SUSTAINABLE WATER PRACTICES IN EVERGLADES AGRICULTURE

October 18, 2012

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Senior Director of Corporate Communications and Public Affairs
WATER SUSTAINABILITY

• Water Supply
  – Rainfall and natural system
  – Lake Okeechobee and managed system
• Water Quality
  – On-Farm BMP program
  – STAs & Regional treatment
• Water Conservation
  – Sugar farms (sub-surface irrigation) & factory
  – Citrus groves (micro-jet irrigation) & factory
• Competitive Interests
  – Urban water use
  – Agricultural water use
  – Natural resources water needs
  – Solutions
• Sugarcane is Florida's most valuable row crop -- $3.1 billion annually, produced on approximately 400,000 acres.

• Approximately 80% of Florida sugarcane is grown on organic “muck” soils (histosols) south of Lake Okeechobee that comprise the Everglades Agricultural Area (EAA).

• These soils are fertile, highly productive and have relatively high water and nutrient holding capacities.

• Approximately 20% of sugarcane in Florida is grown on sandy soils bordering the EAA (lower yields, poor water & nutrient holding capacity)
Because the EAA is dedicated to farming and not paved development, its unconfined aquifer system is recharged every time it rains-- effectively storing water for the system.
WATER SUPPLY

• Rainfall is the primary water supply for sugarcane
• S. Florida averages 55” of rain each year, most of it during the summer growing season (June-Nov)
• Lake Okeechobee = back-up water supply for agriculture & South Florida East coast urban areas in dry season (Nov-May)
• Dry season coincides with sugarcane harvest season
• Adjusting shallow water table below crops
• Florida sugarcane growers irrigate and drain their fields by sub-irrigation (seepage irrigation) and open ditch drainage. Sub-irrigation is defined as supplying water to the crop root zones by controlling the water table
• South Florida lends itself to water table management because of its flat land, relatively high soil hydraulic conductivity underlain by a restrictive layer, and large quantities of available water.
• Each individual grower must have both a surface water management permit and a consumptive use permit --processed by the South Florida Water Management District and the Florida Department of Environmental Regulation.
• The pump stations are generally made up of one or more low head, high capacity pumps, capable of moving water at over 20,000 gallons per minute with lifts between 3 and 5 feet.
• The most common type of pump in use is the axial flow propeller pump.
• Enough water to grow crop (varies by crop & rainfall)
• Rainfall plus back-up irrigation water from Lake Okeechobee
• Ability to drain excess storm water during heavy rain events
• Drought (on farms, Lake O and system-wide)
• Heavy investment in weather prediction/reporting services
• Built largest private Wi-Fi system across 180,000 acres to provide real time information and record farm data
• Front End Planning -- SFWMD permits
  – Consumptive use
  – Drainage and flood control to discharge excess water to save the crop (never 100% effective)
  – Monitor Lake Okeechobee levels, USACOE & District actions (currently releasing water to tide)
**SOIL TYPE IMPACTS WATER REQUIREMENTS**

**Calculations of Irrigation Requirements**

<table>
<thead>
<tr>
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<tr>
<td>RAINFALL STATION: Clewiston</td>
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<td>IRRIGATION SYSTEM: S.A.A. Flood/Gorge</td>
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<tr>
<td>PARCEL ACREAGE: 2.372</td>
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<td>LAND USE: Agricultural</td>
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<td>SOIL TYPE: CLEWISTON SANDY</td>
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<td>PARCEL NAME: CLEWISTON SANDY</td>
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<td>NR, MULTIPLIER: 1.33</td>
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**MEAN RAINFALL**

**IRRIGATION TRANSPIRATION**

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**AVG. EFFECTIVE RAIN**

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**DROUGHT RAINFALL**

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**AVERAGE ENSUATION**

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<td>2.47</td>
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**ANNUAL SUPPLEMENTAL CROP WATER USE**

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<th>TOTAL</th>
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<td>31.85</td>
<td>2.372 AC X 1.33 X 0.02715 MCG/IN =</td>
<td>2,725.06 MG</td>
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**MAXIMUM MONTHLY SUPPLEMENTAL CROP WATER USE**

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<tr>
<td>4.13</td>
<td>2.372 AC X 1.33 X 0.02715 MCG/IN =</td>
<td>363.74 MG</td>
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**TOTAL ANNUAL DEMAND**

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**TOTAL MAXIMUM MONTHLY DEMAND**

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<td>4,132.60 MG</td>
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**CLEWISTON SANDY SOILS**

**EFF. AVG. RAINF. 23.30” OR 46%**

**IRRIG. 27.90” or 54%**

**Page 3 of 3**

Exhibit No: 6
• US Sugar has 95 different water permits (water use, surface water, BMP and others)
• US Sugar has 700 pumps & wells
• Sugarcane drainage pumps go from 10,000 GPM to 60,000 GPM--average 25,000 GPM
• During rain events, our 160,000 acres store water, assisting w/ flood control outside the EAA
• SFWMD S-5A has six pumps –at 360,000 gallons per minute for a total capacity of 2.16 million GPM
The Transformation of South Florida through the Construction of the Water Management System

How did we go from this
TO THIS?

- Hamilton Disston (1880s)
- Napoleon Broward (1905)
- The C & SF Project (1947-1960s)
- Lake Okeechobee boundaries artificially pushed back 1/3 of its original size
- Lake O levels lowered from 20 ft to 15.5 ft
- 3 million acre-feet rainfall annually drained to tide
EAA AND PHOSPHORUS

• EAA basin and its muck soils are rich in naturally occurring phosphorus (P)
• Sugarcane fertilization is not the cause of elevated P in the Everglades
• Historically, P levels in EAA muck soils ranged from 800,000 to 3 million parts per billion (ppb)
• Everglades peat/muck resulted primarily from saw grass decomposition and sediment from Lake Okeechobee (90%+ organic matter)
EVERGLADES CLEAN-UP

• 1994 Everglades Forever Act
• EAA Farmers required to pay $25/acre “Agricultural Privilege Tax”
• Farmers also must implement a series of Best Management Practices (BMPs) on farm to reduce phosphorus levels by 25%
• CERP (Comprehensive Everglades Restoration Plan)
• State and local restoration projects
• Farmers fund additional research
WHAT IS A BMP?

- BMPs are farming methods (new soil and water management techniques) that protect plant growth and minimize adverse environmental effects (reduce phosphorus).
- Different crops, different soil types, and different geology throughout the EAA make it impossible for a “one size fits all” BMP regime.
- Farmers and USDA/UF-IFAS funded researching on water use and nutrient issues in the EAA.
- Florida Department of Agriculture- Oversees BMP program for rest of Florida (Caloosahatchee & St. Lucie basins soon to be regulated under these type programs).
- EAA BMP program is being used as a model for other farming areas, urban run-off.
EAA FARM PHOSPHORUS LOADS

- P LOAD = DRAINAGE VOLUME X P CONCENTRATION
- Concentration of P in farm drainage water
  - Primarily due to soil oxidation (subsidence)
  - Fertilizer application
  - Irrigation quality
- Volume of drainage water pumped off-farm
  - Rainfall: amount and distribution
  - Drainage needs of crop
  - Irrigation quantity
  - Seepage into and off farm
- **BMPs → reduce volume and/or concentration**
- **BMP: must be an economically viable practice**
EAA Runoff vs. Lake Okeechobee Irrigation TP Concentrations (ppb)

Lake Okeechobee Irrigation

EAA FARM RUNOFF

6 Hurricanes
LAKE OKEECHOBEE – IN FLOWS & OUT FLOWS

10/10/2012
# EAA BEST MANAGEMENT PRACTICES – “MENU” (25 PTS)

<table>
<thead>
<tr>
<th>BMP</th>
<th>PTS</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td><strong>NUTRIENT CONTROL: MINIMIZE MOVEMENT OF NUTRIENTS OFF-SITE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrient Application Control</td>
<td>2½</td>
<td>Controlled application of nutrients; banding, controlled application</td>
</tr>
<tr>
<td>Nutrient Spill Prevention</td>
<td>2½</td>
<td>Formal spill protocols: storage, handling, transfer, and education/instruction</td>
</tr>
<tr>
<td>Rotational Vegetable Planting</td>
<td>2½</td>
<td>Rotation planting of high P/low P demand crops to avoid P build up</td>
</tr>
<tr>
<td>Plant Tissue Analysis</td>
<td>2½</td>
<td>Determines plant nutrient requirements via tissue testing</td>
</tr>
<tr>
<td>Soil Test Based Fertilization</td>
<td>5</td>
<td>Determine soil P requirements and follow standard recommendations</td>
</tr>
<tr>
<td>Split Nutrient Application</td>
<td>5</td>
<td>Applying split P without exceeding total recommendation</td>
</tr>
<tr>
<td>Slow Release P Fertilizer</td>
<td>5</td>
<td>Specially treated fertilizer</td>
</tr>
<tr>
<td>Reduced P Fertilization</td>
<td>5</td>
<td>P application rate is at least 30% below recommendation</td>
</tr>
<tr>
<td><strong>WATER MANAGEMENT: MINIMIZE THE VOLUME OF OFF-SITE DRAINAGE DISCHARGE</strong></td>
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<tr>
<td>½ Inch Detained</td>
<td>5</td>
<td>Delay discharge: based on measuring daily rain events using a rain gauge</td>
</tr>
<tr>
<td>1 Inch Detained</td>
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<td>Delay discharge: based on measuring daily rain events using a rain gauge</td>
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<tr>
<td>Improved Infrastructure</td>
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<td>Re-circulate water; fallow field flood; increase water detention</td>
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<tr>
<td>Water Table Management</td>
<td>5</td>
<td>Optimizing drainage and irrigation schedules to decrease discharge</td>
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<tr>
<td><strong>PP AND SEDIMENTS: MINIMIZE MOVEMENT OF PARTICULAT MATTER AND CANAL SEDIMENTS</strong></td>
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<tr>
<td>Any 2</td>
<td>2½</td>
<td></td>
</tr>
<tr>
<td>Any 4</td>
<td>5</td>
<td>Leveling fields</td>
</tr>
<tr>
<td>Any 6</td>
<td>10</td>
<td>Slow drainage velocity near pumps</td>
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<tr>
<td>Any 8</td>
<td>15</td>
<td>Grassed swales/field ditch connections</td>
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<td>Barriers at discharge locations</td>
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<td>Ditch bank stabilization</td>
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<td>Sediment sump/trap in canals</td>
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<td>Soil stabilization through infrastructure improvements</td>
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<td>Cover crops</td>
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<td></td>
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<td>Culvert bottoms above ditch bottoms</td>
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<td>Vegetated ditch banks</td>
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<tr>
<td>Other BMPs</td>
<td>TBD</td>
<td>BMPs proposed by permittee and accepted by SFWMD</td>
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WATER QUALITY MONITORING

• Every time farmers run irrigation/drainage pumps, automatic water quality devices take samples

• Every pump must have farm-provided electronic water quality monitoring equipment
**EXAMPLE:**
**SUGARCANE FARM - DEEP SOIL**

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<th>BMP</th>
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<td>1” Rainfall detention</td>
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<td>Controlled fertilizer application</td>
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<td>Fertilizer spill prevention</td>
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<td>Level fields</td>
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<tr>
<td>Field ditch sumps</td>
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<tr>
<td>Canal cleaning</td>
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<td>Cover crops</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
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SEDIMENT CONTROL

Canal cleaning removes nutrient rich soil from waterways and returns it to the farms.

Vegetation (weeds) reduces wind-blown soil in canals.
Laser leveling fields greatly reduces erosion of soils into canals and waterways.
Delay discharge: based on measuring daily rain events using a rain gauge
Aquatic weed control

Slow drainage velocity near pumps

Sediment sump/trap in canals/pump infrastructure improvements
BMP RESULTS – 71% Reduction in 2012—55% Average Reduction

Phosphorus Reduction by Sugar Farmers in the Everglades Agricultural Area

Data Source: SFWMD
BMP PROGRAM CONCLUSIONS

Results of 100% participation by EAA growers:

- Prevented >2500 metric tons of P from potentially entering the Everglades Protection Areas since 1995
- The EAA basin achieved a 71% reduction P load reduction in WY2012
- 17-year average ~55% reduction in P load

Efforts to improve BMP performance and implementation through research and training programs continue.

The success of the EAA BMP program is the result of a group effort; all involved need to continue to be diligent and conscientious implementing BMPs.
ON-FARM BEST MANAGEMENT PRACTICES (BMPs) + STORMWATER TREATMENT AREAS (STAS) = \( P < 10 \) ppb IN FLORIDA EVERGLADES
EAA farms are net water generators
- Use approximately 1 foot of water off Lake O per year (450,000 acre-ft)
- For every 1 gallon of irrigation water from Lake O, EAA farms we release 3 gallons of water downstream
- EAA water footprint is a net positive for South Florida water balance

Sub-surface irrigation
- Reduced water use vs. spraying & other overhead irrigation
- Reduced labor inputs
- Improved fertilizer efficiency & plant quality and more uniform crop growth
- Does not expose additional water to evaporation
- Allows plant root system to use water efficiently

Citrus uses efficient micro-jet irrigation
- Conserves water
- Delivers water directly to root zone
WATER CONSERVATION

• Researching drought-resistant cane varieties
• Every drop of water leaving EAA farms is measured for quality & quantity
• Irrigation or water release decisions based on experience, data, and crop needs rather than apparent field conditions
• Arcadia Biosciences Project
  – Research on more water & nitrogen-use efficient sugarcane and citrus
  – Reduces overall crop water use w/out impacting production
  – Goal, more production per gallon of water used
  – Reduces the demand for water in irrigated agriculture to help ease strain on water supplies and competing uses
WATER CONSERVATION—FACTORIES

• State-of-the-art, fully integrated sugarcane processing and sugar refining operations, nation’s newest & most efficient citrus processing facility
• Sugar manufacturing operations powered by cane fiber—bagasse—a clean, green, renewable energy source
• One ton of bagasse displaces 42 gallons of fuel (one barrel)
• Co-Generation into electricity, surplus electricity sales
• Water recovered from sugarcane & citrus & re-used in process
  – Sugarcane process recovers & re-uses 330 million gallons
  – Citrus processing recovers 20-40 million gallons, uses, treats, irrigates nearby groves
• State-of-the-Art Emission Controls
• Energy and water conservation measures
• Zero water discharge from sugar processing facilities
• On-site water treatment facility and water re-use
• Mud captured and used to replace fertilizer on sandy soils
• Closed loop—no waste products (every part of the cane/citrus that comes in goes out as a marketable product (sugar, molasses, energy, soil supplement, by-products, cattle feed)
We provide more water to system than we take in
Water leaving farms is cleaner than water we receive
Farm lands are better for water storage and management than paved development
We measure the quantity & quality of water leaving the farms, record the pumping rate and duration of pumping
Our farms, canals, ditches, wetland areas, etc. support a diverse and rich wildlife population
Farms contain wetland areas managed carefully for wild life & water
COMpetitive Interests

• Agricultural water use (producing food & fiber)

• Urban water use
  – Nearly 8 million people today
  – >15 million in next 50 years
  – 50% of all potable water = urban outdoor watering

• Natural resource water needs
SOLUTIONS

• Increase water conservation among all users
• Increase water storage (thus enlarging water pie to prevent competition)
  – Lake Okeechobee—dike repair will allow more storage
  – agriculture vs. people
  – agriculture vs. natural resources
  – people vs. natural resources
• Work cooperatively to educate, balance all interests
• Share lessons learned with each other
STAKEHOLDER ENGAGEMENT

- Professional conferences like NAEM Forum
- Participation in regional water management, water supply groups
- Scientists and staff at SFWMD
- Researchers, universities
- Policy makers at local, state, and national levels
- Environmental organizations
- General public, schools, educators
- Farming community
- Urban and suburban residents
- Media