SOUTH FLORIDA WATER MANAGEMENT DISTRICT

OPERATION PLAN

STORMWATER TREATMENT AREA 2

UPDATED

September 2009

Gary Goforth, Inc.

CERTIFICATION

I hereby certify, as a Professional Engineer in the State of Florida, that the information in this Operation Plan was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse without specific verification or adaptation by the Engineer. This certification is made in accordance with the provisions of the Laws and Rules of the Florida Board of Professional Engineers under Chapter 61G15-29, Florida Administrative Code.

_____
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Certificate of Authorization #26236

Date:_____September 18, 2009_____
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STA-2 OPERATION PLAN STRUCTURE REFERENCE

Structure ID	Structure Type	Function	Design Capacity (cfs)	Emergency Back-up Power	Operation Type	Page With Description	Notes
G-328	Pump station	Inflow to STA-2 & irrigation to adjacent farm	Inflow: 4 @ 111 (total = 444) Irrig.: 1 pump @ 111 & one culvert	Diesel engines	By others	9	
G-329A-D	Four 72-inch diameter culverts with gates	Inflow to Cell 1	4 @ 250 (total = 1,000)	Generator hookup receptacle; generator located at WPB FS	Local & Remote	10	
G-330A-E	Five 66-inch diameter culverts with gates	Outlet from Cell 1	5 @ 200 (total = 1,000)	None	Manual	12	
G-331A-G	Seven 66-inch diameter culverts with gates	Inflow to Cell 2	7 @ 145 (total = 1,015)	Generator hookup receptacle; generator located at WPB FS	Local & Remote	11	
G-332	Spillway with two 16-ft-wide by 7.5-ft high gates	Outlet from Cell 2	2 @ 500 (total = 1,000)	Generator on site – automatic start-up	Local & Remote	13	
G-333A-E	Five 72-inch diameter culverts with gates	Inflow to Cell 3	5 @ 200 (total = 1,000)	Generator hookup receptacle; generator located at WPB FS	Local & Remote	11	
G-334	Spillway with two 16-ft-wide by 8.2-ft high gates	Outlet from Cell 3	2 @ 500 (total = 1,000)	Generator on site – automatic start-up	Local & Remote	13	
G-335	Pump station	Discharges treated water from STA-2 to L-6 Canal	Electric: 2 @ 100 Diesel: 2 @ 470 2 @ 950 (total = 3,040)	Diesel engines	Local & Remote	14	Headwater low limit=7.5 ft; Tailwater high limit=16.9 ft
G-336A-F	Six 10-ft wide x 5-ft high box culverts	Discharges treated water to WCA-2A	6 @ 300 (total = 1,800)	Not applicable	Not operable	15	Flow limited by L-6 levee height

Structure ID	Structure Type	Function	Design Capacity (cfs)	Emergency Back-up Power	Operation Type	Page With Description	Notes
G-336G	Five 96-inch diameter culverts	Discharges treated water from L-6 Canal to WCA-2A	5 @ 250 (total = 1,000)	Not applicable	Not operable	16	Fixed weir crests @ 14.25 ft NGVD
G-337	Pump station	Seepage return	3 @ 80 (total = 240)	Generator is located on site	Local & Remote	16	
G-337A	Four box culverts with 80-inch x 60-inch gates	Control flow to Cell 4	4 @ 255 (total = 1,020)	Generator is located on site	Local & Remote	10	
G-338	Spillway with one 14-ft wide x 12.5-ft high gate	Water supply inflow from Refuge and diversion to Refuge	975	Generator is located on site	Local & Remote	17	
G-339	Spillway with two 18-ft wide x 11.5-ft high gates	Diversion to WCA-2A	2 @ ~1,000 (total ≈ 2,000)	Generator is located on site	Local & Remote	17	
G-341	Spillway with two 25-ft wide x 15-ft high gates	Diversion structure between S-5A and S-2/S-6 basins	Firm capacity of 600; less than 0.5 ft headloss at 1,710 cfs	Generator on site – automatic start-up	Local & Remote	18	
G-367A-F	Six 72-inch diameter culverts with gates	Inflow to Cell 4	6 @ 145 (total = 870)	Generator hookup receptacle; generator located at WPB FS	Local & Remote	12	
G-368A-D	Four 8-ft wide x 8-ft high box culverts with gates	Outlet from Cell 4	4 @ 255 (total = 1,020)	Generator is located on site	Local & Remote	13	
S-6	Pump Station	Inflow to STA-2	3 @ 975 (total = 2,925)	Diesel engines	Local	8	Headwater low limit=9.0 ft; Tailwater high limit=20.5 ft

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1 PROJECT DESCRIPTION

1.1. BACKGROUND

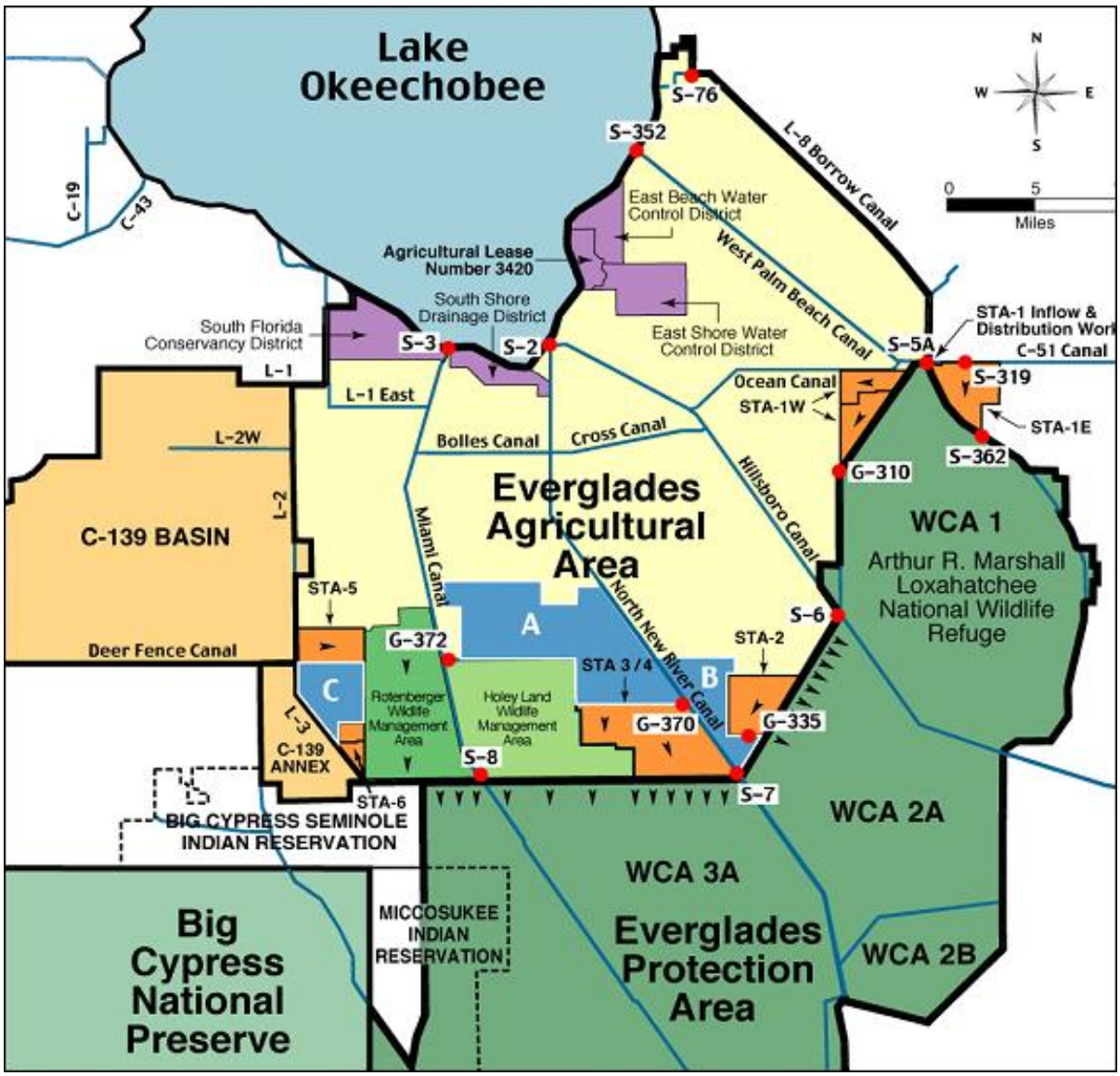
Stormwater Treatment Area 2 (STA-2) is a critical component of the Everglades Construction Project, required by the Everglades Forever Act (Ch. 373.4592, F.S.) and the Everglades Settlement Agreement. The Everglades Construction Project (ECP) consists primarily of six large constructed wetlands, referred to as Stormwater Treatment Areas (STAs) designed to reduce the levels of phosphorus from waters entering the Everglades Protection Area (EPA). **Figure 1** presents an overview of the STAs comprising the Everglades Construction Project. The required works of the overall ECP are described in the *Everglades Protectio*n Project, Conceptual Design (Burns & McDonnell 1994). STA-2 was designed by Brown & Caldwell, Inc. working under contract to the South Florida Water Management District (SFWMD).

STA-2 is located in Palm Beach County. The STA is situated generally on and surrounding the former Brown's Farm Wildlife Management Area and is positioned immediately west of Water Conservation Area 2A (WCA-2A). Approximately half of STA-2 is situated on lands that previously were used primarily for agriculture. STA-2 consists of four parallel treatment paths, or flow-ways, flowing from north to south (see **Figure 2**). The original STA-2 consisted of three treatment cells with 6,430 acres of effective treatment area and began operation in 2000. The treatment area was expanded by 1,902 acres with the construction of Cell 4, which was flow capable by December 2006. The additional treatment cell is operated in parallel with the existing three cells. Because no additional peak flows will be accommodated, Cell 4 was designed hydraulically to replicate the performance of Cell 3. This allows the full STA design flow (3,370 cfs capacity at the S-6 and G-328 pump stations) to be accommodated with any one of the treatment cells out of service.

This and other treatment area expansions are described in the *Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals* (Long-Term Plan) (SFWMD 2003, and as subsequently revised). One of the key assumptions during the development of the Long-Term Plan was that Compartments B and C (see **Figure 1**) would be under consideration for use as part of the Everglades Agricultural Area (EAA) Storage Reservoir Project, a component of the Comprehensive Everglades Restoration Plan (CERP), through FY 2010 and for this reason should not be considered for other Everglades restoration uses until FY 2011. Subsequent to completion of the Long-Term Plan, conceptual level analyses indicated that all of the EAA Storage Reservoir Project's CERP water storage goals could be achieved on Compartment A, and that Compartments B and C would not be needed to meet the storage objectives of the EAA Storage Reservoir CERP Project. In light of the recent availability of the land in Compartments B and C, STA-2 was expanded with a new Cell 4 to assist in maximizing the treatment effectiveness of the STAs in improving water quality entering the EPA.

The District is proceeding with the construction of additional treatment areas on the remaining acreage of Compartments B and C to further assist in maximizing the effectiveness of the STAs in improving water quality entering the EPA. A regional feasibility study was conducted by the District to determine the optimal configuration and operation of the additional treatment areas on the remaining acreage of Compartments B and C (Burns & McDonnell 2005).

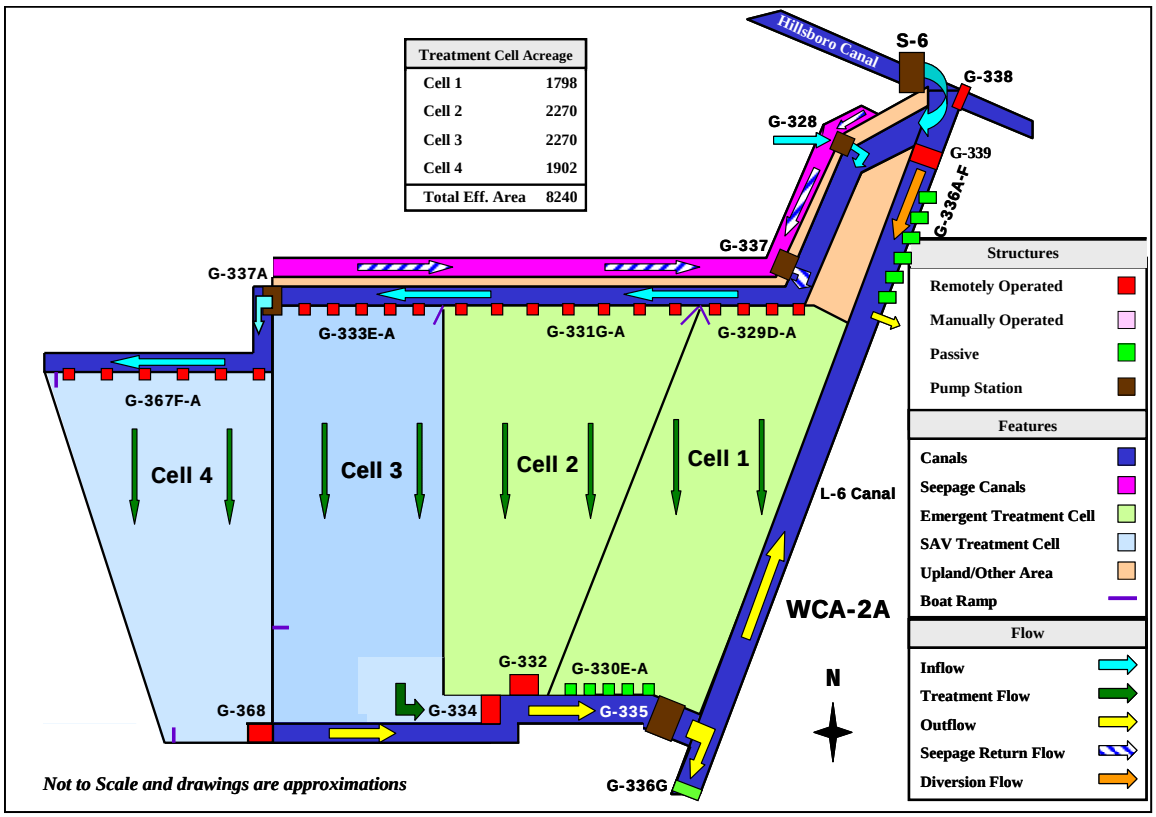
Figure 1. Overview of the Everglades Construction Project.



Operations History. Construction of the initial three flow-ways of STA-2 was completed in June 1999. On September 29, 2000, the Florida Department of Environmental Protection (FDEP)

issued the Everglades Forever Act permit number 0126704 and the associated NPDES permit number FL0177946 for operation of STA-2. Water quality monitoring data at the inlet and outlet locations of Cells 2 and 3 satisfied the "start-up" requirements in the operating permits during the fall of 2000, and discharge operations were authorized at that time for those two cells. Cell 1 data demonstrated a net improvement for phosphorus, but not for the mercury species. On August 9, 2001 the DEP issued a modification to the STA-2 permit that authorized flow through operations for Cell 1. Net improvement for mercury in Cell 1 was demonstrated in December 2002.

Figure 2. Schematic of STA-2 Flows (not to scale).



Cell 4 of STA-2 was flow-capable by December 31, 2006. Vegetation management activities were undertaken in the fall of 2006 to expedite the grow-in of desired treatment vegetation and subsequent flow-through operation, although the 2006-2008 regional drought delayed flow-through operations. Cell 4 demonstrated net improvement of total phosphorus (TP) in July 2007, however, routine discharges did not occur until February 2008.

This Operation Plan is based on information from (a) the Conceptual Design Document for the Everglades Protection Project, dated February 15, 1994, (b) the April 1995 General Design Memorandum for Stormwater Treatment Area No. 2 and WCA-2A Hydropattern Restoration, (c) Brown and Caldwell January 1996 General Design Report, (d) Brown and Caldwell May 1997 Final Design, Stormwater Treatment Area 2 and WCA-2A Hydropattern Restoration (e)

Rule 40E-63 of the Florida Administrative Code, (f) the STA optimization research plan, (RAM 5), (g) operational experience from the existing STAs summarized in the annual South Florida Environmental Reports and its predecessor the Everglades Consolidated Reports, (h) Everglades Protection Area Tributary Basins Long-Term Plan for Achieving Water Quality Goals, (i) November 2004 Revisions to Pre-2006 Strategies, ECP Basins, (j) STA-2 Cell 4 Expansion Project Basis Of Design Report, (k) September 2005 Design Package 3 90% Design Report, (l) Hydraulic Modeling Technical Memorandum for STA 2 Cell 4 Expansion, (m) October 2005 Hydraulic Modeling Of The Internal Works, and (n) October 2005 Everglades Agricultural Area Regional Feasibility Study. By operating in accordance with these documents, the objectives of the ECP for phosphorus will be achieved, in accordance with the EFA, §373.4592(9)(e) and (9)(h), Fla. Stat.

Operation Plan Modifications. In accordance with the District's practice and the operating permits for STA-2, this *Operation Plan* shall be reviewed periodically and revised as appropriate.

All elevations referenced in this *Operation Plan* are based on the 1929 National Geodetic Vertical Datum (NGVD). NAVD88 elevations will be provided in a future STA-2 Operation Plan revision.

1.2. INFLOW SOURCES

STA-2 provides a total effective treatment area of 8,240 acres to treat water from a variety of sources, including

- Agricultural runoff and discharges from the S-6/S-2 Basin;
- A portion of the runoff from the S-5A Basin via the Ocean and Hillsboro Canals;
- Runoff from Ch. 298 drainage districts situated on the easterly shore of Lake Okeechobee;
- Supplemental (irrigation) water from Lake Okeechobee to prevent dryout of the STA submerged aquatic vegetation;
- Best Management Practice Makeup Water, although the magnitude of these flows are anticipated to be minimal;
- Water supply releases from Lake Okeechobee meant for delivery to the Lower East Coast.

As part of the adaptive management process of the Long-Term Plan, the flow and phosphorus contributions from these areas were updated during the EAA Regional Feasibility Study (see **Table 1**). Based on these projections, STA-2 is anticipated to treat a long-term annual average volume of approximately 343,600 acre-feet (AF) of runoff and 43,300 kg of phosphorus per year from a variety of sources upstream of S-6 and G-328 (SFWMD 2005).

Table 1. Estimated Inflows to STA-2 from the Regional Feasibility Study.

	Estimated Average Inflow, WY1966-2000		
Source	**Volume**	**TP Load**	**TP Conc.**
	AF/yr	**kg/yr**	**ppb**
S-2/S-6 Basin	226,654	27,015	97
ESWCD/Closter Farms	29,818	4,588	125
S-5A Basin	59,342	11,260	154
Seepage from WCA-2A	27,500	509	15
Lake Okeechobee	461	48	84
Total Inflow	343,775	43,420	102
Assumed Bypass	461	48	84
Inflow to be treated	343,314	43,372	102

1.3. OPERATIONAL OBJECTIVES

In accordance with the 1994 Conceptual Design for the Everglades Protection Project, the Long-Term Plan, and subsequent design documents, the primary objectives of the STA-2 include the following:

1.3.1 Reduce Phosphorus Levels to Achieve Compliance with Water Quality Standards

In combination with the implementation of the EAA Best Management Practice (BMPs) Program, STA-2 is designed to reduce TP in discharges from the EAA and other sources as necessary to achieve the water quality standard in the Everglades Protection Area.

1.3.2 Supply BMP Make-Up Water

STA-2 will be operated to the maximum extent practical to offset reductions in volumetric discharges to the EPA resulting from the implementation of the EAA BMP Program. Replacement water will be provided from Lake Okeechobee and distributed to the STAs. Calculations conducted for the EAA BMP Program indicate that there have been minimal reductions in volumetric discharges to the EPA resulting from the implementation of the EAA BMP Program.

1.3.3 Hydropattern Restoration

STA-2 will be operated to the maximum extent practical to improve the quality, timing and distribution of water entering the northwest portion of WCA-2A. The Long-Term Plan contemplates that treated water will ultimately be distributed across a large portion of the boundary between WCA-2A and the EAA to re-establish sheet flow to the region, a characteristic that was drastically altered with the completion of the Central and Southern Flood Control Project. Treated water from STA-2 is directed across the northern two miles

and the southern reach of the WCA-2A boundary. Adjacent areas within WCA-2A are already impacted with elevated levels of nutrients.

1.3.4 Reduce Localized Water Quality Problems in Lake Okeechobee

STA-2 will be operated to the maximum extent practical to provide water quality treatment for diversions from the East Shore Water Control District (ESWCD) and from Closter Farms. Prior to completion of the diversion works, these areas discharged into Lake Okeechobee.

2 STRUCTURE AND CANAL DESCRIPTIONS

The total effective treatment area of 8,240 acres within STA-2 is distributed within four parallel treatment cells. Estimates of the effective treatment areas, reference ground elevations and target treatment vegetation for each cell are provided in **Table 2**.

Table 2. STA-2 Cell Characteristics.

Cell	Effective Treatment Area (acres)	Anticipated Normal Peak Flow (cfs)	Reference Ground Elevation (ft NGVD)	Target Dominant Vegetation
1	1,798	788	11.37	Emergent
2	2,270	1,485	10.64	Emergent
3	2,270	1,011	9.72	SAV
4	1,902	1,011	8.69	SAV
Total	***8,240***	***3,050***		

Note: "Reference Ground Elevation" represents the current estimate of average ground elevation.

Summary of Flows through STA-2. Pump station S-6 serves as the primary inflow pump station to STA-2. Additionally, agricultural pump station G-328 has the capacity to discharge up to 444 cfs to STA-2 from drainage of upstream farmlands. Inflow from these two pump stations is conveyed southwesterly towards the treatment cells via the Supply Canal, a distance of approximately 18,500 feet (ft). Inflows are then conveyed along the Inflow Canal to the northern inflow structures of each treatment cell. Water flows by gravity in a southward direction through the treatment cells, eventually discharging to the common Discharge Canal through each treatment cells' discharge structure. Vegetation within the existing treatment cells consists predominantly of existing emergent marsh (e.g., sawgrass and cattail) in Cells 1 and 2, and submerged aquatic vegetation and periphyton communities in Cells 3 and 4. Treated water moves east in the Discharge Canal towards the STA-2 outflow pump station G-335, situated at the southeasterly corner of STA-2. Outflow pump station G-335 discharges to the L-6 Borrow Canal. Discharges within the L-6 Borrow Canal sheet flow across the L-6 Levee into the northwesterly perimeter of WCA-2A via structures G-336A-F and into the southwestern portion of WCA-2A through a 4,800-ft gap in the L-6 levee located just north of the S-7 pump station. The location of these discharges was selected because the downstream areas are already impacted with cattails.

The following sections describe the associated project water control structures, canals and related features.

2.1 INFLOW CONTROL FACILITIES

2.1.1 S-6 Pump Station

The S-6 pump station is a three-unit pumping plant located in the alignment of the Hillsboro Canal, at its intersection with Levee 6 and Levee 7, about 20 miles southeast of the town of Belle Glade in the south-central section of Palm Beach County. The S-6 pump station is the primary inflow pump station for STA-2. Flows originating from S-6/S-2 Basin, S-5A Basin diversions, East Shore Water Control District and Closter Farms diversions, and Lake Okeechobee, will be pumped into STA-2 via S-6. Prior to operation of STA-2, S-6 provided pumping of surplus water via the Hillsboro Canal from the agricultural area northwesterly of the pump station and Lake Okeechobee into Conservation Area 1 (WCA-1), at a maximum rate of 3/4 inch per day from the 146-square mile tributary drainage area. Historically the pump station has been operated whenever the water level in the Hillsboro Canal exceeds the optimum level of 12.5 ft NGVD. The pump station can also be operated upon request of the District Engineer, Army Corps of Engineers Jacksonville District, to provide regulatory discharges from Lake Okeechobee when canal capacity is not needed for removal of surplus water from the agricultural area and when the regulatory discharges can not be accommodated by sending water to STA-3/4, and when treatment capacity is available in STA-2.

Operational Control and Data Acquisition. Headwater and tailwater data are available to the West Palm Beach Operations Control Center, while headwater and tailwater staff gauges and gate position indicators are available for local operation. Pump station headwater stages of 11.5 ft NGVD and 10.5 ft NGVD are maintained during irrigation and drainage seasons, respectively. The pumps can siphon water from WCA-1 for water supply to the EAA; however, excessive floating vegetation often prevents siphoning all three units together. Two 100 KW diesel generators provide alternate power for the station if needed.

Pump Station Description:

Number of Pumps:	3 @ 975 cfs
Pump diameter:	135 inches
Discharge Capacity (combined):	2,925 cfs
Design Headwater elevation:	8.0 – 12.5 ft NGVD

Note: To minimize damage to the canal system resulting from excessive velocities, no pumping should be conducted with the water surface in the intake bay below 9.0 ft NGVD.

Design low water (headwater) elevation:	8.0 ft NGVD
Design Tailwater elevation:	20.8 ft NGVD
Maximum pool-to-pool head differential:	8.3 ft

Note: Pumps may overheat if head differential is greater than 7.0 ft

Nominal pump operating speed:	88 rpm
Motor Speed:	700 rpm
Engine Horsepower:	1240 hp

Gates: 2 per bay with flap gates for back flow protection located on downstream end

Gate size:	10.3-ft high by 21 ± ft wide

It is contemplated that there may eventually occur subsidence of the peat layer throughout the drainage area, making desirable operation of the pumps with intake surface levels below the present normal drawdown limit of El. 9.0 ft. The pump machinery has, therefore, been designed to permit operation at rated conditions of head and capacity with intake water surface down to El. 8.0 ft. If, during a pumping operation, the water surface on the intake bay falls below El. 9.0 ft as indicated by the staff gauge, the speed of all pumps then operating should be reduced to not less than 500 rpm. If this does not restore the water surface in the intake pool to El. 9.0 ft, one or more of the pump units should be shut down until the minimum pool elevation is re-established. The pumps in this station are designed to pump drainage water containing a negligible amount of sediment or other material that might damage the surface of the pump or the bearings. However, the quantity of water being pumped by the station should be reduced at any time the water in the suction bay becomes moderately silted or if it appears that the approach velocities are carrying a bottom load of sand into the sump chambers.

2.1.2 G-328 Pump Station

Relocation of an existing agricultural pump station was required for the construction of the STA-2 Supply Canal. This relocated agricultural pump station, designated as structure G-328, provides drainage for a total permitted area of 9,980 acres. The pump station consists of five diesel engine driven 48-inch diameter pumps. Four of its five pumps are utilized for discharges originating from upstream farmlands, and have a design flow capacity of 444 cfs. The remaining pump provides irrigation water to the farms. Although not a District operated structure, G-328 makes seasonal discharges into and water withdrawals from the STA-2 Supply Canal.

Operational Control and Data Acquisition. G-328 is operated by non-District entities to provide for drainage and irrigation capacity to tributary agricultural lands. Headwater stage, tailwater stage and pump status information is available to the District's West Palm Beach Operations Control Center, while headwater and tailwater staff gauges and gate position indicators are available for local operation.

2.1.3 Supply Canal

The Supply Canal extends from the S-6 Pump Station to the Inflow Canal at the northeast corner of STA-2, a length of approximately 23,950 ft (Brown & Caldwell 1996a). The Supply Canal has a bottom width of 57.0 ft at elevation –4.0 ft NGVD and minimum side slopes of 2.5:1 (H:V). The top of the Perimeter Levee adjacent to canal is at elevation 20.8 ft NGVD with a width of 14.0 ft and toe of the levee elevation at 10.0 ft NGVD. The static water elevation within the Supply Canal is generally 12.0 ft NGVD.

The Supply Canal is designed to convey the peak rates of discharge from pump stations S-6 and G-328 (3,370 cfs) without exceeding a maximum elevation of 18.30 ft NGVD at the tailwater of pump station S-6 (Brown & Caldwell 1996). Design Flow stages range from

18.19 ft NGVD at pump station S-6 tailwater to 17.05 ft NGVD at the end of the Supply Canal. Standard Project Storm stages range from 18.03 ft NGVD at S-6 tailwater to 17.25 ft NGVD at the end of the Supply Canal. The Probable Maximum Storm stages range from 18.20 ft NGVD at S-6 tailwater to 17.79 NGVD at the end of the Supply Canal.

2.1.4 Inflow Canal

The Inflow Canal extends westward from the Supply Canal along the northern boundary of Cells 1-3 to Structure G-337A, and then south approximately 1 mile and then west along the northern boundary of Cell 4 to the east levee of the North New River Canal. The total length of the Inflow Canal is approximately 41,000 ft. The Inflow Canal in the reach along the top of Cell 1 has a bottom width of 20.0 ft at elevation -4.0 ft NGVD and side slope of 3:1 (H:V). The inflow Canal in the reach along the top of Cells 2 and 3 has a bottom width of 20.0 ft at elevation -2.0 ft NGVD and side slope of 3:1 (H:V). The top of the Inflow Canal Perimeter Levee north of Cells 1-3 was established at 20.2 ft NGVD with a width of 14.0 ft and toe of levee elevation at 11.0 ft NGVD. The top of the Inflow Canal Perimeter Levee north of Cell 4 was established during design at 19.0 ft NGVD with a width of 14.0 ft. and a toe of levee elevation at 9.0 ft NGVD.

2.1.5. G-337A

With the construction of Cell 4, G-337A was converted to a 4-gated structure located in the Inflow Canal at the northwest corner of Cell 3. The structure was originally a 4-bay pump station constructed to return seepage to the Inflow Canal, and was retrofitted as a gravity structure by the removal of the pumps and installation of 80-inch x 60-inch gates at the former pump inlet openings to control flow into the Cell 4 inflow canal. The gates are controlled by an electric motor. An emergency generator is available for backup power. Local and remote operation of G-337A is possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structure has a nominal design flow capacity of 1,020 cfs, and flow equations developed for this structure are presented in **Appendix 1**. A generator is located on-site to supply power for gate operations in case the commercial electric service is disrupted.

2.2 INTERIOR CONTROL FACILITIES

2.2.1 G-329A-D (Cell 1 Inflow)

Structures G-329 A-D consist of four gated culverts that serve as the inflow control structures for Treatment Cell 1. Each culvert consists of a 65-ft long 72-inch diameter corrugated metal pipe with a headwall fitted with a 72-inch x 72-inch slide gate and service platform on the upstream end, and a flared end section on the downstream end. These structures convey water

from the Inflow Canal into a spreader canal that runs across the north end of Cell 1. Local and remote operation of the G-329 gates are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structures have a nominal design flow capacity of 250 cfs each, and flow equations developed for this structure are presented in **Appendix 1**. A generator hookup receptacle is available for a portable generator in case commercial service is disrupted; the portable generator is located at the West Palm Beach Field Station.

2.2.2. G-331A-G (Cell 2 Inflow)

Structures G-331A-G consist of seven gated culverts that serve as the inflow control structures for Treatment Cell 2. Each culvert consists of a 65-ft long 66-inch diameter corrugated metal pipe with a headwall fitted with 66-inch x 66-inch slide gate and service platform on the upstream end and a flared end section on the downstream end. These structures convey water from the Inflow Canal into a spreader canal that runs across the north end of Cell 2. Local and remote operation of the G-331 gates are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structures have a nominal design flow capacity of 145 cfs each, and flow equations developed for this structure are presented in **Appendix 1**. A generator hookup receptacle is available for a portable generator in case commercial service is disrupted; the portable generator is located at the West Palm Beach Field Station.

2.2.3. G-333A-E (Cell 3 Inflow)

Structures G-333 A-E consist of five gated culverts that serve as the inflow control structures for Treatment Cell 3. Each culvert consists of a 65-ft long 66-inch diameter corrugated metal pipe with a headwall fitted with a 66-inch x 66-inch slide gate and service platform on the upstream end, and a flared end section on the downstream end. These structures convey water from the Inflow Canal into a spreader canal that runs across the north end of Cell 3. Local and remote operation of the G-333 gates are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structures have a nominal design flow capacity of 200 cfs each, and flow equations developed for this structure are presented in **Appendix 1**. A generator hookup receptacle is available for a portable generator in case commercial service is disrupted; the portable generator is located at the West Palm Beach Field Station.

2.2.4. G-367A-F (Cell 4 Inflow)

Structures G-367A-F consist of six gated culverts that serve as the inflow control structures for treatment Cell 4. Each culvert consists of a 170-ft long 72-inch diameter reinforced concrete pipe with a 8-ft x 8-ft slide gate in the center of the pipe alignment, and mitered end sections. The structures are spaced approximately 1,900 ft apart along the northern levee of Cell 4. These structures convey water from the Inflow Canal into a spreader canal that runs across the north end of Cell 4. Local and remote operation of the G-367 gates are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater and tailwater stage sensors are available at G-367B, G-376C and G-367E, while each gate has a gate position sensor. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structures have a nominal design flow capacity of 145 cfs each, and flow equations developed for this structure are presented in **Appendix 1**. A generator hookup receptacle is available for a portable generator in case commercial service is disrupted; the portable generator is located at the West Palm Beach F. S.

2.3 OUTFLOW CONTROL FACILITIES

2.3.1. G-330A-E (Cell 1 Outflow Structures)

Structures G-330 A-E consist of a series of five culverts situated in the south perimeter levee of Treatment Cell 1 and serve to control the outflow to the Discharge Canal. Each culvert consists of a 90-ft long 66-inch diameter corrugated metal pipe with a weir box, slide gate and a service platform on the upstream end, and a flared end section on the downstream end (**Table 3**). Flow through the structures is controlled by the use of the weir at low flow and by pipe flow at stages associated with extreme events. The weirs also serve to establish the Static Water Level differential between Treatment Cell 1 and the Discharge Canal. The weir box has a total length of approximately 50 ft and the slide gate is 3-ft x 3-ft. These structures convey water from a collector canal that runs across the south end of Cell 1 into the common discharge canal. The structures have a nominal design flow capacity of 200 cfs each, and flow equations developed for this structure are presented in **Appendix 1**. Only local operation of the G-330 gates is possible. Headwater, tailwater stage and gate position information are available to the West Palm Beach Operations Control Center, while headwater and tailwater staff gauges and gate position indicators are available for local operation.

Table 3. Characteristics of the G-330 Structures.

Structure	Invert Elevation Headwater / Tailwater (ft NGVD)	Slide Gate Invert El. (ft NGVD)	Side Weir Crest El. East Side / West Side (ft NGVD)	End Weir Crest El. (ft NGVD)
G-330A	5.82 / 5.68	8.97	12.97 / 13.00	12.98
G-330B	6.63 / 6.61	9.08	13.15 / 13.17	13.16
G-330C	6.72 / 6.50	8.86	13.09 / 13.12	13.10
G-330D	7.04 / 6.70	9.15	13.12 / 13.11	13.10
G-330E	7.17 / 6.96	9.28	13.08 / 13.11	13.10

2.3.2. G-332 (Cell 2 Outflow Structure)

Structure G-332 is situated in the southeast corner of Treatment Cell 2 in the Interior Levee, and serves to control discharges from Treatment Cell 2. G-332 consists of a two-bay reinforced concrete spillway with two 16-foot-wide by 7.5-ft high vertical lift gates installed on the crest of an ogee-shaped weir with a crest elevation of 7.5 ft NGVD. This structure conveys water from a collector canal that runs across the south end of Cell 2 into the common discharge canal. The estimated head loss during the design flow is approximately 3.7 ft. Needles and needle beams are used upstream and downstream of the vertical lift gates to permit dewatering for both maintenance and for an emergency temporary closure should it be necessary to remove a gate. Local and remote operation of G-332 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structure has a nominal design flow capacity of 500 cfs for each of the two bays, for a total of 1,000 cfs. Discharge rating curves for G-332 were developed from District information and are presented in **Appendix 1**. A generator is located on-site to supply power for gate operations in case the commercial electric service is disrupted.

2.3.3. G-334 (Cell 3 Outflow Structure)

Structure G-334 is situated in the Treatment Cell 3 discharge canal, and serves to control discharges from Treatment Cell 3 of STA-2. Structure G-334 consists of a two-bay reinforced concrete spillway provided with two 16-foot-wide by 8.2-ft high vertical lift gates installed on the crest of an ogee-shaped weir, with a crest elevation of 6.75 ft NGVD. The estimated head loss during the design flow is approximately 2.3 ft. Needles and needle beams are used upstream and downstream of the vertical lift gates to permit dewatering for both maintenance and for an emergency temporary closure should it be necessary to remove a gate. This structure conveys water from a collector canal that runs across the south end of Cell 3 into the common discharge canal. Local and remote operation of G-334 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structure has a nominal design flow capacity of 500 cfs for each of the two bays, for a total of 1,000 cfs. Discharge rating curves for G-334 were developed from District information and are presented in **Appendix 1**. A generator is located on-site to supply power for gate operations in case the commercial electric service is disrupted.

2.3.4. G-368A-D (Cell 4 Outlet Structure)

Structures G-368A-D consist of four gated culverts that serve as the outflow control structures for Treatment Cell 4. Each culvert consists of a 153-ft long 8-ft x 8-ft concrete box culvert with an 8-ft x 8-ft slide gate in the center of the culvert alignment, and mitered end sections.

These structures convey water from a collector canal that runs across the south end of Cell 4 into the common discharge canal. Local and remote operation of G-368 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation. The structures have a nominal design flow capacity of 255 cfs for each of the four culverts, for a total capacity of 1,020 cfs under design conditions. Flow equations developed for this outflow structure are presented in **Appendix 1**. A generator is located on-site to supply power for gate operations in case the commercial electric service is disrupted.

2.3.5. Discharge Canal

The Discharge Canal extends eastward from the vicinity of G-332 and G-334 to the outflow pump station G-335 for a distance of approximately 6,000 ft. The new discharge canal from Cell 4 joins the Discharge Canal just east of G-334. The Discharge Canal has a bottom width varying from 50.0 ft to 66.0 ft at elevation –4.0 ft NGVD and side slopes of 3.0 to 1 (H to V) and 2.5 to 1. The tops of the Discharge Canal Perimeter Levee (adjacent to Seepage canal) and the Discharge Canal South Interior Levee (adjacent to treatment cell) varies respectively from 19.7 ft NGVD to 21.9 ft NGVD for the Perimeter Levee and 17.6 ft NGVD to 20.0 ft NGVD for the South Interior Levee. Top width for the Perimeter Levee varies from 12.0 ft to 22.0 ft and top width for the South Interior Levee is established at 12.0 ft.

2.3.6. G-335 Pump Station

G-335 serves as the outflow pump station for STA-2 and is located at the extreme southeast corner of STA-2. G-335 provides a nominal discharge capacity of 3,040 cfs. Hydrodynamic attenuation of flows through STA-2 results in a project outflow capacity of G-335 (3,040 cfs) less than the total project inflow capacity of 3,370 cfs [S-6 (2,925 cfs) + G-328 (444 cfs) ≈ 3,370 cfs]. Water budget analysis performed for a 30-year period of record (1965-95) indicated that during only one event did the outflow capacity exceed the capacity of G-335 which might have resulted in the diversion of 835 AF of water to WCA-2A (Brown and Caldwell, 1996). This diverted volume over a 30-year period is less than 0.02% of the total flows anticipated to pass through STA-2.

Operational Control and Data Acquisition. Local and remote operation of G-335 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and pump station information is available to the remote operators, while headwater and tailwater staff gauges and pump station information are available for local operation.

G-335 includes two 100 cfs pumps, two 470 cfs pumps and two 950 cfs pumps. All pumps are the vertical propeller type. The 100 cfs pumps are electric motor driven. The remaining pumps are driven by diesel engines.

Pump Station Description:	
Number of Pumps:	6
Discharge Capacity (combined):	3,040
Design Headwater elevation:	8.9 ft NGVD
Design low water (headwater) elevation:	7.5 ft NGVD
Design Tailwater elevation:	16.9 ft NGVD
Nominal pump operating speed:	
Electric:	440 rpm
Diesel 470-cfs:	177 rpm
Diesel 950-cfs:	125 rpm
Motor Speed:	
Electric:	440 rpm
Diesel:	720 rpm
Motor Size:	
2-100 cfs electric pumps:	200 hp
2-470 cfs diesel pumps:	1020 hp
2-950 cfs diesel pumps:	1535 hp
Centerline discharge connection:	
Electric:	21.25 ft NGVD
Diesel:	23.0 ft NGVD
Pump station floor elevation:	30 ft NGVD
Intake floor elevation:	
100 cfs electric:	-6.9 ft NGVD
470 cfs diesels:	-4.68 ft NGVD
950 cfs diesels:	-8.45 ft NGVD

2.3.7. G-336 A-F (Interim) Northern WCA-2A Hydropattern Restoration

The six structures G-336 A-F are uncontrolled box culverts situated along the northernmost 3 miles of the L-6 borrow canal between the northeast corner of Cell 1 and G-339. The structures are 18-ft long 10-ft wide by 5-ft high concrete box culverts with a crest elevation of approximately 12.0 ft NGVD. The structures have a nominal design flow capacity of 300 cfs each under design conditions. Treated discharges from STA-2 will help restore a more natural delivery of water to the northwestern portion of WCA-2A, with respect to volumes, timing and distribution. The original design of the STA-2 hydropattern restoration features anticipated delivery of treated water along the entire 7.5 mile reach between G-335 and S-6. However, due to concerns about potential adverse water quality impacts due to concentrations around 50 ppb, the District modified the design to divert, on an interim basis, discharges to areas that were already impacted near S-6 and S-7. G-336 A-F provides for sheet flow along the northwesterly perimeter of WCA-2A. It is anticipated that when the long-term water quality solutions are in place, the remaining reach between G-335 and G-336F will be opened to allow more significant hydropattern restoration of WCA-2A.

2.3.8. G-336G and (Interim) Western WCA-2A Hydropattern Restoration

A divide structure, G-336G, is located just south of G-335 in the L-6 borrow canal. The purpose of this structure is to direct most of the low flows to the north, while allowing a portion of the higher flows from G-335 to pass to the impacted areas of WCA-2A near S-7. The G-336G structure consists of five (5) 96" diameter culverts and associated risers with a weir crest elevation of 14.25 ft NGVD. The structure has a nominal design flow capacity of 250 cfs for each of the five culverts, for a total capacity of 1,250 cfs under design conditions. Treated discharges from STA-2 enter an already impacted area of the WCA-2A along a 3,400-foot gap in the L-6 levee, located just north of S-7. Construction activities consisted of degrading the east L-6 levee to elevation 17.0 NGVD from G-336G to a point approximately 3,500 ft northeast of the S-7 pump station. To provide flow to WCA-2A, the east L-6 levee was degraded to ground level (approximately 12.0 ft NGVD) between that point and a new plug in the L-6 borrow canal just north of S-7. The excavated material was utilized to raise the west L-6 levee to elevation 20.0 ft NGVD, as it became the new WCA-2A perimeter levee.

2.4 SEEPAGE CONTROL FACILITIES

2.4.1. G-337 Pump Station

G-337 provides seepage control service to those private lands adjacent to STA-2 and its Supply Canal. Pump Station G-337 discharges to the Supply Canal for STA-2. Seepage Return Pump Station G-337 is equipped with three 42-inch diameter electric motor driven pumps, each providing a nominal capacity of approximately 80 cfs (240 cfs total). Minimum intake elevation was established at 7.00 ft NGVD. Pump station floor elevation is established at 15.75 ft NGVD. Design headwater elevations are maintained between 8.0 and 8.5 ft NGVD in order to maintain average water level within the Seepage Canal at 9.0 ft NGVD.

It is expected that two of the three 42-inch diameter seepage pumps will provide sufficient pumping capacity for most pumping events (at 160 cfs). The third pump will be an emergency backup pump for extreme events or failure of one of the other two pumps. A generator is located on-site to supply power in case the commercial electric service is disrupted. The pumps operate automatically in response to headwater elevation and the station is normally unmanned. Access to G-337 is from S-6 along the west levee of the Supply Canal.

Operational Control and Data Acquisition. Local and remote operation of G-337 are possible as required to maintain average canal elevation at 9.0 ft NGVD during normal operations, and operated to a minimum intake elevation of 7.0 ft NGVD during drought conditions. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and pump information are available to the remote operators, while headwater and tailwater staff gauges and pump information are available for local operation.

2.4.2. Seepage Collection Canal

The Seepage Collection Canal runs parallel to the supply canal and continues along the Inflow Canal, eventually terminating near structure G-337A. The total distance is approximately 47,000 ft or 8.9 miles. The Seepage Collection Canal has a bottom width of 12.0 ft at approximate elevation varying to +2.3 ft NGVD and side slopes of 3 to 1 (H to V) and 2 to 1. The top of the canal bank is estimated at 11.0 ft NGVD.

2.5 DIVERSION FACILITIES

2.5.1. G-338

Structure G-338 is situated within the Supply Canal approximately 400 ft downstream of pump station S-6 and is connected to the Hillsboro Canal via a short spur canal. G-338 may be operated to achieve multiple purposes:

1. To facilitate water supply delivery to downstream water users;
2. During dry weather conditions, water may be released from WCA-1 into the STA-2 supply canal for use by STA-2 and farming interests located upstream of G-328;
3. During extreme storm events, flows from S-6 may be diverted from STA-2 through G-338 to the Hillsboro Canal.

Structure G-338 has a nominal design capacity of 975 cfs under design conditions. G-338 is a 52-ft long 14 ft wide by 12 ft high concrete box culvert with a 14-ft wide x 12.5-ft high self contained vertical lift roller gate located on its upstream end.

Operational Control and Data Acquisition. Local and remote operation of G-338 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation.

2.5.2. G-339

Structure G-339 is situated in the Supply Canal of STA-2 at the intersection with the existing L-6 Borrow Canal. During extreme storm events, G-339 serves to facilitate flow diversion from Pump Stations S-6 and G-328 to WCA-2A via the L-6 Borrow Canal. Structure G-339 consists of a two-bay reinforced concrete spillway provided with two 18 ft wide by 11.5-ft high vertical lift gates installed on the crest of an ogee shaped weir, with a crest elevation of 8.0 ft NGVD. With both gates open, structure G-339 has a maximum design capacity of over 2,000 cfs with a headwater of 17.5 ft NGVD and tailwater of 16.8 ft NGVD (Burns & McDonnell 1995). Needles and needle beams are used upstream and downstream of the

vertical lift gates to permit dewatering for both maintenance and for emergency temporary closure should it be necessary to remove a gate.

Operational Control and Data Acquisition. Local and remote operation of G-339 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation.

2.5.3 G-341

Structure G-341 is part of the S-5A Basin Diversion Project, a component of the 1994 Everglades Construction Project. Diversion of part of the S-5A Basin runoff to Pumping Station S-6 was a central consideration in the design of STA-1W and STA-2. This diversion was accomplished through the construction of a new divide structure (G-341), enlargement of selected reaches of the Hillsboro and Ocean Canals, and the replacement of bridges as necessary due to the canal enlargements. Structure G-341 consists of a two-bay reinforced concrete spillway provided with two 25-ft wide by 15-ft high vertical lift gates, with a spillway crest elevation of 0.0 ft NGVD. The structure was designed to provide a firm capacity of 600 cfs with 0.46 ft headloss at a flow of 1,710 cfs (Burns & McDonnell 1995). A rating curve developed for this structure is presented in **Appendix 1.**

Operational Control and Data Acquisition. Local and remote operation of G-341 are possible. Remote operation via telemetry is from the District's West Palm Beach Operations Control Center. Headwater, tailwater stage and gate position information are available to the remote operators, while headwater and tailwater staff gauges and gate position indicators are available for local operation.

2.6 RELATED FACILITIES

2.6.1. STA-2 Reserve Canal

The former seepage canal located on the west side of Cell 3 south of the Cell 4 Inflow Canal served as a source of fill for the east levee of Cell 4. No decision has been made on the future use of this area.

2.6.2. Airboat Ramps

Airboat ramps are available in each treatment cell. An airboat ramp was constructed on the north end of Cell 4, at the west end of the spreader canal to provide access to Cell 4. A second airboat ramp was constructed at the west end of the collector canal at the south side of Cell 4.

3 OPERATION

The operation of STA-2 is a function of the operation of both the S-6 Pump Station and G-328 Pump Station, conditions within the treatment area, as well as conditions in the downstream receiving areas. In general, the operation of the S-6 Pump Station is determined by upstream water stages at the pump station in recognition of the seasonal needs of the tributary basin. The canal stage upstream of S-6 is maintained at 10.5 ft NGVD for flood control and 11.5 ft NGVD for water supply. In practice, stages in excess of 12.0 ft NGVD or a rise in stage in the supplying canal of 0.5 ft per hour would be cause to initiate S-6 pumping.

Described below are the anticipated operations of the STA-2 treatment system during normal and other water management conditions.

3.1 NORMAL OPERATION

Proposed structure operations developed and presented herein represent an initial estimate of those operations necessary to achieve the various operational goals of STA-2. Temporal and spatial variations in the distribution of inflows, as well as in the hydraulic response of the treatment areas as vegetative communities mature, will require periodic review and refinement as needed in structure operations to develop and maintain balanced flow distributions. Short-term deviations from the operations described in this Section are anticipated, as District personnel will exercise their best professional judgment based upon existing regional and on-site conditions and data available at the time. Water levels in the STA will be adjusted through operation of the inflow pumps and adjustment of the gates on the interior and outlet structures. Initial operating guidelines are provided below, however, the target water levels and gate openings may need to be refined based on actual operating experience.

3.1.1 Normal Flow Conditions

Normal Operations are defined as those operations for inflows up to and including the Design Flow Condition of 3,370 cfs. This is the sum of the nominal pumping capacities of pump station S-6 (2,925 cfs) and pump station G-328 (444 cfs). For the design flow condition it is assumed that the peak flow is routed through the treatment cells with no flow diversion at structures G-338 and G-339. The design flow passes through the treatment cells and is conveyed to outflow pump station G-335 via the Discharge Canal. Pump station G-335 will discharge at its nominal capacity with a headwater elevation between 8.9 - 13.1 ft NGVD. Flows pumped via G-335 will be discharged into the enlarged L-6 Borrow Canal and distributed to WCA-2A via the G-336A-F structures in the north and G-336G and the L-6 levee gap in the south. For design purposes, the allocation of the 3,370 cfs design flow through the treatment cells was as follows:

- Cell 1: 788 cfs
- Cell 2: 1,485 cfs

- Cell 3: 1,011 cfs
- Cell 4: 1,011 cfs

The Cell 4 design replicated the hydraulic capacity of Cell 3 to provide the operational flexibility to take a cell off line without compromising the capacity of STA-2.

For the design flow condition, updated two-dimensional modeling (Sutron 2007) evaluated two steady-state scenarios, one with all four cells operational and one with Cell 4 off line (**Table 4**).

Table 4. Simulated Stages for the Design Flow Condition (Sutron 2007).

Items	Cell 1	Cell 2	Cell 3	Cell 4	Inflow Canal
	Ft NGVD29	Ft NGVD29	Ft NGVD29	Ft NGVD29	Ft NGVD29
All four cells operational flow scenario (G367A and F closed)					
Upstream end*	14.77	14.15	12.42	11.88	**15.46**
Downstream end*	13.80	11.63	10.40	11.35	**15.01**
All Cells 1, 2 and 3 operational, Cell 4 offline flow scenario					
Upstream end	15.60	14.92	12.70	N/A	**17.86**
Downstream end	14.12	12.86	11.11	N/A	**17.40**

* Cells 1-3 "Upstream end" measured at inflow structure tailwater; Cell 4 "Upstream end" measured at G-337A tailwater; Cells 1-4 "Downstream end" measured at outflow structure headwater. Inflow Canal "Upstream end" at G-337 tailwater; "Downstream end" at G-337A headwater.

Modeling of all four cells in operation (Sutron 2007) indicated that two of the Cell 4 culverts should be closed for storm events up to the design flow, i.e., they are not necessary to pass the design flow and when they are open, the flows to Cell 4 will be too high relative to the other cells. Because of the trapezoidal cell geometry, it is initially suggested that the easternmost (G-367 A) and westernmost gate (G-367 F) be closed. Even with two gates closed at Cell 4, the simulated flows could not achieve the design distribution, yielding

Cell 1: 448 cfs
Cell 2: 856 cfs
Cell 3: 965 cfs
Cell 4: 1,101 cfs

G-335 Tailwater Stage. Modeling of the design discharge (3,040 cfs) conducted during the design of STA-2 discharge culverts assumed a tailwater in WCA-2A of 14.5 ft NGVD, which led to a maximum G-335 tailwater of 17.3 ft, and a stage of 17.2 ft in the north end of the L-6 Borrow Canal (Laura 2000). This simulated G-335 tailwater is above the stated design tailwater of 16.9 ft NGVD, suggesting there may be periods when the tailwater stage at G-335 exceeds its design level due to high water stages in WCA-2A. Such an event occurred in September 2006. In 2008, the L-6 East Levee was raised to the design elevation (17.5 ft NGVD), however, presently (March 2009) several sections of the L-6 West levee are below the design crest elevation of 20.0 ft NGVD. Currently there are plans to raise the L-6 West

Levee to its design elevation as part of the Compartment B construction project. ***In the interim, the tailwater of G-335 should be monitored during high flow events, and pumping should be reduced as required to keep the tailwater below 16.9 ft NGVD. This may necessitate reducing the S-6 inflow pump based on water levels in the treatment cells. Operational options also include diversion to the Refuge through G-338 (with notification of the Refuge Manager), accumulation of water in the treatment cells, pumping into Lake Okeechobee at S-2 (which may require an Emergency Authorization from FDEP), or any combination of these.***

G-341 Operational Strategy. The operational intent of structure G-341 is to provide flexibility for water management in the S-5A and S-2/S-6 basins. Diversion of a portion of the historical S-5A Basin runoff to Pumping Station S-6 was a central consideration in the design of STA-1W and STA-2, and G-341 was constructed to facilitate this diversion[1] (Burns & McDonnell 1995). Approximately 27,550 acres of the historical S-5A Basin is located west of G-341, and full diversion of runoff from that entire area would exceed the targeted diversion by approximately 14 percent; hence, G-341 may be opened during some runoff events and still achieve the diversion objective of the ECP. The following operational strategy is offered as guidance, to be revised as additional operational experience is gained.

1. The structure will normally be closed, except when the L-13 canal is being used for water supply and stormwater runoff from the portion of the historical S-5A Basin located west of the structure will be directed to the S-2/S-6 Basin and subsequently to STA-2 for treatment (Nova Consulting, Inc. 2003).

2. When the hydraulic capacity of the S-6 pump station, or the treatment capacity of STA-2 is insufficient, and excess pumping capacity exists at S-5A, G-341 can be opened to allow runoff from the portion of the historical S-5A Basin located west of the structure to be directed east to the S-5A pump station and subsequently to STA-1W/1E for treatment. In general, G-341 will be opened only when the headwater stage, located on the west side of the structure, is at 12.5 ft NGVD and excess pumping capacity exists at S-5A, unless S-2 has the potential to pump, or is pumping, at which time G-341 may be opened even when the headwater stage is lower than 12.0 ft NGVD (see No. 4 below).

3. When the hydraulic capacity of the S-5A pump station, or the treatment capacity of STA-1W and STA-1E is insufficient, and excess pumping capacity exists at S-6, G-341 may also be opened to allow runoff from the portion of the S-5A Basin located east of the structure to be directed west to the S-6 pump station and subsequently to STA-2 for treatment. In general, G-341 will be opened only when the TW stage, located on the east side of the structure, is at 12.5 ft NGVD and excess pumping capacity exists at S-6, unless S-2 has the potential to pump, or is pumping, at which

[1] An older structure (S-5AX) was located further west in the Ocean Canal at the location of the historical divide between S-5A and S-2/S-6 basins, and was removed as part of the canal conveyance improvement.

time G-341 may be opened even when the headwater stage is lower than 12.0 ft NGVD (see No. 4 below).

4. As part of the regional water management system, G-341 may be operated to achieve regional water management goals. For example, in order to minimize back pumping into Lake Okeechobee via Pump Station S-2, G-341 may be opened to divert runoff from west of the structure to S-5A. When S-2 has the potential to pump, or is pumping, G-341 may be opened even when the headwater stage is lower than 12.0 ft NGVD.

5. During low water conditions in either the EAA, STA-1E, STA-1W or STA-2, G-341 can be opened to
    a. allow runoff from the area west of the structure to be directed east to the S-5A pump station and subsequently to STA-1W/1E.
    b. allow runoff from the area east of the structure to be directed west to the S-6 pump station and subsequently to STA-2.
    c. allow water supply deliveries from the east (or west) to be delivered to the west (or east) of the structure.

3.1.2 General Operation of the Treatment Cells

Operating Depth Ranges. In general, STA treatment cells are operated to encourage colonization by and continued viability of wetland plants and optimize uptake of phosphorus from the stormwater passing through the cells.

- **Minimum Depth.** To the maximum extent practicable, a minimum static water level of 0.5 ft above the reference ground elevation of the treatment cells will be maintained to avoid dryout of the treatment cells, subject to available water from the upstream watershed.

- **Maximum Depth.** To the maximum extent practicable, a maximum static water level of 4.0 ft above the reference ground elevation of the treatment cells will be observed to avoid damage to the levees and marsh vegetation.

Target depths between storm events. Recommended target depths for the different treatment vegetation communities have varied over the years as operating and performance experience has been gained. **Table 5** identifies the reference ground elevation, target vegetation community, target depth and associated target stage between storm events for each treatment cell. As refined topographic data become available and additional operational experience is gained, these reference ground elevations and target stages will be revised.

Table 5. Target Stages for STA-2 Normal Operations.

Cell	Effective Treatment Area (acres)	Reference Ground Elevation (ft NGVD)	Target Dominant Vegetation	Year-round Target Depth (ft)	Target Stage Between Storm Events (ft NGVD)	Minimum Stage (ft NGVD)	Maximum Stage (ft NGVD)	Structure Used for Targets
1	1,798	11.37	Emergent	1.73	13.10	11.87	15.37	G-330
2	2,270	10.64	Emergent	0.96	11.60	11.14	14.64	G-332
3	2,270	9.72	SAV	1.18	10.90	10.22	13.72	G-334
4	1,902	8.69	SAV	1.51	10.20	9.19	12.69	G-368
Total	***8,240***							

Note: "Reference Ground Elevation" represents the current estimate of average ground elevation.

Throughout this operation plan, an operational range of +/- 0.20 ft is applied to all the target stages, unless otherwise stated. For example, if the plan calls for a target stage of 12.0 ft NGVD, then the operational range is 11.8 – 12.2 ft NGVD.

Balance flows and phosphorus loads among treatment cells. To optimize STA phosphorus removal performance, the inflows should be balanced among the flow-ways to the extent practical. Temporal and spatial variations in the distribution of inflows, as well as in the hydraulic response of the treatment areas as vegetative communities mature, will require periodic review and refinement as needed in structure operations to develop and maintain balanced flow distributions. Short-term deviations from the operations described in this Section are anticipated, as District personnel will exercise their best professional judgment based upon existing regional and on-site conditions and data available at the time.

Because the ground elevations differ significantly from the eastern cells to the westernmost cells, it is critical that the appropriate gate settings are put in place to ensure appropriate flow and load distributions. Gate settings shall be implemented by District operations staff that are intended to evenly distribute flows and phosphorus loads among the treatment cells. Revisions to these gate settings are anticipated as operational experience is gained and as STA performance necessitates.

Depth-duration after storm events. To a certain extent, the operation of the inflow and outflow structures can be modulated to minimize damage to the treatment vegetation caused by prolonged durations of high water levels; this will optimize long-term treatment performance of the STA. Previously, the operating guidance (and permit condition) for the STAs had been to ensure that water levels are at the maximum depth of 4.5 ft for no more than 10 days, however, concerns have been raised that 10 days at 4.5 ft is too long to maintain viable treatment vegetation. To minimize impacts to treatment vegetation and associated treatment performance, the following depth-duration thresholds are proposed during non-flood conditions:

- avoid 4.0 ft for more than 3 consecutive days
- avoid 3.5 ft for more than 7 consecutive days
- avoid 3.0 ft for more than 10 consecutive days

To minimize damage to the treatment vegetation caused by prolonged durations of high water levels and to ensure optimal long-term treatment capacity, additional pumping units will be

turned on at G-335 if the above depth-duration thresholds are likely to be met in any of the treatment cells. If turning on additional pumping units at G-335 doesn't achieve the desired depth-duration, pumping will be reduced at S-6 ***if the Hillsboro Canal is not in flood protection mode***. In addition, operations will allow for an adequate rest period following periods of prolonged duration at high depth within the treatment cells.

Maintenance operations. Exercising the water control structures associated with STA-2 including the pumping units is authorized by the EFA operating permit for maintenance purposes.

Summary of Operations During Normal Conditions

- Structure G-341 will normally be closed, except when the L-13 canal is being used for water supply and stormwater runoff from the portion of the historical S-5A Basin located west of the structure will be directed to the S-2/S-6 Basin and subsequently to STA-2 for treatment.
- Inflow pump station S-6 will be operated to maintain flood protection in the tributary basins.
- STA-2 cell inflow structures, including G-337A, will be opened to allow up to a maximum inflow of 3,370 cfs. When not needed to convey the maximum inflow rate, structures G-367A and G-367F should remain closed to assist in balancing the hydraulic and phosphorus loading among the treatment cells. Other gate settings shall be implemented as needed by District operations staff with the goal of evenly distributing flows and phosphorus loads among the treatment cells. Revisions to these initial gate recommendations are anticipated as operational experience is gained and as STA performance necessitates.
- STA-2 treatment cell inflow/interior/outflow flow control structures will be opened accordingly to achieve the target stages in **Table 5**, and to maintain stages within the minimum and the maximum range identified in **Table 5**.
- G-339 Diversion structure will be closed for all Inflow Canal flows up to a G-339 headwater of 17.91 ft NGVD.
- Seepage return pump Station G-337 will be operated to maintain an average water surface stage of 9.0 ft NGVD within the Seepage Canal.
- For Normal Operations, WCA-1 water supply structure G-338 will be operated at the discretion of the District when the criteria of upstream available water and available WCA-1 capacity are met.
- All treatment cell discharges are directed to pump station G-335 via the Discharge Canal. G-335 discharges are directly routed to the L-6 Borrow Canal. Hydropattern Restoration sheet flow via uncontrolled spillways G-336 A-F is then directed to the northwesterly perimeter of WCA-2A and to the southern perimeter of WCA-2A via the gap in the L-6 levee.
- Presently (September 2009) several sections of the L-6 West levee are below the design crest elevations of 20.0 ft, and these are anticipated to be raised as part of the Compartment B construction. ***In the interim, the tailwater of G-335 should be monitored during high flow events, and pumping should be reduced as required to keep the***

tailwater below 16.9 ft NGVD. This may necessitate reducing the S-6 inflow pump based on water levels in the treatment cells. Operational options also include diversion to the Refuge through G-338 (with notification of the Refuge Manager), accumulation of water in the treatment cells, pumping into Lake Okeechobee at S-2 (which may require an Emergency Authorization from FDEP), or any combination of these.

3.1.3 Operational Envelopes

The *Everglades Protection Area Tributary Basins Long Term Plan for Achieving Water Quality Goals* recommends structural, vegetative and operational enhancements for each STA, and provides a predicted range of long-term average outflow phosphorus concentrations once the enhancements are completed. Refinement of the operational strategies for the STAs is required to optimize the phosphorus removal performance of the STAs and to ensure that the STAs are not subject to overload from inflow volume or nutrients. In addition, assessment of annual or long-term performance is aided by a comparison of actual loading to the future loading that was anticipated during the design of the enhancements to the treatment areas. The paper "The Operational Design Envelope for the STAs" develops the operational range for inflow volume and phosphorus loads that were anticipated for each STA, and recommends a method for utilizing the resulting information to assist in tactical operational decisions (Goforth 2005). These operational ranges were updated during the EAA Regional Feasibility Study using anticipated future water management conditions (ADA/Burns & McDonnell 2005). The operational envelopes presented in the tables and figures in **Appendix 2** can be used to track the status of each STA relative to long-term cumulative inflow volumes and loads. In addition, when non-routine discretionary releases are contemplated, these operational envelopes provide an estimate of the cumulative flows and loads that can be captured by the STA without nutrient overloading. This information can be updated as estimates of STA inflow are updated through the permit process.

3.2 PRE-STORM OPERATIONS

The intent of a pre-storm drawdown is to provide storage in STA-2 prior to a heavy rainfall event. Pre-storm drawdown operations may be based upon the District's rainfall forecast. If storage in STA-2 can be created by discharging water prior to the storm event, pre-storm drawdown may be initiated. If a major storm is predicted, the water levels in the treatment cells should be reduced to the target stages in **Table 5**[2]**:**

Cell 2: 11.6 ft NGVD
Cell 3: 10.9 ft NGVD
Cell 4: 10.2 ft NGVD

Cells 2, 3 and 4 outlet structures have emergency back-up power on-site that will help mitigate the impacts of power loss, however, pre-storm operations are accompanied by some risk that a

[2] Discharges through the Cell 1 outlet structures are controlled by fixed crest weirs so no operation is needed

drawdown may be implemented and the actual amount of rainfall does not match the predicted amount, with the result that after the storm passes, the target stages may not be met. The biological consequences of this operation could be potential damage to the vegetation if a source of water is not available after such a pre-storm drawdown and related less-than-predicted rainfall. Such an occurrence in the dry season could result in even higher risk of damage to the vegetation if a source of water can not be found for an extended period of time.

3.3 WATER SUPPLY OPERATION

It is not anticipated that water supply deliveries to the Refuge, WCA-2A or the Lower East Coast will be made through STA-2. However, it is hydraulically possible to convey water from Lake Okeechobee through S-6 and subsequently through G-338 or G-339 to deliver water to the Refuge (and areas downstream) and WCA-2A, respectively, should the need arise. The operation of G-338 in this mode would require raising the stage in the entire Supply Canal higher than the stage in the Refuge prior to opening the gate.

3.4 EXTREME FLOW OPERATION

Discretion in the operation of STA-2 structures is reserved by the District Operations staff as necessary to account for flood protection, excess precipitation and upstream and downstream conditions. The following discussion is offered only as general guidance.

STA-2 has been designed to accommodate Extreme Hydrologic Conditions, SPS (Standard Project Storms) and PMS (Probable Maximum Storms) as described below. The frequency of these events however, is on the order of magnitude of 200 to 500 year/24 hour events, respectively. SPS precipitation is defined as 23.6 inches of rain over a 10 sq. mile basin over a 24-hour duration. The PMS precipitation is 47.2 inches of rain over the same coverage area and duration. STA-2 operations for these events are described below. Inflows resulting from precipitation events smaller than the SPS and PMS events should fall under "Normal Operating Conditions" for the STA. If a major storm is predicted, the water levels in the treatment cells should be reduced to the target stages in **Table 5[3]:**

Cell 2: 11.6 ft NGVD
Cell 3: 10.9 ft NGVD
Cell 4: 10.2 ft NGVD

Stages within STA-2 will rise and fall with the passing of the extreme storm event, and will be influenced by the rainfall amount, the stage at the initiation of rainfall, the operations during the event, and the volume of pumping before and during the event. **Flow diversion via G-339 will begin at its Normal Operations control elevation of 17.91 ft NGVD.** At the District's discretion, additional operational strategies may be applied to maintain G-339 headwater stage

[3] Discharges through the Cell 1 outlet structures are controlled by fixed crest weirs so no operation is needed

elevation below 17.91 ft NGVD during these more frequent precipitation events outside of the SPS and PMS events.

Standard Project Storm. To accommodate the rainfall in the treatment cells from the SPS event, approximately 800 cfs will be diverted from the Supply Canal via control structure G-339 to the L-6 Borrow Canal when the headwater elevation at G-339 rises to 17.91 ft NGVD. The resulting net inflow to STA-2 during the SPS event will be 2,570 cfs. Pump station G-335 will discharge outflows from the STA at its design capacity (3,040 cfs) with a higher headwater intake elevation of 14.20 ft NGVD.

Probable Maximum Storm. To accommodate the PMS rainfall in the treatment cells, approximately 1,970 cfs will be diverted via control structure G-339 to the L-6 Borrow Canal when the headwater stage rises to 17.91 ft NGVD. The resulting net pumped inflow to STA-2 during the PMS event will be approximately 1,400 cfs. Pump station G-335 will discharge at its design capacity (3,040 cfs) with a maximum headwater intake elevation of 16.2 ft NGVD.

During the design of Cell 4, Brown and Caldwell evaluated 4 scenarios to better understand the interaction of the new treatment cell with the existing cells during the SPS and PMS events (Brown and Caldwell 2005d):

Scenario 1. Cells 1, 2 and 4 are operational; Cell 3 opened at the beginning of the events.
The initial stages within the STA for this scenario was established by simulating full flow through Cells 1, 2 and 4 until steady state conditions occurred. Structure gate openings were modeled to balance flows through the four cells as closely as possible.

Scenario 2. Cells 1, 2 and 4 are operational; Cell 3 remains closed during the event.
The initial stages within the STA for this scenario was established by simulating full flow through Cells 1, 2 and 4 until steady state conditions occurred. Structure gate openings were modeled to balance flows through the four cells as closely as possible.

Scenario 3. All four cells are operational throughout the event.
The initial stages within the STA for this scenario was established by simulating full flow through all four treatment cells of the STA until steady state conditions occurred. Structure gate openings were modeled to balance flows through the four cells as closely as possible.

Scenario 4. Cells 1, 2 and 3 are operational; Cell 4 closed during the event.
The initial stages within the STA for this scenario was established by simulating full flow through all four treatment cells of the STA until steady state conditions occurred, as was done for Scenario 3. However, prior to simulating the extreme event, the gates at G-337A and G-368 were closed and the model was again allowed to balance.

Modeling Results. Complete details of the modeling and results are presented in the STA-2 Cell 4 design documents (Brown and Caldwell 2005d), and the peak stages at the headwater

and tailwater of each cells' inlets and outlets are summarized in the tables below. **To avoid any possible oversplash or overtopping from the SPS and PMS events, in the Final Hydraulic Modeling Technical Memorandum (December 2005) Brown & Caldwell recommended that the gates at G-337A and the outflow structure G-368 be fully closed prior to an extreme storm event to isolate Cell 4 while keeping Cells 1-3 fully open (i.e., Scenario 4). The modeling indicated that while water stage was contained within Cell 4 during extreme events if fully open, wind setup and wave runup could cause some levee oversplash at the design elevation of 19.0 ft NGVD. An important constraint resulting from this recommendation is to not take Cells 1-3 offline unless there is the ability to bring them back on-line within the lead time for an impending extreme event.**

Table 6. Results from Scenario 1 (Cells 1, 2 and 4 operational; 3 opened at begining of the events) from Brown & Caldwell 2005d.

	SPS		PMS	
Structure	Max Stage (ft)	Time (hrs)	Max Stage (ft)	Time (hrs)
G-329C HW (IC_270)	17.15	24.25	18.93	24.22
G-329C TW (SC1_270)	16.47	24.27	18.31	24.32
G-330C HW (CC1_740)	16.38	24.29	18.40	24.33
G-330C TW (DC_740)	14.67	45.56	16.64	46.96
G-331C HW (IC_330)	16.95	24.25	18.78	24.23
G-331C TW (SC2_330)	16.50	24.12	18.29	24.22
G-332 HW (DC_716)	15.86	24.40	18.02	24.25
G-332 TW (DC_715)	14.67	45.34	16.64	46.84
G-333C HW (IC_435)	16.69	24.25	18.60	24.25
G-333C TW (SC3_435)	15.04	57.87	16.96	62.71
G-334 HW (CC3_712)	14.99	56.87	16.94	61.93
G-334 TW (DC_715)	14.67	45.34	16.64	46.84
G-XXXC HW (IC_B105)	15.46	53.06	17.38	54.54
G-XXXC TW (SC4_85)	14.96	68.28	16.88	67.44
STRCELL4 HW (CC4_40)	14.93	68.12	16.87	66.80
STRCELL4 TW (DC_620)	14.70	51.01	16.66	50.24

Note: G-XXXC refers to G-367C; STRCELL4 refers to G-368.

Table 7. Results from Scenario 2 (Cells 1, 2 and 4 fully operational; 3 remains closed) from Brown & Caldwell 2005d.

Structure	SPS Max Stage (ft)	SPS Time (hrs)	PMS Max Stage (ft)	PMS Time (hrs)
G-329C HW (IC_270)	17.91	24.00	18.57	24.19
G-329C TW (SC1_270)	16.47	24.28	18.31	24.26
G-330C HW (CC1_740)	16.31	24.32	18.27	24.27
G-330C TW (DC_740)	13.86	42.99	15.93	24.40
G-331C HW (IC_330)	17.77	24.00	18.22	24.19
G-331C TW (SC2_330)	16.67	24.13	18.25	24.18
G-332 HW (DC_716)	15.69	24.22	17.91	24.22
G-332 TW (DC_715)	13.86	43.02	15.93	24.41
G-333C HW (IC_435)	17.66	24.00	18.47	24.19
G-333C TW (SC3_435)	14.92	27.27	17.13	24.79
G-334 HW (CC3_712)	14.92	24.91	17.13	25.50
G-334 TW (DC_715)	13.86	43.02	15.93	24.41
G-XXXC HW (IC_B105)	15.40	60.44	17.00	24.27
G-XXXC TW (SC4_85)	14.40	74.47	16.23	40.22
STRCELL4 HW (CC4_40)	14.32	73.16	16.17	39.55
STRCELL4 TW (DC_620)	13.93	48.19	15.95	26.97

Note: G-XXXC refers to G-367C; STRCELL4 refers to G-368.

Table 8. Results from Scenario 3 (all four cells operational) from Brown & Caldwell 2005d.

Structure	SPS Max Stage (ft)	SPS Time (hrs)	PMS Max Stage (ft)	PMS Time (hrs)
G-329C HW (IC_270)	16.63	24.18	17.61	24.20
G-329C TW (SC1_270)	16.09	24.24	17.63	24.23
G-330C HW (CC1_740)	15.97	24.27	17.60	24.24
G-330C TW (DC_740)	13.98	45.43	15.87	27.51
G-331C HW (IC_330)	16.39	24.19	17.52	24.21
G-331C TW (SC2_330)	15.79	24.19	17.33	24.24
G-332 HW (DC_716)	15.10	24.47	17.09	24.28
G-332 TW (DC_715)	13.98	45.20	15.86	27.43
G-333C HW (IC_435)	16.11	24.21	17.39	24.22
G-333C TW (SC3_435)	14.68	24.30	16.54	24.33
G-334 HW (CC3_712)	14.59	24.36	16.50	24.35
G-334 TW (DC_715)	13.98	45.20	15.86	27.43
G-XXXC HW (IC_B105)	14.83	56.77	16.48	24.28
G-XXXC TW (SC4_85)	14.29	68.53	16.04	38.83
STRCELL4 HW (CC4_40)	14.23	67.50	15.99	38.22
STRCELL4 TW (DC_620)	14.02	51.92	15.87	29.11

Note: G-XXXC refers to G-367C; STRCELL4 refers to G-368.

Table 9. Results from Scenario 4 (Cells 1, 2 and 3 operational; 4 remains closed) from Brown & Caldwell 2005d.

Structure	SPS Max Stage (ft)	SPS Time (hrs)	PMS Max Stage (ft)	PMS Time (hrs)
G-329C HW (IC_270)	17.94	24.25	18.37	24.19
G-329C TW (SC1_270)	16.53	24.30	18.16	24.27
G-330C HW (CC1_740)	16.41	24.37	18.12	24.28
G-330C TW (DC_740)	14.38	34.60	16.16	24.37
G-331C HW (IC_330)	17.80	24.25	18.32	24.20
G-331C TW (SC2_330)	16.71	24.14	18.14	24.19
G-332 HW (DC_716)	15.90	24.22	17.83	24.22
G-332 TW (DC_715)	14.37	34.58	16.16	24.33
G-333C HW (IC_435)	17.69	24.25	18.26	24.20
G-333C TW (SC3_435)	14.89	67.66	16.45	34.98
G-334 HW (CC3_712)	14.80	65.44	16.41	33.64
G-334 TW (DC_715)	14.37	34.58	16.16	24.33
G-XXXC HW (IC_B105)	13.33	37.35	15.36	45.34
G-XXXC TW (SC4_85)	13.33	37.33	15.36	45.37
STRCELL4 HW (CC4_40)	13.33	45.88	15.36	60.31
STRCELL4 TW (DC_620)	14.37	34.40	16.15	24.40

Note: G-XXXC refers to G-367C; STRCELL4 refers to G-368.

Summary of STA-2 Structure Operations During SPS Event:

- Prior to the onset of extreme rainfall events, the average stages within STA-2 Cells 2, 3 and 4 should be lowered to 11.6 ft NGVD, 10.9 ft NGVD and 10.2 ft NGVD, respectively[4].

- G-339 Diversion structure is to be opened at control headwater elevation of 17.91 ft NGVD allowing for diversion flow of approximately 800 cfs to the L-6 Borrow Canal. Maximum G-339 TW for SPS diversion was estimated as approximately 17.60 ft NGVD.

- The inflow and outflow structures for Cells 1-3 should be fully opened allowing for conveyance of all pumped and SPS event flows through the treatment cells. Total pumped inflow via S-6 and G-328 directed to treatment cells should be approximately 2,570 cfs (total S-6 + G-328 capacity of 3,370 cfs – G-339 diversion of 800 cfs). This reduction in pumped inflow is to accommodate for the SPS event rainfall on the treatment cells. Outflow pump station G-335 will discharge at maximum capacity of 3,040 cfs.

[4] Discharges through the Cell 1 outlet structures are controlled by fixed crest weirs so no operation is needed

- **To avoid any possible oversplash or overtopping from the PMS event, Brown & Caldwell recommended that the gates at G-337A and the outflow structure G-368 be fully closed prior to an extreme storm event to isolate Cell 4 while keeping Cells 1-3 fully open (Brown & Caldwell 2005d). If Cells 1, 2 or 3 are off-line, they should be brought back on line and Cell 4 closed prior to an extreme event.**

- **The stage in Cell 4 should be maintained at or below 13.7 ft NGVD (Brown & Caldwell 2005d).**

- **The gates at the Cell 4 inflow or outflow locations should not be opened until the stages in the STA 2 system are such that positive releases (to the outflow canal) would occur from Cell 4.**

- Seepage pump station G-337 will operate at necessary capacity to achieve and or maintain an average stage within the Seepage Canal of 9.0 ft NGVD.

- District personnel will exercise their best professional judgment, based upon existing regional and on-site conditions and data available at the time, and use their discretion for additional structure manipulations (such as operations of structure G-338), to account for flood protection, excess precipitation and upstream and downstream conditions. Treatment cell depths will temporarily exceed 4.0 ft above the reference ground elevation.

Summary of STA Structure Operations During PMS Event:

- Prior to the onset of extreme rainfall events, the average stages within STA-2 Cells 2, 3 and 4 should be lowered to 11.6 ft NGVD, 10.9 ft NGVD and 10.2 ft NGVD, respectively[5].

- G-339 Diversion structure will be opened at control headwater elevation 17.91 ft NGVD allowing for diversion flow of approximately 1,970 cfs to the L-6 Borrow Canal.

- The inflow and outflow structures for Cells 1-3 should be fully opened allowing for conveyance of all pumped and PMS event flows through the treatment cells. Total pumped inflow via S-6 and G-328 directed to treatment cells should be approximately 1,400 cfs (total S-6 + G-328 capacity of 3,370 cfs – G-339 diversion of 1,970 cfs). This reduction in pumped inflow is to accommodate for the PMS event rainfall on the treatment cells. Outflow pump station G-335 will discharge at maximum capacity of 3,040 cfs.

[5] Discharges through the Cell 1 outlet structures are controlled by fixed crest weirs so no operation is needed

- **To avoid any possible oversplash or overtopping from the PMS event, Brown & Caldwell recommended that the gates at G-337A and the outflow structure G-368 be fully closed prior to an extreme storm event to isolate Cell 4 while keeping Cells 1-3 fully open (Brown & Caldwell 2005d). If Cells 1, 2 or 3 are off-line, they should be brought back on line and Cell 4 closed prior to an extreme event.**

- **The stage in Cell 4 should be maintained at or below 13.7 ft NGVD (Brown & Caldwell 2005d).**

- **The gates at the Cell 4 inflow or outflow locations should not be opened until the stages in the STA 2 system are such that positive releases (to the outflow canal) would occur from Cell 4.**

- Seepage pump station G-337 will operate at necessary capacity maintain an average stage within the Seepage Canal of 9.0 ft NGVD.

- Operational discretion for additional physical structure manipulations (such as operations of structure G-338) is reserved by SFWMD Operations, to account for flood protection, excess precipitation and upstream and downstream conditions. Treatment cell depths may temporarily exceed the depth of 4.0 ft above the reference ground elevation.

3.5 DROUGHT OPERATIONS

Subject to water availability, the District shall maintain a minimum water depth in STA-2 at an average of 0.5 ft above the reference ground elevations in **Table 5** to the greatest extent practicable. The ability to maintain this minimum water elevation is determined primarily by the availability of water from rainfall, the S-2/S-6 basins, Lake Okeechobee and the Refuge. If water depths drop below 0.5 ft, and if supplemental water is available, water can be drawn from the Hillsboro Canal or by opening G-338 to draw water from the Refuge. During severe drought condition, the minimum stages may be revised as follows: SAV cells shall still be maintained at 0.5 ft above reference ground elevation to greatest extent practicable (with same above potential optional water sources). Cells 1 and 2 will be maintained at or above 0.5 ft below reference ground elevation.

In the extreme case that there is no water available from the upstream watershed, other sources and/or from rain, the treatment cells may dry out. After an extended dryout, there is a potential that the water quality improvement performance of subsequent discharges of water from treatment cells may be adversely affected. The severity and duration of the dry conditions that may lead to reduced project performance is currently unknown, as is the magnitude and duration of the potential depression of project performance. Analysis of the monthly compliance

monitoring data collected at the project outflow monitoring station will be useful in making these determinations.

The adjacent farmer which utilizes G-328 holds a consumptive use permit authorizing withdrawals of up to 100 cfs from the STA-2 Supply Canal. These withdrawals will need to be replaced, and it is anticipated that G-338 or S-6 will be operated as needed to do so.

Operations Following Dryout. After a prolonged dry period within the treatment cells, there is a potential for the release of phosphorus during the first flush after flow-through operations resume. Management activities following a dry out will vary depending on the severity of the drought and the attendant loss of vegetation. For mild to moderate loss of vegetation, slowly raising depths to 1.0 ft is recommended. For severe loss of vegetation, it may be necessary to limit the initial depth to 0.5 ft to promote re-establishment desirable vegetation. To minimize disturbance to or mortality of wildlife, including the Indigo Snake, the USFWS is now requiring that STA treatment cells be hydrated (initially or after dry-out) at a rate of no more than 0.5 feet per day until water levels are 0.5 feet above average ground elevation of a cell (Bearzotti 2009). Once this depth is reached there is no restriction on fill rate. To reduce the potential for phosphorus loading downstream, it will be advantageous to retain as much of the first pulse of water as possible. The length of time required to allow phosphorus levels to moderate will vary depending on the length of dryout, the type of soils affected, the condition of the plant community and time of year. This scenario may require diversion of flow around the treatment area depending on rainfall levels and the time required for phosphorus stabilization following dryout. Internal phosphorus concentrations will be monitored and calculations made to determine whether unabated flow-through or temporary retention of post dryout flows will contribute the least phosphorus downstream.

In accordance with the State operating permit, the District shall evaluate and correct adverse dryout effects on the water quality performance of STA-2. If the compliance requirements in the permit are not met due to dryout conditions, then the District shall propose modifications to the *Operation Plan* as appropriate and submit the revised plan to the Department.

3.6 TREATMENT CELLS OUT OF SERVICE OPERATION

STA-2 design allows for hydraulic isolation of one or more treatment cells from the treatment system when deemed necessary or desirable. Treatment Cell 1 can be isolated through operations of inflow/outflow structures G-329 A-D and placement of pre-fabricated metal sheets in front of the G-330 A-E culverts. Treatment Cell 2 can be isolated through operations of inflow/outflow structures G-331 A-G and G-332. Treatment Cell 3 can be isolated through operations of inflow/outflow structures G-333 A-E and G-334. Treatment Cell 4 can be isolated through operations of structure G-337A and G-368A-D.

3.7 NUTRIENT REMOVAL PERFORMANCE OPTIMIZATION

The EFA, Section 373.4592(4)(d)3., Fla. Stat., requires the District to conduct research on optimizing the treatment performance of the STAs, recognizing that additional reductions in TP outflow concentrations, beyond the interim goal of 50 ppb, will be beneficial to the EPA. In accordance with this requirement, the Long-Term Plan includes research activities designed to enhance STA performance. Operations shall be conducted to distribute the flows and water levels within STA-2 to optimize the phosphorus reduction performance and shall be updated as necessary to include the results of the District's Process Development and Engineering (PD & E) program being implemented as a part of the Long-Term Plan (SFWMD 2003).

Compliance with Water Quality Standards. The District is committed to the implementation of its responsibilities pursuant to the EFA, §373.4592, Fla. Stat., and its agreements with the federal government. Water quality conditions both upstream and downstream of the STA-2 project will be monitored through a series of programs, including the BMP permit programs required by Rule 40E-63, F.A.C., the permits for this project, and the Long-Term Plan. While this project is directed toward compliance with interim water quality goals, the District is implementing vegetation and operational measures designed to achieve compliance with all water quality standards by December 31, 2006. In 2003 and again in 2004, the District transmitted to the Department strategies to achieve compliance with state water quality standards, including phosphorus, by December 31, 2006. In addition to the Cell 4 expansion, the District is moving forward with the implementation of additional treatment area within the entirety of the Compartment B (see **Figure 1**). Revisions to STA-2 operations will occur as these components are implemented, and this Operation Plan will be revised as appropriate.

Recommended Improvements and Enhancements. Improvements and enhancements recommended for STA-2 are generally consistent with Alternative 1 as it is presented in the October 23, 2002, *Evaluation of Alternatives for the ECP Basins*. The single exception is the proposed routing of power lines to new water control structures, which has been adjusted to reflect the specific construction sequence. The recommended enhancements to STA-2 include the following component elements:

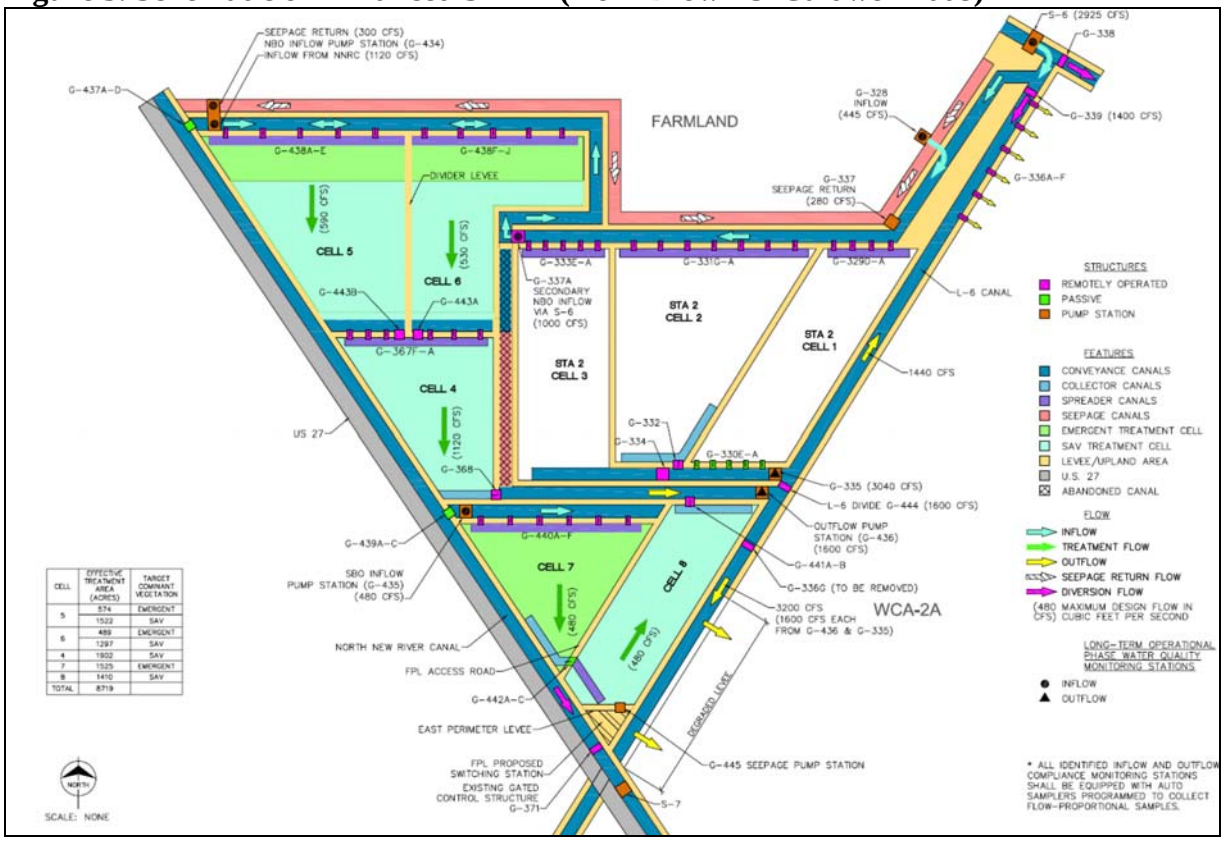
- Construction of approximately 2.2 miles of interior levee, subdividing Cell 1 into Cells 1A and 1B, and Cell 2 into Cells 2A and 2B;
- Construction of additional water control structures through the new levees between cells in series. Four control structures are assigned to each cell, and assumed to be equivalent in number and character to STA-3/4's G-381 Structures (8'x8' gated reinforced concrete box culverts, or RCB's, with telemetric control);
- Extension of an overhead power distribution line to provide electrical service to the new structures;
- One small forward-pumping station along the new interior Cell 2 levee to permit withdrawal from upstream emergent marsh cell to maintain stages in the downstream SAV cell. This

station pumping from Cell 2A to Cell 2B is assigned a preliminary capacity of 14 cfs (equal to a maximum daily evaporation rate from Cell 2B of 0.24"/day);

- Herbicide treatment of Cells 1B and 2B for removal of emergent macrophyte vegetation to permit development of SAV.

A schematic of STA-2 modified as recommended herein is presented in **Figure 3**. As originally simulated in the October 23, 2002, *Evaluation of Alternatives for the ECP Basins*, the subdivision of each of the three flow paths was modeled assigning 40% of the total area in the flow path to the upstream cell, with the remaining 60% of the flow path in the downstream cell. That distribution has subsequently been refined to take advantage of existing topographic features in the interest of construction economy. As presently planned, Cell 1A will occupy 40% of the most easterly flow path and Cell 2A will occupy 30% of the central flow path. Those adjustments in the extent of area converted to SAV would be expected to have a slight beneficial impact on the results of the original simulations. The enhancements to Cells 1 and 2 of STA-2 are anticipated to occur after the full build-out of Compartment B.

Figure 3. Schematic of Enhanced STA-2 (from Brown & Caldwell 2008)



3.8 WCA-2A HYDROPATTERN RESTORATION

STA-2 will be operated to the maximum extent practical to improve the quality, timing and distribution of water entering the northwest portion of WCA-2A. The long-term goal is to re-establish sheet flow to the region, a characteristic that was drastically altered with the completion of the Central and Southern Flood Control Project.

Treated discharges from STA-2 will help restore a more natural delivery of water to WCA-2A, specifically, with respect to volumes, timing and distribution. This will be accomplished in two phases. The original design of the hydropattern restoration features anticipated delivery of treated water along the entire 7.5 mile reach between G-335 and S-6. However, due to concerns about potential adverse water quality impacts due to concentrations around 50 ppb, the District modified the design to divert, on an interim basis, discharges to areas that were already impacted near S-6 and S-7. Initially, treated water from STA-2 is directed across the northernmost two miles and the southern reach of the WCA-2A boundary just north of S-7. Adjacent areas within WCA-2A are already impacted with elevated levels of nutrients. The six structures G-336 A-F are uncontrolled box culverts situated along the northernmost 3 miles of the L-6 borrow canal, just south of G-339. Structures G-336 A-F discharge flows originating from pump station G-335 via the L-6 Borrow Canal into WCA-2A. Structures G-336 A-F provide for hydropattern restoration sheet flow along the northwesterly perimeter of WCA-2A. It is anticipated that when the long-term water quality solutions are in place, the remaining reach between G-335 and G-336F will be opened to allow greater sheetflow into WCA-2A. A divide structure, G-336G, is located just south of G-335 in the L-6 borrow canal, and its purpose is to direct most of the low flows to the north, while allowing a portion of the higher flows from G-335 to pass to the impacted areas of WCA-2A near S-7. The G-336G structure consists of five (5) 96" diameter culverts and associated risers with a weir crest elevation of 14.25 ft NGVD. Treated discharges from STA-2 enter an already impacted area of the WCA-2A along a 3,400-foot gap in the L-6 levee, located just north of S-7.

After long-term water quality solutions are in place, it is anticipated that new discharge structures will be constructed to allow a uniform distribution of treated water along the northwest boundary of WCA-2A. This construction is anticipated in the Long-Term Plan to commence in WY2010. The Hydropattern Restoration projects shown in the 2003 Long-Term Plan were conceptual in nature and these projects' scopes and schedules will be refined in the 2008 Report to the Governor and Legislature that the District will be developing in FY2008.

3.9 ADDITIONAL FLOWS/BMP REPLACEMENT WATER

STA-2 will be operated to the maximum extent practical to offset reductions in volumetric discharges to the EPA resulting from the implementation of the EAA BMP Program. Replacement water will be provided from Lake Okeechobee and distributed to the STAs. However, actual volumes sent to each STA cannot be quantified in advance since the quantities depend on temporal and spatial variables: the annual reduction in discharge due to BMP implementation, available treatment capacity in each STA, and water conditions in the

downstream water conservation areas. In July 2006, authorization was provided by the District Governing Board to enter into rule development to amend the EAA replacement water methodology because of the following reasons:

1. Long-term analysis of rainfall and flow data from the EAA collected between 1965 and 2000 indicates no reduction in flow since BMP implementation.
2. More EAA runoff is being directed south to the EPA.
3. There is concern over competing demands on Lake Okeechobee and it is desired to not overestimate demands.

Upon the completion of rule development, this section will be revised accordingly.

3.10 DEVIATIONS FROM THE OPERATION PLAN

This *Operation Plan* for STA-2 is meant to be updated regularly based on field observations of stage-flow relationships, structure flow calibrations, STA performance and other factors. Best professional judgment on the part of the District's Operations staff shall be used in the operation of the STA structures to deviate from these guidelines to account for flood protection, excess precipitation, site specific conditions, and upstream and downstream conditions. It is anticipated that after the first year of flow-through operation of Cell 4, and annually thereafter, this *Operation Plan* will be reviewed to identify any needed revisions.

4 OPERATING PERMITS

4.1 EVERGLADES FOREVER ACT PERMIT

In March 2009, the FDEP issued an Everglades Forever Act (EFA) permit No. 0126704-008-EM to the District for construction, operation and maintenance of STA-2 and Compartment B Build-out (Cells 5, 6, 7 and 8). However, discharge from the Compartment B Build-out was not authorized by that permit. Relevant provisions of that permit are included in **Appendix 3**. The FDEP concurrently issued Administrative Order AO-010-EV for STA-2 and Compartment B Build-out.

4.2 NPDES PERMIT

In August 2007, the FDEP issued a National Pollutant Discharge Elimination System (NPDES) permit No. FL0177946 for STA-2 and associated works. Relevant provisions of that permit are included in **Appendix 3**. The FDEP did not issue a revised NPDES permit for STA-2 and Compartment B Build-out concurrent with the March 2009 issuance of the updated EFA permit and Administrative Order.

4.3 CLEAN WATER ACT SECTION 404 PERMIT (USACE)

The USACE 404 construction permit for the ECP was modified for the Cell 4 expansion, and was received August 29, 2005. Special Condition 20 was modified to include three provisions relevant to the operation of STA-2 (see **Appendix 3**). The expansion of STA-2 by the addition of Cell 4 has reduced the unit loading of phosphorus to the STA, so overloading should not be a concern, although the total volume is expected to increase above the original design values until the full Compartment B Build out is complete. The STA Management Division will monitor the phosphorus loading rate and coordinate with the Operations staff to minimize overloading. The existing transect sampling program underway downstream of STA-2 will monitor any effects this additional loading may have on WCA-2A. In May 2009, the USACE issued a 404 construction permit for Compartment B Build-out, i.e., Cells 5, 6, 7 and 8, however that permit does not authorize operation of Compartment B Build-out facilities.

5 COORDINATION WITH OTHER PLANS

STA-2 shall be operated to achieve the goal of providing treated water to the Everglades Protection Area and shall, to the maximum extent practicable, be coordinated with and consistent with the Lower East Coast Water Supply Plan, the Lake Okeechobee and Water Conservation Areas Regulation Schedules, CERP and other relevant plans. As modifications to the Central and Southern Florida Project are analyzed through the Lower East Coast Regional Water Supply Plan, Lake Okeechobee and Water Conservation Areas Regulation Schedule, CERP and other plans, the hydraulic and treatment capacities of the current STA designs will be evaluated. If it is deemed necessary, these studies will recommend additional treatment facilities. In addition, the *Long-Term Plan* may be modified to incorporate additional treatment enhancements for these STAs. The operational plans for the STAs will be reviewed by SFWMD staff involved with the aforementioned studies, and modified for consistency with said studies accordingly.

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APPENDIX 1. STRUCTURE RATING CURVES AND PUMP CURVES

Pump Station G-335. The following three tables and figures are from Damisse (2001).

TABLE 3: HEAD-DISCHARGE RELATIONSHIPS FOR 440 RPM (100-CFS PUMP)

Point #	Qobs H-Q Curve	Dynamic Head (Total)	Head Loss	Static Head	Qcalc from Rating Equation	Relative Errors (%)
1	66.84	21	1.17	19.83	67.11	0.40
2	71.29	20.35	1.33	19.02	71.51	0.30
3	75.75	19.5	1.51	17.99	76.53	1.03
4	80.21	18.75	1.69	17.06	80.63	0.53
5	84.66	18	1.88	16.12	84.34	-0.38
6	89.12	17	2.08	14.92	88.47	-0.73
7	93.56	15.5	2.30	13.20	93.28	-0.30
8	98.03	13.5	2.52	10.98	97.88	-0.15
9	102	10.3	2.73	7.57	102.02	0.02
10	102.49	9.5	2.76	6.74	102.61	0.12
11	104.72	6	2.88	3.12	103.87	-0.82

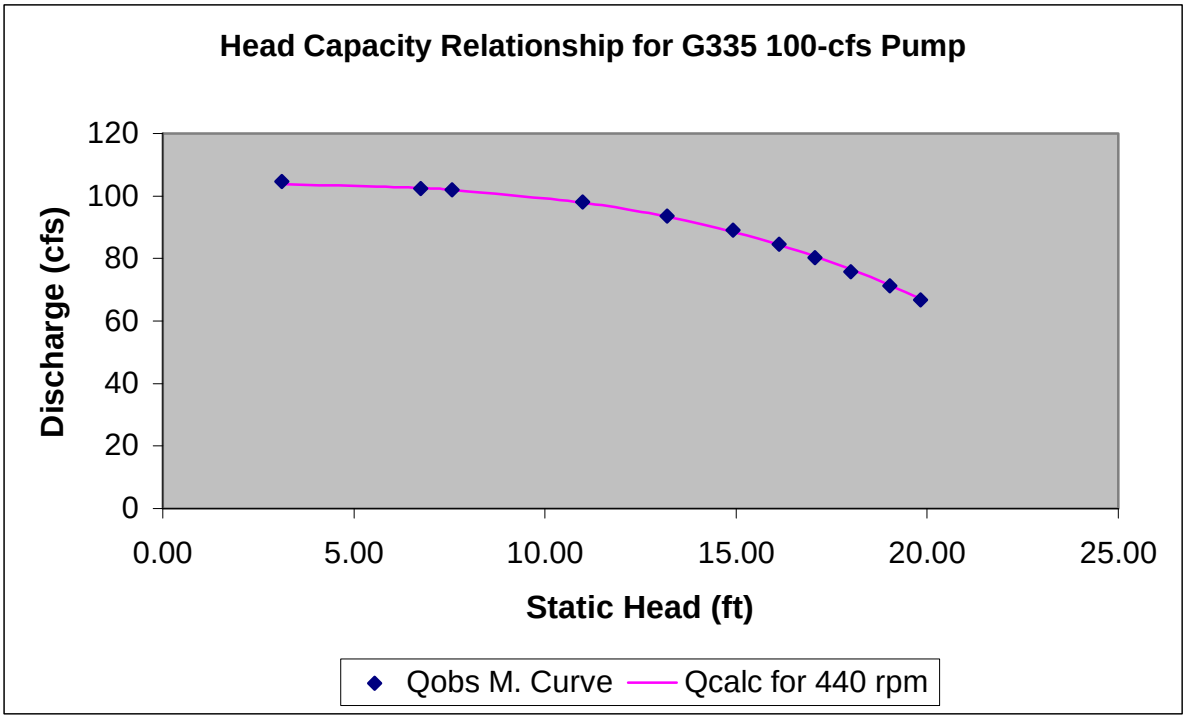


Figure-1

TABLE 4: HEAD-DISCHARGE RELATIONSHIPS FOR DIFFERENT SPEEDS (470-CFS PUMP)

Point #	Qobs H-Q Curve	Dynamic Head	Head Loss	Static Head	QCALC 650 rpm	Qcalc 720 RPM	Qcalc 800 rpm	Errors(%) 720 rpm
1	325	14.5	0.54	13.96	205.92	327.42	442.06	0.74
2	350	13.75	0.63	13.12	236.55	350.90	459.92	0.26
3	375	13	0.72	12.28	265.89	373.39	477.01	-0.43
4	400	12.1	0.82	11.28	298.63	398.48	496.10	-0.38
5	425	11.25	0.92	10.33	327.84	420.88	513.13	-0.97
6	450	10	1.04	8.96	365.87	450.03	535.29	0.01
7	470	9	1.13	7.87	393.27	471.03	551.26	0.22
8	500	7.25	1.28	5.97	433.91	502.18	574.94	0.44
9	525	5	1.41	3.59	471.77	531.20	597.01	1.18
10	550	3.5	1.55	1.95	488.59	544.09	606.81	-1.07

Figure-2

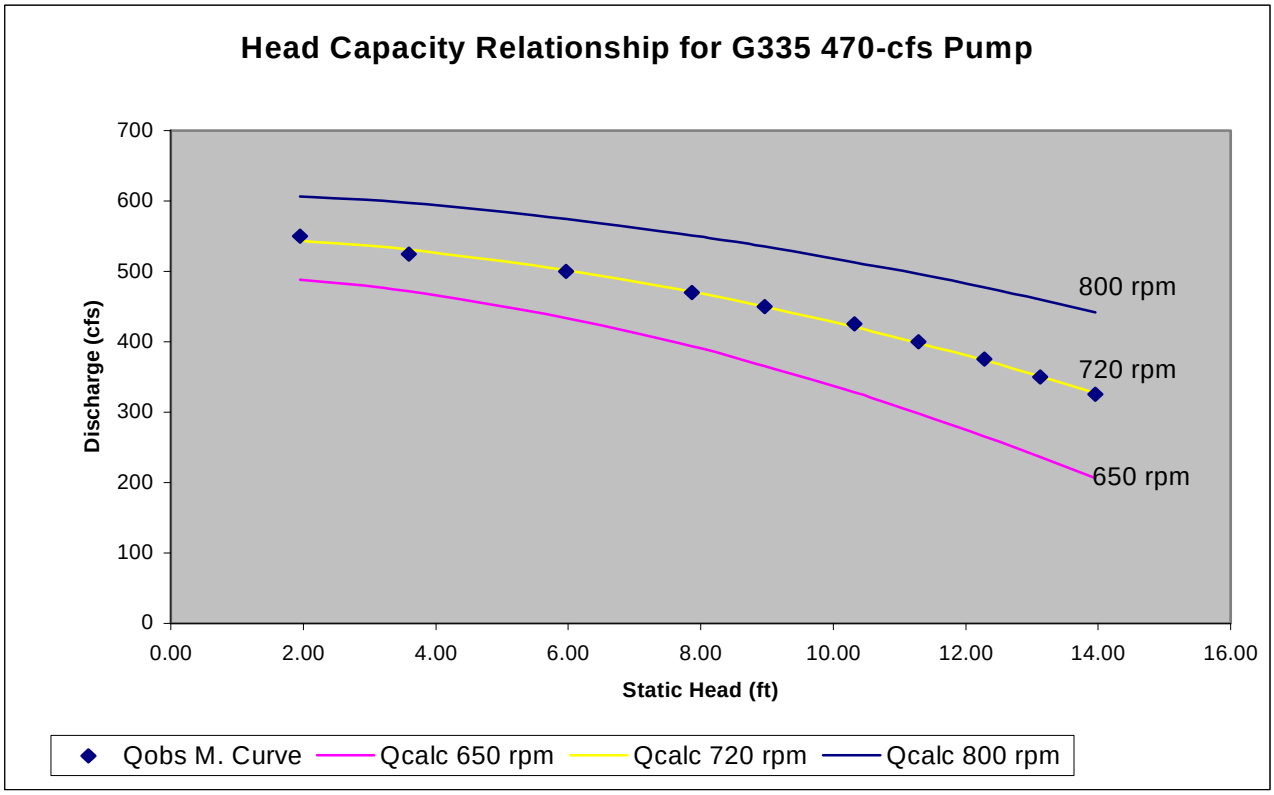
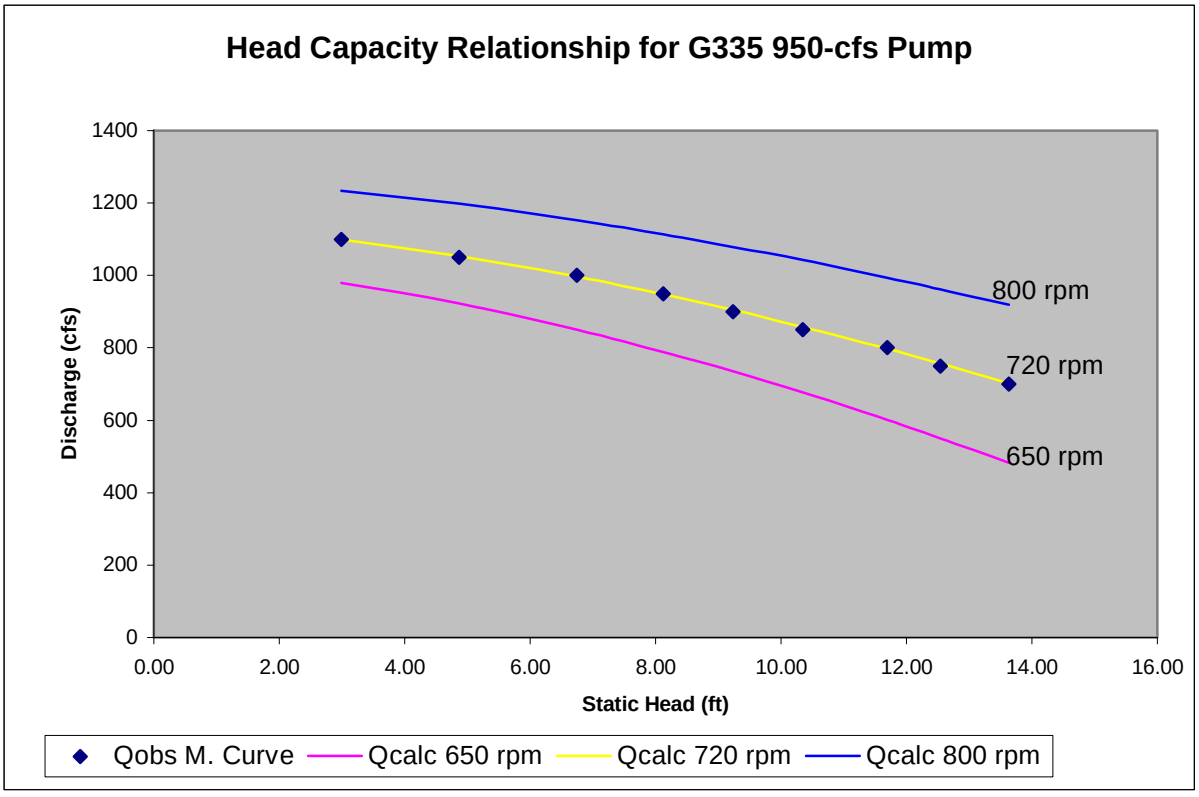


TABLE 5: HEAD-DISCHARGE RELATIONSHIPS FOR DIFFERENT SPEEDS (950-CFS PUMP)

Point #	Qobs H-Q Curve	Dynamic Head	Head Loss	Static Head	Qcalc 650 rpm	Qccalc 720 rpm	Qcalc: 800 rpm	ERRORS (%) 720 rpm
1	700	14.25	0.61	13.64	481.81	702.33	918.86	0.33
2	750	13.25	0.70	12.55	549.92	756.72	961.99	0.90
3	800	12.5	0.80	11.70	600.43	797.05	993.98	-0.37
4	850	11.25	0.90	10.35	676.63	857.90	1042.24	0.93
5	900	10.25	1.01	9.24	734.83	904.37	1079.10	0.49
6	950	9.25	1.13	8.12	789.27	947.84	1113.57	-0.23
7	1000	8	1.25	6.75	850.26	996.54	1152.20	-0.35
8	1050	6.25	1.38	4.87	922.22	1054.00	1197.77	0.38
9	1100	4.5	1.52	2.98	979.23	1099.52	1233.88	-0.04

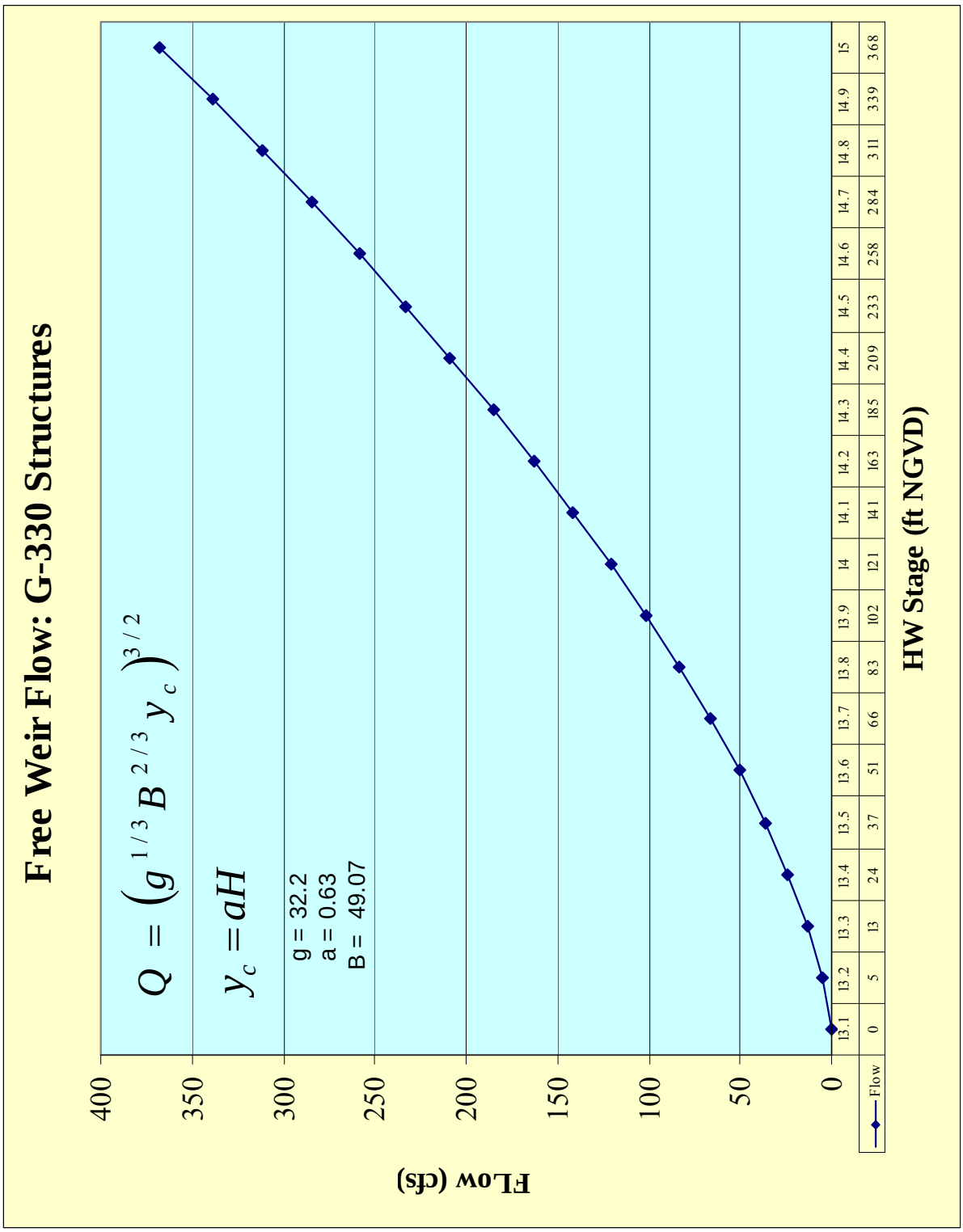
Figure-3



Summary of proposed flow equations at STA 2 inflow culverts (G-329, G-331 and G-333)**.** From Flow Rating Development for STA 2 Inflow Structures (Fru and Guo, November 2004).

Flow Condition	Equation	Restriction
Type-1 Open Channel Flow	$F(\theta) = h_1 - \frac{Q^2}{2gA^2}\left(1 + \frac{2gL}{K_2 K_3}\right) - Y = 0$ Where parameters are same as in Type-2 Open Channel Flow	H/G_0)<1.5, (TW/Yc)<1.0 $S_0 > S_c$
Type-2 Open Channel Flow	$F(\theta) = h_1 - \frac{Q^2}{2gA^2}\left(1 + \frac{2gL}{K_2 K_3}\right) - Y = 0$ where $A = \frac{D^2}{4}\left(\theta_r - \frac{1}{2}\sin 2\theta\right)$, $Y = \frac{D}{2}(1 - \cos\theta)$ and $Q = 0.7093\frac{\left(\theta_r - \frac{1}{2}\sin 2\theta\right)^{1.5}}{(\sin\theta)^{0.5}} D^{2.5}$ $K_x = \frac{1.486}{n} R_x^{2/3} A_x$ where $x = 2$ or 3	(H/G_0)<1.5, (TW/Yc)<1.0 $S_0 < S_c$
Type-3 Open Channel Flow	$Q = C_3 A_3 \sqrt{\frac{2g(h_1 - h_4)}{1 + \frac{2gA_3^2 LC_3^2}{K_2 K_3}}}$ $K_x = \frac{1.486}{n} R_x^{2/3} A_x$ where $x = 2$ or 3 $C_3 = 0.94$	(H/G_0)<1.5 (TW/D)<=1.0 (TW/Yc)>1.0
Orifice Flow	$Q = \sqrt{gD^5 \frac{(\beta - \sin\beta\cos\beta)^3}{64\sin\beta}}$ where $\beta = \cos^{-1}\left[1 - 2\left(\frac{Y_c}{D}\right)\right]$ and $Y_c = G_o * 1.364\left[\frac{(H-h)}{G_o}\right]^{0.3607}$	TW<D and headwater>1.5 Go
Full Pipe	$Q = CA_0 \sqrt{\frac{2g(H-h)}{\left(\frac{A_0}{A_G}\right) + 2C^2\left(1 + \frac{A_0}{A_G} + \frac{gn^2 L}{(1.49)^2 R_0^{4/3}}\right)}}$ C = 0.85 (default)	TW >=D And headwater≥1.5 Go

Coefficients from *Rating Improvement For G330A-E Culverts* (Koben & Jzeng 2008)



From *Flow Rating Development for G332 and G334 Structures* (Guo, George, November 2004)

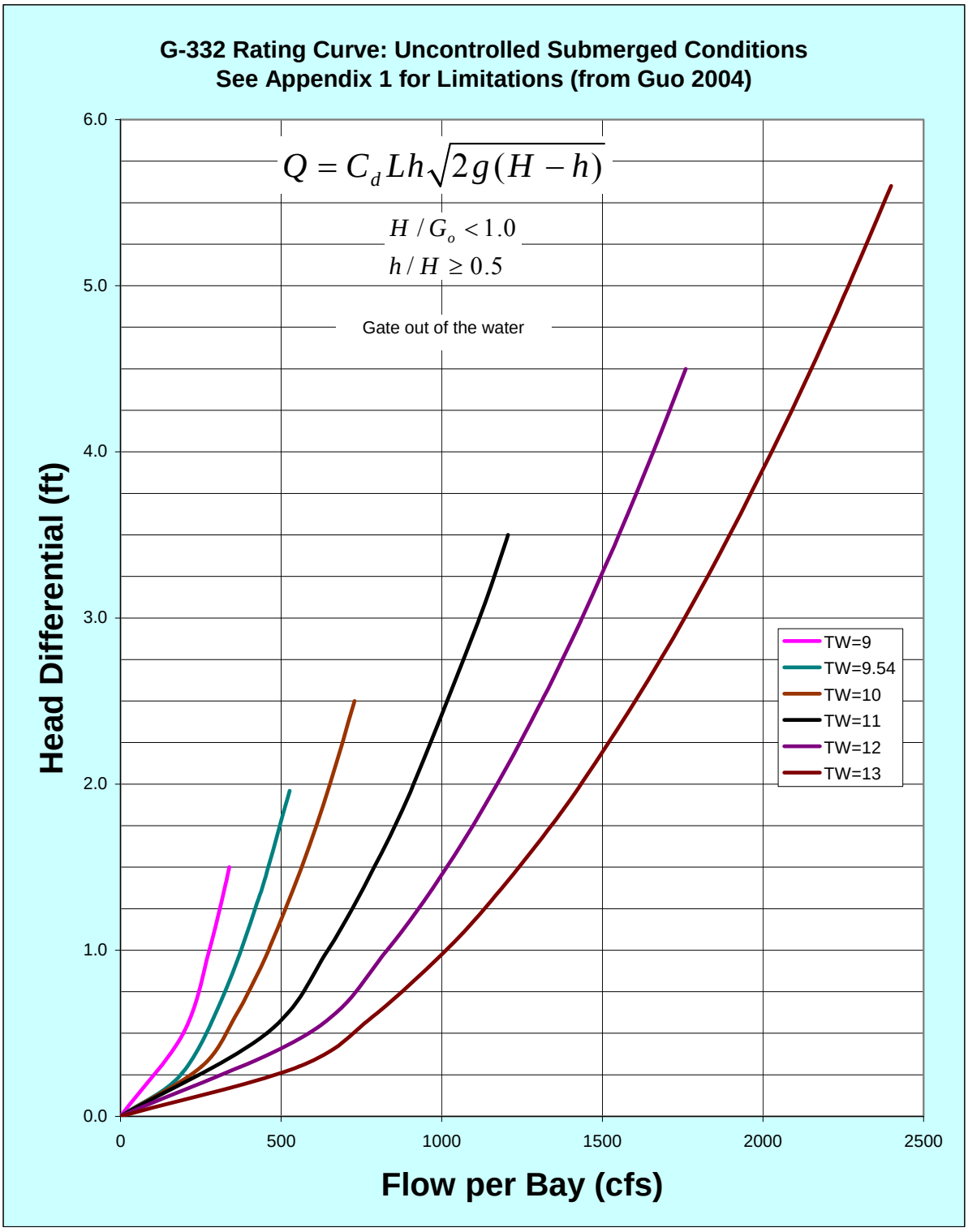
Flow patterns, discharge coefficients and discharge computation in FLOW program for G332 and G334 structures

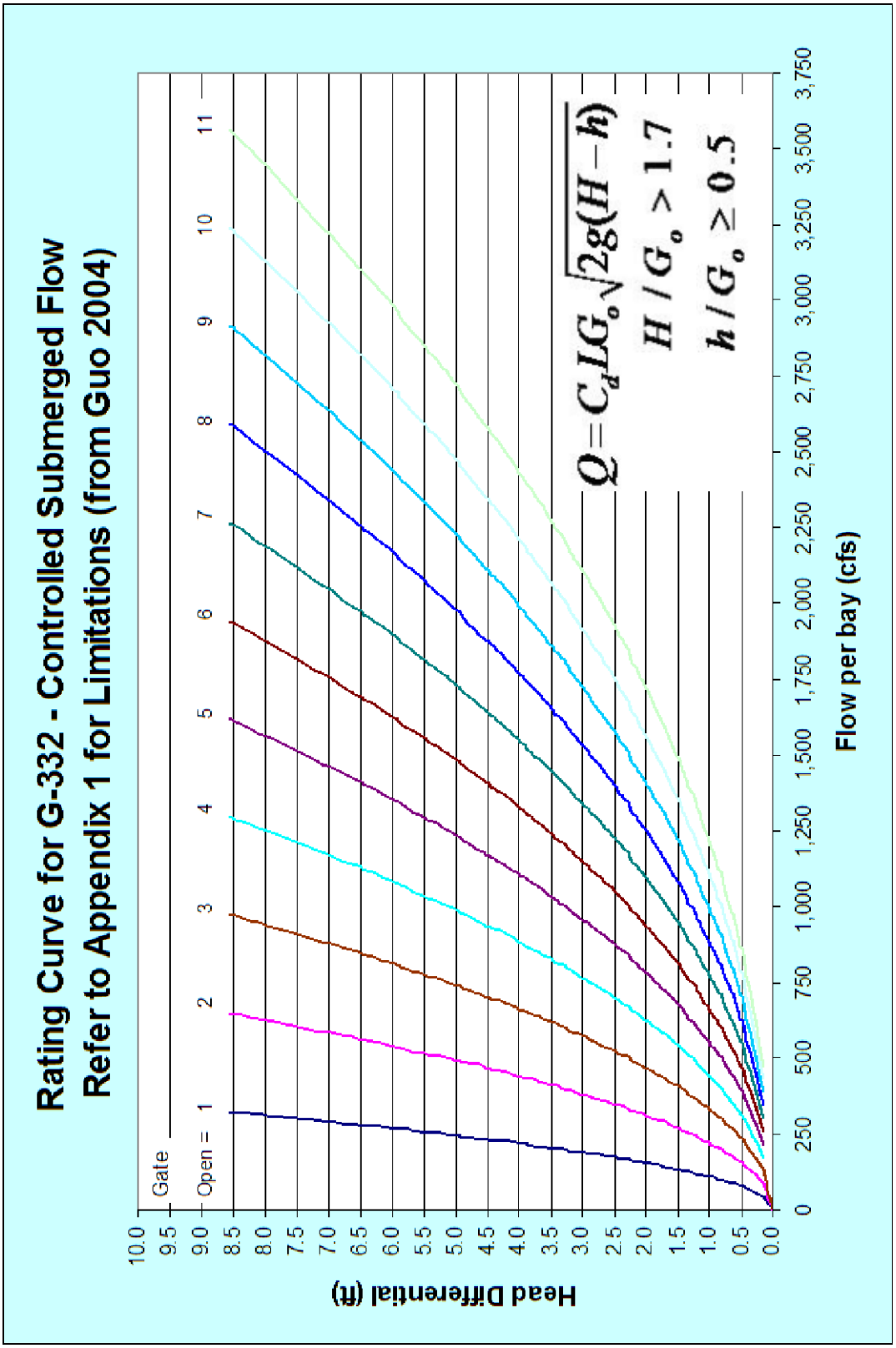
Flow Pattern	Flow Conditions	Computation Formula	Coeff.
Controlled Submerged (CS)*	$H/G_o > 1.7$ $h/G_o \geq 0.5$	$Q = C_d L G_o \sqrt{2g(H-h)}$	C_d =0.75
Controlled Free (CF)	$H/G_o > 1.7$ $h/G_o < 0.5$	$Q = C_d L G_o \sqrt{2g(H-0.5G_o)}$	C_d =0.75
Uncontrolled Submerged (US)*	$H/G_o < 1.0$ $h/H \geq 0.5$	$Q = C_d L h \sqrt{2g(H-h)}$	C_d =1.20
Uncontrolled Free (UF)	$H/G_o < 1.0$ $h/H < 0.5$	$Q = \frac{2}{3} C_{dfw} L \sqrt{2gH^3}$ OR $Q = C_d L H^{3/2}$	C_d =3.10
Transition Submerged	$1.0 < H/G_o < 1.7$ $h/G_o \geq 0.5$	$\min\left\{\begin{matrix}uncontrolled\ submerged\ (US)\\ controlled\ submerged\ (CS)\end{matrix}\right\}$	
Transition Free	$1.0 < H/G_o < 1.7$ $h/G_o < 0.5$	$\min\left\{\begin{matrix}uncontrolled\ \ free\ (UF)\\ controlled\ \ free\ (CF)\end{matrix}\right\}$	

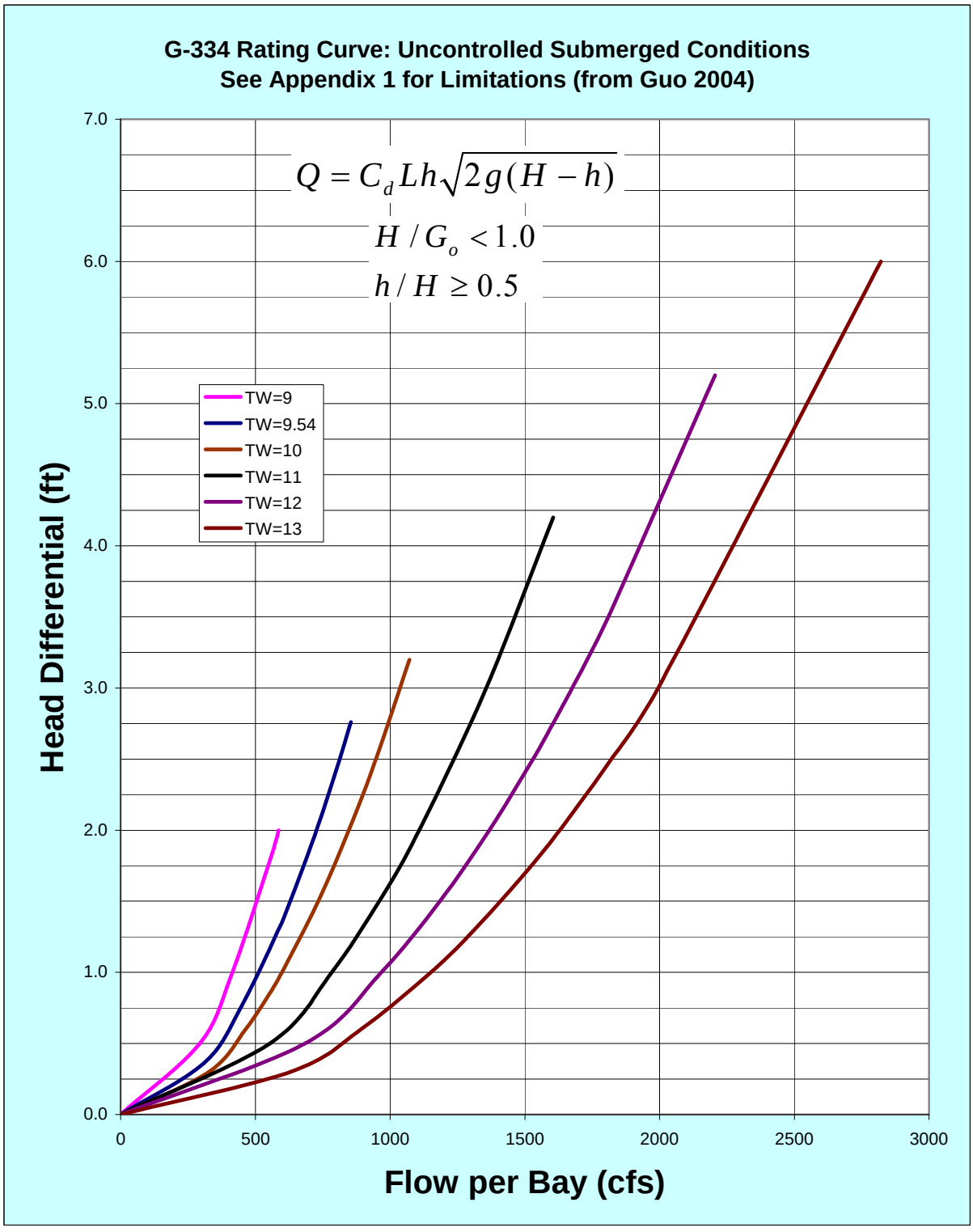
* Prevailing flow patterns at G332 and G334 based on the historical operational conditions

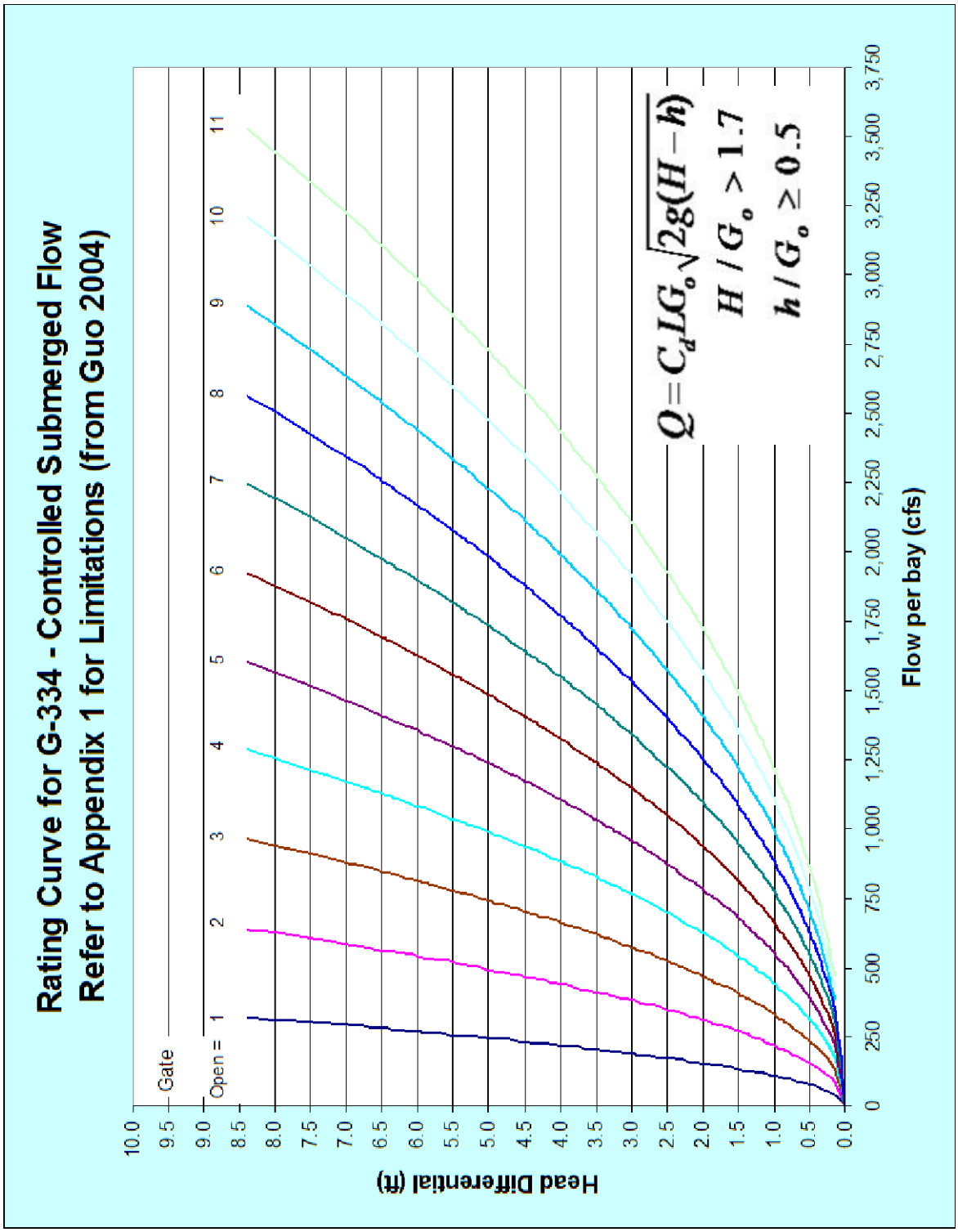
The following recommendation is made in the study: as an interim solution use the improved discharge coefficients:

CSFC = 0.862;
USFC = 1.436.

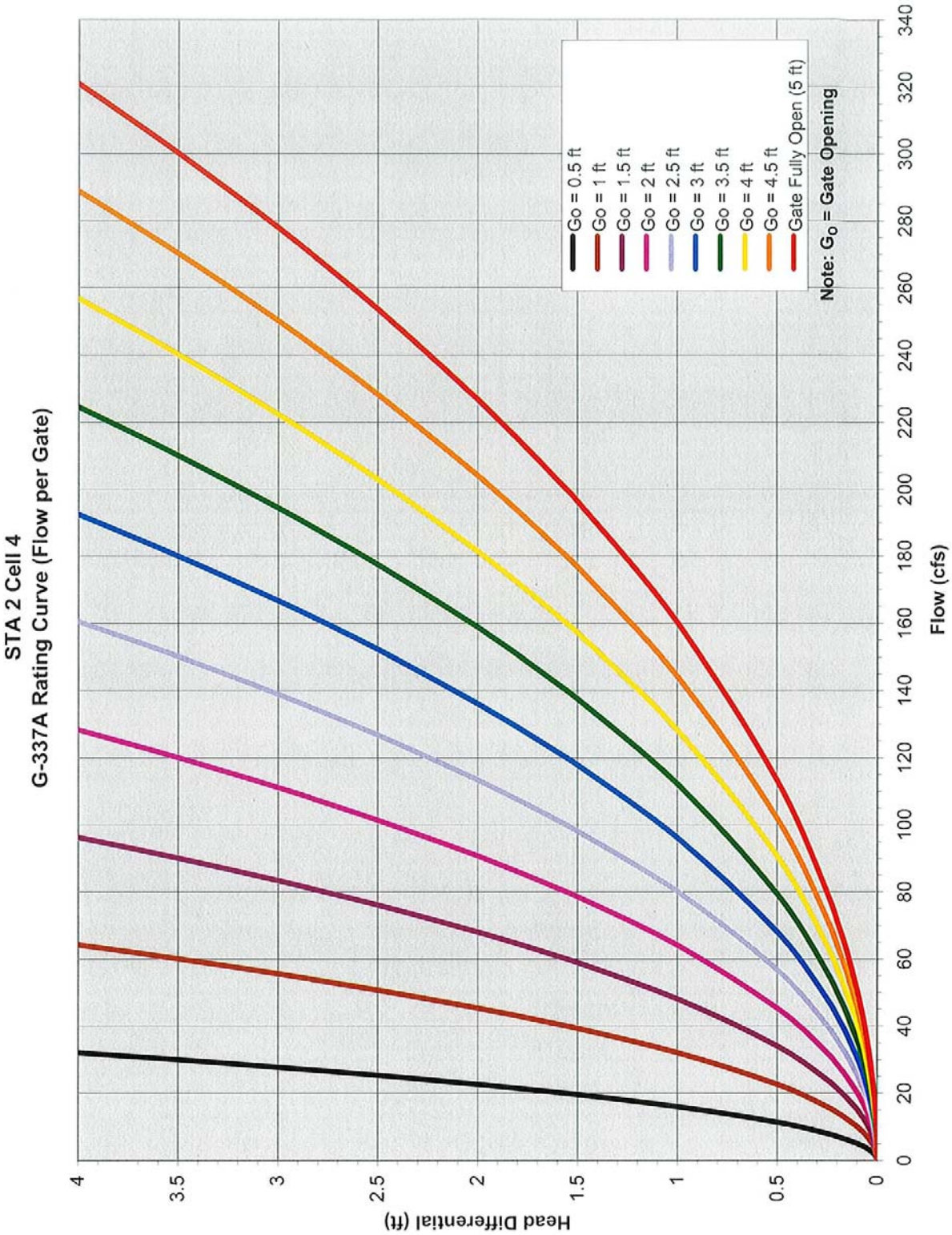

G-332 Rating Curve: Uncontrolled Submerged Conditions
See Appendix 1 for Limitations (from Guo 2004)
$Q = C_d L h \sqrt{2g(H-h)}$
$H / G_o < 1.0$
$h / H \geq 0.5$
Gate out of the water
Head Differential (ft)
Flow per Bay (cfs)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
500
1000
1500
2000
2500
TW=9
TW=9.54
TW=10
TW=11
TW=12
TW=13


Rating Curve for G-332 - Controlled Submerged Flow
Refer to Appendix 1 for Limitations (from Guo 2004)
Head Differential (ft)
Flow per bay (cfs)
Gate
Open = 1
2
3
4
5
6
7
8
9
10
11
$Q = C_d L G_o \sqrt{2g(H-h)}$
$H / G_o > 1.7$
$h / G_o \geq 0.5$

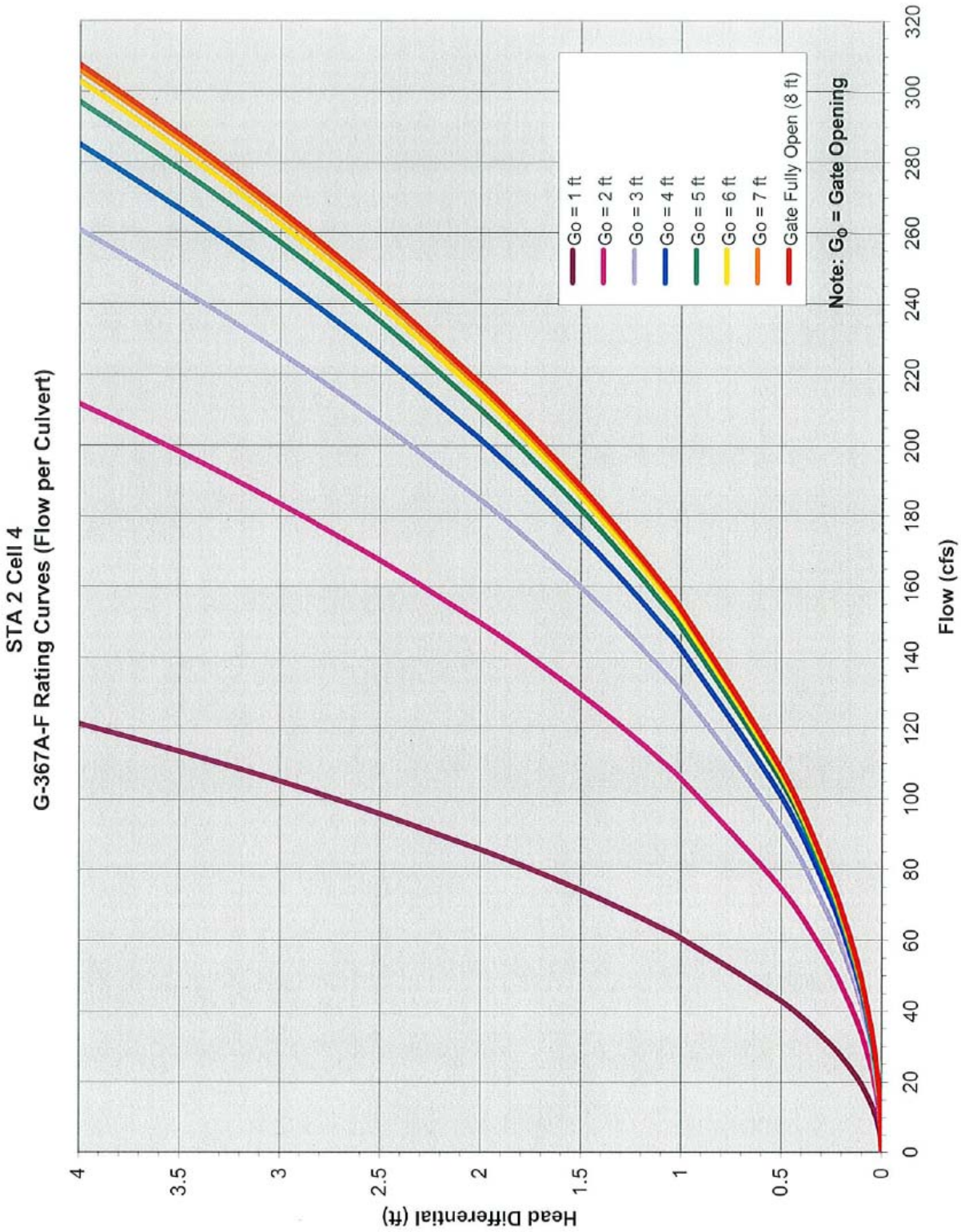

G-334 Rating Curve: Uncontrolled Submerged Conditions
See Appendix 1 for Limitations (from Guo 2004)
$Q = C_d L h \sqrt{2g(H-h)}$
$H / G_o < 1.0$
$h / H \geq 0.5$
TW=9
TW=9.54
TW=10
TW=11
TW=12
TW=13
Head Differential (ft)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
500
1000
1500
2000
2500
3000
Flow per Bay (cfs)


Rating Curve for G-334 - Controlled Submerged Flow
Refer to Appendix 1 for Limitations (from Guo 2004)
Head Differential (ft)
Flow per bay (cfs)
Gate
Open = 1 2 3 4 5 6 7 8 9 10 11
$Q = C_d L G_o \sqrt{2g(H-h)}$
$H / G_o > 1.7$
$h / G_o \geq 0.5$
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
0 250 500 750 1,000 1,250 1,500 1,750 2,000 2,250 2,500 2,750 3,000 3,250 3,500 3,750

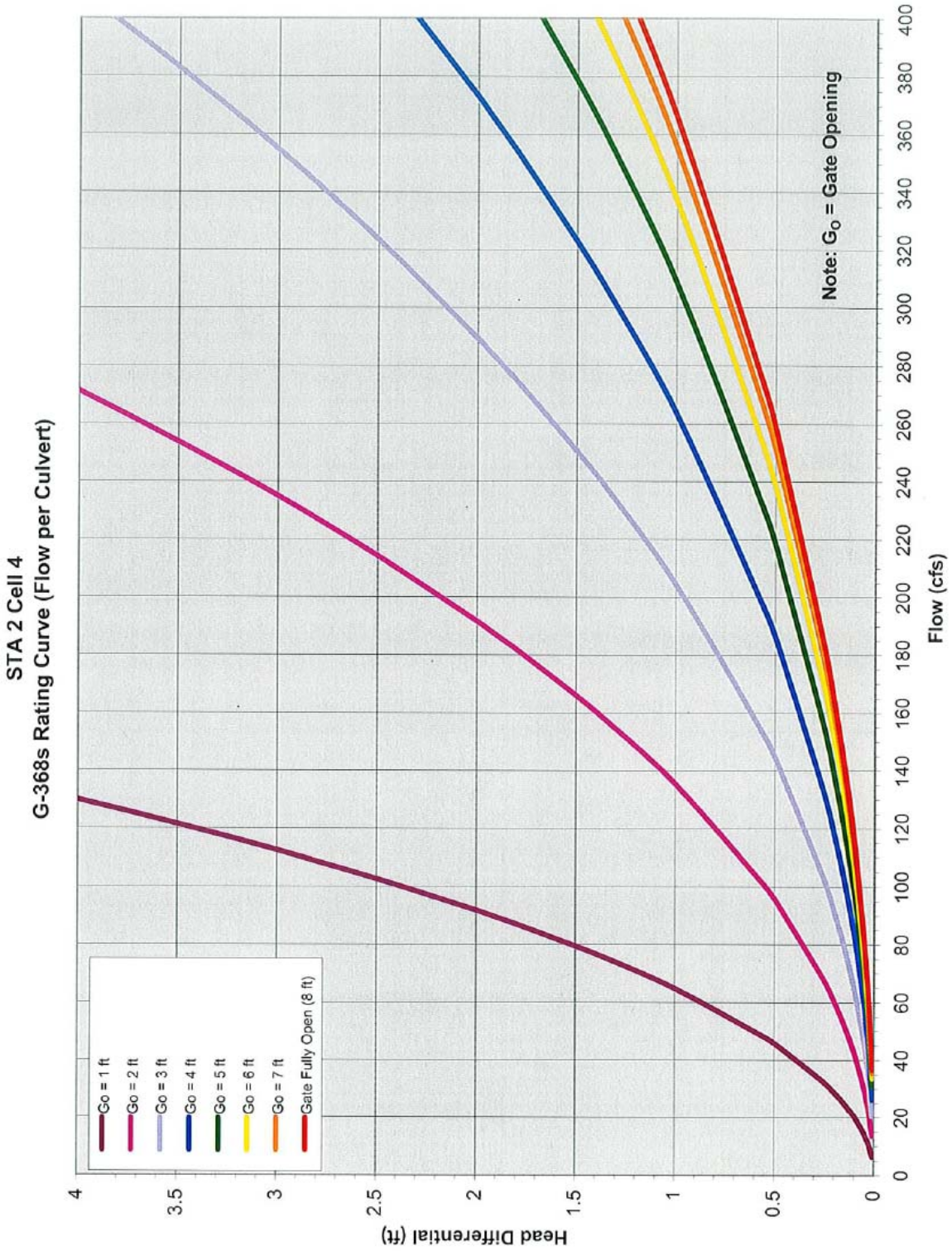
Rating Curves for G-337A - from Brown and Caldwell (2006)



Rating Curves for G-367A-F - from Brown and Caldwell (2006)

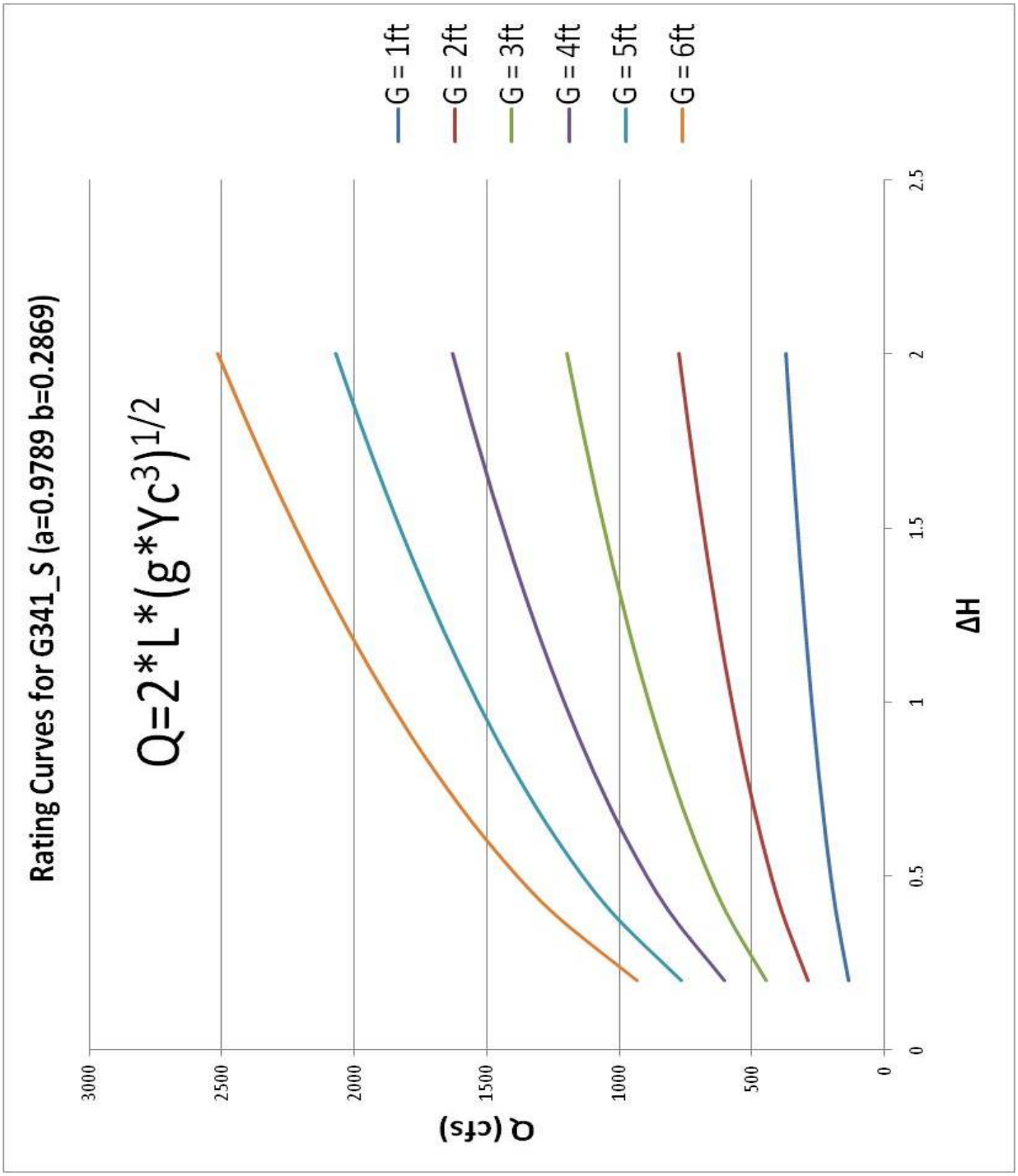


Rating Curves for G-368A-D - from Brown and Caldwell (2006)



Rating Curve for G-341 from *Flow Rating Analysis At Spillway G341*, Jodie Hansing and Jie Zeng, September 2009. Only one flow condition has been observed at spillway G341, and the rating curve shown below is based on Controlled Submerged Flow (CS). Field flow parameters a and b used here are site specific and are shown below. The critical depth

$$Y_c = a*G_0 ((H-h)/G_0)^b$$

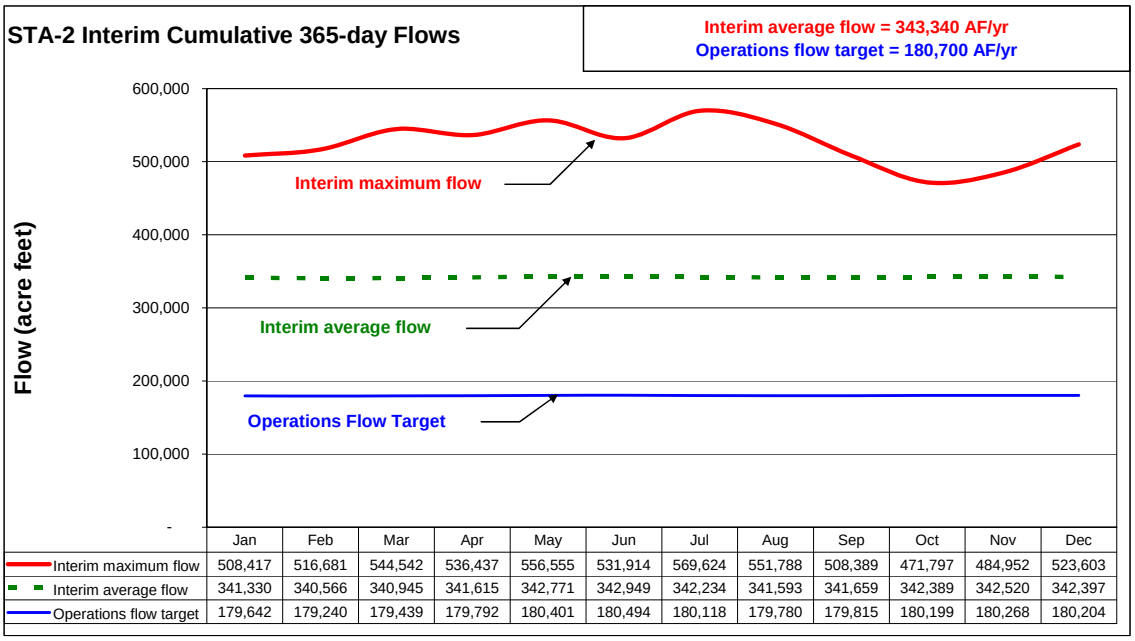


Dimensional Analysis Flow Equations

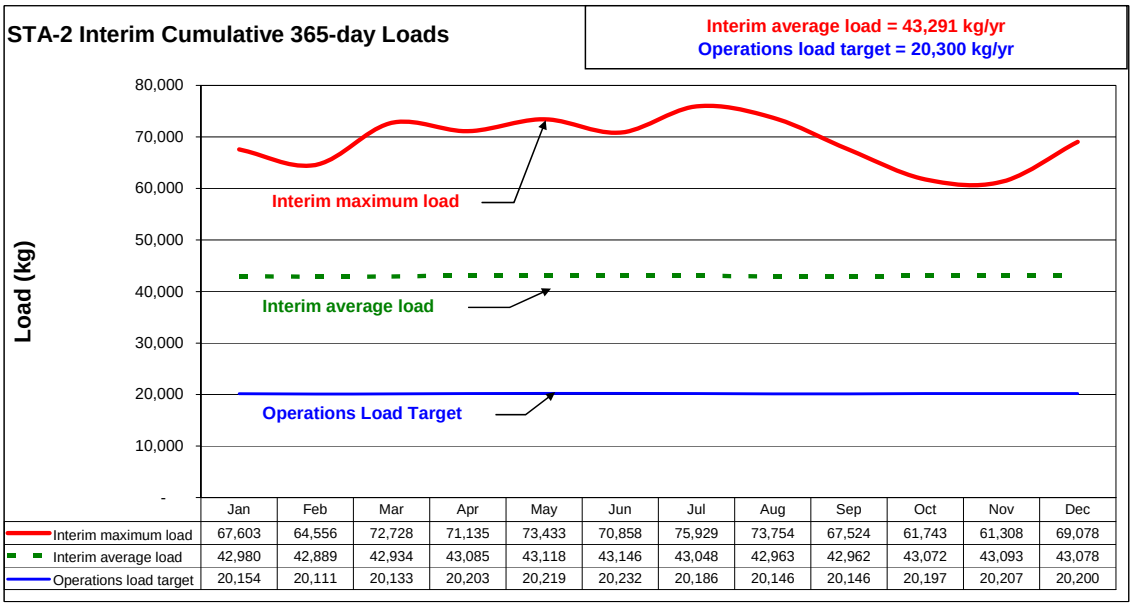
Flow equation: $Q = L\sqrt{g y_c^{\,3}}$		
Spillway flow types	**Critical Flow depth**	**Flow Classification Criteria**
Controlled Free Flow (CF)	$\frac{y_c}{G_o} = a\left(\frac{H}{G_o}\right)^b$	$G_o \geq 0.05$, $\frac{h}{G_o} < 1.0$ & $\frac{H}{G_o} \geq \frac{3}{2}$
Controlled Submerged Flow (CS)	$\frac{y_c}{G_o} = a\left(\frac{H-h}{G_o}\right)^b$	$G_o \geq 0.05$, and $\frac{h}{G_o} \geq 1.0$
Uncontrolled Free Flow (UF)	$y_c = aH$	$G_o \geq 0.05$, $\frac{h}{G_o} < 1.0$, $\frac{H}{G_o} < \frac{3}{2}$ & $\frac{h}{H} < \frac{2}{3}$
Uncontrolled Submerged Flow (US)	$\frac{y_c}{H} = a\left(1-\frac{h}{H}\right)^b$	$G_o \geq 0.05$, $\frac{h}{G_o} < 1.0$, $\frac{H}{G_o} < \frac{3}{2}$ & $\frac{h}{H} \geq \frac{2}{3}$

Where:
H = Headwater above sill crest
h = Tailwater above sill crest
y_c = Critical Depth
G_o = Gate Opening
Q = Discharge
L = Sill Length
g = acceleration due to gravity
a, b = fitting parameters

APPENDIX 2. OPERATIONAL ENVELOPES



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Interim maximum flow	508,417	516,681	544,542	536,437	556,555	531,914	569,624	551,788	508,389	471,797	484,952	523,603
Interim average flow	341,330	340,566	340,945	341,615	342,771	342,949	342,234	341,593	341,659	342,389	342,520	342,397
Operations flow target	179,642	179,240	179,439	179,792	180,401	180,494	180,118	179,780	179,815	180,199	180,268	180,204



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Interim maximum load	67,603	64,556	72,728	71,135	73,433	70,858	75,929	73,754	67,524	61,743	61,308	69,078
Interim average load	42,980	42,889	42,934	43,085	43,118	43,146	43,048	42,963	42,962	43,072	43,093	43,078
Operations load target	20,154	20,111	20,133	20,203	20,219	20,232	20,186	20,146	20,146	20,197	20,207	20,200

APPENDIX 3. RELEVANT PROVISIONS FROM THE EFA AND NDPES PERMITS

Relevant Provisions From the STA-2 EFA Permit

STA-2. In March 2009 the FDEP issued an Everglades Forever Act (EFA) permit No. 0126704-008-EM to the District for construction, operation and maintenance of STA-2 and Compartment B Build-out. Relevant provisions are identified below, and the full text of the permit is contained on the attached DVD.

GENERAL CONDITIONS:

1. Enforcement. The terms, conditions, requirements, limitations and restrictions set forth in this permit, are "permit conditions" and are binding and enforceable pursuant to Sections 373.129, 403.141, 403.727, 403.859 through 403.861 F.S. The permittee is placed on notice that the Department will review this permit periodically and may initiate enforcement action for any violation of these conditions.

2. Scope of permit. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the Department.

6. Operation and maintenance responsibilities. The permittee shall properly operate and maintain the STA and systems of treatment and control (and related appurtenances) that are installed and used by the permittee to achieve compliance with the conditions of this permit, as required by Department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by Department rules.

8. Noncompliance. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately provide the Department with the following information:

A. A description of and cause of noncompliance; and

B. The period of noncompliance, including dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance. The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the Department for penalties or for revocation of this permit.

SPECIFIC CONDITIONS:

6. Project Operation and Maintenance. The permittee shall operate and maintain STA-2 consistent with the design documents, as may be modified and reflected on the record drawings, operations criteria, and operation plan required by Specific Condition 11. Treatment cells existing at the time of permit issuance (STA-2-1, 2-2, 2-3 and 2-4) are authorized to maintain existing operation. Operation of the individual NBO components of Compartment B Build-out (including Cell 4 once hydrologically connected to Cells 5 and 6) and SBO components of the facility are not authorized under this permit.

9. Vegetation and Operational Enhancements. Vegetation and operational enhancements shall be implemented to optimize performance as needed to achieve the phosphorus criterion in the EPA. Vegetation and operational enhancements shall be coordinated with the Department to determine whether a modification to the permit is required.

10. Pump Station Maintenance. Maintenance requirements for the pump stations include operation of the pumps for approximately 2 to 4 hours per month, as necessary, to maintain their mechanical integrity. Therefore, temporary operation of the pump stations for maintenance purposes is allowed and is not subject to the discharge criteria of the specific conditions of this permit. However, the permittee shall document all such temporary maintenance operations, and shall include all such discharge flows and loads as a part of the monitoring requirements of this permit.

11. STA Operation Plan and Modifications. Upon completion of the scheduled Long-Term Plan improvements and enhancements, and within 90 days of the completion of the Compartment B Build-out or any additional Long-Term Plan improvements and enhancements, the permittee shall submit to the Department, at the addresses listed in Specific Condition 1, an updated Operations Plan for the STA-2 facility, as applicable, subject to modifications under the conditions set forth below.

If at any time changes to the STA-2 Operations Plan are warranted to optimize facility operation, and upon verification of data to be supplied by the permittee that justifies the need for such modification, the Operations Plan may be modified as mutually agreed upon by the Department and the permittee. The Operations Plan shall also include the information described in A-G, below.

A. **Minimum Water Level Targets to Avoid Dryout.** In accordance with the relevant design documents, the permittee shall, to the maximum extent practicable, maintain a minimum static water level of 0.5 ft above the average ground elevation of the treatment cells to avoid dryout of the treatment cells, subject to available water from the upstream watershed.
B. **Responding to Dryout Conditions.** The permittee shall evaluate and correct potential adverse dryout effects on the water quality performance of STA-2. If the compliance

requirements in this permit are not met due to dryout conditions, then the permittee shall propose modifications to the Operations Plan and Monitoring Plan as appropriate and submit the revised plan(s) to the Department for review and approval.

C. **Maximum Water Level Targets.** The permittee shall ensure, to the maximum extent practicable, that maximum water depths of 4.0 feet above the average ground elevation of the treatment cells will not be exceeded in order to avoid long-term damage to the treatment vegetation and protection of project levees.

D. **Operational Envelope.** The permittee shall ensure to the maximum extent practicable that operation of the facility does not exceed the operational envelope for STA-2 (this permit does not authorize operation of Compartment B Build-out), as set forth in the existing STA-2 Operations Plan.

E. **Phosphorus Uptake Optimization.** Operations shall be conducted to distribute the flows and water levels within STA-2 to optimize the phosphorus reduction performance and shall be updated as necessary to include the results of the permittee's Process Development and Engineering (PDE) program being implemented as a part of the Long-Term Plan.

F. **Operations Plan Modifications**. The STA-2 Operations Plan should be reviewed and may be revised as appropriate based on operational experience, research results, downstream monitoring and upstream levels of service.

G. **Hydropattern Restoration.** STA-2 shall be operated in such a manner as to be consistent with the activities proposed to restore the hydropattern of the EPA, as described in Specific Condition 12 below.

Under emergency conditions that threaten the safety of life, property, or the STA-2 facility, the permittee may modify the operations of STA-2 and immediately employ any remedial means to protect life and property in accordance with the emergency provisions of Chapter 373, F.S. The permittee shall notify the Department within 48 hours of such occurrence and shall provide data justifying the need to employ the emergency modifications to operations of STA-2.

12. Hydropattern Restoration. In accordance with Subsection 373.4592(4)(b), F.S., the permittee shall operate the STAs in order to improve and restore the Everglades water supply and hydroperiod. The permittee shall operate the ECP to provide additional increased flow to the EPA through the modification of historical operational practices for regulatory releases from Lake Okeechobee and the Water Conservation Areas. The STAs shall be operated to achieve the goal of providing additional flows to the EPA and shall, to the maximum extent practicable, be coordinated with and consistent with the Lower East Coast Water Supply Plan, the Lake Okeechobee and Water Conservation Area Regulation Schedules, Comprehensive Everglades Restoration Plan (CERP), and the entitlement of the Seminole Tribe of Florida to surface water withdrawals under the Water Rights Compact (P.L. 100-228).

15. Water Quantity and Flooding Impacts. The permittee shall be responsible for ensuring that STA-2 is operated so as not to adversely affect adjacent lands with regards to flooding impacts and water supply needs of the region. The permittee shall hold and save the

Department harmless for any and all damages, claims, or liabilities, which may arise from water quantity and/or flooding impacts resulting from the construction and operation of STA-2.

As treatment cells are constructed and managed to optimize performance, they will undergo three operational phases, each with different levels of performance:

17. Start-Up Phase. During the initial Start-Up Phase of a new cell or new flow-way, the permittee shall monitor phosphorus concentrations within the facility to demonstrate that the project is achieving a net reduction in phosphorus. Portions of STA-2 may operate independently of each other. Under those circumstances, Start-Up Phase operation and monitoring within the treatment area shall be performed as follows:

i. ***Establishment of Marsh Vegetation.*** The permittee shall manage water depths in the treatment cells to facilitate the recruitment of marsh vegetation in accordance with the Operations Plan, which may include recirculating waters within the STA.

ii. ***Start-Up Monitoring.*** On a weekly basis, the permittee shall monitor total phosphorus at the upstream side of inflow structure(s). Total phosphorus shall also be monitored on a weekly basis on the upstream side of the outflow structures.

iii. ***Phosphorus Start-Up Test.*** The Phosphorus Start-Up Test for an individual flow-way or cell is based on when the above samples demonstrate, over a four-week period, a net reduction in phosphorus occurs. This net reduction shall be deemed to occur when the 4-week geometric mean total phosphorus water column concentration from samples collected at the applicable outflow structures is less than the 4-week geometric mean total phosphorus water column concentration collected at the applicable inflow structure(s).

iv. ***Discharge Operations.*** Discharge operations, from an individual flow-way or cell that has passed the Phosphorus Start-Up Test described above, may commence once Initial Start-Up Phase documentation and all supporting data and analyses are submitted to the Department via regular or electronic mail. For flow-ways that have not met these tests within six months after issuance of the permit, the permittee shall submit status updates regarding progress toward and identifying strategies and timelines to achieve this test.

v. ***Initiation of Individual Flow-way (Stabilization and Routine Operation) Discharges and Monitoring.*** Once flow-through discharges from a flow-way begin, the permittee shall initiate routine water quality monitoring for that flow-way consistent with the monitoring program described in this permit.

18. Stabilization Phase (Flow-through Operations) – An STA enters the Stabilization Phase after each of three antecedent conditions: (1) once flow-through operations begin following the initial start-up of a new treatment cell; (2) when a treatment cell is undergoing implementation of Long-Term Plan enhancements that may have adverse impacts on STA

performance, or (3) when a treatment cell is undergoing recovery activities associated with a major event that compromises the structural integrity or performance of the STA. During the Stabilization Phase the treatment vegetation will be maturing and the STA performance will generally be improving toward achieving the permit effluent limitation. However, the overall performance of the STA is extremely difficult to evaluate and predict. It is anticipated that the treatment vegetation will require one to three years after flow-through operations begin for the affected cells to continue to improve toward achieving the permit effluent limit. During the stabilization phase, the effluent limitation shall apply. Once the facility achieves the effluent limitation, it shall enter the Routine Operations Phase. During the Stabilization Phase, exceedance of the effluent limitation is anticipated; however, the STA shall be deemed in compliance as long as the actions described in this condition and all other applicable permit conditions are met.

If a flow-way is determined to be incapable of operating or performing effectively as a result of the impacts caused by one or more of the above mentioned circumstances, within 60 days the District shall submit strategies and timelines identified as being the most effective in restoring the impacted flow-way(s) and achieving the permit effluent limit. The District's strategies and timelines shall include, at a minimum, the following:

1. Identify the cause of the incident which resulted in the facility not achieving the effluent limitation
2. A statement that the facility was being properly operated at the time of the incident
3. The period of the anticipated stabilization phase
4. Any remedial steps employed to ensure that the stabilization period will be as minimal as possible

The timely submittal and implementation of these strategies and timelines in conjunction with the Department's review and approval of such submittals and compliance with all other applicable conditions set forth in this permit shall constitute compliance.

In addition to the reporting associated with this condition, as part of the annual reporting requirements in Specific Condition 27, the District shall also provide an assessment of the facility and the steps being taken to meet the permit effluent limit. As part of the first annual report following any adverse impact to the facility, and each subsequent year until the facility achieves the permit effluent limit, the 12 month rolling flow-weighted mean TP concentration of the STA outflow shall be assessed as to whether there is a trend in improvement of performance relative to prior years. If the trend analysis that is applied to this data indicates that there is not a trend in improvement of performance, the permittee shall report as to the causes behind the lack of performance improvement. If during a subsequent annual report the trend analysis applied to these data indicate that there is not a trend in improvement of performance after the affected flow-way has been in flow-through operation for 24 months, the annual report shall include any remedial measures necessary to achieve improved facility performance by the end of next year, and shall provide an estimate of when the permit effluent limit shall be achieved.

19. Routine Operations Phase - During the Routine Operations Phase, discharges from the STA shall meet the permit effluent limitations set forth in Table 1 below.

21. Operational Envelope. As a part of the annual reporting requirements in Specific Condition 28, the District shall provide an annual assessment as to whether the existing components of the STA-2 facility are operating within or outside the operational envelope. The assessment shall be based on annual inflow volumes and phosphorus loads and shall compare flows and loads to the corresponding maximum values contained in the operational envelope described in the current STA-2 Operations Plan. If the annual inflow volumes or phosphorus loads exceed the corresponding maximum values of the operational envelope during an annual compliance period, the District shall conduct a review of potential causes and include this review in the annual report. The review shall include a comparison of the relationships between rainfall, runoff, and phosphorus loads from the compliance year with historical data. Departmental concurrence shall be obtained prior to initiating Lake Okeechobee regulatory or water supply releases that would result in an exceedance of the maximum levels of flow or phosphorus load contained in the operational envelope.

26. Diversion. The District shall notify the Department within 48 hours of any unanticipated diversions of flow through the G-338 and/or G-339 gated structures, and as soon as practicable in advance of anticipated diversions, with the exception of routine maintenance. The submitted notification shall include a description of the circumstances related to the diversion and a projection of the anticipated duration of the diversion. All diversions occurring through the G-338 and G-339 structures shall be monitored for the parameters Total Phosphorus and Calculated Flow listed in Table 2 below. As soon as practicable after cessation of all diversions, the District shall submit a summary of the data collected from the table below, and identify the duration of the diversions.

Relevant Provisions from the STA-2 NPDES permit

STA-2. In August 2007 the FDEP issued an NPDES Permit No. FL0177946 to the District for construction, operation and maintenance of STA-2 and associated works. Relevant provisions are identified below, and the full text of the permit is contained on the attached CD.

I. Effluent Limitations and Monitoring Requirements
E. Other Limitations and Monitoring and Reporting Requirements

4. Diversion, as described in the Fact Sheet, may occur during the operation of STA-2. The District shall notify the Department within 48 hours of any unanticipated diversions of flow through the G-338 and/or G-339 gated structures and the District shall notify the Department as soon as practicable in advance of anticipated diversions, with the exception of routine maintenance and irrigation withdrawals through G-328. The submitted notification shall include a description of the circumstances related to the diversion and a projection of the anticipated duration of the diversion. All diversions occurring through the G-338 and G-339 structures shall be monitored for the parameters listed in the table below. As soon as practicable after cessation of all diversions, the District shall submit a summary of the data collected from the table below, and identify the duration of the diversions.

Parameter/ Station	Units	Sample Type
Total Phosphorus collected at S-6 Pump Station	mg/l	Grab
Flow at G-338 and/ or G-339 structures	CFS	Calculated

V. Operation and Maintenance Requirements
A. Operation of Treatment Facilities

1. The permittee shall ensure that the operation of this facility is as described in the application and supporting documents.

2. The operation of the pollution control facilities described in this permit shall be under the supervision of a person who is qualified by formal training and/or practical experience in the field of water pollution control.

3. Activities such as ongoing maintenance may have adverse impacts on STA performance. In addition, major events may compromise the structural integrity or performance of the STA or section(s) of the STA. Such activities or events will be subject to the planned changes, bypass, and/or upset provisions set forth in Section VIII Paragraphs 17, 22, and 23.

B. Record Keeping Requirements:

1. The permittee shall maintain the following records at the South Florida Water Management District's (District) headquarters and make them available for inspection:

e. Copies of the logs and schedules showing plant operations and equipment maintenance for three years from the date on the logs or schedule.

VI. Schedules

2. A revised Pollution Prevention Plan (PPP) shall be prepared and implemented in accordance with the following schedule:

Action Item		**Scheduled Completion Date**
1	Develop and Implement revised Pollution Prevention Plan	Completion of scheduled Long-Term Plan enhancements to STA-2
2.	Submittal of revised Pollution Prevention Plan if additional enhancements are implemented	Changes that warrant modifications to the current PPP + 90 days

VII. Other Specific Conditions

D. Specific Conditions Related to the Pollution Prevention Plan

1. A revised PPP shall be prepared, submitted to the Department for review and approval, and implemented in accordance with the schedule set forth in Section VI.2.

2. The STA-2 Project shall be operated in accordance with the existing PPP (Exhibit C) until such time as a revised PPP is approved by the Department. If the permitted facilities are demonstrated not to be achieving compliance with the requirements of this permit, the permittee shall submit a modified PPP for Department review and approval as appropriate.

VIII. General Conditions

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit are binding and enforceable pursuant to Chapter 403, F.S. Any permit noncompliance constitutes a violation of Chapter 403, F.S., and is grounds for enforcement action, permit termination, permit revocation and reissuance, or permit revision. *[62-620.610(1), F.A.C.]*

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications or conditions of this permit constitutes grounds for revocation and enforcement action by the Department. *[62-620.610(2), F.A.C.]*

5. This permit does not relieve the permittee from liability and penalties for harm or injury to human health or welfare, animal or plant life, or property caused by the construction or operation of this permitted source; nor does it allow the permittee to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department. The permittee shall take all reasonable steps to minimize or prevent any discharge, reuse of reclaimed water, or residuals use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. *[62-620.610(5), F.A.C.]*

7. The permittee shall at all times properly operate and maintain the facility and systems of treatment and control, and related appurtenances, that are installed and used by the permittee to achieve compliance with the conditions of this permit. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to maintain or achieve compliance with the conditions of the permit. *[62-620.610(7), F.A.C.]*

17. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements. The permittee shall be responsible for any and all damages which may result from the changes and may be subject to enforcement action by the Department for penalties or revocation of this permit. The notice shall include the following information:
a. A description of the anticipated noncompliance;
b. The period of the anticipated noncompliance, including dates and times; and
c. Steps being taken to prevent future occurrence of the noncompliance. *[62-620.610(17), F.A.C.]*

20. The permittee shall report to the Department's Tallahassee Office and the Southeast District Office any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five days of the time the permittee becomes aware of the circumstances. The written submission shall contain: a description of the noncompliance and its cause; the period of noncompliance including exact dates and time, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

a. The following shall be included as information which must be reported within 24 hours under this condition:

(1) Any unanticipated bypass which causes any reclaimed water or effluent to exceed any permit limitation or results in an unpermitted discharge,

(2) Any upset which causes any reclaimed water or the effluent to exceed any limitation in the permit,
(3) Violation of a maximum daily discharge limitation for any of the pollutants specifically listed in the permit for such notice, and
(4) Any unauthorized discharge to surface or ground waters.

b. Oral reports as required by this subsection shall be provided as follows:

(1) For unauthorized releases or spills of untreated or treated wastewater reported pursuant to subparagraph a.(4) that are in excess of 1,000 gallons per incident, or where information indicates that public health or the environment will be endangered, oral reports shall be provided to the Department by calling the STATE WARNING POINT TOLL FREE NUMBER (800) 320-0519, as soon as practical, but no later than 24 hours from the time the permittee becomes aware of the discharge. The permittee, to the extent known, shall provide the following information to the State Warning Point:

(a) Name, address, and telephone number of person reporting;
(b) Name, address, and telephone number of permittee or responsible person for the discharge;
(c) Date and time of the discharge and status of discharge (ongoing or ceased);
(d) Characteristics of the wastewater spilled or released (untreated or treated, industrial or domestic wastewater);
(e) Estimated amount of the discharge;
(f) Location or address of the discharge;
(g) Source and cause of the discharge;
(h) Whether the discharge was contained on-site, and cleanup actions taken to date;
(i) Description of area affected by the discharge, including name of water body affected, if any; and
(j) Other persons or agencies contacted.

(2) Oral reports, not otherwise required to be provided pursuant to subparagraph b.(1) above, shall be provided to Department's Southeast District Office within 24 hours from the time the permittee becomes aware of the circumstances.

c. If the oral report has been received within 24 hours, the noncompliance has been corrected, and the noncompliance did not endanger health or the environment, the Department's Southeast District Office shall waive the written report. *[62-620.610(20), F.A.C.]*

21. The permittee shall report all instances of noncompliance not reported under Conditions VIII.17, 18, 19, and 20 of this permit at the time monitoring reports are submitted. This report shall contain the same information required by Condition VIII.20. of this permit. *[62-620.610(21), F.A.C.]*

22. Bypass Provisions.

a. Bypass is prohibited, and the Department may take enforcement action against a permittee for bypass, unless the permittee affirmatively demonstrates that:
(1) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage; and
(2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventative maintenance; and
(3) The permittee submitted notices as required under Condition VIII.22.b. of this permit.

b. If the permittee knows in advance of the need for a bypass, it shall submit prior notice to the Department, if possible at least 10 days before the date of the bypass. The permittee shall submit notice of an unanticipated bypass within 24 hours of learning about the bypass as required in Condition VIII.20. of this permit. A notice shall include a description of the bypass and its cause; the period of the bypass, including exact dates and times; if the bypass has not been corrected, the anticipated time it is expected to continue; and the steps taken or planned to reduce, eliminate, and prevent recurrence of the bypass.

c. The Department shall approve an anticipated bypass, after considering its adverse effect, if the permittee demonstrates that it will meet the three conditions listed in Condition VIII.22 a.(1) through (3) of this permit.

d. A permittee may allow any bypass to occur which does not cause reclaimed water or effluent limitations to be exceeded if it is for essential maintenance to assure efficient operation. These bypasses are not subject to the provision of Condition VIII.22.a. through c. of this permit.

23. Upset Provisions
a. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed contemporaneous operating logs, or other relevant evidence that:
(1) An upset occurred and that the permittee can identify the cause(s) of the upset;
(2) The permitted facility was at the time being properly operated;
(3) The permittee submitted notice of the upset as required in Condition VIII.20. of this permit; and
(4) The permittee complied with any remedial measures required under Condition VIII.5. of this permit.
b. In any enforcement proceeding, the burden of proof for establishing the occurrence of an upset rests with the permittee.
c. Before an enforcement proceeding is instituted, no representation made during the Department review of a claim that noncompliance was caused by an upset is final agency action subject to judicial review.

Special Condition 20 of the USACE 404 permit for the ECP was modified to include the following provisions relevant to the operation of STA-2:

> d. Operation of STA-2, Cell-4:
>
> (1) The permittee shall modify the existing operational plan for STA-2 to incorporate Cell-4. The plan will define how STA-2, Cell 4 will be operated under the expected range of hydrologic conditions. The plan will also describe anticipated volumes and distribution of flows within the STA as target water levels during normal operations. The operational plans for the STA shall be consistent with and coordinated with: the Lower East Coast Water Supply Plan; Lake Okeechobee Regulation Schedule; schedules for the WCAs; the Comprehensive Everglades Restoration Plan; and the entitlement of the Seminole Tribe of Florida to surface waters withdrawals under the Water Rights Compact (P.L. 100-228).
>
> (2) This permit acknowledges that the expected range in outflow volumes of water discharging from STA-2 into Water Conservation Area (WCA) 2 after implementation of Cell-4 will remain the same as the current range in outflow volumes discharging to WCA 2. This permit also acknowledges STA-2 is currently being operated in an adaptive manner, taking into consideration the needs of the STA as well as the needs of the region. Should the outflow volumes of water exceed the maximum volumes identified in the original design of STA-2, the permittee shall notify the Corps immediately and provide documentation as to the reasons for the excess discharges, provide a plan for implementing adaptive operational strategies to ensure that the STA is not subject to overload from inflow volume or load, and provide a plan for monitoring downstream effects of the excess discharge on WCA 2.
>
> (3) Prior to operation of STA-2, Cell-4, the permittee must receive and submit to the Corps a National Pollutant Discharge Elimination System (NPDES) permit or a modification of the existing NPDES permit for STA-2 to reflect operation of Cell-4.

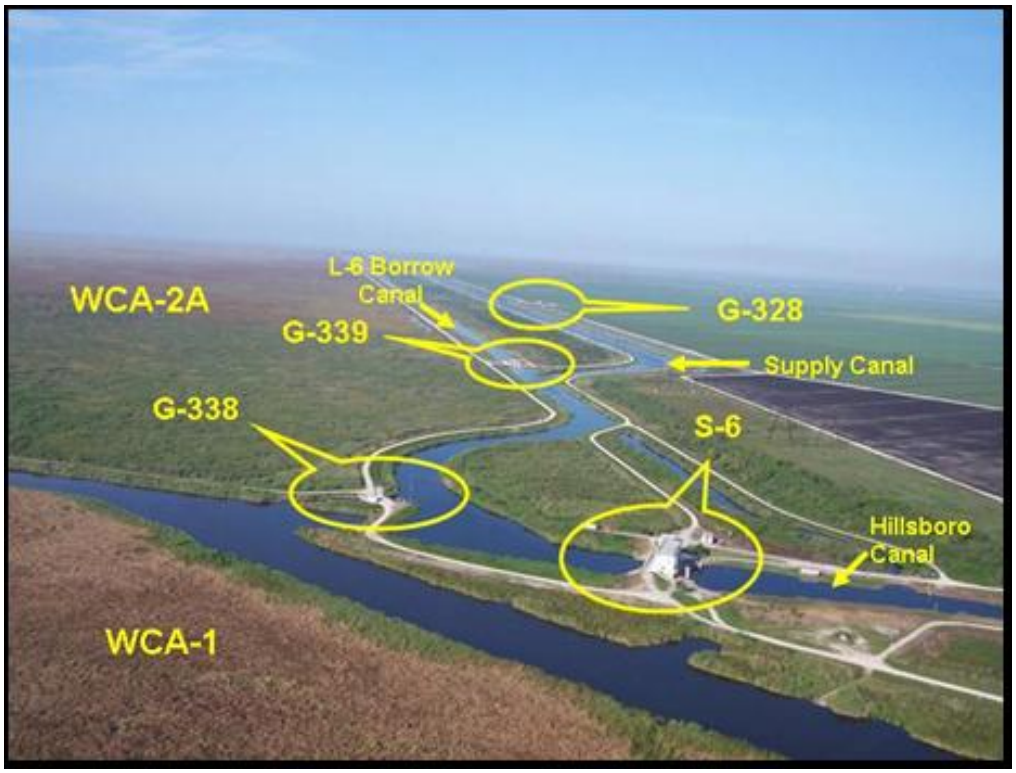
Regarding sub-condition d.(2), the expansion of STA-2 by the addition of Cell 4 will reduce the unit loading of phosphorus to the STA, therefore overloading should not be a concern, although the total volume is expected to increase above the original design values. The existing transect sampling program underway downstream of STA-2 will monitor any effects this additional loading may have on WCA-2A.

APPENDIX 4. STRUCTURE PHOTOGRAPHS

Pump Station S-6

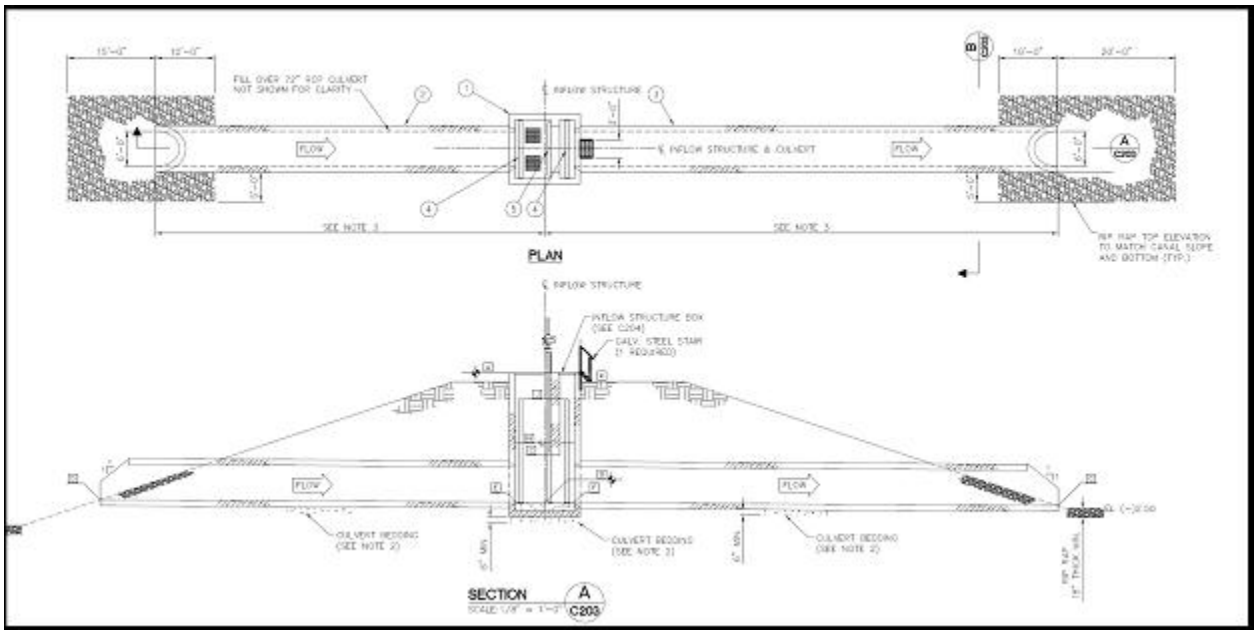
Pump Station G-328.

Aerial Photo of the North End of the Supply Canal.



Structure G-329 (G-331 and G-333 are similar).

Schematic of G-367A-F.



Headworks of Structure G-330 (typical).

Photograph of the tailwater side of G-332.

Photograph of the tailwater side of G-334.

G-337A

G-368A-D.

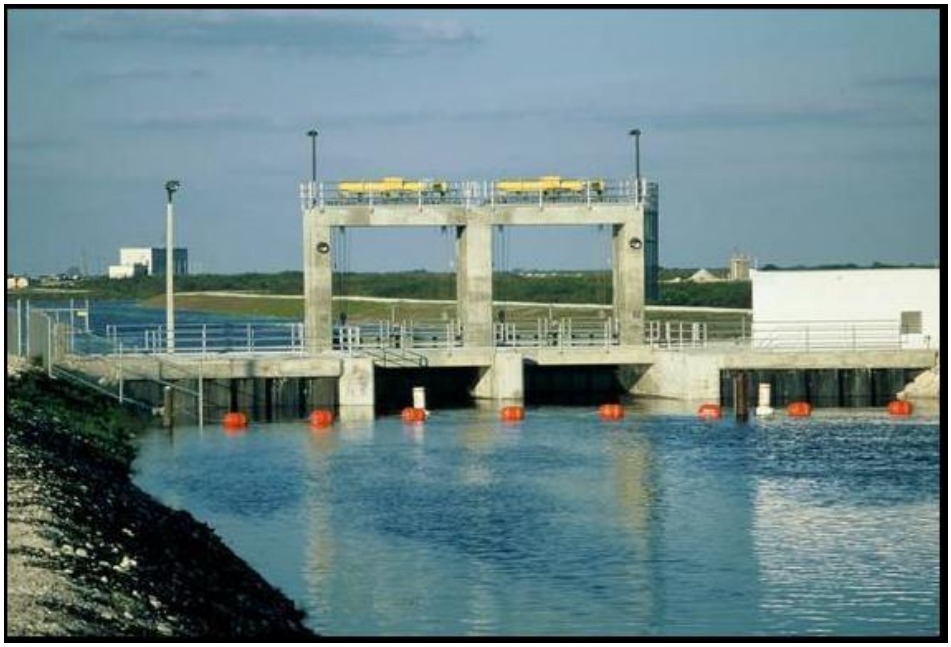
Aerial Photograph of G-335 Pump Station With Cells 1-3 in Background.

(Left) Culvert G-336F with WCA-2A in Foreground and G-337 in Background. (Right) Culverts of G-336G Beneath Roadway Across L-6 Borrow Canal.

Seepage Return Pump Station G-337.

Photograph of the Tailwater Side of G-338.

Photograph of the Tailwater Side of G-339.



Photograph of the Tailwater Side of G-341.

Discharge Canal From Cells 3 and 4

APPENDIX 5. STA-2 STAGE-VOLUME & STAGE-AREA RELATIONSHIPS

Science and Engineering Support Service (SESS) Contract No. C-15988-WO04-05

South Florida Water Management District

November 22, 2005

Prepared by:
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1. Introduction

As stated in the Long-term Plan for Achieving Water Quality goals (Burn & McDonnell, 2003), accurate stage-volume/stage-area relationships need to be developed for every cell of each STA [Bc82(4)]:

A stage-volume relationship for each cell of each STA. A principal use of the new survey data described in section 5.2.1 is to develop the water storage potential in those systems. This aids directly in management of water volumes and indirectly in the correct determination of hydraulic detention times in the STAs. Additionally, the wetted fraction of area may be developed, and used to forecast the loss of effectiveness at low stages (see section 5.2.1). An accurate stage-volume relationship becomes more critical as shallower depth operations come under consideration, because issues of short-circuiting and areal water coverage become more important at low stages.

This technical note summarizes the development of stage-volume and stage-area relationships of STA-2 as specified in Task 2.3.2 of this SESS contract.

2. Topographic Data

The STA-2 new topographical surveys (Wantman Group, 2003) provide the ground surface elevations for each cell of STA-2. These survey data were used for the STA-2 stage-volume and stage-area relationships.

3. Methodology

The survey data were linearly interpolated to a finite element mesh of STA-2. The Surface Water Modeling System (SMS 8.1) calculation tool was used to obtain the storage volume under a specified static water level (SWL) (Figure 1). This is repeated to obtain the relationships for a series of SWL values ranging from minimum to maximum surveyed ground surface elevations. Similarly, the wetted portion of surface area under a certain static water level was determined from the contour lines of specific ground surface elevations.

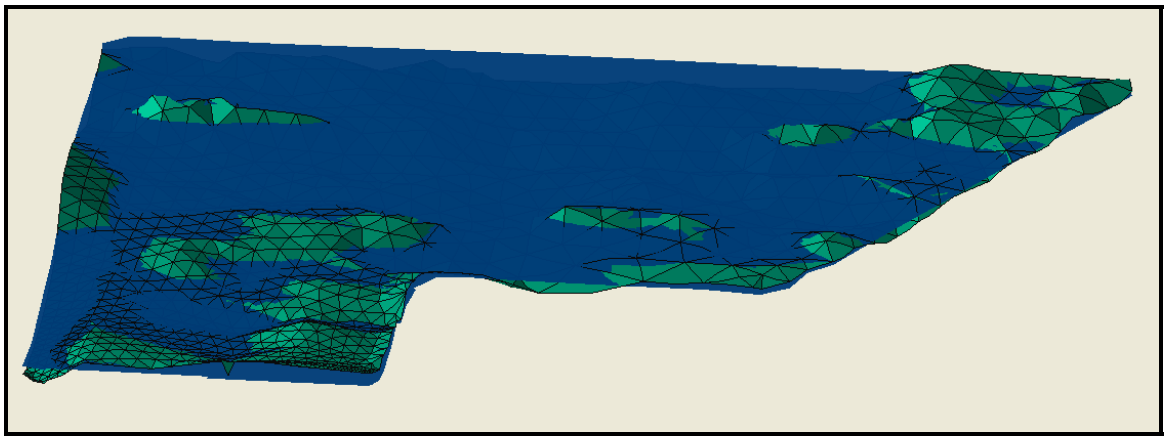


Figure 1. 3-D View of Storage Volume and Wetted Surface Area at a specific Static Water Level

Stage-volume and stage-area relationships are provided in the forms of look-up tables, curve plots for convenient future use.

3. Stage-Volume and Stage-Area Relationships for each Cell of STA-2

3.1 Cell 1:

The surveyed ground elevations in Cell 1 marsh area range from 8.48 ft NGVD to 14.1 ft NGVD. The spatially averaged ground surface elevation is 11.37 ft NGVD. Storage volume and wetted surface area were sampled at various water levels in an increment of 0.25 ~ 0.50 ft. The results are summarized in Table 1 and Figure 2. These storage volume and area data were directly obtained from SMS volume/area estimation.

Table 1: STA-2 Cell 1 Stage-Volume and Stage-Area Relationship

Stage (ft NGVD)	Volume (AF)	Area (acre)
8.48	0.00	0.00
9.00	1.21	2.02
9.50	25.93	96.14
10.00	87.66	173.27
10.50	205.06	313.72
11.00	430.94	618.30
11.25	612.66	854.25
11.50	863.76	1145.50
11.75	1193.21	1530.62
12.00	1624.61	1897.64
12.50	2607.94	1989.36
13.00	3605.59	2000.48

13.50	4607.77	2007.64
14.00	5612.34	2010.21
14.50	6617.45	2010.21
15.00	7622.55	2010.21
15.50	8627.66	2010.21
16.00	9632.76	2010.21
16.50	10637.87	2010.21
17.00	11642.97	2010.21
17.50	12648.08	2010.21
18.00	13653.18	2010.21
18.50	14658.29	2010.21
19.00	15663.39	2010.21
19.50	16668.50	2010.21
20.00	17673.60	2010.21
20.50	18678.71	2010.21
21.00	19683.81	2010.21
21.50	20688.92	2010.21
22.00	21694.02	2010.21
22.50	22699.13	2010.21
23.00	23704.23	2010.21

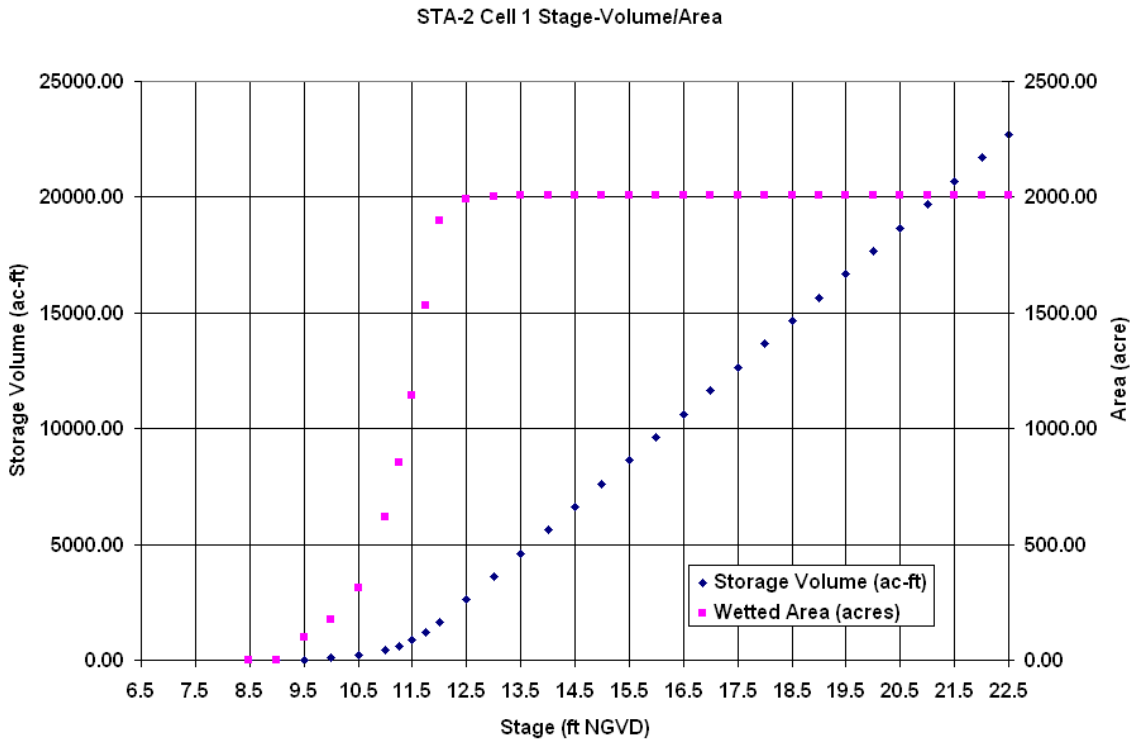


Figure 2. STA-2 Cell 1 Stage – Volume and Stage – Area Curves

3.2 Cell 2:

Surveyed land surface elevations in marsh area range from 7.47 to 12.97 ft NGVD. The spatially averaged ground surface elevation is 10.64 ft NGVD. The stage-volume/area results are summarized in Table 2 and Figure 3. These storage volume and area data were directly obtained from SMS volume/area estimation.

Table 2: STA-2 Cell2 Stage-Volume and Stage-Area Relationship

Stage (ft NGVD)	Volume (AF)	Area (acre)
7.47	0.00	0.00
8.50	1.96	8.01
9.00	29.47	171.78
9.50	199.05	429.98
10.00	449.18	593.13
10.50	826.04	971.98
11.00	1492.86	1731.21
11.25	1965.44	2033.23
11.50	2494.15	2184.97
11.75	3049.85	2254.69
12.00	3617.18	2282.53
12.50	4764.52	2302.41
13.00	5916.34	2304.57
13.50	7068.62	2304.57
14.00	8220.91	2304.57
14.50	9373.20	2304.57
15.00	10525.49	2304.57
15.50	11677.77	2304.57
16.00	12830.06	2304.57
16.50	13982.35	2304.57
17.00	15134.64	2304.57
17.50	16286.92	2304.57
18.00	17439.21	2304.57
18.50	18591.50	2304.57
19.00	19743.79	2304.57
19.50	20896.07	2304.57
20.00	22048.36	2304.57
20.50	23200.65	2304.57
21.00	24352.94	2304.57
21.50	25505.22	2304.57
22.00	26657.51	2304.57
22.50	27809.80	2304.57

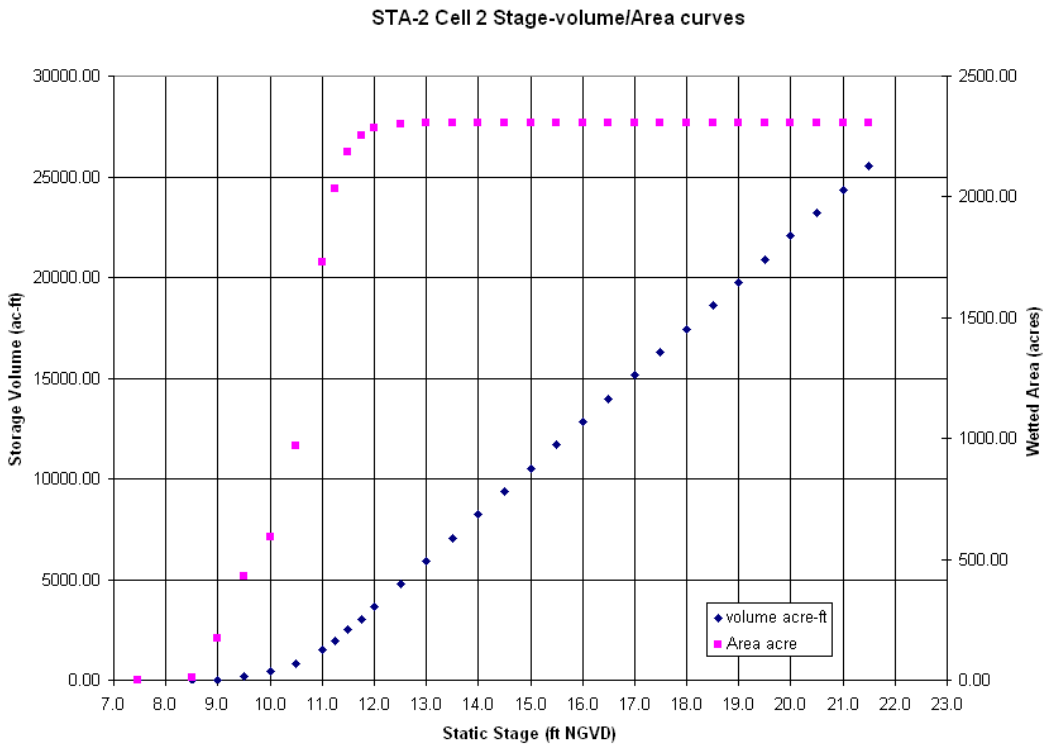


Figure 3. STA-2 Cell 2 Stage – Volume and Stage – Area Curves

3.3 Cell 3:

Surveyed land surface elevations in marsh area range from 7.35 to 12.31 ft NGVD. The spatially averaged ground surface elevation is 9.92 ft NGVD. The stage-volume and stage-area relationship results are summarized in Table 3 and Figure 4. These storage volume and area data were directly obtained from SMS volume/area estimation.

Table 3: STA-1W Cell 3 Stage-Volume and Stage-Area Relationship

Stage (ft NGVD)	Volume (AF)	Area (acres)
7.35	0.00	0.00
8.00	5.01	22.23
8.50	35.04	105.87
9.00	176.69	437.91
9.50	657.13	552.17
9.75	1007.20	1564.47
10.00	1439.27	1894.67
10.25	1938.51	2103.94
10.50	2477.92	2217.74

10.75	3037.59	2260.62
11.00	3604.49	2276.99
11.25	4174.11	2283.99
11.50	4745.41	2288.74
12.00	5889.39	2288.74
12.50	7033.76	2288.74
13.00	8178.13	2288.74
13.50	9322.50	2288.74
14.00	10466.87	2288.74
14.50	11611.24	2288.74
15.00	12755.61	2288.74
15.50	13899.98	2288.74
16.00	15044.35	2288.74
16.50	16188.72	2288.74
17.00	17333.09	2288.74
17.50	18477.46	2288.74
18.00	19621.83	2288.74
18.50	20766.20	2288.74
19.00	21910.57	2288.74
19.50	23054.94	2288.74
20.00	24199.31	2288.74
20.50	25343.68	2288.74
21.00	26488.05	2288.74
21.50	27632.42	2288.74
22.00	28776.79	2288.74

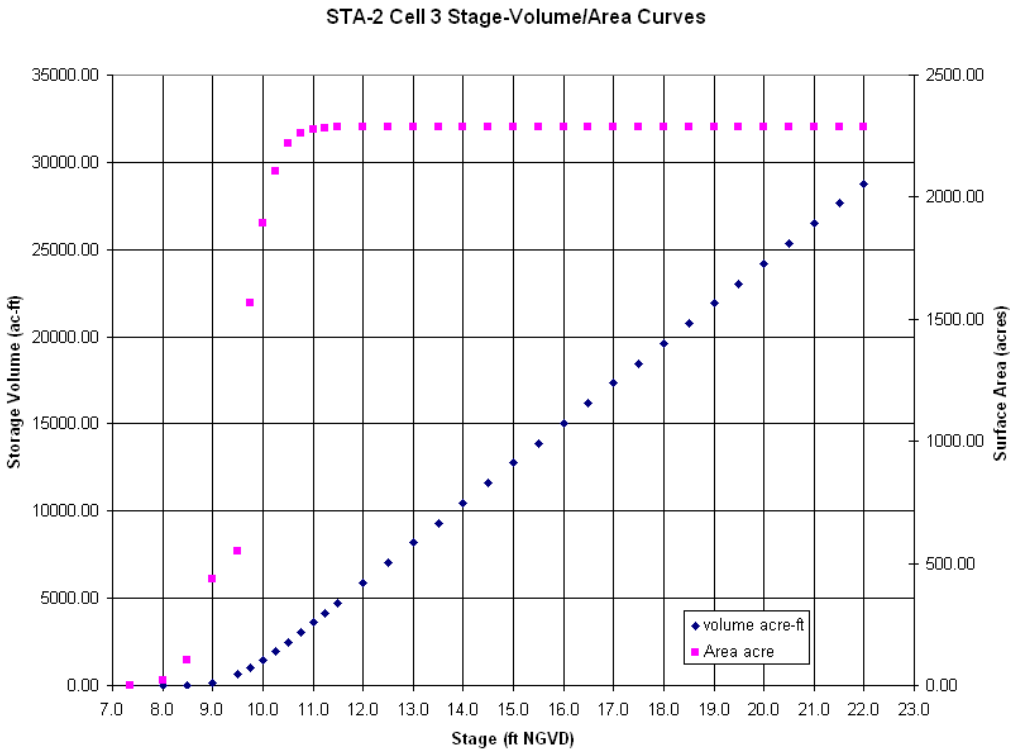


Figure 3. STA-2 Cell 3 Stage – Volume and Stage – Area Curves

4. Summary

The stage-volume and stage-area relationships were derived for each cell of STA-2. These data were reported in tables and plots.

References

[1] Burns & McDonnell, 2003. Long Term Plan for Achieving Water Quality Goals. October 27, 2003.

[2] South Florida Water Management District, 2000. Everglades Consolidated Report: Chapter 6 Status of STAs. West Palm Beach, Florida.

[3] Wantman Group, Inc., 8/25/2003. Stormwater Treatment Area No. 2 Topographic Survey.

Appendix to Sutron 2007: STA-2 Cell 4 stage – volume and state – area relationships

1. Introduction

As stated in the Long-term Plan for Achieving Water Quality goals (Burn & McDonnell 2003), accurate stage-volume/stage-area relationships need to be developed for every cell of each STA [Bc82(4)]:

"A stage-volume relationship for each cell of each STA. A principal use of the new survey data described in section 5.2.1 is to develop the water storage potential in those systems. This aids directly in management of water volumes and indirectly in the correct determination of hydraulic detention times in the STAs. Additionally, the wetted fraction of area may be developed, and used to forecast the loss of effectiveness at low stages (see section 5.2.1). An accurate stage-volume relationship becomes more critical as shallower depth operations come under consideration, because issues of short-circuiting and areal water coverage become more important at low stages."

This appendix summarizes the development of stage-volume and stage-area relationships of STA-2 Cell 4 as specified in Task 1.1 of the Contract ST060589-WO05.

2. Topographic Data

The STA-2 Cell 4 topographical data (Taylor Engineering, April 2005) provided the ground surface elevations for stage-volume and stage-area estimations.

3. Methodology

The topographic data were part of a finite element mesh of STA-2 Cell 4. The Surface Water Modeling System (SMS 9.2) calculation tool was used to obtain the storage volume under a specified static water level (SWL) (Figure 42). This is repeated to obtain the relationships for a series of SWL values ranging from minimum to maximum surveyed ground surface elevations. Similarly, the wetted portion of surface area under a certain static water level was determined from the contour lines of specific ground surface elevations.

By assuming that the effect of the slope of the perimeter levees on storage is negligible, when the static water level reaches or exceeds the maximum surveyed ground surface elevations, the wetted surface area is a constant value and the stage-volume relationship becomes linear.

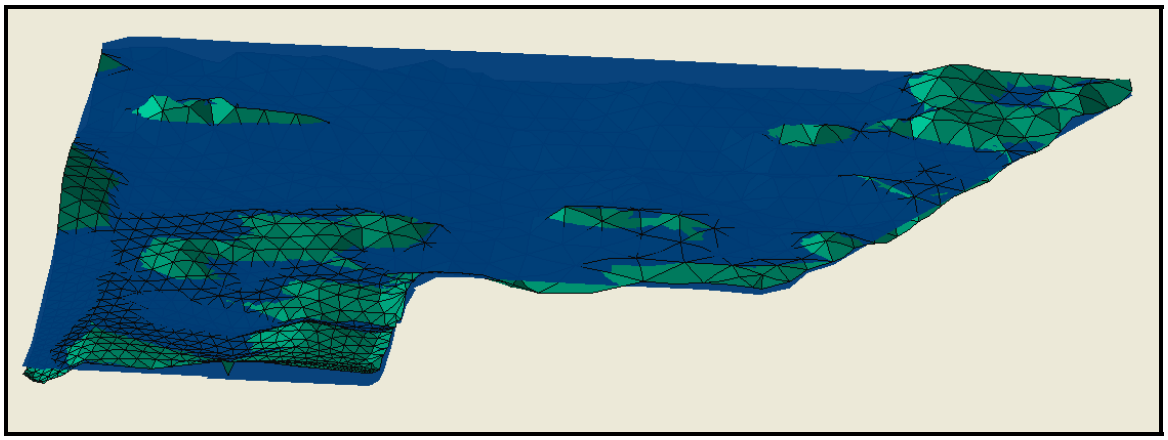


Figure 45. 3-d View of Storage Volume and Wetted Surface Area at a specific Static Water Level

Stage-volume and stage-area relationships are provided in the forms of look-up tables, curve plots for convenient future use.

4. Stage-Volume and Stage-Area Relationships for STA-2 Cell 4

Local topographic features, such as remnant farm ditches and spreader/collection canals and a fish farm were considered in the storage volume and surface area calculation. The land surface elevations in the marsh range from 7.50 ft NGVD to 9.70 ft NGVD (Figure 43).

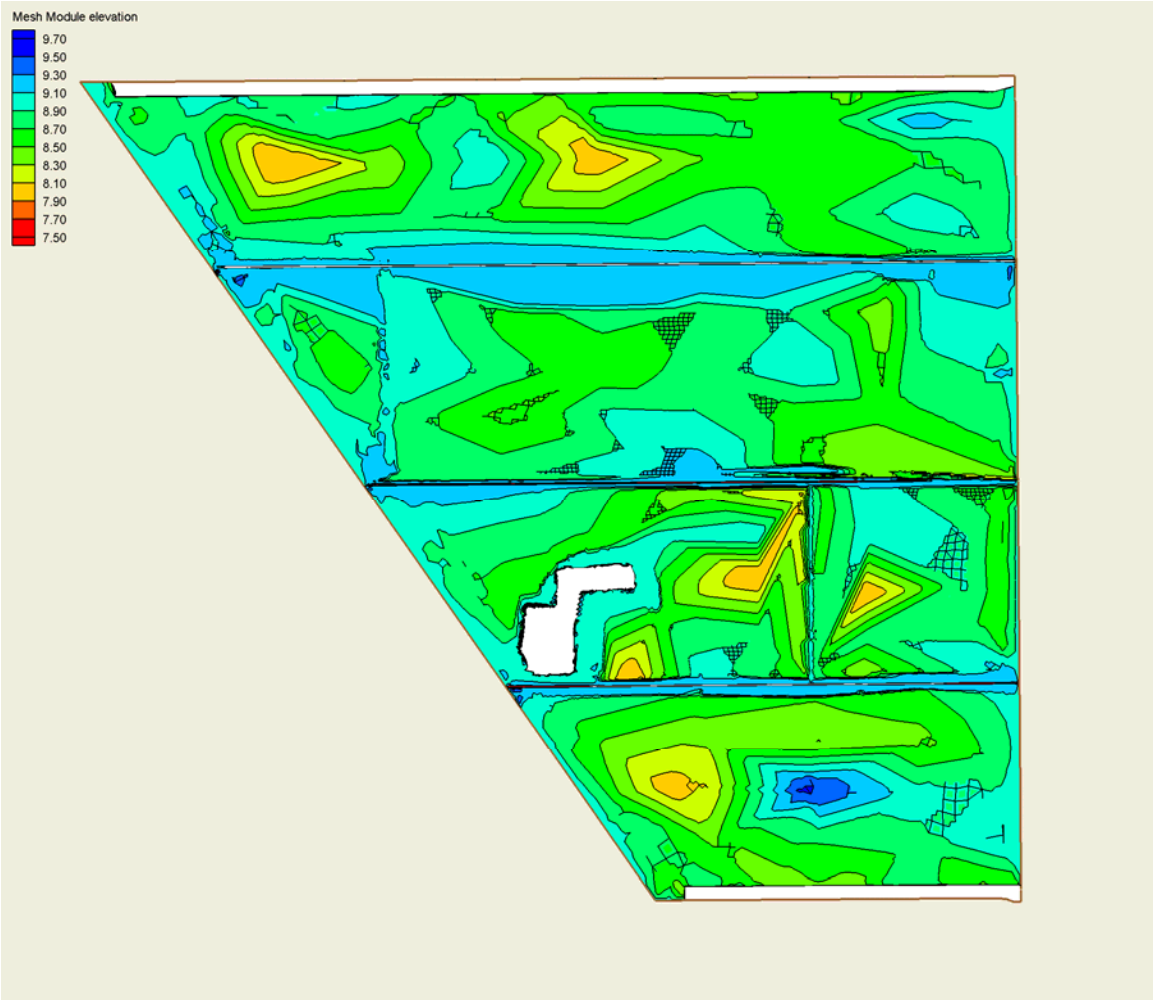


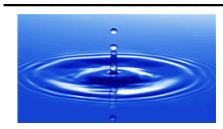
Figure 46. Truncated Land Surface Elevations of STA-2 Cell 4 (7.5 to 9.7 ft NGVD)

The surveyed ground elevations in Cell 4 range from -22.35 ft NGVD in the fish farm to 9.79 ft NGVD in the marsh area. The spatially averaged ground surface elevation is 8.49 ft NGVD. (Note – exclusion of the fish farm area increases the average ground elevation to 8.80 ft NGVD.) Storage volume and wetted surface area were sampled at various water levels in an increment of 0.25 ~ 0.5 ft. The results are summarized in Table 5 and Figure 44. These storage volume and area data were directly obtained from SMS volume/area estimation.

From Table 6 and Figure 44, it can be seen that the marsh area of Cell 4 is very flat. The storage volume below land surface elevation of 8.0 ft NGVD is attributed to the local topographic features (fish farm and local canals).

Table 6: STA-2 Cell 4 Stage-Volume and Stage-Area Relationship

Stage (ft NGVD)	Volume (AF)	Area (acre)
-22.35	0.00	0.00
-17.35	2.54	1.59
-12.35	29.53	9.83
-7.35	89.55	13.96
-5.00	124.78	15.57
0.00	296.15	39.35
0.50	322.76	57.99
1.00	349.47	61.31
1.50	376.39	61.31
2.00	403.46	63.20
2.50	430.78	65.20
3.00	458.48	67.35
3.50	491.97	69.69
4.00	528.15	72.23
4.50	564.65	74.89
5.00	601.45	77.59
5.50	638.52	80.40
6.00	676.31	83.44
6.50	715.02	86.63
7.00	754.49	90.05
7.50	794.56	93.78
8.00	835.26	101.95
8.25	863.70	163.29
8.50	917.33	347.31
8.75	1065.01	940.21
9.00	1379.99	1340.99
9.25	1817.29	1909.47
9.50	2297.20	1924.04
10.00	3258.82	1924.04
10.50	4220.54	1924.04
11.00	5182.31	1924.04
11.50	6144.22	1924.04
12.00	7106.22	1924.04
12.50	8068.22	1924.04
13.00	9030.24	1924.04
13.50	9992.27	1924.04
14.00	10954.29	1924.04
14.50	11916.31	1924.04



15.00	12878.33	1924.04
15.50	13840.35	1924.04
16.00	14802.37	1924.04
16.50	15764.39	1924.04
17.00	16726.41	1924.04
17.50	17688.43	1924.04
18.00	18650.45	1924.04
18.50	19612.47	1924.04
15.00	12878.33	1924.04
15.50	13840.35	1924.04
16.00	14802.37	1924.04
16.50	15764.39	1924.04
17.00	16726.41	1924.04
17.50	17688.43	1924.04
18.00	18650.45	1924.04
18.50	19612.47	1924.04

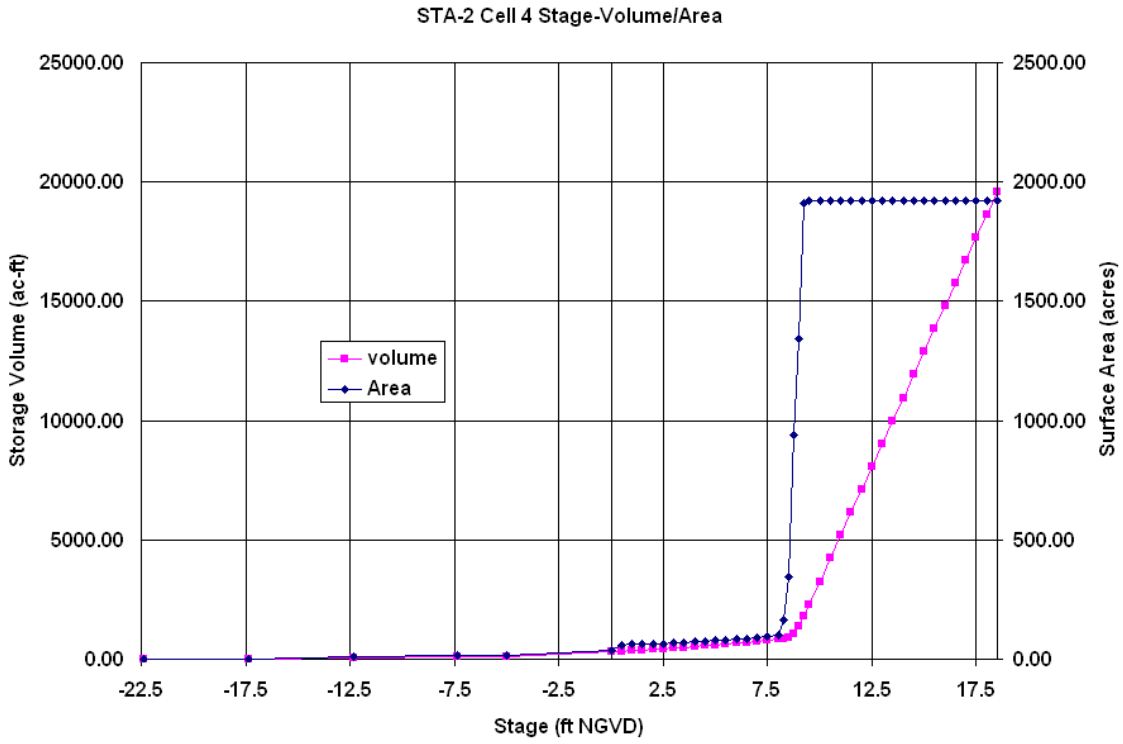


Figure 47. STA-2 Cell 4 Stage – Volume and Stage - Area Curves

APPENDIX 6. SUMMARY OF CHANGES FROM DECEMBER 2007 OPERATION PLAN

Comment Number	Comment	Date Received	Response
1	Page iii-iv: Suggest adding total design flow capacity in parentheses so reader does not have to calculate each time.	July 20, 2009	Added total design flow capacity in parentheses
2	Page iii-iv: Suggest adding headwater and tailwater high and low stage operating limits	July 20, 2009	Added operating limits for structures that had this information available
3	Page iii-iv: Suggest adding a notes column like other Operation Plans Structure Reference Tables	July 20, 2009	Added a "Notes" column
4	Page iii-iv: Center page numbers.	July 20, 2009	Centered page numbers
5	Page iii-iv: suggest replacing "N/A" with "None"	July 20, 2009	Replaced "N/A" with "None"
6	Page iii: Suggest replacing "pipes" with "culverts"	July 20, 2009	Replaced "pipes" with "culverts"
7	Page iii: Suggest adding irrigation to G-328's function and including a note about the 5th pump's capacity. Suggest adding "Diesel engines" to Emergency Back-Up Power	July 20, 2009	Added information to table
8	Page iii: For G-332, suggest replacing "2" with "two" to be similar to other structure type descriptions and avoid confusion that a "216-ft-wide gate" exists here	July 20, 2009	Replaced "2" with "two"
9	Page iii: For G333A-E, replace "Six" with "Five".	July 20, 2009	Replaced "Six" with "Five"
10	Page iii: For G-335, suggest changing function text to "Discharges treated water from STA-2 to L-6 Canal"	July 20, 2009	Changed function text to "Discharges treated water from STA-2 to L-6 Canal"
11	Page iii: For G-336A-F, suggest replacing "Not operable (no gates)" with "Not applicable". Suggest adding the note "Flow limited by L-6 levee height". Suggest changing function text to "Discharges treated water from L-6 Canal to WCA-2A"	July 20, 2009	Replaced "Not operable (no gates)" with "Not applicable". Added the note "Flow limited by L-6 levee height". Changed function text to "Discharges treated

Comment Number	Comment	Date Received	Response
			water from L-6 Canal to WCA-2A"
12	Page iii: For G336G, suggest replacing "Not operable (no gates)" with "Not applicable" and adding "Fixed Weir @ 14.25 ft NGVD" to Structure Type or Note.	July 20, 2009	Replaced "Not operable (no gates)" with "Not applicable" and added "Fixed Weir @ 14.25 ft NGVD" to Note
13	Page iv: G-341: Add "Generator on site – automatic start-up". Add design capacity.	July 20, 2009	Added "Generator on site – automatic start-up". Added design capacity
14	Page v: Make font for Appendix 6 same as other appendix font in table of contents	July 20, 2009	Made font for Appendix 6 same as other appendix font in table of contents
15	Page 1: The effective treatment area of Cells 1-3 (6,430 ac) in 2000 is provided and Cell 4 is stated to be 2,015 acres, however, the effective treatment area is 1,902 acres. Please clarify.	July 20, 2009	Text clarified
16	Page 1: Last sentence of 2nd paragraph - suggest remove "three existing".	July 20, 2009	Removed "three existing"
17	Page 2: Add "(FDEP)" in last sentence and use acronym throughout rest of document	July 20, 2009	Added "(FDEP)" in last sentence and used acronym throughout rest of document
18	Page 4: Last sentence – suggest adding "volume" after "long-term annual average"	July 20, 2009	Added "volume" after "long-term annual average"
19	Page 5: Section 1.3.2 – What criteria determines when replacement water from Lake Okeechobee must be treated?	July 20, 2009	The practice has been to avoid sending untreated water to the WCAs; instead of placing hard and fast criteria in the Operation Plan, discretion is left to the Operations staff and STA Management staff to consider

Comment Number	Comment	Date Received	Response
			numerous regional water management factors.
20	Page 5: Last sentence – "3 miles" should be "2 miles" as that is the distance from G-336A to G-336F	July 20, 2009	Changed "3 miles" to "two miles"
21	Page 5: Is the text in Section 1.3.3 still accurate?	July 20, 2009	Removed discussion of future plans as they are in flux.
22	Page 8-9: Is the minimum upstream headwater elevation 9 or 10 ft NGVD? The first paragraph on page 9 seems inconsistent with the previous page. Please clarify.	July 20, 2009	El. 9 ft NGVD was used as the current drawdown limit throughout the section. The information regarding minimum headwater elevation was obtained from Operations Department – please advise it this information has changed.
23	Page 9: Section 2.1.2: "444 cfs" Many other sections state that the capacity of G-328 is 445 cfs. Pick one and use throughout the document.	July 20, 2009	The text was revised to indicate a design capacity of 444 cfs.
24	Page 9: Check distance of supply canal. Google Earth shows ~ 23,000 ft from S-6 to the NE corner of STA-2.	July 20, 2009	The distance was revised after checking various design documents. The 1994 Conceptual Design listed the distance as 18,500 ft, however the STA-2 Detailed design listed the distance as 23,950 ft.
25	Page 9: Last paragraph – Has the 18.3 ft NGVD value been confirmed? What is the source?	July 20, 2009	Page ES-3 of the January 1996 General Design Report of the Detailed Design identified this design

Comment Number	Comment	Date Received	Response
			criterion, based on the maximum S-6 discharge stage (Brown & Caldwell 1996).
26	Page 12: Table 3: Clarify the two values in the Side Weir Crest El. column.	July 20, 2009	Clarified that the two elevations represent the east side and west side weir crests, respectively
27	Page 14: Replace "G-337" with "G-328"	July 20, 2009	Replaced "G-337" with "G-328"
28	Page 18: Section 2.6.1: What is the source of "connector canal"? In District GIS databases, this canal is called "STA-2 Reserve Canal". Also suggest changing "existing seepage canal" to "former seepage canal" and updating based on the current Comp. B design.	July 20, 2009	Changed "connector canal" to "STA-2 Reserve Canal". Changed "existing seepage canal" to "former seepage canal". Updated text based on the current Comp. B design.
29	Page 19: S-6 upstream canal is maintained at 10.5 ft for flood control 11.5 ft for water supply. Change "personal" to "personnel" in Section 3.1. Remove the word "intake" in Section 3.1.1.	July 20, 2009	Removed sentences: "When the tributary basin needs are centered on irrigation practices, the stages in the supplying canal systems are held higher (11.5 ft NGVD) to facilitate this activity. When the tributary basin needs are centered on flood control, the stages in the supplying canal systems are held lower (10.5 ft NGVD) to facilitate this activity." and replaced with "The canal stage

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			upstream of S-6 is maintained at 10.5 ft NGVD for flood control and 11.5 ft NGVD for water supply." Changed "personal" to "personnel" in Section 3.1. Removed the word "intake" in Section 3.1.1.
30	Page 19: Section 3.1.1 – change "bypass" to "diversion". Add "A-F" after "G-336"	July 20, 2009	Changed "bypass" to "diversion". Added "A-F" after "G-336"
31	Page 20: Suggest adding colons between Cells and design capacities	July 20, 2009	Added colons between Cells and design capacities
32	Page 20: Suggest adding headwater and tailwater stages at G-337A to Table 4 since G-337A is typically used to control inflows to Cell 4.	July 20, 2009	Added headwater and tailwater stages at G-337A to Table 4
33	Page 21: Spell out headwater instead of HW here and throughout the rest of the document.	July 20, 2009	Spelled out headwater instead of HW throughout the document.
34	Page 21: First paragraph – The plan needs to be clear on the sequence of preferred operational options (i.e. diversions and pumping at S-2). Suggest the following text: ***In the interim, the tailwater of G-335 should be monitored during high flow events, and pumping should be reduced as required to keep the tailwater below 16.9 ft NGVD. This may necessitate reducing the S-6 inflow pump based on water levels in the treatment cells. Operational options also include diversion to the Refuge through G-338 (with notification of the Refuge Manager), accumulation of water in the treatment cells, pumping into Lake***	July 20, 2009	Revised text as suggested

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	Okeechobee at S-2 (which may require an Emergency Authorization from FDEP), or any combination of these.		
35	Page 21: Add "except when the L-143 is being used for water supply" in strategy 1 after "normally be closed,". The 12.5 ft stage threshold for opening G-341 would require pumping at S-2 before opening G-341 and may also not be reasonable. G-341 strategy 4 also appears to conflict with G-341 strategies 2 and 3.	July 20, 2009	Added "except when the L-13 is being used for water supply" in strategy 1 after "normally be closed,". Clarified Nos. 2 and 3 for consistency with No. 4 to reflect opening G-341 may occur even when the headwater is lower than 12.0 ft NGVD if S-2 has the potential to pump, or is pumping.
36	Page 22: Fix font of the number 5	July 20, 2009	Fixed font of the number 5
37	Page 22: Is the maximum depth 4.0 ft or 4.5 ft. This and other Operation Plans have both as the maximum depth.	July 20, 2009	4.0 ft is identified as the maximum depth throughout this Operation Plan. This and other plans mention 4.5 ft as the previous maximum depth.
38	Page 23: 2nd to last paragraph – "additional pumping units will be turned on" should be more specific, for example "additional pumping units at G-335 will be turned on"	July 20, 2009	Added "at G-335"
39	Page 23: Change "personal" to "personnel"	July 20, 2009	Changed "personal" to "personnel"
40	Page 24: First bullet – add "during flood control operations" after "closed"	July 20, 2009	Revised bullet consistent with Section 3.1.1
41	Page 24: 3rd bullet – This is presented as a normally applicable provision, however, it does not seem applicable to all scenarios of normal operation.	July 20, 2009	Text was revised to provide more discretion on the part of Operations staff.

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42	Page 24: 6th bullet – add "or less" after "NGVD"	July 20, 2009	Did not revise the bullet, which is applicable during normal operations, and is based on the project design documents. The stage may be lower during drought conditions, but that is not "normal conditions." Let me know if staff would like to discuss this.
43	Page 24: Last bullet – see Comment 34	July 20, 2009	Revised text as suggested
44	Page 26: Does the extreme flow operation assume that G-367A and G-367F remain closed as directed in section 3.1.1?	July 20, 2009	No – Section 3.1.1 provides guidance for normal operations – "inflows up to and including the Design Flow Condition of 3,370 cfs." Extreme flow operations cover larger flows, and as stated: "**Discretion in the operation of STA-2 structures is reserved by the District Operations staff as necessary to account for flood protection, excess precipitation and upstream and downstream conditions."**
45	Page 26: "water depths within STA-2 should be lowered as much as practicable" should be clarified to minimize variations in interpretation and implementation.	July 20, 2009	Text was clarified, as was text in Section 3.2 Pre-Storm Operations
	Page 26: In the Standard Project Storm		Added

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46	section, suggest adding "an average of approximately" before "800 cfs" and changing "nominal" to "design".	July 20, 2009	"approximately" before "800 cfs" and changed "nominal" to "design"
47	Page 26: The Probably Maximum Storm section states that 1,970 cfs will be diverted via G-339. This value exceeds the design capacity (1,400 cfs). Also suggest changing "nominal" to "design"	July 20, 2009	The Plan was revised to reflect the General Design Memorandum capacity of approximately 1,123 cfs per bay at HW=17.5 ft and TW=16.8 ft (Burns & McDonnell 1995). Changed "nominal" to "design"
48	Page 26: Scenario 1 states that Cell 3 should opened at the beginning of the event. Then what?	July 20, 2009	Beginning at simulation time = zero and throughout the storm, structure gate openings were modeled to balance flows through the four cells as closely as possible.
49	Page 27: Scenario 4: "closes" should be "closed". Where is wave runup a concern (entire Cell 4 or inflow canal only)? At what stage limit should inflows stop?	July 20, 2009	Changed "closes" to "closed". The combination of wave runup and wind setup is a concern along the Cell 4 levees, with a crown elevation of 19.0 ft NGVD and a wind fetch of 13,200 ft (Brown & Caldwell 2005d). Brown & Caldwell did not provide a stage limit that inflows should stop, but rather, recommended "closing the Cell 4 inflow and outflow

Comment Number	Comment	Date Received	Response
			gates as analyzed in Scenario 4 if an extreme storm event is expected to occur."
50	Page 30: Change "personal" to "personnel" and "water depths within STA-2 should be lowered as much as practicable" should be clarified to minimize variations in interpretation and implementation. Need trigger stage for closure of G-337A. Regarding G-337, remove "maximum" and see Comment 42.	July 20, 2009	Changed "personal" to "personnel" and "water depths within STA-2 should be lowered as much as practicable" was clarified. The design engineer did not provide a trigger stage for closure of G-337A. Regarding G-337, replaced "maximum" with "average"
51	Page 31: Regarding G-337 remove, "maximum" and see Comment 42	July 20, 2009	Regarding G-337, replaced "maximum" with "average"
52	Page 35: See Comment 20	July 20, 2009	Changed "3 miles" to "two miles"
53	Page 43: Clean up word wrap issues in Appendix 1 Table 5.	July 20, 2009	Increased width of column in Table 5
54	Page 55: Does Appendix 3 need to be updated in accordance with the March 2009 EFA permit and NPDES AO?	July 20, 2009	Section 4 and Appendix 3 were updated in accordance with the March 2009 EFA permit and associated AO
55	Page 89: Suggest adding page number or section to Appendix 6. Or provide detailed table of comments and responses like STA-1E. How was figure 2 updated? What enhancements were added to Figure 3? Suggest adding "A-E" after "G-330".	July 20, 2009	A detailed table of comments and responses was added, similar to what was done for STA-1E. Figure 2 was updated by District staff for consistency with other STA schematics. The old Figure 3 was replaced with a

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			schematic prepared by the design engineer (Brown & Caldwell). The proper designation of culverts G-330E-A is shown on both figures.
56	Should the rating curve for G-341 be added to Appendix 1?	July 20, 2009	Rating curve was added
57	Clarify language regarding supplemental water on page 4	September 18, 2009	Clarified language
58	Page 5 – add "and the continued research and monitoring program," to description of TP removal	September 18, 2009	Did not incorporate comment, as the continued research and monitoring program are addressed in other sections of the Plan, e.g., on pages 33-34
59	No decision has been made on the use of the STA-2 Reserve Canal (page 18).	September 18, 2009	Revised text
60	Page 32 - For Indigo Snake and other wildlife in order to minimize disturbance to or mortality due to drowning, the USFWS is now requiring that STA treatment cells be hydrated (initially or after dry-out) at a rate of no more than 6" per day until water levels are 6" above average ground elevation of a cell. Once this depth is reached there is no restriction on fill rate.	September 18, 2009	Added language as requested
60	Page 33 – delete reference to construction of EAA Reservoir	September 18, 2009	Deleted reference to construction of EAA Reservoir
61	Page 37 – update EFA permit information	September 18, 2009	Updated EFA permit information

Other Revisions to the December 2007 *Operation Plan*
62. Added an operational strategy for divide structure G-341
63. Made minor revisions to the text of the structure reference table in the front of the Plan
64. Updated information regarding Cell 4 net improvement and routine discharges
65. Revised the reference ground elevation for Cell 4 consistent with May 2008 Brown & Caldwell report
66. Presented flow rating curves for G-330 structures based on District technical note
67. Revised the Plan to acknowledge the interim conditions until the L-6 West levee is raised

APPENDIX 7. STA-2 SURVEYS AND RECORD DRAWINGS

Surveys and available record drawings for STA-2 Cells 1-3 are contained in the DVD located in the envelope on the back cover of this *Operation Plan*.