Stormwater Ponds

A Citizen's Guide to Their Purpose and Management

USDA

SARASOTA bay National Estuary Program

Southwest Florida Water Management District

Stormwater Ponds

A Citizen's Guide to Their Purpose and Management

Prepared in Cooperation by:
USDA, National Resources Conservation Service
Florida Department of Environmental Protection
University of Florida, Institute of Food and Agricultural Sciences
Southwest Florida Water Management District
St. Johns River Water Management District, Watershed Action Volunteer Program
Sarasota Bay National Estuary Program
Hillsborough County, Stormwater Management
Manatee County, Environmental Management
Pinellas County, Environmental Management
Sarasota County, Stormwater Environmental Utility
City of Tampa, Stormwater Management

Published by:
Sarasota Soil and Water Conservation District
Sarasota Bay National Estuary Program — Bay Partners Grant
USDA - Natural Resources Conservation Service

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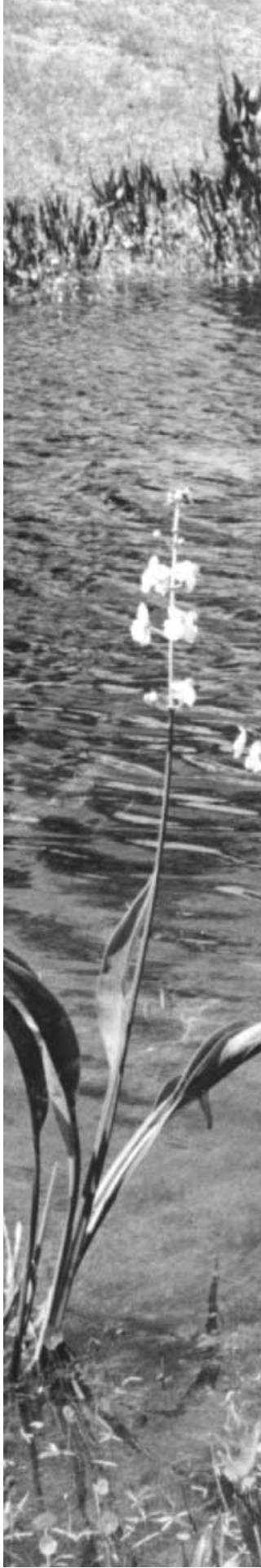

Preface

The present availability of quality materials to educate stormwater managers and the general public is limited. This manual, written for citizens, stormwater managers and practitioners, is a companion document to "Stormwater Management: A Guide for Floridians" produced by the Stormwater/Non-Point Source Management section of the then Florida Department of Environmental Regulation. This citizen's guide focuses on stormwater ponds and their place in the watershed. This new manual is a practical approach to stormwater ponds and their care. It contains information on developing a neighborhood-based care program for your stormwater pond. The information contained in this guide will also aid stormwater pond maintenance companies in their provision of quality services to their customers.

▲ *Stormwater Management, A Guide For Floridians.*

Acknowledgements

We wish to acknowledge the valuable contributions of expertise, writing, editing, coordination and cooperation of the following, without whom this guide would have never happened:

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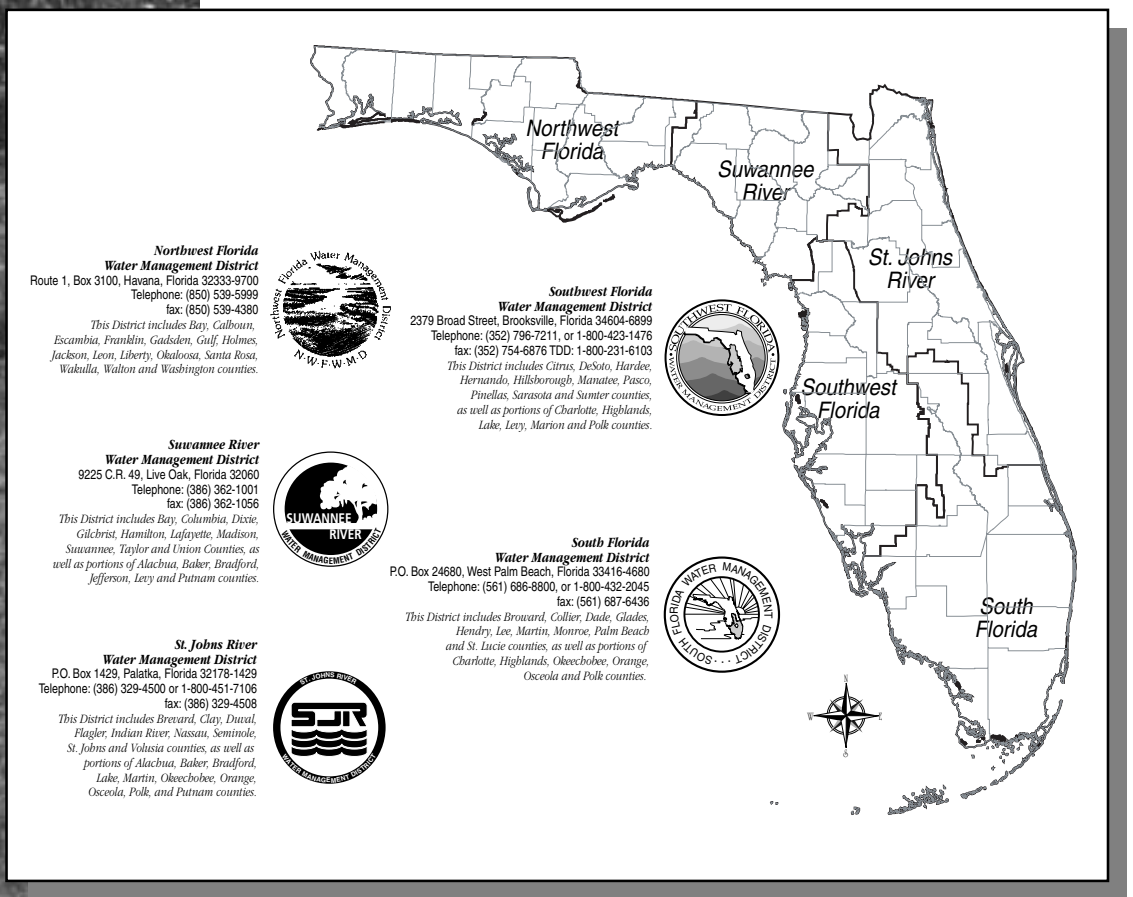
Introduction

What Is the Purpose of This Citizen's Guide?

The guiding theme for the content of this citizen's guide is captured in the following vision statement:

To educate communities about the purposes and benefits of stormwater ponds, and provide guidelines for effective pond management.

The intent of this booklet is to instruct and provide a comprehensive, multi-agency source of reliable information for homeowners, lake management companies and Homeowners' Association (HOA)/Property Owners' Association (POA)/Condominium Owners' Association (COA) officers in their search for management guidelines with respect to stormwater



Northwest Florida Water Management District
Route 1, Box 3100, Havana, Florida 32333-9700
Telephone: (850) 539-5999
fax: (850) 539-4380
This District includes Bay, Calhoun, Escambia, Franklin, Gadsden, Gulf, Holmes, Jackson, Leon, Liberty, Okaloosa, Santa Rosa, Wakulla, Walton and Washington counties.

Suwannee River Water Management District
9225 C.R. 49, Live Oak, Florida 32060
Telephone: (386) 362-1001
fax: (386) 362-1056
This District includes Bay, Columbia, Dixie, Gilchrist, Hamilton, Lafayette, Madison, Suwannee, Taylor and Union Counties, as well as portions of Alachua, Baker, Bradford, Jefferson, Levy and Putnam counties.

St. Johns River Water Management District
P.O. Box 1429, Palatka, Florida 32178-1429
Telephone: (386) 329-4500 or 1-800-451-7106
fax: (386) 329-4508
This District includes Brevard, Clay, Duval, Flagler, Indian River, Nassau, Seminole, St. Johns and Volusia counties, as well as portions of Alachua, Baker, Bradford, Lake, Martin, Okeechobee, Orange, Osceola, Polk, and Putnam counties.

Southwest Florida Water Management District
2379 Broad Street, Brooksville, Florida 34604-6899
Telephone: (352) 796-7211, or 1-800-423-1476
fax: (352) 754-6876 TDD: 1-800-231-6103
This District includes Citrus, DeSoto, Hardee, Hernando, Hillsborough, Manatee, Pasco, Pinellas, Sarasota and Sumter counties, as well as portions of Charlotte, Highlands, Lake, Levy, Marion and Polk counties.

South Florida Water Management District
P.O. Box 24680, West Palm Beach, Florida 33416-4680
Telephone: (561) 686-8800, or 1-800-432-2045
fax: (561) 687-6436
This District includes Broward, Collier, Dade, Glades, Hendry, Lee, Martin, Monroe, Palm Beach and St. Lucie counties, as well as portions of Charlotte, Highlands, Okeechobee, Orange, Osceola and Polk counties.

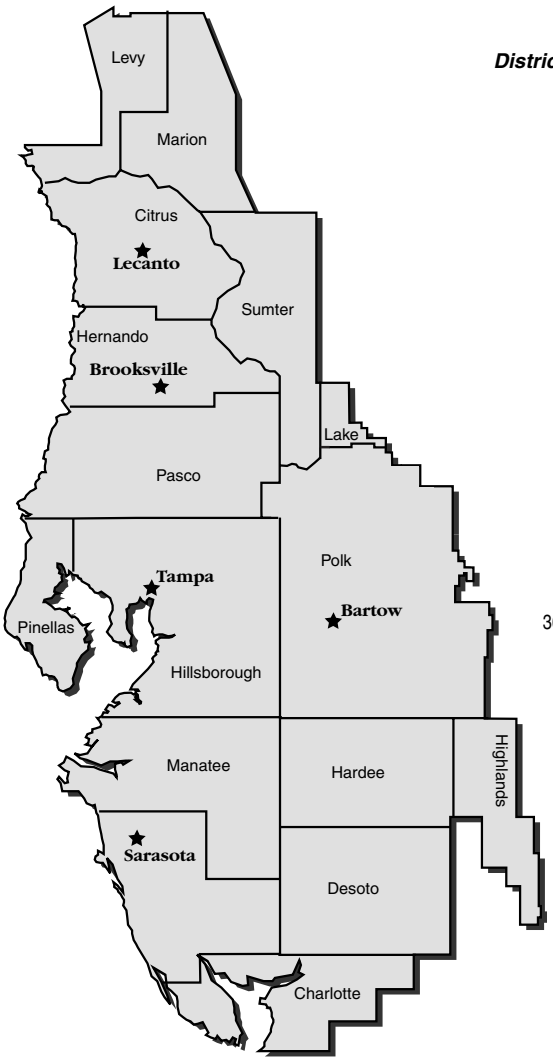
ponds. This guide will help you develop realistic expectations for your Florida stormwater pond.

This guide was developed in Central Florida but is expected to have statewide application. The information is current although always evolving and adapting to new research.

For additional information from the agencies with responsibility for ponds in your area, first read this manual and then call the appropriate stormwater agency for your city or county. You will find a more complete list of these agencies in Chapter 6; Resources and References.

Southwest Florida Water Management District

2379 Broad Street, Brooksville, Florida 34604-6899 WaterMatters.org · 1-800-423-1476



District Service Office Locations:

BROOKSVILLE
2379 Broad Street
Brooksville, Florida 34604-6899
Phone (352) 796-7211
SUNCOM 628-4150

TAMPA
7601 U.S. Hwy. 301
Tampa, Florida 33637-6759
Phone (813) 985-7481
SUNCOM 578-2070

BARTOW
170 Century Blvd.
Bartow, Florida 33830-7700
Phone (863) 534-1448
SUNCOM 572-6200

SARASOTA
6750 Fruitville Road
Sarasota, Florida 34240-9711
Phone (941) 377-3722
SUNCOM 531-6900

LECANTO
3600 West Sovereign Path, Suite 226
Lecanto, Florida 34461-8070
Phone (352) 521-8131
SUNCOM 667-3271

Chapter 1

Why are Ponds Important in Florida?

Florida's Unique Ecosystems.

An ecosystem can be a planet, a forest, a river, a fallen log, or a pond. Ecosystems are made up of nonliving components such as solar energy, soil, water, air, heat, wind, and a variety of essential chemicals and living components - plants and animals. Whether an ecosystem is small or large depends on where boundaries are established for convenience of studying its environmental functioning as a unit in nature.

Water is everywhere in Florida! Surrounded on three sides by water and with a climate varying from temperate to subtropical, every kind of large aquatic ecosystem - lake, pond, river, spring, swamp, estuary, coral reef, sea, and ocean - can be found in, or around Florida. Three types of large terrestrial ecosystems - forests, grasslands, and savannas - are also found in the state. Each of these major types of ecosystems can be divided further, and all are connected to one another.

Florida has an amazing variety of ecosystems, ranging from the upland mixed forests in northern Florida to the mangrove swamps in southern Florida. Estuaries, one of the most productive ecosystems on earth, can be found in every stretch of Florida's vast coastal areas in the form of rivers, bays, and lagoons - each characterized by fresh water mixing with salty water, abundant aquatic vegetation, and large populations of fish. Estuaries are the home and spawning grounds for most of our shellfish and commercial and sport saltwater fish.

From pelicans to wood storks, from manatees to blue crabs, and from treefrogs to panthers, Florida's wildlife is a natural wealth many of us treasure. Just as rare and fascinating as Florida's animals are its plants, some so unique that they are found only in one small region of the state. Plants, animals, rainfall, temperature - all are integral parts of ecosystems.

More than any other animal, humans have a tremendous impact on the health of ecosystems they live in or near. These impacts can be **direct** when man uses local resources to sustain life in communities, or **indirect** when resources are needed from distant lands to help support people living in an *artificial* setting such as a highly urbanized area. Because man is a social and cultural animal and population growth has been so rapid in our state, it is necessary to integrate scientific, behavioral, sociological, political, economic, and ethical factors when considering how to best maintain ecological balance. The future of Florida's ecosystems depends on decisions that will be made by citizens like you.

Stormwater Pond TIP

Stormwater Management is necessary to protect Florida's unique natural ecosystems. Simulating natural ponds is one method to accomplish this goal.

Ponds

Natural ponds play an important role in these connected ecosystems. They capture rainwater as it rushes over the ground, reducing erosion and flooding in rivers and streams. By holding much of the stormwater, these ponds also allow nutrients and other chemicals contained in the runoff to be filtered from the water before it moves through the soil into an underlying aquifer or along the surface into our rivers, lakes, and estuaries. Wildlife depend upon ponds for food, shelter and breeding purposes. During the dry season, ponds act as reservoirs, providing much needed water for birds and wildlife.

After observing natural ponds at work and using these natural ponds in early developments to hold the stormwater, people came up with the idea of building ponds to hold and treat stormwater in communities. This was needed where the potential for flooding is increased by covering the ground with concrete and other hard surfaces, as well as when changes in the natural ecological balance occur as a result of development. These "stormwater ponds" are specifically designed to decrease downstream flooding and remove pollutants from the water before it enters a lake, river, or bay - or before it moves into the aquifer. For stormwater ponds to do their job effectively, they must be managed properly. They are man-made eco-systems that require regular maintenance.

Managing stormwater ponds begins with management of the pond's watershed which contributes the water that flows into the pond. The rest of this manual will look at how ponds fit into the bigger watershed picture, how to take care of the watershed that directly affects your pond and how to manage your stormwater pond.

Natural Pond ▼

The watershed connection

We use water everyday in our homes. Every time we flush the toilet, brush our teeth, take a shower, water the lawn or take a drink - we are making the watershed connection.

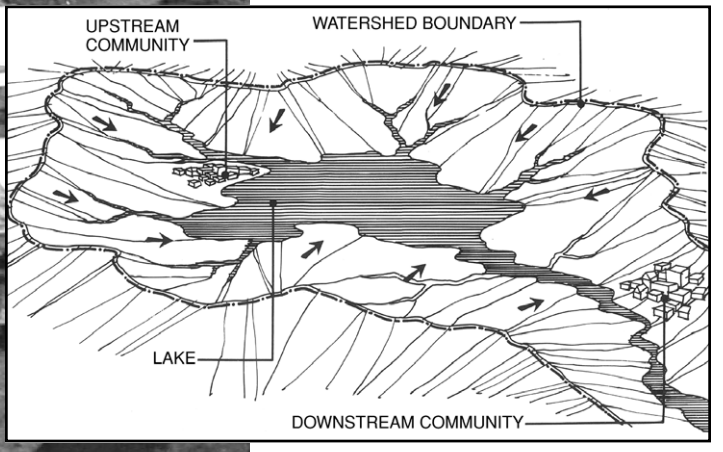
We use water outside our homes. Every time we go swimming in a spring, fishing in a pond, canoeing in a lake or picnicking along the river - we are making the watershed connection.

Every time we pass a storm drain, roadside ditch, a lake, stream or river - we are making the watershed connection.

Everyone, everywhere is connected to a watershed. It doesn't matter if you live in an urban or rural area or next to a water body. We all live in a watershed!

What is a watershed?

What is a watershed? It's an area of land where water falls as precipitation and flows across a variety of land surfaces and drains into a water body. Water bodies receiving this water include ponds, lakes, bays, streams, and rivers. Rivers in Florida either flow into other rivers or empty into the Gulf of Mexico or the Atlantic Ocean.



▲ *A watershed is the land that water flows across or under on its way to a stream, river or lake.*

Some actually disappear into sink holes and are never seen again. Each geographical area that contributes water to a pond, lake, bay, stream or river is a watershed. Large watersheds include a main water body and many smaller tributary watersheds which empty into it.

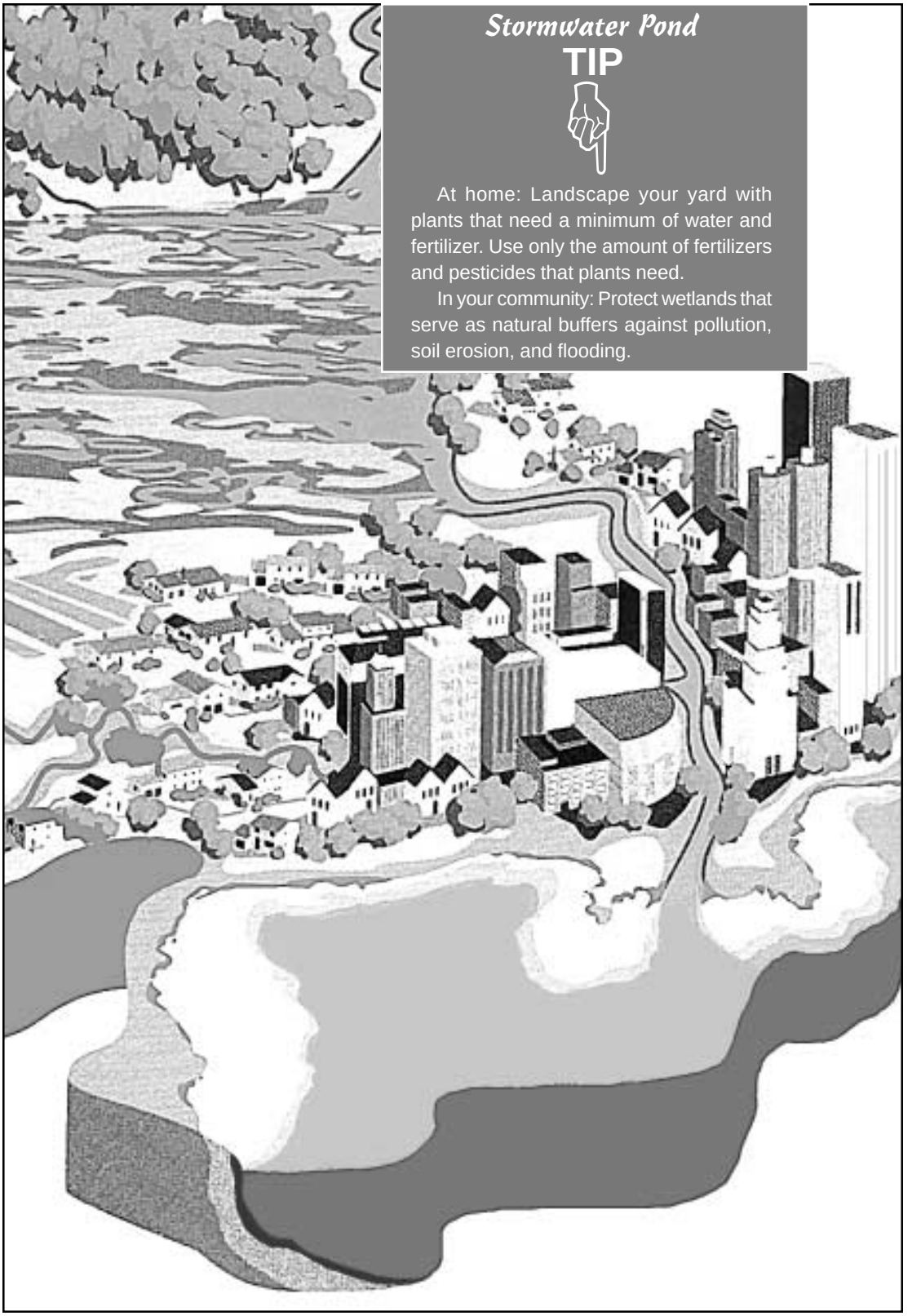
Once precipitation hits the ground, some of the water will be absorbed by the soil or percolate through it to recharge aquifers. The remaining water, especially during heavy rains, runs off the land and is referred to as stormwater. Stormwater takes numerous routes to its final destination. It may run off your driveway and flow down the stormdrain, or off the road into a ditch. Perhaps it will run off a parking lot and into a stormwater treatment system (pond), or it may flow directly from the land into a stream, river, lake, or even the ocean.

Each water body receives water from numerous tributaries, which in turn have received water from countless other sources, including stormdrains, roadside ditches, wastewater treatment facilities or natural sources such as free flowing springs and direct rainfall.

It's easy to see how most of our daily actions connect us to our watershed. For instance, when we wash dishes, water drains from our homes through a series of pipes, to wastewater treatment facilities, and to receiving water bodies. It's as simple as that! The watershed connection is everywhere. It's up to us to make that connection a positive one.

In general, there are two ways for you to make a difference by making a positive watershed connection - *conserve water and protect water.*

Make the watershed connection and take an active role in trying to keep our water as clean as possible. Remember, we are all part of a watershed!



Stormwater Pond TIP

At home: Landscape your yard with plants that need a minimum of water and fertilizer. Use only the amount of fertilizers and pesticides that plants need.

In your community: Protect wetlands that serve as natural buffers against pollution, soil erosion, and flooding.

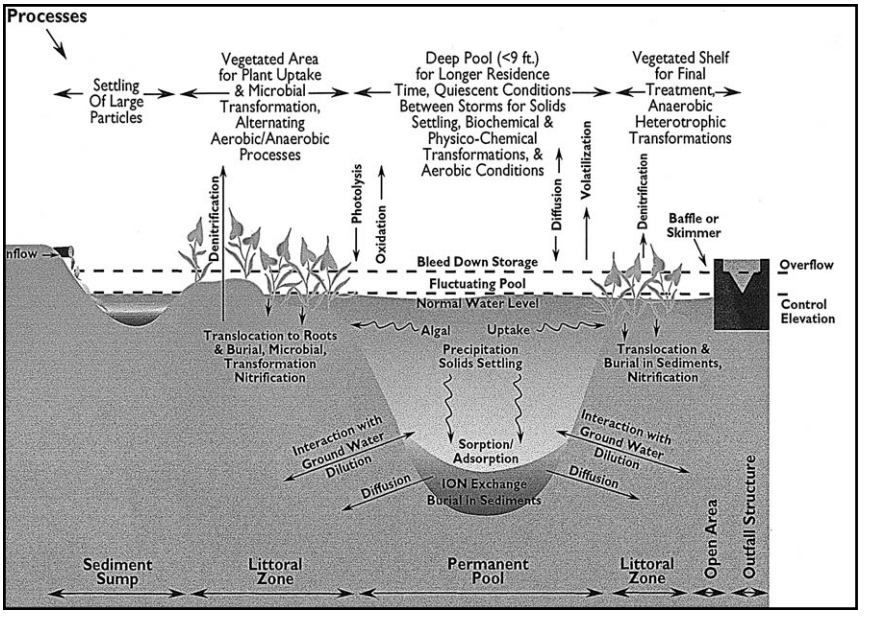
▲ *A healthy watershed is one that is in harmony with the needs of people, land and natural resources.*

Types and Functions of Stormwater Ponds

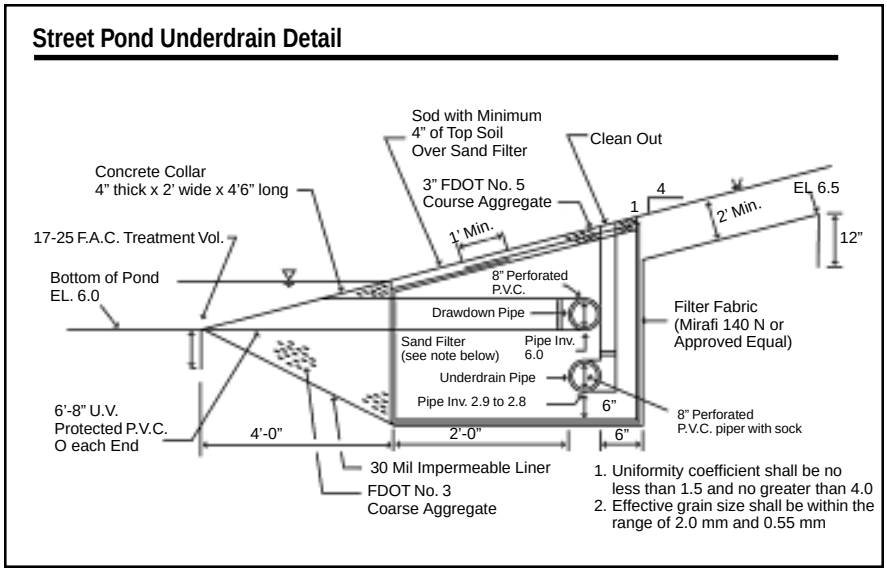
Different Pond Types

Ponds constructed to store excess runoff from storms are called wet detention ponds because they detain and slowly release surface water flow after rain occurs. Initially, detention ponds were built to solve flooding problems by providing temporary storage for storm water. As lakes, streams and estuaries became more polluted because of stormwater runoff, ponds were designed and built to improve stormwater quality.

Several processes take place within the various zones of the pond to remove and transform pollutants before water is discharged downstream. The different zones should include a permanent pool of water, a shallow littoral shelf with aquatic plants, and a fluctuating pool *(Figure 1)*. The **permanent pool** allows particulate forms of pollutants time to settle to the bottom where, through various processes under ideal conditions, they are buried in the sediments. The permanent pool also removes soluble nutrients from the water by physical, chemical and biological reactions in the water column. About 65 percent of the pond area is required to be kept as an open water permanent pool when stormwater ponds are constructed according to SWFWMD criteria. Vegetation in the **littoral zone** provides the substrate for the attachment of decomposer microorganisms that break down and dissolve organic material and behave somewhat like the trickling filters used by sewage treatment plants. A minimum of 35 percent of the pond bottom is required to be shallow enough to support wetland plants according to SWFWMD criteria. Plants also take up pollutants directly but some of these nutrients are released back into the water when the plant dies, with the harvesting of plants, there is a net reduction in pollutants from plant uptake. The **fluctuating pool** slowly releases detained stormwater and reduces peak flows



▲ *Figure 1. Idealized Wet Detention Pond*



▲ *Figure 2. Side view of detention pond with effluent filtration (Man-made underdrains).*

downstream. The fluctuating pool and some water in the permanent pool can provide water for irrigation purposes.

In summary, pollutant removal within the wet detention pond can be attributed to the following important pollutant removal processes: uptake of nutrients by algae and rooted aquatic plants; adsorption of nutrients and heavy metals onto bottom sediments; biological oxidation of organic materials; and sedimentation of suspended solids and attached pollutants.

Stormwater ponds constructed specifically to reduce pollution downstream were first built around 1980, but other kinds of ponds are also found in the urban landscape. They sometimes serve many of the same functions as wet detention ponds and can be maintained using the same practices. These other ponds include borrow pits excavated to provide fill for development, lakes or depressions found naturally in the landscape, and ponds or canals built to drain the land. Another type of pond is often included in new developments (since 1985) that may be confused with wet detention ponds. These ponds use filters buried under the ground either in the banks of the pond or under the pond to remove pollutants by filtration *(Figure 2)*. Since filters are easily clogged by fine grained material, they require more professional maintenance than wet detention stormwater ponds.

▲ *Drawdown pipe.*

Getting To Know Your Pond

Natural Ponds:

In Florida there are several types of ponds. The one that is most familiar to people all over the world are our natural ponds and lakes that are so highly photographed and promoted. These ponds have been formed in depressions, and have developed a surrounding ecosystem that is unique.

▲ *Natural Pond*

Man-made Ponds:

Florida also has many types of man-made ponds. Some of these type are excavated for fill material, commonly referred to as dug outs, where the topography is fairly flat or water is not flowing naturally nearby. Another type of man-made pond is an embankment pond, where there is some rolling topography and a intermittently flowing stream. These ponds have a constructed dam and spillways to convey the water through or around them. Some of these man-made ponds incorporate aspects of both types.

Both of these pond types are generally built and managed for multiple purposes. Several of these uses are recreation, water supply, fish production, flood control, and wildlife habitat. There are several good publications available on their use and management from your local Soil and Water Conservation District, the USDA-Natural Resources Conservation Service or the Cooperative Extension Service. See chapter 6 for a list of these publications. The uses of man-made ponds also include stormwater management. It is the pond built specifically for stormwater management upon which this citizen's guide is focused. The management techniques may apply, however, in part, to these other ponds and their uses.

▲ *Man-made Ponds*

Man-made Stormwater Pond ▶

Man-made Stormwater Ponds:

Water flowing over the land during and immediately following a rainstorm is called stormwater runoff. Stormwater runoff from lands that undergo development cause significant problems for landowners downstream, for local governments, and for the rivers and bays which ultimately receive the runoff. These problems include sediment accumulation, pesticides, excess nutrients from fertilizers, waste and decaying vegetations, litter, oils, and solvents among other lesser known pollutants.

As a result of stormwater, transport, sediment fills our ditches and streams causing flooding and requiring expensive restoration. High stream velocity causes bank erosion, moves sediment downstream, and causes more flooding, loss of wildlife habitat, and property damage. This sediment must be removed, at great cost, from culverts, ditches, streams and navigable waters to restore their capacity. Additionally, the other pollutants mentioned are also carried with the stormwater.

The volume of stormwater generated by a rain storm depends upon the total amount of rainfall, the amount that soaks into the soil, evaporates, or is taken up by plants, and how much is stored in ponds, pools and puddles. These amounts vary with the type of soil, plants, topography and land use.

Changes in land use affect runoff in two important ways: (1) the volume and rate of overland flow, and (2) the potential impacts on water quality. As an area becomes increasingly more urban through the construction of buildings, streets, parking lots and driveways, exposed soil is paved over or compacted by traffic. Consequently, the type and distribution of vegetation in these areas also change, the surface becomes more impervious, less water can soak in, and runoff is increased.

Changes in land use also directly affects water quality. In natural systems natural processes recycle most of the pollutants found in stormwater. We disturb these biological processes with our development and add pollutants to the system with our everyday activities such as: lawn and garden management with fertilizers and pesticides, trips to the store with cars leaving oil, gasoline and tire wear on the roads, walking the dogs, etc. All of these pollutants are carried by stormwater runoff to our ponds, lakes, streams and bays.

These materials create high pollutant loadings of:

- sediment which clogs drainageways, smothers bottom living aquatic life and increases cloudiness of the water;
- organic matter that as it rots removes oxygen from the water that can lead to fish kills and foul smells;
- nutrients, mostly nitrogen and phosphorus, which cause unwanted and in creased growth of algae and weeds in our waters;
- metals, such as lead, copper, zinc, cadmium and chromium, which can accumulate in fish and shellfish disrupting reproduction and making them unusable as food;
- oils and greases which are toxic to many aquatic plants and animals;
- viruses and coliform bacteria which contaminate ponds, lakes, and bays and prevent swimming, fishing and shellfish harvesting; and
- excessive fresh water which changes the salinity of bays, alters the types of life in the bays, and disrupts important nursery areas of the bays.

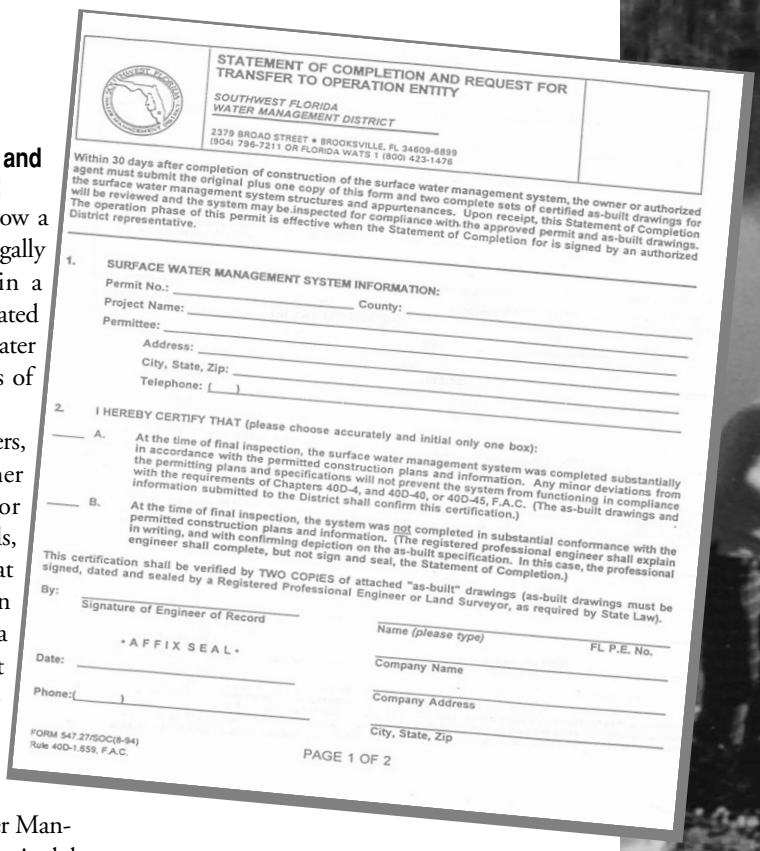
Stormwater is a major source of pollutants to our ponds, lakes, streams and bays. Improved stormwater management will reduce pollutants from our activities.

Of primary importance to minimizing the effects of stormwater on water quality is the first flush. This term describes the washing action that stormwater has on accumulated pollutants. The first few minutes of a thunderstorm will wash 90 percent of the pollutants off the streets and parking lots into the ponds and streams. This creates a shock loading of pollutants. Certain stormwater ponds are designed to accept and treat this loading before passing the water downstream.

Stormwater ponds hold water for a designed period of time to allow streams to flow more slowly and thereby carry less suspended sediment and stretch the storm flow over a longer period of time at a lower level. During this holding time more water soaks into the soil which adds to the recharge of our shallow aquifers.

Additionally, when stormwater ponds are designed properly, wildlife are encouraged to use the ponds and the number of different types of wildlife is increased.

Residential Stormwater Pond ▼



STATEMENT OF COMPLETION AND REQUEST FOR TRANSFER TO OPERATION ENTITY

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

2379 BROAD STREET • BROOKSVILLE, FL 34609-6899
(904) 796-7211 OR FLORIDA WATS 1 (800) 423-1476

Within 30 days after completion of construction of the surface water management system, the owner or authorized agent must submit the original plus one copy of this form and two complete sets of certified as-built drawings for the surface water management system structures and appurtenances. Upon receipt, this Statement of Completion will be reviewed and the system may be inspected for compliance with the approved permit and as-built drawings. The operation phase of this permit is effective when the Statement of Completion for is signed by an authorized District representative.

1. SURFACE WATER MANAGEMENT SYSTEM INFORMATION:

Permit No.: _____ County: _____

Project Name: _____

Permittee: _____

Address: _____

City, State, Zip: _____

Telephone: (___) _____

2. I HEREBY CERTIFY THAT (please choose accurately and initial only one box):

___ A. At the time of final inspection, the surface water management system was completed substantially in accordance with the permitted construction plans and information. Any minor deviations from the permitting plans and specifications will not prevent the system from functioning in compliance with the requirements of Chapters 40D-4, and 40D-40, or 40D-45, F.A.C. (The as-built drawings and information submitted to the District shall confirm this certification.)

___ B. At the time of final inspection, the system was not completed in substantial conformance with the permitted construction plans and information. (The registered professional engineer shall explain in writing, and with confirming depiction on the as-built specification. In this case, the professional engineer shall complete, but not sign and seal, the Statement of Completion.)

This certification shall be verified by TWO COPIES of attached "as-built" drawings (as-built drawings must be signed, dated and sealed by a Registered Professional Engineer or Land Surveyor, as required by State Law).

By: _____ Name (please type) _____ FL P.E. No.

Signature of Engineer of Record

• AFFIX SEAL •

Date: _____ Company Name _____

Phone:(___) _____ Company Address _____

City, State, Zip _____

FORM 547.27/SOC(8-94)
Rule 40D-1.659, F.A.C.

PAGE 1 OF 2

Researching Pond Ownership and Maintenance Responsibilities:

This section will describe how a person can know if he/she is legally permitted to do any work in a stormwater pond or other excavated water body that receives stormwater runoff, and how to find details of required maintenance, if any.

Subdivisions, shopping centers, industrial parks, and any other project creating impervious, or paved, surfaces, including roads, buildings and parking lots that were constructed after 1982 in Florida were required to obtain a Stormwater Discharge permit from the Department of Environmental Protection, or DEP, (formerly called the Department of Environmental Regulation) or from the South Florida Water Management District. This permit required that the runoff generated from the project be collected and "treated" to remove pollutants such as greases and oils, fertilizers, and heavy metals by holding the water in stormwater ponds. In 1984, the various Water Management Districts received stormwater permitting responsibilities, but in some cases, such as using natural wetlands to treat stormwater, the DEP retained permitting responsibilities. Now, the Water Management Districts are responsible for most residential and commercial stormwater permitting in Northeast, Central and South Florida.

Stormwater Discharge permits are issued to the property owner. The permits contain specific maintenance instructions for the stormwater management facilities. These facilities include ponds, culverts and inlets, some wetlands, and conveyance ditches. The instructions may be part of the permit, or may be on the approved construction drawings that are returned to the owner after permit issuance. A copy of the approved construction drawings are also retained by the permitting agency. The owner is required to obtain an "operation permit" after the project is completed. The operation permit designates who is responsible for maintenance and protection of the stormwater facilities. In the case of a commercial or residential subdivision or condominium, the owner is required to transfer the operation permit to the Homeowners, Property Owners or Condominium Owners Association (HOAs, POAs & COAs) after it is legally established, which must occur before the developer moves on.

Residential and Commercial Subdivisions, Including Condominiums:

Stormwater ponds may be owned by individual lot owners, by HOAs, POAs & COAs or by the city or county in which they are located. Ownership can be determined by looking at the recorded plat[1] of the subdivision or condominium. Ownership does not necessarily confer maintenance responsibility. In some cases, a pond shown on a plat as being owned by adjacent lot owners will be included in a drainage conveyance easement[2] recorded in the official county records. Note that an individual lot survey is drawn from both the recorded plat and actual field measurements and will also show the lot line and any drainage easement within the lot if the lot extends into a pond. The easement may dedicate the pond area to an owners association for maintenance, or to the county or city for maintenance, despite the fact that it is owned by the adjacent lot owners. In other cases, the pond area may not have a drainage easement recorded over it, but is designated as a "common area", to be owned and maintained by the subdivision's homeowner's association. In other cases, lot owners may own a pond with no drainage easement, and they may be responsible for its maintenance. Owners Association documents, including the Articles of Incorporation and the Declaration of Covenants and Restrictions, that are received when a lot or condominium is purchased, may often include information designating the entity that is responsible for maintenance of the pond.

To determine who can or must legally maintain a pond, and what restrictions cover pond maintenance, first check your lot survey to see where your lot lines extend. Then:

- Check to see if a drainage easement covers the pond.
- Check with the Owners Association to see a copy of the recorded plat for easement language, and to see to whom the easement was dedicated for maintenance. If the association does not have a copy of the plat, go to the county records office to see or obtain a copy of the plat.
- Check the approved construction plans for maintenance instructions. Read the Owners Association documents. Read the Stormwater Discharge permit. The Owners Association should contain a copy of it.
- Finally, contact the local Water Management District's permitting section (or with the local DEP office if they issued the Stormwater Discharge permit) to verify your conclusions or to fill in any missing information.

▲ *Planted littoral zone in residential stormwater pond.*

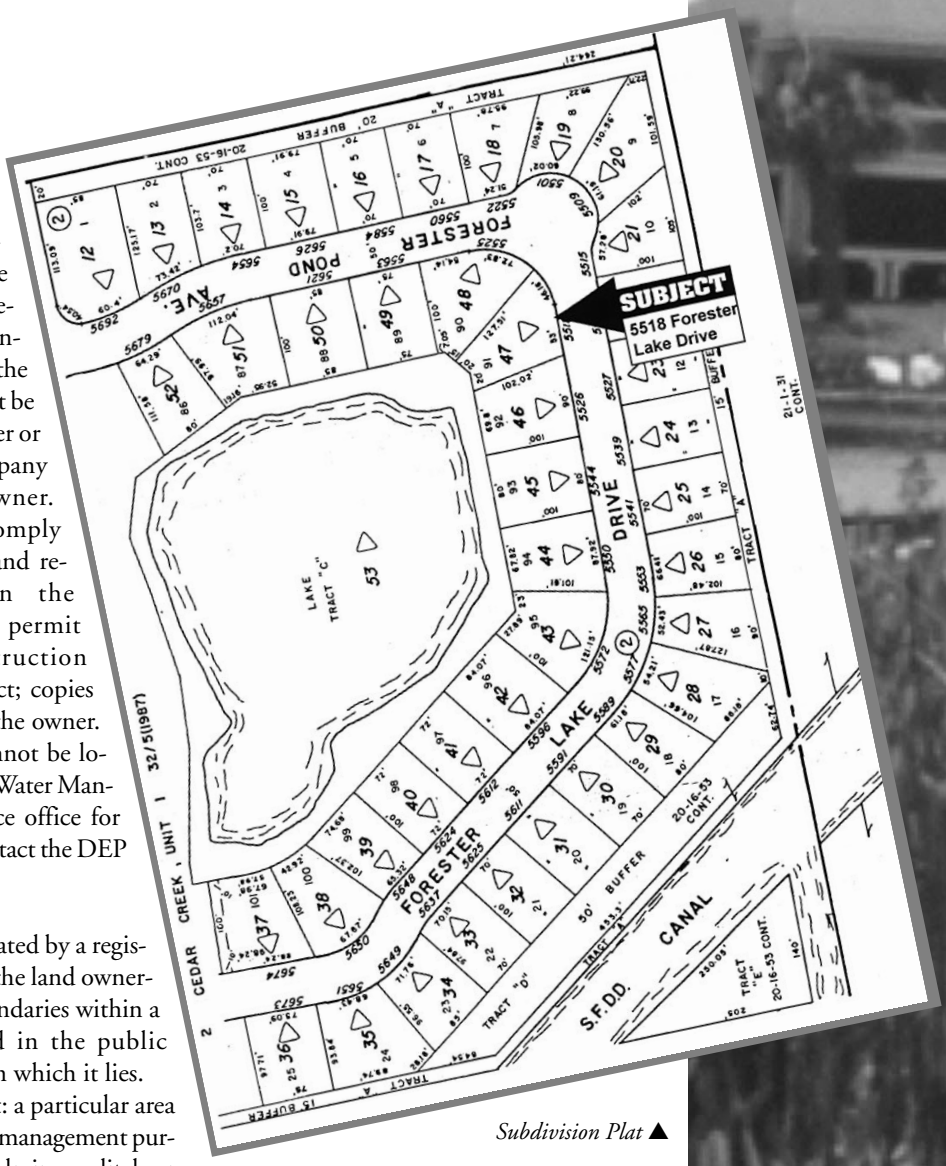
Commercial Sites:

In the case of shopping centers and apartment complexes - where the developer or subsequent owner retains ownership and control over the facilities - the pond must be maintained by the owner or the management company designated by the owner. Maintenance must comply with the instructions and restrictions found in the stormwater discharge permit and approved construction drawings for the project; copies of which are issued to the owner. If these documents cannot be located, contact the local Water Management District service office for this information, or contact the DEP for older projects.

Footnotes:

[1]Plat: a drawing, created by a registered land surveyor, of the land ownership and easement boundaries within a subdivision, recorded in the public records of the county in which it lies.

[2] Drainage easement: a particular area reserved for stormwater management purposes, such as a pond, drainage ditch or swale, or storm sewer line. An easement is recorded over land owned by one entity - a homeowner, for example - and is dedicated to another entity - the city, county or the subdivision's Owners Association, for example - for maintenance. The easement will contain specific restrictions regarding what the land owner and the maintenance entity can do within the easement. The easement may be recorded with a subdivision plat in the county records, or may be recorded separately in the official county records if it does not lie within a subdivision.



Subdivision Plat ▲

Stormwater Pond TIP

Research your water management district permit or your subdivision documents to determine restrictions on stormwater pond maintenance.

Check with the local water management district for stormwater pond maintenance guidance.

Taking a Pond Field Trip:

One of the first steps to take when creating a pond management plan is to obtain a copy of the approved construction drawings and maintenance plans for the pond, as well as for your subdivision. Determine the type of pond yours was designed to be, and what sections of your subdivision were designed to drain to your pond (this area is often called the "drainage basin" or "watershed"). Then, compare the original plans with what you see...take a walk around the subdivision and pond. Inventory the elements that you are required to maintain, and contrast them with your ideas of how you think the pond should look. You might contact the local water management district service office or your local county stormwater utility to see if a biologist or engineer is available to help you with your "pond walk".

Mallard ducks utilizing a stormwater pond. ▼

Major Items to Observe

Inflow and Outflow Structures:

The type of outflow control structure constructed for your pond will give you a clue as to what type of treatment pond design you have. This structure is usually built of concrete and regulates the pond water discharge. Often, the control structure has an iron grate on top, and an aluminum or fiberglass baffle placed in front of the openings. The baffle acts as a skimmer and prevents floating greases, oils and litter from discharging downstream.

- Ponds without outflow structures may have been constructed only for fill and will usually have no permitted main tenance requirements.

- Ponds designed to be wet detention ponds usually have a two stage overflow structure, with a wide rectangular opening and a small hole to slowly drain the water called the bleed-down orifice, usually no larger than 3" in diameter, or with a V-shaped notch. The vegetation at the shallow end of ponds is required to be protected by permit.

- Ponds designed with sand filtration beds (often called effluent filtration or side drain filter ponds) will have a con crete outfall box in which a 6, 8 or 12" diameter PVC pipe is inserted below water line. By removing the grate top, you may see the pipes inside the out fall structure, usually coming in from either side of the box. Also look for PVC "cleanouts" along the pond bank in which the sand filter is embedded; these are inspection ports which run from the filter bed up to the bank, with a PVC cap screwed on for protection. Effluent filtration ponds are required by permit to be inspected frequently to ensure the filters have not clogged.

Check for built up debris, sediment and vegetation at each storm inlet that feeds the pond, and note which structure needs work to maintain free flow. Note where screens, fish excluders[3] (if present), grates and baffles are clogged or not properly positioned. If the pond is equipped with a side bank sand filter or underdrain facility, check the outflow structure to see if water is flowing out after a rain event and see if vegetation has clogged the filter area. Your maintenance plan should include steps to remove excess debris and sediment, replace screens and grates, and replace or unclog the sand filter if it is not functioning properly. All vegetation that becomes established over the filter area must be removed so its roots do not clog the filter.

▲ *Outflow Control Structure*

Pretreatment Sediment Basin ▲

Grading and Sediment Accumulation:

Measure the pond depth below current water level at various locations. If the pond has a designated "littoral zone"[1], take several depth measurements there. Measure the depth in the inflow sediment sumps[2] and at pond outflow structure. Observe pond banks and note erosion channels and areas that must be resodded or otherwise grassed. Note deviations from permitted drawings. Your maintenance plans should include steps to regrade and resod eroded banks.

▲ *A stand of desireable wetland vegetation.*

Vegetation:

Note the amount and location of existing plant coverage, and identify the plants species. Identify which plants are "desirable" and "undesirable" **for your pond or your particular tastes.** You might contact the local Water Management District or Department of Environmental Protection office, or consult the references listed in Chapter 6 - Resources & References, for help in determining the difference between desirable and undesirable species. Note the plant coverage over the pond's designated littoral zone, if there is one. Identify the density and general type of algae (mat- or blob- forming filamentous algae, or water-tinting planktonic algae).

Your maintenance plan should include methods to weed out undesirable vegetation and replace it with desirable species, if an aesthetically-pleasing pond is your goal. If you have more algae than plants, your maintenance plans may include steps to reduce fertilizer use in your yard. Don't forget your neighbors' lawns that either surround the pond, or drain to the storm sewer that drains to the pond. Include steps to create more littoral zone in which to plant attractive vegetation. In general, the more emergent[4] vegetation a pond supports, the less algae grows, unless there is such a huge inflow of nutrients that they can't be taken up by the emergent vegetation. An open water permanent pool also increases the pollution removal capabilities of wet detention ponds.

Special Subdivision Guidance:

Walk through your subdivision with the construction drawings, and note which areas contribute drainage to your stormwater pond via gutters and storm sewers. Anything dumped on the ground within the contributing drainage area can make its way to your pond. Grass clippings blown into gutters are washed into storm sewers and into the ponds, causing nutrient overload. Paints and used motor oils that are dumped into storm sewers flow directly to ponds. Pesticides sprayed on lawns are washed into the ponds via the storm sewer system. Areas of bare soil may erode with heavy rains, and the resulting sediment can also end up in ponds. Your maintenance plan should include ways to prevent these deleterious materials from reaching your pond, mainly by educating your neighbors to be more careful and more aware. Your local stormwater utility may have an inlet marking program you can use to help educate your neighbors.

Also note the other ways water from the drainage basin is designed to reach the pond. Conveyance swales or ditches may carry stormwater from rear lot areas, and are sometimes designed to provide some water quality treatment themselves. Compare the ditch or swale depth and width to the permitted drawings. You may find that some residents have built fences or sheds over or across a swale; because this impedes flow, these items should be removed (many swales and ditches are encompassed by legal drainage easements, which are protected by law, permit, and/or deed restrictions). Lawn or garden clippings dumped in swales and ditches should be removed.

▲ *Typical inflow pipe.*

Footnotes:

[1] Littoral zone:"the shallow zone within a pond or lake with sufficient light penetration to support the growth of rooted, emergent aquatic plants."

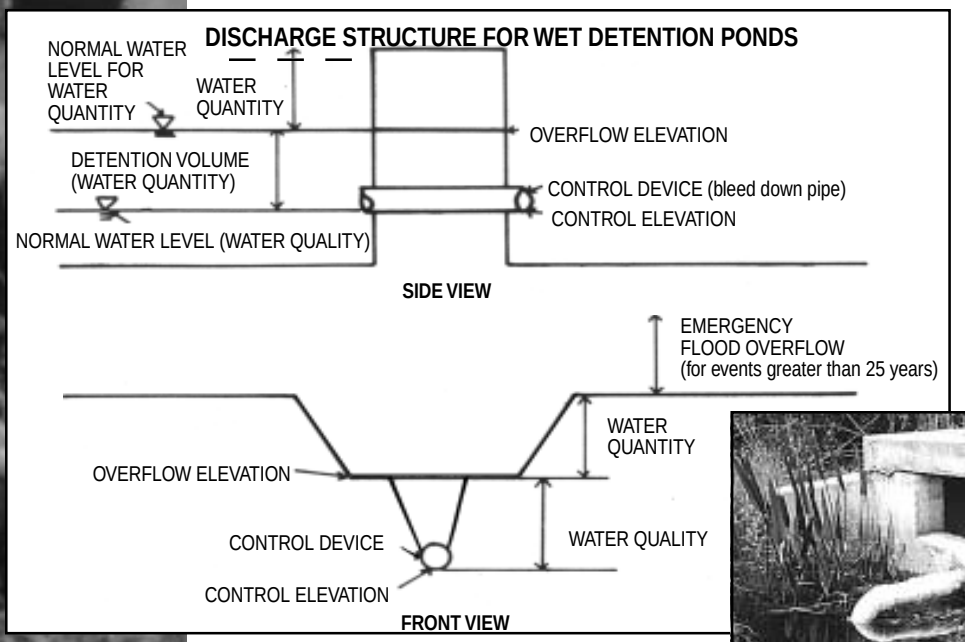
[2] Sediment sump: "a deeper area within a pond specifically constructed as a basin to trap incoming sediments and to provide an area deep enough to prevent the growth of vegetation at inflow and outflow points."

[3] Fish excluder "a device placed on pond outflow points that is required by the Florida Game and Freshwater Fish Commission to prevent stocked grass carp from leaving the pond."

[4] Emergent vegetation: "aquatic vegetation rooted in shallow zones that normally grows leaves and stems above the water surface."

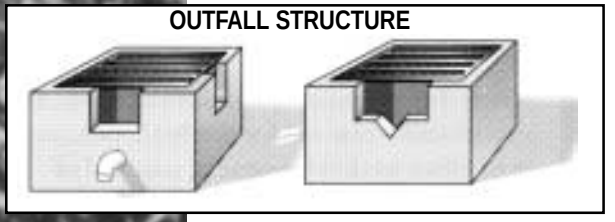
Identifying Your Pond:

The type of pond in your development can often be identified by looking at the outlet structure (usually made out of concrete) where water flows out of the pond after rain events. Systems dug as borrow pits usually have no outfall structure, although they may have a structure to maintain a certain water level. In permitted wet detention stormwater ponds the outfall structure usually has a rectangular or V-notch or pipe that slowly releases the water out of the pond over several days (Figure 3). Wet ponds with filtration (effluent filtration) are systems that have perforated pipes packed with gravel buried in trenches either around the pond or underneath the pond (see Figure 2). Sometimes the end of the pipes can be seen where they enter the sides of the drop box (the deeper rectangular concrete box usually covered by an iron grate) associated with the outfall structure of the pond. These ponds typically do not contain a shallow littoral zone and the entire pond bottom is set at one elevation. Another identifying feature for filtration systems are capped observation wells called "clean-outs" located in the banks around the pond. A good description of different types of stormwater management systems is given in "Stormwater Management: A Guide for Floridians" and "How to Op-



▲ *Figure 3. Weir structure for wet detention pond. Alternative design could have a V-notch.*

▲ *Wet detention pond outfall structure.*



◀ *How to recognize a wet detention pond: Look at the outfall structure. If it looks similar to the ones to the left and about a third of the pond is shallow or covered with vegetation (or recruiting vegetation if the pond is newly constructed) there's a good chance the facility is a wet detention pond.*

erate & Maintain Your Stormwater Management System". Both are available at no charge from your SWFWMD Service Office. You will find the address and telephone number to order your copies in Chapter 6 - Resources & References.

To do any work in permitted stormwater systems including the wet detention and filtration systems described above, permission must be granted by the permitting agency or agencies. Chapter 6; Resources provides the jurisdictional areas and the offices to contact before doing any work in permitted systems in southwest Florida. You will find them cooperative and helpful in analyzing your problems and providing information to keep your system in good working order.

Remember, before doing any work in your permitted stormwater pond be sure to get permission and advice.

Stormwater Pond TIP

The removal of littoral shelf vegetation (including cattails) from permitted wet detention ponds is prohibited unless approved by the permitting agency. Removal includes dredging, the application of herbicide, cutting, and the introduction of grass carp.

▲ *Outlet Structure.*
This photo shows a bleed down notch, shallow rectangular overflow weir and pond skimmer.

Chapter 2

How do I Care for My Stormwater Pond?

Benefits And Limitations of Pond Management

Stormwater ponds may have uses beyond simply retention and detention of water volume. The range of uses and associated benefits spans both public and personal importance. However, coupled with these benefits come some limitations.

Effective stormwater pond management can provide significant local and regional benefits by:

- lowering flood levels;
- protecting ground and surface water quality;
- recharging water supply through infiltration into the aquifer;
- providing a natural cooling system for the area, as well as cooling runoff water before it reaches a surface water body;
- providing an aesthetically attractive environment;
- providing a water storage reservoir for dry periods;
- providing recreational activities like fishing, wildlife watching and boating ***although these activities include critical restrictions on swimming and consumption of fish;*** and,
- enhancing wildlife habitat.

Ponds help recharge water supply through slow infiltration into the aquifer. ▼

General Maintenance Guidelines

Remember that one of the main purposes of the stormwater pond is to remove pollutants before they are transported to natural lakes, rivers and streams. They will never be pristine swimming or fishing lakes because they are designed to trap and transform pollutants before water is released downstream. Some of the algae and plants that home owners find objectionable help provide this pollution removal function.

Stormwater ponds will have to be cleaned out periodically (about every 10-25 years) to keep them functioning properly. There are things that can be done in the pond and especially in the watershed to improve water quality and extend the periods between extensive maintenance efforts. An efficient, functioning stormwater system takes as much time and energy as maintaining the rest of the landscaping. In fact, highly maintained upland landscaping is a big part of the problem in keeping stormwater systems attractive.

Many homeowners do not connect their landscape design and maintenance practices to the problems in their stormwater ponds. Highly maintained lawns and direct discharge of stormwater into ponds cause much of the weedy growth in stormwater ponds. One of the most important steps in having a more attractive stormwater pond is to form a partnership with all the people in the community that have an interest in the pond and then learn as much as possible about your particular pond.

All ages enjoy the recreation that a clean pond provides. ▼

- Develop a specific maintenance plan for the entire drainage basin of the stormwater pond. Find out as much as you can about the history of the drainage basin and why your pond is important in cleaning up stormwater pollution. Enlist the help of the water management districts and the original designer to determine the best strategy for improving the aesthetics without reducing the pollution removal ability of the stormwater system.

The original developer or the Water Management District has site plans for all permitted projects which include specific details. Historic aerial photographs can be obtained through University Libraries. Soil Survey aerials are available through the Natural Resources Conservation Service or the Soil & Water Conservation District in your county.

▲ *Neighborhood watershed and stormwater pond.*

- Follow the maintenance schedule and activities listed in Chapter 5 and keep records of all maintenance needs as well as the work done on the stormwater system. Pay special attention to the conveyance system by removing litter and other debris, repairing eroded surfaces, checking for solution holes, and collecting and disposing of grass cuttings so that they do not wash into the pond and increase algae growth.

- Use pre-settling basins (or other pretreatment strategies) upstream of the stormwater pond to remove the largest particles and minimize the need to disturb the wet detention pond by maintenance dredging. Sediment deposition should be monitored and conditions that contribute to excess sediment transport to the pond should be corrected. If land constraints preclude the construction of a sump area in front of the pond perhaps an area near the inflow in the pond can be used instead.

- Re-suspension of sediments can be minimized by encouraging vegetation to grow in shallow littoral zones. Increased density of vegetation slows the velocity and wave action which increases settling of suspended materials. Also dense vegetation can be effective at removing floatables and litter from stormwater. On the other hand, vegetation should be harvested periodically to improve long-term performance. This can be accomplished during the normal dry season in the spring in Florida, so that vegetation has a chance to become re-established before the summer rainy season.

- Overland flow to a pond should be distributed evenly by use of a swale or a diffuse-inlet structure to minimize short-circuiting through the pond. Make sure the system is functional if it has one.

- Erosion control in the drainage basin should be a top priority. Plant bare areas in the conveyance system and along banks. Use soil stabilization techniques such as sod, straw mulch, degradable ground covering fabrics or temporary vegetative cover such as rye grass until permanent plants are established. Planting trees throughout the drainage basin can help reduce the impact of heavy rains which cause soil erosion.

- If the street is not curbed, turf should be established and maintained below pave ment level so that sheet flow is not blocked and the grass can help remove pollutants and sediments.

- Designate buffer areas around the pond (at least 15 feet wide) where no fertilizers or pesticides can be applied.

Low impact parking lot design - where stormwater treatment begins as soon as rain hits the payment in these small recessed landscape depressions. The raised inlet allows some retention and filtration before the water is routed to wet detention basins. ▼

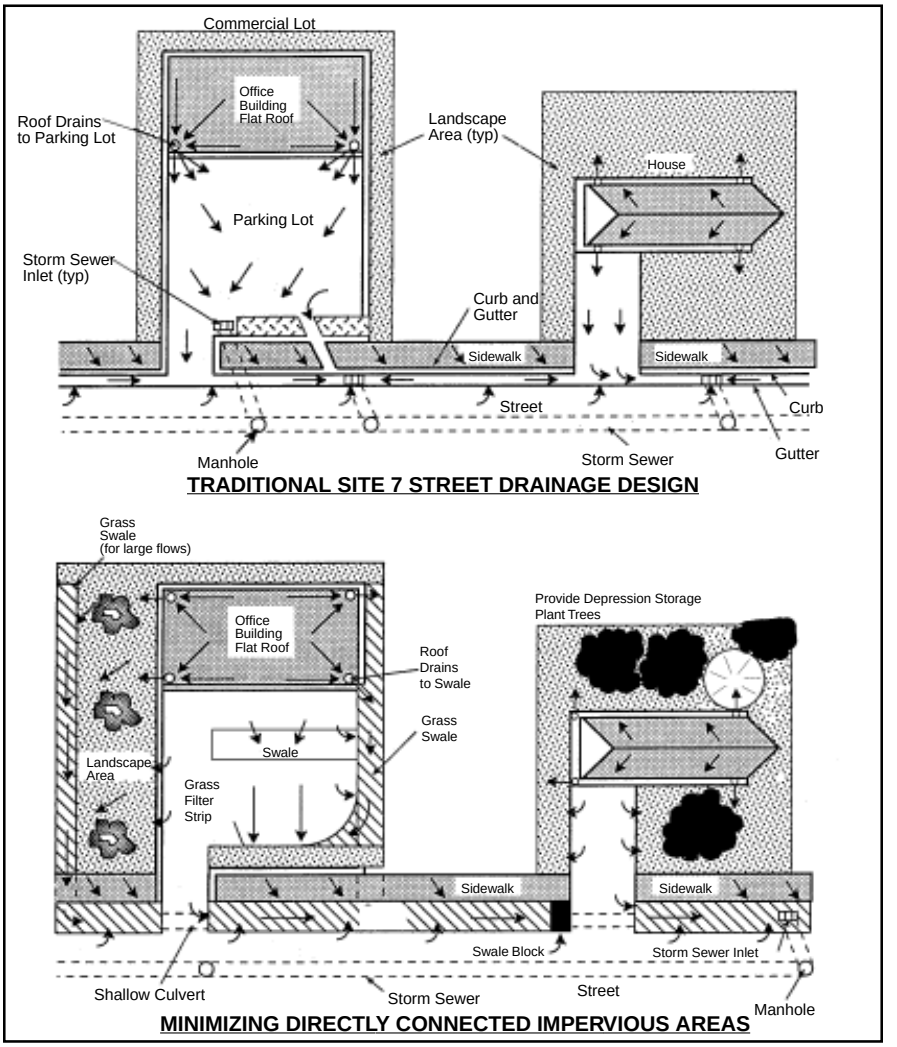
Runoff Management

Stormwater runoff has always occurred after storms, but the difference today is that we have paved over or denuded the land that used to absorb and hold back the runoff. For example, in a natural forested landscape only about ten percent of rainfall runs off into rivers and lakes. The rest infiltrates into the soil and the underground aquifers, or evaporates into the air. As more of the land is paved over with buildings, roads, and parking lots, up to ninety percent of the water runs off. If we want to reduce the pollution going to our stormwater ponds we need to provide opportunities in the watershed for water to infiltrate much like it did in the old days. This can be accomplished by directing stormwater to ditches and swales instead of directly to storm drains, by causing roof runoff to flow to a vegetated landscaped area rather than to the driveway or street, by planting trees to absorb the impact of rainfall, by having some depression storage in landscape designs, by reusing stormwater for watering the yard, and by using permeable paving surfaces where practical. Some examples of how this might be accomplished are shown in Figure 4 and many more good ideas are available from the Florida Yards and Neighborhoods program.

The Wet Detention Pond design is important in maintaining its function for removing pollutants. Make sure there is an open water permanent pool deep enough to hold water all year. This aids in deposition of pollutants and mosquito control. The permanent pool water should contain adequate amounts of dissolved oxygen. If this is a particular problem then perhaps a fountain or other aeration device can be added. Aeration is often effective in reducing filamentous algae mats. Also at least one third of the pond should be maintained as a shallow littoral shelf with desirable plant species to help remove dissolved pollutants. If algae or nuisance plant species removal is part of the plan developed for your pond then work days should be organized to get as many people involved and educated as possible.

Sediment Management and Disposal

As soil is eroded and washed into stormwater treatment ponds it accumulates, becoming part of the bottom sediments gradually filling the pond. This accumulation of sediments decreases the holding capacity of the pond and results in reduced treatment efficiency for pollutants entering the system. The process of eroded soil filling in these ponds is called sedimentation. It is the same process that physically smothers fish habitat and limits navigation in natural water bodies. When stormwater treatment systems are poorly maintained or no treatment system exists, the potential for harmful sedimentation increases in our lakes, rivers and estuaries.



▲ *Figure 4. Adapted from: Urban Storm Drainage: Criteria manual, Denver, Colorado 1992.*

To maintain maximum treatment efficiency for stormwater ponds, sediment materials must be removed periodically and disposed of off site in an uplands area. The depth and slope of the ponds must be maintained for proper treatment of sediments and other contaminants entering the system. It is critical to decrease the velocity and volume of water flowing through the system, thus providing ample opportunity for pollutants to be filtered by plants or settle out into the sediments.

Stormwater pond sediments become contaminated with heavy metals, pesticides, phosphorus, etc. as direct function of a properly designed and maintained treatment system. When sediments are removed, they should be properly disposed of. Florida's solid waste rules define stormwater pond sediments to be a solid waste. Accordingly, they must be disposed of in a Class 1 lined landfill where they can be used as daily cover material.

However, increased caution should be used when unusually high levels of contamination are observed or suspected. These situations can include sediments associated with treatment systems serving industrial and commercial operations and fuel transfer facilities. In these cases, sediments should be tested to determine the proper level of precaution for disposal. Excessive petroleum hydrocarbon contamination can present severe sediment disposal problems. Evidence may include strong odors of gasoline and very dark oily stains, particularly at inlet and outlet structures. The source of such inputs should be found and removed if possible.

Stormwater Pond TIP

For more information on stormwater pond sediment disposal requirements and methods, interested parties should contact the FDEP Stormwater and NPS Management Section regarding appropriate testing and disposal methods.

Algae Growth ▲

Sediment Contamination and Disposal:

Sediments associated with stormwater treatment devices should be regarded as contaminated well beyond the levels in runoff itself. When disposed of haphazardly, this material may become a source of pollution. Pollutants associated with stormwater sediment include high nutrients and oxygen demanding substances, heavy metals, petroleum hydrocarbons and other volatile and semi-volatile organic compounds, pesticides, and infectious organisms. However, absent circumstances which would be expected to result in the regular addition of paints, solvents, cleaning agents, pesticides and spilled fuels there is little probability that the sediment would be a hazardous waste. If space is available at the stormwater system, the sediments can be stockpiled at that location and land spread on-site provided the site is restricted to public access. However, proper practices must be used to prevent wind and water erosion and off-site movement of the sediments. Off-site disposal must be to a Class 1 lined landfill where they can be used as daily landfill cover. Stormwater sediments can be used as fill material or land spread but only if they have been thoroughly tested and they meet the soil cleanup target levels set forth in DEP's Chapter 62-777, F.A.C. Sediment from facilities serving major urban highways or industrial, commercial and fuel transfer facilities should be tested to determine the proper level of precaution for disposal. For more information, interested parties should contact FDEP Stormwater and NPS Management Section regarding appropriate testing and disposal methods for stormwater sediment.

Excessive petroleum hydrocarbon contamination can present severe sediment disposal problems. Evidence may include very dark oily stains particularly at inlet and outlet structures and strong odors of gasoline. The source of such inputs should be found and removed if possible. Otherwise, pretreatment practices should be used as necessary to insure that influent runoff water is not contaminated beyond levels normally observed in runoff from highways and parking lots.

Stormwater Pond
TIP

Off-site sediment disposal must be to an approved landfill for use as landfill cover.

▼ *Table 2.1 Planning and implementing a maintenance plan.*

PARTICIPATION
- Hold meeting for involved citizens
- Identify perceived problems
- Locate helpful reference books (see Chapter 6- Resources, References and Maps)
- Contact appropriate agency for advice (i.e. Water Management District, Stormwater Utility, Natural Resources Conservation Service, Soil & Water Conservation District, Cooperative Extension Service)

ASSESSMENT
- Request site plans and engineered drawings from appropriate entity
- Locate historic aerials of area to understand natural drainage patterns
- Identify the ultimate receiving water body (lake, river, bay or estuary) and understand the goals and objectives that have been recommended for it.

PLANNING
- Outline drainage basin on site plan
- Delineate the conveyance system
- Locate storm management controls
- Outline any natural areas to protect
- Indicate problem areas
- Identify potential sites where improvements can be made
- Prepare an inspection and maintenance plan
- Determine if perceived problems have practical solutions
- Seek professional advice if necessary

IMPLEMENTATION
- Designate the person or committee in charge of the plan
- Obtain approval of the plan from the Water Management District, if appropriate
- Prepare a check list and keep detailed records of work done
- Report back to original group
- Schedule work days if appropriate and seek cooperation
- Educate affected citizens about stormwater management

EVALUATION
- Receive feedback from group
- Update educational effort
- Modify plan if necessary
- Continue implementation

Nutrients

There are 16 chemical elements known to be essential for plant growth. They are divided into two main groups: non-mineral and mineral. The non-mineral nutrients, found in the atmosphere and water, and are essential for photosynthesis.

The 13 Mineral Nutrients are divided into three groups: major, secondary and micronutrients:

Major Nutrients	Secondary Nutrients	Micronutrients
Nitrogen	Calcium	Boron
Phosphorus	Magnesium	Chloride
Potassium	Sulfur	Copper
		Iron
		Manganese
		Molybdenum
		Zinc

The nutrients that are of most concern when considering non-point source (NPS) pollution that can be naturally occurring or added to the soil are Nitrogen (N) and Phosphorus (P).

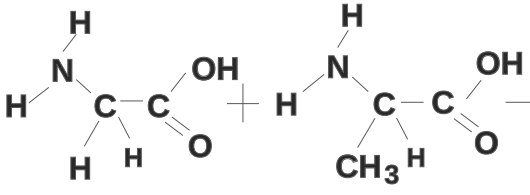
Nitrogen: Nitrogen in surface waters is an issue of concern for many water quality managers because of its effect on the eutrophication of waters (productivity). Nitrogen appears in surface waters as dissolved atmospheric molecular N_2, nitrates, nitrites, ammonia, and organic nitrogen (e.g., proteins and amino acids).

Precipitation, sewage discharges, runoff, or poor management of nitrogen fertilizers are usual sources of nitrogen. The presence of high nitrogenous compound concentrations in surface waters usually indicates organic enrichment via one or more of the sources mentioned above.

Aquatic life is significantly affected by nitrogen depending upon the concentration and form of the nitrogenous compound. Because vertebrate and invertebrate aquatic life do not particularly utilize nitrogen in their physiological processes, the primary effect of nitrogenous compounds is on the primary producers, algae and bacteria.

Algae and bacteria are capable of fixing, reducing, and oxidizing nitrogen through biochemical and metabolic processes. The resulting or intermediate products of these processes alternatively affect other aquatic life to varying degrees. Increased loading of nitrogen into surface waters only enhances these processes.

Of the various forms of nitrogen present in surface waters, the primary concern is with ammonia-nitrogen. Total ammonia exists in water as ionized (NH4+) and un-ionized (NH3) ammonia and it is the primary end product of bacterial decomposition. Ionized ammonia (NH4+) is not appreciably toxic to aquatic life, but the un-ionized (NH3) form is very toxic to fish and aquatic invertebrates. Presence of the un-ionized fraction is a function of pH. At low pH, the un-ionized ammonia molecule (NH3) ionizes to the ammonium ion (NH4+). As pH increases, NH3 increases.

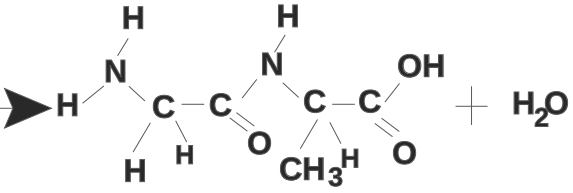


Phosphorus: Phosphorus is a macronutrient necessary for the day to day metabolic activity of aquatic organisms, especially algae and bacteria. It occurs in natural waters and wastewater's almost solely as phosphates (orthophosphates, condensed phosphates, and organically bound phosphates). Orthophosphate is the only form of soluble inorganic phosphorus directly utilized by organisms. The other phosphate compounds are highly reactive with cations, clays, carbonates, and hydroxides and quickly form insoluble compounds and/or adsorb to particulates that precipitate out of the water column.

Since much of the phosphorus potentially available in an aquatic system is adsorbed or complexed, it is often referred to as the "limiting nutrient" in aquatic systems.

Phosphorus enters surface waters primarily from fires, groundwater seepage and overland runoff. Increased phosphorus loads often result from sources such as fertilizers carried in runoff water, commercial cleaning or laundering water, and municipal waste water.

Like nitrogen, phosphorus is a metabolically necessary nutrient for bacteria and algae. And, like nitrogen, increased phosphorus in surface waters can increase algal and bacterial productivity.

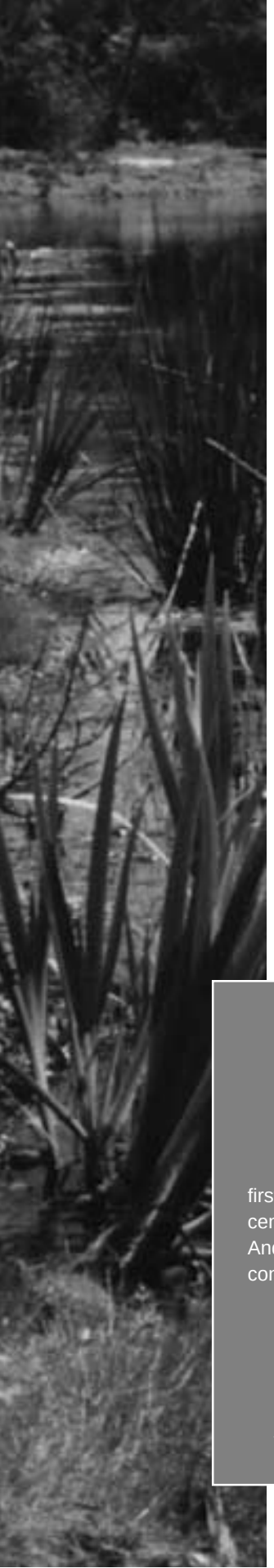


Stormwater Pond TIP

Reducing pollution at the source is the best strategy for protecting your stormwater pond.

- Fertilize sparingly
- Fix erosion sources
- Keep grass clippings out of pond
- Never throw trash or oils into storm drains
- Inspect stormwater systems regularly

▲ *Parking lot inlets are direct connections for pollutants to stormwater systems.*



Pesticides

Pesticides are generally compounds used for pest control in agriculture, industry, and the home. They may be synthetically derived copies of naturally occurring compounds or new man-made compounds. They include insecticides, rodenticides, fungicides, algaecides, miticides, herbicides, and general biocides. Pesticides may be organic or inorganic compounds and they may include simple metal mixtures or complex organic molecules.

Pesticides may undergo transformations in the aquatic environment through processes such as oxidation, reduction, hydrolysis, and photolysis. The resulting compound may be more or less toxic than its parent compound.

The modes of action in organisms vary depending upon their intended targets. For example, an insecticide may have a very different mode of action on its target (mosquito larvae) versus its non-target (frogs or toads) organisms. Generally, pesticides affect organisms through interrupting necessary metabolic or neural pathways.

Because of their widespread use, pesticides are often found in many surface waters especially those streams and rivers adjacent to farmlands, industrial areas, or urbanized areas. These areas are the primary sources of pesticides in waters via runoff and drift from aerial spraying or scattering. Aerial transport aside from direct application may also occur through wind erosion of treated soils, and volatilization.

Pesticides may affect all aquatic life through direct or indirect exposure. Direct exposure is usually the result of acute pesticide contamination. This occurs when high pesticide concentrations are present over a sufficient period of time to cause lethality. Acute effects are relatively localized to the source and area of contamination because of dilution over time and space. The primary effect is on the survival of individuals aquatic organisms exposed. Acute effects may occur for all aquatic organisms. An example of an indirect effect occurred in the migrating ducks in the prairie pothole region of the US. The ducks themselves were not affected by the pesticides, but the microinvertebrates on which they were feeding, were decreasing in numbers. In turn the migration path of the ducks was altered due to the lack of available food.

Direct exposure may also occur when concentrations are low, but persistent, over a period of time. These chronic exposures not only affect survival, but also reproduction.

Chronic exposure may lead to more indirect effects such as pesticide accumulation and concentration in the tissues of an organisms, and/or magnification through the food chain. These indirect effects may lead to a breakdown in higher levels of biological organization including population and community level effects.

Stormwater Pond TIP

Use the least toxic form of pest control first. Use more applications and less concentration of chemical whenever possible. And remember not all bugs are bad, some control the bad bugs.

—INSECTICIDE SPRAY—
1/3 cup liquid dishwashing soap
1/3 cup vegetable oil
1/4 cup baking soda
Apply from 20 gallon hose end sprayer.
Spray on plants every two weeks.

Pesticide Use:

As a rule, pesticides should be avoided in association with the maintenance of stormwater management systems. However, when necessary, use only pesticides approved by US EPA and FDACS for aquatic sites. Violation of water quality standards in receiving waters resulting from the use of chemicals within the treatment facility may be punishable under state law. Pesticide use on landscape plants often are washed off into stormwater ponds, natural areas and streams.

Herbicides:

Careful herbicide selection and application are essential to avoid harm to desirable plants and animals. Applicators must be experienced and well trained in plant identification to selectively control undesirable plants while avoiding detrimental effects on desirable vegetation and possible downstream contamination. For assistance, contact the Florida Department of Environmental Protection, Bureau of Aquatic Plant Management, regional biologist or the local County Cooperative Extension Service agent.

Insecticides:

Many types of insecticides occur including organochlorines, organophosphates, carbamates, pyrethrins, and others. From an aquatic ecosystem point of view we are concerned with how these pesticides fall into two categories, (1) those that are soluble in water, and (2) those that are highly insoluble in water.

Organophosphates such as guthion, parathion, diazanon, and malathion are typically very soluble in water. These types of pesticides are usually not very persistent in the aquatic or terrestrial environment, they become chemically unstable after a period of time and degrade. Often, they may persist for a only a few days before they breakdown.

Stormwater Pond
TIP

Less than one percent of all insects are harmful to plants and many insects are beneficial. Healthy plants can usually fend off pest attacks while predatory insects and birds may keep underirable insects under control.

Integrated Pest Management (IPM) is an environmentally friendly approach to pest control. It emphasizes the use of pest resistant plants, proper landscape management, natural enemies of pests, and the least toxic alternative if pesticides are required. Call Cooperative Extension Agents for further information.

Organochlorines such as DDT, aldrin, dieldrin, lindane, heptachlor, toxaphene, and chlordane are typically very insoluble in water. These types of pesticides, although no longer available for purchase in the U.S., are persistent because they are chemically stable and do not degrade easily. If they were used in the past in your watershed, they may persist for several weeks, months, years or decades.

Because of their insolubility in water, these types of pesticides have high affinities to bind with suspended organic material, sediments, and lipids (fish fat). Many of the more persistent pesticides are no longer used in the US because of their persistence. The reason why concentrations of these pesticides are routinely measured in aquatic organisms and sediments is because of their continued persistence and chronic affects.

Other Pollutants and Their Management

Heavy Metals:

Heavy metals have been identified as the most prevalent toxicant found in urban runoff with concentrations often at levels harmful to aquatic life. In addition, metals attach to bottom sediments where they are consumed by sediment-living organisms and become increasingly concentrated up the food chain, making even small amounts potentially toxic. The metals of concern include: Cadmium (Cd), Cobalt (Co), Chromium (Cr), Copper (Cu), Iron (Fe), Manganese (Mn), Nickel (Ni), Lead (Pb), and Zinc (Zn). Among the metals detected in stormwater, zinc, copper and cadmium are the most abundant. Although lead is sometimes still measured at toxic levels, lead was a much more serious problem before the introduction of lead free gasoline. This is one example of the potential for cleaning up pollution with source reduction.

▲ *Vehicles are a source of heavy metals in stormwater runoff.*

A major source of metals in the environment comes directly from your automobile. Whenever you drive, you leave tire particles on the road and every time you touch your brake pedal, you deposit copper-laden brake residue. Even the road itself and the paint used to mark traffic lanes contribute to toxic pollutants in runoff.

Other sources of heavy metals measured in storm runoff include: Corroding metal surfaces such as roofing and gutter material, industrial processes which produce metal wastes, household chemicals such as cleaning and gardening products, and direct atmospheric deposition containing air pollution from automobiles and smoke stacks. Another major source of metal pollution comes from the improper use of chemicals to control algae and other vegetation in stormwater ponds. This subject is covered in greater detail in other sections of this report. See, for example, the pesticide and vegetation sections.

Metals are of concern in stormwater because toxic levels can pose health risks, cause genetic defects, produce reproductive abnormalities and increase mortality rates of aquatic organisms. Metals that accumulate in certain animal or fish tissues can become more concentrated (bioaccumulate) as larger organisms eat smaller ones. For example, when fish eat zooplankton the metals that have been ingested by the zooplankton are now incorporated in the fish tissues. Of special concern is the fact that the impact of metal pollution are not fully understood since their long-term chronic effects are frequently physiological and may only be manifest in an organism's susceptibility to disease or response to environmental changes such as temperature or pH. In addition, the impacts resulting from intermittent nonpoint discharges into natural waters are extremely difficult to isolate or to identify cause and effect relationships.

Managing Heavy Metals:

Never pour toxic household chemicals down any drain — this includes the drains inside your house as well as storm drains or gutters that lead to storm drains. Also never pour toxic chemicals on the ground where they can seep into the water table and eventually the aquifer or a stream. Take them to hazardous waste collection centers. Some household chemicals that need to be disposed of properly include: Metal polish with solvent, furniture polish, battery acid (or batteries), automatic transmission fluid, brake fluid, car wax with solvent, paint brush cleaner with solvent, paint (oil based), paint thinner, turpentine, varnish, wood preservatives, gun cleaning solvents, ammunition, and many others.

- Recycle used oil and antifreeze by taking them to service stations and other recycling centers.
- Schedule regular tune-ups for your car to reduce deposition of toxic metal pollutants from exhaust gases and fluid drips. Reduce automobile trips. Every trip increases congestion and pollution.
- Wash your car on the grass, not the driveway. Another alternative is to use a car wash facility that captures and reuses water.
- Use chemicals properly or not at all. Inappropriate use of chemicals to control aquatic nuisance species can increase metals to toxic levels.
- Encourage government initiatives which reduce pollutant concentrations by source reduction.
- Recognize that metals are more toxic in soft water or waters that are low in dissolved oxygen or pH. Therefore manage your stormwater system for acceptable levels of these parameters.
- Provide a sediment sump and a schedule for regular maintenance.

Hydrocarbons (Fuels & Oils):

Sources of hydrocarbons to urban stormwaters include accidental spills or deliberate dumping of used oil and fuels, emissions from engines during normal operation (primarily uncombusted exhaust hydrocarbons and crankcase drippings), fallout from atmospheric particulates, and spillage of products during refining and transportation. Newspaper headlines focus on oil spills and industrial effluent, but in fact, the chronic unrecorded drip-by-drip diffuse sources deposited every day in urban runoff contribute a significant amount of petroleum-derived hydrocarbons to the aquatic environment.

Stormwater Pond

TIP

You can reduce your use of hazardous household products by choosing safter, less-toxic products.

Avoid household products with hazardous ingredients, or handle them with extreme care. Many toxic ingredients in paint thinners and drain cleaners, for example can contaminate water sources.

• Use only enough of the product to get the job done.

• Never dump hazardous products down drains, the toilet, or near flowing water, ponds, or lakes.

•Do not dump them on the ground.

•Use natural and less-toxic household products whenever possible.

As with metal pollution, our transportation system is a major contributor to hydrocarbon pollution. Hydrocarbons are found in weathered materials of street surfaces, automobile exhaust, lubricating oils, gasoline, diesel fuel, and tire particles. Probably the most visible sign of hydrocarbon pollution is that dark streak down the middle of highway traffic lanes or those dark patches left in parking lots both of which are manifestations of the oils, greases and heavy metals left by automobiles. One study documented that hydrocarbon deposition in open water bodies is derived 80% from combustion sources and 20% from used motor oil.

Hydrocarbons are of concern because many of them or their derivatives are toxic and some are carcinogenic. Also, if stormwater runoff becomes a part of the drinking water supply, the widely used process of chlorination of water supplies may render the hydrocarbons contained in the treated water much more dangerous to humans. In addition, oils and greases impair fish habitat and may cause oxygen deficiencies by limiting water-air interactions at the surface of ponds.

Managing Hydrocarbons:

Many of the methods for removing hydrocarbons in urban runoff are the same as for metal reduction.

Keep your car in good working order. The deposition of leaked fuels and fluids from vehicles are a key source of hydrocarbon contamination.

- Recycle used oil by taking it to re cycling centers.
- Encourage street sweeping by your community to remove street dust.
- Wash your car on the grass or at an approved car wash facility that reuses wash water.
- Encourage government initiatives that reduces pollution at the source.
- Support the introduction of better built product that don't corrode or otherwise produce break down products that cause pollution.
- Construct a separate sediment sump and provide routine maintenance with sediment removal when necessary as a pre-treatment design element of wet-detention ponds.

A Community Approach to A Pond Management Plan

How can a pond management plan help me and my pond?

Your stormwater pond is a water treatment facility, and it performs a very important job for your drainage basin: *it cleans water.* A management plan will help you make sure that your pond is working at peak performance to keep your water as clean as possible. With a plan for future maintenance of your pond, you and your pond group will avoid spending time and money on "quick fixes" that may degrade water quality and add pollutants.

What should my pond look like?
What could my pond look like?

There are certain elements of your pond you cannot change: the shape, the depth, the surroundings, the underlying soils, the water sources (both groundwater and neighborhood stormwater runoff), and the purpose for which the pond was built. What are the elements of your pond that *can* be changed? You can change the neighborhood's attitude towards the pond, the type of maintenance it receives, the quality of the neighborhood stormwater runoff that enters the pond, the quality of the water as it leaves the pond, the types of plants that grow in and around the pond, and the kinds of wildlife that are attracted to your pond. Your pond can become a neighborhood asset, a place to play with the kids, to teach them about Florida's natural world, and watch the birds. You *can* fool mother nature by making your stormwater pond look like a natural pond, with native flowering plants, trees, and birds. A stormwater pond can have clean clear water, cypress trees, oak trees, iris blooming in the spring, and summer-blooming pickerel weed edging the shoreline.

What is a pond management plan?

A pond management plan is a description of your pond; the problems associated with the pond and its drainage basin; a listing of people who live and work in the drainage basin; a record of meetings, pond evaluations, water quality data, as well as actions proposed and/or taken by the group. A management plan is written by consensus of the group, and is reviewed by everyone in the pond basin, or as many as you can reach. A plan includes goals for the future and helps you measure your progress in achieving those goals. It helps you make better decisions by providing a record of previous decisions and a written record of the neighborhood's vision for your pond. Any proposed actions that may impede or degrade the neighborhood's goals and vision for the pond should be turned down.

Ponds are like lakes.

Ponds and lakes in urban settings share many of the same problems, and so share many management issues. The Florida LAKEWATCH program uses a *fifteen-step process* in helping their volunteers build a lake management plan. Ponds are smaller, with fewer recreational and development issues, so we have shortened the LAKEWATCH process to six steps.

Six Steps To Building Your Pond Management Plan

1. Form a group made up of the people living in your pond's drainage basin.

It is important to include people who live away from the pond, but in the basin.

2. List the problems you are having with your pond.

Problems could include nuisance vegetation, clogged storm drains, eroding banks, litter, pet droppings, algae blooms, compost piles, etc.

3. Collect information about your pond and the drainage basin, including:

- an aerial photograph of the pond and drainage basin
- names and addresses of everyone in the drainage basin
- locations of drainage structures, pipes, under drains, & connections
- ownership & easements, deed restrictions, and/or homeowner's rules that apply to the pond's cur rent maintenance procedures such as grass carp, herbicides, plant re moval, water sample analysis, and Secchi disk measurement.
- identify your pond's drainage basin (which streets drain to your pond).

4. List possible solutions to the problems you have listed.

Solutions could include establishing a buffer of native plantings around the pond, nuisance plant removal, storm drain marking, neighborhood educational meeting, renting a dumpster for a neighborhood pond clean-up, fertilizer-free zones, or door hangers with pollution prevention instructions.

5. Write a management plan with all of the information you've collected.

Your management plan may have these sections:

Section 1. Pond Background Information and Description
Section 2. Pond Group Members
Section 3. Aquatic Weed Control
Section 4. Algae Control
Section 5. Fish & Wildlife
Section 6. Water Quality Monitoring
Section 7. Drainage Structure Maintenance
Section 8. Pond Group Work Days
Section 9. Stormwater Pollution Prevention Program
- Environmental Landscape Maintenance
- Storm Drain Marking
- Door Hangers
- Pond Walk
- Educational Meeting With Experts
- Pond Work Days
- Fertilizer-Free Zones
- Pond Plantings

Section 10. Pond Group Goals & Vision For The Future

6. Implement your plan.

Assign activities to members of your group. Set dates for achieving your goals. Contact local governmental agencies for educational materials, technical guidance, and assistance in managing your pond; ask for speakers to address your pond group members at a meeting or a pond walk.

Use Chapter 4.-A Pond Management Plan Workbook to help you write *Your Pond Management Plan.*

Permits

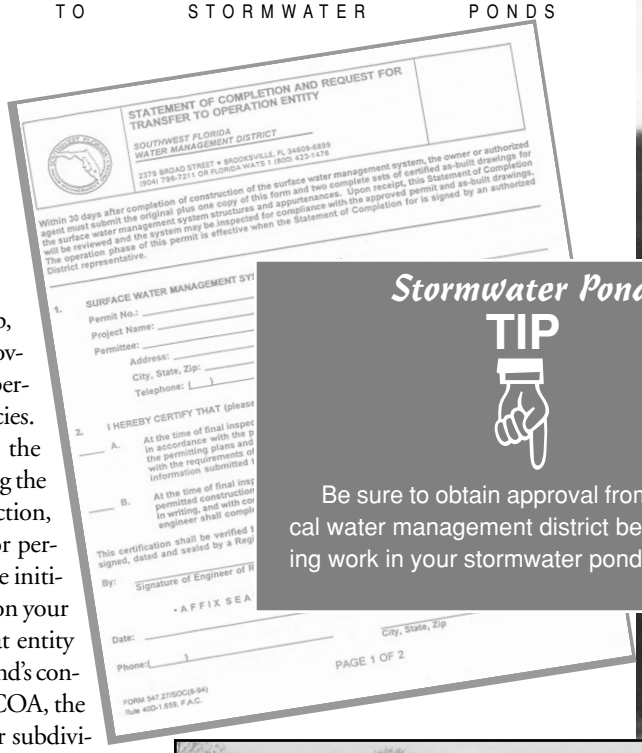
As stated in Chapter 1., Researching Pond Ownership, many stormwater ponds are governed by the conditions of permits issued by various agencies. Once you have investigated the background of your pond using the guidelines included in that section, you will know what permit or permits govern your pond. Before initiating any maintenance work on your pond, you must identify what entity is legally responsible for the pond's condition, be it the HOA/POA/COA, the county, or in the case of older subdivisions, individual owners. Again, this information will be revealed after you investigate your pond's history.

Once you establish your legal rights to work in the pond, study the permit issued to the developer, and the originally-permitted construction drawings, and -'identify the required maintenance guidelines and restrictions. The maintenance plan you develop for your pond may go beyond the basic requirements included with the permit. As long as the proposed maintenance does not conflict with these basic requirements, you may proceed. For instance, you may want to remove weedy vegetation and replace it with desirable species, however, a typical permit condition for wet detention ponds is:

The removal of littoral shelf vegetation (including cattails) from wet detention ponds is prohibited unless otherwise approved by the Water Management District. Removal includes dredging, the application of herbicide, cutting, and the introduction of grass carp.

If your proposal would not affect the water quality treatment capability of the pond, contact the permitting agency (Water Management District, Department of Environmental Regulation, County Development Review departments, etc.) for plan approval. The proposal should specify which native plant species will replace the undesirable species. Understand that if you do the work without first obtaining approval from the permitting agency, you may be in violation of the permit condition, and possibly subject to legal action.

Ponds with side-drain filters are required by permit condition and approved management plans to maintain vegetation-free zone above the filter bed. **This area must not be planted**, but the rest of the shoreline may be planted with attractive vegetation. Again, provide a planting plan to the permitting agency for approval prior to taking any action.


STATEMENT OF COMPLETION AND REQUEST FOR TRANSFER TO OPERATION ENTITY

SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

2379 BROAD STREET • BROOKSVILLE, FL 34609-6899
(904) 796-7211 OR FLORIDA WATS 1 (800) 423-1476

Within 30 days after completion of construction of the surface water management system, the owner or authorized agent must submit the original plus one copy of this form and two complete sets of certified as-built drawings for the surface water management system structures and appurtenances. Upon receipt, this Statement of Completion will be reviewed and the system may be inspected for compliance with the approved permit and as-built drawings. The operation phase of this permit is effective when the Statement of Completion for is signed by an authorized District representative.

1. SURFACE WATER MANAGEMENT SY
Permit No.:
Project Name:
Permittee:
Address:
City, State, Zip:
Telephone: ( )

2. I HEREBY CERTIFY THAT (please
___ A. At the time of final inspec in accordance with the p the permitting plans and with the requirements of information submitted
___ B. At the time of final insp permitted construction In writing, and with co engineer shall comple

This certification shall be verified signed, dated and sealed by a Reg

By: Signature of Engineer of R
• AFFIX SEA

Date:
Phone:( )
City, State, Zip

PAGE 1 OF 2

FORM 547.27/SDC(8-94)
Rule 40D-1.659, F.A.C.

Stormwater Pond
TIP

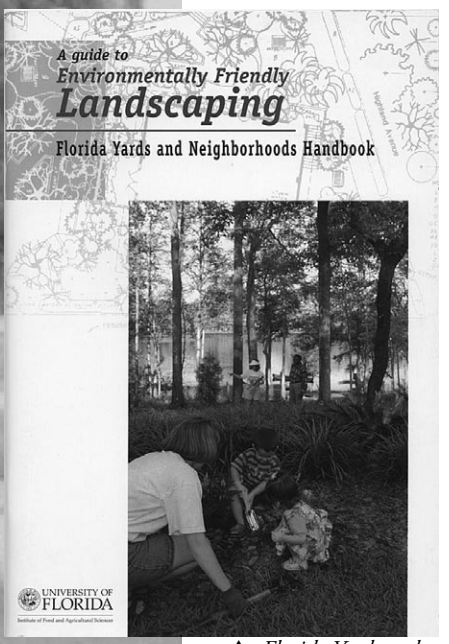
Be sure to obtain approval from the local water management district before doing work in your stormwater pond.

Protecting the Pond Watershed

Pond-Friendly Yards and Common Properties

A stormwater pond evaluation gives us a complete picture of our pond's watershed. We have mapped the homes and common property along the pond's edge. During the evaluation we have also located the storm drains that feed into the pond—and determined the type of property that is served by the storm drains.

Sometimes a pond is surrounded by a natural area, containing cypress trees and other native plants. However, yards and community property usually make up the largest percentage of a pond's watershed. It's important to remember that developed and maintained areas do not inherently cause problems to a pond-it is the way we design and take care of them that determines whether a pond is a thing of beauty or of despair. The fact that we created our yards and community landscapes in the first place means we can *recreate* them in a way to protect the integrity of our stormwater ponds.



▲ *Florida Yards and Neighborhood Handbook.*

The next section discusses the value of routine pond maintenance. As the adage notes, "An ounce of prevention is worth a pound of cure." In the case of pond care, preventing pollutants from entering a pond is much easier and cheaper than continually cleaning out a pond.

Design:

1. Use the Right Plant for the Right Spot

Picking the right plant for the right spot results in less fertilizer, pesticide and water use. However, before you can chose the right plant, you have to know something about the spot-the site conditions. Is your soil sand, marl or clay, and what is the soil pH? How cold does it get during the winter? What are the rainfall patterns? Is there full sun, partial shade or full shade?

Often different conditions exist in one yard. For example, the front yard may be high and dry, while the backyard, bordered by a pond, may often be wet. Few plants will do well under both site conditions, so choose plants carefully.

If you live on a pond, incorporate this *waterscape* into the design of your backyard. Let the native aquatic and shoreline plants add color and beauty to your garden.

2. Design landscapes to control the flow of stormwater runoff.

Stormwater runoff has always existed, to some extent. The difference now is that we have paved over the land that used to absorb rainfall. We have also removed the plants that helped slow runoff and disperse rain water.

In a natural forest approximately ten percent of rainfall runs off into rivers, lakes and ponds. The remaining 90 percent of the rain seeps through the soil replenishing underground aquifers or it evaporated into the air.

The reverse is true today in urban and suburban areas. As more and more of the land is paved over and covered with buildings, roads and parking lots, up to 90 percent of the rainfall runs off of the ground surface. The natural water filtering system has been lost. Now, stormwater runoff, carrying soil, pollution from our cars and fertilizers and pesticides from our yards, flows into stormwater ponds or into lakes, rivers and bays.

We can regain much of that filtering action by adding the following elements to our landscape designs to the yards and community properties in our pond's watershed area:

- Swales, ditches, terraces and shallow, depressed areas.
  — These design features slow down the flow of water, allowing pollutants to settle into ground before the water reaches the pond.

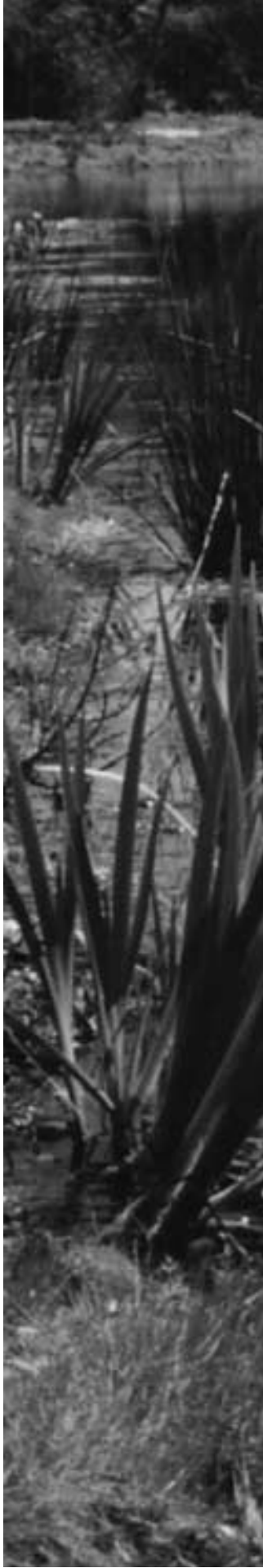
- Trees.
  — Trees slow rainwater before it hits the ground. A rainstorm torrent is dispersed into smaller drops that trickle down the tree, from leaf to leaf, until they reach the ground. Tree roots also help slow the flow by holding the water, allowing it to be absorbed by the soil.

- Landscape buffers between buildings and sidewalks or roads.
  — Landscape buffers, allow some of the water pouring off of a roof to get absorbed into the ground. Direct down spouts away from impervious surfaces and into lawn areas and plant beds.

- Permeable paving surfaces where practical.
  — Brick patios, mulch pathways and pervious concrete are examples of permeable surfaces that add beauty to a landscapes while helping to protect the environment. Unlike standard concrete, permeable surfaces allow water to go into the ground.

Some examples of how these actions can be accomplished are shown on page 48.

Use depression storage to reduce runoff and increase infiltration. ▶



Maintenance:

1. Create 15 to 30 foot buffers around the pond that receive no fertilizers or pesticides. Be careful in using herbicides in this buffer zone area.

Buffer zones of native plants create habitat for Florida's wildlife and add beauty and dimension to your landscape design. Upland areas of yards and community property can be enhanced with Muhly Grass, with its striking purple fall color, and the butterfly-attracting porterweed. The bright yellow flowers of the native canna, flanked by the purple-blue blooms of pickerel weed, are a welcome addition to the pond's edge.

Also, because native plants are adapted to the pond ecosystem, they do not need fertilizer. And in the case of plant pests, we can usually let nature's check-and-balance system of predators and prey keep plant damage to a minimum.

If your pond is surrounded by lawn grass, you can still create a fertilizer/pesticide free zone. Backyards on ponds often slope significantly down from the house. When you apply fertilizer to the upland area around your home, gravity often causes some of the nutrients to move down the slope to the grass area close to the pond. If you need to treat for pests, practice IPM (Integrated Pest Management), discussed later in this section.

2. Take care of your yard in a Florida-friendly way. We often make our yards more high-maintenance than they need to be. There are four steps to having an attractive, healthy yard.

Step 1: Mow your grass at the proper height and don't take off more than 1/3 of the grass blade at a time. Longer grass blades result in longer roots and longer roots make the plant more efficient in taking up water. Also, longer grass will inhibit weeds. Practice selective pruning on your bushes. Hire a certified arborist to prune your trees.

Step 2: Use fertilizers appropriately. Over-fertilizing leads to excess plant growth. Excess growth can attract plant pests and requires additional maintenance, in terms of pruning. Don't apply fertilizers during the summer when rains will leach the nitrogen into the soil past the root zone or wash it into the street or pond. Use ferrous iron to "green-up" the lawn during the summer. Many shrubs and trees require little or no fertilizer once they are well-established.

Step 3: Practice Integrated Pest Management (IPM). Protect the good bugs! They often are hard at work behind the scenes, keeping pest populations under control. Check your lawn and plant beds regularly for pest problems. Identify the pest. Know the good bugs from the bad ones. Is it chinch bugs or big-eyed bug? It makes a difference. Big-eyed bugs eat chinch bugs. Spot treat. For example, if chinch bugs are the problem, don't treat the entire lawn! Treat the area of infestation—and six feet beyond. If one out of ten plants has scale, treat only that plant. Try the least-toxic pesticide first, such as insecticidal soaps, Bt products and horticulture oils. Tolerate some plant damage.

Stormwater Pond
TIP

Let only rain go down the stormdrains: Many people think stormwater goes to a treatment plant and so they dump trash, yard debris, paint or other chemicals down the storm drain. It is important that everyone in the pond watershed know that what goes down the storm drain ends up in the pond, and then into a river, lake or bay.

When you see aphids, wait a day before acting. You may find that ladybugs have come in and devoured the aphids for you.

Step 4: Water Wisely. Over-watering leads to lots of problems for our lawns and plants. Fungus problems are the direct result of over-watering. Many common ornamental landscape plants, such as pittosporum and juniper, also suffer when they receive too much water. Use a rain gauge to track rainfall amounts. And if you have an in-ground automatic sprinkler system, install a rain-sensing shut-off device. Set the device to shut-off your sprinkler system after 1/2 to 3/4 inch of rain. In some parts of Florida, rain shut-off devices are required by law on all systems. Let your plants tell you when they need water. There are five benefits to watering wisely:

1. Your water bills are lower.
2. You reduce the chance for pests in the landscape.
3. Your plants develop longer roots and are better prepared for dry spells.
4. You avoid washing away lawn fertilizers.
5. You allow the soil to act like a sponge during rainfall.

Think about it. When your soil is saturated, like a full sponge, it can't take up anymore water when it rains or when you irrigate. The water, instead of soaking into the ground, becomes stormwater runoff.

Stormwater Pond TIP

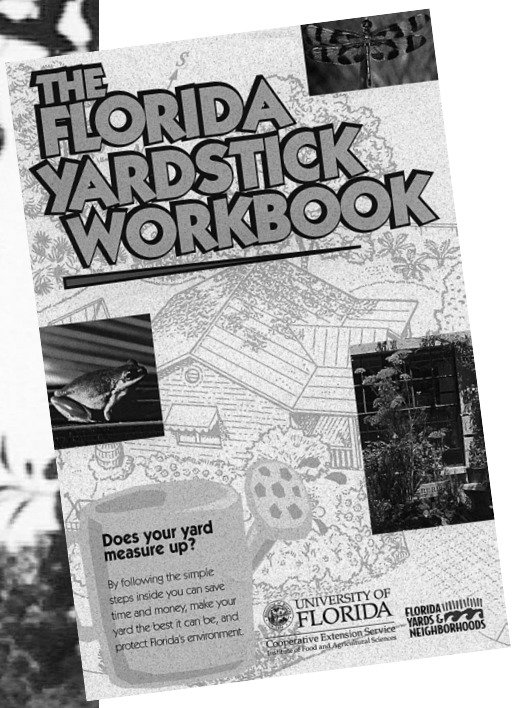
Calibrate your irrigation system-whether you have an in-ground sprinkler system or use a sprinkler at the end of the hose.

Step 1. Place shallow cans or glasses of equal size around the area covered by your sprinkler or one zone of your in-ground system.

Step 2. Turn on the water for fifteen minutes.

Step 3. Measure the amount of water in each container. Add the amounts together and divide by the number of containers. That will tell you the average amount of water your yard received during the fifteen minutes.

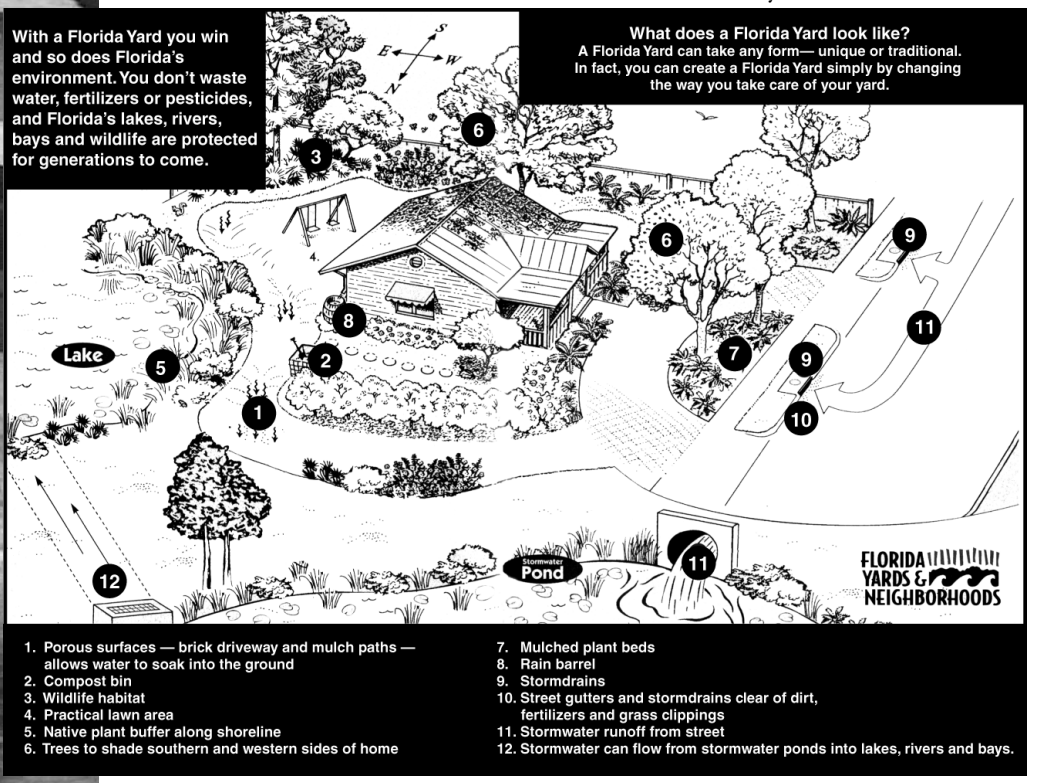
Step 4. Calculate how long you need to run the sprinkler or zone to have your plants receive 1/2 to 1/4 inch of water per application. For example, if you collected an average of an eighth of an inch in 15 minutes using your hose-end sprinkler, you will have to run it for an hour to get one-half inch.



▲ *By following the simple steps inside the Florida Yardstick Workbook you can save time and money. Make your yard the best it can be, and protect Florida's environment.*

Fertilizers and pesticides washing off our lawns during a summer rain also become pollutants when they enter the pond system. The runoff from one yard does not makes a big difference, but the stormwater runoff from many yards or a large community area can add a lot of pollutants into a pond.

- Using too much nitrogen on St. Augustine grass lawns encourages chinch bugs.
- Over-watering and under-watering the lawn results in short grass roots.
- Follow herbicide labels carefully. Note that *Atrazine* can kill trees if used incorrectly.
- Spot treat for pests-protect beneficial insects, reduce the change of insects becoming resistant to pesticides and save money.



▲ *The Florida Yardstick Workbook shows you how to create attractive and healthy yards by working with Florida's environment, rather than against it.*

Aquatic Vegetation Management

Plant life that grows in and around the water ranges from single celled algae, suspended in the water, called phytoplankton, to large woody plants, such as cypress trees. Plant life is vital to the functioning of lakes and wetlands and serves various roles such as production of oxygen and wildlife habitat. Many urban ponds are constructed as wet detention areas for surface water with the primary purpose of flood control. Secondarily, surface water detention ponds are built to protect receiving waters from pollutants and may be used to mitigate destruction of wetlands. Wet detention ponds may be constructed with shallow sloping areas, called littoral shelves. The purpose of the littoral shelf is to provide habitat for rooted plant life. In small urban ponds, plant life that grows in open water or on littoral shelves serves important roles but may also interfere with certain uses and expectations of the pond and can be more of a nuisance than a benefit. Therefore, plant life often needs to be managed in urban ponds and goals of the management will depend on the intended purposes and expectations of the pond.

Roles of Plant Life in Urban Ponds

Green plants capture energy from sunlight and transform it into food through the process of photosynthesis. Plants use simple raw materials (nutrients) to produce food through photosynthesis. The most important of these are carbon, which is derived mostly from carbon dioxide in the air, and nitrogen and phosphorous, which are present in soils or dissolved in the water. By converting raw materials into plant tissues through photosynthesis, phytoplankton, which give water it's green appearance, provide the base for the food chain of ponds. Tiny animals called zooplankton use phytoplankton as a food source. Larger animals including small fish use the zooplankton for food and larger animals such as fish and birds feed on these to make up the higher levels of the food chain. Phytoplankton also produce oxygen, needed by fish and other animals in pond water, through the process of photosynthesis.

Large aquatic plant life (aquatic macrophytes) can grow rooted to the bottom and supported by the water (submersed plants), rooted to the bottom or shoreline and extended above the water surface (emersed plants), rooted to the bottom with their leaves floating on the water surface (floating-leaved plants), or free

▼ *Littoral shelf overgrown with less desireable species still treats stormwater.*

▼ *Common Egret*

floating on the water surface (floating plants). Different types of aquatic macrophytes have different functions in urban ponds. Submersed plants obtain nutrients from both the pond bottom and water. When submersed plants are abundant and actively growing, pond water may be clear and free of phytoplankton because nutrients, which would otherwise be available, are tied up in the higher plants and algae that are attached to their stems. While emersed and floating-leaved plants obtain most of their nitrogen and phosphorus from the pond bottom, algae attached to their stems (called epiphytes) can also tie up some nutrients and thereby suppress phytoplankton growth. Floating leaved plants will also suppress algae growth by shading. Because rooted plants and their epiphytes can absorb nutrients and facilitate transformation of certain pollutants, such as nitrogen containing compounds, to less detrimental forms, plant life growing on littoral shelves may in some cases help protect receiving waters from pollutants present in surface water run off. Floating plants are also effective at suppressing phytoplankton because they obtain all of their nitrogen and phosphorus from the pond water and cause shading.

All types of aquatic macrophytes harbor insects. These may be insects that feed directly on plants (phytophagous) or predatory insects, which prey on other insects or small fish. In turn, these insects provide food for fish and bird life.

The presence or absence and the types of plants in urban ponds may affect the bird life that frequents ponds. Birds use large aquatic plants, including adjacent shrubs and trees for nesting, resting and refuge sites. Macrophytes are also used as food by birds and the plants provide habitat for other food items. For example, cattails are reported to be primary habitat for least bitterns, red-winged blackbirds, and boat-tailed grackles, whereas wading birds, rails, and ducks may avoid tall and medium height (duck potato and pickerlweed) vegetation. Ducks are often found associated with lakes that contain hydrilla, a major food source for them. Trees, such as cypress and black gum provide perches and resting places for a variety of birds, which hunt for food in ponds.

Certain plants can provide ornamental or aesthetic value in urban ponds. Plants such as duck potato and pickerelweed provide showy flowers during bloom. Plants such as bulrush can provide bright green stems and foliage. All plants provide interesting shapes and screens that add aesthetic variety to the pond. And for the butterfly enthusiast, butterfly gardens can be created on pond margins and littoral shelves with proper selection of planting material. The use of aquatic plants to improve the appearance of an urban pond, or aquascaping, can be included as part of the overall landscape design. Additional information pertaining to aquatic plant identification, etc. can be obtained from the IFAS Center for Aquatic Plants (352/392-1799, http://aquatl.ifas.ufl.edu/)or the County Cooperative Extension Service office. See Chapter 6 - Resources & References for the address and phone number in your area.

Problems Associated with Plant Life in Urban Ponds

Abundant phytoplankton in pond water will provide food to support a food chain for wildlife, such as wading birds. However, the more abundant the phytoplankton, the more green pond water will appear, and this is sometimes considered objectionable to homeowners who live on urban ponds. When very high amounts of nutrients are present in water, phytoplankton abundance can become very objectionable, and fishkills can actually occur if phytoplankton die naturally during cloudy weather. Certain types of phytoplankton, called blue-green algae, can cause blooms that result in scums on the surface of pond water and foul odors. Another type of algae, called filamentous algae because they have the form of long intertwined, matted filaments, can also cause unsightly conditions and foul odors.

Plant material produced through photosynthesis is eventually deposited to the pond bottom during a plant's life cycle. This material, called detritus, is broken down by organisms. Part of the detritus is broken down relatively rapidly, while a portion of it is relatively resistant to breakdown. Raw materials incorporated into plant tissue are released back into the pond water as detritus breaks down. Therefore, if large amounts of plant tissue are deposited in the water, algae blooms can occur as these nutrients become available, or the nutrients can be released out of the pond. Breakdown of detritus is slower when oxygen is in short supply therefore, when the pond surface is covered by dense floating plants, such as duckweed, which blocks sunlight for algal production and oxygen diffusion, breakdown of detritus is slower and accumulation of detritus is faster. When plant material is deposited faster than it breaks down, it accumulates on the pond bottom. This accumulation can be objectionable and is often referred to as muck by homeowners. Detrital accumulation gradually reduces the volume of a pond and therefore, its ability to retain storm water. Detritus is flocculent and can easily become resuspended in the pond water, which further reduces water clarity and stimulates algae blooms.

Just as aquatic plant life provides habitat for insects that are food for wildlife, they also provide habitat for mosquitoes, which are a nuisance and health hazard in urban areas. Aquatic plant life aids mosquito survival and reproduction in several ways:

1. Mosquitoes are protected from predators, such as insect-eating fish.

2. Reduced wave action provides better survival of mosquito larvae, which breathe by sticking an air tube up through the water.

3. Detritus produced by aquatic plants provides mosquito habitat.

4. A specialized group of mosquitoes, known as mansonia, have a modified air tube that they insert into aquatic plants to obtain oxygen. These mosquitoes can use most any vegetation that occurs in pond sediments and has soft tissues.

Stormwater Pond
TIP

Maintain an open water permanent pool in stormwater ponds, and stock them with mosquito fish to reduce mosquito problems.

Certain plants grow faster, produce denser growth, produce detritus more rapidly and crowd out more desirable plants. Just as in gardens, landscapes, or crops, unwanted plants occur, which we refer to as weeds. What makes a plant a weed in a pond is that it has one or more attributes that make it undesirable. Weeds are typically more of a problem in new ponds or newly established aquascapes. New ponds are disturbed habitats, which are vulnerable to colonization by plants called pioneering species. Pioneering species are those that have attributes that facilitate colonizing new or disturbed habitats. They produce many seeds that are dispersed by wind or wide-ranging animals, such as birds. Seedlings of pioneering plants are able to grow very quickly and then become dense by spreading via underground stems and tillers. Because of their dense growth and ability to out-compete other plants that may be considered more desirable, pioneering plants are often considered weedy. In addition to natural dispersal mechanisms, weedy, pioneering plants may be introduced into the pond during construction by construction-equipment.

Certain plants may grow faster and denser than others and be considered weeds because they crowd out other plants that are considered desirable for their aesthetic value, bird or butterfly association, or for other reasons. Fast, densely growing plants may also be undesirable because they produce detritus rapidly and therefore increase the rate of muck build-up.

Management of Plant Life in Urban Ponds

Plant life needs to be managed in urban ponds to insure that the pond functions as it was intended. Ponds may be constructed in urban areas strictly for landscape purposes, but they are often constructed with the primary purpose of flood protection from storm water and for treatment of storm water to protect receiving waters. Wildlife habitat is an ancillary benefit in either case and aesthetic value can also be derived from a pond whose primary purpose is storm water detention. Storm water management ponds in which aquatic plants will occur and need management are referred to as wet detention ponds and maintenance of plant life may be regulated under the construction permit issued by the Water Management District. The ponds are often constructed with a littoral shelf that is required by the permit and a requirement for maintaining certain densities of certain plants on the littoral shelf.

An urban pond is like many other things: The more you want out of it, the more you have to put into it. Vegetation is managed differently for different benefits, sometimes called management objectives, that are to be derived from a pond. Options in unpermitted ponds range from open water reflection ponds to intense aquascaping but special practices must often be used to conform to permit requirements in surface water detention ponds. In ponds with littoral plantings, practices to selectively control problem plants without damaging littoral shelves must be implemented. Some permits will stipulate certain control methods that may not be used. Therefore, before using an algicide, herbicide, or grass carp in a permitted surface water detention pond it is necessary to check with a

water management district official to determine permit requirements. Management of vegetation for certain combinations of benefits may be mutually exclusive and certain compromises may have to be made.

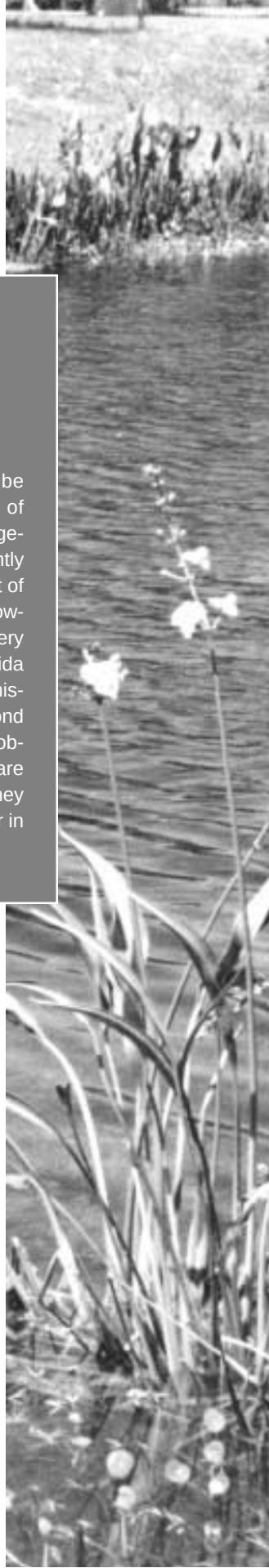
An unmanaged pond will often have vegetation that is objectionable to most homeowners and will also have problems with drainage and mosquito production. Once vegetation in a pond has been allowed to get out of control it is very difficult to get it back down to a manageable level. It is much easier to keep the vegetation managed by frequently attending to problems or potential problems. It is also relatively easy to maintain a pond free of vegetation but trade-offs for certain types of wildlife habitat will be made and certain permitted ponds will have a requirement for vegetation. The most difficult, but most rewarding, situation is to maintain a pond with a population of desirable vegetation, while keeping weedy plants to a minimum.

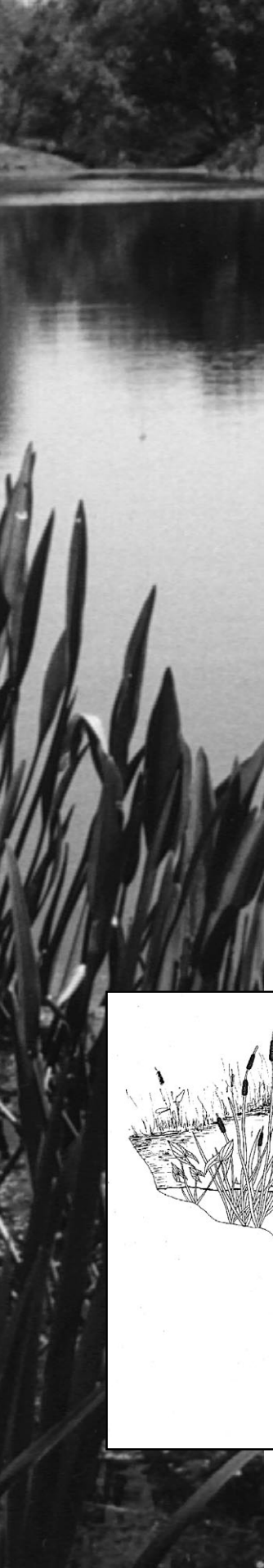
Practices commonly used to manage plant life in ponds include modification of cultural practices surrounding the pond, hand removal of plants, triploid grass carp (a plant-eating fish), and herbicides (and algaecides). Chemicals, which are registered by the US Environmental Protection Agency for use in water should only be used as a last resort. Information on specific herbicides that are registered for aquatic use can be obtained from your County Cooperative Extension Office. The method or combination of methods to be used will depend on the management objectives. Selectivity (the ability of the practice to control certain plants and not others), secondary environmental effects to the pond, and permit restrictions are the most important considerations when determining the vegetation management practices to be used.

Management of aquatic plants in urban ponds should be carried out by individuals who have been certified by the Florida Department of Agriculture and Consumer Services, as restricted use pesticide applicators in the aquatic category, after completion of University of Florida, IFAS certification training. Certification training materials can be obtained from IFAS Publications (352/392-1764). Homeowners are advised to contract a reputable pond management company for most vegetation management programs.

Stormwater Pond TIP

Some pond weed problems can be solved by plant eating fish instead of chemicals. Triploid Grass Carp are a genetically altered variety that can efficiently control some plants when used as part of a comprehensive management plan. However, this fish is not a solution for every pond weed problem. Contact the Florida Fish and Wildlife Conservation Commission to determine if your stormwater pond is right for grass carp. You will need to obtain a permit to buy the fish and there are some guidelines to follow to assure they stay in your pond. Their phone number in Lakeland is (863) 648-3205.





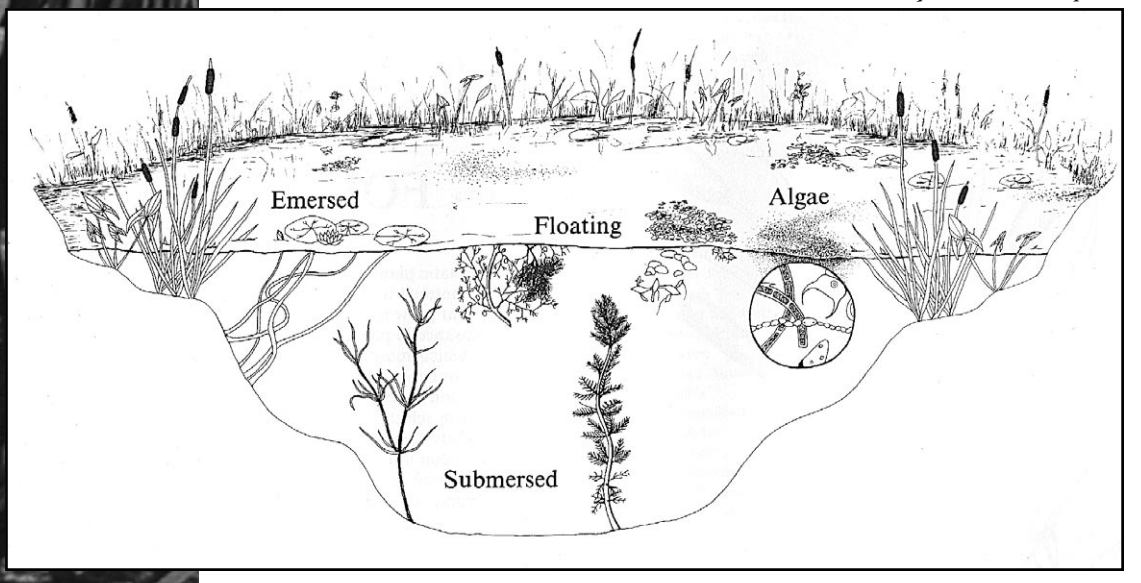
Phytoplankton

Green turbid water caused by abundant phytoplankton is the result of high levels of nutrients in pond water, particularly nitrogen and phosphorous. Nutrients may occur in naturally high amounts but they are also contained in fertilizer, which is applied to lawns in the watershed. If nutrients are naturally high in water that feeds the pond or in soils in the drainage area of the pond, the pond will be highly productive and will either have abundant growth of large plants or phytoplankton. In this situation homeowners must accept green turbid water. Where nutrients are naturally low, relatively clear water will occur unless impacted by cultural practices. In this case, it will be necessary to determine the source of nutrients and remove or minimize the source. Fertilizers used for fertilizing turf grass, faulty septic systems, or re-use water (treated sewage effluent) are common sources of nutrients in urban ponds.

Phytoplankton may occur as blooms when optimum growth conditions occur or as a more or less continuous condition. In either case, use of algaecide to reduce phytoplankton is not recommended for the following reasons: 1)Fish mortality is likely to occur as treated phytoplankton decay and are no longer producing oxygen. 2)Phytoplankton are very resilient, and will quickly re-occur if suitable conditions for growth prevail.

Aeration may help correct certain problems associated with phytoplankton. Certain blue green algae blooms will result in surface scums and aeration will help disperse these. Ponds that are heavily vegetated with macrophytes may have lower phytoplankton abundance compared to nonvegetated ponds and less frequent blooms. However, seasonal blooms may occur when macrophytes senesce and release nutrients into the pond water at the end of the growing season.

Aquatic Plant Groups ▼



Filamentous Algae

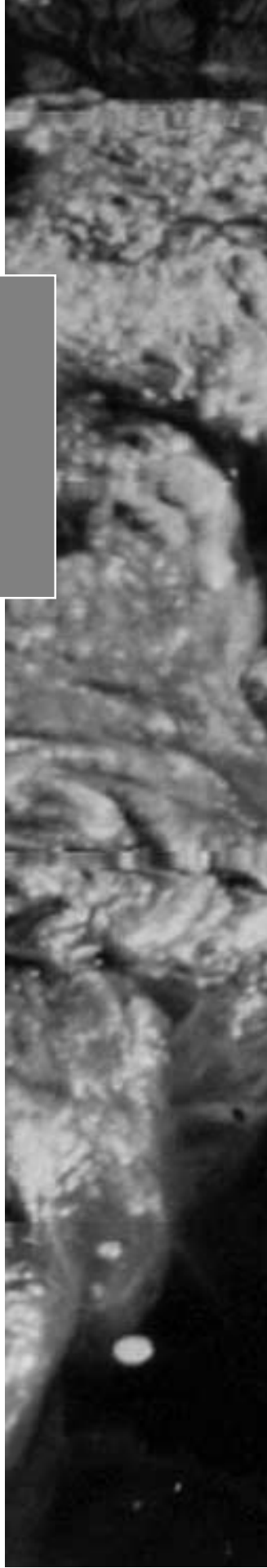
Filamentous algae are one of the most common and most difficult problems to deal with in urban ponds. Like phytoplankton, filamentous algae obtain nutrients from the pond water. Therefore, filamentous algae *may* be reduced if nutrient inputs to the pond water can be reduced and problems may be less if the pond is heavily vegetated with macrophytes. However, some problems with filamentous algae may still occur. Filamentous algae problems that cannot be corrected by reduction of nutrients can be managed by application of algaecide or hand removal or a combination of both. It is best to keep filamentous algae to a minimum by frequent hand removal and/or frequent application of algaecide to small areas of algae. Treatment of the entire pond with an algaecide is likely to cause fish mortality due to lowering of oxygen in the water. Grass carp can be used for managing filamentous algae but high numbers are needed and they cannot be used for selective control when other plants are present.

Endothall amine (Hydrothol 191) and copper compounds are the only currently available and tested algaecides. Hydrothol 191 is toxic to fish at concentrations of about 1 PPM. Filamentous algae can be controlled at concentrations less than this but extreme care must be taken if fish mortality is a concern. Copper compounds too can be toxic to fish in low alkalinity (usually indicated by low hardness) water, while the margin of safety is higher in water with high alkalinity. In addition to the concern for direct toxicity, whole-pond application of algaecide is likely to result in fish mortality as a result of oxygen depletion, and this is a greater concern when water temperature is high. Therefore, the key to filamentous algae control is to keep populations at a low level by frequent spot treatments beginning early in the growing season when water temperature is low. If it is necessary to get dense populations under control, some physical removal may be necessary to reduce the biomass and some fish mortality may have to be accepted. Then, keep the problem to a manageable level.

Certain species of filamentous algae are tolerant to copper. Sometimes, after repeated use of copper for filamentous algae control a population of copper-tolerant population of algae will remain. If this phenomenon is suspected, a sample of the algae population should be identified by a specialist to confirm if this is the case so alternative methods can be used.

Stormwater Pond
TIP

Rake out filamentous algae, dry it on the banks on the pond, and then use it for mulch!



Floating Plants

The most common floating plants that can become problems include water-hyacinth *(Eichhornia crassipes),* water-lettuce *(Pistia stratiotes),* duckweed *(Lemna sp., Spirodela* sp.), watermeal *(Wolfia sp.),* water fern *(Salvinia minima),* and mosquito fern *(Azolla caroliniana).* Floating plants, like algae, will be the greatest problem under high nutrient conditions. Therefore, limiting nutrient run-off from artificial sources may reduce the problem. However, under most circumstances sufficient nutrients will be available to allow for growth of floating plants to problem levels.

Small amounts of floating plants will not be detrimental to ponds but populations should be kept to a minimum. If allowed to proliferate and cover the pond, anoxic conditions will result beneath the mat and organic sedimentation will be increased. Water-hyacinth will aggressively displace other vegetation, which may be desired, in the pond. Uninformed homeowners will sometimes introduce water-hyacinth into a pond. Therefore, education is the first step toward preventing this problem. Other floating plants can be naturally introduced by wildlife.

If detected early enough, water-hyacinth and water-lettuce can be hand removed. However, once detected constant surveillance is necessary to insure that all water-hyacinth plants have been eliminated. With a doubling time of about two weeks under ideal growing conditions, the situation can quickly become out of hand. Once a water-hyacinth population is beyond the hand removal stage, spot treatments of herbicide products that contain the active ingredients 2,4-D (various products) or diquat (Reward®) can be used for selective control, or diquat for water-lettuce. Remove the dead vegetation to reduce bottom build up.

Duckweed, waterfern, and mosquitofern can be kept at low levels by frequent spot applications of Reward®. Watermeal is tolerant to Reward®. Duckweed, waterfern, mosquitofern, and watermeal can be controlled with sequential, low-dose applications of the fluridone containing herbicide Sonar® a.s.(liquid formulation). Some plants used for littoral shelf plantings, such as arrowhead *(Sagittaria* sp.), bulrush *(Scirpus* sp.), pickerelweed *(Pontederia* sp.), and softrush *(Juncus effuses),* are tolerant to fluridone, whereas others, such as waterlily *(Nymphaea* sp.) and spatterdock *(Nuphar luteum)* may be damaged. Therefore, permit requirements or tradeoffs that homeowners are willing to accept must be determined before using Sonar® to control these floating plants. Fluridone will not be effective where rapid water exchange occurs.

Triploid grass carp can be used to help keep duckweed, waterfern, and mosquito fern under control in ponds but their effectiveness is unpredictable and they may damage littoral plantings after a period of time. Therefore, if grass carp are used, littoral shelves should be monitored so that grass carp can be removed if necessary.

Stormwater Pond TIP

Ponds require the same amount of landscape maintenance, weeding, thinning, trimming, as uplands.

Submersed Plants

While submersed plants, such as hydrilla *(Hydrilla verticillata),* provide certain wildlife values, most are objectionable in small urban ponds. Because rooted submersed plants can derive nutrients from both the water and hydrosoil they can proliferate under all but the most nutrient poor conditions. Therefore, they may not respond noticeably to nutrient reductions.

Most submersed plants can be selectively controlled with herbicides without causing permanent damage to littoral shelves. Careful application of potassium endothall (Aquathol K) will control sensitive submersed plants such as hydrilla, southern naiad *(Najas quadalupensis),* bladderwort *(Utricularia* sp.), and others (refer to herbicide labels and other sources), while emergent and floating leaved plants will not be damaged. Routine applications of the herbicide will be necessary during the growing season and the frequency of application will depend on productivity of the pond and other factors.

Hydrilla, southern naiad, and bladderwort can also be controlled with Sonar®, as well as proliferating spikerush, which is tolerant to endothall. Sequential, low-dose applications of fluridone are best. Triploid grass carp will also control these submersed plants but the same precautions for both fluridone and grass carp, previously mentioned, must be taken.

Submersed weed problems can be managed with grass carp, but it is usually best to get the problem under control

with at least one herbicide application and then use grass carp for maintaining the problem. Grass carp can be used to some extent to keep submersed weeds under control with minimal damage to desirable emersed plants. However, as stated earlier, the effect of stocking grass carp in ponds is unpredictable. Desirable vegetation may be damaged or acceptable control may not be achieved.Therefore, it may be necessary to remove some grass carp or stock additional ones as time goes on.

Emersed Plants and Floating-leaved Plants

Among emergent plants are some of the most desirable and most troublesome plants in urban ponds. Maintaining a pond with a diversity of desirable plants requires selective removal of weedy plants and this is the most difficult management scenario, which will require intensive hand removal and careful herbicide applications. In ponds that are densely vegetated with emergent vegetation, it will increase the appearance of the pond and decrease the rate of detrital accumulation if senesced vegetation is removed in the fall or spring.

Cattails *(Typha* sp.) and torpedograss *(Panicum repens)* are considered to be nuisance plants in wet detention ponds. While cattails provide habitat for least bitterns, redwinged blackbirds, and boattailed grackles, their presence is usually at the expense of other emergent plants because of the cattail's prolific growth. Likewise, although torpedograss is good wading bird habitat, it is very prolific and will displace other emergent vegetation and form a floating mat over deep water.

▲ *Spatterdock*

Cattails should be managed by frequently hand pulling, cutting, treating with glyphosate (Rodeo herbicide), and combinations of these methods. Like other prolific weeds, the key is to keep the plants at a low level by frequent attention. If cattails are allowed to become the dominant vegetation on a littoral shelf, reducing their population to a manageable level is very labor intensive and damaging to littoral shelf plantings. Regrowth from rhizome fragments that are left after pulling or cutting should be treated when the shoots are no greater than one foot tall if possible.

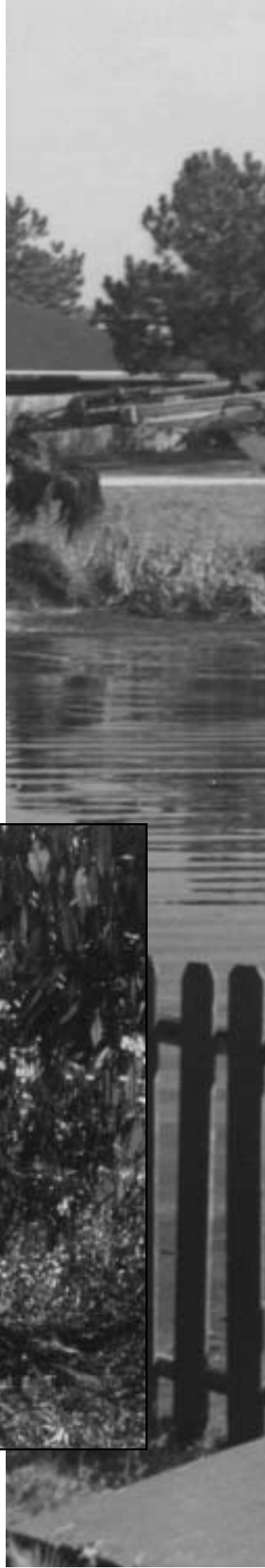
Torpedograss is the most difficult to control emergent weed in ponds. Repeat applications of glyphosate are necessary and up to six applications per year must be made. Careful application is needed to minimize contact to nontarget littoral plantings. Maintaining torpedograss at the lowest level possible is essential. Once it is allowed to proliferate, it will be extremely difficult to get under control.

Sequential applications of low doses of fluridone can be used to control cattails and torpedograss where damage to sensitive plants such as water lily is acceptable.

Emergent littoral plantings are relatively tolerant to concentrations of endothall and copper used for filamentous algae control, especially if careful application is used to avoid contact with foliage. Over spray on to foliage may cause temporary chlorosis but the entire plant will not be killed because the algaecide does not act systemically. Newly planted emergent plants have been observed to be less tolerant.

Vegetation Removal

To maintain the permitted or required treatment efficiency associated with a wet detention pond, the littoral vegetation should *never* be entirely removed or eradicated with chemicals. At least 30% of the surface area of the pond must remain vegetated with appropriate vegetation. A good management plan that provides for periodic removal of aquatic vegetation at select locations on a rotational basis is strongly encouraged. This practice helps to remove accumulated nutrients that otherwise promote over enrichment diminishing the treatment capacity and aesthetic value, and increasing the need for major maintenance like dredging. When done regularly mechanical removal by cutting, raking, hooking and/or digging can help control unwanted aquatics such as cattails and water lettuce. The harvested vegetation should be composted at an upland site and used for mulch. It should not be left in or around the pond. As a secondary benefit to harvest and removal more active growth of desired plants such as pickerelweed and arrowhead is also encouraged. Harvesting the vegetation increases the rate of assimilation of nutrients by increasing plant growth and can balance the loss of treatment associated with the reduction in plants.



Periodic removal of aquatic vegetation by cutting, raking, hooking and/or digging can help control unwanted aquatics such as cattails and water lettuce. ▼

Wildlife Management

Several factors should be considered when trying to select a site or to manage a pond area that will maximize benefits to wildlife. Pond designers and managers need to take into account the many relationships between pond systems and the surrounding uplands. For example, female turtles that live most of their lives in the water must come out of the water one day each spring to dig a hole in a sandy upland area and lay her eggs. Many amphibians spend their adult lives in upland forests. Sometimes culverts or other underpasses can serve as a means of linking surrounding habitats to ponds that may be isolated by roads.

The large scale focus should be on restoring the natural distribution and diversity of ponds within a large area that includes the project site. Some wildlife species, such as wading birds and migratory birds, are very mobile and require access to a variety of different ponds and wetlands. The variety of wildlife that use a pond at a specific location depends on several site conditions, including the intensity of land use surrounding the pond, the size and three-dimensional shape of the pond, and how much the pond is isolated from natural habitats. Many species, especially migratory birds, may only use a pond during limited times of the year as they migrate through an area.

Seeds, fruits and tubers produced by the vegetation found in stormwater ponds are heavily used by a wide variety of insects, birds, and larger wildlife. Many of the nutrients in these plant products are then exported out of the wetland system through feces and through decay when the animal dies. For example, treefrogs leave the aquatic tadpole stage for an adult life in trees.

Wildlife are also important seed dispersers. Animals disperse seeds not only within the same wetland, but they also transport seeds to other wetlands through their migratory and dispersal movement patterns.

A mallard family of ducks enjoying a swim. ▼

Many recreational activities are dependent on wetlands and can be enhanced by improving wetland habitat and are somewhat related to stormwater ponds. Hunting, trapping and fishing are consumptive uses, although limited in stormwater pond settings, of wetland animals. These activities are important economically as well as for their recreational value. Over $300 million is spent annually by about 2 million waterfowl hunters in the US. The nesting success of these birds is wetland dependent. At least half of all saltwater and nearly all freshwater fishing activities are dependent on wetlands to produce their catch. Annually, this provides an economic value of nearly $20 billion dollars in the US.

Nonconsumptive uses of wetlands, such as hiking, bird watching, and photography also are important uses of wetlands. It is estimated that over 60 million Americans visit wetland areas each year for these types of uses. Almost 1/2 billion dollars is spent each year in Florida on bird watching and feeding. Many birds can be found in the vicinity of stormwater ponds.

More than one hundred species of mammals, birds, reptiles, amphibians, and fish can be found in Florida's ponds (*Table 2.* shown on pages 68 and 69).

Stormwater Pond TIP

Do not encourage the feeding of wildlife. Waterfowl become accustomed to handouts and breed accordingly. They can overpopulate and become a nuisance.

Even in dry-down conditions, pond sites provide damp habitats required by many amphibians, reptiles, birds, and small mammals.

Pond Features That Benefit Fish and Wildlife

Shape and Depth:

At least 1/3 of the total pond area should be less than 2 feet deep (littoral zone for plant growth). The shoreline is an extremely productive habitat area of a pond. Many insects, frogs, small fish and, upland visitors to the pond concentrate along the pond edge. An irregular shaped pond will provide more of this important habitat than a circular pond.

Islands:

Islands provide more shoreline for fish habitat and increase the feeding area for species such as wading birds. They also are safe places for birds to nest and roost, and for turtles to sunbathe away from cats, dogs, and people.

Slope and Mudflats:

Gently sloping ponds provide shallow water habitat for plants, wading birds, small fish and aquatic invertebrates. A slope of 10:1 (10 feet from the pond edge, the water would be 1 foot deep) along the pond edge is recommended. A steeper slope would be more suitable for polluted ponds where you want to reduce use by wading birds and other wildlife and to limit plant growth (habitat) along the shoreline.

Mudflats provide unique feeding areas for shorebirds that probe their bills into the soil to feed on invertebrates. Water-level fluctuations and water movement help to keep some areas free from vegetation. Mechanically scraping the shoreline will provide the same result.

Logs and Overhanging Branches:

Turtles, many water birds, and mammals (such as raccoons and otters) use logs as resting and feeding platforms. Fish hide under logs and feed on algae and invertebrates attracted to these structures. Overhanging branches are perfect perches for kingfishers (birds that dive into the water to catch small fish). Fish are also attracted to branches that extend out over the water.

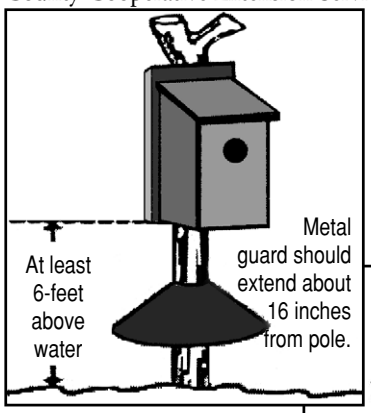
Plants:

Plants provide both food and cover for many species. The sun's energy is transformed into food energy in plants. Animals that consume these plants then expand the flow of energy and nutrients into food webs. Animals, like crawfish, snails, clams, worms and small fish, eat the plant material directly or graze on the bacteria, algae and fungi that grow on the surface of these plants. Large animals, such as fish, wading birds and many mammals, feed on these vegetarians.

Aquatic plants are also good hiding places for prey animals. Such areas are major nursery grounds for many of the larger fish. These nursery grounds are of particular importance to most wading birds and other wildlife that rely on aquatic foods.

Bird Houses:

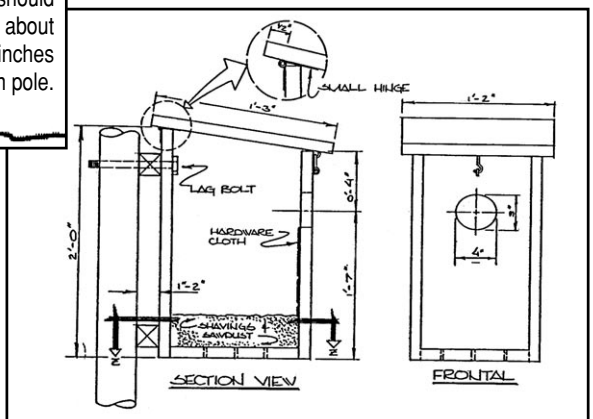
Many birds that use wetlands, such as purple martins, swallows and wood ducks, nest in cavities or holes in trees. These animals are important members of aquatic food webs and may not be able to use a pond that has plenty of food but no nearby nesting structures. Plans and design specifications are available through the County Cooperative Extension Service.



▲ *Increasing wood duck numbers can be accomplished by providing adequate nesting sites that are protected by predators.*

Stormwater Pond TIP

Wood duck nest boxes should be placed over water or in woodland habitat near lakes, ponds, marshes and rivers. If placed above the ground, the box should 30-100 feet from the water's edge and 10-20 feet above ground. The distance to water should be free of obstacles to newly hatched ducklings. One nest box per 5 acres of suitable brood habitat is suggested. Do not erect boxes if brood rearing habitat is not available. Detail plans and design specifications are available through the County Cooperative Extension Service.

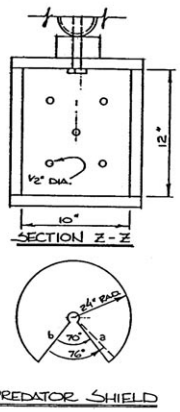


MATERIALS LIST:

1" THICK ROUGH CYPRESS RED WOOD, OR TREATED PINE.

ONE CEDAR, CYPRESS OR TREATED POST, LONG ENOUGH TO ALLOW BOX TO BE ERECTED ABOVE HIGH WATER LEVEL.

4-6 SHT. METAL SCREWS OR POP RIVOTS.
2-SMALL HARDWARE HINGES
1-SMALL SCREEN DOOR HOOK AND EYES.
1-PLATE (4'-0' X 4'-0') OF THIN SHEET METAL.
ONE 12' X 4' X 1/4" MESH HARDWARE CLOTH,
SHAVINGS AND SAWDUST AS ILLUSTRATED.
ONE LAG BOLT.



Negative Considerations of Designing Stormwater Ponds for Fish and Wildlife

Heavy metal accumulation and unnaturally high nutrient loads in ponds can cause unhealthy conditions for fish and wildlife. High concentrations of mercury and zinc can be lethal. Excessively high levels of nitrogen from fertilizers, sewage, or other sources can provide ideal habitat conditions for certain parasitic worms that can kill young wading birds that are fed infected fish. (i.e. eustrongylides ignotus parasitic worm.)

For these reasons, it is not recommended to design ponds for fish and wildlife if these structures will retain water runoff from parking lots, streets, and industrial parks. Ponds in residential settings with an upland vegetation buffer that filters out chemicals from the incoming stormwater are least likely to have problems. Golf courses may be acceptable sites for fish and wildlife ponds depending on the amount of pesticides, and other chemicals which may enter ponds. High levels of nutrients from fertilizers will not directly harm fish. However, the dense algal and aquatic plant growth that is likely to result in productive water may eventually be lethal fish when much of the oxygen in the water is used to decompose large amounts of dead plant material.

In questionable situations, several ponds at different elevations connected by ditches may help to concentrate harmful chemicals in the uppermost ponds (not designed for fish and wildlife) so that the lower ponds in the chain would be the least likely to have toxicity problems. Because most (90%) of the pollutants are carried off site in the first inch of rainfall, treating this first flush is the key to pollution abatement.

Sandhill Cranes and their young.

Dealing With Nuisance Wildlife Situations

Ponds attract a large variety of mammals, birds, reptiles and amphibians. Most all of them have the potential to cause at least perceived problems for people. These problems are endless and include things such as being irritated by frogs singing at night to seeing snakes that are attracted to a pond. Just as positive interactions and attitudes toward wildlife are too numerous to mention, negative encounters also do not deserve attention here. The best method for control and prevention of a wildlife-related problem, whether or not it is associated with a pond, is the same practical procedure most people follow to address problems caused by other adults, children or pets. First clearly define what situation is undesirable and then take steps necessary to reduce or eliminate the specific problem-causing situation. Contact your local extension office for information regarding problems that you are unable to resolve.

Misunderstandings are common causes of many frustrations and fears that people have about wildlife. For example, contrary to popular belief, most snakes in Florida couldn't even hurt you, let alone kill you. Most bats don't carry rabies. Separating myths from facts can alleviate many of these phobias and help you to appreciate wildlife more for their beneficial values, particularly in our urban environments.

Stormwater Pond
TIP

Learn to love your pond dwelling critters... Snakes eat rats!

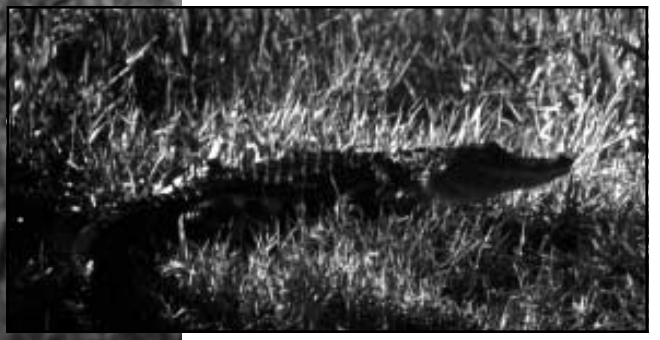
The Florida Constitution has designated the Florida Fish and Wildlife Conservation Commission as the legal steward of the native wildlife resources of the state. The mission of this state agency is to manage freshwater aquatic life and wild animal life and their habitats to perpetuate a diversity of species with densities and distributions that provide sustained ecological, recreational, scientific, educational, aesthetic, and economic benefits.

There are certain laws, rules, and regulations with which anyone who is baiting, trapping, transporting, or killing nuisance wildlife should be aware.

Nuisance Wildlife Management:

Weeds have been defined as plants whose usefulness have not yet been discovered. When growing where they are not specifically wanted, plants can become weeds. Nuisance wildlife pests are like weeds in that their usefulness has not been discovered and they often inhabit areas where they are specifically not wanted, namely, pond areas near homes. This is because stormwater ponds are sometimes the only areas left within developed area that have not been converted to pavement, buildings, or manicured landscapes. Many ponds are not maintained to be "pest free", so wildlife left in the area end up inhabiting the ponds and surrounding areas. Also, ponds may be the only source of water for wild animals remaining in preserved natural areas in the vicinity.

There are many ways to control "pests", depending on the type of "pest" and the amount of time, energy and money available to combat them. When developing a nuisance wildlife pest management plan for pond areas, determine which targets you find most irritating. These are the targets on which you may want to spend most of your resources. But before you decide to exterminate a particular "pest" from your pond site, be aware of the side effects your efforts may have on the wildlife that you enjoy visiting your pond. Also be aware of the impacts your actions can have on the natural predators at your pond, which can provide free pest control. For example, if you want to remove all snakes from your pond site, consider that many snakes feed on mice, rats, and other snakes, so trying to eradicate all snakes may cause an increase in other pests. Also, some chemicals used to combat insects can accumulate in the fish species that feed on those insects, and can eventually kill the fish, or kill the birds that eat the fish, and so on. Finally, it may not be physically possible to eradicate a pest from your pond. The best way to combat pests is to alter their environment so that the pond site is not inviting. They'll go elsewhere.



▲ *Alligators like ponds too...*

Common Pond Pests and Ways to Combat Them:

Alligators: Alligators were once on the endangered species list in Florida due to extensive hunting and loss of habitat; now, due to hunting regulations and protection of their habitat, they are still protected, but have been placed in the less critical "species of special concern" category. Alligators feed on turtles, fish, birds, and most other small animals that cross their paths. They inhabit natural wetlands, swamps, rivers and ponds, however, where natural wetland areas have been eliminated, alligators have moved to urban stormwater ponds and canals. The best way to deal with alligators who have moved to your pond is to accept their presence and stay out of their way. According to the Florida Fish and Wildlife Conservation Commission (FFWCC), in many cases, if left unmolested, alligators three (3) feet and less in length are not aggressive or territorial and will eventually retreat to more preferred habitats away from people. However, they advise you to use ordinary common care and avoid being near thick vegetation along shore-

lines, do not feed alligators (feeding them will reduce their fear of humans and may encourage them to move closer, and feeding alligators is against Florida law), and do not leave pet food out, this too will attract alligators, as well as other unwanted animals and insects. The FFWCC also notes that it is a violation of state law to remove alligators from their natural habitat. If you observe an alligator greater than three (3) feet long call the FFWCC to arrange for its removal.

For removal of nuisance alligators, contact the Florida Fish and Wildlife Conservation Commission at (863) 648-3203 in Lakeland.

Snakes: You may encounter harmless black racers, rat snakes, and mud snakes near water bodies, especially if there is cover provided and sources of food such as rats and mice. So, if you don't want rodents, don't kill snakes! Poisonous cottonmouth snakes do inhabit vegetated ponds and adjacent forested areas, but again these animals feed on rodents, so don't kill them! People often confuse the poisonous cottonmouth snakes with the harmless, and protected, indigo snakes, which is a good reason why the old adage "the only good snake is a dead snake" is WRONG! Harming a protected species is illegal. The best thing to do when encountering a snake is to turn around and go the other way. The snake will usually do the same.

For removal of poisonous, nuisance snakes, contact the FFWCC at (863) 648-3203 in Lakeland. Also contact them to receive guides to venomous and nonvenomous snakes, to help you identify the snakes you encounter.

Mosquitoes: Keeping a pond well-maintained and as free-flowing as possible usually reduces the amount of mosquitoes in the pond. A "well maintained" pond includes keeping inflow and outflow structures free- flowing by removing sediment and clogging vegetation, maintaining a fringe of desirable emergent vegetation (as well as the required littoral zone vegetation in some ponds), removing as much undesirable vegetation as possible (water hyacinth, water lettuce, etc.), maintaining a stock of mosquito-fish (*Gambusia* minnows) and ensuring that a portion of the pond is deep enough to maintain a permanent pool so that the fish can live through dry seasons. Purple martin houses or bat houses can be erected near the pond; these animals feed off of mosquitoes as well as other flying insects and attracting them to your pond may help reduce the amount of mosquitoes. However, know that your pond may not be the only source of mosquito's in your neighborhood - mosquito's thrive in small puddles in flower pots, tires, kiddies pools, tree crevices, bromeliads, bottles, etc., that are left in the yard to collect rain. They survive in grass and under leaves!

In summary, the best way to deal with pests is to avoid them and to make your own yard unattractive to pests. Since we have to share the world with all sorts of animals, and since some of them provide unseen as well as known benefits to humans, keeping a secluded area away from homes in a wild state will attract the pests to that location rather than to yards and will allow us to live with, rather than try to eradicate, these animals.

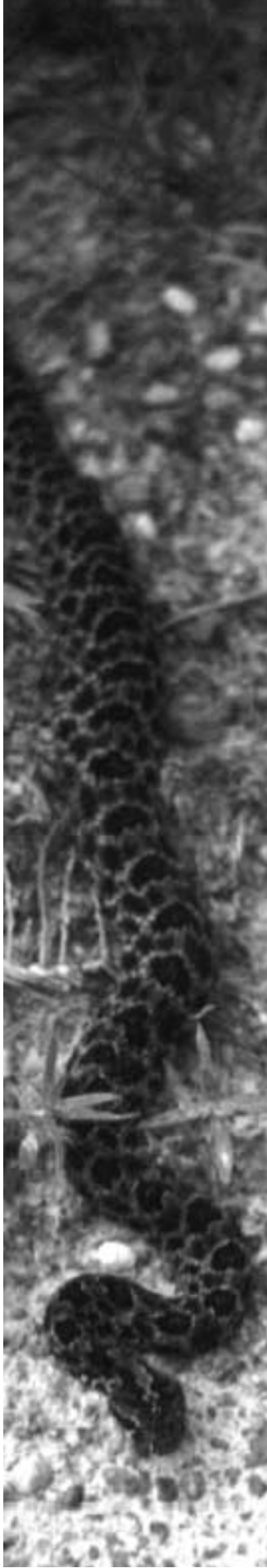


Table 2. Wildlife Species List

Species — Mammals Habitat needs of some **mammals** that may be attracted to ponds.					**Items**					**Location**		
	SW	**S**	**U**	**C**	**I**	**P**	**R**	**M**	**F**	**L**	**W**	**A**
Least Shrew	X	X			X					X		
Marsh Rice Rat	X	X			X	X			X	X	X	
Mink	X	X					X	X	X	X	X	
Bats			X	X	X							X
Raccoon	X	X	X	X	X	X	X	X		X	X	

SW- Shallow water zone
S - Shoreline zone
U - Uplands away from the shoreline
C- Caves and trees
I - Insects and other invertebrates

P - Plants, seeds, and fruits
R - Reptiles and amphibians
M - Mammals
F - Fish

L - Land
W - Water
A - Air

Species — Birds Habitat needs of some **birds** that may be attracted to ponds.	**Nesting**				**Feeding**							
					Items				**Location**			
	SW	**OS**	**U**	**C**	**I**	**F**	**P**	**O**	**D**	**S**	**L**	**A**
Pied-Billed Grebe	X				X	X			X			
Wood Duck	X	X	X	X			X			X		
Green Heron	X	X			X	X				X		
Little Blue Heron	X	X			X	X		X		X		
Great Blue Heron	X	X			X	X		X		X		
Great Egret	X	X			X	X		X		X		
Least Bittern	X				X	X		X		X		
Anhinga	X	X			X	X		X	X			
King Rail	X				X	X	X			X		
Common Moorhen	X				X		X		X	X		
American Coot	X				X	X	X	X	X	X		
Belted Kingfisher			X		X	X		X		X		
Red-Shouldered Hawk			X		X			X			X	
Barred Owl		X	X	X	X			X			X	
Red-Winged Blackbird	X	X			X		X			X	X	
Purple Martin	X	X	X	X	X							X
Common Yellowthroat	X	X			X		X			X	X	
Prothonotary Warbler	X	X			X					X	X	
Green-Winged Teal	These birds do not breed in Southeastern U.S.						X			X	X	
Mallard					X		X			X	X	
Bufflehead					X	X			X			
Hooded Merganser					X	X			X			
Spotted Sandpiper					X	X		X		X	X	
Common Snipe					X		X	X			X	
Swamp Sparrow					X		X			X	X	

SW- Over shallow water
OS - Over shoreline
U - Uplands away from the shoreline
C - In trees cavity or nest box
I - Insects and other invertebrates, including: crustaceans, mollusks, snails, and spiders

F - Fish
P - Plants and/or seeds
O - Other food items include: mammals, reptiles, amphibians, birds, and carrion

D - Deep water
S - Shallow water
L - Land
A - Air

Species — Reptiles Habitat needs of some **reptiles** that may be attracted to ponds.				**Items**				**Location**			
	Li	**S**	**U**	**I**	**F**	**A**	**P**	**B**	**D**	**S**	**L**
Musk Turtle		X	X	X	X			X			
Eastern Mud Turtle			X	X	X	X		X	X		
Chicken Turtle			X	X			X			X	X
Spiny Softshell		X	X	X	X			X			
Snapping Turtle			X	X	X	X	X				
Cooters			X				X				
Sliders			X				X				
Mud Snake		X				X				X	X
Glossy Crayfish Snake	X			X	X	X				X	X
Green Water Snake	X				X				X	X	
Brown Snake	X										
Banded Water Snake	X				X	X			X	X	X
Eastern Ribbon Snake	X				X	X			X	X	X
Eastern Garter Snake	X			X	X	X			X	X	X

Li - Live-bearing
S - Eggs laid in hole dug in shoreline
U - Eggs laid in hole dug in upland away from shoreline
I - Insects and other invertebrates
F - Fish
A - Amphibians and reptiles

P - Plants and vegetation
B - Muddy bottom
D - Deep water
S - Shallow water
L - Land

Species — Amphibians Habitat needs of some **amphibians** that may be attracted to ponds.				**Items**				**Location**		
	D	SW	S	I	C	A	S	W	L	T
Cricket Frog		X		X					X	
Eastern Spadefoot	X	X		X					X	
Bullfrog	X	X		X	X	X	X	X	X	
Spring Peeper		X		X					X	
Green Treefrog	X	X		X						X
Chorus Frog		X		X					X	
Eastern Narrowmouth Toad	X	X		X					X	
Pickerel Frog	X	X		X					X	
Leopard Frog		X		X					X	
Fowlers Toad	X	X		X					X	
Spotted Dusky Salamander			X	X					X	
Central Newt		X		X				X		
Slimy Salamander			X	X					X	
Marbled Salamander			X	X					X	
Tiger Salamander		X		X				X	X	
Lesser Siren			X	X	X	X		X		

D - Eggs laid in deep water
SW- Eggs laid in shallow water, usually attached to vegetation
S - Eggs laid on shoreline or other moist areas on land
I - Insects and other invertebrates
C - Crustaceans

A - Amphibians
S - Any animal smaller than itself
W- Water
L - Land
T - Trees

Chapter 3

Beyond Basic Pond Management

What can you do?

Taking care of your stormwater pond is up to you and your neighborhood. Look through these activity lists to discover the steps to a better pond environment.

Conserve Water

- Fix drips and leaks.
- Take shorter showers.
- Turn off running water while show ering, brushing teeth, washing face, shaving, or washing cars and trucks.
- Operate dishwashers and clothes washers only when fully loaded.
- Install low flow fixtures on shower heads, faucets and toilets.
- Sweep instead of hosing down your driveway or sidewalk.
- Plant drought tolerant vegetation and reduce lawn area. Use drip irrigation.
- Collect roof runoff in cisterns or rainbarrels for irrigation.

Protect Water

- Dispose of hazardous materials properly. Do not dump oils, paints, thinners, antifreeze, motor oil or other hazardous materials down the drain.
- Try reducing the amount of fertilizers and pesticides used on your lawn. Apply only when absolutely necessary.
- Carpool to reduce the amount of cars on the road or use public transportation.
- Wash or rinse vehicles on a porous surface so the water will soak into the ground rather than becoming runoff.
- Volunteer! Get involved in watershed management.

Pond management can be fun!▼

Everyone working together can make a better stormwater pond environment for their neighborhoods. ▶

What You Can Do *TODAY*

- Take pond information to neighbors to educate them about how stormwater ponds work.
- Pick up trash.
- Take pictures of your pond; take pictures of good areas as well as ugly areas and any trash. Take them with you when you talk to neighbors about pond improvements and pollution prevention.
- Remind neighbors to fertilize wisely, with slow release nitrogen, 2 times a year.
- Remind neighbors to keep a "fertilizer-free" zone around the pond.
- Remind neighbors to keep grass clippings and leaves out of storm drains.
- Learn to identify the aquatic plants in your pond.
- Ask your neighbors to join you in forming a quarterly pond maintenance group.
- Be sure to include kids in your educational, planning , and work day efforts; they can be a big help, and someday they might have a pond to care for!
- Clean up pet manure to keep excess "nutrients" and disease-causing micro-organisms away from your pond.
- Practice organic gardening techniques using non-toxic products.
- Call your local government building department and ask for an aerial photograph of your neighborhood including the pond area. Aerials are usually of one square mile, at a scale of 1:200 feet; sometimes they call them "blue-line aerials." Looking at the aerial, determine how your pond connects with the surrounding area:
    - Does your pond drain to a nearby wetland or creek?
    - Is your pond part of a "greenway" that wildlife depends upon?
    - Does your pond connect to another pond in the neighborhood?
    - Are there any businesses in your pond's drainage basin?
    - The building department should also have records of your neighborhood drainage plan, which will tell you exactly which houses are in your pond's "drainage basin." Request a copy of this plan, and ask for help interpreting the plan.

What You Can

- Ask your neighbors to join you in a pond walk; complete a pond inspection form and pond sketch as you walk around the pond.
- Identify two key nuisance plants in your pond that everyone in your pond group will learn to identify and will remove from the pond area every time they see it growing there.
- Schedule four quarterly work days, and tell everyone in your pond group to mark their calendars now!
- Review your pond inspection form and use your notes to plan the activities for the next pond work day.
- Talk with a local native aquatic plant nursery and ask for prices on these plants:

- *Saururus cernuus,* **lizard's tail**
- *Iris virginica,* **blue flag iris**
- *Spartina bakeri,* **sand cordgrass**
- *Canna flacida,* **golden canna**
- *Sagittaria lancifolia,* **duck potato**
- *Sagittaria graminea*
- *Pontederia spp.,* **pickerelweed**
- *Juncus effusus,* **soft rush**
- *Myrica cerifera,* **wax myrtle**
- *Cephalanthus occidentalis,* **button bush**
- *Quercus laurifolia,* **laurel oak**
- *Acer rubrum,* **red maple**
- *Taxodium spp.,* **cypress**
- *Celtis laevigata,* **sugarberry**
- *Ulmus americana,* **elm**
- *Liquidambar styraciflua,* **sweetgum**

Except for the trees and shrubs, ask for bare-root prices; liners are too small, and quarts or gallons leave you with a lot of pots to deal with! It is easy and economical to use bare-root plants when buying aquatic plants.

- Have a meeting with your neighbors to discuss a planting plan: select plants, set a budget, set a pond planting date.
- Get a storm drain marking kit for your neighborhood storm drains. This is a great activity for kids! The markers have pollution prevention messages on them to discourage dumping in the storm drains.

Try these resources to get your kit:

- stormwater department at your city or county government
- local cooperative extension service environmental and horticulture programs
- LAKEWATCH Program at the University of Florida
- local Water Management District (numbers listed in Chapter 6 - Re sources & References)

Spray-paint kits used to be popular for storm drain marking, but it is messy and it doesn't last long. Look for a resource that has metal or plastic markers that glue or fasten onto the concrete.

- Ask for door hangers or other printed material to distribute throughout the neighborhood at the time of the storm drain marking. They should explain what the markers are for and how each household can help im prove water quality and prevent stormwater pollution.

- If your neighborhood has septic systems, ask a septic expert to speak at a homeowners meeting. Send out notices to the neighborhood outlining appropriate inspection and maintenance procedures for septic systems. Improper leaching can pollute your pond! Contact your local government health department for more information.
- Find out if a "swale and berm" contour is appropriate for the yards around your pond; this type of grading will filter water through a soil berm before it enters your pond. Call your local Water Management District for recommendations.
- Get soil testing kits from your local cooperative extension service. Get your soil tested, and pass out kits to your neighbors for their yards. Use the results to achieve proper fer tilizer application levels. Give the recommendations to lawn care services working in the neighborhood so they can adjust their maintenance routine accordingly.
- Order a "Aquatic Plant Identification Deck" from the University of Florida Institute of Food and Agricultural Services:
  Call (352) 392-1799
  or (352) 392-1764 to order.

What You Can *Do IN THE FUTURE*

- Send out a one-page newsletter to your neighborhood that highlights your group's efforts to have a cleaner, safer pond environment.
- Look for "volunteer" native aquatic plant species growing in and around your pond. Don't pull out plants unless you know for sure what it is, and you're sure it shouldn't be there!
- Identify all of the birds and other wild life that visit your pond. Keep a record, and share the "wildlife spottings" with your neighbors. Assign group members different times of day to "watch for wildlife." Include kids in this activity. Remember, insects and benthic organisms are wildlife, too!
- Keep a record of monthly water levels for your pond for at least one full year. This will help you know what is "normal" for your pond. This can be a relative measurement taken from a convenient permanent station.
- Make a Secchi disk and measure water clarity on a monthly basis for at least one full year.
- Assign two pond group members each quarter to complete a pond inspection just before your scheduled pond work day. Use the pond inspection form to plan work day activities.
- Replace water-hungry landscaping and sod with Florida native plants. Native plants will require less water, fertilizer, and pesticides.
- Select porous materials such as gravel for walkways and driveways to increase infiltration and decrease surface runoff.
- Keep fertilizer off paved areas, including driveways and sidewalks, to help prevent rainwater from washing the nutrients into the street and storm drains.
- Watch for construction in your pond's drainage basin, and make sure inlets are protected with filter fabric or hay bales. Report muddy water and other discharges to the building department or stormwater department.
- Keep pavement and gutters free of debris and dirt.

Stormwater Reuse Management

A good way to solve both a water quality and water quantity problem is to reuse stormwater. Wet detention ponds can be designed so that water which is normally part of the fluctuating pool and some of the permanent pool can be reused thereby reducing stormwater runoff and pollution. The runoff water stored in the pond can be recycled for irrigation, car washing, cooling water makeup, or other beneficial uses. The reuse of pond water also has an economical benefit when compared to the cost of potable water.

The reuse of stormwater is also a good conservation practice. As urbanization increases the hydrologic balance of the region also changes. The increase in watershed discharges decrease the amount of water that had previously infiltrated into the ground or evaporated from the watershed. The stormwater that is re-applied to the land provides greater potential for groundwater replenishment and evapotranspiration. In addition there is a decreased use of pumped well water. Reusing stormwater also recycles the excess nutrients that are concentrated in ponds, thus requiring fewer fertilizer applications on the uplands and less maintenance in the pond

▲ *Irrigate only as much and as often as necessary.*

Best Management Practices (BMPs)

Structural BMPs include the use of porous surfaces, implementation of oil skimmers, construction of grass swales, etc. A comprehensive list of these BMPs and their respective maintenance schedules can be found in Chapter 5.

Practical Maintenance Guidelines

Practical Maintenance Guidelines can be accomplished by home owners, but have not been mentioned yet for our publication.

Remember that the purpose of the stormwater pond is to remove pollutants before they are transported to natural lakes, rivers and streams. They will never be pristine swimming or fishing lakes (i.e., clear of vegetation or phytoplankton) because their purpose is to trap and transform pollutants before water is transported downstream. Some algae and plants that home owners find objectionable help provide this pollution removal function.

Stormwater ponds will have to be cleaned out periodically (about every 25 years) to keep them functioning properly. But things can be done in the pond and the watershed to improve water quality and extend the periods between extensive maintenance efforts. An efficient functioning stormwater system takes as much time and effort as maintaining the rest of the landscaping. In fact highly maintained upland landscaping is a big part of the problem in keeping stormwater systems attractive.

Many homeowners do not connect their landscape design and maintenance practices to the problems in their stormwater ponds. Highly maintained lawns and direct discharge of stormwater into ponds cause much of the weedy growth in stormwater ponds. One of the most important steps in having a more attractive stormwater pond is to form a partnership with all the people in the community and then learn as much as possible about your particular pond.

1. Remove debris especially at the inflow and outflow of ponds and give special attention to drains and drop boxes. This will reduce the amount of pollutants that the pond will have to remove.
2. Inspect the entire stormwater system on an annual or semiannual basis and make brief inspection trips after each storm. Cleaning up debris and checking for sinkholes or solution holes especially in swales and sumps is an important part of the inspection. If severe erosion problems occur then professional help may be needed to plug problem holes. Leaves, limbs and other debris should be removed from the conveyance system and grass ground cover kept in good condition. Collect and dispose of grass cuttings off site or use a mulching mower.
3. Keep records of all maintenance needs plus the work done on the pond.
4. Incorporate both a deep (<8 feet) permanent pool and vegetated shallow (< 3 ft.) areas. Make sure there is an open water permanent pool that never goes dry. This helps in sedimentation of pollutants and mosquito control. The permanent pool water should contain adequate amounts of dissolved oxygen. If this is a particular problem then perhaps a fountain or other aeration device can be added. Also, at least one third of the pond should be maintained as a shallow littoral shelf with desirable plant species to remove dissolved pollutants.
5. Removal of algae and nuisance plant species can be accomplished by rakes or hand pulling. If plant removal is part of the plan developed for your lake obtain advice from your water management district and plan work days to get as many people involved and educated as possible.

Stormwater Pond
TIP

Lush green yards contribute to overgrown or green ponds.

Let weeds dry on the pond banks to reduce weight and volume before hauling them away.

Pre-Treatment Alternatives.

If your pond is especially unattractive or weed choked, you may want to enlist the advice of a professional. Some alternatives that can reduce pollution before it reaches the pond can be incorporated using the entire drainage basin.

▼ *Sump Basin*

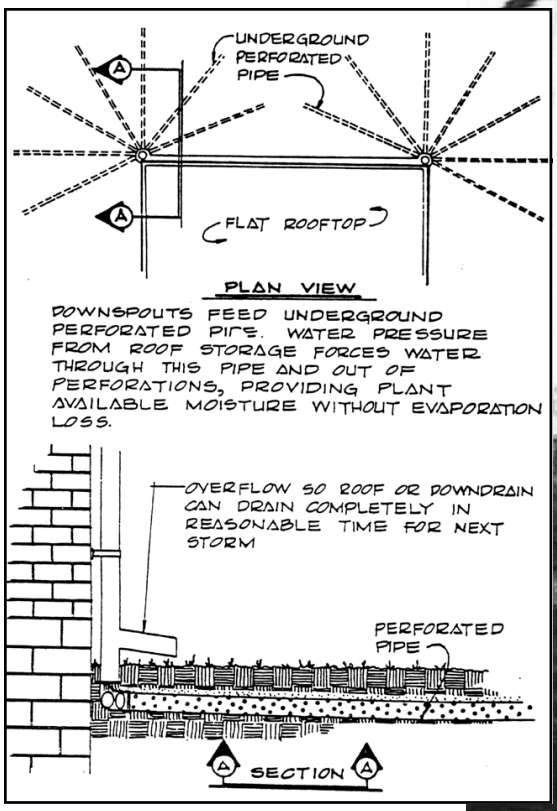
1. **Sump Basins -**
   Pre-treatment basins are probably one of the most important maintenance strategies.
   Large particles will settle out and the basin will be much easier to keep clean and functional than the entire pond. Make it easily accessible by backhoe or other type of equipment. Clean out twice a year and remove debris after every storm.

Swales -
Swales are shallow conveyance systems and an important component for pretreatment. Swales are increasingly more effective the longer the contact time with the vegetation. Check dams or cross blocks and gentle side slopes increase pollution removal. Educate residents that swales are essential components of stormwater systems and should *never* be used as disposal sites for leaf litter, grass clippings and other types of refuse. In fact this practice could lead to flooding of down stream neighbors and plugging of the stormwater inlet or outlet structures.

2. **Grass Filter Strips -**
   Filter strips are linear areas of vegetation (usually 25 to 30 feet wide) that trap suspended solids and promote sheet flow. Flow must enter the filter strip as low-energy sheet flow. Install flow-spreading devices such as shallow weirs, stilling basins, or perforated pipes across the width of the filter strip. Flow velocity should be no greater than 0.9 feet per second and the depth of flow no more than 0.5 inches.

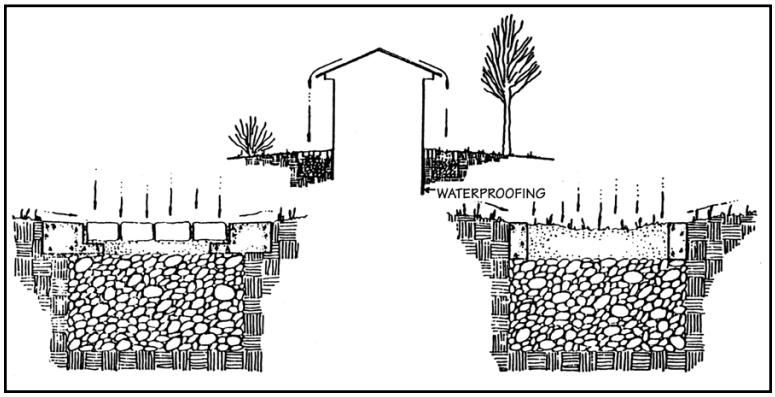
▼ *Grass Filter Strips*

3. Infiltration drainage of roof tops- Rooftop runoff disposal can reduce runoff to the stormwater pond and provide an opportunity for water to infiltrate into the surficial aquifer. The systems consist of perforated pipe and gravel buried under the ground *(Figure A)*. The routine maintenance requirements are not great, however, getting property owners actually to do it may be difficult. Since trenches are smaller and more inconspicuous than most other BMPs and therefore might be overlooked in a routine maintenance schedule. The underground trenches should be checked periodically and cleaned out when sediment depletes more than 10% of available capacity. This can be done manually or by a vacuum pump. Infiltration trenches are also a good strategy under gutter less roof lines *(Figure B)*.



▲ *Figure A. Infiltration Drainage of Rooftop. Source: Virginia Soil and Water Conservation Commission.*

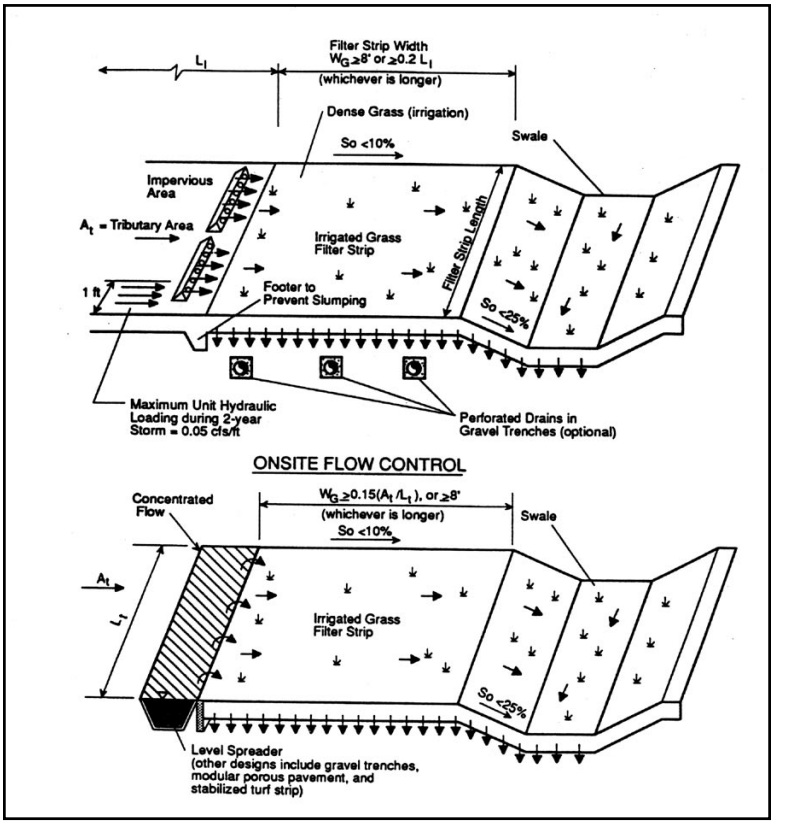
Figure B. Typical Infiltration Trench under gutterless roof. Source: Virginia Soil and
▼ *Water Conservation Commission.*



Stormwater Pond TIP

Begin treating stormwater at every opportunity within the watershed by using grass swales, shallow depressions, and filter strips.

4. **Oil and Grease Catch Basins -** Frequently open land is not available for vegetated pre-treatment solutions. Oil and grit separators are under ground structures that remove floatable and suspended solids from urban runoff *(Figure C).* Oil and grease catch basins are generally incorporated into the traditional storm sewer conveyance system. Since these inlets are relatively small, they can be placed throughout a drainage system to capture coarse sediments, floating wastes, and accidental spills. They must be cleaned out on a regular basis to be effective for pollution removal.



▲ *Figure 3. Onsite and offsite applications of irrigated grass filter strips.*

Chapter 4.

A Pond Management Plan Workbook

This workbook has the basic elements of a pond management plan, including work sheets and forms to help you complete events such as pond walks, pond inspections, and planning work days.

How Can A Pond Management Plan Help Me And My Pond?

Your stormwater pond is a water treatment facility, and it performs a very important job for your drainage basin: *it cleans water.* A management plan will make sure that your pond is working at peak performance to keep your water as clean as possible. With a plan for future maintenance of your pond, you and your pond group will avoid spending time and money on "quick fixes" that may degrade water quality and add pollutants.

What should my pond look like? What could my pond look like?

There are certain elements of your pond you cannot change: the shape, the depth, the surroundings, the underlying soils, the water sources (both groundwater and neighborhood stormwater runoff), and the purpose for which the pond was built. What are the elements of your pond that *can* be changed? You can change the neighborhood's attitude towards the pond, the type of maintenance it receives, the quality of the neighborhood stormwater runoff that enters the pond, the quality of the water as it leaves the pond, the types of plants that grow in and around the pond, and the kinds of wildlife that are attracted to your pond. Your pond can become a neighborhood asset, a place to play with the kids, to teach them about Florida's natural world, and watch the birds. You *can* fool mother nature by making your stormwater pond look like a natural pond, with native flowering plants, trees, and birds. A stormwater pond can have clean clear water, cypress trees, oak trees, iris blooming in the spring, and summer-blooming pickerel weed edging the water.

What Is A Pond Management Plan?

A pond management plan is a description of your pond; the problems associated with the pond and its drainage basin; a listing of people who live and work in the drainage basin; a record of meetings, pond evaluations, water quality data, as well as actions proposed and/or taken by the group. A management plan is written by consensus of the group, and is reviewed by everyone in the pond basin. A plan includes goals for the future and helps you measure your progress in achieving those goals. It helps you make better decisions by providing a record of previous decisions and a written record of the neighborhood's vision for your pond. Any proposed actions that may impede or degrade the neighborhood's goals and vision for the pond should be turned down.

Ponds Are Like Lakes

Ponds and lakes in urban settings share many of the same problems, and so share many management issues. The Florida LAKEWATCH program uses a ***fifteen-step process*** in helping their volunteers build a lake management plan. Ponds are smaller, with fewer recreational and development issues, so we have shortened the LAKEWATCH process to six steps.

▲ *A busy crew is a happy crew.*

Six Steps To Building Your Pond Management Plan

1. Form a group made up of the people living in your pond's drainage basin. It is important to include people who live away from the pond, but in the basin.

2. List the problems you are having with your pond. Problems could include nuisance vegetation, clogged storm drains, eroding banks, litter, pet droppings, algae blooms, compost piles, etc.

3. Collect information about your pond and the drainage basin, including:

- a copy of the drainage plans for your subdivision
- an aerial photograph of the pond and drainage basin
- names and addresses of everyone in the drainage basin
- locations of drainage structures, pipes, under drains, & connections
- ownership & easements
- deed restrictions and/or homeowner's rules that apply to the pond
- current maintenance procedures such as carp, herbicide, plant removal
- water sample analysis, and Secchi disk measurement
- identify your pond's drainage basin (which streets drain to your pond)

4. List possible solutions to the problems you have listed. Solutions could include establishing a buffer of native plantings around the pond, nuisance plant removal, storm drain marking, neighborhood educational meeting, renting a dumpster for a neighborhood pond clean-up, fertilizer-free zones, or door hangers with pollution prevention instructions.

5. Write a management plan with all of the information you've collected. Your management plan may have these sections:

Section 1. Pond Background Information and Description
Section 2. Pond Group Members
Section 3. Aquatic Weed Control
Section 4. Algae Control
Section 5. Fish & Wildlife
Section 6. Water Quality Monitoring
Section 7. Drainage Structure Maintenance
Section 8. Pond Group Work Days
Section 9. Stormwater Pollution Prevention Program
- Environmental Landscape Maintenance
- Storm Drain Marking
- Door Hangers
- Pond Walk
- Educational Meeting With Experts
- Pond Work Days
- Fertilizer-Free Zones
- Pond Plantings

Section 10. Pond Group Goals & Vision For The Future

6. Implement your plan. Assign activities to members of your group. Set dates for achieving your goals. Contact local governmental agencies for educational materials, technical guidance, and assistance in managing your pond; ask for speakers to address your pond group members at a meeting or a pond walk.

Use the following pages to help you write ***Your Pond Management Plan.***


Working together
to create an attractive
stormwater pond.
Sharing the work
as well as the benefits.

A Pond Management Plan

Workbook

A guide to taking care of your stormwater pond.

STEP 1.

Form Your Pond Group

Use the table below to list the people in your neighborhood who are willing to help you plan and implement your pond management goals. You may need to ask people more than once to join your efforts. And, some people may not want to join until they see you've made some progress.

NAME	ADDRESS	PHONE
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		

STEP 2.

List The Problems

Your first few meetings will probably be spent discussing the problems you are having with your pond. It will be important to listen to people who have made an attempt to manage the pond before. Learn the history of your neighborhood's pond management efforts.

PROBLEM	DESCRIPTION
❑ nuisance vegetation	
❑ clogged storm drains	
❑ eroding banks	
❑ litter	
❑ pet droppings	
❑ algae blooms	
❑ improperly disposed yard waste	
❑ "car droppings" (leaks & drips) on driveways	
❑ over-fertilizing	

STEP 3.

Collect Information

You'll need to make a trip downtown for some of this information. Pick up the phone and call first, to make sure the contact person and the information will be there when you arrive. Also, be sure to ask if there is a fee for print outs, maps, etc.

INFO NEEDED	LOCATION/SOURCE	ASSIGNED TO
❑ subdivision drainage plans	local county office contact & phone:	
❑ aerial photograph	local county office contact & phone:	
❑ names and addresses of everyone in the drainage basin	neighbors, homeowners association, tax roll	
❑ locations of drainage structures, pipes under drains, & connections	drainage plans, or local roads & streets office: contact name & phone:	
❑ pond ownership & easements, recorded plats	local county real estate office contact name & phone:	
❑ deed restrictions and/or homeowner's rules	Homeowners Association President name & phone:	
current maintenance: ❑carp yes / no ❑herbicide yes / no ❑plant removal yes / no	check with neighbors, homeowners association	

STEP 4.

List Possible Solutions

Now that you've discussed problems and gathered information about your pond, you can start to think of some possible solutions. At least, you can think of some goals for each problem area, and then think about how to get there. You may need do more research to know what solutions are available.

A pond group like yours utilizes neighborhood responsibility, neighborhood activism, and stormwater pollution prevention as the basis for pond management. Please don't think that you can improve water quality in your environment by solely relying on chemical treatments and herbicide sprays. These methods may indeed be a small part of your management plan, but cannot be the basis for growing a healthy pond. For more ideas on addressing your pond problems, call someone from the lists that appear in the Chapter 6. Resources & References of this manual.

PROBLEM	SOLUTION	RESOURCE
❑ nuisance vegetation	work day targeting single nuisance species; hand pull or rake out	
❑ clogged storm drains	call service unit	
❑ eroding banks	plants; re-grade; terracing	
❑ litter	educate	
❑ pet droppings	educate	
❑ algae blooms	rake algae; fertilizer-free zones; plant pond	
❑ improperly disposed yard waste	educate; formal compost areas	
❑ "car droppings" (leaks & drips) on driveways	carpet remnants to catch drips	
❑ over-fertilizing	educate; twice yearly fertilizing only	

STEP 5.

Write Your Management Plan

Your final management plan will contain 10 sections, including tables, checklists, and group discussion topics to help you write your pond plan. Use the information tables to make new contacts and learn more about your pond. Review the checklists, and select components appropriate to your group. Use the discussion guidelines to help your group agree on goals and direction.

Section 1.

Pond Background Information and Description

In addition to the information you already collected about your pond, use this section to describe

1. How your pond impacts your neighborhood:

2. How people use the pond or view the pond:

3. How the pond, if well-managed, could improve the character and value of your neighborhood:

4. Consider how a better-managed pond could influence the market value of your home:

Write your pond group's other observations here:

Section 2.
Pond Group Organization

Your pond group could be the start of a better-defined, friendlier, safer, more caring, and a more *fun* neighborhood. Remember that not everyone is going to join in from the beginning; some people will wait until they see that you've made some progress before they want to participate. If parents don't want to participate, make sure to invite their kids - give neighborhood kids pride and purpose by allowing them to be members and take on responsibilities.

Ask your group to consider these organizational items:

(sample table)

Meetings	i.e., monthly / bi-monthly / quarterly
Committees	i.e., one for each section of the plan
Work Days	i.e., bi-monthly year 1, quarterly year 2
Pond Dues	i.e., $10 or $20 (paid quarterly)
Governmental Liaison	could be shared by two group members

Meetings	
Committees	
Work Days	
Pond Dues	
Governmental Liaison	

Section 3.
Aquatic Weed Control

Aquatic weed control will be the most challenging goal your group will face.

For successful aquatic weed maintenance:

❑ Done
❑ Need to do

1. Define, identify, and remove ***only nuisance plants;*** for aquatic plant reference materials, contact:
IFAS Publications, University of Florida
PO Box 11011
Gainesville, Florida 32611-0011
1-800-226-1764 or (352) 392-1764
See Chapter 7. Resources & References for full listing of publications.

❑ Done
❑ Need to do

2. Teach all group members how to identify pond plants.
See Chapter 6. Resources & References for full listing of publications.

❑ Done
❑ Need to do

3. Choose a short list of nuisance plants targeted for removal, probably 3 or 4 plants. Refer to Chapter 3. of this manual.

❑ Done
❑ Need to do

4. Strive to achieve a balanced and functioning pond ecosystem.

❑ Done
❑ Need to do

5. Have a long-term goal of chemical-free maintenance. Contact your local University of Florida Cooperative Extension Service, or the Florida Department of Environmental Protection, for a list of commercial licensed applicators.

❑ Done
❑ Need to do

6. Include a combination of several weed control strategies, such as:
- group work days to pull out nuisance plants
- limited and selective herbicide applications
- triploid grass carp
- well-established stands of native plants that can out-compete nuisance plants

❑ Done
❑ Need to do

7. Include weed removal tools that make group work days easier - for ideas, see:
Lake Smarts, Steve McComas, November 1993, Chapter One, Aquatic Weed Control. Available through:
Terrene Institute, 4 Herbert Street,
Alexandra, Virginia 22305. (703) 548-5473.

❑ Done
❑ Need to do

8. Has a plan for plant debris, i.e., community compost site.

Ask your pond group about wildlife:

Section 4.
Algae Control

See Chapter 2. for information about algae. Algae is a natural part of any pond ecosystem. But, an extensive algae bloom can be unsightly, alarming, and may result in a fish kill. There are many species of algae, some planktonic and some filamentous. Planktonic algae population can be measured to a certain extent by using a Secchi disk on a monthly basis. Filamentous algae can appear as floating masses and can be raked out of the pond easily.

The most effective algae control is pollution prevention. Reduced nutrient loads into your pond will go a long way towards reducing extensive algae blooms. Ask everyone in your pond's basin to observe these guidelines:

❑ Done
❑ Need to do

1. Establish fertilizer-free zones around the pond, along the street, and around storm drains; this will reduce direct runoff of fertilizer granules in to the pond.

❑ Done
❑ Need to do

2. Fertilize no more than twice each year, using Cooperative Extension Service guidelines for slow-release fertilizers; call your local Extension Agent for recommendations.

❑ Done
❑ Need to do

3. "Replace" algae with other, attractive aquatic plants which also utilize excess nutrients

❑ Done
❑ Need to do

4. Plant shade trees along the pond; shade will reduce algae productivity.

❑ Done
❑ Need to do

5. Plant Florida native aquatic plants in and around your pond; they will beautify your pond, provide food and shelter for wildlife, and will help reduce algae growth. They will also improve overall water quality in your pond.

Section 5.
Fish & Wildlife

Urban ponds can provide much-needed habitat for Florida's wildlife; your pond may be an important link in a local wildlife "corridor", as animals move through the area. Fish can be important to weed control, mosquito control, and recreation; your pond management needs may vary depending on which type of fish you want in your pond. Contact these agencies to learn more about animals you'd *like* to see more of, or the ones you *don't* want visiting your pond:

Florida Fish and Wildlife Conservation Commission,
Lakeland, (863) 648-3202
Your local University of Florida Cooperative Extension Service, phone:
University of Florida Fisheries & Aquatic Sciences
(352) 392-9617, extension 249

Ask your pond group about wildlife:

ANIMAL	RESOURCE	HABITAT NEEDS	ASSIGNED

Section 6.
Water Quality Monitoring

Similar to the saying "you are what you eat", your pond is a function of the water quality your neighborhood "feeds" it. Although you can look at the water and describe how you clean you think it is, regular testing will give your pond group some very real records on water quality trends for your pond. Your pond's water quality changes with the season: summer brings an influx of pollutants with stormwater runoff, high temperatures encourage algae blooms. A record water quality will help you recognize the seasonal changes in your pond and can give you a place to establish goals for your pond management program.

To learn more about water quality testing, contact:
The Southwest Florida Water Management District 1-800-423-1476
The Florida Department of Environmental Protection 1-813-744-6100

Consider water quality monitoring for your pond:

TEST	FREQUENCY	EQUIPMENT NEEDS	RESOURCE
clarity	monthly	Secchi disk or turbidity tube	
pH	yearly		
nitrogen	monthly		
phosphorous	monthly		

Section 7.
Drainage Structure Maintenance

This work can be dangerous, and when possible, should be left to your local government. It is important to have a contact within the local government to refer problems to. If your pond is not under government maintenance, ask them to at least advise you on any drainage issues you might encounter.

Remember, ***it is illegal to alter*** the function of a drainage pipe or structure on a stormwater pond.

Our local government contacts for stormwater and drainage are:

DEPARTMENT	CONTACT & PHONE	ASSIGNED TO
Water Management District (permits & exemptions)		
mosquito control	local government office contact & phone:	
Stormwater Investigation road flooding & sink holes	local stormwater utility contact & phone:	
maintenance of structures & pipes emergency flooding reports	local roads & streets department, or local stormwater utility contact & phone:	

Section 8.
Pond Group Work Days

All the planning in the world won't do a bit of good if you can't get together and ***do something to make it happen***. On the other hand, if you try to go too quickly, you might wear out your workers really fast and the project will die a swift death. It has probably taken several years for your pond to become a weedy mess, it will take several years to recover. In the meantime, plan some work days and **HAVE SOME FUN DOING IT!**

(sample table)

WORK DAY PLANNING	
DATE / TIME	9 am to noon, Saturday
TASK	remove trash and cattail patch at NE corner
EQUIPMENT NEEDED	trash bags, shovels, wheel barrows
DRINKS COMMITTEE	Sandy & family
BAR-B-Q LUNCH COMMITTEE	Joe, Sally, Fred, Ann
DONATION FOR LUNCH	$3.00 each
SAFETY PATROL	Rita

WORK DAY PLANNING	
DATE / TIME	
TASK	
EQUIPMENT NEEDED	
DRINKS COMMITTEE	
BAR-B-Q LUNCH COMMITTEE	

A work day activity flier appears on the next page. Make copies of the flier to announce your work day plans to your pond group.

Pond Group Activity Day

Please join your neighborhood
Pond Group for this event!

WHAT:

WHEN:

WHERE:

For more info, contact:

Section 9.

Stormwater Pollution Prevention Program

Pollution prevention is one of the most important elements of your pond management plan. You must have pollution prevention in order for your other management tools to be effective. Without pollution prevention you cannot protect or improve water quality, and that is why stormwater ponds were built in the first place!!

ACTIVITY	RESOURCE	ASSIGNED TO
❑ Storm Drain Marking	Center for Marine Conservation 1-813-895-2188	
❑ Door Hangers	Center for Marine Conservation 1-813-895-2188	
❑ Pond Walk	contact a biologist with your local environmental protection agency	
❑ Educational Meeting With Experts	contact your local stormwater utility, or environmental protection agency	
❑ Pond Work Days	Your Pond Work Group	
❑ Fertilizer-Free Zones	Pond Neighborhood	
❑ Pond Plants	Association of Florida Native Nurseries, (352) 931-6908	
❑ Environmental Landscape Maintenance	Your local University of Florida Cooperative Extension Service: *Florida Yards & Neighborhoods* *Urban Horticulturist* *Backyard Wildlife Habitat* *Master Gardener* *Master Composter*	

Section 10.

Pond Group Goals & Vision For The Future

Take time to create a vision of what your pond can be in the future.

1. How people and animals will enjoy it.

2. What it could look like, what the plants will look like, and what the water will look like.

3. How your cleaner and healthier pond could affect water quality outside your neighborhood.

4. What the kids in your neighborhood will learn from taking responsibility for cleaner water.

A good way to involve the group in the visioning process is to ask everyone to pretend they are returning to the neighborhood after a long trip. Ask the group to talk about what they would like to see when they look at the pond after having been away for a long time. Your group's vision can become your group's goals for your pond.

Our vision for our pond:

Chapter 5.

Maintenance Schedule For Structural Controls

Table 5: Stormwater Treatment Ponds — Dry Retention.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
Stormwater Treatment Ponds **(Dry Retention)**	Semi-Annually		• Inspect facility for signs of prolonged wetness and damage to structures including diversion devices and inflow and outflow structures and pipes. • Note any critically eroded areas on banks and pond bottom. • Schedule for stabilization. • Undercutting at the point of discharge and signs of piping in the vicinity of the control structure or inlets, flumes, diversion structures or pipes should be noted and scheduled for immediate repair. • Dead or dying grass on the pond bottom are indications of potential clogging and reduced infiltration capacity. When observed the facility should be checked to insure that it percolates completely within 2-3 days following storms. Scrapping, discing or otherwise aerating pond bottom may be required to restore the infiltration capacity of the soil. • Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately (2).
		As needed	• Mowing and litter and debris removal. • Stabilization of eroded banks. • Repair undercut or eroded areas at inflow and diversion structures or conveyances. • Nutrient and pesticide use management (1). • Dethatch pond bottom and remove thatching. Dispose via composting and land application. As an alternative, remove grass clippings following mowing.
		Annually	• Disc or otherwise aerate pond bottom.
		5 Year Revolving Schedule	• Scrape pond bottom and remove sediment with proper sediment disposal. Restore original cross-section and infiltration rate (2,3). • Seed or sod to restore ground cover.

Footnotes: (1) See Chapter 2, pages 34-37. (2) See Chapter 2, pages 32 & 40. (3) See Chapter 2, Pages 30-37.

Table 5: Stormwater Treatment Ponds — Dry Detention with Sand Filter System.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
Stormwater Treatment Ponds **(Dry Detention with Sand Filter System)**	Semi-Annually		• Inspect facility for evidence of damage and short circuiting of the filter. Close attention should be given to the filter box, bed, trench or mound and appurtenant works. Signs of piping (erosion of filter sand) into underdrain pipes or holes next to junction box and/or discharge control structures or exposure of coarse aggregate or geotextile surrounding the underdrain pipe should be noted and scheduled for immediate repair. • Note any critically eroded areas on banks, pond bottom, or filter. Schedule for stabilization. • Any undercutting at the point of discharge and erosion in the vicinity of inflow pipes, flumes and diversion structures should be noted and scheduled for immediate repair. • Dead or dying grass on the pond bottom and/or standing water following 3 days or more of dry weather are indicative of filter "blinding". When observed the facility should be scheduled for major maintenance. Standing water may need to be pumped from the facility or be otherwise drained to effect restoration of the filter. The owner or owner's representative should contact FDEP or the appropriate WMD to advise the permitting authority of the need to perform the drawdown. • Note signs of excessive petroleum contamination and handle appropriately (2). • If so equipped check "clean out" ports at the end of each underdrain and the junction box or underdrain outlet for evidence of blockage. (i.e. standing water in underdrain lateral accompanied by little or not outflow.) • Schedule cleaning of underdrain pipes via mechanical means or high pressure water jet as appropriate. Also inspect for damage to caps from mowing accidents or any breaks in seals to prevent short circuiting of the filter.
		Semi-annually or as needed	• Minor corrective maintenance of filtration components should be scheduled any time drawdown does not occur within 48 hours after a storm. This activity usually involves simple light discing raking or aeration of sod cover or the surface of the filter. Confined unit "vault or box" type systems may be backflushed (i.e. fluidized) if these capabilities are available.

Dry Detention with Sand Filter System continued on page 101.

(continued) Table 5: Stormwater Treatment Ponds — Dry Detention with Sand Filter System.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
		18 months or as needed to maintain 72 hours drawdown capacity	• Major maintenance of filtration components is required any time that nuisance conditions (standing water) persists for more than 3 days following storms. This activity involves removal and replacement of ballast gravel and geotextile covers when used. Any sod cover or the top 2-3 inches of sand must be removed in cases involving vegetated or open sand filter beds. All discolored, sediment contaminated sand must be removed and replaced with clean sand of a type equivalent to the original grade. • Sediment and contaminated sand must be disposed of properly. (2,3) • Seed or sod to restore any dead or severely damaged ground cover. • At select locations, excavate down to and check underdrain pipe for clogging of the orifices, slots and/or fabric sock surrounding the pipe if used. Clean or otherwise replace pipe as needed to restore drainage capacity.
		Annually or as needed to maintain 72 hours drawdown limit **(Confined Unit or Box Type Filter)**	• Major maintenance of filtration components associated with "confined unit" type filters is usually more frequent than with other filtration devices. The activities required are facilitated however by the unit's compact nature. Complete removal and replacement of geotextile, filter sand, and the ballast stone or gravel when used is normally required. • Restore damaged ground cover on the pond bottom. • Fabric wrapped underdrain pipe should be closely inspected and replaced if clogged. Perforated or slotted pipe should be checked for damage or restricted openings. Replace or clean underdrains as needed to restore drainage capacity.
		As needed	• Mowing and removal of grass clipping. • Litter and debris removal from banks. • Stabilization of eroded banks. • Repair undercut and eroded areas in the vicinity of the discharge point or other structures such as inlet flumes, inflow pipes and energy dissipaters. • Nutrient and pesticide use management (1).
		Bi-monthy	• Litter and debris removal from control structure and screens and remove sediment buildup at inflows.

Footnotes: (1) See Chapter 2, pages 34-37. (2) See Chapter 2, pages 32 & 40. (3) See Chapter 2, Pages 30-37.

Table 5: Stormwater Treatment Ponds — Wet Detention Facility.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
Stormwater Treatment Ponds **(Wet Detention Facility)**	Annual		• Inspect facility for damage. Close attention should be given to the control structure and the point of discharge (POD). • Undercutting at the POD and evidence of piping (erosion of soil into pipe junctions) and/or erosion in the vicinity of inflow pipes, the outlet control structure, or flumes should be noted and scheduled for immediate repair. • Note signs of excessive total petroleum hydrocarbon contamination and handle appropriately (2). • Monitor sediment accumulations and remove when 3 of storage volume is filled (3). • Check for apparent signs of hypereutrophic conditions and note areas which require invasive aquatic plant control. • Bleeder devices such as orifices as well as weirs, stand pipes, box drop inlets, grates, and screens should clean, free of debris and ready for service. • All control gates should be checked for operational capacity by briefly opening and closing valve. • Forebays/sediment sumps should be monitored for sediment accumulation. The "Cleanout Level" should be calculated for each facility and the sump should be scheduled for sediment removal based on the limit established for the facility and the sediment accumulation rate.
	Semi-annually		• Detentionfacilities that include constructed wetlands (littoral shelf) components should be monitored carefully to avoid invasive aquatic plant problems. Schedule removal of invasive species or chemical control when necessary to prevent excessive competition with beneficial or desired plants (1). • Note those areas within the littoral zone where the spread or overcrowding of beneficial plants necessitates management and harvesting.
		As needed	• Repair and stabilize undercut and eroded areas near structures and banks. • Stabilize eroded banks. • Mowing side slopes w/litter and debris removal from banks. • Nutrient and pesticide use management (1).
		Monthy	• Clean and remove debris from orifices, weirs, stand pipes, drop inlets and screens.

Wet Detention Facility continued on page 103.

(continued) Table 5: Stormwater Treatment Ponds — Wet Detention Facility.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
		Annually or as needed	• Aquatic plant management and harvesting. Manage constructed wetland components to prevent overcrowding of beneficial plants and to maintain adequate open water area for aesthetics, light penetration and oxygenation. It is also important to avoid excessive cover for insect (mosquito) larvae which enhances production and inhibits predation. Not more than a 50 percent reduction in open water area is recommended prior to mechanical harvesting and reduction of macrophytes cover to its original level (i.e. 30-35 percent in most instances). • Constructed wetland management (regular selective harvesting) to encourage sites for active growth and enhanced pollutant assimilation is recommended.
		5 year revolving schedule or as needed	• Removal of sediment from forebays or sediment sumps and dispose of properly (2,3). Sediment "cleanout level" should not be higher than 1 foot below the invert elevation of the bay or sump nor should the storage volume be reduced by more than 60 percent of original design, (i.e. Cleanout Level = .2 in/acre drainage area remaining storage volume in most cases.)
		10-15 years or as needed to maintain adequate storage volume and treatment	• Monitor sediment accumulations and remove when storage volume is filled or when hypereutrophic conditions become apparent. Sediment must be disposed of or used properly (2)(3).

Footnotes: (1) See Chapter 2, pages 34-37. (2) See Chapter 2, pages 32 & 40. (3) See Chapter 2, Pages 30-37.

Table 5: Stormwater Treatment Ponds — Wet Detention with Sand Filtration.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
Stormwater Treatment Ponds **(Wet Detention with Sand Filtration)**	Annually		• Inspect filtration component in accordance with type of system as per "Dry Detention with Sand Filter" guidelines. • Inspect detention pond component as described in "Wet Detention" guidelines. • Close attention should be given to the filtration component particularly evidence of short circuiting associated with piping in the vicinity of underdrain junctions and the control structure.
		As needed	• Maintain bank filter bed, trench, or box as described in Dry Detention with Sand Filter guidelines to maintain 72 hour drawdown limit. • Flood control components (weirs, risers, drop boxes and discharge pipes) should be clean and ready for service. • Mowing banks and grass clipping removal. • Litter and debris removal from banks. • Stabilization of eroded banks and repair of undercutting or piping in the vicinity of inlets, outlet control structure and point of discharge. • Nutrient and pesticide use management (1).
		Monthly	• Litter and debris removal from control structure and screens.
		Annually	• Invasive aquatic plant control (1).
		10-15 years revolving schedule or as needed.	• Sediment removal with proper sediment disposal to ensure that the depth of sediments does not exceed that of the design cross-sectional area of the pond (2,3).

Footnotes: (1) See Chapter 2, pages 34-37. (2) See Chapter 2, pages 32 & 40. (3) See Chapter 2, Pages 30-37.

Table 5: Exfiltration Trench.

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
Exfiltration Trench	Semi-Annually		• Monitor facility for sediment accumulation in the pipe (when used) and storage volume recovery (i.e. drawdown, capacity). Observation wells and inspection ports should be checked following 3 days minimum dry weather. Failure to percolate stored runoff to the design treatment volume level within 72 hours indicates blinding of soil in the trench walls and/or clogging of geotextile liner with fine solids. Reductions in storage volume due to sediment in the distribution pipe also reduces efficiency. Minor maintenance measures can restore exfiltration rates to acceptable levels short term. Major maintenance (total rehabilitation) is required to remove accumulated sediment in most cases or to restore recovery rate when minor measures are no longer effective or can not be performed due to design configuration. • Inspect appurtenances such as sedimentation and oil and grit separation chambers of catch basin as well as diversion devices and over flow weirs when used. Diversion facilities and over flow weirs should be free of debris and ready for service. Sedimentation and oil/grit separators should be scheduled for cleaning when sediment depth approaches cleanout level. Cleanout levels should be established not less than 1 foot below the control elevation of the chamber.
		As needed	• Remove sediment from sediment/oil and grease chamber of catch basin inlets and dispose of properly (2,3). • Remove debris from the outfall or "smart box" (diversion device) in the case of off-line facilities.
		5 years or as needed to prolong service.	• When bypass capability is available minor maintenance measures such as extended dry periods may be used to provide short term recovery of exfiltration rate. • Remove accumulated sediment from facilities constructed with manholes or other appurtenant structures to facilitate cleanout. Sediment should be disposed of properly (2,3). This process normally involves facilities with large pipes. Cleanout may be performed by suction hose and tank truck and/or by high pressure jet washing.
		10-15 years or as needed.	• Total rehabilitation of trench to maintain storage capacity within 2/3 of the design treatment volume and 72 hour exfiltration rate limit. Excavate and remove perforated or slotted pipe, surrounding coarse aggregate envelop (bedding) and geotextile fabric (wrap). In most cases renovation will require replacement with new material of equivalent grade and quality. Trench walls should be excavated to expose clean soil. Sediment contaminated soil, coarse aggregate and filter cloth should be disposed of properly (2,3).

Footnotes: (1) See Chapter 2, pages 34-37. (2) See Chapter 2, pages 32 & 40. (3) See Chapter 2, Pages 30-37.

Table 5:Grass Swales (Dry).

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	ACTIVITIES REQUIRED
Grass Swales **(Dry)**	Semi-Annually		• Inspect swales for signs of prolonged wetness and damage to structures including diversion devices, inflow pipes, driveway culverts, and swale blocks. • Note any critically eroded areas on banks and front or back slope and swale bottom. • Schedule for stabilization. • Undercutting at the point of discharge and paved flumes or pipes and culverts should be noted and scheduled for immediate repair. • Dead or dying grass and saturation of the swale bottom are indications of potential clogging and reduced infiltration capacity. When observed the facility should be checked to insure that it percolates completely within 3 days following storms to comply with state regulations. Scraping, discing or otherwise aerating the bottom may be required to restore the infiltration capacity of the soil. For best performance swales should percolate within one day following storms. • Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately (2).
		As needed	• Mowing and litter and debris removal. • Stabilization of eroded side slopes and bottom. • Repair undercut or eroded areas at culverts, flumes, or swale blocks. • Nutrient and pesticide use management (1). • Dethatch swale bottom and remove thatching. Dispose via composting and land application. As an alternative, remove grass clippings following mowing.
		Annually	• Disc or otherwise aerate swale bottom.
		5 Year Revolving Schedule	• Scrape swale bottom and remove sediment with proper sediment disposal.Restore original cross-section and infiltration rate (2,3). • Seed or sod to restore ground cover. • Violation of water quality standards for turbidity will often result following initial construction as well as during major maintenance and restoration activities, unless water can be temporarily diverted while seeding and subsequent germination take place.In lieu of diversion it is advisable to stabilize both the swale bottom an side slopes as quickly as possible by resodding and staking all areas disturbed during swale clean out and restoration operations.Use of netting or geotextile matting in conjunction with seeding operations have also been shown to reduce the potential for erosion and subsequent turbidity problems from roadside swale maintenance.

Footnotes: (1) See Chapter 2, pages 34-37. (2) See Chapter 2, pages 32 & 40. (3) See Chapter 2, Pages 30-37.

Chapter 6.

Resources, Reference, Resource Literature and Maps

Resources:

List of Contacts

Charlotte County

County Courthouse.....941.743.1200
Cooperative Extension Service.....941.639.6255
www.gnv.ifas.ufl.edu/~charlotte
Natural Resources Conserv Service.....941.995.5678
Our Town Charlotte.....www.charlotte-florida.com

Citrus County

County Courthouse.....352.341.6400
Cooperative Extension Service.....352.726.2141
Natural Resources Conserv Services.....352.521.4260
Soil & Water Conserv District.....352.754.4035

Collier County

County Courthouse.....941.774.8999
www.gator.naples.net/govern/
County Manager.....941.774.8383
Emergency Management..... www.collierem.org/index.htm
Cooperative Extension Service.....941.353.4244
www.gator.naples.net/~kuh/cces.htm
Natural Resources Conserv Service.....941.455.4100
Cape Coral..... www.capecoral.net
Naples..... www.naples.net/govern/city/index.htm

DeSoto County

County Courthouse..... 863.993.4800
Cooperative Extension Service.....863.993.4846
Natural Resources Conserv Service.....863.993.4040

Glades County

County Courthouse.....863.946.0113
Cooperative Extension Service.....863.946.0244
Natural Resources Conserv Service.....863.674.4160

Hardee County

County Courthouse..... 863.773.6952
Cooperative Extension Service.....863.773.2164
Natural Resources Conserv Service.....863.773.9644

Hendry County

County Courthouse..... 863.675.5217
Cooperative Extension Service.....863.674.4092
Natural Resources Conserv Service.....863.674.4160

Hernando County

County Courthouse..... 352.754.4000
www.co.hernando.fl.us/index.html
County Engineer's Office..... 352.754.4060
Public Works Department..... . 352.754.4060
Emergency Management..... . 352.754.4083
Cooperative Extension Service..... 352.754.4433
Natural Resources Conserv Service..... 352.796.9600
Soil & Water Conserv District..... 352.754.4009

Highlands County

County Courthouse Clerk.....863.402.6565
Cooperative Extension Service.....863.402.6540
Governmant Center.....863.402.6564
Natural Resources Conserv Service.....863.402.6545

Hillsborough County

County Courthouse..... 813.272.5660
www.hillsboroughcounty.org
Public Works Department.....813.272.5912
Engineering Division of PW.....813.272.5912
http://engineer.co.hillsborough.fl.us/engineer
Stormwater Management Section.....813.272.5912
Cooperative Extension Service.....813.744.5519
Natural Resources Conserv Service.....813.759.6450 Extention 3
City of Tampa-Stormwater Mgmt..... 813.274.8588

Lake County

County Courthouse..... 352.343.9850
Cooperative Extension Service.....352.343.4101
Natural Resources Conserv Service.....352.343.2481 Extention 3

Lee County

County Commissioners.....239.335.2259
County Justice Center.....239.335.2990
www.lee.fl.us
Public Works Department.....239.479.8505
Environmental Sciences Division..... 239.479.8182
Public Resources Division..... 239.335.2260
Natural Resources Management..... 239.479.8109
Cooperative Extension Service..... 239.338.3232
Natural Resources Conserv Service.....239.995.5678 Extention 3

Levy County

County Courthouse..... 352.486.5100
Cooperative Extension Service.....352.486.5131
Natural Resources Conserv Service.....352.486.2672

Manatee County

County Courthouse..... 941.748.4501
www.co.manatee.fl.us
Cooperative Extension Service.....941.722.4524
Natural Resources Conserv Service.....941.907.0011

Marion County

County Courthouse..... 352.620.3904
Cooperative Extension Service.....352.620.3440
Natural Resources Conserv Service.....352.622.3971

Pasco County

County Courthouse..... 352.521.4111
Cooperative Extension Service.....352.521.4288
Natural Resources Conserv Service.....352.521.4260

Pinellas County

County Courthouse.....727.464.3485
www.co.pinellas.fl.us/bcc
Public Works Department.....727.464.3251
Environmental Management.....727.464.4761
Emergency Management.....727.464.3800
Cooperative Extension Service.....727.582.2100
http://coop.co.pinellas.fl.us
Natural Resources Conserv Service.....813.759.6450

Polk County

County Courthouse..... 863.534.4000
Cooperative Extension Service.....863.533.0765
Natural Resources Conserv Service.....863.533.7121

Sarasota County

County Courthouse..... 941.951.5000
Cooperative Extension Service.....941.316.1000
Natural Resources Conserv Service.....941.907.0011
North Port..... www.northport-florida.com
Discover Venice..... www.venice-florida.com

Sumter County

County Courthouse..... 352.793.0200
Cooperative Extension Service.....352.793.2728
Natural Resources Conserv Services.....352.343.2481

Other Contacts

1000 Friends of Florida..... 850.922.6277
Center for Aquatic Plants..... http://aquat1.ifas.ufl.edu
Dept of Environmental Protection..... 850.488.3601
http://www.dep.state.fl.us
Dept of Ag & Consumer Services.....850.488.6249
Farm Bureau.....850.378.1321
Natural Resources Conservation Services.... 352.338.9574 fax
Sarasota Bay National Estuary Program.....941.359.5841
Stormwater News..... www.stormwater.resources.com
Southwest FL Water Mgmt District..... 1.800.423.1476
http://www.swfwmd.state.fl.us
St. Johns River Water Mgmt District....1.800.451.7106 or 904.329.4500
Suwanne River Water Mgmt District....850.362.1001
Northwest FL Water Mgmt District..... 850.539.5999
Tampa Bay Estuary Program..... 727.893.2765
www.tbep.org
U of F Soil & Water Conserv Sciences..352.392.1951
U of F Inst of Food & Ag Sciences..... http://gnv.ifas.ufl.edu
U of F IFAS Coop Extension Services...http://gnv.ifas.ufl.edu/www/agator/htm/ces.htm

Resource Literature

"**The Adopt-A-Pond Notebook: Use it to learn more about your pond environment.**" A 3-ring binder with 5 chapters of information, including booklets and pamphlets from other agencies. Covers wildlife, plants, landscape maintenance, and pond maintenance. FREE.

Hillsborough County Stormwater
Management Section
Adopt-A-Pond Program
P.O. Box 1110
Tampa, FL 33601-1110
(813) 272-5912

"**Lake Smarts: The First Lake Maintenance Handbook - A Do-It-Yourself Guide to Solving Lake Problems.**" By Steve McComas

This how-to manual contains field tested easy and affordable projects to help you clean up, improve and maintain the lakes and ponds in your community. $18.95 plus shipping.

Terrene Institute
4 Herbert Street
Alexandria VA 22305
(703) 548-5473

"**Florida yards and Neighborhoods Handbook: A guide to Environmentally Friendly Landscaping.**" By University of Florida Institute of Food and Agricultural Services. FREE when you complete a survey.

Your yard is the first line of defense for Florida's fragile environment. Tips on cost-saving, environmentally-friendly landscape practices help you reduce water, fertilizer and pesticide use. A helpful section for waterfront homeowners addresses shoreline management.

The Florida Yards and
Neighborhoods Program
5339 South SR. 579
Seffner, FL 33584-3334
(813) 744-5519

"**Planting A Refuge for Wildlife: How to create a backyard habitat for Florida's birds and beasts.**" By Florida Fish and Wildlife Conservation Commission Nongame Wildlife Program, and the United States Department of Agriculture Soil Conservation Service. FREE.

In this booklet, you will find proven ways to encourage a broad cross-section of Florida Wildlife to visit and live around your home.

Nongame Wildlife Program
Florida Fish and Wildlife
Conservation Commission
620 South Meridian Street
Tallahassee, FL 32399-1600

"**Florida Freshwater Plants: A Handbook of Common Aquatic Plants in Florida Lakes.**" By University of Florida Institute of Food and Agricultural Services. $35.00. Catalogs 100+ species found in Florida lakes from Pensacola to Miami. Essential field guide information on each species is provided, including color photographs of every plant, complete botanical description, species' biology and notes of ecological interest, Florida map with locations.

C.M. Hinton
Publications Distribution Center
University of Florida
P.O. Box 11011
Gainesville, FL 32611-0011
1-800-226-1764

"**Stormwater Management, A guide for Floridans.**" By Southwest Florida Water Management District. FREE.

Resource Literature

(continued)

The following are available through University of Florida/Institute of Food and Agricultural Sciences by writing or calling:

IFAS Publications
P.O. Box 110011
Gainsville, FL 32611-0011
(352) 392-1764

Pesticide Training and Safety

"Aquatic Pest Control Training Manual"
Item #SM3- 107 pgs. $15.00

"Applying Pesticides Correctly: A Guide For Pesticide Applicators"
Item #SM1- 240 pgs. $7.00

Plant Identification

"Grasses, Sedges and Rushes of Wetlands Identification Deck"
Item #SP 255- 84 species. $12.00

"Aquatic and Wetland Plant Identification Deck"
Item #SM 50- 67 plants. $10.00

"Florida Wetlant Plants – An Identification Manual"
Pub. #244. $35.00

"Identification and Biology of Non-Native Plants in Florida's Natural Areas"
Pub. #SP257. $16.00

"Florida Freshwater Plants"
Pub. #189. $35.00

"Aquatic Plant Management in Lakes and Reservoirs"
Pub. #A1. $25.00

"Control of Non-Native Plants in Native Plants in Natural Areas of Florida"
Pub. #SP242. $2.00

"Living at The Lake"
Pub. #SP247. $15.00

Aquatic Plant Identification Programs – Video Program
7-part series. Recommended for aquatics managers, field personnel, students, and interested public. 26-55 minutes in length. $15.00 ea.

Catalog #	Title
#VT-360	**"Floating & Floating Leaved Plants"**
#VT361	**"Emersed Plants I"**
#VT362	**"Submersed Plants I"**
#VT363	**"Grasses, Sedges & Rushes I "**
#VT369	**"Emersed Plants II"**
#VT370	**"Submersed Plants II"**
#VT371	**"Grasses, Sedges & Rushes II"**

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University of Florida, 1996, A Guide to Environmentally Friendly Landscaping: Florida Yards and Neighborhoods Handbook, Bulletin 295, Gainesville: University of Florida, Cooperative Extension Service, Institute of Food and Agricultural Sciences.

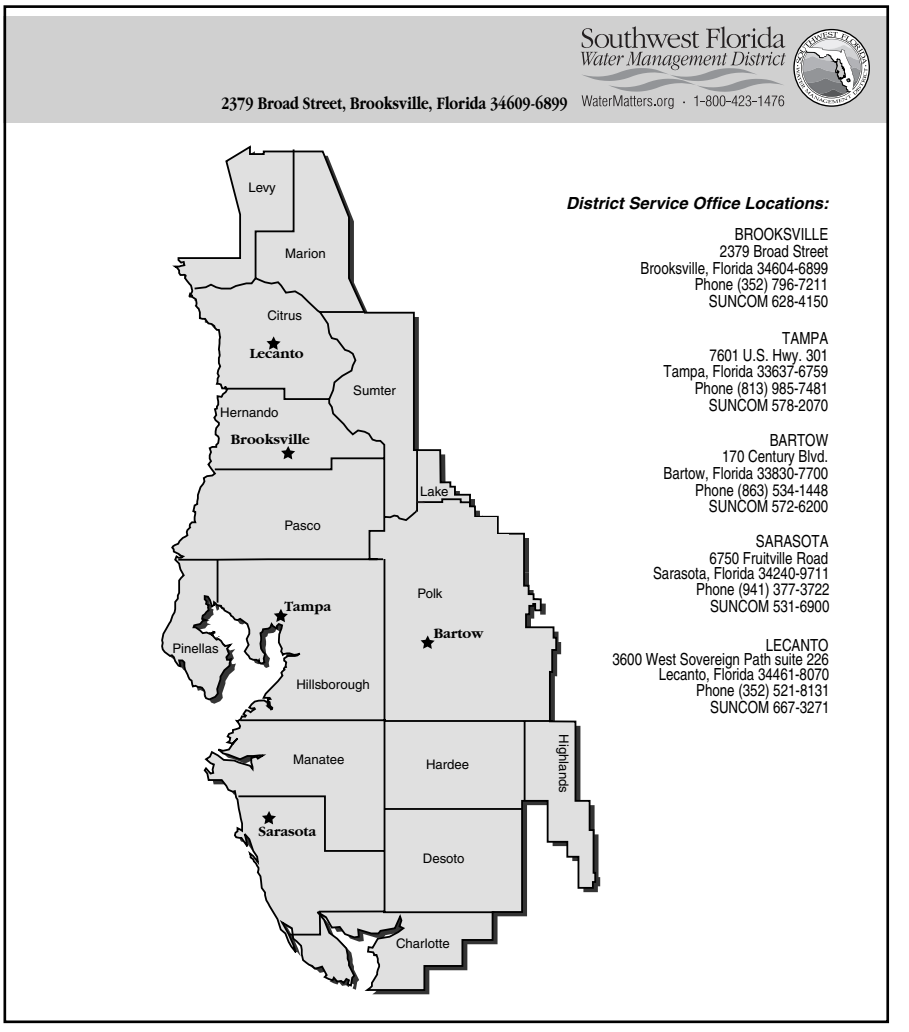
Livingston, Eric and Ellen McCarron, Stormwater Management: A Guide for Floridians, Tallahassee: Florida Department of Environmental Regulation.

Whalen, P. J. And M. G. Cullum. 1988. An assessment of urban land use/stormwater runoff quality relationships and treatment efficiencies of selected stormwater management systems. Technical publication 88-9, South Florida Water Management District, Resource Planning Dept., West Palm Beach, FL.

Terrene Institute. 1996. A Watershed Approach to Urban Runoff: Handbook for Decision makers. Terrene Institute, 4-B Herbert Street, Alexandria, VA 22305.

Whipple, William, Jr. And Joseph V. Hunter. 1979. Petroleum Hydrocarbons in Urban Runoff, Water Resources Bulletin, American Water Resources Association Vol. 15(4): 1096-1105.

Maps:



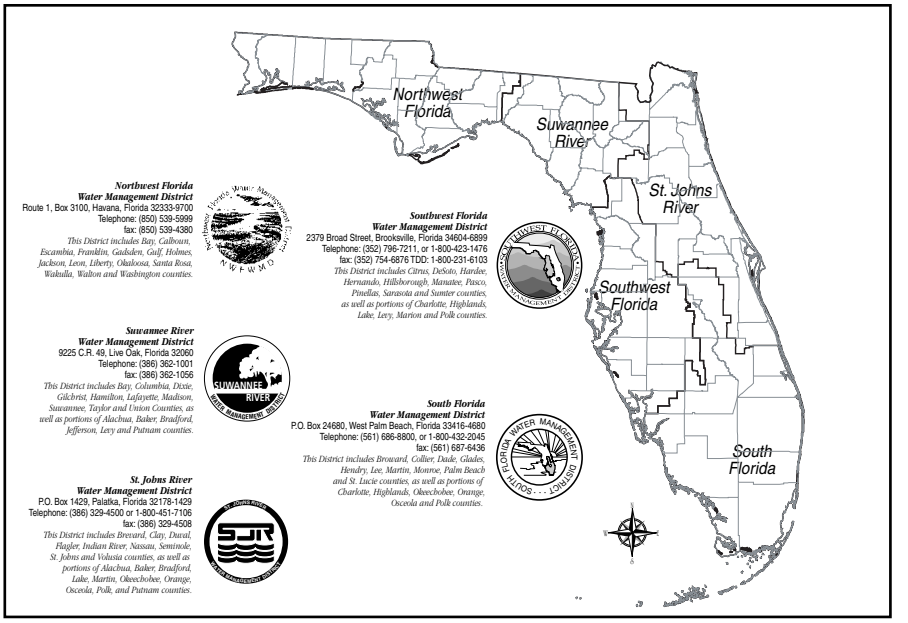
Northwest Florida Water Management District
Route 1, Box 3100
Havana, Florida
32333-9700
phone: (850) 539-5999
fax: (850) 539-4380

Suwannee River Water Management District
9225 C.R.49
Live Oak, Florida
32060
phone: (386) 362-1001
fax: (386) 362-1056

St. Johns River Water Management District
P.O. Box 1429
Palatka, Florida
32178-1429
phone: (386) 329-4500
or 1-800-451-7106
fax: (386) 329-4508

Southwest Florida Water Management District
2379 Broad Street
Brooksville, Florida
34604-6899
phone: (352) 796-7211
or 1-800-423-1476
fax: (352) 754-6876
TDD: 1-800-231-6103

South Florida Water Management District
P.O. Box 24680
West Palm Beach, Florida
33416-4680
phone: (561)686-8800
or 1-800-432-2045
fax: (561) 687-6436



Stormwater Ponds

A Citizen's Guide to Their Purpose and Management

Stormwater management is necessary to protect Florida's unique natural ecosystems.

The purpose of this guide is to provide guidelines for effective pond management; to educate communities about the purposes and benefits of stormwater ponds.

It presents a practical approach to stormwater ponds and their care. It contains information on developing a neighborhood-based care program for stormwater ponds. The information contained in this guide will also aid stormwater pond maintenance companies in their provision of quality services to