist upon any public street or highway in this City. The term City Urban Forester shall mean City Urban Forester or his/her designee.
 - 2. In the exercise of all or any of the powers herein granted, the City Urban Forester shall have the authority to delegate all or any part of his/her powers and duties with respect to the supervision and control of this contract to his/her subordinates and assistants in the employ of the City of Somerville as s/he may determine.

1.2 CONTRACT DOCUMENTS

- A. Shall consist of written specifications and drawings and general conditions. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any part shall be as binding as if called for in all parts.

1.3 APPLICABLE STANDARDS

- A. The standards and documents listed in the following paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section, the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the City Urban Forester.
 - 1. American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock.

2. American National Standards Institute (ANSI): Standard A300. Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.
3. Pruning practices shall conform to recommendations in “Structural Pruning: A Guide for the Green Industry”; 2013; Urban Tree Foundation, Visalia, California.
4. American National Standards Institute (ANSI): Standard Z-133.1-2012. Safety Requirements for Arboricultural Operations.
5. Occupational Safety and Health Administration (OSHA) standards, state and local regulations.
6. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
 - a. USDA - The Germplasm Resources Information Network ([GRIN](http://www.ars-grin.gov/npgs/searchgrin.html)) <http://www.ars-grin.gov/npgs/searchgrin.html>
 - b. Manual of Woody Landscape Plants; Michael Dirr; 2009; Stipes Publishing, Champaign, Illinois; 6th Edition.
7. Glossary of Arboricultural Terms; 2015; International Society of Arboriculture, Champaign IL.

1.4 REGULATIONS

- A. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as specified. If the Contractor observes that a conflict exists between laws and ordinances and the work outlined in the contract documents, the Contractor shall promptly notify the City’s Urban Forester in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.
- B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.
- C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or the City Urban Forester shall determine which shall govern.

1.5 PROTECTION OF WORK, PROPERTY AND PERSON

- A. The Contractor shall adequately protect the work, adjacent property(ies), and the public, and shall be responsible for any damages or injury due to his/her actions.

1.6 CHANGES IN THE WORK

- A. The City Urban Forester may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.
- B. All changes in the work, notifications, and Contractor’s request for information (RFI) shall conform to the contract general condition requirements.

1.7 CORRECTION OF WORK

- A. The Contractor, at their own cost, shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the City Urban Forester, at the soonest as possible time that can be coordinated with other work and seasonal weather demands.

1.8 DEFINITIONS

- A. Whenever used in any of the Contract Documents, the terms shall be defined as in the “Glossary of Arboricultural Terms”, or as herein defined.
1. Bare Root – a tree or shrub with minimal or no soil surrounding the roots of the plant.
 2. Balled and Burlapped (B&B): A tree or shrub dug from the ground with intact soil surrounding its roots. Soil and roots (collectively known as a root ball) are covered by a natural or synthetic burlap material. Burlap-covered root ball may be contained in a wire mesh cage.
 3. Caliper: The measure of a plant’s trunk diameter. Caliper measurement of the trunk shall be taken six inches above the ground up to and including four-inch caliper size. If the caliper at six inches above the ground exceeds four inches, the caliper should be measured at 12 inches above the ground. Caliper will be measured to the *nearest ½ inch*.
 4. Certified Arborist: An individual who has passed and currently maintains an arborist certification with the International Society of Arboriculture, the Massachusetts Arborist Association, or equivalent. Arborist certification shall require continuing education units (CEU’s) in order to maintain certification.
 5. Contract Supervisor: The individual or designated representative responsible for insuring the requirements of this contract are adhered to.
 6. Defective Plant: Any plant that fails to meet the plant quality requirement of this specification.
 7. End of Warranty Final Acceptance: The date when the City accepts that the plants and work in this specification meet all the requirements of the warranty.
 8. Field Grown Trees: Trees growing in field soil for at least 12 months prior to harvest.
 9. Healthy: Plants that are growing in a condition that expresses leaf size, crown density, and color typical of the species and cultivar’s horticultural description; and with typical annual growth rates for the species adjusted for the planting site soil, drainage and weather conditions.
 10. Kinked Root: A root within the root package that bends more than 90 degrees.
 11. Maintenance: Actions that preserve the health of plants after installation and as defined in this specification.
 12. Maintenance Period: The time period, as defined in this specification, which the Contractor is to provide maintenance.
 13. Normal: the prevailing protocol of industry standard(s).
 14. Reasonable and Reasonably: When used in this specification relative to plant quality, it is intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that it is not possible to produce plants free of all defects, but that some accepted industry protocols and standards result in plants unacceptable to this project.
 - a. When *reasonable* or *reasonably* is used in relation to other issues such as weeds, diseases, or insects, it shall mean at levels low enough that no treatment would be

required when applying recognized Integrated Plant Management practices.

- b. This specification recognizes that some decisions cannot be totally based on measured findings and that professional judgment is required. In cases of differing opinion, the City Urban Forester shall determine when conditions are judged as reasonable.
15. Root Ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.
16. Root Ball Package: The material that surrounds the root ball during shipping. The root package may include the material in which the plant was grown, or new packaging placed around the root ball for shipping.
17. Root Collar (a.k.a. root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.
18. Shrub: Woody plants with mature height approximately less than 15 feet.
19. Stem: The trunk of the tree.
20. Stem Girdling Root: Any root more than ¼ inch diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as stem girdling that have, or are likely to have in the future, root to trunk bark contact.
21. Structural Root: One of the largest roots emerging from the root collar.
22. Tree: Single and multi-stemmed plants with mature height greater than ~15 feet.

1.9 SAMPLES AND SUBMITTALS

- A. Complete lists of the available shade and ornamental tree species shall be submitted as part of the Contractor's bid. The species lists shall include common name and scientific name, including the cultivar or variety, when applicable, caliper size range, and number of trees available. The list of species that the City of Somerville currently plants is located near the end of the Technical Specification (see *Recommended Species*). It is expected that the Contractor will be able to acquire most of the species in the Recommended Species list.
- B. Upon award of the contract and at least thirty (30) days prior to intended use, the Contractor shall provide the following samples and submittals to the City Urban Forester for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Delivered materials shall closely match the approved samples. DO NOT order materials until City Urban Forester's approval of submittal has been obtained. Should the source of supply be changed within the course of the contract, the Contractor shall submit new samples or submittals for approval per the original submission.
 1. Plant sources: Submit sources of all plants to the City Urban for approval. Include plant growers' certificates for all plants indicating that each meets the requirements of the specification, including the requirements of tree quality, to the City Urban Forester for approval. Provide submittal 30 days before the installation of plants.
 2. Certify, invoice, and order plants for each shipment grown, free of disease and insect pests. Submit certificates to City Urban Forester.
 3. Planting soil: At least 30 days prior to ordering materials, the Contractor shall submit to the City Urban Forester representative samples, certifications, manufacturer's literature and certified test

results for proposed planting soil.

- a. Test results should include standard nutrient analysis, soil pH, soil textural analysis, organic matter content, and soluble salt content. These tests shall be performed by an accredited and independent laboratory and testing company.
4. Fertilizer: Submit one (1) sample packet of fertilizer, and manufacturer product data and literature product showing fertilizer composition and analysis; also submit invoices of total purchased material for this contract.
5. Mycorrhizal Fungal Transplant Inoculant with hydrogel for bare root trees: Submit one (1) sample packet showing composition and analysis of inoculant; also submit invoices of total purchased material for this contract.
6. Compost: Submit a copy of the lab analysis, performed by a STA Program certified lab, verifying that the compost meets the product parameters listed in Section 2.5 COMPOST (B). The lab analysis should not be more than 90 days old.
7. Planting Mulch: Submit a one- (1) cubic foot sample.
8. Drip irrigation bag product: Submit manufacturer product data and literature, and a sample.
9. Stakes and ties: Submit manufacturer product data and literature, and a sample.
10. Edging: Submit manufacturer product data and literature, and a sample.
- C. Names of Massachusetts Certified Arborist (MCA), or International Society of Arboriculture (ISA) certified arborist(s) that will be on site during all planting activities will be submitted and approved by the City Urban Forester before any planting occurs.
- D. Installation plan submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants. The review will be only for the information of the City for an overall understanding of the project sequence and site utilization. The contractor shall remain responsible for the adequacy and safety of the means, methods, and sequencing of construction. The plan shall include but not be limited to the following items:
 1. Detailed sequence of work
 2. General description of construction methods
 3. Number and location of crews and equipment and manpower to be deployed
 4. Traffic, bicycle and pedestrian management
 5. Proposed location of stockpiles
 6. Maintenance and continued operation of existing infrastructure.
- E. Warranty period site visit records: After each site visit during the warranty period by the Contractor, as required by this specification, submit a written record of the visit to the City Urban Forester for approval. Site visit record shall include details about which planting sites were visited, what maintenance was performed at each site, as well as any problems, potential problems, and any recommended corrective action.

1.10 OBSERVATION OF THE WORK

- A. The City Urban Forester may observe the work at any time. S/he may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and

replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.

- B. The City Urban Forester shall be informed of the progress of the work so the work may be observed at the following key times in the planting and maintenance processes. The City Urban Forester shall be afforded sufficient time to schedule visit to the site. Failure of the City Urban Forester to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.
 - 1. Plant quality: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.
 - 2. Planting activities: Monitor all planting activities, including, but not limited to, tree well excavation, tree placement, backfilling, watering, and mulching.
 - 3. Completion of the planting: Review the completed planting.

1.11 PRE-PLANTING CONFERENCE

- A. Schedule a pre-construction meeting with the City Urban Forester at least five (5) business days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction, and project work schedule.

1.12 QUALITY ASSURANCE

A. General Personnel Requirements:

- 1. Horticulturally skilled workers, trained and experienced in accepted nursery and arboriculture practices shall perform the planting. The work shall be done in a workmanlike manner under the supervision of a qualified planting supervisor demonstrating a background in landscape operations. It is required that the planting supervisor be a Massachusetts Certified Arborist, ISA Certified Arborist, or equivalent pending the City Urban Forester's approval and as defined in Section 1.8 DEFINITIONS (A)(4).
- 2. Each worker shall be trained in worker safety, and in compliance with current OSHA and ANSI standards.
- 3. In the event that the Contractor and/or his/her employees are found to be in violation of applicable safety requirements, the Contractor will be so notified by the City Urban Forester, and said person(s) may order that work be stopped until any and all such violations are corrected.
- 4. The City expects that all employees of the Contractor will interact with the public in a polite and professional manner. If the Contractor or his/her employees are not able to answer a question or satisfy a resident request, then the Contractor shall promptly refer the resident to the City Urban Forester as well as contact the City Urban Forester right away to report the nature of the resident's inquiry.

B. Equipment Requirements

- 1. The equipment used for tree planting and watering shall be of sufficient type, capacity and quantity to safely and efficiently perform the tree planting work as specified.
- 2. The Contractor shall not allow any operator to leave any vehicles/equipment unattended with the motor running.

C. Requirements Regarding Private Property

1. The normal access to a job site shall be along public roadways. Contractor shall not place equipment and/or personnel on private property.
 2. The Contractor shall be required to deal directly with private citizens with respect to repairing and/or replacing damaged bushes, shrubs, and other damage to private property that may be caused by the Contractor in connection with work performed pursuant to this contract. A report in writing concerning such damage and action taken to correct the damages shall be given to the City Urban Forester.
 3. The Contractor shall respond to the City Urban Forester within 24 hours in regards to all complaints of damage to private property alleged to have been caused by work performed by the Contractor. In case of such damage, the Contractor shall be required to make arrangements with the homeowner or business to remedy the damage. The Contractor shall make or effectuate any such repairs within thirty (30) days of the date of the damage, or within such additional times as agreed in writing between the Contractor and homeowner or business owner.
- D. Work scheduling and hours
1. The City intends on having scheduled tree planting work twice a year, during the Spring planting season and the Fall planting season. However, there may be other times during the year that the City will request that trees be planted. The City will make a list of planting location(s) in advance of the work for the Contractor.
 2. Prior to the commencement of work the Contractor shall meet with the City Urban Forester and provide a written schedule for the completion of work. The City Urban Forester requires that this schedule be closely adhered to. Any changes to the schedule must be submitted to the City Urban Forester in writing for approval.
 3. The Contractor shall begin work upon receipt of written and/or verbal orders to begin such work, and the work once begun shall be continuously carried forward with a force of persons adequate in the opinion of the City Urban Forester to complete the work in a continuous, uninterrupted, reasonable and expeditious manner, except in the case of inclement and unseasonable weather conditions. In the event the City Urban Forester determines that the Contractor has not begun work on orders to do so, or that the work once begun has been abandoned without authority, then the City Urban Forester shall give the Contractor seventy-two (72) hours' notice (Sunday excepted) to begin work, or resume work in case of abandonment. Failure of the Contractor to act within this specified time shall be deemed a breach of this contract and the Contractor shall be held liable for any damage or expense arising from such breach of contract.
 4. The work crew(s) will report daily to the City Urban Forester when they start and when they finish work for the day. Completed work locations are to be faxed or emailed on a daily basis to the City Urban Forester.
- E. General Standards
1. The Contractor's work shall be done in a workmanlike manner and performance thereof and all materials and facilities furnished by him/her shall be to the satisfaction of the City Urban Forester.
 2. Approved plant locations shall be marked by the City. Contractor to have planting locations checked by Dig-Safe for utility conflicts before any excavation or pavement removal is started.
 3. Any unexpected Dig-Safe conflicts or obstructions at the site that interfere with the tree planting operation will be communicated to the City Urban Forester to determine a solution before planting occurs. The Contractor will not be compensated for any planting adjustments not approved by the City Urban Forester.

4. All work areas shall be kept in such a manner so as to cause as little inconvenience as possible to the general public and adjacent property owners. When it is necessary to close pedestrian walks, vehicular traffic lanes or private access roads and drives, the Contractor shall provide personnel, barricades, warning signs, cones, flags or other means required by governing rules and ordinances, along with notifying the affected property owner or resident. Driveways are not to be blocked with debris at any time.
5. Contractor shall make no excavation in any public way or utility easement unless at least seventy-two (72) hours, exclusive of Saturdays, Sundays and legal holidays, before the proposed excavation is to be made, s/he has given notice in writing by registered mail if deemed necessary by the Contract Supervisor, of the proposed excavation to such public utility companies as supply gas, electricity and telephone service in the City, to such private companies as supply cable television service in the City and also to the City of Somerville Water Department. Such notice shall set forth the name of the street and a reasonably accurate description of the location in which the excavation is to be made. The Contractor shall comply with DIG SAFE LAW (G.I.C. 82, Sec 40).
6. PERMITTING: It shall be the responsibility of the Contractor to apply for and receive the appropriate permits from Department of Public Works and the Department of Parking and Traffic before the start of work.
 - a. The Contractor shall obtain a permit from the Department of Infrastructure and Asset Management (Engineering Division) prior to any sidewalk or roadway obstruction. A copy of this permit must be available at the work site at all times. The Contractor is required to obtain street excavation and street obstruction permits to complete the work under this contract. Fees for permits to excavate or obstruct the public way shall be waived; all permits must be obtained prior to beginning work on the City streets and sidewalks. Permits will be required for each of the project components.
 - i. Traffic plans and work zones shall be in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) of the U.S. Department of Transportation.
 - b. To restrict parking at the tree planting locations, the Contractor shall obtain "NO PARKING" signs from Somerville Traffic and Parking located at 133 Holland Street, and post them a minimum of forty-eight (48) hours before any sidewalk cutting or tree installation work may begin. All signs must be clearly posted with the dates that work will be done and the reason for the temporary parking restriction (*i.e.*, "tree planting"). Parking may not be restricted for more than three business days, and not outside of the hours of 8:00 a.m. – 7:00 p.m. The signs shall be placed in each location designated for tree service on any and all roadways prior to servicing the area. Signs shall be taped to trees, utility poles or city owned street signage. Both tape and sign shall be removed and disposed of by the Contractor immediately after the planting has been completed. Nails, tacks, wires or staples MAY NOT be used to attach signs to trees.
 - i. Road closures, if necessary, must be approved by the City of Somerville Traffic and Parking Department (telephone 617-666-3311 ext. 7900) not less than 48 hours prior to the Commencement of work.
7. Scheduling Police Details shall be the responsibility of the Contractor. A Police Detail is to be present during all construction activity. Police details are to be paid by the Contractor, who will then be reimbursed by the City upon request and *with proper documentation of the paid police detail expenses. The Contractor will not be paid any administrative or interest costs associated with police details.* An allowance for police details is included in the bid price. Contractor shall pay police traffic detail bills within 14 days of receipt to avoid a 10% late payment surcharge. The City will not pay any late charges.

8. Contractor is required to maintain all work areas in a safe fashion, especially during times when a police detail is not required. The Contractor will set up all necessary caution signs, high visibility flags, traffic cones, etc., at all times while working in the City.
9. The Contractor shall provide, erect and maintain all barricade warning signs, guards or other protection, as necessary and required for the safe execution of this Contract, and shall remove same upon completion of the work. No open tree pits shall be left unattended without safety and warning devices installed.
10. Contractor will not leave any excavated areas left open after securing his/her work site at the end of each day. The Contractor is responsible for barricading and cautioning off such open excavated areas before leaving the work site. The City Urban Forester may require the Contractor to cover over or backfill such excavated areas in reference to the safety of the general public.
11. Contractor shall carefully protect against damage to all existing trees and plants. The Contractor shall be liable for any and all damage to such trees, plants, real property and vehicles, and shall replace, repair, restore or provide for returning the same to their original condition, to the satisfaction of the City Urban Forester.
12. Contractor shall clean up the entire project site before the work will be accepted. All wood, brush, debris, rubbish, asphalt, stones from any excavation material, etc., shall be disposed of by the Contractor, unless specifically ordered by the City Urban Forester to do otherwise. All areas disturbed by the Contractor shall be left in a condition comparable to that originally found and satisfactory to the City Urban Forester.
13. Contractor shall exercise the greatest care to ensure that no material being hauled by the Contractor or Sub-Contractor either to or from the site is spilled onto any way, public or private, within the City limits. In the event that such spillage does occur, it shall be the Contractor's responsibility to remove the spilled material and clean the area promptly but in no event any later than the end of the workday. If in the judgment of the City Urban Forester, the Contractor has not satisfactorily cleaned the area of any spill, the City Urban Forester may then order the area to be cleaned by the City at the Contractor's expense.
14. Contractor shall furnish all the labor, materials, tools and equipment necessary to do all the work required for the completion of each item as specified.

F. Special Provisions

1. All work areas near and around the tree planting areas resurfaced by the Contractor shall be guaranteed against settlement, upheaval or failure of any kind for a period of two (2) years after the City accepts the work, and Contractor shall replace such resurfacing at their own expense. The City Urban Forester and/or the City's Engineering Department, shall be the sole judge as to what constitutes a failure and which portion of the resurfacing is to be replaced, and his/her decision will be final.
2. Before starting the work and from time to time during the project's progress, as the City Urban Forester or the City's Engineering Department may request, the Contractor shall submit to him/her or them a written description of the methods s/he plans to use in doing the work and the various steps s/he intends to take.
3. Contractor shall cooperate with any other Contractors, utility companies and/or City of Somerville staff that may be working at or near this project's work site covered by this contract. The City Urban Forester and/or the City's Engineering Department, will decide as to the respective rights of the parties involved and their decisions shall be final.

G. Semi-Final Acceptance - Acceptance of the work prior to the start of the warranty period:

1. Once the Contractor completes the installation of all trees according to the specifications herein, and has completed the 30-day post-installation watering (2x per week), the City Urban Forester will observe all work for Semi-Final Acceptance upon written request of the Contractor. The request shall be received at least ten (10) calendar days before the anticipated date of the observation.
 2. Semi-Final Acceptance by the City Urban Forester shall be for general conformance to specified size, character and quality and does not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.
 3. Any plants that are deemed defective as defined under the provisions below shall not be accepted.
 4. The City Urban Forester will provide the Contractor with written acknowledgment of the date of Semi-Final Acceptance and the beginning of the warranty and plant maintenance period.
- H. Contractor's Quality Assurance Responsibilities: The Contractor is solely responsible for quality control of the work.

1.13 PLANT WARRANTY

A. Planting Period:

1. All plants shall be warrantied to meet all the requirements for plant quality in this specification. Defective plants shall be defined as plants not meeting these requirements. The Contractor agrees to replace defective work and defective plants. The City Urban Forester shall make the final determination if plants meet these specifications or that plants are defective.
2. Plants determined to be defective shall be removed immediately upon notification by the City Urban Forester and replaced without cost to the City, as soon as weather conditions permit and within the specified planting period.

B. Two-Year Plant Warranty:

1. Plant warranty shall begin on the date of Semi-Final Acceptance and continue for two (2) years.
2. When the work is accepted in parts, the warranty periods shall extend from each of the partial Semi-Final Acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of plant warranty shall terminate at one time.
3. Any work required by this specification or the City Urban Forester during the progress of the work for the purpose of correcting plant defects, including the removal of roots or branches, or planting plants that have been bare rooted during installation to observe for or correct root defects, shall not be considered as grounds to void any conditions of the warranty. In the event that the Contractor decides that such remediation work may compromise the future health of the plant, the plant or plants in question shall be rejected and replaced with plants that do not contain defects that require remediation or correction.
4. Replacements shall conform to the species and size of the original specimen. Replacements shall be subject to all requirements stated in this specification.
5. Replacements shall be maintained and guaranteed for two years from the time of replacement, per the terms of the warranty period.
6. During and by the end of the warranty period, remove all tree stakes, ties, and guying materials unless agreed to in writing by the City Urban Forester that they should remain in place. All trees requiring additional anchorage in windy locations may need to remain staked, if required by the City Urban Forester.

- C. End of Warranty Final Acceptance - Acceptance of plants at the end of the warranty period.
 - 1. At the end of the warranty period, the City Urban Forester shall observe all warranted work, upon written request of the Contractor. The request shall be received at least fourteen calendar days before the anticipated date for final observation.
 - 2. End of Warranty Final Acceptance will be given only when all the requirements of the work under this specification have been met.

1.14 SELECTION AND OBSERVATION OF PLANTS

- A. The City Urban Forester may review all plants to verify size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.
 - 1. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the City.
- B. The City Urban Forester will select and tag all specified tree planting material at the nursery location(s). Only trees that are selected and tagged by the City Urban Forester will be planted in the City. The selecting of plants by the City Urban Forester at the nursery does not preclude the right to reject material while on site that does not conform to this specification.
 - 1. The City Urban Forester may make invasive observation of the plant's root system in the area of the root collar and the top of the root ball in general in order to determine that the plant meets the quality requirements for depth of the root collar and presence of roots above the root collar. Such observations will not harm the plant.
 - 2. The City Urban Forester reserves the right to reject plants that do not meet specifications as set forth in this specification. If a particular defect or substandard element can be corrected at the nursery, as determined by the City Urban Forester, the agreed upon remedy may be applied by the nursery or the Contractor provided that the correction allows the plant to meet the requirements set forth in this specification. Any work to correct plant defects shall be at the Contractor's expense.
 - 3. Corrections are to be undertaken at the nursery prior to shipping. The Contractor shall bear all cost related to plant corrections.

1.15 SITE CONDITIONS

- A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the City Urban Forester, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.
 - 1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the City Urban Forester in writing, stating the conditions, and submit a proposal covering cost of corrections. If the Contractor fails to notify the City Urban Forester of such conditions, s/he shall remain responsible for plant material under the warranty clause of the specifications.
- B. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.
 - 1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather,

such as rain or snow or during extremely hot, cold or windy conditions.

1.16 PLANTING AROUND UTILITIES

- A. Contractor must have planting locations checked by Dig-Safe to determine the location of underground utilities before any excavation or pavement removal is started. Perform work in a manner that will avoid possible damage. Inform the City Urban Forester of any conflicts prior to tree installation. The City Urban Forester will determine alternate planting locations, as needed.

1.17 ALTERNATES

- A. Alternates may be included in the bid document. Alternates, if adopted by the City, shall either increase or decrease the Contractor's base bid contract price and lump sum bid. The City reserves the right to determine the lowest eligible bidder on the basis of the base bid or the adoption of the Alternates, selected in order, and in combination with the base bid. (For example: Base Bid, Base Bid + Alternate 1).
 1. Alternates consist of watering up to 300 young trees throughout city that have been planted by means outside of the current contract. Each tree will be supplied with a 20 gallon irrigation bag by the City. Upon request of the City Urban Forester, the Contractor shall fill the irrigation bag for each tree with 20 gallons of water. Each tree will be required to be watered a maximum of once per week throughout the growing season (May 15th – November 15th), as requested by the City Urban Forester and depending on weather conditions. The location of each tree to be watered for a given growing season and the number of watering incidents for each tree in that growing season will be provided by the City's Urban Forester.
 2. Contractor shall provide the City Urban Forester with a schedule of watering for the alternate trees. The watering schedule shall include details on the order in which the trees will be watered, the frequency of watering (based on the information provided by the City Urban Forester), and the volume of water that will be provided to each tree during each visit.
 3. If any irrigation bag is missing, ripped, or otherwise not functioning according to the manufacturer's specifications, the Contractor will immediately notify the City Urban Forester. The bag will be replaced by the City and watering will continue for the remainder of the growing season.
 4. The specifications for watering described in Sections 3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE) (F) (G) (I) and 3.18 WATERING (2-YEAR WARRANTY PERIOD) (D) apply to the watering of these alternate trees.

PART 2 – PRODUCTS

2.1 TREES: GENERAL

- A. Standards and measurements: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents. City Urban Forester will provide a list of chosen species at least 30 day prior to installation.
 1. The Contractor shall supply the plants necessary to complete the work as intended.
 2. All plants shall be nursery grown balled and burlapped trees or bare root trees (when specified by the City Urban Forester), grown under climatic conditions similar to those in Somerville, Massachusetts.

3. The root ball dimensions to trunk caliper ratio shall conform to American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.
 4. When a range of sizes is given, no plant shall be less than the minimum size, and the average size of all plants furnished will be equal to the average of the two dimensions. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.
 5. Plants larger than specified may be used if acceptable to the City Urban Forester. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
 6. Substitutions: Substitutions will **NOT** be permitted without the consent of the City Urban Forester. If proof is submitted that a plant(s) is not obtainable or does not meet requirements of the Specification, use of nearest equivalent size or variety will be considered. Plants larger than specified may be used at no increase in cost. Proposed substitutions must receive the written approval of the City Urban Forester. When sources for plants are located by the City Urban Forester, there will be no substitutions and those sources will be used at no increase in cost. The City does not guarantee it will accept substitutions. The City will require that the Contractor try every means possible to obtain the specified trees.
- B. Plant Identification: The nomenclature used in the plant list conforms to the USDA Germplasm Resource Information Network (<http://www.ars-grin.gov/npgs/searchgrin.html>) or as in the book "The Manual of Woody Landscape Plants" by Michael Dirr. All trees shall be true to name as ordered, and shall be labeled individually by genus, species, variety and cultivar.
1. Plant labels shall be provided by the Contractor for each tree and shall be durable, legible labels stating the correct tree name and size, in weather resistant ink or embossed process lettering, and can be removed at the end of the Contract.
- C. Plant Quality:
1. **General:** Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, larvae, and all forms of infestations. Tree plantings shall be typical of their species and variety. At the time of installation in the City, all plants shall have a normal balance between height and spread, and root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant. The City prefers trees that have not been treated with neonicotinoid insecticides; whenever possible, Contractor shall source trees from nurseries that do not use neonicotinoids.
 2. **Plant quality above the soil line:** Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves typical of the plant type specified. Plant quality above the soil line shall comply with the project Crown Acceptance details and the following:
 - a. Crown: the form and density of the crown shall be typical for a young specimen of the species or cultivar, pruned to a central and dominant leader.
 - i. Trees shall have a persistent main leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present.
 - ii. Crown specifications do not apply to plants that have been specifically trained in the nursery as topiary, espalier, multi-stem, clump, or unique selections such as

contorted or weeping cultivars.

- b. Leaves: the size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.
 - c. Branches: shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.
 - i. Main branches shall be symmetrically distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
 - ii. Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.
 - iii. The attachment of the largest branches (scaffold branches) shall be free of included bark.
 - d. Trunk: the tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, lesions (mechanical injury), or disfiguring knots.
 - i. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stakes may be used to maintain a straight leader in the upper half of the tree.
 - ii. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.
 - e. Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter.
3. **Plant quality at or below the soil line:** Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:
- a. The roots shall be reasonably free of scrapes, broken or split wood.
 - b. The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high quality root system are not considered injuries.
 - c. A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.
 - i. Plants with structural roots on only one side of the trunk ('J roots') shall be rejected.
 - d. The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.

- e. The root system shall be free of stem girdling roots over the root collar or kinked roots from nursery production practices.
 - i. Plant Grower Certification: The final plant grower shall be responsible to have determined that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous production system used practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage, if needed, to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of stem girdling and kinked roots as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.
- f. At time of plant selection observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.
- g. All plant root balls shall conform to the size requirements specified for the proposed tree species and size at planting identified in the Plant List, and to the code of standards set forth in the current edition of American Standard for Nursery Stock.
 - i. All tree root systems shall be retained as solid units. The diameter and depth of the balls of soil must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of each tree planting.
 - ii. The tree plantings and root balls shall remain intact as a unit during all operations. No tree planting shall be accepted when the ball of each surrounding its roots has been badly cracked or broken, either before or during the process of planting.
- D. Submittals: for each plant type, submit the required plant quality certifications from the grower where plants are to be purchased to the City Urban Forester for approval. The certification must state that each plant meets all the above plant quality requirements.
 - 1. The grower's certification of plant quality does not prohibit the City Urban Forester from observing any plant or rejecting the plant if it is found to not meet the specification requirements.
- E. Inspections: Plants shall be inspected, selected, and tagged at the place of growth by the City Urban Forester with the Contractor. Inspection and approval at the source(s) shall not waive the right of rejection for failure to meet other requirements during progress of work.

2.2 PLANT ROOT BALL PACKAGE OPTIONS

The following root ball packages are permitted. Any type of root ball packages that is not specifically defined in this specification shall not be permitted.

A. Balled and Burlapped Plants

- 1. All Balled and Burlapped (B&B) plants shall be field grown, and the root ball packaged in burlap and twine and/or burlap and wire basket package.
- 2. The root ball dimensions to trunk caliper ratio shall conform to American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock. All tree plantings shall retain root systems as solid units. The diameter and depth of the balls of soil must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of each

tree planting.

3. The tree plantings and root balls shall remain intact as a unit during all operations. Tree plantings shall **NOT** be accepted when the ball of earth surrounding its roots has been badly cracked or broken, either before or during the process of planting.
4. Plants shall be harvested with the following modifications to standard nursery practices.
 - a. Prior to digging any tree that fails to meet the requirement for maximum soil and roots above the root collar, carefully removed the soil from the top of the root ball of each plant, using hand tools, water or an air spade, to locate the root collar and attain requirements for soil depth over the structural roots (maximum of 2" soil depth above the point where the top-most root(s) emerges from the trunk). Remove all stem girdling roots above the root collar. Care must be exercised not to damage the surface of the root collar and the top of the structural roots.
 - b. All root pruning and hardening off procedures shall be accomplished utilizing accepted horticultural practices. Trees that are stored out of the ground shall be placed in a holding area protected from extremes of wind and sun with the root ball protected by covering with mulch or straw and irrigated sufficiently to keep moisture in the root ball above wilt point and below saturation.
 - c. If wire baskets are used to support the root ball, a "low profile" basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less than 4 inches and no greater than 8 inches below the shoulder of the root ball package.
 - i. At nurseries where sandy soils prevent the use of "low profile baskets", baskets that support the entire root ball, including the top, are allowable.
 - d. Twine and burlap used for wrapping the root ball package shall be natural, biodegradable material. If the burlap decomposes after digging the tree then the root ball shall be re-wrapped prior to shipping if roots have not yet grown to keep root ball intact during shipping.

B. Bare Root Plants

1. Harvest bare root plants while the plant is dormant and a minimum of 4 weeks prior to leaf out (bud break).
2. The root spread dimensions of the harvested plants shall conform to ANSI Z60.1 for nursery grown bare root plants for each size and type of plant. Just prior to shipping to the job site, dip the root system into a slurry of hydrogel (cross linked polyacrylamide) and water mixed at a rate of 15 oz. of hydrogel in 25 gallons of water. Do not shake off the excess hydrogel. Place the root system in a pleated black plastic bag and tie the bag snugly around the trunk. Bundle and tie the upper branches together.
3. Keep the trees in a cool dark space for storage and delivery. If daytime outside temperatures exceeds 70 degrees F, utilize a refrigerated storage area with temperature between 35 and 50 degrees.
4. Where possible, plan time of planting to be before bud break. For trees to be planted after bud break, place the trees before bud break in an irrigated bed of pea gravel.
 - a. The pea gravel bed shall be 18 inches deep over a sheet of plastic.
 - b. Space trees to allow the unbundled branches to grow without shading each other.
 - c. Once stored in pea gravel, allow the trees sufficient time for the new root system to flush and spring growth of leaves to fully develop before planting.

- d. Pea gravel stored trees may be kept for up to one growing season.
- e. Pea gravel stored trees shall be dipped, packaged and shipped similar to the requirements for freshly dug bare root trees above.

2.3 PLANTING SOILS

- A. Contractor shall provide all topsoil required to complete the planting operation. Planting soil shall be a natural, fertile, friable loam typical of cultivated topsoil of the locality, containing at least 10% and not more than 20% decayed organic matter (humus). Topsoil shall be free of sub-soil, stones greater than 1-¼ inches in diameter in the longest dimension, earth clods, sticks, stumps, clay lumps, roots, or other objectionable, extraneous matter or debris. Topsoil shall not be by test either excessively acid or alkaline nor contain toxic substances. Soil soluble salt content shall be less than 2 dS/m, and pH shall be between 5.5 and 6.5. Topsoil shall not be delivered or used for planting while in a frozen or muddy condition.
- B. Soil for planting trees shall be one of the following sandy loams; “course sandy loam”, “sandy loam”, and “fine sandy loam”: determined by soil texture analysis and based on the "USDA Classification System" and as defined in this section. It shall be of uniform composition, without admixture of subsoil. Planting soil for trees shall have the following grain size distribution for material passing the #10 sieve:

Millimeter	Percent passing by weight	
	Maximum	Minimum
2	-----	100
1	100	80
0.5	87	67
0.25	78	48
0.10	68	30
0.05	55	22
0.002	7	2

- 1. Maximum size shall be one and one quarter inches largest dimension. The maximum retained on the #10 sieve shall be 25% by weight of the total sample.
- 2. The ratio of the particle size for 80% passing (d80) to the particle size for 30% passing (d30) shall be 6.0 or less. (d80/d30 < 6.0)
- C. Submittals: Representative sample, certification, manufacturer's literature and certified test results for proposed planting soil to be submitted to and approved by the City Urban Forester.

2.4 FERTILIZER

- A. Fertilizer shall be a complete, slow-release, root contact packet, 16-8-16, or equal, that is engineered to stimulate root growth and is a standard product complying with State and Federal Fertilizer Laws. Slow release fertilizer is defined as having more than 50% of the nitrogen in the water insoluble nitrogen form.
- B. Submittals: Name of supplier and sample to be approved by the City Urban Forester.

2.5 COMPOST

- A. Compost mulch shall be a well decomposed, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated waste. The product shall contain no substances toxic to plants and be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, only use a compost that has not received the addition of liming agents or ash by-products. The product shall be certified through the U.S. Composting Council's (USCC) Seal of Testing Assurance (STA) Program.

B. Product Parameters*:

Parameters ^{1,5}	Reported as (units of measure)	General Range
pH ²	pH units	5.5 – 9.0
Soluble Salt Concentration ² (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	25 – 60
Organic Matter Content	%, dry weight basis	> 30
Particle Size	% passing a selected mesh size, dry weight basis	99% pass through 3" screen, >25% passing 3/8" screen
Physical Contaminants (inerts)	%, dry weight basis	< 0.1
Chemical Contaminants ³	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants ⁴ Select Pathogens Fecal Coliform Bacteria, or Salmonella	MPN per gram per dry weight MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

¹ Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, the US Composting Council)

² It should be noted that the pH and soluble salt content of the amended soil mix is more relevant to the establishment and growth of a particular plant, than is the pH or soluble salt content of a specific compost (soil conditioner) used to amend the soil. Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. Most ornamental plants and turf species can tolerate a soil/media soluble salt level of 2.5 ds/m and 4 ds/m, respectively. Seeds, young seedlings and salt sensitive species often prefer soluble salt levels at half the afore mentioned levels. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements, and how they relate to existing soil conditions.

³ US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41ppm, Cadmium 39ppm, Copper 1,500ppm, Lead 300ppm, Mercury 17ppm, Molybdenum 75ppm, Nickel 420ppm, Selenium 100ppm, Zinc 2,800ppm.

⁴ US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4 grams of total solids or Fecal Coliform <1000 MPN/gram of total solids.

⁵ City Urban Forester may modify the allowable compost specification ranges based on specific field conditions and plant requirements.

- C. Submittals: Submit a copy of the lab analysis, performed by a STA Program certified lab, verifying that the compost meets the product parameters listed in Section 2.5 COMPOST (B). The lab analysis should not be more than 90 days old.

2.6 MULCH

- A. Mulch shall be applied for moisture retention in soil, abatement of dust and weeds, and for nutrient enrichment of the soil.
- B. Mulch shall be high quality, premium coarse-grade bark mulch, 15 mm minimum length, consisting of clean organic plant material.
- C. Bark mulch shall conform to the following:
 - 1. Must be a uniform, natural wood color, without dyes, which shall not exhibit a noticeable degree of color change characteristic when wet.
 - 2. Must not have an unpleasant odor.
 - 3. Must be free of dirt, insects, disease, and extraneous debris that would be harmful to the trees being planted.
 - 4. pH: between 4.0 and 8.0.
 - 5. Particle size: 100% passing through a 50mm (2 inch) screen.
 - 6. Soluble salt content: less than 4.0 mmhos/cm.
- D. Submittals: Prior to the Contractor ordering the organic coarse-grade bark mulch material, the Contractor shall submit to the City Urban Forester, at the Contractor's expense, one cubic foot sample of the bark mulch material and the supplier's product specification data sheet. The Contractor shall not order any delivery of the bark mulch material until the Contractor's sample has been inspected and approved by the City Urban Forester.
 - 1. If the City Urban Forester disapproves of the sample submitted by the Contractor, then the Contractor shall continue at no expense to the City, to obtain other sources of bark mulch material as specified until the Contractor's sample of such material, meets with the City Urban Forester's approval.

2.7 WATER AND WATERING BAGS

- A. Water furnished by the Contractor will be free of ingredients harmful to humans and plant life. The Contractor will supply hoses and other watering equipment required for the work.
- B. The Contractor shall be responsible to furnish its own supply of water to the site. At no time will the Contractor seek to use water from private property owners.
- C. Contractor may get water from City of Somerville fire hydrants ONLY with the approval of the City's Water Department. The Contractor will be responsible for following all the procedures and requirements set by the Water Department. The Water Department will provide the Contractor with a meter and/or backflow device and will charge the Contractor a fee for the water and meter and/or backflow device. It is the responsibility of the Contractor to obtain this information. The Somerville Water Department is located at 1 Franey Rd., and can be reached at 617-625-6600 extension 5850, or water@somervillema.gov.
- D. Watering for trees shall be provided through use of a drip irrigation bag which shall be approved by the City Urban Forester. Irrigation bag must:
 - 1. Be constructed of plastic or other flexible watertight material.
 - 2. Have a holding capacity of a minimum of 20 gallons.
 - 3. Have an opening in the top for filling.

4. Have a slow drip hole(s) water release system in the bottom, specifically designed to water establishing trees. Rate of complete water release must be no quicker than 5 hours for a complete fill.
- E. Submittals: Name of drip irrigation bag product supplier, including manufacturer product data and literature, and sample to be approved by the City Urban Forester.

2.8 TREE STAKING AND GUYING MATERIAL

- A. Tree stakes shall be 10 foot long lodge pole wooden stakes free of knots, 3" in diameter, or 2" x 3", and pointed at one end.
- B. Tree ties shall be flat woven straps, made of polyester or polypropylene, 3/4 inch wide, and 900 lb. break strength. Color to be green or black.
- C. Submittals: Samples of stakes and tree ties and manufacturer product data and literature shall be submitted to the City Urban Forester for approval.

2.9 EDGING

- A. For new or expanded tree wells in brick sidewalks or wells with brick borders, the Contractor shall install edging around the perimeter of the tree well to keep the bricks from displacing.
- B. Aluminum edging shall be shop fabricated from aluminum alloy 6063-T6, 3/16 inch thick x 1-5/8 inch or 2-1/4 inch deep, with standard black baked-on acrylic paint finish. Edging shall be furnished in 16-foot lengths.
 1. Adjacent sections shall be adjoined using a 4 inch sliding, locking connector of aluminum alloy 6063-T6.
 2. Stakes shall be spiral steel spikes with insulating plastic washers 10 inches x 3/8 inch.
- C. Name of edging product, supplier and sample to be approved by the City Arborist.

PART 3 – EXECUTION

3.1 SAW CUTTING AND PAVEMENT REMOVAL

- A. Certain locations will require the removal of pavement to allow for the excavation or expansion of the planting holes. Pavement types may include cement, bituminous concrete, brick or stone, and other similar substances.
- B. All areas where pavement will be removed will be marked in the field by white marking paint. Dimensions of each cut will be provided by the City Urban Forester. All edges are to be cut with straight, clean cuts using a saw. Water shall be used during the saw cutting to reduce dust.
- C. The Contractor shall be responsible for the legal disposal of all excavated pavement off site, at the Contractor's expense.
- D. All dust, debris and deposits (including any residue from wet-saw cutting) left behind from the cutting and excavating operation shall be cleaned up immediately and removed from the site following the installation of the tree. Dust, debris, and deposits shall NEVER be left in the newly created tree well.

3.2 REMOVAL OF DEAD OR DYING TREES

- A. Certain locations will require the removal of dead or dying trees prior to the installation of a new tree. Locations of each tree removal will be provided by the City Urban Forester. Trees designated for removal will be a maximum of 9 inches in caliper.
- B. Contractor will be responsible for the removal and legal disposal of any dead or dying trees that are removed.
- C. Saws or other equipment may be necessary for the removal of these dead or dying trees, at the discretion of the contractor.

3.3 REMOVAL OF UNDERGROUND STUMPS

- A. Occasionally the Contractor may find a residual stump below the cement or asphalt where the City has located a new tree to be placed. At the direction of the City Urban Forester, the Contractor will remove the stump or grind it down sufficiently to allow for the site to be planted with a new tree. Any sidewalk that is damaged during the removal or grinding of the stump will be repaired at the expense of the Contractor.

3.4 REMOVAL OF COBBLES FROM EXISTING TREE WELLS

- A. Certain existing tree wells have a border of stone cobbles (ex. on Somerville Avenue). At the direction of the City Urban Forester, the Contractor will remove these cobbles from the tree wells. The stone cobbles will either be reset after the new tree is installed or legally disposed of, as determined by the City Urban Forester.

3.5 TREE GRATE AND GUARD REMOVAL

- A. From time to time prior to the planting of trees and/or at locations with existing trees the City may require that metal tree grates and tree guards be removed. Removal shall be done in such a manner that does not damage an existing tree to remain with whatever tools and equipment the Contractor deems necessary and is approved by the contract supervisor.
- B. The legal disposal of the grate and/or guard shall be the sole responsibility of the Contractor. The City reserves the right to keep the grate and/or guard as it deems necessary.
- C. After removing the grate and/or guard each tree well is to be weeded and cleaned of all debris. Bark mulch is to be replaced in the tree well to a level that meets the surrounding grade/ sidewalk surface.

3.6 EDGING

- A. Edging shall be installed at perimeter of new and expanded tree pits that abut brick paving. Install edging with the base resting on the ground and facing toward the brick paving and sidewalk. Set edging to the required alignment, straight and true and to the required elevation to ensure full paver restraint. Thread spike through insulating washer. Drive spikes into base until spike head firmly wedges washer against flange of aluminum edging.
 - 1. Edging shall be securely staked in required position. Stakes shall be driven every 12 inches in straight runs and into every support section in curved sections.
 - 2. Adjacent lengths shall be attached using manufacturer's standard connections according to manufacturer's published instructions.

3. Edging shall be set plumb and vertical at required line and grade. Straight sections shall not be wavy; curved sections shall be smooth and shall have no kinks or sharp bends.

3.7 TREE PLANTING SEASON

- A. Planting shall only be performed when weather and soil conditions are suitable. No planting shall take place during adverse weather conditions as determined by the City Urban Forester. Adverse weather conditions include extremely hot, dry, windy or freezing weather.
- B. Install plants during the planting time as described below unless otherwise requested by or approved in writing by the City Urban Forester. On occasion, plantings may take place outside of these times. In the event that the Contractor requests planting outside the dates of the planting season, approval of the request does not change the requirements of the warranty.
 1. Spring Planting Season: April 1st – June 15th
 2. Fall Planting Season: September 15th – November 30th

3.8 TREE PLANT SELECTION

- A. The City Urban Forester will select and tag all specified tree planting material at the nursery location(s).

3.9 PLANT MATERIAL HANDLING, DELIVERY, AND STORAGE

- A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.
 1. The Contractor will inspect and approve all trees at the nursery(ies) prior to pick up. However, this does not alter the right of the City Urban Forester to inspect and reject unsuitable trees delivered to the planting site.
 2. During transport, cover trees with a breathable protective mesh covering (no plastic) to prevent wind damage.
 3. When plants cannot be transported and planted immediately upon being dug they shall be stored and protected from desiccation and extremes in temperature by being heeled-in, watered, and covered.
 4. Special care shall be taken to insure that the roots of bare root and balled and burlapped trees are not damaged and not allowed to dry out during the course of a work day. Using a soil moisture meter, periodically check the soil moisture in the root balls of all balled and burlapped plants to assure that the plants are being adequately watered. Volumetric soil moisture shall be maintained above wilting point and below field capacity for the root ball substrate or soil.
- B. Plants shall be handled, transported, and stored so as to prevent damage of any sort, including but not limited to breaking of branches, scraping or bruising the trunk or root collar, breaking root balls or roots.
 1. Bare root and balled and burlapped trees are to be placed on a trailer, truck, or other equipment gently and in a manner that does not damage any portion of the tree. Once placed, they are to be covered in a manner that sunlight does not shine on the roots of the plants and the branches are

protected from wind damage.

2. Move balled and burlapped trees using only the root ball; never pick up or move the tree using the trunk as a handle.
 3. All unplanted tree plantings shall be protected at all times from sunlight and drying winds.
 4. At no time shall the roots of the trees be exposed to direct sunlight, wind, or drying out. Balled and burlapped and bare root plants are to be covered during all forms of transport, and are not to be uncovered until immediately prior to installation. While sitting and waiting to be installed, plants and associated roots must be covered and protected from light and drying out.
- C. Tree plantings shall be delivered to the tree planting site in a well-watered and vigorous condition.
- D. If necessary, provide a suitable remote staging area for plants and other supplies. The City Urban Forester shall approve the duration, method and location of storage of plants.
1. Do not deliver more plants to the site than there is space with adequate storage conditions.
 2. If desired, the Contractor must request a staging area 30 days before the start of any work. Request will be submitted to the City Urban Forester. If the request is made less than 30 days before the start of any work, the Contractor shall be responsible for furnishing and/or leasing any temporary storage or construction staging area required.
 3. All trees shall be stored in an upright position, and grouped according to Genus, Species, and 'cultivar' or 'variety'. Stored trees shall be mulched such that 2/3 of each root ball is covered, and heavily watered twice a day to prevent wilt and undue stress to the trees.
 4. Trees are to be removed from the temporary holding area on a daily basis. Only the plants that can be planted in the course of a normal work day should be removed from the holding area.
 5. Care shall be taken to not damage the trees or roots during the transport from the temporary holding area to the planting site. It is the Contractor's responsibility to determine the best method to ensure that the roots are not damaged and do not dry out during the course of the planting process. Damaged roots/ plants will be the responsibility of the Contractor.
 6. The City Urban Forester may inspect the temporary storage area upon notifications to the Contractor.
 7. The Contractor shall provide the City Urban Forester with a schedule of tree pick-up from the temporary storage location, including the day and time of pick up for each tree.
- E. If it is determined that poor handling and neglect by the Contractor has caused a plant to die or fail to establish, the Contractor shall be responsible for the cost of replacing the plant. Costs shall include the cost of purchase, cost to remove dead plant, and cost to install new plant. Poor handling and/or neglect may result in contract termination.

3.10 SOIL MOISTURE

- A. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	Permanent wilting point	Field capacity
Sand, loamy sand, sandy loam	5-8%	12-18%
Loam, sandy clay, sandy clay	14-25%	27-36%

loam		
Clay loam, silt loam	11-22%	31-36%
Silty clay, silty clay loam	22-27%	38-41%

- B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.
 - 1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent.

3.11 GENERAL TREE PLANTING

- A. Prior to tree planting, the City Urban Forester will supply in writing to the Contractor specified tree planting locations showing the tree species selected and approved.
- B. Contractor installation plan shall be submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants.
- C. Tree planting areas may need pavement removal and/or tree or stump removal, as required by the City Urban Forester. All materials excavated from the tree planting areas and considered detrimental to the growth of the trees, such as an existing tree or stump, old wire baskets, burlap and aeration tubes, sidewalk paving, rocks, sub-soil and debris, shall not be reused for fill or in the planting operation, and must be removed from the site and disposed of properly.
- D. Any unexpected obstructions at the site that interfere with the tree planting operation will be communicated to the City Urban Forester to determine a solution before planting occurs.
- E. Soil of very poor quality or heavy clay encountered by the Contractor must be reported to the City Urban Forester for removal and amended as required.
- F. Observe each plant after delivery and prior to installation for damage or other characteristics that may cause rejection of the plant. Notify the City Urban Forester of any condition observed.

3.12 PLANTING HOLE PREPARATION

- A. For tree planting pits that are surrounded by brick or stone cobbles, carefully remove brick or stone such that it can be reused after the tree has been planted.
- B. Remove all soil, where present, from above the root flare to expose the top-most root where it emerges from the trunk, and measure the distance between the top-most root and the bottom of the root ball or root mass.
- C. Hole shall be dug about 10% shallower than this depth.
- D. Planting pits shall be excavated to the full width and length of the surface opening. In lawn areas, the planting area must be dug to the depth of the root-ball and 3 times the width.
- E. When planting holes are dug using mechanical means, i.e. backhoe, excavator, auger, etc., and the side walls of the pits become plastered or glazed, the plastered or glazed surface shall be properly scarified.
- F. Upon approval of planting locations and pavement removal (where applicable), excavate existing

soils and remove all trees and stumps 9 inches or less in caliper, and any other deleterious materials as specified herein. The Contractor must haul and legally dispose of excavated material off-site.

- G. The tree well will be cut based on the markings on the sidewalk. The dimensions of each tree well will be noted on the planting list given to the Contractor prior to the start of planting. The tree well must be excavated to its full extent. Acceptable material may be put back into tree well and amended as needed with approved planting soil. Remove any stones greater than 1-1/4 inches in diameter in the longest dimension, earth clods, sticks, stumps, clay lumps, roots, or other objectionable, extraneous matter or debris from the excavated soil before using it for backfill. If excavated material cannot be reused refer to Section 3.13 SOIL AND WASTE MANAGEMENT for instruction.
- H. Surplus excavation and unsuitable material from the planting holes shall be removed from the site and disposed of per Section 3.13 SOIL AND WASTE MANAGEMENT of this specification.
- I. Planting pits will require a minimum of 3 feet (36 inches) of walking space for sidewalk pedestrian traffic.
- J. Planting wells and areas shall be approved by the City Urban Forester, or designee, before back filling.
- K. Tree wells shall be at least 18 square feet, 6' x 3' or as directed by the City Urban Forester.

3.13 SOIL AND WASTE MANAGEMENT

- A. For guidelines and policies related to handling and disposal of contaminated soil please refer to the Department of Environmental Protection (DEP) website at <http://www.mass.gov/eea/agencies/massdep/>.
- B. It is the objective of soil/fill management practices specified here to handle all soil/fill excavated during the course of this contract in a cost-effective manner and in accordance with applicable State and Federal regulations. The Contractor shall reuse excavated materials, as approved by the City Urban Forester, prior to using imported fill in order to reduce the volume of material to be disposed off-site provided the material is geotechnically suitable as backfill and does not result in spreading contamination to other areas or other soil/fill strata. Excavated soil/fill, which is displaced by planting of trees, may be used as backfill elsewhere on the project provided the soil/fill is geotechnically suitable and does not result in spreading contamination or degrade the environmental quality at the location of reuse. Imported backfill shall be used only as accepted by the City Urban Forester.
- C. Any soils which exhibit petroleum or chemical odor or visual indications of oil or hazardous materials shall be handled as potentially contaminated soils. Soil which does not have any evidence of contamination can be reused within the *area of excavation*. Soil/fill which is staged and characterized can be reused within the area of excavation or elsewhere on site provided the material has equal or less contamination than the point where it is to be reused.
- D. Contaminated soil/fill (including petroleum-contaminated soil/fill) which cannot be reused on site shall be removed and disposed of by the Contractor, or shall be delivered within the City to a stockpile location to be determined by the City of Somerville.
- E. Notification procedures:
 - 1. In the event of an emergency, the Contractor shall contact the following entities at the earliest possible opportunity:
 - a. City of Somerville designated representatives
 - b. City of Somerville Department of Public Works

- c. City of Somerville Fire Department
 - d. City Urban Forester
 - e. MassDEP
2. The Contractor shall prepare in advance of work activities a notification list, complete with phone numbers, addresses, and contact names for all parties to be notified (including, but not limited to, the parties listed above) in the event of an emergency.

3.14 TREE INSTALLATION

- A. The root system of each plant shall be observed by the Contractor at the time of planting to confirm that the roots meet the requirements for plant root quality in *Part 2.1.C (Part 2 – Products: Trees General: Plant quality)*. The Contractor shall undertake at the time of planting all modifications to the root system required by the City Urban Forester to meet these quality standards.
 - 1. Modifications at the time of planting to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the City Urban Forester may choose to reject the plant rather than permitting the modification.
 - 2. Any modifications required by the City Urban Forester to make the root system conform to the plant quality standards outlined in *Part 2.1.C (Part 2 – Products: Trees General: Plant quality)*, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.
 - 3. The resulting root ball may need additional staking and water after planting. The City Urban Forester may reject the plant if the root modification process makes the tree unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty.
 - 4. The Contractor remains responsible to confirm that the grower has made all required root modifications noted during any nursery observations
- B. Trees shall be plumb and upright, faced to give best appearance, and planted at the center of the planting areas. The tree graft, if applicable, shall be visible above the grade. If the Contractor is unable to install tree at proper grade and/or in center of tree well or designated planting location, the Contractor shall not install tree and immediately contact the City Urban Forester.
- C. Trunk flare must be visible and free of adventitious roots.
 - 1. Place the tree in the planting hole so that the top of the root ball where the trunk flare is visible is 1” above the established sidewalk level. Do not place soil on top of the root ball. If root flare is covered or set significantly higher (or lower) than 1” above sidewalk grade than the Contractor will not be paid for that tree until it is properly adjusted.
- D. Any non-degradable materials used in wrapping the root ball must be entirely and carefully removed so as not to disturb the roots.
 - 1. Carefully cut and remove all rope, string, and twine from the root ball, making sure not to damage the trunk or roots in the process.
 - 2. Cut and remove the entire wire basket from root ball, while keeping the root ball intact. If the root ball is loose, it is acceptable to cut the top 2/3 off of the basket, and cut the sides of the remaining wire such that the roots will not be impaired in the future. In the case of a loose root ball, do not pull the wires out from under the root ball.

3. Remove top 2/3 of burlap from the root ball. DO NOT PULL BURLAP OUT FROM UNDER THE ROOT BALL. Push or fold the remaining sides of the burlap into the bottom of the well after the tree is properly set.
4. All materials cut away from the root ball must be removed from the site.

3.15 FERTILIZING

- A. Insert approved slow-release tree fertilizer packets before back-filling. The number of packets to insert shall be based on the percent nitrogen in the packet and the size of the tree planting area, with the approval of the City Urban Forester.

3.16 BACK-FILLING

- A. Carefully backfill the space around the root ball by hand using the existing soil that was excavated for the planting space and approved topsoil in layers, and water each layer thoroughly to fill all voids and allow to settle. Finish back-filling to a depth such that finished grade level at settlement will be at established sidewalk level.
 1. Fill hole about 1/3 full and gently slice a shovel down into the backfill 15 to 25 times all around the tree. Be careful not to damage the trunk or roots in the process. DO NOT step firmly in the backfill soil because this could compact it and restrict root growth. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density as measured by a standard proctor compaction test, or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.
 2. Water the first third of soil to settle and eliminate air pockets. Backfill the remainder of the tree well in layers not to exceed six 6 inches. Water soil to settle. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill continued until the planting soil is brought to grade level.
- B. When the hole is filled with soil the root ball should remain approximately 2 inches above the backfill soil. The top of the root ball is not to be covered by the backfill soil.
- C. Surround each tree with a shoulder of topsoil around the outside of the root ball to form a temporary saucer, 3 to 4 inches deep. Tamp the berm to reduce leaking and erosion of the saucer.

3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE)

- A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of final acceptance.
- B. At the time of planting judiciously flood plants with water. After installing the tree, bringing soil to grade and forming the planting saucer, thoroughly soak the tree well by repeatedly filling the well with water to the full depth of the saucer, allowing the water to completely percolate into the soil between fillings.
- C. Watering shall be provided from May 15 through November 15 at the discretion of the City Urban Forester.
 1. The Contractor will also include in his base bid costs for watering trees twice per week exclusive of Saturdays, Sundays and holidays for a period of 30 days from the date of planting.

2. Beginning 30 days after planting, the Contractor will water trees once per week.
- D. Watering shall be provided through use of a drip irrigation bag which shall be furnished by the Contractor and installed immediately on each tree following planting per the manufacturer's instructions.
 1. Immediately following the planting of the tree, a drip irrigation bag is to be installed per the manufacturer's instructions.
 2. Drip irrigation bag is to be secured with a zip tie or similar locking device to avoid unwarranted removal.
 3. At the end of the watering period the Contractor shall remove all irrigation bags and deliver them neatly stacked to the Department of Public Works for winter storage.
- E. Contractor shall provide the City Urban Forester with a schedule of watering during the warranty period. The watering schedule shall include details on the order in which the trees will be watered, the frequency of watering, and the volume of water that will be provided to each tree during each visit.
- F. For each day that watering occurs, the watering crew is to report to the City Urban Forester, by phone or in person, as to the locations they will be watering that day.
- G. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures as necessary to ensure the site is safe at all times for any passersby.
- H. All installed trees that are injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct.
- I. The Contractor is to provide a watering truck and water as outlined in the Equipment section (Section 1.12 QUALITY ASSURANCE (B)) and Products section (Section 2.7 WATER AND WATERING BAGS) of this specification.

3.18 WATERING (2-YEAR WARRANTY PERIOD)

- A. Watering during the 2-year warranty period shall be performed as specified in Section 3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE) and shall occur a minimum of once per week (approximately 4x per month) or as acceptable to the City Urban Forester.
- B. Watering and maintenance during the warranty period will be recorded and tracked as described in the Section 3.25 WARRANTY of this specification.
- C. If a tree is dead or damaged and not watered, the Contractor shall notify the City Urban Forester immediately.
- D. The watering bags shall remain the property of the City at the completion of the work.

3.19 COMPOSTING

- A. Applying compost to the soil surface after planting to help inhibit weed growth, conserve soil moisture, and reduce soil erosion.
- B. Compost shall be uniformly applied over the entire area at an average depth of 1- 2 inches immediately after weed removal and planting. Compost is to be applied on top of soil, and underneath wood bark mulch.
- C. Avoid placing compost against the trunk or stem of any plant material.

- D. Water thoroughly before and after placing compost to saturate the root zone and entire compost layer.
- E. All stones, roots, or other debris shall be removed from the surface of the composted area.

3.20 MULCHING

- A. Place coarse grade wood mulch on top of compost immediately after planting. No planting areas shall be left for any longer than thirty minutes without mulch. No mulch material shall be applied prior to the initial watering of plant.
- B. Apply a three inch layer of mulch (after settlement) around plants. Mulched area shall be six feet in diameter around the trunk of the plant, unless otherwise specified by the City Urban Forester. For tree wells that are less than six feet long in any direction, mulch shall be applied to the entire tree well.
- C. Mulch shall NOT come in contact with the trunk of the plant or the root flare. No mulch should be placed within 2 to 3 inches from the trunk.
- D. Periodically throughout the warranty period, at the direction of the City Urban Forester, re-apply mulch to the planting areas in the manner described in this section.
- E. From time to time the City may require additional mulch to be placed at various tree locations and existing planting beds citywide. Mulch is to be applied as outlined in this section.
- F. When the City opts to mulch existing trees and planting beds the Contractor is to first remove all existing unwanted vegetation (i.e. weeds) and debris.

3.21 STAKING

- A. Stake, guy and anchor immediately after planting of each tree. Two stakes shall be used for each tree from 1" caliper up to and including 3-1/2" caliper.
- B. Stakes for supporting trees shall be of uniform size, either 2" x 3" x 10' or 3" diameter x 10', and which are capable of standing in the ground at least two years.
- C. Equally space stakes and set parallel to structures, contours, paving or curbs. Set trees plumb and hold in position until the soil has been solidly backfilled around the root ball and/or roots. Stakes shall be driven to sufficient depth to hold the tree rigid, and shall be fastened to tree with approved strapping, and with appropriate knot.
- D. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer's recommendations and the planting detail for installation.
- E. Stakes shall be driven into the ground, and resulting stakes will be of a uniform height. Place stakes to avoid root damage and at reasonable and proper distance from trunk to prevent movement of tree and root system; tension on stakes and guy wires to be equal and at a slight angle away from tree.
- F. Plants shall stand plumb after staking or guying.
- G. Any stake or strap that becomes displaced or broken shall be reset or replaced promptly.
- H. Stakes and guys shall be removed from all trees by the Contractor after one full growing season, or at other times as required by the City Urban Forester. If the stability of any tree will be compromised by removing the stakes after one full growing season, notify the City Urban Forester immediately. If any tree becomes unstable after removing the stakes, the stakes will be replaced for an additional year, following the protocol outlined in this section, at no additional cost to the City.

3.22 PRUNING

- A. Pruning trees shall be limited to addressing structural defects as shown in details; follow recommendations in book “Structural Pruning: A Guide for the Green Industry” published by Urban Tree Foundation, Visalia, CA.
- B. All pruning shall be performed by a person experienced in structural tree pruning.
- C. Pruning shall be done with clean, sharp tools.
- D. Immediately before or after planting only prune dead, badly bruised, broken, or crossing limbs.
- E. Except for plants specified as multi-stemmed or as otherwise instructed by the City Urban Forester, preserve or create one central leader.
- F. Pruning of large trees shall be done using pole pruners, or, if needed, from a ladder or hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting. Pruning may also be performed at the nursery prior to shipping.
- G. No tree paint or sealants shall be used.
- H. Remove and replace excessively pruned or malformed stock resulting from improper pruning that occurred in the nursery or after.

3.23 CLEAN UP

- A. Removal and disposal of tree and woody vegetation debris.
 - 1. The Contractor shall remove and dispose of all debris resulting from the work at each job site, including, but not limited to: excess planting soil, subsoil, mulch, plants, and packaging. Each job site is to be left in a condition equal to or better than that which existed prior to the execution of work order. The Contractor shall be solely responsible for disposal of all debris.
 - 2. The City reserves the right to retain all debris, chips and wood from work completed on City of Somerville trees at no cost to the City. The City reserves the right to use this material in any way it sees fit.
- B. Restoration of work areas and cleanup.
 - 1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property. Ensure that mulch is confined to planting beds.
 - 2. All areas damaged during the process of the work shall be the responsibility of the Contractor and who shall restore the disturbed and damaged areas to a condition satisfactory to the City Urban Forester. This may include, but not be limited to tilling, grading, paving, fertilizing, mulching, etc.
 - 3. The Contractor shall also be responsible for any other damage caused by his or her process of work operations and shall dispose of all rubbish, excess soil, etc., as directed by the City Urban Forester, all of which shall be done at no expense to the City of Somerville.
 - 4. For trees planted in brick sidewalks or for tree wells that are surrounded by stone cobbles, bricks and/or cobbles will be replaced around the edges of the tree well to match the pattern of the surrounding sidewalk and the other tree wells along the street. Reuse the bricks/cobbles that were set aside prior to planting.

3.24 WATER METER AND BACKFLOW PREVENTION DEVICES

- A. When hydrants are being used, the Somerville Water System must be protected with backflow device and necessary fittings as per Massachusetts Department of Environmental Protection (DEP) Regulations 310 CMR 22.22 and as per the Somerville Water Department. Somerville-specific water meters and backflow devices must be used for any and all hydrant use operations. The Somerville Water Department is located at 1 Franey Rd., and can be reached at 617-625-6600 extension 5850, or water@somervillema.gov.

3.25 WARRANTY

- A. Trees will be warrantied for a minimum period of time of two (2) years after the initial acceptance. Trees planted in the Spring shall be alive and in satisfactory growth on June 1 of the second year after planting [ex. trees planted in Spring 2021 shall be warrantied until June 1, 2023]. Tree planted in the Fall shall be alive and in satisfactory growth on November 30 of the second year after planting [ex. trees planted in Fall 2021 shall be warrantied until November 30, 2023].
- B. During the warranty period, provide all maintenance for all plantings. Tree care and maintenance shall begin immediately after planting and throughout the warranty period to keep the plants in a healthy state and the planting areas clean and neat until final acceptance. Maintenance throughout the warranty period shall include, but is not limited to, the following:
1. **Straightening and resetting plants to proper grades:**
 - a. Maintain all plants in a plumb position throughout the warranty period. Reset any plants that have settled or are leaning as soon as the condition is noticed, and straighten all trees that move out of plumb. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled. Do not straighten plants by pulling the trunk with guys
 2. **Watering:**
 - a. Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.
 - b. Each tree shall be watered at least once per week during the growing season (see Sections 3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE) and 3.18 WATERING (2-YEAR WARRANTY PERIOD) of this specification), except when rainfall provides sufficient moisture.
 - c. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water. Contact the City Urban Forester to approve any adjustments to the watering schedule.
 - d. Maintain all drip irrigation bags and keep them optimally operational.
 3. **Weeding:**
 - a. Keep all tree wells free of weeds. Hand-remove all weeds; chemical weed control is not permitted.
 4. **Mulch replacement:**
 - a. Refresh mulch as directed by the City Urban Forester to maintain complete coverage, but do not over mulch. At no time shall the overall mulch thickness be greater than 3 inches. Do not apply mulch within 2 to 3 inches of the trunks of any trees. Replacement mulch shall meet the requirements of the original approved material.

5. Pruning:

- a. Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the City Urban Forester, do not shear plants or make heading cuts.
- b. At the end of the warranty period each tree must be free of dead branches and shall be pruned for good structure based on industry standards and as directed by the City Urban Forester.

6. Treating for insect pests and diseases:

- a. Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks. The City Urban Forester must approve in advance the use of all chemical pesticide applications. The use of neonicotinoid insecticides is strictly prohibited.

7. Repairing and replacing tree stakes, guys, and anchors:

- a. Maintain plant guys in a taught position.
- b. Complete removal of stakes and guy wires: at the end of 1 year after planting, the Contractor shall remove from the site the stakes and guying materials from all trees, unless otherwise directed by the City Urban Forester, at no additional charge to the City.

8. Trash removal:

- a. Remove all trash and debris from all tree wells and maintain the wells in a neat and tidy appearance.

9. Plant replacement:

- a. Replace all plants that are defective, as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.

- C. The City Urban Forester, at his/her discretion, may require the Contractor to address tree planting related issues as they develop.
- D. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the City Urban Forester, and submit a copy of the logs monthly.
- E. Notify the City Urban Forester in writing if maintenance, including watering, is not sufficient to maintain plants in a healthy condition. Such notification must be made in a timely period so that the City Urban Forester may take corrective action. Notification must define the maintenance needs and describe any recommended corrective action.
 - 1. In the event that the Contractor fails to visit the site and/or notify, in writing, the City Urban Forester of maintenance needs, lack of maintenance shall not be used as grounds for voiding or modifying the provisions of the warranty.
- F. The Contractor shall meet with the City Urban Forester semi-annually during the warranty period to inspect the plantings and shall take immediate action to identify potential problems and undertake corrective measures.
- G. At the end of the warranty period attend a hand-over meeting to formally transfer the responsibilities of maintenance to the City Urban Forester. Provide all information on past maintenance activities and

provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs. Make the Contractor's Supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.

- H. Defective work shall be corrected immediately after becoming apparent, weather and season permitting. The City Urban Forester shall be notified immediately of any plants that die during the warranty period. Dead plants shall be removed at once regardless of the cause of death at no additional charge to the City. Replacement of dead trees will be done immediately if during the specified installation season. If dead tree has been removed out of planting season, the Contractor shall wait until the beginning of the subsequent planting season, at which time the replacement tree will be planted. If tree to be replaced is a fall hazard species the Contractor shall wait until the beginning of the spring planting season, at which time the replacement tree will be planted.
- I. The Contractor will be responsible for all labor, equipment and materials cost associated with the planting of the replacement plants. When this determination has been made the Contractor shall not be entitled to any further payment for the planting of the replacement plant outside of the payment for the original plant installation.
- J. At the end of the warranty period, the Contractor and the City will meet to inspect the plants to determine if they are acceptable. To be accepted, the work must be in like-new condition. Each tree must exhibit the form typical to its species with at least 75% of its original canopy viable. Any plant that has lost its leader will be rejected.
- K. Based on the inspection, the City will prepare a list of deficiencies in the work. When the deficiencies are corrected to the City's satisfaction, the City will issue a written notice that the warranty period has ended.

3.26 REPLACEMENTS

- A. During the warranty period, dead, unsightly or unhealthy trees should be removed promptly and replaced by the Contractor as required by the City Urban Forester.
- B. Vandalized trees should be brought to the attention of the City Urban Forester.
- C. Replacements shall conform to requirements in the Specifications and shall be replaced as many times as necessary to ensure the establishment of healthy plants. Replacements shall be maintained and guaranteed for two years from the time of replacement, per the terms of the Warranty Period.

3.27 SEMI-FINAL INSPECTION

- A. Semi-Final inspection will be made by the City Urban Forester upon completion of all planting work specified herein.
- B. Upon written notice from the Contractor, the City Urban Forester shall perform a semi-final inspection to review the work.
 - 1. Notification shall be at least 5 business days prior to the anticipated inspection dates.
- C. The Contractor may offer for acceptance the entire project or a completed readily defined area, if approved by the City Urban Forester. All work in the Contract shall be found in neat, clean and safe condition.

3.28 SEMI-FINAL ACCEPTANCE

- A. The City Urban Forester will notify Contractor in writing of acceptance in whole or in part of work, exclusive of maintenance and possible replacement of trees subject to warranty, or of requirements for completion if deficiencies exist. Work will not be submitted for payment without the City Urban Forester's written acceptance. Semi-final acceptance can only occur after the 30 day post-installation watering (2x per week) has been completed and confirmed.
- B. The plant Warranty Period begins at date of written notification of semi-final acceptance from the City Urban Forester.

3.29 END OF WARRANTY FINAL INSPECTION AND ACCEPTANCE

- A. At the end of the warranty and maintenance period, and upon written application from the Contractor, the City Urban Forester shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory, including watering and maintenance.
- B. Prior to final acceptance, any dead, missing or unhealthy trees shall be replaced. If a substantial number of plants are unsatisfactory, missing or dead, acceptance will not be granted until replacements are made and the Contractor's responsibility for the maintenance and warranty (which will require extension) is completed.
- C. If the work is satisfactory, the maintenance period will end on the date of the final observation.
- D. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the City until the work has been completed, observed, and approved by the City Urban Forester.

RECOMMENDED SPECIES

This list contains the trees that the city currently installs as street trees. Alternative varieties or cultivars may be considered by the City Urban Forester.

Shade Tree (no wires present)

Species	Preferred Cultivars	Height (feet)
Red maple (<i>Acer rubrum</i>)*	Redpointe®, Red Sunset®, many others	40-60
Armstrong Red maple (<i>Acer x freemanii</i>)*		50-70
River birch (<i>Betula nigra</i>)		40-70
European Hornbeam (<i>Carpinus betulus</i>)	Brownstone, Franz Fontaine, Fastigata	30-60
Sugarberry (<i>Celtis laevigata</i>)	All Seasons	60-80
Hackberry (<i>Celtis occidentalis</i>)	Magnifica	40-60
Katsuratree (<i>Cercidiphyllum japonicum</i>)		40-60
Hardy Rubber Tree (<i>Eucommia ulmoides</i>)		40-60
Ginkgo (<i>Ginkgo biloba</i>)	Autumn Gold, Presidential Gold	40-80
Honeylocust (<i>Gleditsia triacanthos</i>)*	Halka, Perfection, Shademaster®, Skyline®, Street Keeper	30-70
Kentucky coffeetree (<i>Gymnocladus dioica</i>)	Espresso, Stately Manor	60-75
Sweetgum (<i>Liquidambar styraciflua</i>)	Rotundiloba	60-75
Tuliptree (<i>Liriodendron tulipifera</i>)		70-90
Dawn redwood (<i>Metasequoia glyptostroboides</i>)		70-100
London planetree (<i>Platanus x acerifolia</i>)	Bloodgood, Columbia, Exclamation, Liberty	70-100
Fire cherry (<i>Prunus pennsylvanica</i>)		50-80
Black cherry (<i>Prunus serotina</i>)		50-60
Sawtooth oak (<i>Quercus acutissima</i>)		40-60
Swamp White oak (<i>Quercus bicolor</i>)		60-80
Shingle oak (<i>Quercus imbricaria</i>)		50-60
Chestnut oak (<i>Quercus montana</i>)		60-70
Pin oak (<i>Quercus palustris</i>)		60-70
Willow oak (<i>Quercus phellos</i>)		40-60
Red oak (<i>Quercus rubra</i>)		60-75
Japanese pagoda tree (<i>Styphnolobium japonicum</i>)	Regent	50-75
American linden (<i>Tilia americana</i>)	Douglas, Fastigiata, Legend, Redmond	60-80
Littleleaf linden (<i>Tilia cordata</i>)	Greenspire®, Prestige®	60-70
Silver linden (<i>Tilia tormentosa</i>)	Green Mountain, Sterling Silver	50-70
American elm (<i>Ulmus americana</i>)	Jefferson (<i>NOT Princeton, NOT Pioneer</i>)	50-70
Chinese elm (<i>Ulmus parvifolia</i>)	Allee®, Athena®, many others	40-60
Elm cultivars (<i>Ulmus</i> spp.)	Accolade®, Emerald Sunshine®, Homestead, Prospector	40-60
Japanese Zelkova (<i>Zelkova serrata</i>)	Green Vase, Village Green	50-80

Ornamental Tree (overhead wires present)

Species	Preferred Cultivars	Height (feet)
Trident maple (<i>Acer buergerianum</i>)*	Streetwise®	20-35
Hedge maple (<i>Acer campestre</i>)*	Queen Elizabeth	25-30
Paperbark maple (<i>Acer griseum</i>)*		20-30
Miyabe maple (<i>Acer miyabei</i>)*		30-40
Amur maple (<i>Acer tataricum</i> subsp. <i>ginnala</i>)*		15-25
Three-flower maple (<i>Acer triflorum</i>)*		20-30
Shantung maple (<i>Acer truncatum</i>)*		20-25(30)
Serviceberry (<i>Amelanchier</i> spp.)	Autumn Sunset, Cumulus, White Pillar	15-30
American hornbeam (<i>Carpinus caroliniana</i>)		20-30(50)
Eastern redbud (<i>Cercis canadensis</i>)		20-30
Corneliancherry dogwood (<i>Cornus mas</i>)		20-25
Hawthorn (<i>Crataegus</i> spp.)	Princeton Sentry, Winter King, Crimson Cloud	20-30
Amur maackia (<i>Maackia amurensis</i>)		20-30
Osage orange (<i>Maclura pomifera</i> var <i>inermis</i>)	Thornless and fruitless cultivars	30-50
Crabapple spp (<i>Malus</i> spp.)	<i>Malus x zumi</i> , Donald Wyman, Spring Snow	15-25
Persian ironwood (<i>Parrotia persica</i>)	Jennifer Teates, Vanessa	20-40
Purpleleaf plum (<i>Prunus cerasifera</i>)	Atropurpurea, Newport, Thundercloud	15-30
European birdcherry (<i>Prunus padus</i>)		30-40
Sargent cherry (<i>Prunus sargentii</i>)	Accolade	40-50
Kwanzan cherry (<i>Prunus serrulata</i> 'Kwanzan')		25-40
Snowgoose cherry (<i>Prunus serrulata</i> 'Snowgoose')		20
Higan cherry (<i>Prunus subhirtella</i>)	Autumnalis, Autumnalis Rosea	20-40
Common chokecherry (<i>Prunus virginiana</i>)	Shubert	20-30
Okame cherry (<i>Prunus x incamp</i> 'Okame')		20-30
Yoshino cherry (<i>Prunus x yeodensis</i>)	Akebono	(25)40-50
Japanese tree lilac (<i>Syringa reticulata</i>)	Ivory Silk	20-30
Turkish filbert (<i>Corylus colurna</i>)		40-50
Black gum (<i>Nyssa sylvatica</i>)		30-50
American Hophornbeam (<i>Ostrya virginiana</i>)		25-40
Golden raintree (<i>Koelreuteria paniculata</i>)		30-40

*Note: the City of Somerville **only rarely** plants Honeylocust or Maple species.

ROOT OBSERVATIONS DETAIL - BALLED AND BURLAPPED

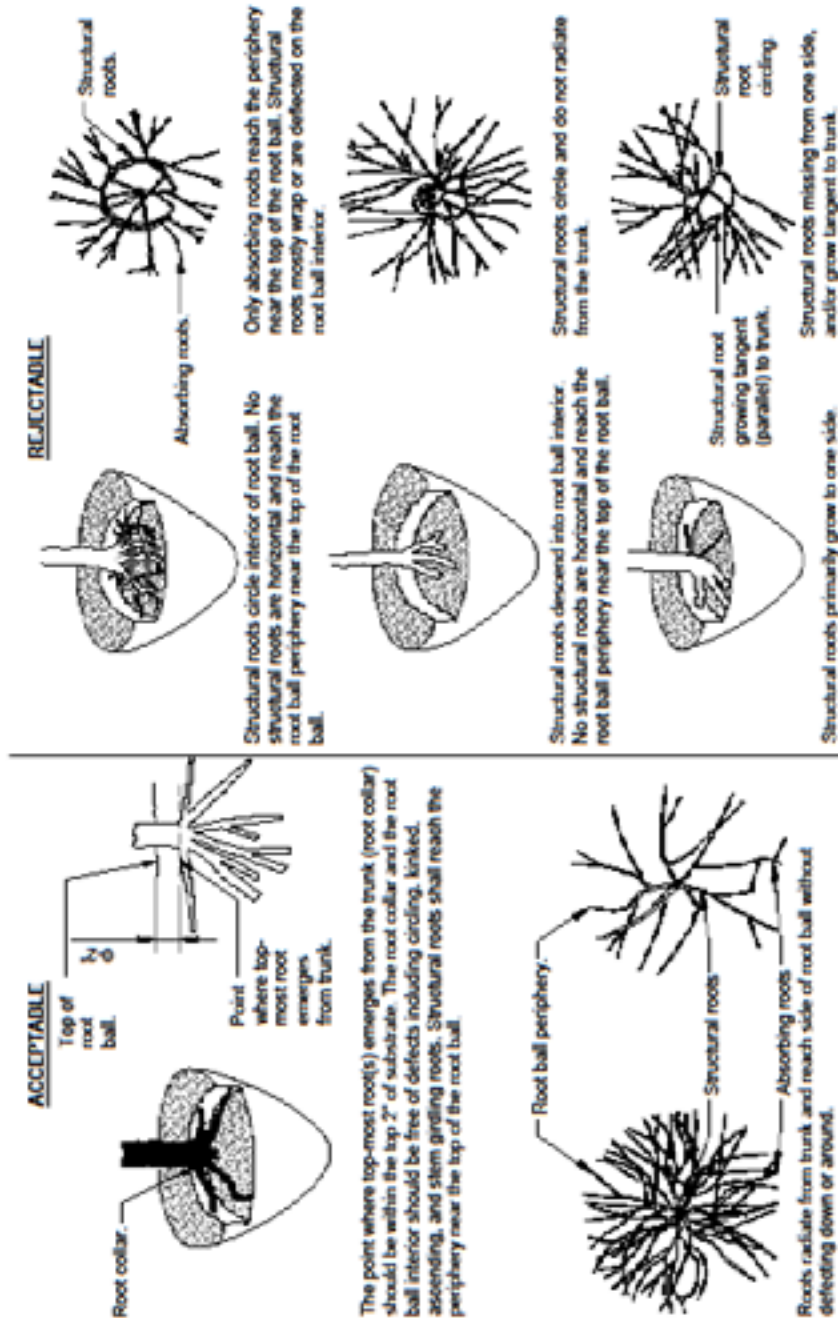
URBAN TREE PLANTATION © JONAS
AND © NATIONWIDE TREE TRUST
CAPTION: BIRCHES IN THE FOREST

2- See specifications for observation process and requirements.

2- See spec

Notes:
1- Observations of roots shall occur prior to acceptance. Roots and soil may be removed during the observation process; substrate/soil shall be replaced after the observations have been completed.

11-11-2014



ACCEPTABLE

One central leader (No codominant leaders)

Aspect ratio is less than 0.66.

Aspect ratio of B/A less than 0.66 as measured 1" above the top of the branch union.

Example		
A	B	Aspect Ratio
1.50"	0.50"	0.33
2.50"	0.90"	0.36
2.0"	1.00"	0.50
2.50"	1.60"	0.64

REJECTABLE

Multiple leaders (Several codominant leaders)

Aspect ratio is greater than 0.66.

Aspect ratio of B/A greater than or equal to 0.66 as measured 1" above the top of the branch union.

Example		
A	B	Aspect Ratio
2.50"	1.80"	0.72
3.0"	2.0"	1.0
2.50"	2.0"	0.80
4.0"	3.0"	0.75

Notes:

- Aspect ratio shall be less than 0.66 on all branch unions. Aspect ratio is the diameter of branch (B) divided by the diameter of the trunk (A) as measured 1" above the top of the branch union.
- Any tree not meeting the crown observations detail may be rejected.

URBAN TREE FOUNDATION © 2014
CROWN OBSERVATION PHOTO BY LISA

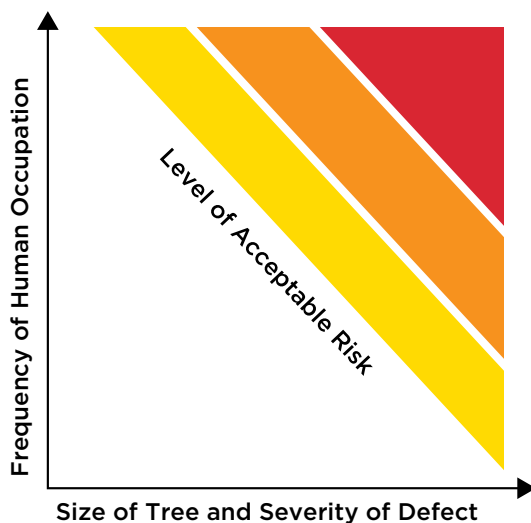
CROWN OBSERVATIONS - HIGH BRANCHED

P-X

RISK ASSESSMENT AND PRIORITY AND PROACTIVE MAINTENANCE

Risk Assessment

Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, Davey Resource Group, Inc. (DRG) performed a Level 2 qualitative risk assessment for each tree and assigned a risk rating based on *ANSI A300 (Part 9)* (ANSI, 2011), and the companion publication *Best Management Practices: Tree Risk Assessment* (Smiley et al., 2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree was assigned during the inventory. The failure mode having the greatest risk served as the overall tree risk rating. The specified time period for the risk assessment is one year.



- **Likelihood of Failure**—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.

» **Improbable**—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.

» **Possible**—Failure could occur but is unlikely during normal weather conditions within the specified time period.

» **Probable**—Failure may be expected under normal weather conditions within the specified time period.

- **Likelihood of Impacting a Target**—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls towards the target.

» **Very low**—The chance of the failed tree or branch impacting the target is remote.

- Rarely used sites
- Examples include rarely used trails or trailheads
- Instances where target areas provide protection

» **Low**—It is not likely that the failed tree or branch will impact the target.

- Occasional use area fully exposed to tree
- Frequently used area partially exposed to tree
- Constant use area that is well protected

» **Medium**—The failed tree or branch may or may not impact the target.

- Frequently used areas that are partially exposed to the tree on one side
- Constantly occupied area partially protected from the tree

» **High**—The failed tree or branch will most likely impact the target.

- Fixed target is fully exposed to the tree or tree part

- **Categorizing Likelihood of Tree Failure Impacting a Target**—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.

- **Consequence of Failure**—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can

vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.

» **Negligible**—Consequences involve low value damage and do not involve personal injury.

- Small branch striking a fence
- Medium-sized branch striking a shrub bed
- Large tree part striking structure and causing monetary damage
- Disruption of power to landscape lights

» **Minor**—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.

- Small branch striking a house roof from a high height
- Medium-sized branch striking a deck from a moderate height
- Large tree part striking a structure, causing moderate monetary damage
- Short-term disruption of power at service drop to house
- Temporary disruption of traffic on neighborhood street

» **Significant**—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- Medium-sized part striking a vehicle from a moderate or high height
- Large tree part striking a structure resulting in high monetary damage
- Disruption of distribution of primary or secondary voltage power lines, including individual services and street-lighting circuits
- Disruption of traffic on a secondary street
- » **Severe**—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.
- Injury to a person that may result in hospitalization
- Medium-sized part striking an occupied vehicle
- Large tree part striking an occupied house
- Serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways
- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Trees have the potential to fail in more than one way and can affect multiple targets.

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

» **None**—Used for planting and stump sites only.

» **Low**—The Low Risk category applies when consequences are “negligible” and likelihood is “unlikely”; or consequences are “minor” and likelihood is “somewhat likely.” Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.

» **Moderate**—The Moderate Risk category applies when consequences are “minor” and likelihood is “very likely” or “likely”; or likelihood is “somewhat likely” and consequences are “significant” or “severe.” In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.

» **High**—The High Risk category applies when consequences are “significant” and likelihood is “very likely” or “likely,” or

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

consequences are “severe” and likelihood is “likely.” In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

» **Extreme**—The Extreme Risk category applies in situations where tree failure is imminent and there is a high likelihood of impacting the target, and the consequences of the failure are “severe.” In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

Trees with elevated (Extreme or High) risk levels are usually recommended for removal or pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. DRG recommends only removal or pruning to alleviate risk. But in special situations, such as a memorial tree or a tree in a historic area, Somerville may decide that cabling, bracing, or moving the target may be the best option for reducing risk.

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enables tree work to be assigned priority based on observed risk. Once prioritized, tree work can be systematically addressed to eliminate the greatest risk and liability first (Stamen 2011).

Risk is a graduated scale that measures potential tree-related hazardous conditions. A tree is considered hazardous when its potential risks exceed an acceptable level. Managing trees for risk reduction provides many benefits, including:



Determination of acceptable risk ultimately lies with city managers. Since there are inherent risks associated with trees, the location of a tree is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.

- Lower frequency and severity of accidents, damage, and injury
- Less expenditure for claims and legal expenses
- Healthier, longer-lived trees
- Fewer tree removals over time
- Lower tree maintenance costs over time

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be found and addressed before they escalate.

In the Urban Forest Management Plan, all tree removals and Extreme and High Risk prunes are included in the priority maintenance program.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Tree work is typically performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest, as every tree in the inventoried population is regularly visited, assessed, and maintained. DRG recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

References

- American National Standards Institute (ANSI). 2011. *ANSI A300 (Part 9)–2011, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management Standard Practices (Tree Risk Assessment a. Tree Structure Assessment)*. Londonderry: Tree Care Industry Association, Inc.
- Smiley, E.T., Matheny, N., Lilly, S. 2011. *Best Management Practices: Tree Risk Assessment*. International Society of Arboriculture [ISA].
- Stamen, R.S. 2011. “Understanding and Preventing Arboriculture Lawsuits.” Presented at the Georgia Urban Forest Council Annual Meeting, Madison, Georgia, November 2–3, 2011.

INVASIVE PESTS AND TREE DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in clean-up costs. Keeping these pests and diseases out of the country is the number one priority of the United States Department of Agriculture's (USDA) Animal and Plant Inspection Service (APHIS).

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

Once they arrive, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this Urban Forest Management Plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.



APHIS, Plant Health, Plant Pest Program Information

www.aphis.usda.gov/plant_health/plant_pest_info



The University of Georgia, Center for Invasive Species and Ecosystem Health

www.bugwood.org



USDA National Agricultural Library

www.invasivespeciesinfo.gov/microbes



USDA Northeastern Areas Forest Service, Forest Health Protection

www.na.fs.fed.us/fhp

Asian Longhorned Beetle



Adult Asian longhorned beetle
Photograph courtesy of New Bedford Guide 2011

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: *Acer negundo* (box elder); *A. platanoides* (Norway maple); *A. rubrum* (red maple); *A. saccharinum* (silver maple); *A. saccharum* (sugar maple); *Aesculus glabra* (buckeye); *A. hippocastanum* (horsechestnut), *Betula* (birch), *Platanus × acerifolia* (London planetree), *Salix* (willow), and *Ulmus* (elm).

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease

was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Massachusetts, and annually kills many of the remaining and newly planted elms (except for DED resistant varieties). The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.

There are two closely-related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elms by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus*).

The species most affected by DED is the *Ulmus americana* (American elm).



Branch death, or flagging, at multiple locations in the crown of a diseased elm
Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

Emerald Ash Borer



Close-up of the emerald ash borer
Photograph courtesy of APHIS (2011a)

Emerald ash borer (EAB) (*Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

The EAB-preferred host tree species are in the genus *Fraxinus* (ash).

Herms et al. (2019) provides an overview of insecticide treatment options for controlling EAB.

Gypsy Moth



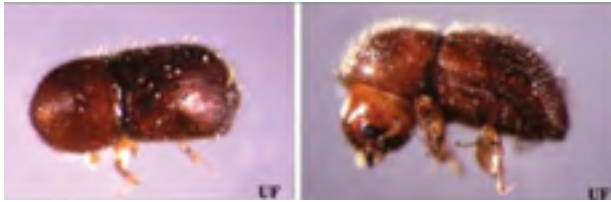
Close-up of male (darker brown) and female (whitish color) European gypsy moths
Photograph courtesy of APHIS (2011b)

The gypsy moth (GM) (*Lymantria dispar*) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, saw-toothed patterns on their wings. Although they have wings, the female GM cannot fly.

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

Granulate Ambrosia Beetle



Adult granulate ambrosia beetle
Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

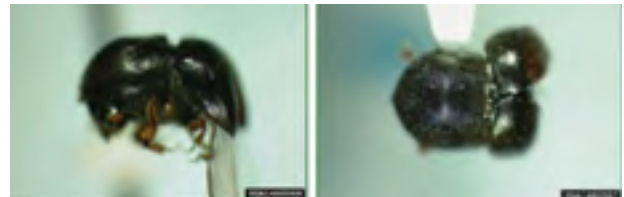
The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark-brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some

shrubs (azalea, rhododendron) but not conifers. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crape myrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Xm Ambrosia Beetle



Xm ambrosia beetle
Photograph courtesy of Michael C. Thomas, Florida Department of Agriculture and Consumer Services (Rabaglia et al 2003)

The Xm ambrosia beetle (*Xylosandrus mutilatus*), is native to Asia and was first detected in the United States in 1999 in traps near Starkville, Mississippi. By 2002, the beetle spread throughout Missouri and quickly became well-established in Florida. The species also has been found in Alabama, northern Georgia, and Texas. In addition to its prevalence in the southeastern United States, the Xm ambrosia beetle is currently found in China, India, Indonesia, Japan, Korea, Malaya, Myanmar, Papua New Guinea, Sri Lanka, Taiwan, and Thailand.

This species generally targets weakened and dead trees. Since the beetle attacks small diameter material, it may be commonly transported in nursery stock. Female adults are prone to dis-

persal by air currents and can travel 1–3 miles in pursuit of potential hosts. This active capability results in a broad host range and high probability of reproduction. The species is larger than any other species of *Xylosandrus* (greater than 3 millimeters) in the U.S. and is easily recognized by its steep declivity and dark brown to black elytra (hard casings protecting the wings). Larvae are white and c-shaped with an amber colored head capsule.

Known hosts in the U.S. include: *Acer* (maple); *Albizia* (silk tree); *Benzoin* (northern spicebush); *Camellia* (camellia); *Carpinus laxiflora* (loose-flower hornbeam); *Castanea* (sweet chestnut); *Cinnamomum camphora* (camphor tree); *Cornus* (dogwood); *Cryptomeria japonica* (Japanese cedar); *Fagus crenata* (Japanese beech); *Lindera erythrocarpa* (spicebush); *Machilus thurnbergii* (Japanese persea); *Ormosia hosiei* (ormosia); *Osmanthus fragrans* (sweet osmanthus); *Parabezion praecox*; *Platycarpa*; and *Sweitenia macrophylla* (mahogany).

Hemlock Woolly Adelgid



Hemlock woolly adelgids on a branch
Photograph courtesy of USDA Forest Service (2011a)

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern

United States in 1951 near Richmond, Virginia.

In their native range, populations of HWA cause little damage to the hemlock trees, as they have natural enemies that feed on them and there is a possibility that tree resistance has evolved with HWA. In eastern North America and in the absence of natural control elements, HWA attacks both *Tsuga canadensis* (eastern or Canadian hemlock) and *T. caroliniana* (Carolina hemlock), often damaging and killing them within a few years of becoming infested.

The HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

Oak Wilt



Oak wilt symptoms on red and white oak leaves
Photograph courtesy of C.E. Seliskar, Bugwood.org

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak) (Rexrode & Brown, 1983). It also attacks trees

in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oaks and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oaks, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

Pine Shoot Beetle



Mined shoot and common pine shoot beetle. Photograph courtesy of Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

The pine shoot beetle (*Tomicus piniperda* L.), a native of Europe, is an introduced pest of Pinus (pine) in the United States. It was first discovered in the United States at a Christmas tree farm near Cleveland, Ohio in 1992. Following the first

detection in Ohio, the beetle has been detected in parts of 19 states (Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin).

The beetle attacks new shoots of pine trees, stunting the growth of the trees. The pine shoot beetle may also attack stressed pine trees by breeding under the bark at the base of the trees. The beetles can cause severe decline in the health of the trees and, in some cases, kill the trees when high populations exist.

Adult pine shoot beetles range from 3 to 5 millimeters long, or about the size of a match head. They are brown or black and cylindrical. The legless larvae are about 5 millimeters long with a white body and brown head. Egg galleries are 10–25 centimeters long. From April to June, larvae feed and mature under the pine bark in separate feeding galleries that are 4–9 centimeters long. When mature, the larvae stop feeding, pupate, and then emerge as adults. From July through October, adults tunnel out through the bark and fly to new or 1-year-old pine shoots to begin maturation feeding. The beetles enter the shoot 15 centimeters or less from the shoot tip and move upwards by hollowing out the center of the shoot for a distance of 2.5–10 centimeters. Affected shoots droop, turn yellow, and eventually fall off during the summer and fall.

P. sylvestris (Scots pine) is preferred, but other pine species, including *P. banksiana* (jack pine), *P. nigra* (Austrian pine), *P. resinosa* (red pine), and *P. strobus* (eastern white pine), have been infested in the Great Lakes region.

Sirex Woodwasp



Close-up of female Sirex Woodwasp
Photograph from Haugen & Hoebeke (2005)

Sirex woodwasp (*Sirex noctilio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the three to six months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly

packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Southern Pine Beetle

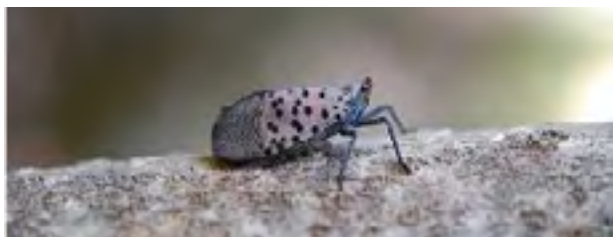


Adult southern pine beetles
Photograph courtesy of Forest Encyclopedia Network (2012)

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern United States. It attacks and kills all species of southern yellow pines including *P. strobus* (eastern white pine). Trees are killed when beetles construct winding, S-shaped egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport food throughout the tree. Furthermore, the beetles carry blue staining fungi on their bodies that clog the water conductive tissues (wood), which transport water within the tree. Signs of attack on the outside of the tree are pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Adult SPBs reach an ultimate length of only 1/8 inch, similar in size to a grain of rice. They are short-legged, cylindrical, and brown to black in color. Eggs are small, oval-shaped, shiny, opaque, and pearly white.

Spotted Lanternfly



Profile of spotted lanternfly adult at rest
Photograph courtesy of USDA APHIS (2014)

The spotted lanternfly (SLF, *Lycorma delicatula*) is native to China and was first detected in Pennsylvania in September 2014. Spotted lanternfly feeds on a wide range of fruit, ornamental and woody trees, with tree-of-heaven being one of the preferred hosts. Spotted lanternflies are invasive and can be spread long distances by people who move infested material or items containing egg masses. If allowed to spread in the United States, this pest could seriously impact the country's grape, orchard, and logging industries.

Adult spotted lanternflies are approximately 1 inch long and one-half inch wide, and they have large and visually striking wings. Their forewings are light brown with black spots at the front and a speckled band at the rear. Their hind wings are scarlet with black spots at the front and white and black bars at the rear. Their abdomen is yellow with black bars. Nymphs in their early stages of development appear black with white spots and turn to a red phase before becoming adults. Egg masses are yellowish-brown in color, covered with a gray, waxy coating prior to hatching.

The spotted lanternfly lays its eggs on smooth host plant surfaces and on non-host material, such as bricks, stones, and dead plants. Eggs hatch in the spring and early summer, and nymphs begin feeding on a wide range of host plants by sucking sap from young stems and leaves. Adults appear in late July and tend to focus their feeding on tree-of-heaven (*A. altissima*) and grapevine (*Vitis vinifera*). As the adults feed, they excrete sticky, sugar-rich fluid similar

to honeydew. The fluid can build up on plants and on the ground underneath infested plants, causing sooty mold to form.

Sudden Oak Death



Drooping tanoak shoot
Photograph courtesy of Indiana Department of Natural Resources (2012)

The causal agent of sudden oak death (SOD, also known as *Phytophthora* canker disease), *Phytophthora ramorum*, was first identified in 1993 in Germany and the Netherlands on ornamental rhododendrons. In 2000, the disease was found in California. Since its discovery in North America, SOD has been confirmed in forests in California and Oregon and in nurseries in British Columbia, California, Oregon, and Washington. SOD has been potentially introduced into other states through exposed nursery stock. Through ongoing surveys, APHIS continues to define the extent of the pathogen's distribution in the United States and limit its artificial spread beyond infected areas through quarantine and a public education program.

Identification and symptoms of SOD may include large cankers on the trunk or main stem accompanied by browning of leaves. Tree death may occur within several months to several years after initial infection. Infected trees may also be infested with ambrosia beetles (*Monar-*

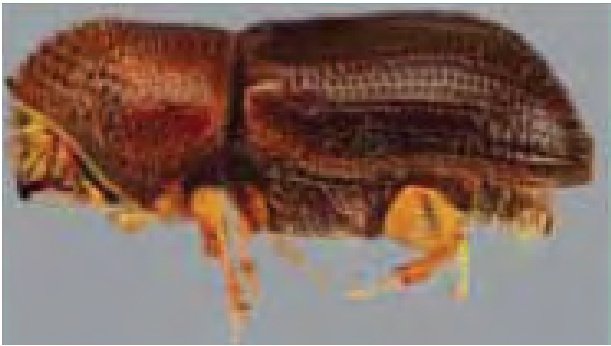
thrum dentiger and *M. scutellarer*), bark beetles (*Pseudopityophthorus pubipennis*), and sapwood rotting fungus (*Hypoxylon thouarsianum*). These organisms may contribute to the death of the tree. Infection on foliar hosts is indicated by dark grey to brown lesions with indistinct edges. These lesions can occur anywhere on the leaf blade, in vascular tissue, or on the petiole. Petiole lesions are often accompanied by stem lesions. Some hosts with leaf lesions defoliate and eventually show twig dieback.

This pathogen is devastating to *Quercus* (oaks) but also affects several other plant species.

cadec, and coupled with the *Geosmithia morbida* fungus, *Juglans* (walnut) mortality has manifested in Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Washington. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. This is the first report east of the 100th meridian, raising concerns that large native populations of *J. nigra* (black walnut) in the eastern United States may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnuts.

Thousand Cankers Disease



Walnut twig beetle, side view
Photograph courtesy of USDA Forest Service
(2011b)

A complex disease referred to as Thousand Cankers disease (TCD) was first observed in Colorado in 2008 and is now thought to have existed in Colorado as early as 2003. TCD is considered to be native to the United States and is attributed to numerous cankers developing in association with insect galleries. TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two de-

References

- APHIS. Plant Health, Plant Pest Program Information. www.aphis.usda.gov/plant_health/plant_pest_info. Accessed April 24, 2012.
- . 2011a. *Beetle Detectives* EAB. APHIS 81-35-016.
- . 2011b. Hungry Pests-Gypsy Moth. <http://www.aphis.usda.gov/hungrypests/GypsyMoth.shtml>. Accessed December 29, 2011.
- Atkinson, T.H., J.L. Foltz, R.C. Wilkinson, and R.F. Mizell. 2011. Granulate Ambrosia Beetle, *Xylosandrus crassiusculus* (Motschulsky) (Insecta: Coleoptera: Curculionidae: Scolytinae). The University of Florida, IFAS Extension, Publication: #EENY131.
- Forest Encyclopedia Network. *Southern Pine Beetle*. <http://www.forestencyclopedia.net/p/p2901>. Accessed March 23, 2012.
- Hermes, D. A., D. G. McCullough, D. R. Smitley, C. S. Sadof, F. D. Miller, and W. Cranshaw. 2019. *Insecticide Options for Protecting Ash Trees from Emerald Ash Borer*. http://www.emeraldashborer.info/documents/Multistate_EAB_Insecticide_Fact_Sheet.pdf. Accessed August 8, 2020.
- Haugen, D. & Hoebeke, E. 2005. *Sirex wood-wasp* – *Sirex noctilio* F. Hymenoptera: Siricidae.
- Indiana Department of Natural Resources. Entomology and Plant Pathology. Sudden Oak Death. <http://www.in.gov/dnr/entomology/4532.htm>. Accessed July 20, 2012.
- Katovich, S. USDA Forest Service, Bugwood.org. *Dutch elm disease*. September 7, 2005. Invasives.org, <http://www.invasive.org/browse/detail.cfm?imgnum=1398053> (October 21, 2011.)
- New Bedford Guide. 2011. *Volunteers Needed for Asian Longhorned Beetle Survey*. <http://www.newbedfordguide.com/volunteers-needed-for-asian-longhorned-beetle-survey/2011/03/30>. Accessed April 3, 2012.
- Rabaglia, R. 2003. *Xylosandrus mutilatus*. 2003. <http://www.invasivespecies.net/database/species/ecology.asp?si=963&fr=1&sts=>. Accessed April 2015.
- Rexrode, C.O. and D. Brown. 1983. *Forest Insect and Disease Leaflet, #29-Oak Wilt*. USDA Forest Service.
- University of Georgia. Center for Invasive Species and Ecosystem Health. www.bugwood.org. Accessed April 24, 2012.
- University of Georgia Bugwood Network. 2018. *New Introduction – Common Pine Shoot Beetle, Tomicus piniperda*. Bark and Wood Boring Beetles of the World. <https://www.barkbeetles.org/other/fpspb.cfm>. Accessed May 5, 2021.
- USDA APHIS. *Spotted Lanternfly*, USDA APHIS, Nov. 2014, www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/spotted-lanternfly/spotted-lanternfly.
- USDA Forest Service. 2011a. *Forest Health Protection—Hemlock Woolly Adelgid*. <http://na.fs.fed.us/fhp/hwa/>. Accessed December 29, 2011.
- . 2011b. (Revised). *Pest Alert-Thousand Cankers Disease*. Northeastern Area State and Private Forestry. NA-PR-02-10.
- USDA National Agricultural Library. National Invasive Species Information Center. www.invasivespeciesinfo.gov/microbes. Accessed April 24, 2012.
- USDA Northeastern Areas Forest Service. Forest Health Protection. www.na.fs.fed.us/fhp. Accessed April 24, 2012.

Tree Emergency Plan Worksheet

For: Urban and Community Foresters, Community Leaders, Public Works and Parks
Departments, Planners, Councils, and other Public Officials

1. Early Warning System/Weather Forecasting Service — Use an early warning procedure to enhance mitigation: communicate with the National Weather Service, a consulting meteorological firm, a designated television weather channel, or the local police department. With a procedure in place, you should have at least three hours of lead time before most tree damaging weather strikes.

Staff Lead: _____
Contact Name: _____
Address: _____
Phone: _____
Mobile: _____
Fax: _____
Email: _____
Website: _____
Description of services provided: _____

2. Local Emergency Manager – Lead contact for a community and responsible for emergency planning and response activities.

Name: _____ **Phone:** _____
Mobile: _____
Role(s): _____

3. Public Relations Coordinator — This is the individual responsible for primary public relations, media contacts, citizen information and communications about the natural disaster. (Must have full knowledge of damage, community issues and capabilities, and be able to make decisions.)

Name: _____ **Phone:** _____
Mobile: _____
Alternate(s):
Name: _____ **Phone:** _____
Mobile: _____
Name: _____ **Phone:** _____
Mobile: _____

4. Disaster Planning and Response Team Members: Your team should include: mayor, selected department heads including specialists in public relations and purchasing, public works specialists (streets, wood utilization and disposal, fleet manager), utilities, parks department, other local government heads, meteorologist, local emergency managers. Include creative people on your team that can think beyond barriers that may be up. Get media involved in planning so they understand what your cleanup priorities are after a storm. Someone involved with public tree management should be part of the community emergency management team. It is critical to include individuals who can make fiscal and administrative decisions because this team will most likely serve in the storm operations command center.

Name:	Role/Responsibility:
1.	Mayor
2.	Fire Chief
3.	Director of Public Works
4.	Utility Representative
5.	Public Relations Representative
6.	City Council
7.	County Emergency Management
8.	Police Chief
9.	Director of Parks
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	

5. Available Disaster Response Staff and Crews: Identify and list all municipal staff and crews available for disaster response work. Consider forestry and parks departments, public works, engineering, streets and sanitation, etc. Where possible, establish teams that can be responsible for specific disaster response activities (primary route clearing, assistance to utility crews, manage debris staging sites, distribute equipment, etc.)

Staff Name:	Role/Responsibility:
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	

6. Emergency Call Out Procedure — phone contact tree for staff.

Name: _____ Will Contact — Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

Name: _____ Will Contact — Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

Name: _____ Will Contact — Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

Name: _____ Will Contact — Name: _____
Phone: _____
Mobile: _____

Name: _____
Phone: _____
Mobile: _____

7. Primary transportation and evacuation corridors and routes for emergency vehicles. Identify and map for reference. Have map available and accessible, and review and update annually.

8. Critical power transmission corridor restoration sites (medical treatment centers). Identify and map for reference. Have map available and accessible, and review and update annually.

9. Identify who is responsible for decision making and priority response setting for multiple life threatening situations.

Name: _____ Phone: _____
Pager: _____ Mobile: _____

10. Tree Damage Clean-up Priorities — List areas that need attention after life threatening situations are abated. Share this information with key staff the will be answering phone calls from residents, businesses, etc. Create a work order form for use when receiving calls.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11. Procedure for Debris Staging and Removal — Identify several areas for staging and processing debris. Establish a contract or agreement securing each site. Choose a processing site that is large, flat, well-drained and accessible to roads that can support truck weights of at least 9 tons per axle. Identify ways to protect significant trees or cultural resources during processing. Potential sites include undeveloped park, industrial, cemetery, fairgrounds, agency and state land. Large parking lots (even paved lots) work well. Remember to consider noise implications near residential areas. Identify multiple sites. Annually reconfirm access and availability to these sites. Make sure the site is large enough for safety considerations (flying debris from tub grinders), if possible, identify sites that can be secured (fencing).

Site 1 – Location: _____

Contact Name/Role:

Phone:

Mobile:

Site 2 – Location: _____

Contact Name/Role:

Phone:

Mobile:

Site 3 – Location: _____

Contact Name/Role:

Phone:

Mobile:

12. Debris and Brush Removal from Private Property — Identify how you will address this issue. A major storm makes it difficult for private property owners to remove brush and debris. Make a decision at the municipal level allowing for debris collection. Determine if your city has adequate equipment and staff available to accomplish this often enormous task. It is critical that you provide guidelines for residents. Specify the types, amounts and piling arrangement of the materials that you will accept. Cities can also assist private homeowners who must contract with private companies for trimming and removal by preparing a list of companies that are licensed, professionally trained and insured.

Person Responsible: _____

Phone: _____ **Mobile:** _____

Minor Storm Policy:

Major Storm Policy:

Listing of available tree care companies:

13. Identify Wood Utilization Options — Develop a list of companies and resources that can process the wood material generated from storm damage. When possible, establish a contract for utilization services.

Wood Utilization Contract:

Company/Organization:

Phone:

Mobile:

Utilization Service Contract: Yes / No

Description of Service:

Wood Utilization Contract:

Company/Organization:

Phone:

Mobile:

Utilization Service Contract: Yes / No

Description of Service:

14. Equipment Listing (available in-house) — Develop a list of public works and parks department equipment and vehicles available for tree clean up work. Keep it current. Include wood chippers, aerial bucket trucks, refuse packers, loaders, supervisory vehicles, chain saws, barricade and lighting equipment, hand saws and pole pruners on the list.

Person Responsible: _____

Phone: _____ **Mobile:** _____

Equipment Available	Quantity	Department/Contact
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

15. Additional Equipment and Assistance Sources — In an emergency, your city administrator may authorize the lease or rental of additional equipment for storm clean-up work. Make a list of potential vendors and keep it current. For certain equipment and assistance needs, it is critical to establish an emergency contract. Guaranteed access to large tub grinders and multiple additional tree trimming crews would be services to guarantee via an emergency contract. The city administrator may also authorize tree contractors to supplement city crews. Assemble a list of licensed and insured potential tree service contractors. Your neighbor cities may be unaffected by a storm that strikes your city. Establish a system to contact neighbor cities that could send staff and equipment to assist you in cleaning up your city.

Person Responsible: _____

Phone: _____ **Mobile:** _____

Equipment Available	Quantity	Department/Contact
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Emergency Contract:

Organization:

Phone:

Contact Name:

Mobile:

Emergency Contract:

Organization:

Phone:

Contact Name:

Mobile:

Emergency Contract:

Organization:

Phone:

Contact Name:

Mobile:

16. Staff, Crew Organization and Equipment Needs – In an emergency, staff members may need to lead crews from other departments or of private contractors. Determine staff who can function in this manner.

Name	Crew#	Equipment Needed

17. Individual(s) Responsible for Record Keeping — This person does documentation and cost accounting during and after disasters. Note – define a specific accounting code for each storm event. If you define a specific code for each storm event, it will allow for effective accounting.

Name:	Phone:
	Mobile:
Name:	Phone:
	Mobile:

Storm Accounting Code:

18. Individual(s) Responsible for Damage Assessment and Damage Survey Reports — This person is familiar with FEMA and Division of Emergency Management procedures and prepares the reports needed for public assistance.

Name:	Phone:
	Mobile:
Name:	Phone:
	Mobile:

19. Disaster Budget (identify potential activities to anticipate costs)

Personnel Regular Time:

Overtime:

Equipment Owned:

Equipment Contracted:

Contracted Work:

Operational Supplies:

Disposal/Recycling:

Administrative Costs (Overhead):

20. Funding Information from Past Storms — review costs from past storms to anticipate costs for future storms and establish funding needs.**Storm:** _____ **Date:** _____**Activity** _____ **Cost** _____

Personnel Regular Time

Overtime

Equipment Owned

Equipment Contracted

Contracted Work

Operational Supplies

Disposal/Recycling

Administrative Costs (Overhead)

TOTAL**Storm:** _____ **Date:** _____**Activity** _____ **Cost** _____

Personnel Regular Time

Overtime

Equipment Owned

Equipment Contracted

Contracted Work

Operational Supplies

Disposal/Recycling

Administrative Costs (Overhead)

TOTAL

21. Individual(s) and/or Organization(s) responsible for community regreening efforts:

Develop a list of contacts for use in efforts to regreen the community after storm events.

Name/Organization: Phone:
Mobile:

Organization Role:

Name/Organization: Phone:
Mobile:

Organization Role:

Name/Organization: Phone:
Mobile:

Organization Role:

Name/Organization: Phone:
Mobile:

Organization Role:

22. Listing of community and neighborhood groups that promote and support community regreening efforts

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

23. Community urban forestry comprehensive management plan —

Comprehensive forest management is your best defense against storms. Well planted and cared for trees stand up to weather better than neglected trees. Develop or modify a forest management plan to include information related to disaster preparedness. Identify critical activities such as hazard tree removal, tree pruning cycles, annual tree care needs, etc.

Name:

Completed:

24. Community tree risk management plan —

A tree risk management plan will provide the community with a systematic approach to accurately identify moderate to high risk trees, an initiate the timely removal or corrective treatment of hazardous trees. Communities that carry out tree risk management strategies will likely see reductions in damage after storms. Go to: <http://www.na.fs.fed.us/spfo/pubs/uf/utrm/index.htm>

Name:

Completed:

25. Storm Damage Assessment —

If a storm is significant enough to receive a formal disaster declaration, state and/or federal funding may be available. To assist communities in the process of applying for reimbursement for storm associated costs, it is important to be able to quickly develop an estimate of damage. Consider using the Storm Damage Assessment Protocol as a tool prior to a storm. This protocol allows a community to provide an assessment of damage in a simple, credible and efficient manner. Go to: <http://www.umass.edu/urbantree/icestorm/>

Name:

Completed:

26. Contacts for additional assistance in natural disaster planning, response and recovery:

Name	Phone
Area or District Forester	
University Extension Agent	
Consulting Foresters	
City Foresters of Neighboring Cities:	
Other	

(Worksheet Prepared by: Lisa Burban (USDA Forest Service), Jim Hermann (Minneapolis Park and Recreation Board), and Katie Himanga (Heartwood Forestry) – Updated May, 2006. Worksheet available on-line at: http://www.na.fs.fed.us/urban/ucfdisasters/tree_emerg_plan/treeemerplanwksheet.htm)

POTENTIAL PLANTABLE AREA BY WARD

Section 1.1: Somerville's Tree Canopy presents the results of a canopy cover analysis for the City of Somerville, as well as an analysis of the potential realistic plantable areas in the city. The amount of tree canopy and potential plantable space in each Ward is shown in **Table 1.4** (reproduced from *Section 1.1: Somerville's Tree Canopy*)

Table 1.4. Amount of Tree Canopy and Potential Plantable Space in Somerville by Ward.

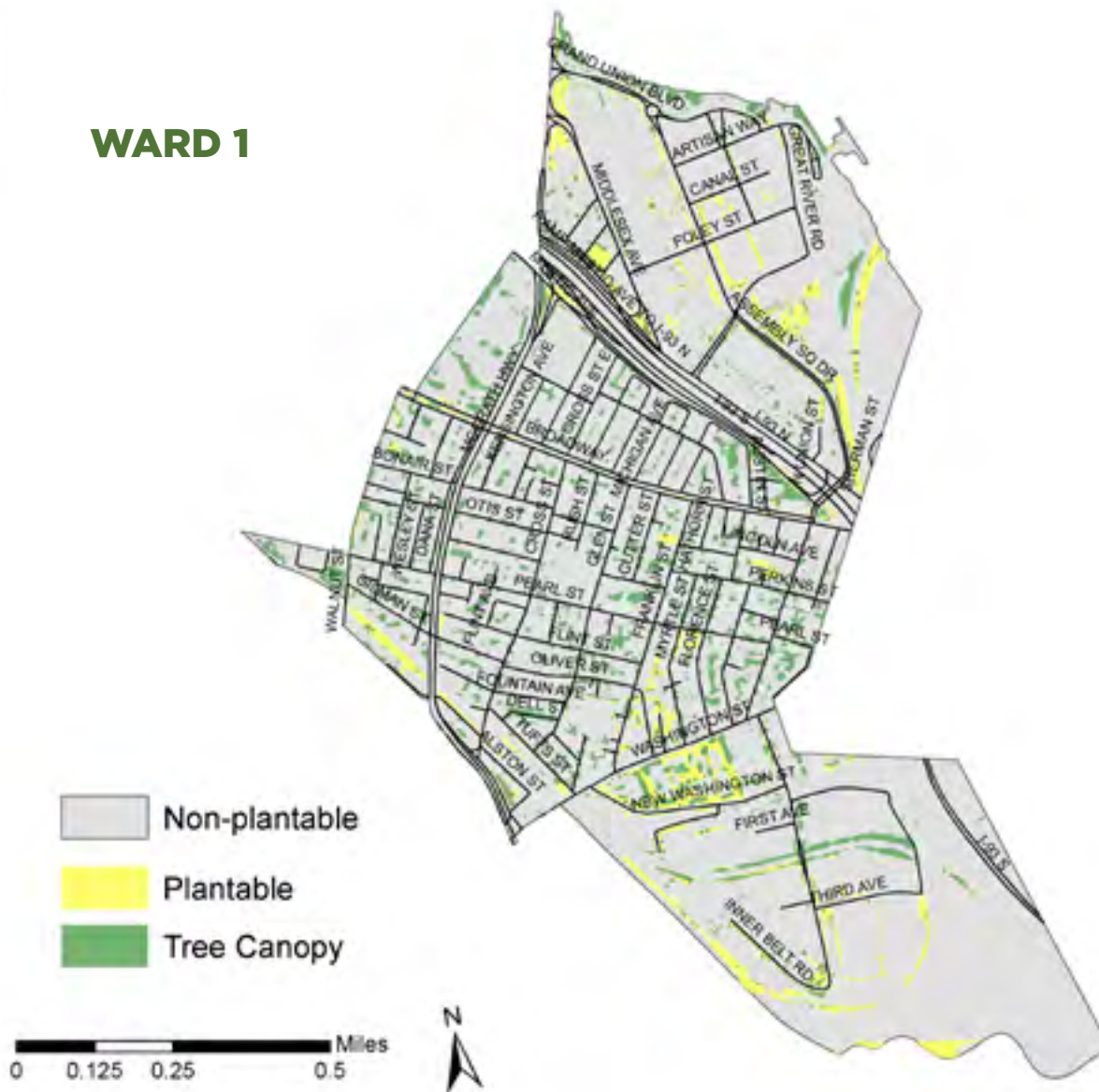
Ward	Ward Area (acres)	2018 Canopy Cover (acres)	2018 Canopy Cover (%)	Potential Plantable Space (acres)	Maximum Canopy Cover (%)*
1	642.9	51.4	8.0%	29.2	12.5%
2	434.5	45.0	10.4%	11.1	12.9%
3	298.8	57.4	19.2%	5.1	20.9%
4	296.0	45.0	15.2%	11.2	19.0%
5	316.4	56.9	18.0%	5.0	19.6%
6	319.3	69.5	21.8%	10.8	25.1%
7	335.4	67.5	20.1%	15.8	24.9%

*Calculated as the sum of 2018 Canopy Cover + Potential Plantable Space



The City of Somerville is organized into seven (7) electoral wards.

To better visualize the extent and locations of the canopy cover and potential realistic plantable areas, maps for each of the seven Wards in Somerville are shown on the following pages.

WARD 1

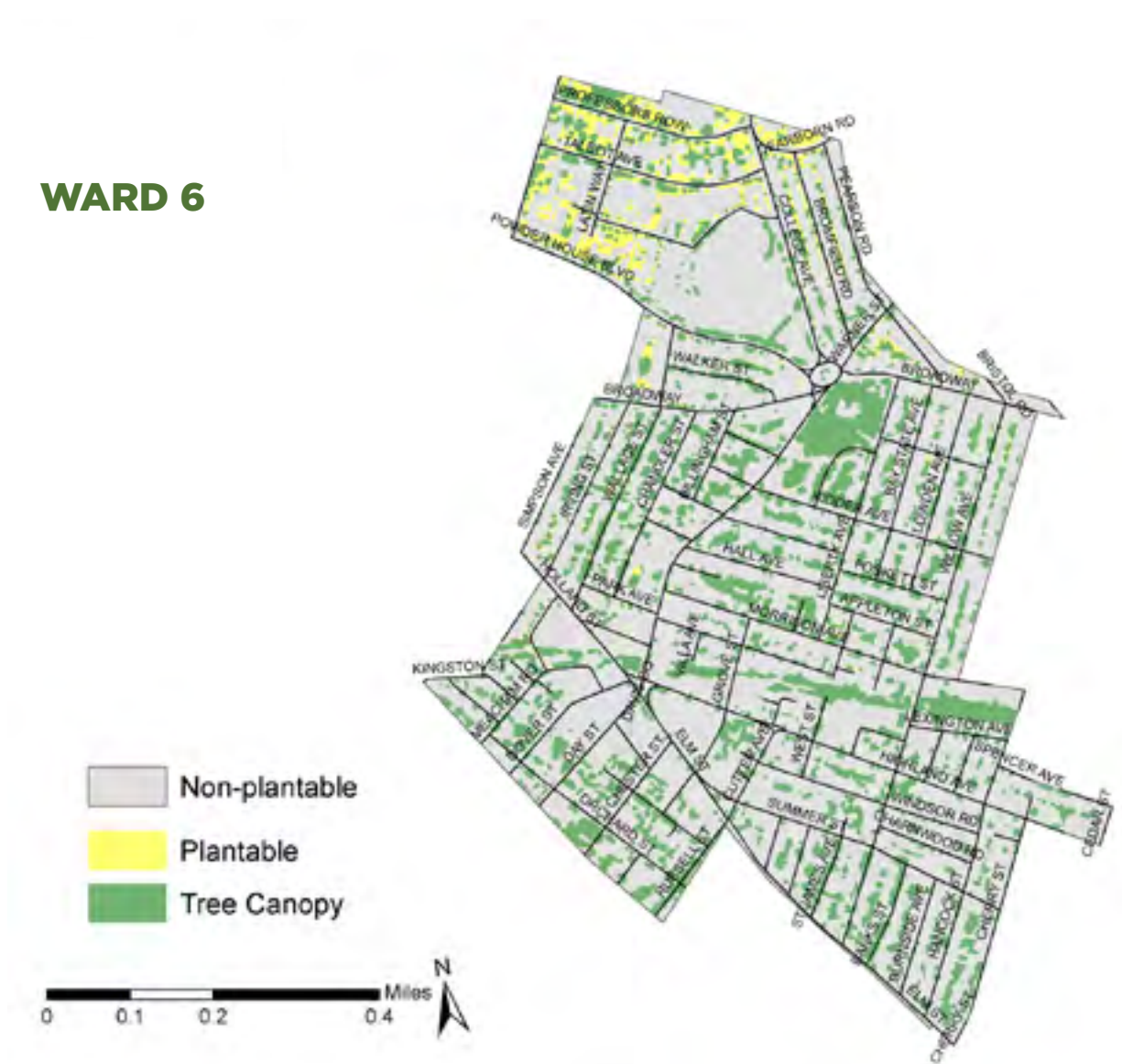
WARD 2



WARD 3



WARD 6



WARD 7