RES 17-06

MEMORANDUM

TO: Jayantha Obeysekera, Director, HSM

THROUGH: Luis Cadavid, Sr. Supervising Engineer, HSM
Ken Tarboton, Sr. Supervising Engineer, HSM

FROM: Raul Novoa, Staff Engineer, HSM
Alaa Ali, Sr. Engineer, HSM

DATE: April 12, 2000

SUBJECT: Special Investigation: Alternative D13R without Lake Belt Reservoirs and ASRs

Definition of Simulation

The Restudy preferred alternative relies heavily on storage features to provide the ability to carry over excess water from wet years to dry years. In this investigation, the degree to which the preferred alternative relies on aquifer storage and deep inground reservoirs in the Lake Belt region is assessed by simulation of the following three scenarios that remove features from alternative D13R (AD13R): (1) both the North and Central Lake Belt Reservoirs are removed (NOLKBTs), (2) all Aquifer Storage and Recovery (ASR) components are removed (NOASRs), and (3) the North and Central Lake Belt Reservoirs in conjunction with all ASR components are removed (NOBOTH). Version 3.5 of the South Florida Water Management Model (SFWMM) was used for the simulations.

Background

The North Lake Belt and Central Lake Belt Storage Areas (NLBSA and CLBSA) are in-ground reservoirs with perimeter seepage barriers. The NLBSA has a storage area of 4500 acres with up to 20 feet of working storage for a total volumetric capacity of 90,000 ac-ft (the SFWMM assumes 5120 acres of surface area with water levels adjusted to simulate equivalent working storage volumes). The reservoir captures a portion of runoff from C-6, western C-11 and C-9 basins and uses the stored water to maintain stages during the dry season in the C-9, C-6, C-7, C-4 and C-2 Canals and to provide deliveries to Biscayne Bay to aid in meeting salinity targets. The CLBSA has a storage area of 5200 acres with up to 36 feet of working storage for a total volumetric capacity of 187,200 ac-ft. The reservoir receives excess water from Water Conservation Areas (WCA) 2B, 3A and 3B. The stored water is provided to Northeast Shark River Slough (NESRS) when it is needed and available. The SFWMM representation of canal and structure features with the Lake Belt storage areas in place is shown in Figure 1, and without the Lake Belt storage areas in Figure 2.

Aquifer Storage and Recovery systems provide regional storage with larger carry over capacity than surface reservoirs because they do not have evapotranspiration losses (as modeled, there is no limit on the bubble size). Excess water is pumped into the aquifer during wet periods and it is removed by pumping from the aquifer during dry periods. Alternative D13R has the capacity to pump 1665 MGD into aquifer storage. This includes 1000 MGD around Lake Okeechobee (LOK), 220 MGD at the Caloosahatchee Reservoir, 170 MGD along the C-51 canal, 150 MGD at the Site 1 impoundment, 50 MGD at the WPB water catchment area, and 75 MGD at the PBC Agricultural Reserve Reservoir. In the simulations without ASR, the entire ASR capacity was removed.

Major Findings

Lake Belt Storage Areas Removed

• The dependence of the Lower East Coast Service Area 3 (LECSA3) on the regional system (LOK and the WCAs) for water supply increases, thereby also increasing the frequency of undesirable low stages in

Lake Okeechobee. Demands not met in the Lake Okeechobee Service Areas (LOSA), Caloosahatchee and St. Lucie basins increased 1-2% and water shortages increased in all service areas due to lower lake stages.

• Flows to Biscayne Bay via Snake Creek and Miami River increased with C9 and C6 basin runoff going to Biscayne Bay rather than to the North Lake Belt Reservoir. Flows to Central Biscayne Bay, which received a contribution from the North Lake Belt Reservoir, decrease.

• Without the Central Lake Belt Reservoir to provide dry season flows to Everglades National Park, the frequency of drawdowns in Northeast Shark River Slough more than doubles and the mean annual hydroperiod is reduced from 98 to 94%.

Aquifer Storage and Recovery Systems Removed

• The frequency of higher high stages and lower low stages in Lake Okeechobee increases, thereby also increasing regulatory discharges to the estuaries and increasing the number of undesirable high and low LOK events. Demands not met in the LOSA, Caloosahatchee and St. Lucie basins increased 6-10% and water shortages increased in all service areas due to lower lake stages.

• The dependence of the Lower East Coast Service Area 1 (LECSA1) on the regional system for water supply increases with removal of ASR.

Detailed Evaluation

• The NOLKBTs simulation shows an increase in the dependence on LOK and the WCAs for water supply to the Lower East Coast Service Area 3 (LECSA3) (Fig. 3) with an increase of 40 kac-ft/yr (from 49 in AD13R to 89 kac-ft/yr). Deliveries from LOK and the WCAs to the Lower East Coast Service Areas 1 and 2 (LECSA1 and LECSA2) are unaffected in the NOLKBTs simulation. In contrast, the NOASRs simulation shows an increase in the dependence on LOK and the WCAs for water supply to the LECSA1 with an increase of 21 kac-ft/yr (from 31 in AD13R to 52 kac-ft/yr). Deliveries from LOK and the WCAs to the LECSA2 and LECSA3 are unaffected in the NOASRs simulation. The increases are even more pronounced when comparing the water supply deliveries during the five drought years (Fig. 4). The NOLKBTs simulation shows an increase of 82 kac-ft/yr (from 148 in AD13R to 230 kac-ft/yr) for water supply to the LECSA3 and the NOASRs simulation shows an increase of 66 kac-ft/yr (from 66 in AD13R to 132 kac-ft/yr) for water supply to the LECSA1. These results indicate the importance of the Lake Belt Reservoirs and the ASR systems to the regional water resources in LECSA3 and LECSA1 respectively.

• The LOK stage duration curve (Fig. 5) shows that the lake stages decreased during dry periods (up to 0.4 ft) in the NOLKBTs simulation. The number of undesirable LOK stage events (Fig. 6) increased by one (from 1 in AD13R to 2) for lake stage less than 11 ft for longer than 100 days. In the NOASRs simulation, high lake stages increased (up to 1.0 ft) and low lake stages decreased (up to 0.9 ft). The total number of undesirable LOK stage events increased by five (from 4 in AD13R to 9). The number of times the LOK stage was greater than 17 ft for longer than 50 days increased by two (from 2 in AD13R to 4); the number of times the LOK stage was greater than 15 ft for longer than 2 years increased by two (from 0 in AD13R to 2); and the number of times the LOK stage was less than 11 ft for longer than 100 days increased by one (from 1 in AD13R to 2). In the NOBOTH simulation, high lake stages increased (up to 1.0 ft) and low lake stages decreased (up to 1.1 ft). The number of undesirable LOK stage events was identical to the NOASRs simulation for each of the criteria.

• The higher high lake stages in the NOASRs simulation caused an increase in regulatory discharges from LOK to the WCAs and the Caloosahatchee and St. Lucie Estuaries (Fig. 7). Regulatory discharges from LOK increased by 32 kac-ft/yr (from 13 in AD13R to 45 kac-ft/yr) to the Caloosahatchee Estuary and by 27 kac-ft/yr (from 11 in AD13R to 38 kac-ft/yr) to the St. Lucie Estuary. The higher high lake stages and lower low lake stages caused the total number of times that the salinity envelope criteria was not met to increase by 15 (from 47 in AD13R to 62) for the Caloosahatchee Estuary (Fig. 8) and by 8 (from 84 in AD13R to 92) for the St. Lucie Estuary (Fig. 9). Regulatory releases from Lake Okeechobee directly to the WCAs increased by 104 kac-ft/yr (from 101 in AD13R to 205 kac-ft/yr).

- The mean annual demands not met in the EAA and other LOSA areas (Fig. 10) increased by one percent in the NOLKBTs simulation (from 5 in AD13R to 6% in the EAA, and from 4 in AD13R to 5% in other LOSA areas). In the NOASRs simulation, the demands not met increased by six percent in the EAA and other LOSA areas (from 5 in AD13R to 11% in the EAA, and from 4 in AD13R to 10% in other LOSA areas). The C43 basin demand not met (Fig. 11) increased from 2.8% in AD13R to 3.6% in NOLKBTs, to 10.1% in NOASRs, and to 11.3% in NOBOTH. The C44 basin demand not met (Fig. 12) increased from 6.6% in AD13R to 8.6% in NOLKBTs, to 16.7% in NOASRs, and to 19.1% in NOBOTH.

- In the NOLKBTs simulation, the number of months of simulated water supply Phase 1 cutbacks in Northern Palm Beach County and LECSA1 (Fig. 13) increased from 14 in AD13R to 20 in NOLKBTs, and to 33 in NOASRs and NOBOTH. For LECSA2, the number of months increased from 21 in AD13R to 26 in NOLKBTs, and to 40 in NOASRs and NOBOTH. For LECSA3, the number of months increased from 19 in AD13R to 25 in NOLKBTs, and to 38 in NOASRs and NOBOTH. All the increases in the number of months of cutbacks were due to lower lake stages in Lake Okeechobee.

- In the NOLKBTs simulation, mean annual surface flows into Snake Creek and Miami River (Fig. 14) increased by 70 kac-ft (from 84 in AD13R to 154 kac-ft) and by 51 ac-ft (from 49 in AD13R to 100 kac-ft) respectively, due to C9 and C6 basin runoff being sent to Biscayne Bay rather than to the North Lake Belt Reservoir. Mean annual surface flows into Central Bay, which received a contribution from the North Lake Belt Reservoir in AD13R, decreased by 26 kac-ft (from 193 in AD13R to 167 kac-ft) with the reservoir removed. The NOASRs simulation shows no change from AD13R in surface flows to Biscayne Bay.

- The Inundation Duration Summary (Table 1) shows a decrease in the average annual hydroperiod in Indicator Region 11 (NE Shark River Slough) from 98% in AD13R to 94% in NOLKBTs. The number of continuous inundation events in IR11 increased from 6 to 15 during the period of simulation. The average annual hydroperiod also decreased in WCA3B, from 99% in AD13R to 96% for IR15 (West WCA3B) and from 98% in AD13R to 93% for IR16 (East WCA3B). Similar decreases are seen in the Pennsuco Wetlands. The High and Low Water Summaries (Tables 2 and 3) indicates an increase in both high water and low water events in the Pennsuco Wetlands (IR52 – North, and IR53 – South). In IR52 the number of high water and low water events increased from 8 and 3 in AD13R to 16 and 11 respectively. In IR53 the number of high water and low water events increased from 9 and 4 in AD13R to 13 and 12 respectively.

RN/AA
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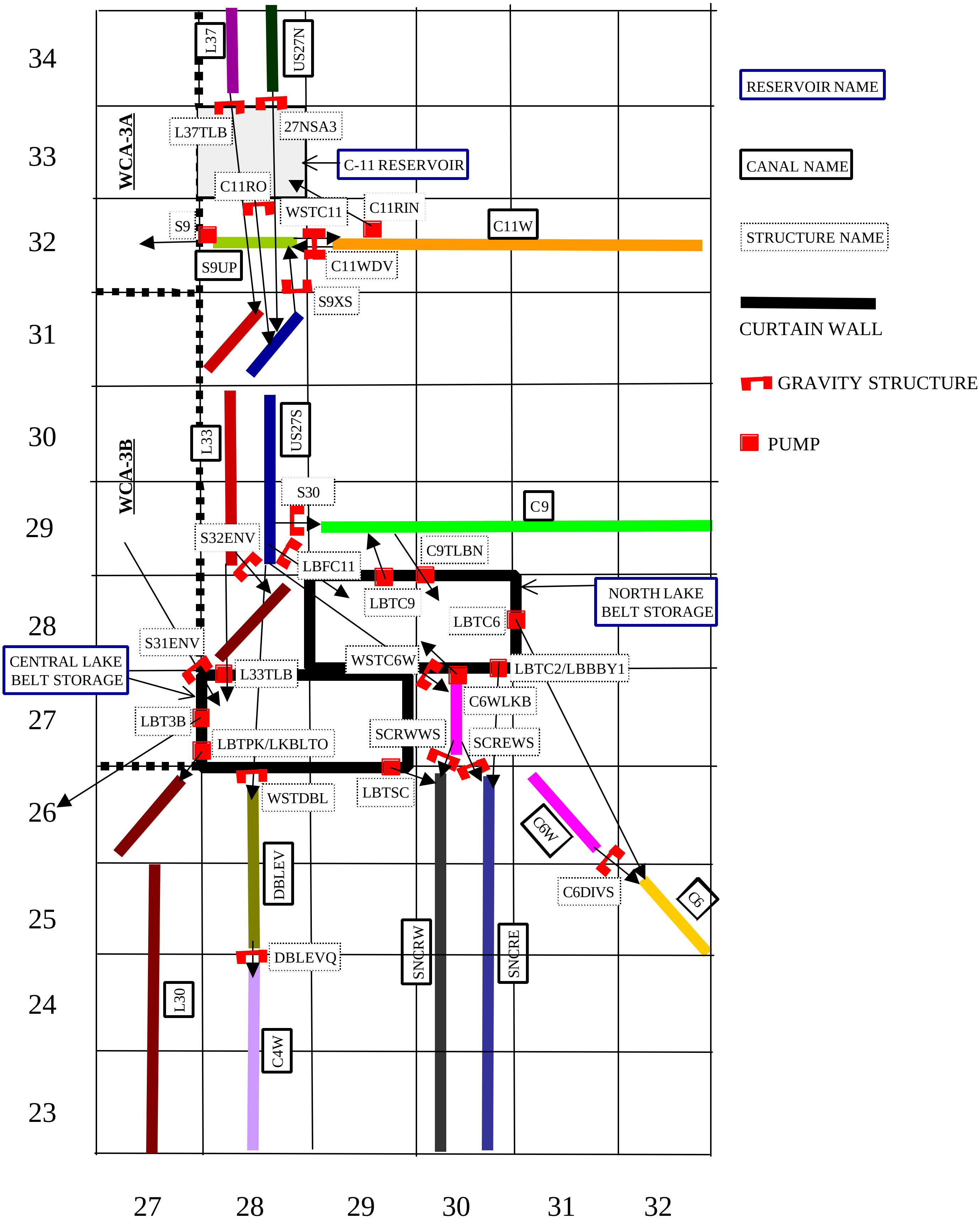


Fig. 1 - SFWMM representation of canals, structures and storage in the Lake Belt area for AD13R

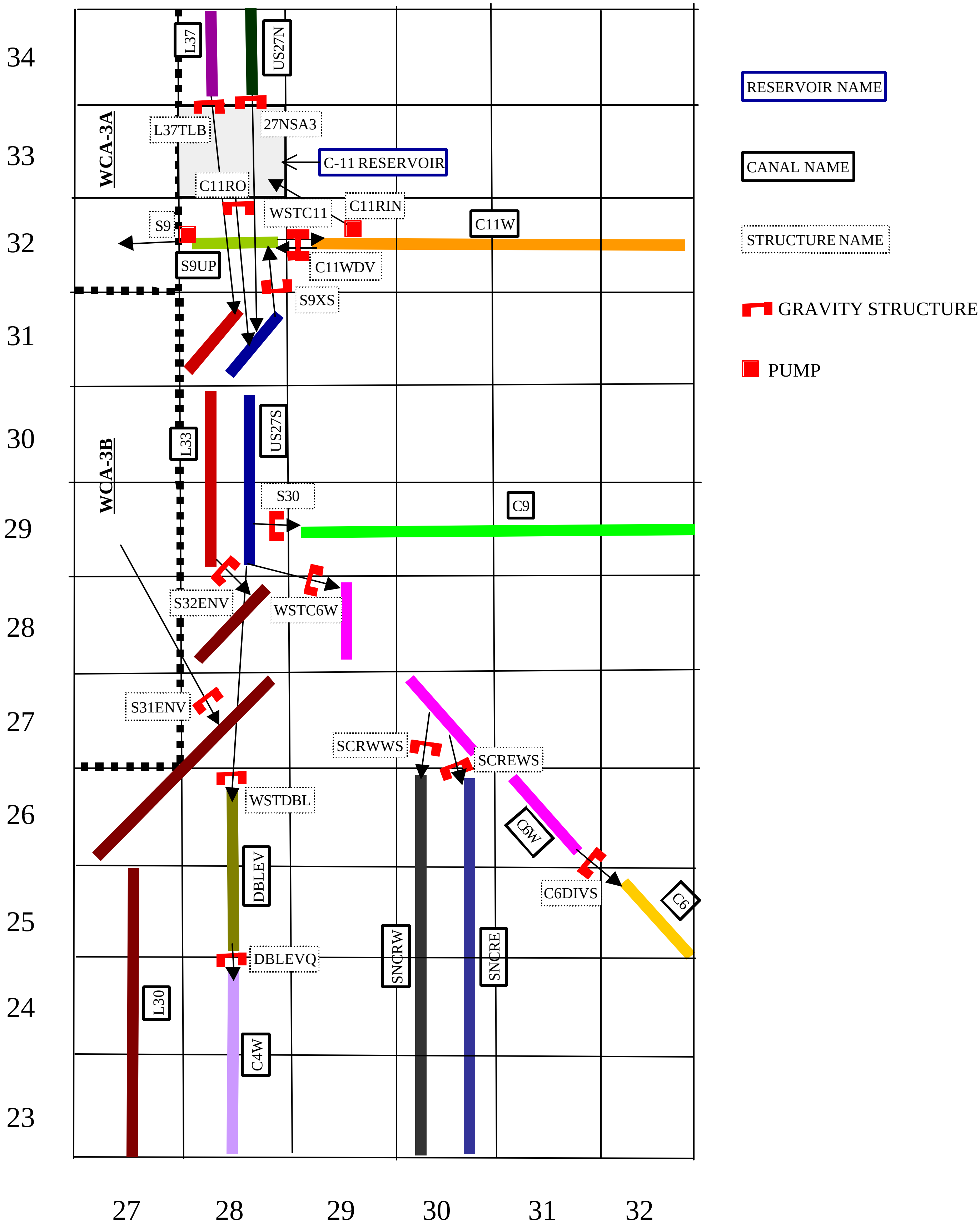
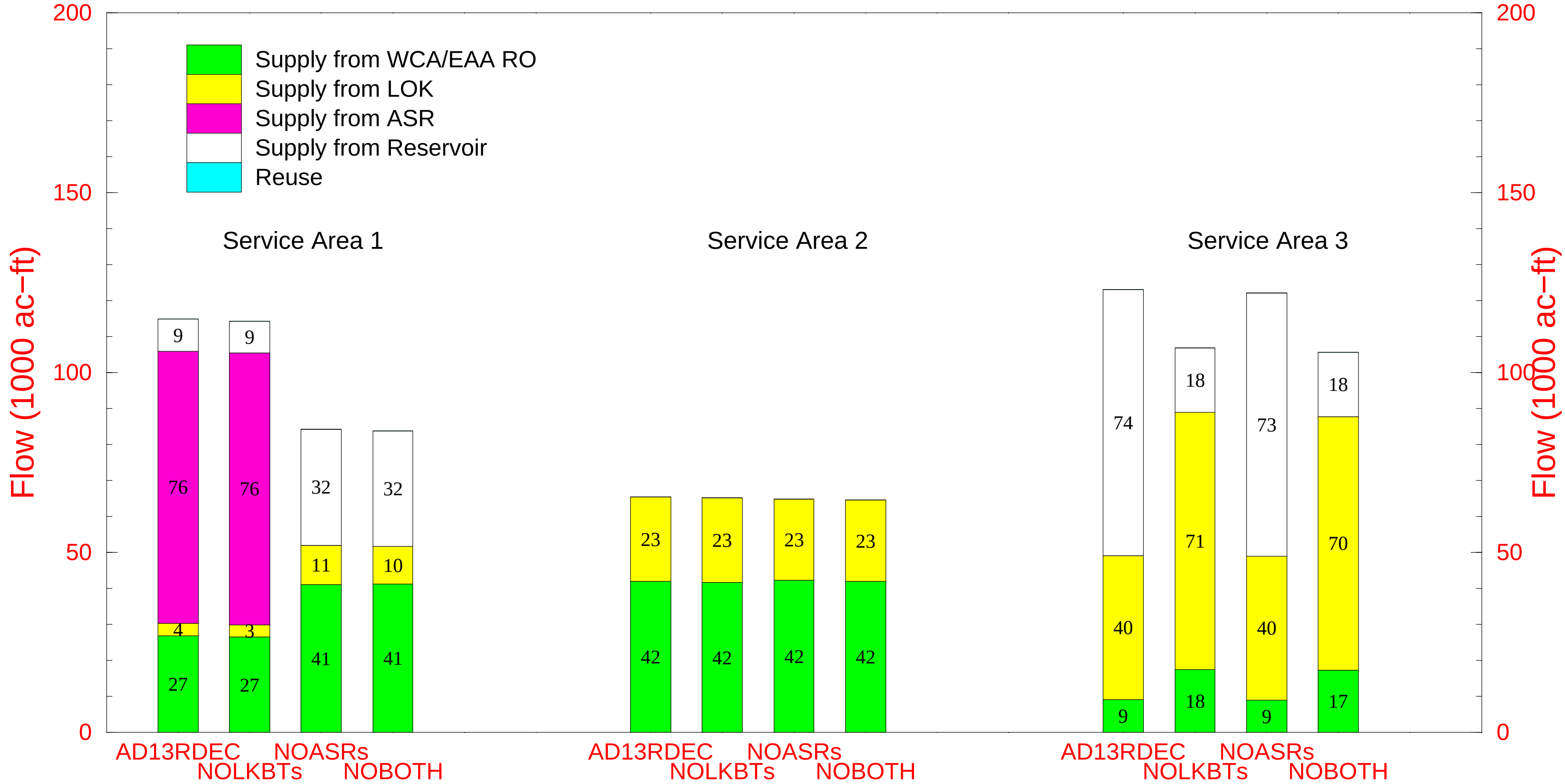


Fig. 2 - SFWMM representation of canals, structures and storage in the Lake Belt area with Lake Belt storage areas removed

Fig. 3 − Average Annual Regional System Water Supply Deliveries to LEC Service Areas for the 1965 − 1995 simulation



Note: Supply RECEIVED from LOK may be less than what is DELIVERED at LOK due to conveyance constraints.
Regional System is comprised of LOK and WCAs.

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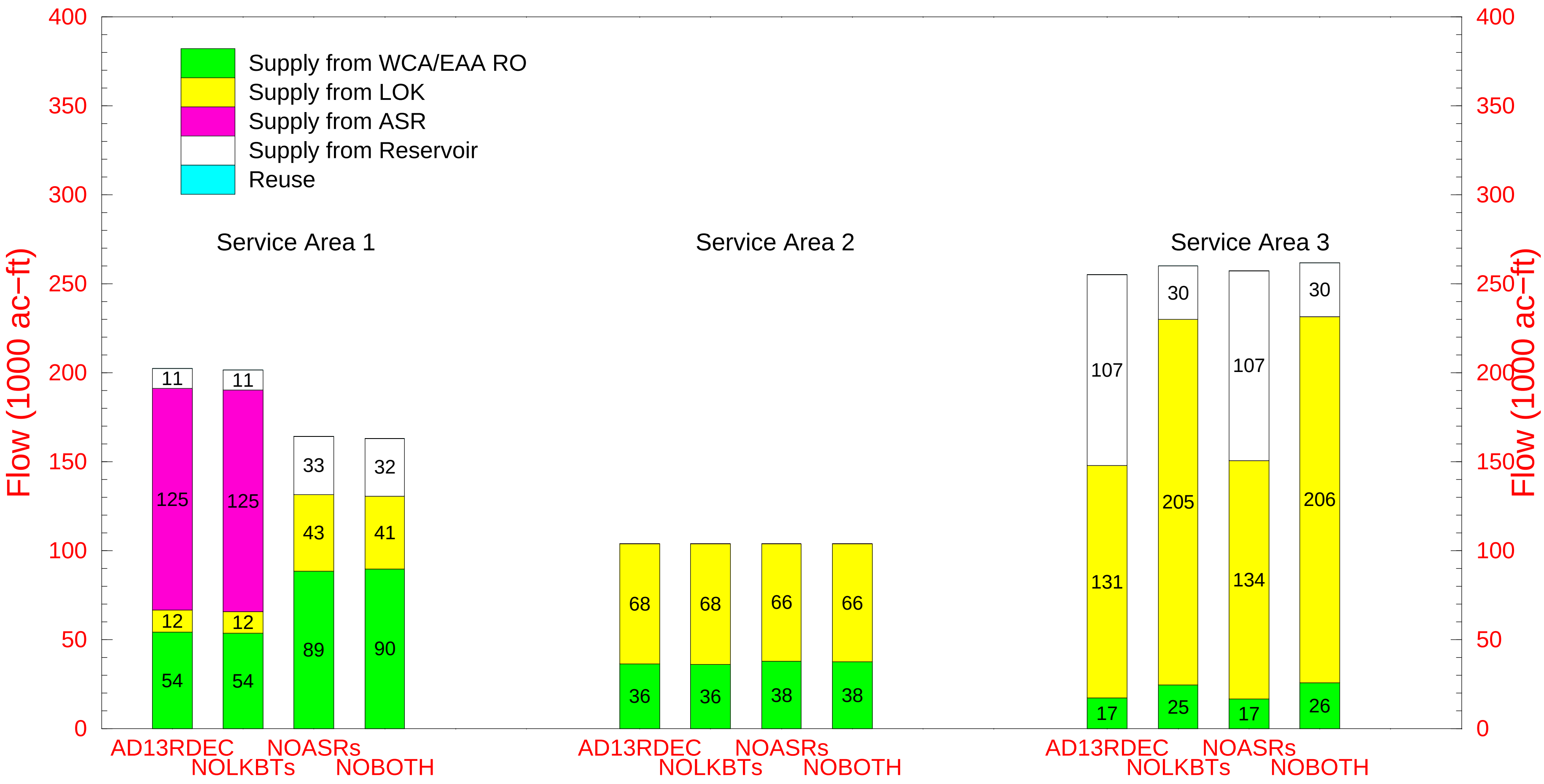
Fig. 4 − Mean Annual Regional System Water Supply Deliveries to LEC Service Areas for the five Drought years (71,75,81,85,89)



Note: Supply RECEIVED from LOK may be less than what is DELIVERED at LOK due to conveyance constraints.
Regional System is comprised of LOK and WCAs.

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Fig. 5 − Lake Okeechobee Stage Duration Curves

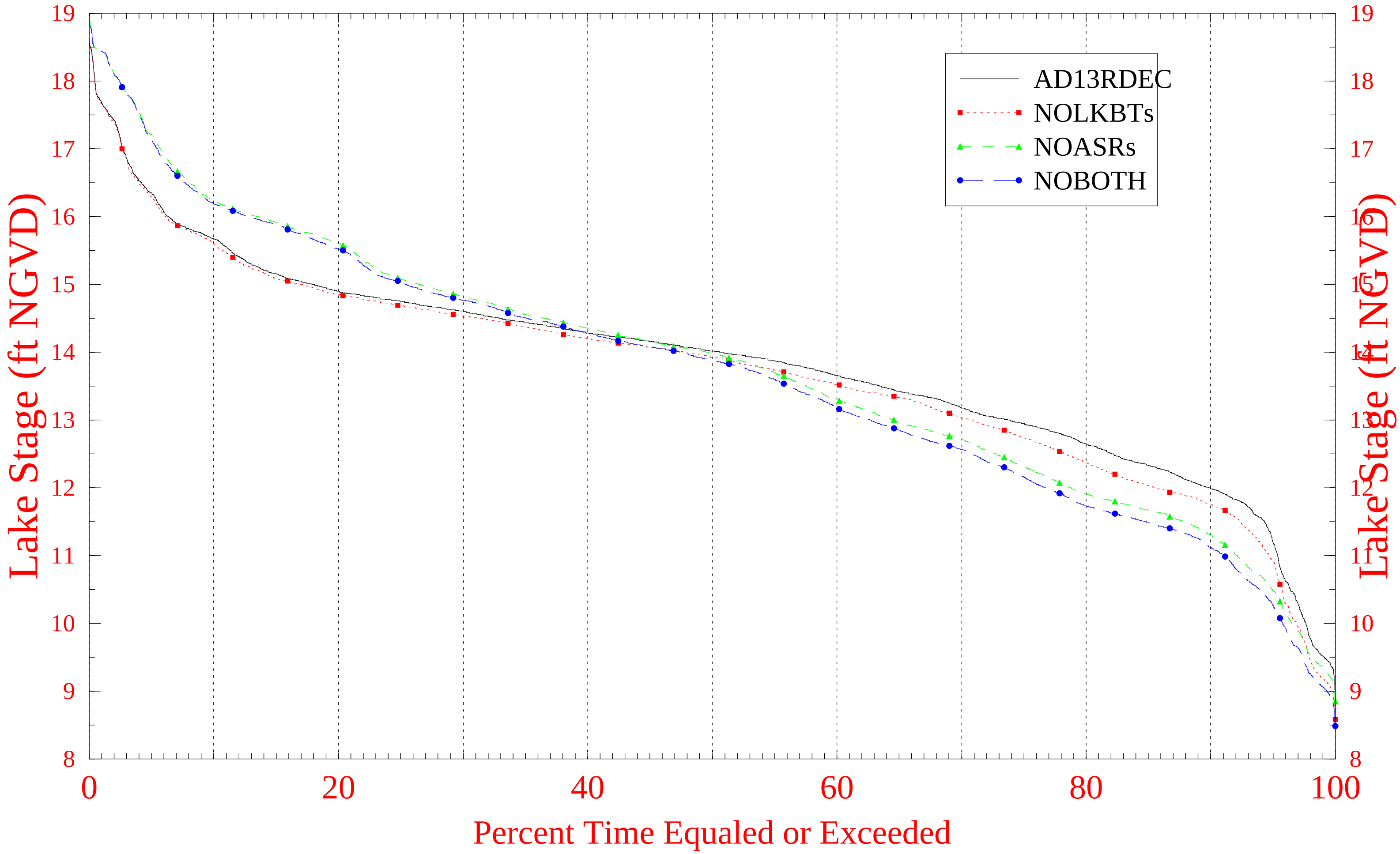

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Fig. 6 − Number of Undesireable Lake Okeechobee Stage Events

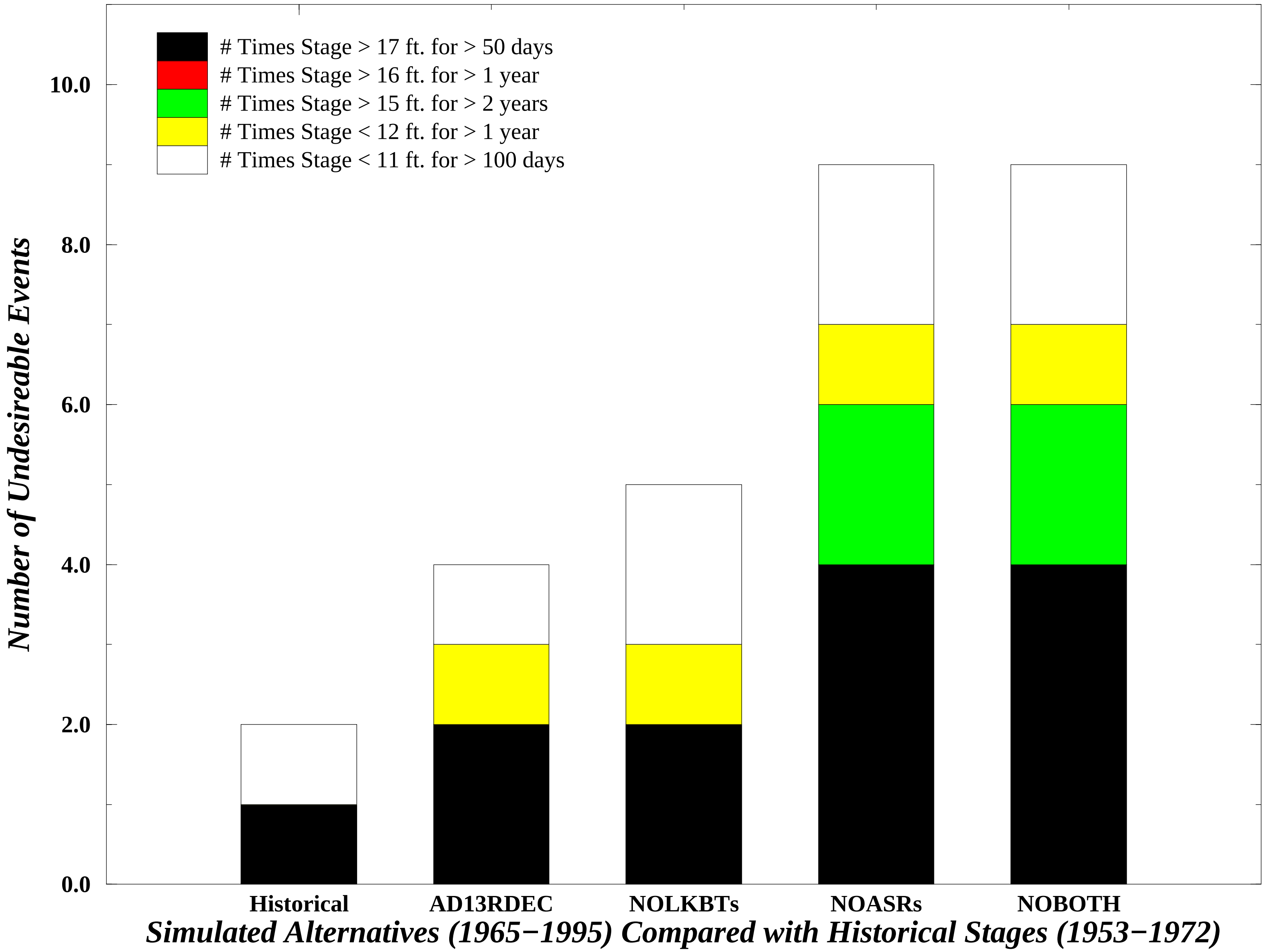

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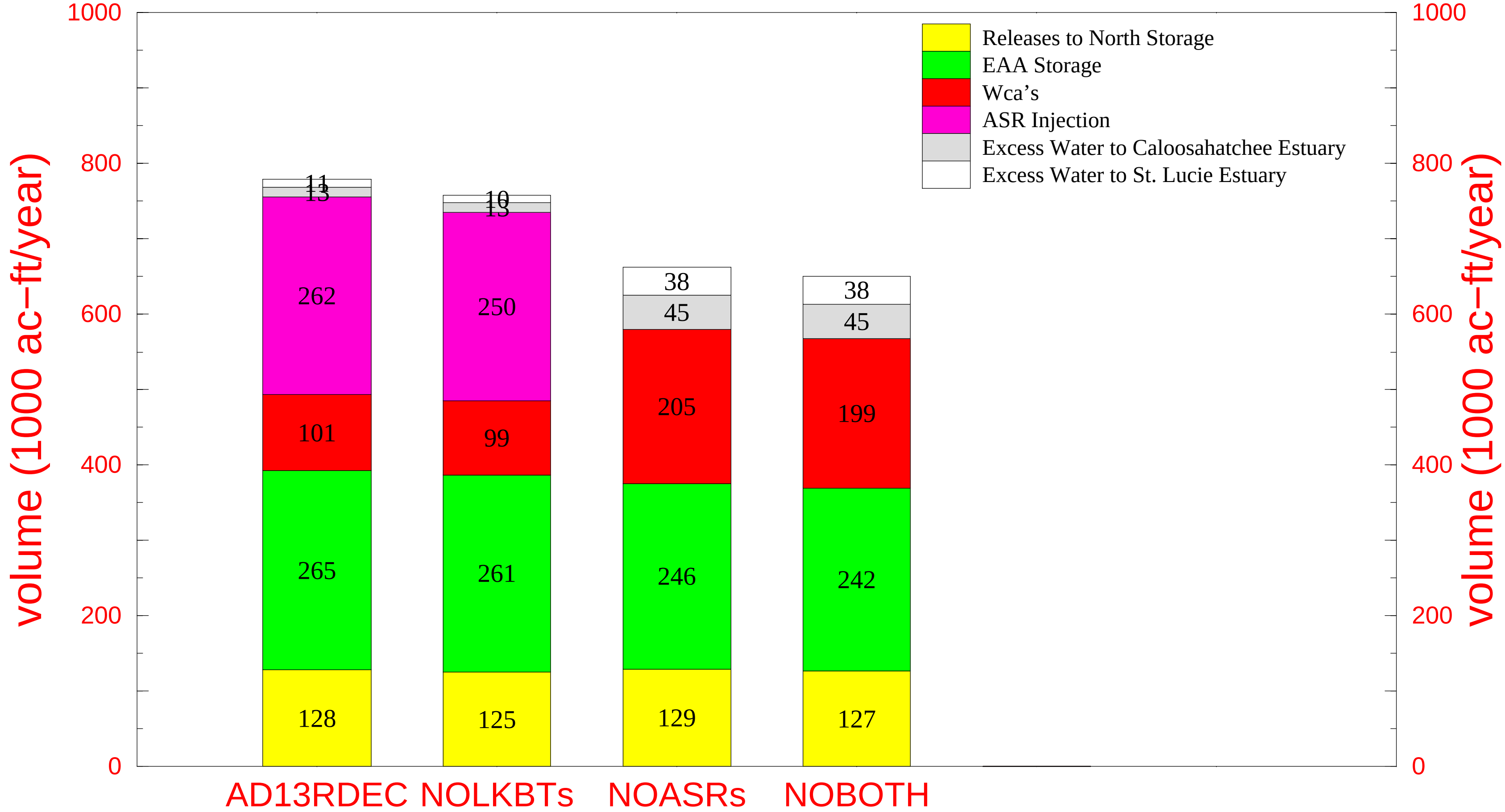
Fig. 7 − Mean Annual Flood Control Releases from Lake Okeechobee for the 31 yr (1965 − 1995) Simulation



Note: Although regulatory (flood control) discharges are summarized here in mean annual values, they do not occur every year. Typically they occur in 2−4 consecutive years and may not occur for up to 7 consecutive years.

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Fig. 8 − Number of times Salinity Envelope Criteria were NOT met for the Caloosahatchee Estuary (mean monthly flows 1965 − 1995)

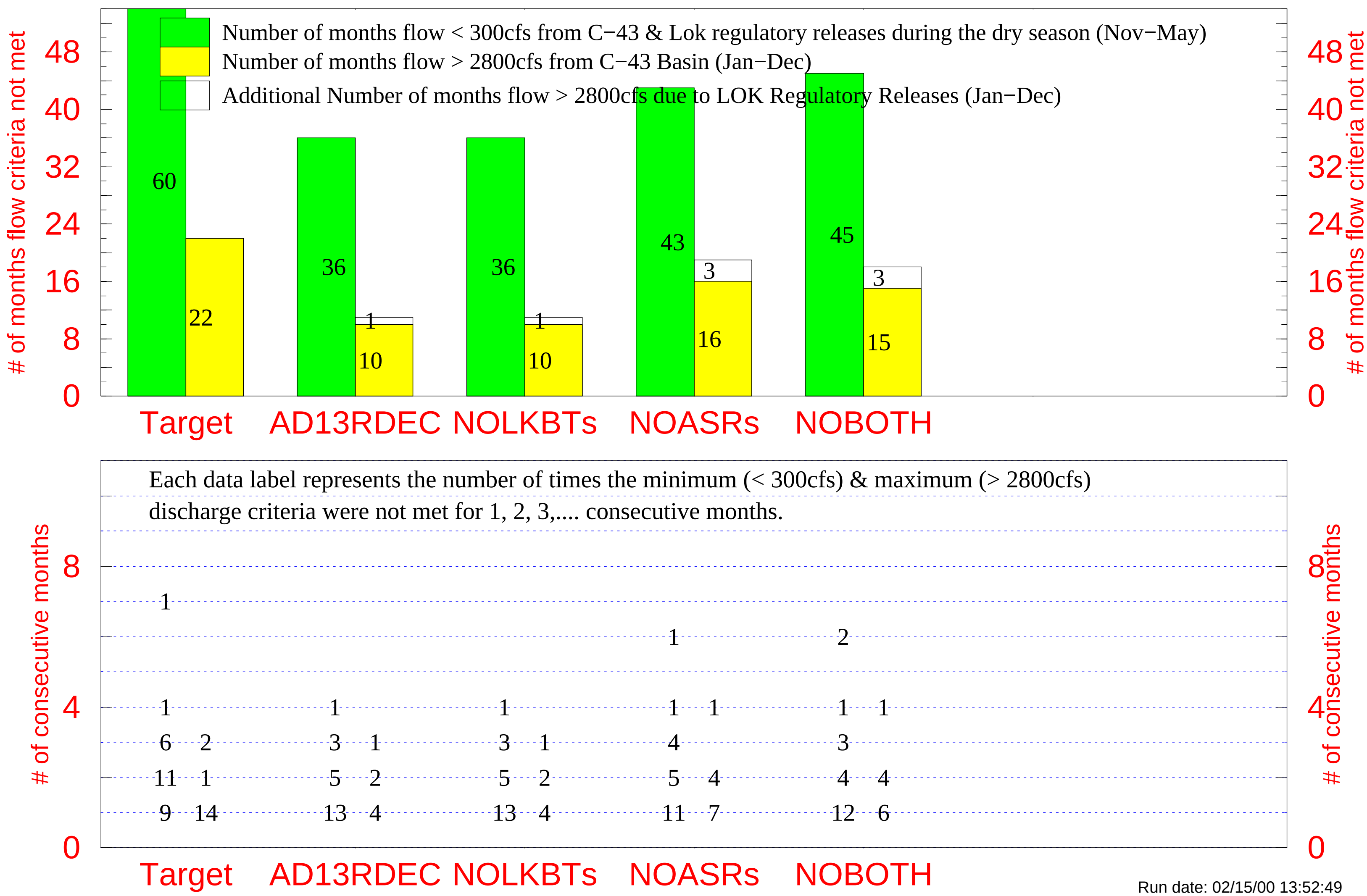

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Fig. 9 − Number of times Salinity Envelope Criteria were NOT met for the St. Lucie Estuary

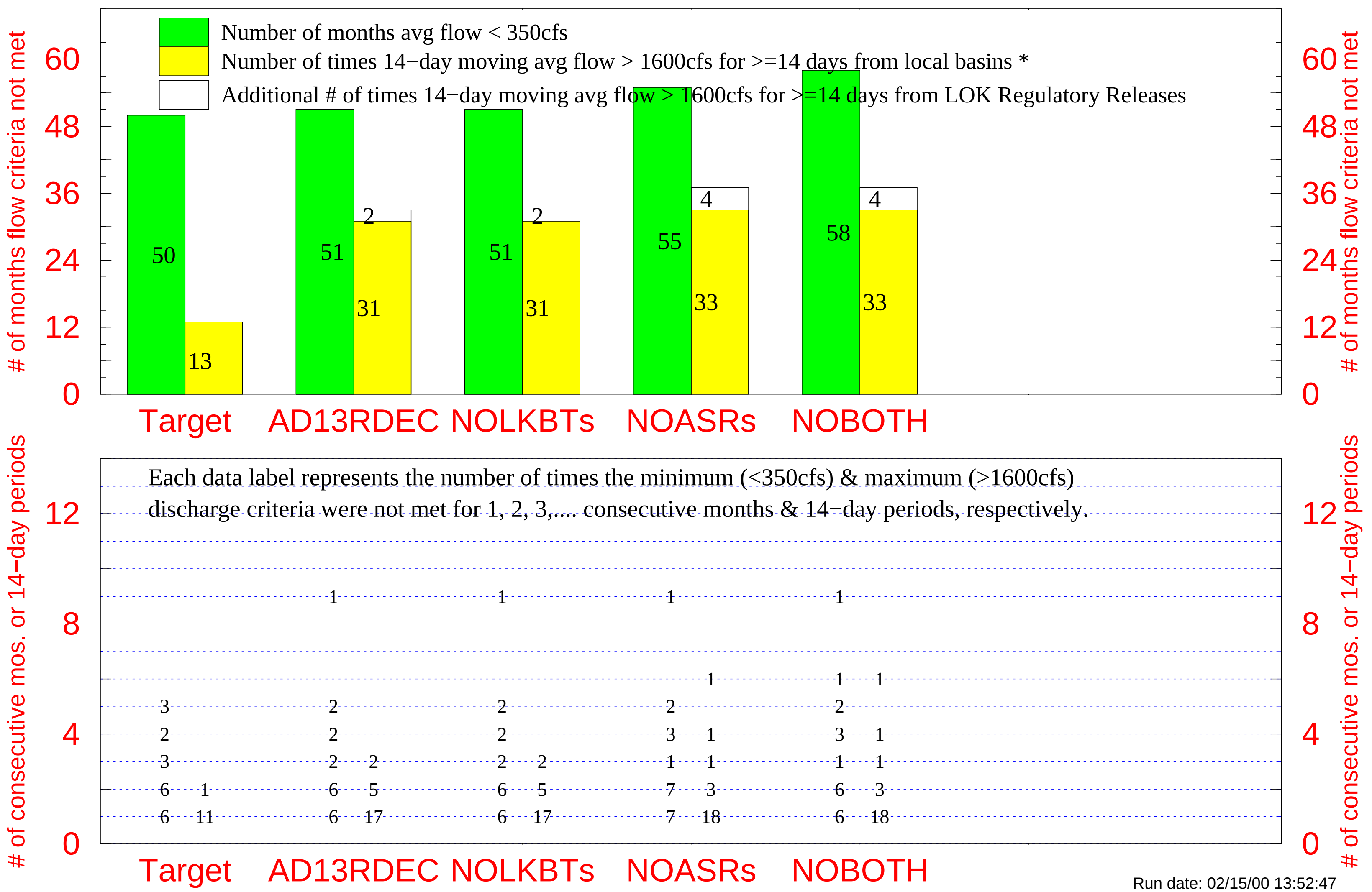
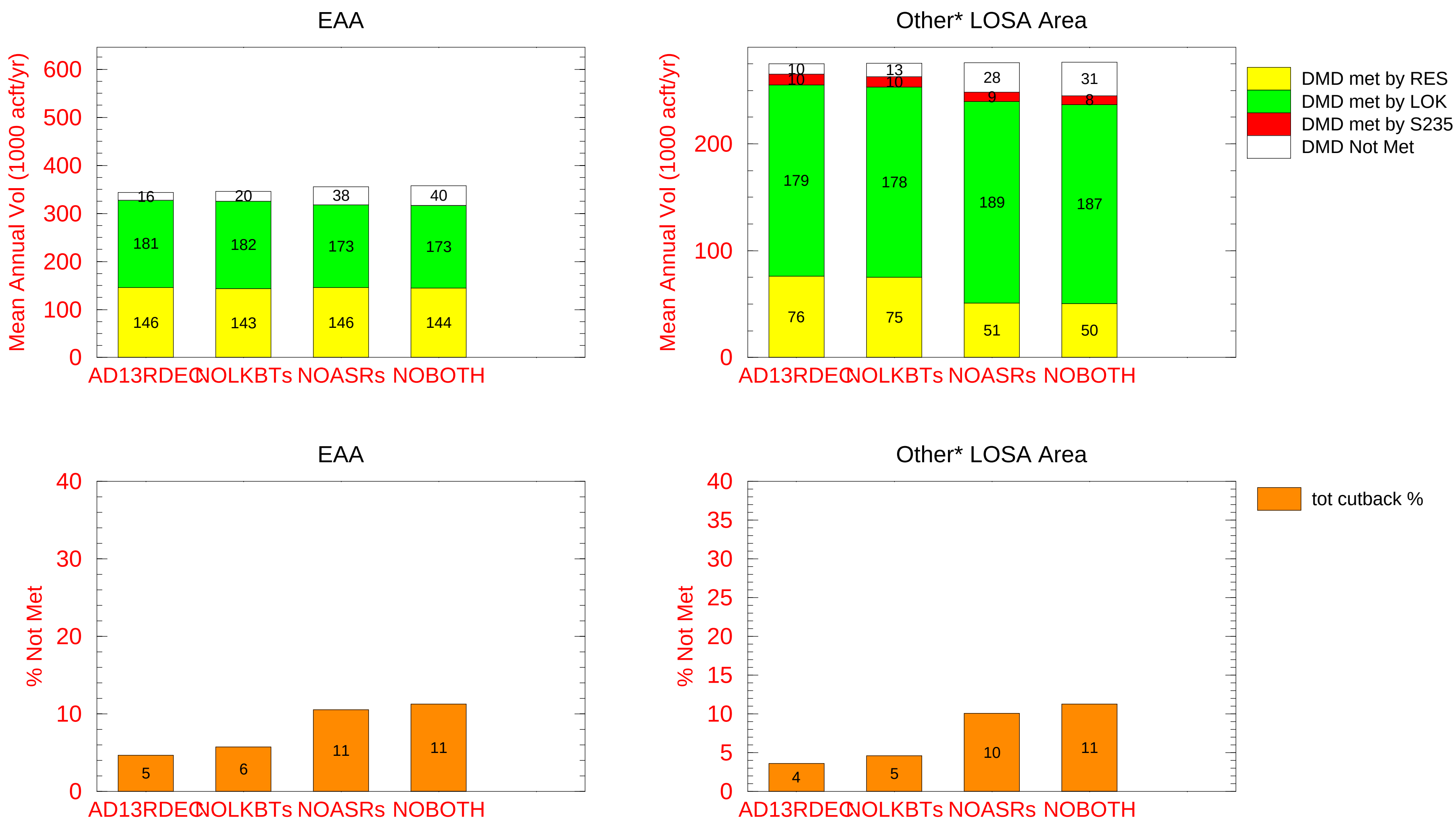


Fig. 10 − Mean Annual EAA/LOSA Supplemental Irrigation: Demands and Demands Not Met

for the 1965 − 1995 Simulation Period



*Other Lake Service SubAreas (S236, S4, L8, C43, C44, and Seminole Indians (Brighton & Big Cypress)).

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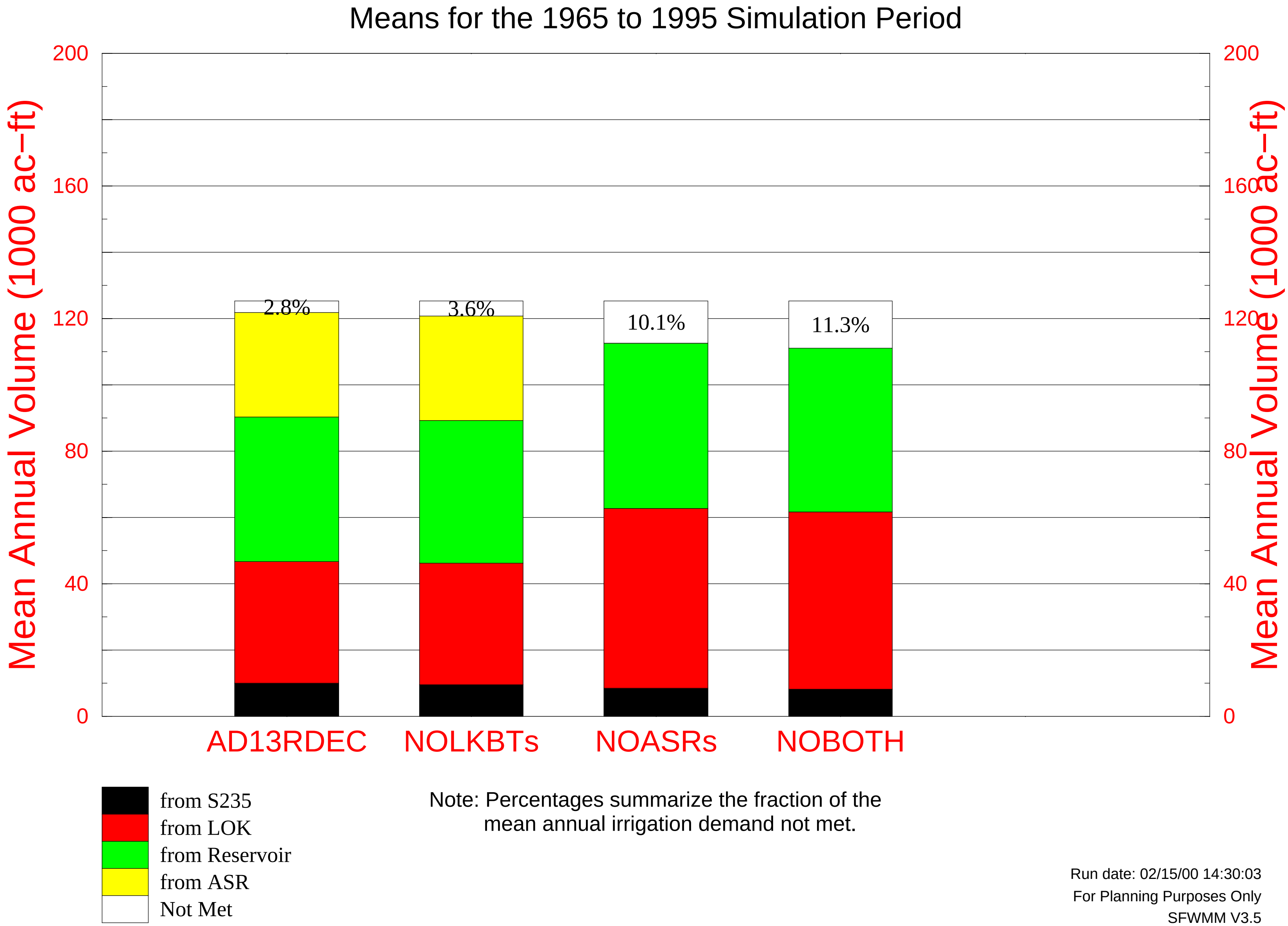
Fig. 11 − C43 Basin Regional Irrigation Supply and Demand Not Met



Note: Percentages summarize the fraction of the mean annual irrigation demand not met.

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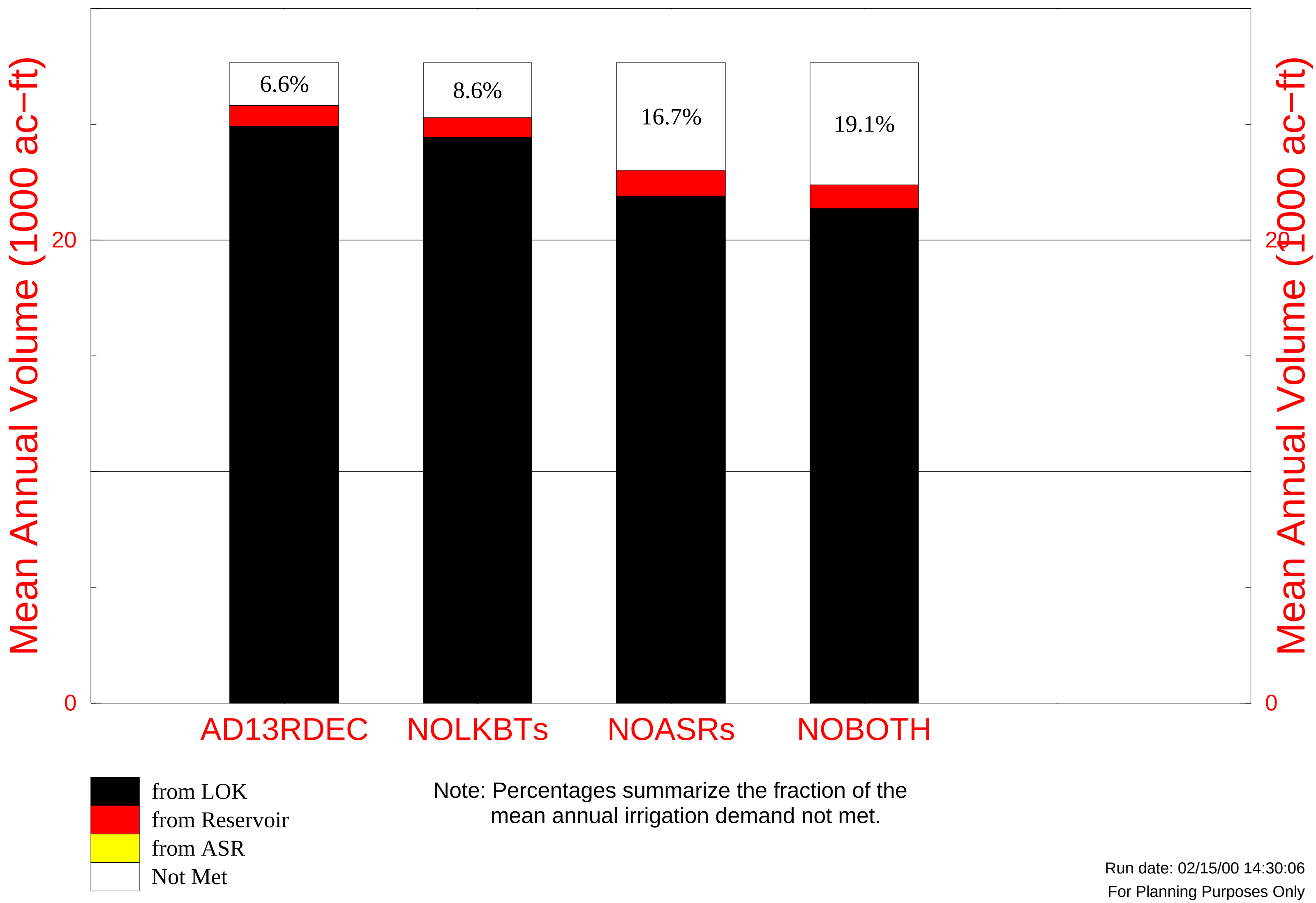
Fig. 12 − C44 Basin Regional Irrigation Supply and Demand Not Met

Means for the 1965 to 1995 Simulation Period



Note: Percentages summarize the fraction of the mean annual irrigation demand not met.

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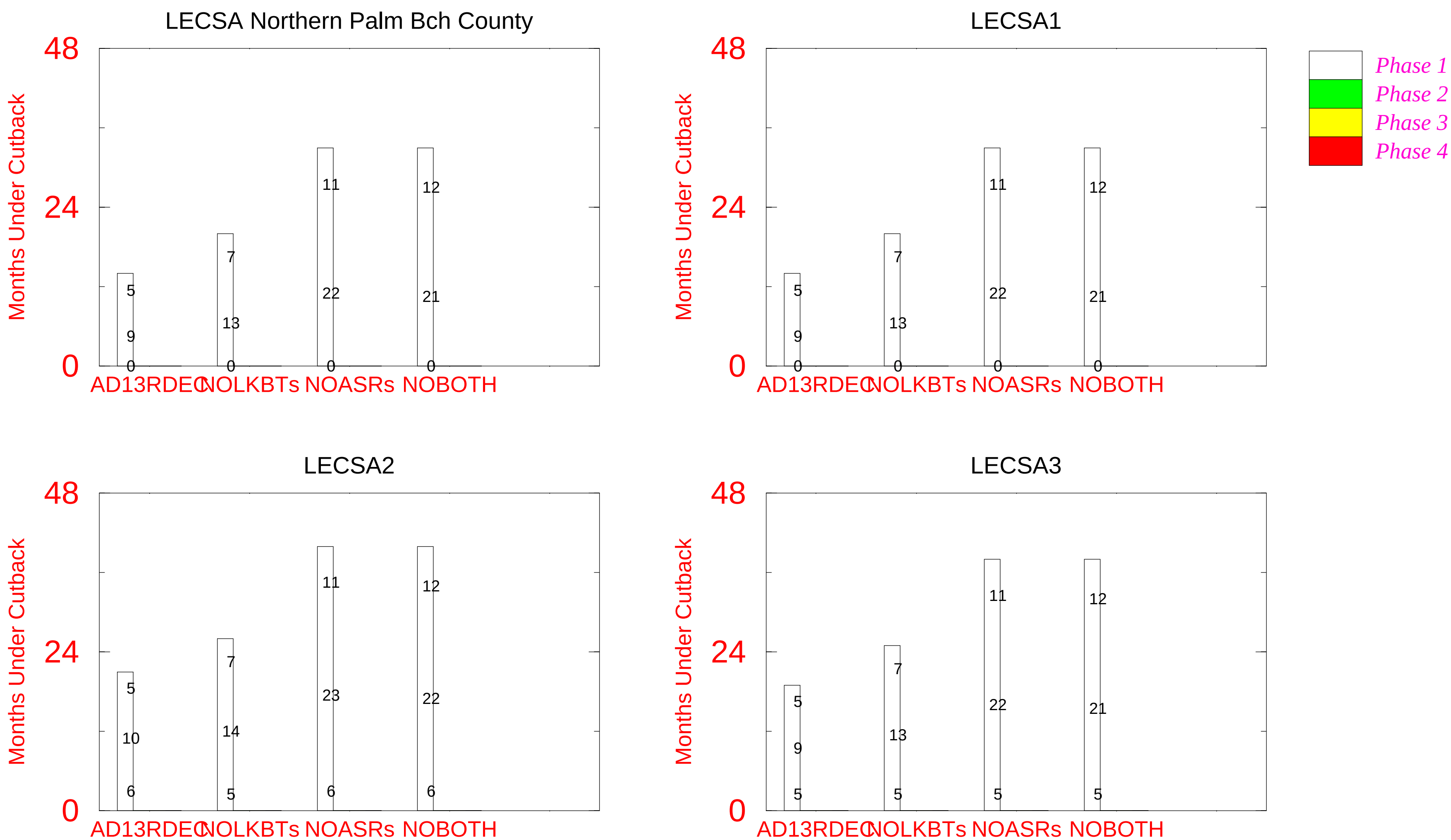
Fig. 13 − Number of Months of Simulated Water Supply Cutbacks
for the 1965 − 1995 Simulation Period



Note: Phase 1 water restrictions could be induced by a) Lake stage in Supply Side Management Zone (indicated by upper data label), b) Local Trigger well stages (lower data label), and c) Dry season criteria (indicated by middle data label).

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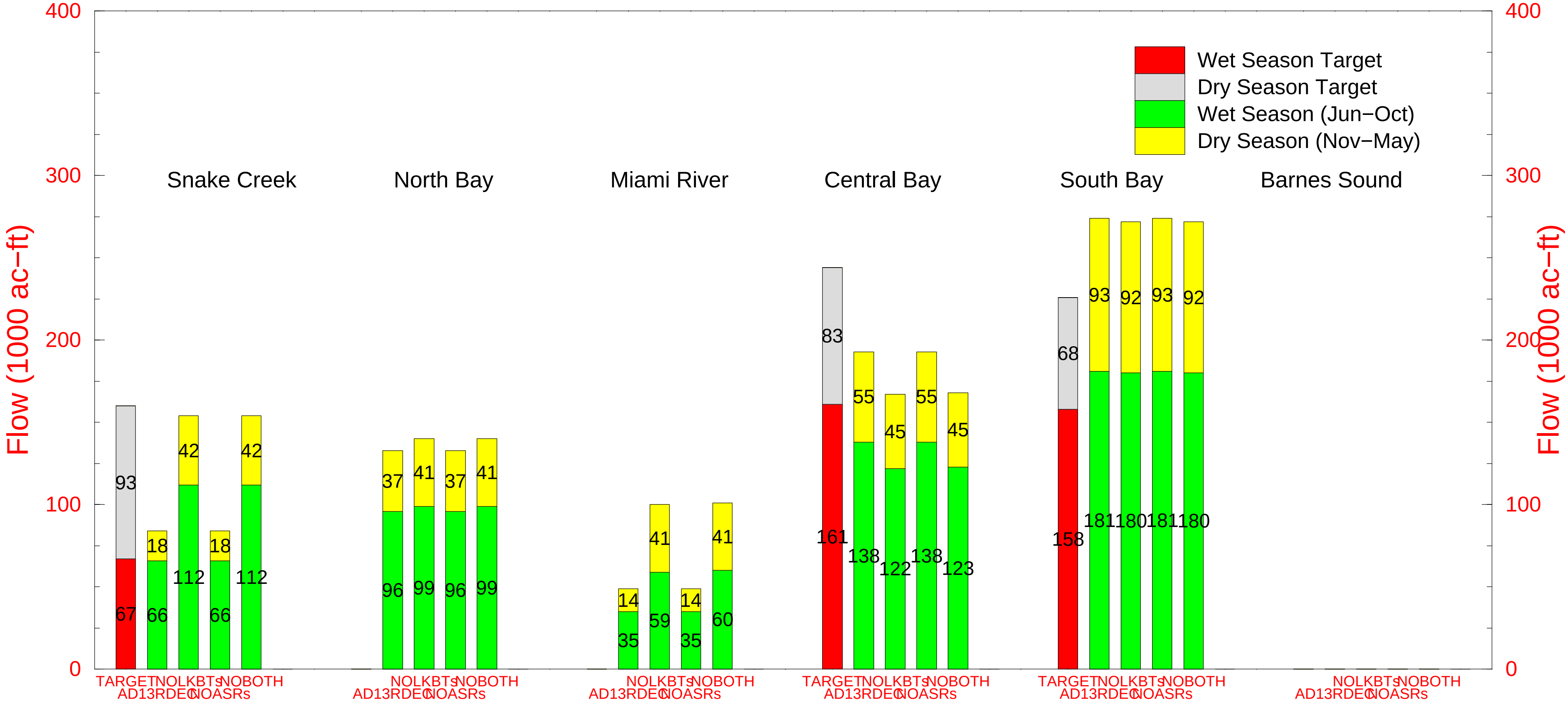
Fig. 14 − Simulated Mean Annual Surface Flows Discharged into Biscayne Bay for the 1965 − 1995 simulation period



Note: Snake Creek=S29; North Bay=G58+S28+S27; Miami River=S26+S25B+S25; Central=G97+S22+S123; South=S21+S21A+S20F+S20G; Barnes Sound=S197

Targets for Central and South Bay reflect a 30% increase in mean annual dry season flows over the 95 Base
Targets for Snake Creek reflect a minimum monthly flow volume of 13,300 ac−ft (x 5 months for wet season and x 7 months for dry season) to maintain salinity levels below 20 ppt.

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Table 1 − Inundation Duration Summary for Indicator Regions

#Events|Avg Flood Dur(Wks/Event)|Avg Ann Hydper(Percent of Yr)

Indicator Region Number	Name	NSM45F			AD13RDEC			NOLKBTs			NOASRs			NOBOTH		
1	Taylor Slough	37	33	76	36	32	72	36	32	72	36	32	72	36	32	72
2	West Perrine Marl Marsh	68	9	39	67	9	39	67	9	39	67	10	39	66	10	39
3	Mid−Perrine Marl Marsh	43	23	60	49	18	54	48	18	54	49	18	54	48	18	54
4	C−111 Perrine Marl Marsh	47	21	62	43	28	76	44	28	76	44	28	76	43	28	76
5	Model Lands South	55	19	64	38	36	85	35	39	84	39	35	85	37	37	84
6	Model Lands North	43	27	72	107	7	46	110	7	45	107	7	46	110	7	45
7	Ochopee Marl Marsh	35	32	70	38	28	66	40	26	66	36	30	66	38	28	66
8	Rockland Marl Marsh	37	28	65	37	26	60	38	25	59	36	27	60	38	25	59
9	SW Shark River Slough	9	176	98	9	174	97	13	116	94	11	142	97	12	126	93
10	Mid Shark River Slough	5	321	100	5	319	99	12	128	96	5	318	99	12	128	95
11	NE Shark River Slough	4	402	100	6	265	98	15	101	94	7	226	98	14	109	94
12	New Shark River Slough	32	42	82	28	50	87	30	46	86	30	46	86	32	43	85
13	West Slough	38	28	66	36	30	67	35	31	66	35	31	67	35	31	67
14	South WCA−3A	17	88	92	12	127	95	12	127	95	11	139	95	12	127	95
15	West WCA−3B	20	74	92	4	398	99	12	129	96	4	398	99	14	110	96
16	East WCA−3B	15	102	95	5	315	98	16	93	93	5	315	98	17	88	92
17	South Central WCA−3A	24	59	87	15	102	95	16	95	95	15	102	95	16	95	95
18	North Central WCA−3A	24	59	89	11	141	97	11	141	96	10	155	96	10	155	96
19	East WCA−3A	25	55	86	15	99	92	15	99	92	16	93	92	15	99	92
20	NW WCA−3A	21	70	91	26	55	89	23	62	89	25	57	88	22	65	88
21	NE WCA−3A	28	49	85	32	41	81	30	43	81	30	43	81	29	45	81
22	NW Corner WCA−3A	20	73	91	20	77	95	19	81	95	20	75	94	21	71	92
23	WCA−2B	21	70	92	21	63	82	20	66	81	21	63	82	21	63	82
24	South WCA−2A	20	74	91	18	78	88	18	78	88	18	78	88	19	74	87
25	North WCA−2A	30	46	86	16	93	92	16	93	92	17	87	92	15	98	92
26	South LNWR (WCA−1)	25	57	89	7	228	99	7	228	99	15	105	98	14	112	97
27	North LNWR (WCA−1)	15	99	92	18	85	95	17	90	95	19	80	95	19	80	95
28	Rotenberger WMA	40	31	76	42	30	79	42	30	79	42	30	79	42	30	79
29	Holey Land WMA	28	50	88	29	49	88	29	49	88	28	51	88	28	51	88
30	Corbett WMA	61	13	50	56	3	11	56	3	11	56	3	11	56	3	11
31	Mullet Slough	64	14	56	58	14	50	58	14	50	59	14	50	59	14	50
32	Upland Pine	56	15	51	57	15	52	57	15	52	57	15	52	57	15	52
33	Upper Mullet Slough	64	8	33	65	8	33	65	8	33	65	8	33	65	8	33
34	Cypress Marsh	36	35	78	42	12	31	42	12	31	42	12	31	42	12	31
35	Wet Prairie	31	43	82	42	19	50	42	19	50	42	19	50	42	19	50
36	Wetter Prairie NE	59	18	65	64	15	59	64	15	59	64	15	59	64	15	59
37	Wetter Prairie SW	58	17	63	68	14	58	68	14	58	68	14	58	69	14	58
38	Drier Cypress NW	67	10	40	68	9	39	68	9	39	68	9	39	68	9	39
39	Drier Cypress NE	62	14	55	67	12	50	67	12	50	66	12	50	66	12	50
40	Cypress	48	23	67	49	21	65	48	22	65	48	22	65	48	22	65
41	NW Big Cypress	54	16	53	59	12	46	59	12	46	59	12	46	59	12	46
42	NE Big Cypress	44	22	61	55	16	53	55	16	53	55	16	53	55	16	53
43	NE Corner Big Cypress	39	31	75	45	14	38	45	14	38	45	14	38	45	14	38
44	SW Big Cypress	62	14	54	60	14	54	60	14	54	60	14	54	60	14	54
45	Racoon Point	61	11	42	64	10	40	64	10	40	64	10	40	64	10	40
47	North C−111	48	20	60	54	10	35	57	10	35	55	10	35	57	10	35
48	North Bisc. Bay Groundwater 1	14	7	6	0	0	0	0	0	0	0	0	0	0	0	0
49	North Bisc. Bay Groundwater 2	49	15	46	0	0	0	0	0	0	0	0	0	0	0	0
50	Central Bisc. Bay Groundwater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	South Bisc. Bay Groundwater	34	5	10	0	0	0	0	0	0	0	0	0	0	0	0
52	Pennsuco Wetlands North	21	70	91	13	119	96	24	61	91	12	129	96	22	67	91
53	Pennsuco Wetlands South	9	176	98	21	70	91	24	59	88	20	74	92	21	67	88
46	Cape Sable Sparrow A	37	30	68	35	30	66	35	30	66	35	31	67	36	30	66
54	Cape Sable Sparrow B	69	9	40	66	10	40	66	10	40	66	10	41	66	10	40

55	Cape Sable Sparrow C	40	22	54	36	21	47	34	22	46	35	22	47	34	22	47
56	Cape Sable Sparrow D	45	22	61	52	17	54	52	17	54	52	17	54	50	17	54
57	Cape Sable Sparrow E	47	17	50	40	19	48	39	20	48	42	18	48	40	19	48
58	Cape Sable Sparrow F	36	30	67	39	24	58	42	22	57	40	24	59	42	22	58
59	Western WCA−3A Snail Kite	22	66	90	14	109	94	14	109	94	15	101	94	14	108	94
60	Southern WCA−3A Snail Kite	18	83	92	19	78	92	19	78	92	20	74	92	20	74	92
61	WCA−2B1	20	72	89	44	23	64	44	23	64	45	23	64	45	23	64
62	WCA−2B2	24	61	91	54	17	58	53	18	58	54	17	58	54	17	58
63	WCA−2B3	20	74	92	17	84	89	18	80	89	18	79	89	18	79	89
64	WCA−2B4	25	56	87	8	198	98	8	199	99	8	198	98	8	199	99
65	WCA−2B5	14	110	95	14	106	92	15	99	92	14	106	92	14	106	92
66	N WCA−3B	27	49	82	11	142	97	20	74	92	10	156	97	19	78	92
67	NE WCA−3B	22	62	85	22	62	84	28	47	82	23	59	84	28	47	82
68	S of NE WCA−3A	28	50	86	28	49	86	29	48	86	28	49	86	28	49	86
69	L−67A	20	69	86	15	102	95	15	102	95	15	102	95	16	95	95
70	Eastern edge of SRS	58	17	61	56	18	61	56	17	61	55	18	61	54	18	61

Notes: #events = number of continuous ponding events over the period of record
Avg Flood Duration = [sum(days of ponding)/7]/#events
Avg Annual Hydroperiod = 100 x [sum(weeks of ponding per year)]/[52 x #years]

Table 2 − High Water Summary for Indicator Regions

#Events|Avg Duration (Wks/Event)|Avg Ann Duration(Percent of Yr)

Indicator Region Number	Name	Depth(ft) Criterion	NSM45F			AD13RDEC			NOLKBTs			NOASRs			NOBOTH		
			#Events	Avg Duration	Avg Ann Duration	#Events	Avg Duration	Avg Ann Duration	#Events	Avg Duration	Avg Ann Duration	#Events	Avg Duration	Avg Ann Duration	#Events	Avg Duration	Avg Ann Duration
1	Taylor Slough	> 1.5	10	2	1	5	2	1	5	2	1	5	2	1	5	2	1
2	West Perrine Marl Marsh	> 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Mid−Perrine Marl Marsh	> 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	C−111 Perrine Marl Marsh	> 2.0	0	0	0	10	3	2	9	3	2	10	3	2	9	3	2
5	Model Lands South	> 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Model Lands North	> 1.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Ochopee Marl Marsh	> 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Rockland Marl Marsh	> 2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	SW Shark River Slough	> 2.5	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
10	Mid Shark River Slough	> 2.5	5	11	4	5	6	2	6	5	2	7	6	3	5	7	2
11	NE Shark River Slough	> 2.5	15	10	9	10	6	4	11	6	4	13	6	5	14	6	5
12	New Shark River Slough	Undefined															
13	West Slough	Undefined															
14	South WCA−3A	> 2.5	0	0	0	2	7	1	3	4	1	3	9	2	4	6	1
15	West WCA−3B	> 2.5	6	6	2	6	9	3	5	9	3	9	8	4	8	7	3
16	East WCA−3B	> 2.5	7	9	4	16	6	6	13	7	5	13	10	8	14	9	7
17	South Central WCA−3A	> 2.5	0	0	0	2	8	1	2	7	1	4	7	2	4	6	1
18	North Central WCA−3A	> 2.5	0	0	0	2	7	1	2	7	1	3	9	2	4	6	1
19	East WCA−3A	> 2.5	0	0	0	29	11	19	31	10	19	29	12	21	29	11	21
20	NW WCA−3A	> 2.5	0	0	0	0	0	0	0	0	0	2	5	1	2	4	0
21	NE WCA−3A	> 2.0	2	2	0	4	5	1	4	5	1	6	6	2	6	6	2
22	NW Corner WCA−3A	> 2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	WCA−2B	> 2.5	4	5	1	24	7	11	24	7	11	24	7	11	24	7	11
24	South WCA−2A	> 2.5	0	0	0	11	6	4	11	6	4	11	8	6	10	8	5
25	North WCA−2A	> 2.5	0	0	0	4	4	1	4	4	1	4	4	1	4	4	1
26	South LNWR (WCA−1)	> 2.5	0	0	0	31	13	25	31	13	25	29	14	26	28	15	26
27	North LNWR (WCA−1)	> 2.5	0	0	0	1	1	0	1	1	0	1	1	0	1	1	0
28	Rotenberger WMA	> 1.5	17	5	5	0	0	0	0	0	0	0	0	0	0	0	0
29	Holey Land WMA	> 1.5	22	8	12	30	4	7	30	4	7	28	5	8	27	5	8
30	Corbett WMA	Undefined															
31	Mullet Slough	Undefined															
32	Upland Pine	Undefined															
33	Upper Mullet Slough	Undefined															
34	Cypress Marsh	Undefined															
35	Wet Prairie	Undefined															
36	Wetter Prairie NE	Undefined															
37	Wetter Prairie SW	Undefined															
38	Drier Cypress NW	Undefined															
39	Drier Cypress NE	Undefined															
40	Cypress	Undefined															
41	NW Big Cypress	Undefined															
42	NE Big Cypress	Undefined															
43	NE Corner Big Cypress	Undefined															
44	SW Big Cypress	Undefined															
45	Racoon Point	Undefined															
47	North C−111	> 1.8	0	0	0	6	2	1	5	2	0	5	2	1	5	2	0
48	North Bisc. Bay Groundwater 1	Undefined															
49	North Bisc. Bay Groundwater 2	Undefined															
50	Central Bisc. Bay Groundwater	Undefined															
51	South Bisc. Bay Groundwater	Undefined															
52	Pennsuco Wetlands North	> 2.0	16	8	8	8	4	2	16	6	6	7	6	3	17	7	8
53	Pennsuco Wetlands South	> 2.0	40	13	33	9	3	2	13	6	5	7	6	2	15	7	6
46	Cape Sable Sparrow A	Undefined															
54	Cape Sable Sparrow B	Undefined															

55	Cape Sable Sparrow C	Undefined															
56	Cape Sable Sparrow D	Undefined															
57	Cape Sable Sparrow E	Undefined															
58	Cape Sable Sparrow F	Undefined															
59	Western WCA−3A Snail Kite	Undefined															
60	Southern WCA−3A Snail Kite	Undefined															
61	WCA−2B1	> 2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	WCA−2B2	> 2.5	3	4	1	10	5	3	10	5	3	10	5	3	10	5	3
63	WCA−2B3	> 2.5	5	7	2	32	17	34	32	17	34	33	17	34	33	17	34
64	WCA−2B4	> 2.5	0	0	0	52	15	50	51	16	50	48	16	49	48	17	49
65	WCA−2B5	> 2.5	13	6	5	28	37	64	28	37	64	29	35	64	29	36	64
66	N WCA−3B	> 2.5	1	1	0	5	10	3	3	11	2	8	8	4	5	9	3
67	NE WCA−3B	> 2.5	0	0	0	8	8	4	3	9	2	10	8	5	3	14	3
68	S of NE WCA−3A	> 2.5	0	0	0	12	11	8	12	10	8	11	14	9	12	12	9
69	L−67A	> 1.5	13	8	6	31	32	61	29	34	62	29	34	61	29	34	62
70	Eastern edge of SRS	Undefined															

Notes: #events = number of events with depths continuously greater than the criterion over the period of record

Avg Duration of High Water Events = [sum(days over criterion)/7]/#events

Avg Annual Duration of High Water(Percent) = 100 x [sum(weeks over criterion)]/[52 x #years]

Table 3 − Low Water Summary for Indicator Regions

#Events|Avg Duration (Wks/Event)|Avg Ann Duration(Percent of Yr)

Indicator Region Number	Name	Depth(ft) Criterion	NSM45F			AD13RDEC			NOLKBTs			NOASRs			NOBOTH		
1	Taylor Slough	< −1.5	20	4	5	28	4	7	28	4	7	27	4	7	27	4	7
2	West Perrine Marl Marsh	< −1.5	36	7	16	35	7	16	35	7	16	35	7	16	35	7	16
3	Mid−Perrine Marl Marsh	< −1.5	28	8	13	32	4	8	33	4	8	32	4	8	33	4	8
4	C−111 Perrine Marl Marsh	< 0.5	54	24	80	51	17	55	50	18	56	50	18	55	51	18	56
5	Model Lands South	< 0.5	56	23	81	79	14	68	80	14	68	79	14	68	78	14	68
6	Model Lands North	< 0.2	54	14	46	52	29	93	52	29	93	51	29	93	52	29	93
7	Ochopee Marl Marsh	< −1.5	17	8	9	22	7	10	22	8	10	23	7	10	23	7	10
8	Rockland Marl Marsh	< −1.5	21	10	13	22	10	14	27	10	16	23	9	13	27	10	16
9	SW Shark River Slough	< −1.0	1	5	0	3	2	0	6	4	1	3	2	0	7	3	1
10	Mid Shark River Slough	< −1.0	1	1	0	2	2	0	4	3	1	2	2	0	4	3	1
11	NE Shark River Slough	< −1.0	1	1	0	2	2	0	4	3	1	3	2	0	4	3	1
12	New Shark River Slough	< −1.0	17	7	8	13	5	4	18	5	6	13	5	4	17	5	6
13	West Slough	< −1.5	22	7	10	20	8	10	20	8	10	21	7	9	21	7	9
14	South WCA−3A	< −1.0	8	4	2	4	4	1	4	4	1	4	4	1	4	4	1
15	West WCA−3B	< −1.0	3	2	0	2	3	0	3	4	1	2	3	0	3	4	1
16	East WCA−3B	< −1.0	1	1	0	3	3	1	7	5	2	4	3	1	7	5	2
17	South Central WCA−3A	< −1.0	8	7	3	5	3	1	4	4	1	5	3	1	6	2	1
18	North Central WCA−3A	< −1.0	9	5	3	1	6	0	1	6	0	1	6	0	4	3	1
19	East WCA−3A	< −1.0	10	6	4	10	3	2	9	4	2	11	3	2	11	3	2
20	NW WCA−3A	< −1.0	6	6	2	5	7	2	8	5	2	9	6	3	10	6	4
21	NE WCA−3A	< −1.0	15	7	7	22	5	6	18	6	6	19	5	6	19	6	7
22	NW Corner WCA−3A	< −1.0	7	5	2	2	6	1	3	4	1	7	3	1	8	4	2
23	WCA−2B	< −1.0	5	5	1	15	6	6	13	7	6	13	7	5	14	6	5
24	South WCA−2A	< −1.0	6	8	3	12	7	6	12	7	6	11	8	6	11	8	6
25	North WCA−2A	< −1.0	8	8	4	4	9	2	4	9	2	7	6	2	9	5	3
26	South LNWR (WCA−1)	< −1.0	10	4	2	0	0	0	0	0	0	0	0	0	0	0	0
27	North LNWR (WCA−1)	< −1.0	8	4	2	1	4	0	1	4	0	1	4	0	1	4	0
28	Rotenberger WMA	< −1.0	18	8	9	18	3	4	17	4	4	18	3	4	18	4	4
29	Holey Land WMA	< −1.0	14	6	5	11	4	2	11	4	3	11	4	3	11	4	3
30	Corbett WMA	Undefined															
31	Mullet Slough	Undefined															
32	Upland Pine	< −7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Upper Mullet Slough	Undefined															
34	Cypress Marsh	< −6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Wet Prairie	< −6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Wetter Prairie NE	< −6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Wetter Prairie SW	< −6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	Drier Cypress NW	< −5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Drier Cypress NE	< −5.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	Cypress	< −4.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	NW Big Cypress	< −3.0	13	5	4	13	5	4	13	5	4	13	5	4	13	5	4
42	NE Big Cypress	< −3.0	6	5	2	9	5	3	9	5	3	9	5	3	9	5	3
43	NE Corner Big Cypress	< −3.0	0	0	0	24	6	8	22	6	9	22	6	9	22	6	9
44	SW Big Cypress	< −3.0	9	6	3	10	7	4	10	7	4	10	7	4	10	7	4
45	Racoon Point	Undefined															
47	North C−111	< 0.0	47	14	41	53	20	66	57	19	67	54	20	66	57	19	67
48	North Bisc. Bay Groundwater 1	< −5.1	18	4	5	1	1612	100	1	1612	100	1	1612	100	1	1612	100
49	North Bisc. Bay Groundwater 2	< −5.0	0	0	0	11	146	100	13	123	99	11	146	100	13	123	99
50	Central Bisc. Bay Groundwater	< −7.5	3	3	1	125	8	60	118	9	63	127	8	60	119	9	63
51	South Bisc. Bay Groundwater	< −3.0	30	9	17	92	11	64	91	11	65	91	11	64	91	11	65
52	Pennsuco Wetlands North	< −1.0	3	2	0	3	5	1	11	5	4	3	5	1	11	5	4
53	Pennsuco Wetlands South	< −1.0	1	1	0	4	6	2	12	7	5	4	6	2	13	6	5
46	Cape Sable Sparrow A	Undefined															
54	Cape Sable Sparrow B	Undefined															

55	Cape Sable Sparrow C	Undefined															
56	Cape Sable Sparrow D	Undefined															
57	Cape Sable Sparrow E	Undefined															
58	Cape Sable Sparrow F	Undefined															
59	Western WCA−3A Snail Kite	Undefined															
60	Southern WCA−3A Snail Kite	Undefined															
61	WCA−2B1	< −1.0	10	5	3	27	10	17	26	10	17	27	10	17	27	10	17
62	WCA−2B2	< −1.0	6	4	2	25	8	13	26	8	13	24	9	13	24	9	13
63	WCA−2B3	< −1.0	4	6	1	6	7	3	6	7	3	6	7	3	7	6	2
64	WCA−2B4	< −1.0	16	4	4	2	5	1	2	5	1	2	4	1	2	4	1
65	WCA−2B5	< −1.0	4	6	2	13	5	4	13	5	4	13	5	4	13	5	4
66	N WCA−3B	< −1.0	21	5	6	3	4	1	10	5	3	3	5	1	11	5	3
67	NE WCA−3B	< −1.0	15	5	5	16	5	5	14	6	6	16	5	5	14	6	6
68	S of NE WCA−3A	< −1.0	13	5	4	13	5	4	13	5	4	13	5	4	14	5	4
69	L−67A	Undefined															
70	Eastern edge of SRS	Undefined															

Notes: #events = number of events with depths continuously less than the criterion over the period of record
Avg Duration of Low Water Events = [sum(days below criterion)/7]/#events
Avg Annual Duration of Low Water(Percent) = 100 x [sum(weeks below criterion)]/[52 x #years]