URBAN FOREST MANAGEMENT PLAN

PEST AND DISEASE PLAN

COLORADO SPRINGS, COLORADO

OCTOBER | 2020

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URBAN FOREST MANAGEMENT PLAN

PEST AND DISEASE PLAN

COMPLETED AS PART OF THE PHASE 2 PRIMARY FRAMEWORK

COLORADO SPRINGS, COLORADO

ACKNOWLEDGMENTS

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- The City of Colorado Springs Contributions -

Colorado Springs Forestry Division
City Council
City of Colorado Springs Supporting Departments
Colorado Springs Utilities
Residents of Colorado Springs

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1 PEST AND DISEASE PLAN

COLORADO SPRINGS TREE PEST AND DISEASE PLAN

A PLAN FOR THE MANAGEMENT OF EMERALD ASH BORER

This pest and disease plan supports the vision of the Colorado Springs Forest Division:

A VISION FOR COLORADO SPRINGS' URBAN FOREST

Our City's trees, forests, and other natural resources are recognized as integral to sustaining life and health for all City residents. A healthy, thriving, and sustainable urban forest is a community priority, to be thoughtfully managed and cared for by partnerships between the City and its residents to maximize public safety and benefits that include a thriving ecosystem, vibrant economy, and livable communities shared by all who live, work, and play in Colorado Springs

This pest and diease plan is also supported by the following actions in the primary UFMP framework:

Table A-1. List of Plan actions supporting the Colorado Springs EAB pest and disease plan.

Action	
V.H.2	Continue to research the threat of emerald ash borer for public and private ash trees and implement actions provided in the tree pest and disease plan for prevention, response, treatment, mitigation, and wood utilization.
VI.A.13	Increase public outreach and notification so residents are aware of the full scope of emerald ash borer impact and urgency and what they can do to support and sustain the urban canopy.
VI.C.2	Continue to engage neighborhoods with volunteer tree planting events. Prioritize those areas with lower urban tree canopy or those expected to be greatly impacted by emerald ash borer.

BACKGROUND AND INTRODUCTION

The Tree Pest and Disease Plan for the City of Colorado Springs provides information for various existing and potential tree pest and disease concerns but focuses on the emerald ash borer. The framework provided for the management of emerald ash borer can be amended and applied to other tree pests and diseases based on recommended approaches, budgets, and data.

Emerald ash borer (EAB) is an extremely destructive insect of ash trees (*Fraxinus* species). The emerald ash borer (*Agrilus plannipennis*) is a wood boring beetle of Asian origin that has become established in many parts of the United States and Canada where native and urban ash are found. Ash tree species such as green and white ash are very common in Colorado landscape settings. It is far more damaging to urban trees than any other insect that has previously been found in the state. As populations of this insect increase in the infested areas, all untreated ash trees will die as a direct result of EAB.

This pest is not very damaging in its native land due to naturally occurring biological control organisms and the natural development of EAB resistance within the native ash populations. Unfortunately, native ash trees in the U.S. have zero resistance to EAB with the small exception of blue ash in the southeast states. In the Midwest and eastern areas of North America, where this insect has been present for several years, EAB has already killed many millions of ash trees resulting in losses of over $4 billion worth of resources. An estimated 15 percent or more of Colorado's urban and community trees are ash, accounting for over 30 percent of urban tree canopy in the state, and many of these trees are located on private property.[1] Experts agree that EAB has a strong potential to ultimately kill every unprotected susceptible ash tree presently growing in North America. Furthermore, if preventative treatments are not implemented within a community it has the capacity to kill every ash tree within a given community inside ten years.

Evidence suggests that this insect was introduced into North America in the late 1980's or early 1990s, probably through wooden shipping or packaging materials originating in China. However, it went undetected until it was discovered in southern Michigan in 2002. It has since spread rapidly and by the end of 2015 had been detected in 25 states and two Canadian provinces.

1. Colorado State Forest Service, Emerald Ash Borer: A Green Menace, www.csfs.colostate.edu, 2019.

This insect was first found in Colorado in the City of Boulder in late September of 2013, making Colorado the 22nd state to detect EAB. As of 2020, EAB has been confirmed in the cities of Boulder, Gunbarrel, Longmont, Lafayette, Lyons, Superior, Broomfield, Westminster, Arvada, and just north of Fort Collins.[2] While it has yet to be detected in Colorado Springs, EAB continues to spread as illustrated in the figure below.

2. Colorado State Forest Service, Emerald Ash Borer: A Green Menace, www.csfs.colostate.edu, 2019.

Figure A-1. (above) Emerald Ash Borer (Agrilus plannipennis) insect and preferred host tree, ash (Fraxinus species).

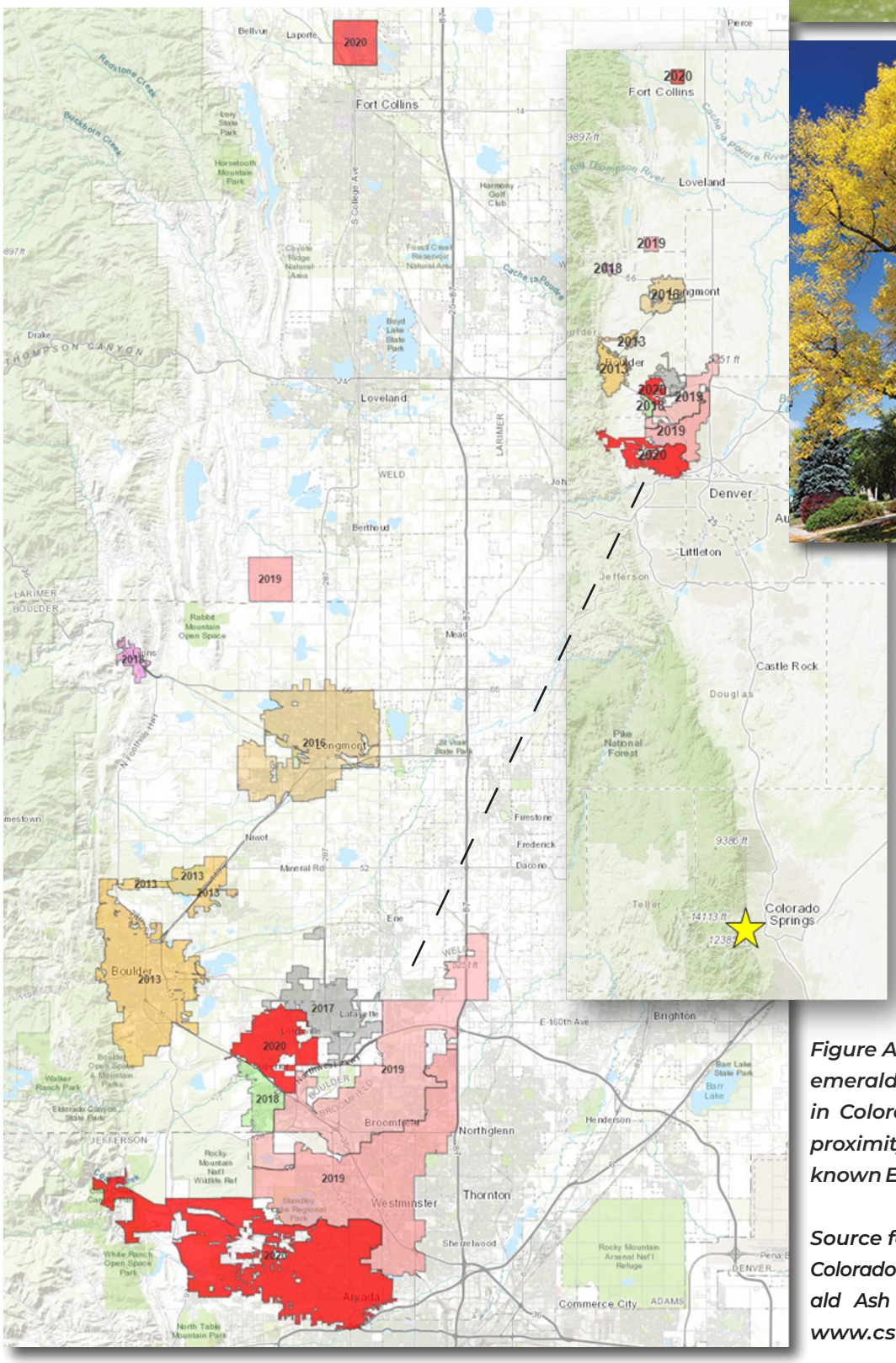


Figure A-2. (left) Cities and year emerald ash borer was detected in Colorado's front range. Inset: proximity of Colorado Springs to known EAB locations in Colorado.

Source for Figures A-1 and 2: Colorado State Forest Service, Emerald Ash Borer: A Green Menace, www.csfs.colostate.edu, 2019

PEST AND DISEASE PLAN PURPOSE

Trees— and collectively the urban forest —are major capital assets in cities across the United States. Just as streets, sidewalks, and public buildings are a part of a community's infrastructure, so are publicly-owned trees. The quality of life of the citizens in any community depends on the urban forest, as trees make a vital and affordable contribution to the sense of community, pedestrian-friendly neighborhoods, energy savings, and air quality. The City's Forestry program ("Forestry") is critical to meeting the City's commitment to climate change mitigation and adaptation, carbon sequestration, water conservation, wildlife habitat enhancement, and stormwater reduction. Trees are one of the few infrastructure investments that, if properly maintained, will grow in value over time.

The Parks, Recreation and Cultural Services' Forestry Division is responsible for the care and management of approximately 270,000 trees in City parks and public street rights-of-way that contribute to the quality of life of all who live, work, and visit Colorado Springs.

Colorado Springs' urban forest canopy includes trees on public and private properties. This living infrastructure shades over 17 percent of the community and provides economic, environmental, and aesthetic benefits: $100 million annually in air filtration, $900 thousand in stormwater retention, $2 million in carbon sequestration, and incalculable moments of beauty and serenity. Our legacy of trees is 150 years old and continues to grow.[3]

A healthy urban forest properly managed for existing and potential tree pests and diseases will provide the City of Colorado Springs with benefits such as shade, water conservation, aesthetics, and a sense of community as the City continues to develop and grow. The 2020 Urban Forest Management Plan (UFMP) for Colorado Springs identified emerald ash borer as an immediate concern and provided actions relating to the implementation of this Tree Pest and Disease Plan as shown in the tables on the next page.

Colorado Springs' efforts to manage emerald ash borer and other pests will have a large impact on the character, health, and sustained benefits of the urban forest. A thriving and well-maintained tree population provides a wide variety of services and benefits to the community. A healthy urban forest contributes to the economic vitality of the City, provides environmental stability, and provides a better quality of life. Routine care of public trees by the City, contractors, citizens, and volunteers is necessary to maintain and enhance the quality of the natural environment. All residents are entitled to the benefits of a healthy urban forest.

The City of Colorado Springs' tree canopy is threatened by a myriad of native and non-native insect pests including spruce ips and EAB, respectively. To help ensure a prospering urban forest, the City has developed the Tree Pest and Disease Plan to address these threats—particularly EAB. To maintain desired urban forest resource conditions, necessary pest management actions need to be executed in a timely manner. This plan provides goals and actions for EAB management to assist the City in minimizing impacts and maximizing the benefits of the urban forest.

The intent of this plan is to guide the City in the mitigation of the disruption to the urban forest caused by the pending infestation of emerald ash borer; to develop strategies that will effectively distribute the costs of the infestation over a period of time; and to lessen the social and economic impact that such an extensive loss would have on the property values and quality of life in the community.

This plan will apply to all ash trees currently growing on City properties (along streets and trails, in parks, medians, and open space, and facility grounds) as well as ash trees growing on private properties that have the potential to adversely impact adjacent private properties, public rights-of-way, or other public properties. The actions recommended in this plan are in addition to the actions provided in the 2020 Urban Forest Management Plan. The Tree Pest and Disease Plan supports the operations of the tree maintenance programs that are currently in place for the management of Colorado Springs' urban forest, but additional personnel and financial resources will be required to enact these additional actions.

The emerald ash borer management strategy's goals and actions are focused on the pre-detection, early infestation, rapidly increasing mortality phase, late infestation stages, and recovery efforts in response to the pest. This document must remain dynamic and sensitive to current conditions, research updates, and planning resources (such as the Steps to an EAB Management Plan in development) as they become available.

3. City of Colorado Springs, Colorado.

Table A-2. Summary of 2020 Urban Forest Management Plan targets relating to EAB.

Priority	Effort	*Co-benefit	V. Green Asset Management Actions	Lead*/Year
			H. Integrated Pest Management	
V.H.2			Continue to research the threat of emerald ash borer for public and private ash trees and implement actions provided in the tree pest and disease plan for prevention, response, treatment, mitigation, and wood utilization.	**PRCS** **Target Year:** Annual
Priority	**Effort**	**Co-benefit**	**VI. Community Engagement Actions**	**Lead*/Year**
			A. Education and Outreach (continued)	
VI.A.13			Increase public outreach and notification so residents are aware of full scope of emerald ash borer impact and urgency and what they can do to support and sustain the urban canopy.	**PRCS**, CD, NSD, PDD, HOAs, SIMDs **Target Year:** Annual
			C. Volunteers	
VI.C.2			Continue to engage neighborhoods with volunteer tree planting events. Prioritize those areas with lower urban tree canopy or those expected to be greatly impacted by emerald ash borer.	**PRCS**, CD, NSD, HOAs, SIMDs **Target Year:** Annual

Table A-3. Summary of 2020 Urban Forest Management Plan actions relating to EAB.

	Plan Targets: Management Scenario A				
V. Green Asset Management	**1-Year**	**2-Year**	**5-Year**	**10-Year**	**20-Year**
H. Integrated Pest Management		(V.H.2)Emerald ash borer plan implemented (V.H.3)Tree susceptibility report		(V.H.2)Partial completion of emerald ash borer plan actions	

INVENTORY OF ASH TREES

It is estimated that Colorado Springs has nearly 25,000 ash trees within City parks and along streets in the public right-of-way. This is nearly 9 percent of the total public tree population of 270,000 trees. This rough estimate is based on inventories from 2005 through 2018 in various locations across the City (Old North End, Southeast, Village 7, street trees, and park trees).

Extrapolating the ash tree data from the sample inventory datasets provides an estimate of nearly 25,000 public ash trees Citywide. Based on the sample data, it is estimated the ash tree population is primarily composed of trees in the 24-30-inch diameter class (31 percent) and the 12-18-inch diameter class (28 percent) shown in Figure A-3.

Table A-4. Estimated total public ash tree population.

Inventory	
Old North End (2018 inventory)	639 ash trees
Southeast (2018 inventory)	390 ash trees
Village 7 (2014 inventory)	618 ash trees
Street Trees (2005 inventory)	10,591 ash trees
Park Trees (2013 inventory)	403 ash trees
TOTAL ASH INVENTORIED	12,641 ash trees
TOTAL INVENTORIED TREES	137,763 trees
% ASH	9% ash trees
TOTAL PUBLIC TREE POPULATION	270,000 trees
ESTIMATED TOTAL ASH POPULATION	**25,000 ash trees**

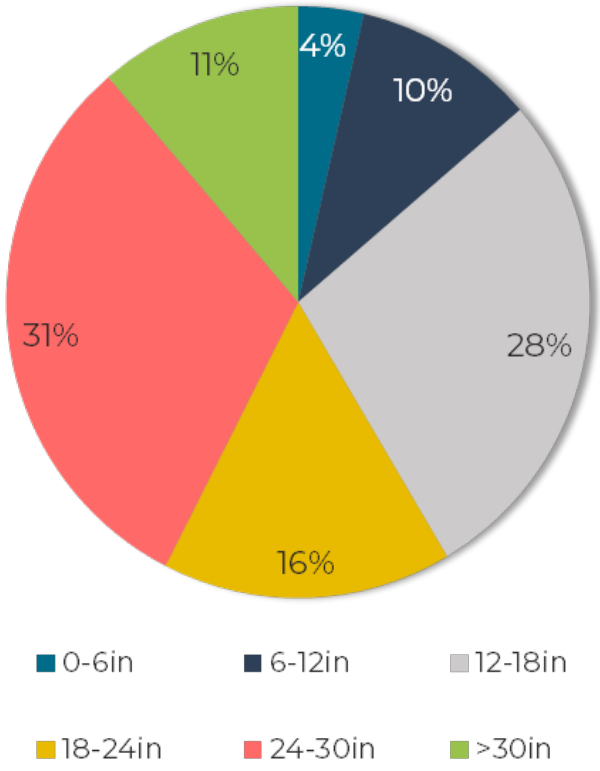


Figure A-3. Estimated diameter class distribution for public ash trees in Colorado Springs.

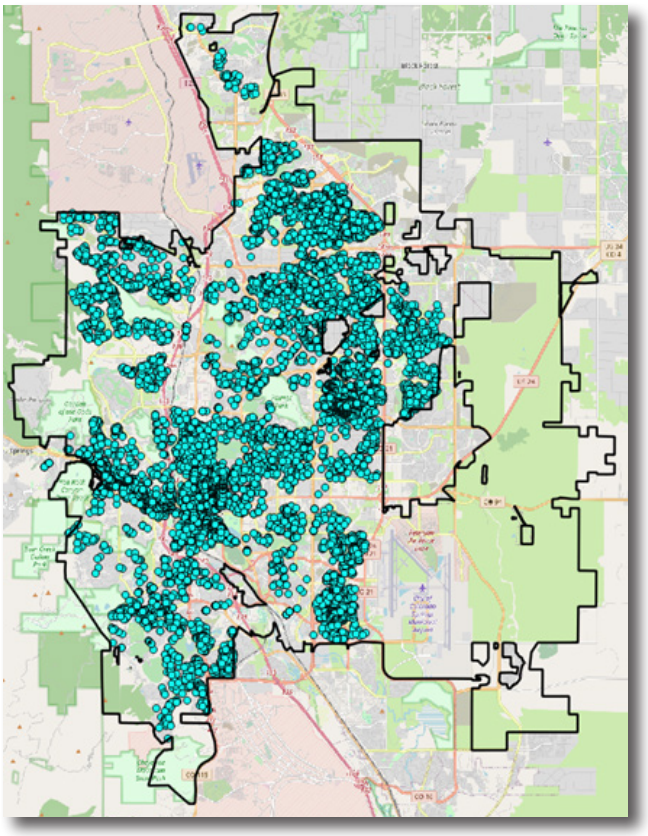


Figure A-4. Map displaying the location of ash trees inventoried from 2005 – 2018.

EAB AND ASH TREE IDENTIFICATION

Early EAB detection protocols are critical to management strategies and budgetary planning. City Forestry's limited resources and staff make this effort difficult, but Forestry should explore options for early detection.

Signs of EAB infestation include:

- Sparse leaves or branches in the upper part of the tree
- D-shaped exit holes approximately one-eighth-inch wide
- New sprouts on the lower trunk or lower branches
- Vertical splits in the bark
- Winding, S-shaped tunnels under the bark
- Increased woodpecker activity

Emerald ash borer has a life cycle that normally takes one year to complete. During winter, the life stage present is a full grown larva that lives within a chamber cut into the outer sapwood of a host tree. In the spring it will transform to a pre-pupal phase and then continue into the pupal stage. It will transition from a pupa into the adult beetle form which will then emerge from the ash. During low population levels, this life cycle may take two years to complete.

Adults emerge from the tree by cutting through the bark, producing a D-shaped exit hole. In Colorado, emerald ash borer will normally begin to emerge in early to mid-May, with peak emergence in June. However, some beetle emergence could extend into midsummer.

After emergence, adults move to the crown of an ash tree (flight season) where they feed on leaves. After about a week of feeding, the now mature adults will begin to mate. A few days after mating the females will begin to lay eggs on the surface of the bark. Females typically live for about a month and during this time will lay several dozen eggs.

Eggs hatch in about a week and the tiny, newly hatched larvae burrow through the bark to feed on the tissues underneath which includes the phloem, cambium, and outer sapwood. This is the primary cause of death to ash trees.

Figure A-5. Ash (Fraxinus) trees have opposite buds, diamond-shaped ridged bark, five to nine leaflets on each stalk, and paddle-shaped seeds. Adult beetles are approximately one-half inch long and have an emerald-green head and back, a coppery reddish purple abdomen, create D-shaped exit holes, and S-shaped galleries when entering the tree in the larval stage. Source of photos: Colorado State Forest Service.

EAB MANAGEMENT STRATEGY

GOAL 1: CREATE AND MAINTAIN AN ACCURATE TREE ASSESSMENT, MAINTAIN RECORDS, AND UPDATE CITY CODE

As with all infrastructure, maintenance is essential to maximize benefits, yet many cities lack the ability to track the maintenance and replacement needs of their urban forest. Management strategies for ash trees should be based on their condition, size, value, location, and ownership. Categories of ash tree populations include forests, public and private trees, high- and low-quality trees, and high- and low-priority areas.

Public Tree Inventory: Forestry has several incomplete datasets of tree information describing the location, species, size, condition, and maintenance needs of public trees at varying levels of detail. In July 2020, Forestry received cost estimates for completing a Citywide right-of-way tree inventory as part of the City Public Works Department's repaving project. Costs to map the location of trees and identify the tree species amount to approximately $268,000. Alternatively, the City may contract tree inventory services Citywide to gather data on the entire public tree population (approximately 270,000 trees) or specifically inventory ash trees (25,000 ash trees estimated). Costs for International Society of Arboriculture (ISA) Certified Arborists to inventory 270,000 trees may range from $800,000 to $1.1 million whereas an ash tree inventory may range between $75,000 and $125,000 (based on 2020 estimates).

A current and accurate tree inventory of City-owned trees is vital to any effort in preparing for an EAB invasion. The inventory should provide current data on the number, size, condition, and placement of all ash trees on developed City-owned properties. This data is vital in determining the value of public ash within the City and should allow Forestry to develop cost/benefit analysis estimates for various treatment or control options. An inventory allows Forestry to identify the condition of individual ash trees. From this, Forestry can determine which trees are worth treating and which are not. It is estimated that Forestry is responsible for 270,000 trees on City property and 9 percent of all those trees are ash (25,000 total ash trees on City property).

If budget or time constraints prevent a comprehensive tree inventory, the first priority is to assess ash trees located in high-priority areas, which are areas within clear view from public lands and rights-of-way. An updated inventory of ash trees with information about each tree's size, condition, and location would allow Forestry to estimate the values and contributions that City-owned ash trees make to the community in terms of property values, stormwater management, carbon storage, energy savings, water savings and other beneficial factors.

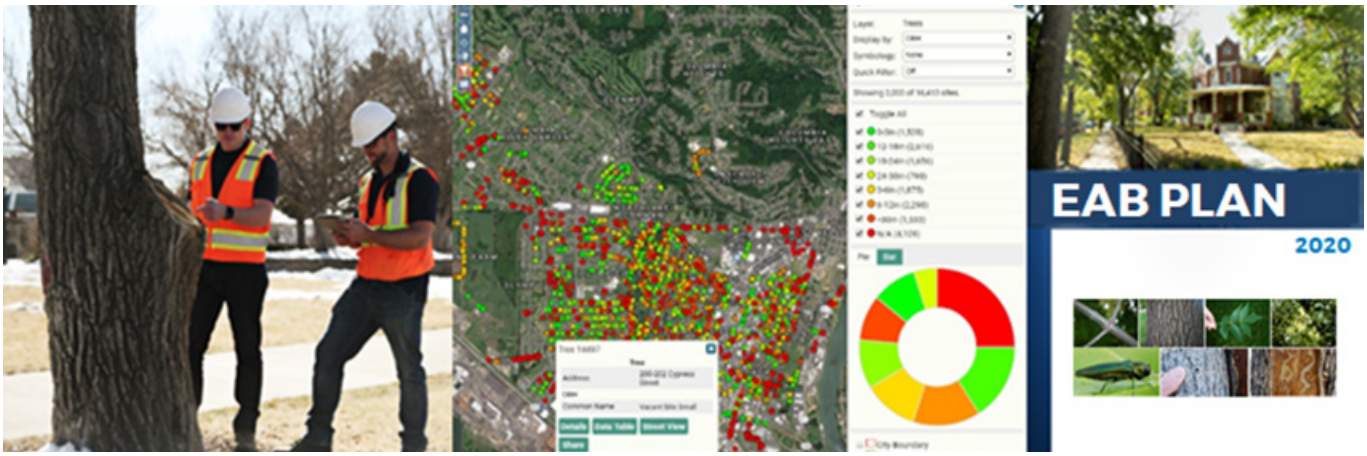


Figure A-6. An update to this plan should integrate data from an ash tree inventory and analysis. Images: PlanIT Geo.

Private Tree Survey: The ash tree population on private property should not be ignored. Most often in cities, the largest percentage of ash trees reside on private property. While City staff may not inventory on private property, many cities throughout the region, specifically, Fort Collins, have contracted services to complete an i-Tree Eco[4] analysis of private trees. This process involves 200 randomized plots distributed across a city to estimate the number of ash trees on private property within the City. In addition to estimating the total private tree ash population, size, and condition, an analysis of the data can estimate the total ecological benefits that the private ash tree population provides each year. Forestry should obtain estimates of private trees based on surveys with a high degree of accuracy to know the extent of their influence. This information would provide an estimation of the total overall impacts that EAB will have on Colorado Springs' urban forest.

Record Keeping: As the actions in this plan are implemented, the tree inventory database should be regularly updated to reflect tree growth, removals, and replanting.

Updating City Code: The infestation of emerald ash borer will likely require updates to City Code in the following ways:

- Nuisance Language: Specific language regarding the control of tree infections and infestations as well as declared tree nuisances, control measures, and control areas should be included in updates to City Code.
- Upgrading Landscape Requirements in the Zoning Code: At a time when it is important to maximize tree canopy as a major strategy to mitigate the effects of climate change, EAB will destroy thousands of trees. To take advantage of every opportunity to plant trees, the City can harness the power of the private sector through the development review process. The zoning code needs to incorporate all the best practices that maximize tree benefits.
- Ash Tree Treatments: Amend City Code to give Forestry the authority to allow the option of an approved chemical treatment, rather than removal, in ash trees showing less than 30 percent crown damage due to EAB. Code language stating the "Notice to Remove" should be changed to "Notice to Remove or Treat". This would only be used early in the infestation as an effort to slow the spread of EAB in the City.
- Trap Trees: Forestry should be permitted to allow EAB infested trees referred to as "trap trees" to remain standing if they pose minimal risk to people and property.

4. i-Tree Eco (www.itreetools.org) is software application designed to use field data from single trees, complete inventories, or random plots throughout a study area to quantify forest structure, environmental effects, and value.

Goal 1 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-5. Summary of EAB plan actions to support Goal 1.

Year	Action
2020	Build the business case to secure funding for the comprehensive or sample tree inventory specifically to gather an understanding of the public ash tree population.
2021	Complete the tree inventory with an emphasis on collecting information about the public ash tree population.
2021	Include City Code language updates relating to EAB management with the proposed Code amendments provided in the 2020 UFMP.
2022	Secure funding and a partner or consulting firm to sample private properties to establish an estimate of ash tree populations on private property.

GOAL 2: EARLY INFESTATION DETECTION AND SUPPRESSION

Monitoring to increase the chances of early EAB detection is another important goal for Forestry in terms of tree pest and disease management. Possible detection methods include visual inspections/ surveys, branch sampling and peeling, trap trees, rearing cages, and attractant traps. Research is ongoing to determine more effective ways to trap and monitor for EAB. The Emerging Pests In Colorado (EPIC) committee and the Colorado EAB Response Team are in continual contact with national and international experts regarding improved ways to conduct sampling. One method is to girdle live ash trees and let stand ("trap trees") during the flight periods of EAB. This method has proven to be slightly more effective than the purple or delta traps at attracting EAB. Forestry should determine whether the creation and use of trap trees could help as the City searches and monitors for EAB.

Early Infestation Detection and Suppression Approach

A. Education: Educate City staff through:
   - EAB University Sessions (www.emeraldashborer.info/eabu.php).
   - Seminars and workshops.
   - Hands-on training in Colorado Springs.
   - Other opportunities as they arise.

B. Inspection: As feasible, Forestry field crews should inspect for EAB in any ash tree they work on.

C. Community Education: Educate and encourage local, licensed arborists to be trained and inspect every ash they work on. This includes tree managers for City HOAs and special districts. Ask them to report directly to Forestry any suspicious trees or samples they encounter.
   - Can occur through local interaction with tree managers for these entities.
   - It is also recommended to host (in-person or virtual) annual licensed arborist meetings where EAB detection can be discussed.

D. Sampling: Forestry should follow sampling parameters as established by researchers:
   1. Create a 1-mile by 1-mile grid system and overlay in GIS. Forestry should sample 5 random City-owned ash trees within each grid. With limited resources, Forestry may consider sampling in only high-value areas or high-risk neighborhoods. Either sampling approach should use the following recommended protocol:
      a. Remove 2 branches, ranging from 2 to 6 inches in diameter, from mid to upper crown on the south side of each tree. It is not recommended to sample ash trees during the summer due to risk of spreading EAB through movement of infested materials.
      b. Look closely in the branch union areas and at the leaders of sampled trees.
      c. Select trees that appear to be stressed (rationale is that stressed trees are more attractive than healthy trees when EAB are at low population levels). Stressed trees may be found in:
         i. Downtown areas and parking lots.
         ii. Distribution centers and large commercial properties.
      d. Catalog each sample for tracking purposes.
      e. Peel the bark and into the outer rings of sapwood following established protocol. Two options include:
         i. Bring branch samples to the Forestry Operations Center (FOC) and peel. If it is during EAB flight risk season then the samples will need to be kept in a closed container during transport.
         ii. Peel the samples in the field utilizing a truck mounted vice or similar device to stabilize the samples.

E. Traps: Place and monitor traps based on APHIS recommendations.

F. Trap Trees or Girdled Trees: Determine if using trap trees is advisable for Colorado Springs in 2021 and 2022. This is a process where existing ash trees are girdled and left standing during the flight season of EAB to serve as "sinks". The terms "sink trees" and "trap trees" are used interchangeably. Preferably, trees that are in moderate to poor condition would be used.

    1. Certain nurseries may have stock they would donate for this purpose.
    2. Identify potential trap trees when doing grid survey work.
    3. Girdling of trees in sunny locations are highly attractive to adult beetles in locations where EAB populations are relatively low. Girdled trees organized in a grid pattern are very effective for detection and assessment. The tree girdling strategy can assess beetle distribution also known as larval density as well as serve as beetle population "sinks" to concentrate and eliminate adult beetles before they can disperse and reproduce. Tree girdling considerations include:
        a. If tree cutting and removal of wood debris and EAB food/nesting source is not a viable option, then creating lethal trap trees should be considered.
        b. Girdled trees deployed in a systematic survey grid can concurrently serve as sinks for the subsequent generation of EAB.
        c. Clustering three or four girdled trees creates a more powerful attraction for EAB adults than isolated single girdled trees in areas with low-density populations.
        d. There is evidence to suggest that at very low EAB population levels, the location of sink trees can influence how beetles disperse. Sink trees will pull some beetles towards them as EAB adults respond to the presence of artificially damaged trees. Placing clusters of sink trees inside the core of an outbreak versus outside the outer edges could pull dispersing beetles away from the edges and potentially reduce spread rates.[5]
        e. Although all native ash trees will attract EAB adults, some species are more attractive than others. If different ash species are present, select by priority, from most to least preferred: (1) green ash, (2) black ash, (3) white ash, and (4) blue ash.

G. Timing for Girdled Trees: Dates for girdling trap trees or setting traps and debarking trees or retrieving traps should be based on accumulated degree days (see Appendix for definitions) for the local area since adults predictably fly at the same time each year.

H. Removal of Infested Trees: The timing for girdling trap trees or setting traps and debarking trees or retrieving traps should be based on the timing of adult EAB flight periods. These occur generally at the same time each year. Girdled trees should be felled and debarked or destroyed in the fall, winter or early spring following their establishment to ensure that larvae die before completing development.

I. Distant Infestation: The following guidelines apply if the closest known infestation is more than 15 miles away:

    1. Forest Detection Trees: Detection trees should be girdled in early spring in accessible areas of forests, ideally in a grid pattern. Focus on areas closest to the expected wave front (area facing the likely origin of EAB). Let trees die in place.
    2. High-Priority Area Detection Trees: Same as above but only girdle low-quality trees and remove them when they risk becoming hazard trees.

J. Proximate Infestation: The following guidelines apply if the infestation is within 15 miles or already within the City:

    1. Forest Trap Trees: Girdle trap trees in the spring in accessible areas of forests, ideally in a grid pattern. Focus on areas closest to the wave front. Remove or process dead trees before adults can emerge in the spring.
    2. High-Priority Area Trap Trees: Girdle low-quality trees in the spring and remove before adults can emerge in the spring.

K. Citizen Requests: Conduct inspections on any suspicious trees reported by citizens or other sources.

5. Hafner, J.M, Orange, J.M, (2015). Model Emerald Ash Borer Management Plan

Figure A-7. Public information, traps, sampling techniques, and girdled trees for early EAB detection and suppression. Source: Colorado State Forest Service.

Goal 2 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-6. Summary of EAB plan actions to support Goal 2.

Year	Action
2020	Educate City staff and departments on this EAB plan and potential management strategies.
Annual	Educate local licensed arborists and tree managers for HOAs and special districts on this EAB plan, detection methods, and management options.
2021	Establish ash tree sampling protocols and procedures.
2022	Develop a removal and trap tree strategy based on sampling results and other data.
Annual	When responding to citizen requests relating to ash trees and ash tree maintenance or removal, inspect trees for EAB.

GOAL 3: POSTPONE AND DECREASE PEAK ASH MORTALITY

Not all ash trees should be preserved. This Tree Pest and Disease Plan for emerald ash borer incorporates an important strategy intended to reduce the overall intensity of the infestation, also known as the pest pressure. Past strategies in other cities have included the removal of lowvalue ash trees to reduce the food supply. For ash trees in forested areas and in low-priority areas, a policy of "benign neglect" or noninterference allows the EAB to kill the trees so the natural forest canopy can grow into the gaps. The issue with the noninterference approach is that it allows EAB populations to increase exponentially wherever ash trees are left untreated. This increases overall pest pressure and hastens its spread. The following best practices are provided to reduce overall pest pressure and to postpone or decrease ash mortality to allow Forestry to proactively manage the infestation. These practices prevent or reduce overwhelming numbers of dead, often hazardous trees.

Approach to Postpone and Decrease Peak Ash Mortality

A. Preemptive Removals and Ash Utilization: The first priority for low-quality trees in high-priority areas is for these trees to serve as detection or trap trees. Trees in low-priority areas can be preemptively removed for ash biomass utilization and to reduce available food for EAB. The removal of other trees can be staged as convenient over time.

   Large ash trees can potentially produce hundreds to thousands of EAB adults, but small ash trees produce relatively few, even when the small trees are abundant. Removing a few large trees can sometimes eliminate much of the available food for EAB larvae. Landowners may recognize some economic benefits by targeted harvests of large ash trees for lumber or firewood. Reducing the ash phloem by itself is unlikely to slow spread. In some cases, local EAB spread rates may increase because beetles are forced to fly further to locate a suitable host tree. An integrated approach that combines ash reduction (e.g. removing selected trees) with insecticide treatments or girdling and sinks will be more effective than simply reducing ash trees. This approach has been termed the SLAM approach or SLow Ash Mortality approach.[6]

   According to the SLAM study, ash trees are often common along road, railroad, utility, or trail rights-of-way, and that these types of corridors enhance EAB dispersal and spread. Therefore, they are excellent, accessible trees for preemptive removals and, if girdled, to serve as valuable sink trees.

B. Reducing Pest Pressure during Moderate and Peak Periods: As the infestation builds, it may be economically preferable to invest in reducing pest pressure near high-quality trees. Strategies include additional preemptive removals of low-quality trees (to reduce the food supply) and the use of trap trees. Lethal trap trees can be used by treating trap trees with insecticide a few weeks before girdling (see Table A-14 for treatment options).

6. McCullough, D.G., Mercader, R.J., (2012). Evaluation of potential strategies to SLow Ash Mortality (SLAM) caused by emerald ash borer (Agrilus planipennis): SLAM in an urban forest. International Journal of Pest Management, Vol. 58, No. 1, January – March 2012, 9-23.

Figure A-8. Ash trees in Toledo, Ohio in 2006 (left) and 2009 (right), after emerald ash borer arrived. Credit: D. Herms.

The effectiveness of girdled trees to function as traps or sinks appears to diminish as EAB densities build in an area, according to studies. The SLAM study has shown that achieving minimum overall treatment rates in an area (10-20 percent of all ash trees) can significantly reduce pest pressure. However, accomplishing these seemingly low overall rates will still require public investment in the management of trees in the early years of the infestation before the beetles kill most of the untreated ash trees.

C. Strategies during Low Pest Pressure: Strategies to reduce pest pressure, such as girdling and removing trap trees, can be expensive. Since ash trees can tolerate low levels of pest pressure, the best strategy is likely to invest only in inspections and treatments of high-quality trees closest to the likely wave front.

D. Encouraging Natural Enemies of EAB: The SLAM study found that treatments may increase the likelihood that beetle parasites and other natural enemies (e.g. beetle eating wasps and woodpeckers) can decrease beetle densities. Woodpeckers remain the most important natural enemy of EAB larvae, but woodpecker predation is not consistent.

Goal 3 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-7. Summary of EAB plan actions to support Goal 3.

Year	Action
2021	Use the inventory data and local knowledge to identify low-quality ash trees in high-priority areas to serve as detection and trap trees.
2022	Identify low-quality ash trees near high-quality ash trees to remove or serve as trap trees. Align efforts with citizen requests and maintenance actions in the UFMP.
Annual	Support habitat and conditions for natural predators such as woodpeckers.

GOAL 4: PRESERVE THE MOST VALUABLE ASH TREES

For Colorado Springs, it is recommended to treat important ash trees with emamectin benzoate every three years to preserve them though other treatments are available (see Table A-14 below).

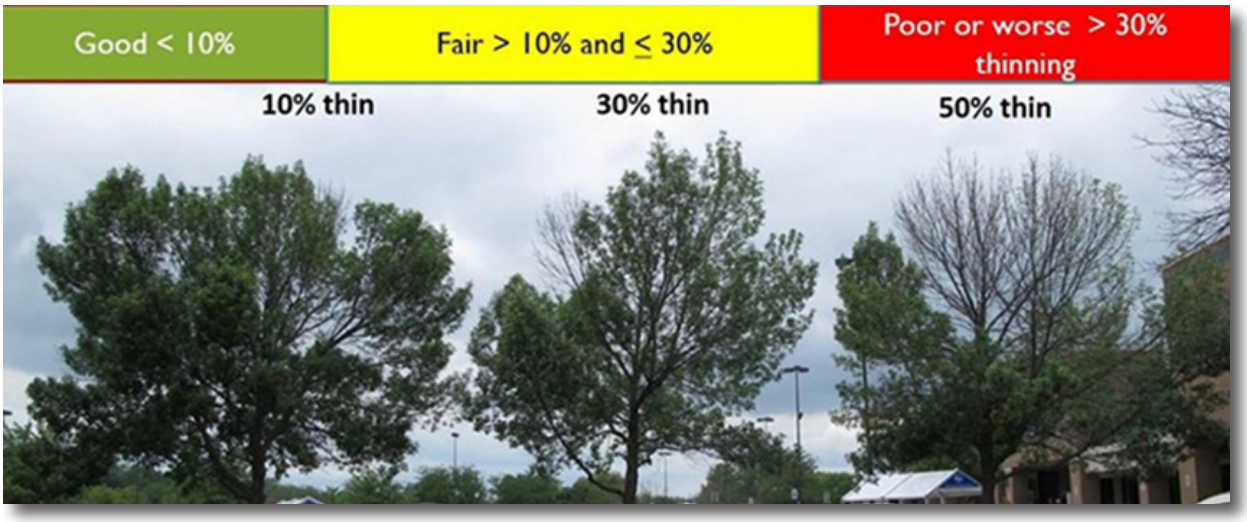


Figure A-9. Trees that have lost more than 30% of their canopy should not be saved with insecticides because too much of the tree is already dead. Source: Purdue University Entomology Extension, https://extension.entm.purdue.edu/EAB/Management.html.

Approach to Preserving the Most Valuable Ash Trees

A. Identify High-Value or High-Quality Ash Trees: Using the tree inventory data, sample surveys, and Forestry institutional knowledge, high-value or high-quality ash trees should be selected and prioritized for treatment in a series of phases. Treatment options and number of trees ultimately depends on funding but a systematic approach to high-value ash tree selection will provide supporting information to acquire funding. Quantifying the ecosystem benefits of these high-value ash trees to counter the costs of treatment argument is another effective measure. Criteria for selecting high-value ash trees may include:

    1. Location: Trees along major arterial roads, pedestrian-heavy districts, major parks and trails, City properties, and trees most seen by the public eye may be prime candidates for treatment if they meet other criteria.

    2. Size: Based on the existing tree inventory, approximately 86 percent of public ash trees are greater than 12 inches in diameter. Generally, it is recommended to consider trees greater than 12 inches for treatment though it can depend on other factors described in this section. The costs for treatment increase with the tree's diameter which is another factor to consider.

    3. Condition: Trees in good health with less than 30 percent dieback due to EAB can be considered for treatment though other factors must be evaluated. These include the estimated lifespan of the tree, the growing site, tree structure, and any signs or symptoms indicating the tree's health may decline.

    4. Significance: Ash trees planted in memoriam or in honor of an individual, group, event, etc. should be considered for treatment if the trees are in healthy condition overall. Trees of cultural and historical value should also be considered.

B. Evaluate Costs and Options: Forestry should use the tree inventory data or estimates of public ash tree populations to estimate potential costs for various management scenarios. Using the estimate of 25,000 public ash trees and estimated distributions of ash trees by diameter class, costs can be simulated by scenario. An example of this can be found in Table A-13 of this plan. The management scenarios to consider include:

1. Remove all ash trees, remove all ash trees with 100 percent tree planting replacements, treat all ash trees, selective ash treatment (high-quality scenario), among other scenarios depending on available budget and desired outcomes. Remove 2 branches, ranging from 2 to 6 inches in diameter, from mid to upper crown on the south side of each tree. It is not recommended to sample ash trees during the summer due to risk of spreading EAB through movement of infested materials.

C. Insecticide Treatments: Insecticide treatments should be used for these public trees:

1. Aggressive Treatment Protocol – Years 1 to 13: Treat 100 percent of high-quality trees beginning with those closest to the infestation wave front, if known. Since trees can tolerate three or more years of low-to-moderate infestation, treat one-third of the trees each year to even out demands on crews, equipment, and budgets. Emamectin benzoate treatments are effective for three years or more.[7]

2. Maintenance Treatment Protocol – Years 13 and beyond: Inspect 100 percent of high-quality trees in Year 13. Treat (and track) those trees that show 30 percent or greater canopy decline thereafter. Implement SLAM study practices by randomly selecting 20 percent of high quality trees for treatment in Year 13. Thereafter, treat 20 percent of randomly selected trees that had not been treated during the prior three years. Field research and the SLAM study confirm that treatments using emamectin benzoate will keep trees completely free of pests for the first two years after the injection, and that it takes three to four years after the start of an infestation for trees to decline to the degree they show at least 30 percent canopy loss and require removal.

D. Staging for Removal and Use of Trap Trees: Where large numbers of ash trees are likely to need removal during the peak of the EAB infestation, Forestry may wish to treat trees so that they can survive long enough to be removed after the main wave of the infestation has passed. Continued inspection can determine when canopy loss exceeds 30 percent, after which they can be treated again to postpone removal or girdled to serve as trap trees and then removed the following spring.

7. Herms, D., Systemic Insecticide Technology for Tree Care, Department of Entomology, Ohio State University, Ohio Agricultural Research and Development Center.

Goal 4 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-8. Summary of EAB plan actions to support Goal 4.

Year	Action
2021	Complete an inventory of ash trees on public property.
2021	Establish protocols for identifying high-value and high-quality public ash trees.
2021	Analyze tree inventory data and local area knowledge to identify high-value and high-quality public ash trees.
2022	Establish the management strategy for staging ash removals, trap trees, trees to treat, and trees to disregard.
2022	Mark ash trees for treatment or management in a tree inventory database, add signage, and alert the adjacent property owner where applicable.
Annual	Prior to EAB arrival and during infestation, implement insecticidal treatments based on the City's decision for application method(s), selected trees, and priorities.

GOAL 5: EXPAND TREE CANOPY AND IMPROVE TREE DIVERSITY

The tree diversity guideline known as the "10-20-30 rule" is an arboriculture guideline to reduce the risk of catastrophic loss due to pests like EAB. This means no more than 10 percent of any tree species, 20 percent of any tree genus, or 30 percent of any tree family should exist in a given tree population. In Colorado Springs, there are a limited range of tree species suitable for the region, especially in harsh urban environments. Therefore, the City should allow flexibility with this rule and perhaps apply the rule on a smaller scale. Additionally, Forestry should continue to experiment with non-conventional street tree options supported by research. Flexibility should also be considered in the use of native and nonnative trees to enable the City to achieve more appropriate levels of tree species diversity.

In Colorado Springs, there exists no comprehensive inventory to determine the exact distribution of ash trees throughout the City's public areas. It is estimated that approximately 9 percent of the public tree population is comprised of ash trees (below the 10-20-30 threshold). The inevitable loss of virtually all untreated ash trees will reduce this population and allow replacement trees to diversify forest and urban tree populations.

This opportunity to diversify the urban forest is countered with the years of progress that will be lost due to EAB. Losing large-canopied trees and replacing with new trees that may take 20 years to mature interrupts the flow of ecosystem services and benefits provided by mature trees. Also, new trees may experience challenges in establishment based on water restrictions and trends toward xeriscaping, especially in the ROW. Therefore, considerations for treating large-canopied ash trees must be made in addition to a robust tree replacement program.

Approach to Expanding Tree Canopy and Improving Tree Diversity

A. Increase Species Diversity: Over the past several years, City Forestry has been proactive in anticipation of the arrival of emerald ash borer. This has included removal of ash trees in poor condition when responding to citizen requests as a preemptive measure and placing a ban on planting ash on any new City projects and on City rights-of-way in new developments.

B. Replacement Trees: The City should establish a policy that replaces trees in high-priority areas with at least a one-to-one ratio from a diversified list of eligible trees. Part of this strategy is to use an updated inventory to identify ash on City property that are rated as being in poor condition. Forestry can begin the process of phasing these trees out and getting replacement trees planted now rather than waiting for the pest to become established. Taking such action will help distribute the overall impact of EAB in the community over a longer period of time. The economic and workload implications of spreading out the impact of tree losses and replacements over a longer period of time are substantial. With additional funding, the City can be more proactive compared to applying for emergency funding or diverting all maintenance funds after EAB is detected.

C. Education: In order to spread pertinent information, public outreach and education efforts should increase. The overall message should include the need to improve species diversity within the urban forest by:

    1. Eliminating ash from the planting palette in design plans, tree nurseries, and big-box stores.
    2. Encouraging property owners or managers to rate the value and condition of their existing ash trees so they can make informed management decisions regarding whether to treat for EAB.
    3. Recommending the use of multiple tree species that will perform well in the City to plant in place of ash.

Outreach efforts should include citizens, HOAs, special districts, nurseries, garden centers and other entities including local arborists, County Extension agents and the Colorado State Forest Service. Coordinating efforts with nearby communities may also be advisable.

Goal 5 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-9. Summary of EAB plan actions to support Goal 5.

Year	Action
Annual	Continue to evaluate ash tree removal when responding to citizen service requests.
Annual	Continue to ban the planting of ash trees for City projects and new developments.
Annual	Discourage private property owners from planting ash trees.
Annual	Plant suitable trees as replacements when removing public ash trees.
Annual	Encourage private property owners to assess trees on their property and identify any ash trees.

GOAL 6: MINIMIZE PUBLIC COSTS

This EAB management strategy provided in the Tree Pest and Disease Plan is significantly less expensive and more effective than a remove-and-replace approach; and it preserves tree canopy and tree benefits. For the cost of removing and replacing two average 17-inch diameter trees, five mature trees can be preserved with treatments for over a decade.[7]

Approach to Minimize Public Costs

A. Budget Balancing: The following provides an approximate budgetary breakout by groups of best practices. It is intended to inform specific EAB management approaches for the City as inventory data becomes available and Forestry continues to gather more information regarding EAB spread and treatment options. During the implementation of this plan, allocations should be expected to vary according to conditions on the ground. The percentage breakouts do not account for the costs of inventorying and estimating tree populations.

   - Cost of detection activities and the management of pest pressure: Approximately 15 percent of EAB management plan budget.
   - Cost of treatments, removals, and replacements: Approximately 80 percent of EAB management plan budget.
   - Cost of public outreach efforts: Approximately 5 percent of EAB management plan budget.

B. Record Keeping: The City must obtain more information about the population of ash trees on public property either through a comprehensive tree inventory or sampling approach. Proper record keeping over the course of the infestation will produce data that will be invaluable to Forestry as well as other government officials and the scientific community as the knowledge base expands on how best to manage this infestation. It is an essential tool to battle the EAB infestation as well as future infestations and diseases. A wide variety of software programs exist for urban forest management, complete with standardized reports and the ability to customize them for EAB data recordation and evaluation. Colorado Springs currently has the TreePlotter software application (www.pg-cloud.com/ColoradoSpringsCO) that should be utilized for this effort. The data needed to evaluate the EAB management program include the following:

   1. High-Quality Ash Trees in Public Areas: Data should include geographic location, setting (street, public yard, park, etc.), condition, size, management protocol (treatment in this case), treatment data (pesticide, treatment method, date of treatment, dosage), inspection history, date of removal.
   2. Low-Priority and Low-Quality Ash Trees in Public Areas: Same as above.
   3. Detection and Trap Trees: Data should include geographic location, setting, management protocol (girdling and removal).
   4. Costs: All program costs must be logged and tracked.
   5. Public Outreach History: Records should include the program description, activity descriptions, and costs.

C. Program Evaluation: Accurate and consistent record keeping will provide the data for Forestry to compare the results on the ground with the predictions in this plan. If higher-than-predicted canopy loss occurs after treatments, the records will indicate changes needed to the dosage, frequency, timing, and/or tree criteria. A practice of early investments in detection and lowering pest pressure (i.e. through detection and trap trees) should be weighed against investing in treatments.

D. Establish an Ash Tree Waste Yard: Forestry currently has a location for storing and processing wood and tree debris from normal, non-EAB tree management activities. All ash material would have to be kept separate from other woody waste. Consider local woodworking operations to utilize wood waste for furniture, lumber, and landscape centerpieces. Encourage the use of proper storage, handling, and disposal of wood materials to prevent the spread of EAB.

E. Explore the Possibility of Adding Staff and Equipment: The workload for the Forestry Division will increase dramatically once emerald ash borer becomes established in Colorado Springs. Consideration should be given toward adding extra staff and equipment. EAB response and management activities will take time and resources away from normal Forestry functions such as pruning, other removal work, citizen requests, and education. Additional staff would help mitigate the impact EAB will have on Forestry operations.

The 2020 Urban Forest Management Plan (UFMP) provided four management approaches based on funding and tree maintenance authority scenarios. The intensity of EAB management will be based on the level of funding secured by implementing the UFMP.

The following table was developed for the UFMP to describe the recommended funding and staffing levels to achieve improvements in urban forest management. These values are based on industry standards, benchmarking comparisons, and analyses of City data. It is recommended for Forestry to have a total of 27 full-time employees (FTEs)— an addition of 16 staff based on 2020 staffing levels. The recommended budget to maintain 270,000 public trees on a pruning rotation is $3.1 million. This does not include the management of trees for EAB. The recommended tree removal annual budget of $1.1 million would allow for the removal of approximately 1,300 trees per year which can be applied to the removal of ash trees though other species of trees may also need to be removed depending on citizen requests and priorities. In summary, the current budget may be utilized to manage pests and diseases as available though it is recommended to secure separate funding specifically for EAB management.

Table A-10. Table from 2020 Urban Forest Management Plan: Summary outcomes from the tree maintenance responsibility transfer case study.

	Current	Recommended	Difference
Total Public Trees	270k trees	270k trees	0
Staffing	11 FTEs	27 FTEs	16 FTEs
Total Maintenance Budget	**$1,558,037**	**$7,400,650**	**$5,842,613**
Maintenance Budget per Tree	$5.77	$27.41	$21.64
Operations & Maintenance (O&M) Costs			
Tree Pruning Budget	$498,572 (32%)	$3,086,860 (42%)	$2,588,288
Tree Removal Budget	$373,929 (24%)	$1,110,098 (15%)	$736,169
Storm Response Budget	$576,474 (37%)	$1,110,098 (15%)	$533,624
Subtotal	$1,448,974	$5,307,056	$3,858,082
Capital Costs			
Planting Budget	$15,580 (1%)	$370,033 (5%)	$354,453
Admin (inspections) Budget	$93,482 (6%)	$888,078 (12%)	$794,596
Other (i.e. education) Budget	$0 (0%)	$835,485 (11%)	$835,485
Subtotal	$109,063	$2,093,596	$1,984,533
Maintenance Budget Update Total	$1,558,037	$7,400,650	$5,842,613
Trees Pruned Per Year	3,700 (1.4%)	38,571 (14%)	34,871
Pruning Cycle	73 years	7 years	-66 years

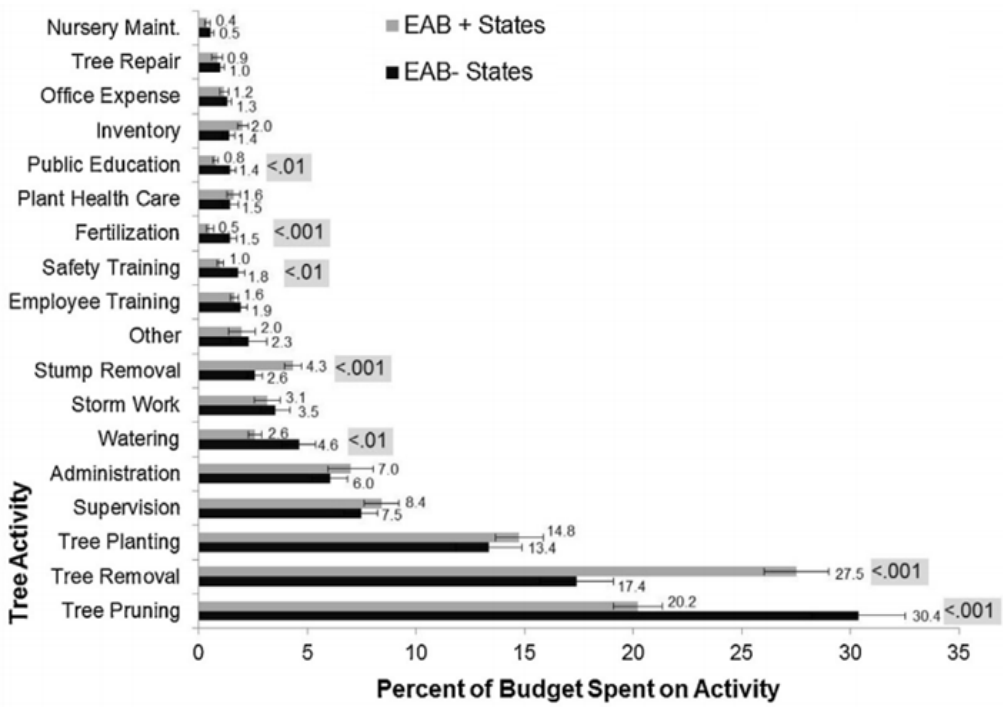


Figure A-10. (Left) Percent of 2014 forestry budget spent on tree activities in states with a confirmed EAB case (EAB+) and states without a confirmed EAB case (EAB-) at the time of this study (2017). Source: Hauer, R.J., Peterson, W.D. (2017) Landscape and Urban Planning 157, 98-105.

Goal 6 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-11. Summary of EAB plan actions to support Goal 6.

Year	Action
2020	Collect and maintain ash tree inventory data. Record information pertaining to the management of EAB and public outreach.
2021	Complete the actions in the 2020 UFMP regarding the analysis of resources to inform the tree maintenance responsibility transfer.
2022	Secure a budget for EAB management with the following allocations: 15 percent for detection, 80 percent for management, and 5 percent for public outreach.
2022	Establish or amend protocols for collecting, transporting, and storing ash wood waste and debris of both public and private trees.
2025	Evaluate the plan's effectiveness based on data, records, and new information.

GOAL 7: ENLIST PRIVATE TREE OWNERS

A coordinated approach in the City will require a strong commitment to public outreach and education, especially in the years preceding the EAB infestation and during peak years.

Approach to Enlist Private Tree Owners

A. Education and Communication: Colorado Springs should use all communication tools available to promulgate the goals and best practices in this Tree Pest and Disease Plan, and to ensure that the owners of private ash trees manage their trees consistent with the plan. Educational and communication tools include the City's website, newsletters, utility billings, and press releases. Community meetings are an excellent way to collaborate with those property owners most interested in preserving their ash trees. In addition to these methods, the City should consider the following:

1. Direct citizens and interested parties to the Colorado State Forest Service (CSFS) EAB website: www.csfs.colostate.edu/forest-management/emerald-ash-borer.
2. Hold educational workshops or meetings (in-person or virtual) to emphasize impact and train attendees on the monitoring and inspection processes.
    a. Inter-Agency: Colorado Department of Agriculture (CDOA), El Paso County, CSFS, university extension services.
    b. Intra-Agency: Departments, Council, Boards and Committees, managers.
    c. Citizens and Businesses: Arborists, landscape companies, tree nurseries, citizens, neighborhood associations, HOAs, special districts.

Source: The City of Colorado Springs.

B. Public Subsidy for Private Trees: Only with a significant increase in funding can Forestry decide to subsidize treatments for certain ash trees on private property in order to help suppress pest pressure and to preserve certain trees. Only high-quality trees located in high-priority areas on streets where the loss of private ash trees would have a significant effect should be eligible for public subsidy. The tree inventory will provide the information needed to craft definitions for eligibility that will be most effective and enforceable. A private tree sample survey conducted through contracted services or neighborhood organizations can better inform this process. Budgetary constraints will determine the percent of the treatment costs to be subsidized. The subsidy should be contingent upon the property owner complying with the best practices described in this Tree Pest and Disease Plan and should end after the third treatment when the peak of the infestation should have already occurred and the wave front will have moved on by the time the trees may need another treatment. Forestry will have to clarify roles and responsibilities as it relates to ash trees managed by HOAs and special districts. Large landowners such as academic institutions need to be included in this discussion.

C. Pesticide Safety: The increasing concerns regarding the overreliance on pesticides is acknowledged in this Tree Pest and Disease Plan. Neonicotinoids and their effects on pollinators, such as bees, and soil-applied products that have the potential to reach stormwater or ground water have all been highly publicized.

The pesticide recommended in this plan, emamectin benzoate (EB), is not a neonicotinoid and is injected into the trunks of the trees. Ash trees are wind pollinated, they are not a substantial nectar source for bees, and they flower early in the growing season and only for a limited number of days. It is highly unlikely that bees would be exposed to systemic insecticides applied to ash. EB has a low toxicity rating for mammals, a low bioaccumulation potential within ecosystems, and is immobile in soil. This means that the insecticide will not build up levels within an ecosystem and will be minimally harmful to people and animals that might encounter tree debris.[8]

While there are valid concerns regarding the overuse of pesticides, those concerns should be aimed at reducing pesticide use where fewer benefits result. The environmental consequences of losing millions of ash trees are vastly greater than the minimal risk associated with inoculating high-quality ash trees to protect them from certain death.

F. Treatment or Removal of Ash Trees in Preparation for Tree Responsibility Transfer: In the event that Forestry transfers the responsibility of public tree maintenance to the adjacent property owner, ash trees will need to be evaluated. Most likely, ash trees will not be a part of the selected trees in the transfer phases and ash trees in public rights-of-way will continue to be Forestry's responsibility. Thus, management approaches described in this plan will continue to apply.

8. Hahn, J., Herms, D.A., McCullough, D.G., (2011). Frequently Asked Questions Regarding Potential Side Effects of Systemic Insecticides Used to Control Emerald Ash Borer, University of Minnesota Extension.

Goal 7 Actions Summary

The following summary provides an overview of actions and the anticipated timeline for completion. The timeline is an estimate and should be adjusted when new information is gathered regarding the timing of EAB infestation in the City. These recommendations support the actions in the 2020 UFMP.

Table A-12. Summary of EAB plan actions to support Goal 7.

Year	Action
2020	Update the City's website with information about this plan, EAB, and contact information.
2020	Add EAB Plan information flier in utility bill to raise public awareness.
2020	Identify partner network for sharing information and resources.
2021	Disseminate EAB information to partners.
Annual	Provide or support educational workshops and meetings for partners and the community.
2021	Explore protocols and options for public subsidy of private trees.
Annual	Stay informed of updates in treatment options and the spread of EAB.
2021	Complete the actions in the 2020 UFMP regarding the analysis of resources to inform the tree maintenance responsibility transfer.

DEFINING MANAGEMENT STRATEGIES

With a comprehensive inventory of public ash trees, Forestry will be better equipped to estimate EAB management budgets and prioritize trees for removal and treatments. As a product of this Tree Pest and Disease Plan, an EAB Management Cost Worksheet was provided to the City. This worksheet allows Forestry to enter estimated or actual ash tree numbers by diameter class for various management strategies: removals, replanting, and treatments. It uses the average cost of emamectin benzoate treatments ($8.50 per DBH-inch) based on the Emerald Ash Borer Cost Calculator tool and research provided by Purdue University's Entomology Extension Service. A more comprehensive calculator tool can be found on Purdue University Extension's website (www.int.entm.purdue.edu/ext/treecomputer/).

The figure below provides an overview of the worksheet developed by PlanIT Geo using Purdue's research. Table A-13 provides estimated costs for four scenarios based on the 25,000 public ash tree estimate. These summaries are provided only as a demonstration and for talking points and should be updated by Forestry with new information and data.

Instructions: Only fill in the shaded cells, all others are autopopulated

Removals

Scenario 1 Tree Counts	
0-3in	449
3-6in	449
6-12in	2,508
12-18in	6,870
18-24in	3,972
24-30in	7,737
>30in	2,790
Total	24,775

Scenario 2 Tree Counts	
0-3in	5
3-6in	5
6-12in	5
12-18in	5
18-24in	5
24-30in	5
>30in	5
Total	35

Scenario 3 Tree Counts	
0-3in	50
3-6in	50
6-12in	50
12-18in	50
18-24in	50
24-30in	50
>30in	50
Total	350

Scenario 4 Tree Counts	
0-3in	100
3-6in	100
6-12in	100
12-18in	100
18-24in	100
24-30in	100
>30in	100
Total	700

Treatments

Scenario 1 Tree Counts	
0-3in	0
3-6in	0
6-12in	0
12-18in	0
18-24in	0
24-30in	0
>30in	0
Total	0

Scenario 2 Tree Counts	
0-3in	20
3-6in	20
6-12in	20
12-18in	20
18-24in	20
24-30in	20
>30in	20
Total	140

Scenario 3 Tree Counts	
0-3in	50
3-6in	50
6-12in	50
12-18in	50
18-24in	50
24-30in	50
>30in	50
Total	350

Scenario 4 Tree Counts	
0-3in	100
3-6in	100
6-12in	100
12-18in	100
18-24in	100
24-30in	100
>30in	100
Total	700

City of Colorado Springs, Colorado Emerald Ash Borer Management Cost Calculator

9/3/2020

Scenarios	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Step 1	*Remove all ash trees, no treatment, no replanting*	*Low intensity removals, treatments, and planting*	*Medium intensity removals, treatments, and planting*	*Higher intensity removals, treatments, and planting*
Timespan (years)	10	10	10	10
Total Trees Removed	24,775	35	350	700
Total Removal Cost	**$29,631,025**	**$31,750**	**$317,500**	**$635,000**
Total Planting Cost	**$0**	**$525**	**$21,000**	**$157,500**
Total Removal & Planting Cost	**$29,631,025**	**$32,275**	**$338,500**	**$792,500**
Total Treatment Cost	**$0**	**$55,080**	**$137,700**	**$275,400**

Tree Removal Summaries

Tree Removal Costs by DBH Class (Step 3)	#/Tree	Cost	#/Tree	Cost	#/Tree	Cost	#/Tree	Cost
0-3in	$100	$44,900	$100	$500	$100	$5,000	$100	$10,000
3-6in	$175	$78,575	$175	$875	$175	$8,750	$175	$17,500
6-12in	$300	$752,400	$300	$1,500	$300	$15,000	$300	$30,000
12-18in	$850	$5,839,500	$850	$4,250	$850	$42,500	$850	$85,000
18-24in	$1,275	$5,064,300	$1,275	$6,375	$1,275	$63,750	$1,275	$127,500
24-30in	$1,550	$11,992,350	$1,550	$7,750	$1,550	$77,500	$1,550	$155,000
>30in	$2,100	$5,859,000	$2,100	$10,500	$2,100	$105,000	$2,100	$210,000
Total Removal Cost		**$29,631,025**		**$31,750**		**$317,500**		**$635,000**

Tree Planting Summaries

Step 4				
Planting Costs per Tree	$300	$300	$300	$300
% Removals to Replant	0%	5%	20%	75%
Total Trees to Plant	0	2	70	525
Total Cost per Year	$0	$53	$2,100	$15,750
Total Planting Cost	**$0**	**$525**	**$21,000**	**$157,500**

Tree Treatment Summaries

Step 5				
Timespan (years)	10	10	10	10
Insecticide Cost ($/DBH)	$8.50	$8.50	$8.50	$8.50
Frequency or Cycle (Year)	3	3	3	3
Total Applications	3	3	3	3
Total Trees Treated	24,775	35	350	700
Treatment Cost per Application	$0	$18,360	$45,900	$91,800
Total Treatment Cost	**$0**	**$55,080**	**$137,700**	**$275,400**
Treatment Cost per DBH Class	0-3in $0	0-3in $255	0-3in $638	0-3in $1,275
	3-6in $0	3-6in $765	3-6in $1,913	3-6in $3,825
	6-12in $0	6-12in $1,530	6-12in $3,825	6-12in $7,650
	12-18in $0	12-18in $2,550	12-18in $6,375	12-18in $12,750
	18-24in $0	18-24in $3,570	18-24in $8,925	18-24in $17,850
	24-30in $0	24-30in $4,590	24-30in $11,475	24-30in $22,950
	>30in $0	>30in $5,100	>30in $12,750	>30in $25,500
Total Cost per Treatment Cycle	**$0**	**$18,360**	**$45,900**	**$91,800**

Figure A-11. A screenshot of the EAB Management Cost Worksheet provided to the City.
Figure A-12. Note: These numbers and values are for demonstration purposely only.

Table A-13. Scenarios for EAB management. Source: PlanIT Geo's EAB Cost Calculator Module, Purdue University, and local estimates.

	Remove All Ash		All Ash Remove & Replant		Treat All Ash		Treat 10% Ash >12" DBH	
Timespan (years)	10		10		10		10	
Total Trees Removed	24,775		24,775		0		0	
Total Removal Cost	**$29,631,000**		**$29,631,000**		**$0**		**$0**	
Total Planting Cost	**$0**		**$7,432,500**		**$0**		**$0**	
Total Removal & Planting Cost	**$29,631,000**		**$37,063,500**		**$0**		**$0**	
Total Treatment Cost	**$0**		**$0**		**$13,571,800**		**$1,292,850**	
Tree Removal Summaries (costs include stump grinding costs)								
Tree Removal Costs by DBH Class	*$/Tree*	*Cost*	*$/Tree*	*Cost*	*$/Tree*	*Cost*	*$/Tree*	*Cost*
0-3in	$100	$44,900	$100	$44,900	$100	$0	$100	$0
3-6in	$175	$78,575	$175	$78,575	$175	$0	$175	$0
6-12in	$300	$752,400	$300	$752,400	$300	$0	$300	$0
12-18in	$850	$5,839,500	$850	$5,839,500	$850	$0	$850	$0
18-24in	$1,275	$5,064,300	$1,275	$5,064,300	$1,275	$0	$1,275	$0
24-30in	$1,550	$11,992,350	$1,550	$11,992,350	$1,550	$0	$1,550	$0
>30in	$2,100	$5,859,000	$2,100	$5,859,000	$2,100	$0	$2,100	$0
Total Removal Cost		**$29,631,025**		**$29,631,025**		**$0**		**$0**
Tree Planting Summaries								
Planting Costs per Tree	$0		$300		$0		$0	
% Removals to Replant	0%		100%		0%		0%	
Total Trees to Plant	0		24,775		0		0	
Total Cost per Year	$0		$743,250		$0		$0	
Total Planting Cost	**$0**		**$7,432,500**		**$0**		**$0**	
Tree Treatment Summaries								
Timespan (years)	10		10		10		10	
Insecticide Cost ($/DBH)	$0		$0		$8.50		$8.50	
Frequency or Cycle (year)	0		0		3		3	
Total Applications	0		0		3		3	
Total Trees Treated	0		0		24,775		2,137	
Treatment Cost per Application	0		0		$4,523,930		$430,950	
Total Treatment Cost	**$0**		**$0**		**$13,571,800**		**$1,292,850**	
Treatment Cost per DBH Class	0-3in	$0	0-3in	$0	0-3in	$5,725	0-3in	$0
	3-6in	$0	3-6in	$0	3-6in	$17,174	3-6in	$0
	6-12in	$0	6-12in	$0	6-12in	$191,862	6-12in	$0
	12-18in	$0	12-18in	$0	12-18in	$875,925	12-18in	$87,593
	18-24in	$0	18-24in	$0	18-24in	$709,002	18-24in	$70,865
	24-30in	$0	24-30in	$0	24-30in	$1,775,642	24-30in	$177,633
	>30in	$0	>30in	$0	>30in	$948,600	>30in	$94,860
Total Cost per Treatment Cycle		**$0**		**$0**		**$4,523,930**		**$430,950**

Table A-14. Treatment options for EAB management. Source: Herms D.A., McCullough D.G., et al. 2019. Insecticide options for protecting ash trees from emerald ash borer. North Central IPM Center Bulletin. 3rd Edition. 16 pp.

Insecticide Formulation	Active Ingredient	Application Method	Recommended Timing
Products Intended for Sale to Professional Applicators			
Merit® (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Early to mid spring or mid fall
Safari™ (20 SG)	Dinotefuran	Soil injection or drench	Mid to late spring
Transtect™ (70WSP)	Dinotefuran	Soil injection or drench	Mid to late spring
Xylam® Liquid Systemic Insecticide	Dinotefuran	Soil injection or drench	Mid to late spring
Xytect™ (2F, 75WSP)	Imidacloprid	Soil injection or drench	Early to mid spring or mid fall
Azasol™	Azadirachtin	Trunk injection	Mid- to late spring after trees have leafed out
Arbormectin™	Emamectin benzoate	Trunk injection	Mid- to late spring after trees have leafed out
Imicide®	Imidacloprid	Trunk injection	Mid- to late spring after trees have leafed out
TREE-äge™	Emamectin benzoate	Trunk injection	Mid- to late spring after trees have leafed out
TreeAzin®	Azadirachtin	Trunk injection	Mid- to late spring after trees have leafed out
SafariTM (20 SG)	Dinotefuran	Systemic basal bark spray	Mid- to late spring after trees have leafed out
Transtect (70 WSP)	Dinotefuran	Systemic basal bark spray	Mid- to late spring after trees have leafed out
Zylam® Liquid Systemic Insecticide	Dinotefuran	Systemic basal bark spray	Mid- to late spring after trees have leafed out
Astro®	Permethrin	Preventive trunk, branch, and foliage cover sprays	Two applications at 4-week intervals; first spray should occur at 450–550 growing degree days (50°F, Jan.1)
Onyx™	Bifenthrin		
Tempo®	Cyfluthrin		
Sevin® SL	Carbaryl		
Products Intended for Sale to Homeowners			
Bayer Advanced™ Protect and Feed II	Clothianidin + Imidacloprid	Soil drench	Early to mid spring
Bayer Advanced™ Tree & Shrub Insect Control	Imidacloprid	Soil drench	Early to mid spring
Optrol™	Imidacloprid	Soil drench	Early to mid spring
Ortho Tree and Shrub Insect Control Ready to Use Granules®	Dinotefuran	Granules	Mid to late spring after trees have leafed out

Table A-15. Considerations for application methods for EAB management.

Application Method	Benefits	Considerations
Soil Injection	▪ Minimized excess runoff ▪ Direct contact with roots	▪ Soil injection equipment ▪ Uptake may be slow ▪ Dilution in soil ▪ Compaction issues
Drench	▪ No equipment	▪ Runoff ▪ Bind to other plant material ▪ Dilution
Trunk Injection	▪ Good uptake ▪ No dilution from wet areas ▪ 2-year treatment	▪ Causes tree wounds ▪ Equipment needed
Trunk Sprays	▪ Quick and easy to apply ▪ No wounds to tree	▪ Not always absorbed ▪ Time for absorption ▪ Wasted materials ▪ Multiple applications
Canopy Spray	▪ Quick and easy to apply ▪ No wounds	▪ Multiple applications ▪ Wasted material ▪ Multiple applications

As summarized in Table A-13, different management strategies have varying costs and approaches. Using the 25,000 public ash tree estimate, a "remove all ash tree" scenario would cost over $29.6 million with the costs most likely distributed over multiple years. To remove all ash trees and replant at a 1:1 ratio, the removal costs would be the same ($29.6 million) and the planting costs would amount to approximately $7.4 million. To demonstrate costs on an extreme level, to treat all 25,000 ash trees would cost a total of $13.6 million— a highly unlikely strategy but less than the cost of removing all ash trees. To demonstrate a strategy that aims to treat only high-value ash trees, the scenario of treating 10 percent of all ash trees greater than 12 inches in diameter was applied to Table A-13. This amounts to 2,137 theoretical high-value ash trees to treat at a cost of $431,000 per treatment application or $1.3 million over a ten-year timespan (requires three treatment applications).

The summaries provided in Table A-13 serve as a demonstration of potential costs to remove, treat, and/or replant the urban forest in response to EAB. Forestry should gather additional information such as the total public ash tree counts and finalize treatment methods based on the information provided in Table A-14 and Table A-15. Securing a budget specific to EAB management and completing and inventory of ash trees will enable Forestry to develop accurate management scenarios using the EAB Management Cost Worksheet provided as part of this tree pest and disease planning effort.

In any approach, community education is essential as is proper bookkeeping and training to stay up-to-date on the spread of EAB and management options. The arrival of EAB is inevitable for Colorado Springs but proper detection, sampling, and early management can reduce the overall financial burden and the loss of ecosystem benefits provided to the community.

Table A-16. Summary of Tree Pest and Disease Plan actions and implementation timeframe.

Annual Actions	
Goal 2	Educate local licensed arborists and tree managers for HOAs and special districts on this EAB plan, detection methods, and management options.
Goal 2	When responding to citizen requests relating to ash trees and ash tree maintenance or removal, inspect trees for EAB.
Goal 3	Support habitat and conditions for natural predators such as woodpeckers.
Goal 4	Prior to EAB arrival and during infestation, implement insecticidal treatments based on the City's decision for application method(s), selected trees, and priorities.
Goal 5	Continue to evaluate ash tree removal when responding to citizen service requests.
Goal 5	Continue to ban the planting of ash trees for City projects and new developments.
Goal 5	Discourage private property owners from planting ash trees.
Goal 5	Plant suitable trees as replacements when removing public ash trees.
Goal 5	Encourage private property owners to assess trees on their property and identify any ash trees.
Goal 7	Provide or support educational workshops and meetings for partners and the community.
Goal 7	Stay informed of updates in treatment options and the spread of EAB.
2020 Actions	
Goal 1	Build the business case to secure funding for the comprehensive or sample tree inventory specifically to gather an understanding of the public ash tree population.
Goal 2	Educate City staff and departments on this EAB plan and potential management strategies.
Goal 6	Collect and maintain ash tree inventory data. Record information pertaining to the management of EAB and public outreach.
Goal 7	Update the City's website with information about this plan, EAB, and contact information.
Goal 7	Add EAB Plan information flier in utility bill to raise public awareness.
Goal 7	Identify partner network for sharing information and resources.

Table A-38 continued. Summary of Tree Pest and Disease Plan actions and implementation timeframe.

2021 Actions	
Goal 1	Complete the tree inventory with an emphasis on collecting information about the public ash tree population.
Goal 1	Include City Code language updates relating to EAB management with the proposed Code amendments provided in the 2020 UFMP.
Goal 2	Establish ash tree sampling protocols and procedures.
Goal 3	Use the inventory data and local knowledge to identify low-quality ash trees in high-priority areas to serve as detection and trap trees.
Goal 4	Complete an inventory of ash trees on public property.
Goal 4	Establish protocols for identifying high-value and high-quality public ash trees.
Goal 4	Analyze tree inventory data and local area knowledge to identify high-value and high-quality public ash trees.
Goal 6	Complete the actions in the 2020 UFMP regarding the analysis of resources to inform the tree maintenance responsibility transfer.
Goal 7	Same as above; Complete the actions in the 2020 UFMP regarding the analysis of resources to inform the tree maintenance responsibility transfer.
Goal 7	Disseminate EAB information to partners.
Goal 7	Explore protocols and options for public subsidy of private trees.
2022 Actions	
Goal 1	Secure funding and a partner or consulting firm to sample private properties to establish an estimate of ash tree populations on private property.
Goal 2	Develop a removal and trap tree strategy based on sampling results and other data.
Goal 3	Identify low-quality ash trees near high-quality ash trees to remove or serve as trap trees. Align efforts with citizen requests and maintenance actions in the UFMP.
Goal 4	Establish the management strategy for staging ash removals, trap trees, trees to treat, and trees to disregard.
Goal 4	Mark ash trees for treatment or management in a tree inventory database, add signage, and alert the adjacent property owner where applicable.
Goal 6	Secure a budget for EAB management with the following allocations: 15 percent for detection, 80 percent for management, and 5 percent for public outreach.
Goal 6	Establish or amend protocols for collecting, transporting, and storing ash wood waste and debris of both public and private trees.
2025 Actions	
Goal 6	Evaluate the plan's effectiveness based on data, records, and new information.

OTHER TREE PEST AND DISEASE CONCERNS

Plans may be developed for other tree pests and diseases that exist in or are a threat to Colorado Springs' urban forest. The extent of management depends on the pest or disease, the City's budget, and the count of pest- or disease-preferred tree species. This section provides an overview of common tree pest and disease concerns for the City, beyond emerald ash borer.

Scale Insects:

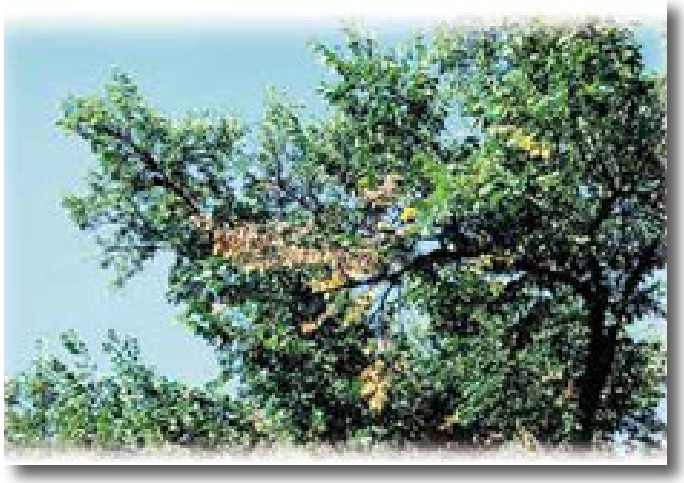
The most common scales are found on shade trees, typically on the twigs rather than the leaves. The oystershell scale (*Lepidosaphes ulmi*) is an armored scale that is highly damaging to deciduous trees, specifically aspen, ash, willow, and lilacs. The pine needle scale (*Chionaspis pinifoliae*) feeds on evergreen needles of pines, spruce, and fir. Primary control for scale involves systemic insecticides prior to the crawler stage so timing is critical. Cultural methods include conserving natural scale predators.

Aphids:

Aphids feed by sucking sap from plants. When the number of aphids on a tree are very high for an extended period, their feeding can cause wilting and sometimes even dieback of shoots and buds. Some aphids can cause leaf curling when the insect infests emerging leaves. The honeydew secreted from the aphid while feeding can be a sticky nuisance for vehicles, sidewalks, benches, and other structures. Insecticide soaps have proven most effective for aphids.

Dutch Elm Disease:

Dutch elm disease (DED) is an aggressive fungal disease of elms that are native to America. The fungus (*Ophiostoma novo-ulmi*) is spread from tree to tree via the European elm bark beetle. As the beetles tunnel in to lay eggs, the fungus enters the plants' water-conducting system. Once inside the tree, the fungus begins to plug the vascular system. As a result, leaves wilt and the affected tree dies within a few months to a year. DED was devastating to American elms (*Ulmus americana*) but the disease has since declined due to a lack of host trees and other factors. The best control for DED is to plant resistant elms and cultivars.



Source of images on this page: Rocky Mountain Chapter ISA.

Ips Beetles:

Ips beetles, also known as "engraver beetles," are bark beetles that damage pine and spruce trees. Mature ips beetles enter trees and tunnel, producing a yellowish- or reddish-brown boring dust. The affected parts of the tree discolor and die. Small round holes in the bark of infested trees indicate the beetles have completed development in that part of the tree and have exited. Symptoms include needle color changing from green to yellow and bright red to brown. The presence of woodpeckers, a common predator of the ips beetle, may indicate infestation. These symptoms are similar to mountain pine beetle. The best control is prevention by maintaining healthy trees, preventive insecticides, and removing infected woody material.

Mountain Pine Beetle:

Mountain pine beetle (*Dendroctonus ponderosae*) activity subsided and remained low with a total of 5,000 acres of active mountain pine beetle infestation detected in the state in 2015. The epidemic has ended in many areas of Colorado as mature pine trees have been depleted following the outbreak that impacted more than 3.4 million-acres of Colorado forestland from 1996-2013. Many of the pine forests impacted by the outbreak look vastly different due to the large numbers of dead trees. Trap trees, removal of infected woody material, and preventive insecticide sprays are the best controls.

Lilac Ash Borer:

In addition to the emerald ash borer (EAB), the lilac/ash borer (*Podosesia syringae*) is a common wood borer associated with ash throughout Colorado and a species that is native to North America. Damage is caused by the larvae which tunnel into the trunks and lower branches of ash trees. Almost all larval feeding activity occurs in the lower trunk, particularly around the soil line. External evidence of lilac/ash borer activity in trees can include irregularly round (unlike the D-shaped holes of EAB) exit holes of about a quarter-inch diameter on trunks. Lilac/ash borer can be easily controlled by spraying the trunk and lower branches in spring with an insecticide during the time when adult females lay eggs on the trunk and the newly hatched caterpillars begin to tunnel into the wood.

Source of images on this page: Colorado State University Extension.

Western Spruce Budworm:

Western spruce budworm (*Choristoneura freemani*), a native insect, feeds upon and defoliates Douglas-fir, true fir (e.g. subalpine fir and white fir) and spruce trees. Damage is caused by larvae feeding on the buds and current year's foliage, causing a reddish-brown hue in the tips of branches and treetops. The best controls are insecticides and natural predators

Source of four images above: Colorado State Forest Service.

Spruce Beetles:

Spruce beetles (*Dendroctonus rufipennis*) are native bark beetles that infest Engelmann spruce (*Picea engelmannii*) and occasionally Colorado blue spruce (*P. pungens*) in high elevation forests in Colorado. The spruce beetle typically completes a generation in one to three years, with a two-year life cycle being the most common in spruce trees growing above 9,000 feet. Adults fly to seek new hosts in late May through July, preferring large diameter trees until they are depleted from the forest. Trap trees, removal of infected woody material, and preventive insecticide sprays are the best controls

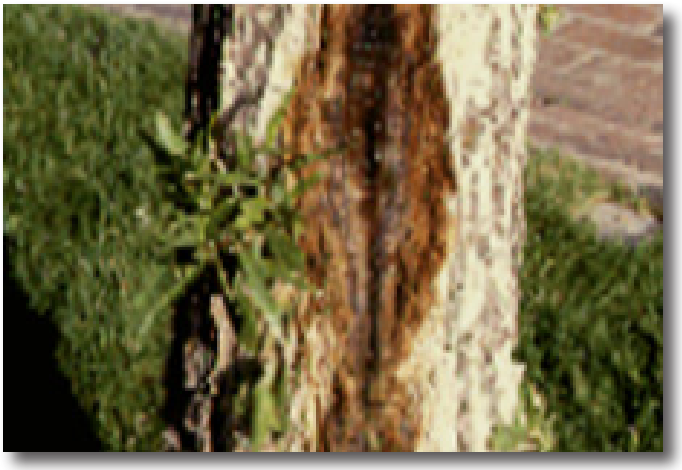
Cytospora Canker:

Cytospora canker is caused by various species of the fungus *Cytospora*. This pathogen can affect trees such as aspen, cottonwood, poplars, fruit trees, birch, maple, honeylocust, willow, mountain ash, spruce, and Siberian elm. The symptoms of this disease are yellow or orange-brown to black discolored areas on the bark of the trunk and branches. Liquid ooze and cankers or sunken dead areas of bark with black pinhead-sized speckling or pimples may be evident depending on the *Cytospora* species. The most effective preventative measure is to keep trees healthy and undamaged (by mowers, string trimmers). If a tree is infected with the pathogen, removal of infected plant parts and sanitation are effective practices.

Source of two images above: Colorado State University Extension.

Bacterial Wetwood:

Bacterial wetwood can be caused by a variety of bacteria such as *Enterobacter*, *Klebsiella*, and *Pseudomonas*. These bacteria are most prevalent in trees such as elm, cottonwood, and aspen, but can affect ash, maple, sycamore, poplar, and more. Symptoms include a yellow-brown discoloration of the wood in the center of the trunk. The affected wood is wetter than surrounding wood due to high internal pressure. This pressure causes a foul-smelling ooze to exit the tree. The bacteria are common in soil and enter primarily through root wounds. The best control for wetwood is prevention of damage to tree roots and stems.



Fire Blight:

Fire blight is a bacterial disease (*Erwinia amylovora*) that affects certain tree species such as apple, pear, and crabapple. Symptoms include wet blossoms, light brown to blackened leaves, crooked twigs, and dried fruits. The bacteria can spread by insects, rain splash, and contaminated pruning tools. Controls include resistant varieties, cultural practices, pruning, and preventive sprays.

Thyronectria Canker and Tubercularia Canker:

Thyronectria canker (pictured) is caused by the fungus *nectrid (Thyronectrie) austro-americana* and Tubercularia canker is caused by the fungus *Tubercularia ulmea*. Both of these fungus affect honeylocust trees and kill living bark and outer wood. Symptoms include dieback of affected branches, reduced foliage, and early leaf drop. Cankers can be found on branches and trunks of honeylocust. The best control for cankers is to prevent wounds and promote tree vigor.

Aspen and Poplar Leaf Spots:

The fungus *Marssonina* (image A) causes the most common foliage disease on aspens and poplars. The fungus creates dark brown spots or flecks often with yellow halos. Other leaf spots include septoria leaf spot (*Septoria* fungus, image B), ink spot of aspen (*Ciborinia* fungus, image C), leaf and shoot blight (*Venturia* fungus, image D), and leaf rusts (*Melampsora*, image E). Proper identification of the leaf spot is crucial to determine treatment and control options to align with the fungus lifecycle.

Source of images on this page: Colorado State University Extension.

EAB MANAGEMENT PLAN SUMMARY

The City of Colorado Springs can choose to proactively manage the inevitable infestation of emerald ash borer or delay management until the beetles arrive and cause tension in an already strained budget. EAB has been in the U.S. since 2002 and the research shows that the best management strategy is a holistic, landscape-based response that is centrally managed resulting in minimized costs and maximized value of the remaining urban forest. This approach not only saves money, it reduces liabilities. A city that delays action or relies on a removals-only approach will be overwhelmed with public hazard trees and potentially the lawsuits that will follow. The time to act is now— before the infestation exponentially increases in population, and tree deaths escalate as seen in other cities. As the pest population increases and a greater number of trees die, the number of management options goes down.

The City should immediately act by conducting an inventory of ash trees that includes sampling and, preferably, the entire public tree population should be inventoried because of future pest and disease concerns for other tree species. From the inventory, Forestry should develop management scenarios and identify the necessary budget for various management intensities. Proper record keeping and up-to-date information is essential to adaptive management for EAB and future pests and diseases. Adequate staffing and resources to monitor trees and to educate the public for a shared commitment to the health of the urban forest is the only viable approach for a sustainable urban forest in Colorado Springs.

DEFINITIONS

- **Trap trees**: Trees that are not removed and serve as a nesting and feeding location for pests such as emerald ash borer (EAB). These trees concentrate the pests in a more preferred location rather than impacting high-quality or high-value trees. The concentration of pests to the attractive trap trees reduces or slows the spread of the pest, specifically EAB.
- **Sink trees**: These trees are also referred to as trap trees. The terms are used interchangeably to describe the method of girdling standing trees to kill the tree and induce pheromone release that is attractive to pests such as the emerald ash borer (EAB).
- **Girdling**: Also called ring-barking, this process involves the complete removal of a strip of bark from around the entire circumference of either a branch or trunk of a woody plant. Girdling results in the death of the area above the girdle over time by cutting off the flow of nutrients.
- **Growing Degree-Day**: Measure of heat accumulation used by horticulturists, gardeners, and farmers to predict plant and animal development rates such as the date that a flower will bloom, an insect will emerge from dormancy, or a crop will reach maturity. Unless stressed by other environmental factors like moisture, the development rate from emergence to maturity for many plants depends upon the daily air temperature. Because many developmental events of plants and insects depend on the accumulation of specific quantities of heat, it is possible to predict when these events should occur during a growing season regardless of differences in temperatures from year to year. Growing degrees (GDs) is defined as the number of temperature degrees above a certain threshold base temperature, which varies among plant species.

REFERENCES

1. State of Colorado, Emerald Ash Borer Response Team FAQs, 2015.
2. Colorado State Forest Service, Emerald Ash Borer: A Green Menace, www.csfs.colostate.edu, 2019.
3. City of Colorado Springs, Colorado
4. i-Tree Eco (www.itreetools.org) is software application designed to use field data from single trees, complete inventories, or random plots throughout a study area to quantify forest structure, environmental effects, and value.
5. Hafner, J.M, Orange, J.M, (2015). Model Emerald Ash Borer Management Plan
6. McCullough, D.G., Mercader, R.J., (2012). Evaluation of potential strategies to SLow Ash Mortality (SLAM) caused by emerald ash borer (*Agrilus planipennis*): SLAM in an urban forest. International Journal of Pest Management, Vol. 58, No. 1, January – March 2012, 9-23.
7. Herms, D., Systemic Insecticide Technology for Tree Care, Department of Entomology, Ohio State University, Ohio Agricultural Research and Development Center.
8. Hahn, J., Herms, D.A., McCullough, D.G., (2011). Frequently Asked Questions Regarding Potential Side Effects of Systemic Insecticides Used to Control Emerald Ash Borer, University of Minnesota Extension.

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URBAN FOREST

PEST AND DISEASE PLAN

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