Everglades Agricultural Area Regional Feasibility Study

Deliverable 4.2 – Final Operating Strategy for Optimizing STA Performance with Existing EAA Goals

(Work Order No. CN040912-WO04 Phase 2)



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EVERGLADES AGRICULTURAL AREA REGIONAL FEASIBILITY STUDY

DELIVERABLE 4.2 – FINAL OPERATING STRATEGY FOR OPTIMIZING STA PERFORMANCE WITH EXISTING EAA GOALS

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1.0 INTRODUCTION

The EAA Regional Feasibility Study (RFS) is being conducted by A.D.A. Engineering, Inc. for SFWMD through Work Order Numbers CN040912-WO03 and WO04. Under the Everglades Construction Project (ECP), SFWMD has constructed several Stormwater Treatment Areas (STAs) to help improve the quality of water released to the Everglades Protection Area (EPA). In addition to the existing STAs, SFWMD is planning certain STA expansions and enhancements, EAA canal improvements, construction of the EAA Storage Reservoir Project, and other EAA improvements. With recognition of these planned improvements, the EAA RFS will evaluate alternatives for redistributing inflow volumes and phosphorus loads to the various STAs to optimize phosphorus removal performance. This study is not intended to define the final arrangement, location, or character of these proposed projects but is a fact-finding exercise to develop the information necessary for the subsequent planning, design, and construction of these future projects.





2.0 SCOPE OF WORK

This document is an interim deliverable for Phase 1 Task 3 – Operating Strategy for Optimizing STA Performance with Existing EAA Canals. This task will define an operating strategy for redistributing the inflows to the STAs to optimize phosphorus reduction prior to the completion of EAA Canal Improvements, the A-1 Reservoir, and the Build-outs of Compartments B and C (these improvements are anticipated to be completed by 2010). This interim deliverable will define the hydraulic constraints to redistributing inflows to the STAs. The draft deliverable that will follow this interim deliverable will define the optimum redistribution of inflows to achieve optimum operation of the STAs between 2006 and 2010. The scope-of-work for Phase 1 Task 3 was limited to the Miami, North New River, Bolles, Cross, Hillsboro, West Palm Beach, Ocean, and STA 3/4 Supply Canals. However, this assessment also includes canals, flow-ways, and hydraulic control structure for the Rotenberger Tract, the Holeyland Wildlife Management Area, all STAs and the L-canals.





3.0 AVAILABLE DATA

SFWMD measures flows, stages, gate levels, and rainfall at numerous stations in the EAA. These data are available from DBHYDRO. Documents from SFWMD were used for dimensions of various EAA structures and STAs. **Table 3.1** presents a summary of available data used for this task. Detailed references are presented in the References section of this report.

Table 3.1 – Data Used in This Assessment						
Source	Title	Data Used	Data Type			
SFWMD	STA Operation Plans for STA	Pump and gate	Reports			
	1E, STA 1W, STA 2, STA	operations, pump				
	3/4, STA 5, and STA 6	sizes				
SFWMD	EAA Farm Runoff daily flows	EAAWQDWN.dat	Data			
SFWMD	S-6, STA 2 gates, G-335, G-	2004 Hourly gate	Data			
	370, STA 3/4 gates	level, stage, and flow				
		data. STA 2 data				
		from DBHYDRO,				
		STA 3/4 data from				
		spreadsheets				
SFWMD	S-5A Diversion Structure G-	Gate dimensions	Plans			
	341 Design Drawings	-				
Burns &	Addendum to the Design	Gate dimensions, cell	Report			
McDonnell	Documentation Report, STA	bottom elevations,				
	1E	pump capacities,				
		target water levels				
Brown and	Final BODR for STA 2 Cell 4	Gate, canal, and cell	Reports			
Caldwell		dimensions				
URS	Draft BODR for STA 5 Flow-	Gate, canal, and cell	Reports			
	way 3 and STA 6 Section 2	dimensions				
Stanley	EAA Permitted Farm Area	Fstruct and dsub	Shape files			
Consultants	and pump station GIS data	shape files				
US ACE	MIKE 11 Model and database	3				
/DHI	of daily flows and stages –	measured stage and				
	selected stations	flow data (122 and				
		59 stations)				

Table 3.1 – Data Used in This Assessment

3.1 Measured Hourly Data Used to Verify STA Operations

3.1.1 STA 2

Hourly data were obtained for the STA 2 inflow pump stations S-6, the outflow pump station G-335, and selected gates. These data were used to confirm predicted water levels at the headwater of S-6, predicted water levels within STA 2, and the operation protocols for STA 2 gates and outflow pump station G-335. **Figure 3.1** presents flows and headwater stages for pump station S-6. **Figure 3.2** presents gate elevations for the cell 3





inflow (G-333) and outflow (G-334) gates. **Figure 3.3** presents overall flows from STA 2 at pump station G-335. Key aspects of STA 2 operation are summarized below:

- Water levels at S-6_H drop from above 10 ft-NGVD to 9 ft-NGVD within approximately 5 hours after S-6 begins operation.
- S-6 operates during the day and not at night. Although not presented in this document, S-6 operates 24-hours per day if headwater elevations remain closer to elevation 10 than elevation 9.
- Inflow gate operation for STA 2 cells closely follows S-6 pump station operation.
- Outflow gate operation for STA 2 cells is not related to the inflow pump station operation.
- Significant variation over periods of a number of hours are experienced in the vicinity of STA 2 due to operational issues. Oscillations in water levels upstream of the STA inflow pump stations can be expected due to the relatively small number of large pumps (S-6 has three 975 cfs pumps).

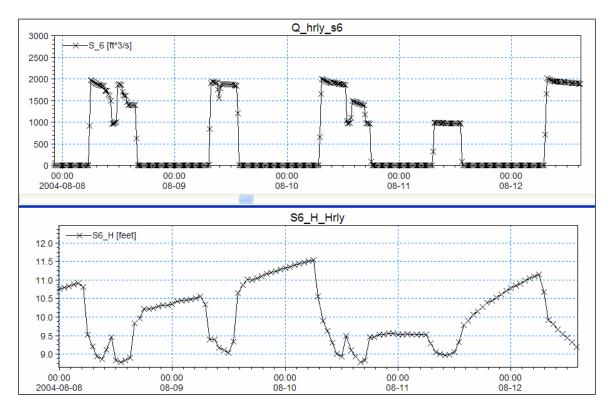


Figure 3.1 – Measured Flows and Headwater Stages at S-6





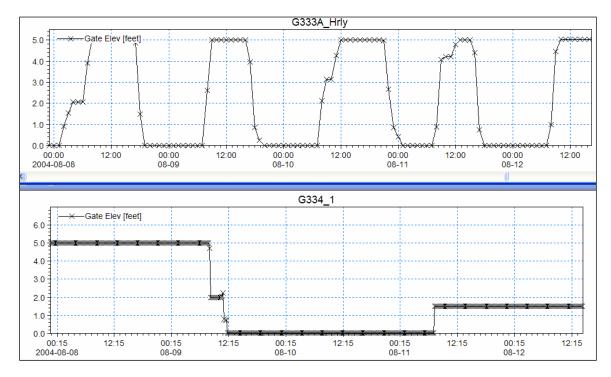


Figure 3.2 – Measured Gate Elevations for Cell 3 of STA 2 (Level 0.0 is closed)

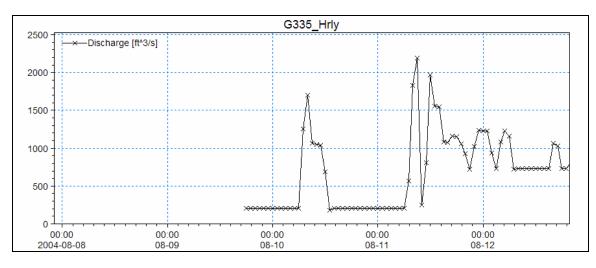


Figure 3.3– STA 2 Outflows at Pump Station G-335

3.1.2 STA ³/₄

Hourly data was obtained for STA 3/4 inflow pump station G-370 and gate elevations at the inflow and outflow of selected cells. These data were obtained from spreadsheets that are used to pre-process data prior to entry into DBHYDRO. STA 3/4 was in a start-up mode in 2004 and therefore, less data is available which must be processed prior to analysis. **Figure 3.4** presents hourly stage and flow data for G-370. Pump station G-370 flows in October, 2004 (a time of significant runoff due to prior hurricanes) ranged from 925 cfs to 2,775 cfs. Flows at G-370 in fall 2004 did not follow the S-6 pattern of operation during daylight hours. As with





S-6, depressed water levels are observed at the G-370 headwater during pumping. S-6 and G-370 have the same pump station capacity (2,775 cfs), however a runoff to the North New River will be less between 2006 and 2010 because Compartment C (9,590 acres) and STA 3/4 (16,543 acres) do not contribute runoff. The expansion of the Cross and Bolles Canals by 2010 will restore additional runoff to the North New River.

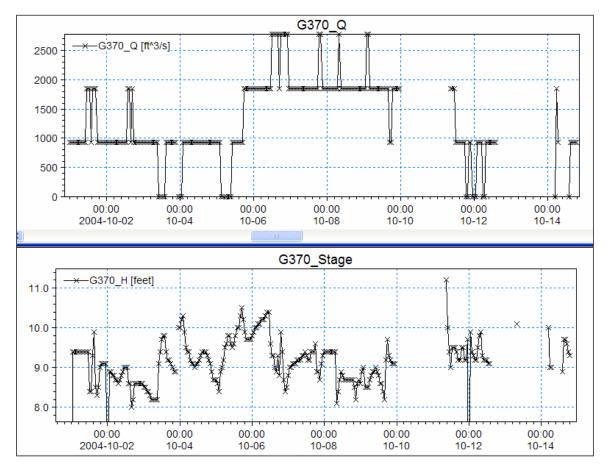


Figure 3.4 – Hourly Flow and Headwater Stage Data for STA 3/4 Inflow Pump Station G-370





4.0 MODEL DEVELOPMENT

The initial scope-of-work for this contract stated that an existing conditions HEC-RAS hydraulic analysis model would be developed for the Miami, North New River, Bolles, Cross, Hillsboro, West Palm Beach, Ocean, and STA 3/4 Supply Canals. The Phase 1 Task 2 Report (Evaluation Methodology and Evaluation Criteria, ADA, 2005) described the recommended hydraulic analysis approach. The hydraulic analysis will not use HEC-RAS but will use an existing MIKE 11 model of the EAA canals that includes the L canals and five of the six STAs.

4.1 Model Provided by U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers is conducting the Project Implementation Report (PIR) for the EAA Storage Reservoirs, and a MIKE SHE/MIKE 11 model was developed to assist in the development of the PIR. This integrated surface/ground water continuous simulation model describes the full hydrologic cycle of the EAA including rainfall, evapotranspiration, infiltration, groundwater, runoff, canal hydraulics, and canal/aquifer exchanges. Structure details and operations of over 150 hydraulic control structures are handled by the surface water hydraulics model MIKE 11. The model represents 2004 conditions, and included STA 3/4 with structures G-371 and G-373 on the North New River and Miami Canals, respectively. G-371 and G-373 are gated structures that are closed for headwater elevations less than 12.5 feet and are intended to direct all EAA runoff from these canals into STA 3/4. The MIKE 11 portion of the MIKE SHE/MIKE 11 model was provided by US ACE to SFWMD for use in the EAA RFS. The EAA RFS Phase 1 Task 3 hydraulic analysis of existing EAA canals will use MIKE 11 with boundary inflows that represent the rainfall/runoff process for EAA farms, as described below. The MIKE SHE portion of the model (rainfall, overland flow, groundwater) was decoupled from the MIKE 11 model and not used. Rainfall and evapo-transpiration can be modeled in either MIKE SHE or MIKE 11, and was used in this study for the canals, STAs, and reservoirs. A number of refinements were made to the network to represent 2006 conditions (see section 4.4) and to improve hydraulic control structure operations to remove model instabilities (see section 5). The MIKE 11 hydraulic network is shown in Figure 4.1.





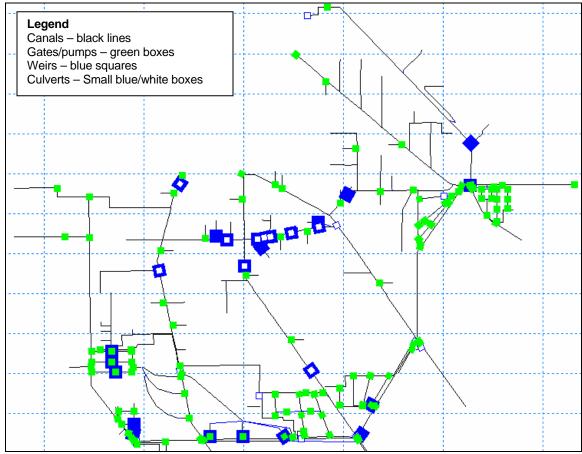


Figure 4.1 – MIKE 11 Hydraulic Network

4.2 Hydrology

There are 226 farms in the EAA that have SFWMD permits to discharge to the main EAA canals. These permits are for specific farm areas and specific intake and discharge locations. The discharges are pumped outflows from the EAA farms, and the maximum flow for each pump is defined in the permit (there are 292 permitted pumps). Typically, the maximum pump discharge is equal to 1.5" per day, and the average permitted discharge is ³/₄"-NGVD/day. The irrigation inflows are either pumped or are regulated by gated structures. The permit stipulates that farm runoff volume and Total Phosphorus (TP) concentration shall be measured using approved methods and reported to SFWMD. SFWMD maintains a data base of daily average discharge flows and discharge TP concentrations. EAA farms utilize best management practices (BMPs) to control the runoff with the intent of retaining at least 25% of the TP load on the farm. This is achieved by a variety of methods including in-canal retention upstream of the farm outflow pump station. When possible, EAA farms will not discharge any runoff for small storms and will use the runoff stored in internal canals for irrigation during periods following the runoff event. Some EAA farms are over 10,000 acres in size, and often experience heavy rainfall in one part of the farm while crop stresses are experienced in other fields due to low groundwater elevations. The net effect of the BMP program is that farm runoff is very difficult to predict.

The analysis conducted during this assessment assumes that runoff from EAA farms will range from 3/8"-NGVD to 3/4"-NGVD. The runoff rate can be varied by major EAA





drainage basins (STA 1E, STA 1W STA 2, STA 3/4 East, STA 3/4 West, STA 5 and STA 6, and others). The initial assessment analyzed a uniform rate of runoff in each basin equal to 3/8". Then, 3/4" of runoff was used is a portion of the EAA to test if inter-basin transfers would be possible with the existing canal network.

The 292 EAA farm pumps have been grouped by ADA into 148 discharge locations, and the area for a "grouped pump" is equal to the combined area for the pumps included in that one "grouped pump". Pumps were grouped when the distance between pumps was less than 0.5 miles and there were no bridges or culverts between the pumps. **Figure 4.2** presents the farm pumps and the grouped farm pumps. The runoff rate for the 148 discharge locations is presented in **Table 4.1**.

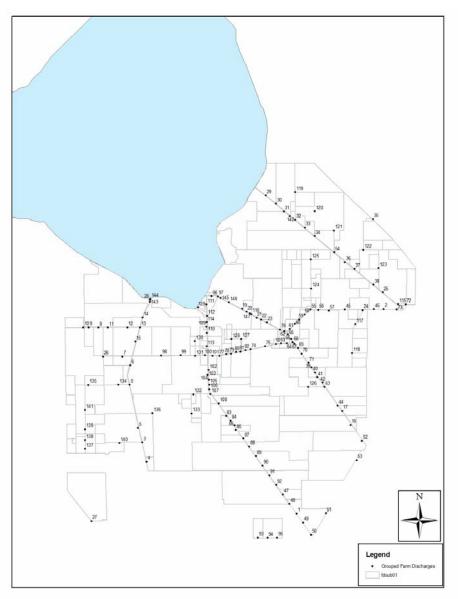


Figure 4.2 – Locations of Runoff Inputs







BEODUTS 18 Adsder DCO:TTN IFC231TS 30 Adsder HC23STN01 NTR12TWO 110 Adsder REVEX/03.06.06 BCOLSTN 7 Adsder BC01STS L00.1TS 0 NtR12TWO 10 Adsder Ntr22TWO7.09.10 BC012TN 7 Adsder BC01STS L00.1TS 0 NtR12TE 10 BC02STN 58 Adsder BC024TS L106.1TS 40 NtR12TE 24 BC02STN 68 Adsder BC024TS L106.1TS 40 NtR12TWO 800 BC02STN 70 L50.5TN 0 NtR2STW 40 NtR2STW 40 BC02STN0 20 L50.6TN 40 NtR2STW 47 Adsder NtR2STW 7 BC02STN2 40 Adsder BC05.TTN0 L0.0A.0C.0C.0SC.0SC L60.1TN 27 NtR2STW 1 Adsder NtR2STW 1 BC02STN2 40 Adsder BC05.TTN0 L0.0A.0C.0SC.0SC.0SC.0SC.0SC.0SC.0SC.0SC.0SC.	Structure	Flow (cfs)	Comments	Structure	Flow (cfs)	Comments	Structure	Flow (cfs)	Comments
BOT 2TN 7 Construct L103.1TS 0 PRIS TTE 130 BOD 2TN 68 Added BOD:1STS L105.1TS 40 NR19.7TE 24 BOD 2TN 68 Added BOD:1STS L105.1TS 40 NR19.7TE 24 BOD 2TN 68 Added BOD:1STS L105.1TS 40 NR19.7TE 24 BOD 2TN 68 Added BOD:2ATS L105.1TS 40 NR29.7TW 30 BOD 2TN 28 L005.0TN 20 NR29.7TW 46 Added N29.2TW, 27.TE, 27.TE BOD 2TN 28 Added BOD 2TN L005.0TN 40 NR29.7TW 46 Added N29.7TW, NR27.2TE BOD 2TN 27 Added BOD 2TN L001.0TN 127 NR29.4TTE 18 Added N29.7TW, NR27.2TE BOD 2TN 7 Added BOD 2TN MC10.7TW 12 Added MC00.7TS 16 Added N29.7TW, NR27.2TE BOD 2TN 7 Added BOD 2TS L001.7TW 18 Added MC00.7TS 16 Added MC00.7TS	BC00.1TS	18	Added BC00.1TN	HC23.1TS	30	Added HC23.5TN01	NR18.2TW04	116	Added NR18.2TW02,03,05,06
BOTI STM 15 Added BO2 ATS L104.1TS 0 PMIP 2TE 47 BOD23TM 65 Added BO2 ATS L105.1TS 40 NR1027TC 24 BOD3TM 0 L406.0TM1 33 NR202TW 309 BOD5STN01 20 L406.0TM1 0 NR23.TW 66 Added N22.TW, 27.TE, 27.TE BOD5STN01 20 L604.0TM1 0 NR23.TW 66 Added N22.TW, 27.TE, 27.TE BOD5STN01 20 L604.0TM1 40 NR25.TW 0 BOD5STN1 40 NR25.TW 0 Added N22.TW, 27.TE, NR22.TE 0 BOD5STS 47 Added BOD7TN L004.0TTW 0 Added N20.TTE 1 BOD3TS 37 Added BOD7TN MC10.TTW0 1 Added N10.TTW-167 0 Added N10.TTW-17 0 Added N10.TTW-17 0 Added N10.TTW-17 0 Added N10.TTW-17 0 Added AD02.TTE 44 Added AD02.TTE, N2.TE, N2.TE	BC00.6TN	5	Added BC00.6TS	L101.1TS	0		NR18.2TW08	10	Added NR18.2TW07,09,10
BOI2 STN 68 Added BC02 ATS L105.1TS 40 PRIS 7TE 24 BC045TN 0 L105.5TS 39 NR8207TE 0 BC05STN 10 L05.5TNN 0 NR237TE 0 BC05STN 10 L05.5TNN 0 NR237TV 68 Added NR232TW, 22.7E, 23.7E BC05STN 40 NR24.5TW 47 Added NR24.2TW, 27.7E, NR242TW E05.5TN BC05STN 40 NR25.5TW 40 Added NR27.TTE, NR242TW E05.5TN BC05STN 40 NR25.5TW 7 Added NR27.TTE, NR242TW E05.5TN BC05DTN 47 Added DC05.5TN L05.5TN 7 Added NR27.TTE, NR282TW BC020TN 7 Added DC07.TN L05.5TN MC10.7TW1 59 Added MC10.7TW-E C002.0TN 10 Added C02.5TS BC10.2TN3 10 Added DC12.2TN1 MC10.7TW1 123 Added MC10.7TW0.01.01.2 C024.1TS 29 Added C02.5TS BC11.2TN 120 Added MC10.7TW1.01	BC01.2TN	7		L103.1TS	0		NR18.7TE	130	
BC04.5TN 0 LI05.6TS 39 NR202TW 900 BC05.5TN01 0 L406.5TN01 3 NR23.1TW 66 Added NR23.2TW, 22.TE, 23.TE BC05.5TN01 20 L503.6TN 0 NR23.1TW 66 Added NR23.2TW, 22.TE, 23.TE BC05.5TN01 20 L505.6TN 40 NR25.2TW 7 BC05.5TN01 40 Added BC06.5TN01.03.04.05.06 L601.5TN 27.6 NR25.2TW 7 BC05.5TS 40 Added BC06.5TN01.03.04.05.06 L601.5TN 27.6 NR26.2TW 4 BC07.0TS 16 Added BC06.5TN1 L606.5TN L606.5TN NR26.2TW 4 Added MC08.7TW-A 1 BC07.0TS 16 Added BC06.2TN MC00.7TW01 120 Added MC10.7TW-E OC02.0TN 116 Added OC02.5TS BC07.5TS 10 Added BC10.2TNN MC10.7TW10 122 Added MC10.2TW-E OC02.0TR 116 Added OC10.2TNC.6TN.2TN.2TN.2TN.2TN.2TN.2TN.2TN.2TN.2TN.2	BC01.8TN	15	Added BC01.8TS	L104.1TS	0		NR19.2TE	47	
BODGSTNI 0 L406_0TNO1 33 RE20_TTE 0 TEXPTIE 0 BODGSTNI 0 L504_GTN 0 NR24_GTW 46 Added NR23_TW, 22_TE, 23_TE BODGSTNI 100 L506_GTN 40 NR24_GTW 47 Added NR23_TW, 22_TE, 23_TE BODGSTNI 40 Added BODG_GTNO1, 03,04,05,06 L601_GTN 17 Added BODG_GTN 160 NR25_TW 7 BODGSTNI 40 Added BODG_GTN L511_GTW 0 NR25_GTW 1 Added NR22_TE, NR24_2TW 1 BODGSTS 47 Added BODG_GTN L511_GTW 0 NR25_GTW 1 Added NR22_TE, NR24_2TW BODGSTS 37 Added BOD_GTN MC10TTW1 0 Added MC10TW_E OC00GTN 11 BODGSTS 37 Added BOD_GTN MC10TTW1 120 Added MC10TW_E OC00GTN 10 Added OC12_STS BO117TN 120 Added BOD_GTTW15 20 Added MC10TW_E OC00GTN 0 Added OC14_GOD_GTA_GOT14_GOT14_GOT14_GOT14_GOT	BC02.9TN	58	Added BC02.4TS	L105.1TS	40			24	
BCIB.STN01 20 NR23.TW 66 Added NR23.2TW_22.TE, 23.TE BCIB.STN 108 L504.5TN 0 NR24.2TW 4 Added NR23.2TW_22.TE, 23.TE BC0B.STN 28 Added EC06.5TN01.03.04.05.06 L505.5TN 40 NR25.2TW 0 BC0B.STN2 40 Added EC06.5TN01.03.04.05.06 L505.5TN 40 NR25.2TW 7 BC0B.STN3 48 Added EC06.5TN01 L505.2TN L507.2TN NR25.2TW-A 1 BC07.STN 17 Added EC07.3TN MC00.5TE 120 Added MC00.7TW-C OC0.5015 6 BC09.2TN 27 Added EC0.2TNN MC00.7TW01 120 Added MC10.7TW-E OC0.201TN 116 BC01.2TN1 120 Added MC10.7TW01 0.23 Added MC10.7TW-E OC0.201TN 116 BC10.2TN1 120 Added MC10.7TW01 0.23 Added MC10.7TW04.0 OC0.41TS 28 Added OC10.2TA.S OC10.4.5.TS BC11.7TN 120 Added MC10.7TW04.0 OC0.41TS Added OC10.2TA.S	BC04.5TN	0		L105.6TS	39		NR20.2TW	309	
BODE STS 108 LEDG ETN 0 NR24 GTW 47 Added NR24.7TE, NR24.2TW BODE STN02 40 Added BC06.STN LEDS STN 40 NR26.STW 7 BC06.STN02 40 Added BC07.STN LEDS STN 27 NR26.STW 7 BC07.STN 17 Added BC07.STN LEDT STN 27 NR26.STW-A 1 BC07.STN 16 Added BC07.STN MC0.STE 120 NR26.STW-A 1 BC02.STS 37 Added BC07.STN MC10.TTW 120 OC00.STS 6 BC02.STN 30 Added BC0.STN MC10.TTW01 50 Added MC10.TTW0.F OC00.STS 6 BC11.TTN 120 MC10.TTW0.F 0.200.STS 6 116 7 BC11.TTN 120 MC10.TTW1.S 23 Added MC10.TTW0.F 0.200.STN 0 Added OCT04.STSN BC11.TTN 120 MC10.TTW1.S 24 Added OCT04.STSN 0.10.207.00.B.COL1TSN 0 BC11.TTN 120 <td>BC05.0TN</td> <td>0</td> <td></td> <td>L406.6TN01</td> <td>33</td> <td></td> <td>NR20.7TE</td> <td>0</td> <td></td>	BC05.0TN	0		L406.6TN01	33		NR20.7TE	0	
BODE ONT 28 Less ETN 40 NR2s.2TW 0 Control BODE STOR 20 40 Added BODE STN 0.050.06 L608.2TN L276 NR2s.4TE 18 Added NR2s.TW, NR27.2TE BODE STS 3 48 Added BODE STN 0.050.06 L601.0TN L271 NR2s.4TE 18 Added NR2s.TW, NR27.2TE BODE STS 37 16 Added BOD.TTN MC10.0TTE 120 Added MD2.TTN 9 Added MD2.TTN 10 Added OCT0.TTN 10 Added OCT0.TTN 10 Added OCT0.TTN 10 Added OCT0.TTN 120 Added OCT0.TTN 121 Added MD2.TTN 127 Added OCT0.TTSN 4dde OCT0.TTN 120 Added OCT0.TTN 127 Added OCT0.TTN Added OCT0.TTN 127 Added OCT0.TTN Added OCT0.TTN Added OCT0.TTN 127 Added OCT0.TTN Added OCT0.TTN Added O	BC05.5TN01	20		L503.6TN	0		NR23.1TW	66	Added NR23.2TW, 22.7TE, 23.7TE
BODE STINQ 40 Added BODE STIND 103.04.05.06 LODI STIN 276 NR25.8TE 18 Added BODE STIN LOBI STIN Added BODE STIN LOBI STIN NR25.8TE 18 Added BODE STIN Added BODE STIN Added BODE STIN NR25.8TE 18 Added BODE STIN Added ADDE STIN Added	BC05.5TS	108		L504.6TN	0		NR24.6TW	47	Added NR24.7TE, NR24.2TW
BOBESTS 46 Added BODERTN LOBEZTN 127 Image: Construint of the state of the stat	BC06.0TN	28		L505.6TN	40		NR25.2TW	0	
BQ07.01N 17 Adde BQ07.01S Left 10TW 0 NR26.7TW-A 1 C BQ07.81S 37 Adde BQ07.7TN MC0.0TE 120 Adde MC0.7TE01 NR27.6TW-9 9 Addel N27.7TE, NR28.2TW BQ08.21N 27 Addel BC07.3TN MC10.7TW 120 Addel MC0.7TW-E OC0.0TN 16 BC10.21N3 30 Addel BC10.2TN10.02 MC10.7TW02 9 Addel MC10.7TW04 OC0.03TN 0 Addel OC0.4TS 29 Addel MC10.7TW04 OC0.04 TTS 290 Addel OC10.4.0CT0.4.0CT0.4.5TN Addel OC10.4.0CT0.4.0CT0.4.5TN 200 Addel MC10.7TW09.10.12 OC0.4.1TS 291 Addel MC10.7TW09.10.12 OC0.4.1TS 294 Addel OC10.4.0CT0.4.5TS 204 Addel OC10.4.1SS-CD Addel OC10.4.1SS-CD 200 10.20.70.8.8.C.H 0 10.20.7	BC06.5TN02	40	Added BC06.5TN01,03,04,05,06	L601.8TN	276		NR25.8TW	7	
BODY STS 16 Added BCOT/TIN MC086TE 21 Added MC07TE01 NP22 FW 9 Added N27.7TE, N2282TW BC086TS 37 Added BC0.2TN01 20 Added BC0.2TN01 0 0 0 0 Added BC0.2TN0 0 0 Added BC0.2TN0 0 Added AC0.2TN0 0 Added AC0.2TN 0 Added AC0.2TN0 0 Added AC0.2TN0 0 0 0 0 Added AC0.2TN0 0 Added AC0.2TN0 0 0 0 0 0 0 0	BC06.5TS	48	Added BC06.6TN	L608.2TN	127		NR26.4TE	18	Added NR26.7TW, NR27.2TE
BOOB.STS 37 Deck MC10.7TE 120 Concent DCC00.5TS 6 BC002.TN0 27 Added BC09.3TS MC10.7TW01 59 Added MC10.7TW-107 COC03.0TN 10 Added OC0.2TS BC10.2TN0 10 Added BC10.STN MC10.7TW101 123 Added MC10.7TW020 00.041TS 259 Added OC0.4STS BC1.2TN 120 Added MC10.7TW11 123 Added MC10.7TW0.05 OC04.1TS 259 Added OC10.4S.0G1.4K,LM.N BC13.7TN 120 Added MC10.7TW0.05 OC04.1TS 240 O10.207.0S.8,C,H BC13.7TS 246 Added DC19.2TN,19.2TN,19.7TS01 MC13.2TE03 0 Added MC10.7TE04 OC05.8TN 13 BC13.7TS 244 Added DC02.8TN MC18.8TE 4Added MC16.8TW OC06.8TNP 13 Added OC10.85.0TN14.23.24 HC00.ESTN 51 Added HC0.5.TTN01-03.HC05.2TS01 MC18.8TW CO13.0TN 9 Added OC10.8TN14.23.25 HC04.5TN 51 Added HC0.5.TTN01-03.HC05.2TS01 MC18.8TW CO13.0TN 9		17	Added BC07.0TS		0			1	
BOOB.STS 37 Deck MC10.7TE 120 Concent DCC00.5TS 6 BC002.TN0 27 Added BC09.3TS MC10.7TW01 59 Added MC10.7TW-107 COC03.0TN 10 Added OC0.2TS BC10.2TN0 10 Added BC10.STN MC10.7TW101 123 Added MC10.7TW020 00.041TS 259 Added OC0.4STS BC1.2TN 120 Added MC10.7TW11 123 Added MC10.7TW0.05 OC04.1TS 259 Added OC10.4S.0G1.4K,LM.N BC13.7TN 120 Added MC10.7TW0.05 OC04.1TS 240 O10.207.0S.8,C,H BC13.7TS 246 Added DC19.2TN,19.2TN,19.7TS01 MC13.2TE03 0 Added MC10.7TE04 OC05.8TN 13 BC13.7TS 244 Added DC02.8TN MC18.8TE 4Added MC16.8TW OC06.8TNP 13 Added OC10.85.0TN14.23.24 HC00.ESTN 51 Added HC0.5.TTN01-03.HC05.2TS01 MC18.8TW CO13.0TN 9 Added OC10.8TN14.23.25 HC04.5TN 51 Added HC0.5.TTN01-03.HC05.2TS01 MC18.8TW CO13.0TN 9	BC07.8TS	16	Added BC07.7TN	MC08.6TE	21	Added MC09.7TE01	NR27.6TW	9	Added NR27.7TE, NR28.2TW
BC002.TN 27 Added BC0.3TS MC10.7TW01 59 Added MC10.7TW-E OC20.2TN 116 BC10.2TN03 30 Added BC10.2TN10.02 MC10.7TW02 9 Added MC10.7TW07.0 OC20.1TN D Added OC102.4TS 259 Added OC104.A, OCT04.5TN BC10.3TN 120 Added MC10.7TW09.10.12 OC04.1TS 259 Added OCT04.6.00.1KL.MN BC11.7TN 120 MC10.7TW15 20 Added MC10.7TW09.10.12 OC04.1TS-E 204 Added OCT04.50.9L.LM.NN BC17.7TS 36 MC10.7TW15 20 Added MC10.7TW04.05 OCC4.1TS-E 204 Added OCT04.50.9L.LM.NN BC17.7TS 46 Added BC19.2TS.19.2TN.19.7DN MC13.7TEG 0 Added MC13.7TEG MC COC0.5TS 180 HO00.5TW 433 ESWCD MC18.8FCD 564 SFCD CO09.5TNO 131 Added OCT09.5TN02.13.2.4 HO02.5TS 13 Added HO02.5TN MC18.8TW06 275 Added MC18.3TWCD OC09.5TNV 132 Added OCT09.5TN14.2.3.2.5 HO02.5TS 14 Add									,
BC10.2TN03 30 Added BC102TN01.02 MC10.TW02 9 Added MC10.TW147 COC0.0TN 0 Added OC124.5TS BC10.3TS 10 Added BC10.5TN MC10.TW13 123 Added MC10.TW06 COC4.1TS 224 Added OC104.4S CTA15 BC11.TTN 120 MC10.TW15 20 Added MC10.TW09.10.12 COC0.1TS Added OC104.1TS Added OC104.1TS Edde OCT04.4S Edde OCT04.4S Edde OCT04.4S Edde OCT04.1TS Added MC10.TW09.10.12 COC0.1TS I0 Added OC104.1TS Edde OCT04.4S Edde OCT04.4S Edde OCT04.4S Edde OCT04.5TS ID Added AC12.2TN ID Added AC12.4TN ID COC0.5TIS ID ID Added AC12.5TN ID ID <td></td> <td></td> <td>Added BC09.3TS</td> <td></td> <td></td> <td>Added MC10.7TW-E</td> <td></td> <td>116</td> <td></td>			Added BC09.3TS			Added MC10.7TW-E		116	
BC10.3TS 10 Added BC10.5TN MC10.7TW03 129 Added MC10.7TW06 CC04.1TS 259 Added CCT04.6QC14,TN BC11.7TN 120 MC10.7TW15 20 Added MC10.7TW06,D CC04.1TS 137 Added CCT04.6QC14,TS BC13.7TN 120 MC10.7TW15 20 Added MC10.7TW04,05 CC04.1TS-E 204 OL0.07.08,B,C,H BC17.7TS 36 MC10.2TN,19.7TS01 MC13.2TE03 0 Added MC10.7TW04,05 OC04.1TS-E 204 OL0.07.08,B,C,H BC17.7TS 204 MC13.STE00 504 SFCD OC06.7TN 13 HC00.7TS 204 MC16.8TW0 Added MC16.8TW0 OC09.STN07 313 Added OCT09.STN02.13,24 HC02.7TS 274 Added HC02.8TN MC16.8TW0 223 MC16.8TW0 OC09.STN19 162 Added OCT09.STN14.23,25 HC02.5TS 51 Added HC05.TTN-0.3,HC5.STS MC16.8TW0 Added MC16.8TW OC10.3TN 99 Added OCT0.3TS HC02.5TS 61 Added HC05.TTN-0.3,KC5.STS Added HC06.TTNN		-							Added OC02.5TS
BC11.TN 120 MC10.TTW11 123 Added MC10.TTW09.10,12 OC04.1TS06 137 Added OCT04.05.00.KL,N.N BC13.TN 120 MC10.TTW15 20 Added MC10.TTW04.05 OC06.1TS0 0 0.02.07.08.B,C.H BC17.TS 36 MC12.ZTW 231 OC06.0TN 0 0 BC17.TS 246 Added BC19.2TS, 19.2TN, 19.7TS01 MC13.3FCD 504 SFCD OC06.5TN 13 Added OCT0.95.TN02-13.24 HC00.ES/WO 439 ESWCD MC16.8TW03 234 Added MC16.8TW OC09.STN1 13 Added OCT0.95.TN12-13.24 HC00.ES/WO 439 ESWCD MC16.8TW06 225 Added MC16.8TW07 OC09.STN1 18 Added OCT0.95.TN14-23.25 HC04.STN 51 Added HC05.STN MC16.8TW06 275 Added MC18.8TW7 OC0.9STN1 18 Added OCT0.95.TN14-23.25 HC06.STS 51 Added HC05.STN MC16.8TW06 CC1.8TW OC11.1TN 28 Added OCT0.9STN14-23.25 Added OCT0.9STN14.23.25 CC1.1TN 20 Adde									
BC13.TIN 120 MC10.TIW15 20 Added MC10.TIW04,05 OC04.1TS-E 204 Added OCT04.1TS- 0.02,07.08.B.C.H BC17.TIS 36 MC12.ZTW 231 OC08.0TN 0 0 0.02,07.08.B.C.H BC17.TS 46 Added BC19.2TS, 19.2TN, 19.2TN, 19.2TN, 19.2TN MC13.SFCD 564 SFCD OC08.0TN 13 HC00.ESWD 439 ESWCD MC16.8TE 34 Added MC16.9TW OC09.5TNO7 313 Added OCT09.5TN02-13.24 HC02.TS 274 Added HC02.8TN MC16.8TW03 239 MC16.8TW01.02.40,05 OC09.5TN19 162 Added OCT09.5TN02-13.24 HC02.5TS 51 Added HC05.TTN1-03, HC05.2TS01 MC18.8TE 0 Added MC18.8TW OC10.3TN 99 Added OCT10.3TS HC07.6TS-A 0 Added HC03.TTN 464 Added MC23.3TE 148 Added MC23.4TW OC11.1TN 20 Added OCT10.3TS HC07.6TS-A 0 Added HC03.TTN 464 MC23.5TW OC11.5TN 0 Added WC04.7TN.9PO.8TS HC07.									
BC17_TYS 96 MC12_TW 231 COC6_OTN 0 BC19_TYS 46 Added BC19_ZTS, 19_ZTN, 19_TSO1 MC13_TE03 0 Added MC13_TE04 OC07_STS 180 HC00_TS 204 MC13_SFCD 504 SFCD OC08_TNN 13 Added OCT09_STN02-13_24 HC00_TS 274 Added HC02_STN MC16_STWOF 239 MC16_STWOF 230 Added MC16_STW OC09_STN1 18 Added OCT09_STN12-13_24 HC02_TS 274 Added HC05_ITN01-03_HC05_ZTSO1 MC16_STWOF 275 Added MC16_STWO OC09_STN1 18 Added OCT0_STN1 13 HC04_STN 51 Added HC05_ITN01-03_HC05_ZTSO1 MC18_STE 0 Added MC18_STWO OC13_TN 99 Added OCT0_STS HC07_STS_A 0 Added HC05_ITN1-03_HC05_ZTSO1 MC18_STE 0 Added MC2_STS 0 Added OCT10_STS 0 Added OCT0_STS 0 Added OCT0_STS 0 Added OCT0_STS 0 Added MC2_STS 0 Added MC2_STS 0 Added MC2_STS 0<									Added OCT04.1TS-
BC19.7TS 46 Added BC19.2TS, 19.2TN, 19.7TS01 MC13.3TE03 0 Added MC13.7TE04 OC07.6TS 180 HC00.7TS 204 MC13.SFCD 504 SFCD OC08.7TN 13 Added OC109.5TN02-13.24 HC02.7TS 274 Added HC0.28TN MC16.8TW03 239 MC16.8TW01.02.04.05 OC09.5TN19 162 Added OC109.5TN14-23.25 HC04.5TN 51 Added HC05.1TN1-03, HC05.2TS01 MC18.8TW07 OC09.6TN 18 Added OC109.2TN HC05.7SS 0 MC16.8TW03 239 MC16.8TW07 OC11.1TN 25 HC07.6TS 0 Added HC07.6TS-8 MC23.0TE 148 Added MC23.3TW OC11.1TN 20 Added OCT19.8TS HC08.TN 240 MC26.1TW 67 WP00.8TN 294 Added WP00.7TN, WP00.8TS HC09.4TS MC26.1TW 67 SSDD WP01.6TN 0 HC10.8TN Added WP00.7TN, WP00.8TS HC09.4TN 38 Added HC10.7TS NR01.8TE 0 WP07.5TN 0 Added WP0.7TN03		-						-	
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HC02_TTS Added HC02_8TN MC16_8TW03 239 Added MC16_8TW01_02_04_05 OC09_STN19 162 Added OCT09_STN14_23_25 HC04_STN 51 MC16_8TW0 275 Added MC16_8TW01_02_04_05 OC09_STN1 18 Added OCT09_STN14_23_25 HC05_STS 51 Added HC02.8TN MC16_8TW0 OC10_3TN 99 Added OCT09_STN14_23_25 HC07_6TS_A 0 Added HC07.8TS-8 MC23_0TE 148 Added MC23_3TW OC11.1TN 20 Added OCT10.3TS HC08.1TN 240 MC24_1TE 42 Added MC24.1TE OC12_STN 0 HC08.1TN 38 Added HC07.5TS MC26_SSDD 178 SSDD WP01.6TN 0 HC16.0TN 81 NR0.3TE 0 WP04.8TN 91 Added WP04.TN3 HC11.8TN 55 Added HC13.6TN-A, B K13.TE 0 WP04.8TN 91 Added WP04.TN3 HC11.8TN 55 Added HC13.6TN-A, B HC13.8TS NR06.3TE 22 Added NR04.2TW WP06.3TN03 201 </td <td></td> <td>-</td> <td>FSWCD</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Added OCT09 5TN02-13 24</td>		-	FSWCD						Added OCT09 5TN02-13 24
HC04.5TN 51 MC16.8TW06 275 Added MC16.8TW07 OC09.6TN 18 Added OCT09.2TN HC05.2TS 51 Added HC05.1TN01-03, HC05.2TS01 MC18.8TE 0 Added MC18.8TW OC10.3TN 99 Added OCT09.2TN HC07.6TS-A 0 Added HC07.6TS-B MC21.5TW 141 OC11.1TN 20 Added OCT1.1STS HC08.1TN 240 MC24.1TE 42 Added MC23.3TW OC11.1TN 20 Added OCT1.1STS HC08.8TS 87 MC24.1TE 42 Added MC24.1TE OC12.5TN 0 HC09.4TN 38 Added HC09.5TS MC26.1TW 67 WP00.8TN 294 Added WP0.7TN, WP00.8TN HC10.6TN 37 Added HC10.7TS NR03.3TE 0 WP04.1TN01 93 Added WP04.TN03 HC13.6TN 55 Added HC11.8TS NR03.0TE 22 Added NR03.0TW WP04.8TN 91 Added WP04.TN03 HC13.6TN 26 Added HC13.6TN-A,B HC13.8TS NR05.4TE 39 WP07.5TN 47 <t< td=""><td></td><td></td><td></td><td></td><td></td><td>Added</td><td></td><td></td><td></td></t<>						Added			
HC05.2TS 51 Added HC05.1TN01-03, HC05.2TS01 MC18.8TE 0 Added MC18.8TW OC10.3TN 99 Added OCT10.3TS HC07.6TS 0 Added HC07.6TS-B MC23.0TE 141 OC11.1TN 2.0 Added OCT10.3TS HC07.6TS-A 0 Added HC07.6TS-B MC24.1TE 42 Added MC23.3TW OC11.1TN 2.0 Added OCT10.8TS HC08.1TN 240 MC24.1TE 42 Added MC24.1TE OC1.5TN 0 Added WP0.7TN, WP0.8TS HC09.4TN 38 Added HC09.5TS MC26.SDD 178 SSDD WP0.8TN 0 HC10.6TN 37 Added HC10.7TS NR0.3TE 0 WP0.4TN01 93 Added WP0.TN03 HC11.8TN 55 Added HC1.8TS NR03.0TE 0 WP0.5TN03 201 Added WP0.7TS.01.02 HC12.5TN 30 NR04.1TE 0 Added NR04.2TW WP0.7TN 47 Added WP0.7TS.01.02 HC13.6TN A.9 Added HC13.5TN-A.B.HC13.8TS NR06.5TE 42 Added NR06.6TW			74466411662.6114						
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HC07.6TS-A 0 Added HC07.6TS-B MC23.0TE 148 Added MC23.3TW OC11.7TN 20 Added OCT11.8TS HC08.1TN 240 MC24.1TE 42 Added MC24.1TE OC12.5TN 0 HC08.1TN 38 Added HC07.6TS-B MC26.1TW 67 WP00.8TN 294 Added WP00.7TN, WP00.8TS HC09.4TN 38 Added HC07.5TS MC26.SSDD 178 SSDD WP01.6TN 0 HC10.0TN 81 NR0.3TE 0 WP03.6TN 0 HC11.8TN 55 Added HC10.7TS NR0.8TE 0 WP04.8TN 91 Added WP04.TN03 HC12.5TN 30 NR0.4TE 0 Added NR04.2TW WP06.7TN03 201 Added WP04.TS HC13.6TN 226 Added HC13.6TN-A,B HC13.8TS NR06.6TE 42 Added NR06.6TW WP06.7TN3 312 Added WP04.TS1.01.06 HC14.2TN 32 NR07.8TE 0 WP10.1TN 51 Added WP10.6TS.10.8TN.09.9TS HC14.2TN 34			7446411003.11101.00,11003.21001						
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HC08.8TS 87 MC26.1TW 67 WP00.8TN 294 Added WP00.7TN, WP00.8TS HC09.4TN 38 Added HC09.5TS MC26.SSDD 178 SSDD WP01.6TN 0 HC10.0TN 81 NR0.3TE 0 WP03.6TN 0 HC10.6TN 37 Added HC10.7TS NR01.8TE 0 WP04.1TN01 93 Added WP04.TN03 HC11.8TN 55 Added HC11.8TS NR03.0TE 222 Added NR04.2TW WP04.8TN 91 Added WP04.TN03 HC12.5TN 30 NR04.1TE 0 Added NR04.2TW WP06.7TN03 201 Added WP04.TN0.46G HC13.6TN 226 Added HC13.6TN-A,B HC13.8TS NR06.6TE 42 Added NR06.6TW WP08.TTS 312 Added WP04.TNN.A0.9.9TS HC14.2TN 34 Added HC14.7TS NR09.0TE 165 WP10.1TN 51 Added WP1.6TN.A.D.E,F HC14.7TN 34 Added HC15.4TS, 15.5TS, 15.5TS.E NR1.4TE 241 WP12.8TN 293 Added WP12.STN.A.D.E,F,I									
HC09.4TN 38 Added HC09.5TS MC26.SSDD 178 SSDD WP01.6TN 0 HC10.0TN 81 NR0.3TE 0 WP03.6TN 0 HC10.6TN 37 Added HC10.7TS NR01.8TE 0 WP04.1TN01 93 Added WP04.TN03 HC11.8TN 55 Added HC11.8TS NR03.0TE 222 Added NR03.0TW WP04.8TN 91 Added WP04.1TS, WP04.5TS01.02 HC12.5TN 30 NR04.1TE 0 Added NR04.2TW WP06.7TN03 201 Added WP06.7TN01-06 HC13.6TN 226 Added HC13.8TS NR06.6TE 42 Added NR06.6TW WP08.7TS 312 Added WP09.1TN HC14.2TN 32 0 NR07.8TE 0 WP10.1TN 51 Added WP0.1TN-AD,E,F HC14.2TN 34 Added HC14.7TS NR09.0TE 165 WP10.1TN-C 0 Added WP12.8TN-AB,P1.2NP1.2UTN HC14.2TN 34 Added HC16.4TS, 15.5TS, 15.5TS-E NR1.3TE 37 Added NR10.3TW WP12.8TN-C 60 Added WP1						huded mozer. The		-	Added WP00 7TN WP00 8TS
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Table 4.1 – Lateral Inflows Runoff Rate





4.3 Boundary Conditions

MIKE 11 requires a boundary condition for the terminal end of each MIKE 11 branch. This boundary condition can be specified as zero flow, a specified constant head elevation, a specified constant flow, or a time series of head or flow. Inflows are specified for the L-8, C-51W, C-139, and C-139 Annex basins, as presented in **Table 4.2**.

Basin	Boundary	Value	Source
L-8	L-8 North 1	750 cfs	Ph 2 Task 1.3
	L-8 North 2	750 cfs	Ph 2 Task 1.3
	L-8 Tieback	-150 cfs	CH2M Hill (2005)
C-51W	Local runoff	2,000 cfs	Ph 2 Task 1.3
C-139	L-1	400 cfs	Ph 2 Task 1.3
	L-2W	800 cfs	Ph 2 Task 1.3
	Deerfence	800 cfs	Ph 2 Task 1.3
C-139 Annex	Local runoff	452 cfs	URS, 2005
S-2, S-3, S-352,	Lake Okee	L006 stage	DBHYDRO
L-8 at Lake			
G-300, G-301, S-	WCAs	12 ft	Review of data from
6, S-7, S-8, L-			DBHYDRO, limit flow
3Ext, L-28			within WCAs
C-51W	G-155A	8 ft	G-155A design

 Table 4.2 – Inflow Boundary Conditions

The L-8 and C-51W inflows were estimated based on an inspection of measured daily flows as part of Phase 2 Task 1.3 of this project (Historic Inflow Volumes and Total Phosphorus Concentration by Source (Draft Report), May, 2005. **Figures 4.3 and 4.4** present graphs of the daily flows for L-8 and C-51W. **Figure 4.5** presents calculated C-139 runoff daily peak flows, and flows in the range of 1000 – 1700 cfs were observed eight times from 2000-2004. **Figures 4.3-4.5** were generated from files used to prepare the Phase 2 Task 1.3 draft report.





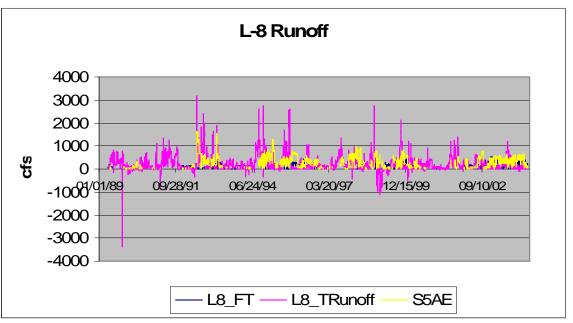


Figure 4.3 – Observed L-8 Flow Through (from Lake Okeechobee), L-8 Runoff, and S-5AE eastward flows

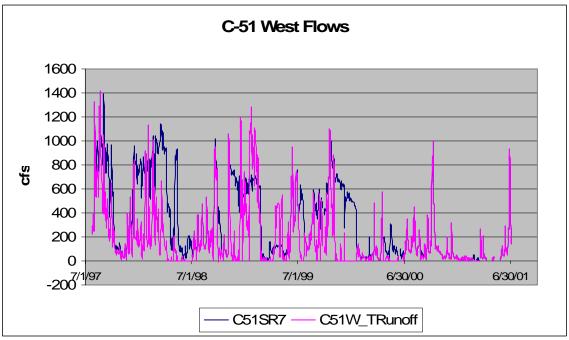


Figure 4.4 – Observed C-51W Runoff and Flows in C-51W at SR 7





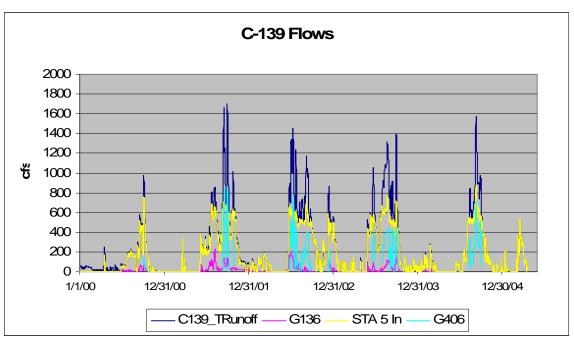


Figure 4.5 – Observed C-139 Flows

Precipitation and evaporation are included in the reservoir mass balance. The time series of reservoir precipitation and evaporation are presented in **Figure 4.6**. ET values were taken from an ET station in WCA 1, and the rainfall values were taken from an October 2000 event at station ROTNWX. The daily values for this event were adjusted down by 33% so that the total rainfall was equal to the average rainfall observed at Stations S-6, EAA5, NNRC, ROTNWX, and G-343.

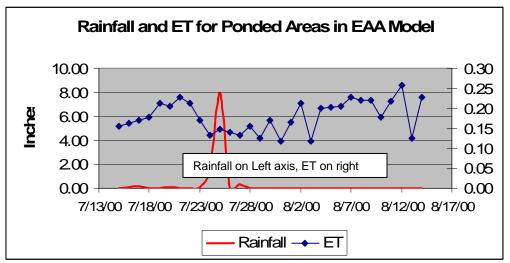


Figure 4.6 – Rainfall and ET values used for Ponded Areas within the EAA



4.4 MIKE 11 Model Refinements

4.4.1 STA 1E

STA 1E was added to the MIKE 11 model so that the distribution of flows between STA 1E and 1W could be described at high flow conditions. It was not part of the original MIKE 11 network but was added so that the distribution of flows between STA 1E and 1W could be addressed. It was decided to add a somewhat simplified representation of STA 1E as shown in **Figure 4.7**. Pump station S-361 is not included, and approximate ground elevations were used for the STA cells.

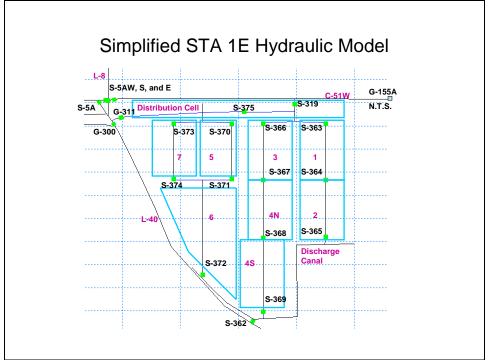


Figure 4.7 – Representation of STA 1E

4.4.2 C-51W

Approximate cross sections were used for C-51W from S-5A E to S-155W. Detailed cross sections have been obtained from US ACE and were added to the model. The as-built cross sections differ somewhat from the design, however conveyance is similar. The S-155W tailwater elevation has been assumed to be constant at 8 feet.

4.4.3 G-341

G-341 is currently under construction and will be completed in 2005. This structure is located on the Ocean Canal 1,900 feet east of the Gladeview Canal. There are two 25-ft wide x 15-ft high underflow gates that have an invert elevation of 0.0 ft NGVD when closed. This structure was added to the model using design drawings, and has been programmed to open if water levels west of the structure exceed



4-8



12.5 ft NGVD, which is consistent with the design of G-341 (Burns & McDonnell, 1995, SFWMD, 2004).

4.4.4 STA 2 Cell 4

STA 2 Cell 4 cross sections were obtained from Brown and Caldwell (2005). The outflow structure discharges to the west end of the existing STA 2 discharge canal and consists of two 8'x8' gated box culverts. The gates are programmed to open if the water level upstream of the structure is greater than 11.5 ft NGVD. The gate will be fully open when water level upstream of the structure reaches 12.5 ft NGVD. Additionally, gate operations are limited to once every three hours. Based on discussions with SFWMD Operations staff, the sequence of filling STA 2 was changed to be consistent with actual operation of this STA. The current practice is to fill cell 3, then cell 2, and finally cell 1. It was assumed that cell 4 would be filled at the same time as cell 3.

4.4.5 STA 3/4 Enhancements

Structure operations for G-370 and G-372 were modified to reduce pump oscillations. The following operation logic was employed:

Pump A:	If H in NNR > 10 ft NGVD, pump on using pump curve
	If H in NNR < 9 ft and pumps B&C off, pump off
Pump B	If H in NNR > 10 ft and pump A on, pump on
	If H in NNR < 9 ft and pump C off, pump off
Pump C	If H in NNR > 10 ft, and pumps A&B on, pump on
	If H in NNR < 9 ft, pump off

Pump operations are limited to once/hour. The same basic strategy is used to control G-372 on the Miami Canal.

4.4.6 G-136

G-136 is a stop-log overflow structure that is used to control flows between the L-1 canal south to STA 5 and L-1 E canal to the Miami Canal. The SFWMD Structure Book states that the stop logs are maintained at elevation 13 ft NGVD, and raised to 14 ft NGVD when the tailwater (east side of structure in L-1 E canal) reaches 15.5 ft. Model results indicate that the water levels in the tailwater never go above elevation 12, so the weir elevation is always 13. Water levels in L-1 at the upstream end of this structure are commonly above elevation 13, and significant flow enters L-1 E Canal. Measured flows are relatively rare through G-136 and are never above 200 cfs. Accordingly, the overflow invert elevation of this structure was changed to 16 ft NGVD unless the L-1E elevation reached 15.5 ft, at which point the invert elevation drops to 14 ft.

4.4.7 STA 5 Flow-way 3, STA Discharge Canal, and G-406

Draft BODR documents for STA 5 Flow-way 3 were reviewed to obtain design information for Flow-way 3 (URS, 2005a). **Figure 4.8** provides details of how this





flow-way was added to the model. Flow-way 3 receives water from L-2 just north of G-406. The MIKE 11 network includes inflow gates G-342E&F, Flow-way 3a outflow gates G-343 I-K, and Flow-way 3b gates G-344E-F. Dimensions and invert elevations were obtained from URS (2005).

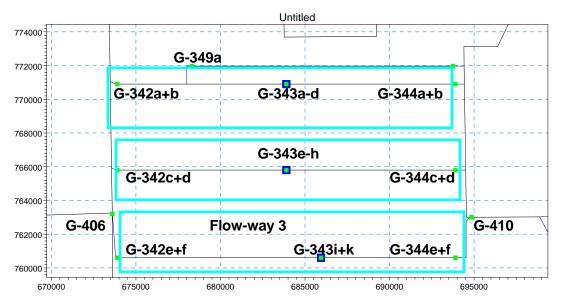


Figure 4.8 – Representation of STA 5 in MIKE 11 Network

Gate operations are:

G-342: Closed at upstream head elevation 16 ft NGVD, fully open at 17 ft

G-343: Always open

G-344: Closed at upstream head elevation 13 ft NGVD, fully open at 17 ft

G-410: Pumps when there is a positive outflow from STA 5 and the water level in the Rotenberger Tract is below regulation schedule

G-349a: Pump on if seepage canal head elevation exceeds 10.5 ft NGVD, full flow at 17.8 ft

The STA 6 Operations Manual states that Gate G-406 is closed until the headwater (north of the structure) elevation reaches elevation 16 ft NGVD. The purpose of this gate operation was to prevent hydraulic overloading of STA 5. G-406 operation will be modified after construction of STA 5 Flow-way 3 and STA 6 Section 2. G-406 will remain open most of the time unless inflows to STA 6 exceed the design capacity of that STA (personal communication, M. Brungard, URS, June, 2005). The STA 5 discharge canal to the Miami Canal has been modified to reflect the design of the STA 5 Outlet Canal to transport water from the STA Discharge Canal around STA 3/4 inflow pump station G-372 to the Miami Canal downstream of gate G-373. This discharge canal will eliminate STA 3/4 treatment of STA 5 outflows (SFWMD, 2005). The construction of this bypass is over 90% complete and will commence operation in 2005. Cross sections for this outlet canal were obtained from the Outlet Canal design plans.





4.4.8 STA 6 Section 2

STA 6 Section 2 is currently under design and is anticipated to be flow-ready in 2006. Draft BODR documents for STA 6 Section 2 were reviewed to obtain design information for the new treatment cell (URS, 2005b). **Figure 4.9** provides details of how this treatment cell was added to the model.

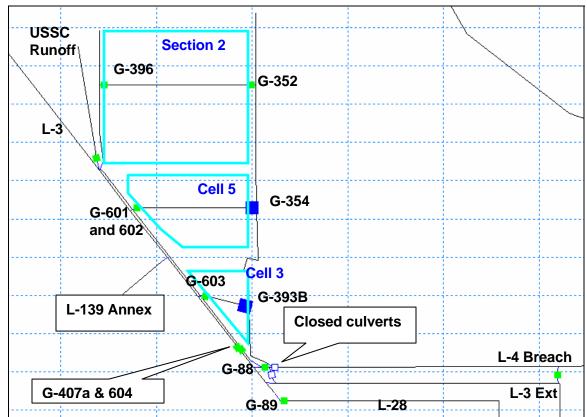


Figure 4.9 – MIKE 11 Representation of STA 6 and Confusion Corner

The design of this new section of STA 6 includes significant changes in the operation of Canal L-3. The plans call for a new structure (G-407a) presented in Figure 13 that will isolate L-3 from the rest of the L-canals during normal operation. G-407a will normally be closed but will open if stages in the L-3 Canal exceed 19.5 ft NGVD. L-3 will be an inflow distribution canal for STA 6, and gates G-353 A-C control the inflow to STA 6. The MIKE 11 network includes inflow gates G-601, 602, and 603 to existing cells 3 and 5, Section 2 inflow gates G-396 A-C, Section 2 outflow gates G-352 A-C, Cell 5 outflow gates G-354 A-C, cell 3 outflow gates G-393 A-C, the STA 6 Discharge Canal, and G-607. Dimensions and invert elevations were obtained from URS (2005). Gate operations are:

G-396: Closed at upstream head elevation 16 ft NGVD, fully open at 18 ft

G-353: (now G-601 and 602): same as above

G-353c: (now G-603): same as above

G-352: Closed at upstream head elevation 15.5 ft NGVD, fully open at 16.5 ft





4.4.9 Confusion Corner

G-155 was removed from the US ACE MIKE 11 model, and a branch was added from L-4 to L-3 Extension at G-607 (see **Figure 4.9**). A closed gated structure was added to L-4 just east of this new branch, and G-88 operations were modified so that it is normally closed.

4.4.10 Rotenberger Tract and Holeyland Wildlife Management Area

The Rotenberger Tract and the Holeyland Wildlife Management Area were not explicitly modeled by US ACE in MIKE 11 as MIKE SHE was able to effectively handle the rainfall/runoff process. Branches were added to this MIKE 11 project because MIKE SHE is not being run. Cross sections were added to represent the expected flow paths through these natural wetland systems. Rainfall and ET time series are part of the hydraulic balance for these systems.





CHANGES MADE TO IMPROVE MODEL STABILITY 5.0

5.1 **Operation of Pumps and Gates for STA 2**

The headwater is maintained at elevation 11.5 ft NGVD in the dry season and 10.5 ft NGVD during the wet season. The pump-off level is 9.75 ft NGVD. Manning's n values in cells 1 and 2 were increased to a value of 1.0. The Manning's n value for SAV cells 3 and 4 remained at 0.25.

The control operation of STA2 inflow structures was modified according to "Meeting Minutes" (meeting with George Hwa, SFWMD Operations). The details are summarized below:

- Cell 1 opens @ 14.5' and closes @ 14', •
- Cell 2 opens @ 15' and closes @ 14.5', and
- Cell 3 opens @ 14' and closes @ 13.5'.
- Gates open fully and remain unchanged for at least 3 hrs.
- The proposed inlet structure for Cell 4 opens @ 13.2' and closes 10.5'. •

Only positive flow through the inlet and outlet structures is allowed (the structures close if the gradient becomes negative). G-335 operation is a function of upstream water levels, as described below:

- No change less than hourly. •
- If the flow upstream is <1000 and Hups>13 ft, outflow is 1000. •
- Close if the Hups<12.5 ft and Qups<1000. •
- If the Qups<2000 and Hups>11.5, Q = 2000. •
- If the Qups<2000 and Hups<11, Q = 1000. •
- Otherwise, flow is according to the following H/Q table: •

Upstream Stage, ft	G-335 Q, cfs
-99	2000
8.9	2000
9.4	3370
99	3370

5.2 **Operation of Pumps and Gates for STA 3/4**

The inflow gates are programmed to be fully open at all times. This is not correct for low flow conditions but is acceptable for modeling of high flow conditions. Modifications would be necessary if this model were used for long-term simulations.

The outflow gates are programmed as follows:

Cell 1: Open if upstream elevation > 12.8 ft NGVD, full open at 13 ft NGVD Cell 2: Open if upstream elevation > 12.9 ft NGVD, full open at 13 ft NGVD Cell 3: Open if upstream elevation > 13.8 ft NGVD, full open at 14 ft NGVD







6.0 SUMMARY OF MODELING RESULTS

6.1 Hydrologic Scenarios

Hydraulic modeling was conducted to define the capacity of existing EAA canals and to determine if operational changes could be employed to direct runoff from the S-5A and S-6 basins to the S-7 basin. A number of alternatives were simulated as described below in **Table 6.1**.

Table 6.1 Specific Result Files Used In Simulations

Alt.#	Model Run	Output File Name
1	Existing Conditions, 3/8" runoff for entire EAA	EAA_2006EXISTINGCONDITIONS.res11
2	Existing Conditions, higher runoff for S-5A and S-6 Basins	EAA_2006EXCOND_2XS5A_6.res11
3	Ex. Conditions, higher runoff for S-5A and S-6 Basins, No Cross bridges & culverts	EAA_2006EXCOND_2XS5A_6_NOCRBR.res11
4	As run 3, with S-6 Pump 3 at 500 cfs	EAA_2006EX_2XS5A_6NOCRBR_S6_3_500.res11

Flow and water elevations are summarized at selected locations in this section. MIKE 11 result files include flows, elevations, depths, and velocities at numerous locations. Flow results are available at over 800 locations, and stage results are available at over 1100 locations. The MIKE 11 additional result file includes information at 231 structures:

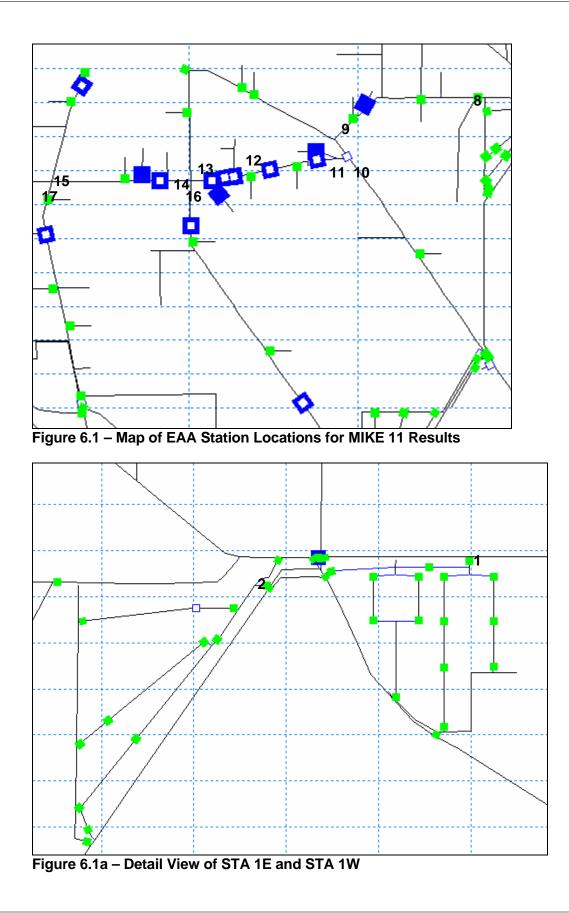
- Structure flows
- Structure velocities
- Structure flow areas
- Structure gate levels

Boundary inflows and outflows are also available. These data are viewed through a nonproprietary graphical user interface called MIKE VIEW (see <u>www.dhisoftware.com</u>). This program allows the user to select results as plots or water surface profile animations, cross section animations, and plan view animations with flow directions indicated as arrows.

Model results at key station locations are summarized below in a tabular format. The key station locations listed in **Table 6.1** are shown below in **Figures 6.1, 6.1a, 6.1b, and 6.1c**.

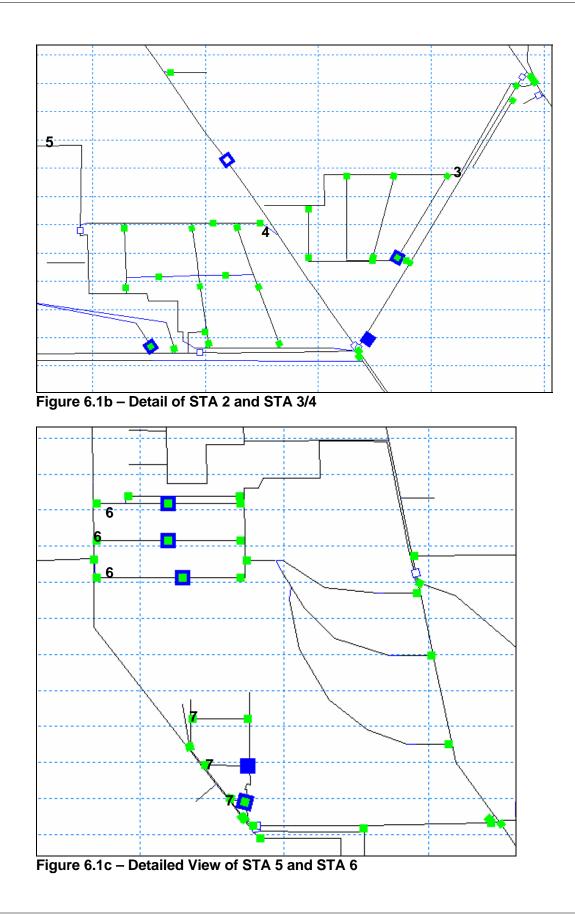
















6.1.1 Flows and Water Levels for Uniform Runoff

The MIKE 11 model was run with a uniform rate of runoff equal to 3/8" for all farms. The results are summarized in **Table 5**. Peak stages in the Ocean Canal west of G-341 remain below 12.5 ft NGVD, therefore G-341 remains closed. There is no flow into Lake Okeechobee through S-2 and S-3. Flows in the southern portions of the Hillsboro, North New River, and Miami Canals oscillate because basin runoff is in between the flow levels of S-6 (975, 1,950, and 2,925 cfs), and G-370 and G-372 (925, 1,850, and 2,775 cfs). Water levels are higher in the center of the Cross Canal than at the east and west ends of the canal, which results in westerly flow (negative flow) on the west end and easterly flow on the east end (positive flow). Flow in the Bolles Canal is westerly (negative) at both ends because stages are lower in the Miami Canal than in the North New River Canals.

 Table 6.2 - Flows and Stages at Key Locations in the EAA for 3/4" Runoff in S-5A and S-2/S-6 Basins

2/S-6 Basins				
Location	Alternative 1		Alternative 2	
	3/8" Runoff in Entire EAA		High Runoff in S-5A/S-6	
	Flow, cfs	Stage, ft	Flow, cfs	Stage, ft
1. STA 1E Inflow	1,600	19.2	1,560	19.3
2. STA 1W Inflow	2,500	15.5	3,000	16.1
3. STA 2 Inflow	2,500	14.3	3,300	15.0
4. STA 3/4 Inflow G-370	2,250	13.6-14.6	1,814	13.0-13.6
5. STA 3/4 Inflow G-372	2,250	15.7	1,349	15.1
6. STA 5 Inflow	900	13.6-15.4	900	15.1 - 15.3
7. STA 6 Inflow	1,116	15.5-15.7	965	15.6 – 16.0
8. Ocean Canal, Gladeview	0	11.8	457	12.7
46400				
9. Ocean Canal at Hillsboro	-700	11.6	-975	12.4
Canal				
10. Hillsboro Canal South of	1,210	11.4	1,430	12.25
Cross				
11. Cross Canal E	143	11.9	68	12.4
12. Cross Canal Mid-point	-53	12.0	-16	12.4
20579				
13. Cross Canal W	-230	11.4	-225	11.79
14. Bolles Canal E	-80	11.3	-125	11.7
15. Bolles Canal W	-240	10.3	-278	9.6
16. NNR South of Cross	700 – 720	11.2-11.4	1,020	11.74
17. Miami Canal South of Bolles	1,220	10.0–10.2	725	9.6

6.1.2 Flows and Water Levels for High Runoff in the S-5A Basin

The MIKE 11 model was run with 3/4" of runoff in the S-5A and S-2/S-6 basin and 3/8" runoff elsewhere. The purpose of this simulation was to provide a base run to compare to simulations of minor canal improvements to the Cross Canal that are





discussed in the next section of this document. Flows and stages at key locations are presented in **Table 5**. This model run did not change the directions of flow in the Cross Canal. As with uniform runoff from all EAA farms, flows in the Cross Canal were easterly at the east end and westerly on the west end. As expected, there were higher flows to STA 1W and STA 2 with this model run. Runoff from the Gladeview Drainage District flowed primarily to STA 2, however there was 457 cfs of easterly flow through G-341 to STA 1W.

6.2 Flows and Water Levels with Minor Changes to Cross Canal

Two simulations were conducted to determine if minor changes in the Cross Canal could enhance flows from the Hillsboro Canal to the North New River Canal. The first simulation tested the effect of removing flow constrictions along the Cross Canal assuming higher runoff in the S-5A and S-6 basins. The second simulation was an extension of the first simulation with higher stages in the Hillsboro Canal to generate a greater head differential between the east and west side of the Cross Canal. The greater head differential was generated by decreasing S-6 flow in the third pump station at S-6 from 975 cfs to 500 cfs. The results are presented in **Table 6**. Flow in the west side of the Cross Canal in the first scenario was -207 cfs, which is a discharge from the Cross Canal to the NNR. Flow from the Cross Canal to the Hillsboro Canal was 89 cfs, which is runoff from EAA farms discharging to the Cross Canal. Flow in the west side of the Cross Canal in the second scenario was -314 cfs, which is a discharge from the Cross Canal to the NNR. Flow in the east side of the Cross Canal was -26 cfs, which indicates flow from the Hillsboro Canal to the Cross Canal. The flow in the west side of the Cross Canal was higher because Cross Canal culvert constrictions were removed (two constrictions on the east end of the Cross Canal are significant restrictions).

The conclusion of this analysis is that it is possible to increase flows to the North New River by 107 cfs during a high runoff period where rainfall is higher in the S-5A and S-6 basins if total S-6 flows are reduced by 475 cfs. However, there are some negative impacts of this scenario:

• The peak stage in the Ocean Canal is 13.15 feet, which could result in flooding of some farms along portions of the Ocean and Hillsboro Canals.

• The peak stage in the Ocean Canal will open G-341 on the Ocean Canal, thereby delivering flow from the Gladeview Drainage District to STA 1W (G-341 opens if stages west of G-341 are higher than 12.5 ft NGVD).

Therefore, if it is decided to operate S-6 at a lower capacity during a large runoff event in the S-5A and S-6 basins, it will be necessary to modify the gate operations at G-341 and levee heightening will be necessary at a number of low spots along the Ocean and Hillsboro Canals.





Improvements and 3/4" Runotf in S-5A and S-2/S-6 Basins					
ocation Alternative 3			Alternative 4		
	High Runoff	ligh Runoff in S-5A/S-6		High Runoff in S-5A/S-6,	
	without Cross	bridges	no Cross b	oridges, and	
			decreased S-	6 flows ¹	
	Flow, cfs	Stage, ft	Flow, cfs	Stage, ft	
STA 1E Inflow	1630	19.9	1,500	19.8	
STA 1W Inflow	2933	16.0	3,000	16.1	
STA 2 Inflow	3260	14.8	2,800	14.7	
STA 3/4 Inflow G-370	1835	13.0-13.6	2160	14.6-13.3	
STA 3/4 Inflow G-372	1400	15	1400	15	
STA 5 Inflow	900	15.1–15.3	900	15.1-15.3	
STA 6 Inflow	968	15.6-16.0	968	15.6-16.0	
Ocean Canal, Gladeview 46400	460	12.65	563	13.31	
Ocean Canal at Hillsboro Canal	-966	12.36	-857	13.15	
Hillsboro Canal South of Cross	1450	12.29	948	13.13	
Cross Canal E 44844	89	12.31	-26	13.13	
Cross Canal Mid-point 20579	4.8	12.34	-107	13.10	
Cross Canal W 1402	-207	11.76	-314	12.10	
Bolles Canal E	-120	11.74	-160	12.07	
Bolles Canal W	-271	9.7	-307	9.7	
NNR South of Cross	1020	11.73	1332	12.02	
Miami Canal South of Bolles	9.7	759	9.65		
1. C. C. numer station modified: 2 rd numer consolity shores of from 075 of a to 500 of a					

Table 6.3 - Flows and Stages at Key Locations in the EAA Assuming Cross Canal Improvements and 3/4" Runoff in S-5A and S-2/S-6 Basins

1. S-6 pump station modified: 3rd pump capacity changed from 975 cfs to 500 cfs





7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This modeling study evaluated the existing capacity of EAA canals. The purpose of this assessment was to determine the maximum potential for re-directing flows from STA 1W to STA 3/4 since STA 1W outflow concentrations are above the target concentration of 50 ppb. The simulations included the following alternatives:

- 1. Runoff equal to 3/8" for all EAA farms
- 2. Runoff equal to 3/4" for farms in the S-5A and S-6 basins and 3/8" runoff in all other areas
- 3. Scenario 2 with bridges and culverts removed in the Cross Canal
- 4. Scenario 3 with the third pump at S-6 reduced from 975 to 500 cfs



