

Emerald Ash Borer Management Plan



Borough of West Chester, Pennsylvania



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[modified form model plan prepared by PADCNr, Bureau of Forestry]

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Larva feeding gallery under bark



Adult

Administration

The Borough of West Chester Emerald Ash Borer Management Plan is administered by the Borough EAB Manager. The EAB Manager reports to the Borough Council on this plan. Borough residents are encouraged to contact the Borough EAB Manager for any questions or concerns related to this plan.

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Executive Summary

The Borough of West Chester recognizes the benefits of urban trees to the quality of life, air pollution reduction, energy conservation, storm water mitigation, carbon uptake and storage and property value for its residents. Ash is an important part (200-300 trees) of our Borough tree population. One hundred and twenty four (124) ash trees are found on our streets and in our parks. These trees are appraised at \$685,000. Unfortunately, the emerald ash borer (EAB) threatens the future of ash trees in the Borough. The EAB is now located in 29 Pennsylvania counties, the closest being Bucks County.

To manage the ash tree population and to mitigate potential damages, we have adopted a selective management approach toward the management of this invasive pest over the next 10 years (2013-2023). A total of 106 ash trees on public streets and parks will be protected using a systemic insecticide called Tree-age. The remaining 18 street and parks trees will be removed and replaced with 36 non-host tree species.

The total cost for this program is estimated at over 10 years is \$180,799, with yearly costs ranging from \$3,442 - \$29,368. Awards and grants from federal, state, and local agencies, organizations, and institutions will be actively sought by the Borough to offset a portion of the cost for this program.

Ash trees on private properties (including street trees) are the responsibility of the property owners. Technical assistance will be provided by West Chester University (Department of Biology) and the PADCNR, Bureau of Forestry.

The program will be administrated by the Borough's Urban Forester who also serves as the EAB Program Manager. Annual auditing of the program will be conducted by the Borough Council. Necessary adjustments will be recommended each year based on progress reports on the status of forest conditions and EAB infestations within the Borough.

Activities of community outreach will be carried out throughout the program period as public support is the key to the success of this kind of program. The Borough will inform the public about the progress of the program on a timely fashion. Recommendations and suggestions on how to deal with this natural disaster of the ash forests are welcome. Furthermore, Borough residents are encouraged to be part of this program through cooperation and volunteering and other types of involvement.

All data for this report were collected by WCU and all the decisions as to treatments were made by the Borough's EAB Program Manager. The report format was provided by the Pennsylvania Department of Conservation & Natural Resources, Bureau of Forestry, Division of Forest Pest Management.

Authority:

The health of the ash trees in the Borough is threatened by the emerald ash borer (EAB). Damages to those trees will have a negative impact on public safety and quality of life for Borough residents. Federal and state regulations provide local authority to manage this pest and mitigate its damage in Pennsylvania.

Jurisdiction. The Borough shall have control of all street trees now or hereafter in any street, park, public right-of-way or easement, or other public place within the Borough limits, and shall have the power to plant, care for, maintain, remove, and replace such trees. (See tree code 102 Trees (<http://www.ecode360.com/6471559>). The Borough has determined that the health of ash trees are threatened by the EAB and hereby declares the following to be a public nuisance:

- Any living or standing tree or part thereof infested by this pest;
- Any dead tree or part thereof, including infested logs, branches, stumps, or other materials;
- Any infested firewood infested with this pest.

Abatement of Nuisance. If the Borough Urban Forester upon inspection or examination determines that any public nuisance as herein defined exists in or upon any public street, alley, park, or other public place; and that the danger to public safety is imminent, she shall:

- Immediately cause it to be treated or removed;
- Otherwise abate the nuisance in such a manner as to destroy/prevent the spread of this pest.

Cost of Abatement. The cost of abatement of any public nuisance (street tree) may be chargeable and assessed against the parcel or lot upon which such tree or material stands.

Transporting of Wood Prohibited. No person, firm, corporation shall transport within the Borough any infested materials without first securing the written permission of the Borough Urban Forester.

Introduction

West Chester, Pennsylvania is not just known for the county seat, but also known for its breath-taking landscape and exceptional natural beauty. As part of the piedmont plateau, the trees were here first and the town was built among the trees and many early residents planted trees. Trees are an integral part of the Borough's infrastructure and identity, and their foliage (crowns) cover 25% of the Borough (Dr. Joan Welch, personal communication). The southeast sector has the least canopy cover (northeast 32%, northwest 30%, southwest 26%, southeast 13%, [West Chester University 19%]). Included in the sectors are 124 ash trees. Most (85) are located in Hoopes Park. We estimate that twice as many ash trees are found in peoples yards within the Borough.

The emerald ash borer (EAB), *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae), a woodborer from northeast Asia, that was first discovered attacking ash trees in Michigan in 2002. Since then, it has been found in 17 additional states and two Canadian provinces across . It is found in 29 counties in PA and was found close to Chester Co in 2012 (Bucks Co) (Appendix 1).

Adult females lay their eggs under the bark where they hatch. Larvae feeding in the cambial region disrupts water and nutrient transport inside the tree, resulting in 99% tree mortality within 4-5 years after initial attack. An estimated 20 to 55 million ash trees have been killed by this pest so far. The potential economic damage may exceed \$10 billion in 25 states expected to be affected within in the next 10 years (Kovacs et al. 2010).

Managing this pest in North America has been confounded by difficulties in early detection, limitations in control options, and scarcity in available resources. Tree removal is the only option for sick & dying trees, whereas chemical control can be effective on high-value ash trees.

The Borough of West Chester is committed to preserve its urban forest resources as a designated "Tree City USA" community. The *Emerald Ash Management Plan* is to serve as the master plan for the Borough to manage its urban ash trees on streets and in parks over the next 10 years. Property owners are encouraged to manage their ash trees according to the guidelines set by this document.

There are three goals for this plan:

- △ Protect high value ash trees for its social and environmental benefits;
- △ Minimize public safety and liability risk from EAB infestation within the community;
- △ Replace canopy cover that will be lost to EAB infestation.

The Following actions will be carried out in the next 10 years:

- Maintain an updated ash inventory within the Borough and monitor EAB infestation on Borough trees yearly;
- Remove dead or dying ash trees from roadways and public areas;
- Utilize ash wood from tree removal activities and dispose ash-related material properly;
- Treat valuable ash trees with an insecticide;
- Replant non-host tree species at locations where ash trees were removed;
- Conduct outreach and public education and involve private property owners.

The Ash Resource

An ash inventory was conducted by West Chester University (Department of Biology) in June 2012 (Map 1). A total of 124 ash trees are recorded from Borough streets and parks and they ranged in diameter from 3 to 61 inches at breast height (Table 1). Fifty three percent of the trees are less than 25 inches in diameter, while 35% are between 26-35 inches. Six percent of the ash trees are in excellent shape (< 1% crown dieback) 40% are good, 34% in fair and 20% in poor condition. The total compensatory value of the street ash trees is estimated at \$685,000 (Dana 2006)(Appendix 5) .

Ash is 4.1% of West Chester public trees, which makes up 19% of all trees in Hoopes Park, 3% in Everhart Park, 1.2% in Marshall Square and 0.5% of the street trees.

Map 1. Location of 124 public ash trees in Borough of West Chester (Hoopes Park=85 trees; Everhart Park=21; Marshall Square=2; Street trees=16)

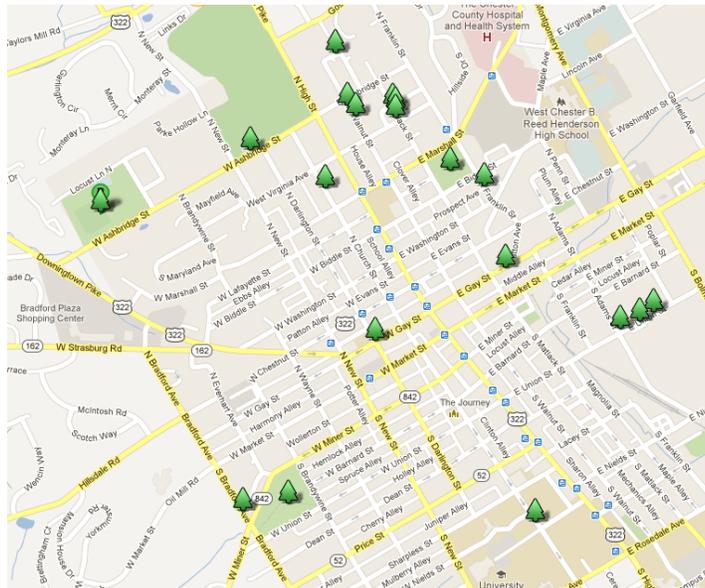


Table 1. Diameter and condition of street and park ash trees in

Tree Conditions	Diameter class (inches)					Total
	0<10	10-25	26-35	36-50	>50	
Excellent	3	1	1	2	0	7
Good	4	32	16	6	1	59
Fair	2	12	16	2	2	34
Poor	0	12	11	1	0	24
Dead	0	0	0	0	0	0
Total	9	57	44	11	3	124

There are probably another 100-200 ash trees on private properties in West Chester. No inventory was conducted . However, property owners are strongly encouraged to identify ash trees on their property or so appropriate actions can be taken. Contact your Borough Urban Forester for suggested resources for assistance in species identification, inventory, and tree health evaluation.

Management Options

Trees are valuable natural resources in urban communities (Dwyer et al. 1992, Nowak et al. 2002), with compensatory values on shade, air quality, storm water discharge, heating/cooling costs, and aesthetic or property value. With the arrival of EAB, all communities will be forced to respond to the infestations in some degree, regardless of the strategies they choose to adopt. Dead trees on streets and in community parks present real threats to public safety. Removing ash from the local ecosystem will permanently alter the natural habitats for related species. Sudden changes in urban canopy cover may result in negative impacts to local communities. Addressing some or all of these concerns requires a well conceived management plan with specific goals and implementable mechanisms.

There are four management options a community can choose from, each with its own pros and cons:

Option A. No Special Actions. The result will be that most ash trees will be killed by the end of the infestation.

Option B. Preemptive Management. In this option, ash trees on streets and in the parks will be removed preemptively and replaced with non-host species. No EAB survey activity will be conducted. As a result, treatment areas will contain no ash trees, with no concerns over EAB in the future either. The initial cost of this option could be very high because of expenses associated with tree removal and replacement. Streets and parks also need to deal with major canopy gaps temporarily at the beginning before replacement trees become well established. However, no annual cost will be incurred after the completion of the project.

Option C. Aggressive Management. In this option, all ash trees in the community will be managed actively with all available management tools. EAB survey activities will be carried out on both roadways, parks and in peoples yards. Information from the surveys will be used to determine proper management actions across the Borough. Chemical control will be actively pursued to protect the maximum portion of ash trees and their canopy. Only dead or dying ash trees will be replaced with non-host species. As a result, most high value ash trees will be saved from EAB damage, whereas a small portion will be replaced with non-host species. Community suffers the least socially and environmentally from the infestation, with less risk of losing urban canopy cover. However, annual cost to the community is the highest among all options.

The Borough of West Chester has selected an Selective Management option:

Option D. Selective Management. In this option, high-value ash trees in selected areas (streets and parks) within the community will be managed actively, whereas those in other private property will be left alone. Ash trees will be monitored for their health and levels of EAB infestation. Chemical control and tree removal will be applied wherever appropriate in a cost-effective manner. Tree replacement (2:1) will be done. As a result, most ash trees in peoples yards will be killed by the end of the infestation, whereas a large portion of high-value ash trees are protected for future generations to enjoy. Monitoring of tree health and for the beetle will be done as needed.

EAB Infestation

EAB has not been found in the Borough of West Chester . Trapping that was begun in 2012 will be continued in the future. Once the EAB arrives (3-5 years) all the ash trees in the parks and on the streets will be intensively surveyed using pest signs and symptoms. A pest status component will be added to routine maintenance and sanitation operations for the Departments of Public Works and Parks & Recreation.

Private citizens will be encouraged to report suspicious pest activities on their ash trees to the Borough Urban Forester (610)-696-6121 and (or) the Pennsylvania Department of Agriculture (866)-253-7189.

Management Approaches

Chemical treatment, tree removal, and replacement of ash trees will begin in 2013.

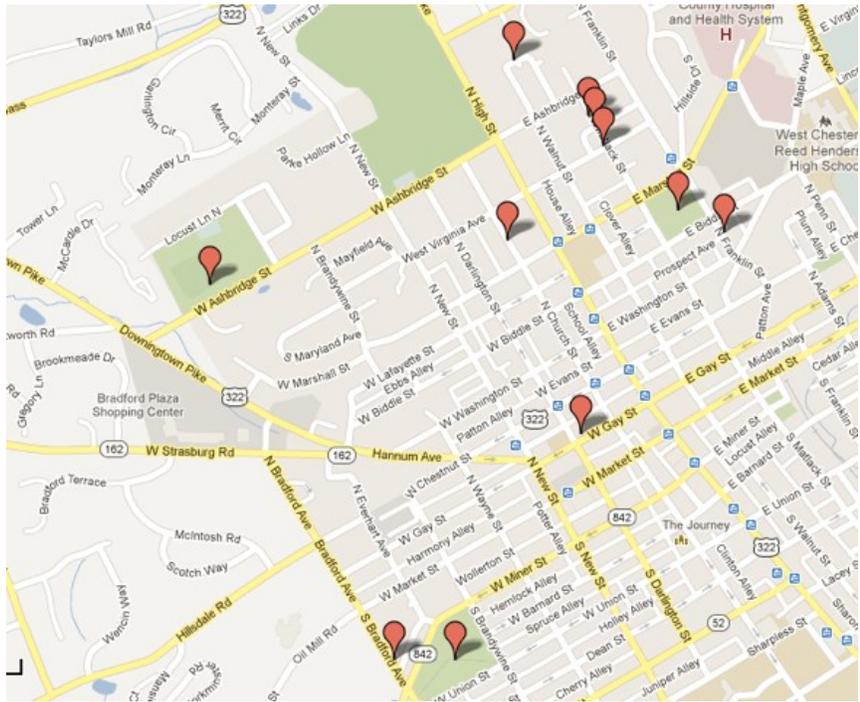
Chemical Treatment

High-value ash trees in the Borough will be treated with Tree-äge (Map 2). A human health and ecological risk assessment was done by the Syracuse Environmental Research Associates, Inc. (http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-23-03b_Emamectin-benzoate.pdf). (Appendix 2). This pesticide provides excellent protection against EAB larval development for 2-3 years with a single application. Trees in excellent and good conditions are considered for this treatment since they are better positioned to survive the pest onslaught. Large diameter trees are favored over small diameter trees as they typically have higher value and provide more benefits to the community. Other factors such as cost, location, logistics, and local support are also considered during the process. A total of 106 trees were selected to receive six treatments for the next 10 years (Table 2) (Appendix 3).

Table 2. Proposed ash trees for chemical treatment in West Chester

Tree Conditions	No. of treated trees by diameter class					<i>Total</i>
	0<10	11-20	21-30	31-40	>41	
Excellent (5)	3	0	2	0	2	7
Good (4)	4	11	20	9	4	48
Fair (3)	2	8	18	8	2	38
Poor (2)	0	4	8	1	0	13
Dead (1)	0	0	0	0	0	0
Total	9	23	48	18	8	106

Map 2. Ash trees in the Borough that will be treated with Tree-äge



Tree Removal

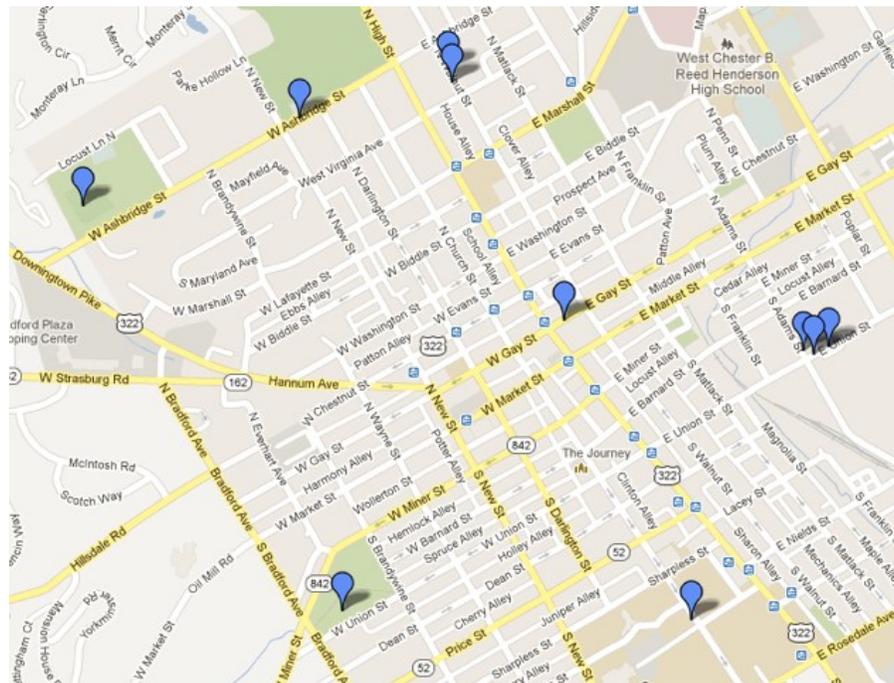
EAB kills 99% of ash trees after several years of infestation. Assuming all untreated ash trees in the Borough will be dead or dying within the next decade, a total of eighteen (18) remaining trees on streets and in parks will need to be removed to protect public safety and reduce liability (Map 3). To accomplish this goal, an average of two (2) trees will be removed each year over the next 10 years. However, preemptive removal of healthy trees is not recommended by this plan. Trees that are dead, or in poor or fair conditions will be selected for removal each year. Removal of other trees that are currently in good or excellent condition in the following years will be determined by Borough staff based on the progression of the infestation at the beginning of each year. Priorities are given to trees in areas where heavy EAB infestations are located, trees with potential high hazard, and trees with small diameters.

Tree removal in the Borough parks will be minimal given the number of ash trees found in those areas. An estimated 18 ash trees (14% of all trees) will need to be cut or removed to reduce human risk in the next 10 years.



Tree removal

Map 3 Locations of the ash trees that are selected for removal each year.



Replanting

All removed ash trees will be replaced for canopy cover in the community. A 1:2 replacement ratio will be used. Temporary reduction of canopy cover is expected in affected streets and parks as replacement trees are usually small and not guaranteed at 100% survival rate. The Borough will work with Arbor Day Foundation, Tree City USA, Tree Vitalize, Master Gardeners, International Society of Arbor Culture, Society of Municipal Arborist, and other nonprofit organizations, and private citizens for the replanting efforts.

Community Outreach

Information about EAB, ash trees, quarantine regulations, tree removal, chemical control, replanting, and other program activities will be disseminated through news conferences, seminars, public hearings, trainings, demonstrations, community events, neighborhood meetings, and awareness campaigns throughout the program period. Interested individuals are encouraged to contact the Borough forester or other administrators for more information.

Ash trees on private properties are the responsibility of the property owners. It's up to the property owner to decide whether he/she wants to treat his/her ash trees, or to remove and replace their hazardous trees. However, Pa Cooperative Extension Service and West Chester University will make the technical staff available to assist property owners on EAB and ash related problems. Contact the Borough forester for details (610) 696-5282 or PA Department of Conservation and Natural Resources (DCNR) (717) 948-3941.

Cost/Benefit Analysis

The total cost for this program is estimated at \$180,799 over 10 years, about 1/3 of the total compensatory value of all ash trees. It is assumed that all management activities will be conducted by contracted commercial companies under Borough supervision, including \$122,340 for chemical treatment, \$31,223 for tree removal, and \$26,176 for replanting. The Borough can choose to pull its resources together and train its staff to carry out all tasks to save money. However, this may result in added costs from new hiring and delay or cancellation of other tasks previously assigned to Borough workers.

Chemical Treatment

A total of six treatments are needed for the project period since Tree-äge is effective against EAB larvae for at least two years (up to three years). The total cost for chemical treatment is estimated at \$122,340 with \$22,488 (2013), \$20,451 (2014), \$18,449 (2016), \$20,859 (2017), \$18,817 (2018), and \$21,276 (2020) for each treatment, respectively (Table 3) (Appendix 4). A public bidding process will be conducted to select a tree care company with the lowest reasonable bid for this activity. The tree injection system will be a one time cost of \$5,100, which will be purchased in year one.



Table 3. Cost of chemical treatment of ash trees in West Chester for 10 years

Year	No. trees	Total DBH (inch) *	Injection System	Chemical Treatment*	Application (Labor)*	Cost (\$)
2013	53	1269	5,100	8,420	9,668	22,488
2014	53	1406	0	9,420	11,031	20,451
2015	0	0	0	0	0	0
2016	53	1322	0	8,588	9,861	18,449
2017	53	1459	0	9,608	11,251	20,859
2018	0	0	0	0	0	0
2019	53	1375	0	8,759	10,058	18,817
2020	53	1512	0	9,800	11,476	21,276
Total						122,340

*2% annual increase in chemical treatment cost is assumed.

Tree Removal

A total of 18 ash trees are street and park trees, will be removed within the next 10 years (2013-2023). About two (2) trees on Borough streets and parks will be removed each year at the cost ranging from \$650 to \$2,000 per year. The total cost of tree removal is estimated at \$31,223 with an average of \$3,122 per year (Table 4)(Appendix 3).

Table 4. Cost of tree removal in West Chester for 10 years (2013-2023) *

Year	Street and Park Trees		<i>Total Cost (US dollars)</i>
	No. trees	Unit Price (\$)	
2013	2	1,600	3,200
2014	2	1,632	3,264
2015	2	1,664	3,328
2016	2	1,697	3,394
2017	2	1,730	3,460
2018	2	1,764	3,528
2019	2	1,799	3,598
2020	2	1,835	3,670
2021	1	1,872	1,872
2022	1	1,909	1,909
Total	18		31,223

* 2% annual increase in removal cost is assumed.

Replanting

A total of 36 trees will be replanted with non-host species to replace the lost ash trees, with a total cost of \$ 26,176 over 10 years, ranging from \$670.00 to \$1,340.00 per year (Table 5) (Appendix 3). Re-planting cost includes cost of two (2) ball and burl and labor (e.g. \$130 for 2 ball and burl and \$540 for labor in 2013).

Table 5. Cost of replanting in West Chester for 10 years (2013-2023)

Year	No. trees	Average DBH (inch)	Unit price (\$) *	<i>Cost (\$)</i>
2013	4	2-3	670	2,680
2014	4	2-3	683	2,732
2015	4	2-3	697	2,788
2016	4	2-3	711	2,844
2017	4	2-3	725	2,900
2018	4	2-3	740	2,960
2019	4	2-3	755	3,020
2020	4	2-3	770	3,080
2021	2	2-3	785	1,570
2022	2	2-3	801	1,602
Total	36			26,176

* 2% annual increase in replanting cost is assumed.

Fiscal Planning

To support the EAB management plan, the Borough of West Chester will create a new line item in its budget for this program, with an estimated annual cost of \$3,442 to \$29,368 (Table 6)(Appendix 4). The Borough will aggressively explore potential cost saving measures such as public bidding and auction, in house absorption and service, corporate and private donations, volunteering, etc. to lower the fiscal burden. In addition, the Borough will work diligently with federal, state, and local government agencies, organizations, and institutions to secure awards and grants to fund a portion or an entire project in chemical treatment, tree removal, or replanting.

Table 6. Annual cost of West Chester EAB management plan for 10 years 2013-2023)

Year	Chemical treatment	Tree removal	Replanting	<i>Total</i>
2013	22,488	3,200	2,680	29,368
2014	20,451	3,264	2,732	26,447
2015	0	3,328	2,788	6,116
2016	18,449	3,394	2,844	24,687
2017	20,859	3,460	2,900	27,219
2018	0	3,528	2,960	6,488
2019	18,817	3,598	3,020	25,495
2020	21,276	3,670	3,080	28,026
2021	0	1,872	1,570	3,442
2022	0	1,909	1,602	3,511
Total	122,340	31,223	26,176	180,799

Time Table

A 10-year time table is developed to specify program objectives and procedures for each year. Activities such as tree inventory, EAB monitoring, chemical treatment, tree removal, replanting, efficacy evaluation, etc. will be included. Necessary adjustments will be made at the beginning of each year to reflect the changes of the field situation.

Data Collection & Reporting

All data from the program are collected according to established guidelines and entered electronically into a centralized database. Status reports are required for all aspects of the program. An annual report is used to summarize the progress of the program for the current year. A final report will be issued by the end of the program.

Contacts and Information

Pennsylvania Department of Conservation and Natural Resources (www.dcnr.state.pa.us/forestry/fpm_invasives_EAB.aspx)

Pennsylvania Department of Agriculture EAB hotline: 1-866-253-7189 or Badbug@state.pa.us

Pennsylvania State University Extension
(<http://ento.psu.edu/extension/trees-shrubs/emerald-ash-borer>)

Emerald Ash Borer (www.emeraldashborer.info)

USDA APHIS
(http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/regulatory.shtml)

USDA Forest Service (<http://na.fs.fed.us/fhp/eab/>)

i-Tree - Tools for Assessing and Managing Community Forests (<http://www.itreetools.org/>)

TreeVitalize - A partnership to restore tree cover in Pa. communities
(<http://treevitalize.net/TreeCare/SelectingTrees.aspx>)

EAB Cost Calculator (<http://extension.entm.purdue.edu/treecomputer/index.php>)

National Tree Benefit Calculator (<http://extension.entm.purdue.edu/treecomputer/index.php>)

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Kovacs, K.F., Height, R.G., McCullough, D.G., Mercader, R.J., Siegert, N.W., and Liebhold, A.M. 2010. Cost of potential emerald ash borer damage in U. S. communities, 2009-2019. *Ecological Economics* 69: 569-578.

Nowak, D.J., Crane, D.E., and Dwyer, J.F. 2002. Compensatory value of urban trees in the United States. *Journal of Arboriculture* 28: 194-199.

Acknowledgment

We would like to acknowledge and extend my heartfelt gratitude to the following persons who have made the completion of the Emerald Ash Borer Management Plan possible:

Our Mayor, Carolyn T. Comitta for her vital encouragement and support.

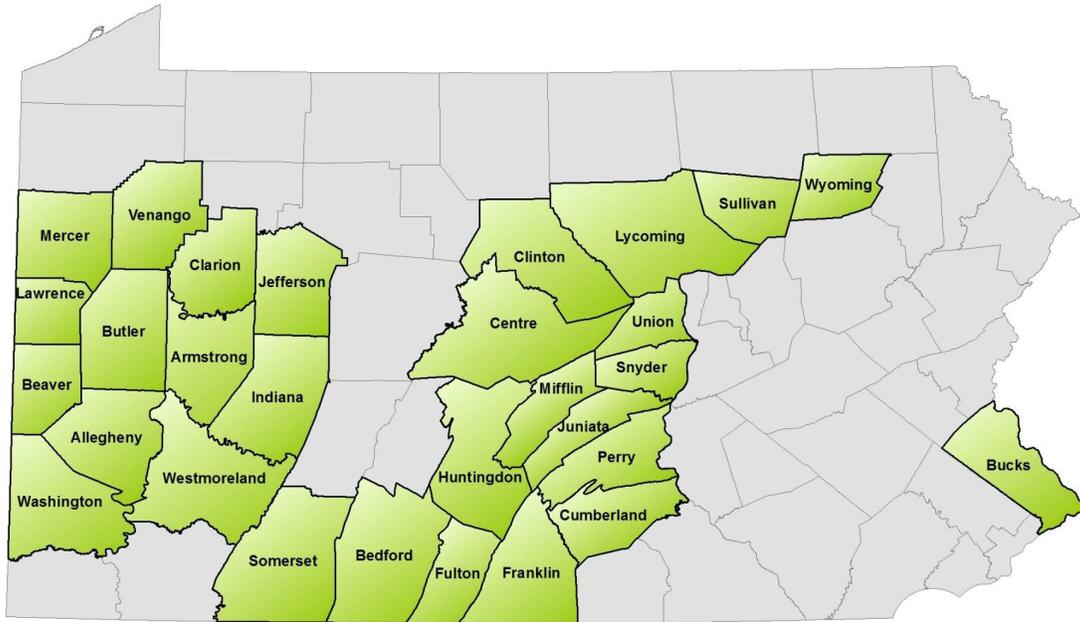
President Greg Weisenstein and Dean Lori Vermeulen for making us available for this project.

Delchester Tree for maintaining and keeping the Borough of West Chester ash trees healthy.

Donald Eggen Forest Health Manager, Department of Conservation and Natural Resources for his understanding and assistance.

Appendix

1– Emerald As Borer Distribution Map in Pennsylvania (Aug 2012)



Appendix– 2

General Considerations

Emamectin benzoate is used for control of the emerald ash borer (*Agrilus planipennis* Fairmaire, commonly abbreviated as EAB), an insect pest of ash trees (*Fraxinus spp.*). This document provides human health and ecological risk assessments to support an assessment of the environmental consequences of using this pesticide in Forest Service programs. Emamectin benzoate is an insecticide that acts by adversely affecting the nervous system. This insecticide is registered for national use on a variety of agricultural commodities. The anticipated uses of emamectin benzoate in Forest Service programs is limited to one formulation of emamectin benzoate, Tree-äge, and one application method, tree injection. Relatively little information is available on the transport of emamectin benzoate in trees following tree injection and uncertainties with the movement of emamectin benzoate in ash trees following tree injection is a dominant factor in the current Forest Service risk assessment in terms of adequately assessing exposures to humans and other nontarget species.

Human Health

In terms of potential human health effects, the most plausible exposure scenarios are those for workers applying emamectin benzoate in a manner that is consistent with labeled directions including the proper use of chemical resistant gloves. If workers handle emamectin benzoate with care and effectively use chemical resistant gloves, no substantial or significant risks to workers are anticipated. If workers fail to effectively use chemical resistant gloves or if workers do not effectively and rapidly respond to accidental exposures, adverse effects in workers, possibly including degenerative changes in nerve tissue, could occur.

Substantial exposures to members of the general public do not appear to be plausible although quantitative estimates of expected exposures and hence quantitative estimates of risks cannot be developed at this time. Based on accidental exposure scenarios associated with the spill of emamectin benzoate into a pond, the central estimates of hazard quotients are below the level of concern (HQ=1). The upper bound estimates of the hazard quotients range from 0.6 to 3. The inability to estimate exposures to members of the general public associated with the normal and expected use of emamectin benzoate – i.e., injection into ash trees – is a serious limitation in this risk assessment. Nonetheless, the upper bound HQ for all of the accidental exposure scenarios is only 3. Thus, in the normal use of emamectin benzoate, about one-third of the emamectin benzoate that is injected into an ash tree would need to be transported to surface water in order for the HQs associated with non-accidental exposures to reach a level of concern. It does not seem reasonable to assert that this level of exposure would or could occur.

Continue Appendix 2- Ecological Effects

As with the human health risk assessment, the ecological risk assessment for emamectin benzoate is dominated by uncertainties in the exposure assessment. Because of limited information on the transport of emamectin benzoate in trees following tree injection and the lack of information on the transport of emamectin benzoate in ash trees, reliable estimates of exposures in nontarget species associated with the injection of emamectin benzoate into ash trees cannot be made. The inability to estimate expected exposures of nontarget species limits confidence in the risk characterization for nontarget species.

Uncertainties in the exposure assessments associated with the potential contamination of surface water in the normal use of emamectin benzoate for the injection of ash trees is addressed with an accidental spill scenario. Based on the accidental spill scenario, no risks are apparent for mammals, birds, fish, aquatic plants, or tolerant species of aquatic invertebrates. The lack of risk in the accidental spill scenarios for these groups of organisms suggests that the contamination of surface water associated with the normal use of emamectin benzoate to inject ash trees is not likely to adversely impact these organisms. Risks to sensitive species of aquatic invertebrates, however, are apparent in the accidental spill scenario with an upper bound HQ of 120. Thus, in the event of an accidental spill of a significant amount of emamectin benzoate into a pond, adverse effects including mortality could be anticipated. The high hazard quotients for sensitive species of aquatic invertebrates associated with the accidental spill scenario also prevent a clear risk characterization for this group of organisms in the normal use of emamectin benzoate. At least in situations in which high doses of emamectin benzoate are used or a relatively large number of trees are treated near surface water, risks to sensitive species of aquatic invertebrates can neither be discounted nor characterized clearly.

While uncertainties associated with contaminated surface water can be addressed reasonably well, other exposure pathways are problematic. The most likely exposures for mammals or birds involve the consumption of bark, stem tissue, or seeds of ash trees as well as the consumption of herbivorous insects that may feed on ash leaves. Only the pathway involving the consumption of herbivorous insects is developed quantitatively. Under worst-case exposure assumptions, risks to mammals are marginal (an upper bound HQ of 1.1) and risks to birds are negligible (an upper bound HQ of 0.03). For herbivorous insects, however, the risk characterization is well-defined. Both tolerant and sensitive species or populations of herbivorous insects are likely to be adversely affected if they feed on ash trees injected with effective doses of emamectin benzoate.

While the risk characterization for emamectin benzoate is dominated by uncertainties in the exposure assessments, it is worth noting that the most relevant toxicity studies on aquatic organisms and birds are limited to relatively standard bioassays on relatively few species of organisms compared to other more fully studied pesticides. In addition, no data are available on reptiles, amphibians, or soil invertebrates.