



**Water Quality/Quantity
Best Management Practices
for
Florida Citrus**

**FLORIDA DEPARTMENT OF AGRICULTURE AND
CONSUMER SERVICES**



2011 Edition

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Draft

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COMMENTS BY COMMISSIONER ADAM H. PUTNAM

Dear Agricultural Producers:

This manual, *Water Quality/Quantity Best Management Practices for Florida Citrus*, reflects the hard work of representatives of the industry; federal, state, and local government; and other stakeholders. In general, agricultural lands maintain valuable water recharge areas and preserve open spaces. The BMPs in this manual address water quality and quantity impacts from production activities and help maintain the environmental advantages of keeping the land in agriculture.

While best management practices have been in place for many years in our state, their role in environmental protection was formally established in 1999 with the passage of the Florida Watershed Restoration Act. This legislation provides the framework for implementing Florida's Total Maximum Daily Load program, which sets water quality targets for impaired waters. It also identifies best management practices implementation as the means for agriculture to help meet those targets.

As Florida's population continues to increase, there are more impacts to and competition for Florida's limited water resources. All Floridians must take part in conserving and protecting these resources. This manual represents the industry's commitment to do just that.

As a native Floridian whose family has long been involved in agriculture, I want to thank all who participated with the Department in the development of this important manual. With the active support and participation of so many dedicated people, I am optimistic about the future of Florida's agricultural industry. I trust that you will join me in supporting this valuable water resource protection effort.

Sincerely,



Adam H. Putnam
Commissioner of Agriculture

ACKNOWLEDGEMENTS

This statewide BMP manual for the citrus industry consolidates existing regional programs and extends rule-adopted BMPs for areas of the state not already covered. The following is a list of individuals who participated in the development of this manual. Each of these individuals and their organizations made important contributions to the process, and their work is sincerely appreciated.

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INTRODUCTION

Operations Intended to Use this Manual

This manual is designed for use by commercial agricultural operations that produce citrus crops (oranges, grapefruit, tangerines, tangelos, limes, lemons, or similar citrus cultivars). Citrus nurseries may enroll in the Container Nursery BMP manual.

Things to Keep in Mind as You Use this Manual

- Italicized words that appear in ***bolded red italics*** are defined in the glossary.
- Specific record-keeping requirements are noted using a pencil icon: 

You can access this manual electronically at www.floridaagwaterpolicy.com.

Overview of the Industry

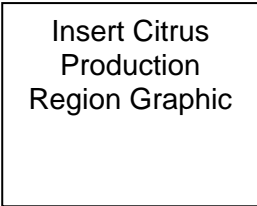
There are approximately 569,000 acres of citrus in Florida, and the state remains the number one producer of citrus in the country. Most of the industry grows oranges for juice plant processing; however, the bulk of the grapefruit grown is for the fresh market, and most of this is exported.

Florida citrus producers have faced many challenges in the past two decades. The land boom in Florida caused pressure on the industry as urban development expanded into historically agricultural areas. Escalating land values made the sale of agricultural land to development more likely, and development of land surrounding citrus groves has limited their expansion. The industry has also dealt with two severe exotic diseases, citrus canker and greening. Attempts to control canker through eradication programs resulted in the destruction of nearly 90,000 commercial acres. Many growers were affected by decreased demand and lower prices for Florida citrus, due to interstate shipping bans imposed by the United States Department of Agriculture in an attempt to limit the spread of canker. These combined pressures have also led to a total loss of approximately 143,000 acres of citrus. However, many of these citrus groves are either being replanted with disease-free nursery stock or are being converted to other agricultural land uses such as blueberries.

Despite these difficulties, the citrus industry has been a leader in embracing ***Best Management Practices*** (BMPs) for water quality and water conservation purposes. Much of the industry utilizes low-volume under-tree irrigation systems to conserve water, and incorporates precision application equipment into their nutrient management regimes.

The citrus industry has had a long-standing role in BMP development. In 1998, the Production Committee of the Indian River Citrus League, in conjunction with the Florida Department of Agriculture and Consumer Services (FDACS) and the University of Florida Institute of Food and Agricultural Sciences (UF-IFAS), took the initiative to develop BMPs for Indian River Area citrus groves. The objective was to identify

practices that have the potential to improve water quality and reduce the quantity of runoff water draining into the St. Lucie Estuary and Indian River Lagoon. A steering committee was formed to guide the BMP development process. The steering committee consisted of representatives from FDACS, the Florida Department of Environmental Protection (FDEP), the South Florida Water Management District (SFWMD), UF-IFAS, the Natural Resources Conservation Service (NRCS), the Florida Farm Bureau, and the Indian River Citrus League. The BMPs were adopted in June, 2002. Because growers were engaged in the development of the BMP manual, many were early implementers of the BMPs once they were adopted by FDACS.



Other citrus-producing areas in the state faced their own unique environmental issues, and grower organizations spearheaded the effort to develop BMP manuals for the Central Florida Ridge, the Peace River and Manasota basins, and the Gulf Citrus area. A stakeholder involvement process similar to that used in developing the Indian River Citrus BMPs was followed in the other three citrus areas. The Ridge Citrus rule was adopted in February 2003, followed by the Peace River manual in February 2005, and the Gulf Citrus manual in May 2007.

Some areas in the state that produce citrus did not fall under any of the previous rule-adopted BMPs. There were also large producers and caretaking companies whose operations were covered by more than one manual, and occasionally questions arose regarding the specific manual in which an operation should be enrolled. This provided the impetus to consolidate the existing manuals into a single document that addresses both statewide and region-specific practices for water quality and water conservation.

The citrus industry remains committed to protecting water resources through the implementation of BMPs. This manual, which has been endorsed by industry associations, has been developed to promote BMPs for citrus groves throughout Florida. Although these practices are designed primarily to protect water quality, some of the BMPs also will have water conservation benefits.

Best Management Practices Defined

BMPs are individual practices or combinations of practices that, based on research, field-testing, and expert review, have been determined to be the most effective and practicable means for maintaining or improving water quality. BMPs typically are implemented in combination to prevent, reduce, or treat pollutant discharges. BMPs must be based on sound science, be technically feasible, and be economically viable.

BMPs and Water Quality

Studies conducted in 2002 by the Environmental Protection Agency (EPA) indicate that nonpoint sources (both urban and agricultural) are the nation's greatest contributors to water pollution. Much of the contribution is due to rainwater carrying pollutants into lakes, rivers, wetlands, estuaries, and ground water. It is good stewardship and makes

good sense for growers to prevent or minimize these impacts by using BMPs. In fact, the Florida Legislature has established BMP implementation as the non-regulatory means for agricultural nonpoint sources to comply with state water quality standards. When you implement BMPs you are also confirming the Legislature's support for this approach.

Total Maximum Daily Loads

Under the Federal Clean Water Act and Florida law, FDEP must identify impaired surface waters and establish Total Maximum Daily Loads (TMDLs) for pollutants entering these waters. A TMDL establishes the maximum amount of a pollutant that can be discharged to a waterbody and still meet state water quality standards. Some pollutants for which TMDLs have been set include: total phosphorus, total nitrogen, total suspended solids, and coliform bacteria.

FDEP may develop and adopt Basin Management Action Plans (BMAPs), which contain the activities that affected interests will undertake to reduce point and nonpoint source pollutant loadings. In **watersheds** with adopted BMAPs, and in some other areas, agricultural producers either must implement FDACS-adopted BMPs or conduct water quality monitoring prescribed by FDEP or the water management district (WMD).

Florida already has adopted a significant number of TMDLs, and many more waterbodies are listed for TMDL development. This list encompasses lakes, rivers, streams, springs, and estuarine systems. More information on listed waterbodies and adopted TMDLs is available at <http://www.dep.state.fl.us/water/tmdl/index.htm> . To see a map of BMAP areas and learn more about BMAP development, go to <http://www.dep.state.fl.us/water/watersheds/bmap.htm> . If you need help figuring out whether you are in a BMAP area, call (850) 617-1727, or e-mail AqBMPHelp@freshfromflorida.com .

Federal Numeric Nutrient Criteria

The EPA has finalized numeric nutrient water quality standards for lakes and flowing waters in Florida (including rivers, streams, and springs), and is scheduled to take effect in March 2012. EPA also will be proposing numeric nutrient water quality standards for Florida's estuarine coastal and southern inland flowing waters. In its public hearing sessions on the proposed standards, EPA staff specifically acknowledged BMPs as the means for agriculture to address numeric nutrient criteria.

Benefits of Implementing BMPs

Before FDACS adopts BMPs, the FDEP reviews them and determines whether they will be effective in addressing water quality impacts from agricultural operations. Benefits to enrolling in and implementing FDACS BMPs include:

- A presumption of compliance with state water quality standards for the pollutants addressed by the BMPs. Even if EPA numeric nutrient criteria become part of state standards, producers who enroll in and implement the BMPs still have the

presumption of compliance.

- Release from the provisions of s. 376.307(5), Florida Statutes (F.S.), (fines for damages) for pollutants addressed by the BMPs.
- Technical assistance with BMP implementation
- Eligibility for cost-share for certain BMPs (as available).
- The Florida Right to Farm Act generally prohibits local governments from regulating an agricultural activity that is addressed through rule-adopted BMPs that growers implement.
- Producers who implement FDACS-adopted BMPs might qualify for exemptions from WMD surface water permitting, and/or satisfy other permitting requirements.
- Some BMPs increase production efficiency and reduce costs.
- BMP participation demonstrates agriculture's commitment to water resource protection, and maintains support for this approach to meeting water quality and conservation goals.

Implementation of BMPs does not excuse agricultural operations from complying with applicable permitting or other regulatory requirements.

Permit Exemptions

Some agricultural activities, especially those that alter on-site hydrology, may require an Environmental Resource Permit (ERP) or other surface water permit, for example, the construction of a stormwater management system (e.g., retention or detention pond). Check with your WMD before beginning construction of any stormwater management system to see whether a permit is needed, or whether the following exemptions apply:

- Under subsection 373.406(2), F.S., any person engaged in the occupation of agriculture may alter the topography of any tract of land for purposes consistent with the practice of agriculture. However, these activities may not be for the sole or predominant purpose of impounding or obstructing surface waters. Agricultural activities that meet these criteria may qualify for a statutory exemption from an ERP. Ask your WMD whether there are any notification requirements.
- Under subsection 373.406(9), F.S., environmental restoration activities on agricultural lands that have minimal or insignificant impacts to water resources may also be exempt from an ERP, upon written request by the producer and written notification from FDEP or the WMD that the proposed activity qualifies for the exemption.

Even if an exemption applies, agricultural producers within a watershed with an adopted BMAP that addresses agricultural loadings either must implement BMPs or conduct water-quality monitoring.

Local Government Regulation

In general, nonresidential farm buildings are exempt from the Florida Building Code and associated county building codes, in accordance with sections 604.50 and 553.73, F.S. However, permits may still be required for construction or improvement of certain farm buildings, so it is important to check with your county building and permitting office before beginning construction.

The Florida Right to Farm Act (section 823.14, F.S.) provides that, with certain exceptions, a farm that has been in operation for one year or more and was not a nuisance at the time of its established date of operation is not a public or private nuisance, if the farm conforms to generally accepted agricultural management practices. In addition, the Act provides that a local government may not adopt any ordinance, regulation, rule, or policy to limit an activity of a bona fide farm operation (with an agricultural land classification under s. 193.461, F.S.) if the activity is regulated through implemented BMPs adopted by FDEP, FDACS, or a WMD. Not all activities conducted on a farm are addressed by adopted BMPs.

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POTENTIAL WATER QUALITY IMPACTS ASSOCIATED WITH CITRUS

Most of the groves in Florida have been constructed in the flatwoods, which is a landform characterized by sandy soils and high water tables with little relief or slope, thereby requiring drainage infrastructure. The groves in “interior” Florida are mostly constructed on the Central Florida Ridge, which is a landform characterized by very sandy soils and low water tables, thereby requiring no drainage facilities. These differences create regional production and water quality challenges.

Nutrients

Excess nitrogen and phosphorus are the most common causes of water quality impairments in Florida. These nutrients can enter surface waters through stormwater or irrigation runoff, or leach through soils into ground water.

The nitrogen form most abundant in natural waters is nitrate. Due to its high mobility, nitrate can also leach into ground water. Phosphorus is one of the key elements necessary for growth of plants and animals. In terms of freshwater ecology, it tends to be the (growth) limiting nutrient. Phosphorus is more effectively retained in the soil than nitrogen. However, phosphorus enters waterbodies attached to particulate matter via sediment transport, or can be dissolved in water. In some soils, phosphorus is prone to leaching into ground water.

Excess Algal Growth

Algae are essential to aquatic systems. As a vital part of the food chain, algae provide the nutrition necessary to support aquatic animal life. Certain types of algae also provide habitat for aquatic organisms. However, high levels of nutrients in surface waters result in abnormal plant growth, including algae. Excess algal production can cause many problems in a waterbody. The presence of algal blooms, noxious weeds, and too many floating aquatic plants can block sunlight necessary for photosynthesis by submerged aquatic plants. The mass die off and decomposition of these materials lowers the available dissolved oxygen, which can lead to fish kills.

Blue-green algae (**Cyanobacteria**) can become so abundant that they will cause a scum layer to form on the surface, shading the sunlight-dependent life below and disturbing the food chain. Livestock and pet deaths have been attributed to consumption of water with an abundance of Cyanobacteria, which produce toxins known to cause liver and nervous system effects in humans. Potential risks from recreational contact include skin, respiratory, and mucous membrane irritation.

Sedimentation

Sedimentation occurs when eroded soils are washed into surface waters, creating a buildup of solids on the bottom and suspended solids (turbidity) in the water column. Sedimentation impacts most commonly associated with agricultural operations come from the erosion of unprotected soils.

Sediment can fill in water bodies, clog waterways, carry pollutants, and affect water clarity. These effects combine to reduce fish, shellfish, and plant populations, and decrease the overall productivity of lakes, streams, estuaries, and coastal waters. Decreased penetration by sunlight can affect the feeding and breeding behaviors of fish, and the sediments can clog gills and cause irritation to the mucous membranes covering the eyes and scales. As the sediment settles, fish eggs can be buried. Recreational use may also decline because of reduced fish populations, less visibility, and reduced desirability of downstream swimming areas.

Deposited sediment also reduces the flow capacity of ditches, streams, rivers, and navigation channels, which can require more frequent maintenance dredging or result in flooding. Nutrients and other contaminants can attach to sediments, which can contribute to downstream water quality impairments. Chemicals, such as some pesticides, phosphorus, and ammonium, may be transported in sediment. Over time, these chemicals may be released from the sediment and become suspended in the water column.

Fecal Coliforms

Fecal coliforms from uncomposted manure or improperly treated or applied **biosolids** are another cause of water quality degradation. The likelihood of contamination is increased if these materials are applied in excess of agronomic rates or under wet weather conditions. The decomposition of fecal and other organic matter in water can lead to increased biological oxygen demand and lower dissolved oxygen levels. Fecal coliforms also can have health impacts such as dysentery, gastrointestinal infections, ear infections, and skin infections, especially in open wounds.

KEYS TO POLLUTION PREVENTION

It is the agricultural industry's responsibility to protect water quality by implementing good land and water management practices. BMPs include many prevention measures that minimize potential water quality and quantity impacts. Implementing BMPs helps demonstrate the industry's commitment to protecting water resources, and garners support for this non-regulatory approach. Below are key guidelines for implementing the specific BMPs in this manual.



Understand Water Quality Issues on Your Operation

Water quality includes chemical, biological, and physical characteristics. Elevated levels of phosphorus, nitrogen, sediment, bacteria, and organic material contribute to the degradation of water quality. The potential for discharges from agricultural operations to cause water quality problems varies, depending on soil type, slope, drainage features, nutrient management, and activities in or near **wetlands**, surface waters, or karst features. Grove management practices determine an operation's impact on water quality. For more information on surface water quality, go to the following link: <http://lakewatch.ifas.ufl.edu/LWcirc.html>. For information on groundwater quality, go to: <http://edis.ifas.ufl.edu/ss194>



Manage Nutrient Sources Properly

Minimize the pollutants that leave your property by controlling the types and uses of materials used on your operation. Nutrient-related pollutant discharges can come from excess use or inefficient placement or timing of commercial fertilizer, manure, and/or biosolids applications. Managing nutrients carefully is critical to protecting water quality.



Manage Irrigation Carefully

Water is the carrier for nearly all pollutants. Precisely managing irrigation inputs to keep moisture primarily in the plant's root zone will significantly reduce nutrient-related impacts from fertilizers. Over-irrigating may exceed the soil's water-holding capacity and lead to runoff or leaching.



Minimize the Potential for Erosion Impacts

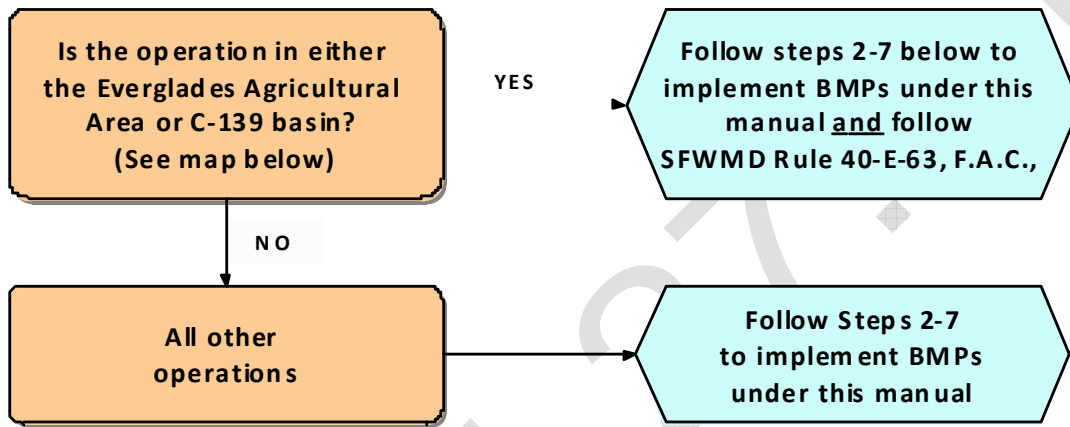
Land clearing, culvert installation, road building, ditch and canal maintenance, and grove rehabilitation can expose soil and lead to erosion that can increase pollutant loading. It is important to take appropriate erosion control measures during these activities.

USER'S GUIDE

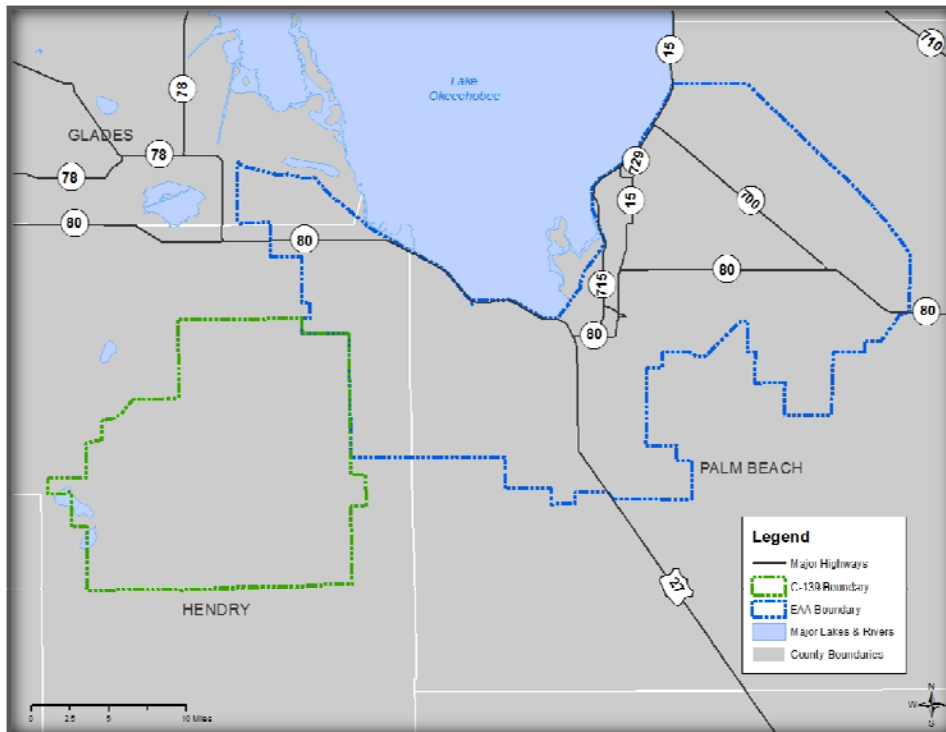
TO BMP ENROLLMENT AND IMPLEMENTATION

The steps below will help you select which BMPs to implement to reduce or avoid impacts to water quality coming from your operation.

1. **Choose the pathway applicable to you:** In the flowchart below, identify the circumstances that apply to you.



Note: In areas where FDEP has adopted a Basin Management Action Plan, agricultural operations must implement applicable FDACS-adopted BMPs or monitor water quality.




2. **Request assistance, as needed, in assessing your grove(s) and selecting BMPs:** FDACS field staff, UF-IFAS BMP Implementation Teams, and some Soil and Water Conservation Districts (SWCDs) are available to assist you with evaluating what BMPs are applicable to your operation. To get assistance, call (850) 617-1729 or email AgBmpHelp@FreshFromFlorida.com.
3. **Conduct an inventory:** The selection of BMPs begins with a basic inventory of the operation's natural features, which will help you determine how the operation of your grove(s) may affect environmentally sensitive areas. When developing the inventory, sketch your grove(s), noting buildings, well locations and other water sources, ditches, retention/detention areas, flow control structures, etc. Identify areas of particular concern that need to be addressed. These may include streams, wetlands, springs, **sinkholes**, and ponded or other poorly drained areas, among others. You can use the inventory as a starting point to select the BMPs applicable to your operation. To help you conduct your inventory effectively, the following tools are available:
 - ✓ Aerial photographs (<http://earth.google.com/index.html>, or other providers)
 - ✓ NRCS soil survey maps (<http://websoilsurvey.nrcs.usda.gov/app/>)
 - ✓ USGS topographic maps (<http://topomaps.usgs.gov>)
 - ✓ National Wetlands Inventory (<http://www.fws.gov/wetlands/data/index.html>)
 - ✓ Historic rainfall records (<http://www.ncdc.noaa.gov/oa/ncdc.html>)
4. **Select the Applicable BMPs:** Carefully read BMP sections 1.0 through 7.0 and select all of the BMPs in the manual that are applicable to your operation and are technologically and economically feasible for you to implement. Record the BMPs on the checklist in **Appendix 9** of this manual. The checklist includes a column for you to schedule BMP implementation if a practice is not already in place.

The BMPS in this manual focus primarily on management actions, rather than structural practices. In general, the BMPs should not require cost share to implement, though there may be a few exceptions. Depending on the location and specific conditions of the operation, not all of the BMPs may be applicable to a particular site.

It is advisable to consolidate your inventory and all your BMP decision-making, including the BMP Checklist, into a simple implementation plan. This can serve as a record of scheduled and completed BMPs, including operation and maintenance activities. A well thought-out, written plan enables managers and owners to schedule their activities and accomplish their objectives. Remember to keep the plan available and update it regularly. It will help you communicate with your employees, your county extension agent, NRCS staff, or others.

5. **File a Notice of Intent to Implement (NOI) BMPs:** Complete and submit to FDACS an NOI, contained in **Appendix 9** of this manual, along with the BMP checklist. Once received by FDACS, the Notice of Intent formally enrolls your operation under

the BMP program. Implementation of the BMPs provides a presumption of compliance with state water quality standards for the pollutants the BMPs address. Implementation includes ongoing record keeping and maintenance of the BMPs.

6. **Implement the BMPs:** Implement all applicable BMPs as soon as practicable, but no later than 18 months after submittal of the Notice of Intent to Implement.
7. **Keep Records on BMP Implementation:** FDACS rule requires record-keeping to document BMP implementation. Record-keeping requirements are highlighted in the manual using this figure:  Fertilizer applications and rainfall amounts are two types of record-keeping. All BMP records should be accurate, clear, and well-organized. You may develop your own record-keeping forms or use the ones provided in **Appendix 6**. You must retain the records for at least 5 years; however, it is desirable to retain records for as long as possible, to address any potential future legal issues. All documentation is subject to review.

BMP Implementation Follow-Up

FDACS has developed a BMP “Implementation Assurance” program to help evaluate how BMPs are being implemented, and to gather feedback on whether there are obstacles to using any of the practices. On a cyclical basis by BMP program, FDACS mails surveys to enrollees, which contain questions about BMP-related activities on enrolled operations. Also, FDACS staff may visit selected operations to get more direct input from producers. The Implementation Assurance effort helps in:

- Documenting the level of participation in implementing agricultural BMPs.
- Identifying needs for education and implementation assistance.
- Reinforcing the importance of BMP implementation.
- Evaluating the effectiveness of FDACS BMP programs.
- Updating FDACS NOI records.

Your participation in these follow-up activities is vital to the continuing success of agricultural BMP programs in Florida.

BEST MANAGEMENT PRACTICES

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1.0 Grove Development and Renovation

Insert Image of Resets

GROVE DEVELOPMENT AND RENOVATION ARE PRACTICAL MEASURES TO CAPITALIZE ON INCORPORATING UPFRONT DESIGN FEATURES WHEN DEVELOPING NEW GROVES OR RENOVATING EXISTING GROVES AFFECTED BY CATASTROPHIC DISEASE AND/OR INSECT PRESSURE LOSS.

Site preparation will vary between regions of the state, depending on crop type, soil type(s), seasonal-high ground water conditions, topography, and climate. Eliminating potential problems through simple adjustments made during development and renovation can reduce inputs, water quality impacts, and production costs. Follow the guidance below, as appropriate for your citrus grove site.

General Guidance for Site Preparation and Planting

If planting a new grove, it is a good idea to have a wetland delineation performed prior to site preparation, to establish the boundaries of all onsite wetlands that may be in the planned production area. This will allow for the establishment of appropriate setbacks and/or buffers pursuant to the BMPs in this manual. Install or maintain grove borders when creating new groves adjacent to highly urbanized areas. If using soil amendments and/or pH-adjusting materials, manage these inputs to optimize nutrient management and water conservation.

For more information, go to the UF-IFAS publication, *Water and Environmental Considerations for the Design and Development of Citrus Groves* at: <http://edis.ifas.ufl.edu/CH163>

Land Leveling for New Plantings

Develop a plan for land leveling, consulting a public or private engineer to discuss your site-specific needs. Periodic re-grading may be needed to eliminate mounds or depressions that form. Deposit unused **spoil** material in an appropriate upland location. If suitable, consider reusing this material somewhere on-site for road base, dike construction, etc.

For more information on land leveling, see the NRCS, Precision Land Farming, Code 462; and Irrigation Land Leveling, Code 464, in Section IV of the Field Office Technical Guide at: <http://www.nrcs.usda.gov/technical/efotg>

Well-Drained Sandy Soils of the Central Florida Ridge

This includes soil series such as Astatula, Archbold, Tavares, Candler, etc. In these soils, planting on unaltered ground is generally adequate. In areas of native vegetation, the main requirements for land preparation are to clear, pile, and burn the existing vegetation. Most areas can be cleared with front-end loaders fitted with root rakes. Some may require heavier equipment, such as bulldozers or backhoes for pine stump

removal. Further physical alteration of the land surface is generally unnecessary. Soil amendments are usually required, and should be guided by the results of soil testing. On previously cleared land, the main requirement for land preparation would be disking.

Poorly Drained Sandy Soils of the South Florida Flatwoods

This includes soil series such as Basinger, Immokalee, Myakka, Pineda, Riviera, Smyrna, Wabasso, Winder, etc. In these sandy soils, control of the naturally high water table and rapid removal of excess surface water from rainfall are essential. In addition, removal of trees and shrubs is important. These can be cleared in a single operation with heavy machinery, then piled and burned. Alternatively, pines can be sold as timber, after which stumps must be removed with a backhoe. Native flatwoods soils will usually require adjustment of pH with the application of lime or dolomite. All soil amendments should be based on the results of soil tests.

Grove Renovation

Due to the threat and effects of diseases like canker and greening, more and more citrus growers are removing affected trees, and even entire blocks. The need for erosion control primarily depends on what scale of grove renovation will take place. If growers are contemplating a completely new layout and bed orientation, then aggressive erosion control measures will be needed.

More information from K. Morgan.

1.1 GROVE RENOVATION BMPs

With pest pressures, increasing age, and/or lack of proper management, groves may experience significant decline. Renovation can involve replanting of just a few trees or an entire grove. Important things to consider during renovation include:

- Evaluating the ability/need to construct or retrofit the irrigation and drainage systems so that they perform more efficiently.
 - Instituting proper sediment control measures before and during replanting, especially on highly erodible lands.
 - More frequent inspection and maintenance of the irrigation system, including applicable filters, lines, hoses and emitters, as the need for unplugging, repair, and/or replacement of these components may increase.
- ✓ 1. Use applicable temporary sedimentation and erosion control measures for major earthmoving activities such as water control structure replacement/repair, land leveling, and soil bedding. These can include hay or straw bales, silt fences, etc.
 - ✓ 2. Upon completion of soil bedding, stabilize all bare soil areas (except tree rows) with grass or other desirable vegetation to minimize loss of soil from erosion.

REFERENCES:

- 1) The Florida Stormwater, Erosion, and Sedimentation Control Inspector's Manual, FDEP.
<http://www.dep.state.fl.us/water/nonpoint/docs/erosion/erosion-inspectors-manual.pdf>
- 2) UF-IFAS, Flatwoods Citrus Best Management Practice: Soil Stabilization, SL-195. <http://edis.ifas.ufl.edu/ss408>

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2.0 NUTRIENT MANAGEMENT

Insert Image of Fertigation

NUTRIENT MANAGEMENT IS CONTROL OF THE SOURCE, RATE, PLACEMENT, AND APPLICATION TIMING OF NUTRIENTS AND SOIL AMENDMENTS TO ENSURE SUFFICIENT SOIL FERTILITY FOR CITRUS TREE PRODUCTION AND MINIMIZE IMPACTS TO WATER QUALITY.

Fertilizer Sources

Citrus growers typically use fertilizer materials that contain nitrogen (N) and potassium (K). Fertilizer mixtures also will contain phosphorus (P) if the grower determines that the soil P supply is not sufficient for optimum growth. These three elements are referred to as macronutrients because they are required in relatively large amounts by plants. In terms of fertilizer composition and analysis, N is usually expressed as total N; P as available phosphate, or P_2O_5 ; and K as potash, or K_2O . To calculate the cost per pound of elemental P or K, a conversion factor must be used, as noted below. No conversion is needed for N, since it is already expressed in elemental form. The conversions for P and K are:

Equation (1): $P = P_2O_5 / 2.29$

Equation (2): $P_2O_5 = 2.29 \times P$

Equation (3): $K = K_2O / 1.21$

Equation (4): $K_2O = 1.21 \times K$

Availability to plants of both macronutrients and micronutrients is necessary to ensure proper plant growth and maintain plant health.

Applying N and P in excess of the plant nutrient requirement can result in nutrient runoff to surface waters and/or leaching to ground water, especially in Florida's sandy soils. Although K is not considered an environmental pollutant, K fertilization in combination with saline irrigation water increases the toxicity hazard due to excess soil salinity. Using fertilizers with a low salt index will help in managing salinity within groves. Refer to <http://edis.ifas.ufl.edu/ae171> to assist you in selection of fertilizer materials with a low salt index.

Macronutrient fertilizer sources commonly used to produce Florida citrus include:

- Ammonium nitrate or sulfate
- Calcium nitrate
- Urea
- Mono-ammonium or di-ammonium phosphate
- Ordinary or concentrated superphosphate
- Potassium chloride, sulfate, or nitrate

- Potassium-magnesium sulfate

These ingredients, which are all inorganic materials, are not the only constituents used in citrus fertilizers. Organic sources of fertilizers, such as biosolids, composts, and animal manures, are also used, and they contain both macronutrients and micronutrients.

Soils

It is important to understand the physical, chemical, and biological properties of your soil in order to choose effective nutrient management practices. For example, the natural N supply in Florida's sandy soils is low because organic matter degrades rapidly and does not accumulate. Therefore, growers must apply N fertilizer to meet the demand of a commercial citrus crop. Proper management of this fertilizer constituent is important because N compounds are readily oxidized to nitrate in most citrus grove soils, which then subjects the nitrate to leaching because it is not held by the soil due to its charge.

Citrus grove soils typically provide sufficient phosphorus if they have received P fertilizer applications in the past, as long as the soil pH is within the recommended range of 6.0 to 6.5. If soil P supply is low, it is usually associated with an extremely sandy, acidic, highly leached soil. Soil and leaf tests help determine the need to apply P fertilizer. Inorganic P fertilizers are water- or acid-soluble, which allows P to be readily absorbed by plants.

Phosphorus must be managed carefully, especially if the citrus grove contains soils predominantly composed of coarse, uncoated sands. These types of sands are prone to leaching P and are common throughout Florida. Uncoated soil series where P leaching may be a concern include the following:

Adamsville	Estero	Neilhurst	Ridgewood
Archbold	Hallandale	Nettles	Satellite
Basinger	Hobe	Oldsmar	St. Lucie
Broward	Immokalee	Orsino	Smyrna
Canaveral	Jonathan	Ortega	Tavares
Candler	Kershaw	Ousley	Valkaria
Dade	Lawnwood	Penney	Wabasso
Deland	Leon	Pomello	Wauchula
Duette	Myakka	Pomona	Waveland
EauGallie	Narcoosee	Pompano	Zolfo

Soil Testing

Soil testing is important not only for measuring organic matter and pH, but also to help determine appropriate fertilization amounts of P, magnesium (Mg), calcium (Ca), and copper (Cu). Soil test-based nutrient recommendations rely on a correlation between

nutrients extracted from the soil and a measure of plant response, such as yield. However, in Florida, information to make this correlation for readily leached elements such as N and K is limited.

Soil samples are not difficult to obtain. **Figure 1** shows a common soil probe used to obtain representative soil samples. Soil testing for citrus should be conducted on a yearly basis. Collecting and maintaining records of soil tests throughout many years will help document the effectiveness of a nutrient management program.

Figure 1

Leaf Tissue Testing

One of the best tools to aid in fertilization decision-making is leaf tissue analysis for measuring citrus nutritional status. For perennial plants such as citrus, past records of leaf tissue composition can be used to fine-tune a fertilization program for optimum plant growth and minimum environmental impact. Leaf tissue analysis, along with observation and soil testing, can help determine the effectiveness of a fertilization program, and is especially useful for detecting micronutrient deficiencies even before visual symptoms appear. As with soil testing, collecting and maintaining records of leaf tissue tests throughout many years will help document the effectiveness of a nutrient management program.

Proper methods to collect soil and leaf samples, and guidelines for interpreting test results, are detailed in the UF-IFAS publication, *Nutrition of Florida Citrus Trees (Second Edition)* at: <http://edis.ifas.ufl.edu/ss478>.

Fertilizer Applications

Timing Applications

To minimize the potential for adverse impacts to water quality from excessive fertilization and reduce costs, growers should base fertilization on specific crop nutrient requirements and related timing factors.

For Florida citrus, the period of highest nutrient requirement begins in late winter and extends through early summer. Based on nutritional demands during a typical year, a basic fertilizer application schedule divides the total annual requirement into three equal increments, avoiding the summer rainy season as much as possible:

- The first increment is applied between early February and the initiation of flowering.
- The second increment is applied between flowering and late May.
- The third increment is applied between September and mid-October.

Splitting fertilizer applications also will decrease the potential for salt damage and leaching.

Fertilizer may not be taken up readily if soils are cold. If a frost or freeze occurs shortly

after a fertilizer application, much of the fertilizer may be lost through leaching. This loss can be exacerbated by the additional runoff created when irrigation is used for freeze protection.

Targeting Applications

When applying fertilizer to the soil surface, target the area above the root zone. It is especially effective to apply nutrients from the tree canopy drip-line to the tree trunk, as this encompasses the predominant root zone area. Boom application fertilizer equipment can be used to do this, and can also be used to apply pesticides at the same time. Avoid application of nutrients/pesticides in areas prone to off-site runoff, such as water furrows.

Most Florida citrus groves are irrigated; therefore, fertilization and irrigation practices should be designed to minimize fertilizer loss through leaching. To achieve this goal, some growers are increasing the relative amount of fertilizer applied via low-volume irrigation systems (fertigation) and/or using slow-release or controlled-release fertilizers as a portion of their overall nutrient program. It should be noted that slow/controlled-release fertilizers may be particularly useful for grove resets.

Precision Agriculture Technologies for Fertilizer Application

Precision agriculture tools increasingly are used in citrus production. The most common of these are variable-rate application equipment, grid soil sampling, and yield mapping. The primary benefits of using these tools include reducing inputs (fertilizer, lime, and crop protection products), optimizing nutrient uptake, enhancing fruit quality and yield, and automating grove operations to increase overall efficiency.

The use of variable-rate fertilizer application equipment has reduced fertilizer use in groves by as much as 40%. Fertilizer is precisely quantified and placed in optimum position for plant uptake based on tree age (using photo-electric recognition of canopies) and/or prescription mapping (using Global Positioning System or GPS-assisted grid soil sampling). Use of these techniques avoids application of fertilizer where there are no trees, adjusts the fertilizer application rate based on age-related nutritional needs, and/or considers soil properties that influence tree growth and fertilizer availability.

In citrus yield mapping, producers use GPS-enabled data loggers to record the grove position(s) where fruit was harvested. This data can be used to identify both high- and low-production sites within a grove. Inputs can be adjusted accordingly to increase efficiency, reduce costs, and aid in the protection of water resources.

NUTRIENT MANAGEMENT BMPs




2.1 FERTILIZER SOURCES

- ✓ 1. Reduce the potential for nutrient loss and improve nutrient use efficiency by choosing appropriate sources and formulations of fertilizer based on nutritional needs, season (rainy vs. dry), and anticipated weather conditions.
- ✓ 2. If using reclaimed water, adjust fertilization rates as warranted. You can estimate the N and P contribution from the reclaimed water by multiplying the average nutrient analysis in the water by the volume of water applied.
- ✓ 3. If using organic compost, manure, or biosolids, adjust fertilization rates as warranted. You can estimate the N and P contribution by multiplying the nutrient analysis by the amount of material applied.

REFERENCES:

- 1) UF-IFAS, The Basics of Biosolids Application to Land in Florida, SL-205, <http://edis.ifas.ufl.edu/SS424>
- 2) FDEP, Biosolids Rule, Chapter 62-640, F.A.C. <http://www.dep.state.fl.us/legal/Rules/mainrulelist.htm>

2.2 DETERMINING FERTILIZER RATES

- ✓ 1.  Base P fertilization rate on soil and leaf tissue tests results from a lab that uses a standard testing method used by UF-IFAS Extension's Soils Testing Laboratory. Keep a copy of all laboratory test results to track changes over time.
- ✓ 2. Base N and K fertilization rate on UF-IFAS recommendations as established in document SL 253. *See Reference 1 below.*
- ✓ 3.  Use leaf tissue test results to determine the need for and appropriate rates of supplemental fertilizer applications, and to diagnose the effectiveness of N, K, and micronutrient fertilization programs. Keep a copy of all laboratory test results.
- ✓ 4.  Keep records of all nutrient applications. Include, at a minimum: date of application, total amount applied, acreage covered, fertilizer analysis or grade, rate per acre, and application method.

REFERENCES:

- 1) UF-IFAS, Nutrition of Florida Citrus Trees, 2nd Edition, February 2011, SL253, <http://edis.ifas.ufl.edu/SS478>
- 2) UF-IFAS, Producer Citrus Test Information Sheet, http://soilslab.ifas.ufl.edu/ESTL_files/ProducerCitrus.pdf
- 3) NRCS, Web Soil Survey, <http://websoilsurvey.nrcs.usda.gov/app/>

Note: See Appendix 3 for important details about soil and tissue sampling.

2.3 FERTILIZER APPLICATION

- ✓ 1. Calibrate fertilizer application equipment to ensure desired distribution and precise fertilizer placement at the root zone.
- ✓ 2. Time fertilization events to match the tree's highest nutritional requirement periods.
- ✓ 3. When applying soluble fertilizers, use smaller, more frequent (split) applications to minimize the potential for leaching. Guidance for split application frequencies can be found in Chapter 8 of SL 253.
- ✓ 4. Do not apply fertilizer under high-risk situations, such as before a forecasted rainfall or frost/freeze event.
- ✓ 5. To the extent practicable, avoid applying fertilizer during the rainy season.
- ✓ 6. Nitrogen applications on Ridge soils made during the rainy season must not exceed 40 lbs N/acre.

REFERENCES:

- 1) UF-IFAS, Fertigation Nutrient Sources and Application Considerations for Citrus, Circular 1410, <http://edis.ifas.ufl.edu/CH185>
- 2) UF-IFAS, Nutrition of Florida Citrus Trees, 2nd Edition, SL253, <http://edis.ifas.ufl.edu/SS478>

2.4 FERTILIZER STORAGE AND HANDLING

- ✓ 1. Protect stored fertilizer from wind and rainfall.
- ✓ 2. Ensure that fertilizer spilled on the ground during loading is immediately collect and re-loaded.
- ✓ 3. Provide training to workers on proper fertilizer storage and handling.

REFERENCES:

- 1) NRCS, Nutrient Management, Code 590, FOTG Section IV. <http://www.nrcs.usda.gov/technical/efotg/>
- 2) UF-IFAS, Nutrition of Florida Citrus Trees, 2nd Edition, SL253, <http://edis.ifas.ufl.edu/SS478>

Note: See Appendix 6 for list of record-keeping requirements and example record-keeping forms.

3.0 IRRIGATION MANAGEMENT

Insert Image of Pressure Gauge

IRRIGATION MANAGEMENT INVOLVES SELECTING AND MAINTAINING THE APPROPRIATE IRRIGATION SYSTEM FOR YOUR CROP; AND ADJUSTING IRRIGATION METHODS, SCHEDULING, AND AMOUNTS TO MAXIMIZE IRRIGATION EFFICIENCY, BASED ON MONITORING SOIL, PLANT, AND WEATHER CONDITIONS.

The goal of proper irrigation management is to keep both the irrigation water and the fertilizer in the crop root zone. This requires knowledge of the characteristics of the crop (particularly rooting depth), so that water and fertilizer inputs can be precisely targeted and properly managed. It also requires knowledge of the characteristics of the primary soil type to determine how these influence the availability of water to the plant.

The Central Florida Ridge features well-drained soils that permit rapid infiltration of rain and irrigation water; consequently, they are vulnerable to nutrient leaching. The maximum irrigation depth to wet the majority of the root zone in these sandy soils is 1 to 2 feet. Nitrate leaching is significantly reduced in poorly drained flatwoods soils, such as those in the Gulf, Peace River, and Indian River citrus production areas, which require artificial drainage to produce high-quality citrus. The citrus root zone in flatwoods soils is typically 12 inches or less, although some roots may be found deeper in groves with a lower than average water table.

Irrigation System Design and Installation

Irrigation system design generally depends on factors such as topography, soil type, crop type, peak water requirements, and water source. It is important to know the volume and quality of the irrigation water source before designing and installing an irrigation system, because this may affect the selection, design, and operation of the system.

Irrigation system design requires in-depth technical knowledge, and should be handled by trained professionals. These professionals use existing standards and criteria, as well as manufacturers' recommendations, to design the most appropriate irrigation system for a particular location and water source. For information about professionals who design and install irrigation systems, please visit the Florida Section of the American Society of Agricultural and Biological Engineers at: http://www.fl-asabe.org/fasabeweb_006.htm.

Pressurized Irrigation Systems

Figure 2

Pressurized systems deliver water under pressure via closed pipelines and/or laterals. The irrigation system most used for citrus production in Florida is pressurized low-volume micro-sprinkler or drip, as shown in **Figure 2**. When properly designed, operated and maintained, these systems efficiently deliver precise amounts of water, nutrients and other materials to the citrus root zone.

A typical irrigation system consists of four main components:

- 1) **Water Supply Mechanisms** (e.g., a water source, pumps, filters, valves, water gates and/or level controls.)
- 2) **Water Conveyance Mechanisms** (e.g., canals and main ditches, a main pipe, manifold pipes, lateral hoses or pipes, and/or isolation valves.)
- 3) **Water Application Mechanisms** (e.g., spigots; sprinkler, micro-sprinkler, or wobbling heads; spaghetti tubes; and/or spray guns.)
- 4) **Control Mechanisms** (e.g., manual or automatic float switches, computerized control systems, weather stations, and/or soil moisture sensors.)

Irrigation Water Sources

Agricultural irrigation water sources can come from ground or surface water. Depending on the aquifer characteristics, ground water can contain high levels of minerals that can form scale, which may plug emitters. Additionally, elevated chloride and total dissolved solids (TDS) concentrations greater than 1,200 micro-Siemens per centimeter (an electrical conductivity measurement) can significantly stress crops, leading to low fruit yield, leaf drop, twig dieback and reduction in growth. Young citrus trees are especially vulnerable. High TDS irrigation water that is allowed to run off may cause impacts to both on-site and off-site water resources. Obtaining routine water quality analyses will help you determine whether the water is appropriate to use on your crop based on its chemistry.

Well water may also be vulnerable to iron and/or sulfur-reducing bacteria effects that can cause emitter plugging issues. Chlorination (done before filtration) is the most common method for treating bacterial slimes, and should be considered on micro-irrigation systems.

Surface water sources can present problems with algal and bacteria growth. Algal cells and organic residues of algae can pass through irrigation system filters and form aggregates that may plug emitters. Surface water can also contain organic debris, which must be filtered to prevent irrigation system plugging. If using surface water sources, consider chemical treatment of the pond water (especially during algal blooms) to reduce the incidence of emitter clogging.

For more information on irrigation water source issues, go to: <http://edis.ifas.ufl.edu/AE032>.

Well Construction Permits

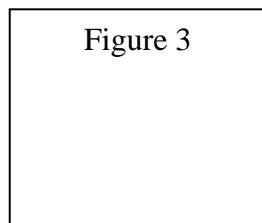
Florida's five WMDs have the primary regulatory authority for issuing well-construction and water-use permits for agriculture. Well-construction permits are required prior to the drilling, construction and/or repair of a well. These permits ensure that wells are constructed by qualified, licensed contractors to meet safety, durability, and resource protection standards. The WMDs sometimes delegate the issuance of well-construction permits to county governments. For more information about WMD permitting requirements, go to: <http://www.dep.state.fl.us/water/waterpolicy/districts.htm>

Alternative Irrigation Water Sources

As Florida continues to grow in population and water supply demands increase, growers are being asked to use alternative sources of irrigation water, such as reclaimed water, tailwater recovery, and rainfall harvesting. Use of alternative sources can also benefit water quality. For instance, tailwater recovery allows nutrients to be re-used on-site and not discharged to downstream waters.

Note: The use of alternative water sources has both advantages and drawbacks, and growers should evaluate their potential use thoroughly. In some cases, food safety or other legal restrictions apply.

Reclaimed Water



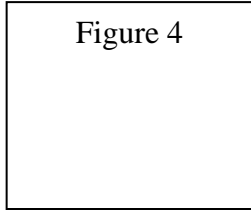
In recent years, the use of reclaimed water has been on the rise in Florida, as shown in **Figure 3**. This is mostly due to the high influx of people to the state over the last twenty years and the resulting increase in treated domestic wastewater available for use. Regulations governing reclaimed water use are contained in Chapter 62-610, Florida Administrative Code (F.A.C.). According to the rule, any type of irrigation system may be used to grow crops, such as citrus, that will be peeled, skinned, cooked, or thermally processed before human consumption.

Using reclaimed water involves a contractual arrangement with a wastewater treatment plant. Many wastewater treatment plants have a need to dispose of their water, often during rainy times when crops do not need water. It is important to review your contract so that you are not obligated to over-irrigate during wet-weather periods. Over-irrigating wastes water and can damage crops and cause excessive leaching of nitrogen or phosphorus from the soil.

Citrus growers should work with the WMD to arrange for a backup water source in case the reclaimed water source is insufficient or becomes unavailable or economically unfeasible.

Tailwater Recovery

Detention/retention areas allow all or a portion of the drainage water to be stored on-site temporarily. In some cases, the excess water can be stored for tailwater recovery or released later at low flow rates. Tailwater recovery systems are designed to collect and re-apply irrigation water and/or rainfall that discharges or seeps from production areas. An example layout is depicted in **Figure 4**. These systems can be constructed also to intercept subsurface lateral flow, which makes them very suitable in high-water-table environments. The size, type, and location of proposed tailwater recovery ponds are variables considered when determining the need for an ERP.



Tailwater recovery systems can also help protect and preserve water resources, since they retain and/or reuse excess nutrients, rather than allowing them to reach downstream natural systems. Take into consideration the following when determining whether and/or how to implement tailwater recovery:

- A tailwater recovery system typically consists of collection and storage components (ditches, ponds), and also delivery components (pump stations, pipes).
- Tailwater recovery ponds should be located at the lowest elevation(s) on your operation, and sized according to runoff volume and rates. In some cases, tailwater cannot be collected by gravity and must be collected via pumps.
- Seek technical assistance so that your pond(s) can be appropriately sized and built to maximize use and minimize impacts to your operation or neighboring properties.
- Offsite seepage from the tailwater recovery system should be controlled and managed properly, especially if the system is expected to receive chemical-laden waters. Control may be in the form of dike compaction, natural-soil liners, soil additives, commercial liners, drain tile, or other approved methods.
- In order to minimize disease risk when growing high-value crops, use chlorine or other approved disinfectants, as applicable, in the collected tailwater.
- Tailwater recovery and/or surface water reservoir systems may require additional filtering and purification infrastructure, depending on the quality of the water, and the type of irrigation system being used.
- Tailwater should be analyzed for nutrient content and electrical conductivity, and the fertilization program should be adjusted accordingly.
- Implement routine maintenance of all mechanical components, and maintain dikes and berms to keep the tailwater recovery pond structurally sound.

Note: The installation of tailwater recovery ponds may require an Environmental Resource Permit or other type of authorization, so growers should check with their WMD before installing them.

Horizontal Wells

Horizontal wells allow access to shallow surficial aquifers as a water source for irrigation, if the soil type and aquifer yield characteristics are suitable. Trenching and the placement of a horizontal well screen in the surficial aquifer create a flow path through impermeable layers, and provide an efficient means of recovering shallow groundwater.

Protecting the Water Source

Backflow Prevention

It is important to ensure that the irrigation water source does not become contaminated through the backflow of chemicals being injected into the irrigation system. Florida law requires backflow prevention (antisiphon) devices on all irrigation systems used for the application of pesticides or fertilizers (i.e., fertigation) (see **Appendix 5**). An example of such a device is shown in **Figure 5**.



Figure 5

Backflow prevention should include a check valve between the irrigation pump and the injection device to prevent backward flow; a low-pressure drain to prevent seepage past the check valve; a vacuum relief valve to ensure that a siphon cannot develop; and a check valve on the injection line. For more information on backflow prevention, go to: <http://edis.ifas.ufl.edu/AE032>

Saline Water

All natural waters contain soluble salts; however, the amount and type of salts they contain vary greatly. Irrigation water can degrade when wells are pumped at high rates or for prolonged periods. Sometimes “up-coning” can occur from pumping, whereby saline water, rather than fresh water, is drawn into the well. Similarly, saltwater intrusion from ground water pumping near coastal areas can create a problem with some irrigation wells. During the dry season salinity levels in ditches, canals, and reservoirs can increase through evaporation and irrigation water re-use (tailwater recovery).

Saline water typically is unsuitable for irrigation because of its high content of TDS. Saline irrigation water remediation consists of a few options:

- **Back-Plugging** - If fractures or flow zones in the well casing can be identified through well logging instrumentation, then the well may be a candidate for back-plugging. In this case, a cement-type material is injected into the well casing and sealed to a particular depth.
- **Surface Water Augmentation** - If a surface water reservoir exists, then saline groundwater can be mixed (blended) with the reservoir water to lower the total salt concentration. If using augmentation, water quality monitoring is important to ensure that salt concentrations are in the acceptable range.

- **Fertilizer Selection and Split Application** - A fertilization program that uses soluble fertilizers with a relatively low concentration of salts in frequent applications (more than 2-3 times per year), and/or that incorporates controlled release fertilizer (CRF), normally results in less potential for salt injury.
- **Irrigation Frequency** - To manage saline water effects, irrigate more frequently using greater amounts of water to move soil salt accumulations downward beyond the root zone.

Irrigation System Maintenance

Maintenance is necessary on any irrigation system to keep it operating at peak efficiency according to manufacturer's recommendations. The benefits of maintaining irrigation systems in good working condition include water conservation, uniform plant growth and production, and reduced operation and maintenance costs.

A primary goal of an irrigation maintenance program is to ensure that the system is always capable of uniformly delivering the proper amount of water. This includes: (1) application efficiency measurements; (2) meter calibration; (3) preventative maintenance; (4) corrective maintenance/repairs; and (5) appropriate recordkeeping. Regular visual inspections aid in identifying necessary repairs and corrective actions.

For traditional open-ditch seepage irrigation systems, water control structures (such as risers and culverts) should be kept clean and operational. Ditch banks should be maintained at their designed side slope, and vegetative cover should be adequate to maintain the structural integrity of the ditch and prevent erosion.

Maintenance of pressurized pipe systems includes operational checks of pump stations, valves, and irrigation emitters, and maintenance of irrigation lines through chlorination/acidification and flushing. **Chelating** and **sequestering agents** are available to prevent plugging caused by scale deposition. Malfunctioning or worn-out nozzles need to be replaced with similar ones that have the same flow and pressure characteristics. Conserving water and improving efficiency through proper maintenance also may enhance yields.

In some parts of the state, Mobile Irrigation Laboratories (MILs) are available, free of charge, to perform irrigation system evaluations and propose system improvements and basic maintenance recommendations. System improvements to increase uniformity and efficient scheduling can help growers conserve significant amounts of irrigation water while still providing the water required to meet citrus crop needs. For more information on MILs, go to:

<http://www.floridaagwaterpolicy.com/MobileIrrigationLabs.html>

Tracking Irrigation System Performance

It is also important to measure the amount of water that is actually delivered through the irrigation system, via a water meter or a calibrated flow measurement device. Knowing

the flow or volume will help you determine how well your irrigation system and irrigation schedule are working.

Keeping irrigation records (amount applied, duration of irrigation events, etc.) will help you track and minimize the amount of water used and reduce the costs associated with running the irrigation system.

Managing Irrigation

Efficient irrigation management provides greater water resource protection and reduced operational costs through more efficient water use. It conserves water, reduces the chances of over- or under-irrigating, and reduces leaching of agrichemicals in areas that are prone to such losses. Efficient irrigation targets the application of water to the plant's root zone, using only the amount needed for proper plant growth. Over-irrigation wastes water and promotes nutrient leaching.

Ensuring efficient irrigation requires development of a site-specific irrigation management plan that incorporates the use of information on soil properties, topography, crop types, **evapotranspiration** (ET), and seasonal climatic conditions in order to generate customized irrigation methods and schedules. This can be part of an overall BMP implementation plan.

Precision Irrigation

Precision irrigation for citrus can range from simple to more elaborate techniques. Simple techniques that rely on soil moisture measurement devices will require a high level of "hands-on" management decisions. More complex techniques usually involve high-technology methods employing computers, geographic information systems, remote-sensing equipment, etc. At its most sophisticated level, precision irrigation allows irrigation events to be adjusted in real time for location, frequency, and duration, based on soil properties and weather conditions. You may want to explore the feasibility of installing equipment and computer software that will provide you with real-time, site-specific irrigation and/or weather information for your operation. You may contact FDACS, UF-IFAS Extension, or an independent contractor for help.

Irrigation Scheduling

Irrigation scheduling consists of determining when to start irrigating, at what intervals to irrigate, and how long to irrigate. In order to develop an irrigation schedule, you should:

- Estimate irrigation water requirements.
- Make adjustments based on available soil moisture content, soil water tension, or historic or real-time ET and appropriate crop factors.
- Make further adjustments based on replenishment of soil moisture through rainfall.

Irrigation Water Amounts

Irrigation water amounts are determined primarily by the crop's water requirements, the water-retention characteristics of the soil, the chemical characteristics of the irrigation water, and type and efficiency of the irrigation system. Crop water requirements refer to the actual water needs for plant growth, taking into account ET and other climatic factors.

Citrus irrigation requirements vary with soil type, climate, ground cover, cultivation practices, weed control, tree size and age, and tree health. Large, vigorous, healthy trees require more water than young or non-productive trees. Enough water should be applied only to wet to the bottom of the root zone area. Citrus trees should not be water-stressed in the spring. In general, soil water depletion should be no greater than 25% in the spring, but can range from 50 to 75% in the fall and winter season. The amount of irrigation area covered will depend on tree spacing and canopy size. For mature trees irrigated with micro-sprinklers two to three times per week in the spring, 50% or more of the area should be covered. If frequent pulses can be applied daily with drip irrigation, less area can be covered.

Most citrus producers have WMD consumptive use permits that allocate an approximate irrigation water amount on an annual average basis. The WMDs use irrigation allocation models to determine how much water will be granted via the permit. Permits take into consideration factors such as grove spacing, root depth, soil types, average rainfall, etc., to account for regional differences. For more specific information about citrus water use requirements, go to UF-IFAS "Handbook of Florida Water Regulation: Consumptive Use" at: <http://edis.ifas.ufl.edu/fe604>

Irrigation Scheduling Considerations

Irrigation scheduling should be based on information such as: potential ET rates, as noted in **Table 2**; rainfall total, which can be determined by rain gauges; and soil moisture, which can be determined by sensors. More refined ET rates can be obtained from the University of Florida's *Florida Automated Weather Network* (FAWN) and the National Weather Service. Coupled with this technology, the observation of visual symptoms, such as wilting, will enhance the efficiency of irrigation scheduling. Prior to implementing an irrigation schedule, the irrigation system must be evaluated to determine the system's rate of application per acre. MILs can help with this.

Measuring Soil Moisture

There is no universally recognized standard method to measure soil moisture and no uniform way to compute and present the

Month	North Region ETp (inches/day)	South Region ETp (inches/day)
Jan	0.07	0.09
Feb	0.10	0.12
Mar	0.13	0.15
Apr	0.17	0.19
May	0.19	0.2
June	0.19	0.19
July	0.18	0.19
Aug	0.17	0.17
Sept	0.15	0.16
Oct	0.12	0.14
Nov	0.09	0.11
Dec	0.06	0.09

results. The most commonly used device is the tensiometer, however **capacitance** sensors are rapidly gaining in popularity.

Tensiometers indicate the water status of a soil by measuring the soil water potential, or tension, which is related to the force a plant must exert to extract water from the soil. Using capacitance methods, soil water content is determined by measuring the capacitance between two electrodes implanted in the soil. Capacitance sensors provide a near-instantaneous measure of soil water content.

Weather-Related Information

Weather is one of the most important factors that affect citrus growth and production. Irrigation system water-loss rates are affected by sunlight, wind speed, relative humidity, and air temperatures. When scheduling irrigation, it is important to have good rainfall and temperature data. Water loss can be reduced by irrigating when conditions do not favor excessive evaporation, especially when overhead irrigation systems are used.

Figure 6

The FAWN system, which maintains weather stations throughout most of the state, provides growers accurate, real-time weather data that can be accessed via the internet or by phone. A FAWN station is depicted in **Figure 6**. Each station measures air temperature, soil temperature, ET, wind speed and direction, rainfall, relative humidity, and solar radiation. These parameters are critical to calculate supplemental irrigation requirements for your crop. FAWN also provides information on other irrigation tools. You can access this information at: <http://fawn.ifas.ufl.edu>.

Irrigation should occur in the early morning hours before air temperatures rise and relative humidity drops. Irrigating at this time also allows sufficient time for infiltration into the soil, and allows the plant canopy to dry, thereby reducing disease development.

Special-Case Irrigation Measures

Frost/Freeze Protection

Options for protecting citrus crops from frosts and freezes include micro-sprinkler and flood irrigation, tree-wraps, heaters, and soil banking. Each method has application for specific regions and crops.

Most citrus growers use irrigation water to protect crops. When used for cold protection, the proper application and timing of water is critical. FAWN has developed tools to help determine under what climatic conditions to use your irrigation system for frost and freeze protection (see <http://fawn.ifas.ufl.edu/tools/>). Adhere to any frost/freeze protection provisions in your consumptive use/water use permit.

Drought

The National Drought Mitigation Center maintains a number of tools to assist growers in monitoring the intensity level of a drought. You can access these tools at <http://drought.unl.edu/dm/monitor.html> . Closely monitor soil moisture levels, and irrigate at night or at other times when the least amount of evaporative loss will occur. Irrigation frequency and duration should be based on rooting depth, to provide adequate moisture to the crop root zone. Contact the WMD to inquire about water shortage requirements.

IRRIGATION MANAGEMENT BMPs

NOTE: You can refer to SL-253 (*Nutrition of Florida Citrus Trees*) for general guidance on citrus irrigation management to help you implement the applicable BMPs below.

3.1 IRRIGATION DECISION-MAKING AND MANAGEMENT PRACTICES

Using the practices below, maintain soil moisture within the recommended range for the crop and soil type. Base your irrigation amounts and timing on crop water demands, soil moisture availability, and weather conditions. Contact your local UF-IFAS Extension or NRCS office to obtain specific information (i.e., water-holding capacity, depth to water table) about the soils on your operation, and to determine what the water demand is for your particular crop(s). This is usually expressed as an inch-per-acre or gallons-per-plant application amount.


- ✓ 1. Use available tools and data to assist in making irrigation decisions, such as on-site soil moisture sensors to determine available soil moisture, crop water use information, and weather data pertinent to your operation. Real-time weather data is available by visiting FAWN, United States Geological Survey (USGS), and WMD websites. If one is available, get a Mobile Irrigation Lab evaluation to assist you.
- ✓ 2. Minimize application losses due to evaporation and wind drift by appropriate irrigation scheduling (e.g., irrigating early in the morning, late in the afternoon, at night, and/or when cloud cover is abundant and wind speed is minimal).
- ✓ 3. Do not irrigate beyond field capacity. When irrigation needs are greater or when plants are flowering or developing fruit, splitting irrigation events may be of benefit.

REFERENCES:

- 1) UF-IFAS, Tensiometers for Soil Moisture Measurement and Irrigation Scheduling, CIR-487, <http://edis.ifas.ufl.edu/AE146>
- 2) Food and Agricultural Organization, Crop Evapotranspiration – Guidelines for Computing Crop Water Requirements, FAO Paper 56, [CITRUS BMP 3 25 11 DRAFT.docxhttp://www.fao.org/docrep/X0490E/X0490E00.htm](http://www.fao.org/docrep/X0490E/X0490E00.htm)

- 3) UF-IFAS, Field Evaluation of Micro-irrigation Water Application Uniformity, BUL-265, <http://edis.ifas.ufl.edu/AE094>
- 4) UF-IFAS, Field Devices for Monitoring Soil Water Content, BUL-343, <http://edis.ifas.ufl.edu/AE266>
- 5) USDA- NRCS, Irrigation System-Sprinkler, Code 442; and Irrigation Water Management, Code 449, FOTG Section IV, <http://www.nrcs.usda.gov/technical/efotg/>

3.2 GENERAL IRRIGATION SYSTEM MAINTENANCE

- ✓ 1. Test irrigation source water quality annually to detect issues with water chemistry that may affect maintenance and fertilization requirements. Adjust your maintenance actions as needed.
- ✓ 2. Use water meters (flow or volume) or other measuring devices/calculations to determine how much water is applied to the irrigated area. Document this information and use it to help you determine how well your irrigation system and irrigation schedule are working, and make any needed schedule adjustments or system repairs.
- ✓ 3. Monitor water meters or other measuring devices for unusually high or low readings to detect possible leaks or other problems in the system. Make any needed repairs.
- ✓ 4. If one is available, get an MIL to check the distribution or emission uniformity and the conveyance efficiency of the irrigation system(s). This should be done every three to five years.
- ✓ 5. Maintain pump stations and wells, and related components, in good working order. Check them on an annual basis. Replace parts as needed.
- ✓ 6.  Maintain a record-keeping system for inspection and maintenance of all irrigation system components. Records should be compared over time for any changes that would indicate problems with the system.

REFERENCES:

- 1) UF-IFAS, Potential Impacts of Improper Irrigation System Design, Agricultural Engineering Fact Sheet 73, <http://edis.ifas.ufl.edu/AE027>
- 2) UF-IFAS, Maintenance Guide for Florida Microirrigation Systems, Circular 1449, <http://edis.ifas.ufl.edu/ss436>

3.3 PRESSURIZED IRRIGATION SYSTEMS

- ✓ 1. Examine sprinkler nozzles or emitters for wear and malfunction, and replace them as necessary.
- ✓ 2. Clean and maintain filtration equipment so it will operate within the recommended pressure range.

- ✓ 3. Flush irrigation lines regularly to prevent emitter clogging. To reduce sediment build up, make flushing part of a regular maintenance schedule. If fertigating, prevent microbial growth by flushing all fertilizer from the lateral lines before shutting down the irrigation system.

REFERENCES:

- 1) UF-IFAS, Evaporation Loss During Sprinkler Irrigation, BUL290, <http://edis.ifas.ufl.edu/pdffiles/AE/AE04800.pdf>
- 2) UF-IFAS, Causes and Prevention of Emitter Plugging in Micro-Irrigation Systems, BUL 258, [CITRUS BMP 3 25 11 DRAFT.docx](http://edis.ifas.ufl.edu/ae032)
<http://edis.ifas.ufl.edu/ae032>

3.4 NON-PRESSURIZED IRRIGATION SYSTEMS

- ✓ 1. Clean debris and control weeds in irrigation ditches and canals, to maintain water flow and direction.
- ✓ 2. Keep water-level-control structures (such as culverts and risers) in irrigation ditches in good working order.

REFERENCES:

- 1) NRCS, Irrigation Systems, Surface and Subsurface, Code 443, <http://www.nrcs.usda.gov/technical/efotg/>

3.5 RECLAIMED WATER

If you are using reclaimed water:

- ✓ 1. As needed, design or retrofit irrigation systems to handle reclaimed water, taking into account source water quality and delivery pressures.
- ✓ 2. Separate reclaimed water supplies from existing ground or surface water sources to prevent cross-contamination.

REFERENCES:

- 1) FDEP, Water Reuse for Florida: Strategies for Effective Use of Reclaimed Water. http://www.dep.state.fl.us/water/reuse/docs/valued_resource_FinalReport.pdf
- 2) FDEP, Reuse of Reclaimed Water and Land Application Rule, Chapter 62-610, F.A.C. <http://www.dep.state.fl.us/legal/Rules/rulelistnum.htm>

3.6 SPECIAL-CASE IRRIGATION MEASURES

- ✓ 1. When using irrigation for frost/freeze protection, monitor wet-bulb temperatures to conserve water as much as possible. You can find this information at <http://fawn.ifas.ufl.edu/tools/>.
- ✓ 2. During a drought, closely monitor soil moisture levels. Whenever practicable, irrigate at times when the least amount of evaporative loss will occur.

During drought or freeze events, contact your WMD to inquire about water shortage requirements. It is critical that you adhere to any frost/freeze protection provisions in your consumptive use/water use permit.

Note: See Appendix 6 for list of record-keeping requirements and example record-keeping forms.

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4.0 DRAINAGE MANAGEMENT

Insert Image of Pump Station

DRAINAGE MANAGEMENT IS THE ABILITY TO MANIPULATE AND CONTROL THE WATER TABLE, RUNOFF, AND/OR RATE OF DISCHARGE TO ENSURE ADEQUATE CITRUS TREE PRODUCTION WHILE MINIMIZING IMPACTS TO WATER QUANTITY AND QUALITY.

On poorly drained soils, effective drainage management is essential for profitable citrus production. It also allows air to move into the soil, and prevents oxygen-deprived conditions. Drainage management has environmental benefits as well. Holding water on-site for as long as possible and releasing it slowly will provide water quality treatment, and help prevent an excess volume of water being discharged downstream.

Drainage management systems in flatwoods groves may contain some or all of the following components: canals, retention/detention areas, open ditches, subsurface drains, beds, water furrows, swales, and pumps required to move surface water. These systems require continuous maintenance to minimize the chances of root damage from prolonged exposure to waterlogged soils caused by poor drainage, high-intensity rains, and high water tables.

Flooding Damage

Water table levels vary greatly in flatwoods areas during the rainy season, due to the effects of different soil types, non-uniform rainfall, and high-intensity rainstorms. Drainage of soil-water is especially important in the wet season, since citrus root damage may occur under prolonged high water-table conditions. Research has shown that there is potential for water damage to citrus roots (**Figure 7**) if water saturates beds for four days or more during extended summer rains. During the cooler months of December-February, citrus trees can tolerate flooded conditions for much longer periods than in the summer.

Figure 7. Severely water damaged roots (top) and healthy (bottom) Flatwoods citrus roots.

Water table observation wells are good tools for observing soil-water dynamics. They are a reliable method for evaluating water-saturated zones in sites subject to chronic flooding injury. These wells also can be used to measure the rate of water-table drawdown, which is the key to discovering for how long roots can tolerate flooding. Wells with measuring rods allow observation of water tables while driving by the well site.

Drainage Rate and Volume

Following intense rainfall events, drainage rates and release volumes should provide for an adequately drained root zone while minimizing off-site impacts. Structures and/or

pumps that regulate off-site water discharge should be designed, constructed, and maintained so that target water-table levels within the grove can be achieved.

When the water table approaches the target level, off-site discharges should be moderated. Depending on the grove design, irrigation method (e. g. micro-irrigation or drip), and soil characteristics, this may require adjusting pump speed and the discharge structure or pulse drainage. Pulse drainage involves discharging for short periods of time and then allowing for recharge in the ditches. If adequate drainage in one portion of a grove results in water tables that are below target levels in another area, ditch cleaning, drainage system redesign, or auxiliary pumps may be needed to achieve more uniform drainage.

For additional information on drainage rates, contact your local NRCS representative.

Permitting Considerations

Construction or alteration of a drainage management system may alter on-site hydrology, and therefore may require an ERP or other WMD surface water management permit. Check with your WMD before beginning construction of any drainage management system.

DRAINAGE MANAGEMENT BMPs

4.1 WATER TABLE MANAGEMENT

- ✓ 1. Install water table observation wells and inspect them periodically for any needed repairs. Calibrate wells after installation and/or after any maintenance.

REFERENCES:

- 1) UF-IFAS, Water Table Measurement and Monitoring for Flatwoods Citrus. Circular 1409. <http://edis.ifas.ufl.edu/AE085><http://edis.ifas.ufl.edu/ch151>

4.2 STRUCTURES AND CONVEYANCES


- ✓ 1. For board risers, remove only the boards necessary to achieve desired drainage.
- ✓ 2. Keep water velocities near drainage structures slow enough to prevent soil particles from entering the drainage system.
- ✓ 3. To the extent practicable, maximize the distance the water must travel in surface ditches before it reaches the main discharge point.
- ✓ 4. Operate and maintain all drainage conveyances (swales, ditches, canals, etc.) to ensure they perform their intended function and do not fill in over time.

REFERENCES:

- 1) UF-IFAS, Simple Water Level Indicator for Seepage Irrigation, Circ. 1188.
<http://edis.ifas.ufl.edu/AE085>
- 2). Obreza and Boman, 1992. Simulated Citrus Water Use from Shallow Groundwater.
- 3). Obreza and Admire, 1985. Shallow Water Table Fluctuations in Response to Rainfall, Irrigations, and Evapotranspiration in Flatwoods Citrus.
- 4). UF-IFAS, Manual Monitoring of Farm Water Tables, Circ. 731.
<http://edis.ifas.ufl.edu/AE130>
- 5). UF-IFAS, Water Budgeting for High Water Table Soils. Circ. 769.
<http://edis.ifas.ufl.edu/ae374>
- 6). UF-IFAS, Manual Monitoring of Farm Water Tables. Bul. 251
<http://edis.ifas.ufl.edu/ae130>.

4.3 STORMWATER MANAGEMENT

LEVEL I BMPs:

- ✓ 1. Operate and maintain all stormwater management conveyances (swales, ditches, and canals) to ensure they perform their intended function.
- ✓ 2.  If you have an existing flatwoods grove that does not have an ERP or other WMD surface water permit and has a history of downstream flooding issues, develop and implement a written stormwater management plan that provides specific responses to various types and levels of rainfall, as feasible. The goal of the plan should be a reduction in volume of off-site discharge while maintaining a healthy rooting environment for citrus trees.
- ✓ 3. Evaluate the plan's effectiveness, and make adjustments as needed.

In developing the plan:

- Contact your local NRCS District Conservationist to help you identify soil types that are historically prone to flooding or standing water. Evaluate the storage capacity, size, and elevations of existing ditches, ponds, creeks, rivers, and wetlands, and the size, layout, and elevations of the fields. You should also contact your county or WMD to obtain maps (FEMA, FIRM) or other information related to flooding issues at the proposed or existing location. You can access this information via the web at <http://www.fema.gov/hazard/map/firm.shtm>.
- You may wish to consult with a public or private agricultural engineer to discuss your stormwater management needs and considerations. If so, find an engineer qualified to provide an appropriate analysis for your site.
- Include target water table levels and pump/drainage structure operating procedures that will be used for extreme rainfall events.

REFERENCES:

- 1) NRCS, Runoff Management System, Code 570, FOTG-Section IV.
<http://www.nrcs.usda.gov/technical/efotg>
- 2) Water Management Districts, ERP Stormwater Quality Applicant's Handbook.
- 3) ANSI/ASABE, Design and Construction of Surface Drainage Systems on Agricultural Lands in Humid Areas, EP302.4.
<http://www.asabe.org/standards/index.html>
- 4) UF-IFAS, Detention/Retention for Citrus Stormwater Management. Circ. 1405
<http://edis.ifas.ufl.edu/ae216>

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5.0 Sediment and Erosion Control Measures

Insert Image of Herbicide Application under Drip Line

SEDIMENT AND EROSION CONTROL MEASURES ARE TEMPORARY OR PERMANENT PRACTICES TO PREVENT SEDIMENT LOSS, SLOW WATER FLOW, AND/OR TRAP AND COLLECT DEBRIS AND SEDIMENTS IN RUNOFF.

Sediments or suspended solids are recognized forms of water pollution and often result in the loss of ditch or canal capacity. Unlike many chemical pollutants, sediment is a natural component of water bodies and the resources they support. Excessive amounts of suspended solids or sediments are often a product of erosion from un-stabilized or disturbed land areas. These solids originate from four primary sources:

- Soil-particles eroded into ditches
- Soil-particles eroded from ditches
- Plant material washed into ditches
- Plant and biological material growing within the ditches and canals

Excessive sediments deposited on stream bottoms and suspended in the water column can affect fish spawning and impair fish food sources, reduce habitat complexity, potentially harm public water supply sources, and reduce water clarity. Reduction in water clarity can affect aquatic resources, such as sea grasses and oysters, in the receiving estuary.

In addition to potential downstream water quality impacts, the build-up of silts and sediments in the grove, ditches, and canals can negatively affect the operation. This reduction in cross-sectional area results in higher water velocities, as compared to an unfilled ditch or canal. This higher water velocity (compared to unfilled ditches/canals) may induce greater amounts of erosion of fine and coarse particles from ditch and canal banks. The presence of shoals and sandbars are good indicators of soil losses. Field erosion also results in site degradation, with increased costs for ditch cleaning and reshaping of beds and furrows.

Minimizing downstream transport of sediments from groves and canal/ditch banks requires an integrated approach of managing erosion at the grove-level and in the primary and secondary canal systems. Efforts should focus on keeping soils in the groves and stabilizing canal and ditch banks. While the BMPs that follow generally help reduce sediment losses at the grove-level, many of these practices may be applicable for the primary and secondary canal systems. Significant sediment losses from groves are expected during construction of new groves or renovation of older ones. Losses from mature, well-managed groves will be much lower.

SEDIMENT AND EROSION CONTROL BMPs

5.1 Vegetative Cover

- ✓ 1. Stabilize water furrows and ditch and canal banks by encouraging a good coverage of noninvasive vegetation.
- ✓ 2. Maintain desirable vegetation on bed “middles” to minimize erosion and trap sediments.
- ✓ 3. Restrict the area of tree-row applied herbicides to within the citrus tree canopy drip line.

5.2 Erosion Control

- ✓ 1. Create and maintain settling basins/sumps upstream of drainage inlets within water furrows and/or upstream of pump intakes in collector ditches.
- ✓ 2. Use PVC drain pipe or flexible pipe to connect all water furrows to lateral ditches. Extend the pipe on the downstream side far enough away from the ditch bank to prevent bank scouring.
- ✓ 3. Contour ditch bank top edges or berms to divert surface water away from drainage ditches and canals. This is especially important when there is an access road adjacent to the water feature.
- ✓ 4. In areas subject to high water velocities, protect ditch and canal banks from erosion using rip-rap, concrete, headwalls, or other materials that buffer turbulence.
- ✓ 5. Maintain ditch and canal drainage function by removing unconsolidated sediments in order to retain the original design cross-sectional area.

REFERENCES:

- 1) NRCS, Runoff Management System, Code 570, FOTG-Section IV.
<http://www.nrcs.usda.gov/technical/efotg>

6.0 WATER RESOURCES PROTECTION

Insert Image of Wetland or Spring

WATER RESOURCES ARE DISTINCT HYDROLOGIC FEATURES, INCLUDING WETLANDS, SPRINGS, STREAMS, AND AQUIFERS.

Wetlands, Springs, and Streams Protection

Under Florida Law, wetlands are areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Florida wetlands generally include swamps, marshes, bayheads, bogs, cypress domes and strands, sloughs, wet prairies, riverine swamps, hydric seepage slopes, tidal marshes, mangrove swamps and other similar areas. Florida wetlands generally do not include longleaf or slash pine flatwoods with an understory dominated by saw palmetto.

Chapter 62-340, Florida Administrative Code, entitled *Delineation of the Landward Extent of Wetlands and Surface Waters*, contains the methodology that must be used by all state and local governments in Florida to determine the boundary between wetlands and uplands and other surface waters. The National Food Security Act manual is used by NRCS to determine wetlands boundaries on agricultural lands. In most cases, both methodologies produce the same or nearly the same determinations.

Springs are defined by the Florida Geological Survey as a point where underground water emerges to the earth's surface. They flow naturally from underlying aquifers and are classified based on their magnitude, or amount of flow coming from the spring vent. Springs and spring runs attract wildlife, provide over-wintering habitat for endangered manatees, contain unique biological communities, and are important archeological sites.

The area within ground water and surface water basins that contributes to the flow of the spring is a spring's recharge basin, also called "springshed," as depicted in **Figure 8**. This area may extend for miles from the spring, and the size of the area may fluctuate as a result of underground water levels. First magnitude springs discharge 64.6 million gallons per day (MGD) or more; second magnitude springs discharge between 6.46 to 64.6 MGD. FDEP has initiated an effort to delineate springsheds in the state, on a prioritized basis.

Figure 8

Wetlands and springs are important components of Florida's water resources. Wetlands often serve as spawning areas and nurseries for many species of fish and wildlife,

perform important flood-storage roles, cycle nutrients in runoff water, contribute moisture to the hydrologic cycle, and add plant and animal diversity. They can also provide limited grazing opportunities. Both wetlands and springs offer valuable recreational opportunities for the public and can provide an economic benefit to the surrounding communities.

Rivers and streams are naturally flowing watercourses. There are approximately 51,000 miles of rivers and streams in Florida. They are generally classified as sand-bottom, calcareous, swamp and bog, alluvial, or spring-fed systems. There are three measurable components that contribute to stream flow: base flow, interflow, and surface runoff. Surface runoff is most affected by rainfall (stormwater runoff), and contributes most to peak flow. Rivers and streams can readily transport pollutants received in stormwater runoff to wetlands, lakes, estuaries, and other water bodies. Consequently, it is important to minimize pollutant discharges to rivers and streams.

Conservation Buffers

Conservation buffers are permanently vegetated, non-cultivated areas that function to retain water and soil onsite to help reduce pollutants in surface water runoff. They include grove borders, filter strips, grassed waterways, and *riparian* buffers, and are particularly effective in providing water quality treatment near sensitive discharge areas.

- *Grove Borders* are strips of permanent vegetation, either natural or planted, at the edge or perimeter of groves. They function primarily to help reduce erosion from wind and water, protect soil and water quality, and provide wildlife habitat. Consider installing borders in existing groves, based on the intensity of your operation and surrounding properties.
- *Filter strips and grassed waterways* are areas of permanent vegetation between grove areas that drain to natural waterbodies. Their main purpose is to decrease the velocity of runoff water and remove sediment particles before they reach surface waters.
- *Riparian buffers* can be forested or herbaceous areas located adjacent to streams, which help reduce amounts of sediment, organic material, nutrients, and pesticides in surface water sheetflow. Riparian buffers are most effective on highly sloped lands when next to perennial or intermittent streams with high ground water recharge potential.

Consider using native vegetation to establish conservation buffers. Conservation buffers should be inspected periodically, and restored as needed in order to maintain their intended purpose. Any use of fertilizers, pesticides, or other chemicals should be done so as to not compromise the intended purpose of the buffer. As necessary, use prescribed burns in accordance with Division of Forestry (DOF) guidelines, to maintain the native vegetation and discourage the establishment of nuisance vegetation.

Aquifer Protection

With the majority of Florida's water supply originating from underground sources (*aquifers*), it is extremely important that agricultural operations help protect wellheads from contamination. Successful wellhead protection includes complying with regulatory requirements and using common-sense measures with regard to well placement and agricultural practices near wells. For existing wells, the focus should be on management activities near the wellhead, aimed at reducing the potential for contamination. For new-well construction, the initial focus should be on well location and following sound well-construction practices, followed by proper maintenance.

WATER RESOURCES PROTECTION BMPs

6.1 WETLANDS PROTECTION

Do not dredge or fill in wetlands. Consult with the WMD and the NRCS prior to conducting activities in or near wetlands to ensure that you are complying with any permitting or NRCS program eligibility requirements.

Minimize adverse water quality impacts to receiving wetlands by progressively applying measures until the problem is adequately addressed. Practices such as filter strips, conservation buffers, swales, or holding water on-site may preclude the need for more aggressive treatment measures.

Note: Use a NRCS county soil survey map to help identify the location of wetlands, hydric soils, or frequently flooded areas. If you do not have an environmental resource permit (which provides a wetlands delineation), seek technical assistance from the WMD or NRCS to determine the landward boundary of wetlands on your operation.

- ✓ 1. Install and/or maintain a minimum 25-foot, non-fertilized *vegetated buffer* upland of the landward boundary of all wetlands, unless you have an existing WMD permit (e.g., ERP, or management and storage of surface waters permit) that specifies a different buffer.
- ✓ 2. For existing operations without an ERP that are unable to meet the 25-foot vegetated buffer, submit to FDACS a written description of the alternative measures you will take to protect the wetlands from water quality impacts (see BMP checklist).

When broadcast-applying fertilizer near a wetlands buffer, ensure that the fertilizer does not land inside the buffer.

REFERENCES:

- 1) NRCS, Wetland Enhancement, Code 659, Nutrient Management, Code 590, FOTG-Section IV
<http://www.nrcs.usda.gov/technical/efotg>
- 2) EPA, National Management Measures for the Control of Nonpoint Pollution from Agriculture <http://www.epa.gov/nps/agmm/chap4c.pdf>

6.2 STREAMS PROTECTION

- ✓ 1. Install and/or maintain a riparian buffer along **perennial streams** on production areas that exceed 1-percent slope and discharge directly to the streams. Contact FDACS, NRCS, or a NRCS Technical Service Provider for assistance in properly designing the riparian buffer in accordance with NRCS Codes 390 and/or 391 in Reference (1) below.
- ✓ 2. Locate and size any stream crossings to minimize impacts to riparian buffer vegetation and function. Refer to NRCS Stream Crossing, Code 578 for design criteria.

REFERENCES:

- 1) NRCS Field Border, Code 386, Riparian Herbaceous Cover, Code 390, Riparian Forest Buffer, Code 391, Filter Strip, Code 393 and Grassed Waterway, Code 412, FOTG-Section IV: <http://www.nrcs.usda.gov/technical/efotg>

6.3 PROTECTION FOR FIRST- AND SECOND-MAGNITUDE SPRING RECHARGE BASINS

- ✓ 1. Install and/or maintain a 100-foot vegetated, non-fertilized buffer upland of the landward boundary of springs and spring runs.
- ✓ 2. Install and/or maintain a 50-foot vegetated, non-fertilized buffer around sinkholes and other karst features.
- ✓ 3. If you have a sinkhole on your property, never use it to dispose of used pesticide containers or other refuse.

REFERENCES:

- 1) Department of Community Affairs, Protecting Florida's Springs, Land Use Planning Strategies and Best Management Practices <http://www.dca.state.fl.us/fdcp/DCP/publications/Files/springsmanual.pdf>


6.4 WELL OPERATION AND PROTECTION

When installing a new well, contact your regional WMD to see whether the well requires a consumptive use/water use permit. Potable water wells as defined by Chapter 62-521, F.A.C, must follow the requirements of that rule.

Locate new wells up-gradient as far as possible from likely pollutant sources, such as petroleum storage tanks, septic tanks, chemical mixing areas, or fertilizer storage facilities. Use a licensed Florida water well contractor, and drill new wells according to local government code and WMD well construction permit requirements.

- ✓ 1. Use backflow-prevention devices at the wellhead to prevent contamination of the water source.
- ✓ 2. Inspect wellheads and pads at least annually for leaks or cracks, and

make any necessary repairs.

- ✓ 3. Cap or valve wells in accordance with WMD requirements.
- ✓ 4. Exclude citrus production activities within a 75-foot radius of drinking water wellheads. This radius can be reduced to 25 feet if well-construction records show well-casing depths that extend through **confining layers**.
- ✓ 5.  Maintain records of new well construction and modifications to existing wells.

REFERENCES:

- 1) NRCS Water Well, Code 642, FOTG-Section IV
<http://www.nrcs.usda.gov/technical/efotg>
- 2) FDEP, Water Well Permitting and Construction Requirements Rule, Chapter 62-532, F.A.C., <http://www.dep.state.fl.us/legal/Rules/rulelistnum.htm>
- 3) Florida Water Permits. <http://flwaterpermits.com/>

Note: See Appendix 6 for list of record-keeping requirements and example record-keeping forms.

7.0 INTEGRATED PEST MANAGEMENT

Insert Image of Nurse Tank Mix/Load Activity

INTEGRATED PEST MANAGEMENT (IPM) COMBINES THE MONITORING OF PEST AND ENVIRONMENTAL CONDITIONS WITH THE JUDICIOUS USE OF CULTURAL, BIOLOGICAL, PHYSICAL, AND CHEMICAL CONTROLS TO MANAGE PEST PROBLEMS.

Under Florida law (section 482.021, F.S.), IPM is defined as: *...“the selection, integration, and implementation of multiple pest control techniques based on predictable economic, ecological, and sociological consequences, making maximum use of naturally occurring pest controls, such as weather, disease agents, and parasitoids, using various biological, physical, chemical, and habitat modification methods of control, and using artificial controls only as required to keep particular pests from surpassing intolerable population levels predetermined from an accurate assessment of the pest damage potential and the ecological, sociological, and economic cost of other control measures.”*

Most cultural control methods are designed to help plants avoid contact with pests, create unfavorable conditions for pests, and eradicate or reduce the incidence of pests in a grove. Biological controls (and some cultural controls) improve plant resistance to pests, or utilize organisms that prey upon pests. Physical methods are generally used to deter, trap, destroy, or provide barriers to pests. Chemical methods involve the use of chemical pesticides or other repellants.

The basic steps of an IPM program are as follows:

- Identify key pests.
- Determine the pest's life cycle and which stage of the life cycle to target (for an insect pest, whether it is an egg, larva/nymph, pupa, or adult).
- Use cultural, biological, and physical methods to prevent problems from occurring (for example, prepare the site and select resistant plant cultivars); and/or reduce pest habitat (for example, practice good sanitation). Consider all of the cultural, biological, and physical control measures available and appropriate before moving to a chemical control method for preventing and controlling pest infestations.
- Decide which pest management practices are appropriate, and implement associated corrective actions.
- Direct the control where the pest lives or feeds. Use properly timed preventive chemical applications only when your experience indicates that they are likely to control the target pest effectively, while minimizing the economic and environmental costs.

Scouting

Scouting is the most important element of a successful IPM program. It involves monitoring pest presence and development throughout the growing season. By observing plant conditions regularly and noting which pests are present, an informed decision can be made regarding severity of damage and what pest control method is necessary.

Pests may be present for some time before they are observed or actual crop damage occurs. Therefore, it is essential to record the results of scouting in order to develop historical information, document patterns of pest activity, and document the treatment's success or failure. It is also important to determine whether the "corrective actions" actually reduced or prevented pest populations, were economical, and minimized risks. It is recommended that growers record this information, and use it when making similar decisions in the future.

Cultural Controls

Site selection, plant selection and establishment, and production techniques are cultural control practices. Growers should practice strict sanitation and use only registered planting stock that is disease-free. Planting schemes should promote good air circulation, which reduces the incidence of disease.

Groves near wooded areas, power lines, and ponds are generally more vulnerable to pests. Managing the habitat around crop production areas to encourage predator species of nuisance animals or reducing the habitat of the nuisance animals is another control method option. Using native vegetation in borders and buffers can attract beneficial insects and help reduce the imbalance in which crop pests thrive.

Biological Controls

Biological controls involve the use of natural enemies to control or suppress pests, or the active manipulation of antagonistic organisms to reduce pest population densities to acceptable levels. Natural enemies help to reduce the amount of pesticides needed to control pests, thus protecting water quality and reducing production costs. Biological control techniques should be tailored to the pest's life cycle, availability of effective predators and parasites, environmental conditions, and historical data.

Predators and parasites (insects, mites, and microbes) are the most commonly used biological control agents, and are known as "beneficials." These alone will generally not prevent damage from pests, but can reduce the severity. A management plan for the use of beneficials must be closely adhered to in order for it to be effective and economical over the long-term. **Figure 9** is a good example of biological control on citrus.

Figure 9

Physical Controls

The EPA regulates various mechanical devices and allows their use in order to

minimize or prevent negative impacts from nuisance pests. EPA refers to these as “pest control devices.” A product is a *pest control device* if it uses only physical or mechanical means to trap, destroy, repel, or mitigate any pest and does not include any pesticidal substance or mixture of substances.

Pest control devices alone are not required to be registered with EPA. However, if a device and a pesticide product are packaged together, the combined product is a pesticide product subject to registration requirements. For more information, refer to the website: <http://www.epa.gov/pesticides/factsheets/devices.htm>

Chemical Controls

The EPA and FDACS regulate the use of pesticides in Florida. The term pesticide is defined by EPA as any substance or mixture of substances intended for *preventing, destroying, repelling, or mitigating* any pest. Chemical control involves the use of pesticides, as necessary. Factors that influence the selection of chemical controls in Florida include:

- The product’s registration status within Florida
- The effectiveness of the product against the target pest
- The potential risk of a particular pesticide for beneficial organisms (e.g., honey bees)
- The product’s cost effectiveness
- The potential hazards to applicators, bystanders (e.g., residents, nearby businesses), the environment (i.e., non-target organisms, water quality), food safety, and the viability of a citrus crop
 - Certain pesticides may be of concern because of the potential toxicity to non-target plant, invertebrate, fish, and wildlife species
 - Pesticide use may result in **phytotoxicity** to trees, foliage, and/or the crop. Some combinations of pesticides or overlapping applications of incompatible materials can cause phytotoxicity
 - Limitation of or restrictions on application areas - Product selection may be influenced by a farm’s location relative to residential areas, human traffic in the vicinity, and weather conditions favoring drift of materials to non-target sites.
 - Impact on development of pest resistance - Resistance develops because one or more individuals in any given pest population may tolerate or resist effects of exposure to a specific pesticide active ingredient. When used consecutively for several applications, the offspring of resistant individuals multiply, and eventually establish a resistant population. Consequently, management decisions need to consider the known impacts of a pesticide on pest resistance development. In general, repeated use of any pesticide over a short period of time should be avoided

Choosing the proper pesticide in this class also requires familiarity with product labels and performance. **Always follow the label directions.** The label is the single most important document in determining the correct use of a pesticide, and state and federal pesticide laws require strict adherence to label directions. Adjuvants are substances added to pesticides to enhance their performance, and include surfactants, compatibility agents, anti-foaming agents and spray colorants (dyes), and drift control agents. They may enhance the performance of the pesticide's active ingredient and increase its efficacy. For more information on adjuvants, go to: <http://edis.ifas.ufl.edu/wg050>.

Proper records of all pesticide applications should be kept according to state and federal requirements. These records help to establish proof of proper use, facilitate the comparison of results of different applications, or find the cause of an error. Sample record keeping forms can be found at the FDACS Bureau of Compliance Monitoring at: <http://www.freshfromflorida.com/onestop/forms/13340.pdf>.

Certain pesticides are classified as Restricted Use Pesticides (RUPs). Florida Pesticide Law (Chapter 487, F.S.) requires licensed applicators to keep records of all RUP use. Pursuant to Rule 5E-9.032, F.A.C., information on RUPs must be recorded within two working days of the application and maintained for two years from the application date. There are many other important issues involving pesticide use that affect storage, calibration, mixing and loading, and spill management decisions. For additional information, contact your County Extension Agent or the Division of Agricultural Environmental Services of the Florida Department of Agriculture and Consumer Services at <http://www.flaes.org>

Before applying pesticides, citrus growers are encouraged to review recommendations in the applicable *Florida Citrus Pest Management Guide* at: <http://edis.ifas.ufl.edu/>.

Aquatic Plant Control

An over-abundance of aquatic weeds in ditches/canals can clog or restrict drainage, and can cause nutrient-rich organic sediments to be transported downstream into receiving water bodies during heavy rain events.

As aquatic weeds decompose, nutrients are easily released back into the water column by wind or wave action and remain suspended for long periods of time. These "organic particles" contribute to increased water turbidity, block light from penetrating into the water, and as a result, cause a reduction in sea grasses and other aquatic species in affected areas.

Citrus growers who are considering an aquatic plant chemical control program should carefully select herbicides based on their efficacy on target species, mode of action, non-target toxicity, and residual behavior. Remember to only apply herbicides that are registered and labeled for aquatic applications, and give consideration to chemical drift, target species habitat (submersed, emergent, or floating), and movement of herbicidal materials into non-target areas. For more information about aquatic weed

management, go to *Aquatic Weed Management in Citrus Canals and Ditches* at: <http://edis.ifas.ufl.edu/ch181>

Proper records of all pesticide applications should be kept according to state and federal requirements. These records help to establish proof of proper use, facilitate the comparison of results of different applications, or find the cause of an error. Sample record keeping forms can be found at the FDACS Bureau of Compliance Monitoring at: <http://www.doacs.state.fl.us/onestop/forms/13340.pdf>

Certain pesticides are classified as restricted use pesticides or RUPs. The Florida Pesticide Law (Chapter 487, F.S.) requires licensed applicators to keep records of all RUP use. Pursuant to Chapter 5E-2, F.A.C., information on RUPs must be recorded within two working days of the application and maintained for two years from the application date.

There are many other important issues involving pesticide use that affect storage, calibration, mixing and loading, and spill management decisions. For additional information, refer to *Best Management Practices for Agrichemicals and Farm Equipment Maintenance* at: <http://www.floridaagwaterpolicy.com/BestManagementPractices.html>

PEST MANAGEMENT BMPs

Practice IPM and use all pesticides in accordance with the label. Rinse, recycle, or dispose of empty pesticide containers following federal, state, and local regulations. When applying a pesticide close to a stream, canal, pond, or other waterbody, choose a pesticide with an active ingredient that has a lower toxicity to aquatic organisms.

7.1 PESTICIDE STORAGE AND MIXING

- ✓ 1. Store pesticides in an enclosed, roofed structure with an impervious floor and lockable door, at least 100 feet from wetlands or other waterbodies.
- ✓ 2. When practicable, construct a permanent mix/load facility with an impermeable surface, and locate it at least 100 feet from wells and/or surface waters. Where permanent facilities are not practicable, use portable mix/load stations.
- ✓ 3. When field mixing is necessary, conduct loading activities at random locations in the field, with the aid of nurse tanks if applicable. Use a check valve or air gap separation to prevent backflow into the tank when filling a sprayer.

7.2 AQUATIC PLANT MANAGEMENT

- ✓ 1. Use barriers, traps, screen devices and debris baffles to control floating aquatic weeds.

- ✓ 2. Use mechanical harvesters with slotted or cross-drilled backhoe buckets for removal of floating aquatic weeds. When removing vegetation from ditch bottoms, avoid disrupting ditch side slopes, and deposit vegetation in a appropriate upland location.
- ✓ 3. Use biological control agents that have a narrow range and host-specific predation on target weed species.
- ✓ 4. Use herbicides registered and labeled for aquatic applications, when chemical control is warranted.

References:

- 1) FDACS/FDEP, Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance Manual. <http://www.floridaagwaterpolicy.com/BestManagementPractices.html>
- 2) UF-IFAS, Integrated Pest Management Program. <http://ipm.ifas.ufl.edu/>
- 3) Southern Region Integrated Pest Management Center. <http://www.sripmc.org/>
- 4) UF-IFAS, Protecting Water Resources from Agricultural Pesticides, CIR PI-1. <http://edis.ifas.ufl.edu/PI001>

APPENDIX I

ACRONYM LIST AND GLOSSARY

Aquifer: Soil or rock formation that contains ground water and serves as a source of water that can be pumped to the surface.

Best Management Practices (BMPs): A practice or combination of practices based on research, field-testing, and expert review, to be the most effective and practicable on-location means, including economic and technological considerations, for improving water quality in agricultural and urban discharges. Best management practices for agricultural discharges shall reflect a balance between water quality improvements and agricultural productivity.

Biosolids: Solid, semisolid, or liquid residue generated during the treatment of domestic wastewater in a domestic wastewater treatment facility.

BMAP: Basin Management Action Plan

Ca: Calcium

Capacitance: The ratio of the electric charge transferred from a pair of conductors to the resulting potential difference between them.

Chelating: Process by which a molecule can form several bonds to a single metal ion.

Confining Layer: A layer of earth material, usually clay, which does not readily transmit water; thus restricting the vertical movement of water into and out of an aquifer.

CREP: Conservation Reserve Enhancement Program

CRP: Conservation Reserve Program

CSP: Conservation Security Program

CRF: Controlled Release Fertilizer

Cu: Copper

Cyanobacteria: Also known as blue-green bacteria, which produce their energy through photosynthesis. Certain Cyanobacteria produce cyanotoxins that can be toxic to animals and humans

DOF: Division of Forestry

ECP: Emergency Conservation Program

EDIS: Electronic Document Information System

EPA: Environmental Protection Agency

EQIP: Environmental Quality Incentives Program

ERP: Environmental Resource Permit

Evapotranspiration (ET): The combined loss of water through evaporation and emission of water vapor through plant leaf openings (stomata).

F.A.C.: Florida Administrative Code

FAWN: Florida Automated Weather Network

FDACS: Florida Department of Agriculture and Consumer Services

FDEP: Florida Department of Environmental Protection

FOTG: Field Office Technical Guide

F.S.: Florida Statutes

FSA: Farm Services Agency

GCGA: Gulf Citrus Growers Association

GPS: Geographical Positioning System

IPM: Integrated Pest Management

IRCL: Indian River Citrus League

Mg: Magnesium

MGD: Million Gallons Per Day

MIL: Mobile Irrigation Lab

N-P-K: Nitrogen, Phosphorus and Potassium

NOI: Notice of Intent

NRCS: Natural Resources Conservation System

Perennial Streams: Streams or rivers that flow in a well-defined channel throughout most of the year under typical climatic conditions.

Phytotoxicity: The toxic effect of a compound on plant growth. Such damage may be caused by a wide variety of compounds, including trace metals, pesticides, or salinity.

PVC: Poly Vinyl Chloride

Restricted Use Pesticides (RUPs): Pesticides registered by EPA that may only be applied by or under the direct supervision of trained and certified applicators.

Riparian: Vegetated areas along a watercourse through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent watercourse.

Sequestering Agents: A chemical compound used to tie up undesirable ions, keep them in solution, and eliminate or reduce their effects.

SFWMD: South Florida Water Management District

Sinkhole: For the purposes of this manual, a sinkhole is an opening in the ground resulting from the collapse of overlying soil, sediment, or rock into underground voids created by the dissolution of limestone or dolostone.

Spoil: The soil material obtained from excavating an area to construct such works as canals/ditches and/or ponds. This material is typically used to build berms and/or dikes along or in the vicinity of the excavation site.

SWCD: Soil and Water Conservation District

TDS: Total Dissolved Solids

TMDL: Total Maximum Daily Load

UF-IFAS: University of Florida, Institute of Food and Agricultural Sciences

Uncoated sands: Sand particles that lack clay and organic matter coating, and have poor water and nutrient holding capacities.

USGS: United States Geological Survey

Vegetated Buffer: An area covered with vegetation suitable for nutrient uptake and soil stabilization, located between a production area and a receiving water or wetland.

Watershed: Drainage basin or region of land where water drains downhill into a specified body of water.

Wetlands: As defined in section 373.019(25), F.S., wetlands means those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soils. Soils present in wetlands generally are classified as hydric or alluvial, or possess characteristics that are associated with reducing soil conditions. The prevalent vegetation in wetlands generally consists of facultative or obligate hydrophytic macrophytes that are typically adapted to areas having soil conditions described above.

WHIP: Wildlife Habitat Incentives Program

WMDs: Water Management Districts

WRP: Wetland Reserve Program

APPENDIX 2

ADDITIONAL BMP REFERENCES

Draft 4.27.11

APPENDIX 3

SOIL AND TISSUE TESTING INFORMATION

Soil Testing

The soil testing process comprises four major steps, and understanding each one clearly will increase the reliability of the process tremendously. The steps in the soil testing process are:

- soil sampling
- sample analysis
- interpretation of test results
- nutrient recommendations

Soil Sampling: Soil samples need to be representative of the field and soil types and the soil analysis results will be only as good as the submitted sample is. Samples collected from areas that differ from typical characteristics of the farm should be submitted separately and should not be consolidated with the primary samples. Using a management zone (area on the farm that is managed similarly) as a guiding factor to collect and consolidate samples is strongly recommended to optimize resources. Consult the IFAS Extension Fact Sheet SL181 for further information on soil sampling strategies and/or to obtain the appropriate soil test sheet which can be found at: <http://soilslab.ifas.ufl.edu/ESTL%20Tests.asp>

Sample Analysis: The soil samples that are submitted to the testing laboratories undergo a series of physical and chemical processes that are specific to the soil types, crops, and management regimes. Once the soil samples are homogenized through grinding and/or sieving, a precise volume of the sample will be extracted for plant nutrient through an extraction procedure. The following standard methods are followed at the IFAS Soil Testing Laboratories for different soils in Florida:

- a) Mehlich-1 extraction - this method is performed on all acid-mineral soils up to a soil pH of 7.3.
- b) AB-DTPA extraction – this method is performed on alkaline (calcareous) soils with a pH of 7.4 and above.
- c) Water extraction - this method is used for extraction of P in all organic soils.
- d) Acetic acid extraction - this method is performed on all organic soils for extraction of K, Mg, Ca, Si, and Na.

It is extremely important that procedures used at the laboratories are well understood before submitting the samples since most BMPs are tied to the standardized procedures used by the labs at the land-grant universities in the state such as UF/IFAS. Similarly, it is also very important to note that the IFAS laboratory does not offer any test for N since there is no reliable test for plant available N under Florida conditions. N recommendations are based on crop nutrient requirements found in the research

literature. More information regarding the procedures used at the IFAS Extension Soil Testing Laboratory in Gainesville can be found in the extension publication, Circular 1248.

Interpretation of Test Results: The primary goal of state laboratories in offering the soil testing service is to provide interpretation of the soil test results based on soil test-crop response trials and field calibration of the test results with the optimum economic yields of the various plant species. Economic yield increases resulting from added nutrients cannot be obtained once the test results are interpreted as 'High' resulting in no recommendation for that particular nutrient. The interpretations provided are specific to the soil and plant species. Current interpretation tables can be obtained from SL 189 - IFAS extension fact sheet.

Nutrient Recommendations: To reiterate, nutrient recommendations based on soil test results are formulated based on the optimum economic crop response to an added nutrient to the soil.

Tissue Testing

Tissue testing is the analysis and diagnosis of the plant's nutritional status based on its chemical composition. It is commonly performed as analyses on dried blades, leaves or dried *petioles* or on sap from fresh petioles, with results compared to recommended nutrient ranges.

Efficient fertilizer management is important to reduce costs, conserve natural resources, and to minimize potential impacts on the environment. These goals can be achieved through optimum management of the fertilizer component. Timely tissue testing is an important tool used in fertilizer management through monitoring the plant's nutritional status, and such testing is also used in diagnosing suspected problems like nutritional deficiency, toxicity or imbalance. As a management tool, tissue testing can increase your return by preventing deficiencies that can reduce yield(s), market quality, and profitability.

Methodology: Begin sampling soon after the crop is established and continue at regular intervals (weekly or biweekly). Individual plants, even side-by-side, may have different nutritional status. Therefore, by sampling a sufficiently large number of plants, the effect of this error due to inherent variability should be minimized. It is preferable to include a soil sample together with a tissue sample when submitting samples to a diagnostic lab, since the soil sample may indicate other factors - such as pH - that may influence crop growth, nutrient availability, and uptake. Avoid plant tissue testing if the field has received foliar nutrient sprays containing micronutrients or nutrient-containing pesticides. Also, avoid sampling plants damaged by pests, diseases, or other chemicals when trying to monitor the nutritional status of the sod.

Whole-leaf sampling will be most useful early in the season, while later in the season, it can help to point to changes in fertilization practices that are needed for the next season. Fresh petiole sap testing for N and K, practiced regularly throughout the

season, can help manage the current crop as well as provide guidance for the next crop. Sample a recently matured leaf blade. Collect enough leaf material so that the sample is representative of the crop stand, and that the sample is large enough to perform the required analyses.

If a deficiency is suspected, collect one *composite sample* from the area exhibiting the disorder and a second sample from an otherwise “normal” section for comparison when trying to diagnose a nutrient deficiency. Separate and properly label the “disorder” sample and the “normal” sample in order to make a valid comparison after analyses. Keep notes on condition of the sod and stage of growth, weather, and other variables for future reference.

Be careful not to crush or damage samples during cleansing. Avoid using tap water to rinse blade samples, since it can be high in nutrients such as calcium, iron, magnesium, or sulfate sulfur. Use distilled water instead. In most situations, cleansing is not needed. Blot the samples dry with absorbent paper after rinsing, and air-dry the samples several hours before shipment. Wrap the samples in absorbent paper and place them in a large envelope if a plant analysis kit is not available, and mail immediately.

Select a reputable laboratory that provides interpretations and recommendations based upon test results, which are appropriate for your growing region. Interpretation guidelines should be based on actual field research, not on “typically observed” or historical lab databases. The laboratory should be reliable and accredited and also offer a routine turnaround of less than 48 hours.

For more information please see SL 131, Plant Tissue Information Sheet, Soil and Water Science Department, at: <http://edis.ifas.ufl.edu/SS182>.

REFERENCES:

- 1) Sartain, J.B. 2001. Soil Testing and Interpretation for Florida Turfgrasses. SL181. Soil and Water Science, Cooperative Extension Service. IFAS, p. 2. <http://edis.ifas.ufl.edu/SS317>.
- 2) Mylavarapu, R.S. and E.D. Kennelley. 2002. UF/IFAS Extension Soil Testing Laboratory Analytical Procedures and Training Manual. Soil and Water Science, Circular 1248, Cooperative Extension Service, IFAS, <http://edis.ifas.ufl.edu/SS312>.
- 3) Mylavarapu, R.S. 2002. The Process of Standardized Nutrient Recommendation Development for Successful Crop Production and Environmental Protection. SL 189, Soil and Water Science, Cooperative Extension Service, IFAS. <http://edis.ifas.ufl.edu/SS401>.

APPENDIX 4

INCENTIVE PROGRAMS FOR QUALIFYING OPERATIONS

The implementation of Best Management Practices can reduce non-point sources of pollution, conserve valuable soil and water resources, and improve water quality. The implementation of these management practices can also be expensive and, in some cases, may not be economically feasible for agricultural producers. To reduce the financial burden associated with the implementation of selected practices, several voluntary cost-share programs have been established. These programs are designed to conserve soil and water resources and improve water quality in receiving watercourse. The narrative below is intended to provide basic information regarding the primary federal, state, and regional cost-share programs. Sources of additional information have also been included, and growers are encouraged to contact the identified agencies or organizations for current information about each program.

I. Programs Administered by USDA - Farm Services Agency (FSA)

Conservation Reserve Program (CRP): This program encourages producers to convert highly erodible cropland or other environmentally sensitive lands to vegetative cover including grasses and/or trees. This land use conversion is designed to improve sediment control and provide additional wildlife habitat. Program participants receive annual rental payments for the term of the contract in addition to cost share payments for the establishment of vegetative cover. CRP generally applies to highly erodible lands and is more applicable to North Florida.

Conservation Reserve Enhancement Program (CREP): CREP uses a combination of federal and state resources to address agricultural resource problems in specific geographic regions. This program (which is not limited to highly erodible lands) is designed to improve water quality, minimize erosion, and improve wildlife habitat in geographic regions that have been adversely impacted by agricultural activities.

Emergency Conservation Program (ECP): The ECP provides financial assistance to producers and operators for the restoration of lands on which normal agricultural operations have been impeded by natural disasters. More specifically, ECP funds are available for restoring permanent fences, terraces, diversions, irrigation systems, and other conservation installations. The program also provides funds for emergency water conservation measures during periods of severe drought.

For further information on CRP and CREP, including eligibility criteria, please contact your local USDA Service Center. Information is also available on the Internet at www.fsa.usda.gov.

II. Programs Administered by NRCS

Conservation Plans

Conservation planning is a natural resource problem-solving and management process, with the goal of sustaining natural resources. Conservation Plans include strategies to maintain or improve yields, while also protecting soil, water, air, plant, animal, and human resources. They are particularly well-suited to livestock operations and farming operations that produce multiple commodities.

Conservation Plans are developed in accordance with the NRCS FOTG. Because not all the specific BMPs in this manual may be contained in the FOTG, Conservation Plans developed under this manual must also include the applicable Level I and II BMPs. Assistance in developing a plan can be obtained through the local Soil and Water Conservation District (SWCD), the NRCS, the Cooperative Extension Service, and private consultants who function as technical service providers. However, the decisions included in the Conservation Plan are the responsibility of the owner or manager of the farm. Conservation Plans are usually required to receive cost share for any of the programs described below.

Environmental Quality Incentives Program (EQIP): EQIP provides financial assistance for the implementation of selected management practices. Eligibility for the program requires that the farm have a NRCS approved conservation plan. Practices eligible for EQIP cost share are designed to improve and maintain the health of natural resources and include cross-fences, water control structures, brush management, prescribed burning, nutrient management and other erosion control measures.

Conservation Security Program (CSP): CSP is a voluntary conservation program that supports ongoing stewardship on private lands. It rewards farmers and operators who are meeting the highest standards of conservation and environmental management. Its mission is to promote the conservation and improvement of soil, water, air, energy, plant and animal life.

Wetlands Reserve Program (WRP): WRP is a voluntary program designed to restore wetlands. Program participants can establish easements (30-year or perpetual) or enter into restoration cost-share agreements. In exchange for establishing a permanent easement, the landowner usually receives payment up to the agricultural value of the land and 100 percent of the wetland restoration cost. Under the 30-year easement, land and restoration payments are generally reduced to 75 percent of the perpetual easement amounts. In exchange for the payments received, landowners agree to land use limitations and agree to provide wetland restoration and protection.

Wildlife Habit Incentives Program (WHIP): The Wildlife Habitat Incentives Program provides financial incentives for the development of fish and wildlife habitat on private lands. Program eligibility requires that landowners develop and implement a Wildlife

Habitat Development Plan. Participants enter multiyear (5 to 10 year) agreements with NRCS.

For further information on these programs, including eligibility criteria, please contact your local USDA Service Center. Information is also available on the Internet at the following web site: www.nrcs.usda.gov

III. Programs Administered by State and Regional Entities

Office of Agricultural Water Policy: In order to assist agricultural producers in the implementation of BMPs, the Florida Department of Agriculture and Consumer Services/Office of Agricultural Water Policy contracts with several of the state's Soil and Water Conservation Districts and Resource Conservation and Development Councils to provide cost share, as funding is available.

Water Management District Cost-Share Programs: Some of the WMDs may have agricultural cost-share programs in place for eligible producers.

IV. Payment for Services Programs

Water Farming: Water farming is the utilization of fallow/out of production lands to store water, attenuate nutrients, manage stormwater as an alternative water supply, and improve overall water quality. Pilot projects are under way in the St. Lucie and Caloosahatchee estuaries to determine the overall feasibility of the water farming concept. These projects will provide information to compare environmental benefits gained to the estimated costs of on-site construction, infrastructure improvements, environmental assessments, and facility maintenance. Potentially, landowners could sell stored water to public or private entities, or otherwise receive payment for the environmental benefits of water farming.

These projects are being conducted by cooperative agreement between the SFWMD, Indian River Citrus League (IRCL), and Gulf Citrus Growers Association (GCGA). Under the agreement, the IRCL and GCG each will use guidelines developed jointly with the SFWMD to select a "typical" citrus grove on which to gather scientific and engineering data and other information to determine the costs/benefits of water farming. This portion of the pilot project will be considered *Phase I Information Gathering*, which is necessary to support *Phase II Project Implementation*. The pilot projects will take about 3 to 4 years to complete. You can check for updates to the status of these pilot projects by visiting [\[REDACTED\]](#).

For further information on these programs, including eligibility criteria, please contact your soil and water conservation district, your WMD, or FDACS. Information and links to other sites are also available on the Internet at the following web site: www.floridaagwaterpolicy.com

APPENDIX 5

CHEMIGATION/FERTIGATION STATUTORY REFERENCES

487.064 Antisiphon requirements for irrigation systems.

(1) Any irrigation system used for the application of pesticides must be equipped with an antisiphon device adequate to protect against contamination of the water supply. The requirements of this section shall also apply to water supply lines to pesticide mixing-loading equipment other than those systems which incorporate a physical gap between the water source and the application equipment.

(2) It is unlawful for any person to apply chemicals through an irrigation system which is not equipped with an antisiphon device as required by this section, or to mix and load pesticides for application unless there is a physical gap or its equivalent between the line from the water source and the application equipment.

(3) The department may establish by rule specific requirements for antisiphon devices and for sites where pesticide mixing-loading occurs.

(4) Any governmental agency which requires antisiphon devices on irrigation systems used for the application of chemicals shall use the specific antisiphon device requirements adopted by the department.

576.087 Antisiphon requirements for irrigation systems.

(1) Any irrigation system used for the application of fertilizer must be equipped with an antisiphon device adequate to protect against contamination of the water supply.

(2) It is unlawful for any person to apply fertilizer through an irrigation system which is not equipped with an antisiphon device as required by this section.

(3) The department shall establish specific requirements for antisiphon devices.

(4) Any governmental agency which requires antisiphon devices on irrigation systems used for the application of fertilizer shall use the specific antisiphon device requirements adopted by the department.

NOTE: THE FDACS BUREAU OF COMPLIANCE MONITORING IS RESPONSIBLE FOR ANTISIPHON REQUIREMENTS. GO TO THEIR WEBSITE FOR MORE INFORMATION AT:

[HTTP://WWW.FLAES.ORG/COMPLIMONITORING/INDEX.HTML](http://www.flaes.org/complimonitoring/index.html)

APPENDIX 6

EXAMPLE RECORD-KEEPING FORMS

Record keeping aids in operating and maintaining BMPs. The following record keeping is required:

- 2.2.1** Base P fertilization rate on soil and leaf tissue tests results from a lab that uses a standard testing method used by UF/IFAS Extension Soils Testing Laboratory. Keep a copy of all laboratory test results to track changes over time.
- 2.2.3** Use leaf tissue test results to determine the need for and appropriate rates of supplemental fertilizer applications, and to diagnose the effectiveness of N, K, and micronutrient fertilization programs. Keep a copy of all laboratory test results.
- 2.2.4** Keep records of all nutrient applications. Include, at a minimum: date of application, total amount applied, acreage covered, fertilizer analysis or grade, rate per acre, and application method.
- 3.2.6** Maintain a record-keeping system for inspection and maintenance of all irrigation system components. Records should be compared over time for any changes that would indicate problems with the system.
- 6.4.5** Maintain records of new well construction and modifications to existing wells.

The tables below serve as a set of templates to develop your own record-keeping system. You may maintain your records as hard copies or in an electronic format, depending on your preference. You may use these tables, develop your own, or choose commercially available record-keeping software suited to your commodity.

Soil Sample Records (Retain all Lab Results)

SAMPLE DATE	FIELD LOCATION	# OF SAMPLES	NAME OF LAB	RECORDS LOCATION

Tissue Sample Records (Retain all Lab Results)

SAMPLE DATE	FIELD LOCATION	# OF SAMPLES	NAME OF LAB	RECORDS LOCATION

Fertilization/Nutrient Records (Retain all Receipts)

DATE	LOCATION	ACREAGE COVERED	TYPE ¹	FORMULATION ²	GRADE ³	RATE (LBS/ACRE)

Irrigation Maintenance

DATE	LOCATION	LAST INSPECTED	MOTOR VALUES ⁴	WITHDRAW RATE (GPM)	PUMP VALUES ⁵	CURRENT SYSTEM EFFICIENCY ⁶	IRRIGATION LINES CONDITION

Rainfall (in.)

JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.

Well Records

LOCATION	YEAR CONSTRUCTED	CONSTRUCTED BY	LAST MODIFIED	MODIFIED BY	RECORDS LOCATION

¹ Organic, Inorganic, Chemical
² Granular, Water Soluble, etc.
³ e.g. 10-10-10
⁴ Energy Consumption (Kwh) and Motor Amperage (Amps)
⁵ Discharge Rate (GPM) and PSI (lb/in²)
⁶ Ratio, Source Withdraw vs. Crop Available (V₁:V₂)

APPENDIX 7

CONTACT INFORMATION

EMERGENCY INFORMATION

Emergency Reporting Numbers

State Warning Point

Division of Emergency Management - contact in case of oil or hazardous substance spill	24 hours/ Toll-Free	1-800-320-0519
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Emergency Information and Follow-Up Numbers

	Monday – Friday	
State Warning Point Information Line	8:00 am - 5:00 pm	(850)413-9900
DEP Emergency Response	8:00 am - 5:00 pm	(850)245-2010
State Emergency Response Commission	Toll-Free	1-800-635-7179
For follow-up reporting only.		

NON-EMERGENCY INFORMATION

Florida State Agency Numbers

Toll Free

Department of Agriculture and Consumer Services www.freshfromflorida.com

Office of Agricultural Water Policy	(850) 617-1727
Division of Agricultural and Environmental Services	(850) 488-3731
Bureau of Pesticides	(850) 487-0532
Bureau of Compliance Monitoring	(850) 488-8731

Department of Environmental Protection www.dep.state.fl.us

Non-point Source Management Section	(850) 245-7508
Hazardous Waste Management Section	(850) 245-8707
Northwest District Office (Pensacola)	(850) 595-8300
Northeast District Office (Jacksonville)	(904) 807-3300
Central District Office (Orlando)	(407) 894-7555
Southeast District Office (West Palm)	(561) 681-6600
Southwest District Office (Tampa)	(813) 632-7600
South District Office (Ft. Myers)	(941) 332-6975

Water Management Districts www.flwaterpermits.com

Northwest Florida (Tallahassee)	(850) 539-5999	
Suwannee River (Live Oak)	(386) 362-1001	1-800-226-1066
St. John's River (Palatka)	(904) 329-4500	1-800-451-7106
Southwest Florida (Brooksville)	(352) 796-7211	1-800-423-1476
South Florida (West Palm)	(561) 686-8800	1-800-432-2045

Other Helpful Numbers - Main offices

NRCS - Florida Office (Gainesville)	(352) 338-9500
UF/IFAS Extension Administration	(352) 392-1761
Association of Florida Conservation Districts	(407) 321-8212
Soil and Water Conservation Districts	(321) 241-5200
Florida Fruit and Vegetable Association	(321) 241-5200

APPENDIX 8

RULE 5M-_____

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APPENDIX 9

NOTICE OF INTENT AND BMP CHECKLIST

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