



Creating Sustainable Community Parks and Landscapes

*A Guide to Improving Quality of Life by
Protecting Natural Resources*

2ND EDITION



pennsylvania
DEPARTMENT OF CONSERVATION
AND NATURAL RESOURCES

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Photo credits can be found on page 95.

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The first edition of “Creating Sustainable Community Parks” was released in 2007. While only a few years have passed, the ideas and technologies for being more environmentally-friendly, sustainable and “green” have made leaps and bounds since then. As budgets get tighter, as staffing is reduced, as the pressure to do more with less becomes stronger—that is when the importance of sustainability becomes even more obvious. While there is no guarantee that the tools and ideas outlined in this book will save land managers time or money, evidence shows that in many cases sustainable land management can do just that. The case studies in Chapter 6 will show you just a few of the many ways to do so.

Since the release of the first edition, the Department of Conservation and Natural Resources (DCNR) has been involved in numerous sustainability initiatives to raise awareness about the importance of balancing human needs with natural resource protection: a conference on sustainable parks was held at DeSales University; a conference on sustainable landscapes took place at The Milton Hershey School; another conference is planned for the fall of 2010 at Marywood University; a sustainable landscapes bus tour will travel through the Lehigh Valley in the spring of 2010; a brochure for conservation industrial parks was developed; and “green” criteria were added to the DCNR grant program. Information about these and other sustainable initiatives can be found at www.dcnr.state.pa.us/sust-lands/index.aspx.

We hope that you continue to find the information in this edition useful and that you will be able to implement some of the ideas on your lands. Sustainability is an important concept for all living beings and we can each do our part to improve the quality of life for all. For as Betty Morrow writes, “It can be argued that it is only when economic growth, environmental protection and social equity overlap that we achieve sustainability.”ⁱ

i - Morrow, Betty. *Community Resilience: A Social Justice Perspective*, CARRI Research Report 4, September 2008, www.resilientus.org/library/FINAL_MORROW_9-25-08_1223482348.pdf



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Introduction

In too many instances, parks, shopping centers, housing developments and other landscapes provide barren vistas of mowed turf grass, ornamental trees and pavement. Little thought is given to incorporating a more naturalistic setting into the design. A majority of survey respondents in the 2009 State Comprehensive Outdoor Recreation Plan (SCORP) responded that, “There is still not enough protected open space near where I live,”¹ and that they desire the opportunity to be outdoors more frequently. Research done at the Human-Environment Research Laboratory at the University of Illinois Urbana-Champaign has shown that more trees, wild-flowers, and other greenery in a neighborhood promotes a multitude of community and individual benefits. These benefits range from lower crime rates to stronger social ties, positive effects on health and higher test scores in children. The environmental benefits that come from an increase in trees, wildflowers and other native vegetation are also numerous: reduced flooding and erosion, air pollution filtration, air cooling and protection of biodiversity, to name a few. Sustainable development, which incorporates more native greenery along with other environmental considerations, improves the quality of life for the present without compromising the ability of future generations to meet their needs.² A shift from



Turfgrass is the most abundant plant in many landscapes



Here is the same view after a sustainability makeover

the traditional grass and pavement landscapes that we are familiar with, to sustainable landscapes, not only improves the quality of the natural environment, but also directly benefits people and communities.

By devoting more attention to the natural resources in the design of different land uses, the livability of our towns and municipalities will be enhanced. Sustainable land management may also help reduce some of the potential negative impacts of climate change: more native vegetation near buildings can reduce air conditioning costs, while trees along streams can reduce flooding impacts.

This guidebook was created to outline the benefits of enhancing the natural resources in local parks and other landscapes, to maintain these areas in a sustainable manner, and to provide a step-by-step guide to help staff and volunteers achieve those results. What does it mean to enhance natural resources? Well, everyone has a slightly different definition of nature. It can range from parks to backyard gardens to fields and forests. Nature can be small or large, nearby or far away, and can be closely managed or left to fend for itself. None of these is right or wrong, because all types of natural settings are beneficial to our quality of life.³ Enhancing natural resources and creating sustainable landscapes means that the flora, fauna and the habitats (including the area’s geology) they inhabit will be managed in a manner that protects them from disturbances.

This guidebook is directed primarily towards those charged with the design and maintenance of parklands, retail centers, housing developments, industrial parks, schools and other land uses, although the principles outlined in the book could also be used by individual homeowners.



This guidebook is broken into six chapters, each of which highlights a step in the process of creating a new sustainable landscape, or enhancing an existing land use, so that the design and maintenance of the area is more environmentally focused.

- ♦ Chapter 1 highlights the impacts of traditional landscapes on the environment, and contrasts the economic, environmental and health benefits of a sustainable landscape.
- ♦ Chapter 2 defines “sustainable community park” and “sustainable landscape,” as well as the elements that are needed to create them. These include “environmentally friendly” landscaping principles, attracting wildlife, protecting water resources, the differences between native and invasive species and balancing human uses with conservation. **New to this edition** are sections on soil compaction, indoor air quality, an enhanced section on riparian buffers and other natural stormwater management methods and updated invasive species information.
- ♦ Chapter 3 is the design guide. It provides information for people wishing to change just one or a few aspects of their land, to those who wish for a complete landscape makeover. **New to this edition** are sections on model ordinances, the Green Building Council’s Leadership in Energy and Environmental Design (LEED) certification program, Low Impact Development (LID), the Sustainable Sites Initiative and information on how climate change may impact the way we design buildings and landscapes.
- ♦ Chapter 4 is the maintenance guide. This Chapter covers the necessary steps to a healthy landscape and ways to promote human well-being through an environmentally friendly building environment. **New to this edition** are updated sections on tree shelters, pruning, goose management and prescribed burning.
- ♦ Chapter 5 involves a key piece of the puzzle: education. Making these sometimes drastic changes to an area will require buy-in from the public and staff. This chapter outlines the public relations campaigns, educational materials and programs, use of volunteers and training that can be used to make the landscape’s transition much more appealing. **New to this edition** is a section on environmental justice and the role it plays in creating and maintaining sustainable community parks and landscapes.
- ♦ Chapter 6 provides **six new case studies** of landscapes in Pennsylvania that have successfully incorporated natural resource conservation and sustainability into their design and maintenance practices. These examples can provide ideas and inspiration for others wishing to make similar changes. The examples include Spring Grove High School, the U.S. headquarters of the Bayer Corporation, Triangle Park, Pennsburg Nature Preserve, The Village at Springbrook and Flourtown Country Club.

At the end of the guidebook are six appendices full of useful information. Appendix 1, **new to this edition**, provides a list of grants and other funding sources for habitat restoration, invasive plant control work, community revitalization, energy efficiency projects, environmental education and more. Appendix 2 provides an updated map of the plant hardiness zones in Pennsylvania. Appendix 3 provides a list of native plants that can be used to enhance the wildlife habitat and aesthetic quality. Appendix 4 lists those invasive plants that should not be used, and should be removed if they are already present. Appendix 5 provides an updated list of valuable Internet resources and publications that will supplement the information presented in this guidebook. Appendix 6 provides a list of photo credits for this publication.



Costs of Traditional Land Use Design and Maintenance

When people think of an area like their local park, the images that come to mind probably include ball fields, playgrounds, grassy areas and perhaps a few trees. While these places offer benefits to residents, such as exercise opportunities and a place to relax, they offer limited value to the environment, and can in fact degrade the local ecosystem through the maintenance practices that are used to keep everything green and tidy. The same may hold true for many residential developments, shopping plazas and industrial parks. The problems with maintaining these land uses with traditional methods are numerous. Maintenance can be very labor and resource intensive, thus costly. As stated in *The Excellent City Park*

System: What Makes it Great and How to Get There by Peter Harnik, “It is so much more expensive to create and operate ‘designed’ landscapes (constructed parks and landscapes that are mowed or regularly cleaned up) than natural landscapes (those which are left alone, except for the occasional trail).”⁴

The turfgrass that dominates most parks, yards and highway medians can require frequent mowing, raking, irrigation and periodic applications of chemical fertilizers and pesticides. The use of gasoline and diesel powered lawn equipment contributes to air pollution, sometimes of a greater magnitude than automobiles since the mowers lack the same emission controls that have been placed on autos. The use of this equipment contributes to smog conditions and ozone warnings, not to mention plays a large role in creating carbon dioxide that contributes to global climate change. Grass is typically mowed to the edge of ponds and streams, which can leave the bank unstable and foster a habitat highly suited towards nuisance geese. Even the noise from the mowers can disturb nesting wildlife.

“A flat patch of grass may be perfect for organized sports, but not for unstructured or natural play.”

-From *Last Child in the Woods*, by Richard Louv

When irrigation is used, the excess water travels over hard surfaces like pavement and can carry away fertilizers that could promote the growth of algae and invasive plant species. When pesticides are improperly used or disposed of, any excess pesticide could potentially reach drinking water supplies and could harm native plants and animals.

In addition to maintenance practices, the design of these areas is not always helpful to conserving and enhancing the natural environment. Roads and parking lots fragment habitats. Plants are chosen for their looks rather than their wildlife benefits, and human uses like recreation and industry can

degrade or eliminate habitat for most animal and plant species. Furthermore, a site’s geology and soils may not naturally support the chosen plants. So as development pressures rise, wildlife have nowhere to go, with all the turf yards, shopping plaza

parking lots and freeways taking up all available habitat, creating an unbalanced landscape.

This guidebook is certainly not advocating for an end to all land use development, but rather tries to encourage developers, landscape architects and planners to incorporate more wildlife habitat, natural resource protection efforts and environmentally

sustainable building and maintenance practices into their designs so that parks and other built landscapes work with their natural surroundings.



**Wildflower meadow at
The Milton Hershey School**



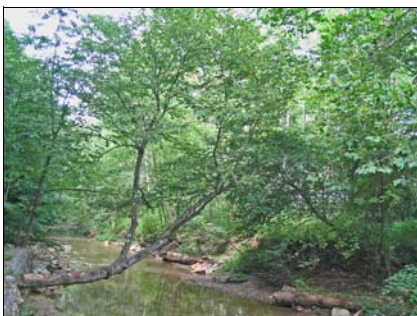
Benefits of Sustainable Community Parks and Landscapes

A sustainable community park or landscape, for the purposes of this guidebook, is one where the natural resources are protected, where wildlife habitat is improved and where human uses and maintenance practices do not harm the environment. Native vegetation is used whenever possible, and the use of turfgrass is minimized. Maintenance practices are chosen to reduce their impact on the environment, while at the same time save money. Landscapes that are managed to enhance natural resources and that use sustainable practices have been shown to have numerous benefits, some of which are highlighted below.

Economic Benefits

Native vegetation can provide flood control and storm water benefits by absorbing and storing precipitation. They can also store pollutants in their roots and stems, instead of allowing the pollution to end up in streams and lakes. Run-off, which is water that flows over the land into ponds and streams, can lead to flooding, which in turn may lead to property damage. The more native vegetation left onsite, the lower the volume of run-off and likelihood of flooding.

In areas with large amounts of vegetation like parks and forests, the rate of run-off is estimated to be just 10 to 20 percent. Compare that to areas with large areas of hard surfaces like roads and



Riparian buffer at Duff Park

rooftops, where the rate of runoff is 60 to 70 percent. The more native plants in an area, the greater the protection against flooding and water pollution.⁵

Landscapes are more than just pretty views. They can provide economic benefits and create more appealing places to live

Developing sustainable parks, shopping plazas and industrial parks in urban areas can help revitalize failing or threatened commercial areas, thus bringing in revenues vital to a city's success.

According to the Brookings Institution report, *Back to Prosperity: A Competitive Agenda for Renewing Pennsylvania*,⁶ the Commonwealth is suffering from an out-migration of our young and highly skilled workers. These "knowledge workers" prefer places with lots of greenery and outdoor activities, from trails to rock climbing.

Improving the sustainability of our lands can help attract and retain these "knowledge workers" who will then put money back into the economy through investments in housing, consumer goods and taxes.⁷ Improvements to parks and other green spaces may also increase tourism,⁸ an industry sector that contributes significant revenues to the Commonwealth, and is expected to increase over the years.

Environmental Benefits

The biodiversity, or the variety of living things, in a municipality depends in large part on the quality of parks, forests, backyards and farmlands. When these areas are designed to minimize fragmentation from roads, and link to other green spaces, they are more capable of benefiting people, wildlife, environmental quality and the economy. Many species of wildlife need large tracts of land to find food, shelter and mates. Linked sustainable landscapes would provide pathways for wildlife moving from one area to the next, particularly in places where development pressures are high. Integrating parks, housing developments and other land uses with riparian corridors, wetlands and other natural areas will benefit wildlife and people throughout the Commonwealth.



As was mentioned previously, increasing the number of native plants in an area, where they can be supported by the geology and soils, would help prevent flooding events that can damage stream and rivers banks and destroy wildlife habitat. With the potential threat of increased flooding from climate change, this benefit is now more important than ever. According to the US Forest Service, just one tree can generate \$31,250 worth of oxygen, provide \$62,000 worth of air pollution control, recycle \$37,500 worth of water and control \$31,250 worth of soil erosion over a 50-year lifespan.⁹ So planting more native trees and other vegetation in a sustainable landscape can protect and enhance environmental quality, particularly when combined with the maintenance practices outlined in Chapter 4.

Health and Safety Benefits

Scientists at the University of Illinois¹⁰ have discovered that time spent in nature relieves mental fatigue and the feelings of violence and aggression that can spring from it. Two groups of young adults were studied; one that took a walk through a nature reserve, the other took a walk through an urban setting. Performance on tests improved in the nature group, and they expressed less feelings of anger than the urban group. These observations can be seen closer to home, as well. A survey done for the 2009 Comprehensive Outdoor Recreation Plan (SCORP) found that over 80 percent of respondents visit parks to reduce stress and anxiety.¹ Nearly everyone experiences mental fatigue now and then, and natural settings can provide great activities to relieve this fatigue.

Natural resources provide many “activities” that require little to no effort, yet provide ways to restore a person’s health and mental well-being: viewing fall foliage, gazing at the clouds and watching squirrels climb trees. These are not “passive” activities, as some might consider them.

**Roughly half as many
quality-of-life crimes
were reported in areas
with high amounts of
vegetation**

They are active recreational activities in that they actively engage the mind. We all need to feel “away” at times, and areas that focus on natural resources and sustainability can provide that.

Researchers from the University of Illinois also found that areas with many trees, wildflowers and other vegetation help neighbors form social ties that create stronger, safer neighborhoods. The researchers found that roughly half as many quality-of-life crimes were reported in urban areas

with high amounts of vegetation. These crimes include littering, graffiti and disruptive neighbors. Over 80 percent of SCORP survey respondents agree that “the availability of local recreation programs reduce youth crime.”¹

The creation of new parks, or the enhancement of existing parks, and the addition of trees to a streetscape, are some of the quickest and most effective ways local politicians can improve the image of their community.¹¹

The richer and more diverse a landscape is, the richer the learning opportunities can be for children. Particularly for children in urban areas, parks and schoolyards not only offer opportunities for healthy physical activity, but also provide a connection with the natural world. Recent scientific studies have demonstrated that natural areas have positive health impacts on development issues, particularly behavioral disorders like attention deficit hyper-activity disorder (ADHD).¹²

Health studies have also shown that contact with nature offers a range of medical benefits such as lower blood pressure and cholesterol levels.²



**A state park educator with
a budding naturalist**



According to the University of Washington's Center for Urban Horticulture, a mature tree canopy can reduce air temperature by five to ten degrees, while the addition of blacktop and other hard, non-porous surfaces contribute to higher temperatures. The evaporation from one large tree can produce the same cooling effect of 10 room-size air conditioners operating 24 hours a day.⁹ Considering that more people die in summer hot spells than all other U.S. weather events combined, the public health benefits of increased native trees and other greenery in our landscapes, particularly when combined with a reduction in hard paved surfaces, is staggering. When you think about the possible negative impacts that climate change may bring—hotter temperatures, more unpredictable weather events—combined with rising energy costs, the importance of trees and their cooling effects become even more pronounced.

For instance, trees and other plants can retain carbon in their roots, stems and leaves, removing it from the environment where it may contribute to climate change. This is referred to as terrestrial carbon sequestration. It has been estimated that roughly 15 percent of total U.S. carbon dioxide emissions from the energy, transportation and other sectors are offset by the net sequestration by forests, urban trees and agricultural soils.¹³ In addition, trees have the capacity to remove pollutants like sulfur dioxide and nitrogen from the air, thus reducing the incidences of asthma and other respiratory diseases.

In summary, sustainable landscapes not only have tremendous value for the environment and wildlife habitat, but also for human health, safety and the state of the economy. When creating new, or enhancing old parks, housing developments and other landscapes, focusing more attention towards natural resource conservation and sustainability is a step that can improve the quality of life for everyone in a community.

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The traditional landscape typically consists of turfgrass, with a few trees, shrubs and flowers interspersed throughout. The layout and maintenance of these areas offers limited habitat for wildlife, may require considerable inputs of water and nutrients to maintain, and can contribute to various forms of environmental degradation. Sustainable landscapes, on the other hand, focus on creating an environment that is beneficial for both human uses and natural resource conservation in both the short and long-terms. Ideally, it is in harmony with the entire environment, both above ground and beneath the vegetation and soils. More attention is focused on selecting appropriate native plants, on minimizing human impacts on the environment, and on selecting other methods that will preserve the community's natural resources and character and improve overall quality of life. Chapter 2 outlines the various components that make up a sustainable landscape, from identifying the area's natural resources to managing for better wildlife habitat.

Principles of Sustainable Community Park and Landscape Design

This section is a quick reference guide for someone wishing to create a sustainable community park or landscape. The following 12 suggestions highlight various principles to consider when designing and landscaping in a sustainable manner. Each suggestion could be used separately for an area that has a modest budget and staff, or the suggestions can be combined to create a landscape that protects and enhances all of its natural resources while still providing for human uses.

1. Retain as much of the pre-existing landscape as possible during new construction, including the soil, rocks, native vegetation, wetlands and contours. This will minimize disturbances, which can open up an area to invasive species. It can also keep costs down, as fewer new plants, soil amendments and habitat enhancements will be needed.
2. Maintain high quality soils that will hold water and supply plants with proper nutrients. During construction, leave as much existing topsoil as possible. When new soil is brought in, ensure that it is certified weed free, in order to prevent the spread of new invasive species. Using compost and other natural products for mulch and fertilizer will help enhance the soil and feed the native plants. Good quality soil will reduce the need for fertilizers and supplemental watering.
3. Connect new landscape components with the surrounding native vegetation to create larger contiguous areas of habitat. Many wildlife species need large ranges to find adequate food, mates and shelter. By reducing the amount of roads, parking lots and turf areas, or by placing these together, habitat quality will be enhanced.
4. Create natural storm water management systems and other green infrastructure, such as rain gardens and swales with native grasses. These systems help to minimize downstream flooding, recharge and filter groundwater and are more cost-effective and environmentally-sound than man-made systems of pipes and storage tanks.
5. Protect wetlands from disturbance and fill. Avoid placing construction projects, active recreation areas and roads or parking lots near or in wetlands. Natural wetlands provide many benefits to the environment that cannot easily be duplicated with man-made ones.
6. Use integrated pest management (IPM) strategies to minimize the use of chemical pesticides to control plant and insect pests. IPM is an ecologically-based approach to pest control that helps maintain strong and healthy plants. IPM can include the use of traps, sterile male pests and quarantines.



7. Minimize non-porous surfaces like roads, parking lots and paved trails. Consider replacing asphalt and concrete with porous pavement, mulch paths, gravel lots and native vegetation. Porous surfaces help to recharge ground water, reduce erosion, lessen flooding events and filter out pollutants. When non-porous surfaces must be used, arrange them in an area where they will not fragment habitat, make them as small in area as possible, and keep them far away from water bodies.



Porous concrete paving at Villanova University

8. Use green building practices in new and retrofit construction projects. This may include renewable lighting and HVAC sources, low-flow toilets, motion-sensors on lights and recycled-content carpets, walls and ceiling panels. Green buildings are not only economically smart, they also may be healthier for the people that live, work and spend time inside.
9. Reduce turf to only those areas essential for recreational and other human use activities. Turf offers little habitat benefit and is not as effective as many native plants in pollution filtration, flood prevention and erosion control. In addition, turf maintenance can have negative impacts on the surrounding environment and can require lots of mowing, watering and fertilizing. Replace non-native turfgrasses with native warm season grasses, which, once they are established, have lower maintenance needs.
10. If you must have some turfgrass, follow these guidelines: mow early in the morning or late evening, mow high (3 inches), never remove more than 1/3 of the grass blade at a time, leave the grass clippings on the lawn as a natural source of fertilizer and moisture-retention, and choose a native turf grass variety.
11. Use native plants, especially trees, in riparian buffers around any stream, lake, or wetland. Riparian buffers help to filter pollutants before they reach water bodies, and the vegetation discourages nuisance geese from staying in the area. Roots from riparian forests also prevent erosion of soils into the water body and minimize flooding events. Shade from these buffers acts as a temperature control for the water body, which enhances habitat value for aquatic organisms. The food and shelter values of these buffers also enhances habitat. By selecting the right kinds of plants, the scenic views of the water bodies can be enhanced.
12. Identify and remove invasive plant species whenever possible. Invasive plants have a number of detrimental effects on natural habitats. Most invasive plants grow so densely and spread so rapidly that native vegetation is choked out. Appendix 4 lists some invasive plant species in Pennsylvania.



Japanese barberry dominates the forest understorey at Hickory Run State Park campground



Enhancing Wildlife Habitat

Pennsylvania has a wealth of wildlife ranging from black bears and Jefferson salamanders to gray squirrels and northern cardinals. Various land uses can protect the Commonwealth's wide variety of animal species by enhancing existing habitats, and creating new ones. This will open up many opportunities for wildlife viewing, bird watching and other outdoor activities.

In order to attract and retain wildlife, it is important to meet the **four basic needs of all wildlife**, which are described below. For further information on attracting wildlife, visit the Audubon Society's *Audubon at Home* program website at <http://audubonathome.org>.

1. Food

Native plants that include one or more of the following will provide valuable food for wildlife; fruits like berries and crab-apples, seeds such as nuts or acorns, and nectar from flowers. The color of the flower can determine what types of birds and insects might appear. For instance, hummingbirds prefer red and orange flowers, while butterflies are attracted to yellow, purple, blue or pink.¹⁴ See the text box on the right for more information on attracting butterflies.

Some examples of native plants that provide food for wildlife include white pine, oak species, dogwoods, big and little bluestem grasses and New England aster. A list of additional native plants with wildlife benefits can be found in Appendix 3.



New England Aster

2. Water

Landscapes that contain lakes, ponds, streams or other water bodies have a preexisting water source for wildlife. These areas can be made more attractive to wildlife if riparian buffers, particularly ones made up of a variety of native tree species, are created around them. For areas without obvious sources of water, man-made ponds and wetlands could be created, or birdbaths could be utilized, in order to provide this necessity to the local wildlife.

Butterflies of Pennsylvania

There are approximately 149 different species of butterflies in Pennsylvania. Many people enjoy the added color and movement that butterflies can bring.

The first step in attracting butterflies to a landscape is figuring out which types live in the area, and choosing the right plants for those butterflies. For more information, visit www.butterfliesandmoths.org.

Caterpillars, the juvenile form of butterflies, typically eat plant leaves, while adults tend to drink flower nectar. You will need to include food and water sources for both life stages in order to have a successful butterfly garden.

Butterflies also need to stay warm in order to fly. Having a few flat rocks in the garden will provide them with a place to get some sun. The butterflies should also be protected from the wind by some well-placed trees.

Do not use herbicides near butterfly habitat, as it could harm them. Use Integrated Pest Management (IPM) instead. See Chapter 4 for more information.



Brush Piles

Brush piles can be created from a variety of dead woody and herbaceous plant materials. These piles are used for cover by many animals, such as the eastern cottontail rabbit and other small mammals. Birds may use brush piles as perching sites, particularly if food or nesting sites are located nearby. Even reptiles and amphibians could make a brush pile their home if the pile is located near a source of water.

When creating a brush pile, it is best to place the largest materials (pole-sized logs) on the bottom and smaller materials (branches and small shrubs) on the top. This arrangement will slow the rate of the pile's decay and allow small animals to hide underneath the pile.

Place the brush piles near a food source and in an area where natural cover is sparse, like forest and field edges. This will make it more likely that the pile will be used.

3. Cover

Wildlife need places to hide from predators, raise their young and find shelter from harsh weather and temperatures. Standing and downed dead trees (*snags*) of various sizes provide habitat for over 35 species of birds, 20 species of mammals and numerous reptiles, insects and amphibians in the state,¹⁵ so consider leaving some of them in the landscape unless they pose a hazard to property or human safety.

More information on snags can be found in the Penn State Cooperative Extension publication *Dead Wood for Wildlife*, which is available free of charge at county extension offices or online at <http://pubs.cas.psu.edu>.



Eastern cottontail rabbits use brush piles

Brush piles are also an excellent form of wildlife cover (*see the box above*).

A variety of native plant species, with differing foliage heights and arranged as naturally as possible, will provide the best cover for a variety of wildlife species. Nest boxes can be used to supplement natural cover sites and are particularly useful for cavity nesters like Eastern bluebirds and bats.

4. Space

The size of an area needed for food, water and cover will depend on the species of animal. The more a landscape can be left in a natural state, the more wildlife that may be attracted to the area. Human-use areas should be arranged in such a way as to maximize the connectivity between natural habitat areas.

Wildlife corridors are used to connect two undeveloped habitat areas that are isolated from one another. Forming partnerships with nearby counties, townships or municipalities to connect several local parks by a corridor would be a great way to expand wildlife habitat regionally. Wildlife bridges, like the one from central Germany shown below, are another way to ensure that habitats are not fragmented (and to reduce the number of animal-vehicle accidents). Wildlife corridors will become even more important in the future as animals and plants try to shift their habitat range due to climate change.



A wildlife bridge helps animals cross a highway



Conserving and Protecting Water Resources

Maintaining a landscape, whether it is in a park, residential area, shopping plaza or school, can use up large quantities of water. Determining water budgets, a topic that will be described below, can help define sustainability in terms of overall water use and impacts. Water uses can range from irrigating turf fields to filling up swimming pools to flushing toilets. With higher water consumption comes higher water bills and less water available for the natural resources, including the plants and animals. This section offers suggestions on how a sustainable landscape can reduce its water use and preserve water resources in a manner that will be beneficial to humans, wildlife and the environment.

Monitor and Minimize Water Uses

A water budget quantifies all the water flowing into and out of a defined area, such as a watershed or a local park, over a fixed period of time. A water budget looks at precipitation rates, the infiltration of water through the soil – which depends in large part on the amount of non-porous surfaces like roads – evaporation, and the various water users in the area.

A water budget can show how much water will be needed for things like restrooms, drinking fountains and irrigation, versus how much water is available. The amount of water being used will depend on factors such as the efficiency rating of faucets and toilets, the time of year (water use is typically higher in the spring and summer) and a whole host of site-specific conditions. The amount of water available will depend on precipitation rates, groundwater levels and stored water. To learn how to create a water budget, visit <http://waterbudget.sustainablesources.com>.

Knowing the amount of water in an area will help to make decisions on how to use and preserve water resources. A sustainable landscape will ensure that human uses of water do not negatively impact the water available for wildlife, plants and the environment. The use of low-flow toilets, soaker hoses instead of sprinklers for irrigation and checking for leaky pipes can all help reduce water waste. This can not only save money in the long run, but also ensure that water remains available for other water users, including wildlife and plants.

Reuse Water

Another option is to reuse graywater. Graywater is any water that has been used in a home, park or business setting (except from toilets) that can then be reused for things such as irrigation, mixing with herbicides and in commercial toilet flushing. Graywater reuse has many benefits including a reduction in fresh water demands and the cost savings that go with that. There are many strict

Did you know that every day 5 billion gallons of potable water are used to flush toilets?¹⁶

guidelines to follow when using graywater, however. If graywater is to be used for irrigation, it will have to undergo secondary treatment followed by filtration and disinfection. These processes may be cost-prohibitive for a single business, but a collaboration between local businesses or municipalities might make it affordable. Before starting anything, consult the technical guidance and permitting materials available through the Department of Environmental Protection (DEP), www.dep.state.pa.us. To learn more about graywater in general, visit www.graywater.net.

Stormwater may be captured and used for irrigation purposes as well. Rain barrels or cisterns attached to downspouts will collect rainwater from roofs for later use. The EPA estimates that one 55-gallon rain barrel can save homeowners 1300 gallons of water during peak summer months.¹⁷ Reusing this rainwater instead of letting it run into storm drains may also protect the environment; many communities have combined sewer overflows (CSO) that can dump untreated wastewater into streams if flows get too heavy after a storm.



Create and Enhance Riparian Buffers

Riparian buffers are areas of vegetation alongside streams and other bodies of water. Thousands of miles of riparian buffers in Pennsylvania have been degraded or lost over the years, due to development.¹⁸ These losses are damaging to the environment because buffers offer many water quality benefits for people and wildlife. Riparian buffers mitigate floods, recharge groundwater, prevent erosion and sedimentation of the stream, trap pollutants within plant roots and improve aquatic and terrestrial species habitat. This is accomplished in several ways. Riparian buffer plants slow runoff from precipitation and allow it to infiltrate into the soil. This settles out sediment, nutrients and pollution before they can reach the stream.

Forested buffers have the greatest filtration capacity; these buffers can absorb 10 to 15 times more water than turfgrass areas. Studies have also shown a 30 to 90 percent reduction of pollution and excess nutrients in surface and groundwater that have passed through a forested buffer.¹⁹ According to research done by the Stroud Water Research Center (www.stroudcenter.org), forested streams in Eastern Pennsylvania were able to remove 200 to 800 percent more nitrogen pollution than non-forested streams. The trees found in forested buffers also help to regulate the water temperature of a stream by providing shade. The higher the water temperature, the more likely algae and aquatic nuisance plant species are to grow. Dissolved oxygen levels are reduced as temperatures increase, and this can lead to increased mortality of aquatic wildlife. Trees provide leaves and woody debris that are used by aquatic life for food and habitat. Forested streams tend to be wider and slower moving, helping reduce the impacts of flooding downstream.¹⁸

Riparian buffers, especially forested ones, help to prevent floods, reduce erosion, protect water quality and provide wildlife habitat

While trees will provide better shade in riparian areas than grasses and other vegetation, any buffer is better than none at all. Using a combination of trees, warm season grasses and other native vegetation in the riparian buffer will not only protect the water body, but also provide a variety of habitats for both aquatic and terrestrial species. Stroud Water Research Center suggests the use of eight to 10 species in a buffer planting to restore a wide range of stream functions.

The quality of the riparian buffer and its wildlife habitat increases as the size of the buffer increases. Riparian buffers 100 feet wide or greater on each side of the stream are very effective, but buffers under this width will still provide some value to

habitat quality and environmental protection. Buffers with a width of 100 to 300 feet on each side provide the most significant benefits to wildlife, but dedicating that much space may be a challenge. Deciding on the width of the buffer will depend on many factors, including the quality of the water body for human and wildlife uses, the extent of the floodplain, the degree of slope on the banks and the amount of land not already devoted towards some other use. In any case, as much land as possible should be devoted towards the buffer.

Riparian buffers are a new concept to many people, and the appearance of the buffer is something to keep in mind prior to its creation. Care should be taken to ensure that maintenance crews do not accidentally mow or remove plants within the riparian buffer.

Using signs to distinguish a no-mow area from those that can be mowed will help protect it





Visitors to parks and other public areas that have come to expect easy access to the stream will need to be educated on the importance of the riparian buffer. They should also be provided with a few well-marked access points to the water. Otherwise the visitors might see the buffer as a “weedy” nuisance and request that it be mowed down. This occurred in a housing development along the Turkey Run stream in Lower Southampton Township, outside of Philadelphia. Wildflower meadows and no-mow areas were installed to protect the stream from pollutants, which included droppings from hundreds of aggressive geese. An education campaign helped to gain acceptance and buy-in of the buffer from the local residents.²⁰

Federal money may be available to landowners with non-forested streams running through their property for the planting of riparian buffers. The Conservation Reserve Enhancement Program (CREP), managed by the USDA, is a program that rewards landowners for installing conservation practices like forested riparian buffers on their land. It offers up to 100 percent cost-share reimbursement for the installation, annual rent payments and cash incentives. It is a way to protect the environment while making money at the same time. For more information about CREP, call 1-800-941-CREP or visit www.creppa.org.

Protect Wetlands and Critical Recharge Areas

Just like riparian buffers, wetlands have a crucial function in the health of not just aquatic ecosystems, but terrestrial ones as well. Wetlands act as a natural flood control by slowing down storm water. They also recharge groundwater and trap sediment, fertilizers and pollutants before they enter the water cycle. Most of Pennsylvania’s wildlife spends some or all of their life in a wetland environment. And nearly half of all isolated wetlands provide habitat for federally listed species under the Endangered Species Act.²¹

**Since the 1700s
more than half of
Pennsylvania’s
wetlands have
disappeared**

Unfortunately, more than half of Pennsylvania’s wetlands have disappeared since the 1700s because of development, agriculture and habitat degradation. Nowadays, less than two percent of Pennsylvania is covered by wetlands,²⁰ like the seasonal pool shown below. Seasonal pools, also referred to as vernal pools or ponds, are small shallow wetlands that dry up at certain times of the year, making the pools inhospitable for fish but great habitat for many species like Jefferson salamanders and fairy shrimp.



A seasonal pool in northeastern Pennsylvania

Luckily, there are many ways that landowners can protect wetlands. Construction and other forms of disturbance should be avoided in and near wetlands. Filling in or building near a wetland can have negative impacts on the environment, and so, should be avoided at all costs. Keep roads, trails and buildings as far away from wetlands as possible. Another source of protection can come from planting riparian buffers around wetlands.

Sometimes protecting wetlands depends on protecting critical recharge areas. Critical recharge areas are typically large contiguous areas of land that allow precipitation and other surface waters to infiltrate through the soil to recharge the ground-water. Typically 80 percent of precipitation infiltrates through the soils in Pennsylvania, and plants then take more than half of that water up.



The rest of that water feeds wetlands, streams and drinking water aquifers. Without this constant recharge, periods of drought could leave streams and wells dry, thus affecting available drinking water and wildlife habitat.²² An estimated 37 percent of Pennsylvanians get their drinking water from groundwater wells, so it is imperative to protect these critical recharge areas.²³

Developing a sustainable community park or other passive land use in a critical recharge area is one way to ensure that the area is protected from the large areas of hard, non-porous surfaces like pavement and the pollution that can come from traditional forms of development. If your land is located within one of these recharge areas, care should be taken to minimize the use of synthetic fertilizers and pesticides, reduce the amount of roads and parking lots, and increase the area covered by native vegetation, to ensure groundwater protection.

How do you know if your land is located within a critical recharge area? Several factors contribute to an area being designated as such: groundwater is the primary source of water in the area, adequate groundwater flow is required for aquatic organisms in a nearby stream, there is little to no existing groundwater contamination, the area is at risk from development or other land uses and groundwater conditions will remain high quality if protected.²⁴ The underlying geology and soils of the area also play a large part in the effectiveness of precipitation recharging back into the groundwater. To find information on the groundwater and recharge rates in your county, visit, www.dcnr.state.pa.us/topogeo/groundwater/index.aspx

**A vegetated swale
in a residential
subdivision**



Manage Stormwater Naturally

Stormwater is all the water that accumulates from precipitation on land and can include runoff from the built environment (i.e. roofs and roads).

Traditionally this water was treated as a waste product; people wanted to get it off their land as soon as possible. Gray infrastructure was typically used, consisting of drains and underground pipes that send irregular, high velocity water flows into natural bodies of water, along with high loads of sediment and pollutants, which can negatively harm wildlife and their habitat.

Natural stormwater systems, on the other hand, treat this water as a resource, reusing it on-site and letting it trickle into the ground where it can replenish groundwater and remove pollutants.

Natural stormwater management systems can filter out pollutants and increase wildlife habitat

There are several forms of natural stormwater systems, including swales, rain gardens and vegetated detention ponds. A *swale* is a gently sloped vegetated ditch where pollutants are removed from stormwater by filtration through native grasses and other plants (*see photo on left*). Their design lends itself to roadsides and edges of parking lots, where oil, gasoline and salts can be trapped before reaching surface or ground water. Swales are a less expensive alternative than underground stormwater pipes and holding tanks, and they can provide wildlife habitat if the right plants are chosen. Properly maintained swales should drain completely within 24 hours.²⁵ This will reduce mosquito levels, as their eggs take 48 hours in water to hatch.²⁶

Detention ponds are basins that act in a similar manner to swales but typically hold water for a longer amount of time. Both swales and basins should be planted with a variety of native plants to help absorb pollutants, provide habitat, and create an aesthetically-pleasing site. For a list of native Pennsylvania plants that can be used in natural stormwater systems, visit www.dep.state.pa.us/dep/subject/adv coun/stormwater/Manual_DraftJan05/Appendix-B-jan-rev.pdf.



A rain garden is a shallow depression in the ground, filled with sandy soil and planted with deep-rooted native vegetation. The garden is situated in an area where it can receive runoff from hard surfaces like parking lots and sidewalks. The gardens slow down the speed of runoff and hold the water so it can naturally infiltrate into the ground.

Rain gardens, like the one shown on the right, offer many benefits to the environment including the creation of habitat for birds and butterflies, pollution filtration and a decreased need for irrigation. The basic steps to create a rain garden are to (1) pick a location that has suitable soils for infiltration, (2) measure the drainage area, (3) draw a simple design, (4) choose the plants, (5) layout and dig the garden, (6) plant the vegetation, (7) and perform regular maintenance. For more information on creating rain gardens visit www.raingardennetwork.com.

Even just the planting of more trees near roads and parking lots can reduce the need for large, expensive stormwater management systems,



A rain garden helps stormwater infiltrate into the ground

according to the American Forests Urban Resource Center.²⁷ The conservation group American Forests estimates that trees save U.S. cities \$400 billion in the cost of building stormwater retention facilities.²⁸ For further information on stormwater management, visit www.stormwaterauthority.org.

Tips for Natural Stormwater Management Success²⁹

1. **Assess your site.** Look for areas that already have wetlands, wet meadows and forested riparian buffers. Retain those areas whenever possible.
2. **Look for areas where water flows and ponds on its own.** This could occur at the base of a slope, in a ditch or an area with thick vegetation. These are ideal areas for natural stormwater management systems.
3. **Study the soil.** Loamy or sandy soils allow more stormwater to infiltrate into the ground, so areas with these soils are ideal. Areas with clay soils can still be used for stormwater management, they will just take additional steps to ensure infiltration. Compacted soil is not recommended.
4. **Convert turfgrass to native plantings.** Native plants have deeper roots, resulting in better stormwater uptake and filtration. Turfgrass has a low permeability rating so more stormwater runs across its surface, rather than infiltrating through.
5. **Reduce the amount of hard, non-porous surfaces.** Pavement is an enemy to natural stormwater management. No water can infiltrate through. Replace pavement with porous surfacing or native plants (*see next page for more details*).

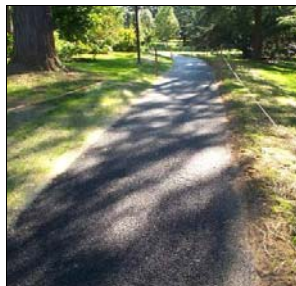


Minimize Hard, Non-Porous Surfaces and Turf Areas

Another way to effectively manage stormwater is to minimize the areas of hard, non-porous surfaces such as roads, rooftops and parking lots. This can be accomplished through narrower roads, porous pavements and rainwater catchment systems on roofs. Non-porous surfaces do not allow precipitation to infiltrate into the soils, so there is less ground water recharge, which in turn can lead to less available drinking water. Precipitation flows quickly over non-porous surfaces and carries with it soil, valuable nutrients, pollutants and weed seeds. Turf that has been mown low to the ground also has a higher runoff rate than native vegetation, particularly on steeper slopes.

Without riparian buffers and natural stormwater systems, the pollutants end up in streams and lakes where they can poison aquatic life and encourage the spread of invasive species. The Maryland Department of Natural Resources has found that in watersheds covered by more than 25 percent hard, non-porous surfaces, only pollution tolerant reptiles and amphibians can thrive. When a watershed is more than 15 percent non-porous, it never has a “good” stream health rating, and even at 2 percent non-porous land cover, sensitive species like brook trout are never found.³⁰ Brook trout are a cold water fish that are already facing environmental stresses in Pennsylvania, and are poised to be negatively impacted by the effects of climate change. They need all the protection they can get. It is essential to limit the area covered by non-porous surfaces and turfgrass within sustainable community parks and landscapes. By doing so, you will not only help protect water resources, but you also may save money in the process (Chapter 4 describes cost savings from reduced turf and pavement maintenance).

Porous bike path



Some hard, non-porous surfaces can be replaced by porous pavement, mulch, gravel or vegetation. There is a variety of porous surfaces available including asphalt, concrete, and grass and block pavers. Even porous athletic surfaces like basketball and tennis courts can be made (*see photo below*). These surfaces allow water to trickle through the material into the soil below. Benefits of these surfaces include no ponding of water and ice that can lead to accidents, longer product life-span with proper installation and maintenance, and reduced need for stormwater management systems.



Precipitation can flow through a porous pavement basketball court

Cost savings can result from the use of porous surfaces as well. For instance, at Penn State University’s Berks Campus they installed 320 porous parking spaces in 1999. The University had budgeted \$3500 per space for traditional paving yet it ended up costing them only \$2700 per space when they used the porous pavement.³¹ That is a savings of \$800 per parking space! Smaller projects may not reap quite so large a savings, but the economic and environmental benefits of porous surfaces will still be there. For additional information on the various porous surfaces, as well as other stormwater best management practices, visit www.dauphincd.org/swm/bmptour.html.

For those hard, non-porous surfaces that must be kept, like roads, their width should be minimized as much as possible. Paved parking lots should have just enough spaces for low-use times of year, with gravel or grass overflow parking for busier seasons. Turf should be limited to recreational areas (ball fields and picnic areas).



**Warm season grass planting at
The Milton Hershey School**

Turf in other areas can be replaced with native warm season grasses such as big and little bluestem or with wildflower meadows and shrubs. These plants have a higher rate of absorption, and provide many more habitat benefits, than do turfgrasses. Plus they require less frequent maintenance than turf once they have established. For more information on warm season grasses, visit www.dcnr.state.pa.us/news/resource/res2005/05-0510-naturenotes.aspx.

Reduce Soil Compaction

Soil compaction occurs when soil particles are pressed together, reducing the pore space where air and water typically can be found. If soil becomes too compacted there is no longer room for the air and water, making it more difficult for plants to grow and for stormwater to infiltrate through the soil into groundwater. Soil compaction can occur during building construction, from vehicle and pedestrian traffic, and from heavy precipitation.

To give you an idea of what compacted soil is like, consider that in undisturbed lands like forests the soil and its pore spaces have a density of 1.03 grams per cubic centimeter and a high infiltration rate of 15 inches per hour. The higher the density of soil, the fewer the air pockets and pore spaces present, making it more compact. The higher the infiltration rate, the more water that is able to percolate through the soil. On the other hand, soil in disturbed areas like parks, golf courses and residential neighborhoods can have a density of up to 1.97 grams per cubic centimeter and an infiltration rate as low as .04 inches per hour. Compare that with concrete which has a density of 2.2 grams per cubic centimeter and an infiltration rate of zero and you can see that there isn't much difference between compacted soil and concrete!³²

What does soil compaction mean for a sustainable landscapes? Simply put, it can mean bad habitat because plant roots cannot spread through the soil, poor water quality from erosion, and increased maintenance costs to fix the soil's problems and replace any plants that might have died. Therefore

it is essential that compaction is avoided whenever possible. To do so, reduce the use of heavy machinery during construction and maintenance (*like in the photo below*) and discourage people from walking and biking off trail. If soil compaction is a problem in your

area, tilling the soil and applying an organic fertilizer or compost may alleviate some of the problems and help plants to grow.³³ Quality soil leads to better quality plants, so knowing what your soil is like before planting anything is imperative.

**Compacted soil can
have nearly the same
infiltration rate as
concrete**

**Large
equipment like
this can lead to
soil compaction**





Reduce the Use of Chemicals

Building construction and maintenance might involve the use of many chemical substances, including chemically-treated wood for picnic tables and decks, synthetic fertilizers on turf areas, herbicides on weeds and window cleaner inside the buildings. In some cases, their use is justified and essential for proper maintenance. However, these chemicals may have negative effects on human health, the environment and wildlife habitat, particularly in aquatic ecosystems. The use of chemical substances should be minimized whenever possible. If alternatives exist that have less of a negative impact on staff health and natural resources, they should be used, especially in high quality habitats and indoors.

The U.S. Green Building Council (USGBC) developed the Leadership in Energy and Environmental Design (LEED) building certification program (discussed in more details in Chapter 3) to verify that buildings or communities are designed for cost-savings, emissions reductions, resource stewardship and **improved indoor environmental quality**. Indoor air quality is affected by the various chemicals used in building design and maintenance and can affect staff productivity levels. The USGBC points to studies that show that workers in buildings that have “people-friendly” design and maintenance report productivity gains of up to 16 percent.¹⁶

No matter what the chemical is, and what it is being used for, it should be used, stored and disposed of in an appropriate manner so that it does not cause harm to people or natural resources. By following the suggestions given in the following section, you will help ensure that aquatic habitats, natural resources and human health are protected and enhanced.



Signs like these are placed on lawns after a professional herbicide treatment

Pesticides

Many times the use of herbicides, insecticides and fungicides is the only way to remove nuisance and invasive species from an area. To minimize the risks these chemicals pose to non-target organisms and the environment, always be sure to read the label carefully and follow the directions exactly, in order to minimize the accidental use of too much chemical, using a chemical that is not approved for that area or applying it in the wrong way. When applying pesticides in or near a body of water, be sure that it is specifically formulated for use in aquatic habitats. To legally apply many of the pesticides available, you must be certified as a pesticide applicator. The Pennsylvania Department of Agriculture offers this certification. Information on certification can be found at www.agriculture.state.pa.us/agriculture/cwp/view.asp?a=3&q=128271.

Chemical Fertilizers

Chemical fertilizers are sometimes used to keep turfgrass and other vegetation green, particularly in areas with poor soil quality. Problems can arise when these fertilizers are misused or after strong rains. Applying too much fertilizer can cause burn-out of the plants. It also increases the chance that these extra nutrients will get washed into a water body where they could cause algal blooms and outbreaks of invasive plants. Chapter 4 discusses alternatives to chemical fertilizers that could have less of a negative effect on the environment and may cost less money in the long-run.

Swimming Pool Chemicals

Just like other chemicals, swimming pool chemicals can become dangerous when improperly used or stored. Dangers can include fires, toxic vapors and personal injuries. The EPA provides information on the proper use of these chemicals at www.epa.gov/oem/docs/chem/spalert.pdf. Alternatives to traditional pool chemicals exist that are more environmentally-sound, but they may be more expensive. These alternatives include salt-based sanitation systems, ionization and ozonation.



Pressure-treated Lumber

Until recently, most pressure-treated lumber contained a compound called chromated copper arsenate (CCA). This chemical protected the wood from rot and insect damage. However, in 2003 the Environmental Protection Agency (EPA) requested that these compounds be phased out of wood used for residential purposes and in children's play areas because it found that arsenic in the wood raised the risk of several forms of cancer.³⁴ Some wood playgrounds, picnic tables, park benches and decks were built prior to this ban and may have been leaching arsenic into the environment for years.



Playgrounds should be safe for all age groups

These should be replaced with composites, or plastic, vinyl or rubber “wood” whenever possible, and the soil in those areas should be tested to make sure it does not contain potentially dangerous levels of arsenic. For more information on arsenic and its potential health threats, visit www.epa.gov/ttn/atw/hlthef/arsenic.html.

There are other pressure-treated lumbers available that are treated with different chemicals such as ACQ and copper azole. Research into the environmental effects has so far been limited in scope, but studies show that they do not produce the dangerous arsenic byproducts that the CCA does. However, they still should not be used for bird and bat houses, or other structures that could be used by wildlife. For more information on CCA and other pressure-treated lumbers, see www.epa.gov/opad001/reregistration/cca.

Cleaning Supplies, Paints, etc.

Traditional cleaning products, paints, varnishes and sealants may contain toxic or hazardous ingredients, such as Volatile Organic Compounds (VOCs). Some VOCs are toxic when inhaled or they may cause burns, rashes or cancer when they come in contact with skin. Janitorial staff face the greatest risks from the use of such chemicals, but all staff may be exposed to these products with effects building up over time.³⁵

To reduce the risks to human health and the environment, choose what are deemed “environmentally-preferable products.” A truly environmentally-preferable product includes ingredients that are certified to contain lower or insignificant amounts of toxic or hazardous materials and have low adverse impacts on the environment.³⁵ There are many cleaning products, paints and other materials on the market that claim to be “green,” “all natural” or “environmentally-friendly.” How do you know that what they state is true and how can you choose the healthiest product for your employees and the natural world?

The national non-profit organization Green Seal uses science-based standards to independently rate products like cleaning solutions. They rate industrial and institutional cleaners, floor waxes and other products based on criteria like aquatic toxicity, eye and skin irritation and carcinogens. The LEED green building certification program recognizes Green Seal certified products and encourages their use in buildings wishing to obtain a LEED rating. For additional information about Green Seal go to www.greenseal.org.

The Pennsylvania Governor's Green Government Council has developed a “Green at Work Guide” that not only discusses the purchasing of environmentally-friendly cleaning products but also covers the topics of recycling, travel and the purchasing of office supplies and furnishings. This document can be accessed at www.gggc.state.pa.us.



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A Few Simple Steps

While an ideal park or landscape would equally balance human uses with natural resource protection and sustainability, this is not always a feasible option. Landscapes will typically have multiple uses, but multiple uses cannot take place in every part of an area without degrading the quality of wildlife habitat. Lands with good habitat, or near such areas, should focus more on sustainable uses such as natural resource protection, while sites with poor habitat potential can be used for human activities.³⁶ But even in areas designed for human use, small steps can be taken towards improving and enhancing the natural resources and operating in a sustainable manner.

It may help to do a small “experiment” first in one area to see how staff or visitors react, and to see the benefits firsthand. For example, this experiment could involve replacing an infrequently used turf-grass area with a butterfly garden. Once this smaller project is completed, a more comprehensive and labor-intensive project could be done, such as planting a riparian forest buffer along all the streams. The next step could be to form partnerships with nearby municipalities to create a chain of high quality habitat sites throughout a region. This will be more effective at protecting natural resources than a single sustainable landscape would, since natural landscapes, and the high quality human uses that rely on these landscapes, are based on natural, not jurisdictional boundaries.³⁷

Chapter 3 highlights the planning and design needs of a sustainable community park or landscape, condensing a lot of information into 5 simple steps. These steps do not act alone; they can be implemented at the same time as the others and you do not necessarily need to follow steps 1 through 5 in order. But taken together these steps will help guide the design of a successful sustainable landscape.

The following few suggestions are for landscapes with limited time, staff or budgets. These options can be used alone, or in concert with one another, to make a land use that is more sustainable.

- Plant native trees or shrubs that produce food for wildlife. Appendix 3 lists examples of these. Incorporate these plants into a naturalistic landscape design that mimics the surrounding natural habitat.
- Plant a riparian buffer around water bodies. Riparian buffers help protect the water from erosion by stabilizing the banks, and they offer wildlife habitat and discourage nuisance geese. For the best results, the buffer should be at least 50-100 feet wide on each side of the water body and consist of a mix of native trees and shrubs, warm season grasses and other native herbaceous plants. The wider the buffer, the better the results.
- Minimize non-porous surfaces like roads, parking lots and paved trails. Consider replacing asphalt and concrete with porous pavement, mulch paths, gravel lots and areas of native vegetation. Porous surfaces will help to recharge ground water, reduce erosion, lessen flooding events and filter out pollutants before they reach a source of water.
- Prioritize species of invasive plants that are in the area, particularly near high quality habitat. Remove as much of the population as possible for those priority species. The use of volunteers can aid in the project’s success, and can help with continued monitoring to ensure that when new invasives appear, they are found and controlled right away.



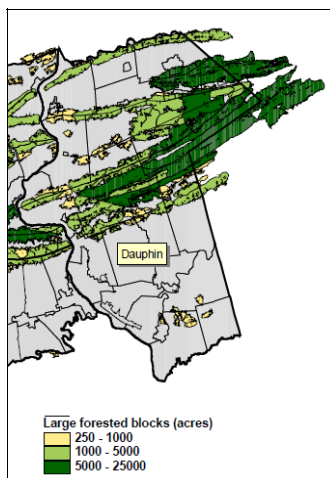
Natural Resource Inventory

Before any steps can be taken towards creating and managing a sustainable landscape, you will have to know what kinds of natural resources are found within the area. A natural resource inventory will help do that. A *natural resource inventory* is a list and description of all the characteristics of the land, including soils, bedrock, ground and surface water, vegetation and wildlife. The inventory could also include the built landscape (roads, trails, utility rights-of-way, buildings).

The following resource categories are typically used to define the natural environment in a natural resource inventory:³⁷

- ◆ significant wildlife habitat
- ◆ scenic areas
- ◆ riparian corridors
- ◆ recreational resources
- ◆ productive forest resources
- ◆ wetlands and floodplains
- ◆ historical and cultural resources
- ◆ moderate and steep slopes
- ◆ geology and soils

Natural resource inventories are made up of a map of the locations of all resources, a description of the relationships between resources, identification of the stresses and threats to the resources, uses affecting the resources, benchmarks to use when measuring future change and suggestions for the future.³⁸



County inventories have been created for all counties in the state, and include maps of different resources, like forests

The inventory should also include a Pennsylvania Natural Diversity Inventory (PNDI) search of the proposed site. PNDI is a project-screening tool for locating species of special concern that may occur on a site. The tool is operated by the Pennsylvania Natural Heritage Program (PNHP), which is a collaborative effort between DCNR, the Western Pennsylvania Conservancy and The Nature Conservancy. The PNHP website, www.naturalheritage.state.pa.us/whypnhp.aspx, contains more information on PNDI, and also contains downloadable county inventories for the entire state.

Inventories can be done by staff (if they are knowledgeable in geology, hydrology and biology), by a consultant or by an environmental organization experienced in conducting natural resource inventories. Inventories should be repeated on a regular basis to ensure that changes to the natural resources and the stresses on them are identified.

For parks or schools, you could hold a BioBlitz event, to complement the information in the inventory. A BioBlitz is a rapid assessment, over the course of 24 hours, intended to identify as many species as possible within a selected area. During a BioBlitz, scientists work alongside park staff, amateur naturalists and the general public to complete an inventory of the park. Holding such an event can be a great way to raise public awareness of the natural world, but there is a lot of planning and coordination needed for it to work successfully. To learn more about organizing a BioBlitz or to join a discussion group on the topic, go to www.pwrc.usgs.gov/blitz.html.

At a BioBlitz, the public gets to interact with scientists





Natural Resource Management Plan

A *natural resource management plan* is a document that outlines the objectives for the area's management and provides a list of actions for meeting the objectives. The plan is like a road map, directing you where to go next. The results from the inventory form the basis of the natural resource management plan. The structure of the plan typically includes the background information on the area (ownership, acreage, location, history of the property), the results from the natural resource inventory, management objectives, management recommendations, a timeline for upcoming construction and maintenance projects, and budget estimates for a three or five-year term. However, the plan should be tailored to meet an area's specific needs, so the structure might differ somewhat from what is listed above.

Staff or hired consultants can write management plans. The decision on who should write the plan will come down to staff time, budget and the level of detail desired for the plan.

However, if a consultant is chosen to write the plan that does not mean that staff can sit back and let the consultant do all the work. The more involvement staff has in the development of the plan, the easier it will be for them to implement it in the future.



Environmental consultants could be hired to do inventories

Other stakeholders - like park visitors, home and business owners and others - should also be involved in developing the plan, as they are the ones who will be using the area and impacting its natural resources. For more on working with consultants for plan development, visit www.jonkohl.com/publications/n-z/sol-plans.pdf.

The most integral part of the management plan is the objectives section. Objectives are the short-term and long-term goals for the landscape.

To help determine management objectives for the landscape, there are many questions³⁹ you can ask yourself, other staff members and visitors:

- ♦ How many acres are in forest? Grass? Wetland? Total?
- ♦ What is the management history?
- ♦ What active and passive uses will you have in the area? (bird watching, walking, picnicking, other)
- ♦ What are your priorities for the area? (recreation, aesthetics, business, wildlife management, erosion control, other)
- ♦ What wildlife would you like in the area?
- ♦ What are your management constraints? (limited capital, lack of equipment, financial or technical assistance needs, other)
- ♦ Are there outstanding or unique features that require special management or protection?
- ♦ What are some threats to the area? (steep streambanks, nearby development pressures, invasive species, other)

DCNR's Bureau of Forestry has completed a statewide Resource Management Plan that can be viewed at www.dcnr.state.pa.us/forestry/sfrmp/index.htm. This document may provide you with ideas on how to complete a plan for your area, as it encompasses not only information on natural resources but also covers recreational uses and infrastructure. You may also want to complete an invasive species management and control plan to help prioritize a few of the most damaging species. More information on invasive species management plans is included in Chapter 4.

Once the management goals are established, determine what can be done to reach those goals. Management recommendations are the actions that can be taken to achieve the objectives outlined in the plan. These recommendations can be made for the area as a whole, or for individual segments of the landscape.



The recommendations will outline best management practices (BMPs) to use, along with a discussion of the expected results. BMPs can include where to plant native vegetation, when to mow or burn warm-season grasses and which herbicides to use, among others.

When the inventory and plan writing process are finished, and the outside stakeholders have had a chance to comment on them and feel involved, then work on the natural resource design and maintenance can begin. However, management plans should be reviewed on a five to 10-year basis to include new changes to the landscape, and to ensure that the suggestions are up-to-date. Natural resource planning in your sustainable landscape will be a continuous process if it is to be effective.

Model Natural Resource Ordinances

Rapid growth and development can present challenges to municipal governments statewide. Model natural resource ordinances can be created to give legal authority to these governments to direct development away from sensitive areas and quality habitat. Model ordinances can be written to cover a variety of topics such as zoning, stormwater management, landscaping, alternative energy sites and subdivision development, to name just a few.



Ordinances can direct alternative energy sites, like wind farms, away from sensitive habitats

For national examples of model ordinances, visit www.epa.gov/nps/ordinance/preface.htm. For real-world Pennsylvania specific examples, visit www.dcnr.state.pa.us/09slc/index.aspx.

Complete Design Process

The following steps provide staff or hired engineers and architects with guidance on how to design or enhance a landscape that focuses on sustainability and natural resource protection. Remember that any step towards natural resource conservation, such as removing invasive species, planting a few native plants that provide food for wildlife or reducing the amount of turfgrass, is better than doing nothing at all.

Step 1: Map the Area

There is a saying, “If you don’t measure, you can’t manage.” It is very important that land managers know the extent of their natural and man-made resources: land, flora, geology, waterways, paths, buildings and roads. Mapping the area will help with visualizing what already exists, and finding the optimal locations for additions and enhancements. Some factors to consider when mapping out the landscape include areas of sun and shade, wind direction, slope of the terrain, moisture levels of soil, plants already growing in the area and soil type (sand, clay, loam). Also be sure to map out existing buildings, utility lines, recreational areas, parking lots and natural features such as streams, wetlands, brush piles and fields.

Keep in mind the land surrounding your landscape as well, because it can influence what should be designed within. For example, a neighboring property contains a stream and wetland that run adjacent to your property. It would be highly beneficial to keep human activities away from this section and instead plant a riparian forest buffer to protect the water quality and enhance wildlife habitat. Once this is done, map out what will be added to the landscape. This step in the process may have been done during the natural resource inventory phase (*see page 22*). If that is the case, just review the map briefly to make sure any new structures and changes to the natural resources are included.



Step 2: Design Facilities

The addition of structures should be carefully thought out. Their placement should be in areas where they will not have a negative impact on wildlife habitat, geologic hazards, water quality or scenic vistas. A building should be oriented with its long axis in an east-west direction. The longest wall with the most windows should face the south or southeast, while the number and size of windows on the north and west-facing sides should be minimized because of the prevailing winter winds. This will help to maximize sun exposure and minimize winter drafts.⁴⁰

Structures should be designed to blend in with the natural surroundings as much as possible, instead of standing in stark contrast to them. For example, choose a color scheme that includes browns, greens and other neutral colors. Choose buildings that sit low to the ground and are arranged in groups, rather than being spread throughout the landscape. For instance, the visitor center and park office at Ricketts Glen State Park (*shown below*) was built in a location that would connect it to existing trails and parking areas, rather than carve up excess land. The color scheme compliments the natural surroundings, rather than detract from it.



A LEED certified green building at Ricketts Glen State Park

The use of “green” building materials is growing in popularity, and can help reduce a building’s impact on the natural surroundings. Green buildings are more energy efficient and take advantage of recycled materials and alternative energy sources, thus saving both money and valuable natural resources.

There are several programs that certify green buildings, the most well-known of which is the

U.S. Green Building Council’s Leadership and Excellence in Energy and Design (LEED). LEED is an internationally-recognized program that provides third-party verification that a building uses sustainable practices like energy efficient lighting, alternative heating sources and water conservation measures. LEED can apply to new and existing

residential, commercial and industrial properties. Buildings can earn a ranking of bronze, silver, gold or platinum, depending on the quality and number of sustainable practices in use. For more information about LEED certification, go to www.usgbc.org/LEED.

When laying out where your buildings should go, consider Low Impact Development (LID) principles. LID ties together sustainable land use with effective stormwater management. LID aims to preserve open space, minimize disturbances from development and protect water quality and habitat. It does this by reducing street widths, using green infrastructure like rain gardens, and clustering buildings to leave more natural area intact. LID methods tend to save municipalities money by reducing the need for costly infrastructure and it saves developers money by reducing grading and revegetation costs. These practices have been integrated into numerous municipal zoning, subdivision and stormwater management ordinances throughout the US. One of the case studies in Chapter 6 also highlights some LID principles. For more information about Low Impact Development, visit www.lowimpactdevelopment.org.

Low Impact Development (LID) can save money by reducing the need for costly infrastructure



Step 3: Test the Soil

Once your buildings are in place it is time to think about the landscaping. The different species of plants used will have different soil nutrient needs: some thrive when the nutrient quality is high, while others prefer low nutrient conditions. For example, most of Pa.'s forests grow in low nitrogen soils. Using plants that can grow under the existing soil conditions can help save money because they will have fewer maintenance needs than those that require soil amendments such as organic fertilizers and supplemental irrigation.

Nitrogen, phosphorus and potassium are some of the macronutrients that plants might need. The pH level of the soil (whether acidic, basic or neutral) is also an important consideration because it determines which nutrients are available to the plants. Certain plants will grow only in acidic soils, while others will grow only in basic soils. Macro-nutrients are usually less readily available in soils with a low pH. The geology of an area is the key to soil types and chemical characteristics.

To find out the nutrient composition of the soil, a soil test kit can be used. Because soil conditions can vary from one area of a park to another, it is very important to test the soil in multiple locations, in order to determine the availability of nutrients and to figure out what plants to put where. Standard soil test kits are available from local Penn State University Cooperative Extension offices. These tests analyze the pH, phosphorus, potassium, magnesium and calcium levels in the soil. The analysis also comes with recommendations on how to improve the nutrient quality of the soil. More specific soil analyses can be ordered through their offices for an extra fee.

To find the nearest Extension office, visit www.extension.psu.edu/extmap.html.

This landscape is complex and interesting to people because of the variety of plants



Particularly for human-use areas, it is also a good idea to know whether or not there are lead, arsenic and other toxins in the soil, since they have been shown to have negative impacts on human health, particularly among children and the elderly. These toxins sometimes occur naturally in the soils, or might come from human sources such as lead-based paints and metal ore smelters. For more information on planting in soils with these toxins, read "Gardening on Lead and Arsenic Contaminated Soils," at <http://cru.cahe.wsu.edu/CEPublications/eb1884/eb1884.pdf>.

Step 4: Landscape the Area

If an outside contractor does your landscaping work, consider choosing a landscape company that uses ecologically sound practices. The Ecological Landscape Association⁴¹ (ELA), a nonprofit organization of landscape professionals, can be of assistance in locating such a company. Whether the work is done internally or externally, be sure to follow the guidance on native plants (*see page 28*) and use native plants whenever possible.

People like to see order, even though nature typically does not follow such predictable rules. There is a preference for *coherence* in a natural scene. Coherence occurs where trees, other vegetation and natural features are arranged in an orderly fashion with some repeated themes and unifying textures. People also like to see a lot of complexity, or diversity, in their landscapes.³ Balancing these preferences with the desire to create as natural an environment as possible can be challenging, but not impossible.

The key is to create a setting that is both visually appealing and useful to wildlife in terms of finding

food and shelter. The diversity part will be easier, since nature abounds with diverse plants and wildlife. Choose a variety of native plants that offer food and shelter to wildlife, as well as provide colorful flowers and foliage.



Coherence will in part come from proper siting and selection of the native vegetation. Planting in levels, where low-lying vegetation is arranged in the foreground, and taller shrubs and trees are in the background, can help with coherence. In addition, educating people on the value of “disarray” in the natural landscape will help them understand that nature is not always neat and tidy; and that is ok! Chapter 5 will discuss how to go about the awareness process. Even small degrees of coherence and complexity will make people feel more welcome and comfortable.

The landscape and layout of the area can encourage exploration, which in turn can make people feel more familiar and comfortable in the area. A lack of familiarity can breed fear. Fears include being attacked by a bear or other dangerous animal, getting lost and coming across illicit activities. Obstructed views can help fuel these fears, so the landscape’s design should keep this in mind. Trails through sustainable landscapes should provide enough visibility for people to see what is coming up ahead. They should also be compatible with the natural surroundings, as studies have shown that this is what people prefer. Trails that go through open areas with little vegetation and distinguishable features are less preferred, but trails in dark densely wooded areas are not always looked upon favorably either.

A combination of open spaces and wooded areas appeal best to people while still providing wildlife habitat. Including some man-made elements in a natural area, such as walkways through meadows, bridges over streams and fences along trails, is another good idea. To strike a balance with the natural resources, these elements should be made of natural materials like stone and wood, and be designed to blend in with the surroundings as much as possible.³



Sustainable Sites

If you are looking for additional ways to make your landscape design more sustainable, look to the *Sustainable Sites Initiative* (SSI). This is an effort of the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center and the United States Botanic Garden to create voluntary national guidelines for sustainable land design, construction and maintenance practices. SSI is like “LEED for Landscapes;” it will set a standard for rating the sustainability of landscapes like LEED does for buildings.

In 2008, the SSI draft guidelines report was released to the public. The report details how a site can “protect, restore, and regenerate ecosystem services – benefits provided by natural ecosystems such as cleaning air and water, climate regulation and human health benefits.” Over 50 draft prerequisites and credits for site development are included, ranging from site selection to landscape maintenance. The Guidelines Report, as well as case studies and other resources, can be accessed at www.sustainablesites.org.

The Pa. Department of Conservation and Natural Resources (DCNR) is incorporating many of the SSI prerequisites into their Community Conservation Partnerships Program (C2P2) grants to ensure that state funding goes to local parks and land acquisition projects that are more environmentally-friendly. C2P2 grants are given to municipalities and non-profits each year for the acquisition, planning and development of parklands in the state. As part of the program, one “green park” applicant will win an award each year. Winners are chosen by how well they have implemented sustainable practices into their design and maintenance. For more information on this source of funding and the award program, visit www.dcnr.state.pa.us/brc/grants.

Wood and earthen steps blend in more naturally with the surroundings than concrete does



Plant Selection

The selection and location of plants will rely in large part on the uses within each area. Items to take into consideration include people and vehicular traffic, recreation (active versus passive, group versus individual), storm water management, natural resource protection, aesthetics and wildlife habitat. Areas of human use will require resilient ground cover like drought-resistant native cool season turfgrass, whereas areas of low or no-impact use can be planted with native wildflowers, warm season grasses, trees and shrubs.

Plant selection depends on the soil, moisture, slope, climate, hardiness zone and light conditions in a given site. Planting a wetland plant (*like marsh marigold*) in a dry sunny area is a waste of time and money, as the plant will mostly likely not survive a season. By matching the plant type to the site conditions, the more likely the plant will establish and thrive.



Marsh marigold is a native plant that grows in wet areas

Because the way a landscape is designed will determine the benefits it offers, including reduced pollution, food for wildlife or aesthetics, the design and plant selection process should be a thoughtful one. The process may be ongoing for several seasons, but careful planning upfront will make it much easier.

Native plants may require fewer resources to maintain

Native plants are those that have grown in Pennsylvania prior to the arrival of the first European settlers. These plants have adapted to the soils, pests and other conditions in the different ecoregions of Pennsylvania. An ecoregion is a geographic area with its own composition of native plants, soils and natural communities. Information on each of Pennsylvania's 18 ecoregions can be found at www.dcnr.state.pa.us/forestry/sfrmp/docs/PA%20Ecoregions%20section%20descriptions%20&%20links.pdf.

Using plants that are native to Pennsylvania is usually the best choice. However, it is better to grow a plant from your ecoregion but a different state, rather than use a plant from a different ecoregion in Pennsylvania. For example, it might be acceptable to plant a wetland plant from West Virginia in a wetland here in Pennsylvania, but it would not be appropriate to plant a shore grass from Erie in a city park outside of Pittsburgh.

Growing native plants by ecoregion is important because of the different geology and soils in each ecoregion. For instance, highbush and lowbush blueberries cannot be sustainably grown in an area of limestone terrain. You need to match the plant to the soils and geology that are found within your particular ecoregion.

Pennsylvania's ecoregions may change in the near future, however, due to climate change. Whether climate change is occurring naturally or because of human impacts, it is widely accepted as truth in the scientific community, so we need to prepare for possible changes. When deciding which plants to use in your landscape, it is important to keep climate change in the back of your mind. Which plants would you choose if you knew that temperatures were going to rise over the next few decades or if you knew that less rain would fall over the spring growing season? These are just some of the questions to think about.



Through various modeling programs and monitoring of actual changes taking place, here are some of the possible effects of climate change to Pennsylvania that may impact the way our plants grow:⁴²

- Temperature increases
- Reduced winter snowfall
- Increased frequency of summer droughts
- More quick, heavy rains leading to floods

These changes will affect how much precipitation is available to water landscape plants and crops, while periodic heavy rains may scour the land, taking with it valuable nutrient-rich topsoil and any fertilizers that were used. As the climate changes it may become more favorable for some invasive species that can out-compete and chase out native plant and animal species (*see next section*). Due to climate change it is now even more important than ever to use native species in our landscapes, but which ones we choose may change with time.

One reason why using native plants, like New York ironweed, is so beneficial is that once they are established they tend to require less supplemental watering, fertilizer and other maintenance needs – assuming that they have been properly selected and planted. A list of plants that are native to Pennsylvania can be found in Appendix 3. These plants can be purchased from nurseries throughout the state. The Pennsylvania Native Plant Society's website provides a list of these nurseries at the following website: www.pawildflower.org. Another great native plant resource is available through DCNR's iConserve program website,



New York Ironweed

www.iConservePA.org. This site will explain the benefits of native plants, go through the how-to's, and provide other helpful resources.

While there are many non-natives that might work well in a landscape and not become invasive, they might not necessarily offer the same benefits which natives do, since our native wildlife has adapted alongside native plants and uses them as food and sources of cover. For instance, if you look closely at the wingstem photo to the right, you will see some native insects. Research has shown that native plants may support 10 to 50 times as many species as non-natives.⁴³ If non-natives are used, make sure they will grow under the site conditions and offer benefits to wildlife.



Wingstem

Be aware that some native plants available for sale have been collected from the wild, thus threatening their populations. Be sure to ask where the plants came from before purchasing them. Something else to consider is the difference between perennials and annuals. Perennial plants should be chosen over annuals whenever possible. Perennials continue to grow for many years, while annuals typically only last one year. Maintenance costs are therefore lower on perennials, as they will not need to be replanted every year like annuals.

Planting times vary depending on the species, but they typically fall between September and October for trees and shrubs, and April through May for herbaceous plants. Planting during the summer months runs the risk of not having enough precipitation, while planting after October might not give the plant enough time to establish before the first frost. Planting during the wrong time of year could result in the death of the plant. Also, ensure that each plant is capable of growing in the hardiness zone of the area. A map of the updated hardiness zones in Pennsylvania (*which takes into consideration climate changes*) can be found in Appendix 2.



Proper Tree Care

As has been stated earlier, planting native trees can have many benefits. Properly placed trees can act as a temperature buffer for buildings, thus lowering heating and cooling costs by up to as much as 25 percent.⁴⁴ Trees on the north and western sides of a building will block cold winter winds, while trees on the eastern side of a building will provide shade from the hot summer sun. Two rows of evergreen trees are best for blocking wind, but five to six rows of deciduous trees will also work.

Trees can be purchased as bareroot seedlings, as containerized stock, as ball and burlap stock or as live stakes. Containerized and ball and burlap trees are more expensive than bare-root seedlings, however they have greater immediate visual impact and are less likely to be mowed down or damaged by wildlife. After five years, however, it is often difficult to tell the difference between trees that started in containers versus seedlings.

One way to protect seedlings from potential damage is to use tree shelters. Tree shelters are plastic tubes that can help seedlings grow and protect them from pests like voles and white-tailed deer. Shelters may increase the moisture available to the seedlings and block wind, helping the trees to grow taller, faster. They can also facilitate the application of herbicides and fertilizers to the area around the trees, helping remove invasive plants and grasses that could hinder the tree's growth. Tree shelters typically cost several dollars each, but can be worth the cost to protect the seedlings in areas of high deer or vole densities, in areas that will be mowed, or in areas prone to flooding.

Shelters are not without their flaws, however. Bees and wasps may nest inside the tube and their honey may attract bears that can destroy the seedling. Too much moisture inside the tube can cause disease and rot. If the tube is not removed in a timely manner the tree may grow too large and get girdled, or strangled, by the shelter.

**Plant a tree high,
the tree won't die.
Plant a tree low,
the tree won't grow**

It is important to continuously monitor tree shelters for potential problems. You have invested considerable time and money into your trees; make sure they survive. For more information on tree shelter maintenance, visit www.stroudcenter.org/education/ChesapeakeBayLandowner.pdf.

The types of trees you choose will depend on your budget and the availability of the trees. The Tree Vitalize program website (www.treevitalize.net) offers a wealth of resources and a variety of publications that can help you select and plant appropriate native trees. The site will explain the proper way to plant, prune and mulch trees.



**Volunteer tree planting at Jacobsberg
Environmental Education Center**

A properly planted tree will grow twice as fast and live at least twice as long as one improperly planted. As some land managers say, "If you plant a tree high, the tree won't die. But if you plant a tree low, the tree won't grow." When planting trees, do not dig the hole too deep. If you plant the tree at the proper depth, the tree will be less likely to die. If you plant it deeper, the tree may not grow because not enough oxygen will reach the roots. Also be sure to plant small trees at least five feet away from any buildings, and medium to large trees at least 15 to 20 feet away, in order to protect the building from tree roots and branches as the trees mature.



Step 5: Plan for Climate Change

Within the next 50 to 100 years, Pennsylvania is expected to see average summer temperatures like what currently occurs in North Carolina or Georgia, with more 100-plus-degree days. Less snow in winter, an increase in summer droughts and more severe storm events are all predicted to occur in the state due to climate change.⁴²

Until recently, most work with climate change focused on *mitigation*. Mitigation involves reducing carbon and other greenhouse gas emissions in order to slow and ultimately eliminate the negative consequences of climate change.



Less snow would impact winter recreation and affect animal migrations

Climate change adaptation, on the other hand, involves steps to reduce our vulnerability to expected climate change impacts. Adaptation recognizes that even if all emissions of carbon ended today, the carbon that already exists in the environment will take decades, if not centuries, to disappear. Therefore, we will need to adapt the way we live and do business to cope with the expected impacts of climate change.

Sustainable community parks and landscapes should incorporate climate change adaptation into their planning, design and maintenance practices. How can this be done? Because of the uncertainty surrounding the future impacts of climate change there is no one tried-and-true solution. However, some suggestions are outlined on the right.

Adaptive management, which is a set of processes tying together learning and management, can help a landscape manager deal with the uncertainties that come with climate change and adaptation. This management style attempts to determine how human interventions, like using alternative energy sources or controlling invasive species, may affect the environment (both positively and negatively).

Adaptive management can either be *active* — directly manipulating the environment to see how the different systems interact, or *passive* — forming a “best guess” idea of how the environment will respond to changes based on historical information. Regardless of which management style is chosen, adaptive management will help you to understand how the environment works in order to adapt and refine your management goals for the future.⁴⁵

The U.S. Climate Science Program⁴⁵ suggests four steps for integrating climate change adaptation into park and landscape management:

- Identify the resources at risk from climate change
- Develop monitoring and assessment programs to gauge the impacts of climate change
- Define the conditions to protect and restore an area
- Develop and implement management strategies for adaptation

All this may sound overwhelming, and in some ways it is. But we can take a proactive step towards protecting our sustainable landscapes through climate change adaptation. To learn more about climate change in Pennsylvania go to www.pecpa.org/roadmap. For additional information on climate change adaptation visit www.heinzctr.org and www.pewclimate.org.



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Sustainable maintenance consists of any practice that protects the area's natural resources while providing for some appropriately-sited human uses. Maintaining a sustainable community park or landscape will be somewhat different from a traditional turf and pavement dominated landscape. For instance, those staff involved with maintenance may fear that a reduction in mowing needs will take away their jobs. However, while less time could indeed be focused on mowing, more time might be spent monitoring for invasive species and maintaining soil nutrient conditions. Maintenance in sustainable landscapes is just as important as in others because it shows that the landscape is being properly cared for, and not "abandoned." A shift in the types of maintenance duties may take staff some time to get used to, and may require additional training, but it will in no way diminish the importance of the maintenance staff. Plus, it may save money in the long-term.

Maintaining Soils

Keeping plants healthy depends in large part on the quality of the soil. There are many maintenance practices that can ensure nutrients remain in the soil, or are added as needed. The most important step is to retain as much existing soil as possible during construction and planting projects. The best option is to stockpile and reuse the existing topsoil instead of removing it. This soil must be covered by a tarp or non-invasive annual vegetative groundcover in order to prevent erosion by wind and precipitation. Using the existing topsoil not only saves money, but also minimizes disturbance that could encourage the growth of invasive plants.

Bringing in soil from somewhere else not only could upset the nutrient balance but could also introduce invasive plant seeds. Once invasive plants become established, they can be difficult if not impossible to remove. If fill materials must be used, try to use fill from other parts of the landscape that have the same characteristics, or from similar nearby sources. This will help minimize the chances of introducing a new invasive plant into the area and will reduce the need for costly shipping and the energy use associated with it. The use of certified "weed-free fill" may be the best choice, but these materials are not yet readily available within Pennsylvania.



**Healthy soil is
needed for
healthy plants**

Fertilizing

Most native plants will not need fertilizer once they have established. When fertilizers are used, they should be of the organic or "slow release" varieties, should be used no more than once or twice a year and should be used in as small a quantity as possible. The use of too much fertilizer can burn a plant out, and the excess may leach into and pollute groundwater or other water bodies. Excess nutrients can also encourage the growth of invasive and nuisance plants. The Pennsylvania Department of Environmental Protection (DEP) provides some fertilizer guidelines at www.dep.state.pa.us keyword "non-point source management."

To determine whether fertilizers should be used, soil nutrient levels should be tested every three years. Penn State Cooperative Extension offices can perform this service and provide guidance specifically directed toward the soil conditions in a particular area. They also have many publications at <http://pubs.cas.psu.edu> that can provide more information.

Here are some quick fertilizing suggestions:

- ♦ If the soil pH needs to be adjusted, proper amounts of lime or soil acidifying materials may be added.
- ♦ Nitrogen levels can be improved by leaving grass clippings on a lawn or by applying compost.
- ♦ If neither of those suggestions works, vegetable meal or fish emulsion can be used.
- ♦ Adding loam to the topsoil before planting can also be beneficial.



Loam is soil that is made up of sand, silt, clay and organic matter in evenly mixed particles of various sizes. Loam not only provides beneficial nutrients to the plants, but also holds water more effectively than the soils typically found in developed areas like parks and homes. For more information on loam and soil amendments, read the Penn State Cooperative Extension publication, “Soil Management in Home Gardens and Landscapes,” at <http://pubs.cas.psu.edu>.

Nutrient uptake can be affected by soil moisture levels, soil physical conditions, nutrient balances and soil pH, so be sure to take these conditions into consideration before utilizing any soil amendments. In

addition, nutrient requirements vary from plant species to species. Trees, especially, can have drastically different requirements than grasses and flowers. Tree nutrition experts, therefore,



Track soil moisture levels to maintain healthy plants

strongly recommend that an annual leaf or needle analysis be used in conjunction with a periodic soil test. This analysis can confirm suspected nutrient problems, identify nutrient stress before visual symptoms appear and offer suggestions on ways to fine-tune fertilization. Penn State Extension offices can provide these services as well.⁴⁶

Analysis is a valuable tool in diagnosing problems because once a tree is showing visual nutrient deficiency symptoms, such as smaller-than normal foliage, off-color foliage or general lack of vigor, it has been suffering for a very long time. Without the analysis, you might treat for the visual symptoms of a disease without getting to the underlying problems associated with nutrient deficiency.⁴⁶ Trees are a costly expense; protect your investment with proper soil maintenance. Additional information about planting and maintaining trees is provided on the following pages.

Composting

Compost can improve the nutrient quality of the soil and help retain some of its moisture content. Compost benefits the levels of nitrogen, phosphorus and potassium in the soil. Compost is the result of a controlled process of decomposition, and can consist of materials such as grass clippings, dead leaves, shredded newspaper and manure from herbivorous animals (no dog or cat waste). While invasive plants could be composted, this should not be done once the plants have gone to seed, or for plants that spread through their roots (such as tree-of-heaven and Japanese knotweed). You should also not use meat, dairy or oils in compost piles because of odor issues that could attract pests.

Compost can be made on-site, or can be brought in from a municipal composting facility (sometimes for free). For a list of these facilities, visit the Professional Recyclers of Pennsylvania (PROP) website at <http://pacompost.org>. In order to make your own compost, you will need to have a compost bin. These can be purchased from many garden supply stores, or you can make your own out of a trashcan with holes poked in it, a cylinder of chicken wire or a square bin made from wood pallets. The Pennsylvania DEP provides more information on composting at www.dep.state.pa.us keyword “composting.”

The steps to composting are:

1. Add three parts “browns,” which can be dead leaves, straw, shredded paper, wood chips, sawdust and pine needles.
2. Add one part “greens,” which can be grass clippings, vegetable and fruit waste, eggshells, coffee grounds and filters, and manure.
3. Mix or layer materials. After every 12 inches add a few shovels of soil.
4. Keep it damp and aerated, and within a few months there will be compost that can be used to “feed” the soil.



Compost should be warm and moist to the touch, but not soggy. To help keep odors down, the compost should be turned regularly to keep it aerated (every three days to six weeks, depending on the thickness of the compost). The more the compost is turned, the faster it will decompose. The compost will be ready after about two to four months, once it has fully decomposed. An easy way to tell if the compost is ready to use is to seal a small amount in a plastic bag for 24 to 48 hours. If there are no strong odors after that time period, the compost is ready to be used.⁴⁷

When the compost is ready, you can either work in one to three inches of compost into 6 to 12 inches of topsoil into a new planting bed, or add one-quarter to half an inch of compost around existing plants. This should be done every spring and fall. This will help hold in nutrients and water and feed the beneficial soil organisms that aid in plant growth.⁴⁸

Mulching

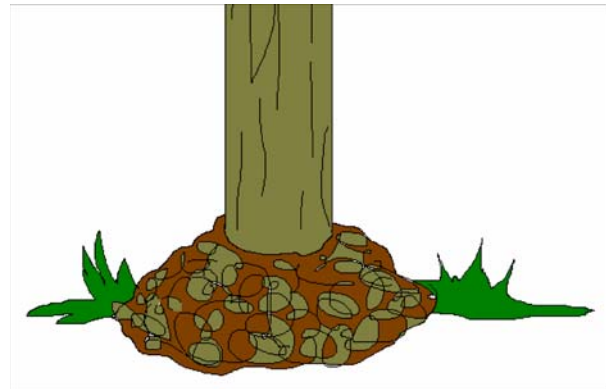
The use of mulch can do many things: retain moisture in the soil, moderate soil temperature, prevent erosion and the washing away of nutrients, and keep unwanted plants from growing. Mulch should be kept no more than two to three inches deep, because excess mulch can damage plant stems or prevent water from reaching the soil. Insects like termites, and small mammals, might be tempted to build their nests in deeper mulch.

Be especially careful when mulching around trees (*see the drawings on the right*). The wrong way to apply mulch is to push it up onto the sides of the trunk like a mountain slope. The correct way is to make it look like a flat donut, where there is an inch or more of open space between the mulch and the tree trunk. If you do not leave a space between the mulch and the trunk the decomposing mulch can rot the bark and expose the tree to insect damage, disease and possible tree death.

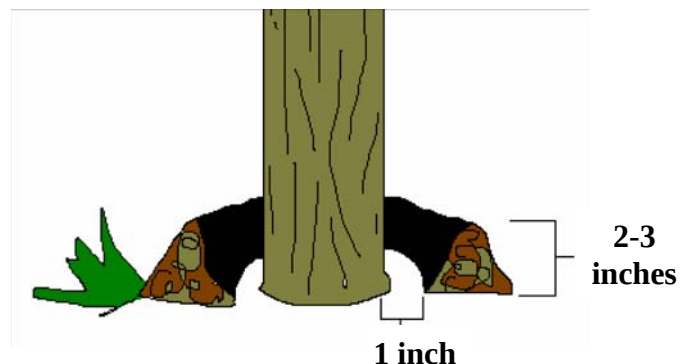
Next to buildings, ensure that the mulch does not come near wood siding, latticework and door-frames, because the warmth and moisture of mulch can be attractive to termites. It does not matter what type of mulch is used, since the termites do not actually eat the mulch, but use it to protect themselves from poor weather conditions.⁴⁹

Once a year, preferably during the fall, remove the old decomposing mulch and add fresh mulch on top. If bare spots appear before that time, fill in those areas with new mulch. When mulch decomposes it can use up the nitrogen in the soil, thus taking it away from plants that may need it to grow. The quicker the mulch degrades, the more the nitrogen is used up. So whenever possible, choose a mulch that lasts longer, such as bark mulch.

The Wrong Way to Mulch: mulch piled against tree trunk



The Correct Way to Mulch: Space between mulch and tree trunk





Many different types of mulch are available, some of which are described below.⁵⁰ Recycled mulches should be used whenever possible, because they not only cost less than virgin material mulches, but they reduce the amount of materials entering landfills and use up less natural resources in their production. Mulch materials should be certified “weed-free” whenever possible, to ensure that new invasive plants are not brought into the landscape.

- ♦ **Bark mulch** – This mulch breaks down more slowly than wood chips, so it has less of a negative impact on soil nitrogen levels. Because it lasts longer, it may cost less per year to replace than other types of mulch. Hardwood mulch typically breaks down more quickly than softwood mulch.
- ♦ **Wood chips** – Drawbacks to this mulch include: insects may be attracted to it, chips discolor quicker than bark mulch and they can deplete the soil of nitrogen, instead of allowing plants to take it into their roots.
- ♦ **Leaves** – Leaves and grass clippings that have been mown over can be used as mulch, but they decompose more quickly than other types, so they will have to be replaced more frequently. They may be useful in small flower and vegetable gardens.
- ♦ **Newspaper**⁵¹ – This type can be laid down in sheets and covered with other mulch, or it can be shredded. A drawback with newspaper is that it may blow away quickly. You should never use colored newspaper, as the dyes will bleed into the soil.
- ♦ **Hay and straw** – This mulch is not recommended because it may harbor weed seeds.

- ♦ **Agricultural by-products** – These can include cottonseed, buckwheat, corncobs, cocoa bean and rice hulls. These are typically lower in costs than other mulch, but are usually only available in bulk and during certain times of the year in certain areas of the country. This mulch also breaks down more quickly and can blow away more easily. **A note of caution about cocoa bean mulch:** dogs and other animals can be attracted to the chocolate scent of this mulch and can get sick or die from the theobromine compound in the cocoa shells, if they eat it. Some cocoa mulches now claim to be “theobromine-free” and “pet safe” but caution should still be used, particularly in park or residential settings.⁵²

Vegetation Maintenance

Once you are certain that soil quality is at its peak, it is time to think about the other factors that affect the health of the trees and other vegetation that you have planted. Proper vegetation maintenance can extend the life of your trees, shrubs, grasses and perennials, thus protecting your investment.

Tree Shelters

If you use tree shelters to protect young seedlings there is maintenance involved. While properly installed and maintained tree shelters can ensure that trees grow up strong and healthy, an improperly maintained one can lead to tree death. In February and March of each year:⁵³

- ♦ Fix any damaged or leaning shelters
- ♦ Fix or replace damaged stakes
- ♦ Remove nets from trees that will reach the net that season
- ♦ Remove any wasp nests
- ♦ Remove shelter from trees that are 1.5 to 2 inches in diameter at top of shelter (*unless in an area of high deer density, where you may wait a little longer. Check back frequently*)

Herbicides may be applied around the tubes in in the spring and fall to reduce the threat of invasive plants and voles. See pages 18 and 43 for more information on herbicides.



Pruning

Pruning is another important step in maintaining healthy landscape trees and shrubs, but care must be taken to ensure that it is done correctly. Too many times people prune too much of a tree, leaving it exposed to disease and fungus. The biggest mistake inexperienced pruners make is to “top” a tree. Tree topping involves removing the top or crown of a tree. Many times this is done for trees under power lines or by people who want to save time by pruning the quick and inefficient way. Cutting off the top of a tree weakens it by reducing its ability to photosynthesize its food and exposes more limbs to insects and diseases. Topping can also reduce the value of large ornamental trees by thousands of dollars!⁵⁴

Pruning should be done to trees with weak, decayed, or dead branches or trees that may damage property or human safety. When pruning involves climbing into the tree to cut branches, using chainsaws or cutting near utility lines, a professional should be called in to do the work. This will protect your safety and the tree’s health. To get the best results, look for a Certified Arborist. Your local extension office (<http://extension.psu.edu/extmap.html>) or the International Society of Arboriculture (www.isa-arbor.org) can help you find a reputable tree company.

Standing trees that are completely dead or dying are called snags and they provide habitat for a wide variety of wildlife. Woodpeckers, salamanders, flying squirrels and mushrooms all rely on dead trees for their homes and a source of food. Some snags can be left in a natural landscape as long as they are not close to buildings, trails, roads or other areas where they may pose a risk to property or human safety. Human health and safety should always be the number one priority, but if you have assessed the area and determined that the snag poses no threat, consider letting it stand for the benefit of wildlife.

Turfgrass Maintenance

Traditional methods of maintaining grass can be very expensive and time consuming. The average landowner spends over \$1000 per acre per year on mowing, fertilizers and herbicides for their turf lawn.⁵⁵ The use of gas powered lawnmowers and synthetic chemicals may pollute the environment and harm human health. In a sustainable landscape the use of traditional turfgrasses is minimized as much as possible, saving time, money and protecting natural resources.

Sustainable community parks and landscapes may have two types of grasses, each with its own maintenance needs. Cool season turfgrass, a staple of traditional landscapes, should be limited to human-use areas such as ball fields and picnic groves. Native cool season grasses, such as Canada and Virginia wildrye, should be used in place of non-native cool season grasses like Kentucky bluegrass and tall fescue.

Turfgrass can be maintained in a more environmentally-sustainable way by mowing high (3 inches tall, not removing more than 1/3 of the blade of grass), mowing during the early morning hours, and leaving the grass clippings on the turf. Longer blades of grass help the roots grow deeply, which in turn will prevent erosion and help the grass obtain more water and nutrients from the soil. Mowing during the heat of midday can contribute to smog and ozone warning days.

Leaving grass clippings on the turf, or composting them, turns them into a natural fertilizer that will benefit the soil and the grass. If you do choose to leave the clippings on the ground, this process can be facilitated by removing the grass catcher from the lawnmower, and using a mulching blade that will chop the clippings into finer pieces than a regular mower blade.⁵⁶ If you decide to recycle the grass clippings or leaves, locate the nearest yard waste recycling facility at <http://myecoville.com/us/pa/home>.



Near stream, ponds and other bodies of water, do not mow the grass right up to the edge. A vegetative buffer around the water will help prevent pollution from entering the water, prevent erosion of the soil and provide wildlife habitat for some species, while deterring nuisance geese.

Traditional turfgrass maintenance may require large quantities of water for irrigation, which is wasteful, both in terms of money and natural resources. For information on irrigating turfgrass and other vegetation in a sustainable manner, see page 46.

Goose Management

Geese can make being outdoors unpleasant when their droppings are concentrated at a site. These droppings may also contribute to high fecal coliform bacteria levels in lakes and ponds, making swimming unhealthy and potentially dangerous. Geese prefer flat, open, mowed grass areas and tend to avoid dense, high grasses and other vegetation. They need to be able to see if any predators are nearby; tall grasses make that difficult. To reduce the number of geese on beaches and shorelines, plant and maintain an un-mowed six-foot wide buffer of tall native grasses or a 20 to 30-inch tall hedgerow.⁵⁷ Other methods of goose management - harassment by dogs, loud noises, chemical deterrents - have mixed results. Detering geese naturally with the use of tall native vegetation is ideal.



Canada goose

Warm Season Grass Maintenance

Warm season grasses are the second type of grass that could be used in a sustainable landscape, and it will be planted for wildlife habitat and as attractive landscaping. Native warm season grasses include big bluestem (*Andropogon gerardii* Vitman), little bluestem (*Schizachyrium scoparium*) and switchgrass (*Panicum virgatum*).

These grasses have ecological benefits because they grow in tall thick tufts that offer food and cover benefits for wildlife throughout the year. The photo below shows a meadow of warm season grasses in Chester County, Pennsylvania.

To ensure that these grasses establish and continue to thrive, maintenance of these grasses will be more intense during the first several years after planting. However, time spent on maintenance will be considerably lower in subsequent years, especially when compared to the time spent maintaining other types of vegetation. The document, “A Landowner’s Guide to Native Warm Season Grasses in the Mid-South,” (www.utextension.utk.edu/publications) provides information on establishing native warm season grasses. The guide states that some of the biggest problems that arise with establishing these grasses come from planting too deeply, planting too late in the season and having poor weed control. The best time to plant native warm season grasses is mid-April to early July, at a depth of ¼ inch or less.

Depending on what you are managing for, whether it’s mammals, birds, insects or a combination, will determine when and how often to mow native warm season grasses. Mowing prior to April 1 and after October 1 is acceptable for mammal and bird habitat. Mowing between those dates can have adverse effects on species breeding, nesting and rearing. But for insects, mowing during the end of summer and early fall can have a negative impact on their food sources and hiding places. For instance, mowing in September can destroy the common milkweed that monarch and other butterflies depend on for food and places to pupate. Therefore it is suggested that areas should not be mowed until after October 1 for insect habitat.



Warm season grass meadow at Warwick County Park



In terms of how often to mow, once every one to three years is fine for mammal and bird habitat, but for insects the rate is closer to once every five to 10 years, but mowing so infrequently can create weed problems. The best option for all wildlife is to have a rotational mowing mosaic, where some patches of grass are mowed in the current year, and then left unmowed for several years, while mowing takes place in other patches. This will ensure that there are always some older-growth patches available for wildlife, while still helping to deter the growth of invasive plants and slow the succession into forest habitat. For more information on growing and maintaining warm season grasses, visit <http://cropsoil.psu.edu/extension/facts/agfacts29.cfm>.

Prescribed Burns

An alternative to mowing is the use of prescribed burns (*see photo below*). Using fire as a way to manage grasses must be done under the supervision of someone knowledgeable and experienced with prescribed burns, in order to ensure that the fire does not get out of control or harm non-target species. Your local DCNR service forester may be able to perform the burn, or put you in touch with someone who can. To contact the nearest service forester go to www.dcnr.state.pa.us/forestry/dcontacts.aspx.

In the past, many people were hesitant about using prescribed burns because of liability issues. However, in July of 2009 the Pennsylvania state legislature passed the



**Professionals conducting
a controlled burn**

Prescribed Burning Practices Act (House Bill 262). This act provides protection in situations where burn plans have been reviewed and meet the standards set up by DCNR. Criminal and civil liabilities for those contracting and performing those approved burns will be limited under the Act.

For the full text from this Act go to www.legis.state.pa.us, click on “Legislation Enacted Since 1975,” and enter in “2009” into the *Year* box.

As a general rule, prescribed burns should take place in the early spring, typically from late March to the first half of May. The fire from prescribed burns removes the previous year’s dead top-growth of the warm season grasses, and also can kill new competing cool season grasses or invasive plants. The fire does not destroy the warm season grasses because their roots grow so deeply, and the next year they will grow denser and healthier than before.

A note of caution: some invasive plants actually grow more after being burned (tree-of-heaven, for instance), so be sure to know what types of plants are in the area, and how they will react, before starting a burn. Another consideration to keep in mind is that certain habitats, such as serpentine barrens, derive their unique plant communities from the lack of certain nutrients. In habitats like that, a prescribed burn can be counterproductive because the burn introduces potash and nutrients that will upset the balance and sustainability of the soil chemistry. The key is to know your landscape’s vegetation, geology and soils before starting a prescribed burn.

Weed and Pest Control

Weeds are plants that are considered unattractive, undesirable or troublesome in the place where they are growing. Depending on a person’s mindset, weeds can be native plants, non-native non-invasives or invasives. There are many ways to deal with weeds, and the methods will depend on the species, its location and other pressing management projects. The same applies to pests, a term that could include weeds, unwanted wildlife like white-tailed deer and nuisance geese, insects like hemlock woolly adelgid and diseases like *Armillaria* root disease. The suggestions on the next page will provide information for controlling and managing for invasive species and other pests.



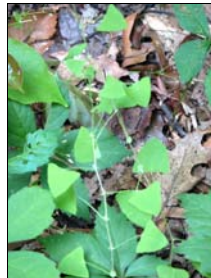
Overview of Invasive Species

Invasive species are species that are non-native to the ecosystem under consideration, and whose introduction causes or is likely to cause harm to the economy, to the environment or to human health. Invasives are able to out-compete our native species due to a lack of natural predators, fast growth rates, tolerance of a wide range of habitat conditions and other characteristics that give them a leg-up in the natural world. These species arrived in Pennsylvania through many means - accidentally in packing material or in ship ballast water, intentionally through the horticulture or agriculture trade, and naturally by birds and other wildlife, the wind and water spreading seeds. Because there are so many different invasive species out there, it is near impossible to know them all. The following section highlights some to watch out for.

According to the DCNR publication, “Invasive Plants of Pennsylvania,” there are more than 50 species of invasive plants in the Commonwealth. In many areas of Pennsylvania, one quarter or more of the plant species in a given area are invasive. Examples of invasive plants are shown below.



Japanese knotweed



Mile-a-minute



Japanese stilt grass



Japanese barberry

Appendix 3 lists many plants in the Commonwealth that are considered to be invasive. For further information on identifying and controlling invasive plants, visit www.dcnr.state.pa.us/forestry/invasivetutorial/info.htm. This is a comprehensive site that includes invasive plant factsheets that include photos and control options.

There are also many invasive insects, animals and pathogens to deal with. This includes forest pest insects like hemlock wooly adelgid, emerald ash borer (EAB) and Asian longhorn beetle, which have the potential to destroy large areas of hemlock, ash and maple tree species, respectively. As of June, 2009 seven counties in Pennsylvania have a quarantine against moving ash trees and lumber, as well as any wood chips and firewood, in order to stop the spread of EAB. To learn more about this pest and what is being done to combat it, go to www.dcnr.state.pa.us/forestry/fpm_invasives_EAB



Emerald ash borer feeds on our native ash trees

Invasive birds in Pennsylvania include the European starling, the European house sparrow and the mute swan. These birds are a concern because they can out-compete native birds for food and nesting sites, and in the case of the swans, can



European starlings are a common invasive bird

consume large quantities of aquatic native vegetation that is vital to the health of aquatic ecosystems, like the Chesapeake Bay.



Invasive mammals are currently not very common in the state, but there are two that could grow into a bigger concern in the future: wild pigs and nutria. Wild pigs (either Eurasian boar, feral swine or hybrids of the two) have escaped from hunting preserves in south central Pennsylvania and Maryland. They are a concern because they destroy habitat and can spread diseases to domesticated pigs. As of the summer of 2009, the Pa. Game Commission is drafting regulations to regulate the control of this species. Check on their website for updates on this, www.pgc.state.pa.us.



Wild pig

Nutria are large rodents from South America that live in aquatic habitats. Nutria cause significant damage to wetlands by over-consuming the vegetation, which can lead to erosion. Nutria are not in Pennsylvania yet, but are in some neighboring states and could cross the border in the future. The website www.invasive.org can provide more information on these and other invasive species.



Nutria

Invasives are not restricted to the land; there are a variety of aquatic invasive plants and animals as well. These species can negatively impact recreation like boating and fishing, destroy quality habitat for native species and cost millions of dollars to the economy. Aquatic invasives include snakehead and round goby fish, whirling disease and rusty crayfish. More information on these and other aquatic invasives is available at www.fishandboat.com/ais.htm and www.erie.psu.

One aquatic species of particular interest is the zebra mussel. These fingernail-sized fresh-water mussels are found within Lake Erie and have spread to some tributaries and parts of the Susquehanna River.



Zebra mussels

These mussels are dangerous for a variety of reasons: they clog water intake pipes at wastewater and drinking water facilities, clog up boat motors and consume large amounts of plankton, leaving less for native species. It has been estimated that the yearly economic impact to the United States and Canada from zebra mussels is about \$140 million in damage and control costs.⁵⁸ Pennsylvania SeaGrant is looking for individuals and groups to monitor for these small creatures in the hopes of stopping their spread. To get involved in this project, visit <http://seagrant.psu.edu/zm>.

It is important to remember that not all nonnative species are invasive. For instance, many of our domesticated animals and plants are nonnative, but they are not considered invasive because they do not spread from the farm fields into the surrounding wild habitats. Invasives, on the other hand, can out-compete native vegetation, offer little to no value to wildlife and can negatively impact recreational activities and the economy.

Once an invasive species becomes established, it could be difficult if not impossible to completely eradicate. It is therefore essential to be able to identify the various invasive species so you can monitor for, prevent and remove them right away. The best way to manage for invasives is to prevent them from entering the area to begin with. Once they are there, it comes down to controlling them.



Invasive Species Prevention

Preventing and controlling invasive plants can sometimes be a complicated project, particularly in areas of heavy infestation. Prevention is the most important step you can take in managing invasive species, because once an invasive is in an area, it may be too late to easily control it. One prevention method is the washing of maintenance equipment after it has been used (and prior to moving it to another site), particularly in areas of known or suspected invasive species populations.

Invasive weeds and their seeds can become attached to this equipment at one location and moved to a new spot where they may be able to grow. The tires, axles, blades and other parts of the equipment that come in contact with vegetation or soil should be cleaned before being moved from the location. The same goes for staff cars and trucks that travel through areas where invasives may be present. Further information on road and trail management of invasives can be found through the US Forestry Service's *Backcountry Road Maintenance and Weed Management*, at www.fs.fed.us/invasivespecies/documents/BackcountryRdMtceWeed.pdf.

Staff, visitors, and the general public should be educated on the dangers of invasives so that they can actively prevent their spread (*see Chapter 5 for more on raising awareness*), since people can spread invasives on their shoes, bike tires, clothing and pet's fur. One idea comes from states like Ohio and Indiana, where they use boot brush stations at trailheads to help cut down on this problem.⁵⁹ Pennsylvania DCNR is following in these states' steps, installing similar boot brush signs in six state parks in 2010 (*see image on right*).

In terms of aquatic invasives, if you have a lake or stream on the property where people recreate, encourage visitors and staff to clean off any visible mud and plants from boats and fishing gear before leaving the area. Hot water or a high-pressure water spray should be used for this. These preventative measures will reduce the likelihood of invasions from zebra mussels, *Hydrilla*, and other aquatic nuisance species (ANS). Visit www.protectyourwaters.net for more information on preventing ANS.

Several of the most problematic invasive insects, like emerald ash borer and *Sirex* wood wasp, can enter an area in firewood. It is therefore very important to inform visitors to your landscape of this problem, and make sure that if they do use firewood, they bought it locally. This reduces the chances of bringing in a new pest insect. For more information on emerald ash borer (EAB), visit www.emeraldashborer.info. To learn more about *Sirex*, visit www.dcnr.state.pa.us/FORESTRY/fpm_invasives_woodwasp.aspx.

Another way to prevent invasives from entering your landscape is to minimize soil disturbances. Soil disturbances can come from bringing in heavy machinery to create new trails and roads, from people recreating on steep slopes and other places where they shouldn't go, and from flooding events.





Invasive plants are frequently the first plants to colonize a bare patch of soil. So protecting the soil with native vegetation will help keep out at least some invasives. You should also avoid creating new roads, trails and parking lots in areas of known infestations in order to prevent their spread.

Invasive Plant Control

For invasive populations that are already established, or where prevention methods were not successful, control methods should be used. To make an invasive control project more feasible, the area should have an invasive species management plan that will prioritize control options for the various invasives, based on their impacts on the area's management goals. The suggested format for these plans is found at The Nature Conservancy website, www.invasive.org/gist/products/plans/WeedTemp.rtf.

Control efforts might work best if they are targeted towards one or two problem species, or focus on one or more areas of valuable habitat, instead of taking on the daunting task of controlling all invasives in all areas at the same time, especially since there are so many options for control. Sometimes manual methods like hand pulling and cutting can work, while other times herbicides are the only method that will get rid of the invasives. The methods used will depend on the type of invasive, the location of the invasive (wetland, fragile habitat, along trail), the time of year and the resources available. It is very important to match the control method to the invasive species in order to maximize its efficacy. Websites like www.dcnr.state.pa.us/forestry/invasivetutorial/index.htm can provide species specific control options.



Using a weed wrench to remove an invasive shrub

Because there are so many choices in terms of invasive plant control, they cannot all be mentioned here. However, the following is a brief description of some manual and chemical methods. In terms of manual control, there are a variety of tools that can be used, such as the weed wrench and root talon. These help pull out shrubs and small trees by providing leverage. The weed wrench comes in four sizes and is made of steel, which makes it durable, but heavy (*see photo on bottom left*). The root talon, on the other hand, is made of plastic, so it is cheaper and lighter, but not as durable.

Machines like flail mowers and brush hogs can mow down invasives that are too big or in too large a quantity to hand-pull. Girdling, a process in which a three to four inch band of bark is cut off from the tree or shrub, is a method that can be used to kill the plant but leave it standing to provide wildlife habitat. **A word of caution about pulling and cutting:** some invasives like autumn olive and tree-of-heaven will actually grow in thicker and more abundant if they are cut or pulled.

Therefore, you must use herbicides in conjunction with other methods when trying to control these invasives.



This large machine can cut down and shred small invasive trees in just a minute or two

There are many brands of herbicide that may be effective at controlling invasive plants. A description of these chemicals and how to use them can be found at http://rvm.cas.psu.edu/Publications/Herbicides_in_Non-Crop.pdf. If any herbicides are used, it is important to follow the label exactly and take care to avoid the surrounding native plants. Herbicides can be a great tool in controlling invasives, but they can also pose negative impacts to the environment if they are misused.



Herbicides can be applied to the leaves, to the bark, or applied to a cut stem. Spraying it on, painting or wiping it on, or injecting it can do this. There are a variety of tools to do this, including backpack sprayers, handheld squirt bottles, wick applicators, saturated gloves and EZ-Ject lances. For larger scale infestations you can mount boom applicators and canisters to an ATV or truck.



Hack and squirt is one method for controlling invasives. A cut is made with a small axe, then herbicide is squirted into the cut

The types of equipment used will depend in large part on your budget and the size of the infestation. Each method has its benefits and drawbacks – you can learn about these through trial-and-error or by networking with other experienced land managers.

No matter which control method you choose, remember that timing is critical, that each invasive plant reacts differently to the various control methods, and that many herbicides must be applied by a certified pesticide applicator. If no one on your staff is certified, you can hire a professional or contact the Pennsylvania Department of Agriculture to become certified (www.agriculture.state.pa.us).



Galerucella beetles are used to control purple loosestrife

Integrated Pest Management

When someone controls pests with chemicals, all of the beneficial and benign creatures could be killed along with the pests. In addition, there is the possibility of negative side effects to the environment from the chemical's use. While there are some situations where pesticides must be used to control invasives, many times alternatives can be used that are targeted towards the specific pest and are more environmentally-friendly.

Integrated Pest Management (IPM) is a more effective and longer-lasting approach that minimizes pest problems by maintaining healthy plants. IPM is the “integration of various management strategies – including biological, cultural and chemical methods – into a comprehensive program of pest control.”⁶⁰

IPM is used in conjunction with proper planting techniques, and may consist of choosing pest-resistant plants, quarantining suspected plants and insects, releasing sterile male pests to inhibit breeding, using traps to catch pests, releasing predator insects to eat the pests and choosing chemicals, like pheromones, that target specific pest species. An example of an IPM biocontrol insect is shown below. This is a photo of the *Galerucella* beetle, which has been introduced in various locations throughout Pennsylvania and other states in order to feed on the leaves of the invasive purple loosestrife plant.

The *Pa. Integrated Pest Management Program* (<http://paipm.cas.psu.edu>) states that IPM techniques typically cost less money than traditional pest control methods, but they can involve more work up-front. There are six steps to IPM: identify the pest, understand its life cycle and the food it eats, figure out how many pests there are, determine how many are too many, choose the control methods and evaluate whether the method(s) worked.



White-tailed Deer Management

In many areas of Pennsylvania, white-tailed deer are so abundant that they have completely destroyed the forest understory and reduced the vegetated groundcover to ferns and invasive species. In 2006, aerial surveys of over 460,000 acres of DCNR and Game Commission lands showed that average deer densities range from 8 to 18 deer per square mile, with some areas having as many as 126 deer per square mile.⁶¹ Deer densities over 20 per square mile have been shown to limit the forest ecosystem's chances for regeneration. Higher deer densities can also lead to greater potential for increases in car accidents and cases of Lyme disease, as the deer are forced to move into populated areas to find sources of food.⁶²

In any landscape, too many deer can be a nuisance, but in a sustainable community park or landscape the damage could theoretically be even worse, considering there will be more native vegetation for the deer to eat. Luckily there are ways to manage for deer. One step is to choose plants that are “deer-proof,” meaning that deer will not eat them unless there is absolutely nothing else for them. These plants include big bluestem grass, switchgrass, milkweeds and spicebush. A list of these plants is on the site, www.bhwp.org (click on the “Native Plants & Resources” link).

Another option is to spray deer repellent around vegetation and any other area where you want to keep deer out. These repellents work by giving off a bad odor or taste that will repel all but the hungriest of deer. They will need to be re-applied after precipitation, however. Noise repellents have a very short-term efficacy, as deer become accustomed to the noise within a week, so their use is not recommended. The use of fencing can help keep deer out, and would be especially beneficial for tree saplings and areas of high habitat value. In order to be effective, fencing should be eight feet tall. More deer damage management information is available at www.dnr.cornell.edu/deerpeopleparks.



Minimizing the Risk of Deer Ticks⁶²

- ◆ Deer and white-footed mice predominantly spread deer ticks. Both of these animals need to be present in order for deer ticks to thrive.
- ◆ Deer ticks can spread Lyme disease if they bite and remain on a person for 12 hours or more.
- ◆ Ticks tend to live in dense shrubs and tall grasses. If deer are a problem in your area, plant heavily used areas with “deer-proof” vegetation and educate people on how to identify and properly remove ticks.
- ◆ The best protection from Lyme disease is to inspect yourself frequently while outdoors, and then again once inside. There are also a variety of tick repellent products available.
- ◆ The use of pesticides should be considered only in severe tick infestations, as they can have negative effects on beneficial species.
- ◆ Sustainable community parks and landscapes will not necessarily have deer ticks, but be aware of the possibility.



Water Use and Conservation

When the soil is properly maintained, and plants have been chosen according to the existing moisture, climate and light conditions of the area, little supplementary water should be needed, except for the first few years while the plants establish. In areas where water restrictions are common, or as part of a climate change adaptation plan that prepares for future changes in precipitation, selecting drought-tolerant species is a good choice. Visit www.bhwp.org/native/native_plant_info_sheets/Native_Plants_for_Dry_Soil_Conditions.pdf for a list of these hardy native plants.

In areas where newly planted natives are found, be sure to water deeply, especially during the spring and fall growing seasons, when it has not rained. This encourages the roots to grow deeper, thus keeping the plants healthy and helping to prevent soil erosion. One inch of water per week is all that is required. The best time to water is during the early morning, although evening is the next best choice. Watering during midday or afternoon is less effective because the sun will evaporate the water much more quickly. Turfgrass will let you know when it needs to be watered. If you walk on grass and it remains flat and shows footprints, it may need water. Similarly, shrubs and wildflowers will wilt and droop when they need water. In both cases, remember to water deeply and thoroughly.⁶³

The use of a sprinkler system is typically not necessary, considering the amount and frequency of precipitation in Pennsylvania. However, if sprinklers are to be used, also use a rain gauge. This device makes sure that the sprinklers do not come on if it has recently rained. A timing device on the sprinklers will also help save both water resources and money by limiting the length of time that the sprinklers operate. There are certified irrigation specialists out there that can help maximize the efficiency of your irrigation system. To find one of these professionals or to become certified through the Irrigation Association, go to www.irrigation.org.

Alternatives to sprinklers include *soaker hoses* and *drip irrigation systems*. These systems may use up to 70 percent less water than conventional irrigation systems.⁴³ Soaker hoses look like a typical garden hose, except that they are made of a material that allows water to soak out of the entire length of the hose, providing moisture for up to 18 inches of soil on each side of the hose. Drip irrigation systems are similar, except that they have small holes along the length of the hose with which to target specific plants. These hoses are more useful for small flower gardens and plants in rows, rather than large turf areas.

Rain barrels can be placed under gutter downspouts and the water used for irrigating small, vegetated areas around the landscape. To prevent mosquitoes from breeding in the barrel, either empty the water every 24 to 36 hours (it takes 48 hours or more for mosquito eggs to hatch²⁶) or place a thin layer of vegetable oil on the surface of the water, which will kill any existing eggs. The barrel should be scrubbed once a week to remove any eggs that may be attached. In order to hold more rainwater, a cistern could be used. A *cistern* (like in the photo below) is an underground storage tank that captures hundreds of gallons of rainwater from roofs and other non-porous surfaces like parking lots for later use.⁶⁴



A cistern stores water underground

No matter which water conservation solution you choose for your sustainable landscape, proper maintenance is essential for prolonging the life of the equipment and saving money in the long term.



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Public Relations

Because sustainable community parks and landscapes differ from traditional human-focused landscapes in many ways, the average park user, staff member or municipal official may not initially appreciate or understand the changes. Therefore, before any sustainable landscape is designed and constructed, information should be obtained to find out about the staff and public's concerns, wishes and ideas. These stakeholders should be included in every stage of the design process in order to gain their buy-in and involvement. The goal should be to have a landscape that not only protects natural resources and is environmentally-sustainable, but also is appealing to people with diverse interests. In order to do that, you need to know what the people's needs and knowledge base are. Information exchange and an established public relations campaign will be essential for determining that.

Staff and the public should be included in the design process as early on as possible. Increased participation in the early stages of a project increases the chances that all stakeholders can have a real impact on the outcome, and that they will agree with the final results. They will welcome the chance to have their opinions heard, particularly if they know it can actually lead to direct action or change. You will get better results if you show them photos or models of various alternatives, and have them pick or rank the design they like the best, rather than asking them, "What do you want in this landscape?" because they will usually either have no opinion or have unrealistic desires. This process can take place at public meetings, community festivals, through mail and phone surveys, or through other means.³ The design that secures the most votes should be the one that is chosen - with minor modifications to fit budgetary and space constraints, if necessary.

Once a new sustainable landscape is designed and constructed, or once changes to an existing landscape are made, the public relations and education process will still need to continue. Park visitors that are accustomed to ball fields and large facilities may need a little extra information and encouragement to see the beauty and importance of a sustainable community park. Staff members that are used to mowing large swaths of turfgrass around the office will need to see that their job is still important and that maintenance will still need to be done. This can be accomplished through a variety of means, one of them being the development of educational materials. The following section describes a variety of educational materials and programs that could be implemented to enhance staff and public experiences and knowledge.

Educational Materials and Programs

When conveying information, keep in mind that people often resent being told something they already know, but will appreciate new information that helps expand on their previous knowledge. Relating this new information to what they already know will help them understand it more fully and remember it better. The serious mistake made most often is giving so much information to people that they cannot retain and understand it all. Using visual information along with bulleted sentences or phrases usually helps to get a point across much more effectively.³

You have to find a way to overcome these communication roadblocks when dealing with staff and the public because making the switch to a sustainable landscape may create situations that upset some people. As was mentioned earlier, for instance, creating a riparian buffer limits the areas where people can access the water. Fishermen may not find that situation appealing, so you must find a way to show how the change benefits them - more vegetation around the water body means better habitat for aquatic insects, which translates to more fish.



When creating written educational materials you can use several steps to make sure that the maximum amount of information is received and understood by the majority of people. The first step is to figure out what you hope to accomplish through the educational material. Who is your target audience, and why do you expect them to be interested in your message? What subject matter will you cover? Once you determine these elements, it is time to decide what type of educational materials you want to create. The following is a small sampling of the types of educational materials that could be used to get your natural resource protection messages across. For more information on crafting communication strategies and publications, read *Life. Nature. The Public. Making the Connection*, available at www.biodiversityproject.org.

Brochures

When writing a brochure, the key is not to include too much information. The more words, the less likely people are to read it. Use bulleted phrases and graphics to break-up the text. Make sure the language is basic enough for most people to understand. Technical terminology will turn many people off. It also helps to incorporate the audience's knowledge, fears and concerns in the document so that they can relate to what is being said.³

Your key message should be prominently displayed on the front of the brochure. This way, even busy people who quickly scan the front of the brochure will take away the gist of your message. There should also be a unifying theme throughout your educational materials that will "hook" the reader. This hook should emphasize why your message is unique, and how that uniqueness benefits the reader.



Brochures and posters can help to inform the public of various subjects

For example, your commercial development recently planted a large butterfly garden that attracts numerous butterfly varieties not normally seen in a typical strip mall development. Your unifying theme could be "Rare and Beautiful Butterflies are a Sight to Behold." The brochure would show people some of the butterfly varieties, as well as people enjoying the butterfly watching.

A brochure is meant to spur someone to action, whether it's volunteering to help out in your park, creating wildlife habitat in their own backyard, donating money to an agricultural preservation society or simply learning more about a subject. If the brochure isn't increasing the number of people supporting your landscape in one way or another, the brochure isn't doing its job.

Fact Sheets

There are already a wide variety of fact sheets on various subjects available. For example, a Google search for "invasive species" and "fact sheet" will return tens of thousands of hits. Therefore, you may find what you are looking for without having to re-create it. Many existing fact sheets can be tweaked to apply to your landscape. Most organizations will allow you to reproduce their publications as long as you credit their group as the original author and as long as your organization will not make money from the publication.

A good source of invasive species fact sheets is available on the DCNR online invasive species tutorial for land managers at www.dcnr.state.pa.us/forestry/invasivetutorial/List.htm. A source of plant fact sheets (both native and nonnative) can be found through the USDA at <http://plants.usda.gov/java/factSheet>. If you are looking for wildlife fact sheets, the Pa. Game Commission's *Wildlife Notes* could come in handy. Go to www.pgc.state.pa.us and click on the "Education" tab.



Just like in brochures, include colorful pictures and drawings, and write in a bulleted format. You want to keep a fact sheet to just that, one sheet. To cut down on the amount of information, include web links for people who want to learn more.



Factsheets should be easy to read, colorful and brief

Newsletters

Newsletters can come in either paper or electronic format. Many organizations are going the electronic route (ie. Internet or email-based) to be more environmentally-friendly and to save money on ink and paper costs. Deciding between the two will depend on newsletter budget, the technologic know-how of staff and the availability of computers among the newsletter audience. By going electronically you are not limited by page numbers or article length as much as with printed materials, but you may miss a segment of the population who does not own a computer. Weigh those two sides before settling on one form over the other.

Other factors that can determine whether or not a newsletter is successful include a commitment of staff time and the quality and quantity of written material available for inclusion. Newsletters occur on a regular basis, whether monthly, bimonthly or quarterly. You will need to decide in advance which schedule will work best. Each issue should be published on the same day of the month to establish credibility and good readership.

The content and format of the newsletter is where the creativity and uniqueness can come in. Make the newsletter a reflection of your landscape and all that it has to offer to staff and visitors.

Articles describing the various natural resources, educational programs, staff expertise and upcoming events are just a few of the items you could include in a newsletter. You can involve readers by asking them to send in questions, opinions, photos and articles. The more they feel connected to the newsletter, the more likely they will be to continue reading future issues.

Educational Curriculum

You don't have to be a professional educator to teach, although it certainly helps. This section is for those people who do not have a formalized background in education. This is a very quick and generalized overview of what is needed to run educational programs in an informal setting.

Once you have an idea of the subject you want to teach and the audience you want to reach, you will develop an original lesson plan, or find an existing lesson plan that will fit your needs. This is not always as easy as it might seem, but there are online resources that can help. One source of information is a free online course available at www.eppley.org (click on the National Park service link, then scroll down to *Foundations of Interpretation*). Another source of quick, yet detailed step-by-step directions for creating lesson plans is available at www.lessonplanspage.com/WriteLessonPlan.htm.

Other sources of information are out there—some that are free or come with a cost—so you don't have to create educational curriculum on your own. You can tailor existing lesson plans to meet specific educational programming needs. The Pennsylvania state park educators are available to provide state-specific lesson plans. To find a park educator near you, go to www.dcnr.state.pa.us/stateparks/education. You can also find lesson plans online at www.lessonplanpage.com and www.leassonplansearch.com.



If you are developing lesson plans for K-12 students, it helps to incorporate state education standards and anchors into your curriculum. Formal classroom educators are more likely to use educational materials that are developed in concert with these standards, since standardized tests have become so important. For a list of Pennsylvania state standards and anchors go to www.pdesas.org.

Interpretive Displays

Interpretive displays are temporary or permanent posters or signs that provide information to people. Display panels in sustainable landscapes may include hiking trail maps, business hours of Operation, and rules and regulations. Sustainable landscapes can use interpretive displays to educate staff and the public about the differences between this and traditional landscapes. Signs can highlight the variety of wildlife and plants found within the landscape. If an invasive species control project is underway, the display can let people know about what is being done, and why it's being done. This helps to cut down on visitors saying, "Why are you cutting those trees?" or "Why is that guy spraying chemicals on those plants?" An interpretive display will help to educate visitors when there are no staff or volunteers around to answer questions.



Colorful, informative displays can quickly and effectively educate

Volunteer Programs

Involving staff and the public in every step of the process — from design to management and maintenance — is a valuable way to minimize controversy and increase the chances that a project will be done on time and under budget. Planting natives, removing invasives, stabilizing stream-banks and leading nature hikes are just a few of the projects local volunteers can be involved in. But while having volunteers can be a great help, it is not without its challenges. You will need a certain level of organization and leadership to be able to coordinate the volunteers and keep them motivated. With all the other management concerns in a landscape, keeping up an active volunteer group can easily fall by the wayside.

The use of volunteers for work in a landscape typically falls into one of three categories: one-time events, often using a large number of volunteers focused on one issue; regular volunteer work days, typically once a month on the same day; and independent, well-trained volunteers who come in on a regular basis to work on one or more issues. The amount of staff time and resources available will determine which category to use.⁶⁵

One-time events require a lot of up-front planning and coordination. One or more staff should be dedicated towards planning the event. One-day events are good for removing large amounts of invasives, planting large areas with trees and other vegetation, or trash clean-ups. However, these events should not be used for every site and situation. In areas prone to erosion, in places with valuable native vegetation or in places that may be hazardous to volunteers, large groups should not be used, as they may create more disturbance that could further spread invasives or increase erosion. An ideal rule-of-thumb is to have a ratio of no more than 10 volunteers for each supervisor, when working in the field, to ensure that all volunteers are working in a safe and effective manner.⁶⁵



Regular volunteer work days are more appropriate for long-term maintenance and control of invasive plants and garden upkeep. This type of volunteer commitment requires the continued involvement of at least one dedicated staff member to ensure that volunteers remain interested in the effort. The use of trained independent volunteers works well for monitoring large control areas over an extended period of time, landscaping, and leading educational programs for the general public. Again, however, you will need a staff member to train these volunteers and keep them motivated.⁶⁵

Motivation and retention of your volunteers will depend on many factors, some within your control, others not. People volunteer for many reasons. Some may have grown up near the park or landscape and do not like how the invasives have taken over, while others like to garden but don't have a yard of their own. Still others are retired school teachers looking for a way to reconnect with children and learning. Whatever their reason for volunteering, it is key to keep them happy and feeling appreciated for the work they do for you.

One simple thing is to make sure to communicate the importance of the volunteers' work as part of a larger purpose: that of making the landscape a nicer place. Show them how their individual work adds up to something spectacular.



These volunteers helped build deer exclosures to protect native plants in Pittsburgh's Schenley Park as part of a regular volunteer work team

Make sure to give volunteers enough to do so that they feel that they are not wasting their time. Whether these volunteers are just there for the day or come in every week, give them a sincere "thank you" in person, followed by a note or certificate for their involvement. If the budget allows, giving out t-shirts or other small tokens of appreciation can do wonders for volunteer morale.



A happy volunteer is a productive volunteer

Recognize also that weather can have a major impact on volunteer spirit. Extremely hot or cold days, as well as rainy ones, can put a damper on a volunteer day. Planning ahead for such weather situations can mean the difference between happy, efficient volunteers (with plenty of water and ponchos for the rain) versus grumpy, sluggish volunteers (getting dehydrated or frostbitten).

Another option is to get AmeriCorps or Student Conservation Association (SCA) members to do work around your park. AmeriCorps State programs offer grants to help non-governmental and governmental organizations hire AmeriCorps members to perform direct services for unmet community needs in education, public health and the environment. A team of AmeriCorps members may be able to come to your landscape for full- or part-time work for up to one year. AmeriCorps members have been involved in park improvements and recruiting community volunteers to expand the reach and effectiveness of programs for the organizations they serve. For instance, Pennsylvania state parks like Raccoon Creek, as well as other park systems, have used AmeriCorps volunteers restore habitats. More information on starting an AmeriCorps program in Pennsylvania can be found at, www.dli.state.pa.us/landi/cwp/view.asp?a=143&q=207609.



The National Park Service, the US Fish and Wildlife Service and park agencies in states such as Pennsylvania, Florida and New York have used the Student Conservation Association (SCA) environmental stewards for hands-on projects in the field. You can hire either one intern, or a whole crew, that specializes in construction, maintenance and restoration projects. For more information on SCA, visit www.thesca.org. For more general information on running volunteer programs, visit www.volunteertoday.com.

Staff and Volunteer Training

The management and maintenance of sustainable community parks and landscapes will differ in some respects from traditional turf and facility focused land uses. Therefore, your staff and volunteers will need to be trained and educated on the differences, in order to be effective and efficient in their jobs. Using this guidebook is a great first step in educating your staff. Use the information presented in the book during training sessions and staff meetings, as well as during everyday duties and responsibilities. Communicate with other local organizations and landowners to find out what has and has not worked for them, and share your ideas as well.

The following are four recommendations for designing a training program:⁶⁶

1. Assess the learning needs of the anticipated participants. The content of the training should be built around the difference between what the staff and volunteers need to know to successfully do their jobs and what they already know.
2. Once you know the main topics of the training, specify the key learning objectives, which deal with knowledge, skills and attitudes. These objectives describe what a participant should be able to know or do at the end of the training.

3. Choose a moderate level of content, as opposed to throwing in everything you know, where everything is rushed and little is remembered. Be selective – choose the “need to know” before the “nice to know.”

4. Provide printed resources (handouts, training manual, fact sheets). These will enhance the learning, as long as they are closely tied to the presentation.

A typical sequence of training events is as follows: in the beginning, go over the training’s purpose, learning objectives and key concepts, and then do an ice breaker. The bulk of the training will then focus on learning the objectives and key concepts. A variety of activities exist to get the concepts across: lectures, role playing, Power Point presentations, panel discussions, brainstorming, case studies and hands-on demonstrations. Breaks should be included after any activity that will last 90 minutes. To end the training, summarize the content, have participants discuss how the training will affect the way they do their jobs in the future and hand out evaluation forms.



Know your audience when planning a training session



Environmental Justice

Easy access to parks, scenic natural views, clean river corridors and other greenspaces should be a given, but unfortunately there is sometimes a disparity between urban versus rural, rich versus poor, one race versus another. While in the past *environmental justice* has typically been used in reference to uneven exposures to pollution, the term can also be applied to the presence or absence of quality natural areas within a community because access to these areas can contribute to better health, as was stated in Chapter 1. Studies have shown that in places where people have fewer resources like money and personal transportation, coupled with factors such as perceived neighborhood safety, they are less likely to be physically active, leading to higher rates of obesity, diabetes and other health risks.⁶⁷

Managers of sustainable community parks and landscapes should work in conjunction with their municipal and county governments to ensure that access to greenspaces is as equitably distributed as possible. For as Betty Morrow, a sociology professor at Florida International University, once wrote, “It can be argued that a truly sustainable community is impossible without environmental and social justice.”⁶⁸

The subject of environmental justice is certainly a heavy one and too large to discuss in great detail here. However, when creating and managing a sustainable landscape, keep these thoughts in mind to minimize the chances of leaving anyone out or placing a heavier burden on a certain population:

- Involve the public in the landscape planning process from the beginning to get their input on location, design and amenities.
- Look at maps of the area to see where quality greenspace and sustainable landscapes are lacking. Consider building your landscape in areas of high grayfields and brownfields to provide much needed outdoor space.

- Look at where public transportation stops are located and try to place your sustainable landscape within walking distance of these.
- Partner with local schools, after-school programs and other organizations to get children outdoors in a safe environment.

It isn't just about access to natural areas, it is also about the size and quality of these natural areas. For instance, a study done on parks in Baltimore showed that while African American communities lived within walking distance of more parks than white communities, the parks near the white communities spanned more acres and were less crowded than the parks in predominantly African American neighborhoods.⁶⁹ Other studies, like one done in the Chicago area, showed that parks in low-income and minority neighborhoods had poorer vegetation quality, lower maintenance, and accessibility issues that deterred residents from using the parks.⁷⁰ Just because the greenspace is there, doesn't mean that someone will necessarily use it. A sustainable landscape must be well-designed and properly maintained in order to be of use to the surrounding community and the plants and wildlife that inhabit it.



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Spring Grove High School

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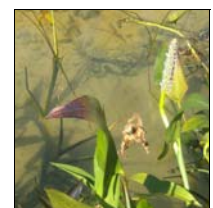
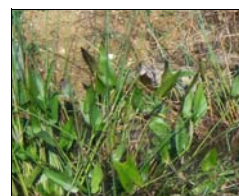
The Spring Grove Area School District opened a new high school during the 2008-09 school year. A growing population base and an outdated existing school were the driving forces behind the need for this new facility, which accommodates 1,400 students and over 100 staff members. This facility shares the expanded 230-acre “campus” where the district’s Middle, Intermediate and newest Elementary schools exist.

The need to preserve natural environments on this campus was a key concern to many since the inception of the design phase. Protecting and preserving the woodlands and wetlands for their educational as well as environmental benefits continues to be a focus of the educators in this district. These landscapes are incorporated into learning opportunities for students, creating outdoor learning centers from what some considered problem areas that should be cleared or filled-in, seeded and then mowed.

Specifically, environmental science students at the new high school work to enhance the existing wetland environment, making it an extension of the classroom, available to all in the community. Such involvement benefits students, who often experience nature only from a distance, if at all. In a society where nature must compete with electronics and a sedentary lifestyle, now more than ever before, this is a benefit which is hard to put a price on.



There are 3 wetland sites that are the focus of current activity; one is on the side of the building that borders a housing development, one is between the student parking lot and the physical education practice fields, and the other is behind the practice fields, bordering a farm. To convert these wetlands into outdoor classrooms, areas of improvement included erosion control for steep hills, removal of invasive plants such as multiflora rose, and restoration of wildlife habitat by reclaiming areas filled in from construction. A key lesson learned from working on this project was to never underestimate runoff from a sloped grade. At the site closest to the building, the major adjustment came in the form of a retaining wall to support the bank from the drainage and runoff. Through the creative efforts of many people and organizations, this unbudgeted expense was constructed successfully to support the area behind the wetland (*as seen in photo below*).





Access to the site nearest the building was created in a way that has minimal impact on the wetland, yet also provides students with a means to study the plants and animals residing there. Recent on-site student projects include water and soil testing for contaminants (*see photo below*), macroinvertebrate identification and building a succession timeline. This wetland ecosystem also offers opportunities for authentic outdoor learning experiences beyond those obvious in science. Population studies have connections to math class, journaling with English, construction of bird boxes and benches by Tech Ed. students, surveying for Physical Education, and connecting to nature for health class. Two students even took it upon themselves to build bridges as their graduation project. These extensions of the traditional classroom allow students to take information taught in the classroom and apply and explore them in natural surroundings.



Spring Grove is a rural community in south-central Pennsylvania, about half way between York and Hanover. The school has a strong sense of community and we are very proud of what has been accomplished with this new facility. Students are simply in awe of the new surroundings, yet one of the initial challenges was to help them find ways to take ownership of the brick and mortar structure; one more “thing” that adults have provided them. If current participation is any indication, these students consider this “their wetland.”

That is a very real benefit of the wetland habitat from the staff’s perspective; providing students the outlet to invest their individual and collective time and efforts into improving their own schoolyard. Designing, planning, negotiating, compromising, waiting, sacrificing, getting dirty, sharing, promoting, educating—these are all areas of involvement where the students will become personally vested in the success of this wetland, and of giving back to the community.





Milton Hershey School

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Founded in 1909 by chocolate industrialist Milton S. Hershey and his wife Catherine, the Milton Hershey School (MHS) is a private residential school, located in Hershey, Pa., that provides a home, quality education, food and clothing to students in financial and social need, free-of-cost to the students and their families.

In an effort to provide enhanced wildlife habitat on the MHS' approximately 10,000 acres, installation of warm season grass meadows began in the Spring of 1997 with a fifteen acre plot of indiangrass (*Sorghastrum nutans*), eastern gamagrass (*Tripsacum dactyloides*) and, predominately, switchgrass (*Panicum virgatum*). Since that time, the area covered by meadows has increased to approximately 150 acres.

The meadows have become a major constituent of the campus landscape at MHS. Benefits of the meadow installation include:



Warm season grass meadows are a predominant feature of the campus

- Meadows provide excellent habitat elements for a variety of wildlife species, particularly ground nesting birds (the group of birds that contains the greatest number of species of special concern in Pennsylvania). Uncommon birds that may be sighted in campus meadows are Meadow-larks (see photo on right), Grasshopper Sparrows and Bobolinks.
- Meadows control rainwater run-off. The vertical growth and extensive root systems of the meadows help absorb rain. By keeping run-off in the landscape, rather than shuttling it directly into campus streams, meadows reduce downstream flood potential. At the same time, root systems direct run-off water to underground aquifers. Aquifers store water and slowly release it into the streams. This lessens drought severity by keeping streams flowing.





- Meadows provide a low-cost alternative to mowing grass. Annual maintenance budgets are reduced \$30 less per acre by converting from turfgrass to warm season grass meadows. Generally, established meadow maintenance consists of an annual mowing or prescribed burn (*see photo below*).



Students help perform the prescribed burn under adult supervision

- Most importantly to MHS' mission, the meadows provide excellent teaching tools for academic staff to assist students to achieve scholastic standards.



Students use the meadows and streams as outdoor classrooms

During the years since first installing a meadow on the MHS campus, we have learned the following:

- Lower people's expectations as to how long the meadow will need to "look good." If all goes well in years 3 to 5 a meadow will begin to achieve its objectives. Remember that at 20 to 25 years, a meadow is just beginning to reach its mature state.
- Herbicide need only be used prior to seeding a meadow. Attempts at using selective herbicides and spot treating for specific pest species are generally futile.
- Plant the seed for all the species desired in the meadow at the time of installation. This is a bit more expensive, but worth it as attempts to add wildflowers to established warm season grass stands, in our experience, have met with limited success.



A three-year old meadow

- While a late Winter/early Spring mowing will aid in suppressing invasion by woody species, the use of managed burning takes meadows to a completely different level. Burning during the first five years of establishment quickly discourages competition from annual weeds. Generally speaking, the plants which are desired in a meadow have evolved and adapted to periodic burning, while those species that are considered weeds have not done so, and are therefore eliminated by fire.



Bayer Corporation U.S. Headquarters—Pittsburgh, PA

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Sustainability is a concept that is integrated into all facets of the Bayer Corporation's business, not just added on as an after thought. Before being "green" was mainstream, Bayer was looking at how what they do impacts the environment and human health. According to the company's North American Sustainability Coordinator, Valerie Patrick, sustainability is a powerful concept that provides a way to take responsibility for your actions and how they impact the natural world.

It was this commitment to sustainable development and the company's empowerment of their employees that prompted one staff member to contact the Wildlife Habitat Council (WHC) in 1997 to see how to better utilize their Pittsburgh campus for natural resource protection and environmental education. Bayer's Pittsburgh campus covers 300 acres; 200 of which are now managed as wildlife habitat in the form of deciduous forests, open meadows, ponds, and two natural wetlands. The WHC helped Bayer create a wildlife management plan to guide the onsite work.



Students look inside one of the many on-site bluebird boxes

One of the highlights of the Pittsburgh campus is the award-winning bluebird nest box program. Throughout the campus and the adjoining Settler's Cabin Park are 42 nest boxes that are monitored by the Wildlife Sustainability Team (WST) — a group of Bayer employee volunteers—and Boy Scout troops. The WST volunteers meet once a month to plan out their activities. Projects are a reflection of the employees interests, ranging from nature photography to bird watching. Rich Polaski, the manager of the WST, says that using the employees' expertise and interests has been the key to their success throughout the years.



Students perform a pond study

Schools link up with Bayer through the BASIC program—Bayer Association for Science in Communities. BASIC is the Pittsburgh branch of *Making Science Make Sense®*, a Bayer initiative dedicated to inquiry based, hands-on science learning at elementary schools located near key Bayer sites. Members of BASIC cultivate children's natural curiosity about science by bringing interactive presentations into approximately 175 local elementary school classrooms, as well as summer camps and museums, reaching nearly 15,000 students in the region.

All photos courtesy of the Bayer Corporation



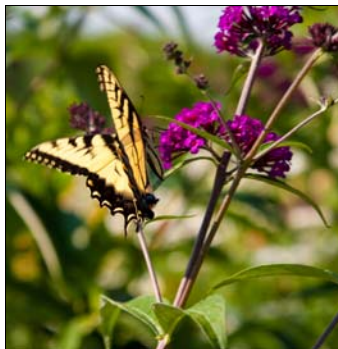
Bayer also sponsors an annual International Summer Sustainability Camp where select high school students from the United States and Germany travel to Pittsburgh to learn from BASIC and WST volunteers about the effects of environmental sustainability and climate change.



Exploring some of the 200 acres of wildlife habitat

Bayer partners with a variety of local organizations for their habitat and environmental education projects. For instance, the WST partnered with the Western Pennsylvania Conservancy to plant wildlife habitat, using recycled leaf compost mulch, that has the added benefit of erosion control. The team also works with the Pa. Chapter of the American Chestnut Foundation to plant blight-resistant hybrid American chestnut trees on-site.

The WST is also involved in maintenance for the site's wildflower mounds and pollinators gardens, which attract a range of hummingbirds, butterflies and other insects. Maintenance includes seasonal weeding, planting and mulching. While native plants are not used exclusively on-site they are promoted whenever possible. In forested areas standing dead trees and brush piles are left in place for wildlife habitat.



Zebra swallowtail

Mowing was halted in many areas that were originally covered by turfgrass, allowing the grasses to grow tall. These grasses now provide wildlife habitat and save the company roughly \$30,000 each year in reduced mowing costs! The reduced mowing has led to a slight increase in the tick population that goes hand-in-hand with the white-tailed deer on-site. The tick threat is minimal, but some blue bird nest boxes had to be moved from no-mow areas to mowed areas along the trails in order to reduce the risk of tick/human interactions.

The Bayer U.S. Headquarters was certified as a WHC *Corporate Lands for Learning* site in 2003 for their public education programs, and they have retained that certification ever since. In 2008, the WHC awarded Bayer's Pittsburgh site with the "Signature of Sustainability Award," a distinction that only 21 of the 400 WHC-certified sites in the United States have been given. The Bayer Pittsburgh campus received this prestigious award due to the many community partnerships, environmental education programs, and wildlife habitat initiatives that they are involved in.

Bayer believes that making their sites as sustainable as possible makes good business sense. Their actions show the public that they are a responsible leader in the region, thereby encouraging their employees to echo the company's values through the volunteer work that they do. Bayer demonstrates a commitment to environmental sustainability by putting into practice new ways to protect the land they share with the animals and plant life that make the Bayer Pittsburgh campus so beautiful and unique.

Bayer staff encourage other companies to take sustainability seriously. Use the expertise of your employees and the resources and buy-in of the corporation to create a successful, sustainable site. As Valerie Patrick says, "Sustainability is a journey. Take a purposeful approach."



Triangle Park

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Triangle Park is a 2.5-acre neighborhood park with a playground, baseball field and basketball court located in an older, densely developed area of Rutledge Borough, Delaware County. The park, surrounding residential neighborhood, as well as nearby Stoney Creek, have a history of flooding. The Borough, eager to improve these conditions, participated in an urban stormwater retrofit project sponsored by the Pennsylvania Environmental Council (PEC) and the Darby-Cobbs Watershed Partnership, which provided technical assistance and support with project fundraising.

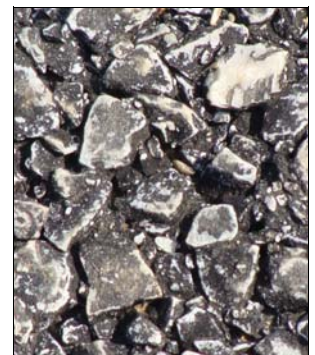
Borough residents and a team of stormwater professionals, including a licensed engineer, looked at existing conditions in the park and the surrounding area to identify retrofit opportunities and best management practices (BMPs) that could alleviate flooding and water quality problems in Stoney Creek. The park's asphalt basketball court and grassy ball field, with its heavily compacted earth, were essentially impervious to stormwater, which meant that instead of rain soaking into the ground, it accumulated on the surface. Combined with runoff from nearby development, this stormwater contributed to local flooding. Over many years, the volume of uncontrolled runoff caused erosion and damage to the creek.

In addition to flooding, uncontrolled urban runoff flushes pollutants, including oil and grease residues from streets, nutrients from unabsorbed residential fertilizers, and sediment from eroded land and stream banks, into the waterways. Rutledge Borough worked actively with PEC to identify BMPs that would better control runoff within the park and provide new stormwater management for runoff from adjacent streets.

Proposed retrofit concepts featured sustainable stormwater practices including both structural BMPs and non-structural, or biological, BMPs. Triangle Park BMPs were designed to divert and infiltrate runoff to reduce overland flow and flooding and, in so doing, reduce erosion and wash-out in and around the park. BMPs also trap and filter pollutants from stormwater runoff. The proposed BMPs were designed to manage the small frequently-occurring storms, reduce flooding and improve conditions in Stoney Creek.

Once the land and soil surveys were completed and BMP concepts accepted by the community, the Borough's engineer prepared final designs and bid the project for construction. Due to budget limitations, construction was bid in two phases. Phase I included the basketball court resurfacing and an underground infiltration system, and new inlets and pipe. Phase II included rain gardens and inlet modifications.

Phase I: the porous asphalt basketball court and subsurface infiltration system was successfully installed over a 5-week period in the summer of 2008. These BMPs work in tandem with the porous asphalt conveying rainwater directly into the underground infiltration system. New storm inlets installed along the street also convey runoff into the subsurface infiltration structure. A modified asphalt mix with larger pore spaces (*see photo on right*) was used for the porous asphalt basketball court, which allows water to rapidly drain down into the underlying system.





Stormwater is then temporarily stored in the underground infiltration structure and slowly percolates into the ground below, where it recharges groundwater. Once underground, the water gradually flows through the earth toward the creek, eventually seeping out of the stream bank and recharging the creek with clean, cool water.



Installed in 2008, the construction of this porous asphalt court was timed to coincide with planned court resurfacing

Water typically does not collect or pond on porous asphalt, since rain rapidly drains into the underground stormwater infiltration system. Therefore, this pavement is less prone to freeze-thaw problems than traditional pavement, and it dries much more quickly, giving basketball players more court time.

The cost to complete Phase 1 construction of the court, infiltration system, two new inlets and conveyance pipe totaled \$75,000.

Implementing state-of-art BMPs, particularly an underground structure, require making a commitment to routine inspect and monitoring. As with any infrastructure, inspections should occur regularly and after major storms. Maintenance should be scheduled and budgeted on an as-needed basis. When used on parking lots, porous asphalt requires routine vacuum cleaning to prevent litter, dirt or other particles from accumulating on the surface, which impedes porosity and drainage.

It is recommended that porous asphalt parking lots be vacuum cleaned at least annually and more often if debris, including fallen leaves and litter, accumulates. Since the park's basketball court is a lower intensity use, the Borough will routinely clean and sweep the surface and hire a contract vacuum service only when needed to prevent clogging. (For example, if it appears that particles or dirt are accumulating on the surface or water is ponding, this is an indicator that the court should be vacuum cleaned.) Trash cans in the vicinity of the court are emptied regularly to prevent litter from collecting on or near the court. Streets and storm inlets are cleaned regularly to prevent trash and debris from impeding flow into the inlets.

The second phase, which includes the final design and installation of rain gardens, demonstrates another sustainable practice that will better manage stormwater and provide attractive landscape features. The location within the park selected for two small rain gardens is a formerly under-used area near the playground subject to run-off and erosion. Another consideration influencing the location of the gardens was the community's interest in creating a visual break between the tot lot playground and the basketball court. Rain gardens are considered a non-structural BMP, which can be adapted for site conditions.



Borough Council was interested in a more manicured appearance, so the designer comprised the planting plan and used rock in the center. This "rock-garden" element may be modified at a later date, depending upon its functionality and appearance over time



Pennsburg Nature Preserve

John W. Munro
Munro Ecological Services, Inc.
990 Old Sumneytown Pike
Harleysville, PA 19438

Pennsburg Borough
Municipal Building
76 West 6th Street
Pennsburg, PA 18073

During early 2001, members of the Pennsburg Shade Tree Committee decided that the Borough's one and only "natural" park, inherited from a local golf course, needed some serious work in order to meet its namesake: the Pennsburg Nature Preserve.

The Committee requested the expertise of Munro Ecological Services, Inc. (MES) to provide inventory and concept planning with the intent that the Committee would search for grant funding to do the planned work. Some of the concerns of the Committee were that the stream in the park was badly eroded, there was too much grass to mow, the park wasn't "natural" and it lacked decent riparian vegetation and floodplain forest. The Committee agreed with the consultant that ecological restoration was needed.



Macoby Creek, which runs through the park, suffered from steep eroding banks

The consultant drew up a **concept plan** that includes:

- 1.3 acres of conversion from mowed lawn to native tallgrass meadow

- 490 feet of streambank stabilization using MES structural fascines and timber crib face bio-structural design (*these are structures with specifications designed by MES staff*)
- Series of 4 stream sills, to begin elevating the incised channel back to its pre-disturbance level
- Planting of two acres of floodplain forest where golf course mowing had recently ceased
- Planting a series of 15 native shrub and tree patches in the existing mowed lawn to: provide visual variety in the stark lawn setting; include habitat for native birds and small animals; cluster examples of native riparian shrub species; and reduce mowing requirements
- A walking trail around the meadow and along the stream

The Borough accepted the concept plan and the Committee wrote a grant application for the Pa. Department of Environment Protection's (DEP) Growing Greener grant program, while its consultant prepared detailed plans and got the permit for the work stream work from DEP. Both the grant (with slightly less funding than requested) and the permit (with requirement for proof that bog turtles were not present) were approved and work got underway.

During 2005 most of the restoration work was performed. The work formula was for the ecological consultant to provide direction, assistance and oversight of the installation team: the "volunteers." Even with a novice crew the work still had to be done properly and according to design and permit, or it would not succeed.



The volunteer groups used on various days throughout the season included Pennsburg Borough staff and elected officials including some family and friends, biology and science classes from local middle and high schools, a group of driving or drug offenders doing community service time, a group of graduate students from the University of Pennsylvania working on a “team” project, members of a local Quaker Meeting, and a very willing crew of workers from the local county prison working for time off from their sentences (who regarded their trips to this suburban small town as “going to Mayberry”).



These middle school student volunteers from the Upper Perkiomen School District carried structural fascines to Macoby Creek in order to help stabilize the banks

The volunteers, under the supervision of the consultant, were involved in a variety of park improvement projects, including:

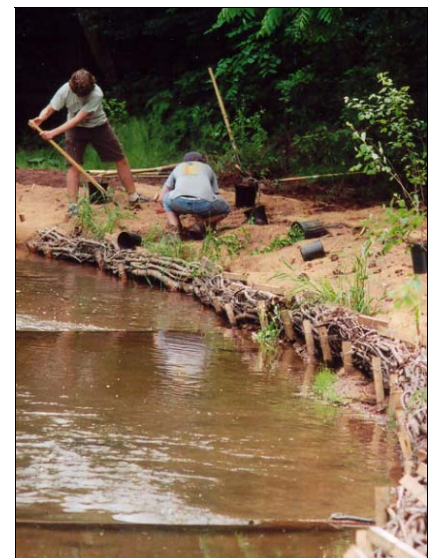
The streambanks – The series of seven different bio-structural formulae were used and worked as expected, and the previously excessive rate of bank erosion was stopped. It was noted that in one section of 200 foot length, a stream bank of 2 feet in height eroded between one and three horizontal feet in a two year period just prior to the restoration work (many tons of soil, if you do the math).

The plantings in most of the bio-structures grew rapidly and have begun to perform their long-term rooting and erosion control function. The few places where initial plantings in the interstices of the log structures did not grow, are gradually being replanted during yearly Earth Day events. The Macoby Creek is now stable through the Nature Preserve. Only a few areas are in need of small structure repairs.



A stream sill and planted structural fascines

The stream sills- The sills began to work immediately upon installation and have performed the intended function of re-accumulating gravel beds in the stream bed. The previous stream scouring and incision (down cutting) were the result of increased flood flows resultant from development of the headwaters.



Volunteers planting native trees and shrubs in the riparian buffer. Structural fascines line the creek edge



It is estimated that the stream incision in the park was at least 12 inches and as much as 24 inches in various stream segments in the park. The stream water level has now been raised by 8 to 12 inches and the areas behind the sills have filled in with gravel sufficiently to provide spawning and macro-invertebrate habitat that had been lost (in some areas the scouring had cut to bedrock).

The meadow - The tallgrass meadow installation was finally finished in 2009, after the first seeding was followed the next day by a very heavy rain and flooding of most of the meadow with consequent loss of most of the new seed. After the first year, and as a result of an underperforming meadow and uninformed borough mowing staff, large sections of the designated meadow area were mowed to one inch height, killing off some of the struggling native plants. This discovery provided the opportunity to firmly mark the edges of the meadow and provide explicit instruction to mowing personnel that has prevented excessive mowing since that time.

The first growing season was mostly in drought condition, but during several Earth Day events in following years, in which local volunteers planted Borough-purchased seed and grass plugs, the meadow finally grew thickly and tall.



Warm season grass meadow and native flower plantings

The variety of native species planted include 10 sedge and rush species, 15 species of meadow grasses and flowering forbs, 11 species of riparian shrubs as cuttings and tubelings, 14 riparian shrub species and 9 tree species.

Exotic invasive plants - Associated removals of exotic invasive plants such as multiflora rose (*Rosa multiflora*) have had a significant positive effect on user access to the streams and viewing of the stream and wetland area. The elimination of aggressive strains of the native invasive reed canary grass has not been done yet but may be considered in the future. The issue of neighbor practices of dumping lawn clippings and yard waste in the stream or floodplain area has been reduced but not eliminated. The local presence of Joint Head (*Arthraxon hispidus*), an extremely aggressive and invasive exotic grass, is in many of the floodplains, including the Nature Preserve, has not been addressed. Some year when it becomes appropriate to do a controlled burn of the tallgrass meadow, it will be interesting to find out how cooperative the local fire department and residents will be.

The process of transforming parts of a small local park into wild “natural” areas is not arduous but takes some tenacity. It is not a once-and-done job, but rather takes corrections, tinkering and maintenance. It can be inspiring for the one-time volunteer, and is definitely able to instill a sense of “ownership” in the park and in “natural” areas. One thing that became repeatedly apparent was that many volunteers became aware for the first time that because of the pressures of exotic invasive plants, the increasing surges of floodwaters related to development, and lack of large areas of wild native vegetation, people have to do things to keep “nature” from being overrun. The idea that natural areas don’t or can’t just take care of themselves when surrounded by suburban development, just hadn’t occurred to them. It did occur to them during the volunteer work and was definitely something that they took home with them.



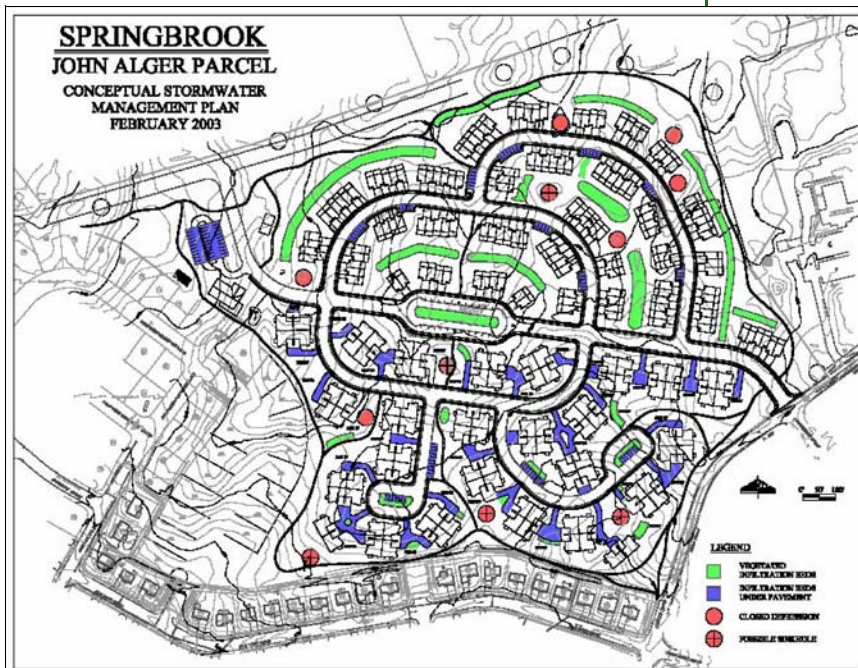
The Village at Springbrook Farms

Editor's Note: While we do not necessarily advocate the conversion of farmland for residential, commercial or industrial purposes, we have chosen to highlight this project because it incorporates low impact development (LID) principles and green stormwater management methods to minimize the impact to the larger environment. While building on brownfields or reusing existing housing stock may be more sustainable, this is a dense, walkable development and the best management practices (BMPs) used in this project serve as a model.

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CH2M HILL
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Many traditional neighborhood developments increase the amount of stormwater runoff in an area, due to large amounts of non-porous pavement and turfgrass. This runoff can cause ecological and economic devastation through flooding, erosion and water pollution. The Village at Springbrook Farm is a 259-unit (149 townhomes, 96 quads, 17 single-family homes) low-impact development (LID) residential neighborhood in Campbelltown, Lebanon County.

The way the 59-acre site was designed aims to avoid such negative consequences by incorporating sustainable stormwater management practices. According to Wes Horner, former associate at CH2M HILL (the engineering firm responsible for the LID design), “Our approach at Springbrook was to keep the stormwater as close to the source as possible, cleansing and recycling it with many different ‘best practices’.” All in all there will be 124 storage/infiltration elements on the site.



The site's stormwater management plan map

The development project began in 2002. One of the first steps in the process was to do extensive geological and hydrological studies of the site to ensure that the chosen BMPs did not cause structural damage to the underlying geology and groundwater. Much of Lebanon County is home to karst topography and limestone, a combination that makes the area prone to sinkholes. Before any homes could be built on such a site, the sink hole problem had to be dealt with. Nearly half of the site's stormwater drained into closed depressions like the one shown on the next page.



If standing water like that remained, sinkholes could potentially open up. On a farm field those issues are a nuisance, but in a residential neighborhood they can be dangerous. Therefore, any stormwater management method used on the site needed to have water infiltrate at a controlled rate and infiltration beds needed to be as close to the surface as possible, and spread out through the site. This allows the system to effectively remove pollutants from the runoff, while reducing the risk of sinkhole formation. Because of the site's topography, traditional stormwater management methods would have required excessive grading and excavation, which is costly and not recommended over limestone.



Evidence of karst topography on site, pre-development

Instead of using several large, unsightly detention basins, as is typically used in residential neighborhoods of this size, CH2M HILL chose several sustainable methods of mitigating stormwater runoff. Porous asphalt paving was used for the sidewalks, parking areas and paths (*see photos on right*). The porous paving is installed on top of a stone-filled recharge bed that purifies stormwater as it infiltrates into the ground. On-site rain gardens and vegetated swales also help to cleanse stormwater, while providing aesthetically pleasing landscape views for the residents.

Homeowners are pleased with the stormwater elements and the realty company uses them for marketing purposes: "The Village is a low impact development offering some of the newest and most unique storm water management systems in the area. Our environmentally friendly system uses aesthetically pleasing rain gardens and infiltration beds which are incorporated into the landscape providing plenty of green space while recharging the ground water source."



Individual home rain garden



Porous asphalt bike path (above) and sidewalk (on right)





As with most, if not all large construction projects, some small glitches had to be taken into consideration, such as the need to continuously maintain rigorous erosion and sediment control measures, ensuring that infiltration areas were not placed too close to limestone pinnacles, and the coordination of overall site construction with storm-water BMP construction, in terms of phasing, site protection, and materials (*see photo below*). These issues become all the more important on multi-phased residential projects, like this one, that can go on for years.



Coordinating construction presented challenges

You may ask yourself why an engineering firm would choose to implement these sustainable practices, especially considering that many green technologies like porous pavement can have a greater upfront cost. For one thing, with all of these technologies in place the site is able to have no net increase in runoff volume during a 2-year frequency, 24-hour duration storm event and no increase in peak flow rates for 1-year through 100-year storms. This helps the project meet government regulations and protect property from flooding. Long-term maintenance costs on systems like rain gardens can be much lower than in traditional gray infrastructure, as well.

But it's also deeper than that. For CH2M's Andrew Potts, P.E., "Sustainability is critical to me. My goal is to instill sustainability as much as possible in every project. To me it's so ingrained that I have to ask, "why not?" Why wouldn't we protect and sustain our drinking water supply? Why wouldn't we improve water quality in our stream systems and the Chesapeake Bay? Why wouldn't we want to create beautiful, walkable, bikeable residential communities with native vegetation instead of nothing but turf grass?"

For the most part, maintenance has been straightforward and handled in the same manner as any residential common area would be handled. One minor difficulty that was encountered was that the mulch originally used in the rain gardens tended to float when the gardens took on water. This led to the need for filter baskets in the rain garden overflow structure to catch mud, debris, leaves and other detritus.



Mulch in the rain garden caused some minor difficulties

CREDITS

LID/Stormwater design —
CH2M HILL
(formerly Cahill Associates)

Owner/Developer —
Brownstone Real Estate Company

Landscape Architect —
RGS Associates

Site Contractor —
Abel Construction



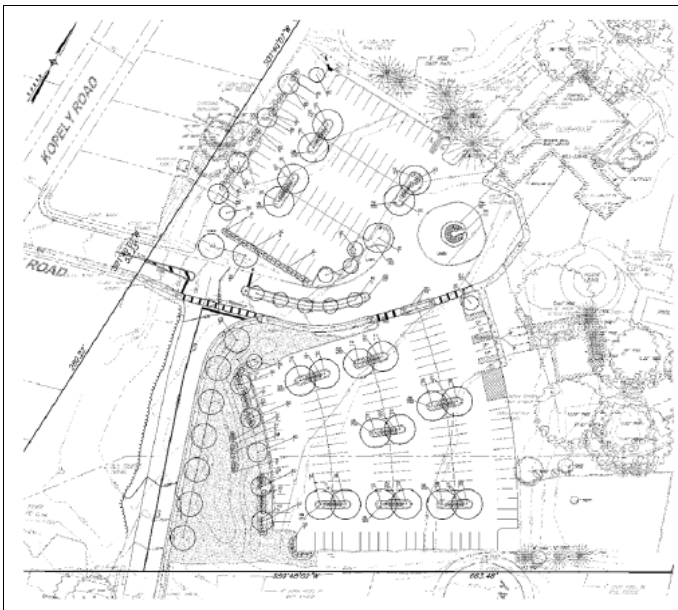
Flourtown Country Club

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The Flourtown Country Club was an existing facility owned by Springfield Township (Montgomery County, Pa.). It consisted of a nine hole golf course, a banquet facility, swimming pools and a parking area that essentially was a vast field of asphalt with poor circulation patterns and poor lighting. The Township determined that improvements to the facility were needed and decided to create a new entrance to the club with more defined circulation to enhance the safety of both pedestrian and vehicular traffic.

The Township Engineer Firm, Boucher & James, Inc., saw an opportunity to create a more sustainable site, while still meeting the needs of the Township and addressing the immediate safety concerns.



The Landscape Plan for the redesigned country club

Specifically, Boucher & James, Inc. identified the following opportunities:

- Create green spaces in areas that were formerly paved (minimize and decrease pavement and non-porous surfaces)
- Address stormwater concerns, both quality and quantity, since no storm sewers exist in the area
- Grade new/redesigned pavement areas to maintain the pre-development drainage patterns
- Reintroduce native species into the landscape design of the facility to both promote native species and to reduce maintenance needs and demands

Springfield Township was very receptive to these ideas and plans and designs were prepared to meet their needs. A new entry sequence was designed to complement and enhance the new architectural features proposed and to direct the public to the proper entrance areas for their functions. Design continued for the new parking area and emphasis was placed on circulation and safety for both pedestrian and vehicular traffic. The new parking lot and entry area was designed to include planted islands that serve several functions. They serve to separate and direct the traffic; they provide areas for native plantings; and they provide the opportunity to plant vegetation to provide shade and to mitigate the affects of the sun beating down on the paved areas.



After a series of soil pits were dug and testing was completed to determine the feasibility of utilizing infiltration for stormwater management, it was determined that the potential for infiltration was only marginal, at best, and therefore not a primary option for this site. Stormwater detention facilities were also eliminated as an option, as there was nowhere to outlet such facilities. After a thorough study of available options and alternatives, a design solution for stormwater management was formed.

The design solution consisted of a two-tiered concept of informal stormwater infiltration with significant soils amendment and the planting of a conservation seed mix. Landscaping (with native vegetation) was proposed along parking areas to reduce the rate of run-off and to filter pollutants such as sediment and petroleum hydrocarbons from the run-off. The upper tier was designed to take the first flush of stormwater. It would then reduce the rate of the stormwater and permit sediment and pollutants to settle prior to spilling over into the lower tier. Each tier was designed to permit marginal infiltration (as much as the soils would permit). The cumulative effect of the two tiers and the vegetation was designed to provide dissipation of stormwater run-off and increased quality of run-off beyond what currently exists at the site and beyond what would exist if overland flows were permitted to occur unabated, even with the reduced paving and new parking lot design.



Soil quality did not allow for infiltration beds, so an informal solution was designed, using native plants

During construction, issues arose which required design modifications.

- Standing water was evident in the two tiers during and after storm events. Unfortunately, the soils were not able to absorb/infiltrate as much as the testing indicated would be possible and standing water for extended periods of time was not acceptable to the residents or the community. To address this issue, stone beds were created to remove standing water from the surface and detain it underground while the infiltration process occurred, at a slower rate. The stone beds under the tier gardens were then connected underground to permit overflow from the upper bed to enter the lower bed just as surface grading had previously permitted.
- After the first set of modifications, the tier gardens were able to drain totally in three to four days. Neighbors expressed concern over any standing water, even though it was infiltrating, and seemed to base many of their concerns on fear of the spread of the West Nile Virus. In response to these concerns, the Township installed a drain pipe to permit water in the upper surface of the garden/bed to drain to the curb line.

Although other methods may have been available to address the threat of the spread of West Nile Virus (such as the introduction of bats/bat houses), it was clear that the concerns of the neighbors were not going to be addressed unless and until the standing water was eliminated from the site. The Township chose to address the concerns of their residents by modifying the original design.

Even though the site ended up being not quite as “sustainable” as was originally planned and designed, the end result is that the site is now much improved and more sustainable than it was previously.



Sustainable site design elements include:

- Reduced paving and impervious surfaces
- Use of “tiered gardens” to slow the rate of runoff
- Use of native vegetation to filter sediments and pollutants from the stormwater
- Use of graded landforms (a small berm between the upper and lower tier) to force water to settle and cleanse prior to overtopping the berm and continuing down to the lower tier
- Shade trees were planted along the perimeter of the parking and in islands to provide shade and cool the pavement, thereby improving the microclimate of the site
- Use of native vegetation that is suited to the area and will require less maintenance than exotic species

The end result is the Township now has an attractive, functional and more sustainable entrance and parking area for the Flourtown Country Club. The primary needs of improving pedestrian and vehicular safety were met with an attractive design that also was able to include sustainable elements.



The parking lot and entrance to the country club are now more visually appealing and sustainable, in addition to being safer for pedestrians and drivers



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While many of the sustainable landscape design, management and maintenance practices outlined in the book will save money in the long-term they do come with upfront costs. Fortunately there are numerous grants, technical assistance funds and other sources of funding that can be applied toward creating and maintaining sustainable parks and other landscapes. The following sources will give you a good sense of what programs are out there and how to find more information about them. Website addresses may change over time; if you find a broken website link do an internet search for the funding source's title and you should be able to find updated information, although some grant programs may have ended due to financial constraints.

AQUATIC HABITAT RESTORATION and INVASIVES CONTROL

FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Clean Water Grants Program	(1) community organizations and other nonprofit groups	Creative and innovative projects to teach boaters to reduce their impact on the waters they use, including invasives education.	www.boatus.com/cleanwater/grants/
Aquatic Invasive Species Research and Outreach Program	(1) Individuals (2) institutes of higher education (3) non-profits (4) businesses (5) State, local and Tribal governments (6) foreign governments and international organizations	Develop information and tools to prevent, monitor and control aquatic invasives of coastal, oceanic and Great Lakes ecosystems.	www.seagrant.noaa.gov/funding/rfp.html
Chesapeake Bay Program Grants	(1) Nonprofits (2) educational institutions (3) State, local and Tribal governments	Reduce and prevent pollution, and improve living resources in the Bay.	www.epa.gov/region3/chesapeake/grants.htm
Great Lakes Program	(1) community/watershed groups (2) nonprofits (3) educational institutions (4) conservation districts (5) Federal, State, local and Tribal governments	Address invasive species issues, protect and restore habitat, correct erosion problems.	www.epa.gov/glnpo/fund/glf.html
FishAmerica Foundation Grants	(1) nonprofits (2) State and local agencies to a lesser degree	Enhance fish populations and improve water quality, including invasives issues.	www.fishamerica.org/grants/index.html
Great Ships Initiative Grants		Offers research services to developers of treatment systems designed to minimize the presence of live organisms in ballast water discharge.	www.nemw.org/GSI/solicitation.htm
Delaware Estuary Watershed Grants	(1) nonprofits (2) State and local governments (3) educational institutions	Provides grants for local organizations that focuses on protecting, improving and taking care of Watersheds in the Delaware Estuary.	www.nfwf.org
Sustainable Watershed Assets Grant	(1) Nonprofits in the greater Philadelphia region	Promote policies, investments and projects that ensure land and water protection.	www.williampennfoundation.org



FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Ballast Water Management Demonstration Program		Supports development, testing and demonstration of technologies that treat ships' ballast water to reduce threat of aquatic invasive species.	www.seagrant.noaa.gov/funding/rfp.html
Watershed Cooperative Agreement Program	(1) Nonprofits with 501(c) 3 status	Restore stream habitat - fishery resources, riparian buffers, pollutant removal.	www.osmre.gov/acsiapplication.htm
Great Lakes Protection Fund	(1) nonprofits (2) for-profits (3) government agencies (4) individuals	Protect and restore the health of the Great Lakes ecosystem.	www.glpf.org/faq/index.html#guidelines
Chesapeake Bay Small Watershed Grants Program	(1) organizations working on a local level	Restore important habitats within the basin, encourage environmentally-sensitive development, land conservation, and land-use planning.	www.nfwf.org
Emergency Watershed Protection	(1) Private landowners (2) conservation districts (3) State and local governments (4) Tribes	Protects against floods, drought, wildfires, etc. Funds for clearing of debris, restoring vegetation and stabilizing river banks.	www.pa.nrcs.usda.gov/programs/ewp.html
Watershed Protection and Flood Prevention Program	(1) conservation districts (2) State, local and Tribal governments	Projects related to erosion and sediment control, wetland creation and restoration and habitat enhancement.	www.pa.nrcs.usda.gov/programs/watershed.html
Wetlands Reserve Program	(1) Landowners (2) Tribes	Provides technical and financial assistance to address wetland, wildlife habitat, soil, water and related natural resource concerns.	www.nrcs.usda.gov/PROGRAMS/wrtp
North American Wetlands Conservation Fund	(1) Private or public organizations (2) individuals who have developed partnerships	Restore, manage or enhance wetland ecosystems and other habitat for migratory birds and other wildlife.	www.doi.gov/partnerships/wetlands.html
Partners for Fish and Wildlife Program	(1) Private landowners	Restore habitat, particularly those that protect migratory birds, anadromous fish and species federally-listed as threatened or endangered.	www.fws.gov/partners/index.htm
Floodplain Land Use Assistance Program	(1) municipal governments	Preparation, administration and enforcement of floodplain regulations.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=99



FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Coastal Zone Management Grant	(1) state and local governments (2) non-profits; in the Lake Erie or Delaware River watersheds	Funding for wetlands, coastal hazard areas, public access for recreation, non-point source pollution prevention, biodiversity, fisheries management, etc.	www.dep.state.pa.us/river/grants/crmgrants/crmgrants.htm
Coastal Non-Point Pollution Program	(1) state and local governments (2) non-profits; in the Lake Erie or Delaware River watersheds	Improve onsite sewer systems, upgrade marinas, create out-reach materials, reduce storm-water impacts.	www.dep.state.pa.us/river/grants/cnpp/cnpp.htm
Coastal and Estuarine Land Conservation Program	(1) state and local governments in the Lake Erie or Delaware River watersheds	Provides matching funds to purchase significant coastal and estuarine lands or conservation easements on such lands.	www.dep.state.pa.us/river/grants/celcp/celcp.htm
Growing Greener Watershed Grants	(1) County and local governments (2) school districts (3) non-profits (4) conservation districts (5) watershed associations	Restore watersheds and streams, remediate acid mine drainage, reclaim mine lands.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=65
Nonpoint Source Implementation Program	(1) county and municipal governments (2) school districts (3) non-profits (4) conservation districts (5) watershed groups	Funding for abandoned mine drainage, agriculture and urban run-off, streambank stabilization and development of watershed restoration plans.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=4
*** Other grants that may be of use to local governments: Department of Community and Economic Development at www.newpa.com/find-and-apply-for-funding/index.aspx Federal Government Grants Website at www.grants.gov Federal Economic Recovery Website at www.recovery.gov			



TERRESTRIAL HABITAT RESTORATION and INVASIVES CONTROL

FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Bring Back the Natives	(1) nonprofits (2) universities (3) Federal, State, tribal and local governments	Restore native species to their historic range. Preference will be given to projects that will keep sensitive or declining species off of the Endangered Species List, or for listed species that have a chance for recovery and de-listing within 5-10 years.	www.nfwf.org
Treevitalize	(1) community groups and local partnerships	Grants and technical assistance to plant trees in neighborhoods and along streams.	www.treevitalize.net
Grassland Reserve Program	(1) private lands of 40 or more contiguous acres (2) smaller acreage under special circumstances	Helps landowners restore, protect and rehabilitate grassland, rangeland, pastures and shrub land.	www.pa.nrcs.usda.gov/programs/grp/index.html
General Matching Grants Program	(1) Federal, State, local and Tribal governments (2) educational institutions (3) conservation organizations	Address priority actions promoting fish and wildlife conservation and habitats.	www.nfwf.org
Native Plant Conservation Initiative	(1) nonprofits (2) Federal, State and local governments	Restore or protect native plant communities, or conduct inventories and assessments.	www.nfwf.org
Environmental Action Grants	(1) small, grass-roots activist organizations	Build public involvement and support for a specific and focused environmental issue, including biodiversity and ecosystem protection. Must be very action oriented and target the root cause of a problem.	www.patagonia.com/web/us/patagonia.go?assetid=2942
Conservation Reserve Enhancement Program	(1) producers	Land retirement program that protects environmentally sensitive land, decreases erosion, restores wildlife habitat and protects water resources.	www.fsa.usda.gov/FSA
Pulling Together Initiative	(1) nonprofits (2) State and local governments (3) field staff of federal government agencies	Prevent, manage or eradicate invasive and noxious plants and increase public awareness of their adverse impacts.	www.nfwf.org
Environmental Quality Incentive Program Assistance	(1) State and local governments (2) higher education institutions (3) Tribes (4) 501 c3 nonprofits	Projects optimize environmental benefits on farm land that reduce nonpoint source pollution like erosion, and promote at-risk species habitat conservation.	www.pa.nrcs.usda.gov/programs/eqip/Index.html



FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Integrated Research, Education, and Extension Competitive Grants Program	(1) Land grants (2) Cooperative extension offices	Address priority national needs associated with integrated pest management programs. Help pest managers implement IPM methods that will enhance farm conservation efforts and the protection of natural resources.	www.csrees.usda.gov/fo/nationalextensionipmspecial-projectsprogram.cfm
Program of Research on the Economies of Invasive Species Management	(1) public or private research institutions or organizations (2) individuals meeting peer-reviewed professional criteria as economic researchers	Focus on economic issues related to invasive species of agricultural significance or other pests that fall under USDA programs.	www.ers.usda.gov/Briefing/InvasiveSpecies/#Feature
Small Business Innovation Research	(1) Small businesses	Develop new or improved technologies and environmentally sound approaches for wildlife management to reduce the adverse impact of wildlife on agriculture and people (including invasive animal species), and enhance the sustainability of wildlife populations.	www.csrees.usda.gov/fo/fundview.cfm?fonum=1220
Global ReLeaf	(1) government entities (2) private landowners under special circumstances	Fund tree planting on government-owned land (or private land under special circumstances), particularly on larger tracts of land damaged by human or natural causes.	www.americanforests.org/global_releaf/grants
Environmental Initiative Program	(1) nonprofits (2) Local governments	Initiate or implement projects in rural areas to undertake consensus-based activities in environmental stewardship.	www.musserfund.org/enviro.php
Education Foundation of America Grants	(1) Tax-exempt non-profits	The environment, national security issues, the arts, and other interests of the Board members.	www.efaw.org/Inquiry%20Guidelines.htm
Merck Family Fund Grants	(1) non-profits	Protect and restore ecologically valuable land, sustainable forestry.	www.merckff.org/grantguidelines.html
Keystone Initiative Grants	(1) educational institutions (2) Federal, State, Tribal and local governments (3) non-profits	Engage private landowners, particularly farmers and ranchers, in the conservation of wildlife and natural resources on their lands.	www.nfwf.org
Five Star Restoration Matching Grants Program	(1) any public or private entity, but must include partnership of five organizations	Support community-based wetland, riparian and coastal habitat restoration projects.	www.nfwf.org



FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Matching Awards Program	(1) nonprofits working on or adjacent to National Forests and Grasslands (2) educational institutions	Community-based forestry, watershed health and restoration, wildlife habitat improvement and recreation.	www.natlforests.org/consp_04_map.html
Conservation Innovation Grants	(1) non-Federal governments (2) non-governmental organizations (3) Tribes (4) individuals **project must include producers eligible under EQIP	Stimulate development and adoption of innovative conservation approaches and technologies for environmental enhancement and protection, in conjunction with agricultural production.	www.nrcs.usda.gov/programs/cig
Wildlife Habitat Incentives Program	(1) private landowners (2) owners of Federal land (3) owners of State and local government land on a limited basis (4) owners of Tribal land	Develop and improve wildlife habitat primarily on private lands.	www.nrcs.usda.gov/Programs/whip
Cooperative Endangered Species Conservation Fund Grants	(1) State agencies (2) Private landowners (3) organizations	Aid implementation of various conservation projects and land acquisition to protect Federally listed or endangered species.	www.fws.gov
Landowner Incentive	(1) State agencies with lead management responsibility for fish and wildlife resources	Provide technical or financial assistance to private landowners to protect, restore, or manage habitat for Federally listed, proposed, or other at-risk species.	http://wsfrprograms.fws.gov/Subpages/GrantPrograms/LIP/LIP.htm
Conservation Technical Assistance	(1) private landowners (2) communities (3) units of State and local governments (4) Federal agencies	Provides conservation technical assistance to participants in USDA cost-share and conservation incentive programs. Can be used for erosion control, habitat enhancement, wetland improvements and other natural resource issues.	www.nrcs.usda.gov/programs/cta
Private Stewardship Grants Program	(1) Individuals (2) groups	Aid conservation efforts that benefit Federally listed, proposed, or candidate species or other at-risk species.	www.fws.gov/endangered/grants/private_stewardship/index.html
State Wildlife Grants	(1) State agencies with lead management responsibility for fish and wildlife resources that has a comprehensive wildlife conservation plan	Develop and implement programs for the benefit of wildlife and their habitat, including those species not hunted or fished.	http://wsfrprograms.fws.gov/Subpages/GrantPrograms/SWG/SWG.htm
Wildlife Forever Challenge Grant	(1) Conservation groups (2) Sportsmen's groups (3) Outdoor recreation groups	Habitat restoration and acquisition, research and management, and educational projects. Special emphasis on grassroots projects.	www.wildlife-forever.org/grants/overview.aspx



COMMUNITY IMPROVEMENT

FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Community Conservation Partnerships Program	(1) Local governments (2) county governments (3) non-profit groups	Assist with recreation and conservation needs and support economically beneficial recreational tourism initiatives. Three project types: planning, acquisition, development	www.dcnr.state.pa.us/brc/grants
Illegal Dump Cleanup Grant	(1) community groups (2) municipal governments	Assist with cleanup efforts on illegal dump sites.	www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1418&Q=505018
Enactment of Ordinances and Implementation of Stormwater Management Plans	(1) municipal governments	Reimburse for costs incurred in the adoption or revision of ordinances or regulations in complying with PA Stormwater Management Act.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=6
Flood Protection Grant Program	(1) county and municipal governments	Provides funds to entities responsible for the operation and maintenance of flood protection projects for non-routine maintenance and project improvements.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=61
Household Hazardous Waste Collection Program	(1) county and municipal governments	Reimburse 50% of costs of household hazardous waste programs.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=38
Municipal Recycling Program Grant	(1) county and municipal governments	Reimburse up to 90% of costs associated with government recycling programs.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=34
Recycling Markets Infrastructure Development Grant	(1) Non-profits (2) for profit businesses	Provide reimbursement for equipment costs associated with increasing the use of recycled content in products.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=89
Community Development Block Grant	(1) Municipal governments	Housing rehabilitation, public services, community facilities, infrastructure improvements, planning and development.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=71
Elm Street Program	(1) Municipal governments (2) non-profits (3) economic development groups	Revitalize residential and mixed-use neighborhoods near central business districts.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=74
Land Use Planning and Technical Assistance Program	(1) County government (2) partnership of 2 or more municipalities	Preparing and updating county comprehensive plans.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=100



FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Local Municipal Resources and Development Program	(1) municipal government (2) non-profits	Construction or rehabilitation of infrastructure, building rehab, acquisition of land, crime prevention, recreation, etc.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=78
Main Street Program	(1) municipal governments	To hire a Main Street program manager and do physical improvements of downtown area.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=79
Urban Development Program	(1) municipal governments (2) non-profits	Construction or rehab of infrastructure, building rehab, land acquisition, crime prevention, recreation, etc.	www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/funding-detail/index.aspx?progId=81
** Other grants that may be of use to local governments, community groups, and businesses can be found through: Department of Community and Economic Development at www.newpa.com/find-and-apply-for-funding/index.aspx Federal Government Grants Website at www.grants.gov Federal Economic Recovery Website at www.recovery.gov			

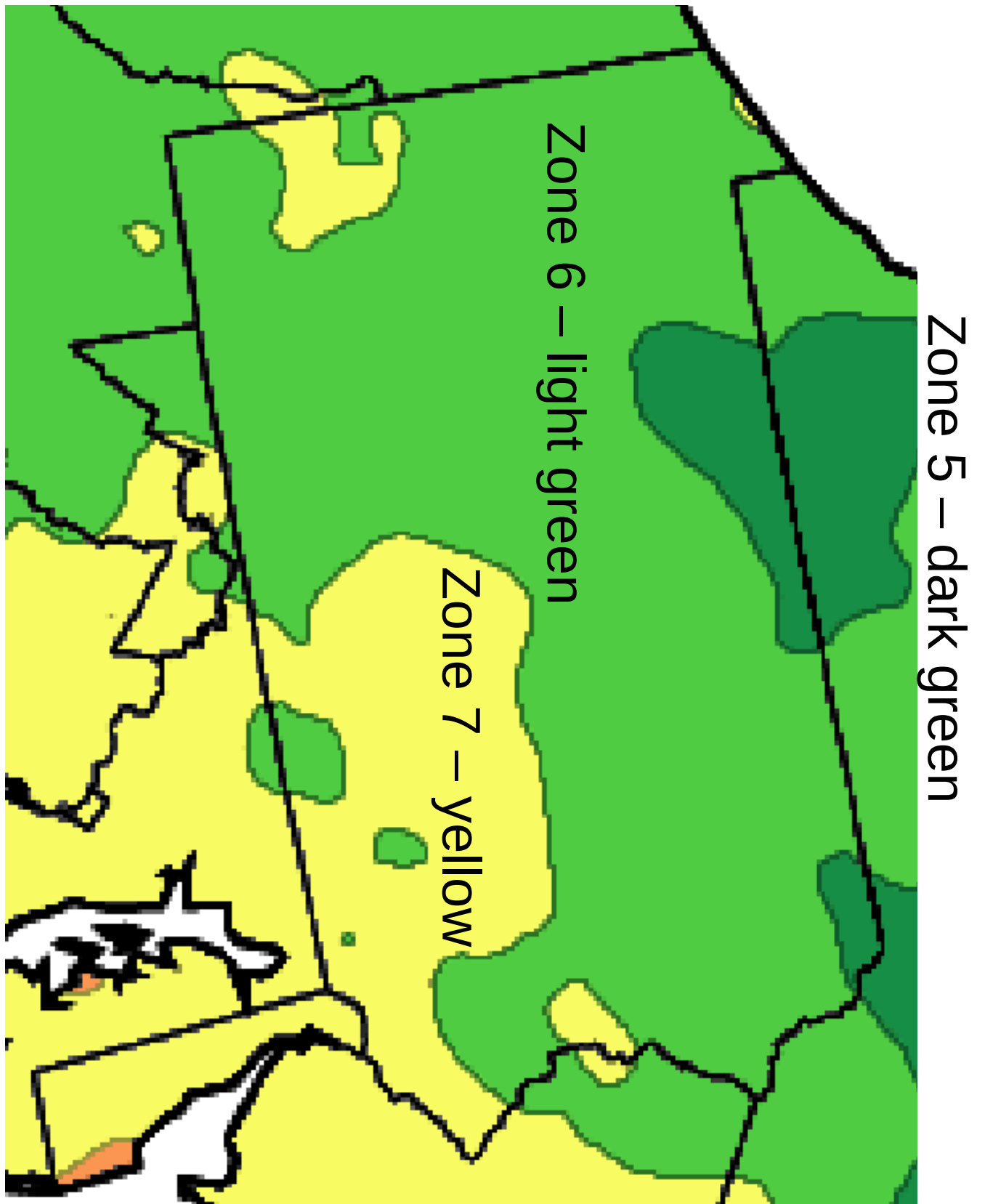
ENVIRONMENTAL EDUCATION and OUTREACH

FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Environmental Education Grants	(1) County and local government (2) school districts (3) non-profits (4) colleges (5) conservation districts	Support environmental education programs throughout the state.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=57
Nonpoint Source Pollution Educational Mini-Grants	(1) conservation districts	Inform and educate people about the causes and consequences of non-point source water pollution.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=23
Watershed Education Grants	(1) county and local governments (2) conservation districts (3) school districts (4) non-profits (5) other	Support community coalitions undertaking public education projects aimed at mitigating or preventing nonpoint source pollution in PA's watersheds.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=56



ENERGY EFFICIENCY

FUNDING SOURCE	ELIGIBLE GROUPS	DESCRIPTION	WEBSITE
Alternative Fuels Incentive Grant	(1) school districts (2) municipal governments (3) non-profits (4) limited liability corporations	Promote the use of biofuels statewide. Retrofit existing fleet vehicles to run on alternative fuels or purchase new vehicles.	www.depweb.state.pa.us/enintech/cwp/view.asp?a=1412&Q=502176&enintechNav=
Compost Infrastructure Development Grant	(1) non-profits (2) for-profit businesses	Incorporate recovered organic materials into products or increase the amount of organic material processed at composting facilities.	www.depweb.state.pa.us/landrecwaste/cwp/view.asp?a=1244&Q=468611&landrecwasteNav= 38587
Keystone HELP Energy Efficiency Loan and Rebate Program			www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=143
Local Government Greenhouse Gas Pilot Grant Program	(1) County and municipal governments	To develop greenhouse gas emissions inventories and emission reduction action plans.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=138
PA Energy Development Authority Grants	(1) County and local governments (2) school districts (3) non-profits (4) Businesses	Grants or loan guarantees for alternative energy projects and related research into manufacturing those technologies.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=129
PA Energy Harvest Grant	(1) County and local governments (2) school districts (3) non-profits (4) conservation districts (5) Businesses	To deploy cleaner energy sources that protect water or air quality and have positive economic benefit.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=93
Small Business Advantage Grant Program	(1) PA business with fewer than 100 full time employees	To incorporate energy efficient and pollution preventative equipment or processes to increase business competitiveness and improve the environment.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=92
Small Business Energy Efficiency Grant Program	(1) PA for-profit business with fewer than 100 full time employees	To incorporate energy efficient equipment or processes to increase business competitiveness while improving the environment.	www.dep.state.pa.us/grantscenter/ProgramSummary.asp?ID=141
** Other grants that may be of use to local governments: Federal Government Grants Website at www.grants.gov Federal Economic Recovery Website at www.recovery.gov			





Adapted from “Landscaping with Native Plants,” a DCNR publication available at www.dcnr.state.pa.us/forestry/wildplant/native.aspx.

	Common Name	Latin Name	Bloom Period	Wildlife Value	Height	Hardiness Zone	Water	Light
Medium to Large Trees	Red maple	<i>Acer rubrum</i>	Mar-Apr	very high	40-60 ft	5-6	wet to dry	full sun to shade
	Sugar maple	<i>Acer saccharum</i>	Apr-May	very high	60-75 ft	5-6	moist	partial sun to shade
	Yellow birch	<i>Betula alleghaniensis</i>	Apr-May	very high	60-80 ft	5	moist	partial sun to shade
	Black birch	<i>Betula lenta</i>	Apr-May	very high	45-55 ft	—	Moist to dry	partial sun to shade
	River birch	<i>Betula nigra</i>	Apr-May	very high	60-80 ft	—	wet to moist	full sun to shade
	American beech	<i>Fagus grandifolia</i>	Apr-May	high	50-70 ft	5-6	moist	full sun to shade
	White ash	<i>Fraxinus americana</i>	Apr-May	intermediate	50-80 ft	6	moist to dry	full sun to shade
	Green ash	<i>Fraxinus pennsylvanica</i>	Apr-May	intermediate	30-50 ft	—	wet to moist	full sun to shade
	Tulip poplar	<i>Liriodendron tulipifera</i>	—	intermediate	75-100 ft	6	moist to dry	full sun to shade
	Black gum	<i>Nyssa sylvatica</i>	Apr-May	high	30-60 ft	—	wet to moist	full sun to shade
	Eastern white pine	<i>Pinus strobus</i>	—	very high	50-80 ft	5-6	moist to wet	full sun to shade
	Sycamore	<i>Platanus occidentalis</i>	Apr-May	low	75-100 ft	—	moist	full sun to shade
	White oak	<i>Quercus alba</i>	May-June	very high	5-100 ft	6	moist to dry	full sun to shade
	Chestnut oak	<i>Quercus montana</i>	May-Jun	very high	40-75 ft	6	dry	partial sun to shade
	Pin oak	<i>Quercus palustris</i>	Apr-May	very high	60-70 ft	6	wet to moist	full to partial sun
	Red oak	<i>Quercus rubra</i>	Apr-May	very high	60-80 ft	5-6	moist to dry	full to partial shade
	Sassafras	<i>Sassafras albidum</i>	April	high	30-50 ft	6	moist	full sun to shade
	Basswood	<i>Tilia americana</i>	May-June	very low	60-80 ft	5-6		full to partial sun



	Common Name	Latin Name	Bloom Period	Wildlife Value	Height	Hardiness Zone	Water	Light
Small Trees and Shrubs	Smooth alder	<i>Alnus serrulata</i>	Mar-Apr	high	6-10 ft	6	wet	full sun to shade
	Serviceberry	<i>Amelanchier arborea</i>	Mar-May	high	15-25 ft	6	moist to dry	full sun to shade
	Black chokeberry	<i>Aronia melanocarpa</i>	Mar-Jul	intermediate	3-6 ft	—	wet to dry	full sun to shade
	New Jersey tea	<i>Ceanothus americanus</i>	May-Sept	intermediate	<3 ft	6	moist to dry	full sun to shade
	Buttonbush	<i>Cephalanthus occidentalis</i>	Jun-Sept	intermediate	6-15 ft	6	wet to moist	full sun to shade
	Redbud	<i>Cercis canadensis</i>	April	very low	20-35 ft	—	moist to dry	partial sun to shade
	Alternate-leaved dogwood	<i>Cornus alternifolia</i>	May-June	very high	15-25 ft	5-6	moist	partial sun to shade
	Silky dogwood	<i>Cornus amomum</i>	May-Jul	very high	6-12 ft	6	wet to moist	full to partial sun
	Flowering dogwood	<i>Cornus florida</i>	Apr-June	very high	10-30 ft	6	wet to moist	partial sun to shade
	Witch-hazel	<i>Hamamelis virginiana</i>	Sept-Nov	low	20-30 ft	5-6	moist	partial sun to shade
	Wild hydrangea	<i>Hydrangea arborescens</i>	June-Jul	low	3-5 ft	6	moist	partial sun to shade
	Winterberry	<i>Ilex verticillata</i>	May-June	high	6-10 ft	6	wet to moist	full sun to shade
	Mountain laurel	<i>Kalmia latifolia</i>	May-Jul	very low	7-15 ft	6	wet to dry	full sun to shade
	Spicebush	<i>Lindera benzoin</i>	Mar-May	high	6-12 ft	6	wet to moist	partial sun to shade
	Ninebark	<i>Physocarpus opulifolius</i>	May-Jul	intermediate	5-10 ft	6	wet to moist	full to partial sun
	Wild plum	<i>Prunus americana</i>	Apr-May	high	15-25 ft	6	moist to dry	full sun to shade
	Rosebay	<i>Rhododendron maximum</i>	Jun-Jul	very low	10-30 ft	—	wet to moist	shade
	Pinxter-flower	<i>Rhododendron periclymenoides</i>	May-Jun	low	4-8 ft	6	moist to dry	full sun to shade
	Black willow	<i>Salix nigra</i>	Apr-May	intermediate	30-50 ft	6	moist to dry	full sun to shade



	Common Name	Latin Name	Bloom Period	Wildlife Value	Height	Hardiness Zone	Water	Light
Shrubs	Silky willow	<i>Salix sericea</i>	May	intermediate	<12 ft	5-6	wet	full sun to shade
	Elderberry	<i>Sambucus canadensis</i>	Jun-July	very high	6-15 ft	5-6	wet to dry	full sun to shade
	Lowbush blueberry	<i>Vaccinium angustifolium</i>	May-June	very high	1-2 ft	—	moist to dry	full to partial sun
	Highbush blueberry	<i>Vaccinium corymbosum</i>	May-June	very high	6-12 ft	—	wet to moist	full sun to shade
	Maple-leaved viburnum	<i>Viburnum acerifolium</i>	May-June	intermediate	4-6 ft	5-6	wet to dry	partial sun to shade
	Arrow-wood	<i>Viburnum recognitum</i>	May-June	very high	3-15 ft	—	wet to moist	full sun to shade
Grasses	Big bluestem	<i>Andropogon gorardii</i>	Jun-Sept		3-5 ft	—	moist	full to partial sun
	Lurid sedge	<i>Carex lurida</i>	Jun-Oct		1-2 ft	5-6	wet	full to shade
	Bottlebrush grass	<i>Elymus hystrix</i>	Jun-Aug		2-4 ft	6	moist	partial sun to shade
	Riverbank wild-rye	<i>Elymus riparius</i>	Jul-Sept		3-5 ft	5-6	wet to moist	full to partial sun
	Virginia Wild-rye	<i>Elymus virginicus</i>	Jul-Sept		2-4 ft	5-6	wet to moist	full sun to shade
	Switch grass	<i>Panicum virgatum</i>	Aug-Sept		3-6 ft	—	moist to dry	full sun
	Little bluestem	<i>Schizachyrium scoparium</i>	Jul-Sept		2-4 ft	6	dry	full sun
	Indian grass	<i>Sorghastrum nutans</i>	Aug-Sept		3-6 ft	—	moist to dry	full sun
Ferns	Maidenhair fern	<i>Adiantum pedatum</i>			1-2 ft	5-6	moist	shade
	Evergreen fern	<i>Dryopteris marginalis</i>			1-3 ft	5-6	moist to dry	partial sun to shade
	Interrupted fern	<i>Osmunda claytoniana</i>			2-4 ft	5-6	moist	partial sun to shade
	Christmas fern	<i>Polystichum achrostichoides</i>			1-2 ft	5-6	moist	partial sun to shade



	Common Name	Latin Name	Bloom Period	Bloom Color	Height	Hardiness Zone	Water	Light
Flowers	Dolls' eyes	<i>Actaea pachypoda</i>	Apr-June	white	1-3 ft	5	moist	shade
	Wild columbine	<i>Aquilegia canadensis</i>	Apr-June	red & yellow	1-3 ft	5-6	moist to dry	partial sun to shade
	Jack-in-the-pulpit	<i>Arisaema triphyllum</i>	Apr-June	green-purple	1-3 ft	5-6	wet to moist	partial sun to shade
	Wild ginger	<i>Asarum canadense</i>	Apr-May	maroon	<1 ft	5-6	moist	shade
	Swamp milkweed	<i>Asclepias incarnata</i>	Jul-Aug	rose	2-4 ft	6	wet to moist	full to partial sun
	Common milkweed	<i>Asclepias syrica</i>	Jun-Aug	pink	2-6 ft	5-6	moist to dry	full to partial sun
	Butterfly weed	<i>Asclepias tuberosa</i>	May-Sept	orange	1-3 ft	6	moist to dry	full sun to shade
	New England aster	<i>Aster novae-angliae</i>	Aug-Oct	purple	2-6 ft	6	moist	full to partial sun
	Turtlehead	<i>Chelone glabra</i>	Jul-Sept	whitish	1-3 ft	6	wet to moist	full to partial sun
	Joe-Pye weed	<i>Eupatorium fistulosum</i>	Jul-Oct	purple	3-6 ft	6	wet to moist	full to partial sun
	White snakeroot	<i>Eupatorium rugosum</i>	Jul-Oct	white	2-3 ft	6	moist to dry	full sun to shade
	Gaura	<i>Gaura biennis</i>	Jul-Sept	white	1-6 ft	6	moist	full to partial sun
	Wood geranium	<i>Geranium maculatum</i>	Apr-Jul	rose	1-2 ft	5-6	moist	full sun to shade
	Common sneezeweed	<i>Helenium autumnale</i>	Aug-Oct	yellow	2-6 ft	6	wet to moist	full sun to shade
	Sunflowers	<i>Helianthus spp.</i>	Jul-Sept	yellow	4-6 ft	6	wet to dry	full sun to shade
	Oxeye sunflower	<i>Heliopsis helianthoides</i>	Jul-Sept	yellow	1-5 ft	6	moist	full sun to shade
	Alum-root	<i>Heuchera americana</i>	May-Aug	greenish	1-2 ft	6	moist	full sun to shade
	Cardinal flower	<i>Lobelia cardinalis</i>	Jul-Sept	scarlet	2-5 ft	6	wet to moist	full sun to shade
	Great blue lobelia	<i>Lobelia siphilitica</i>	Jul-Oct	blue	1-3 ft	6	wet to moist	full sun to shade



	Common Name	Latin Name	Bloom Period	Bloom Color	Height	Hardiness Zone	Water	Light
Flowers	Monkey-flower	<i>Mimulus ringens</i>	Jul-Sept	violet	2-3 ft	5-6	wet to moist	full to partial sun
	Partridge-berry	<i>Mitchella repens</i>	Jun-Jul	white	<1 ft	5-6	moist to dry	partial sun to shade
	Bee-balm	<i>Monarda didyma</i>	Jul-Aug	red	2-5 ft	5	moist	full sun to shade
	Sundrops	<i>Oenothera fruticosa</i>	Jun-Sept	yellow	1-3 ft	6	moist	full to partial sun
	Beard-tongue	<i>Penstemon digitalis</i>	May-July	white	2-5 ft	6	moist to dry	full sun
	Phlox	<i>Phlox divaricata</i>	May-Jun	lilac	1-2 ft	6	wet to moist	full sun to shade
	May-apple	<i>Podophyllum petalum</i>	May	white	1-2 ft	6	moist	partial sun to shade
	Jacob's ladder	<i>Polemonium reptans</i>	Apr-June	blue	1-2 ft	—	moist	full sun to shade
	Solomon's seal	<i>Polygonatum pubescens</i>	Apr-June	yellow	1-3 ft	6	moist	full sun to shade
	Black-eyed Susan	<i>Rudbeckia hirta</i>	May-Sept	orange	2-3 ft	5-6	wet to moist	full to partial sun
	Cutleaf coneflower	<i>Rudbeckia lacianata</i>	Jul-Sept	yellow	2-6 ft	5-6	wet to moist	full to partial sun
	Bloodroot	<i>Sanguinaria canadensis</i>	Mar-May	white	<1 ft	6	moist	partial sun to shade
	Wrinkle-leaf goldenrod	<i>Solidago rugosa</i>	Jul-Nov	yellow	2-6 ft	5-6	moist	full sun to shade
	Foamflower	<i>Tiarella cordifolia</i>	Apr-June	white	<1 ft	5	moist	partial sun to shade
	Trillium	<i>Trillium grandiflorum</i>	Apr-June	white	1-2 ft	—	moist	shade
	Blue vervain	<i>Verbena hastata</i>	Jun-Sept	blue	2-5 ft	5-6	wet to moist	full to partial sun
	New York Ironweed	<i>Veronica noveboracensis</i>	Jul-Sept	purple	3-6 ft	6	wet to moist	full sun to shade
	Common blue violet	<i>Viola sororia</i>	Apr-May	violet	<1 ft	6	moist	full sun to shade
	Golden-Alexanders	<i>Zizia aurea</i>	Apr-June	gold	1-2 ft	—	moist	full sun to shade



Adapted from “Invasive Plants of Pennsylvania,” available at
www.dcnr.state.pa.us/forestry/wildplant/invasivelist.aspx

Flowers	Common Name	Latin Name	Notes
	Goutweed	<i>Aegopodium podagraria</i>	Spreads aggressively by roots
	Garlic mustard	<i>Alliaria petiolata</i>	Spreads aggressively by seeds; may alter soil conditions
	Musk thistle	<i>Cardinus nutans</i>	PA Noxious Weed
	Canada thistle	<i>Cirsium arvense</i>	PA Noxious Weed
	Bull thistle	<i>Cirsium vulgare</i>	PA Noxious Weed
	Jimsonweed	<i>Datura stramonium</i>	PA Noxious Weed
	Goatsrue	<i>Galega officinalis</i>	PA and Federal Noxious Weed
	Giant hogweed	<i>Heracleum mantegazzianum</i>	PA and Federal Noxious Weed; sap can cause blisters
	Dame’s rocket	<i>Hesperis matronalis</i>	Planted in gardens; naturalized along roadsides
	Purple loosestrife	<i>Lythrum salicaria</i>	PA Noxious Weed; garden escapee; grows near water
	Eurasian water-milfoil	<i>Myriophyllum spicatum</i>	Aquatic plant
	Star-of-Bethlehem	<i>Ornithogallum nutans</i>	Common garden plant that has widely escaped
	Wild parsnip	<i>Pastinaca sativa</i>	Found commonly along roads
	Beefsteak plant	<i>Perilla frutescens</i>	Garden escapee; common along roads
	Japanese knotweed	<i>Polygonum cuspidatum</i>	Spreads by roots and seeds; very aggressive growth
	Lesser celandine	<i>Ranunculus ficaria</i>	Very aggressive in wetlands; spreads by roots & shoots
	Water chestnut	<i>Trapa natans</i>	Wetland plant; dangerous spiky nuts
Grasses	Cheatgrass	<i>Bromus tectorum</i>	Annual grass; spreads by seed
	Japanese stilt grass	<i>Microstigium vimineum</i>	Annual grass; spreads by seed and rhizome
	Maiden grass	<i>Miscanthus sinensis</i>	Commonly planted ornamental; spreads by seed
	Reed canary grass	<i>Phalaris arundinacea</i>	Aggressive wetland plant
	Common reed	<i>Phragmites australis</i>	Native and exotic strains; wetland plant
	Shattercane	<i>Sorghum bicolor sp. drummondii</i>	PA noxious weed
	Johnson grass	<i>Sorghum halepense</i>	PA noxious weed; spreads by roots and seeds
Trees	Norway maple	<i>Acer platanoides</i>	Common landscaping tree; spreads by numerous seeds
	Sycamore maple	<i>Acer pseudoplatanus</i>	Escaped from cultivation; spread by seed
	Tree-of-heaven	<i>Ailanthis altissima</i>	Very aggressive; spreads by seeds and root sprouts
	Empress tree	<i>Paulownia tomentosa</i>	Purple flowers; spreads by seed
	Callery pear	<i>Pyrus calleryana</i>	Common landscaping tree that escapes; weak wood
	Siberian elm	<i>Ulmus pumila</i>	Escaped from cultivation



Shrubs	Common Name	Latin Name	Notes
	Japanese barberry	<i>Berberis thunbergii</i>	Common landscaping plant; spread by birds
	European barberry	<i>Berberis vulgaris</i>	Escaped from cultivation; spread by birds
	Russian olive	<i>Eleagnus angustifolia</i>	Escaped from cultivation; spread by birds
	Autumn olive	<i>Eleagnus umbellata</i>	Escaped from cultivation; spread by birds
	Winged Euonymus/ burning bush	<i>Euonymus alatus</i>	Common landscaping plant that escapes
	Border privet	<i>Ligustrum obtusifolium</i>	Escaped from cultivation; spread by birds
	Common privet	<i>Ligustrum vulgare</i>	Escaped from cultivation
	Amur honeysuckle	<i>Lonicera maackii</i>	Escaped from cultivation; spread by birds
	Morrow's honeysuckle	<i>Lonicera morrowii</i>	Escaped from cultivation; spread by birds
	Bell's honeysuckle	<i>Lonicera tararica</i>	Escaped from cultivation
	Standish honeysuckle	<i>Lonicera standishii</i>	Escaped from cultivation; spread by birds
	Tartarian honeysuckle	<i>Lonicera tatarica</i>	Escaped from cultivation; spread by birds
	Common buckthorn	<i>Rhamnus catharticus</i>	Becoming a problem in PA
	Glossy buckthorn	<i>Rhamnus frangula</i>	Becoming a problem in PA
	Multiflora rose	<i>Rosa multiflora</i>	PA Noxious Weed; very common; spread by birds
	Wineberry	<i>Rubus phoenicolasius</i>	Common bramble; spreads by seeds
	Japanese spirea	<i>Spirea japonica</i>	Common landscaping plant that escapes
	Guelder rose	<i>Viburnum opulus</i>	Common cultivated plant; resembles <i>Viburnum trilobum</i>

Vines	Fiveleaf akebia	<i>Akebia quinata</i>	Escaped from cultivation; problem in Philadelphia area
	Porcelain-berry	<i>Ampelopsis brevipedunculata</i>	Escaped from cultivation; spreads by birds
	Oriental bittersweet	<i>Celastrus orbiculatus</i>	Escaped from cultivation; spreads by birds and hobby trade
	Japanese honeysuckle	<i>Lonicera japonica</i>	Common along farm fields
	Mile-a-minute	<i>Polygonum perfoliatum</i>	PA Noxious Weed; blue berries and thorns
	Kudzu	<i>Pueraria lobata</i>	PA Noxious Weed; “vine that ate the South”

Some plants become problematic in certain parts of the state. These “**situational invasives**” include: Crown-vetch, *Coronilla varia*; English ivy, *Hedera heli*; Tall fescue, *Festuca elatior*; Orange day-lily, *Hemerocallis fulva*; Periwinkle, *Vinca minor*; and Chinese and Japanese wisteria, *Wisteria sinensis* and *W. floridbunda*.



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Chris Evans: University of Georgia, www.bugwood.org — front cover (top left)

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