A System Within a System: Operating the System

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C&SF PROJECT for Flood Control & Other Purposes

USACE – Federal Project

Specified Operational Criteria

SFWMD Local Sponsor

SFWMD O&M Implementation

Operations

Field Stations

Flood Control

Protection of Fish and Wildlife

Water Supply

Navigation
“ORIGINAL” C&SF SYSTEM

300 Water Control Structures

200 Operable Structures
25 Pump Stations
75 Culverts and weirs
1000+ Project Culverts

Estimate of pre-2000 numbers
HISTORIC FLOOD CONTROL OPERATIONS – Example S5A into WCA-1

FLOOD CONTROL: When it rained a pump station was turned on or a spillway gate was opened. There was less need for coordination during an event because the criteria was relatively simple.
TODAY’s COMPLEX MULTI-PURPOSE WATER MANAGEMENT OPERATIONS – Example S5A into STA 1W or STA 1E or to Tide via C51

FACTORS AFFECTING OPERATING DECISIONS:

Stormwater Treatment Areas:
- How deep can the water be?
- How fast can the water be allowed to move through the cell?
- Is there any species of concern that would limit flow (Black neck stilts)?
- Are there STA cells offline for maintenance?
- Is treatment capacity available?
- What is the likelihood of a diversion?
- Any special permit issues?

Other Factors:
- Flood potential for EAA & western C-51
- Does eastern C-51 have capacity?
- L-8 Reservoir diversion/discharge
- Lake Okeechobee releases
- City of West Palm Beach & 298 District operations
- Has the proper agency coordination been made?
- All parties notified?
- etc
653 Major Water Control Structures

- 411 Gated Culverts
- 110 Gated Spillways
- 66 Pump Stations
- 17 Locks
- 49 Weirs
- 2,669 miles of Canals
- Berms and Levees

322 of these are in STAs
Infrastructure Growth 1996 - 2009

- STRUCTURES
- MILES CANALS
- PUMP STATIONS

- Infrastructure Growth
- 1996 - 2009
- Graph showing growth in structures, miles canals, and pump stations from 1996 to 2009.
2010 C&SF PROJECT “Complexities”

- Hydrometeorological Variability
- Field Sensors
- SCADA Reliability & Security
- SFWMD Operations Control Center
- Water Supply
- Water Quality
- Navigation
- Recreation
- Socio-Economic Issues
- H&H Modeling Performance Measures
- Infrastructure Maintenance
- Operational Criteria
- Field Stations
- Flood Control
- Natural Systems
- Threatened & Endangered Species
- Inter Agency Coordination
- Field Observations
Seasonal Variation of South Florida Rainfall

Average Monthly Rainfall 1965-1995

- **Dry**
- **Wet**

Approximate Pan Evaporation

Average Monthly Rainfall 1965-1995
Rainfall above and below the average annual of 52 inches
Hydraulic Gradient Based on Historical Average Stage

Distance in miles (Lake Tohopekaliga to Florida Bay)

Water surface elevation (ft. NGVD)

Lake Tohopekaliga
Lake Kissimmee
Lake Okeechobee
EAA
WCA 1
STAs
WCA 2
WCA 3
ENP
FL Bay

Legend:
- Everglades Agricultural Area
- Everglades Protection Area

(Ch 2. SFER 2007)
How does SFWMD manage the system?

**FIELD INFRASTRUCTURE (WMFS)** + **INFORMATION MANAGEMENT (WMIS)** = **WATER MANAGEMENT SCADA SYSTEM (WMSS)**

**Remote Terminal Units (RTUs)** – RACUs, MOSCADS, CR10s
Sensors – environmental, structure monitoring
Actuators – pump, gate control
Data acquisition, test, maintenance, problem-tracking systems

**Data management/warehousing**
Data verification and validation
Quality control/quality assurance
Analysis, Web publishing
Database - DBHYDRO

**Microwave backbone**
Spread-spectrum
RF feeder networks
District WAN interfaces (T1, etc.)

**SCADA (Supervisory Control and Data Acquisition)**
Software/hardware systems for data acquisition and control
System administration / Software development
Operations Control Center (OCC) staff
Water managers / SCADA technicians
Meteorologists / STA Site Managers

ModComp to Telvent conversion
Operation Decision Support System (ODSS)
160 Drainage Basins

Composed of linked areas that water managers think of as “Water Control Units”
How operational decisions are made
Supervisory Control and Data Acquisition - (SCADA)
Remotely Operated Structures

• Canal levels are monitored through extensive network of gages
• Structures have automatic control
• Rainfall is monitored and amounts are forecasted daily
• Canal level optimum generally measured at structure upstream water level.
• Primary Modes
  ▪ Flood Control
  ▪ Water Supply
Remotely Operated Structures

Operable Culverts

Spillways

Pump Stations

Weirs
Managing Every Drop!
Normal Dry Season Operations

Canals serve two primary purposes:
1. Flood Control
2. Water Supply

Canal stages held high to facilitate groundwater recharge and assist supplemental irrigation.

Low groundwater levels due to low, dry season rainfall.
Normal Wet Season Operations

Canal stages held lower to facilitate surface drainage of urban & agriculture lands

Long-term low canal stages depress regional groundwater levels
Canal / Groundwater Interaction

Wet Season Pre-Storm Drawdown Operations

Canal stages lowered up to an additional ~1 foot to increase surface drainage of urban & ag lands prior forecasts storms.

Short-term lowering of canal stages generally does not significantly decrease regional groundwater levels.

** Problems occur during a water shortage with pre-storm drawdown if the rainfall does not occur and the water is lost from the system.
Decisions, Decisions, Decisions...
Inflows & Outflows

Lake Okeechobee's drainage basin covers more than 4,600 square miles.

Inflow capacity exceeds outflow capacity

80% East & West
20% South

St Lucie may inflow if Lake is < 14.5

S-308

S-354
S-351
S-352
C-10
S-135
S-308
St Lucie may inflow if Lake is < 14.5

S-77

Fisheating Creek (Uncontrolled) & C-5

C-41A, C-40 & C-41

Kissimmee

Taylor Creek

Nubbin Slough
Everglades Protection Area Flow Patterns

- Levees surround the Water Conservation Areas
  - Primary inflow sources
    - EAA Drainage
    - Lake Okeechobee
      - Flood control discharge
      - Water supply to Lower East Coast
  - Major structures move excess water south
  - Smaller structures can discharge some excess water to the ocean
    - Provide water supply to maintain coastal canals
Average Storage in Lakes and Water Conservation Areas

- Upper Chain of Lakes: 0 ac-ft
- Lake Kissimmee: 400,000 ac-ft
- Lake Istokpoga: 400,000 ac-ft
- Lake Okeechobee: 4,000,000 ac-ft
- Water Conservation Areas: 200,000 ac-ft

Percent of Total Storage:
- Upper Chain of Lakes: 0%
- Lake Kissimmee: 10%
- Lake Istokpoga: 10%
- Lake Okeechobee: 50%
- Water Conservation Areas: 20%
Summary

• Original C&SF system designed to allow rapid response to rainfall by using pump stations, Lake Okeechobee, Water Conservation Areas & Coastal spillways to provide flood control.

• Complex C&SF system includes Environmental, Statutory and Other Legal Mandates that have increased the challenge of water management.

• Multiple coordination, adjustment and contingency is required in order to meet multi-purpose objectives while providing same level of flood control.
Questions
Gated Spillway Basics

- Upstream or Headwater Elevation
- Downstream Tailwater Elevation
- Gate
- Concrete Superstructure
- Concrete Foundation
- Spillway Crest
- Baffle Blocks
- Energy Dissipation
Gated Spillway
(coastal structures)
Gated Spillway
(coastal structures)

Headwater

Gate Open Elevation

Gate Close Elevation

Tailwater (tidal)