

Adding plants to stormwater ponds and detecting and controlling problems early can improve their beauty, community value and stormwater treatment capacity. These benefits will, in turn, increase the value of the ponds to owners, nearby residents and the surrounding environment.

## New and Improved Stormwater Ponds

Thousands of stormwater ponds have been installed in coastal communities to capture and treat stormwater runoff generated through development. Most of these features are installed for the purpose of meeting state or local requirements, which are intended to protect water quality. They do this by capturing and retaining stormwater runoff after it rains, and then releasing it slowly over time. This process allows some of the pollutants in the water, including sediment and nutrients, to settle out or be removed by the plants or microbes within the pond.

Most ponds are designed to meet minimum regulatory requirements, without regard for their value as landscape features. Pond maintenance is often neglected, leading to undesirable conditions and appearance. Design modifications that include adding plants, and early detection and control of problems, can improve the beauty,

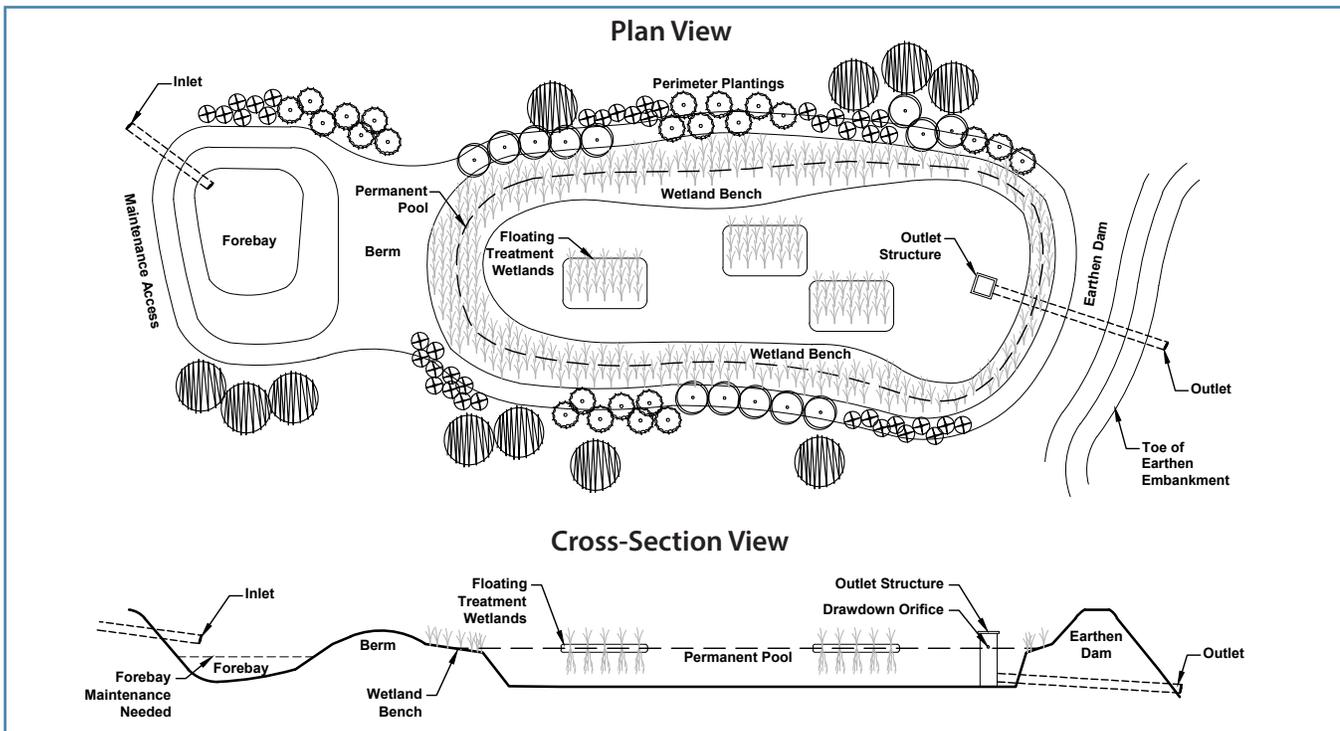
community value and stormwater treatment capacity of the ponds. These benefits will, in turn, increase the value of the ponds to the owners, nearby residents and surrounding environment.

## Adding New Elements

Significant improvements to a stormwater pond can be achieved by adding elements that make it more like a natural landscape. Each of the following strategies can improve pollution treatment, aesthetics, and environmental benefits: incorporating a ring of herbaceous (non-woody) plants along the perimeter, floating wetlands within the pond, or a “shelf” of wetland plants along the edge of the pond. If considered in advance, these elements can be included in the original pond design. They also can be added to existing ponds as retrofits if space is available.



Before and After: Currituck County added vegetation around a stormwater pond at the Cooperative Extension Center, improving stormwater treatment and converting an eyesore into an amenity. (Photos: North Carolina Sea Grant)



Wetland benches, floating treatment wetlands and perimeter plantings can be added to stormwater ponds to improve both treatment and aesthetics. (Natalie Carmen, Dept. of Biological and Agricultural Engineering, North Carolina State University)

## Perimeter Plantings

A ring of native vegetation can be established around the perimeter of a pond to improve water quality, prevent shoreline erosion (bank slumping), provide wildlife habitat, and deter nuisance Canada geese. Native vegetation will reduce the need for fertilizers, and also prevent fertilizers, herbicides and pesticides used on surrounding landscaped areas from running off into the pond. Having fewer nutrients in the pond reduces the potential for algal blooms. A diverse plant community will provide habitat for a variety of wildlife, including beneficial insects, amphibians and birds, all of which keep mosquito populations in check. Tall, native grasses can discourage Canada geese from inhabiting the pond and adjacent lawns, reducing bacterial pollution that can be harmful to human health. A dense band of plants also can help discourage children from entering open-water areas.

## Installation

Prior to planting, soil testing is recommended to determine if modifications are necessary to establish a healthy vegetated buffer. Be sure the soil is well-tilled before sowing seeds or installing plants, and add soil amendments as needed. These may include compost, fertilizer or topsoil. For information regarding soil testing, contact your local



Native plants around a pond provide a more natural landscape that adds beauty and color, and attracts beneficial insects and amphibians. (Photos: Perimeter plantings, Currituck County; Black Swallowtail (*Papilio polyxenes asterius*), Tricia Shears, Wikipedia Commons; Pinewoods Treefrog (*Hyla femoralis*), Mike Sanderson)

County Cooperative Extension Office or visit the NC Department of Agriculture and Consumer Services website at <http://www.ncagr.gov/agronomi/sthome.htm>.

A mix of native grasses and flowering plants can be installed as plants or as seed. If seed is used, expect it to take one to two years for the vegetation to become fully established because of the long germination times for many native grasses. Plan to water seeds to ensure they germinate successfully and keep young plants irrigated during the first year if there is insufficient rain. Plants will need about one inch of water each week during this time to become well-established.

Many suppliers of native seeds carry riparian or stormwater pond seed mixes that will include species of plants appropriate for planting around ponds in the coastal plain. It is best if seeds are collected from sources within 200 miles of the pond to ensure survival and vigor of the plants. Install as wide a planting as possible around the pond, with a goal of at least a 10-foot wide ring. The seed mix for planting one acre costs approximately \$250.

### Initial and Ongoing Maintenance

Perimeter plantings will require minor maintenance to prevent woody vegetation and non-native invasive species from taking over once established. This ring should not be mowed as is done with typical turfgrass. Perennials and grasses should be mowed only two times per year – once in the spring and once in the fall – to a height of six to eight inches. This should largely control trees, shrubs and other woody plants and allow wildlife to flourish and utilize the plants that have been installed. If mowers cannot be set to the preferred height, a weed eater can be used. It is crucial that the riparian grasses not be trimmed low and maintain sufficient height to ensure their continued survival.

While seeds are germinating and new plants are establishing themselves, it is especially important to keep out unwanted plants. Weeding should continue while the plants are maturing to their full size. It is vital for maintenance staff or contractors to be able to identify plants that should remain and those that should be removed. If starting with potted plants, you can leave on the plant tags for the first year for easy identification. Otherwise, consider supplying a list of plants with pictures (both young and mature) to the contractor or select a contractor that is knowledgeable of the various plant species used.

Once the perimeter vegetation is established, fertilizer should not be applied in this area. In general, it is advisable to not apply fertilizer within 20 feet of the pond's edge. This will help to prevent algae from growing in the pond and

from degrading downstream water quality.

Be sure to include all your landscaping requirements in a maintenance agreement/contract that you have for your pond. This will help ensure maintenance staff are aware of and follow the necessary mowing heights and schedule.

### Floating Treatment Wetlands

Floating treatment wetlands (FTWs) are additions that may be made to stormwater ponds to improve their treatment performance, provide wildlife habitat, and add aesthetic qualities. FTWs are typically large plastic mats that float half above and half below water. Wetland plants, such as rushes, sedges, hibiscus, lizard's tail and pickerelweed, are planted in the mesh and grow by taking up nutrients from the stormwater pond. The plants grow very quickly – nearly to maturity within the first growing season. The roots dangle into the water about three feet (depending upon species), providing flow resistance and filtration of pollutants from the water column. Research has



Top: A newly-planted FTW is installed at a pond in Durham, N.C. Bottom: The plants on the FTW are maturing after five months of growth. (Photos: Ryan Winston)

shown that these additions help improve a pond's capacity to remove excessive nutrients, sediment and heavy metals.

## Installation

FTWs may be purchased from several suppliers in the southeastern United States, and range in size from 10 square feet to over 250 square feet. Recent research has determined that about 20% of a pond's surface area needs to be covered by FTWs to provide significant water quality benefits. Aesthetic and habitat goals can be achieved with much less coverage. Typical costs for FTW mats range from \$10-20 per square foot.

Prior to installing FTWs, the pond should be inspected for invasive aquatic weeds. A specialist should be consulted if invasive weeds are present. These weeds should be completely removed prior to installation or they will establish on the FTW and expand their presence in the pond. This can create nuisance conditions and interfere with proper functioning of the pond, including clogging the outlet structure.

Installation of FTWs can be completed with a few volunteers. Once the FTWs are on site, install peat moss or potting soil in the mat (typically in pre-drilled holes), and



*The root mass of a floating treatment wetland is extensive, providing substantial uptake of nutrients. Roots in this photo are from Juncus and are three feet long. (Photo: Ryan Winston)*

plant the wetland plugs (one-inch diameter works well) in the islands. Plants are typically installed at a density of one plant per three to four square feet. The FTWs need to be anchored to the bottom of the pond to prevent them from clogging the pond's outlet structure during a large rainfall such as a tropical storm or hurricane.

Attach stainless steel or durable plastic cables (affixed to the FTW) to cinderblocks to use as anchors. Ensure that the cables are at least as long as the maximum depth of the pond (from the bottom sediment to the top of the outlet structure). To prevent loss of juvenile plants, install fencing over the island to hinder geese intrusion. Fencing may be made out of twine and draped over the FTW, or pre-made retail deer fencing (or other similar fencing) can be purchased. The island must then be dragged down the pond bank, and floated in the water. The cinderblock anchors can be dropped at a desired location so that the island stays in place. Before installing the islands, be sure of the pond depth (to avoid drowning).



*The vegetated FTW provides wildlife habitat, as evidenced by a bird's nest. (Photo: Ryan Winston)*

## Initial and Ongoing Maintenance

After installation, it is important to protect the island from geese and other herbivores that might eat the juvenile plants. After about six months, the plants will be fully established and the geese fencing can be removed. Some die-off of juvenile plants can be expected, and a second planting (perhaps 10% of the first) may be needed after three months.

Long-term maintenance includes weeding, as airborne seed or seeds in wildlife excrement will take root in the FTWs. Woody vegetation (trees and shrubs) should be removed immediately, as their weight will cause the FTWs to sink, potentially drowning the beneficial wetland plants. General monitoring of plant health and weeding should occur quarterly. Experience has shown that the anchoring cables deteriorate over a period of about five years and will need to be replaced to prevent the FTWs from drifting freely.

## Wetland Benches

In some cases, stormwater pond shorelines can be physically reconstructed to include shallow water wetlands. These wetlands can increase the pollutant-removal capacity of the stormwater pond, ensuring that the water discharged from the pond is cleaner. Aquatic vegetation prevents erosion and can increase nutrient uptake. Vegetation in a pond also may slow water flow and remove more suspended sediment. Native wetland plants not only provide water quality benefits, but also add beauty and color to the landscape. They attract beneficial insects and amphibians, such as dragonflies, damselflies and frogs that eat mosquitoes.

### Installation at an Existing Pond

Construction of a wetland bench in an existing pond will require grading equipment (i.e. backhoe or excavator), and an experienced contractor or equipment operator. Wetland benches should not be graded in such a way that causes the existing volume of the pond to be reduced. Before beginning, contact your regional N. C. Department of Environment and Resources office to determine the permit(s) required for your project. Detailed engineering plans should then be prepared and approved. Grading will cost \$7 to \$20 a cubic yard, depending on whether soil can be spread on-site or if it has to be hauled away.



The wetland bench is added to the perimeter of an existing pond by removing soil using an excavator. (Photo: North Carolina Sea Grant)

### Design Specifications

It is vital that the wetland shelf be constructed with a height that allows appropriate soil moisture conditions for

emergent wetland plants to thrive. Grading should occur at an elevation where the mean annual water level is two to four inches above the surface of the wetland shelf.

In many areas of the coast, the seasonal groundwater table significantly affects the water level of a stormwater pond; therefore, it is advisable to monitor the water level of the pond over a period of six months to one year to determine the appropriate elevation for the proposed wetland bench. To do this, a simple staff gauge can be installed at the edge of the pond (see photograph below). This gauge will allow visual inspection and recording of the water level every month. All recorded water levels can be averaged over the monitoring period to determine the mean water level.



A staff gauge can be installed in the pond, similar to how it is placed at the edge of this creek, to monitor water levels and determine the wetland shelf's appropriate design elevation. (Photo: Dan Line)

A minimum width of three feet is recommended for the bench, but if there is space, a 10-foot or wider bench is preferred. Bench areas may comprise 10-20% of the total pond area. The surrounding property should gradually slope down to the wetland bench. A slope of 3:1 (three feet horizontal to one foot vertical) or shallower is recommended.

Emergent vegetation, such as native wetland grasses and sedges, should be planted on the bench (see plant list for wetland benches on page 6). Other wetland species may voluntarily grow on bench areas, supplementing the wetland plant community. Wetland plants should be installed at a density of one plant per four square feet of wetland bench area. These can include peat plugs or potted plants. The cost of wetland plants is estimated to be

\$3 to \$4 per square foot, depending on the size and type of plants selected.

It may be necessary to apply topsoil and/or compost and fertilizer to the wetland bench if the soils are not fertile. Contact your local N.C. Cooperative Extension program for

assistance with determining if soil amendment is necessary for the wetland bench. Two to four inches of topsoil added to the bench can greatly increase the growth and survival of the wetland plants. Topsoil delivered and spread on the bench will cost between \$15 to \$20 per cubic yard.

### Native Plants for Wetland Benches

| Species                               | Common Name               |
|---------------------------------------|---------------------------|
| <i>Acorus americanus</i>              | Sweet Flag                |
| <i>Alisma subcordatum</i>             | Water Plantain            |
| <i>Cladium jamaicense</i>             | Sawgrass                  |
| <i>Decodon verticillatus</i>          | Water Willow              |
| <i>Echinodorus cordifolius</i>        | Creeping Burhead ①        |
| <i>Hydrocotyle spp.</i>               | Pennywort                 |
| <i>Iris virginica</i>                 | Southern Blue Flag Iris ② |
| <i>Peltandra virginica</i>            | Arrow arum                |
| <i>Pontederia cordata</i>             | Pickerel weed ③           |
| <i>Sagittaria lancifolia</i>          | Bulltongue                |
| <i>Sagittaria latifolia</i>           | Duck Potato               |
| <i>Saururus cernuus</i>               | Lizard Tail ④             |
| <i>Schoenoplectus tabernaemontani</i> | Softstem Bulrush          |
| <i>Scirpus americanus</i>             | Three-square              |
| <i>Sparganium americanum</i>          | Bur-reed                  |
| <i>Zizaniopsis miliacea</i>           | Water Millet              |



(Photos 1 to 4: USDA-Natural Resources Conservation Service, R. W. Smith, Albert F. W. Vick, Stefan Bloodworth)

### Initial and Ongoing Maintenance

The wetland bench should be maintained during the first two years to ensure the plants become established. If drought conditions result in very low water levels, then watering during the warm season may be necessary.

If the pond is frequented by geese and/or ducks, a waterfowl exclusion string, wire and/or net system should be constructed to protect the wetland bench immediately after the wetland plants are installed. The exclusion needs to prevent aerial landing of the birds onto the wetland bench and eliminate walking access along its perimeter. One grid exclusion design specification that was successfully used for a newly established wetland bench in northeastern North Carolina is described in the text at the bottom of the page. Other designs may function appropriately as well.



Exclusion structures such as the one used in Currituck County help prevent Canada geese from feeding on young wetland plants. (Photo: North Carolina Sea Grant)

Over time, some wetland shelves may become overgrown with cattails. While cattails are native to North Carolina, they crowd out other desirable plants and promote habitat for mosquitos to thrive and breed. Another highly unwanted species is *Phragmites*. It is important to remove both these plant species as soon as they are noticed. For specific information about removal techniques, see *Urban Waterways – Maintenance of Stormwater Wetlands and Wet Ponds* (AGW-588-07): <http://www.bae.ncsu.edu/stormwater/PublicationFiles/WetlandMaintenance2006.pdf>



After two growing seasons, vegetation is becoming established on a wetland bench added to the stormwater pond in front of the Currituck County Cooperative Extension building. (Photo: North Carolina Sea Grant)

### Constructing a Goose Exclusion System

The goose exclusion grid system can be constructed of either high-tensile wire or ultraviolet-resistant polypropylene line (50-pound test or stronger) strung two to three feet above the ground surface. The wire (or line) should be strung on two-inch by two-inch wooden or metal stakes (six feet long) driven securely two feet deep into the ground and spaced a maximum distance of 10 feet apart. Grid square openings shall be a maximum of four feet by four feet to establish full aerial coverage of the wetland plant area. Lines shall be tied or securely fixed to each stake and strung tightly enough to minimize sagging.

In addition, a wire boundary fence should be placed along the edge of the entire goose exclusion area to prevent them from entering along the sides. The boundary fence should be secured to the ground and extend to three feet above the ground surface. Wire openings shall not exceed four inches. The fence should be securely fastened to stakes driven securely into the ground (two feet deep) and spaced no more than eight feet apart.

## Trails, Signs and Other Amenities

Trails and benches provide a setting for viewing and photographing birds, enjoying wildflowers and fall colors, and for short strolls. They can be as simple as a footpath around the pond or a mowed trail winding through the clusters of planted trees and shrubs. Access and signs also can provide an opportunity for visitors to learn about stormwater ponds and their value to water quality, as well as other messages you may want to convey about using native plants or ways individuals can reduce pollution in stormwater. Signs also can be used for indicating safety (i.e. no swimming) or to designate limits on mowing.

## Controlling Unwanted Plants

Not every plant is beneficial to a pond and being vigilant about inspecting for and removing invasive and potentially harmful plants is one of the best ways to keep a pond attractive and functioning properly. Addressing problem vegetation early also will save time and money. Avoiding introduction of potential nuisance plants is another important way to manage unwanted or detrimental vegetation.

### Aquatic Weeds

Aquatic vegetation thrives in the warm, humid climate of North Carolina, so monitoring and managing aquatic plant growth in ponds is imperative. Aquatic plants grow in water or in soil that is permanently saturated with water. The primary factor controlling distribution (survival and where they occur) is the depth and duration of flooding. There are many suitable locations in a pond for aquatic plants to grow.

For desirable native species to thrive, weed species must be correctly identified and controlled. The resources listed on page 11 can help with accurate identification. Some plants can be controlled by pulling or cutting, especially if caught early. Noxious, floating weeds sometimes require careful chemical or physical removal. For information regarding identification and removal of floating weeds, contact your local County Cooperative Extension Office or the Division of Water Resources' Aquatic Weed Control Program at [http://www.ncwater.org/Education\\_and\\_Technical\\_Assistance/Aquatic\\_Weed\\_Control/](http://www.ncwater.org/Education_and_Technical_Assistance/Aquatic_Weed_Control/).

### Woody Plants

Trees and woody plants on earthen dams (embankments) and near outlet pipes and structures can be detrimental to the function and long-term stability of a pond (see figure on page 2). Tree roots can penetrate

an earthen dam and lead to water seepage through the embankment, which may threaten its structural integrity. If left unchecked, the embankment can erode or fail over time.

Therefore, it is important to avoid planting trees on the earthen embankment and to remove any volunteer trees and woody plants. Black willows are common volunteers that will thrive in shallow areas and along the shoreline of a pond. These and other woody plants should be removed.

Follow these guidelines for woody plants in the vicinity of the stormwater pond:

- Remove and do not plant trees:
  - within 20 to 25 feet from the toe or base of the slope of the dam, any underground perforated drain pipes, or the spillway structures that allow overflow of water;
  - close enough to the pond shoreline such that limbs would extend over the pond itself.
- Maintenance access to the forebay and outlet structure should not be blocked by trees or shrubs.
- Regular mowing of the embankment is necessary to prevent volunteer woody plant growth.
- Inspection of the pond and removal of volunteer trees from critical areas should be conducted annually.

Outside of the areas noted above, trees can be established to improve aesthetics, screen unattractive views, or stabilize slopes (not associated with the dam). If strategically planted, trees also can reduce heating of pond water by shading inflow and outflow channels, and southern exposures of ponds. Native species should be selected over exotic species.

### Common Aquatic Weeds in Eastern NC

| Species                            | Common Name               |
|------------------------------------|---------------------------|
| <i>Alternanthera philoxeroides</i> | Alligator Weed ①          |
| <i>Hydrilla verticillata</i>       | Hydrilla ②                |
| <i>Ludwigia grandiflora</i>        | Creeping Water Primrose ③ |
| <i>Murdannia keisak</i>            | Asian Dayflower ④         |
| <i>Myriophyllum aquaticum</i>      | Parrot feather ⑤          |
| <i>Myriophyllum spicatum</i>       | Eurasian Watermilfoil ⑥   |
| <i>Phragmites australis</i>        | Common Reed ⑦             |
| <i>Typha spp.</i>                  | Cattails ⑧                |



(Photos: 1-3, 5, 6, 8: Justin Nawroski, North Carolina State University; 4: G. A. Cooper, courtesy of Smithsonian Institution; 7: Le.Loup.Gris, via Wikimedia Commons)

## Pond Maintenance 101: Common Issues & Solutions

Stormwater ponds that are permitted have regular inspection and maintenance requirements. In case of the situations listed below, action or precautionary steps should be taken as appropriate. If expert advice is needed, a list of certified BMP inspection and maintenance professionals can be found at <http://www.bae.ncsu.edu/topic/bmp-im/professionals.html>.

### ***The forebay is more than 50% full of sediment or if the forebay depth is less than one foot.***

The forebay depth may be measured with a depth finder (used for fishing) and compared against the engineering plans to determine if the forebay needs to be dipped (i.e. cleaned out with an excavator). See the cross-section in the figure on page 2 for more information. For ponds in residential areas, forebay sediment may be spread on the ground with seed and straw applied for erosion control.

### ***Insects and/or odor are a problem.***

Kill all cattails using a 2% glyphosate solution to reduce mosquito habitat. You must have an aquatic endorsement on a North Carolina pesticide license to do this work. Glyphosate should be applied using appropriate gloves, and rubbed on the cattail frond. Remove trash from the forebay and pond banks regularly.

### ***Algae blooms occur in the summer months or the water is dominated by a single aquatic plant.***

Fountains, which help to aerate and move the water, may provide some reduction in algal growth. To curb algal growth, use fertilizers without phosphorus (i.e. 10-0-10) in the pond watershed.

### ***The embankment or the outlet structure are damaged.***

If major repair is needed, contact a local engineer for design assistance.

### ***Seeps are visible on the downstream dam face.***

Contact a local engineer for design assistance. This situation may constitute an imminent threat to downstream property and/or human life.

### ***Woody vegetation is growing on the dam.***

For woody vegetation less than six inches in diameter, removal may be completed without a permit. For woody vegetation with a diameter greater than six inches, a permit must be obtained from the N.C. Department of Environment and Natural Resources.

### ***Beavers are present in the forebay or pond.***

Contact a local trapper and have the beavers removed from the pond and relocated.

### ***Muddy water is flowing from the slope or toe of the dam, cracks are forming in the dam or spillway, or movement or sliding of earth is observed.***

These are signs that a dam failure may be imminent. Consult a professional engineer for design of the dam repair.

## Resources (Publications)

*Going Native: Landscaping for wildlife with native plants*

North Carolina State University

<http://www.ncsu.edu/goingnative/>

*Stormwater Best Management Practices Manual*

North Carolina Dept. of Environment and Natural Resources

N. C. Division of Water Quality

<http://portal.ncdenr.org/web/wq/ws/su/bmp-manual>

## Resources (Web Information & Training)

Aquatic Plant Resources

North Carolina State University

<http://www.weedscience.ncsu.edu/aquaticweeds/factsheets.asp>

Common Wetland Plants of North Carolina

North Carolina Dept. of Environment and Natural Resources

[http://portal.ncdenr.org/c/document\\_library/get\\_file?uuid=d0f7bb32-5585-4acf-a399-8d484488d234&groupId=38364](http://portal.ncdenr.org/c/document_library/get_file?uuid=d0f7bb32-5585-4acf-a399-8d484488d234&groupId=38364)

Managing Conflicts with Canada Geese

[http://web.extension.illinois.edu/wildlife/files/IL\\_WS\\_Canada\\_Goose.pdf](http://web.extension.illinois.edu/wildlife/files/IL_WS_Canada_Goose.pdf)

<http://www.ncwildlife.org/Hunting/HaveProblem.aspx>

Stormwater Management Training, Research and Education

North Carolina State University

Stormwater Engineering Group

<http://www.bae.ncsu.edu/stormwater/>

Water Gardens and Weeds

North Carolina State University

<http://www.weedscience.ncsu.edu/aquaticweeds/watergarden/WATERGRD2.HTM>

Wetland Plant Identification

North Carolina State University

[http://harvest.cals.ncsu.edu/applications/plant\\_biology/wetland/library/PrefaceNEW.cfm](http://harvest.cals.ncsu.edu/applications/plant_biology/wetland/library/PrefaceNEW.cfm)

## Resources (Plant Supplies and Services)

Carolina Wetland Services, Inc.

550 East Westinghouse Blvd.

Charlotte, NC 28273

704-408-1683

Cill Ide Native Plant Nursery

621 Starburst Lane, Raleigh, NC 27603

919-302-6900

Email: [info@wetlandplantnursery.com](mailto:info@wetlandplantnursery.com)

Coastal Plain Conservation Nursery

3067 Conners Drive

Edenton, NC 27932

252-482-5707

<http://wetlandplantsinc.com/>

Cure Nursery

880 Buteo Road

Pittsboro, NC 27312

919-542-6186

[www.curenursery.com/](http://www.curenursery.com/)

Email: [curenursery@mindspring.com](mailto:curenursery@mindspring.com)

ERNST Conservation Seeds

9006 Mercer Pike

Meadville, PA 16335

814-336-2404

[www.ernstseed.com](http://www.ernstseed.com)

Email: [ernstsales@ernstseed.com](mailto:ernstsales@ernstseed.com)

Mellow Marsh Farms

1312 Woody Store Rd.

Siler City, NC 27344

919-742-1200 Telephone

[www.mellowmarshfarm.com](http://www.mellowmarshfarm.com)

Email: [mellowmarsh@mindspring.com](mailto:mellowmarsh@mindspring.com)

Other pieces in the Sustainability Series are available by searching the term "Sustainability" at [www.ncseagrant.org](http://www.ncseagrant.org). For more information on specific topics, coastal communities should contact Gloria Putnam or Barbara Doll at North Carolina Sea Grant: [gloria\\_putnam@ncsu.edu](mailto:gloria_putnam@ncsu.edu), 919/513-0117; or [barbara\\_doll@ncsu.edu](mailto:barbara_doll@ncsu.edu), 919/515-5287.



In addition to the wetland bench that was added to the stormwater pond at the Currituck County Cooperative Extension Center, native plants were placed around the pond's perimeter and a small garden was planted by Master Gardeners. A walking trail and benches are also planned that will provide easy access for enjoying the enhanced pond and other improvements. (Photo: North Carolina Sea Grant)

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Information for this document was drawn from:

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- Hunt, W. F. Urban Waterways series, *Maintenance of Stormwater Wetlands and Wet Ponds*. AGW-588-07, Online: <http://www.bae.ncsu.edu/stormwater/PublicationFiles/WetlandMaintenance2006.pdf>
- Maryland Department of the Environment, *Maryland Stormwater Design Manual Volumes I and II* (October 2000, Revised May 2009). Appendix A: *Landscaping Guidance for Stormwater BMP's*. Online: [http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Documents/www.mde.state.md.us/assets/document/sedimentstormwater/Appnd\\_A.pdf](http://www.mde.state.md.us/programs/Water/StormwaterManagementProgram/MarylandStormwaterDesignManual/Documents/www.mde.state.md.us/assets/document/sedimentstormwater/Appnd_A.pdf)
- Northern Virginia Regional Commission, (2007). *Maintaining Stormwater Systems: A Guidebook for Private Owners and Operators in Northern Virginia*, Online: <http://www.novaregion.org/DocumentCenter/Home/View/1675>
- South Carolina Department of Health and Environmental Control (8/00). *A citizen's guide to stormwater pond maintenance in South Carolina*. CR-003069. Online: <http://www.scdhec.gov/environment/ocrm/docs/ponds.pdf>
- Southeast Wisconsin Fox River Partnership Team, *Managing Your Open Space*. Online: [http://basineducation.uwex.edu/southeastfox/pdf/Open%20Space%20Files/stormwater\\_ponds.pdf](http://basineducation.uwex.edu/southeastfox/pdf/Open%20Space%20Files/stormwater_ponds.pdf)



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