SUBMITTAL TO:
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Reevaluation of the C-51 Basin Rule Number: C-13412

Technical Memorandum # 3: Model Application

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July 2004

CERTIFICATION

Project Name:	Reevaluation of the C-51 Basin Rule
	Technical Memorandum #3: Model Application
	SFWMD Contract No. C-13412

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TABLE OF CONTENTS

Section Page

CERTIFICATION ii

1.0 INTRODUCTION 1
1.1 Study Area Description 1
1.2 Project Objective 1
1.3 Scope of Work 2
1.4 Level of Service 4
1.5 Sources of Data 5

2.0 BASIN MODEL CHARACTERISTICS 6
2.1 Basin Description 6
2.2 Stormwater Conveyance Features 6
2.3 Basin Modeling Methodology and Calibration 12
2.4 Basin Parameters 13
2.5 Design Storm Events 15
2.6 Geometric and Structural Features 16
2.7 Unsteady Flow Conditions 17

3.0 MODEL APPLICATION: BASIN RULE EVALUATION 20
3.1 Alternative A0: Baseline (Existing Rule) Simulation 20
3.1.1 Description of Alternative 20
3.1.2 Peak Discharge Simulation for Baseline Condition 20
3.1.3 Peak Stage Simulation for Baseline Condition 23
3.2 Alternative A1: Unrestricted Flow Simulation 26
3.2.1 Description of Alternative 26
3.2.2 Peak Discharge Simulation for Alternative A1 26
3.2.3 Peak Stage Simulation for Alternative A1 26
3.3 Alternative A2: USACE Design Manning’s n Simulation 29
3.3.1 Description of Alternative 29
3.3.2 Peak Discharge Simulation for Alternative A2 29
3.3.3 Peak Stage Simulation for Alternative A2 29
3.4 Alternative A3: USACE Design Flow Simulation 32
3.4.1 Description of Alternative 32
3.4.2 Peak Discharge Simulation for Alternative A3 32
3.4.3 Peak Stage Simulation for Alternative A3 32
3.5 Discussion on Basin Rule Evaluation Simulations 36
3.5.1 Basin Rule Peak Discharge Simulation 36
3.5.2 Basin Rule Peak Stage Simulation 40

4.0 MODEL APPLICATION: ACME BASIN B ALTERNATIVES EVALUATION 44
4.1 General 44
4.2 Alternative B1: Inflow to C-51 through ACME Basin A 44
4.2.1 Description of Alternative 44
4.2.2 Peak Discharge Simulation for Alternative B1 46
4.2.3 Peak Stage Simulation for Alternative B1 46
4.3 Alternative B2: Direct Discharge to C-51 West of Basin A 49
4.3.1 Description of Alternative 49
4.3.2 Peak Discharge Simulation for Alternative B2 49
4.3.3 Peak Stage Simulation for Alternative B2 49
4.4 Alternative B3: Direct Discharge to STA-1 East 53
4.4.1 Description of Alternative 53
4.4.2 Peak Discharge Simulation for Alternative B3 53
4.4.3 Peak Stage Simulation for Alternative B3 53
4.5 Discussion on ACME Basin B Alternatives Evaluation 57
4.5.1 Peak Discharge Simulation 57
4.5.2 Peak Stage Simulation 61

5.0 BASIN RULE LANGUAGE AND RECOMMENDATION 65
5.1 Recommended Allowable Discharges and Stages 65
5.2 Basin Rule Language 65

6.0 REFERENCES 70

APPENDICES
Appendix A Meeting Minutes and Response to Comments
A-1 Meeting Minutes
A-2 Response to Comments
Appendix B Basin Parameter Calculations
B-1 Design Storm Events for Basin Rule Development
B-2 Ground Water Discharge Computation
Appendix C Model Results and Electronic Deliverables
C-1 HEC-HMS Model Results
C-2 HEC-RAS Model Results
C-3 Electronic Format of Deliverables

LIST OF FIGURES

Figure 1-1	Site Location Map
Figure 2-1	Stormwater Conveyance System
Figure 3-1	Nodal Diagram for Basin Rule Alternatives (A0 through A3)
Figure 3-2A	Maximum Water Surface Profiles Along C-51 for 10-Yr, 72-Hr Storm Event for Alternatives A0 through A3
Figure 3-2B	Time-Stage Hydrographs at Selected Locations Along C-51 for 10-Yr, 72-Hr Storm Event for Alternatives A0 through A3
Figure 3-3A	Maximum Water Surface Profiles Along C-51 for 100-Yr, 72-Hr Storm Event for Alternatives A0 through A3
Figure 3-3B	Time-Stage Hydrographs at Selected Locations Along C-51 for 100-Yr, 72-Hr Storm Event for Alternatives A0 through A3
Figure 4-1	Nodal Diagram for Alternative B1
Figure 4-2	Nodal Diagram for Alternative B2
Figure 4-3	Nodal Diagram for Alternative B3
Figure 4-4A	Maximum Water Surface Profiles Along C-51 for 10-Yr, 72-Hr Storm Event for Alternatives B1 through B3
Figure 4-4B	Time-Stage Hydrographs at Selected Locations Along C-51 for 10-Yr, 72-Hr Storm Event for Alternatives B1 through B3
Figure 4-5A	Maximum Water Surface Profiles Along C-51 for 100-Yr, 72-Hr Storm Event for Alternatives B1 through B3
Figure 4-5B	Time-Stage Hydrographs at Selected Locations Along C-51 for 100-Yr, 72-Hr Storm Event for Alternatives B1 through B3
Figure 5-1	Discharge Coefficients for the Sub-basins of the C-51 Basin in Palm Beach County, Florida [Figure 41-8 (Revised 2004)]
Figure 5-2	Peak Flood Stage (ft-NGVD) During A 1-in-100 Year Storm Event and Minimum Floor Elevation [Figure 41-9 (Revised 2004)]

LIST OF TABLES

Table 2-1a	Summary of Information for C-51 West Basin
Table 2-1b	Summary of Information for C-51 East Basin
Table 2-2a	Summary of Stormwater Conveyance Features (Baseline: C-51 West)
Table 2-2b	Summary of Stormwater Conveyance Features (Baseline: C-51 East)
Table 2-3	Summary of Basin Parameters for Basin Rule Development
Table 2-4	Storm Event Rainfall Quantities for Basin Rule Development
Table 2-5	Summary of Information on Lateral Structures and Pump Stations
Table 3-1	Summary of Existing Rule Conditions
Table 3-2a	Summary of Peak Discharge Simulation Results for Alternative A0
Table 3-2b	Summary of Peak Stage Simulation Results for Alternative A0
Table 3-3a	Summary of Peak Discharge Simulation Results for Alternative A1

Table 3-3b Summary of Peak Stage Simulation Results for Alternative A1
Table 3-4a Summary of Peak Discharge Simulation Results for Alternative A2
Table 3-4b Summary of Peak Stage Simulation Results for Alternative A2
Table 3-5 Summary of Design Discharge Conditions Used for Alternative A3
Table 3-6a Summary of Peak Discharge Simulation Results for Alternative A3
Table 3-6b Summary of Peak Stage Simulation Results for Alternative A3
Table 3-7a Comparison of Alternatives for Allowable Peak Discharge (10-yr, 72-hr Storm)
Table 3-7b Comparison of Alternatives for Allowable Peak Stage (100-yr, 72-hr Storm)
Table 4-1a Summary of Results for 10-Year Design Storm for Alternative B1
Table 4-1b Summary of Results for 100-Year Design Storm for Alternative B1
Table 4-2a Summary of Results for 10-Year Design Storm for Alternative B2
Table 4-2b Summary of Results for 100-Year Design Storm for Alternative B2
Table 4-3a Summary of Results for 10-Year Design Storm for Alternative B3
Table 4-3b Summary of Results for 100-Year Design Storm for Alternative B3
Table 4-4a Comparison of Alternatives for 10-Year, 72-Hour Storm Event
Table 4-4b Comparison of Alternatives for 100-Year, 72-Hour Storm Event
Table 5-1 Summary of Recommended Allowable Discharges and Stages

1.0 INTRODUCTION

1.1 STUDY AREA DESCRIPTION

The C-51 basin has a drainage area of approximately 177 square miles and is located in east central Palm Beach County, Florida. The basin is comprised of two major sub-basins: C-51 West (104 square miles) and C-51 East (73 square miles). State Road 7 (SR-7) is generally the boundary between these two major sub-basins. The C-51 canal is the portion of the West Palm Beach Canal that is east of the intersection of the L-8 and the L-40 levees (S-5AE) and is the only Central and Southern Florida Project canal in the basin. The area is bounded on the north by Northlake Boulevard and the Grassy Waters Preserve; to the south by Lake Worth Road; to the west by L-8 and L-40; and to the east by U. S. Highway 1 (US-1). The size of the contributing area has increased as a result of interagency agreements to alleviate pressure on the L-8 basin. The general site location map is shown on Figure 1-1, which was prepared by superimposing the sub-basin boundary on 7.5-minute U.S. Geological Survey quadrangle maps of West Palm Beach 2 SE, Delta, Rivera Beach, Loxahatchee, Palm Beach Farms, Palm Beach, Loxahatchee SE, Greenacres City, and Lake Worth in Palm Beach County, Florida.

The study area is located within the resource management jurisdiction of the South Florida Water Management District (SFWMD). However, multiple local water control districts are involved in the operation and management of water control facilities within the basin.

1.2 PROJECT OBJECTIVE

In order to better manage unplanned growth and to provide flood protection to residents within the C-51 drainage basin, SFWMD adopted a non-structural approach by implementing a set of basin-specific development regulations in 1984. This rule, at the time, represented the most stringent set of criteria for permits in regards to both discharge limits and water quality treatment standards. The primary intent of the basin rule was to provide "hold the line" standards, which prevented any increased flood damages until a structural solution could be implemented. This is known as the C-51 Basin Rule (Part III, Ch. 40E-41, Rules 40E-41.220 through 40E-41.265, FAC).

Recently, a structural solution has been designed and is in the process of being implemented under the leadership of the Jacksonville District of the U.S. Army Corps of Engineers (USACE). The structural solution includes a stormwater treatment area (STA-1E), a pump station (S-319), and a control structure (S-155A) along the C-51 canal. With the potential for completion of the structural solution in the immediate future, the District intends to revisit the rule making process to provide better protection to the current and future residents in the C-51 drainage basin.

The project objective is therefore to reevaluate the C-51 Basin Rule. This involves hydrologic and hydraulic modeling and then assisting the District during rule development and the rule making process. In order to achieve this objective, the project has been divided into several technical and deliverable tasks as given below.

Task 1 – Data Acquisition

This included data collection, field reconnaissance, initial evaluation and verification, digital terrain model development, basin and sub-basin delineation, and storage of data for future usage during the modeling phase.

Task 2 – Basin Modeling System

This involved development of the hydrologic and hydraulic models for the existing conditions of the C-51 basin that included development of design storm, generation of sub-basin runoff hydrographs, and evaluation of the performance of the C-51 canal system.

Task 3 – Model Application

This involves application of the models developed in Task 2 and modified for Federal Improvements for specific design storms to evaluate and support the basin rule modifications. This includes baseline simulations (with existing basin rule criteria) and modified simulations (with modified allowable discharges) for design storm events (10-year and 100-year, 72-hour storms). The scope also includes preparation of revised figures for the rule 40E-41.263 (similar to Figures 41-8 and 41-9) and recommendation of revised rule language.

Task 4 – Assistance During Rule Development and Rule Making

This includes participation on an as-needed basis in the rule development process, attending public meetings, and participating in public outreach programs.

1.3 SCOPE OF WORK

The scope of work for Task 1 was completed in December 2002. The findings of data acquisition, including production of a digital terrain model and basin/sub-basin delineation, were presented in the Task 1 Draft Report, which was reviewed by members of the review committee and the District technical staff. The review comments were addressed, and a final report was prepared as Technical Memorandum #1 dated December 30, 2002, which was then accepted by the District.

The scope of work for Task 2 was completed in August 2003. The results of the Basin Modeling System, including HEC-HMS and HEC-RAS models and calibration results, were presented in the Task 2 Draft Report, which was reviewed by members of the review committee and the District technical staff. The review comments were addressed, and a final report was prepared as Technical Memorandum #2 dated August 25, 2003, which was then accepted by the District.

This report (Technical Memorandum #3 or TM #3) includes the scope of work outlined for Task 3. This report represents the revised TM #3 and replaces the initial TM #3 in its entirety. The initial TM #3 was prepared and accepted by the District in November 2003. However, there were some revisions to the model geometric input parameters that impacted a couple of sub-basins. Therefore, the initial TM #3 was revised and replaced in entirety by this report (TM #3). The technical activities in Task 3 are based on the findings presented in Technical Memorandum #2. In accordance with the contractual agreement with the District (Contract Number: C-13412 and amendments), the following scope of work was completed as part of this task (Task 3).

- Sub-Task 3.1: Baseline Simulations
- Sub-Task 3.2: 10-Year Design Storm Simulation
- Sub-Task 3.3: 100-Year Design Storm Simulation
- Sub-Task 3.4: Documentation of 10-Year and 100-Year Storm Events (Technical Memorandum #3)

The contract amendment for Task 3 includes evaluation of the following three (3) alternatives for the ACME Basin B CERP Project.

- Include ACME Basin B as additional inflow to C-51 through ACME Basin A
- Include ACME Basin B as a new inflow to C-51 along the west side of ACME Basin A
- Include ACME Basin B as a new inflow to STA-1 East

The scope of work for Task 4 includes assisting the District in developing the basin rule and attending the public meeting to support the District staff during the basin rule development process.

1.4 LEVEL OF SERVICE

A level of service designation is a relative assessment of overall performance of a stormwater management system based upon the hydraulic performance of the individual stormwater management system elements (e.g., culverts, channels, storm sewers, ponds, etc.) contained throughout the basin. Prioritization of facility improvement funding, operations and maintenance, and regulatory enforcement of development programs can be properly and efficiently addressed once a level of service standard is established.

The minimum level of service standard for Task 3 (Model Application) is specified as the 10-year, 72-hour and 100-year, 72-hour storm events. Further details on these design storm events were presented in TM #2, and discussed later in Section 2 of this report (TM #3).

1.5 SOURCES OF DATA

Available drainage data from local, state, and federal sources have been researched and compiled during preparation of this report. Especially important and useful data and information was provided by Patrick Martin, Lake Worth Drainage District, Jay G. Foy, StormwaterJ Engineering, Alan Wertepny, Mock-Roos & Associates, Clete J. Saunier, Loxahatchee Groves Water Control District, and Ken Todd, Palm Beach County. The listing of materials and the sources used in the development of this report are presented below.

Maps, Plans, and Drawings:
- Data collected and summarized in Technical Memorandum #1
- Data collected and summarized in Technical Memorandum #2

Reports and Information:
- Hydrologic Modeling System (HEC-HMS) User's Manual, Version 2.1, January 2001
- Hydrologic Modeling System (HEC-HMS) Release Notes, Version 2.2.1, October 2002
- River Analysis System (HEC-RAS) User's Manual, Version 3.1.1, May 2003

Meetings, Discussions, and/or Communications:
- Tony Waterhouse, South Florida Water Management District
- Suelynn Dignard, South Florida Water Management District
- Kathy Collins, South Florida Water Management District
- Ron Mierau, South Florida Water Management District
- George Hwa, South Florida Water Management District
- Mark Wilsnack, South Florida Water Management District
- Cal Neidrauer, South Florida Water Management District
- Bob Howard, South Florida Water Management District
- Jay Foy, Indian Trail Improvement District
- Patrick Martin, Lake Worth Drainage District
- Clete J. Saunier, Loxahatchee Grove Water Control District
- Alan Wertepny, Mock Roos & Associates
- Ken Todd, Palm Beach County
- Ken Konyha, South Florida Water Management District
- Damon Meiers, South Florida Water Management District
- Tom Conboy, South Florida Water Management District
- Karen Brandon, LBFH
- Keith Jones, U.S. Army Corps of Engineers

2.0 BASIN MODEL CHARACTERISTICS

2.1 BASIN DESCRIPTION

The basin and sub-basin boundaries are excerpted from TM #2, shown on Figures 1-1 and 2-1, and further details are given below.

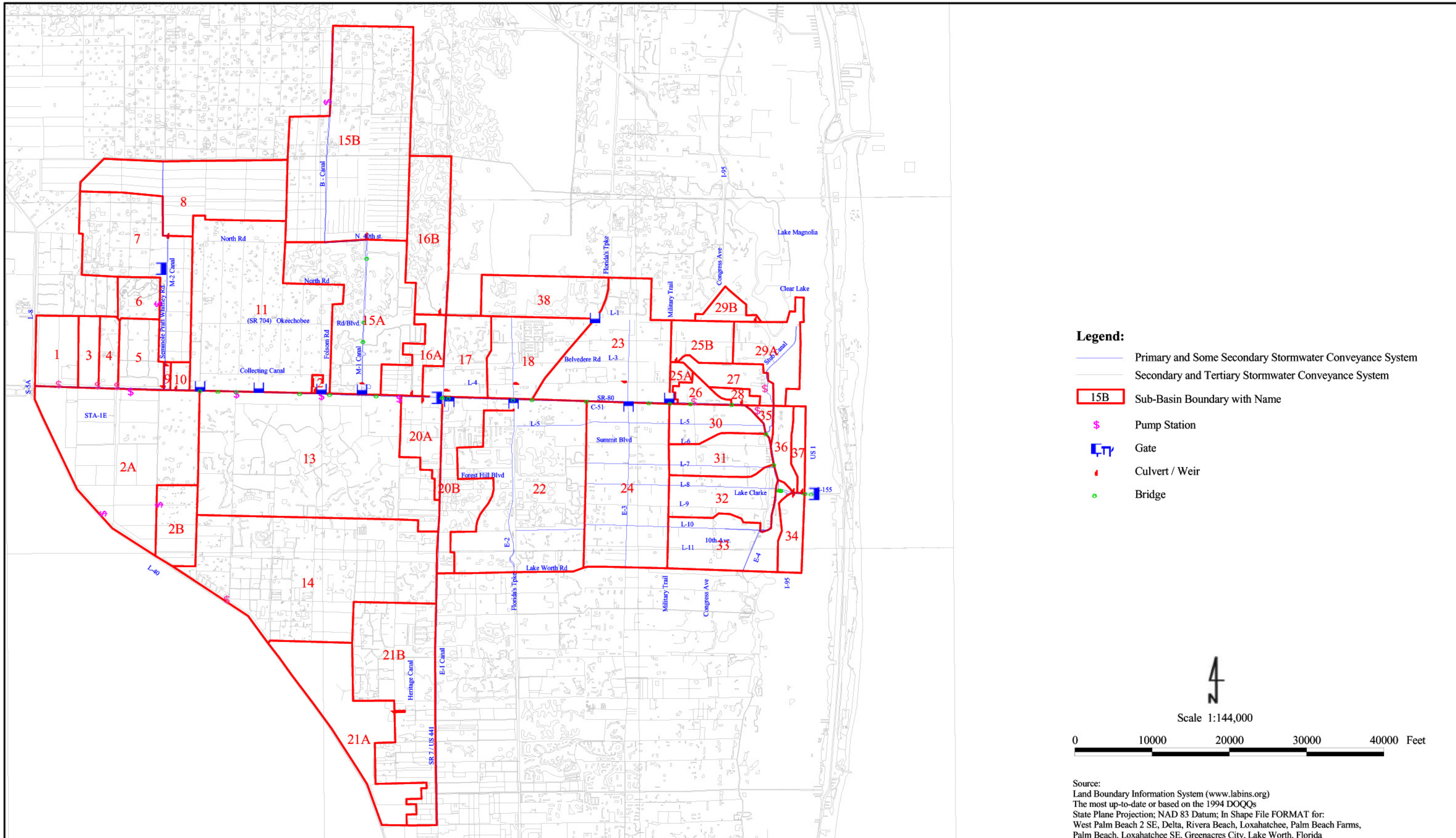
As shown on Figure 2-1, the C-51 basin encompasses a drainage area of approximately 113,810 acres (177.8 square miles). The basin extends from Northlake Boulevard and Grassy Waters Preserve on the north to Lake Worth Road on the south, and from L-8 and L-40 on the west to US-1 on the east.

The runoff from various sub-basins within the study area discharges to the C-51 canal through a number of lateral and equalizer canals. The tidal gate S-155 located east of US-1 ultimately controls the outfall from the C-51 canal. Section 2.2 presents a complete description of the primary drainage pattern and features within the project area. The project area is divided into 44 sub-basins designated as 1 through 38 (alternately, designated as B1 through B38) as shown on Figure 2-1. The basin information is summarized in Tables 2-1a and 2-1b.

In addition, the study area includes three federal projects. They are a) S-155A, which is an in-line control structure located on the C-51 canal dividing the basins into the C-51 West and C-51 East basins; b) STA-1E, which is a storage and treatment reservoir built with approximately the same footprint as Basin 2A; and c) Pump Station 319, which is located along the C-51 canal, that pumps from the C-51 canal to STA-1E as per pre-defined operational criteria. All of these federal projects are located within the C-51 West drainage basin. These features are also shown on Figure 2-1 and summarized in Table 2-2a.

2.2 STORMWATER CONVEYANCE FEATURES

Figure 2-1 presents the drainage or stormwater conveyance features within the basin boundary and shows both primary and secondary canal systems. The present study is limited to the performance of the primary canal system. As shown on Figure 2-1, the primary conveyance features include the primary canal (C-51 canal) and some of the secondary canals (M-1 canal, M-2 canal, Homeland canal, equalizer canals E-1 through E-4, and Stub canal). Some of the other secondary canals, such as the lateral canals L-4 through L-11 are also shown on this figure. The detailed descriptions of the above listed stormwater conveyance features for the baseline condition are given below, and also summarized in Table 2-2a for the C-51 West basin, and in Table 2-2b for the C-51 East basin.



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APPROVED BY		07/06/04
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I hereby certify that this document was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Florida.

SIGNED NA
NAME
DATE REG. NO.

STORMWATER CONVEYANCE SYSTEM

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 2-1

FILE NUMBER FL02006 SHEET ___ OF ___

Table 2-1a
Summary of Information for C-51 West Basin

Sub-Basin		Area		Locality	Other Information
ID	**Other ID**	**(acre)**	**(sq mi)**		
1	B1	1164.3	1.82	Palm Beach Aggregate	
STA-1E	B2A	6715.7	10.49	Same as Basin 2A	SFWMD
2B	B2B	1226.3	1.92		SFWMD
3	B3	579.4	0.91		Fleming Property
4	B4	540.0	0.84		Leonard Property
5	B5	1142.4	1.78		Fox Trail
6	B6	673.5	1.05		Lion Country Safari
7	B7	4126.9	6.45	Indian Trail Improvement District	M-2 Basin
8	B8	3966.7	6.20	Seminole Improvement District	Callery-Judge Groves
9	B9	72.8	0.11		
10	B10	208.0	0.32	Entrada Acres	Developed by Henry Schieffer
11	B11	8138.3	12.71	Loxahatchee Groves	LGWCD
12	B12	74.1	0.12	HCA Health Services	Palms West Hospital
13	B13	10537.9	16.46	ACME Improvement District	ACME Basin A
14	B14	9270.2	14.48	ACME Improvement District	ACME Basin B
15A	B15A	5116.6	7.99	Village of Royal Palm	M-1 Canal, Gates and Structures: Indian Trail Improvement District
15B	B15B	8640.6	13.50	Indian Trail Improvement District	M-1 Acreage Area Lower Basin
16A	B16A	1064.4	1.66		
16B	B16B	2448.8	3.83		
20A	B20A	1138.6	1.78	Lake Worth Drainage District	
TOTAL		**66845.5**	**104.42**		

Table 2-1b
Summary of Information for C-51 East Basin

Sub-Basin		Area		Locality	Other Information
ID	Other ID	(acre)	(sq mi)		
17	B17	1650.5	2.58	Lake Worth Drainage District	
18	B18	2294.9	3.58	Lake Worth Drainage District	FDOT Structure
20B	B20B	2341.8	3.66	Lake Worth Drainage District	
21A	B21A	3540.3	5.53	Strazulla Wetlands	SFWMD
21B	B21B	5056.2	7.90		
22	B22	7375.2	11.52	Lake Worth Drainage District	
23	B23	4206.9	6.57	Lake Worth Drainage District	
24	B24	5282.0	8.25	Lake Worth Drainage District	
25A	B25A	205.8	0.32	Palm Beach County	PBIA
25B	B25B	972.1	1.52	Palm Beach County	
26	B26	376.1	0.59	Palm Beach International Airport	
27	B27	830.7	1.30	Palm Beach International Airport	
28	B28	223.4	0.35	Palm Beach International Airport	
29A	B29A	1578.1	2.46		
29B	B29B	440.3	0.69		
30	B30	1153.0	1.80	Palm Beach County	
31	B31	1467.7	2.29	Lake Worth Drainage District	
32	B32	1812.7	2.83	Lake Worth Drainage District	
33	B33	2323.8	3.63	Lake Worth Drainage District	
34	B34	711.3	1.11	City of Lake Worth	
35	B35	172.9	0.27	City of Cloud Lake	Palm Beach County
36	B36	603.3	0.94	Dreher Park	
37	B37	390.2	0.61	City of West Palm Beach	
38	B38	1955.2	3.05		Vista Centre
TOTAL		**46964.4**	**73.35**		

Table 2-2a
Summary of Stormwater Conveyance Features (Baseline: C-51 West)

Sub-Basin ID	Sub-Basin Other ID	Control Structure	Structure Description and Operations	Conveyance System
1	B1	Pump	1-20,000 gpm Pump and 1-25,000 gpm Pump; Only one pump at a time. Allowable discharge=47.6 cfs	C-51 Canal
STA-1E	B2A	Pump	Pump Station 319; 2-550 cfs and 3-960 cfs Pumps; on @12’ to 12.4’ (at 0.1’ increment) and off @11’ to 11.4’ (at 0.1’ increment) at S-155A HW on C-51 canal.	C-51 Canal to STA-1E
2B	B2B	Pump	Pump Station 361; 3-25 cfs pumps; on @11’, off @10’; Initial Stage @10’.	STA-1E
3	B3	Pump	11,830 gpm Pump	C-51 Canal
4	B4	Pump	13,170 gpm Pump	C-51 Canal
5	B5	Weir	1-54” x 40’ CMP; Allowable discharge=47 cfs	M-2 Canal
6	B6	Pump	30,000 gpm Pump	M-2 Canal
7	B7	Slide Gate	2-36” x 75’ Culverts controlled by Sluice Gates (6’ wide, sill @8’).	M-2 Canal
8	B8	Weir	4-72” Sharp Crested Weirs (crest @17.5’)	M-2 Canal
9	B9	Weir	2 ft Flash Board Riser	M-2 Canal
		Channel M-2 Canal	M-2 discharges to C-51 via 3-84” CMP with Risers with control elevation @ 12 ft-NGVD.	C-51 Canal
10	B10	Riser Weir	36” Riser with Control Elevation at 17.5 ft.	C-51 Canal
11	B11	Gate & Weir	1-6’ Slide Gate (4’ opening, open @16’, close @15’, sill @10’) at A and at G; 2-12’ Sluice Gates (2’ opening, open @16.5’, close @15’, sill @9’) and 2-12’ Weirs (crest @18.5’) at D.	C-51 Canal
12	B12	Riser Weir	24” x 250’ RCP Riser (Palms West Hospital), crest @14’.	C-51 Canal
13	B13	Pump	1-60,000 gpm Discharge Pump (PS#4); 1-60,000 gpm Discharge Pump (PS#3); 1-62,000 gpm Discharge Pump (PS#6); on @13’, off @12’ (same as Existing).	C-51 Canal
14	B14	Pump	1-100,000 gpm and 1-120,000 gpm Discharge Pumps; on @13’, off @12’.	WCA 1
15A	B15A	Channel	Open Channel flow to M-1, weir crest @13’.	M-1 Canal
		Culvert	2-72” RCP to C-51 from Lake Challenger	C-51 Canal
		Amil Gate & Slide Gate	1-Automatic D-710 Amil Gate (12’ wide, sill @5’) and 4 Slide Gates (5.9’ wide each, sill @2.7’) on M-1 controlling the discharge to C-51	C-51 Canal
15B	B15B	Culvert	Roach Structure: 2-84” x 80’ RCP with Slide Gates. 40th Structure: 4-large & 2-small Gates. Outflow controlled by 1-60” x 76’ RCP. No Flow to M-1 in 72 hrs.	M-1 Canal
16A	B16A	Weir	30’ wide Weir; Control Elevation @ 13 ft-NGVD.	C-51 Canal
16B	B16B	Weir	2-72” RCP controlled by 3-48” control structures with weir elevation @ 17.5 ft.	Sub-Basin 16A
20A	B20A	Culvert	2-60” CMP upstream of STA 4+94 on S-4 Canal, Invert @10’.	C-51 Canal
--	S-155A	Gate	Control Structure, divides C-51 West from C-51 East, remains closed, designed discharge capacity 1,000 cfs.	C-51 Canal

Table 2-2b
Summary of Stormwater Conveyance Features (Baseline: C-51 East)

Sub-Basin ID	Sub-Basin Other ID	Control Structure	Structure Description and Operations	Conveyance System
17	B17	Channel	L-1, L-2, L-3, L-4 Lateral Canals to E-1 Canal ; weir with crest @8.5’	C-51 Canal
18	B18	Culvert	E-2 Canal discharging through 10’ wide x 11’ high FDOT Box Culvert, crest @8.5’.	C-51 Canal
20B	B20B	Radial Gate	Control Structure #2: 2-12’ Radial Gates on E-1, sill @8.5’.	C-51 Canal
21A	B21A	Overflow	Land Locked Basin controlled by Stage-Storage relationship. Overflows to Basin 21B when stage reaches 18.5 ft-NGVD.	Sub-Basin 21B
21B	B21B	Channel	Homeland Canal discharging to E-1 Canal.	E-1 Canal
22	B22	Radial Gate	Control Structure #4: 2-12’ Radial Gates on E-2, sill @8.5’.	C-51 Canal
23	B23	Channel	L-1, L-2, L-3, L-4 Lateral Canals to E-3 Canal.	C-51 Canal
24	B24	Radial Gate	Control Structure #6: 3-12’ Radial Gates on E-3, sill @6.5’.	C-51 Canal
25A	B25A	Slide gate	2-10’ wide x 8’ high Box Culverts with Slide Gate, sill @8.5’.	C-51 Canal
25B	B25B	Culvert	2-8’ high x 10’ wide Box Culverts under Belvedere Road.	Sub-Basin 25A
26	B26	Pump	Southern PBIA Pump Station: 4-106.6 cfs Pumps; Pump 4 only operates when one of the other 3 fails.	C-51 Canal
27	B27	Pump	Eastern PBIA Pump Station: 4-106.6 cfs Pumps; Pump 4 only operates when one of the other 3 fails.	Stub Canal
28	B28	Culvert	40’ wide x 8’ high FDOT Box Culvert: Structure S-199, invert @7’.	C-51 Canal
29A	B29A	Channel	Discharge to C-51 through Stub Canal, weir crest @9’	Stub Canal
29B	B29B	Weir	6-6’ wide Weirs with Gates	Sub-Basin 29A
30	B30	Channel	L-5 Canal Open Channel flow to C-51, weir crest @9’.	C-51 Canal
31	B31	Channel	L-6, L-7 Canals Open Channel flow to C-51, weir crest @9’.	C-51 Canal
32	B32	Channel	L-8, L-9 Canals Open Channel flow to C-51, weir crest @9’.	C-51 Canal
33	B33	Channel	L-10, L-11 Open Channel flow to C-51, weir crest @9’.	E-4 Canal
34	B34	Culvert	1-48”x1800’ RCP; 1-36”x1000’ RCP, invert @7.5’	C-51 Canal
35	B35	Pump	Pump Station: 45 cfs pump	C-51 Canal
36	B36	Culvert	Dreher Zoo control structure: 30’ wide Weir (crest @10’); 60”x2500’ RCP at Municipal Golf Course (invert @7.5’); 36”x3000’ RCP at Georgia Ave (invert @7.5’).	C-51 Canal
37	B37	Culvert	1-36” x 2000’ RCP; 1-36” x 2500’ RCP, invert @7.5’.	C-51 Canal
38	B38	Slide Gate	2-66” RCP; One is plugged and the other is controlled by a 5.5 ft wide Gate (sill @8.5’, opening 2’).	C-51 Canal
--	S-155	Gate	Outfall Structure, remains operational, designed discharge capacity approximately 4,800 cfs.	C-51 Canal

As can be seen from the background hydrologic feature map shown on Figure 2-1, the secondary and tertiary stormwater conveyance system within the project basin consists of a myriad of interconnected canals and water bodies. These secondary and tertiary canals are generally evaluated on a local scale. This study presents the hydrologic and hydraulic evaluations on a basin wide scale, and therefore, did not include detailed evaluations of the secondary and tertiary conveyance systems.

The general information related to stormwater conveyance control structures directly connected to primary conveyance features are summarized in Tables 2-2a and 2-2b. The topographic variation over the site along with the stage-area-storage relationships for the sub-basins was obtained from TM #2. Further details on the canals, control structures, and stage-area-storage relationships for each sub-basin are presented later in Section 2.4 of this report.

2.3 BASIN MODELING METHODOLOGY AND CALIBRATION

Methodology

The major computational components of a basin model include hydrologic and hydraulic analyses. The basin hydrological computation begins with a storm event distributed over the basin that generates runoff (runoff hydrograph) after initial abstraction. The runoff fills the available storage through topographic depressions, and then overflows or outflows from the basin. The available storage for a specific basin behaves like a reservoir, which intakes the runoff hydrograph, stores the water in accordance with the available stage-storage relationship, and then outflows from the reservoir according to the control structure(s). The outflow from the basin or reservoir is then conveyed to the discharge point through a stormwater conveyance system consisting of canal, stream, river, and flow control structures. In other words, the hydrologic computation includes runoff generation for each sub-basin, while the hydraulic computation constitutes the flow routing within the canal system including the hydraulically connected storage or reservoir system.

The hydrologic and hydraulic models used for calibration in Task 2 (Report TM #2) were continued to compute the hydrologic and hydraulic performance of the sub-basins during this task for basin rule development. The hydrologic computation was performed using the Hydrologic Modeling System (HEC-HMS) software. The hydraulic computation was performed using the River Analysis System (HEC-RAS) software. Both HEC-HMS (HMS) and HEC-RAS (RAS) have been developed by the Hydrologic Engineering Center, USACE. The latest versions of the HMS (Version 2.2.1 with release date of October 2002) and RAS (Version 3.1.1 with release date of May 2003) models are used for this project. Further discussion on the principles of these models applicable to this study was presented in TM #2.

Calibration

The calibration of the basin models was completed during Task 2 (Report TM #2). The model calibration was performed for the storm event of Hurricane Irene that occurred from 14th October to 16th October, 1999. For better performance and integrity of the model calibration, a longer duration was selected as the calibration period, which started two days prior to the calibration storm and continued two days after the designated storm. Based on the available records and types of measurements, C51WEL and C51SR7 were designated as key locations for peak stage calibration, and S155 was designated as key location for peak discharge calibration. The River Stations (RS) for the calibration locations are C51WEL at RS 65500, C51SR7 at RS 56807, and S155 at RS 720 or RS 750 (upstream of the gated structure).

The major basin characteristics that were adjusted during the model calibration in Task 2 included curve numbers and time lags for the sub-basins, and Manning's n coefficients for the channel sections and overbanks. The relevant calibrated basin characteristics are summarized later in Section 2.4 of this report. Complete details on the model calibration process, including the initial and boundary conditions and the transient hydraulic computational parameters are presented in TM #2.

Interpretation of Model Results

The peak stage in storage areas for each sub-basin determines the flood stage and duration of flood for the corresponding sub-basin. For the basin rule development, the allowable flows are determined from model results for the 10-year, 72-hour design storm, and the allowable stages are determined from model results for the 100-year, 72-hour design storm.

2.4 BASIN PARAMETERS

Basin Area and Land Use

The land use description and computed sub-basin areas presented in TM #2 were assumed to remain unchanged for this task of the study. The computed sub-basin areas are presented in Table 3-1, which are excerpted from TM #2.

Curve Number (CN)

The curve numbers (CN) for the sub-basins were obtained from the calibrated model results, which were presented in TM #2. These calibrated CN values were used for model applications except for the following exception: Basin 2A or STA-1E is a storage reservoir, and therefore the CN value of 99 was assigned to this sub-basin. The calibrated curve numbers for the sub-basins are presented in Table 2-3.

Table 2-3
Summary of Basin Parameters for Basin Rule Development

Sub-Basin		Area		Calibrated * Curve Number (CN)	Calibrated Time of Concentration (Minute)	Calibrated Time Lag (Minute)
ID	Other ID	(acre)	(sq mi)			
1	B1	1164.3	1.82	71.5	252	151
2A	B2A	6715.8	10.49	99.0	651	390
2B	B2B	1226.4	1.92	74.3	138	83
3	B3	579.4	0.91	73.9	231	139
4	B4	540.0	0.84	75.2	260	156
5	B5	1142.5	1.78	77.4	232	139
6	B6	673.5	1.05	81.5	146	88
7	B7	4126.9	6.45	76.0	501	300
8	B8	3966.8	6.20	76.0	401	241
9	B9	72.8	0.11	76.1	93	56
10	B10	208.0	0.32	81.9	226	136
11	B11	8138.3	12.71	77.0	518	310
12	B12	74.1	0.12	86.0	94	56
13	B13	10537.9	16.46	82.0	521	313
14	B14	9270.3	14.48	75.0	429	258
15A	B15A	5116.7	7.99	86.0	551	330
15B	B15B	8640.6	13.50	78.0	592	355
16A	B16A	1064.4	1.66	83.4	308	185
16B	B16B	2448.8	3.83	89.0	752	450
20A	B20A	1138.6	1.78	80.0	255	153
17	B17	1650.5	2.58	84.8	303	182
18	B18	2294.9	3.58	83.5	287	172
20B	B20B	2341.8	3.66	80.7	364	218
21A	B21A	3540.4	5.53	96.9	534	320
21B	B21B	5056.2	7.90	76.4	493	296
22	B22	7375.2	11.52	80.0	518	310
23	B23	4206.9	6.57	81.0	364	218
24	B24	5282.0	8.25	81.5	440	264
25A	B25A	205.8	0.32	77.0	104	63
25B	B25B	972.1	1.52	79.0	131	79
26	B26	376.1	0.59	80.1	162	97
27	B27	830.7	1.30	84.5	274	164
28	B28	223.4	0.35	83.0	92	55
29A	B29A	1578.1	2.46	80.5	130	78
29B	B29B	440.3	0.69	85.9	144	86
30	B30	1153.0	1.80	78.3	159	95
31	B31	1467.8	2.29	80.0	157	94
32	B32	1812.7	2.83	81.0	271	162
33	B33	2323.9	3.63	80.0	228	137
34	B34	711.3	1.11	75.0	262	157
35	B35	172.9	0.27	82.7	74	45
36	B36	603.3	0.94	72.1	187	112
37	B37	390.2	0.61	69.0	184	111
38	B38	1955.2	3.05	86.0	225	135

* Basin 2A or STA-1E is the only exception, where the CN value was changed from 75 to 99

Time of Concentration (T_c) and Time Lag (T_l)

The time of concentration (T_c) and the time lag (T_l) values for the sub-basins were obtained from the calibrated model results, which were presented in TM #2. These calibrated T_c and T_l values were used for model applications without any exception. The calibrated T_c and T_l values for the sub-basins are presented in Table 2-3.

Stage-Area-Storage Relations

The stage-area and stage-storage relations were computed and presented in TM #2. It was assumed that these stage-area-storage relationships would remain unchanged for the model applications during this task.

2.5 DESIGN STORM EVENTS

As indicated in Section 1.4 describing the level of service, the design storms for the basin rule evaluations are identified as 10-year, 72-hour and 100-year, 72-hour storm events. The 24-hour (1-day) and 72-hour (3-day) duration maximum rainfalls are the most commonly considered storm events by the District's Regulation Department in the permit review process described in "Management and Storage of Surface Waters, Permit Information Manual, Volume IV". The District is committed to maintaining the most accurate and updated rainfall frequency data for use in evaluating the permit applications within its jurisdiction. In order to maintain such commitment, the District initially developed rainfall frequency curves for 24-hour through 120-hour durations in 1981 (MacVicar). Based on the increased number of stations and rainfall measurement records, Trimble (1990) published revised rainfall frequency curves in the "Technical Memorandum, Frequency Analysis of One and Three-Day Rainfall Maxima for Central and Southern Florida", SFWMD in October 1990. Since then the Regulation Department of the SFWMD has been using these new rainfall frequency curves as the basis of review for permit applications.

A more comprehensive discussion on the development of the design storm events was presented in TM #2. For consistency of the permitting review process for the entire jurisdiction, we recommended in TM #2 to continue the use of the SFWMD rainfall frequency curves of 1990. Based on this publication, Table 2-4 presents the estimated storm event rainfall quantities for the C-51 basin, which were used for the present study during this task. A single storm depth is used over the entire C-51 basin. The 15-minute interval rainfall distribution consisting of unit hydrograph and cumulative percentage of 24-hour peak rainfall for a 72-hour storm event is presented in Appendix B-1.

Table 2-4
Storm Event Rainfall Quantities for Basin Rule Development

Storm Frequency (year)	Storm Duration (hour)	Storm Depth (inch)
10	24	7.4
	72	10.1
100	24	12.0
	72	16.3

Note: the 100-year, 24-hour storm depth is same as in the FEMA study, and 72-hour storm depths were calculated by multiplying the 24-hour depth by 1.359.

2.6 GEOMETRIC AND STRUCTURAL FEATURES

Reaches and Junctions

The C-51 canal and the major tributary canals (equalizer canals) are included in the model as shown on Figure 2-1. The equalizer canals include E-1 through E-4 canals. In addition, the Stub canal and some of the lateral canals (L-5 through L-11) are also included in the model. Each equalizer canal, one lateral canal for each sub-basin where applicable, and the Stub canal are represented as separate reaches in the model. Eleven reaches represent the C-51 canal, which are separated by junctions where one or more of the tributary canals intersect with each other or with the C-51 canal. The reaches and junctions are shown on a corresponding nodal diagram for each alternative as presented later in Sections 3 and 4 of this report.

Canal Cross-Sections

Channel cross-sections are necessary to accurately simulate the stage in the conveyance system. The cross-sections documented in TM #2 were utilized for the C-51 east during this model application effort. USACE developed certain design cross-sections for the C-51 west during their design of STA-1E and the associated structures (S-155A and S-319). These cross-sections were used in the present model to define the channel geometry for the C-51 canal west of S-155A. The remaining cross-sections along the C-51 canal were generated from interpolation at 50-foot intervals. All other channel sections including those for lateral and equalizer canals were identical to the cross-sections documented in TM #2.

Bridges

A total of 28 bridges were included in the model application. Figure 2-1 shows the bridge locations along the C-51 canal. The bridge profiles and the station-elevation data for bridge sections used in this phase of the study are identical to the information documented in TM #2. The only exception to this is the Lowes Bridge (Future) that was a new bridge as documented by USACE in their design study of STA-1E. This new bridge is located at River Station 57926 in reach R3 along the C-51 canal in the C-51 West.

Inline Structures

The inline structures include culverts, weirs, and gates that are located along the canal and directly control the flow along the conveyance system. There are two inline structures along the C-51 canal. They are S-155A and S-155. The Structure S-155 is a gated outfall structure located at the downstream section of the C-51 canal (C-51 East). S-155A is also a gated structure that is designed to control the flow from the C-51 West basin. This structure is assumed to be operational for the purpose of this study. The operational conditions for these gates were summarized in Section 2.2 of this report.

The other inline structures that are incorporated into the model include radial gates along E-1, E-2, and E-3 canals, Amil gate and slide gates along M-1 canal, and discharge weirs at the confluence of the lateral canals. The technical specifications for these structures were summarized in TM #2, and remained unchanged for the purpose of this study.

Lateral Structures and/or Pump Stations

A lateral structure and/or pump station option was used to connect the storage area with the channel flow for each sub-basin as documented in TM #2. The lateral structures were weir, culvert, or gate, and were connected to appropriate reaches at corresponding river stations as shown on corresponding nodal diagram for each alternative (see Sections 3 and 4 of this report). The information related to lateral structure and pump station connections used in the RAS model is summarized in Table 2-5.

Manning's n

As documented in TM #2, the calibrated values of Manning's n coefficient ranged from 0.03 to 0.05 along the main channel, and 0.5 along the overbanks. The calibrated coefficient was 0.03 along the main channel for the M-2, M-1, E-1 through E-4, and L-5 through L-11 canals. The calibrated coefficients along the C-51 canal were 0.04 along the reaches R1 and a segment of R2, and 0.05 for remainder of the C-51 canal. All calibrated values of Manning's n remained unchanged for the purpose of this model application, unless explicitly noted otherwise.

2.7 UNSTEADY FLOW CONDITIONS

Simulation Period

The duration of the design storms is 72-hours. In order to ensure the occurrences of the peak discharge and the peak flow resulting from the design storms, the simulation period was

Table 2-5
Summary of Information on Lateral Structures and Pump Stations

Basin Name	Storage Name	Canal Name	Reach Name	Structure River Station	Structure Type	Basin Storage	Description
B1	S1	C51	R1	106604	Pump	S1	PS1C51: 47.6 cfs pump
B2A	S2A	C51	R1	104304	Pump	S2A	PS2AC51A: 55.7 cfs pump
B2A	S2A	C51	R1	99068	Pump	S2A	PS2AC51B: 44.6 cfs pump
B2A	S2A	C51	R1	93530	Pump	S2A	PS2AC51C: 40.1 cfs pump
B3	S3	C51	R1	101600	Pump	S3	PS3C51: 26.3 cfs pump
B4	S4	C51	R1	101600	Pump	S4	PS4C51: 29.3 cfs pump
B5	S5	M2	RM2	436	Culvert	S5	54" CMP
B6	S6	M2	RM2	10124	Pump	S6	PS6M2: 66.8 cfs pump
B7	S7	M2	RM2	15788	Gate	S7	6' wide Slide Gate
B8	S8	M2	RM2	19975	Weir	S8	4-72" wide weir
B9	S9	M2	RM2	3262	Weir	S9	2' Flash Board Riser (Weir)
B10	S10	C51	R2	91618	Weir	S10	9' wide Weir
B11	S11	C51	R2	88526	Gate	S11	Gate A: 1-6' Slide Gate
B11	S11	C51	R2	80973	Weir	S11	Gate D: 2-12' Sluice Gates & 2-12' Weir
B11	S11	C51	R2	72778	Gate	S11	Gate G: 1-6' Slide Gate
B12	S12	C51	R2	73679	Weir	S12	2' wide Weir
B13	S13	C51	R2	83455	Pump	S13	PS13C51A: 133.7 cfs pump
B13	S13	C51	R2	72838	Pump	S13	PS13C51B: 133.7 cfs pump
B14	S14	--	--	--	Pump	S14	PS14WCA: 222.8 cfs pump
B15A	S15A	C51	R3	67560	Culvert	S15A	2-72" RCP
B15A	S15A	M1	RM1	1438	Weir	S15A	Open Channel
B16A	S16A	C51	R3	61174	Weir	S16A	30' Wide Weir
B17	S17	E1N	RE1N	1712	Weir	S17	S17 to E1N
B18	S18	E2N	RE2N	1979	Weir	S18	S18 to E2N
B20A	S20A	C51	R3	59869	Culvert	S20A	2-60" CMP
B20B	S20B	E1S	RE1S	3951	Weir	S20B	S20B to E1S
B21B	S21B	E1S	RE1S	33752	Canal	S21B	Homeland Canal
B22	S22	E2S	RE2S	3423	Weir	S22	S22 to E2S Canal
B23	S23	E3N	RE3N	2641	Weir	S23	S23 to E3N Canal
B24	S24	E3S	RE3S	2713	Weir	S24	S24 to E3S Canal
B25A	S25A	C51	R7	28070	Gate	S25A	2 Slide Gates
B26	S26	C51	R7	24880	Pump	S26	PS26C51: 3-106.6 cfs pumps
B27	S27	Stub	R7	16882	Pump	S27	PS27SC: 3-106.6 cfs pumps
B28	S28	C51	R7	18858	Culvert	S28	8' x 40' Box Culvert
B29A	S29A	Stub	RSC	8615	Weir	S29A	S29A to Stub Canal
B30	S30	L5	RL5	450	Weir	S30	S30 to L5 Canal
B31	S31	L7	RL7	1930	Weir	S31	S31 to L7 Canal
B32	S32	L8	RL8	1771	Weir	S32	S32 to L8 Canal
B33	S33	L10	RL10	1453	Weir	S33	S33 to L10 Canal
B34	S34	C51	R11	2843	Culvert	S34	1800' of 48" RCP
B34	S34	C51	R11	1400	Culvert	S34	1000' of 36" RCP
B35	S35	C51	R8	14700	Pump	S35	PS35C51: 45 cfs pump
B36	S36	C51	R9	12243	Weir	S36	30' wide weir at Dreher Zoo
B36	S36	C51	R11	2853	Culvert	S36	2500' of 60" RCP
B36	S36	C51	R11	2467	Culvert	S36	3000' of 36" RCP
B37	S37	C51	R11	2167	Culvert	S37	2000' of 36" RCP
B37	S37	C51	R11	1335	Culvert	S37	2500' of 36" RCP
B38	S38	C51	R6	45825	Gate	S38	1-5.5' Wide Slide Gate

extended 24 hours beyond the design storm durations. Therefore, the simulation period considered for the model applications was 96 hours.

Boundary Conditions

The river station 0+00 is considered the downstream end of the C-51 canal reach for the model, which is located approximately 720 feet downstream of structure S155. The boundary condition at the downstream end is specified as normal depth boundary condition. The upstream boundary is at river station 109730 that coincides with the location of structure S5A-E. The upstream boundary condition is specified by an inflow hydrograph with a constant flow value of 300 cfs for the simulation period. The inflow value of 300 cfs was taken from the seepage estimation performed by USACE for design of the STA-1E. The gates at the structure S-155A were kept closed at all times during the simulations, which effectively separates the flows in the C-51 West basin from those in the C-51 East basin.

In addition, the model requires a specification of boundary conditions at the upstream end of each canal. Since, the stage or flow measurements at the upstream ends of the secondary canals are not available, an assumed constant minimum flow equal to the initial condition was assumed for each canal. The assumed flow ranged from 10 to 30 cfs for the equalizer and lateral canals.

Initial Conditions

It is also necessary to provide an initial condition at the upstream and downstream ends of each reach. The initial conditions for the present study refers to the conditions at 00:00 hour of the simulation period. The initial conditions for the reaches were specified by assuming flows. An initial flow in the range of 10 to 30 cfs was specified for the equalizer and lateral canals. The initial conditions for the reaches along the C-51 canal were approximated based on professional judgment that varied from 100 cfs at the western boundary of the C-51 east to 500 cfs at the eastern end of the C-51 east. These initial conditions may be viewed as an approximation of initial base flows from the adjacent surficial ground water systems.

3.0 MODEL APPLICATION: BASIN RULE EVALUATION

The following alternatives were simulated as part of the model application for the basin rule evaluation.

- Alternative A0: Baseline (Existing Rule) Simulation
- Alternative A1: Unrestricted Flow Simulation
- Alternative A2: USACE Design Manning's n Simulation
- Alternative A3: USACE Design Flow Simulation

Further details for each alternative are given later in this section of the report. A brief discussion along with a comparison of the various alternatives is given at the end of this section.

3.1 ALTERNATIVE A0: BASELINE (EXISTING RULE) SIMULATION

3.1.1 Description of Alternative

This model application establishes a baseline simulation that involves generating the hydrologic conditions for each sub-basin under the existing rule with the federal projects in operational condition. The federal projects for this alternative include: STA-1E, S-319, S-361, S-362, and S-155A. These structures are all located in the C-51 west, and there is no physical change considered for the C-51 East basin. The existing rule includes the peak discharge coefficients and peak stages for each sub-basin that are currently used for permitting purposes. The peak flow or discharge coefficients were based on the 10-year, 72-hour design storm event, while the peak stages were based on the 100-year, 72-hour design storm event. For convenience, Table 3-1 summarizes the existing rule conditions.

The link-node diagram for this alternative is shown on Figure 3-1 for the C-51 basin. Figure 3-1 also represents a geographically based nodal diagram for this alternative. The details on the model simulation for the C-51 basin are presented below.

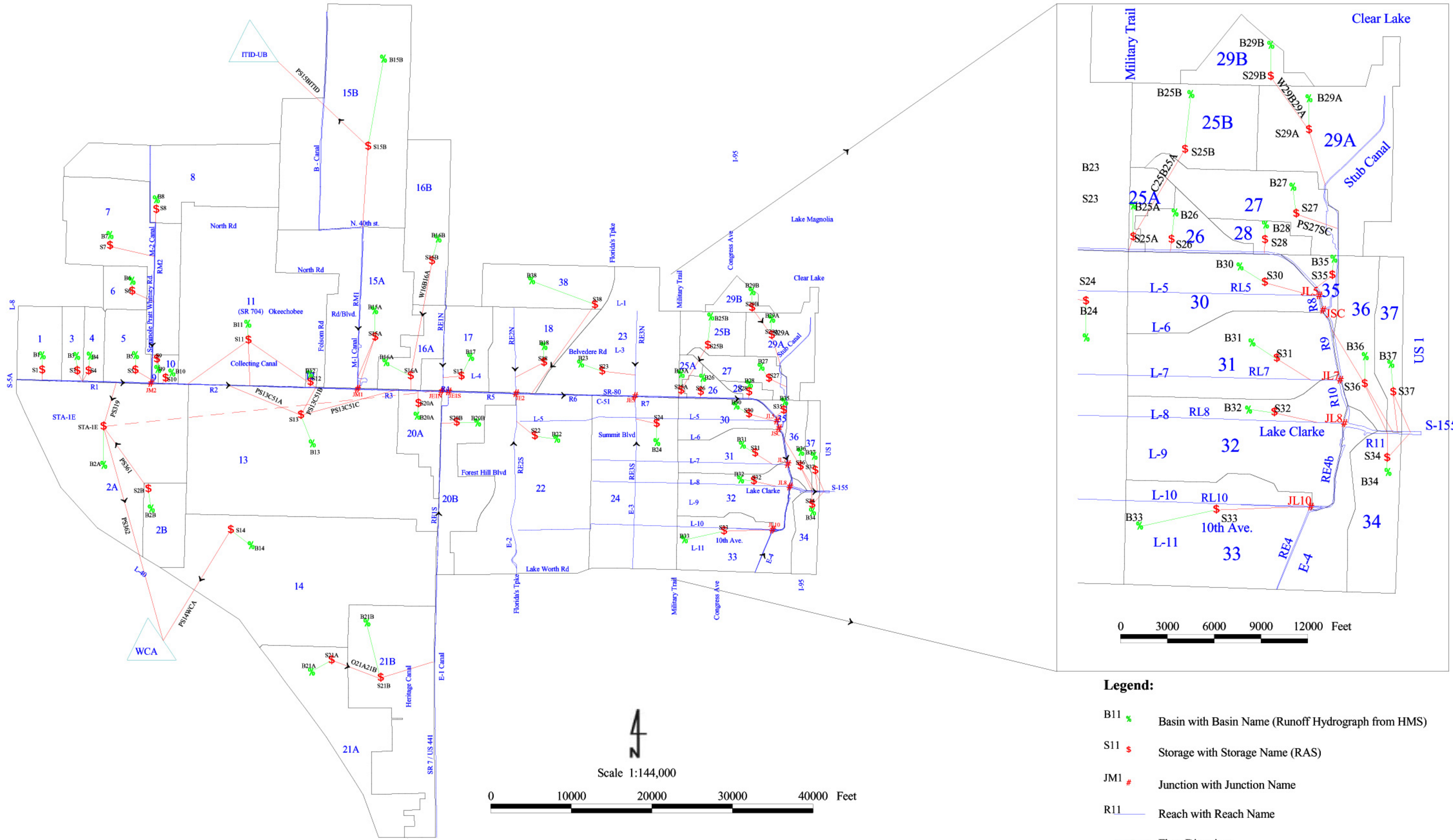
3.1.2 Peak Discharge Simulation for Baseline Condition

The RAS model was initially applied for a case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 3-1. The peak discharge simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The simulated peak discharge values were then compared to the existing rule allowable flows as summarized in Table 3-1. The peak discharges were then adjusted as described below.

Table 3-1
Summary of Existing Rule Conditions

Sub-Basin		Area		Allowable Discharge (10-yr, 72-hr)		Allowable Stage (100-yr, 72-hr) (ft-NGVD)
ID	Other ID	(acre)	(sq mi)	(CSM)	(cfs)	
1	B1	1164.3	1.82	27	49	18.2
2A	STA1E	6715.8	10.49	--	--	17.2
2B	B2B	1226.4	1.92	27	52	17.2
3	B3	579.4	0.91	27	24	18.3
4	B4	540.0	0.84	27	23	18.3
5	B5	1142.5	1.78	27	48	18.7
6	B6	673.5	1.05	24	25	21.0
7	B7	4126.9	6.45	24	155	21.0
8	B8	3966.8	6.20	54	335	22.0
9	B9	72.8	0.11	24	3	21.0
10	B10	208.0	0.32	0	0	20.1
11	B11	8138.3	12.71	27	343	20.2 – 21.0
12	B12	74.1	0.12	27	3	20.2
13	B13	10537.9	16.46	18	296	17.5
14	B14	9270.3	14.48	--	--	--
15A	B15A	5116.7	7.99	70	560	19.0
15B	B15B	8640.6	13.50	--	--	--
16A	B16A	1064.4	1.66	0	0	18.1
16B	B16B	2448.8	3.83	0	0	19.1
20A	B20A	1138.6	1.78	0	0	18.1
17	B17	1650.5	2.58	27	70	18.0
18	B18	2294.9	3.58	27	97	17.9
20B	B20B	2341.8	3.66	16	59	18.3
21A	B21A	3540.4	5.53	0	0	19.8
21B	B21B	5056.2	7.90	0	0	19.8
22	B22	7375.2	11.52	35	403	19.0
23	B23	4206.9	6.57	35	230	19.1
24	B24	5282.0	8.25	35	289	19.3
25A	B25A	205.8	0.32	35	11	16.6
25B	B25B	972.1	1.52	35	53	16.6
26	B26	376.1	0.59	35	21	15.9
27	B27	830.7	1.30	35	45	15.6
28	B28	223.4	0.35	35	12	15.6
29A	B29A	1578.1	2.46	35	86	15.6
29B	B29B	440.3	0.69	35	24	15.6
30	B30	1153.0	1.80	35	63	16.4
31	B31	1467.8	2.29	35	80	15.2
32	B32	1812.7	2.83	35	99	15.3
33	B33	2323.9	3.63	35	127	15.3
34	B34	711.3	1.11	35	39	20.0
35	B35	172.9	0.27	35	9	15.6
36	B36	603.3	0.94	35	33	15.7
37	B37	390.2	0.61	35	21	20.0
38	B38	1955.2	3.05	0	0	18.8

-- did not contribute to the Basin Rule evaluation or not applicable



Legend:

B11	Basin with Basin Name (Runoff Hydrograph from HMS)
S11	Storage with Storage Name (RAS)
JM1	Junction with Junction Name
R11	Reach with Reach Name
	Flow Direction

	NAME	DATE
DESIGNED BY	NA	
DRAWN BY		
CHECKED BY		
APPROVED BY		07/06/04
FILE NAME: FL02006-TM3-FIG 3-1.APR		

I hereby certify that this document was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Florida.

SIGNED NA
NAME
DATE REG. NO.

NODAL DIAGRAM FOR BASIN RULE ALTERNATIVES (A0 THROUGH A3)

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 3-1

FILE NUMBER FL02006 SHEET ___ OF ___

- If the simulated peak discharge was less than the existing rule condition, then no change was made to the outflow hydrograph.
- If the simulated peak discharge was higher than the peak discharge condition of the existing rule, then the control structure specifications were modified and re-simulated using the RAS model to obtain a peak discharge equal to or nearly equal to that of the existing rule condition.

The results for this alternative are summarized in Table 3-2a, which also presents the deviation of the simulated peak discharge from the existing rule allowable discharge for each sub-basin. The peak stage for each sub-basin for the 10-year, 72-hour storm baseline condition is also included in Table 3-2a. As can be seen from this table, the simulated baseline condition closely represents the existing rule allowable flows with the federal structures being operational. Further discussion is presented in Section 3.5 of this report.

3.1.3 Peak Stage Simulation for Baseline Condition

The RAS model was applied for a case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 3-1. This is consistent with the existing rule peak stage conditions as presented in Table 3-1. The peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The simulated peak stages for this alternative are summarized in Table 3-2b, which also presents the deviation of the simulated peak stage from the existing rule allowable stage for each sub-basin. The peak discharge for each sub-basin for the 100-year, 72-hour storm baseline condition is also included in Table 3-2b. As can be seen from this table, the simulated baseline condition consistently produces lower peak stages than the existing rule conditions with the federal structures being operational. Further discussion is presented in Section 3.5 of this report.

Table 3-2a
Summary of Peak Discharge Simulation Results for Alternative A0

Sub-Basin		Area		10-yr, 72-hr Peak Values		Deviation of Peak Discharge from Existing Rule (cfs)
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Stage (ft-NGVD)	
1	B1	1164.3	1.82	48	13.4	-1
2A	STA-1E	6715.8	10.49	--	--	--
2B	B2B	1226.4	1.92	50	13.1	-2
3	B3	579.4	0.91	24	15.0	0
4	B4	540.0	0.84	23	15.9	0
5	B5	1142.5	1.78	53	16.6	+5
6	B6	673.5	1.05	25	18.8	0
7	B7	4126.9	6.45	152	19.2	-3
8	B8	3966.8	6.20	260	19.9	-75
9	B9	72.8	0.11	5	17.1	+2
10	B10	208.0	0.32	0	17.8	0
11	B11	8138.3	12.71	357	18.7	+14
12	B12	74.1	0.12	5	17.7	+2
13	B13	10537.9	16.46	296	15.8	0
14	B14	9270.3	14.48	--	--	--
15A	B15A	5116.7	7.99	559	17.7	-1
15B	B15B	8640.6	13.50	--	--	--
16A	B16A	1064.4	1.66	0	17.1	0
16B	B16B	2448.8	3.83	0	18.4	0
20A	B20A	1138.6	1.78	0	9.5	0
17	B17	1650.5	2.58	63	16.5	-7
18	B18	2294.9	3.58	100	15.1	+3
20B	B20B	2341.8	3.66	62	16.6	+3
21A	B21A	3540.4	5.53	0	16.7	0
21B	B21B	5056.2	7.90	0	17.1	0
22	B22	7375.2	11.52	371	16.7	-32
23	B23	4206.9	6.57	230	16.7	0
24	B24	5282.0	8.25	292	17.3	+3
25A	B25A	205.8	0.32	13	15.6	+2
25B	B25B	972.1	1.52	40	14.9	-13
26	B26	376.1	0.59	21	13.5	0
27	B27	830.7	1.30	45	13.2	0
28	B28	223.4	0.35	11	13.7	-1
29A	B29A	1578.1	2.46	89	13.9	+3
29B	B29B	440.3	0.69	26	16.4	+2
30	B30	1153.0	1.80	61	13.2	-2
31	B31	1467.8	2.29	75	12.7	-5
32	B32	1812.7	2.83	99	12.5	0
33	B33	2323.9	3.63	128	12.8	+1
34	B34	711.3	1.11	35	16.4	-4
35	B35	172.9	0.27	9	10.7	0
36	B36	603.3	0.94	36	13.0	+3
37	B37	390.2	0.61	18	16.1	-3
38	B38	1955.2	3.05	0	16.6	0

-- did not contribute to the Basin Rule evaluation or not applicable

Table 3-2b
Summary of Peak Stage Simulation Results for Alternative A0

Sub-Basin		Area		100-yr, 72-hr Peak Values		Deviation of Peak Stage from Existing Rule (ft-NGVD)
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Stage (ft-NGVD)	
1	B1	1164.3	1.82	48	14.2	-4.0
2A	STA-1E	6715.8	10.49	--	--	--
2B	B2B	1226.4	1.92	50	13.8	-3.4
3	B3	579.4	0.91	26	15.8	-2.5
4	B4	540.0	0.84	29	16.6	-1.7
5	B5	1142.5	1.78	80	17.4	-1.3
6	B6	673.5	1.05	67	19.2	-1.8
7	B7	4126.9	6.45	226	19.9	-1.1
8	B8	3966.8	6.20	418	20.6	-1.4
9	B9	72.8	0.11	38	17.6	-3.4
10	B10	208.0	0.32	17	18.3	-1.8
11	B11	8138.3	12.71	1424	18.9	-2.1
12	B12	74.1	0.12	52	17.5	-2.7
13	B13	10537.9	16.46	406	16.6	-0.9
14	B14	9270.3	14.48	--	--	--
15A	B15A	5116.7	7.99	1000	18.2	-0.8
15B	B15B	8640.6	13.50	--	--	--
16A	B16A	1064.4	1.66	508	16.8	-1.3
16B	B16B	2448.8	3.83	58	19.0	-0.1
20A	B20A	1138.6	1.78	126	16.1	-2.0
17	B17	1650.5	2.58	534	16.6	-1.4
18	B18	2294.9	3.58	431	15.7	-2.2
20B	B20B	2341.8	3.66	750	16.8	-1.5
21A	B21A	3540.4	5.53	0	17.3	-2.5
21B	B21B	5056.2	7.90	143	17.7	-2.1
22	B22	7375.2	11.52	527	17.5	-1.5
23	B23	4206.9	6.57	849	17.1	-2.0
24	B24	5282.0	8.25	602	17.9	-1.4
25A	B25A	205.8	0.32	449	14.6	-2.0
25B	B25B	972.1	1.52	391	14.7	-1.9
26	B26	376.1	0.59	320	13.8	-2.1
27	B27	830.7	1.30	320	13.2	-2.4
28	B28	223.4	0.35	428	12.3	-3.3
29A	B29A	1578.1	2.46	474	14.8	-0.8
29B	B29B	440.3	0.69	830	15.2	-0.4
30	B30	1153.0	1.80	268	14.1	-2.3
31	B31	1467.8	2.29	670	13.1	-2.1
32	B32	1812.7	2.83	527	13.0	-2.3
33	B33	2323.9	3.63	546	13.6	-1.7
34	B34	711.3	1.11	169	17.0	-3.0
35	B35	172.9	0.27	45	11.3	-4.3
36	B36	603.3	0.94	158	14.0	-1.7
37	B37	390.2	0.61	108	16.4	-3.6
38	B38	1955.2	3.05	151	17.2	-1.6

-- did not contribute to the Basin Rule evaluation or not applicable

3.2 ALTERNATIVE A1: UNRESTRICTED FLOW SIMULATION

3.2.1 Description of Alternative

This alternative simulates the 10-year, 72-hour and 100-year, 72-hour design storm events that involve generating the hydrologic conditions for each sub-basin under the unrestricted discharge condition with the federal projects in operational condition. The peak discharges and the peak stages were computed for the 10-year, 72-hour and the 100-year, 72-hour design storm events. The federal projects for this alternative include: STA-1E, S-319, S-361, S-362, and S-155A. These structures are all located in the C-51 west, and there is no change considered to the C-51 east. This alternative considers unrestricted flow through the control structures for each sub-basin except for sub-basin 15B. In addition, sub-basin 14 (ACME Basin B) is not considered as a part of the C-51 West, and is modeled to discharge to the WCA as described in TM #2.

The link-node diagram for this alternative is shown on Figure 3-1 for the C-51 basin. Figure 3-1 also represents a geographically based nodal diagram for this alternative. The details on the model simulation for the C-51 basin are presented below.

3.2.2 Peak Discharge Simulation for Alternative A1

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 3-1. The only exceptions were the sub-basins 14 and 15B as described above in Section 3.2.1. The peak discharge simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 3-3a that presents a summary of the simulated peak flow and peak stage for each sub-basin for the design storm event (10-year, 72-hour storm). Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 3.5 of this report.

3.2.3 Peak Stage Simulation for Alternative A1

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 3-1. The only exceptions were the sub-basins 14 and 15B as described above in Section 3.2.1. The peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 3-3b that presents a summary of the simulated peak flow and peak stage for each sub-basin for this design storm event (100-year, 72-hour storm). Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 3.5 of this report.

Table 3-3a
Summary of Peak Discharge Simulation Results for Alternative A1

Sub-Basin		Area		10-yr, 72-hr Peak Values		10-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 1400	13.4	09-04-03 0300
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 2200	13.1	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 1800	15.0	09-04-03 0300
4	B4	540.0	0.84	29	09-02-03 0500	15.8	09-04-03 0300
5	B5	1142.5	1.78	53	09-03-03 2100	16.6	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1800	18.6	09-03-03 2200
7	B7	4126.9	6.45	151	09-04-03 0800	19.2	09-04-03 0800
8	B8	3966.8	6.20	260	09-04-03 0400	19.9	09-04-03 0400
9	B9	72.8	0.11	9	09-03-03 2000	17.1	09-03-03 2000
10	B10	208.0	0.32	3	09-04-03 0400	17.8	09-04-03 0400
11	B11	8138.3	12.71	1360	09-04-03 0000	18.1	09-04-03 0200
12	B12	74.1	0.12	35	09-03-03 1500	16.7	09-03-03 1500
13	B13	10537.9	16.46	406	09-02-03 0300	15.7	09-04-03 0800
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	826	09-04-03 0300	17.5	09-04-03 0300
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	384	09-03-03 1900	16.0	09-03-03 1900
16B	B16B	2448.8	3.83	26	09-04-03 1800	18.4	09-04-03 1900
20A	B20A	1138.6	1.78	131	09-03-03 1500	15.4	09-04-03 1200
17	B17	1650.5	2.58	384	09-03-03 2000	15.8	09-03-03 2000
18	B18	2294.9	3.58	322	09-03-03 2200	14.7	09-03-03 2300
20B	B20B	2341.8	3.66	535	09-03-03 2100	16.1	09-03-03 2100
21A	B21A	3540.4	5.53	0	--	16.7	09-04-03 2100
21B	B21B	5056.2	7.90	111	09-04-03 0000	17.0	09-04-03 0900
22	B22	7375.2	11.52	371	09-04-03 0700	16.7	09-04-03 0700
23	B23	4206.9	6.57	675	09-03-03 2300	16.3	09-03-03 2300
24	B24	5282.0	8.25	452	09-04-03 0400	17.1	09-04-03 0400
25A	B25A	205.8	0.32	370	09-03-03 1600	13.8	09-03-03 1600
25B	B25B	972.1	1.52	344	09-03-03 1900	14.0	09-03-03 1600
26	B26	376.1	0.59	107	09-03-03 1400	13.1	09-03-03 1700
27	B27	830.7	1.30	320	09-03-03 1400	12.0	09-03-03 1800
28	B28	223.4	0.35	270	09-03-03 1400	11.6	09-03-03 1400
29A	B29A	1578.1	2.46	309	09-03-03 1900	13.8	09-03-03 1900
29B	B29B	440.3	0.69	628	09-03-03 1400	14.5	09-03-03 1400
30	B30	1153.0	1.80	123	09-03-03 2200	13.0	09-03-03 2200
31	B31	1467.8	2.29	333	09-03-03 1800	12.3	09-03-03 1800
32	B32	1812.7	2.83	278	09-03-03 2200	12.2	09-03-03 2200
33	B33	2323.9	3.63	272	09-03-03 2300	12.6	09-03-03 2300
34	B34	711.3	1.11	137	09-03-03 1800	15.7	09-03-03 2000
35	B35	172.9	0.27	45	09-03-03 1500	10.5	09-03-03 1600
36	B36	603.3	0.94	79	09-03-03 2100	12.7	09-03-03 2100
37	B37	390.2	0.61	93	09-04-03 0900	15.7	09-03-03 1800
38	B38	1955.2	3.05	145	09-04-03 0100	16.2	09-04-03 0200

-- did not contribute to the Basin Rule evaluation or not applicable

Table 3-3b
Summary of Peak Stage Simulation Results for Alternative A1

Sub-Basin		Area		100-yr, 72-hr Peak Values		100-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 0700	14.2	09-04-03 0400
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 1500	13.8	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 0600	15.8	09-04-03 0300
4	B4	540.0	0.84	29	09-01-03 2000	16.6	09-04-03 0400
5	B5	1142.5	1.78	80	09-04-03 0400	17.4	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1200	19.2	09-04-03 0100
7	B7	4126.9	6.45	226	09-04-03 0700	19.9	09-04-03 0800
8	B8	3966.8	6.20	418	09-04-03 0400	20.6	09-04-03 0400
9	B9	72.8	0.11	38	09-03-03 1500	17.6	09-03-03 1500
10	B10	208.0	0.32	17	09-04-03 0200	18.3	09-04-03 0200
11	B11	8138.3	12.71	1424	09-03-03 1900	18.9	09-04-03 0500
12	B12	74.1	0.12	52	09-03-03 1500	17.5	09-03-03 1500
13	B13	10537.9	16.46	406	09-01-03 1900	16.6	09-04-03 1000
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	1000	09-04-03 0500	18.2	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	508	09-03-03 1900	16.8	09-03-03 1900
16B	B16B	2448.8	3.83	58	09-04-03 1700	19.0	09-04-03 1700
20A	B20A	1138.6	1.78	126	09-03-03 1300	16.1	09-04-03 2300
17	B17	1650.5	2.58	534	09-03-03 2100	16.6	09-03-03 2100
18	B18	2294.9	3.58	431	09-03-03 2000	15.7	09-04-03 0000
20B	B20B	2341.8	3.66	750	09-03-03 1900	16.8	09-03-03 2300
21A	B21A	3540.4	5.53	0	--	17.3	09-04-03 2200
21B	B21B	5056.2	7.90	143	09-03-03 1900	17.7	09-04-03 1100
22	B22	7375.2	11.52	527	09-04-03 0700	17.5	09-04-03 0700
23	B23	4206.9	6.57	849	09-04-03 0100	17.1	09-04-03 0100
24	B24	5282.0	8.25	602	09-04-03 0500	17.9	09-04-03 0500
25A	B25A	205.8	0.32	449	09-03-03 1700	14.6	09-03-03 1700
25B	B25B	972.1	1.52	391	09-03-03 1900	14.7	09-03-03 1700
26	B26	376.1	0.59	320	09-03-03 1600	13.8	09-03-03 1600
27	B27	830.7	1.30	320	09-03-03 1300	13.2	09-03-03 2000
28	B28	223.4	0.35	428	09-03-03 1400	12.3	09-03-03 1400
29A	B29A	1578.1	2.46	474	09-03-03 1900	14.8	09-03-03 1900
29B	B29B	440.3	0.69	830	09-03-03 1400	15.2	09-03-03 1400
30	B30	1153.0	1.80	268	09-03-03 2000	14.1	09-03-03 2000
31	B31	1467.8	2.29	670	09-03-03 1700	13.1	09-03-03 1700
32	B32	1812.7	2.83	527	09-03-03 2100	13.0	09-03-03 2100
33	B33	2323.9	3.63	546	09-03-03 2100	13.6	09-03-03 2100
34	B34	711.3	1.11	169	09-04-03 0400	17.0	09-03-03 2200
35	B35	172.9	0.27	45	09-03-03 1300	11.3	09-03-03 1700
36	B36	603.3	0.94	158	09-03-03 2000	14.0	09-03-03 2000
37	B37	390.2	0.61	108	09-03-03 2200	16.4	09-03-03 1900
38	B38	1955.2	3.05	151	09-04-03 1700	17.2	09-04-03 0300

-- did not contribute to the Basin Rule evaluation or not applicable

3.3 ALTERNATIVE A2: USACE DESIGN MANNING'S N SIMULATION

3.3.1 Description of Alternative

This alternative is identical to Alternative A1 with the only exception being the use of different Manning's n coefficients along the C-51 canal in the C-51 West basin. A Manning's n coefficient of 0.03 was used for the segment of the C-51 canal in the C-51 West basin. This was the design value used by the USACE for design of the C-51 canal improvements. The primary purpose of this alternative was to generate comparative information on the head difference between the headwater at S-155A and the pump station S-319 along the C-51 canal resulting from a change in Manning's n.

3.3.2 Peak Discharge Simulation for Alternative A2

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system similar to the Alternative A1 as described in Section 3.2.2.

Similar to the Alternative A1, the peak discharge simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 3-4a that presents a summary of the simulated peak discharge and peak stage for each sub-basin for the design storm event. Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 3.5 of this report.

3.3.3 Peak Stage Simulation for Alternative A2

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system similar to the Alternative A1 as described in Section 3.2.3.

Similar to the Alternative A1, the peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 3-4b that presents a summary of the simulated peak flow and peak stage for each sub-basin for the design storm event (100-year, 72-hour storm). Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 3.5 of this report.

Table 3-4a
Summary of Peak Discharge Simulation Results for Alternative A2

Sub-Basin		Area		10-yr, 72-hr Peak Values		10-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 1400	13.4	09-04-03 0300
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 2200	13.1	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 1800	15.0	09-04-03 0300
4	B4	540.0	0.84	29	09-02-03 0500	15.8	09-04-03 0300
5	B5	1142.5	1.78	52	09-03-03 1900	16.6	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1800	18.6	09-03-03 2200
7	B7	4126.9	6.45	151	09-04-03 0800	19.2	09-04-03 0800
8	B8	3966.8	6.20	260	09-04-03 0400	19.9	09-04-03 0400
9	B9	72.8	0.11	9	09-03-03 2000	17.1	09-03-03 2000
10	B10	208.0	0.32	3	09-04-03 0400	17.8	09-04-03 0400
11	B11	8138.3	12.71	1357	09-03-03 2300	18.1	09-04-03 0200
12	B12	74.1	0.12	35	09-03-03 1500	16.7	09-03-03 1500
13	B13	10537.9	16.46	406	09-02-03 0300	15.7	09-04-03 0800
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	827	09-04-03 0300	17.5	09-04-03 0300
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	384	09-03-03 1900	16.0	09-03-03 1900
16B	B16B	2448.8	3.83	26	09-04-03 1800	18.4	09-04-03 1900
20A	B20A	1138.6	1.78	126	09-03-03 1500	15.3	09-04-03 0900
17	B17	1650.5	2.58	384	09-03-03 2000	15.8	09-03-03 2000
18	B18	2294.9	3.58	322	09-03-03 2200	14.7	09-03-03 2300
20B	B20B	2341.8	3.66	535	09-03-03 2100	16.1	09-03-03 2100
21A	B21A	3540.4	5.53	0	--	16.7	09-04-03 2100
21B	B21B	5056.2	7.90	111	09-04-03 0000	17.0	09-04-03 0900
22	B22	7375.2	11.52	371	09-04-03 0700	16.7	09-04-03 0700
23	B23	4206.9	6.57	675	09-03-03 2300	16.3	09-03-03 2300
24	B24	5282.0	8.25	452	09-04-03 0400	17.1	09-04-03 0400
25A	B25A	205.8	0.32	370	09-03-03 1600	13.8	09-03-03 1600
25B	B25B	972.1	1.52	344	09-03-03 1900	14.0	09-03-03 1600
26	B26	376.1	0.59	107	09-03-03 1400	13.1	09-03-03 1700
27	B27	830.7	1.30	320	09-03-03 1400	12.0	09-03-03 1800
28	B28	223.4	0.35	270	09-03-03 1400	11.6	09-03-03 1400
29A	B29A	1578.1	2.46	309	09-03-03 1900	13.8	09-03-03 1800
29B	B29B	440.3	0.69	626	09-03-03 1400	14.5	09-03-03 1400
30	B30	1153.0	1.80	123	09-03-03 2200	13.0	09-03-03 2200
31	B31	1467.8	2.29	333	09-03-03 1800	12.3	09-03-03 1800
32	B32	1812.7	2.83	279	09-03-03 2200	12.2	09-03-03 2200
33	B33	2323.9	3.63	272	09-03-03 2300	12.6	09-03-03 2300
34	B34	711.3	1.11	136	09-03-03 1700	15.7	09-03-03 2000
35	B35	172.9	0.27	45	09-03-03 1500	10.5	09-03-03 1600
36	B36	603.3	0.94	79	09-04-03 0500	12.7	09-03-03 2100
37	B37	390.2	0.61	94	09-04-03 0900	15.7	09-03-03 1800
38	B38	1955.2	3.05	145	09-04-03 0100	16.2	09-04-03 0200

-- did not contribute to the Basin Rule evaluation or not applicable

Table 3-4b
Summary of Peak Stage Simulation Results for Alternative A2

Sub-Basin		Area		100-yr, 72-hr Peak Values		100-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 0700	14.2	09-04-03 0400
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 1500	13.8	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 0600	15.8	09-04-03 0300
4	B4	540.0	0.84	29	09-01-03 2000	16.6	09-04-03 0400
5	B5	1142.5	1.78	80	09-04-03 0300	17.4	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1200	19.2	09-04-03 0100
7	B7	4126.9	6.45	226	09-04-03 0700	19.9	09-04-03 0800
8	B8	3966.8	6.20	418	09-04-03 0400	20.6	09-04-03 0400
9	B9	72.8	0.11	38	09-03-03 1500	17.6	09-03-03 1500
10	B10	208.0	0.32	17	09-04-03 0200	18.3	09-04-03 0200
11	B11	8138.3	12.71	1425	09-03-03 1900	18.9	09-04-03 0500
12	B12	74.1	0.12	52	09-03-03 1500	17.5	09-03-03 1500
13	B13	10537.9	16.46	406	09-01-03 1900	16.6	09-04-03 1000
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	1013	09-04-03 0500	18.2	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	508	09-03-03 1900	16.8	09-03-03 1900
16B	B16B	2448.8	3.83	58	09-04-03 1700	19.0	09-04-03 1700
20A	B20A	1138.6	1.78	146	09-03-03 1400	16.1	09-04-03 1900
17	B17	1650.5	2.58	534	09-03-03 2100	16.6	09-03-03 2100
18	B18	2294.9	3.58	431	09-03-03 2000	15.7	09-03-03 2400
20B	B20B	2341.8	3.66	750	09-03-03 1900	16.8	09-03-03 2300
21A	B21A	3540.4	5.53	0	--	17.3	09-04-03 2200
21B	B21B	5056.2	7.90	143	09-03-03 1900	17.7	09-04-03 1100
22	B22	7375.2	11.52	527	09-04-03 0700	17.5	09-04-03 0700
23	B23	4206.9	6.57	849	09-04-03 0100	17.1	09-04-03 0100
24	B24	5282.0	8.25	602	09-04-03 0500	17.9	09-04-03 0500
25A	B25A	205.8	0.32	449	09-03-03 1700	14.6	09-03-03 1700
25B	B25B	972.1	1.52	391	09-03-03 1900	14.7	09-03-03 1700
26	B26	376.1	0.59	320	09-03-03 1600	13.8	09-03-03 1600
27	B27	830.7	1.30	320	09-03-03 1300	13.2	09-03-03 2000
28	B28	223.4	0.35	428	09-03-03 1400	12.3	09-03-03 1400
29A	B29A	1578.1	2.46	474	09-03-03 1900	14.8	09-03-03 1900
29B	B29B	440.3	0.69	828	09-03-03 1400	15.2	09-03-03 1400
30	B30	1153.0	1.80	268	09-03-03 2000	14.1	09-03-03 2000
31	B31	1467.8	2.29	670	09-03-03 1700	13.1	09-03-03 1700
32	B32	1812.7	2.83	527	09-03-03 2100	13.0	09-03-03 2100
33	B33	2323.9	3.63	546	09-03-03 2100	13.6	09-03-03 2100
34	B34	711.3	1.11	173	09-04-03 0300	17.0	09-03-03 2200
35	B35	172.9	0.27	45	09-03-03 1300	11.3	09-03-03 1700
36	B36	603.3	0.94	158	09-03-03 2000	14.0	09-03-03 2000
37	B37	390.2	0.61	109	09-03-03 1900	16.3	09-03-03 2100
38	B38	1955.2	3.05	151	09-04-03 1700	17.2	09-04-03 0300

-- did not contribute to the Basin Rule evaluation or not applicable

3.4 ALTERNATIVE A3: USACE DESIGN FLOW SIMULATION

3.4.1 Description of Alternative

The purpose of this alternative is to simulate the design scenario that USACE used to design the STA-1E. USACE assumed that most of the sub-basins in the C-51 West will have one inch of allowable peak discharge resulting from a 10-year, 72-hour storm event, except for sub-basins 8, 11, and 15A. The sub-basins in the C-51 East were not considered a part of the design process for the 10-year, 72-hour design storm event as they do not contribute flows to the S-319 pump station. This scenario assumes that there will be unrestricted flow from the sub-basins to the primary conveyance system in the C-51 East basin. Table 3-5 summarizes the design discharges that were considered by the USACE for the C-51 West basin. This table also includes the peak discharges that were considered for all sub-basins during simulation of this alternative. The peak stage simulation corresponding to the 100-year, 72-hour storm event is identical to the conditions of Alternative 1.

3.4.2 Peak Discharge Simulation for Alternative A3

The RAS model was applied for this case with restricted flow through the control structures from each sub-basin in C-51 West discharging to the corresponding canal system. Table 3-5 documents the flow restrictions for this alternative. The flow restrictions were achieved by adjusting the control structure specifications, e.g., restricting the dimensions and raising the crest elevations of the controlling structures.

Similar to other alternatives, the peak discharge simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The simulated peak discharge values for the sub-basins are presented in Table 3-5 for a direct comparison of the simulated peak discharge against the USACE design discharge values. The simulated results for this alternative are summarized in Table 3-6a that presents a summary of the simulated peak discharge and peak stage for each sub-basin for the design storm event. Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 3.5 of this report.

3.4.3 Peak Stage Simulation for Alternative A3

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system similar to the Alternative A1 as described in Section 3.2.3.

Similar to the Alternative A1, the peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 3-6b that presents a summary of the simulated peak flow and peak stage for each sub-basin for the design storm event (100-year, 72-hour storm). Further discussion along with a comparison of this alternative with the baseline condition and

Table 3-5
Summary of Design Discharge Conditions Used for Alternative A3

Sub-Basin		Area		USACE Allowable Design Discharge (10-yr, 72-hr)		Simulated Discharge
ID	Other ID	(acre)	(sq mi)	(CSM)	(cfs)	(cfs)
1	B1	1164.3	1.82	27	49	49
2A	STA1E	6715.8	10.49	--	--	--
2B	B2B	1226.4	1.92	27	52	52
3	B3	579.4	0.91	27	24	24
4	B4	540.0	0.84	27	23	23
5	B5	1142.5	1.78	27	48	49
6	B6	673.5	1.05	27	28	28
7	B7	4126.9	6.45	27	174	166
8	B8	3966.8	6.20	54	335	333
9	B9	72.8	0.11	27	3	7
10	B10	208.0	0.32	27	9	9
11	B11	8138.3	12.71	81	1030	1027
12	B12	74.1	0.12	27	3	3
13	B13	10537.9	16.46	27	445	445
14	B14	9270.3	14.48	--	--	--
15A	B15A	5116.7	7.99	70	560	579
15B	B15B	8640.6	13.50	--	--	--
16A	B16A	1064.4	1.66	27	45	45
16B	B16B	2448.8	3.83	27	103	103
20A	B20A	1138.6	1.78	27	48	53
17	B17	1650.5	2.58	Unrestricted	Unrestricted	384
18	B18	2294.9	3.58	Unrestricted	Unrestricted	322
20B	B20B	2341.8	3.66	Unrestricted	Unrestricted	535
21A	B21A	3540.4	5.53	Unrestricted	Unrestricted	0
21B	B21B	5056.2	7.90	Unrestricted	Unrestricted	111
22	B22	7375.2	11.52	Unrestricted	Unrestricted	371
23	B23	4206.9	6.57	Unrestricted	Unrestricted	675
24	B24	5282.0	8.25	Unrestricted	Unrestricted	452
25A	B25A	205.8	0.32	Unrestricted	Unrestricted	369
25B	B25B	972.1	1.52	Unrestricted	Unrestricted	329
26	B26	376.1	0.59	Unrestricted	Unrestricted	107
27	B27	830.7	1.30	Unrestricted	Unrestricted	320
28	B28	223.4	0.35	Unrestricted	Unrestricted	266
29A	B29A	1578.1	2.46	Unrestricted	Unrestricted	309
29B	B29B	440.3	0.69	Unrestricted	Unrestricted	626
30	B30	1153.0	1.80	Unrestricted	Unrestricted	123
31	B31	1467.8	2.29	Unrestricted	Unrestricted	333
32	B32	1812.7	2.83	Unrestricted	Unrestricted	278
33	B33	2323.9	3.63	Unrestricted	Unrestricted	272
34	B34	711.3	1.11	Unrestricted	Unrestricted	128
35	B35	172.9	0.27	Unrestricted	Unrestricted	45
36	B36	603.3	0.94	Unrestricted	Unrestricted	94
37	B37	390.2	0.61	Unrestricted	Unrestricted	85
38	B38	1955.2	3.05	Unrestricted	Unrestricted	145

-- did not contribute to the Basin Rule evaluation or not applicable

Table 3-6a
Summary of Peak Discharge Simulation Results for Alternative A3

Sub-Basin		Area		10-yr, 72-hr Peak Values		10-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	49	09-03-03 1400	13.4	09-04-03 0300
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	52	09-01-03 2200	13.1	09-04-03 0200
3	B3	579.4	0.91	24	09-02-03 1800	15.0	09-04-03 0300
4	B4	540.0	0.84	23	09-02-03 0500	15.9	09-04-03 0300
5	B5	1142.5	1.78	49	09-04-03 2300	16.6	09-04-03 0300
6	B6	673.5	1.05	28	09-01-03 1800	18.8	09-04-03 0200
7	B7	4126.9	6.45	166	09-04-03 0800	19.2	09-04-03 0700
8	B8	3966.8	6.20	333	09-04-03 0300	19.8	09-04-03 0300
9	B9	72.8	0.11	7	09-03-03 2100	17.2	09-03-03 2100
10	B10	208.0	0.32	9	09-04-03 0300	17.7	09-04-03 0300
11	B11	8138.3	12.71	1027	09-04-03 0300	18.3	09-04-03 0300
12	B12	74.1	0.12	3	09-04-03 0100	17.7	09-04-03 0100
13	B13	10537.9	16.46	445	09-02-03 0300	15.7	09-04-03 0800
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	579	09-04-03 0500	17.7	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	45	09-04-03 0400	17.1	09-04-03 0400
16B	B16B	2448.8	3.83	103	09-04-03 1200	18.2	09-04-03 1200
20A	B20A	1138.6	1.78	50	09-04-03 1400	15.5	09-04-03 0300
17	B17	1650.5	2.58	384	09-03-03 2000	15.8	09-03-03 2000
18	B18	2294.9	3.58	323	09-03-03 2200	14.7	09-03-03 2300
20B	B20B	2341.8	3.66	535	09-03-03 2100	16.1	09-03-03 2100
21A	B21A	3540.4	5.53	0	--	16.7	09-04-03 2100
21B	B21B	5056.2	7.90	111	09-04-03 0000	17.0	09-04-03 0900
22	B22	7375.2	11.52	371	09-04-03 0700	16.7	09-04-03 0700
23	B23	4206.9	6.57	675	09-03-03 2300	16.3	09-03-03 2300
24	B24	5282.0	8.25	452	09-04-03 0400	17.1	09-04-03 0400
25A	B25A	205.8	0.32	369	09-03-03 1600	13.8	09-03-03 1600
25B	B25B	972.1	1.52	330	09-03-03 1900	13.9	09-03-03 1600
26	B26	376.1	0.59	107	09-03-03 1400	13.1	09-03-03 1700
27	B27	830.7	1.30	320	09-03-03 1400	12.0	09-03-03 1800
28	B28	223.4	0.35	267	09-03-03 1400	11.6	09-03-03 1400
29A	B29A	1578.1	2.46	309	09-03-03 1900	13.8	09-03-03 1800
29B	B29B	440.3	0.69	628	09-03-03 1400	14.5	09-03-03 1400
30	B30	1153.0	1.80	123	09-03-03 2200	13.0	09-03-03 2200
31	B31	1467.8	2.29	333	09-03-03 1800	12.3	09-03-03 1800
32	B32	1812.7	2.83	278	09-03-03 2200	12.2	09-03-03 2200
33	B33	2323.9	3.63	272	09-03-03 2300	12.6	09-03-03 2300
34	B34	711.3	1.11	128	09-04-03 0500	15.7	09-03-03 2100
35	B35	172.9	0.27	45	09-03-03 1500	10.5	09-03-03 1600
36	B36	603.3	0.94	94	09-03-03 1900	12.7	09-03-03 1900
37	B37	390.2	0.61	85	09-04-03 0100	15.7	09-03-03 1800
38	B38	1955.2	3.05	145	09-04-03 0100	16.2	09-04-03 0200

-- did not contribute to the Basin Rule evaluation or not applicable

Table 3-6b
Summary of Peak Stage Simulation Results for Alternative A3

Sub-Basin		Area		100-yr, 72-hr Peak Values		100-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 0700	14.2	09-04-03 0400
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 1500	13.8	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 0600	15.8	09-04-03 0300
4	B4	540.0	0.84	29	09-01-03 2000	16.6	09-04-03 0400
5	B5	1142.5	1.78	80	09-04-03 0400	17.4	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1200	19.2	09-04-03 0100
7	B7	4126.9	6.45	226	09-04-03 0700	19.9	09-04-03 0800
8	B8	3966.8	6.20	418	09-04-03 0400	20.6	09-04-03 0400
9	B9	72.8	0.11	38	09-03-03 1500	17.6	09-03-03 1500
10	B10	208.0	0.32	17	09-04-03 0200	18.3	09-04-03 0200
11	B11	8138.3	12.71	1424	09-03-03 1900	18.9	09-04-03 0500
12	B12	74.1	0.12	52	09-03-03 1500	17.5	09-03-03 1500
13	B13	10537.9	16.46	406	09-01-03 1900	16.6	09-04-03 1000
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	1000	09-04-03 0500	18.2	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	508	09-03-03 1900	16.8	09-03-03 1900
16B	B16B	2448.8	3.83	58	09-04-03 1700	19.0	09-04-03 1700
20A	B20A	1138.6	1.78	126	09-03-03 1300	16.1	09-04-03 2300
17	B17	1650.5	2.58	534	09-03-03 2100	16.6	09-03-03 2100
18	B18	2294.9	3.58	431	09-03-03 2000	15.7	09-04-03 0000
20B	B20B	2341.8	3.66	750	09-03-03 1900	16.8	09-03-03 2300
21A	B21A	3540.4	5.53	0	--	17.3	09-04-03 2200
21B	B21B	5056.2	7.90	143	09-03-03 1900	17.7	09-04-03 1100
22	B22	7375.2	11.52	527	09-04-03 0700	17.5	09-04-03 0700
23	B23	4206.9	6.57	849	09-04-03 0100	17.1	09-04-03 0100
24	B24	5282.0	8.25	602	09-04-03 0500	17.9	09-04-03 0500
25A	B25A	205.8	0.32	449	09-03-03 1700	14.6	09-03-03 1700
25B	B25B	972.1	1.52	391	09-03-03 1900	14.7	09-03-03 1700
26	B26	376.1	0.59	320	09-03-03 1600	13.8	09-03-03 1600
27	B27	830.7	1.30	320	09-03-03 1300	13.2	09-03-03 2000
28	B28	223.4	0.35	428	09-03-03 1400	12.3	09-03-03 1400
29A	B29A	1578.1	2.46	474	09-03-03 1900	14.8	09-03-03 1900
29B	B29B	440.3	0.69	830	09-03-03 1400	15.2	09-03-03 1400
30	B30	1153.0	1.80	268	09-03-03 2000	14.1	09-03-03 2000
31	B31	1467.8	2.29	670	09-03-03 1700	13.1	09-03-03 1700
32	B32	1812.7	2.83	527	09-03-03 2100	13.0	09-03-03 2100
33	B33	2323.9	3.63	546	09-03-03 2100	13.6	09-03-03 2100
34	B34	711.3	1.11	169	09-04-03 0400	17.0	09-03-03 2200
35	B35	172.9	0.27	45	09-03-03 1300	11.3	09-03-03 1700
36	B36	603.3	0.94	158	09-03-03 2000	14.0	09-03-03 2000
37	B37	390.2	0.61	108	09-03-03 2200	16.4	09-03-03 1900
38	B38	1955.2	3.05	151	09-04-03 1700	17.2	09-04-03 0300

-- did not contribute to the Basin Rule evaluation or not applicable

the other alternatives is presented in Section 3.5 of this report.

3.5 DISCUSSION ON BASIN RULE EVALUATION SIMULATIONS

This section presents a direct comparison of all the alternatives simulated for the basin rule evaluation.

3.5.1 Basin Rule Peak Discharge Simulation

Table 3-7a summarizes the simulated peak discharge for the design storm event (10-year, 72-hour) for all the basin rule alternatives. This table also presents the improvement on allowable discharge for various alternatives over the existing rule conditions (Table 3-1). As can be seen from this table, there is a significant improvement on peak discharge for each sub-basin resulting from these alternatives (Alternatives A1 through A3) over the baseline (Alternative A0) and the existing rule conditions. Intuitively, the peak discharge values for Alternatives A1 and A2 are similar since there was no difference in sub-basin conditions between the two alternatives. The difference between the two alternatives is the Manning's n coefficient along the western segment of the C-51 canal, which does not significantly impact the sub-basin discharge characteristics. Since, the flow was restricted for Alternative 3 (according to the USACE design conditions) for the sub-basins in the C-51 West, the peak discharge values in C-51 in the restricted sub-basins are obviously lower than the other two alternatives representing unrestricted flow condition, except for sub-basins where the allowable discharges for Alternative A3 are greater than those for Alternatives A1 and A2. This exception is for sub-basins 1, 2B, 7, 8, 10, 13, 16B and 36. The allowable discharge values for Alternative A3 are given in Table 3-5.

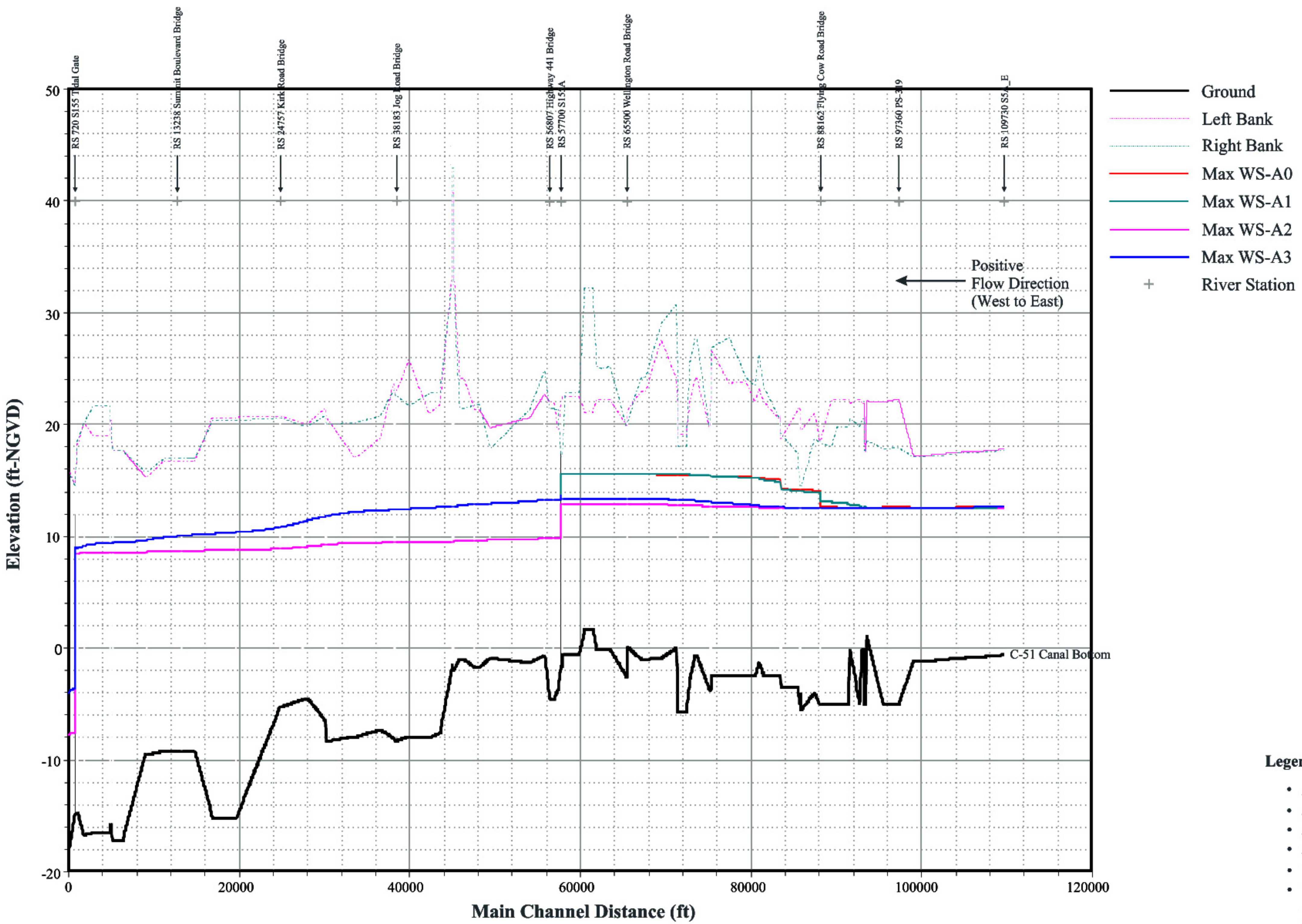
Figure 3-2a presents the simulated maximum water surface profiles along the C-51 canal for all the alternatives, including that for the baseline condition. This figure provides a direct comparison of the water surface profiles for all the alternatives along the C-51 canal. As can be seen from this figure, the baseline condition (Alternative A0) has the lowest water surface profile since it has the lowest discharge to convey through the C-51 canal, and Alternative A3 has the smoothest transition across the Structure S-155A. The data table for the Figure 3-2a is included in the Appendix C-2.

Figure 3-2b presents the simulated time-stage hydrographs at selected cross-sections along the C-51 canal west of S-155A. The hydrographs for all alternatives are plotted in the same graph for each selected cross-section. This allows for a direct comparison of the hydrographs resulting from various alternatives. The Alternatives A1 and A2 generally produced the highest stages along the C-51 canal that is consistent with the fact that these alternatives have the highest (unrestricted) discharge to the C-51 conveyance system. The maximum stage difference between the pump station 319 and the structure S-155A is approximately 4.0 feet for all the alternatives. The data table for the Figure 3-2b is included in Appendix C-2.

Table 3-7a
Comparison of Alternatives for Allowable Peak Discharge (10-year, 72-hr Storm)

Sub-Basin		Area (sq mi)	Existing Rule Flow (cfs)	Flow for Various Alternatives (cfs)				Improvement Over Existing Rule (cfs)			
ID	Other ID			A0	A1	A2	A3	A0	A1	A2	A3
1	B1	1.82	49	48	48	48	49	-1	-1	-1	0
2A	STA1E	10.49	--	--	--	--	--	--	--	--	--
2B	B2B	1.92	52	50	50	50	52	-2	-2	-2	0
3	B3	0.91	24	24	26	26	24	0	2	2	0
4	B4	0.84	23	23	29	29	23	0	6	6	0
5	B5	1.78	48	53	53	52	49	5	5	4	1
6	B6	1.05	25	25	67	67	28	0	42	42	3
7	B7	6.45	155	152	151	151	166	-3	-4	-4	11
8	B8	6.20	335	260	260	260	333	-75	-75	-75	-2
9	B9	0.11	3	5	9	9	7	2	6	6	4
10	B10	0.32	0	0	3	3	9	0	3	3	9
11	B11	12.71	343	357	1360	1357	1027	14	1017	1014	684
12	B12	0.12	3	5	35	35	3	2	32	32	0
13	B13	16.46	296	296	406	406	445	0	110	110	149
14	B14	14.48	--	--	--	--	--	--	--	--	--
15A	B15A	7.99	560	559	826	827	579	-1	266	267	19
15B	B15B	13.50	--	--	--	--	--	--	--	--	--
16A	B16A	1.66	0	0	384	384	45	0	384	384	45
16B	B16B	3.83	0	0	26	26	103	0	26	26	103
20A	B20A	1.78	0	0	131	126	50	0	131	126	50
17	B17	2.58	70	63	384	384	384	-7	314	314	314
18	B18	3.58	97	100	322	322	323	3	225	225	225
20B	B20B	3.66	59	62	535	535	535	3	476	476	476
21A	B21A	5.53	0	0	0	0	0	0	0	0	0
21B	B21B	7.90	0	0	111	111	111	0	111	111	111
22	B22	11.52	403	371	371	371	371	-32	-32	-32	-32
23	B23	6.57	230	230	675	675	675	0	445	445	445
24	B24	8.25	289	292	452	452	452	3	163	163	163
25A	B25A	0.32	11	13	370	370	369	2	359	359	358
25B	B25B	1.52	53	40	344	344	330	-13	291	291	277
26	B26	0.59	21	21	107	107	107	0	86	86	86
27	B27	1.30	45	45	320	320	320	0	275	275	275
28	B28	0.35	12	11	270	270	267	-1	258	258	255
29A	B29A	2.46	86	89	309	309	309	3	223	223	223
29B	B29B	0.69	24	26	628	626	628	2	604	602	604
30	B30	1.80	63	61	123	123	123	-2	60	60	60
31	B31	2.29	80	75	333	333	333	-5	253	253	253
32	B32	2.83	99	99	278	279	278	0	179	180	179
33	B33	3.63	127	128	272	272	272	1	145	145	145
34	B34	1.11	39	35	137	136	128	-4	98	97	89
35	B35	0.27	9	9	45	45	45	0	36	36	36
36	B36	0.94	33	36	79	79	94	3	46	46	61
37	B37	0.61	21	18	93	94	85	-3	72	73	64
38	B38	3.05	0	0	145	145	145	0	145	145	145

-- did not contribute to the Basin Rule evaluation or not applicable



Legend/Notes:

- A0 Alternative A0: Baseline (Existing Rule) Simulation
- A1 Alternative A1: Unrestricted Flow Simulation
- A2 Alternative A2: USACE Design Manning's n Simulation
- A3 Alternative A3: USACE Design Flow Simulation
- WS Water Surface
- Vertical lines represent locations of hydraulic structures (such as bridges, culverts, etc.)
- Main Channel Distance is measured from downstream end (same as River Station)

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MAXIMUM WATER SURFACE PROFILES ALONG C-51 FOR 10-YR, 72-HR STORM EVENT FOR ALTERNATIVES A0 THROUGH A3

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FIGURE 3-2A

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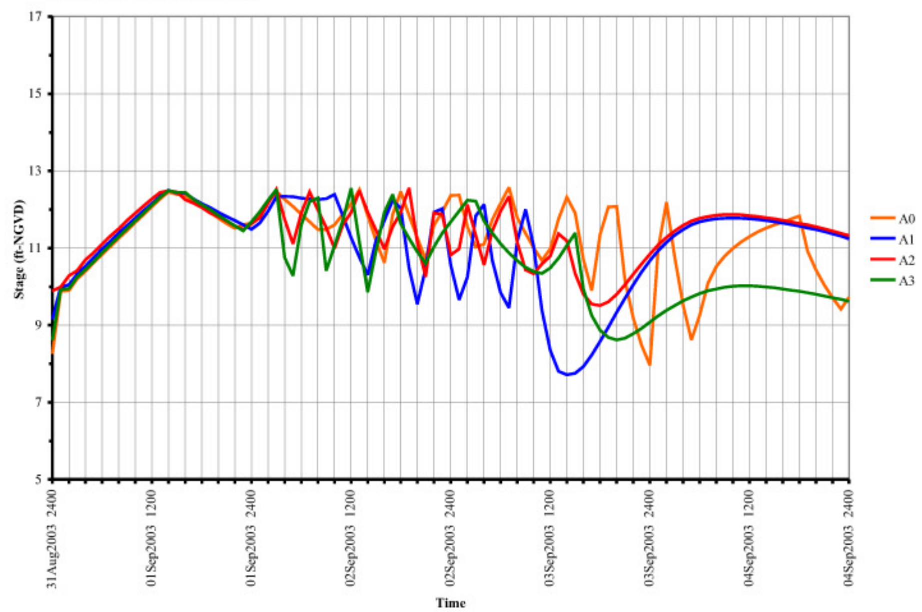
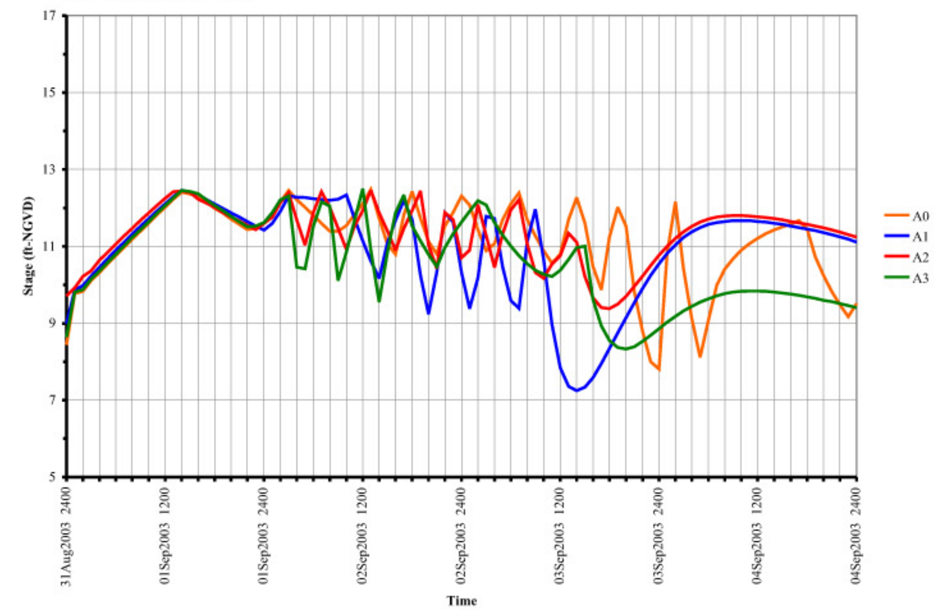
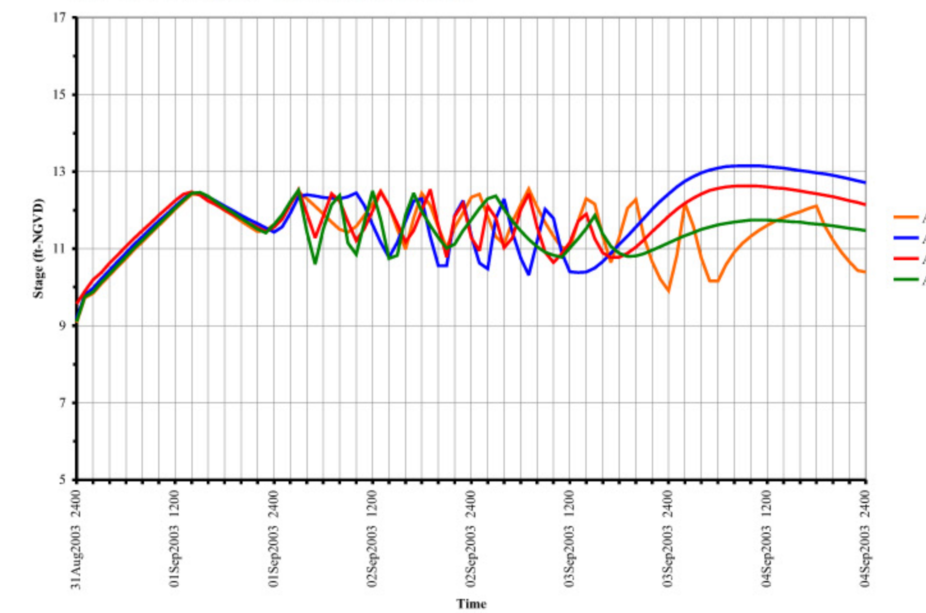
RS 109730 S5A-E



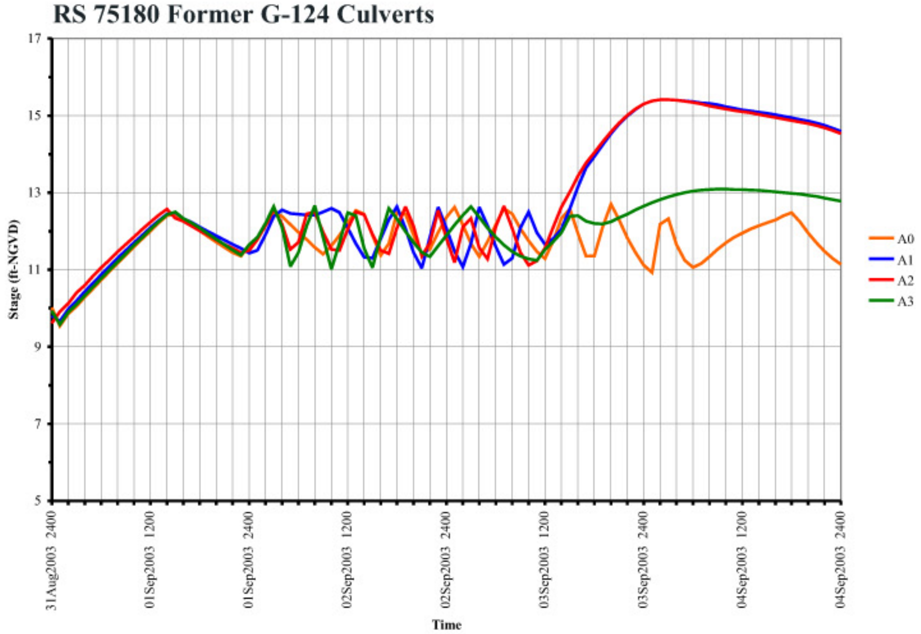
RS 97360 PS-319



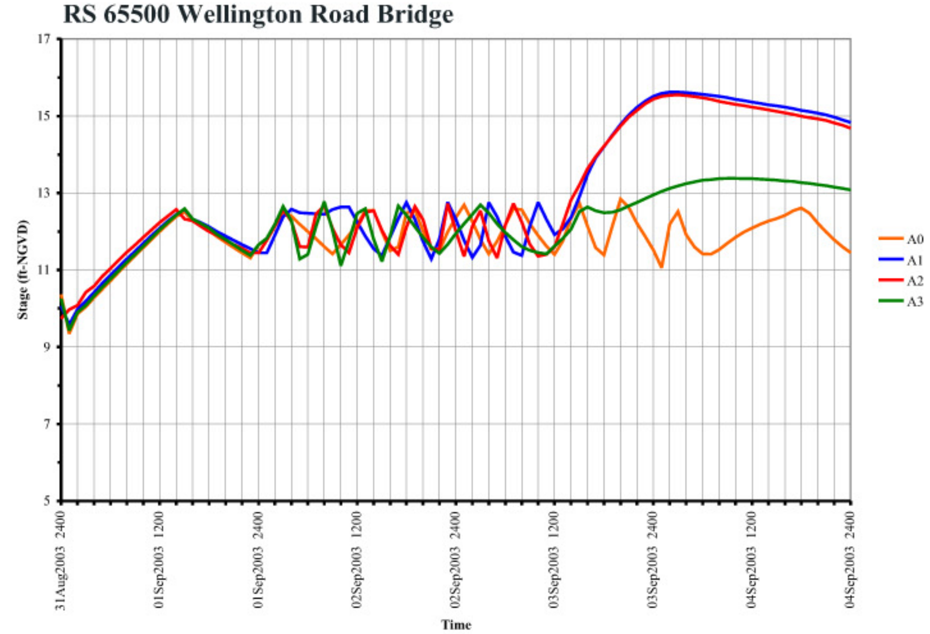
RS 88162 Flying Cow Road Bridge



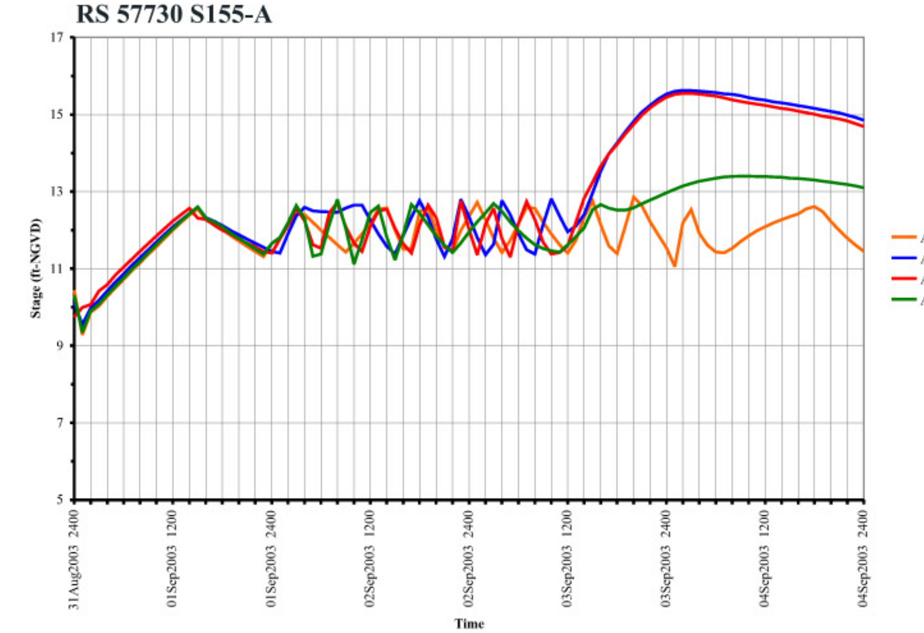
RS 75180 Former G-124 Culverts



RS 65500 Wellington Road Bridge



RS 57730 S155-A



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TIME-STAGE HYDROGRAPHS AT SELECTED LOCATIONS ALONG C-51 FOR 10-YR, 72-HR STORM EVENT FOR ALTERNATIVES A0 THROUGH A3

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 3-2B

FILE NUMBER FL02006 SHEET ___OF___

3.5.2 Basin Rule Peak Stage Simulation

Table 3-7b summarizes the simulated peak stage for this design storm event (100-year, 72-hour) for all of the alternatives. This table also presents the improvement on allowable stage for various alternatives over the existing rule conditions (Table 3-1). As can be seen from this table, there is insignificant difference in peak stage for each sub-basin amongst the Alternatives A1 through A3. However, in most cases, there is a significant improvement on peak stage for the sub-basins resulting from these alternatives over the existing rule condition.

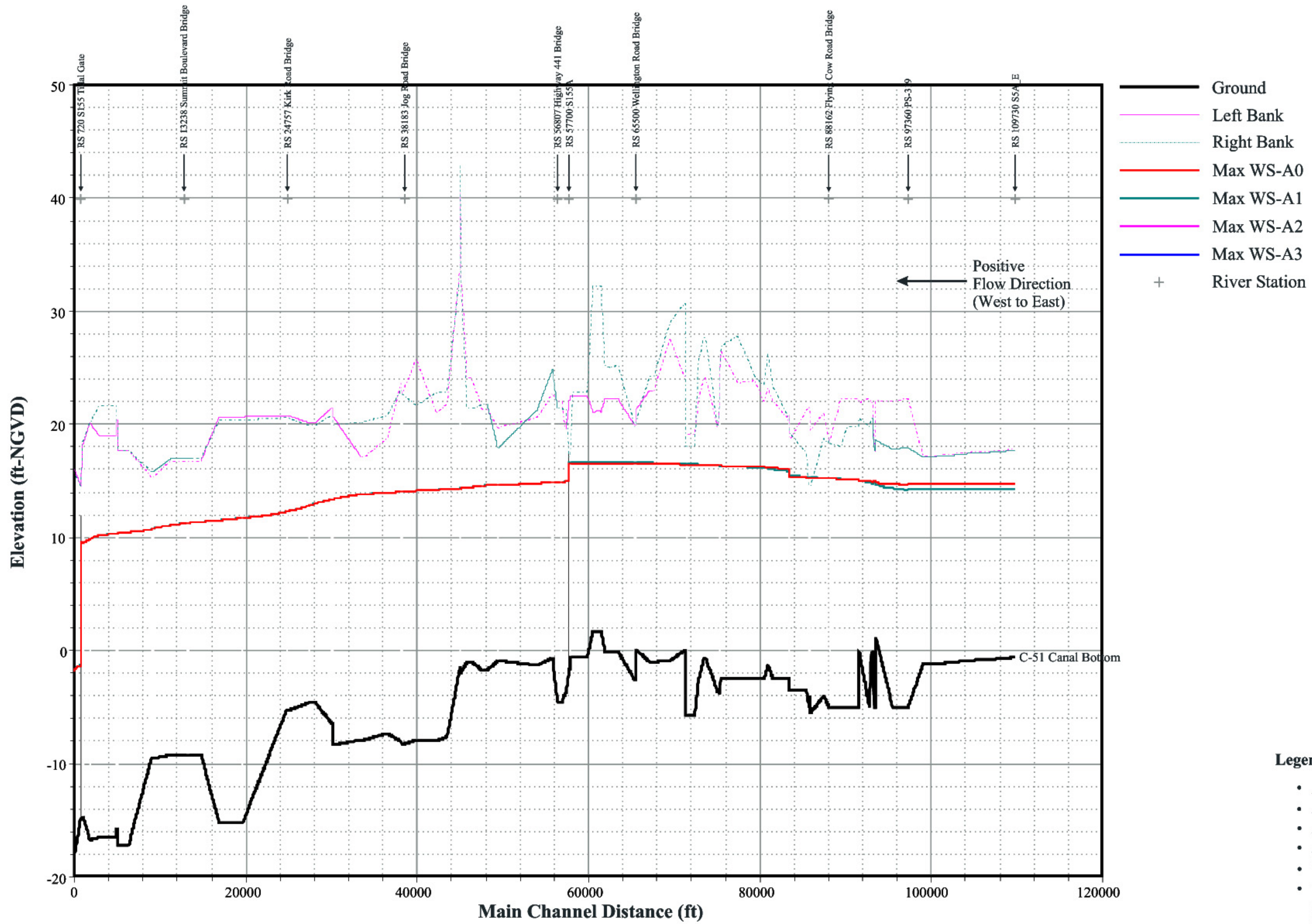
Figure 3-3a presents the simulated maximum water surface profiles along the C-51 canal for all the alternatives, including that for the baseline condition. This figure provides a direct comparison of the water surface profiles for all the alternatives along the C-51 canal. As can be seen from this figure, all the alternatives have maximum water surface profiles close to one another except for a C-51 canal segment from S5A-E to close proximity of pump station 319. This is consistent with the fact that all the alternatives have unrestricted discharge to the C-51 conveyance system for the 100-year, 72-hour design storm, and majority of the inflow points to the C-51 canal are located east of pump station 319. The data table for the Figure 3-3a is included in the Appendix C-2.

Figure 3-3b presents the simulated time-stage hydrographs at selected cross-sections along the C-51 canal west of S-155A. The hydrographs for all alternatives are plotted in the same graph for each selected cross-section. This allows for a direct comparison of the hydrographs resulting from various alternatives. All the alternatives generally produced identical high stage along the C-51 canal, which is consistent with the fact that all the alternatives have unrestricted discharge to the C-51 conveyance system for the 100-year, 72-hour design storm. The maximum stage difference between the pump station 319 and the structure S-155A is approximately 2.0 feet for all the alternatives. The data table for the Figure 3-3b is included in the Appendix C-2.

Table 3-7b
Comparison of Alternatives for Allowable Peak Stage (100-year, 72-hr Storm)

Sub-Basin		Area (sq mi)	Existing Rule Stage (ft-NGVD)	Stage for Various Alternatives (ft-NGVD)				Improvement Over Existing Rule (ft)			
ID	Other ID			A0	A1	A2	A3	A0	A1	A2	A3
1	B1	1.82	18.2	14.2	14.2	14.2	14.2	-4	-4	-4	-4
2A	STA1E	10.49	--	--	--	--	--	--	--	--	--
2B	B2B	1.92	17.2	13.8	13.8	13.8	13.8	-3.4	-3.4	-3.4	-3.4
3	B3	0.91	18.3	15.8	15.8	15.8	15.8	-2.5	-2.5	-2.5	-2.5
4	B4	0.84	18.3	16.6	16.6	16.6	16.6	-1.7	-1.7	-1.7	-1.7
5	B5	1.78	18.7	17.4	17.4	17.4	17.4	-1.3	-1.3	-1.3	-1.3
6	B6	1.05	21.0	19.2	19.2	19.2	19.2	-1.8	-1.8	-1.8	-1.8
7	B7	6.45	21.0	19.9	19.9	19.9	19.9	-1.1	-1.1	-1.1	-1.1
8	B8	6.20	22.0	20.6	20.6	20.6	20.6	-1.4	-1.4	-1.4	-1.4
9	B9	0.11	21.0	17.6	17.6	17.6	17.6	-3.4	-3.4	-3.4	-3.4
10	B10	0.32	20.1	18.3	18.3	18.3	18.3	-1.8	-1.8	-1.8	-1.8
11	B11	12.71	20.2 – 21.0	18.9	18.9	18.9	18.9	-2.1	-2.1	-2.1	-2.1
12	B12	0.12	20.2	17.5	17.5	17.5	17.5	-2.7	-2.7	-2.7	-2.7
13	B13	16.46	17.5	16.6	16.6	16.6	16.6	-0.9	-0.9	-0.9	-0.9
14	B14	14.48	--	--	--	--	--	--	--	--	--
15A	B15A	7.99	19.0	18.2	18.2	18.2	18.2	-0.8	-0.8	-0.8	-0.8
15B	B15B	13.50	--	--	--	--	--	--	--	--	--
16A	B16A	1.66	18.1	16.8	16.8	16.8	16.8	-1.3	-1.3	-1.3	-1.3
16B	B16B	3.83	19.1	19.0	19.0	19.0	19.0	-0.1	-0.1	-0.1	-0.1
20A	B20A	1.78	18.1	16.1	16.1	16.1	16.1	-2	-2	-2	-2
17	B17	2.58	18.0	16.6	16.6	16.6	16.6	-1.4	-1.4	-1.4	-1.4
18	B18	3.58	17.9	15.7	15.7	15.7	15.7	-2.2	-2.2	-2.2	-2.2
20B	B20B	3.66	18.3	16.8	16.8	16.8	16.8	-1.5	-1.5	-1.5	-1.5
21A	B21A	5.53	19.8	17.3	17.3	17.3	17.3	-2.5	-2.5	-2.5	-2.5
21B	B21B	7.90	19.8	17.7	17.7	17.7	17.7	-2.1	-2.1	-2.1	-2.1
22	B22	11.52	19.0	17.5	17.5	17.5	17.5	-1.5	-1.5	-1.5	-1.5
23	B23	6.57	19.1	17.1	17.1	17.1	17.1	-2	-2	-2	-2
24	B24	8.25	19.3	17.9	17.9	17.9	17.9	-1.4	-1.4	-1.4	-1.4
25A	B25A	0.32	16.6	14.6	14.6	14.6	14.6	-2	-2	-2	-2
25B	B25B	1.52	16.6	14.7	14.7	14.7	14.7	-1.9	-1.9	-1.9	-1.9
26	B26	0.59	15.9	13.8	13.8	13.8	13.8	-2.1	-2.1	-2.1	-2.1
27	B27	1.30	15.6	13.2	13.2	13.2	13.2	-2.4	-2.4	-2.4	-2.4
28	B28	0.35	15.6	12.3	12.3	12.3	12.3	-3.3	-3.3	-3.3	-3.3
29A	B29A	2.46	15.6	14.8	14.8	14.8	14.8	-0.8	-0.8	-0.8	-0.8
29B	B29B	0.69	15.6	15.2	15.2	15.2	15.2	-0.4	-0.4	-0.4	-0.4
30	B30	1.80	16.4	14.1	14.1	14.1	14.1	-2.3	-2.3	-2.3	-2.3
31	B31	2.29	15.2	13.1	13.1	13.1	13.1	-2.1	-2.1	-2.1	-2.1
32	B32	2.83	15.3	13.0	13.0	13.0	13.0	-2.3	-2.3	-2.3	-2.3
33	B33	3.63	15.3	13.6	13.6	13.6	13.6	-1.7	-1.7	-1.7	-1.7
34	B34	1.11	20.0	17.0	17.0	17.0	17.0	-3	-3	-3	-3
35	B35	0.27	15.6	11.3	11.3	11.3	11.3	-4.3	-4.3	-4.3	-4.3
36	B36	0.94	15.7	14.0	14.0	14.0	14.0	-1.7	-1.7	-1.7	-1.7
37	B37	0.61	20.0	16.4	16.4	16.3	16.4	-3.6	-3.6	-3.7	-3.6
38	B38	3.05	18.8	17.2	17.2	17.2	17.2	-1.6	-1.6	-1.6	-1.6

-- did not contribute to the Basin Rule evaluation or not applicable



Legend/Notes:

- A0 Alternative A0: Baseline (Existing Rule) Simulation
- A1 Alternative A1: Unrestricted Flow Simulation
- A2 Alternative A2: USACE Design Manning's n Simulation
- A3 Alternative A3: USACE Design Flow Simulation
- WS Water Surface
- Vertical lines represent locations of hydraulic structures (such as bridges, culverts, etc.)
- Main Channel Distance is measured from downstream end (same as River Station)

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MAXIMUM WATER SURFACE PROFILES ALONG C-51 FOR 100-YR, 72-HR STORM EVENT FOR ALTERNATIVES A0 THROUGH A3

Reevaluation of the C-51 Basin Rule

Technical Memorandum #3: Model Application

South Florida Water Management District, Contract No. C-13412

FIGURE 3-3A

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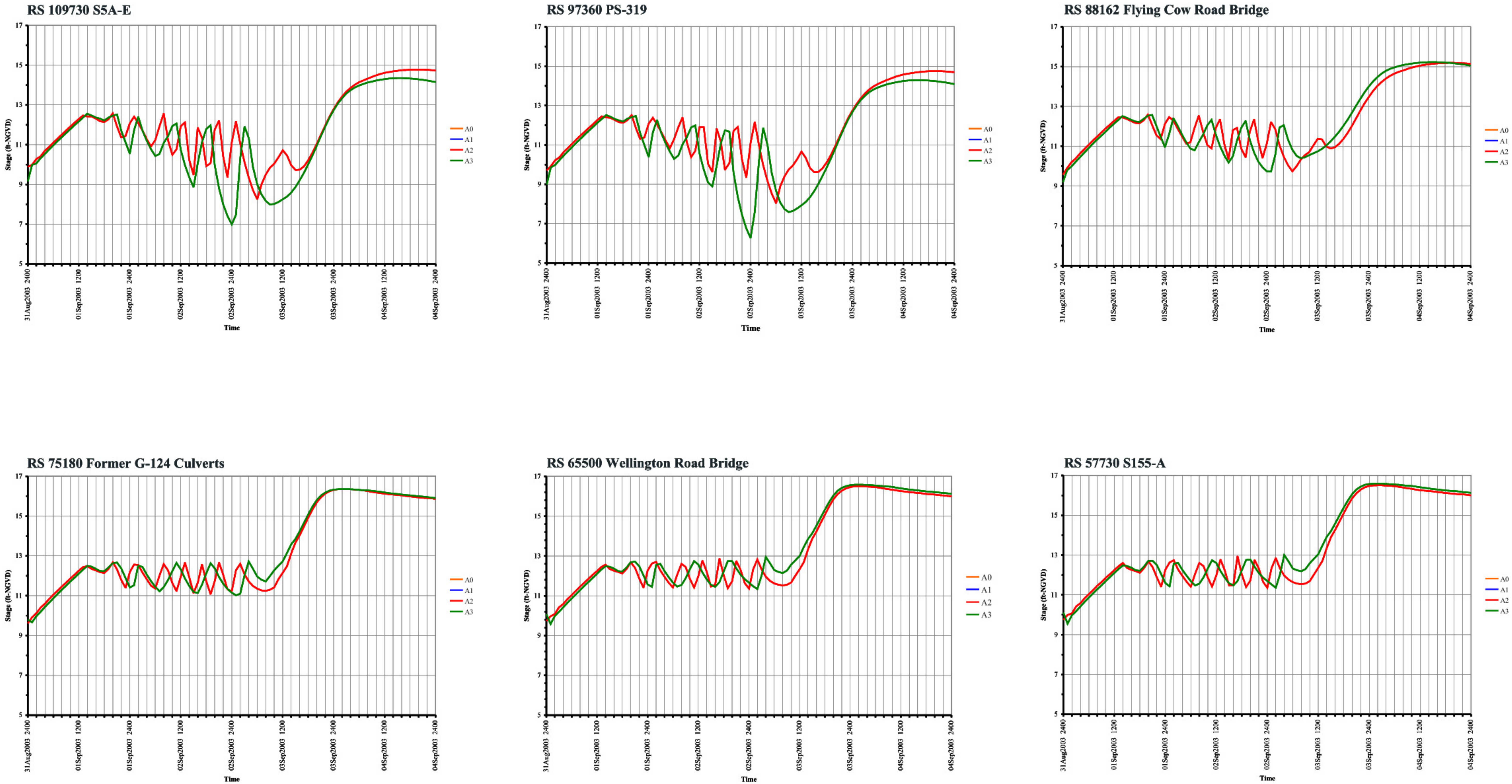

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TIME-STAGE HYDROGRAPHS AT SELECTED LOCATIONS ALONG C-51 FOR 100-YR, 72-HR STORM EVENT FOR ALTERNATIVES A0 THROUGH A3

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 3-3B

FILE NUMBER FL02006

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4.0 MODEL APPLICATION: ACME BASIN B ALTERNATIVES EVALUATION

4.1 GENERAL

The basin rule conditions did not include ACME Basin B (sub-basin 14) discharging to the C-51 canal. However, the scope of the study was amended to include the evaluation of the impact of Basin B on the C-51 canal for various improvement conditions as given below.

- Alternative B1: Inflow to C-51 from Basin B through Basin A (sub-basin 13)
- Alternative B2: Direct Discharge to C-51 from Basin B at the west boundary of Basin A (sub-basin 13)
- Alternative B3: Direct Discharge to STA-1E from Basin B

Each of these options is associated with assumed drainage improvement plans. Further details for each option (alternative) are given later in this section of the report. The hydrologic and hydraulic conditions were computed for each alternative considering the proposed improvements.

4.2 ALTERNATIVE B1: INFLOW TO C-51 THROUGH BASIN A

4.2.1 Description of Alternative

This option assumes that the runoff from sub-basin 14 flows to sub-basin 13, and then is pumped to the C-51 canal through upgraded pumps in sub-basin 13. The design assumptions are that the peak discharge from sub-basin 14 is likely to be 491 cfs (220,000 gpm), and the Pump Stations #3 and #4 are increased by a combined capacity of 491 cfs thus providing a complete replacement of existing discharge to WCA. The runoff conveyance from Basin B to Basin A is proposed to occur through six existing CMPs (Acme Culvert #40, #42, #43, #44, #45, and #72) and six 60-inch diameter new CMPs. Under this alternative, one new culvert would be placed next to each of the existing six installations.

For the purpose of modeling this alternative, the pump capacity for each of the two pumps (Pumps #3 and #4) in sub-basin 13 was increased from 133.7 cfs to 379.2 cfs. This increase in pump capacity was in addition to the new pump station #6 in sub-basin 13 that was recently permitted by the District to serve ACME Basin A. In addition, similar to the basin rule evaluation cases presented in Section 3, it is assumed that all the federal projects are in operational condition. The invert for each of the 12 culverts was specified at 11.5 ft-NGVD.

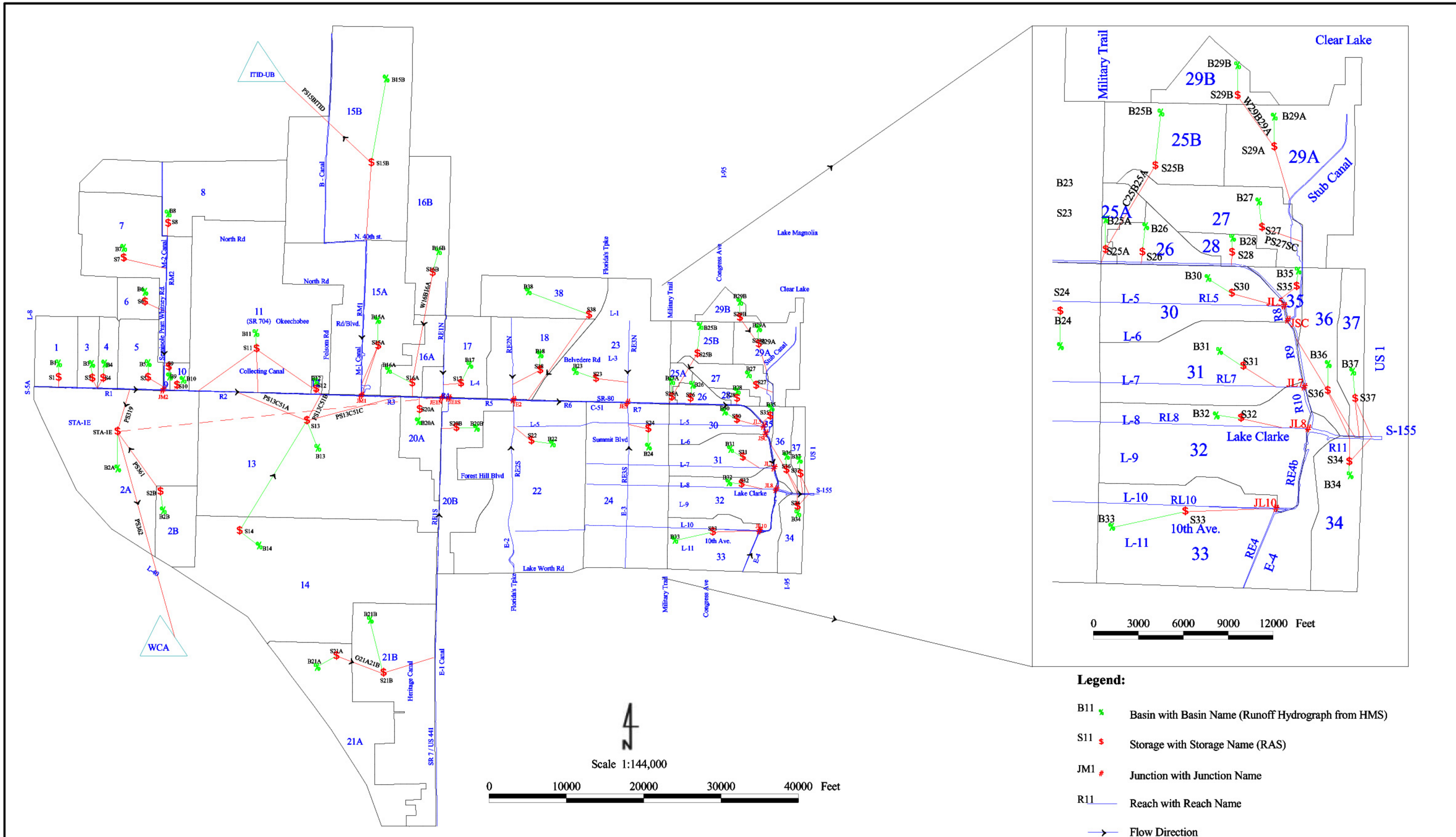
The link-node diagram for this alternative is shown on Figure 4-1 for the C-51 basin. Figure 4-1 also represents a geographically based nodal diagram for this alternative. The details on the model simulation for the C-51 basin are presented below.

4.2.2 Peak Discharge Simulation for Alternative B1

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 4-1. The only exception to this assumption is that sub-basin 15B does not contribute flows in this analysis. The peak discharge simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 4-1a that presents a summary of the simulated peak flow and peak stage for each sub-basin for the design storm event (10-year, 72-hour design storm). Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 4.5 of this report.

4.2.3 Peak Stage Simulation for Alternative B1

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 4-1. The only exception to this assumption is that sub-basin 15B does not contribute flows in this analysis. The peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 4-1b that presents a summary of the simulated peak flow and peak stage for each sub-basin for the 100-year, 72-hour design storm. Further discussion along with a comparison of this alternative with the baseline condition and the other alternatives is presented in Section 4.5 of this report.



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NODAL DIAGRAM FOR ALTERNATIVE B1

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South Florida Water Management District, Contract No. C-13412

FIGURE 4-1

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Table 4-1a
Summary of Results for 10-Year Design Storm for Alternative B1

Sub-Basin		Area		10-yr, 72-hr Peak Values		10-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 1400	13.4	09-04-03 0300
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 2200	13.1	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 1800	15.0	09-04-03 0300
4	B4	540.0	0.84	29	09-02-03 0500	15.8	09-04-03 0300
5	B5	1142.5	1.78	50	09-04-03 0200	16.6	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1800	18.6	09-03-03 2200
7	B7	4126.9	6.45	151	09-04-03 0800	19.2	09-04-03 0800
8	B8	3966.8	6.20	260	09-04-03 0400	19.9	09-04-03 0400
9	B9	72.8	0.11	9	09-03-03 2000	17.1	09-03-03 2000
10	B10	208.0	0.32	3	09-04-03 0400	17.8	09-04-03 0400
11	B11	8138.3	12.71	1314	09-03-03 1700	18.2	09-04-03 0300
12	B12	74.1	0.12	35	09-03-03 1500	16.7	09-03-03 1500
13	B13	10537.9	16.46	897	09-02-03 0300	15.4	09-04-03 0300
14	B14	9270.3	14.48	501	09-04-03 0300	15.2	09-04-03 1300
15A	B15A	5116.7	7.99	825	09-04-03 0300	17.5	09-04-03 0300
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	384	09-03-03 1800	16.1	09-04-03 0400
16B	B16B	2448.8	3.83	26	09-04-03 1800	18.4	09-04-03 1900
20A	B20A	1138.6	1.78	97	09-03-03 1400	15.6	09-04-03 2200
17	B17	1650.5	2.58	384	09-03-03 2000	15.8	09-03-03 2000
18	B18	2294.9	3.58	323	09-03-03 2200	14.7	09-03-03 2300
20B	B20B	2341.8	3.66	535	09-03-03 2100	16.1	09-03-03 2100
21A	B21A	3540.4	5.53	0	--	16.7	09-04-03 2100
21B	B21B	5056.2	7.90	111	09-04-03 0000	17.0	09-04-03 0900
22	B22	7375.2	11.52	371	09-04-03 0700	16.7	09-04-03 0700
23	B23	4206.9	6.57	675	09-03-03 2300	16.3	09-03-03 2300
24	B24	5282.0	8.25	452	09-04-03 0400	17.1	09-04-03 0400
25A	B25A	205.8	0.32	368	09-03-03 1600	13.8	09-03-03 1600
25B	B25B	972.1	1.52	325	09-03-03 1900	13.9	09-03-03 1600
26	B26	376.1	0.59	107	09-03-03 1400	13.1	09-03-03 1700
27	B27	830.7	1.30	320	09-03-03 1400	12.0	09-03-03 1800
28	B28	223.4	0.35	267	09-03-03 1400	11.6	09-03-03 1400
29A	B29A	1578.1	2.46	309	09-03-03 1900	13.8	09-03-03 1900
29B	B29B	440.3	0.69	628	09-03-03 1400	14.5	09-03-03 1400
30	B30	1153.0	1.80	123	09-03-03 2200	13.0	09-03-03 2200
31	B31	1467.8	2.29	333	09-03-03 1800	12.3	09-03-03 1800
32	B32	1812.7	2.83	278	09-03-03 2200	12.2	09-03-03 2200
33	B33	2323.9	3.63	272	09-03-03 2300	12.6	09-03-03 2300
34	B34	711.3	1.11	138	09-03-03 1700	15.7	09-03-03 2100
35	B35	172.9	0.27	45	09-03-03 1500	10.5	09-03-03 1600
36	B36	603.3	0.94	81	09-04-03 0400	12.7	09-03-03 2100
37	B37	390.2	0.61	95	09-04-03 0700	15.6	09-03-03 1800
38	B38	1955.2	3.05	145	09-04-03 0200	16.2	09-04-03 0200

-- did not contribute to the Basin Rule evaluation or not applicable

Table 4-1b
Summary of Results for 100-Year Design Storm For Alternative B1

Sub-Basin		Area		100-yr, 72-hr Peak Values		100-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 0700	14.2	09-04-03 0400
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 1500	13.8	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 0600	15.8	09-04-03 0300
4	B4	540.0	0.84	29	09-01-03 2000	16.6	09-04-03 0400
5	B5	1142.5	1.78	81	09-04-03 0300	17.4	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1200	19.2	09-04-03 0100
7	B7	4126.9	6.45	226	09-04-03 0700	19.9	09-04-03 0800
8	B8	3966.8	6.20	418	09-04-03 0400	20.6	09-04-03 0400
9	B9	72.8	0.11	38	09-03-03 1500	17.6	09-03-03 1500
10	B10	208.0	0.32	17	09-04-03 0200	18.3	09-04-03 0200
11	B11	8138.3	12.71	1249	09-03-03 1300	18.9	09-04-03 0500
12	B12	74.1	0.12	52	09-03-03 1500	17.5	09-03-03 1500
13	B13	10537.9	16.46	897	09-01-03 1900	16.2	09-04-03 0500
14	B14	9270.3	14.48	503	09-04-03 0500	16.0	09-04-03 2000
15A	B15A	5116.7	7.99	968	09-04-03 0400	18.2	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	480	09-03-03 1700	17.0	09-04-03 0900
16B	B16B	2448.8	3.83	58	09-04-03 1700	19.0	09-04-03 1700
20A	B20A	1138.6	1.78	93	09-03-03 0200	16.4	09-04-03 2400
17	B17	1650.5	2.58	534	09-03-03 2100	16.6	09-03-03 2100
18	B18	2294.9	3.58	431	09-03-03 2000	15.7	09-04-03 0000
20B	B20B	2341.8	3.66	750	09-03-03 1900	16.8	09-03-03 2300
21A	B21A	3540.4	5.53	0	--	17.3	09-04-03 2200
21B	B21B	5056.2	7.90	143	09-03-03 1900	17.7	09-04-03 1100
22	B22	7375.2	11.52	527	09-04-03 0700	17.5	09-04-03 0700
23	B23	4206.9	6.57	849	09-04-03 0100	17.1	09-04-03 0100
24	B24	5282.0	8.25	601	09-04-03 0500	17.9	09-04-03 0500
25A	B25A	205.8	0.32	449	09-03-03 1700	14.6	09-03-03 1700
25B	B25B	972.1	1.52	392	09-03-03 1900	14.7	09-03-03 1700
26	B26	376.1	0.59	320	09-03-03 1600	13.8	09-03-03 1600
27	B27	830.7	1.30	320	09-03-03 1300	13.2	09-03-03 2000
28	B28	223.4	0.35	476	09-03-03 1400	12.4	09-03-03 1400
29A	B29A	1578.1	2.46	474	09-03-03 1900	14.8	09-03-03 1900
29B	B29B	440.3	0.69	830	09-03-03 1400	15.2	09-03-03 1400
30	B30	1153.0	1.80	268	09-03-03 2000	14.1	09-03-03 2000
31	B31	1467.8	2.29	670	09-03-03 1700	13.1	09-03-03 1700
32	B32	1812.7	2.83	527	09-03-03 2100	13.0	09-03-03 2100
33	B33	2323.9	3.63	546	09-03-03 2100	13.6	09-03-03 2100
34	B34	711.3	1.11	169	09-04-03 0600	17.0	09-03-03 2200
35	B35	172.9	0.27	45	09-03-03 1300	11.3	09-03-03 1700
36	B36	603.3	0.94	157	09-03-03 2100	14.0	09-03-03 2000
37	B37	390.2	0.61	109	09-04-03 0100	16.4	09-03-03 2000
38	B38	1955.2	3.05	151	09-04-03 1700	17.2	09-04-03 0300

-- did not contribute to the Basin Rule evaluation or not applicable

4.3 ALTERNATIVE B2: DIRECT DISCHARGE TO C-51 WEST OF BASIN A

4.3.1 Description of Alternative

This option assumes that the runoff from sub-basin 14 flows through the C-1 canal (ACME canal) along the west side of Basin A (sub-basin 13), and then is pumped to the C-51 canal through a new pump station #7 located along the west boundary of sub-basin 13. The design assumptions are that the C-1 canal would be improved to convey 500 cfs to satisfy the peak discharge requirement of 491 cfs from sub-basin 14, and the Pump Station #7 would be constructed with a capacity of 491 cfs at the west boundary of sub-basin 13 thus providing a complete replacement of existing discharge to WCA. For the purpose of modeling this alternative, the pump station #7 is located at river station 89727 with a capacity of 491 cfs. In addition, similar to the basin rule evaluation cases presented in Section 3, it is assumed that all the federal projects are in operational condition.

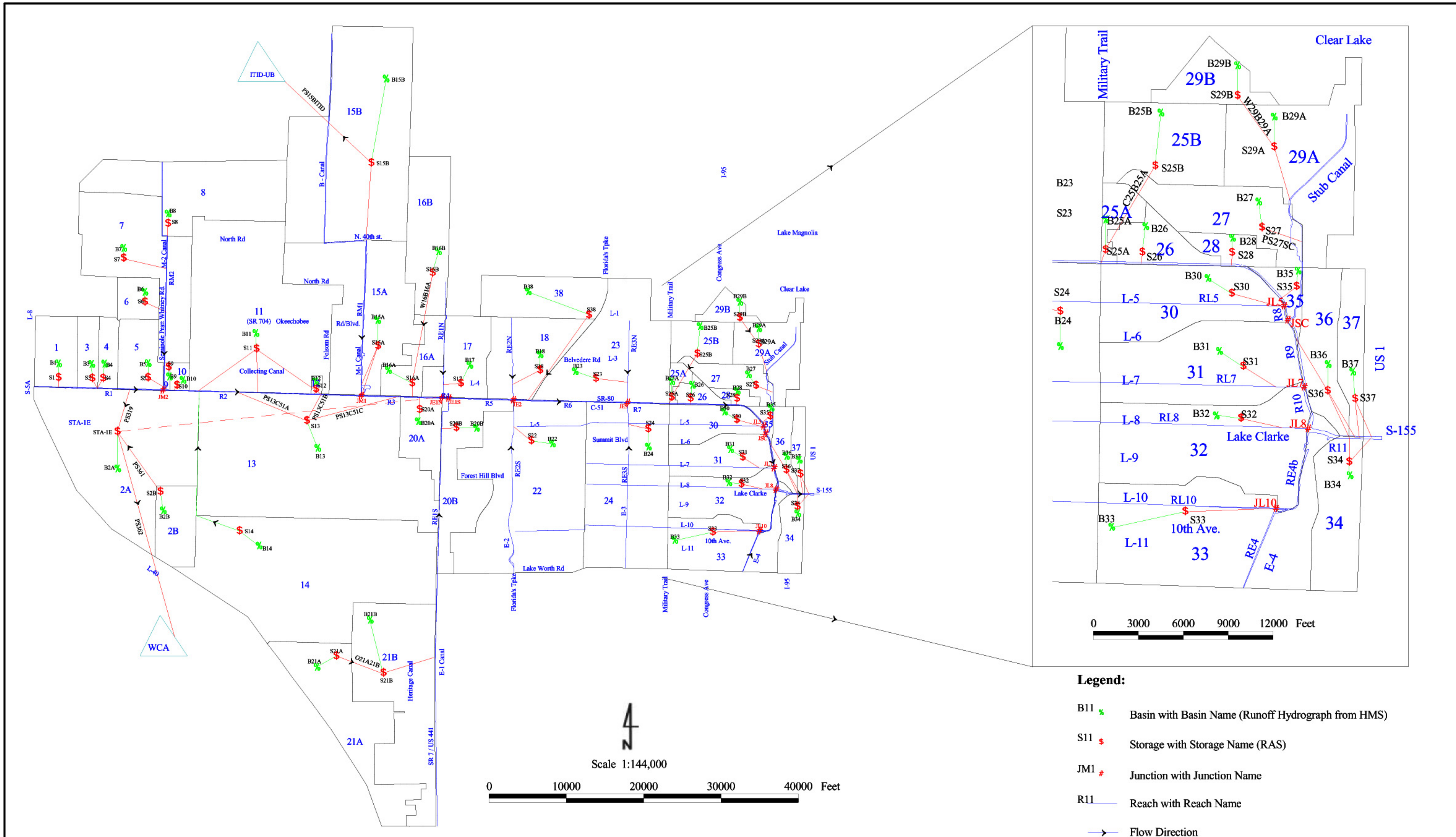
The link-node diagram for this alternative is shown on Figure 4-2 for the C-51 basin. Figure 4-2 also represents a geographically based nodal diagram for this alternative. The details on the model simulation for the C-51 basin are presented below.

4.3.2 Peak Discharge Simulation for Alternative B2

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 4-2. The only exception to this assumption is that sub-basin 15B does not contribute flows in this analysis. The peak discharge simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 4-2a that presents a summary of the simulated peak flow and peak stage for each sub-basin for the 10-year, 72-hour design storm. Further discussion along with a comparison with the other alternatives is presented in Section 4.5 of this report.

4.3.3 Peak Stage Simulation for Alternative B2

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 4-2. The only exception to this assumption is that sub-basin 15B does not contribute flows in this analysis. The peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 4-2b that presents a summary of the simulated peak flow and peak stage for each sub-basin for the 100-year, 72-hour design storm. Further discussion along with a comparison with the other alternatives is presented in Section 4.5 of this report.



	NAME	DATE
DESIGNED BY	NA	
DRAWN BY		
CHECKED BY		
APPROVED BY		07/06/04
FILE NAME: FL02006-TM3-FIG 4-2.APR		

I hereby certify that this document was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Florida.

SIGNED NA
NAME
DATE REG. NO.

NODAL DIAGRAM FOR ALTERNATIVE B2

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 4-2

FILE NUMBER FL02006 SHEET ____ OF ____

Table 4-2a
Summary of Results for 10-Year Design Storm for Alternative B2

Sub-Basin		Area		10-yr, 72-hr Peak Values		10-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 1400	13.4	09-04-03 0300
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 2200	13.1	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 1800	15.0	09-04-03 0300
4	B4	540.0	0.84	29	09-02-03 0500	15.8	09-04-03 0300
5	B5	1142.5	1.78	54	09-04-03 0100	16.6	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1800	18.6	09-03-03 2200
7	B7	4126.9	6.45	150	09-04-03 0800	19.2	09-04-03 0800
8	B8	3966.8	6.20	260	09-04-03 0400	19.9	09-04-03 0400
9	B9	72.8	0.11	9	09-03-03 2000	17.1	09-03-03 2000
10	B10	208.0	0.32	3	09-04-03 0400	17.8	09-04-03 0400
11	B11	8138.3	12.71	1357	09-03-03 2300	18.1	09-04-03 0200
12	B12	74.1	0.12	35	09-03-03 1500	16.7	09-03-03 1500
13	B13	10537.9	16.46	406	09-02-03 0300	15.7	09-04-03 0800
14	B14	9270.3	14.48	491	09-02-03 0100	14.7	09-04-03 0500
15A	B15A	5116.7	7.99	826	09-04-03 0300	17.5	09-04-03 0300
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	384	09-03-03 1900	16.0	09-03-03 1900
16B	B16B	2448.8	3.83	26	09-04-03 1800	18.4	09-04-03 1900
20A	B20A	1138.6	1.78	127	09-03-03 1500	15.4	09-04-03 1500
17	B17	1650.5	2.58	384	09-03-03 2000	15.8	09-03-03 2000
18	B18	2294.9	3.58	323	09-03-03 2200	14.7	09-03-03 2300
20B	B20B	2341.8	3.66	535	09-03-03 2100	16.1	09-03-03 2100
21A	B21A	3540.4	5.53	0	--	16.7	09-04-03 2100
21B	B21B	5056.2	7.90	111	09-04-03 0000	17.0	09-04-03 0900
22	B22	7375.2	11.52	371	09-04-03 0700	16.7	09-04-03 0700
23	B23	4206.9	6.57	675	09-03-03 2300	16.3	09-03-03 2300
24	B24	5282.0	8.25	452	09-04-03 0400	17.1	09-04-03 0400
25A	B25A	205.8	0.32	368	09-03-03 1600	13.8	09-03-03 1600
25B	B25B	972.1	1.52	328	09-03-03 1900	13.9	09-03-03 1600
26	B26	376.1	0.59	107	09-03-03 1400	13.1	09-03-03 1700
27	B27	830.7	1.30	320	09-03-03 1400	12.0	09-03-03 1800
28	B28	223.4	0.35	264	09-03-03 1400	11.5	09-03-03 1400
29A	B29A	1578.1	2.46	309	09-03-03 1900	13.8	09-03-03 1900
29B	B29B	440.3	0.69	628	09-03-03 1400	14.5	09-03-03 1400
30	B30	1153.0	1.80	123	09-03-03 2200	13.0	09-03-03 2200
31	B31	1467.8	2.29	333	09-03-03 1800	12.3	09-03-03 1800
32	B32	1812.7	2.83	278	09-03-03 2200	12.2	09-03-03 2200
33	B33	2323.9	3.63	272	09-03-03 2300	12.6	09-03-03 2300
34	B34	711.3	1.11	136	09-03-03 2100	15.7	09-03-03 2000
35	B35	172.9	0.27	45	09-03-03 1500	10.5	09-03-03 1600
36	B36	603.3	0.94	84	09-03-03 2000	12.7	09-03-03 2100
37	B37	390.2	0.61	92	09-04-03 1100	15.7	09-03-03 1800
38	B38	1955.2	3.05	145	09-04-03 0200	16.2	09-04-03 0200

-- did not contribute to the Basin Rule evaluation or not applicable

Table 4-2b
Summary of Results for 100-Year Design Storm For Alternative B2

Sub-Basin		Area		100-yr, 72-hr Peak Values		100-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 0700	14.2	09-04-03 0400
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 1500	13.8	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 0600	15.8	09-04-03 0300
4	B4	540.0	0.84	29	09-01-03 2000	16.6	09-04-03 0400
5	B5	1142.5	1.78	80	09-04-03 0300	17.4	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1200	19.2	09-04-03 0100
7	B7	4126.9	6.45	223	09-04-03 0600	19.9	09-04-03 0800
8	B8	3966.8	6.20	418	09-04-03 0400	20.6	09-04-03 0400
9	B9	72.8	0.11	38	09-03-03 1500	17.6	09-03-03 1500
10	B10	208.0	0.32	17	09-04-03 0200	18.3	09-04-03 0200
11	B11	8138.3	12.71	1425	09-03-03 1900	18.9	09-04-03 0500
12	B12	74.1	0.12	52	09-03-03 1500	17.5	09-03-03 1500
13	B13	10537.9	16.46	406	09-01-03 1900	16.6	09-04-03 1000
14	B14	9270.3	14.48	491	09-01-03 1700	15.6	09-04-03 0700
15A	B15A	5116.7	7.99	992	09-04-03 0400	18.2	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	508	09-03-03 1900	16.8	09-04-03 1600
16B	B16B	2448.8	3.83	58	09-04-03 1700	19.0	09-04-03 1700
20A	B20A	1138.6	1.78	122	09-03-03 1500	16.2	09-04-03 2400
17	B17	1650.5	2.58	534	09-03-03 2100	16.6	09-03-03 2100
18	B18	2294.9	3.58	431	09-03-03 2000	15.7	09-04-03 0000
20B	B20B	2341.8	3.66	750	09-03-03 1900	16.8	09-03-03 2300
21A	B21A	3540.4	5.53	0	--	17.3	09-04-03 2200
21B	B21B	5056.2	7.90	143	09-03-03 1900	17.7	09-04-03 1100
22	B22	7375.2	11.52	527	09-04-03 0700	17.5	09-04-03 0700
23	B23	4206.9	6.57	849	09-04-03 0100	17.1	09-04-03 0100
24	B24	5282.0	8.25	602	09-04-03 0500	17.9	09-04-03 0500
25A	B25A	205.8	0.32	449	09-03-03 1700	14.6	09-03-03 1700
25B	B25B	972.1	1.52	392	09-03-03 1900	14.7	09-03-03 1700
26	B26	376.1	0.59	320	09-03-03 1600	13.8	09-03-03 1600
27	B27	830.7	1.30	320	09-03-03 1300	13.2	09-03-03 2000
28	B28	223.4	0.35	441	09-03-03 1300	12.4	09-03-03 1400
29A	B29A	1578.1	2.46	474	09-03-03 1900	14.8	09-03-03 1900
29B	B29B	440.3	0.69	830	09-03-03 1400	15.2	09-03-03 1400
30	B30	1153.0	1.80	268	09-03-03 2000	14.1	09-03-03 2000
31	B31	1467.8	2.29	670	09-03-03 1700	13.1	09-03-03 1700
32	B32	1812.7	2.83	527	09-03-03 2100	13.0	09-03-03 2100
33	B33	2323.9	3.63	546	09-03-03 2100	13.6	09-03-03 2100
34	B34	711.3	1.11	169	09-04-03 0600	17.0	09-03-03 2200
35	B35	172.9	0.27	45	09-03-03 1300	11.3	09-03-03 1700
36	B36	603.3	0.94	157	09-03-03 2200	14.0	09-03-03 2000
37	B37	390.2	0.61	108	09-04-03 0100	16.4	09-03-03 2000
38	B38	1955.2	3.05	151	09-04-03 1700	17.2	09-04-03 0300

-- did not contribute to the Basin Rule evaluation or not applicable

4.4 ALTERNATIVE B3: DIRECT DISCHARGE TO STA-1 EAST

4.4.1 Description of Alternative

This option assumes that the runoff from sub-basin 14 would be pumped directly to STA-1 East through a new pump station. The design assumptions are that the internal infrastructure improvements would be identical to the Alternative B2, but the new pump station would be directly pumping to STA-1E thus providing a complete replacement of existing discharge to WCA. For the purpose of modeling this alternative, the pump station is located in sub-basin 14 with a capacity of 491 cfs. In addition, similar to the basin rule evaluation cases presented in Section 3, it is assumed that all the federal projects are in operational condition.

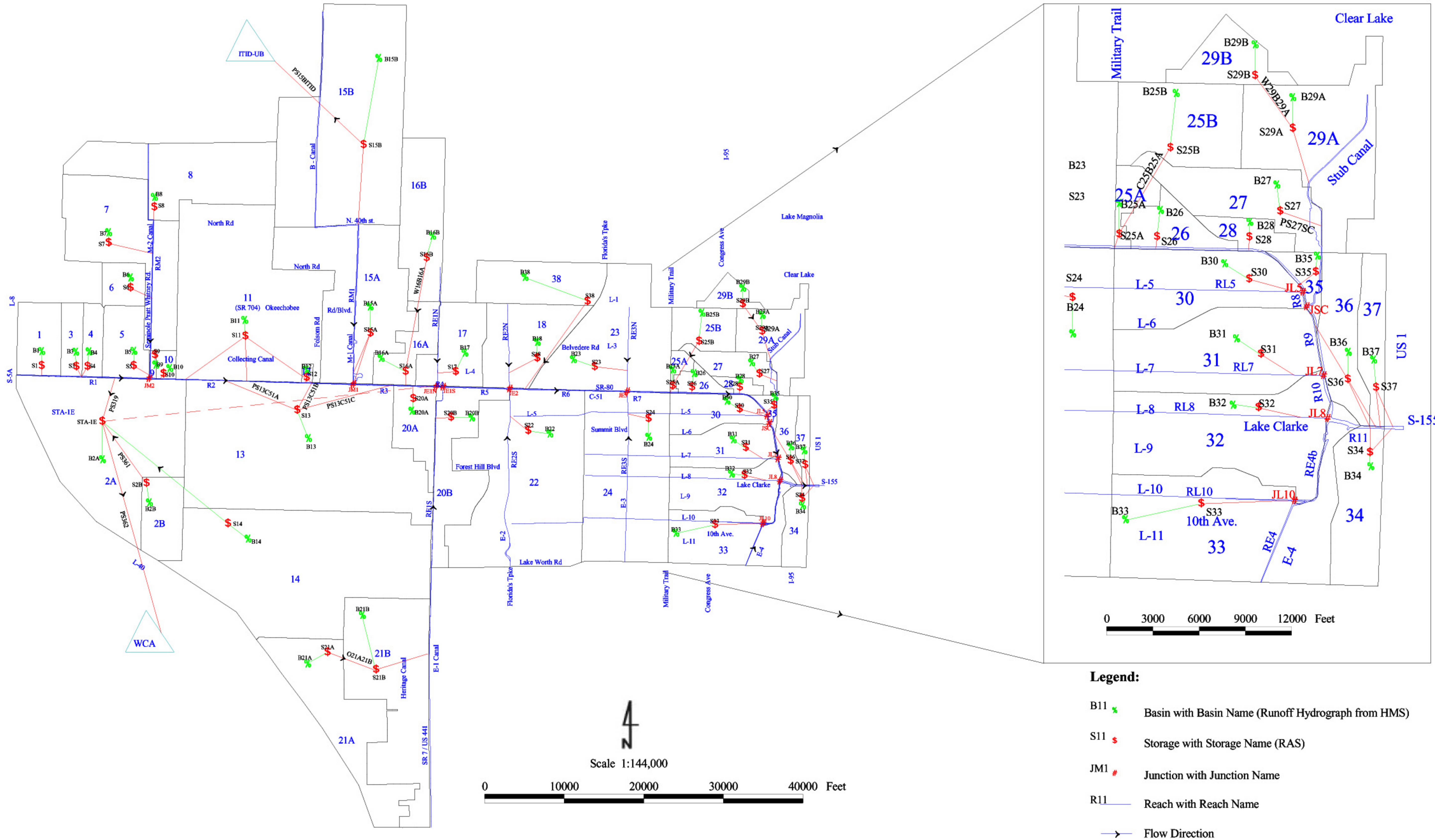
The link-node diagram for this alternative is shown on Figure 4-3 for the C-51 basin. Figure 4-3 also represents a geographically based nodal diagram for this alternative. The details on the model simulation for the C-51 basin are presented below.

4.4.2 Peak Discharge Simulation for Alternative B3

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 4-3. The only exception to this assumption is that sub-basin 15B does not contribute flows in this analysis. The peak flow simulation was performed for the 10-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 4-3a that presents a summary of the simulated peak flow and peak stage for each sub-basin for the 10-year, 72-hour design storm. Further discussion along with a comparison with the other alternatives is presented in Section 4.5 of this report.

4.4.3 Peak Stage Simulation for Alternative B3

The RAS model was applied for this case with unrestricted flow through the control structures from each sub-basin discharging to the corresponding canal system as shown on Figure 4-3. The only exception to this assumption is that sub-basin 15B does not contribute flows in this analysis. The peak stage simulation was performed for the 100-year, 72-hour design storm event as documented in Section 2.5 of this report. The results for this alternative are summarized in Table 4-3b that presents a summary of the simulated peak flow and peak stage for each sub-basin for the 100-year, 72-hour design storm. Further discussion along with a comparison with the other alternatives is presented in Section 4.5 of this report.



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FILE NAME: FL02006-TM3-FIG 4-3.APR		

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NODAL DIAGRAM FOR ALTERNATIVE B3

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 4-3

FILE NUMBER FL02006 SHEET OF

Table 4-3a
Summary of Results for 10-Year Design Storm for Alternative B3

Sub-Basin		Area		10-yr, 72-hr Peak Values		10-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 1400	13.4	09-04-03 0300
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 2200	13.1	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 1800	15.0	09-04-03 0300
4	B4	540.0	0.84	29	09-02-03 0500	15.8	09-04-03 0300
5	B5	1142.5	1.78	53	09-03-03 2100	16.6	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1800	18.6	09-03-03 2200
7	B7	4126.9	6.45	151	09-04-03 0800	19.2	09-04-03 0800
8	B8	3966.8	6.20	260	09-04-03 0400	19.9	09-04-03 0400
9	B9	72.8	0.11	9	09-03-03 2000	17.1	09-03-03 2000
10	B10	208.0	0.32	3	09-04-03 0400	17.8	09-04-03 0400
11	B11	8138.3	12.71	1360	09-04-03 0000	18.1	09-04-03 0200
12	B12	74.1	0.12	35	09-03-03 1500	16.7	09-03-03 1500
13	B13	10537.9	16.46	406	09-02-03 0300	15.7	09-04-03 0800
14	B14	9270.3	14.48	491	09-02-03 0100	14.7	09-04-03 0500
15A	B15A	5116.7	7.99	827	09-04-03 0300	17.5	09-04-03 0300
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	384	09-03-03 1900	16.0	09-03-03 1900
16B	B16B	2448.8	3.83	26	09-04-03 1800	18.4	09-04-03 1900
20A	B20A	1138.6	1.78	131	09-03-03 1500	15.4	09-04-03 1200
17	B17	1650.5	2.58	384	09-03-03 2000	15.8	09-03-03 2000
18	B18	2294.9	3.58	323	09-03-03 2200	14.7	09-03-03 2300
20B	B20B	2341.8	3.66	535	09-03-03 2100	16.1	09-03-03 2100
21A	B21A	3540.4	5.53	0	--	16.7	09-04-03 2100
21B	B21B	5056.2	7.90	111	09-04-03 0000	17.0	09-04-03 0900
22	B22	7375.2	11.52	371	09-04-03 0700	16.7	09-04-03 0700
23	B23	4206.9	6.57	675	09-03-03 2300	16.3	09-03-03 2300
24	B24	5282.0	8.25	452	09-04-03 0400	17.1	09-04-03 0400
25A	B25A	205.8	0.32	370	09-03-03 1600	13.8	09-03-03 1600
25B	B25B	972.1	1.52	344	09-03-03 1900	14.0	09-03-03 1600
26	B26	376.1	0.59	107	09-03-03 1400	13.1	09-03-03 1700
27	B27	830.7	1.30	320	09-03-03 1400	12.0	09-03-03 1800
28	B28	223.4	0.35	270	09-03-03 1400	11.6	09-03-03 1400
29A	B29A	1578.1	2.46	309	09-03-03 1900	13.8	09-03-03 1900
29B	B29B	440.3	0.69	628	09-03-03 1400	14.5	09-03-03 1400
30	B30	1153.0	1.80	123	09-03-03 2200	13.0	09-03-03 2200
31	B31	1467.8	2.29	333	09-03-03 1800	12.3	09-03-03 1800
32	B32	1812.7	2.83	278	09-03-03 2200	12.2	09-03-03 2200
33	B33	2323.9	3.63	272	09-03-03 2300	12.6	09-03-03 2300
34	B34	711.3	1.11	137	09-03-03 1800	15.7	09-03-03 2000
35	B35	172.9	0.27	45	09-03-03 1500	10.5	09-03-03 1600
36	B36	603.3	0.94	79	09-03-03 2100	12.7	09-03-03 2100
37	B37	390.2	0.61	93	09-04-03 0900	15.7	09-03-03 1800
38	B38	1955.2	3.05	145	09-04-03 0100	16.2	09-04-03 0200

-- did not contribute to the Basin Rule evaluation or not applicable

Table 4-3b
Summary of Results for 100-Year Design Storm For Alternative B3

Sub-Basin		Area		100-yr, 72-hr Peak Values		100-yr, 72-hr Peak Stages	
ID	Other ID	(acre)	(sq mi)	Flow (cfs)	Time to Peak Flow	Stage (ft-NGVD)	Time to Peak Stage
1	B1	1164.3	1.82	48	09-03-03 0700	14.2	09-04-03 0400
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	50	09-01-03 1500	13.8	09-04-03 0200
3	B3	579.4	0.91	26	09-02-03 0600	15.8	09-04-03 0300
4	B4	540.0	0.84	29	09-01-03 2000	16.6	09-04-03 0400
5	B5	1142.5	1.78	80	09-04-03 0300	17.4	09-04-03 0300
6	B6	673.5	1.05	67	09-01-03 1200	19.2	09-04-03 0100
7	B7	4126.9	6.45	226	09-04-03 0700	19.9	09-04-03 0800
8	B8	3966.8	6.20	418	09-04-03 0400	20.6	09-04-03 0400
9	B9	72.8	0.11	38	09-03-03 1500	17.6	09-03-03 1500
10	B10	208.0	0.32	17	09-04-03 0200	18.3	09-04-03 0200
11	B11	8138.3	12.71	1425	09-03-03 1900	18.9	09-04-03 0500
12	B12	74.1	0.12	52	09-03-03 1500	17.5	09-03-03 1500
13	B13	10537.9	16.46	406	09-01-03 1900	16.6	09-04-03 1000
14	B14	9270.3	14.48	491	09-01-03 1700	15.6	09-04-03 0700
15A	B15A	5116.7	7.99	999	09-04-03 0400	18.2	09-04-03 0400
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	508	09-03-03 1900	16.8	09-03-03 1900
16B	B16B	2448.8	3.83	58	09-04-03 1700	19.0	09-04-03 1700
20A	B20A	1138.6	1.78	130	09-03-03 1300	16.1	09-04-03 2400
17	B17	1650.5	2.58	534	09-03-03 2100	16.6	09-03-03 2100
18	B18	2294.9	3.58	431	09-03-03 2000	15.7	09-04-03 0000
20B	B20B	2341.8	3.66	750	09-03-03 1900	16.8	09-03-03 2300
21A	B21A	3540.4	5.53	0	--	17.3	09-04-03 2200
21B	B21B	5056.2	7.90	143	09-03-03 1900	17.7	09-04-03 1100
22	B22	7375.2	11.52	527	09-04-03 0700	17.5	09-04-03 0700
23	B23	4206.9	6.57	849	09-04-03 0100	17.1	09-04-03 0100
24	B24	5282.0	8.25	602	09-04-03 0500	17.9	09-04-03 0500
25A	B25A	205.8	0.32	449	09-03-03 1700	14.6	09-03-03 1700
25B	B25B	972.1	1.52	391	09-03-03 1900	14.7	09-03-03 1700
26	B26	376.1	0.59	320	09-03-03 1600	13.8	09-03-03 1600
27	B27	830.7	1.30	320	09-03-03 1300	13.2	09-03-03 2000
28	B28	223.4	0.35	430	09-03-03 1400	12.3	09-03-03 1400
29A	B29A	1578.1	2.46	474	09-03-03 1900	14.8	09-03-03 1900
29B	B29B	440.3	0.69	830	09-03-03 1400	15.2	09-03-03 1400
30	B30	1153.0	1.80	268	09-03-03 2000	14.1	09-03-03 2000
31	B31	1467.8	2.29	670	09-03-03 1700	13.1	09-03-03 1700
32	B32	1812.7	2.83	527	09-03-03 2100	13.0	09-03-03 2100
33	B33	2323.9	3.63	546	09-03-03 2100	13.6	09-03-03 2100
34	B34	711.3	1.11	170	09-04-03 0500	17.0	09-03-03 2200
35	B35	172.9	0.27	45	09-03-03 1300	11.3	09-03-03 1700
36	B36	603.3	0.94	158	09-03-03 2000	14.0	09-03-03 2000
37	B37	390.2	0.61	108	09-03-03 2300	16.4	09-03-03 1900
38	B38	1955.2	3.05	151	09-04-03 1700	17.2	09-04-03 0300

-- did not contribute to the Basin Rule evaluation or not applicable

4.5 DISCUSSION ON ACME BASIN B ALTERNATIVES EVALUATION

This section presents a direct comparison of all the alternatives simulated for the ACME Basin B evaluation.

4.5.1 Peak Discharge Simulation

Table 4-4a summarizes the simulated peak discharge for the design storm event (10-year, 72-hour) for all the ACME Basin B improvement alternatives. This table also presents the improvement on the allowable discharge for various alternatives over Alternative A1 conditions (Table 3-3a). A comparison of this table with Table 3-7a reveals that there is no significant adverse impact on the sub-basin discharges due to incorporation of the ACME Basin B into the stormwater conveyance system. A review of the Table 4-4a also indicates that there is insignificant difference in peak discharge values for the sub-basins amongst the three alternatives (Alternatives B1 through B3).

Figure 4-4a presents the simulated maximum water surface profiles along the C-51 canal for all three alternatives. This figure provides a direct comparison of water surface profiles for all the alternatives along the C-51 canal. As can be seen from this figure, Alternative B3 has the lowest water surface profile since it has no discharge to the C-51 canal, rather it directly pumps to the STA-1E, and thus has the least impact on the C-51 canal. Compared to Alternative B1, Alternative B2 has a higher water profile west of Flying Cow bridge. This is primarily due to the fact that Alternative B2 discharges to the C-51 canal at a single location (river station 89727) downstream of pump station 319 (river station 97360), while the discharge in Alternative B1 is distributed among three locations (PS #3, #4, and #6) along the C-51 canal. The data table for Figure 4-4a is included in Appendix C-2.

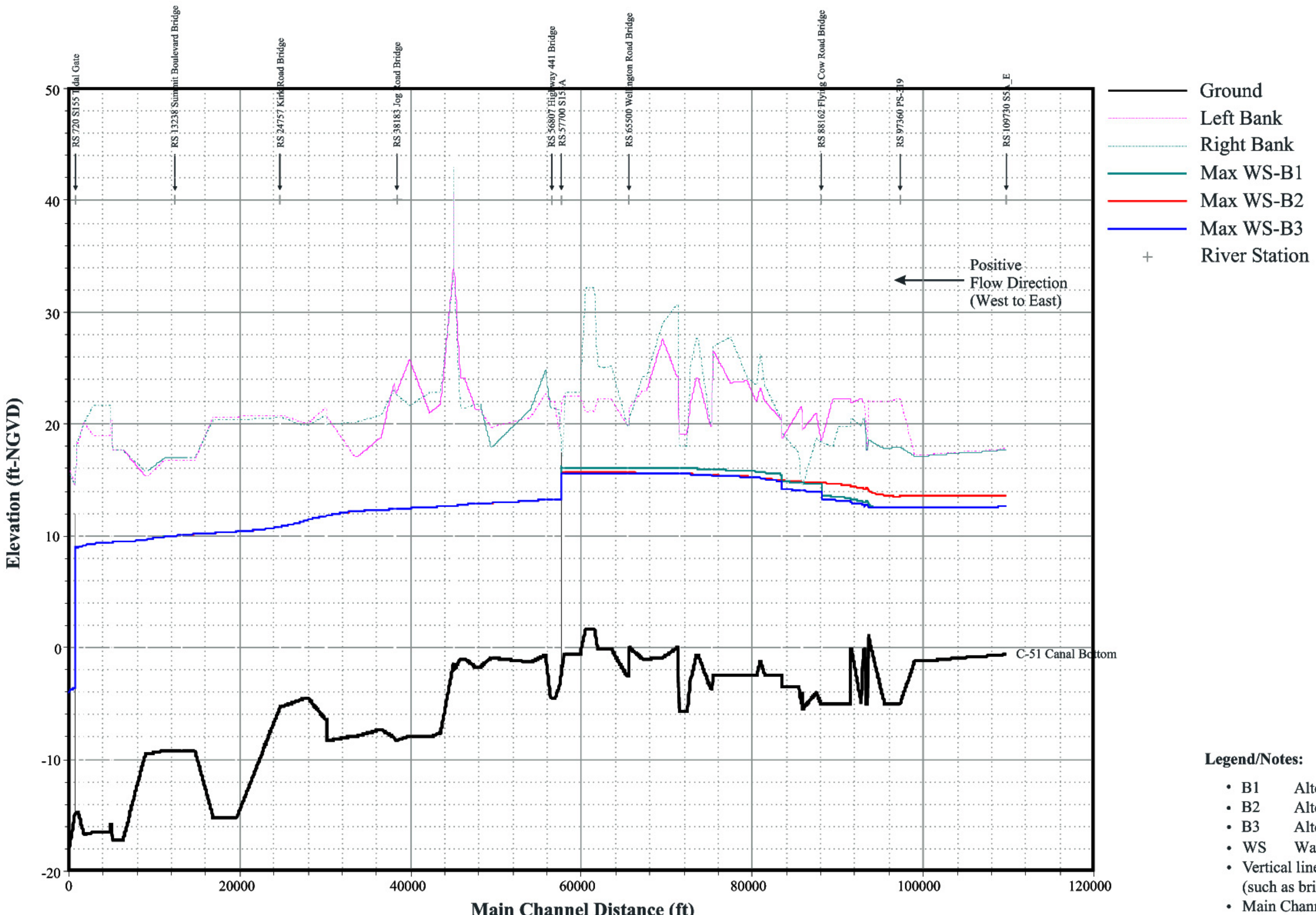
Figure 4-4b presents the simulated time-stage hydrographs at selected cross-sections along the C-51 canal west of S-155A. Hydrographs for all alternatives are plotted in the same graph for each selected cross-section. This allows for a direct comparison of the hydrographs resulting from various alternatives. Alternative B2 generally produced the highest stage in close proximity and west of the pump station 319, while Alternative B1 generally produced the highest stage farther east of the pump station 319 near the structure S-155A. The maximum stage difference between the pump station 319 and the structure S-155A is approximately 4 feet for B1 and about 2.5 feet for other alternatives. The data table for the Figure 4-4b is included in the Appendix C-2.

The peak stage along the C-51 canal occurs at the structure S-155A for the C-51 West basin. The peak stages at this station (RS 57730) for Alternatives A1, B1, B2, and B3 are 15.6, 16.1, 15.7, and 15.6 ft-NGVD, respectively. This demonstrates that there is insignificant difference in stages between Alternatives A1, B2 and B3. The difference in stages at this station between Alternatives A1 and B1 is only 0.5 ft that is attributed to the location of pumps discharging from sub-basin 13 to the C-51 canal.

Table 4-4a
Comparison of Alternatives for 10-Year, 72-Hour Storm Event

Sub-Basin		Area		Flow for Various Alternatives (cfs)			Improvement Over Alternative A1 (cfs)		
ID	Other ID	(acre)	(sq mi)	B1	B2	B3	B1	B2	B3
1	B1	1164.3	1.82	48	48	48	0	0	0
2A	STA1E	6715.8	10.49	--	--	--	--	--	--
2B	B2B	1226.4	1.92	50	50	50	0	0	0
3	B3	579.4	0.91	26	26	26	0	0	0
4	B4	540.0	0.84	29	29	29	0	0	0
5	B5	1142.5	1.78	50	54	53	-3	1	0
6	B6	673.5	1.05	67	67	67	0	0	0
7	B7	4126.9	6.45	151	150	151	0	-1	0
8	B8	3966.8	6.20	260	260	260	0	0	0
9	B9	72.8	0.11	9	9	9	0	0	0
10	B10	208.0	0.32	3	3	3	0	0	0
11	B11	8138.3	12.71	1314	1357	1360	-46	-3	0
12	B12	74.1	0.12	35	35	35	0	0	0
13	B13	10537.9	16.46	897	406	406	491	0	0
14	B14	9270.3	14.48	501	491	491	--	--	--
15A	B15A	5116.7	7.99	825	826	827	-1	0	1
15B	B15B	8640.6	13.50	--	--	--	--	--	--
16A	B16A	1064.4	1.66	384	384	384	0	0	0
16B	B16B	2448.8	3.83	26	26	26	0	0	0
20A	B20A	1138.6	1.78	97	127	131	-34	-4	0
17	B17	1650.5	2.58	384	384	384	0	0	0
18	B18	2294.9	3.58	323	323	323	1	1	1
20B	B20B	2341.8	3.66	535	535	535	0	0	0
21A	B21A	3540.4	5.53	0	0	0	0	0	0
21B	B21B	5056.2	7.90	111	111	111	0	0	0
22	B22	7375.2	11.52	371	371	371	0	0	0
23	B23	4206.9	6.57	675	675	675	0	0	0
24	B24	5282.0	8.25	452	452	452	0	0	0
25A	B25A	205.8	0.32	368	368	370	-2	-2	0
25B	B25B	972.1	1.52	325	328	344	-19	-16	0
26	B26	376.1	0.59	107	107	107	0	0	0
27	B27	830.7	1.30	320	320	320	0	0	0
28	B28	223.4	0.35	267	264	270	-3	-6	0
29A	B29A	1578.1	2.46	309	309	309	0	0	0
29B	B29B	440.3	0.69	628	628	628	0	0	0
30	B30	1153.0	1.80	123	123	123	0	0	0
31	B31	1467.8	2.29	333	333	333	0	0	0
32	B32	1812.7	2.83	278	278	278	0	0	0
33	B33	2323.9	3.63	272	272	272	0	0	0
34	B34	711.3	1.11	138	136	137	1	-1	0
35	B35	172.9	0.27	45	45	45	0	0	0
36	B36	603.3	0.94	81	84	79	2	5	0
37	B37	390.2	0.61	95	92	93	2	-1	0
38	B38	1955.2	3.05	145	145	145	0	0	0

-- did not contribute to the Basin Rule evaluation or not applicable



Legend/Notes:

- B1 Alternative B1: Inflow to C-51 through ACME Basin A
- B2 Alternative B2: Direct Discharge to C-51 West of ACME Basin A
- B3 Alternative B3: Direct Discharge to STA-1 East
- WS Water Surface
- Vertical lines represent locations of hydraulic structures (such as bridges, culverts, etc.)
- Main Channel Distance is measured from downstream end (same as River Station)

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APPROVED BY		07/06/04
FILE NAME: FL02006-TM3-Figure 4-4A.cdr		

I hereby certify that this document was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Florida.

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NAME

DATE REG. NO.

MAXIMUM WATER SURFACE PROFILES ALONG C-51 FOR 10-YR, 72-HR STORM EVENT FOR ALTERNATIVES B1 THROUGH B3

Reevaluation of the C-51 Basin Rule

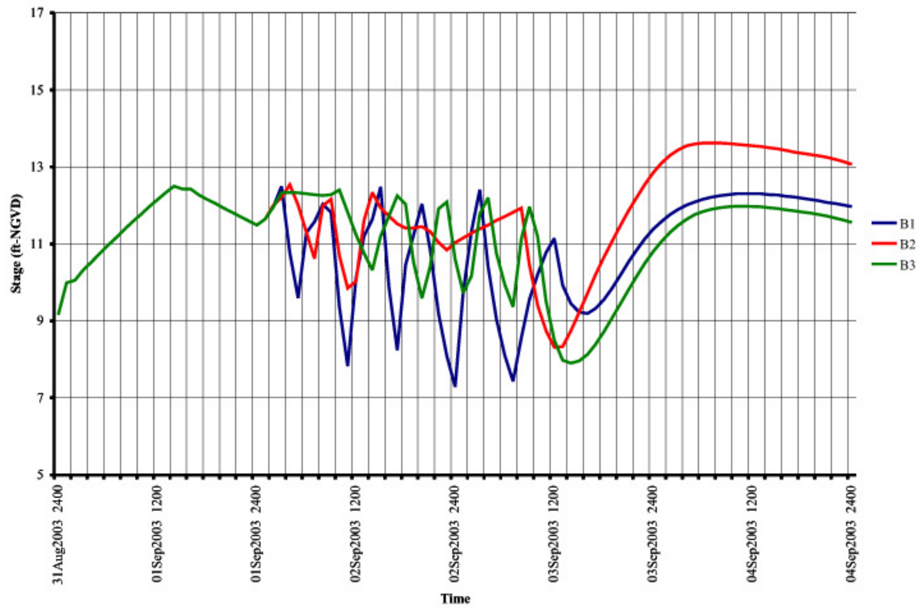
Technical Memorandum #3: Model Application

South Florida Water Management District, Contract No. C-13412

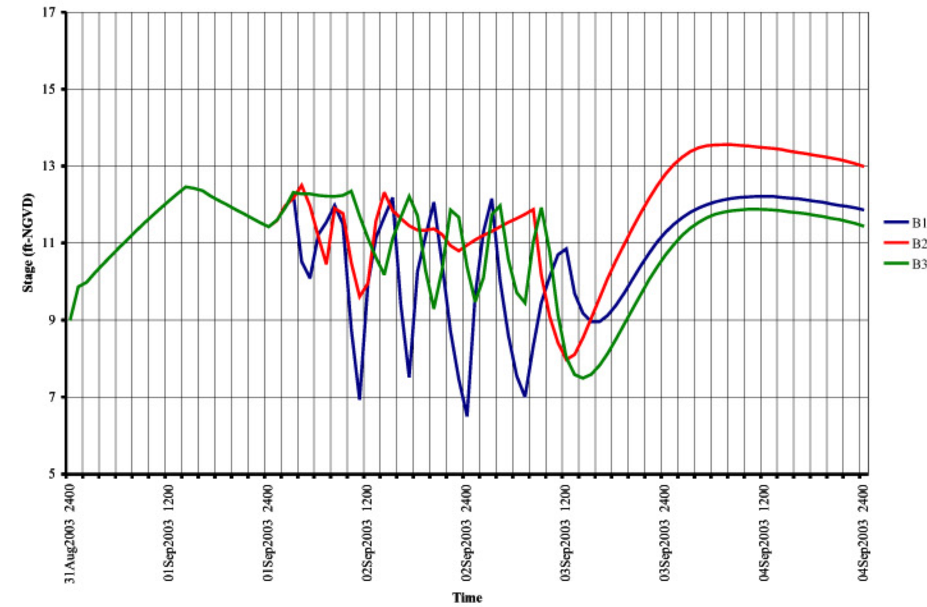
FIGURE 4-4A

FILE NUMBER FL02006 SHEET __OF__

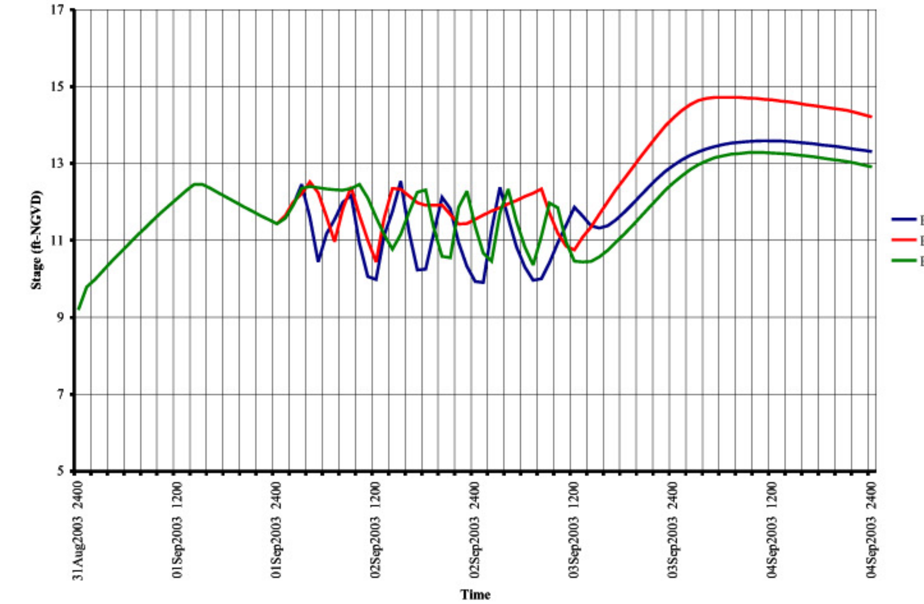
RS 109730 S5A-E



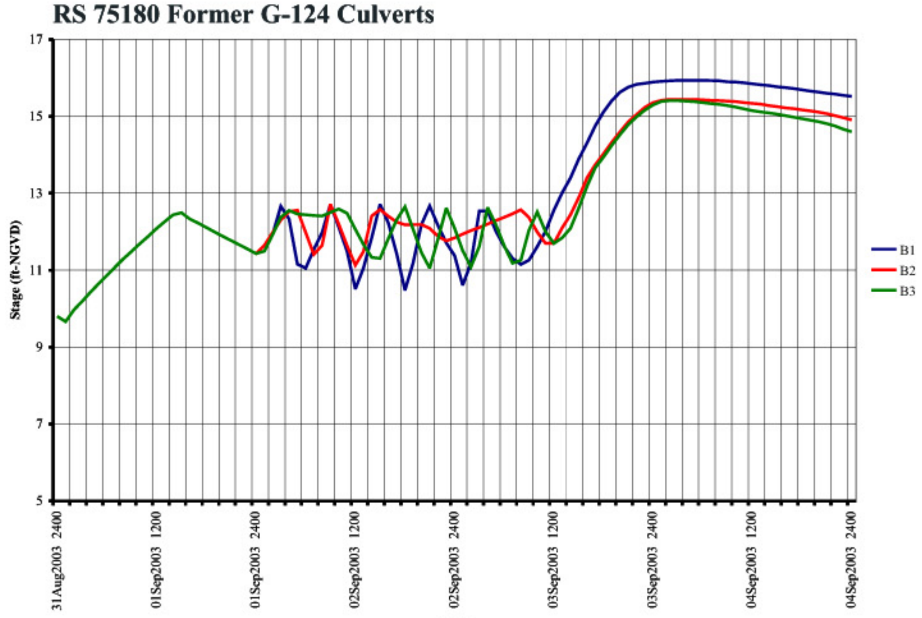
RS 97360 PS-319



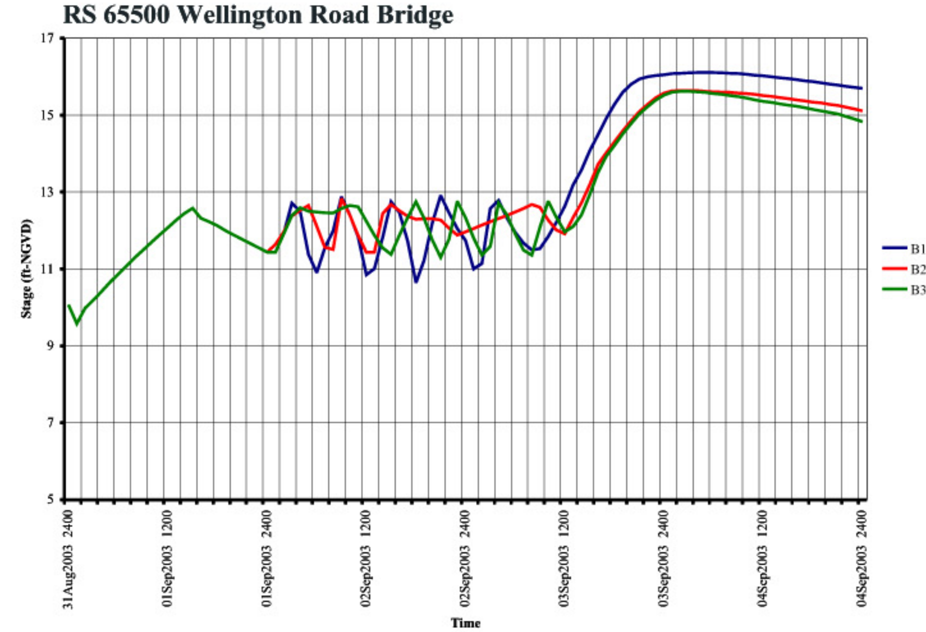
RS 88162 Flying Cow Road Bridge



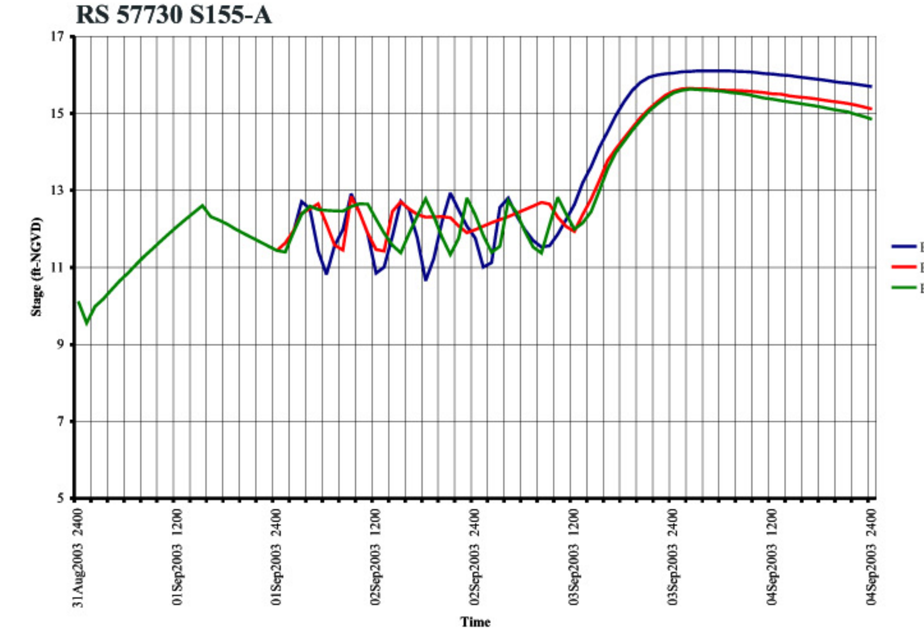
RS 75180 Former G-124 Culverts



RS 65500 Wellington Road Bridge



RS 57730 S155-A



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FILE NAME: FL02006-TM3-Figure 4-4B.cdr		

I hereby certify that this document was prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Florida.

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TIME-STAGE HYDROGRAPHS AT SELECTED LOCATIONS ALONG C-51 FOR 10-YR, 72-HR STORM EVENT FOR ALTERNATIVES B1 THROUGH B3

Reevaluation of the C-51 Basin Rule

Technical Memorandum #3: Model Application

South Florida Water Management District, Contract No. C-13412

FIGURE 4-4B

FILE NUMBER FL02006 SHEET ___OF___

4.5.2 Peak Stage Simulation

Table 4-4b summarizes the simulated peak stage for the design storm event (100-year, 72-hour) for all the ACME Basin B improvement alternatives. This table also presents the improvement on allowable stage for various alternatives over Alternative A1 conditions (Table 3-3b). As can be seen from this table, there is insignificant difference in peak stage for each sub-basin amongst the Alternatives B1 through B3. A review of this table also indicates that there is no adverse impact on the peak stages for each sub-basin due to the incorporation of the ACME Basin B into the C-51 basin conveyance system. Like the Alternatives A1 through A3 (Table 3-7b), there is a significant improvement on peak stage for the sub-basins resulting from these alternatives over the existing rule condition. Compared to the basin rule alternatives (Section 3.5.2), only sub-basin 13 will have slightly lower (by about 0.4 ft) stage for the Alternative B1. This is attributed to the ACME Basin B runoff being routed through the ACME Basin A prior to discharging to the C-51 canal and the increased pumping capacities serving both basins.

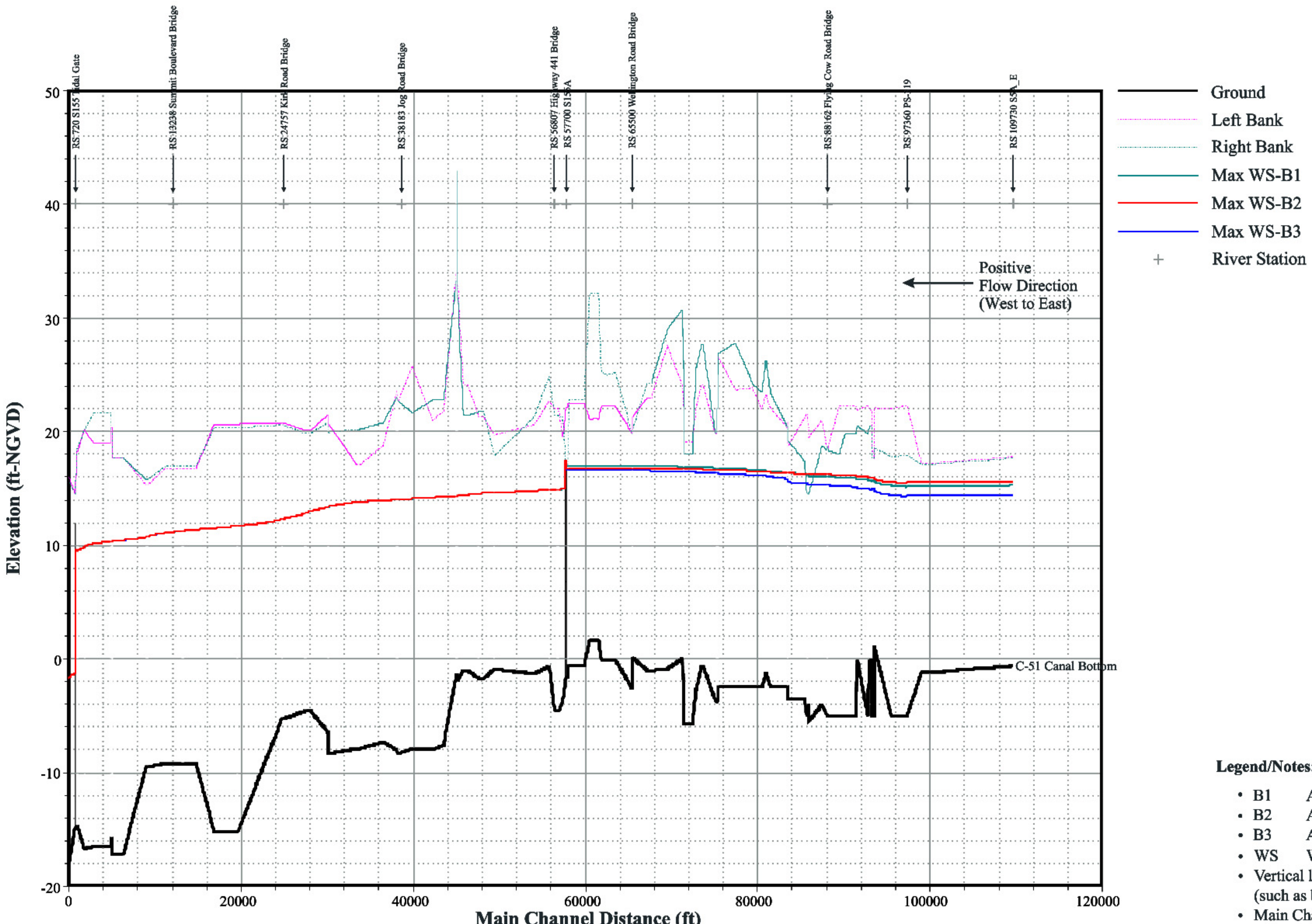
Figure 4-5a presents the simulated maximum water surface profiles along the C-51 canal for all the alternatives. This figure provides a direct comparison of the water surface profiles for all the alternatives along the C-51 canal. As can be seen from this figure, Alternative B3 has the lowest water surface profile since it has no discharge to the C-51 canal, rather it directly pumps to the STA-1E, and thus has the least impact on the C-51 canal.

Figure 4-5b presents the simulated time-stage hydrographs at selected cross-sections along the C-51 canal west of S-155A. The hydrographs for all alternatives are plotted in the same graph for each selected cross-section. This allows for a direct comparison of the hydrographs resulting from various alternatives. Alternative B2 generally produced the highest stage in close proximity to the pump station 319, while Alternative B1 generally produced the highest stage farther away from the pump station 319 near the S-155A structure. The maximum stage difference between pump station 319 and the S-155A structure is approximately two feet for all of the alternatives. The data table for Figure 4-5b is included in Appendix C-2.

Table 4-4b
Comparison of Alternatives for 100-Year, 72-Hour Storm Event

Sub-Basin		Area		Stage for Various Alternatives (ft-NGVD)			Improvement Over Alternative A1 (ft)		
ID	Other ID	(acre)	(sq mi)	B1	B2	B3	B1	B2	B3
1	B1	1164.3	1.82	14.2	14.2	14.2	0	0	0
2A	STA1E	6715.8	10.49	--	--	--	--	--	--
2B	B2B	1226.4	1.92	13.8	13.8	13.8	0	0	0
3	B3	579.4	0.91	15.8	15.8	15.8	0	0	0
4	B4	540.0	0.84	16.6	16.6	16.6	0	0	0
5	B5	1142.5	1.78	17.4	17.4	17.4	0	0	0
6	B6	673.5	1.05	19.2	19.2	19.2	0	0	0
7	B7	4126.9	6.45	19.9	19.9	19.9	0	0	0
8	B8	3966.8	6.20	20.6	20.6	20.6	0	0	0
9	B9	72.8	0.11	17.6	17.6	17.6	0	0	0
10	B10	208.0	0.32	18.3	18.3	18.3	0	0	0
11	B11	8138.3	12.71	18.9	18.9	18.9	0	0	0
12	B12	74.1	0.12	17.5	17.5	17.5	0	0	0
13	B13	10537.9	16.46	16.2	16.6	16.6	-0.4	0	0
14	B14	9270.3	14.48	16.0	15.6	15.6	--	--	--
15A	B15A	5116.7	7.99	18.2	18.2	18.2	0	0	0
15B	B15B	8640.6	13.50	--	--	--	--	--	--
16A	B16A	1064.4	1.66	17.0	16.8	16.8	0.2	0	0
16B	B16B	2448.8	3.83	19.0	19.0	19.0	0	0	0
20A	B20A	1138.6	1.78	16.4	16.2	16.1	0.3	0.1	0
17	B17	1650.5	2.58	16.6	16.6	16.6	0	0	0
18	B18	2294.9	3.58	15.7	15.7	15.7	0	0	0
20B	B20B	2341.8	3.66	16.8	16.8	16.8	0	0	0
21A	B21A	3540.4	5.53	17.3	17.3	17.3	0	0	0
21B	B21B	5056.2	7.90	17.7	17.7	17.7	0	0	0
22	B22	7375.2	11.52	17.5	17.5	17.5	0	0	0
23	B23	4206.9	6.57	17.1	17.1	17.1	0	0	0
24	B24	5282.0	8.25	17.9	17.9	17.9	0	0	0
25A	B25A	205.8	0.32	14.6	14.6	14.6	0	0	0
25B	B25B	972.1	1.52	14.7	14.7	14.7	0	0	0
26	B26	376.1	0.59	13.8	13.8	13.8	0	0	0
27	B27	830.7	1.30	13.2	13.2	13.2	0	0	0
28	B28	223.4	0.35	12.4	12.4	12.3	0.1	0.1	0
29A	B29A	1578.1	2.46	14.8	14.8	14.8	0	0	0
29B	B29B	440.3	0.69	15.2	15.2	15.2	0	0	0
30	B30	1153.0	1.80	14.1	14.1	14.1	0	0	0
31	B31	1467.8	2.29	13.1	13.1	13.1	0	0	0
32	B32	1812.7	2.83	13.0	13.0	13.0	0	0	0
33	B33	2323.9	3.63	13.6	13.6	13.6	0	0	0
34	B34	711.3	1.11	17.0	17.0	17.0	0	0	0
35	B35	172.9	0.27	11.3	11.3	11.3	0	0	0
36	B36	603.3	0.94	14.0	14.0	14.0	0	0	0
37	B37	390.2	0.61	16.4	16.4	16.4	0	0	0
38	B38	1955.2	3.05	17.2	17.2	17.2	0	0	0

-- did not contribute to the Basin Rule evaluation or not applicable



Legend/Notes:

- B1 Alternative B1: Inflow to C-51 through ACME Basin A
- B2 Alternative B2: Direct Discharge to C-51 West of ACME Basin A
- B3 Alternative B3: Direct Discharge to STA-1 East
- WS Water Surface
- Vertical lines represent locations of hydraulic structures (such as bridges, culverts, etc.)
- Main Channel Distance is measured from downstream end (same as River Station)

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MAXIMUM WATER SURFACE PROFILES ALONG C-51 FOR 100-YR, 72-HR STORM EVENT FOR ALTERNATIVES B1 THROUGH B3

Reevaluation of the C-51 Basin Rule

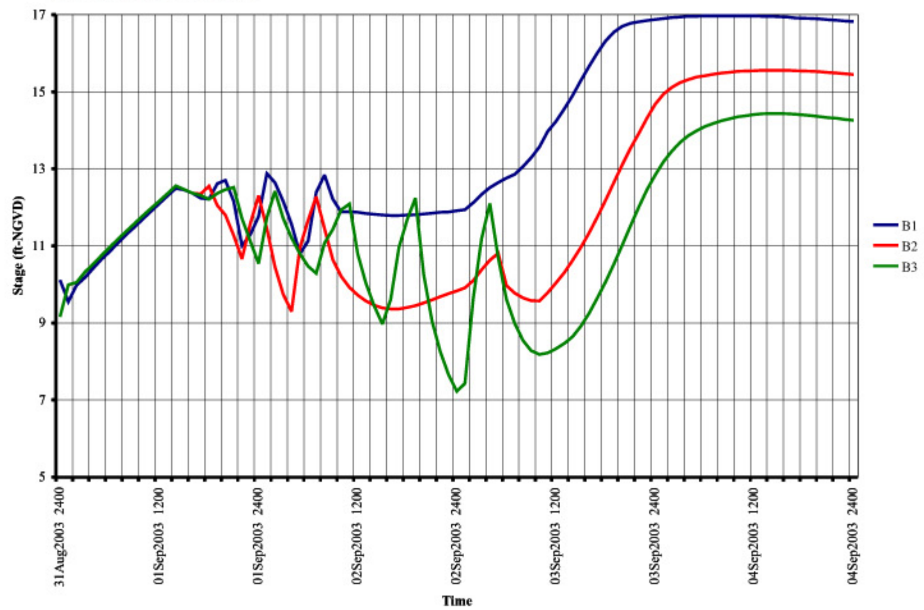
Technical Memorandum #3: Model Application

South Florida Water Management District, Contract No. C-13412

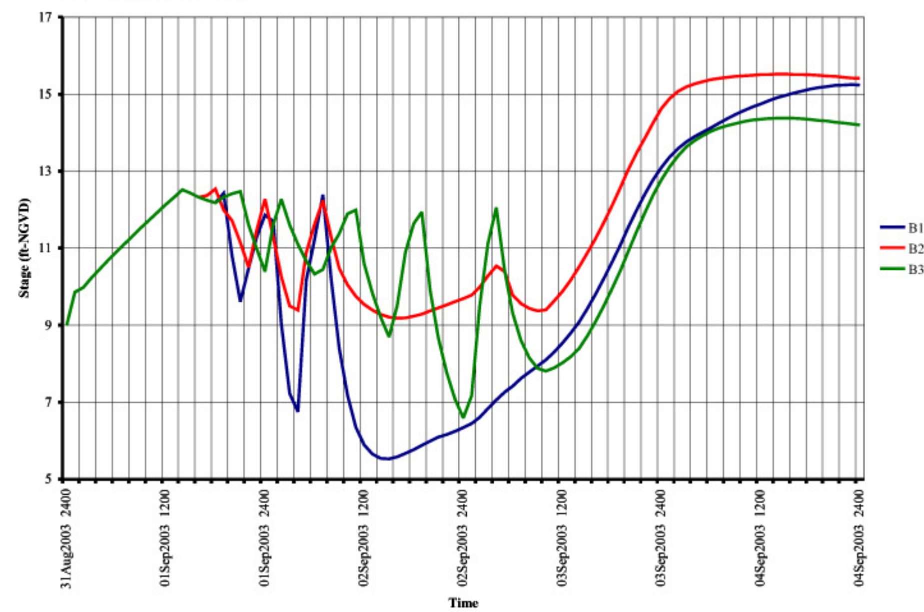
FIGURE 4-5A

FILE NUMBER FL02006 SHEET ___ OF ___

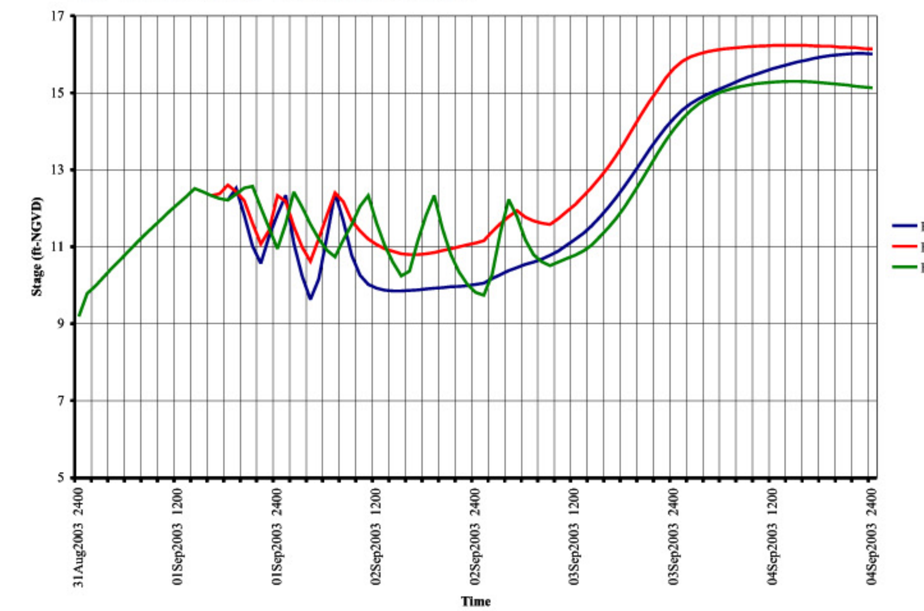
RS 109730 S5A-E



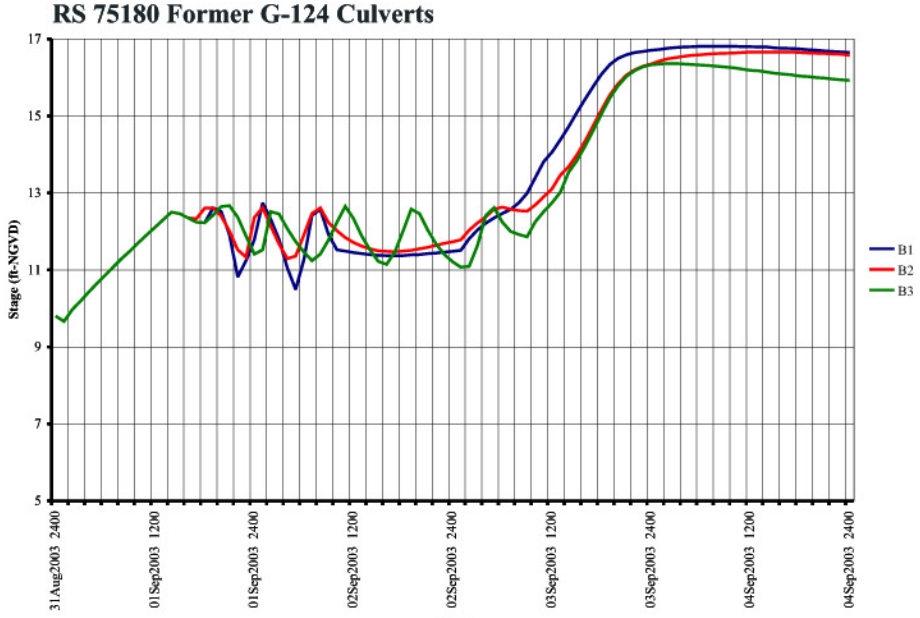
RS 97360 PS-319



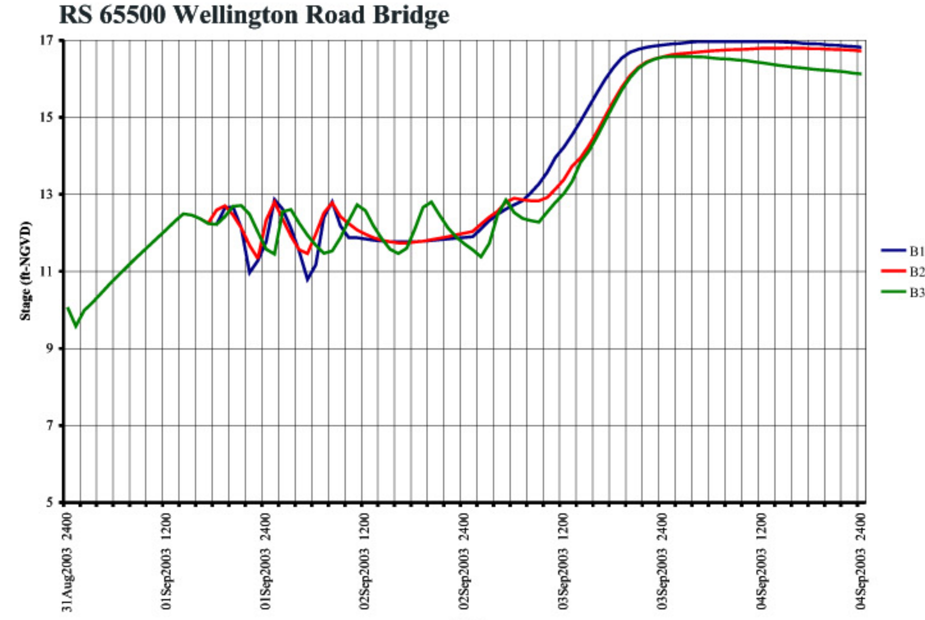
RS 88162 Flying Cow Road Bridge



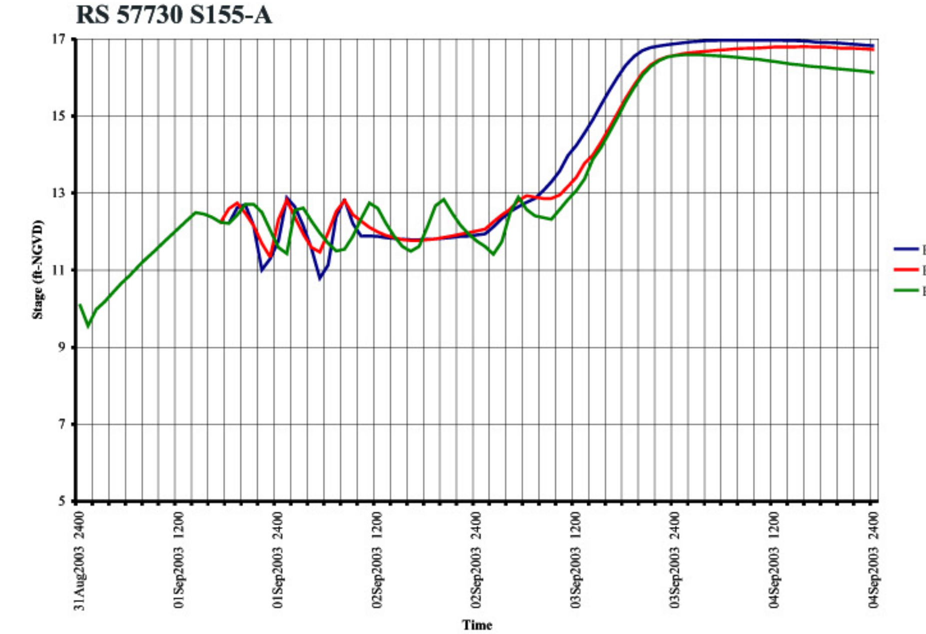
RS 75180 Former G-124 Culverts



RS 65500 Wellington Road Bridge



RS 57730 S155-A



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TIME-STAGE HYDROGRAPHS AT SELECTED LOCATIONS ALONG C-51 FOR 100-YR, 72-HR STORM EVENT FOR ALTERNATIVES B1 THROUGH B3

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 4-5B

FILE NUMBER FL02006 SHEET ___OF___

5.0 BASIN RULE LANGUAGE AND RECOMMENDATION

5.1 RECOMMENDED ALLOWABLE DISCHARGES AND STAGES

In accordance with the contractual scope of services, the model application was completed in this task (Task 3). In order to begin the basin rule, based on the results presented in this report, we conclude that higher allowable discharges than the existing rule can be allocated for most of the sub-basins. In addition, the allowable 100-year peak stages can be lower than the existing rule conditions for all sub-basins.

Based on the model applications presented in this report, the recommended allowable discharge coefficients and peak stages are summarized in Table 5-1. The recommended allowable discharge coefficients for all sub-basins are shown on Figure 5-1. The recommended 100-year peak stages for all sub-basins are shown on Figure 5-2. These recommended discharge values are the same as the USACE Design discharge values for the C-51 West sub-basins. The recommended discharge values for the C-51 East sub-basins are equivalent to the USACE design capacity of the S-155 Spillway of 4,800 cfs divided by its service area of 73.4 square miles (equals to 65 CSM).

5.2 BASIN RULE LANGUAGE

The scope of work calls for assisting the District in developing the basin rule, which includes proposing draft language and attending the public meetings with the District staff. The recommended language for the new Basin Rule is as follows:

"40E-41.263 – Conditions for issuance of Surface Water Management Permits in the C-51 Basin.

The following criteria shall apply:
(1)(a) The allowable discharge shall be based upon the post development discharge rate not exceeding the rate as depicted on Figure 41-8 (revised 2003) during a design storm of 10-year 3-day duration. The allowable discharge rate shall be calculated by the formula:

Q = (Csub) (A/640)
Where
Q = allowable flow in cubic feet per second (cfs);
A = Project size in acres;
Csub = discharge coefficient under design conditions

(b) This criteria is not intended to limit inflows to the C-51 canal to the rates specified in subsection (a) above during non-flood conditions. Discharge capacity during non-flood conditions shall be considered on a case-by-case basis pursuant to the criteria in Rule 40E-4.091 (1)(a), Florida Administrative Code, (Basis of Review) and Rule 40E-4.301, Florida Administrative Code, (Conditions for Issuance).

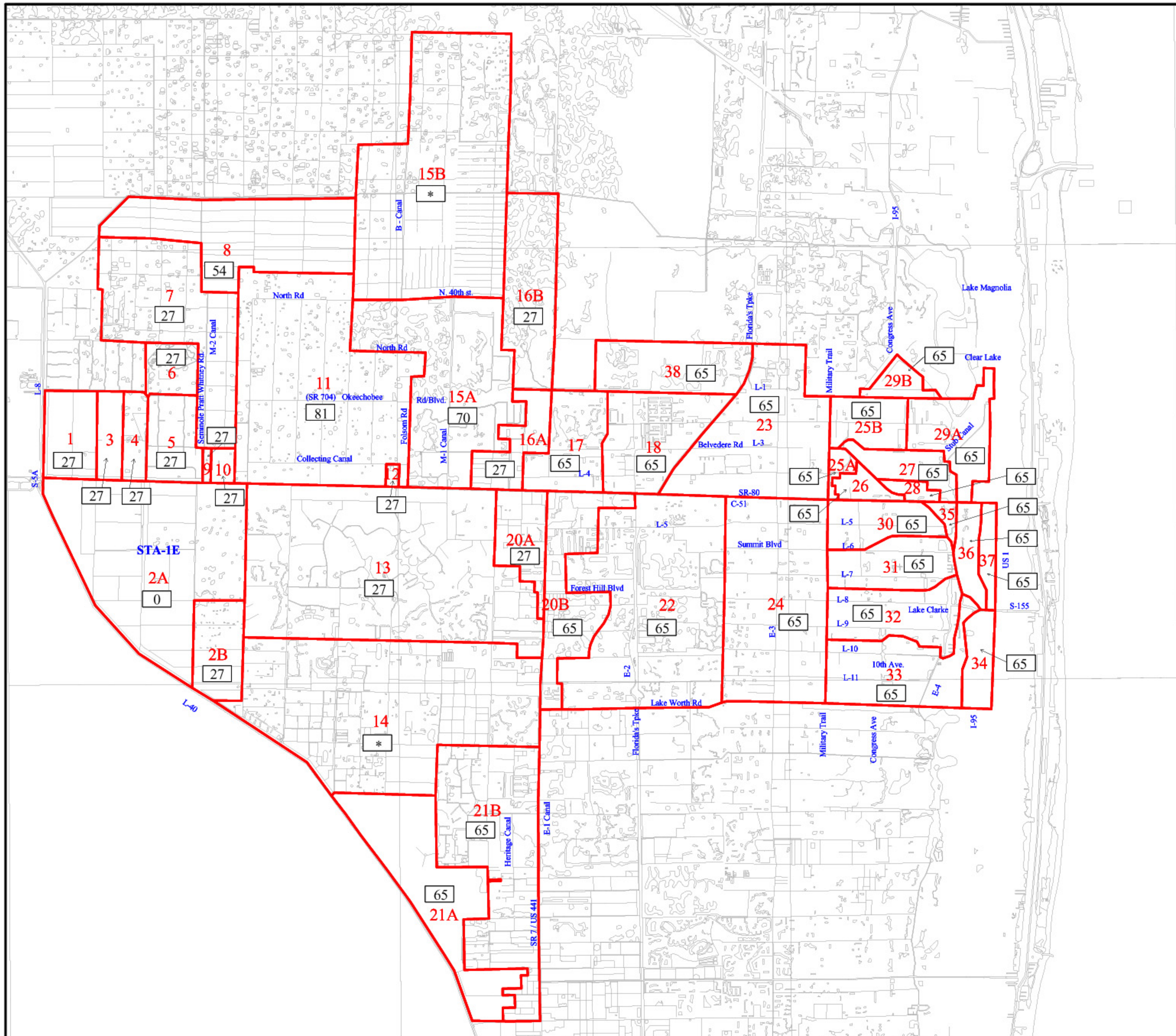
(2) Finished building floor elevations shall be above the most restrictive of the following:
(a) the 1-in 100 year storm elevations as determined by peak flood stages in the C-51 Basin as depicted on the attached Figure 41-9 (revised 2003), or
(b) the on-site stage created by a 100-year 3-day storm event assuming no offsite discharge.
(3) No net encroachment into the floodplain shall be allowed. Any water storage volume removed from the floodplain must be accommodated by an equal volume of open storage compensation. Water Storage volume shall be computed by utilizing Figure 41-9 (revised). For the purposes of this part, the minimum volume of water which must be accommodated on site shall be that quantity equal to the volume of water stored below the level shown on Figure 41-9 (revised 2003) and above the existing grades. Compensation for any reduction in soil storage shall also be accommodated on-site.
(4) All criteria in the Basis of Review which is incorporated and adopted by Florida Administrative Code Rule 40E-4.091, (Environmental Resource Permits, Publications, Rules and Interagency Agreements Incorporated by Reference).
(5) Projects within the C-51 Basin shall provide one half inch of dry retention/detention pretreatment as part of the required retention/detention.
Specific Authority 373.044, 373.113 FS.
Law Implemented 373.085, 373.413, 373.416 FS.
History – Revised 2003."

This proposed language includes consideration of additional Best Management Practices for the entire C-51 Basin for water quality improvement. The original Basin Rule in 1987 included this for the western basin because of the concerns for the quality of water entering the Water Conservation Area 1. During this rule reevaluation process concerns were expressed by local representatives over the potential impacts of new development on the Lake Worth Lagoon. The federal improvement project will greatly improve the quantity, timing and delivery of runoff to the Lagoon. By extending the extra pretreatment criteria to new projects in the eastern basin, the Lake Worth Lagoon can also benefit from improved water quality over time.

Table 5-1
Summary of Recommended Allowable Discharges and Stages

Sub-Basin		Area		10-yr, 72-hr Allowable Discharge			100-yr, 72-hr Stage
ID	Other ID	(acre)	(sq mi)	Flow (CSM)	Flow (cfs)	Flow (in/day)	(ft-NGVD)
1	B1	1164.3	1.82	27	49	1.0	14.2
2A	STA1E	6715.8	10.49	--	--	--	--
2B	B2B	1226.4	1.92	27	52	1.0	13.8
3	B3	579.4	0.91	27	25	1.0	15.8
4	B4	540.0	0.84	27	23	1.0	16.6
5	B5	1142.5	1.78	27	48	1.0	17.4
6	B6	673.5	1.05	27	28	1.0	19.2
7	B7	4126.9	6.45	27	174	1.0	19.9
8	B8	3966.8	6.20	54	335	2.0	20.6
9	B9	72.8	0.11	27	3	1.0	17.6
10	B10	208.0	0.32	27	9	1.0	18.3
11	B11	8138.3	12.71	81	1,030	3.0	18.9
12	B12	74.1	0.12	27	3	1.0	17.5
13	B13	10537.9	16.46	27	444	1.0	16.6
14	B14	9270.3	14.48	--	--	--	--
15A	B15A	5116.7	7.99	70	559	2.6	18.2
15B	B15B	8640.6	13.50	--	--	--	--
16A	B16A	1064.4	1.66	27	45	1.0	16.8
16B	B16B	2448.8	3.83	27	103	1.0	19.0
20A	B20A	1138.6	1.78	27	48	1.0	16.1
17	B17	1650.5	2.58	65	168	2.4	16.6
18	B18	2294.9	3.58	65	233	2.4	15.7
20B	B20B	2341.8	3.66	65	238	2.4	16.8
21A	B21A	3540.4	5.53	65	360	2.4	17.3
21B	B21B	5056.2	7.90	65	514	2.4	17.7
22	B22	7375.2	11.52	65	749	2.4	17.5
23	B23	4206.9	6.57	65	427	2.4	17.1
24	B24	5282.0	8.25	65	536	2.4	17.9
25A	B25A	205.8	0.32	65	21	2.4	14.6
25B	B25B	972.1	1.52	65	99	2.4	14.7
26	B26	376.1	0.59	65	38	2.4	13.8
27	B27	830.7	1.30	65	85	2.4	13.2
28	B28	223.4	0.35	65	23	2.4	12.3
29A	B29A	1578.1	2.46	65	160	2.4	14.8
29B	B29B	440.3	0.69	65	45	2.4	15.2
30	B30	1153.0	1.80	65	117	2.4	14.1
31	B31	1467.8	2.29	65	149	2.4	13.1
32	B32	1812.7	2.83	65	184	2.4	13.0
33	B33	2323.9	3.63	65	236	2.4	13.6
34	B34	711.3	1.11	65	72	2.4	17.0
35	B35	172.9	0.27	65	18	2.4	11.3
36	B36	603.3	0.94	65	61	2.4	14.0
37	B37	390.2	0.61	65	40	2.4	16.4
38	B38	1955.2	3.05	65	198	2.4	17.2

-- did not contribute to the Basin Rule evaluation or not applicable



Legend:

65	Csub = Allowable Discharge Coefficient in CSM
CSM	Cubic Feet per Second per Square Mile
*	Sub-basin NOT included in Rule

N

Scale 1:144,000

0 10000 20000 30000 40000 Feet

Source:
Land Boundary Information System (www.labins.org)
The most up-to-date or based on the 1994 DOQQs
State Plane Projection; NAD 83 Datum; In Shape File FORMAT for:
West Palm Beach 2 SE, Delta, Rivera Beach, Loxahatchee, Palm Beach Farms, Palm Beach, Loxahatchee SE, Greenacres City, Lake Worth, Florida

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SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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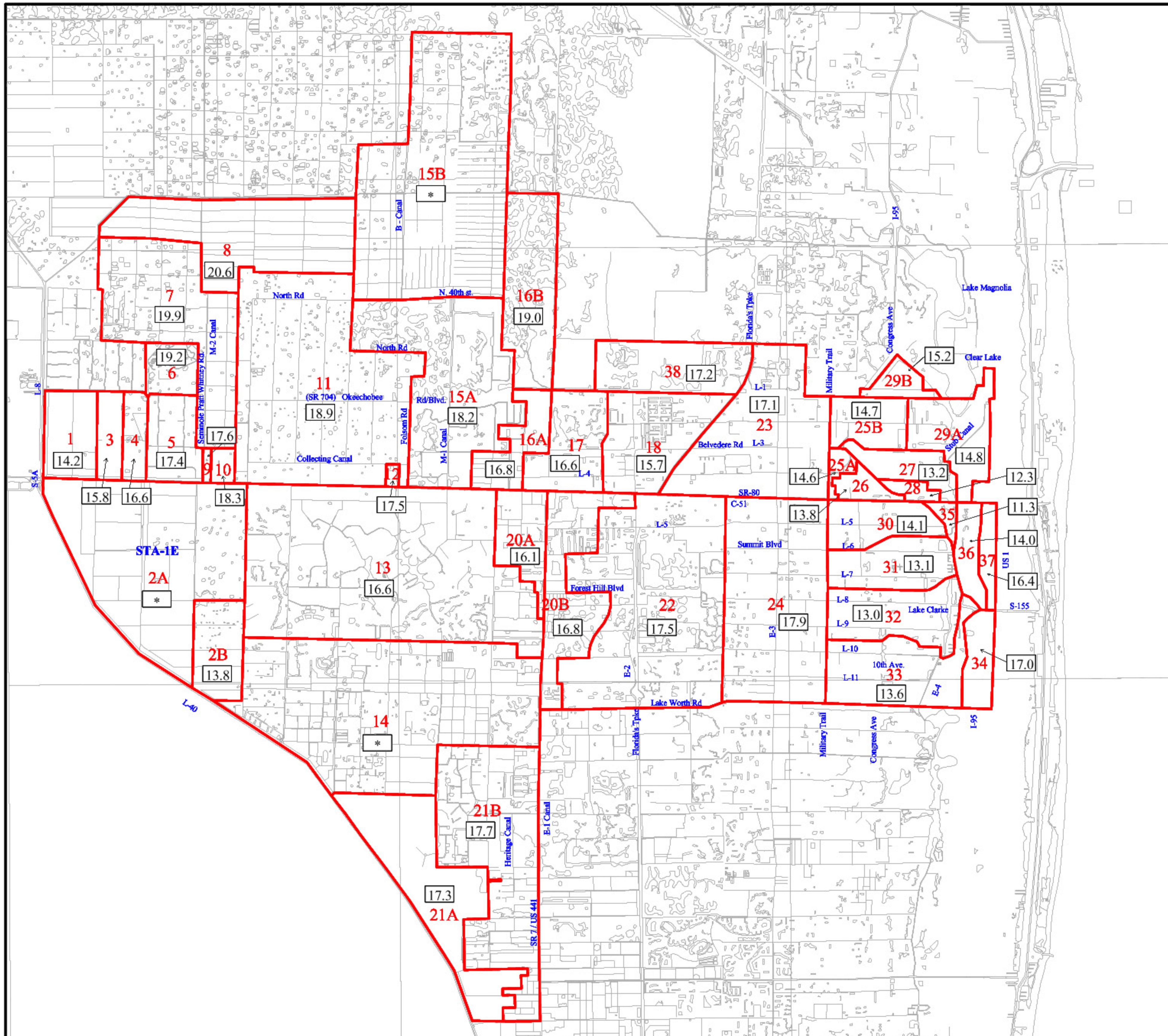
DISCHARGE COEFFICIENTS FOR THE SUB-BASINS OF THE C-51 BASIN IN PALM BEACH COUNTY, FLORIDA
[FIGURE 41-8 (REVISED 2004)]

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 5-1

FILE NUMBER FL02006 SHEET ____ OF ____



Legend:

13.1	Peak Flood Stage in ft-NGVD during a 1-in-100 year Storm Event (Minimum Floor Elevation)
*	Sub-basin NOT included in Rule

Scale 1:144,000

0 10000 20000 30000 40000 Feet

Source:
Land Boundary Information System (www.labins.org)
The most up-to-date or based on the 1994 DOQQs
State Plane Projection; NAD 83 Datum; In Shape File FORMAT for:
West Palm Beach 2 SE, Delta, Rivera Beach, Loxahatchee, Palm Beach Farms, Palm Beach, Loxahatchee SE, Greenacres City, Lake Worth, Florida

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PEAK FLOOD STAGE (ft-NGVD) DURING A 1-IN-100 YEAR STORM EVENT AND MINIMUM FLOOR ELEVATION
[FIGURE 41-9 (REVISED 2004)]

Reevaluation of the C-51 Basin Rule
Technical Memorandum #3: Model Application
South Florida Water Management District, Contract No. C-13412

FIGURE 5-2

FILE NUMBER FL02006 SHEET ____ OF ____

6.0 REFERENCES

Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55), Soil Conservation Service, 2nd Edition, June 1986

Hydrologic Modeling System (HEC-HMS) User's Manual, Version 2.1, January 2001

Hydrologic Modeling System (HEC-HMS) Release Notes, Version 2.2.1, October 2002

River Analysis System (HEC-RAS) User's Manual, Version 3.1.1, May 2003

APPENDICES