Hennepin County

Tree canopy enhancement and emerald ash borer management plan

All of the trees on the property of the Sumner Library in Minneapolis are mature ash trees that the county plans to preserve to prevent infestation by the emerald ash borer.

Hennepin County
Public Works
Environment and Energy

Updated October 2016

Introduction

The tree canopy is an important and integral part of the Hennepin County's green infrastructure. Properly planned and managed, the tree canopy provides significant ecological, social and economic benefits. The benefits include improved air and water quality, reduced soil erosion and stormwater runoff, increased wildlife habitat, savings in heating and cooling, improved health, enhanced livability, and increased property values.

The biggest current threat to the tree canopy in Hennepin County is the emerald ash borer (EAB), an invasive tree pest from Asia that kills ash trees. Although the county's tree canopy is relatively diverse, ash trees make up about 15 percent of the canopy. There are about one million ash trees on maintained areas, which include parks, yards, boulevards and parking lots, in the county. This includes 31,000 ash trees on county-owned properties. Additionally, Minnesota has the greatest number of ash trees in the U.S. with nearly one billion ash trees in forests and urban areas. Ash trees were planted extensively along streets and on private and public property to replace elm trees lost to Dutch elm disease. All of Minnesota's native ash species – green, black and white ash – are susceptible to EAB. Based on experiences with EAB in other states, nearly all untreated native ash trees in Hennepin County could be killed within the next 10 to 15 years (Figure 1).

Figure 1: Anticipated ash tree die-off in Hennepin County

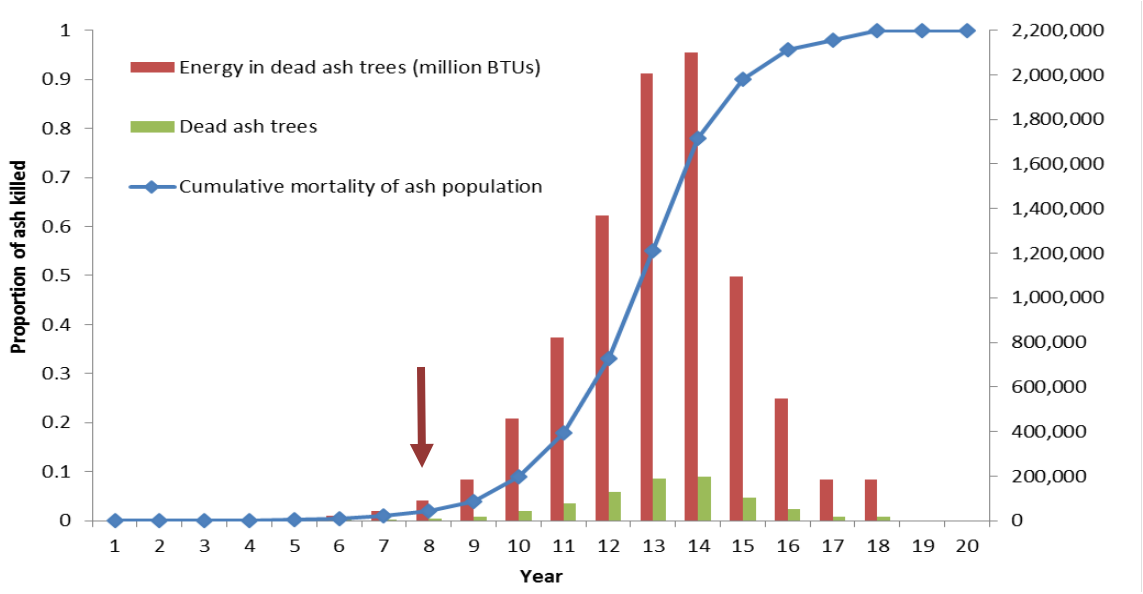

Figure 1. Predicted number of standing dead ash trees and energy available in dry dead ash trees by year after initial infestation. This represents a worst case scenario and is based on mortality observations in eastern regions of the U.S. where little ash or EAB management occurred. Ash population estimates are based on both U.S. Forest Service Forest Inventory and Analysis Program and Minnesota Department of Natural Resources (DNR) data from maintained areas of Hennepin County. EAB was first detected in the Twin Cities metro area in 2009. Current mortality rates in 2016 are representative of years 7 to 9 (red arrow). Mortality is expected to increase exponentially in the next 1 to 3 years.

Losing one million ash trees in Hennepin County, including 31,000 ash trees on county-owned properties, within a short timeframe will put significant demands on local and state financial and forest resources (Figure 1). In addition to the costs associated with removing or treating trees, significant resources will be needed to store, chip and transfer wood waste to waste-to-energy facilities and for reforestation efforts (Figure 1). As a result, advanced planning and budgeting for EAB by Hennepin County and its municipalities is imperative.

Although the potential economic and environmental impacts of losing these trees is substantial, Hennepin County plans to use EAB as an opportunity to promote the preservation and replacement of ash trees and to enhance and diversify the county's tree canopy to maximize the associated benefits. This plan provides multi-year strategies to manage the county's response to EAB and identifies potential roles for Hennepin County in countywide EAB management efforts. This plan also includes strategies for mitigating tree loss on county properties and evaluating unmet resources in cities throughout the county.

History of EAB in North American and Minnesota

EAB is a metallic-green, wood-boring beetle native to Asia that attacks all species of Minnesota's native ash trees. The adult EAB beetle lives outside of trees during the summer flight season (May 1 to September 1) while it feeds on ash foliage and breeds. Female EAB deposit eggs on the bark of ash trees during this period. The larvae hatch and bore through the bark into the vascular system of the tree. The larvae move just under the bark feeding on the trees phloem, cambium, and outer sapwood, severing the water and nutrient transport system between the tree's roots and crown. The larvae overwinter under the bark of the tree until they mature and bore out of the tree, leaving "D" shaped exit holes the following spring (Figure 2). The adult beetles emerge capable of flight.

Figure 2. Small diameter green ash tree in Minneapolis infested with emerald ash borer in April 2016. The tree has splitting bark and wood pecker damage (left). Peeled back bark reveals sinuous, "S-shaped" EAB larval galleries under the bark (right). "D-shaped" adult beetle exit holes are present but difficult to see as they are 1/8th inch in diameter.

EAB spreads slowly on its own, typically feeding and breeding close to where it was born. If food is scarce, EAB can spread naturally about a half mile per year. EAB can spread much further and faster when infested firewood or wood waste is transported. EAB

was first discovered in North American in Detroit, Michigan and Ontario, Canada in 2002. It is believed to have been transported to North America via infested wood shipping crates. Since its discovery, EAB has expanded into various eastern and Midwestern states.

EAB was first confirmed in Minnesota in May 2009 in western St. Paul. Because of its proximity to the initial infestation, Hennepin County was included in an emergency quarantine by the Minnesota Department of Agriculture in May 2009. The quarantine was intended to limit the spread of EAB by prohibiting transport of infested wood outside of the quarantined areas.

Since the initial confirmation, EAB has been identified in several locations in Minneapolis and, most recently, in Bloomington, Plymouth and Richfield (Figure 3). Despite the quarantine, EAB as of October 2016 has been identified in 14 Minnesota counties (Anoka, Chisago, Dakota, Dodge, Fillmore, Hennepin, Houston, Olmsted, Ramsey, Scott, St. Louis, Wabasha, and Winona counties) (Figure 4).

Figure 3: EAB infestations in Hennepin County

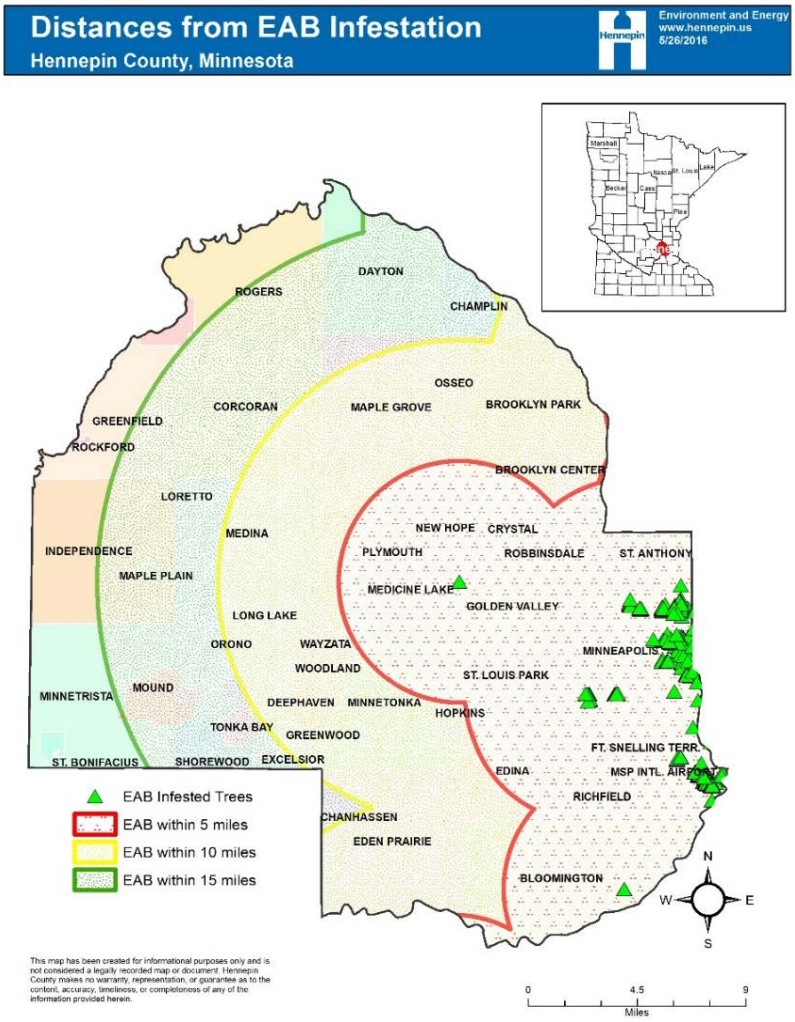

Figure 3. Location of EAB infestations within Hennepin County along with 5, 10, and 15 mile buffers around known infestations to demonstrate proximity to Hennepin County municipalities as of March 2016. Experience from other states that have dealt with EAB indicates that treatment for preservation should begin when EAB infestations are within 15 miles.

Funding for EAB in Minnesota

To date, the State of Minnesota has not committed significant resources to EAB planning or mitigation. The Minnesota Department of Agriculture is responsible for establishing and regulating EAB quarantines and the transport of wood but has no funding available for municipalities. The Minnesota Department of Natural Resources was recently allocated $800,000 by the Legislative-Citizen Commission on Minnesota Resources to support EAB efforts statewide using the Improving Community Forests through Citizen Engagement Program, but only one Hennepin County city was awarded a grant for the 2016-2017 cycle. This $800,000 split among 12 different communities is a small amount compared to the anticipated financial impact of EAB statewide.

Figure 4: EAB quarantines in Minnesota

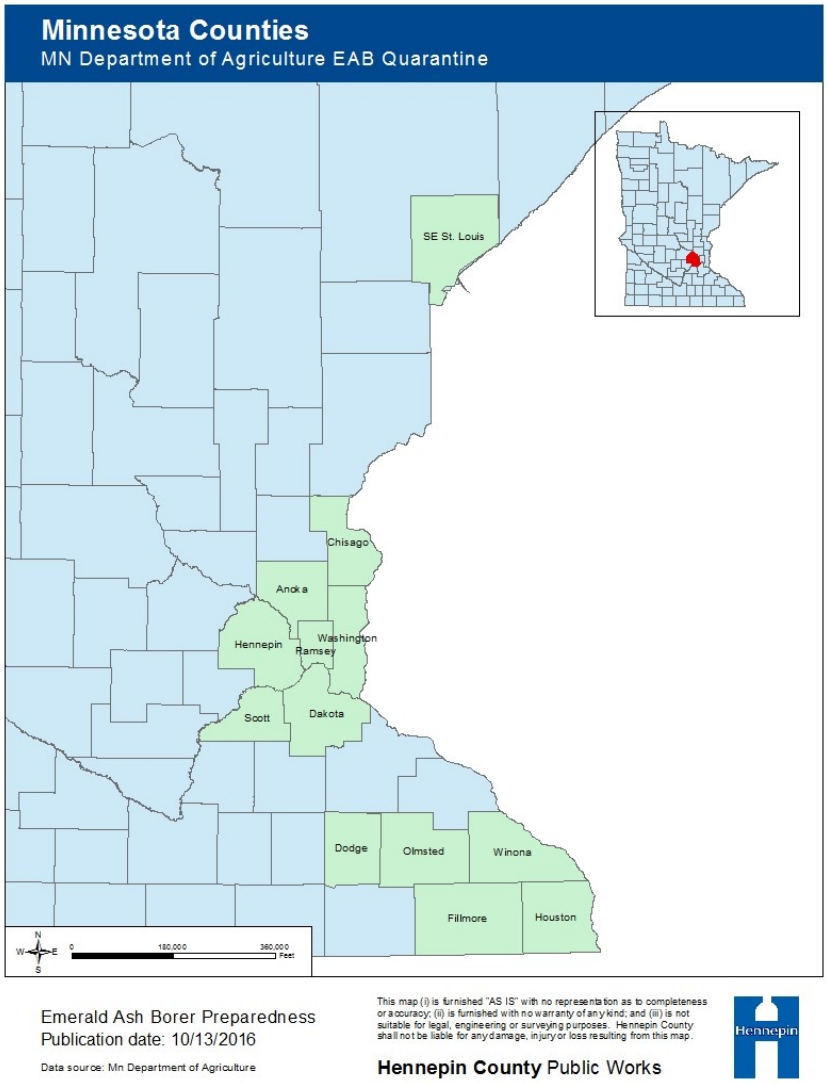

Figure 4. Minnesota Counties under Minnesota Department of Agriculture EAB quarantines as of July 2016. Park Point in Duluth, MN is also quarantined but not shown.

Ash trees on Hennepin County properties

Hennepin County owns and manages numerous tracts of land, many of which surround public buildings or are thoroughfares. There are approximately 31,000 ash trees on Hennepin County properties that will be infested by the emerald ash borer in the next 10 to 15 years. The properties are managed by numerous departments in Public Works including Facility Services, Resident and Real Estate Services, Community Works, Transportation (Project Delivery and Operations), and the Hennepin County Regional Railroad Authority.

Hennepin County manages a wide range of properties with varying uses and needs. The tree canopy is one of a variety of resources managed on these sites, and each of these business lines manages the different property types to address various concerns and responsibilities relating to the tree canopy. A short summary of each follows.

Community Works

Community Works manages several transit corridors and properties along transit corridors, including Lowry Avenue North, Hiawatha Avenue and the Cepro bike/pedestrian ramp property. There are no known ash trees on these corridors and properties. However, there are ample opportunity for canopy enhancements. Community Work's Real Estate Division acquires properties for new county facilities and for road construction projects. In many cases, the properties acquired include ash trees. Community Works is working with Environment and Energy to develop EAB and ash management plans.

Figure 5. Hennepin County's Sumner Library has a well-established tree canopy dominated by green ash. These ash trees provide significant environmental benefits including capturing rainwater and particulates and providing shade to the building and parking lot (top). Those benefits are lost without the ash canopy as demonstrated in the bottom photo when the leaves were off the trees in the spring (bottom).

Facility Services

Facility Services manages 117 facilities throughout Hennepin County, 80 of which are owned by the county and 37 are leased. The types of facilities include general government, libraries, human services and public health, public safety, adult and youth corrections, public works, transfer stations, and medical clinics (Figure 5). Limited canopy surveys commissioned in 2010 and again in 2014 identified 689 ash trees on 35 of the properties managed by Facility Services. Facility Services has an ash tree management plan for its properties, and implementation of that plan began in 2015.

Resident and Real Estate Services

As of May 2015, Resident and Real Estate Services has a total of 615 active tax-forfeited properties, 383 of which are within the City of Minneapolis and 232 are in the suburbs. Approximately 50 of these properties are commercial properties, and the rest are residential properties or vacant lots. The quantity and distribution of ash trees on Resident and Real Estate Services properties is currently unknown, but given the urban nature of many tax-forfeited properties, a relatively large number of ash likely exist on these properties. Environment and Energy staff recently provided an EAB primer to Resident and Real Estate Services staff to assist in an ash inventory effort they have undertaken. Environment and Energy is currently working with Resident and Real Estate Services to develop a tree canopy enhancement and ash tree management plan for the tax-forfeited land it administers on behalf of the State of Minnesota.

Transportation

Hennepin County maintains 571 miles of roadway. Surveys of ash trees conducted in 2016 along 5 miles of county corridor running through Maple Grove, Orono, and Plymouth identified about 28 ash trees per mile. If this is representative of all county rights-of-ways, about 16,000 ash trees could be present along the entire county road system. The vast majority of these trees are under 10 inches in diameter.

Annually, Transportation directs its staff to monitor the health of trees along its property lines. Trees identified as dead or with declining health are marked and removed by being felled and chipped in place. This annual effort was expanded in summer 2016 to include mapping and inventorying of all tree species within the right-of-ways to allow for planning of tree maintenance and EAB mitigation. Additionally, Environment and Energy and Transportation staff will survey all county corridors for diseased trees in 2016. When dead, dying, or diseased trees are marked for removal, adjacent ash trees will also be marked for removal. This proactive effort will minimize the amount of hazardous trees needing removal as EAB spreads through the county. Environment and Energy plans to replace removed trees with saplings from the county gravel-bed nursery where appropriate.

Hennepin County Regional Railroad Authority

The Hennepin County Regional Railroad Authority owns 55 miles of railroad corridor and 11 “corridor-supporting parcels” adjacent to the corridors for future station sites and/or development. The Hennepin County Regional Railroad Authority commissioned an ash tree survey that was completed by Tree Trust along all corridors. The survey found an estimated 13,000 ash trees along the 55 miles of trail corridors, with 75 percent of trees being 1 to 6 inches in diameter. Smaller diameter trees such as these provide fewer environmental benefits and are significantly cheaper and easier to remove than larger diameter trees. The Hennepin County Regional Railroad Authority is preemptively removing ash trees and replacing them with tubed seedlings as well as larger saplings from the gravel-bed nursery.

Coordinating across business lines

EAB's significant effect on ash trees will impact site characteristics, including the aesthetics, energy use and stormwater management, as well as operating budgets of Hennepin County properties. Proper planning and preemptive coordinated action can alleviate the negative effects of EAB and the loss of ash trees.

This plan describes and unifies the efforts of each business line to preserve, remove, and replace the county's ash trees while adhering to our commitment to maintain and enhance the county's tree canopy. To this end, Hennepin County Environment and Energy will coordinate the inventorying, monitoring, sanitation, preservation, removal, and replacement activities across county business lines. To simplify planning while recognizing the differences in the types of properties that the county owns and manages, the remainder of this document is organized by ash management strategies and describes the coordinator role of Environment and Energy and planned implementation throughout the Public Works and Operations business lines.

EAB management strategies

Inventory and monitoring

An inventory and assessment of trees on county properties will be conducted before the implementation of any strategy to remove and replace the estimated 31,000 ash trees on Hennepin County properties is carried out. Mapping and inspecting all trees on all county properties will provide the necessary details to assess, budget and plan for the removal and replacement of both infested (sanitation) and yet-to-be infested ash trees (planned removal). Inventory work will be led by Environment and Energy starting in spring 2016.

The inventory will include an assessment of the tree type, size, health, and location. Environment and Energy staff worked with the county GIS department to develop a smartphone program to collect, store, and update the countywide inventory in real time. By mapping and cataloging the locations of these trees on county owned and managed properties, the county can plan the logistics and budget for both the preservation and thoughtful phased removal of ash trees over the next several years.

Inventory and monitoring strategies

Public Works	Environment and Energy will conduct a tree inventory and assessment along county corridors within 5 miles of known infestations in spring 2016 and will work with Road and Bridge maintenance staff to monitor for new EAB infestations (Figure 2). Environment and Energy will continue to coordinate inventories with the Hennepin County Regional Railroad Authority and Tree Trust on rail authority administered properties and corridors, with priority given to properties within 5 miles of known infestations (Figure 2). Tree Trust staff will continue to actively inspect for EAB infestations along Hennepin County Regional Railroad Authority corridors.

Operations Environment and Energy will coordinate a complete tree inventory and assessment on Facility Services properties in spring 2016. Environment and Energy will work with Resident and Real Estate Services to identify and inventory tax-forfeited properties within 5 miles of know infestations to identify ash trees (Figure 2). Environment and Energy will continue to work with Resident and Real Estate Services on a strategy to identify, remove, and replace ash trees on tax-forfeited properties.

Figure 6. Large diameter ash at Oxboro Library in Bloomington displaying several signs and symptoms of EAB, including branch dieback (pictured), "blonding" of bark from wood pecker activity (not pictured), and a proliferation of shoots on the main stem (pictured). Tree death as a result of EAB can be quick. The photo on the left was taken in May 2016, and the photo on the right was taken approximately three weeks later in June 2016.

Sanitation

Sanitation is the immediate removal and disposal of infested ash trees following Minnesota Department of Agriculture guidelines. The 2016 Minnesota Department of Agriculture EAB quarantine affects those counties with verified infestations of EAB within their borders and clearly prohibits the movement of regulated materials outside of quarantined areas.

To date, one infested ash tree has been found on county property (in summer 2014 in a Hennepin County Regional Railroad Authority corridor) near the Mississippi River. This ash tree was removed by the Minneapolis Park and Recreation Board along with several infested trees on an adjacent property. This tree was double chipped to reduce chip size so that it could be transported outside of the county for incineration and power generation at Great River Energy in Dakota County.

Sanitation strategies

Public Works Infested trees along road and trail corridors pose a hazard and nuisance to the public. Identified infested trees will be removed promptly by contracted arborists or county staff and disposed of following Minnesota Department of Agriculture guidelines, which prohibit movement of ash material outside of quarantined areas. If ash material is moved outside a quarantine, a compliance agreement must be in place for the transporting entity, and ash material must be chipped to a certain dimension, fumigated, debarked, heated to 140 degrees for four days, or transported to an approved facility during the non-flight season (October 1 to May 1). The county's preferred method of disposal would include chipping and using the material within Hennepin County or adjacent quarantined areas. Currently, all diseased material is removed outside of the growing season and is chipped and burned at private facilities in Plymouth (Len Busch Roses) and St. Paul (District Energy).

Operations Infested trees at county facilities and tax-forfeited properties pose a hazard and nuisance to residents (Figure 6). Identified infested trees will be removed promptly and disposed of following Minnesota Department of Agriculture guidelines. Diseased material will go to the aforementioned disposal facilities used by Public Works.

Planned removal and replacement

Planned removal is the proactive, staged and systematic removal of non-infested ash trees. Removal of non-infested ash trees that are smaller in diameter or in declining health will reduce the number of ash trees that will ultimately require removal when infestations reach epidemic levels.

Tree replacement can be done before or after the ash tree is removed. Early tree replacement, sometimes referred to as "buddy planting," involves planting a replacement tree one to several years before the other tree is removed (Figure 7). This strategy allows the replacement tree to become established, reducing the ecological and aesthetic impacts of tree removal.

Environment and Energy facilitates tree replacement by maintaining a gravel-bed nursery at the Hennepin County Adult Corrections Facility in Plymouth that holds 500 bare-root replacement trees. Gravel-bed nurseries consist of a raised gravel-based growing medium enclosed by a barrier system. Bare-root trees are purchased from commercial nurseries in the spring, planted in the gravel-bed nursery, watered daily and are available for transplanting throughout the growing season (Figure 8).

Figure 7. Example of a buddy planting at the Sheriff's Water Patrol Station in Spring Park. Here, a variety of American elm that is resistant to Dutch elm disease has been planted alongside a green ash scheduled for removal.

The gravel-bed nursery produces trees with a well-developed, fibrous root system, which gives these trees a higher survival rate than conventional nursery trees. Use of bare-root stock also provides access to a wider variety of tree species throughout the growing season. The gravel-bed nursery allows the county to make healthy trees available to county business lines at a significantly reduced cost compared with containerized or ball-and-burlap trees purchased from private nurseries. The reduced tree cost enables Environment and Energy to plant more trees at county properties without increasing planting budgets.

Figure 8. The county gravel-bed nursery located at the Adult Corrections Facility in Plymouth can hold at least 500 trees annually. Seedlings and saplings are typically installed in the spring and transplanted to permanent sites in the fall. The gravel-bed nursery provides diverse and inexpensive trees with healthy root systems that are easy to plant throughout the growing season.

Planned removal and replacement strategies

Public Works

Public Works is considering the planned removal of ash trees along road corridors as an expanded part of the annual disease tree management activities. Wood is chipped and burned for energy by two local companies (Len Busch Roses and St. Paul District Energy). Where possible, removed trees will be replaced with gravel-bed trees. Along Hennepin County Regional Railroad Authority corridors, planned tree removal will take place with tree replacement where appropriate. Estimates for the cost per tree for removals by county staff are not available; however, MINNOWA, an energy cooperative in southeastern Minnesota that is responsible for ash removals in utility corridors, budgeted an additional $1.6 million for removals related to EAB in 2016. Hennepin County has a similarly sized population of ash in road corridor right-of-ways and should plan on a similar budget to complete additional removals of ash trees.

Operations

Facility Services is planning to remove and replace 470 ash trees, which is about 80 percent of the total ash trees on their properties, over the next 5 to 7 years. They will begin with trees that are either small in diameter, of poor quality, in declining health, or in locations that pose a greater risk to the users or nearby populations. Removed trees will be replaced with a minimum of two trees from the county's gravel-bed nursery, which will help meet canopy enhancement goals. Based on regional average tree removal costs, the removal of 80 percent of Facility Services ash trees will cost $280,120 including stump grinding (Figure 9). Replacement costs would be approximately $75,200, which is significantly less than the average regional cost due to the use of more affordable gravel-bed trees. Gravel-bed trees have a tree planting cost of $80 per tree. Planned ash removal and replacement by this group started in 2015.

Figure 9: Tree removal and replacement costs

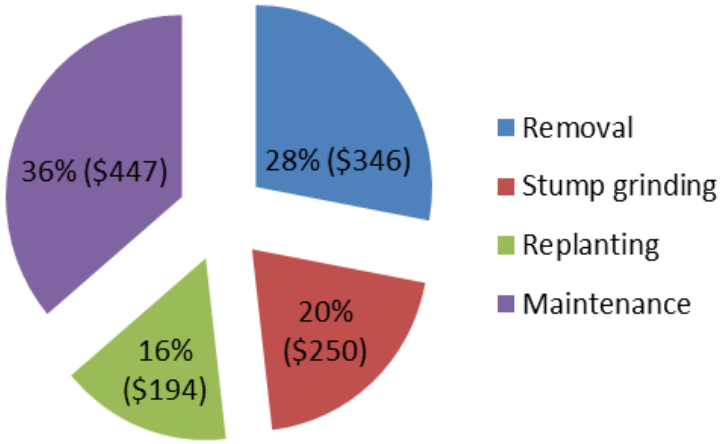

Figure 9. Regional average municipal costs for individual tree removal, stump grinding, replanting and initial maintenance. Replanting costs include the average regional price for a single containerized or balled and burlapped sapling. Total cost of $1,237 is based on average tree diameter at breast height of 16 inches.

Reforestation and diversification goals

Replacing ash trees with a variety of tree species is an important aspect of the EAB management program. It is also a key strategy for the county in creating a healthy urban forest and reducing the probability of future canopy loss stemming from the over planting of any one family, genera, or species susceptible to destructive pests or pathogens. At a minimum, Hennepin County will follow the "20-10-5 rule" to ensure diversification of the county tree canopy. The "20-10-5 rule" incorporates canopy diversity goals into planning as it requires that no more than 20 percent of one family, 10 percent of one genera, or 5 percent of one species be planted in a given geographic area. As an example, if 5 percent of the canopy was red oak (*Quercus rubra*), 5 percent was white oak (*Quercus alba*), 5 percent was American beech (*Fagus grandifolia*), and 5 percent was American chestnut (*Castanea dentata*), then 10 percent of the trees would be in the *Quercus* genus (red oak + white oak), 5 percent would be in the *Fagus* genus

(American beech), and 5 percent would be in the *Castanea* genus (American chestnut). Further, 20 percent of the canopy would be comprised of the *Fagaceae* family (oak + beech + chestnut).

Selection will emphasize families, genera, and species native to North America but will accommodate new species and varieties expected to be well-adapted to Minnesota's changing climate. Hennepin County will seek guidance from the University of Minnesota and the USDA Forest Service Northern Research Station on potential neo-native and nonnative species to Minnesota.

As described above, one strategy Environment and Energy is immediately employing to preemptively replace ash trees includes the use of a gravel- bed nursery capable of holding 500 or more bare-root replacement trees annually (Figure 10). In 2015 and 2016, the gravel bed housed nearly 1,100 trees of 38 different species and cultivars (Appendix A). The gravel-bed nursery supplies trees to a variety of county projects ranging from library landscapes to reconstructed county corridors. The success and long-term viability and effectiveness of the gravel-bed nursery will be assessed in 2017.

Additionally, Environment and Energy will explore opportunities to collaborate with municipalities and other organizations on canopy enhancement projects using the county's gravel-bed nursery or by allowing municipalities to site gravel-bed nurseries at the Hennepin County Adult Corrections Facility. Environment and Energy will also explore opportunities to site additional nurseries for educational, community works and project-specific purposes (Figure 10).

Figure 10. A gravel-bed nursery was installed as part of a pilot program at Minneapolis' North High School in partnership with Minneapolis Public Schools, the City of Minneapolis, Project Sweetie Pie, and Hennepin County. The 40 trees held and irrigated in the gravel-bed were planted in the fall to replace 15 mature ash trees in the school courtyard that will have to be removed once EAB arrives.

Ash tree preservation

Preservation of environmentally significant ash trees can be achieved using pesticides. When used as one of several tactics, preservation with pesticides can effectively manage pest populations and preserve desired tree benefits. There are a number of pesticide treatment options available, most of which need to be repeated on a biennial or triennial basis and will need to continue as long as EAB is present. The frequency of application may decrease as EAB populations decrease. The most effective EAB insecticides are systemic, which means that the chemical is carried throughout the tree via its vascular tissue. The insect must then ingest a sufficient amount of the tree tissue containing insecticide for it to be effective. Certain systemic pesticides, like emamectin benzoate, have been effectively used to protect EAB-vulnerable ash as well as decrease EAB populations. Past use has shown that it is possible to apply systemic insecticides after partial canopy loss has occurred (up to 50 percent); however, nearly all insecticide treatments are most effective when applied while the tree is still relatively healthy.

Hennepin County plans to use injected pesticide treatments to preserve high-value ash trees. Ash selected for long-term pesticide treatment on Hennepin County property will be larger trees in good health that are visible to the public and whose location will continue to provide a suite of conservation benefits. Environment and Energy will coordinate pesticide selection, organize the selection of contractors for pesticide application, and monitor effectiveness.

At this point, pesticide use for EAB protection on county parcels will be restricted to only a few high-value trees per property. The county has selected emamectin benzoate as the active ingredient to be used to protect selected ash trees. This systemic pesticide does not contain neonicotinoids, which is suspected by researchers to play a role in pollinator colony collapse disorder. The pesticide is also injected into selected trees, which reduces the potential for groundwater contamination. Additionally, impacts to pollinators should be negligible as ash is a wind pollinated tree species that is not favored by pollinators. Pesticide selection and use will be reviewed by Environment and Energy on an annual basis to ensure it continues to conform to the county's Integrated Pest Management Plan, best management practices and pollinator-friendly policies.

Preservation Strategies

Operations	Facility Services is planning to treat with injected emamectin benzoate 20 percent, or about 120, of the higher value ash trees identified in their ash inventory. These include large ash trees that are visible to the public, provide environmental benefits, and are not easily or quickly replaced. Treatment will be carried out every 2 to 3 years for the life of the trees. Treating, as opposed to removing and replacing 120 trees, represents a 10 percent savings, and this does not account for the benefits of preserving mature trees. The discounted value of treating 120 ash trees on Facility Services properties for the next 30 years at approximately $100 per tree is $553,266. For comparison, the discounted value of removing and replacing (1 for 1) all 120 trees would be $621,182 over that same time period.
Public Works	Pesticide use for EAB management is not being planned by any Public Works land management groups.

Countywide issues

Status of municipal forestry programs

Determining the county's role regarding EAB beyond county-owned land depends greatly on what Hennepin County municipalities need in order to deal with the disaster expected to affect their tree canopy. These needs vary widely as does the makeup of municipalities' tree canopy and human and financial resources. In order to get a better handle on these needs, efforts have been made to survey all 45 municipalities within Hennepin County (Appendix B). The objective of the survey was to get a better sense for municipalities' capacity to deal with the economic and ecological effects associated with the spread of EAB. About 70 percent of Hennepin County cities (32 of the 45 contacted) responded. Their responses show a range of EAB planning and preparedness actions being taken across the county.

The first step in planning for any natural resource is an inventory of what is present. One-third of municipalities have initiated tree canopy inventories, and only about a quarter of the cities in the county have a completed an up-to-date inventory (Appendix B). Approximately half of the ash trees in maintained spaces of the county, or 452,000 ash trees, are located in municipalities that have a public tree inventory. About 11 percent of all ash trees in maintained areas, or 91,433 ash trees, are accounted for in municipal inventories. That is due to the fact that roughly 90 percent of ash shade trees in maintained areas exist on either residential or commercial private property. This poses an enormous urban canopy management challenge.

Dealing with an epidemic such as EAB requires that the proper policies be in place and enforced to ensure private and public canopy are being managed similarly to deal with the epidemic disease or pest. Nearly 90 percent of cities in the county have some sort of tree program or disease tree policy in place with trained staff or a contracted arborist. Plans and policies dealing with disaster (e.g., storm damage, EAB, etc.) were in place for two-thirds of the cities.

Funding and upper-level organizational support are critical to maintaining and enhancing tree programs, and disease tree management is critical to program success. This was conveyed by the majority of cities that took part in the survey. Funding sources varied, with a great deal of cities receiving funds dedicated from general funds while other municipalities received funds from stormwater fees. Budgets were typically focused on tree removal and replacement. The 10 cities that had budget amounts available reported an average of $18,150 annually.

Removal and replacement figures vary widely by city and depend on the resources cities have available to manage EAB. Some cities are not acting, some cities are acting but are limited in the strategies they can employ, and some cities are employing the full suite of management strategies available. For example, the cities of Eden Prairie and Long Lake are waiting to gather more information and see how other communities deal with EAB. Cities like Plymouth, Robbinsdale, and St. Louis Park are removing and replacing 75 to 300 lower quality ash trees per year and preserving 500 to 1,500 high value trees with systemic pesticides. The Minneapolis Park and Recreation Board is unable to use systemic pesticides to protect or preserve high-value ash trees. As a result, they are currently in year three of an eight year plan

to remove and replace all 30,000 ash trees in Minneapolis. They have removed and replaced roughly 5,000 ash trees each year since 2014. Wood is being disposed of and used at a number of facilities within and outside of the county. County wood waste is usually chipped and transported to Len Busch Roses in Plymouth where it is burned to heat 500,000 square feet of greenhouse space. Environmental Wood Services, associated with District Energy in St. Paul, operates a handful of satellite wood processing sites where wood is processed transported to St. Paul where it is burned to generate steam for heat and electricity.

Cities, regardless of size, seldom have all the resources they need to deal with a disaster like EAB. Cities expressed several needs that could be addressed through county action or state funding. Many ideas focused on funding, including a grant program that provided general canopy enhancement funding, dedicated funding for wide-scale ash removal, and dedicated funding for forestry focused hires. Smaller cities sought a streamlined grant application process given limited personnel as well as supplemental technical advice for their tree workers.

Figure 11. A small group of approximately 15 standing dead ash trees in Minneapolis in June 2016. All trees were alive in 2015, and their EAB infestation was not known at that time.

Several cities also expressed interest in having the county assist with wood storage and utilization through the implementation of county managed marshalling yards (Appendix C). The availability of multiple marshalling yards will be a critical as ash mortality rates increase in Hennepin County over the next several years. A worst case scenario predicts that at year 13 and 14 after an initial EAB find there will be nearly 200,000 standing dead trees and over 2 trillion BTUs of energy available in ash wood within Hennepin County alone (Figure 1).

Hennepin County's role

During the height of Dutch elm disease, Hennepin County assisted municipalities by providing a series of marshalling yards in Maple Grove where municipalities lacking capacity could deliver their tree waste for processing and disposal. These marshalling yards were operated by Hennepin County. The marshalling yard was discontinued once tree waste volumes declined. Hennepin County continues to assist municipalities on an as-needed basis with the removal of storm-damaged trees. Hennepin County no longer owns this property and lacks a readily available replacement facility for use in conjunction with EAB.

Based on experiences elsewhere, municipal resources could be quickly overrun by EAB without proper advance planning (Figure 11). Although the rate of the spread of EAB in Hennepin County cannot be

predicted, in other locations EAB has tended to expand exponentially once a critical infestation mass was reached, leaving the majority of ash trees dead or dying within the span of a few years. The infested trees need to be removed quickly to minimize the danger to the public posed by falling limbs, a risk that is increased by EAB's tendency to catalyze the drying of trees and thus increasing the likelihood of breakage. Assuming EAB affects Hennepin County in a similar manner, the county will be called upon to provide assistance to municipalities. Further discussion is required to establish what the county's role should be. The county has or is planning to take action on the following items:

- Develop a countywide EAB task force that includes Public Works Directors and/or natural resource professionals to raise awareness, plan, and develop strategies for pooling resources.

- Develop outreach and education materials that will be available to municipalities to inform private property owners of EAB, its destructive potential, benefits of a healthy tree canopy, and potential ash management options. Materials will be available in print for municipalities and on a Hennepin County web page dedicated to Environment and Energy forestry activities and EAB preparedness.

- Participate in legislative initiatives requesting adequate statewide funding for EAB.

- Provide approximately $500,000 annually via a grant program for municipalities to complete tree inventories, develop canopy management plans, preserve ash trees, and remove and replace trees. Our surveys indicate that a number of municipalities have not completed inventories. An inventory that determines the number, location and size of ash trees is necessary in order for a municipality to develop an accurate budget for EAB. This could be accomplished via a county grant program, preferably with a cost-sharing component.

- Assist municipalities with inventory and reforestation efforts by providing technical assistance, partnering to seek state grant and staffing opportunities (e.g., MPCA GreenCorps), and/or providing pass-through funding.

- Assist with efforts to identify and secure marshalling yards for tree waste and contracts for the operation of the marshalling yards and the use of this biomass. There are several local facilities that accept biomass. Additional investigation is needed to compare available tree waste storage capacity with anticipated needs and to determine the capacities of biomass-to-energy facilities with anticipated biomass volumes (Figure 1)

Appendices

Appendix A: Species held and transplanted from Hennepin County gravel-bed in 2015 and 2016

Species	Common name	Native to MN	Native to US	Non-native
Acer rubrum	Red maple	Yes		
Acer saccharinum	Silver maple	Yes		
Acer saccharum	Sugar maple	Yes		
Aescleus glabra	Ohio buckeye		Yes	
Alnus hirsuta	Manchurian alder 'Prairie Horizon'			Yes
Betula nigra	River birch	Yes		
Carpinus caroliniana	Blue beech	Yes		
Catalpa speciosa	Northern catalpa		Yes	
Celtis occidentalis	Hackberry	Yes		
Crataegus spp.	Hawthorn 'Crimson Cloud'			Yes
Fagus sylvatica	European beech 'Copper'			Yes
Gleditsia triacanthos	Honey locust 'Skyline'	Yes		
Gymnocladus dioica	Coffeetree 'Espresso'	Yes		
Halesia monticola	Mountain silverbell 'Arnold Pink'		Yes	
Liriodendron tulipifera	Tulip tree		Yes	
Maackia amurensis	Amur maackia 'Summertime'			Yes
Malus spp.	Apple 'Haralson'			Yes
Malus spp.	Apple 'Honeycrisp'			Yes
Malus spp.	Crabapple 'Indian Magic'			Yes
Ostraya virginiana	Ironwood	Yes		
Populus balsamifera	Balsam poplar	Yes		
Populus deltoides	Cottonwood 'Highland Poplar'	Yes		
Prunus domestica	Plum 'Mount Royal'			Yes
Prunus padus	Bird cherry			Yes
Prunus serotina	Black cherry	Yes		
Pyrus spp.	Pear 'Parker'			Yes
Pyrus spp.	Pear 'Summercrisp'			Yes
Quercus alba x *macrocarpa*	Oak 'Jordan Street'			Yes
Quercus robur x *bicolor*	Oak 'Regal Prince'			Yes
Quercus robur x *alba*	Oak 'Prarie Stature'			Yes
Syringa reticulata	Tree lilac			Yes
Tilia americana	Linden 'Frontyard'	Yes		
Tilia americana	Linden 'Redmond'	Yes		
Tilia americana	Basswood	Yes		
Ulmus americana	American elm 'St. Croix'	Yes		
Ulmus americana	American elm 'Princeton'	Yes		
Ulmus americana	American elm 'Valley Forge'	Yes		
Zelkova serrata	Zelkova 'Kiwi Sunset'			Yes
	Total	18	4	16

Appendix B: Survey of Hennepin County municipal forestry programs and EAB preparedness

City	Survey year	Do you have a tree inventory?	Do you have funding dedicated to tree-related work?	Do you have ordinances specific to EAB?	Do you had means of disposing of wood waste? If yes, how is wood waste utilized?	Do you have a plan to deal with increased wood waste resulting from EAB or other natural disaster?	Identified potential additional marshalling yards?	Do you have funding dedicated to managing for EAB?	Will your city treat ash trees to prevent infestation?	Do you have a plan for removals of ash?	Do you have a plan to replace those trees you remove?
Bloomington	2015	No	Yes	Yes	Biomass	No	Yes	Yes	No	Yes	Yes
Brooklyn Center	2015	Yes	Yes	Yes	-	-	-	-	-	-	-
Brooklyn Park	-	-	-	-	-	-	-	-	-	-	-
Champlin	2015	Yes	Yes	No	-	-	-	-	-	-	-
Chanhassen	2015	Yes	Yes	No	-	-	-	No	-	-	-
Corcoran	2010	No	-	-	Mulch/Firewood	No	No	No	No	No	No
Crystal	2015	Yes	Yes	No	Contracted-	-	Yes	No	No	Yes	Yes
Dayton	2015	No	No	No	-	-	-	-	-	-	-
Deephaven	2010	No	Yes	-	-	No	No	No	No	No	No
Eden Prarie	2015	No	Yes	No	Biomass	Yes	Yes	No	No	Yes	Yes
Edina	2015	Yes	Yes	No	-	-	-	No	-	-	-
Excelsior	-	-	-	-	-	-	-	-	-	-	-
Golden Valley	2015	Yes	Yes	Yes	Yes	No	-	Yes	No	Yes	Yes
Greenfield	2010	No	No	-	Open-burned	No	Yes	No	No	No	No
Greenwood	-	-	-	-	-	-	-	-	-	-	-
Hanover	-	-	-	-	-	-	-	-	-	-	-
Hopkins	2015	No	Yes	No	Mulch/biomass	No	Yes	No	Yes	No	No
Independence	-	-	-	-	-	-	-	-	-	-	-
Long Lake	2010	No	No	-	Biomass	Yes	Yes	No	No	No	No
Lorreto	-	-	-	-	-	-	-	-	-	-	-
Maple Grove	2015	Yes	Yes	No	Mulch	Yes	No	No	Maybe	No	No
Maple Plain	-	-	-	-	-	-	-	-	-	-	-
Medicine Lake	-	-	-	-	-	-	-	-	-	-	-
Medina	-	-	-	-	-	-	-	-	-	-	-
Minneapolis	2015	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes
Minnetonka	2015	Yes	Yes	No	Mulch/biomass	No	No	Yes	Yes	Yes	Yes
Minnetonka Beach	-	-	-	-	-	-	-	-	-	-	-
Minnetrista	2015	No	No	-	Mulch/Open-	No	Yes	No	No	No	No
Mound	2015	No	Yes	No	Yes	Yes	-	No	-	-	-
New Hope	2015	Yes	Yes	Yes	Yes	Yes	-	Yes	-	Yes	Yes
Orono	2015	No	No	-	Mulch	No	No	No	No	No	No
Osseo	-	-	-	-	-	-	-	-	-	-	-
Plymouth	2015	Yes	Yes	Yes	Biomass	No	Yes	Yes	Yes	Yes	Yes
Richfield	2015	Yes	Yes	-	Biomass	No	No	Yes	Yes	Yes	Yes
Robbinsdale	2015	Yes	Yes	Yes	Mulch/biomass	Yes	No	Yes	Yes	Yes	Yes
Rogers	-	-	-	-	-	-	-	-	-	-	-
Saint Louis Park	2015	Yes	Yes	Yes	Biomass	Yes	No	Yes	Yes	Yes	Yes
Shorewood	2010	No	Yes	-	Contracted-	No	Yes	Yes	Maybe	-	No
Spring Park	2010	Yes	Yes	-	Contracted-	No	No	No	No	No	No
St. Anthony	-	-	-	-	-	-	-	-	-	-	-
St. Bonifacius	-	-	-	-	-	-	-	-	-	-	-
Three Rivers Park District	2010	Yes	Yes	-	Mulch/Firewood	No	No	No	No	Yes	Yes
Tonka Bay	2010	Yes	No	-	Biomass	No	-	No	No	No	No
Wayzata	-	-	-	-	-	-	-	-	-	-	-
Woodland	2010	No	Yes	-	Contracted-	No	No	No	Maybe	No	No

Appendix C: Marshalling yard parameters.

A marshalling yard is a tree wood handling and disposal site whose purpose is to help prevent diseased or infested wood from being transported out of a quarantined area. They can be used as staging sites for wood processing and disposal, such as, chipping, grinding, debarking, sawing and hauling activities.

- Operators:
  - Municipalities, tree service companies, utilities, individuals

- Size:
  - 5 to 10 acres would be ideal, several acres would be ok if isolated

- Locations:
  - Public or private land
  - On or near highway corridors with easy access for users
  - Must have access for trucks
  - Non-residential areas
  - Possible use of tax-forfeited lands

- Site conditions:
  - Relatively flat, with ability to control runoff
  - Fenced with a gate
  - Visible signage needed
  - As few neighbors as possible as grinding and chipping is noisy and dusty
  - Paved to avoid access issues related to weather