APPENDIX E

Simulation of Operational Alternatives For The Lake Okeechobee Regulation Schedule Study

Hydrologic Evaluation Final Report
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INTRODUCTION

Purpose and Scope of this Report

In support of the Lake Okeechobee Regulation Schedule Study (LORSS), the system-wide effectiveness of several alternative regulation schedules were simulated with the South Florida Water Management Model (SFWMM). The major assumptions and results of this effort are presented in this report to provide other study team members with information for further analysis. Also included in this report is a precursory evaluation of the trade-offs between the competing objectives for managing Lake Okeechobee.

The synthesis of the findings of these multiple analyses will be prepared by the U.S. Army Corps of Engineers (USACE). This report is intended to help document the characteristics of each alternative and provide a cursory review of the performance associated with each alternative.

Background

Lake Okeechobee is the second largest freshwater lake lying wholly within the boundaries of the United States. Lake Okeechobee benefits south Florida by storing enormous volumes of water during wet periods for subsequent environmental, urban and agricultural needs during dry periods. However, extended periods of high water levels within Lake Okeechobee have been identified as causing stress to the integrity of the Herbert Hoover Dike (HHD) as well as Lake Okeechobee's littoral zone. To accommodate south Florida's potential for heavy rains and severe tropical storms, a lower lake regulation schedule is desired to facilitate levee (HHD) remediation and to assist with long-term ecological restoration. This accommodation requires that water levels in the lake do not rise to levels that would threaten the structural integrity of the levee system surrounding Lake Okeechobee. Therefore, when water levels in the lake reach certain elevations designated by the regulation schedule, discharges are made through the major outlets to control excessive buildup of water in Lake Okeechobee. The timing and magnitude of these releases is not only important for preserving the flood protection of the region, but also for protecting the natural habitats of downstream estuaries and the Everglades.

The multiple objectives associated with managing Lake Okeechobeewater levels are:

- Ensure public health and safety
- Manage Lake Okeechobee at optimal lake levels to allow recovery of the lake's environment and natural resources
- Reduce high regulatory releases to the Caloosahatchee and St. Lucie estuaries to ensure the health of the estuaries are not compromised
- Continue to meet Congressionally authorized project purposes including: flood control, water supply, navigation and recreation, as well as fish and wildlife enchancement

OVERVIEW OF THE SCHEDULES EVALUATED

This report presents the hydrologic simulation results and an evaluation of the hydrologic performance of the final array of regulation schedule alternatives designed to lower the normal operating limits of Lake Okeechobee while meeting the above objectives.

Following completion of the first draft LORSS Supplemental Environmental Impact Study (SEIS) in July 2006, the report was released for public commit and a series of public meetings were held in accordance with the National Environmental Policy Act (NEPA) process to allow the public time to express their views on the plan's effectiveness in managing Lake Okeechobee. Public meetings held on both the east and west coast with stakeholders and the general public provided valuable comments on the Tentatively Selected Plan (TSP) and draft SEIS report. These meetings provided a barometer of the general public's acceptance of the proposed regulation schedule. Recommendations, feedback and comments received were considerable, with many of the comments questioning the viability of the recommended plan. Feedback, especially from stakeholders and the general public on Florida's west coast were critical of the TSP, and concerns were raised that the plan did not go far enough in protecting the Caloosahatchee River and Estuary by further reducing the number of high flow releases being discharged from Lake Okeechobee. Stakeholders representing the Caloosahatchee Estuary expressed concerns that the TSP shows minimal benefits, if any, for the estuary. Concerns were also raised on the plan's impacts to water supply, navigation and on the Everglades ecology.

Based on the comments and recommendations received by the USACE following the completion of the LORSS public meetings, the decision was made to move forward with additional formulation and modeling in order to improve the performance of the recommended plan. During the formulation process and prior to the start of the new round of modeling, the USACE conducted a detailed review of the assumptions and data sets included in the original modeling. As with most projects, the modeling data sets and assumptions used for the LORSS evolved during the duration of the project, and the new round of modeling presented an opportunity to reset and ensure the most current data sets and assumptions were included for modeling evaluations of the TSP refinements resultant from the additional plan formulation.

The inclusion of updated assumptions and data sets required use of a modified version of the SFWMM. The model output included in the July 2006 draft LORSS SEIS (2006 SEIS) was not utilized during evaluation of the new modeling. Three alternatives from the 2006 SEIS were carried forward and modeled again with the updated assumptions and data sets used for the new round of modeling: the No Action Alternative (2007LORS), alternative 1bS2-m (July 2006 draft LORSS SEIS TSP), and alternative 1bS2-A17.25 (the simulation used as the starting point for development of alternative 1bS2-m). The model outputs for the alternatives included in the 2006 SEIS are comparable to each other, and the conclusions drawn from the comparisons between these original alternatives remain valid. The original alternatives from the 2006 SEIS represented a wider range of alternative regulation schedules than the new round of modeling, which built on the conclusions drawn from the detailed evaluation of the original alternatives by the LORSS Project Delivery Team (PDT).

To provide a complete documentation of the array of alternative regulation schedules evaluated for the LORSS, the following general overviews are provided in this section: the final seven alternative regulation schedules and No Action Alternative evaluated for the 2006 SEIS, documentation of updated assumptions and data sets used for the new round of modeling, and the final five alternative regulation schedules and No Action Alternative evaluated for the TSP refinements during additional plan formulation. The alternative descriptions include a listing of changes to the current Lake Okeechobee Regulation Schedule (LORS), Water Supply and Environment (WSE). Alternative descriptions include reference to the regulation schedule decision trees for releases to the Water Conservation Areas (WCAs) (Part 1), decision trees for releases to tide (Part 2), and regulation schedule zone or band breakpoints, which are provided in Attachment A of this Appendix. All elevations referenced within this Appendix for the regulation schedules or Lake Okeechobee stages refer to the National Geodetic Vertical Datum, 1929 (NGVD 1929).

The WSE regulation schedule divides Lake Okeechobee stages into regulation zones including Zone A, Zone B, Zone C, Zone D (including D1, D2, and D3), and Zone E. Modifications to these WSE regulation Zones are referenced in the alternative descriptions within this section. Following completion of the 2006 SEIS LORSS modeling, operations staff determined that the new LORSS would modify the terminology from Lake Okeechobee Zones to Lake Okeechobee Operational Bands, as follows: High Lake Management Band (comparable to WSE Zone A), High Band (Zone B), Intermediate Band (Zone C), Low Band (Zone D, including Zones D1, D2, and D3), a Base Flow Band (not included in WSE), and a Beneficial Use Band (Zone E).

Final Alternatives: 2006 LORSS SEIS

The final seven alternative regulation schedules, plus the No Action Alternative, include the following:

- The No Action Alternative: current regulation schedule, WSE, with the addition of temporary forward pumps;
- The LORS-FWO (future with operations modified) Alternative which is similar to the No Action Alternative with a general lowering of the top two regulatory release lines and the addition of a new regulatory base flow zone for the Caloosahatchee Estuary;
- Alternative 1bS2-A17.25 which is a similar approach to WSE with a general lowering of the top three regulatory release lines, reduced magnitude of maximum discharge decisions in Zone B and Zone C to the St. Lucie Estuary (SLE), a reshaping of the line representing the divide between Zone D and Zone E, redefinition of some of the WSE meteorological inputs, and the addition of a new regulatory base flow zone for the Calosahatchee Estuary;
- Alternative 1bS2-m which is similar to Alternative 1bS2-A17.25 but with a lowering of the second and third regulatory release lines and a lowering of the top three regulatory release lines during the late hurricane season from September 15 through November 1;
- Alternative 2a-B which represents a new appoach to defining the regulatory release bands (based on a defined target operational guideline), and includes removal of the seasonal and multi-seasonal forecasting indices utilized under the WSE decision tree framework, and the addition of a new regulatory base flow zone for the Caloosahatchee Estuary;

- Alternative 2a-m which represents a more aggressive approach to Alternative 2a-B in passing low-level, non-damaging releases to the estuaries to further reduce the normal lake levels, and includes increased magnitude releases to tide in advance of reaching the highest release band;
- Alternative 3-B which represents an approach similar to Run22AZE, from the last regulation schedule study, but with a lowering of the upper two regulatory lines and addition of a new regulatory base flow zone for the Caloosahatchee Estuary;
- Alternative 4-A17.25, a more agressive modification–but similar to–Alternative 1bS2-A17.25, which includes higher maximum release magnitudes to tide for Zone B and Zone C, increased maximum release magnitudes to tide under dry seasonal forecast in Zone C and Zone D, and lowering of the top three regulatory release lines during the late hurricane season.

With the exception of the No Action Alternative, the final set of alternatives, above, were developed to achieve a few common goals: to achieve zero or close-to-zero days above lake elevation of 17.25 ft NGVD; to provide a base flow to one or both of the estuaries in order to minimize the occurrence of undesirable high-volume releases to the estuaries; to include a maximum limit of the lake regulatory releases passed through Stormwater Treatment Area (STA) 3/4, based on assumed treatment capacity given the current nutrient levels within Lake Okeechobee; and to provide lake operators with as much flexibility as possible to lower the lake stages when needed to achieve the project objectives. All alternatives, except Alternative 2a-B and Alternative 2a-m, included similar use of the WSE meteorological guidelines and decision tree framework; all alternatives included use of the Tributary Hydrological Conditions (THC) indicators concept, as found in WSE but modified to utilize the Palmer Drought Index (PDSI) (in the place of net basin rainfall) and Lake Okeechobee net inflows (in the place of inflows at S-65E). The South Florida Water Management District (SFWMD) Supply Side Management (SSM) line is assumed to be lowered by one foot from the current SSM line under all alternatives. The assumption of a lowered SSM line serves as a surrogate for the SSM update effort anticipated to be completed by the SFWMD prior to implementation of a new lake regulation schedule (to be identified by this LORSS), but the assumption is unable to be included as part of the No Action Alternative; the assumption of a one-foot lowering of the SSM line for all alternatives is based on a recommendation from the SFWMD technical staff working on the parallel effort to update the SSM rules. Completion of the SFWMD SSM update effort requires identification of the TSP by the USACE.

The schedules which included the WSE decision tree framework were designed to increase operational flexibility. Considering the many competing purposes for managing Lake Okeechobee, it appears desirable to design flexible operating rules that give water managers some latitude to utilize best available multi-disciplinary information, and adjust operations as necessary to achieve a better balance of the competing objectives. Considering the potential benefits from recent lake inflow forecasting tools, and the rapid increase in the state-of-the-art in forecasting technology, it is practical to establish more flexible rules which allow lake managers to utilize supplemental information and apply their best professional judgement in making operational decisions. A detailed discussion of WSE will not be provided in this report; however, differences from WSE will be discussed as part of the individual alternatives.

A. LORS-FWO Alternative

The No Action Alternative, which includes the current WSE regulation schedule for Lake Okeechobee and assumes SFWMD temporary forward pumps in place, calls for maximum practicable releases from Lake Okeechobee when lake stages are within Zone A--a range from elevation 17.00 feet on May 31 to elevation 18.50 feet from October through March. The No Action Alternative does not include a zone for base flow releases to either the Caloosahatchee or St. Lucie Estuary. In order to properly evaluate the potential effects of allowing for maximum releases above 17.25 elevation and base flow to the estuaries, in the absence of additional changes to the WSE regulation schedule, alternative LORS-FWO was developed with the following changes to the No Action Alternative:

1. Zones A and B are lowered where necessary to allow maximum practicable releases under all conditions when the Lake Okeechobe stage exceeds 17.25 ft, NGVD. The regulation schedule is shown in Figure A-1.

2. An additional regulatory zone is added (below Zone D) to allow for base flow releases to the Calosahatchee Estuary. During the alternative formulation process, data and recommendations were evaluated and the recommended base flow release was determined to be 450 cubic feet per second (cfs) to the Caloosahatchee Estuary (measured at S-79) and zero base flow to the SLE.

B. Alternative 1bS2-A17.25

Alternative 1bS2-A17.25 was developed from the current WSE decision tree structure. The regulation schedule and decision trees for Lake Okeechobee discharges to the WCAs and discharges to tidewater for Alternative 1bS2-A17.25 are shown in Figure A-2, Figure A-3, and Figure A-4, respectively. Operational experience under WSE and the availability of additional climatological data led to the following recommended modifications to WSE for this alternative:

1. Regulation schedule lines for Zone A, Zone B, and Zone C are lowered. If the stage of Lake Okeechobee exceeds 17.25 ft, NGVD, the regulation schedule decision tree specifies maximum practicable releases to the WCAs and tidewater. The lowering of the upper regulatory zones results in a regulation schedule that is more pro-active in limiting potential high water conditions within Lake Okeechobee.

2. THC are applied that represent longer term wet or dry conditions that have persisted in the tributaries. Updated THC indicators enable the proposed regulation schedule to avoid frequent breaks in the regulatory outflows that may occur due to shorter dry periods. The PDSI is proposed to replace the 30-day net rainfall, and the 14-day mean Lake Okeechobee net inflow (LONIN) is proposed to replace the 14-day mean S-65E flow. The classification bands for the PDSI and LONIN THC indicators are summarized in Table 1.

3. The line representing the divide between Zone D and Zone E is reshaped; the bottom of Zone D is flattened during the periods in which the estuary ecological systems may be

more impacted by large freshwater discharges, especially in late winter, early spring, and during the October through November period. The modified regulatory line promotes a quicker response in the autumn and winter months to large inflows that often are generated during the hurricane season.

TABLE 1: DEFINITION OF TRIBUTARY CONDITIONS BASED ON THE PALMER DROUGHT INDEX AND NET INFLOW

Tributary Hydrologic Classification	Palmer Index Class Limits	2-wk mean L.O. Net Inflow Class Limits
Very Wet	3.0 or greater	Greater >= 6000 cfs
Wet	1.5 to 2.99	2500-5999 cfs
Near Normal	-1.49 to 1.49	500-2499 cfs
Dry	-1.5 to -2.99	-5000 – 500 cfs
Very Dry	-3.0 or less	Less than -5000 cfs

4. A new base flow zone (Zone D0) is established below the bottom of the re-shaped Zone D. Base flow is allowed when Lake Okeechobee water levels are in Zone D0 or above (Zone C decision tree outcome for dry THC, seasonal, and multi-seasonal forecasts is base flow), but no base flow releases are called for when the stage falls below the bottom of Zone D (Zone D0). During the alternative formulation process, data and recommendations were evaluated and the recommended base flow release was determined to be 450 cfs to the Caloosahatchee Estuary (measured at S-79) and zero base flow to the SLE. Risks to the water supply performance objective are anticipated to be minimized with the forward pumps assumed in place to allow for water supply at lower lake water levels. The bottom of the base flow zone ranges from 11.5 ft, NGVD on May 31 to 13.0 feet during October and November. For Figure A-3 (discharges to WCAs), releases to the WCAs when in Zone D0 adhere to the same decision tree as the remainder of Zone D; for Figure A-4 (discharges to tidewater), releases when in Zone D0 will be base flow, and the decision tree of Zone D is not applicable.

5. THC and seasonal climate forecasts are updated to allow increased operational flexibility in managing lake stages, and specifically to avoid extreme high lake stages. A significant number of decision tree outcomes for THC and seasonal forecast are updated to allow the quicker release of lake water, as compared to WSE (for example, "Extremely wet" THC is changed to "very wet" or "wet to very wet" is changed to "normal to wet"). The additional inclusion of lake stages forecasted to rise into Zones A or B also introduces additional operator flexibility by allowing for utilization of all available hydrologic and meteorological forecasting data. The changes to WSE for Alternative 1bS2-A17.25 are indicated by the red font in Figure A-4.

6. Moderate to extreme high discharges to the SLE are reduced by modifying the maximum discharge rates for Zone B and Zone C from 3500 to 2800 cfs, and 2500 to 1800 cfs, respectively. The intention of this modification was to reduce the potential impacts associated with high-volume discharge events to the SLE.

C. Alternative 1bS2-m

Alternative 1bS2-A17.25 simulation output (SFWMM) showed the 17.25 feet stage criteria for Lake Okeechobee extreme high water to be exceeded for 12 days during the 36-year simulation period-of-record (POR). Alternative 1bS2-A17.25 was modified to remove any simulated daily stage in excess of 17.25 feet within Lake Okeechobee. The modifications to Alternative 1bS2-A17.25 to create Alternative 1bS2-m are summarized below:

1. Regulation Zones A, B, and C are lowered during the late hurricane season (September 30 stage breakpoints are changed to November 1).

2. Regulation lines for the bottom of Zones B and C were lowered. Zone B breakpoints were first lowered to be mid-way between the bottom of Zone A and the bottom of Zone C. The bottom of Zone B was then lowered by an additional 0.15 feet and the bottom of Zone C was lowered by 0.10 feet, as required to achieve zero days with lake stage greater than 17.25 ft elevation.

As the result of the modifications to develop Alternative 1bS2-m, the simulated peak stage for Lake Okeechobee is 17.23 feet. The peak stage of 17.23 feet is less than the maximum target stage identified to be 17.25 feet. The regulation schedule for Alternative 1bS2-m is shown in Figure A-5; the decision tree remains unchanged from Alternative 1bS2-A17.25 (Figure A-3 and Figure A-4).

D. Alternative 2a-B

Alternative 2a-B represents a new appoach to defining the regulatory release bands, based on a defined target operational guideline. The regulation schedule and decision trees for Lake Okeechobee discharges to the WCAs and discharges to tidewater for Alternative 2a-B are shown in Figure A-6, Figure A-7, and Figure A-8, respectively. The operational details of Alternative 2a-B are summarized below:

1. The operational guideline was developed by the USACE Water Management Section based on evaluation of historical stages of Lake Okeechobee from 1965 through 2005. As the lake stages increase further above the operational guideline, regulatory releases increase according to the specified regulatory bands.

2. The upper two regulatory lines were defined based on the probability (50% and 25%) of Lake Okeechobee stages reaching 17.50 feet within the next 90 days, assuming discharge outlets to tidewater were significantly limited. If the stage of Lake Okeechobee exceeds 17.25 ft, NGVD, the regulation schedule decision tree specifies maximum practicable releases to the WCAs and tidewater (same as Alternative 1bS2-A17.25).

3. Below the operational guideline, base flow to the Caloosahatchee Estuary of 450 cfs is permitted but discontinued if the lake falls below the assumed 12.56 feet elevation for navigation (Lake Okeechobee navigation may be impaired at lower stages) or the current SSM line, whichever is higher.

4. The decision tree for Alternative 2a-B includes removal of the seasonal and multi-seasonal forecasting indices utilized under the WSE decision tree framework, utilizing only the THC indicators of the PDSI and LONIN, as used in all alternatives.

5. Regulatory releases fom Lake Okeechobee to the WCAs are discontinued when the lake stage falls below 13.50 ft, NGVD.

E. Alternative 2a-m

Alternative 2a-B was modified to significantly reduce the frequency of extreme high discharge to the Caloosahatchee and St. Lucie estuaries, with the resulting alternative being Alternative 2a-m. The modifications to Alternative 2a-B are summarized below, and the regulation schedule is shown in Figure A-9. The decision tree for Alternative 2a-m is unchanged from the decision tree utilized for Alternative 2a-B (Figure A-7 and Figure A-8).

1. Releases to tidewater for the regulatory band between the 25 percent and 50 percent high water probability lines (Blue band) are increased from 6500 cfs to Caloosahatchee/3500 cfs to St. Lucie to 7500 cfs/5000 cfs, with the intention to reduce the duration of extreme high-volume estuarine discharges but also recognizing the possibility that these higher release volumes may cause additional impacts to public health and safety downstream of the St. Lucie lock (S-80).

2. Releases to tidewater for the regulatory band between the operational guideline and 13.50 feet elevation (magenta band) is modified from a regulatory band for Caloosahatchee Estuary baseflow to a low level regulatory release of 800 cfs to the Caloosahatchee Estuary and 400 cfs to the SLE. The magenta regulatory band was also extended to include the area between 13.50 feet elevation and the operatinal guideline minimum elevation of 12.50 feet, which was not included for Alternative 2a-B.

3. The bottom of the base flow regulatory band (bottom of orange band/top of red band) was modified to be consistent with Alternative 1bS2-A17.25 and Alternative 1bS2-m, with a minimum elevation of 11.50 feet and a maximum elevation of 13.0 feet.

F. Alternative 3-B

The conceptualization for Alternative 3 was developed from Run22AZE. The operational schedule Run22AZE was evaluated under the previous LORSS (2000) that resulted in the selection of WSE, at which time Run22AZE was recommended as the most desirable schedule for the Lake Okeechobee littoral zone system. The regulation schedule for Run22AZE is shown in Figure A-10. The regulation schedule for Run22AZE was modified for this regulation schedule study with the following changes, as shown in Figure A-11:

1. The upper two regulatory lines are lowered. If the stage of Lake Okeechobee exceeds 17.25 ft, NGVD, the regulation schedule decision tree specifies maximum practicable releases to the WCAs and tidewater (same as Alternative 1bS2-A17.25). The Run22AZE operational schedule included maximum practicable releases when stages exceeded 18.50 feet for October through February.

2. A new regulatory base flow zone for base flow to the Caloosahatchee Estuary is defined below the bottom regulatory line of the Run22AZE operational schedule. Base flow releases for the Calooschatchee Estuary are discontinued if Lake Okeechobee falls below the assumed 12.56 feet elevation for navigation (Lake Okeechobee navigation may be impaired at lower stages) or the current SSM line, whichever is higher.

The operational criteria for releases to the WCAs and releases to the estuaries remain unchanged from the zones defined for Run22AZE; Zone A and Zone B breakpoints have, however, been modified as noted in item 1 above.

G. Alternative 4-A17.25

Alternative 4 was developed similarly to Alternative 1bS2-A17.25. Alternative 4, however, was intended to provide additional operational flexibility to manage the lake stages at lower levels than Alternative 1bS2-A17.25. The regulation schedule for Alternative 4 is shown in Figure A-12. Alternative 4 includes all of the modifications to the No Action Alternative that were included in Alternative 1bS2-A17.25, with the following additional modifications:

1. Maximum releases in Zone B and Zone C for normal to wet THC are unchanged from the No Action Alternative: 6500 cfs to Caloosahatchee Estuary/3500 cfs to SLE in Zone B and 4500 cfs/2500 cfs in Zone C. If the stage of Lake Okeechobee exceeds 17.25 feet, NGVD, the regulation schedule decision tree specifies maximum practicable releases to the WCAs and tidewater (same as Alternative 1bS2-A17.25).

2. Regulation Zones A, B, and C are lowered during the late hurricane season (September 30 stage breakpoints are changed to November 1).

3. Zone D decision tree outcome for THC "normal" and seasonal climate outlook "otherwise" (not "normal or wetter"), or THC "wet" or "normal" and multi-season climate outlook "otherwise" (not "wet to very wet") is changed from base flow to the Caloosahatchee Estuary to "up to level 1 pulse release."

4. Zone C decision tree outcome for THC, seasonal climate outlook, and multi-season climate outlook "dry" is changed from base flow to the Calosahatchee Estuary to "up to level 2 pulse release."

5. Zone D0 for base flow to the Caloosahatchee Estuary is re-defined to discontinue base flow releases if Lake Okeechobee falls below the assumed 12.56 feet elevation for navigation (Lake Okeechobee navigation may be impaired at lower stages) or the current

SSM line, whichever is higher (Alternative 1bS2-A17.25 allowed base flow to elevation 11.50 feet at the minimum).

6. Consideration of active huricane season forecast was recommended for inclusion with the THC decision, but this variable was not defined in detail adequate for SFWMM modeling, and it was therefore not included in the Alternative 4 simulation.

Additional assumptions common to all previous alternatives are next briefly reviewed. All alternatives include the SFWMD temporary forward pumps at S-351, S-352, and S-354 for water supply, as included in the No Action Alternative. The regulation schedules for the WCAs (including WCA-1, WCA-2A, WCA-2B, WCA-3A, and WCA-3B), including environmental water supply deliveries from Lake Okeechobee, are not modified from the No Action Alternative for the LORSS alternatives. For alternatives formulated to include base flow releases to the Caloosahatchee and/or St. Lucie Estuaries (measured at S-79 and S-80, respectively) when Lake Okeechobee stages are within an estabished base flow regulatory band, it is recognized that very dry climate conditions may require that releases to the estuaries be discontinued; this note will be included on the 2007 LORSS regulation schedule, and this consideration is represented in the SFWMM simulations with a 0.50 million acre-feet threshold for the multi-seasonal forecast of Lake Okeechobee inflow (base flow releases are discontinued if the inflow forecast is below this threshold). All alternatives assume backflow from the St. Lucie Canal (C-44) to Lake Okeechobee to be allowed to occur at lake stages of 14.50 feet or 0.25 feet below the bottom of the lowest non-baseflow regulatory zone, whichever is lower. These operations were developed to achieve similar performance as the No Action Alternative, while seeking to avoid frequeny oscillation between regulatory releases and backflow at S-308. The No Action Alternative assumes backflow below Lake Okeechobee stages of 14.50 feet, consistent with operations under WSE and always more than 0.25 feet below the lowest regulatory release zone for the WSE regulation schedule. All LORSS alternatives and the No Action Alternative assume backflow from the Caloosahatchee River Canal (C-43) to Lake Okeechobee to be allowed to occur for lake stages below 11.10 feet. Operations for gravity flow from the West Palm Beach Canal and L-8 Canal to Lake Okeechobee are not modified from the No Action Alternative for the LORSS alternatives and remain consistent with existing operations.

SFWMM Updates: 2007 LORSS SEIS

Based on the comments and recommendations received by the USACE following the completion of the LORSS public meetings to review the 2006 SEIS, the decision was made to move forward with additional formulation and modeling in order to improve the performance of the 2006 SEIS recommended plan. During the formulation process and prior to the start of the new round of modeling, the USACE conducted a detailed review of the assumptions and data sets included in the original modeling. The inclusion of updated assumptions and data sets required use of a modified version of the SFWMM. Three alternatives from the 2006 SEIS were carried forward and modeled again with the updated assumptions and data sets used for the new round of modeling: the No Action Alternative (2007LORS), alternative 1bS2-m (July 2006 draft LORSS SEIS TSP), and alternative 1bS2-A17.25 (the simulation used as the starting point for development of alternative 1bS2-m). Documentation of updated assumptions and data sets used for the new round of modeling are provided below:

A. Documentation for Updated 2007LORS base condition

1. The seasonal and multi-seasonal forecast files used until July 2006 (as used for the previous LORSS modeling) for all SFWMM modeling was mistakenly computed with La Nina threshold of -0.04. The updated base condition simulation is corrected by utilizing re-computed seasonal and multi-seasonal forecast input data files based on the correct threshold. The La Nina threshold error dates back to the 2005 Lower East Coast Water Supply Plan (LECRWSP) simulation, selected as the best available SFWMM representation of WSE operations in February 2006 (start of the LORSS alternative modeling). The LONIN control volume used in the computation is based on S-80, which is specified in the WSE Water Control Plan (WCP).

2. SFWMD recommends use of the pump option at the S-8 structure to provide additional water supply deliveries to the Big Cypress Seminole Tribe reservation. Previous base condition and alternative modeling assumed gravity deliveries. Based on discussions with SFWMD staff, the pump operation is likely to be used to ensure delivery of water supply, specifically under drought conditions.

3. The SFWMM subroutine that computes the capacity of the Everglades Agricultural Area (EAA) canals under the neutral case had some legacy code that made it rely on parameter values for other "Low Lake Okeechobee Stage Management" (as opposed to using the SSM operations). The source code was modified to correct this minor error. Updated source code was provided to USACE by SFWMD on 06 October 2006 and utilized to update the base condition simulation of 2007LORS.

4. L-8 regulatory releases from Lake Okeechobee and L-8 local basin runoff are routed to tide (through S-155A) and will not be routed through STA-1E. Based on discussions with SFWMD technical staff, STA-1E is not designed to treat L-8 local basin runoff or Lake Okeechobee discharges (associated with higher nutrient load). Previous LORSS base condition and alternative modeling assumed treatment of L-8 local basin runoff and Lake Okeechobee discharges by STA-1E, resulting in additional volumes of water being passed through STA-1E, WCA-1, WCA-2, and into WCA-3A. Updated source code was provided to USACE by SFWMD on 06 October 2006 utilized to update the base condition simulation of 2007LORS.

The updated simulation for the 2007LORS base condition was developed from the 2007LORS base condition simulation evaluated in the 2006 SEIS, and the simulation is updated to include the above assumptions and new SFWMM source code.

B. Documentation for Updated LORSS alternatives (1bS2-A17.25 and 1bS2-m)

1. The seasonal and multi-seasonal forecast files used up to July 2006 (as used for the previous LORSS modeling) was mistakenly computed with La Nina threshold of -0.04. The updated base alternative simulations are corrected by utilizing re-computed seasonal and multi-seasonal forecast input data files based on the correct threshold.

A new time series developed for updated computation of LONIN, based on a control volume that includes the S308 structure. The previous LORSS base conditions and alternatives were simulated with a time series for a control volume that included S-80. Updated input files for the seasonal and multi-seasonal forecast, as well as THCs were provided by the SFWMD on 13 October 2006, and the updated assumptions were reviewed and supported by the USACE water management technical staff.

The following equation was used for the computation:

LONIN = DeltaStorage + L8CP + HG5 + S2 + S3 + S308 + S77

Minor formatting problems in the THC input data files were also identified and corrected.

The updated input files for seasonal and multi-seasonal forecasts and THC used for the alternatives were computed based on the correct La Nina threshold and changed control volume for LONIN that includes S-308 (not S-80); the updated alternatives include the THC shift to LONIN and PDSI from S-65E discharge and net rainfall THCs used under WSE; the LONIN Time series was updated based on the S-308 control volume (consistent with the intent of the original alternative 1b proposed by the SFWMD).

2. SFWMD recommends use of the pump option at the S-8 structure to provide additional water supply deliveries to the Big Cypress Seminole Tribe reservation. Previous base condition and alternative modeling assumed gravity deliveries. Based on discussions with SFWMD staff, the pump operation is likely to be used to ensure delivery of water supply, specifically under drought conditions.

3. The SFWMM subroutine that computes the capacity of the EAA canals under the neutral case had some legacy code that made it rely on parameter values for other "Low Lake Okeechobee Stage Management" (as opposed to using the SSM operations). The source code was modified to correct this minor error. Updated source code was provided to USACE by SFWMD on 06 October 2006 and utilized to update the alternatives.

4. L-8 regulatory releases from Lake Okeechobee and L-8 local basin runoff are routed to tide (through S-155A) and will not be routed through STA-1E. Based on discussions with SFWMD technical staff, STA-1E is not designed to treat L-8 local basin runoff or Lake Okeechobee discharges (associated with higher nutrient load). Previous LORSS base condition and alternative modeling assumed treatment of L-8 local basin runoff and Lake Okeechobee discharges by STA-1E, resulting in additional volumes of water being passed through STA-1E, WCA-1, WCA-2, and into WCA-3A. Updated source code was provided to USACE by SFWMD on 06 October 2006 and was utilized to update the alternatives.

5. Updated SSM methodology (now termed Lake Okeechobee Water Shortage Management Plan [LOWSM]) is included in the updated modeling. 2006 SEIS alternative simulations assumed a one-foot lowering of the SSM line as a surrogate for

this LOWSM plan that was under development by the SFWMD. The operational details of the draft LOWSM plan were provided to the LORSS PDT by the SFWMD on 10 October 2006.

Updated source code was provided to USACE by SFWMD and was utilized to update the alternatives.

The LOWSM methodology is not included within the base condition simulation (2007LORS) and separate SFWMM code versions were used to simulate the base condition and all alternatives included in the new round of modeling. The LOWSM option is controlled by input file parameters, and the same source code could have been used for alternatives and base if no additional changes were required; however, minor code changes to the Lake Okeechobee decision tree are also included in the source code used to simulate the alternatives, compared to the base condition (WSE).

To allow PDT evaluation of the difference between the 2006 SEIS assumption (lowering the SSM line by one foot) and the assumption for the new round of modeling (draft LOWSM), SFWMM simulations of the updated alternative 1bS2-m (2006 SEIS TSP) with and without LOWSM were provided on the LORSS modeling web page. The updated regulation schedule graphics for Alternative 1bS2-A17.25 and Alternative 1bS2-m, with the draft LOWSM line included, are provided in Figures A-14 and A-15.

6. Modify Low band breakpoints to assume Level 1 pulse release within the bottom one third of the band, Level 2 pulse release within the middle one third of the band, and Level 3 pulse release within the upper one third of the band. The previous modeling of Alternatives 1b, 1bS2, 1bS2-a17.25, 1bS2-m, and 4 included model inputs that resulted in a narrow band for level 3 pulse releases within the Low band; the previous modeling did not modify the Low band breakpoints when the bottom of the intermediate band was lowered from Alternative 1a to Alternative 1b (and all derivatives from Alternative 1b). The LORSS PDT was informed of this inconsistency in an email dated 30 June 2006, and updated modeling to correct the low band breakpoints was provided to the team on the LORSS modeling web page. The operational decision tree for the low band does not specify the level of pulse release within the band (up to Level 3 pulse is allowed), and both modeling approaches do fall within the operational range permitted within the low band. The alternate approach for Alternative 1bS2-m (the 2006 SEIS TSP) was demonstrated to not alter the performance of the TSP, and it was identified that there would be no change to the 2006 SEIS TSP plan.

The WSE simulation, as included in the 2007LORS base condition modeling for LORSS, also includes the even-thirds assumption for pulse releases, and the new round of alternative modeling will include this change for consistency.

Final Alternatives: 2007 LORSS SEIS

Based on consideration of public and agency comments to the 2006 SEIS, three additional alternatives (Alternatives T1, T2, and T3) were developed as TSP refinements during additional plan formulation. The updated simulations for the 2006 SEIS TSP (Alternative 1bS2-m) and the parent of this TSP Alternative (Alternative 1bS2-A17.25) were also carried forward for evaluation within the new round of modeling. The alternative descriptions include a listing of changes to the current LORS, WSE. The WSE regulation schedule divides Lake Okeechobee stages into regulation zones including Zone A, Zone B, Zone C, Zone D (including D1, D2, and D3), and Zone E, and modification to these WSE regulation zones are referenced in the alternative descriptions within this section. Following completion of the 2006 SEIS LORSS modeling and before completion of the new round of modeling, operations staff determined that the new LORSS regulation schedule would modify the terminology from Lake Okeechobee Zones to Lake Okeechobee Operational Bands, as follows: High Lake Management Band (comparable to WSE Zone A), High Band (Zone B), Intermediate Band (Zone C), Low Band (Zone D, including Zones D1, D2, and D3), a Base Flow Band (not included in WSE), and a Beneficial Use Band (Zone E). The regulation schedule graphics and alternative descriptions for Alternatives T1, T2, and T3 include the modified terminology for operational bands.

The five alternative regulation schedules, plus the updated No Action Alternative, evaluated for the TSP refinements during additional plan formulation include the following:

- The updated No Action Alternative: current regulation schedule, WSE, with the addition of temporary forward pumps;
- Updated Alternative 1bS2-A17.25 which is a similar approach to WSE with a general lowering of the top three regulatory release lines, reduced magnitude of maximum discharge decisions in Zone B and Zone C to the SLE, a reshaping of the line representing the divide between Zone D and Zone E, redefinition of some of the WSE meteorological inputs, and the addition of a new regulatory base flow zone for the Calosahatchee Estuary;
- Updated Alternative 1bS2-m (2006 SEIS TSP) which is similar to Alternative 1bS2-A17.25 but with a lowering of the second and third regulatory release lines and a lowering of the top three regulatory release lines during the late hurricane season from September 15 through November 1;
- Alternative T1 was developed based on recommendations from Lee County and Sanibel to improve Caloosahatchee Estuary performance demonstrated with Alternative 1bS2-A17.25 and Alternative 1bS2-m; Alternative T1 included increased high and intermediate band (same as Zone B and Zone C used in WSE) discharges to the SLE, base flow releases to the SLE, and increased base flow releases to the Caloosahatchee Estuary, but Alternative T1 did not demonstrate significant improvements to the Caloosahatchee Estuary;
- Alternative T2 was developed based on evaluation of Lake Okeechobee Operations Screening (LOOPS) model output to reduce high flows greater than 4500 cfs to the Caloosahatchee Estuary and allow a minor increase in high stages within Lake Okeechobee; Alternative T2 included measuring of all Caloosahatchee Estuary pulse releases at S-79 (instead of S-77), the lowering of the bottom of the pulse band to encourage more low-level regulatory pulse releases, and a base flow to the St Lucie Estuary;

- Alternative T3 was developed from Alternative T2 in an effort to maintain the performance balance of Alternative T2, reduce the magnitude and duration of high lake stages, and further reduce the frequency and duration of undesirable high-volume discharges to the Caloosahatchee Estuary

The three new alternatives for the new round of modeling were developed in an effort to demonstrate potential improvements to the TSP plan based on the following guidance: evaluate the 17.25 feet Lake Okeechobee elevation as a performance measure, not as a constraint; evaluate additional alternatives to reduce the frequency of high flows greater then 4500 cfs to the Caloosahatchee Estuary; evaluate alternatives to obtain an equitable balance between the coastal estuaries; and evaluate alternatives to improve the balance between all system-wide performance measures.

PDT performance evaluation of 2006 SEIS Alternatives 1bS2-A17.25 and 1bS2-m demonstrated similar performance between the two alternatives; the notable difference between the two alternatives is that Alternative 1bS2-A17.25 was modified to demonstrate zero days in the SFWMM POR with Lake Okeechobee stage above 17.25 feet to generate Alternative 1bS2-m. With the guidance to evaluate the 17.25 feet Lake Okeechobee elevation as a performance measure (not as a constraint), the starting point for the three additional alternatives was the updated version of Alternative 1bS2-a17.25. The new alternatives incorporate all assumptions included in the updated simulation of Alternative 1bS2-A17.25, except where changes are noted in the alternative descriptions. Complete details regarding the key components of the regulation schedules for Alternative 1bS2-A17.25 and Alternative 1bS2-m have been previously discussed, as these two alternatives are carried forward from the 2006 SEIS evaluation and only updated to include the most current assumptions and data sets. A brief overview of Alternative 1bS2-A17.25 is provided below in order to clearly convey all of the regulation schedule details that will be included in Alternatives T1, T2, and T3, which were developed from Alternative 1bS2-A17.25.

The naming convention used during the SFWMM modeling in support of the 2007 LORSS SEIS is referenced throughout this appendix. The naming convention for the alternatives was later modified during preparation of the 2007 LORSS SEIS main report, as follows: Alternative A (Alternative 1bS2-A17.25), Alternative B (Alternative 1bS2-m), Alternative C (Alternative T1), Alternative D (Alternative T2), and Alternative E (Alternative T3). The output and performance measure results of the SFWMM simulations are not affected by the modified naming convention, and the two names for an alternative may be used interchangeably.

A. Alternative 1bS2-A17.25 (same as 2006 SEIS alternative)

Alternative 1bS2-A17.25 included the following modifications_to the current WSE regulation schedule (2007LORS simulation represents the current WSE regulation schedule with the SFWMD temporary forward pumps, which are also included in all LORSS alternatives):

1. The bottom elevations for the upper three regulatory zones are lowered, resulting in a more pro-active schedule to control high water conditions in Lake Okeechobee; "up to

maximum" releases to tidewater are called for if Lake Okeechobee stage exceeds 17.25.

2. The re-shaping of the line representing the divide between Zone D and Zone E.
3. THCs are used that represent longer-term wet or dry conditions that have persisted in the tributaries–PDSI and 14-day mean Lake Okeechobee net inflow.
4. Base flow releases to the Caloosahatchee River Estuary (CRE) of 450 cfs (measured at S-79) are allowed when Lake Okeechobee water levels are within a new base flow zone (Zone D0) or above; the original proposed elevation (original Alternative 1b) for the bottom elevation of Zone D0 was lowered by one foot.
5. Zone B and Zone C discharges to the SLE are reduced: maximum discharge to the SLE under normal to wet THC is reduced from 3500 to 2800 cfs in Zone B and reduced from 2500 to 1800 cfs in Zone C; maximum discharge to the SLE is reduced from 3500 to 2800 cfs in Zone C under very wet THC; maximum discharge to the SLE is reduced from 2500 to 1800 cfs in Zone D under very wet THC. The intention of this modification was to reduce the potential impacts associated with high discharge events to the SLE.

B. Alternative T1

Alternative T1 (TSP modification 1) was proposed by the USACE, Water Management Section. The decision tree, Part 1 (releases to WCAs) for Alternative T1 remains unchanged from Alternative 1bS2-A17.25, and the decision tree with updated terminology is shown in Figure A-15. The decision tree, Part 2 and regulation schedule for Alternative T1 are shown in Figure A-16 and A-17. The following changes were made to Alternative 1bS2-A17.25:

1. Lake Okeechobee late season break points are changed from September 30 to November 1 for the top of the High, Intermediate, and Low bands to address the potential of late season hurricanes.
2. Level 3 pulse measured at S-77 is changed from average daily flow of 3000 cfs to 2800 cfs.
3. A base flow of 350 cfs to the SLE measured at S-80 in low and intermediate bands is included in this alternative.
4. Base flow to the Caloosahatchee Estuary is changed from up to 450 cfs at S-79 to up to 650 cfs measured at S-77 in the low and intermediate bands. It is recognized that discharge at S-79 of up to 800 cfs could be recommended for occasional implementation, but this infrequent recommendation would not be consistent with inclusion for the complete POR modeling; additional flow at S-79 could be delivered by redistribution of the baseflow releases to the SLE.
5. No changes to base flow of 450 cfs measured at S-79 in the base flow band.
6. The bottom of the base flow band is raised by 0.25 feet.
7. Change the High and Intermediate band flow of up to 2800 cfs measured at S-80 back to WSE level of up to 3500 cfs.

C. Alternative T2

Alternative T2 (TSP modification 2) was proposed by the SFWMD, based on screening results from the LOOPS model. The decision tree, Part 1 (releases to WCAs) for Alternative T2 remains unchanged from Alternative 1bS2-A17.25, and the decision tree with updated terminology is shown in Figure A-15. The decision tree, Part 2 and regulation schedule for Alternative T2 are shown in Figures A-18 and A-19. The following changes were made to Alternative 1bS2-a17.25:

1. Zone D0 raised to 12.6 feet to maintain Zone D0 higher than navigation minimum Lake Okeechobee elevation of 12.56 feet.
2. All Caloosahatchee Estuary pulse releases measured at S-79 instead of S-77, in all lake bands when pulse releases are called for, to reduce high flow exceedences caused by lake release plus local C-43 basin runoff.
3. Bottom of Zone D1 lowered by one half foot, to encourage more pulse releases which help reduce steady high-volume discharges.
4. Add a small baseflow of 200 cfs (low volume regulatory discharge) to SLE (below S-80, to include accounting of C-23 and C-24 basin inflows) whenever base flow releases are called for in decision tree. Additional base flow deliveries at S-79 (450 cfs at S-79 is included, per Alternative 1bS2-A17.25) could be delivered by redistribution of the baseflow releases to the SLE.

D. Alternative T3

Alternative T3 (TSP modification 3) was developed through the collaborative efforts of the USACE and SFWMD, following LORSS PDT review of the updated 2006 SEIS alternatives (Alternatives 1bS2-A17.25 and 1bS2-m) and the new T1 and T2 alternatives. The decision tree, Part 1 (releases to WCAs) for Alternative T1 remains unchanged from Alternative 1bS2-A17.25, and the decision tree with updated terminology is shown in Figure A-15. The decision tree, Part 2 and regulation schedule for Alternative T3 are shown in Figure A-20 and A-21. Alternative T3 was developed from Alternative T2, with the following changes:

1. Lake Okeechobee late season break points are changed from September 30 to November 1 for the top of the High, Intermediate, and Low bands to address the potential of late season hurricanes (consistent with Alternative T1).
2. Inclusion of an October 1 breakpoint at 13.0 feet for the bottom of the baseflow zone D0 (consistent with original 2006 SEIS Alternatives 2a and 4), to provide some protection to low lake levels at the end of the wet season.
3. Caloosahatchee Estuary Level 1 pulse level increased from average daily rate of 1600 cfs to 2000 cfs, to allow for increased releases below 2800 cfs to reduce higher lake levels and the associated higher releases.
4. Caloosahatchee Estuary Level 2 pulse level increased from average daily rate of 2300 cfs to 2500 cfs, to allow for increased releases below 2800 cfs to reduce higher lake levels and the associated higher releases.
5. Caloosahatchee Estuary Level 3 pulse level unchanged, at average daily rate of 3000 cfs.

6. Maximum Caloosahatchee Estuary discharges reduced from 4500 cfs to 4000 cfs when the Lake Okeechobee stage is within the intermediate (THC: normal to wet) or low (THC: very wet) bands.

Additional assumptions common to all previous alternatives are next briefly reviewed. All alternatives include the SFWMD temporary forward pumps at S-351, S-352, and S-354 for water supply, as included in the No Action Alternative. The regulation schedules for the WCAs (including WCA-1, WCA-2A, WCA-2B, WCA-3A, and WCA-3B), including environmental water supply deliveries from Lake Okeechobee, are not modified from the No Action Alternative for the LORSS alternatives. For alternatives formulated to include base flow releases to the Caloosahatchee and/or SLEs (measured at S-79 and S-80, respectively) when Lake Okeechobee stages are within an estabished base flow regulatory band, it is recognized that very dry climate conditions may require that releases to the estuaries be discontinued; this note will be included on the 2007 LORSS, and this consideration is represented in the SFWMM simulations with a 0.50 million acre-feet threshold for the multi-seasonal forecast of Lake Okeechobee inflow (base flow releases are discontinued if the inflow forecast is below this threshold). All alternatives assume backflow from the St. Lucie Canal (C-44) to Lake Okeechobee to be allowed to occur at lake stages of 14.50 feet or 0.25 feet below the bottom of the lowest non-baseflow regulatory zone, whichever is lower. These operations were developed to achieve similar performance as the No Action Alternative, while seeking to avoid frequeny oscillation between regulatory releases and backflow at S-308. The No Action Alternative assumes backflow below Lake Okeechobee stages of 14.50 feet, consistent with operations under WSE and always more than 0.25 feet below the lowest regulatory release zone for the WSE regulation schedule. All LORSS alternatives and the No Action Alternative assume backflow from the Caloosahatchee River Canal (C-43) to Lake Okeechobee to be allowed to occur for lake stages below 11.10 feet. Operations for gravity flow from the West Palm Beach Canal and L-8 Canal to Lake Okeechobee are not modified from the No Action Alternative for the LORSS alternatives and remain consistent with existing operations.

Alternative T3 was selected in December 2006 as the recommended plan for the 2007 LORSS SEIS. For the purpose of this appendix, standard performance measure output included from the SFWMM will generally include a summary of all alternatives. For those instances where additional analysis or graphics have been prepared for this appendix, the summary discussion may only include the No Action Alternative and the recommended plan, Alternative T3.

OVERVIEW OF THE SFWMM

Brief description of the SFWMM

The SFWMM is an integrated surface water-groundwater model that was developed and is maintained by the SFWMD. The SFWMM simulates the hydrology and water management of southern Florida from Lake Okeechobee to Florida Bay. The SFWMM spans a region of over 7,600 square miles with a two-mile by two-mile grid (Figure B-1); and simulates the system-wide hydrologic response to daily climatic inputs (rainfall and reference evapotranspiration). Other areas tributary to Lake Okeechobee (e.g., Kissimmee River, C-43 and C-44) are also part of the model, even though they are not explicitly simulated with the four square mile grid cells.

The SFWMM simulates infiltration, percolation, evapotranspiration, surface and groundwater flows, levee underseepage, canal-aquifer interaction, well withdrawals for irrigation and/or public water supply, and current or proposed water management structures (i.e., canals, spillways, reservoirs, pump and wellfields), and current or proposed operational rules (i.e., regulation schedules and drought management plans). The SFWMM is not a succession model: that is, it fixes the land use/cover and associated infrastructure for the entire simulation period. Thus the simulations represent the response of a fixed structural and operational scenario, to historical climatic conditions. This provides a very useful means for comparing the effects of alternative structural and/or operational proposals.

The ability to simulate key water shortage policies affecting urban, agricultural, and environmental water supply facilitates the investigation of tradeoffs between different water demands and sub-regions. Two dimensional regional hydrologic processes are simulated at a daily time step using a mesh of (2 x 2 mile) grid cells producing extensive output that can be summarized into numerous performance measures for plan evaluation. The model has been calibrated and verified using water level and discharge measurements at hundreds of locations distributed throughout the region within the model boundaries. The SFWMM (also referred to as the 2x2 model) is the premier hydrologic simulation model used to evaluate regional plans for Everglades' restoration and sustainable development in south Florida. Documentation (SFWMD, 2005) including model calibration, verification and peer review can be viewed at http://www.sfwmd.gov/org/pld/hsm/models/sfwmm. Original documentation of the SFWMM was completed in 1984. However, since that time several documentation and peer review efforts have been completed. The documentation and peer review of the model was completed for the current SFWMM version 5.5, in November of 2005. Excerpts from the latest documentation have been included within the report to provide the reader with an introduction to the capabilities of the SFWMM, but the reader should refer to the complete documentation for a complete review of the SFWMM.

Numerical solution

The model uses a daily time step, consistent with the minimum time increment for which input climatic data are available and can be run for time periods ranging from one month to 36 years. A distributed finite difference modeling technique is used to model the gridded portion of the model domain with two-mile by two-mile square grid cells. Lumped parameter modeling approaches are used for Lake Okeechobee and the northern lake service areas, which include the Caloosahatchee and St. Lucie Basins. Homogeneity of physical and hydrologic characteristics is assumed within each model grid cell. The grid discretization in the SFWMM is sufficiently fine to describe the solution to the overland and groundwater flow equations with reasonable resolution and to minimize numerical errors (Lal, 1998).

A diffusion wave approximation of the full equations for overland flow from cell-to-cell is solved using an Alternating Direction Explicit (ADE) scheme with four six-hour time slices. Groundwater flow is solved using the vertically-averaged, transient groundwater flow equation with a variation of the unconditionally stable and explicit Saul'yev (1964) method. To minimize bias, the numerical formulation is solved in four different directions in four successive time steps.

Groundwater flow beneath levees is simulated using separate regression equations, based on more detailed two-dimensional finite element modeling developed to simulate localized levee under-seepage (SFWMD, 2005). To simulate the canals in the system, and to account for changes of storage in the canal due to inflows and outflows, the SFWMM utilizes a mass balance approach. An iteration scheme solves for the equilibrium canal stage each time step. A backwater profile solution scheme is used each time step for the primary canals in the EAA that are intensively managed by pumping.

Simulation outputs are generally available daily for each canal, structure, and grid cell within the model domain, including existing gage locations. Figure B-2 displays the gage locations readily output by the model, and Figure B-3 displays the simulated canal network in the SFWMM used for the LORSS. Model output is additionally aggregated for pre-defined groups of adjacent grid cells (indicator regions in Figure B-4; additional maps are also available through the Restoration Coordination and Verification (RECOVER) Evaluation Team, at the following web address: http://www.evergladesplan.org/pm/recover/eval_team_maps.cfm) or for larger areas or basins (examples include WCAs and Everglades National Park [ENP]). Transects used for the comparison of overland flow volumes are provided in Figure B-5.

<u>Overview of Lake Okeechobee Management Processes in the SFWMM (SFWMD, 2005)</u>

In the SFWMM, Lake Okeechobee is simulated as a lumped hydrologic system as contrasted to the majority of the model domain where a distributed system of two-mile by two-mile grid cells is used. There is only one water level that is associated with Lake Okeechobee at any given time step. For each daily time step the water budget equation is solved for Lake Okeechobee. This equation relates the change in storage within Lake Okeechobee as a control volume, and incoming and outgoing flows for the same control volume. Mathematically, lake hydrologic components (rainfall, evapotranspiration and seepage) and managed flows (structure discharges) account for changes in lake storage. Net levee seepage and regional groundwater movement in Lake Okeechobee are assumed to be small relative to the other hydrologic components of the lake water budget and are, therefore, not calculated in the model.

Lake Okeechobee water levels are checked against the defined operational zones. Depending on which zone simulated lake stages fall after adjusting for water supply and storage injection discharges, the additional criteria as defined in the decision tree are applied. In the SFWMM, weekly pre-processed time series data is input and user input options define the thresholds for classification of tributary conditions. Climatic and meteorological forecasts consider several longer-term (up to twelve month) regional, global, and solar indicators in helping to estimate the potential volume of water that can be expected to flow into Lake Okeechobee. As with the tributary conditions, information provided by these indices helps to determine when there is an opportunity to 'hedge' water management practices. The decision tree operational guidelines for WSE (and other similar schedules) utilize three different outlooks in the decision making process: meteorologic forecast, seasonal outlook and multi-seasonal outlook. Each of these measures has an associated classification scheme for determining hydrologic regimes. In the SFWMM, monthly pre-processed non-perfect hind-cast data is input and user options define the thresholds for classification of outlooks. An additional simplifying assumption is made in the model in which the meteorologic forecast is not considered and the seasonal forecast is assumed to apply in both decision boxes. This assumption is necessary due to the difficulty in deriving hind-cast meteorologic forecasts over the 1965-2000 period of simulation.

Examining the WSE "Part 2" decision tree outcomes for discharges to tide, considerable flexibility can be observed in the final determination of discharge volumes. Several of the outcome boxes indicate releases "up to" a determined level. In real time operations, this allows water managers to optimize the performance of the competing considerations when making regulatory discharges. In the SFWMM, simplifying assumptions are made that enable users to retain some flexibility in determining the operations associated with the decision tree outcome. For boxes that dictate a release "up to" maximum discharge or a determined steady flow, the model will always simulate the maximum allowable flow rate. In the case of decision boxes that indicate "up to maximum pulse release", users have the option of specifying which of the three levels of pulse discharges to make to both the St Lucie and Caloosahatchee Estuaries. Pulse releases are designed to mimic the flow pattern associated with naturally occurring rainfall events and as such should result in less impact to the estuary ecology by allowing time for recovery of the salinity envelope prior to resuming high discharge rates. Once a ten-day outflow pulse is initiated by the schedule, the release rule is continued to completion even if lake stage drops below that pulse level. After a ten-day period is completed, the need for additional releases is re-evaluated.

<u>SFWMM Version to Be Used</u>

SFWMM v5.5 was used for the LORSS. Version 5.0 and later of the model includes a major effort to upgrade the model including adding an additional five years of climatic data from 1996-2000, updating land-cover for 2000 conditions, reviewing methods to estimate potential evapotranspiration, and updating rainfall data used. Complete documentation is available on the SFWMD webpage for the SFWMM: http://www.sfwmd.gov/org/pld/hsm/models/sfwmm/ (SFWMD, 2005).

Period of Simulation

The SFWMM produces daily output for a 36-year POR: 1965-2000. Efforts are ongoing by the SFWMD to compile the climatological data needed to extend the SFWMM POR through 2005. The additional information, through desirable, will not be available for the 2007 LORSS SEIS study.

Strengths and Weaknesses of the SFWMM

The major strength of the SFWMM is that it is a regional integrated surface water/groundwater model covering a large portion of south Florida. The model is well-suited to modeling of the hydrologic conditions which characterize south Florida, including the flat terrain, high water table, and high aquifer transmissivity. The SFWMM has been used in the past for project analysis, and the model is familiar to many interested stakeholders. Particular strengths of the SFWMM include:

a. It is capable of simulating the interdependency between hydrology and management (operations), and among different components of the regional system.
b. Canal routing, overland flow, unsaturated zone mass balance, two-dimensional single-layer aquifer flow, spatially-distributed rainfall, and evapotranspiration are included in the model.
c. Hydrologic impacts on agriculture, urban, and environmental areas can be jointly evaluated through the use of comprehensive, post-processed model output.
d. The SFWMM is a useful tool in evaluating long-term and short-term effects of management decisions. A 36-year POR for rainfall data (1965-2000) can be simulated in a short runtime of less than two hours.
e. Regional impacts of hydraulic infrastructure changes are readily evaluated with the suite of model output.
f. Routines are readily available for modifying model output into performance measure sets, useful tools for comparing regional and area-specific performance of several alternatives.
g. The SFWMM can provide guidance as to where future data collection and additional modeling efforts should proceed. SFWMM can effectively be used as a regional-scale screening tool to help identify locations and particular years when finer-scale analysis may be needed.

The weaknesses of the SFWMM are related mostly to the sub-regional or localized applicability of the model. The two-mile by two-mile grid cells are described by a single average value for all hydrologic characteristics, including land surface elevation, storage coefficient, permeability, infiltration rate, and roughness coefficient.

Other weaknesses or limitations (that would also apply to other similar models) include:

a. Model scale is too coarse for studies/investigations that require finer detail of local hydrologic response, for example drawdown analyses and localized levee seepage. Subtle gradients in topography (at a scale smaller than two miles) that may have ecological implications cannot be represented in the model. The coarse scale of SFWMM limits but does not discount its utility for quantifying potential flood impacts.

The SFWMM is not appropriate for detailed farm-scale flood analysis but is appropriate for identifying potential regional flooding impacts.

b. Groundwater equations are simplified under the assumption of two-dimensional flow, such that transmissivity, storage coefficient, recharge, and hydraulic head can be vertically averaged. The model's solution to the general groundwater flow equations represents regional groundwater flow while empirical levee seepage equations are used to solve for levee seepage.
c. Quality assurance/quality control (QA/QC) of the model output and performance measure sets is difficult due to the regional nature of the model and the resultant size of the performance measure set. This activity usually requires substantial staff time.
d. Model was calibrated for stage at monitoring points and control structure flow. The model is not calibrated for overland flow. Note however that the state-of-the-art in modeling and data collection do not allow calibration of any regional scale model to overland flow or groundwater flow volumes. In versions of the SFWMM prior to version 5.0, the comparison of simulated versus historical water levels were compared on an end-of-week, not a daily, basis. For SFWMM V5.0 and later, calibration for stage in marsh gages is completed on a daily time step, while canals are evaluated on a weekly basis.
e. Intended use of the model is to provide long-term planning-type guidance to water managers with regards to making water policy decisions. The SFWMM is not intended to estimate system responses to extreme conditions whose timing may be on the order of hours or even minutes.
f. Structure operations are subject to a limited degree of operational flexibility given code and input limitations. The inclusion of complex operational rules may not be possible for all structures. Operational rules for a control structure may change from wet season to dry season, but operations must remain constant for the POR simulated.

<u>Parameter Uncertainty within the SFWMM</u>

The following discussion regarding parameter uncertainty, with specific application for SFWMM performance measures, has been excerpted from the draft RECOVER Comprehensive Everglades Restoration Plan (CERP) System-wide Performance Measures report (RECOVER, 2006).

Parameter uncertainty is estimated by running a series of SFWMM simulations using historic flows assigned at major control structures where reliable flow records exist. Parameters are incrementally varied one at a time from the original calibrated parameters to estimate the 90 percent certainty band for each parameter. The compartmentalization of south Florida's hydrologic system by structures and levees presents a unique situation that allows the effects of varying individual parameters within several regional compartments at the same time. The same parameter value is applied everywhere the physical characteristic is the same, restricting the range in which a specific parameter value may be varied without causing major impacts to the calibration of one or more compartment. The effect of compartmentalization is to reduce uncertainty associated with selection of parameter values. The uncertainty of a given model output variable can be represented by the half-width of the 90 percent uncertainty band. The general rule is the narrower the bands, the greater the level of certainty.

The estimate of performance measure uncertainty was made with version 2.4 of the SFWMM. Structural flows were estimated based on operational rules in place at the time of the simulations (1995) for the high and low values recommended from sensitivity analysis. Parameter uncertainty was estimated by comparing water levels measured at a particular site to those simulated with the calibration version (historical flows assigned to major structures) of the SFWMM for the two-by-two mile cell that contains the measurement site. A large portion of the uncertainty that exists in simulated water levels in this analysis is associated with scaling, process aggregation, the location of the gauging site within the cell, and estimates of regional rainfall and evapotranspiration. These types of uncertainty can be reduced by considering 1) regional performance measures that include model output simulated at several cells and 2) relative benefits of system performance measures between an alternative and the base condition or between alternatives. When considering uncertainty of simulated performance measures, it is important to realize that the certainty of meeting individual performance measures depends on the priority that a particular water management objective has relative to other water management objectives. Therefore, simulated performance measure uncertainty associated with the SFWMM is estimated by replacing the historical flows of the calibration version of the model with simulated flows estimated within the operational version of the model and varying the parameters. The same exercise would need to be completed for each alternative as performance measure uncertainty will vary with each alternative. This can require a great deal of effort that may not be practicable when considering the cost-benefit ratios of taking on such a task and considering that other causes of uncertainty outside the modeling realm may be greater than those of the modeling realm. A large portion of uncertainty that exists in estimating performance measures is caused by such factors as natural climate variability, anthropogenic climate change, and sea level rise.

SIMULATION ASSUMPTIONS

Baseline Assumptions

As a result of the current LORSS, a new regulation schedule is expected to be in place by July 2007 (implementation date assumed for the 2006 SEIS was January 2007). Soon after that time, a new LORSS will be initiated with an expected duration of approximately three years, at which time a new regulation schedule is anticipated for operation with the Acceler8 and CERP Band 1 projects. The baseline assumptions for SFWMM modeling of the No Action Alternative includes the existing water management structures plus those expected to be in place prior to January 2007:

- 2000 land use and associated irrigation demands for the Lower East Coast Service Area (LECSA). The LECSA includes the developed portions of Palm Beach, Broward, and Dade Counties.
- 2000 public water demands at the existing wellfields.
- 2005 water management facilities and associated operating procedures, including Interim Operational Plan (IOP) operations for WCA 3A and South Dade County in the Lower East Coast.
- Current regulation schedules for Kissimmee Chain of Lakes, WCA 1, WCA 2A and WCA 3A, with the WSE regulation schedule for Lake Okeechobee.
- Temporary forward pumps as proposed by the SFWMD for permitted water supply operations, to be available starting in 2007. The pump capacities will be 600 cfs at S-351, 400 cfs at S-352, and 400 cfs at S-354. Based on preliminary operational guidance from the SFWMD, the pumps will be simulated to trigger on for water supply demands if the Lake Okeechobee stage falls below 10.2 feet, and the pumps are assumed turned off when the Lake stage recovers to 11.2 feet.
- STA 3/4 treatment capacity of approximately 64,000 acre-feet (average annual) for Lake Okeechobee regulatory releases, assumed based on current nutrient levels in Lake Okeechobee.

The baseline model (also referenced as the No Action Alternative or LORSS 2007) was developed from the available SFWMM model determined by the LORSS PDT as the closest representation of the existing conditions prior to implementation of the new LORSS. The LORSS baseline model and all alternatives were developed from the SFWMM modeling previously completed by the SFWMD for the 2005 LECRWSP.

The detailed list of assumptions for the 2005 LECRWSP, as used for the LORSS baseline, are included as Attachment E. Attachment E includes documentation of the SFWMM assumptions for climate, topography, land use, land cover, municipal and agricultural water supply (including Lake Okeechobee Service Area (LOSA), Caloosahatchee and S-4 Basins, St. Lucie Basin, the Seminole Brighton Reservation, the Seminole Big Cypress Reservation, the Seminole Hollywood Reservation, and the EAA), basin runoff calculations for areas not included in the SFWMM internal computation grid (including Kissimmee Basin, Caloosahatchee and S-4 Basin, St. Lucie Basin, and the EAA), and regulation schedules not proposed for modification under the LORSS (including Kissimmee Basin, Holey Land Wildlife Water Management Area (WMA), Rotenberger Wildlife WMA, WCA 1, WCA 2A and 2B, and WCA 3A and 3B). Changes to the assumptions documented in Attachment E are included in description of alternatives (modifications to the LORS) and documentation of updated assumptions (including the draft LOWSM plan), previously provided in this appendix.

The assumed treatment capacity constraint for STA-3/4 is simulated in the SFWMM by restricting the wet and dry season conveyance capacities for the Miami and North New River canals to pass approximately 58,500 acre-feet, average annual during the dry season and 4,700 acre-feet, average annual during the wet season from Lake Okeechobee to the STA-3/4. The simulations of all LORSS baseline modeling and alternatives do not assume unconditional by-pass of the STAs if the Lake Okeechobee stage is within the highest zone of the regulation schedule, although the need for STA by-pass operations may need to be operationally considered under certain conditions.

SIMULATION RESULTS: 2007 LORSS SEIS

An enormous amount of output is generated from each SFWMM simulation and post-processed performance measures and indicators. The general performance of each alternative evaluated for the 2007 LORSS SEIS are reviewed and discussed in this section. Selected graphics to illustrate the performance of each alternative are presented in Attachment C, most of which will be referenced in the discussion. Attachment D includes the performance overview and selected graphics for the alternatives evaluated in the 2006 LORSS SEIS, which are included to provide additional background material to the reader. The complete set of performance measure output for all alternatives evaluated under this study is available on the USACE web page for LORS Modeling, at the following web address: http://hpm.sfrestore.org/loweb/sfwmm/. SFWMM simulation results for the new round of modeling is available at this web address, while 2006 SEIS simulations are available only by further clicking the link for informational runs from this web address. The 2006 SEIS simulations are not directly comparable to the new round of modeling due to updated model assumptions, more current data sets, and different source code versions, as previously documented in this appendix. This appendix seeks to include the sub-set of SFWMM output tables and performance measure graphics that were regularly utilized and referenced during the LORSS PDT evaluation of alternatives. The appendix does not attempt to include all possible SFWMM model output tables and performance measure graphics.

The best hydrologic performance measures are those which provide a quantitative indication of how well (or poorly) an alternative meets a specific objective. These hydrologic performance measures are useful surrogates for ecosystem benefits and impacts. Although not presented herein, further evaluations of the results from water quality, ecological, and economic perspectives will be performed as part of the LORSS. Because it was not possible to include all seven alternatives (plus the No Action Alternative) into one graphical plot, two plots including the same performance measures are generated and included in this appendix to show the appropriate comparisons. Simulation results for all alternatives, compared to the No Action Alternative, are summarized for the following regions: Lake Okeechobee, Estuaries and Bays (includes Caloosahatchee and St. Lucie estuaries), WCAs and ENP Flows, and Water Supply. Table 2 summarizes the naming convention used to display the performance measures for each 2007 LORSS SEIS alternative, as names are limited to six to eight characters.

TABLE 2: PERFORMANCE MEASURE LABELS FOR ALTERNATIVES

Alternative	PM data label
no action alternative	07LORS
alternative 1bS2-A17.25	1bS2-aL
alternative 1bS2-m	1bS2-mL
alternative T1	1b-T1
alternative T2	1b-T2
alternative T3	1b-T3

Lake Okeechobee

A review of the simulation output for Lake Okeechobee requires consideration of a wide range of performance metrics including flood protection, lake ecology, and navigation. Figures C-1 through C-10 are examples of the modeling results as related to the following discussion points for Lake Okeechobee performance. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. Regulatory Releases

An overview of the trends of alternative performance is captured from a review of the performance measure showing average annual flood control releases from Lake Okeechobee and the associated distribution to tidewater through the L-8 canal, the SLE through S-308, the Caloosahatchee Estuary through S-77, and south to the WCAs through S-351 (to the Hillsborough and North New River Canals) and S-354 (to the Miami River Canal), which are shown in Figures C-1 and C-2. The numbers shown in the average annual flood control graphic do not include low-level regulatory base flow releases to the estuaries when the base flow release is simulated as estuarine demand in the SFWMM, an option used for several alternatives. Average annual base flow releases from Lake Okeechobee to the SLE are summarized: 0.0 thousand acre-feet (kAF) for Alternative T1 (base flow simulated as regulatory release measured at S-80, not below S-80 at the estuary); 19 kAF for Alternative T2; and 19 kAF for Alternative T3. Average annual base flow releases from Lake Okeechobee to the Caloosahatchee Estuary are summarized: 60 kAF for Alternative 1bS2-A17.25; 59 kAF for Alternative 1bS2-m; 44 kAF for Alternative T1; 41 kAF for Alternative T2; and 40 kAF for Alternative T3. Ranking the alternatives with respect to average annual flood control (regulatory) discharge to the STE (including base flow), the following trend is observed (highest to lowest): Alternative T2 (167 kAF); Alternative T3 (164 kAF); Alternative T1 (145 kAF); No Action Alternative (142 kAF); Alternative 1bS2-m (135 kAF); and lastly, Alternative 1bS2-A17.25 (130 kAF). Ranking the alternatives with respect to average annual flood control discharge to the Caloosahatchee Estuary (including base flow), the following trend is observed (highest to lowest): Alternatives 1bS2-m and T1 (464 kAF); Alternative 1bS2-A17.25 (460 kAF); Alternative T3 (415 kAF); Alternative T2 (410 kAF); and lastly, No Action Alternative (labeled as 07LORS in all performance measure graphics, 379 kAF). Ranking the alternatives with respect to average annual flood control releases to the L-8 canal to be routed to Lake Worth Lagoon, the following trend is observed (highest to lowest): Alternative 1bS2-m and Alternative 1bS2-A17.25 (114-115 kAF); Alternative T1 (107 kAF); Alternative T2 (102 kAF); Alternative T3 (100 kAF); and No Action Alternative (77 kAF). Generally, the alternatives that most significantly lower the lake stages result in the most significant increase in discharge volume to the estuaries, including the Callosahatchee, St. Lucie, and Lake Worth Lagoon. This point is emphasized by the assumption of the treatment capacity constraint for STA-3/4, which is utilized to limit the average annual volume of lake regulatory releases passed south to STA-3/4 from S-351 and S-354 to a comparable volume for the No Action Alternative condition and all evaluated LORSS Alternatives. Potential changes in flows to the estuaries will be later discussed in this section.

B. Stage Duration Curves: Flood Protection and Navigation

The stage duration curve for Lake Okeechobee is a key indicator of relative alternative performance (Figures C-3 through C-6). All alternatives demonstrate a trend to reduce lake stages by approximately 1.0 to 1.3 feet under normal to wet conditions. Alternatives in the new round of modeling were all developed from alternative 1bS2-A17.25 based on the performance evaluations from the 2006 LORSS SEIS; more significant spread is observed in the range of alternatives previously evaluated for the 2006 SEIS. Peak stages for the No Action Alternative and other alternatives are summarized as follows: 18.53 ft, NGVD for the No Action Alternative; 17.38 ft for Alternative 1bS2-A17.25; 17.21 ft for Alternative 1bS2-m; 17.23 ft for Alternative T1; 17.57 ft for Alternative T2; and 17.33 ft for Alternative T3. Three of the alternatives plus the No Action Alternative show simulated stages above 17.25 ft, NGVD: 348 days for the No Action Alternative; 9 days for Alternative 1bS2-A17.25; 15 days for Alternative T2; and 8 days for Alternative T3 (note: 13,149 days in the SFWMM 36-year POR). Minimizing the frequency of exceedance of the 17.25 feet elevation offers additional protection for public safety and the HHD; this criteria was evaluated as a project performance measure. Extreme high lake stages have also been documented to adversely impact the plant and animal communities, through processes which include the following: physical uprooting of emergent and submerged plants; reduced light levels in the water column due to increased suspended sediment; and littoral zone exposure to increased nutrient levels from the water column. The frequency of occurence for lake stages above 16.0 feet, 16.5 feet, 17.0 feet, and 17.25 feet are summarized in Figure C-7.

The reduction of extreme high water stages for Lake Okeechobee is accompanied by a general lowering of the lake stage duration curve, and the potential for extreme low lake levels was also considered during the altrenative evaluation process. Increased fequency of low water conditions can adversely impact the health of the Lake Okeechobee littoral zone through increased susceptibility to fire and drought conditions, habitat loss, expansion of exotic and invasive vegetation, and oxidation of organic soils. The minimum simulated stages for Lake Okeechobee are summarized as follows: 9.46 feet for the No Action Alternative; 8.86 feet for Alternative 1bS2-A17.25; 8.84 feet for Alternative 1bS2-m; 8.76 feet for Alternative T1; 8.68 feet for Alternative T2; and 8.71 feet for Alternative T3. Increased frequency of low water conditions may also potentially impact recreational and commercial navigation and availability of lake supply for water supply needs. The number of days below 12.56 feet elevation is stated in the following summary: 2876 days for the No Action Alternative; 4839 for Alternative 1bS2-A17.25; 4922 days for Alternative 1bS2-m; 4909 days for Alternative T1; 5156 days for Alternative T2; and 5128 days for Alternative T3. Extended duration of low water conditions in Lake Okeechobee trigger a minimum flows and levels (MFL) violation if stages remain below 11 feet for greater than 80 consecutive days. The number of MFL violations during the 36-year POR for the alternatives is summarized: five for the No Action Alternative; six for Alternative 1bS2-A17.25; seven for Alternative 1bS2-m; eight for Alternative T1; six for Alternative T2; and six for Alternative T3 (Figures C-8 and C-9).

Over the SFWMM POR from 1965 to 2000, climate conditions varied significantly within the study area. In response to the wide range of climatologic and meteorologic conditions over the POR, Lake Okeechobee stages vary from year to year and seasonally within each year. To provide a graphical illustration of intra-annual Lake Okeechobee stage variability for the 2007 LORSS SEIS recommended plan (Alternative T3), stage exceedance probabilities were computed for each day within the year (36 data points for each day, corresponding to each of the 36 years in the POR). The stage exceedance curves for Alternative T3 provided in Figure C-10 include the following: maximum daily stage, 90 percent exceedance, 75 percent exceedance, median daily stage (same as 50 percent exceedance), mean daily stage (same as average daily stage), 25 percent exceedance, 10 percent exceedance, and minimum daily stage.

C. Lake Okeechobee Ecology: Extreme High Stage, Extreme Low Stage, Stage Envelope

RECOVER is the branch of the CERP responsible for linking science and the tools of science to a set of system-wide planning, evaluation and assessment tasks. The most current (as of March 2006) RECOVER performance measures for Lake Okeechobee extreme low lake stage, Lake Okeechobee extreme high lake stage, and Lake Okeechobee stage envelope were utilized to evaluate the alternatives of the LORSS effort. RECOVER has since developed additional Lake Okeechobee performance measures (unable to be included for this LORSS study) and reviewed the performance measures used for LORSS, with no proposed changes to the evaluation response curves cited in this section. In-depth documentation and rationale for these performance measures is available through the RECOVER performance measure documentation in the draft RECOVER CERP System-wide Performance Measures report (RECOVER, 2006), at the following web address: www.evergladesplan.org/pm/recover/eval_team_perf_measures.cfm. Extreme low and extreme high lake stage are evaluated with response curves. For extreme low lake stage, zero weeks below 10 feet elevation responds to a score of 100, and 540 weeks or greater with stages below 10 feet elevation responds to a worst case situation and a score of zero (15 weeks per year over 36 year simulation period), with scores linearly varied between the two extremes. For extreme high lake stage, zero weeks above 17 feet elevation responds to a score of 100, and 396 weeks or greater with stages above 17 feet responds to the assumed worst case situation and a score of zero (11 weeks per year), with scores linearly varied between the two extremes. The resultant standard scores for extreme low and high lake stage are summarized as follows, with low score followed by high score: 97/81 for the No Action Alternative; 86/99 for Alternative 1bS2-A17.25; 86/99 for Alternative 1bS2-m; 86/99 for Alternative T1; 83/98 for Alternative T2; and 84/99 for Alternative T3.

The stage envelope performance measure similarly documents the benefits of seasonally-variable water levels within the range of 12.5 feet (June-July low) and 15.5 feet (November-January high) on the plant and animal communities of Lake Okeechobee. The conceptualization of the optimal stage envelope seasonal variation is shown in Figure C-11 (the comparison actually utilizes smoothed boundaries for the upper and lower envelope); in simplified terms, penalty points are assigned to each alternative based on deviations outside of the envelope, with increased penalty points with increased distance away from the optimal envelope. The worst case scenario for variability above the stage envelope is assumed to be one where the lake stage hydrograph is always in the poor zone (one foot outside of the stage envelope), which equates to a total score of 1872 foot-weeks; the response curve is a line between 0 (target, score of 100) and 1872 foot-weeks (score of 0). For deviation of lake stage below the envelope, the target is 192 weeks. This is the score that would be obtained if all years had hydrographs within the optimal zone, except for once per decade the stage falling to just below 11 ft, elevation NGVD for an average of three months. The response curve is a line between 192 (192 foot-weeks or less receives a score of 100) and 1872 foot-weeks (worst case scenario receives a score of zero). The resultant standard scores for lake daily stage (RECOVER performance measure specified weekly stage, but only daily stage comparisons are available within the LORSS evaluation timeframe) above and below the stage envelope are summarized as follows, with the above score followed by the below score: 55/70 for the No Action Alternative; 80/33 for Alternative 1bS2-A17.25; 82/31 for Alternative 1bS2-m; 83/30 for Alternative T1; 81/26 for Alternative T2; and 81/26 for Alternative T3. The percentage of time within the stage envelope was also identified for all alternatives as comparable, ranging within a narrow band from 25 percent (Alternatives T2 and T3) to 28 percent (No Action Alternative) of the 36-year POR. Given the similiarity of time within the stage envelope band, additional focus was placed on the deviation of stages when outside the stage envelope band; alternatives observed to most significantly reduce the extreme high water stages for Lake Okeechobee will score better for the stage envelope above and tend to score lower for the stage envelope below.

Estuaries and Bays

One of the objectives for managing Lake Okeechobee levels was to reduce the number of high regulatory discharges to the Caloosahatchee and St. Lucie estuaries. Recognizing the objective to lower the high lake levels, a strategy was incorporated into the alternatives to make more low-level (environmentally friendly) releases to avoid the high-level regulatory releases. Figures C-12 through C-35 are examples of the modeling results as related to the following discussion. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. Caloosahatchee Estuary

For all the alternatives, the mean monthly flows between 2800 and 4500 cfs were similar, all alternatives showed a reduction of 10 to 13 months compared to the No Action Alternative. For mean monthly flows greater than 4500 cfs, three alternatives showed an increase in the number of events compared to the 29 months of the No Action Alternative: Alternative 1bS2-A17.25 (36 months), the 2006 SEIS TSP Alternative 1bS2-m (35 months), and Alternative T1 (34 months). Two alternatives maintained the performance of the No Action Alternative, consistent with one of the objectives of the TSP revisions for the 2007 SEIS: Alternative T2 and Alternative T3.

In addition to the number of mean monthly flows, the longer durations of high-flow releases (consecutive weeks of seven-day moving average flow >4500 cfs) are of concern for protecting aquatic resources, including juvenile oysters. The base condition (No Action Alternative) shows zero events of six to seven week duration; one event of eight week duration; and two events of 10-12 week duration (28 total weeks of high flows greater than five weeks). All alternatives had high flows of longer duration than the base. The total number of weeks for events of greater than five week duration is summarized: 88 weeks for Alternative 1bS2-A17.25; 83 weeks for Alternative 1bS2-m, including one event of 13 week duration; 66 weeks for Alternative T1, including one event of 13 week duration; 79 weeks for Alternative T2; and 65 weeks for Alternative T3. During the critical period when many estuarine dependent species reproduce (March–June), the alternatives all show reductions in the number of mean monthly flows greater than 2800 cfs, compared to the base condition.

For the mean monthly flows less than 450 cfs, all the alternatives significantly reduced the number of events: 198 months for the No Action Alternative, 104 months for Alternative 1bS2-A17.25, 105 months for Alternative 1bS2-m, 116 months for Alternative T1, 131 months for Alternative T2, and 131 months for Alternative T3.

Over the SFWMM POR from 1965 to 2000, climate conditions varied significantly within the study area. The average annual regulatory releases from Lake Okeechobee to the Caloosahatchee Canal outlets (S77) have been previously summarized. In response to the wide range of climatologic and meteorologic conditions over the POR, the annual release volumes to the estuary from the combination of Lake Okeechobee and the Caloosahatchee (C-43) Basin varies both annually and seasonally. The annual (1965-2000) and seasonal (January through December) distribution of flows to the Caloosahatchee Estuary, including the contribution from Lake Okeechobee (S-77 outflows) and total flows at the estuary (at S-79, which includes local runoff from the C-43 Basin), are shown in Figures C-16 through C-19 for the No Action Alternative and the 2007 LORSS SEIS recommended plan (Alternative T3).

During the SFWMM POR, the cumulative volume of regulatory releases from Lake Okeechobee to the Caloosahatchee Estuary (S-77) is shown to increase from 13.63 million acre-feet under the No Action Alternative to 14.96 million acre-feet under Alternative T3; the cumulative volume of releases at the Caloosahatchee Estuary (at S-79, including C-43 Basin runoff) is shown to increase from 37.33 million acre-feet under the No Action Alternative to 38.15 million acre feet under Alternative T3. The total contribution percentage of Lake Okeechobee regulatory releases increases from 37 percent in the No Action Alternative to 39 percent in Alternative T3. Annual regulatory releases from Lake Okeechobee (S-77) range from zero to 2.04 million acre-feet (the latter in 1995) in the No Action Alternative; annual regulatory releases from Lake Okeechobee (S-77) range from zero to 2.19 million acre-feet (the latter in 1995) in Alternative T3. To address the question of how frequently specified high flow volumes are discharged from Lake Okeechobee to the Caloosahatchee Estuary, Table 3 provides a summary for the exceedance frequency of specified annual regulatory discharge volumes.

TABLE 3: EXCEEDANCE FREQUENCY FOR ANNUAL LAKE OKEECHOBEE REGULATORY RELEASES TO CALOOSAHATCHEE ESTUARY (S-77)

Annual LOK Regulatory Release	Frequency for 1965-2000 (years)	
Volume (millions of acre-feet)	No Action Alternative	Alternative T3
> 0.00	22	30
> 0.10	17	20
> 0.20	15	20
> 0.30	13	14
> 0.40	12	11
> 0.50	11	11
> 0.60	10	10
> 0.70	9	8
> 0.80	7	7
> 0.90	7	6
> 1.00	4	5
> 1.50	2	1

B. St. Lucie Estuary

For all alternatives, the mean monthly flows between 2000 and 3000 cfs were nearly the same or slightly decreased from the base condition: 43 months for the No Action Alternative, 36 months for Alternative 1bS2-A17.25, 38 months for Alternative 1bS2-m, 37 months for Alternative T1, 44 months for Alternative T2, and 42 months for Alternative T3. For mean monthly flows greater than 3000 cfs, all alternatives demonstrate the same or improved performance compared to the base condition: 31 months for the No Action Alternative, 30 months for Alternative 1bS2-A17.25, 27 months for Alternative 1bS2-m, 28 months for Alternative T1, 31 months for Alternative T2, and 31 months for Alternative T3.

In addition to the number of mean monthly flows, the longer durations of high-flow releases (consecutive two-week periods with of 14-day moving average flow >3000 cfs) are of concern for protecting aquatic resources, including oysters and submerged aquatic vegetation. The base condition (No Action Alternative) shows 25 total two-week periods of two to three period (four to six weeks) duration; 13 total periods of four to five period (eight to ten weeks) duration; and zero periods of six or greater two-week periods (12 weeks) duration (38 total periods of greater than two-week duration). All alternatives had high flows of longer maximum duration than the base. The total number of two-week periods of greater than two-week duration (one two-week period) are summarized: 35 periods for Alternative 1bS2-A17.25; 34 periods for Alternative 1bS2-m, including one event of eight period duration (16 weeks); 35 periods for Alternative T1; 36 periods for Alternative T2, including one event of eight period duration; and 36 periods for Alternative T3, including one event of eight period duration. During the critical period when many estuarine dependent species reproduce (March–June), the alternatives all show reductions in the number of mean monthly flows greater than 2000 cfs, compared to the base condition.

For the mean monthly flows less than 350 cfs, the minimum flow needs were generally thought to be met by groundwater flows and basin runoff from C-23 and C-24 basins. The three alternatives with base flow releases to the SLE provided slight reduction in the number of months with total estuary mean monthly flows less than 350 cfs: four month reduction with Alternative T1 (base flow measured at S-80), 24 month reduction with Alternative T2 (base flow measured below S-80 in the estuary), and 24 month reduction for Alternative T3 (base flow measured below S-80).

Over the SFWMM POR from 1965 to 2000, climate conditions varied significantly within the study area. The average annual regulatory releases from Lake Okeechobee to the St. Lucie canal outlets (S308) have been previously summarized. In response to the wide range of climatologic and meteorologic conditions over the POR, the annual release volumes to the estuary from the combination of Lake Okeechobee, the St. Lucie Basin (C-44), and local drainage basins downstream of C-44 at S-80 (C-23 and C-24 Basins) varies both annually and seasonally. The annual (1965-2000) and seasonal (January through December) distribution of flows to the SLE, including the contribution from Lake Okeechobee (S-308 outflows) and total flows at the estuary (below S-80, which includes local runoff from the C-44, C-23, and C-24 Basins), are shown in Figures C-24 through C-27 for the No Action Alternative and the 2007 LORSS SEIS recommended plan (Alternative T3).

During the SFWMM POR, the cumulative volume of regulatory releases from Lake Okeechobee to the SLE (S-308) is shown to increase from 5.11 million acre-feet under the No Action Alternative to 5.93 million acre-feet under Alternative T3; the cumulative volume of releases at the SLE (at S-308, including C-44, C-23, C-24 Basin runoff) is shown to increase from 28.42 million acre-feet under the No Action Alternative to 30.23 million acre feet under Alternative T3. The total contribution percentage of Lake Okeechobee regulatory releases increases from 18 percent in the No Action Alternative to 20 percent in Alternative T3. Annual regulatory releases from Lake Okeechobee (S-308) range from zero to 0.78 million acre-feet (the latter in 1995) in the No Action Alternative; annual regulatory releases from Lake Okeechobee (S-308) range from zero to 0.86 million acre-feet (the latter in 1995) in Alternative T3. To address the question of how frequently specified high flow volumes are discharged from Lake Okeechobee to the SLE, Table 4 is provided to provide a summary for the exceedance frequency of specified annual regulatory discharge volumes.

TABLE 4: EXCEEDANCE FREQUENCY FOR ANNUAL LAKE OKEECHOBEE REGULATORY RELEASES TO ST. LUCIE ESTUARY (S-308)

Annual LOK Regulatory Release	Frequency for 1965-2000 (years)	
Volume (millions of acre-feet)	No Action Alternative	Alternative T3
> 0.00	22	30
> 0.05	17	22
> 0.10	12	16
> 0.20	11	11
> 0.30	6	8
> 0.40	5	5
> 0.50	3	3
> 0.60	3	2
> 0.70	2	1
> 0.80	0	1
> 0.90	0	0

C. Lake Worth Lagoon

The RECOVER hydrologic performance measures for the Central Zone of Lake Worth Lagoon are based on the salinity tolerances of oysters. Discharges of 500 cfs or less, quantified with a seven-day moving average, will maintain salinity at or above the 15 part per thousand criteria. To reflect the potential adverse effects of very high discharges (>1000 cfs), a two-day moving average is used. Review of these two performance measures indicates that all alternatives either show slight improvement or equal the base condition (No Action Alternative).

D. Biscayne Bay

Flows to Biscayne Bay were essentially unchanged ($\pm$ 1 to 2 kAF/yr) in all the alternatives.

E. Whitewater Bay

For all alternatives, there was less than a +/- 4 kAF/yr change in overland flow (Transect 21; refer to Figure B-5).

F. Florida Bay

Flows to Florida Bay were unchanged under all alternatives (Transect 23; refer to Figure B-5).

WCA and ENP Flows

The flow changes compared to the No Action Alternative (or base condition), as related to the various alternatives, in the WCAs and ENP are discussed in this section. Generally, the flow changes (as indicated by the transect flows; refer to Figure B-5) in these areas are relatively small. As a result of greater-than-normal lake mixing from recent hurricanes, the assumed STA-3/4 inflow treatment capacity constraint of approximately 63,000 acre-feet/yr reduces the amount of flow from Lake Okeechobee south to WCA 3A; this is because of the increased loading that could occur due to an increased suspension of nutrients in Lake Okeechobee. The STA-3/4 flow constraint is included in all the alternatives as well as in the no action base condition. Figures C-36 through C-69 are examples of the modeling results as related to the following discussion. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. WCA-1

Average annual flows across Transect T1 show no net change from the No Action Alternative for all alternatives. All alternatives show a slight increase in stage (less than 0.10 feet) in the average to wet portion of the stage duration curve (10-40 percent). Alternative 1bS2-A17.25 and Alternative 1bS2-m generally show a slight increase in stage throughout the full POR. This trend is observed throughout WCA-1, including indicator regions 100 (north), 101 (central) and 102 (south). The No Action Alternative and all LORSS alternatives operate consistent with actual operations to route local basin runoff (C-51 basin) to STA-1E, while passing Lake Okeechobee releases (made to the L-8 canal) and L-8 local basin runoff to tide via S-155A, S-155, S-140, and S-141. Increased regulatory releases from Lake Okeechobee to the L-8 canal under the alternatives may result in increased need for flood control pumping from the C-51 basin to STA-1E, with an associated minor increase in STA-1E flow through volume and WCA-1 stage downstream of the STA.

B. WCA-2A and WCA-2B

Flows across Transect T2 show some variation in the alternatives. Alternative 1bS2-A17.25, Alternative 1bS2-m, and Alternative T1 show an increase of 4-7 kAF/yr; Alternative T2 shows a slight increase of 2 kAF/yr, and Alternative T3 shows no net increase or decrease in average annual flows compared to the No Action Alternative. No significant differences in the stage duration curves for WCA-2A (Indicator Region 111 figure is provided) are observed between the alternatives and the No Action Alternative. A slight increase in stage (less than 0.1 feet) is observed for the average to dry portion of the stage duration curve for WCA-2B for Indicator Regions 112 and 113.

C. WCA-3A and WCA-3B

Average annual flows across northern WCA-3A (Transect 6) show no net change from the No Action Alternative for all alternatives. Average annual flows across central WCA 3A (Transects T7 and T8) show slight variations between alternatives. For Transect 7, no net change in average annual flows is observed for Alternative 1bS2-A17.25 and Alternative 1bS2-m, and a slight reduction (1-2 kAF/yr) in average annual flows is observed for Alternatives T1, T2, and T3. For Transect 8, a minor reduction of average annual flows (1 kAF/yr) is observed for all alternatives. No significant differences in the stage duration curves for WCA-3A are observed between the alternatives and the No Action Alternative, based on inspection of Indicator Region 118, 123, and 124. Indicator Region 14 from the CERP Restudy (generally slightly south of the current Indicator Region 124 for southern WCA-3A) also shows no significant differences.

Review of the high and low depth criteria for Indicator Region 124 in southern WCA-3A shows the high water depth criteria (weeks with depth greater than 2.5 feet) to be increased from the No Action Alternative by five to six weeks for Alternative 1bS2-A17.25 and Alternative 1bS2-m. No change to the high water weeks are observed for Alternative T1 (404 weeks), and a reduction of high water weeks by four to five weeks are observed for Alternative T2 and Alternative T3. Indicator Region 14 from the CERP Restudy also shows no a similar trend for the alternatives.

The assumed treatment capacity constraint for STA-3/4 is simulated in the SFWMM by restricting the wet and dry season conveyance capacities for the Miami and North New River canals to pass approximately 58,500 acre-feet, average annual during the dry season and 4,700 acre-feet, average annual during the wet season from Lake Okeechobee to the STA-3/4. Due to the SFWMM limitations for the modeling of this constraint, all alternatives are shown to send slightly less water south from Lake Okeechobee to STA-3/4 than the No Action Alternative, which is manifested as a slight reduction in average annual overland flow volumes south of STA-3/4. In actual operations, the treatment capacity constraint for STA-3/4 would be an annual constant for the No Action Alternative and all alternatives, and the volume and timing of releases south would not be expected to change.

Minimal differences in the stage duration curves for northern WCA-3B (Indicator Region 125) and western WCA-3B (Indicator Region 126) are observed for the alternatives compared to the No Action Alternative. Review of the stage duration curve for eastern WCA-3B (Indicator Region 128) shows that the LORSS alternatives are slightly higher (less than 0.1 feet) under average to dry conditions and slightly lower (less than 0.15 feet) under extreme dry conditions. The stage reduction in eastern WCA-3B is influenced by the reduced availability of Lake Okeechobee water for Lower East Coast water supply needs during the extreme dry conditions, times at which the Lake Okeechobee stage is lower under the alternative regulation schedules than under the No Action Alternative. Review of the low water criteria for eastern WCA-3B shows an increase in weeks with water depths greater then one foot below ground surface for all alternatives (No Action Alternative includes 69 weeks) of 12 (Alternative T1) to 16 weeks (Alternative T3).

D. ENP

Overland flows into ENP are shown as Transects T17 and T18. Average annual flows across Transect 17 (western Shark Slough) are unchanged or slightly increased for Alternative 1bS2-A17.25 and Alternative 1bS2-m; average annual flows across Transect 17 are slightly reduced by less than one percent for Alternatives T1, T2, and T3 (1-6 kAF/yr). Average annual flows across Transect 18 (eastern Shark Slough) are slightly increased by 2-3 kAF/yr for all alternatives.

Water Supply

All alternatives evaluated, including the No Action Alternative, assume operation of the SFWMD temporary forward pumps for water supply at S-354 (400 cfs), S-351 (600 cfs), and S-352 (400 cfs). Based on preliminary operational guidance from the SFWMD, the pumps are simulated to trigger on for water supply demands if Lake Okeechobee stage falls below 10.2 feet; the pumps are assumed triggered off when Lake Okeechobee stage recovers to 11.2 feet. The No Action Alternative assumes the existing SSM line (set by the SFWMD) to be in place. Based on guidance from the SFWMD, a modified SSM line and operations are anticipated to be implemented in advance of any new regulation schedule resultant from LORSS.

All alternatives evaluated for the 2006 SEIS assumed a one foot lowering of the existing SSM line as a surrogate for the anticipated SSM changes by the SFWMD (this assumption was based on a recommendation from the SFWMD). During the additional plan formulation period for consideration of TSP refinements, the operational details of the draft LOWSM plan were provided to the LORSS PDT by the SFWMD. In order to ensure that the 2007 SEIS LORSS alternatives are evaluated with the best available data for this new SSM plan (name changed to LOWSM), the decision was made to incorporate the SFWMD draft LOWSM plan into the new round of modeling (including the updates for 2006 SEIS Alternatives 1bS2-A17.25 and 1bS2-m, and the three new 2007 LORSS Alternatives T1, T2, and T3). Based on guidance from SFWMD, the September 2006 draft LOWSM plan was not anticipated to undergo significant change prior to approval by the SFWMD Governing Board later in 2007; the draft LOWSM plan was therefore incorporated into the SFWMM simulations for the 2007 LORSS SEIS alternatives. It is recognized that the draft LOWSM plan assumed for the 2007 LORSS SEIS evaluation of alternatives is subject to change; SFWMD modifications to the draft LOWSM may change the anticipated water supply performance, compared to the impacts reported and evaluated for the LORSS alternatives in the 2007 LORSS SEIS. The evaluations were conducted by using the best available data at the time of alternative modeling (a more likely scenario than either the current SSM or the one-foot lowering surrogate previously assumed for the 2006 LORSS SEIS), and all alternatives were evaluated relative to each other with the same LOWSM assumptions in place. The September 2006 draft LOWSM plan lowers the existing SSM line by 0.80 feet (cutbacks start at lower Lake Okeechobee stages), and includes modified lake stage criteria for the varied cutback percentages below the LOWSM line.

The No Action Alternative is the only alternative to utilize the existing SSM line. In order to provide additional data related to the assumed lowering of the SSM line and modified cutback rules, a sensitivity model run was completed for the 2007 SEIS recommended plan alternative (Alternative T3) with the existing SSM rules to replace the September 2006 draft LOWSM plan assumed for all LORSS alternatives. A brief discussion of selected water supply performance measures for this sensitivity run set is provided in this water supply performance section. Figures C-86 through C-93 are examples of the modeling results for the discussion of this SSM sensitivity simulation. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm/info_runs.

Several performance measures are presented to compare the potential water supply impacts of the alternatives. Particular emphasis is given to water supply impacts under the most significant drought conditions experienced within the simulation POR, as water supply needs under drought conditions are highly susceptible to the observed lowering of Lake Okeechobee stages under the alternatives. Figures C-70 through C-93 are examples of the modeling results as related to the following discussion of SFWMM water supply performance measures. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. Everglades Agricultural Area

Simulated water supply effects to the EAA are shown based on the performance measure for mean annual EAA Supplemental Irrigation, demands and demands not met. The alternatives are ranked in order of the mean annual volume of demands not met during the 1965-2000 POR: 22,000 acre-feet of demand not met for Alternative T2 (6% of total demand is not met); 21,000 acre-feet for the No Action Alternative and Alternative T3 (6% not met); 20,000 acre-feet for Alternative 1bS2-m (6% not met); and 19,000 acre-feet for Alternative 1bS2-A17.25 and Alternative T1 (5% not met). The alternatives are ranked in order of the mean annual volume of demands not met during the drought years of 1971, 1975, 1981, 1985, and 1989, with increased demand not met indicative of higher potential impacts to EAA water supply: 57,000 acre-feet of demand not met for Alternative 1bS2-A17.25 (11% of total demand is not met); 58,000 acre-feet for Alternative 1bS2-m (11% not met); 57,000 acre-feet for Alternative T1 (13% not met); 58,000 acre-feet for Alternative T3 (13% not met); 59,000 acre-feet for Alternative T2 (13% not met); and 61,000 acre-feet for the No Action Alternative. All alternatives show reduced water supply impacts to the EAA during severe drought conditions. Reported percentages for demands not met are rounded to the nearest percent.

B. Lake Okeechobee Service Area

Simulated water supply effects to the LOSA are shown based on the performance measure for mean annual LOSA Supplemental Irrigation, demands and demands not met. The alternatives are ranked in order of the mean annual volume of demands not met during the 1965-2000 POR: 9,000 acre-feet of demand not met for the No Action Alternative (4% of total demand is not met); 8,000 acre-feet for Alternative T2 and Alternative T3 (3% not met); and 7,000 acre-feet for Alternative 1bS2-A17.25, Alternative 1bS2-m, and Alternative T1 (3% not met). The alternatives are ranked in order of the mean annual volume of demands not met during the drought years of 1971, 1975, 1981, 1985, and 1989, with increased demands not met indicative of higher potential impacts to LOSA water supply: 20,000 acre-feet of demand not met for Alternative 1bS2-A17.25 (6% of total demand is not met); 21,000 acre-feet for Alternative 1bS2-m, Alternative T1, Alternative T2, and Alternative T3 (6% not met); and 26,000 acre-feet for the No Action Alternative. All alternatives show reduced water supply impacts to the LOSA for overall performance and severe drought conditions. Reported percentages for demands not met are rounded to the nearest percent. Performance measure graphics for Water Year LOSA demand cutback volumes for the seven drought years with the most significant cutbacks are additionally provided (Figures C-74 and C-75).

C. Lower East Coast

Simulated water supply effects to the Lower East Coast are shown based on the number of months of water supply cutbacks for the 36-year POR. The performance measure graphics selected show the number of months under cutback (all cutbacks are phase 1 cutbacks for the LORSS Alternatives) for each of the following LECSA: Northern Palm Beach County, LECSA1, LECSA2, and LECSA3. Phase 1 cutbacks can be induced by one of three triggers: Lake stage in SSM Zone (indicated by upper label on the figures C-80 and C-81), local trigger well stages (lower data label; as expected, this changes minimally for the regulation schedule alternatives), or dry season criteria (indicated by the middle data label; phase 1 restrictions remain in place until the end of the dry season if water restrictions from the Lake or local groundwater triggers occurred anytime during the dry season). For LECSA Northern Palm Beach County, the No Action Alternative shows 38 months of simulated cutbacks; slight increases to 39 months are observed in the simulation results for Alternatives T1 and T2; reduction of cutback months are observed with 33 months under cutback for the Alternatives 1bS2-A17.25, 1bS2-m, and T1. The same trend is observed in the simulation results for LECSA1, LECSA2, and LECSA3. The No Action Alternative simulation results show 38 cutback months for LECSA1, 87 cutback months for LECSA2, and 38 cutback months for LECSA3. Alternatives T2 and T3 show slight increases to 39 cutback months for LECSA1, 88 cutback months for LECSA2, and 39 cutback months for LECSA3. Alternatives 1bS2-A17.25, 1bS2-m, and T1 show a reduction to 33 cutback months for LECSA1, 82 cutback months for LECSA2, and 33 cutback months in LECSA3. Compared to the No Action Alternative, all alternatives show a reduced availability of Lake Okeechobee water for Lower East Coast water supply needs during extreme dry conditions when the Lake Okeechobee stage is lower under the alternative regulation schedules than under the No Action Alternative (Figures C-76 through C-79).

D. Seminole Tribe Reservations: Brighton and Big Cypress

Simulated water supply effects on the Brighton and Big Cypress Seminole Tribe Reservations are summarized for the percent of water supply demand not met, based on SFWMM performance measure graphics shown in Figures C-82 through C-85. Unmet demand for the Brighton Reservation is summarized as follows: 3.5 percent for the No Action Alternative; 2.0 percent for Alternative 1bS2-A17.25; 2.1 percent for Alternative 1bS2-m; 2.1 percent for Alternative T1; 2.4 percent for Alternative T2; and 2.4 percent for Alternative T3. Unmet demand for the Big Cypress Reservation is summarized as follows: 4.6 percent for the No Action Alternative; 7.1 percent for Alternative 1bS2-A17.25; 7.3 percent for Alternative 1bS2-m; 7.1 percent for Alternative T1; 7.7 percent for Alternative T2; and 7.6 percent for Alternative T3.

The SFWMM operations for the water supply delivery to the Seminole Reservations, including assumed structures and operational triggers, were not modified for the LORSS simulations. It is recognized that modifications or improvements to the water supply delivery network may be necessary to continue to provide water supply deliveries per Tribal agreements with the state. Modifications to improve existing canal conveyance, addition of new pump structures, and modified structure operations are not easily accomplished within the SFWMM, and modifications to the existing configuration were not included in the LORSS simulations for the No Action Alternative base condition or other LORSS alternatives.

E. SSM Assumption and Sensitivity Simulation

The general overview of water supply performance measure trends is dependent on the assumption for the SSM line. As previously summarized, modified SSM line and operations are anticipated to be implemented in advance of any new regulation schedule resultant from LORSS. All alternatives (with the exception of the No Action baseline alternative) assume the operational details of the September 2006 SFWMD draft LOWSM to be in place, in order to ensure that the 2007 SEIS LORSS alternatives are evaluated with the best available data for this new SSM plan. It is recognized that the draft LOWSM plan assumed for the 2007 LORSS SEIS evaluation of alternatives is subject to change; SFWMD modifications to the draft LOWSM may change the anticipated water supply performance, compared to the impacts reported and evaluated for the LORSS alternatives in the 2007 LORSS SEIS.

Generally, the inclusion of the temporary forward pumps allows for the assumption of the lowered SSM (or similar LOWSM) line, meaning that water supply restrictions would be initiated at lower lake stages than currently in practice. To bracket the potential worst case scenario for water supply impacts that could be associated with future modification of the draft LOWSM plan by the SFWMD, additional data is available for the evaluation of the 2007 LORSS SEIS recommended plan (Alternative T3) through a sensitivity model simulation with the existing SSM line assumed in place (consistent with the No Action Alternative). The assumed LOWSM operations does alter the performance of the Preferred Alternative, as shown in Figures C-86 through C-93. With the existing SSM line assumed in place with the operational rules and regulation schedule of Alternative T3, the simulation results show mean annual EAA supplemental demands not met to increase from an average annual volume of 21,000 acre-feet and average drought year (1971, 1975, 1981, 1985, and 1989) volume of 58,000 acre-feet under Alternative T3 to an average annual volume of 55,000 acre-feet and average drought year volume of 167,000 acre-feet; the percentage of demands not met for the EAA is increased from six to 15 percent for the average year and 13 to 33 percent during the drought years. With the existing SSM line assumed in place with the operational rules and regulation schedule of Alternative T3, the simulation results show mean annual LOSA supplemental demands not met to increase from an average annual volume of 8,000 acre-feet and average drought year volume of 21,000 acre-feet under Alternative T3 to an average annual volume of 23,000 acre-feet and average drought year volume of 58,000 acre-feet; the percentage of demands not met for the LOSA is increased from three to ten percent for the average year and six to 17 percent during the drought years. The number of months of simulated water supply cutbacks for the four LECSAs also show increased cutback months for the 2007 LORSS SEIS recommended plan without the assumption of LOWSM operations: 39 to 49 months for Northern Palm Beach County; 39 to 49 months for LECSA1; 88 to 95 months for LECSA2; and 39 to 49 months for LECSA3. The inclusion of the LOWSM operations with Alternative T3 reduces the number of MFL violations for Lake Okeechobee from seven events with the existing SSM line assumed in place to six events. Both simulations experience MFL conditions during seven individual years within the POR, but Alternative T3 with LOWSM simulation does not show a stage recovery above 11 feet during the 1981-1982 drought period. Alternative T3 with existing SSM shows the stage to briefly rise above 11 feet, before dropping below 11 feet for another MFL violation (counting as two MFL violations for 1981-1982, compared to only one with LOWSM assumed in place). For the six MFL violation periods common to both simulations (assuming the 1981-1982 total days below 11 feet as a single event for the SSM simulation), Alternative T3 with LOWSM shows an increase in average MFL duration by approximately 18 percent compared to Alternative T3 with existing SSM. Additional performance measure graphics, consistent with the performance measures presented for the water supply performance review, are provided in Attachment C.

Alternative T3 with SSM does not change the Lake Okeechobee stage duration curve during wet and average conditions (upper 60% of the stage duration curve), compared the Alternative T3 with SSM. The increased water supply user cutbacks under Alternative T3 with SSM maintain Lake Okeechobee stages up to 0.50 feet higher than Alternative T3 with LOWSM during drier periods of the period of record. Alternative T3 with SSM does demonstrate a small increase in average annual regulatory discharge to the Caloosahatchee (2.7 percent increase), St. Lucie (3.4 percent increase), and L-8 (4.0 percent increase) regulatory outlets from Lake Okeechobee. The increased flows can trigger additional high volume discharges to the estuaries, but the monthly flow distribution is not significantly changed from the Alternative T3 with LOWSM recommended plan simulation, noting that flows of comparable volumes may tend to fall on either side of the performance measure criteria (2800 or 4500 cfs for the Caloosahatchee Estuary, 2000 or 3000 cfs for the St. Lucie Estuary).

Select performance measures have been summarized; the complete performance measure set is available on the LORSS study web page previously cited (the performance measure set includes "alt1bS2-T3-exSSM" in the title and the abbreviation of "T3exSSM" on the performance measure set graphics). The SSM Line is set by the SFWMD, at elevations below the Lake Okeechobee regulation schedule zones established by the USACE. Modified SSM rules and a modified SSM line are under development by the SFWMD; a draft version of the LOWSM plan has been provided by the SFWMD and included in the LORSS alternative evaluation as a representation of best available data for the LORSS study timeframe. The final SFWMD efforts are anticipated to be completed prior to implementation of any new regulatory schedule for Lake Okeechobee, and the efforts will be able to consider the additional data provided from the 2007 LORSS SEIS recommended plan. The water supply effects of the alternatives, as shown by a review of the performance measures, must be evaluated with consideration of this parallel and ongoing effort by the SFWMD. The performance measure output is dependent on the SSM (or LOWSM) line and rule assumptions; modification of the LOWSM line or draft LOWSM rules (as assumed in place under all alternatives evaluated) will affect the simulated performance, and the nature of the LOWSM changes (changes to the September 2006 SFWMD draft LOWSM plan) will determine the significance of the potential observed improvement or potential additional impact seen in the simulation results. It is anticipated that the SFWMD will provide a summary of performance changes to the 2007 LORSS SEIS recommended plan evaluation based on the final LOWSM plan, compared to the September 2006 draft LOWSM plan previously provided by SFWMD and assumed in place for the 2007 LORSS SEIS alternative evaluation SFWMM simulations.

Lower East Coast Stage Levels

Stage duration curves for SFWMM grid cells in the urban and agricultural areas of the Lower East Coast are provided in Figures C-94 through C-111. No significant differences are noted compared to the No Action Alternative.

Additional Information from LOOPS Model for 2001-2005 period:

The SFWMM produces daily output for a 36-year POR: 1965-2000. It is recognized that additional data could be provided from an extended POR. The 36-year POR includes a wide range of climatologic and meteorologic conditions. All alternatives are evaluated for this common POR and compared to the No Action Alternative.

Efforts to extend the SFWMM POR are ongoing by the SFWMD, but the additional POR is not available for the 2007 LORSS SEIS study. The SFWMM is a regional-scale computer model that simulates the hydrology and the management of the water resources system from Lake Okeechobee to Florida Bay, and the SFWMM remains the best available tool for performing a comprehensive evaluation.

The LOOPS model is a simple mathematical model of the hydrology and operations of Lake Okeechobee and its primary outlets, developed by the SFWMD on the platform of Microsoft Excel® spreadsheet software. Analysts can use the LOOPS model to test a broad variety of operating strategies and receive instant feedback showing the performance for the primary lake-management objectives. LOOPS is not intended to replace the more comprehensive SFWMM; rather it is a screening tool that can help design schedules for further, more in-depth, analysis via the SFWMM. LOOPS is based on similar algorithms as the SFWMM, but its domain is limited to Lake Okeechobee and its tributaries.

To provide additional information for the expected performance of the recommended plan (Alternative T3) for the 2001 through 2005 POR, LOOPS simulations were conducted by the SFWMD during December of 2005 for the No Action Alternative and Alternative T3. For informational purposes, a brief summary of the hydrologic output is provided.

The LOOPS simulations for the No Action Alternative and Alternative T3 are assumed to be extensions of the SFWMM POR, and the starting Lake Okeechobee stage for the 2001 through 2005 LOOPS simulations were extracted from the end of the POR for the SFWMM simulations (December 31, 2000). The Alternative T3 simulation shows a reduction in peak Lake Okeechobee stage from 17.95 in the No Action Alternative to 17.01, with the number of days above the 17.25 feet performance measure reduced from 84 days to 0 days. A similar reduction in minimum Lake Okeechobee stage is also observed, with stages lowered from 9.95 with the No Action Alternative to 8.01 with Alternative T3. The number of months with average discharge to the Caloosahatchee Estuary greater than 2800 cfs is reduced from 25 months (out of 60 months during 2001-2005) to 22 months under Alternative T3, with an increase of two months with average flows greater than 4500 cfs (13 to 15 months). The number of months with average discharge to the SLE greater than 2000 cfs is increased from 18 to 21 months with Alternative T3, with no change in the number of months with average flows greater than 3000 cfs. To evaluate the sensitivity of 2001-2005 Lake Okeechobee stage to the assumed initial stage condition, a LOOPS simulation was also completed with the No Action Alternative and Alternative T3 starting from the historical Lake Okeechobee stage on January 1, 2001 (11.11 feet). Stage hydrographs for Lake Okeechobee 2001-2005 from the two LOOPS simulations are provided as Figure C-112 and Figure C-113.

SUMMARY

The No Action Alternative, along with five other alternatives, were modeled using the SFWMM. The modeling intent and differences of the alternatives were presented. Model output and post-processed products were used in the selection of the 2007 LORSS SEIS recommended plan, Alternative T3. Selected examples of the model output and performance measures are included as attachment C (Figures C-1 through C-113).

REFERENCES

Lal, A.M.W. 1998. Performance Comparison of Overland Flow Algorithms. *Journal of Hydraulic Engineering,* ASCE, Volume 124, Number 4, April 1998, pp. 342-349.

Restoration Coordination and Verification (RECOVER). March 16, 2006. Comprehensive Everglades Restoration Plan System-wide Performance Measures, RLG Review Draft. Comprehensive Everglades Restoration Plan, Central and Southern Florida Project. http://www.evergladesplan.org/pm/recover/eval_team_perf_measures.cfm.

Saul'yev V.K. 1964. *Integration of Equations of Parabolic Type by the Methods of Nets.* New York, New York: Pergamon Press.

South Florida Water Management District (SFWMD) and the Interagency Modeling Center. November 2005. Final Documentation for the SFWMM (v5.5). South Florida Water Management District, West Palm Beach, Florida.

ATTACHMENT A

Regulation Schedule Figures for LORSS Alternatives Evaluated

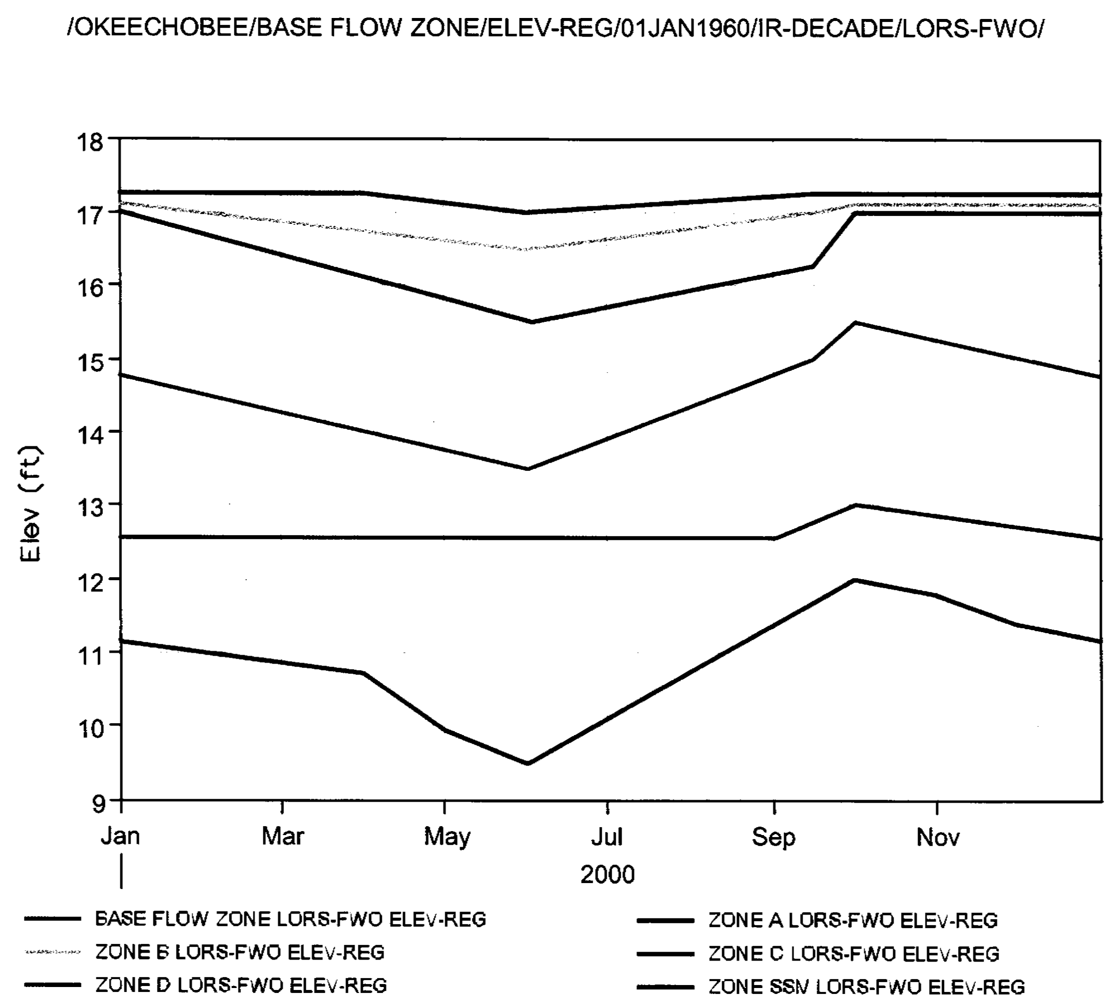


FIGURE A-1: REGULATION SCHEDULE FOR ALTERNATIVE LORS-FWO

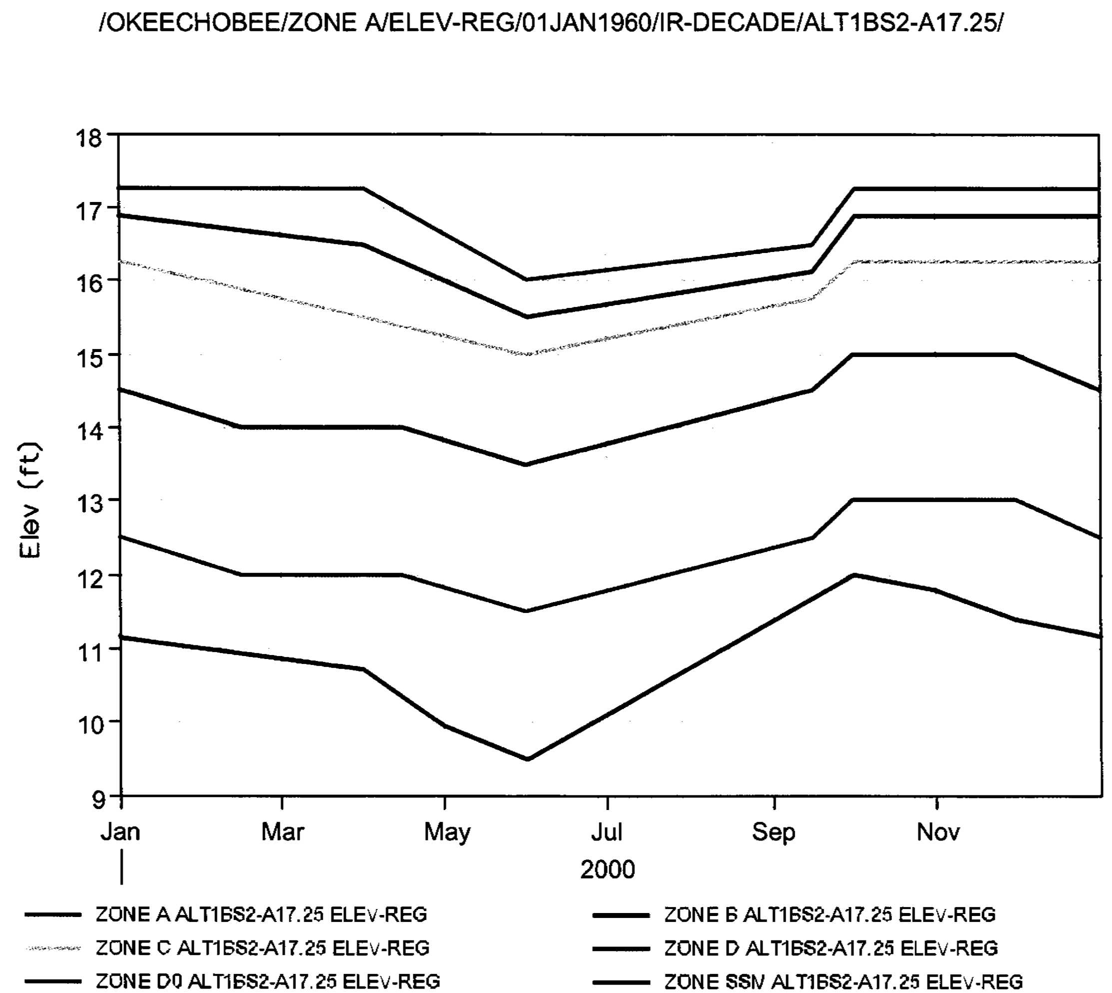


FIGURE A-2: REGULATION SCHEDULE FOR ALTERNATIVE 1BS2-A17.25 (2006 SEIS)

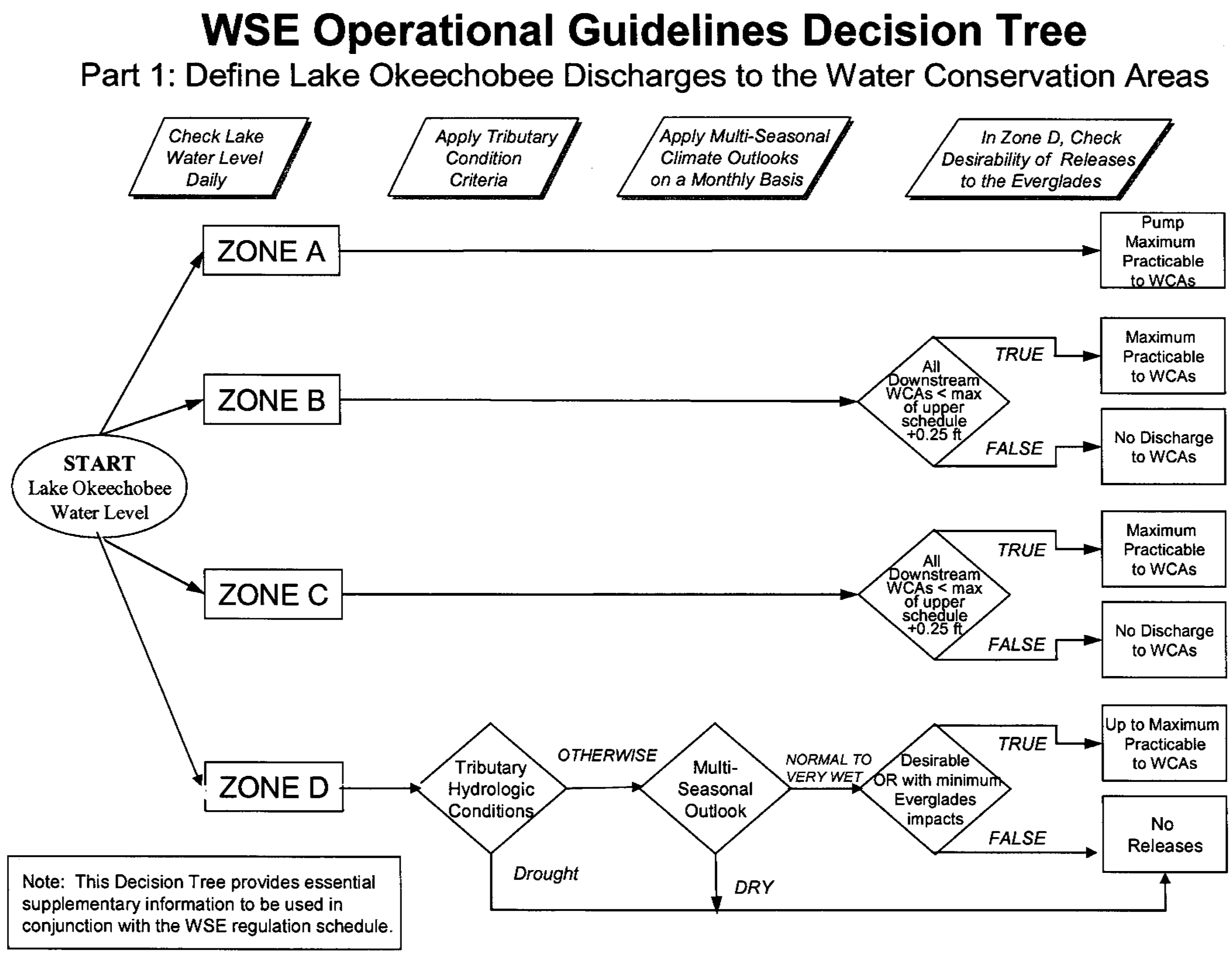


FIGURE A-3: DECISION TREE, PART 1 FOR ALTERNATIVE 1BS2-A17.25, ALTERNATIVE 1BS2-M, AND ALTERNATIVE 4-A17.25

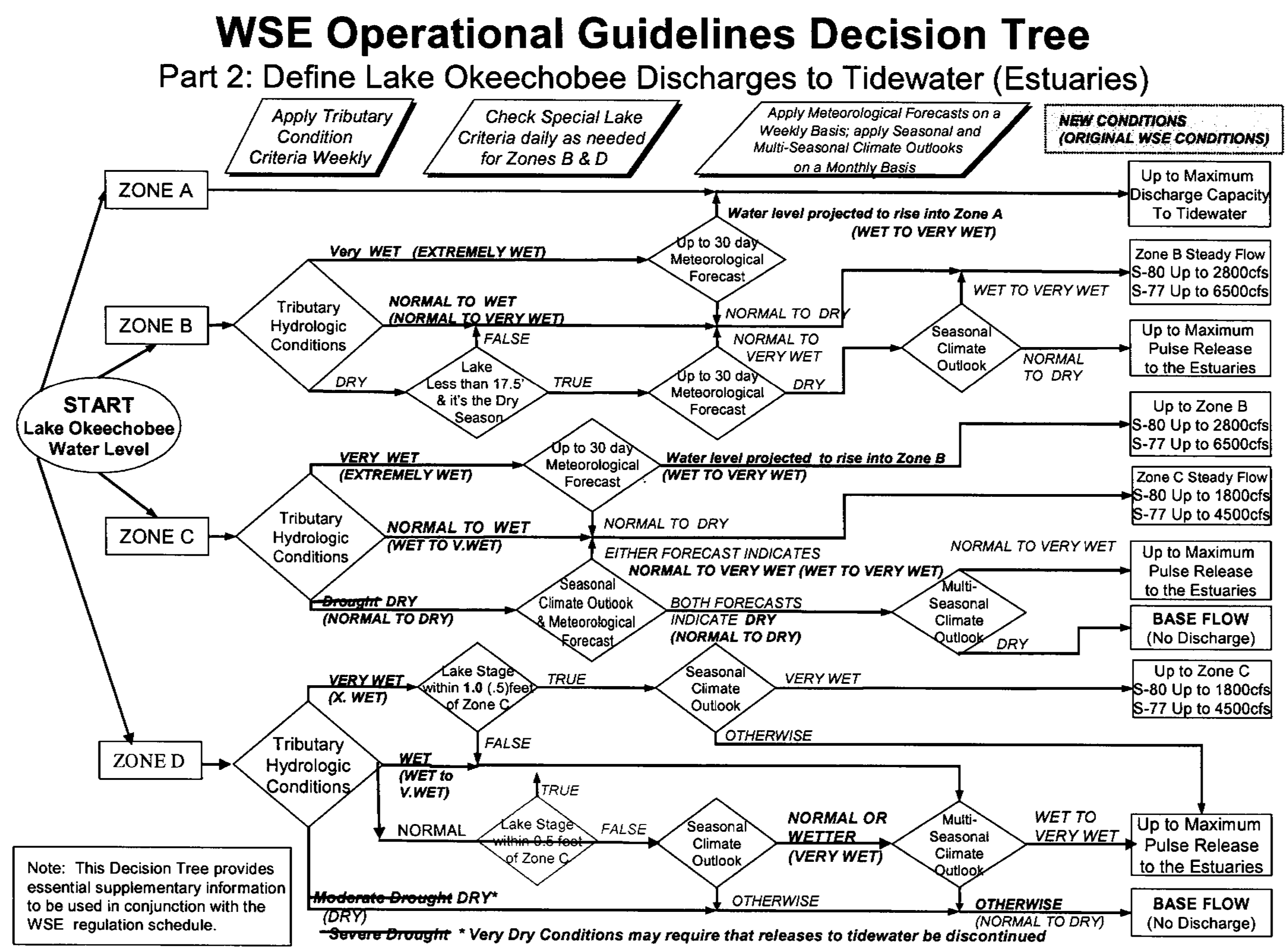


FIGURE A-4: DECISION TREE, PART 2 FOR ALTERNATIVE 1BS2-A17.25, ALTERNATIVE 1BS2-M, AND ALTERNATIVE 4-A17.25

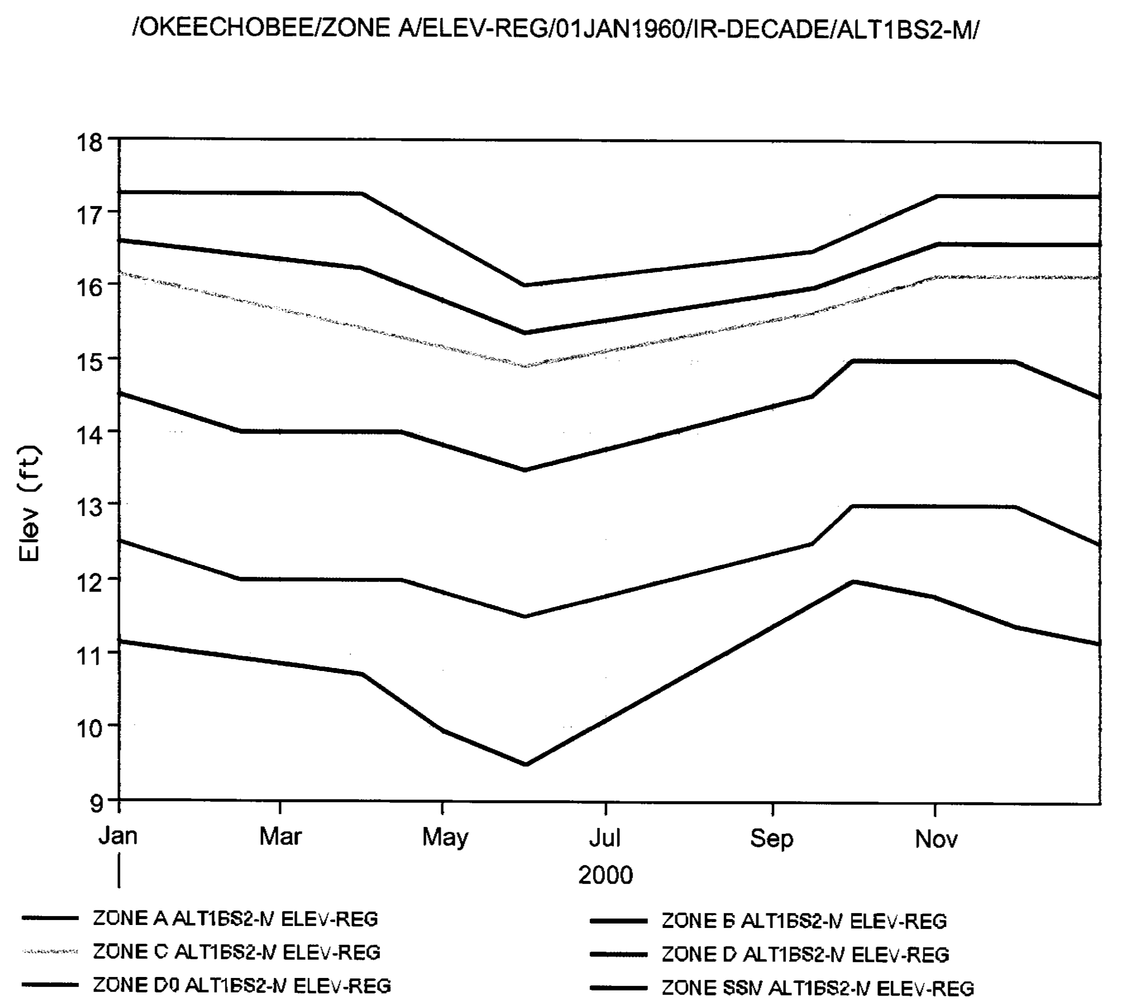


FIGURE A-5: REGULATION SCHEDULE FOR ALTERNATIVE 1BS2-M (2006 SEIS)

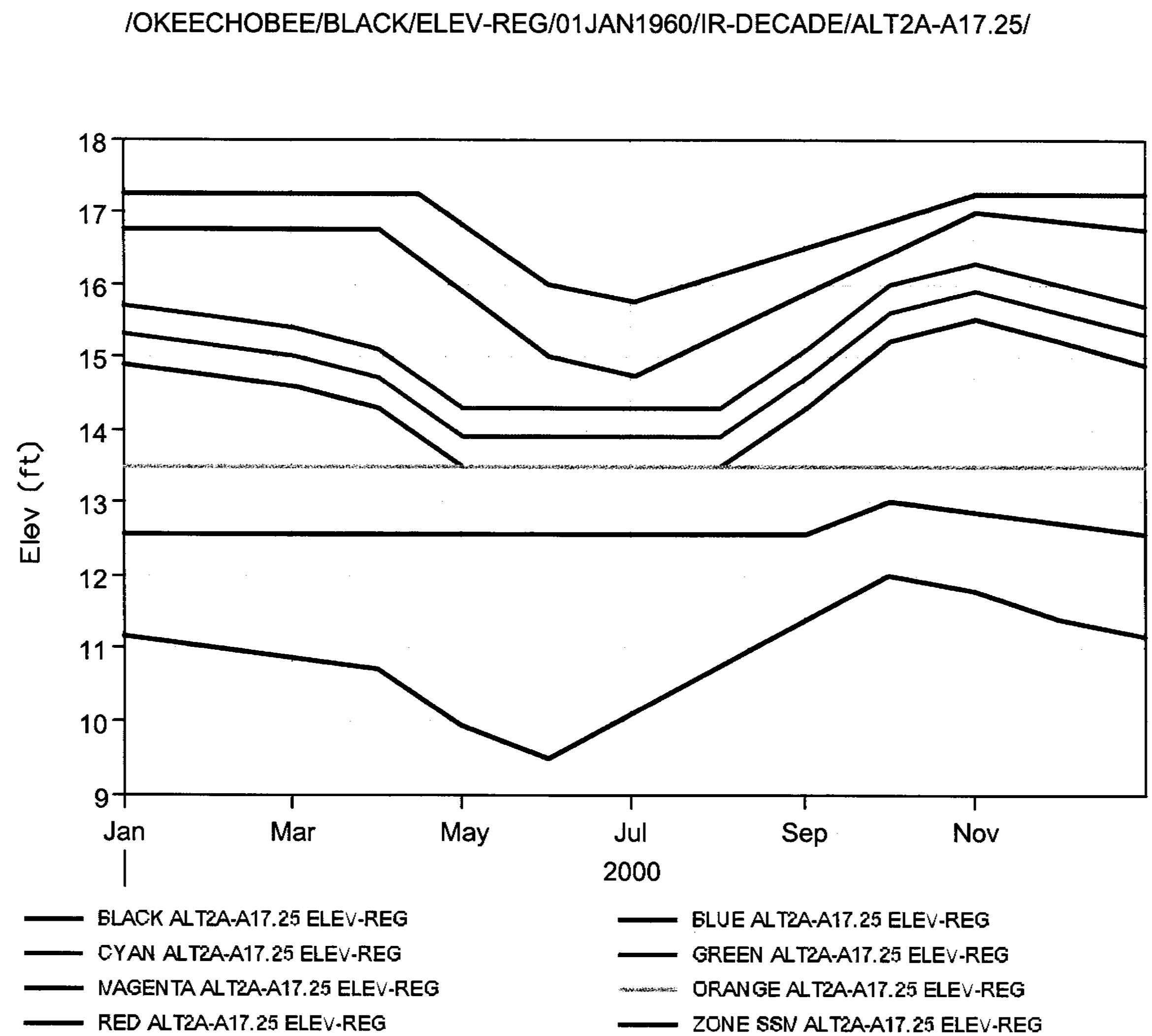


FIGURE A-6: REGULATION SCHEDULE FOR ALTERNATIVE 2A-A17.25

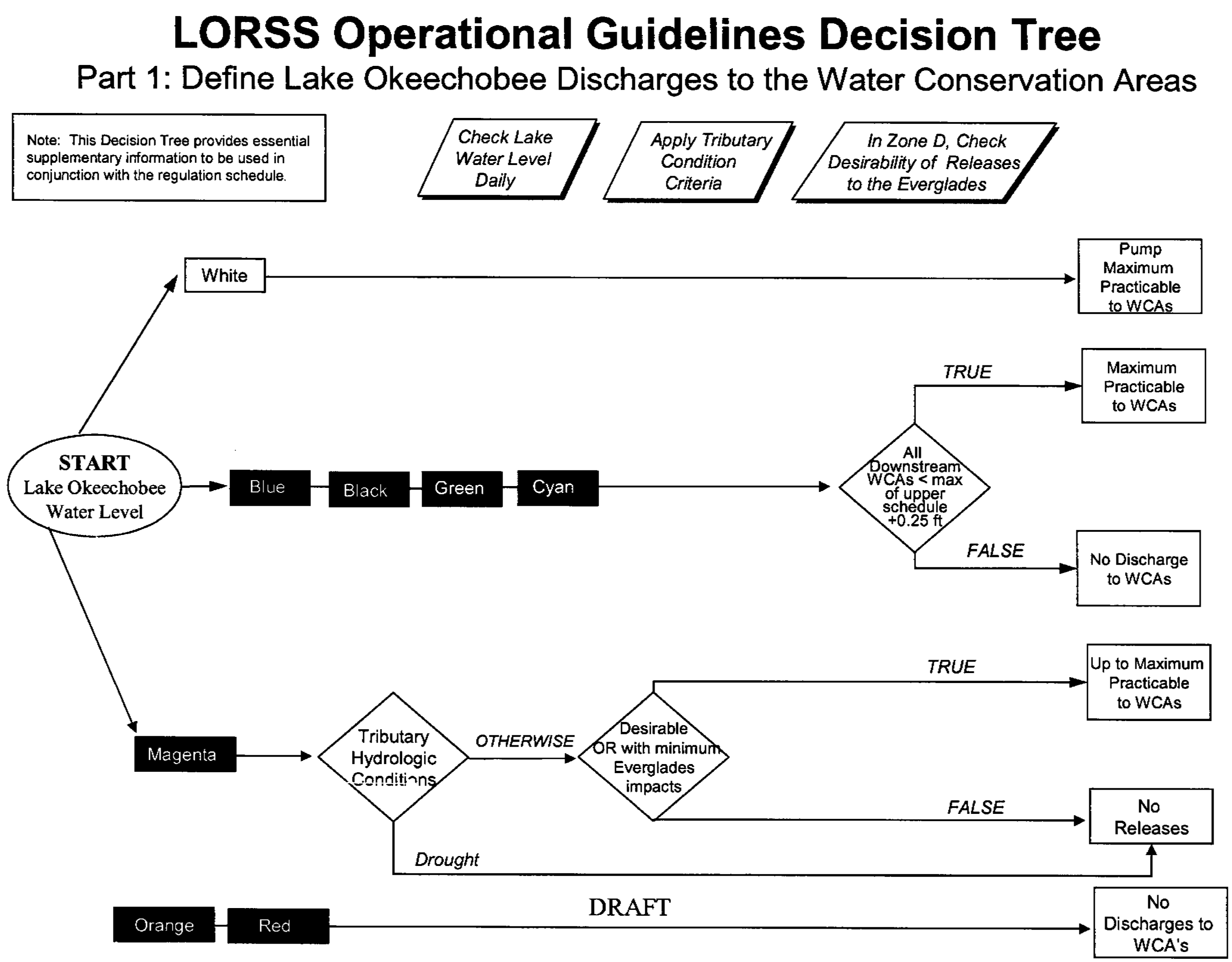


FIGURE A-7: DECISION TREE, PART 1 FOR ALTERNATIVE 2A-B AND ALTERNATIVE 2A-M

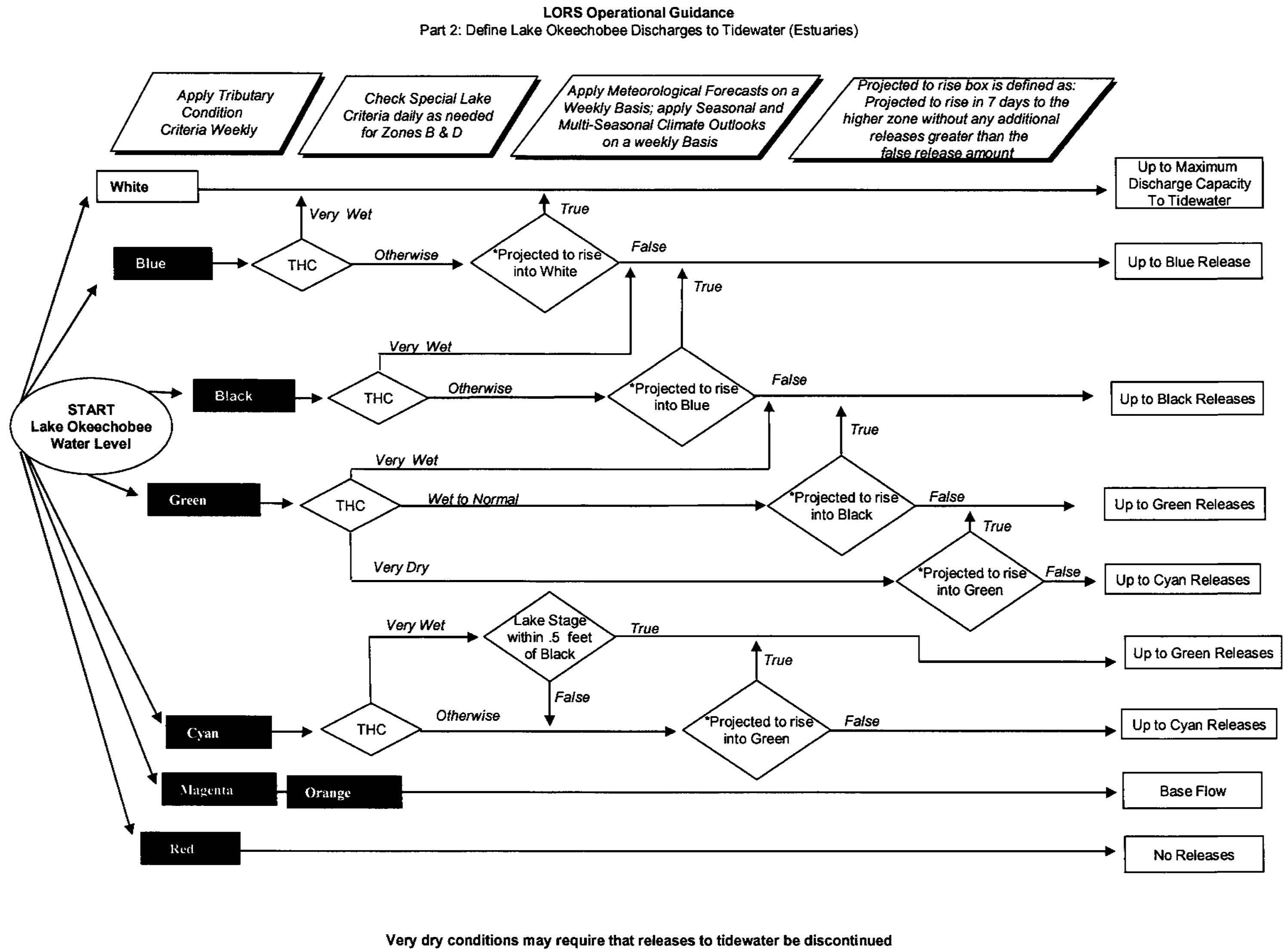


FIGURE A-8: DECISION TREE, PART 2 FOR ALTERNATIVE 2A-B AND ALTERNATIVE 2A-M

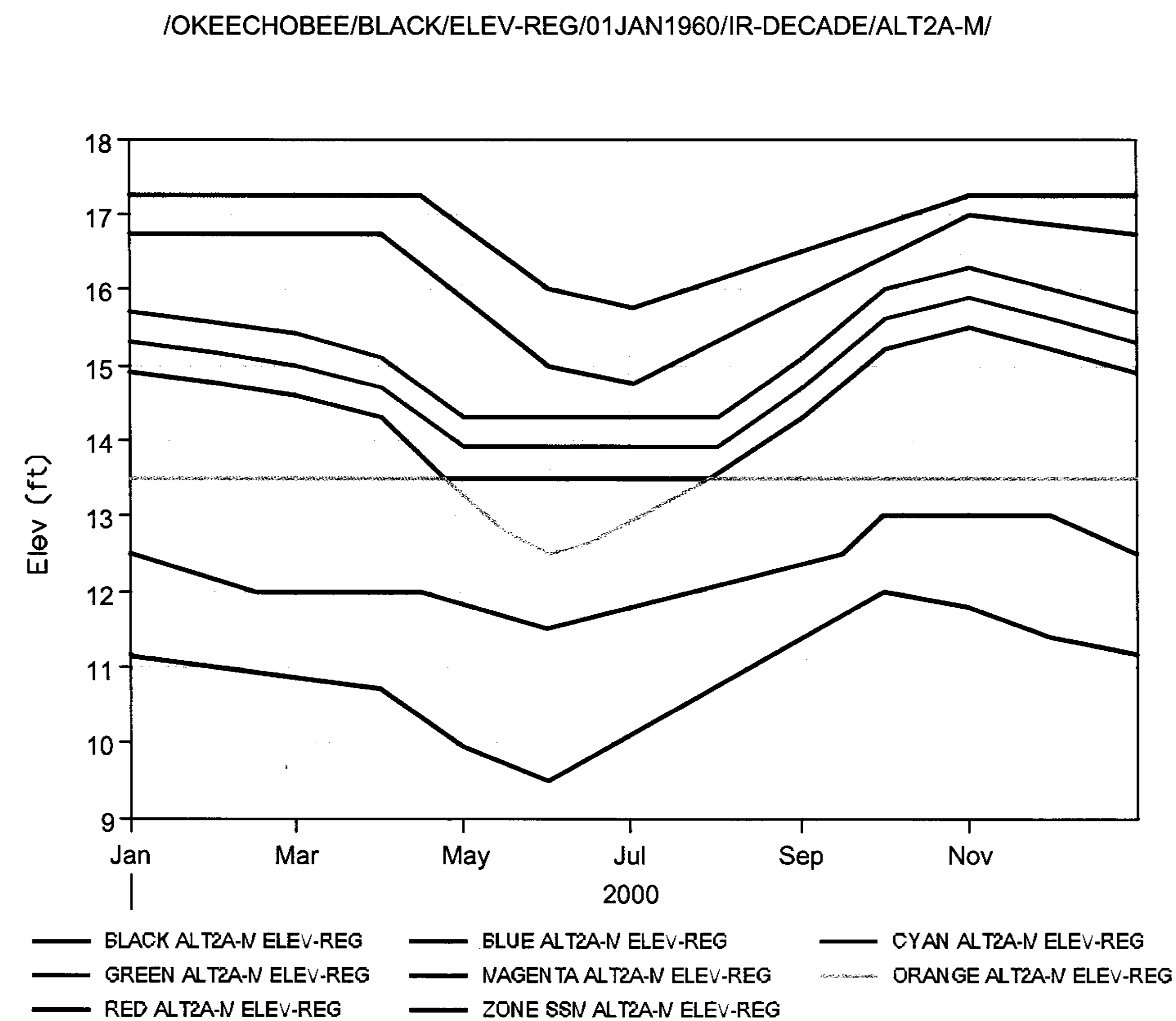
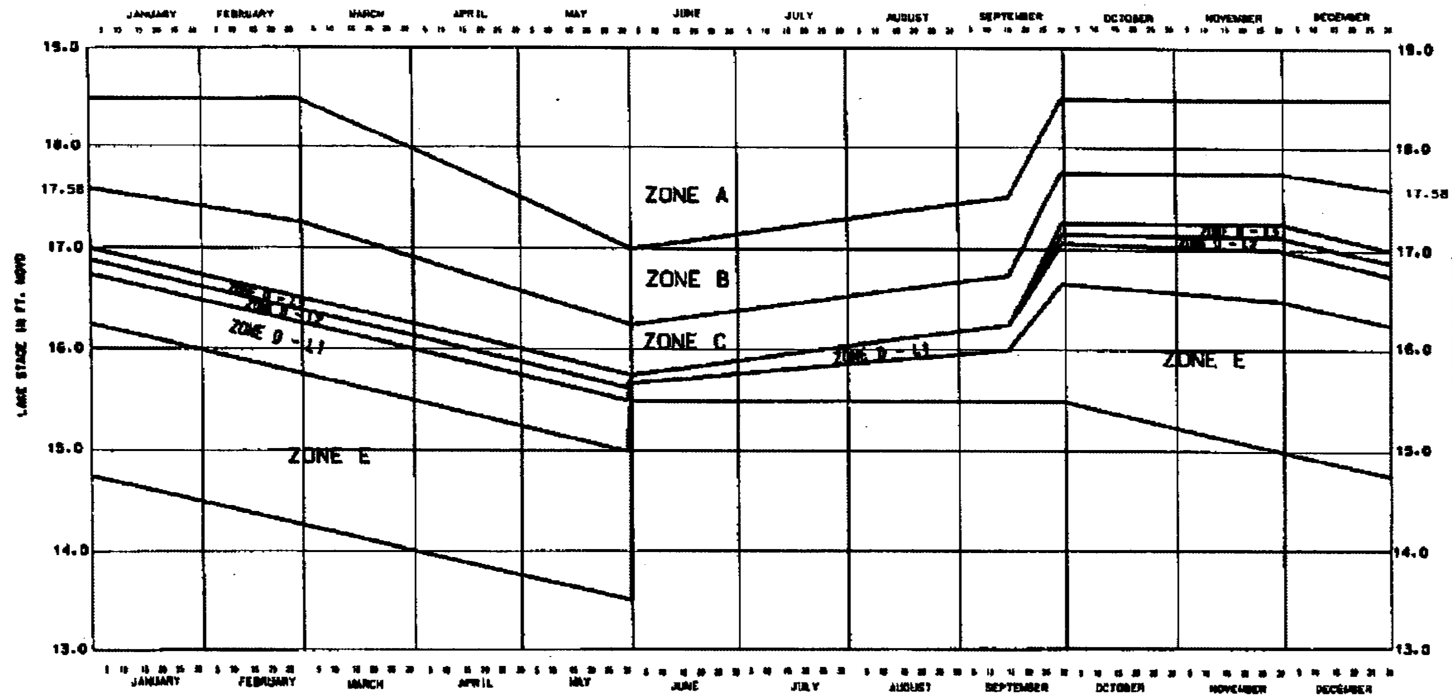


FIGURE A-9: REGULATION SCHEDULE FOR ALTERNATIVE 2A-M



LAKE OKEECHOBEE RELEASES

ZONE	AGRICULTURAL CANALS (2)	CALOOSAHATCHEE RIVER (2)	ST. LUCIE CANAL
A	Maximum Practicable Releases to Water Convervation Areas	Up to Maximum Capacity at S-77	Up to Maximum Capacity at S-80
B		6500 CFS	3500 CFS (3)
C		4500 CFS	2500 CFS (3)
D Level 3 Level 2 Level 1		10-day Pulse with a Mean Discharge of: Level 3 = 3000 CFS Level 2 = 2300 CFS Level 1 = 1600 CFS	10-day Pulse with a Mean Discharge of: Level 3 = 1170 CFS Level 2 = 900 CFS Level 1 = 730 CFS
E		No Releases	No Releases

NOTES: (1) RELEASES THROUGH VARIOUS OUTLETS MAY BE MODIFIED TO MINIMIZE DAMAGES OR OBTAIN ADDITIONAL BENEFITS.
(2) SUBJECT TO FIRST REMOVAL OF LOCAL RUNOFF.
(3) EXCEPT WHEN EXCEEDED BY LOCAL INFLOW.

CENTRAL AND SOUTHERN FLORIDA
PROPOSED REGULATION SCHEDULE
LAKE OKEECHOBEE
DEPARTMENT OF THE ARMY, JACKSONVILLE DISTRICT
CORPS OF ENGINEERS, JACKSONVILLE, FLORIDA

R22AZE

Figure 5.2.2-1

FIGURE A-10: REGULATION SCHEDULE FOR RUN22AZE

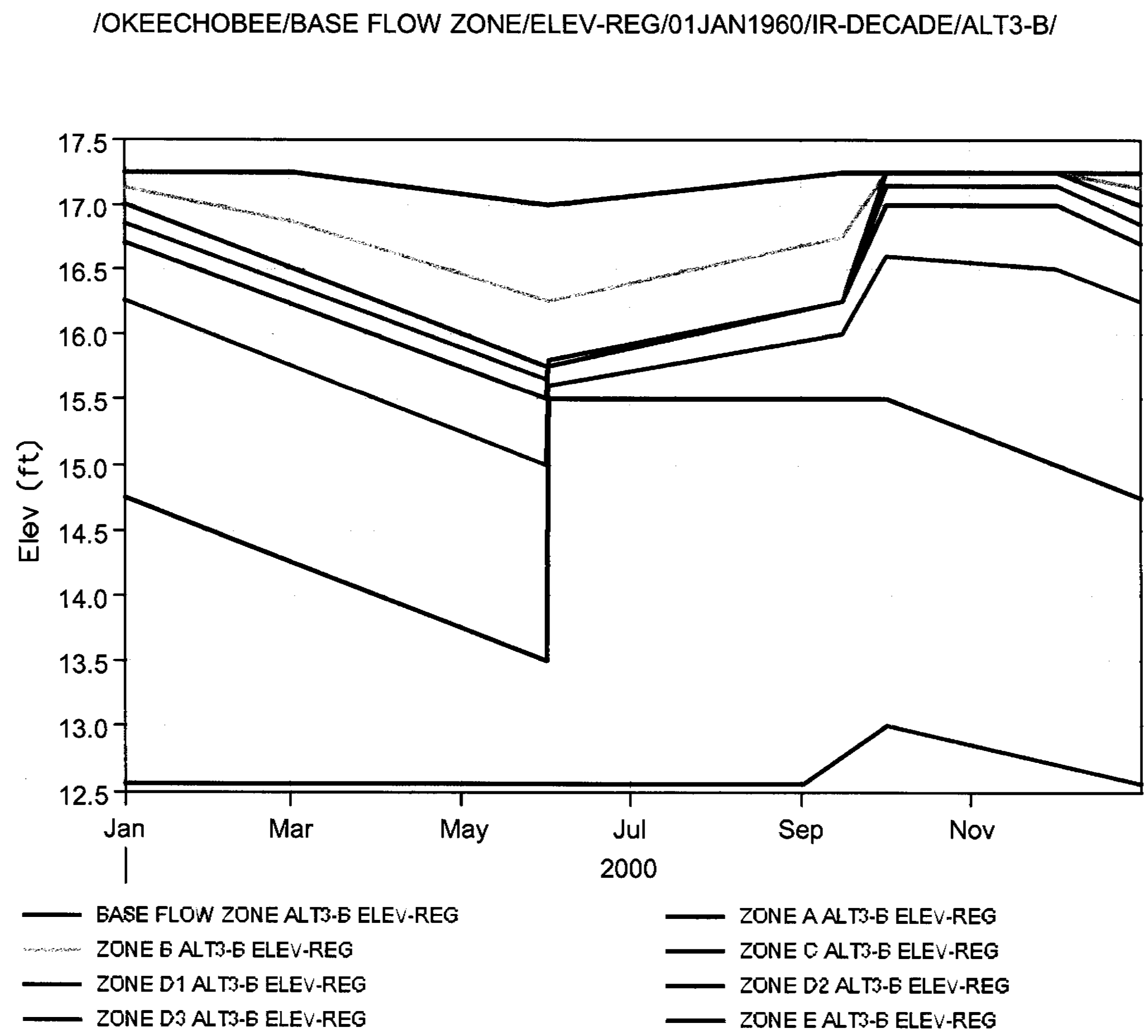


FIGURE A-11: REGULATION SCHEDULE FOR ALTERNATIVE 3-B

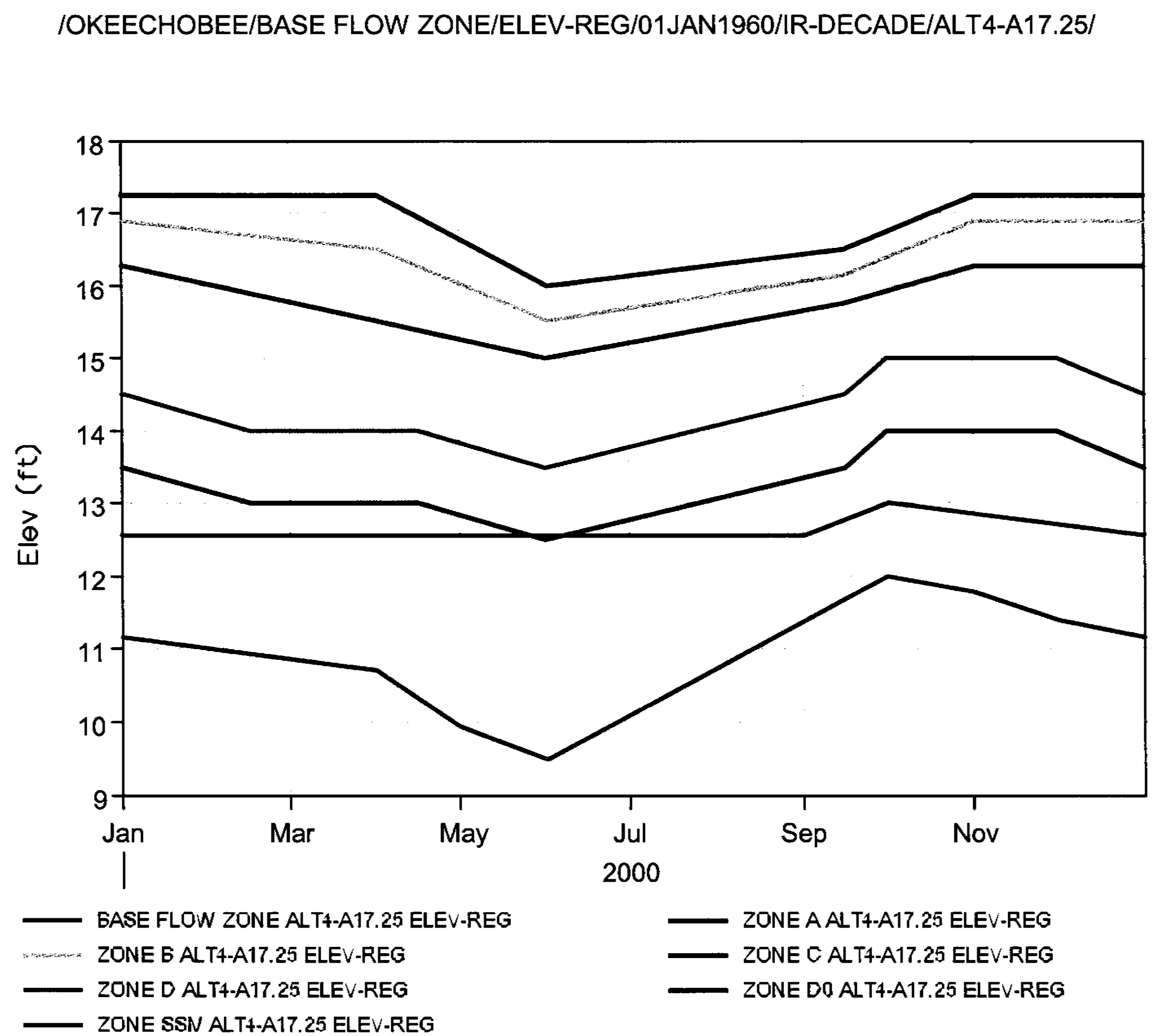


FIGURE A-12: REGULATION SCHEDULE FOR ALTERNATIVE 4-A17.25

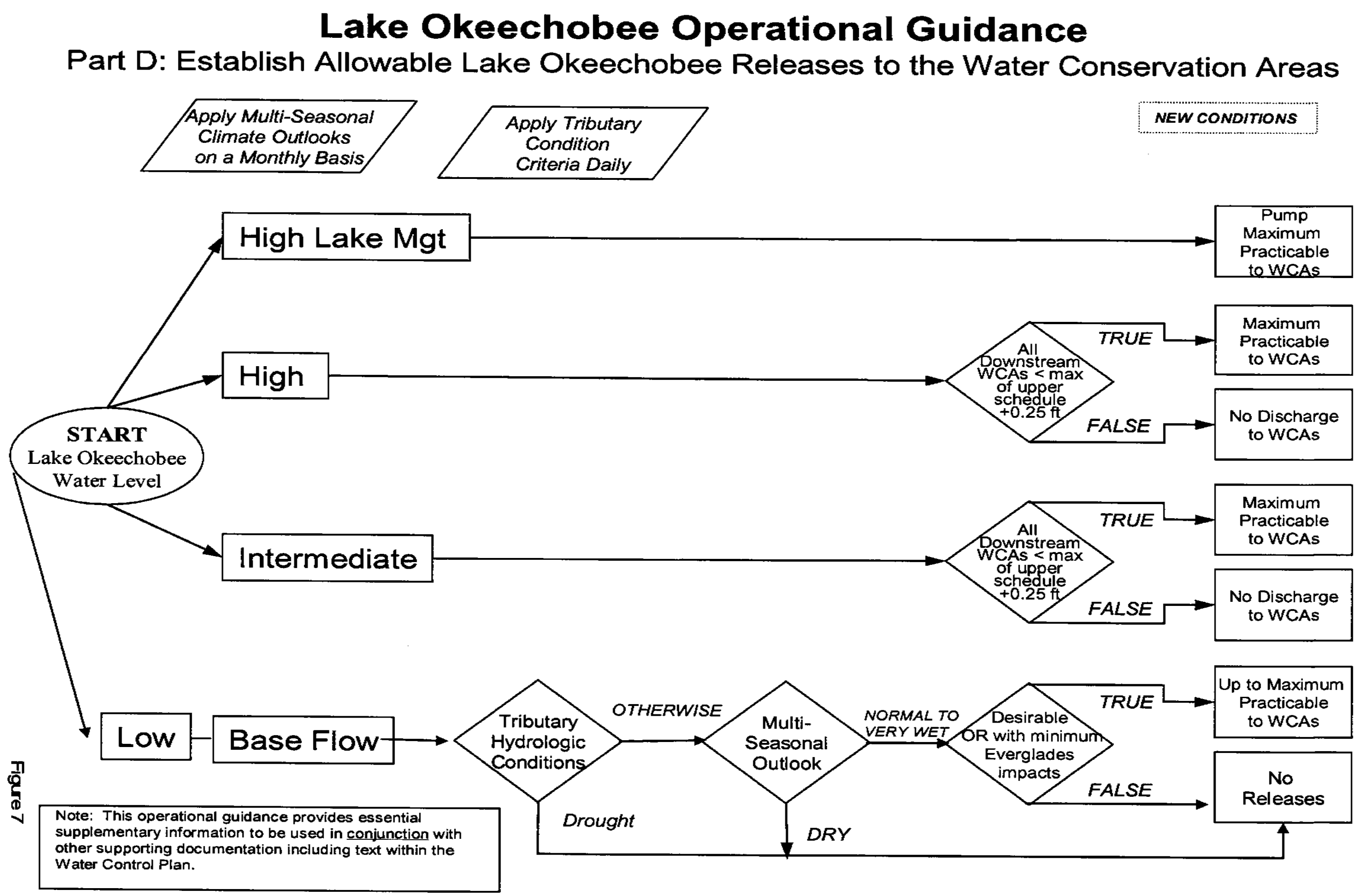


FIGURE A-13: DECISION TREE, PART 1 FOR ALTERNATIVE 1BS2-A17.25, ALTERNATIVE 1BS2-M, ALTERNATIVE T1, ALTERNATIVE T2, AND ALTERNATIVE T3

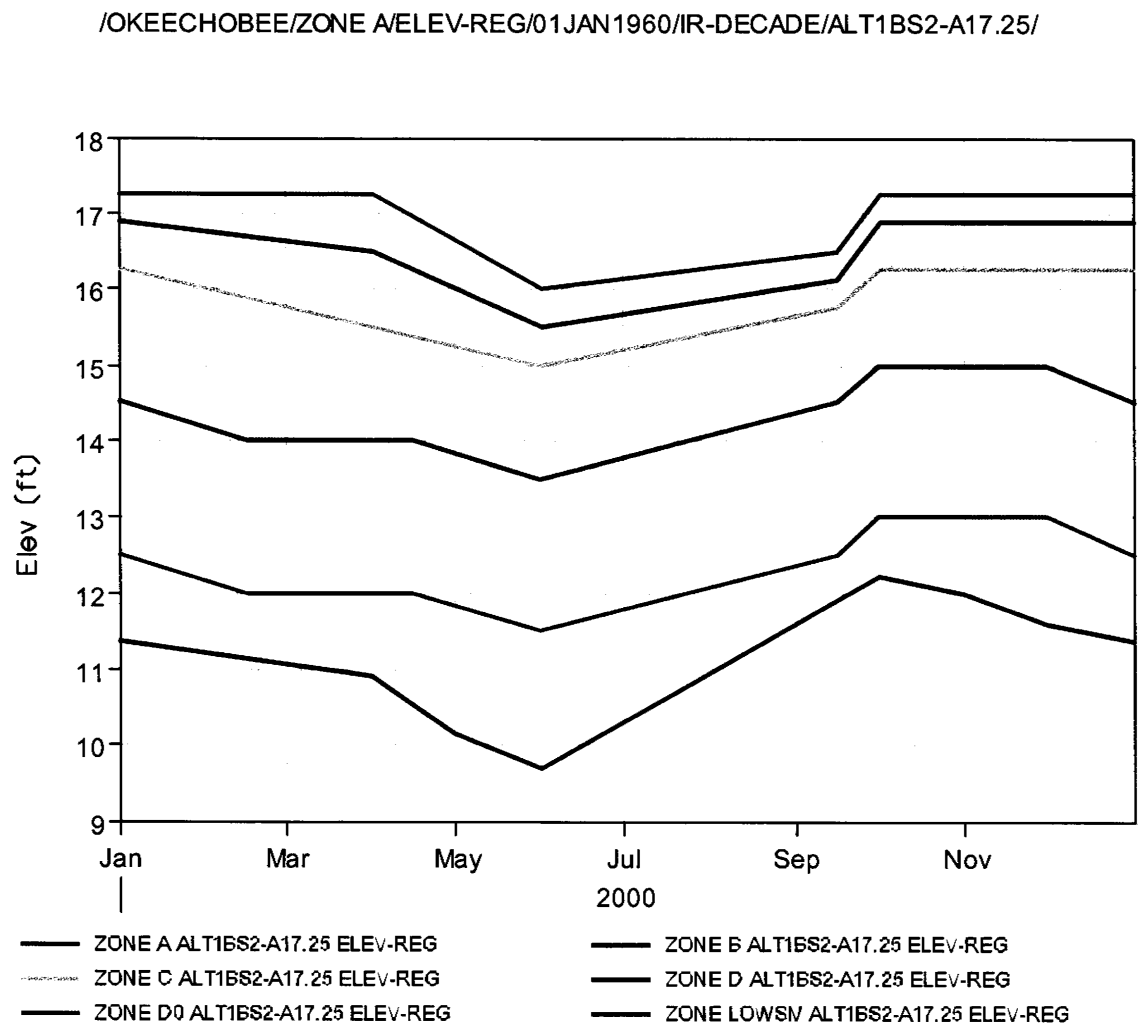


FIGURE A-14: REGULATION SCHEDULE FOR ALTERNATIVE 1BS2-A17.25 (2007 SEIS)

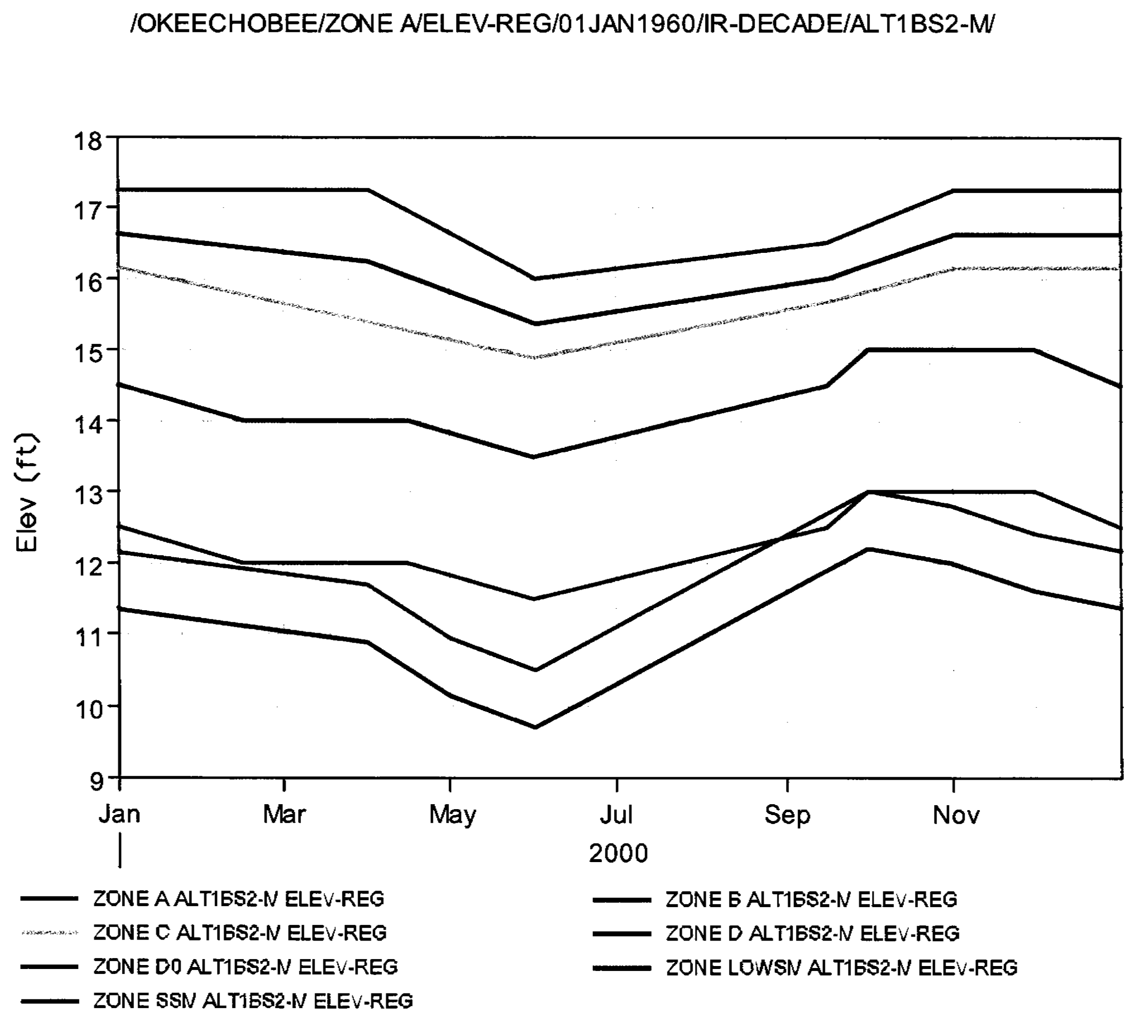


FIGURE A-15: REGULATION SCHEDULE FOR ALTERNATIVE 1BS2-A17.25 (2007 SEIS)

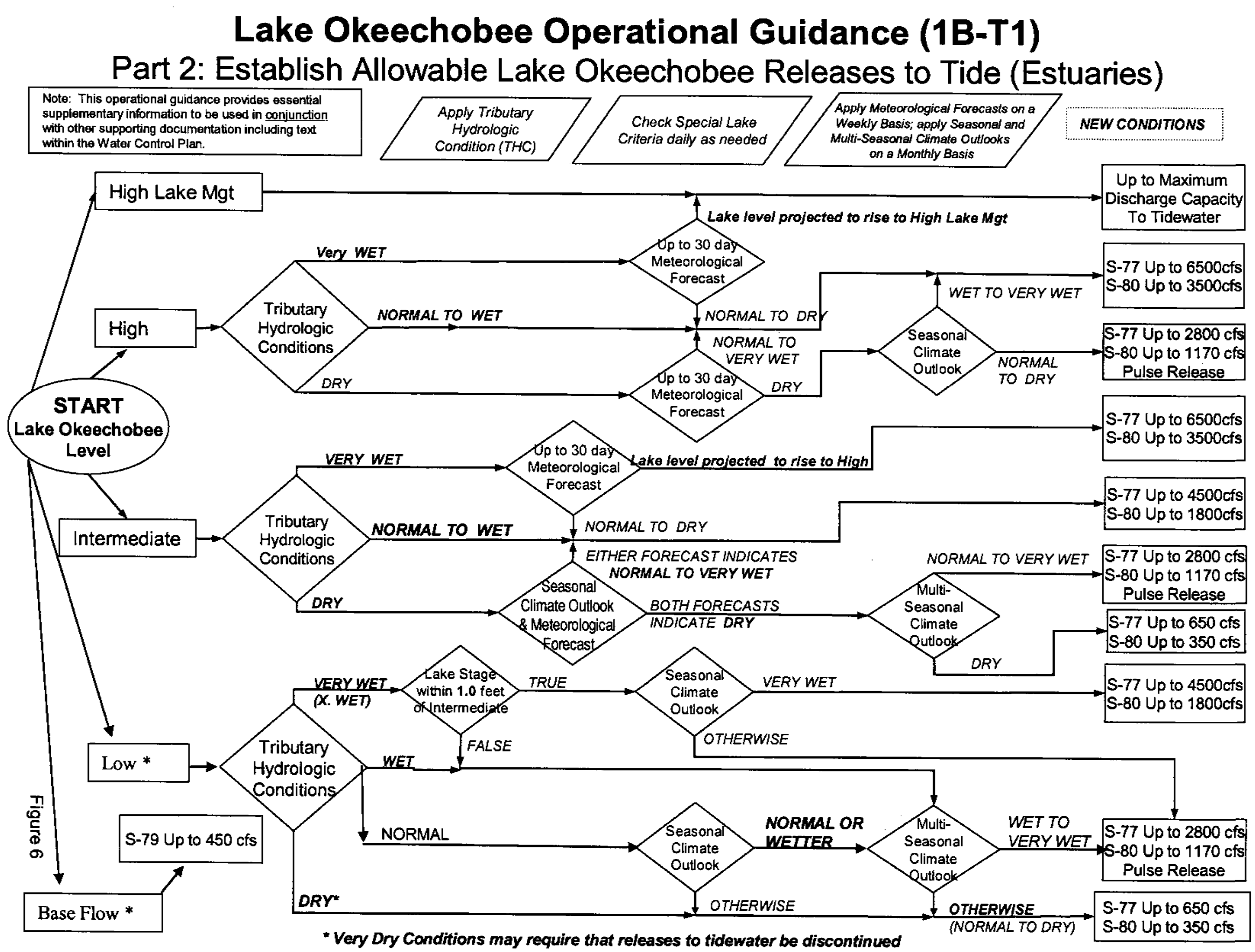


FIGURE A-16: DECISION TREE, PART 2 FOR ALTERNATIVE T1

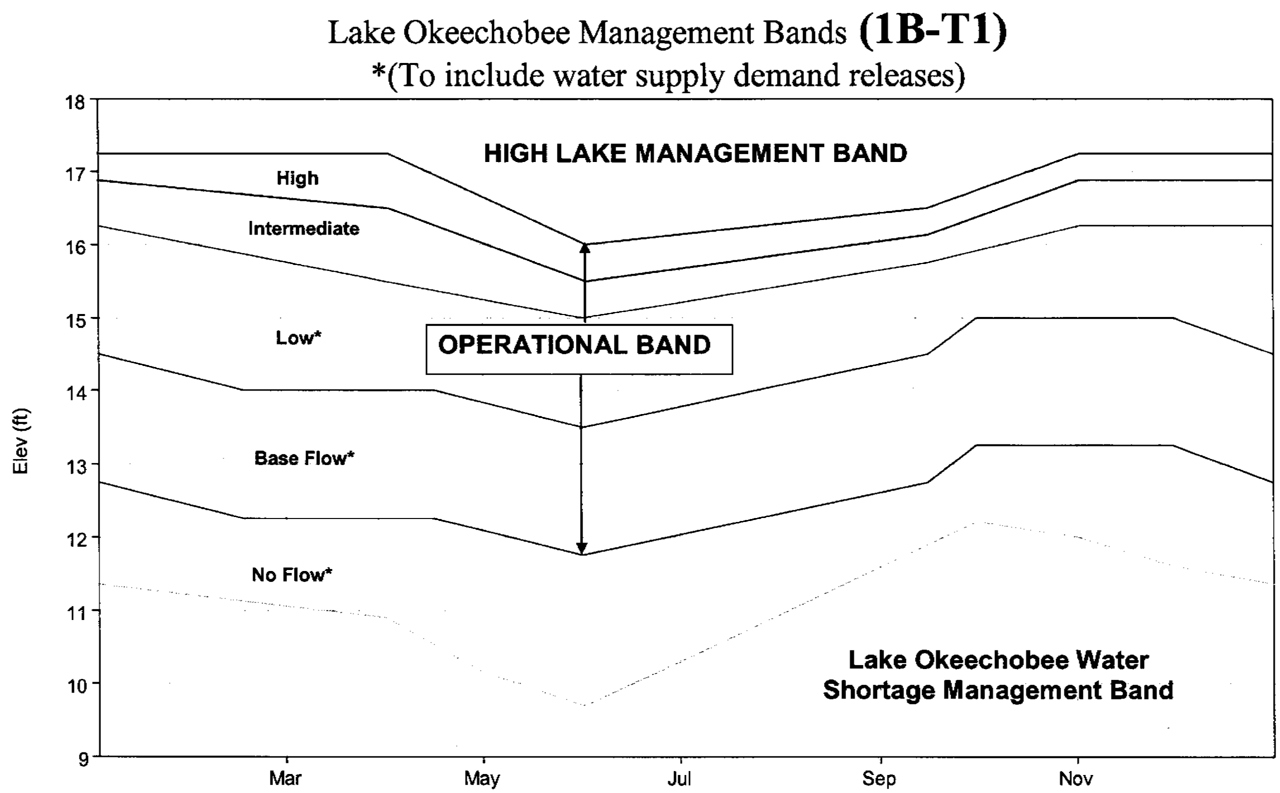


FIGURE A-17: REGULATION SCHEDULE FOR ALTERNATIVE T1

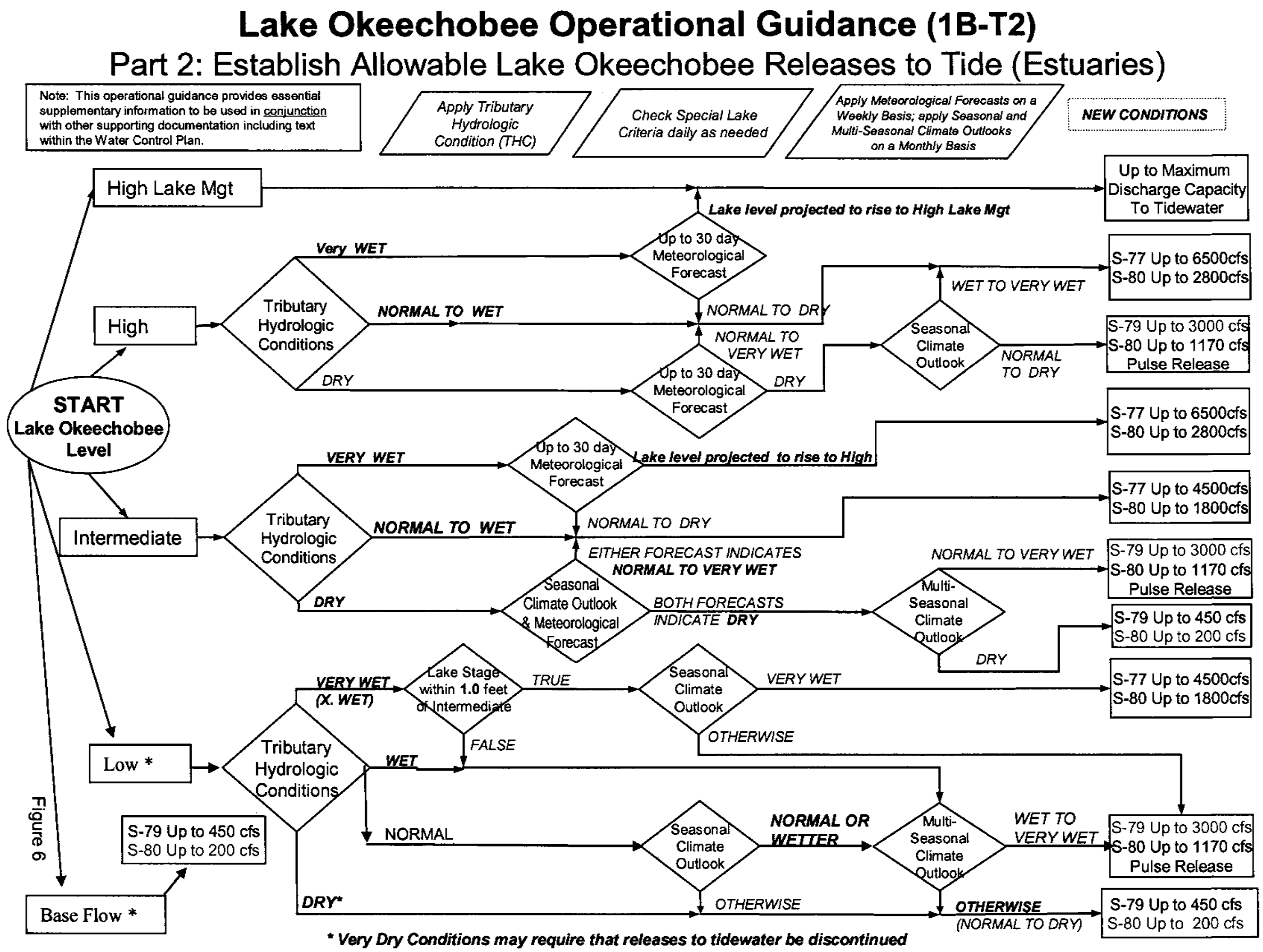


FIGURE A-18: DECISION TREE, PART 2 FOR ALTERNATIVE T2

Lake Okeechobee Management Bands **(1B-T2)**
*(To include water supply demand releases)

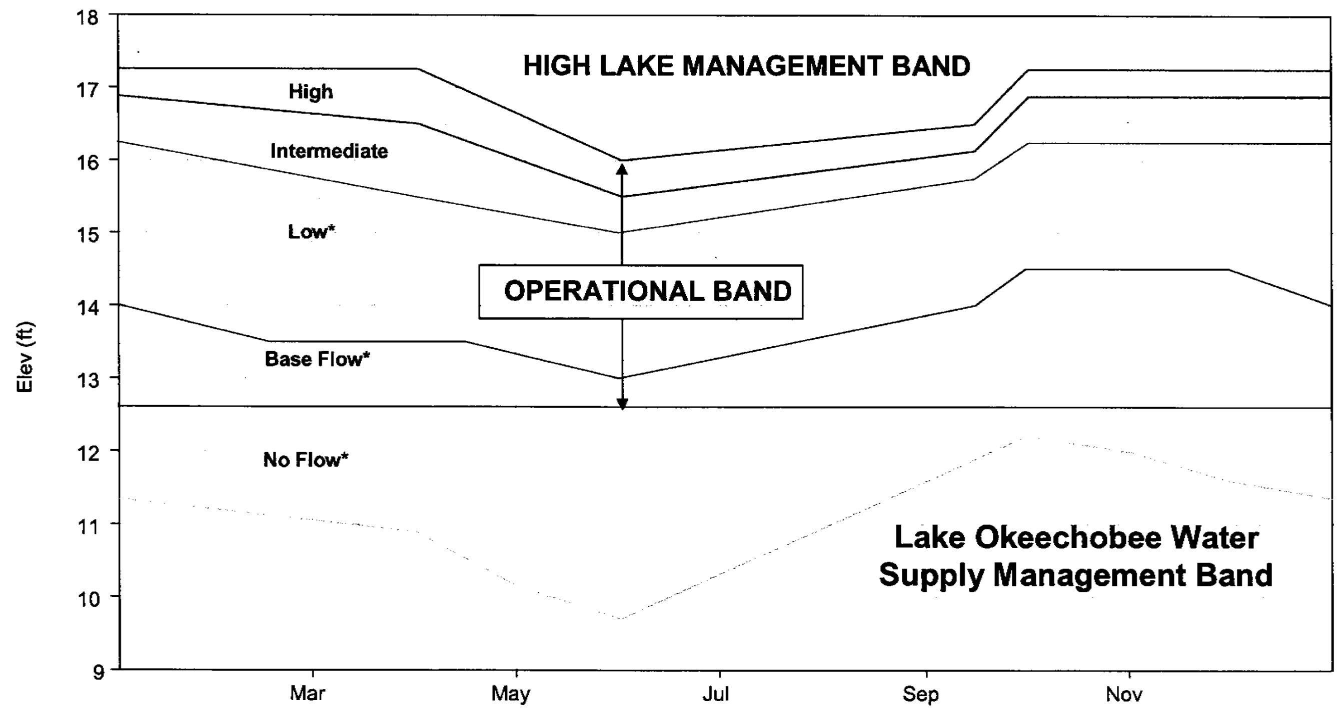


FIGURE A-19: REGULATION SCHEDULE FOR ALTERNATIVE T2

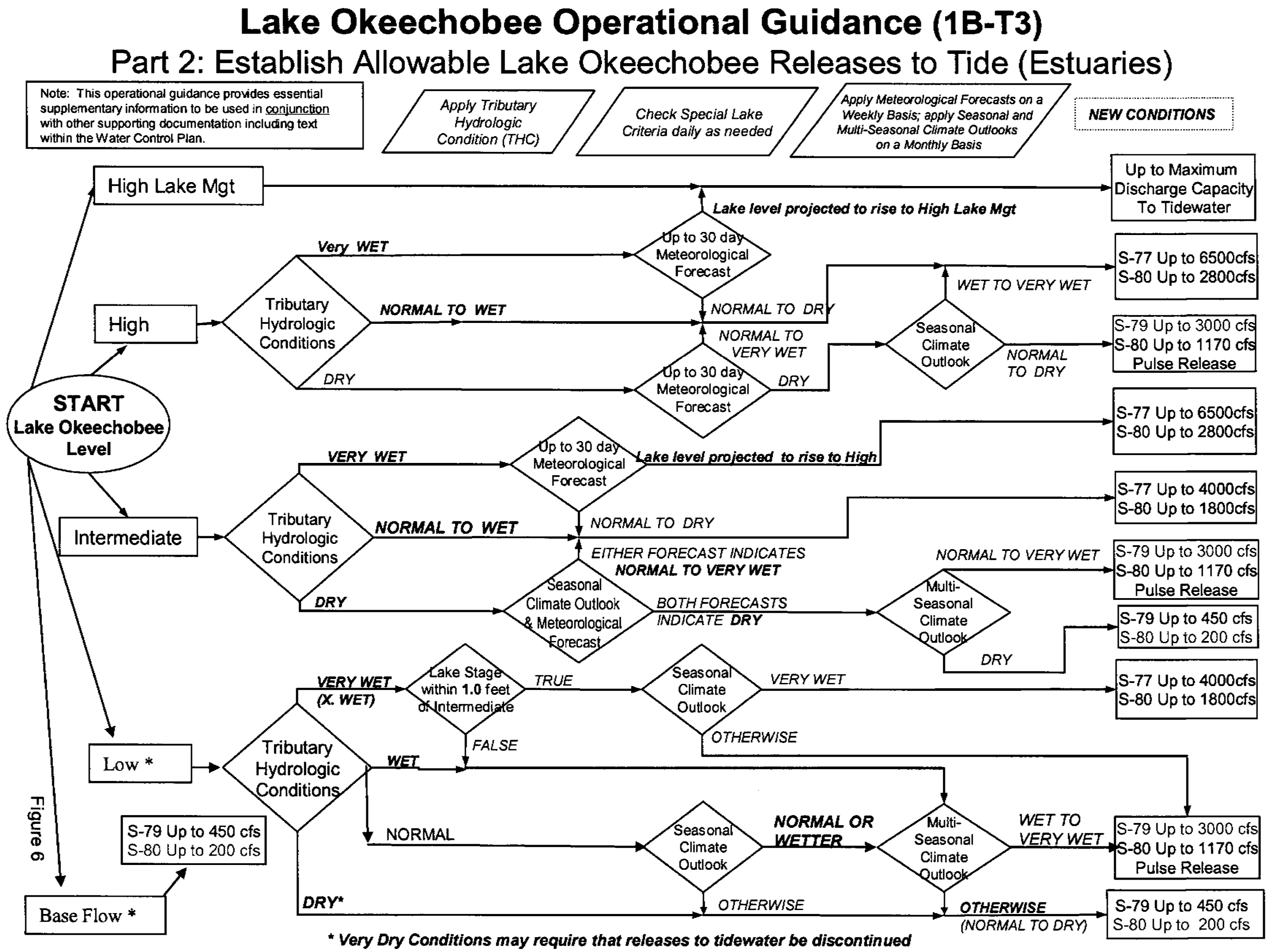


FIGURE A-20: DECISION TREE, PART 2 FOR ALTERNATIVE T3

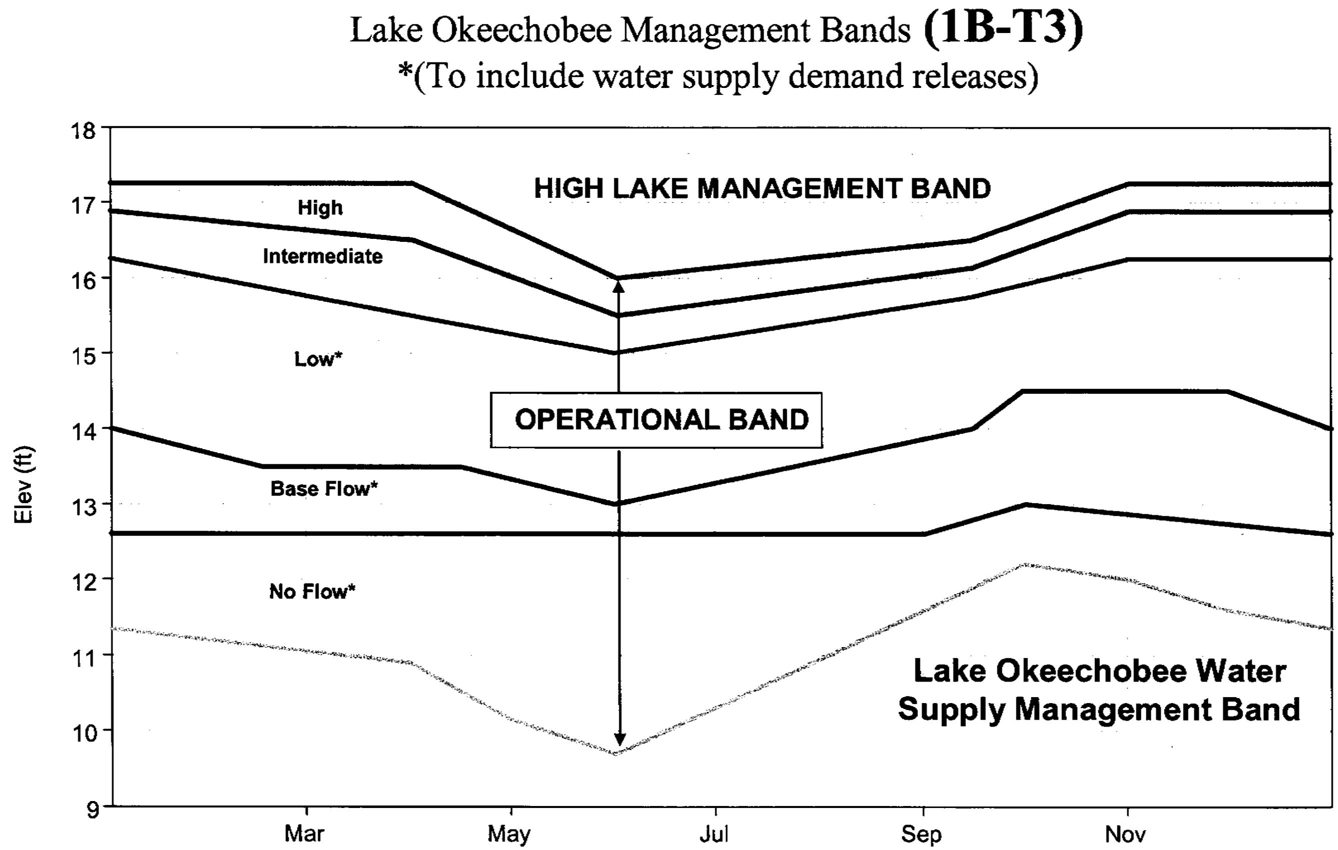


FIGURE A-21: REGULATION SCHEDULE FOR ALTERNATIVE T3

ATTACHMENT B

SFWMM Background Figures

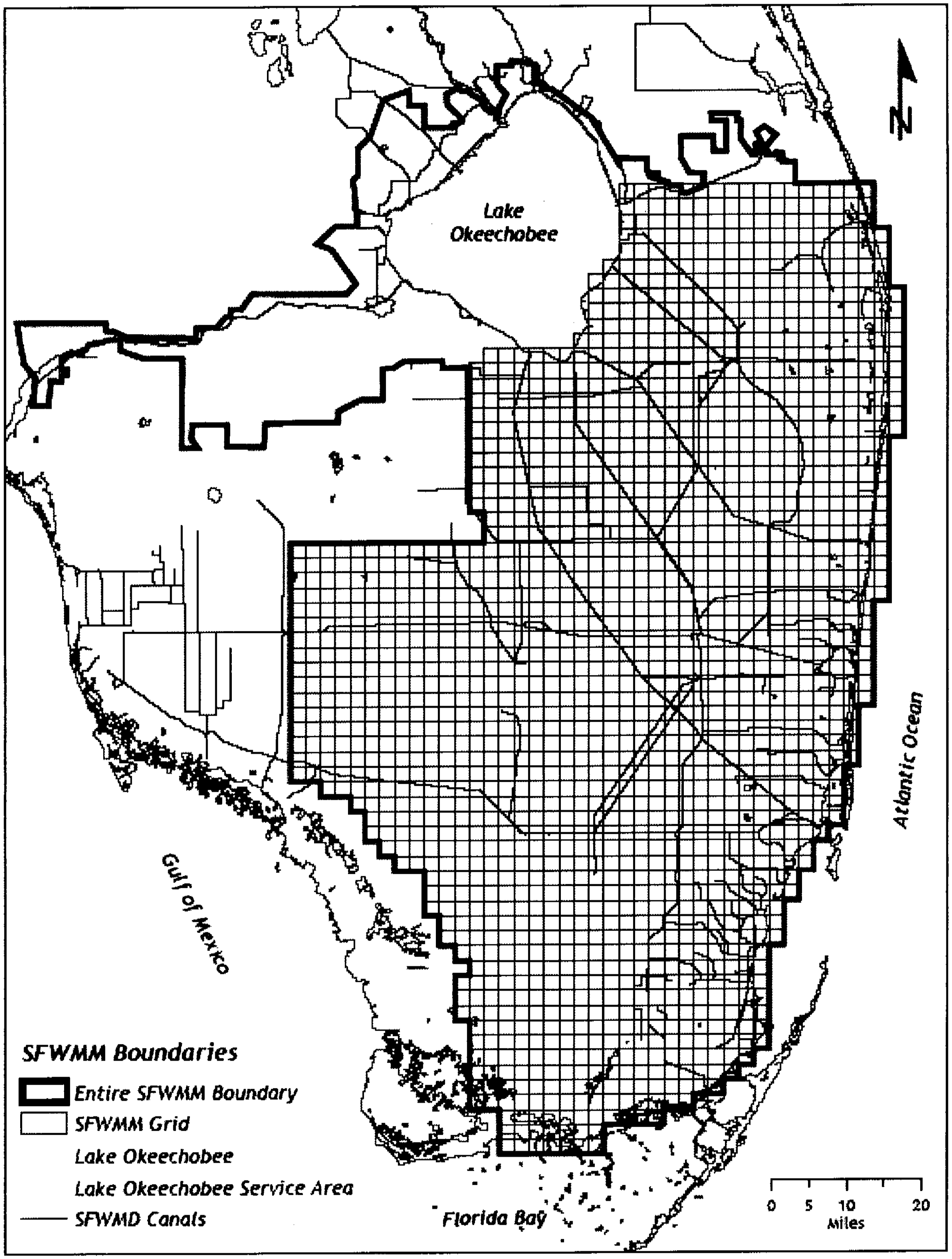


FIGURE B-1: SOUTH FLORIDA WATER MANAGEMENT MODEL BOUNDARIES

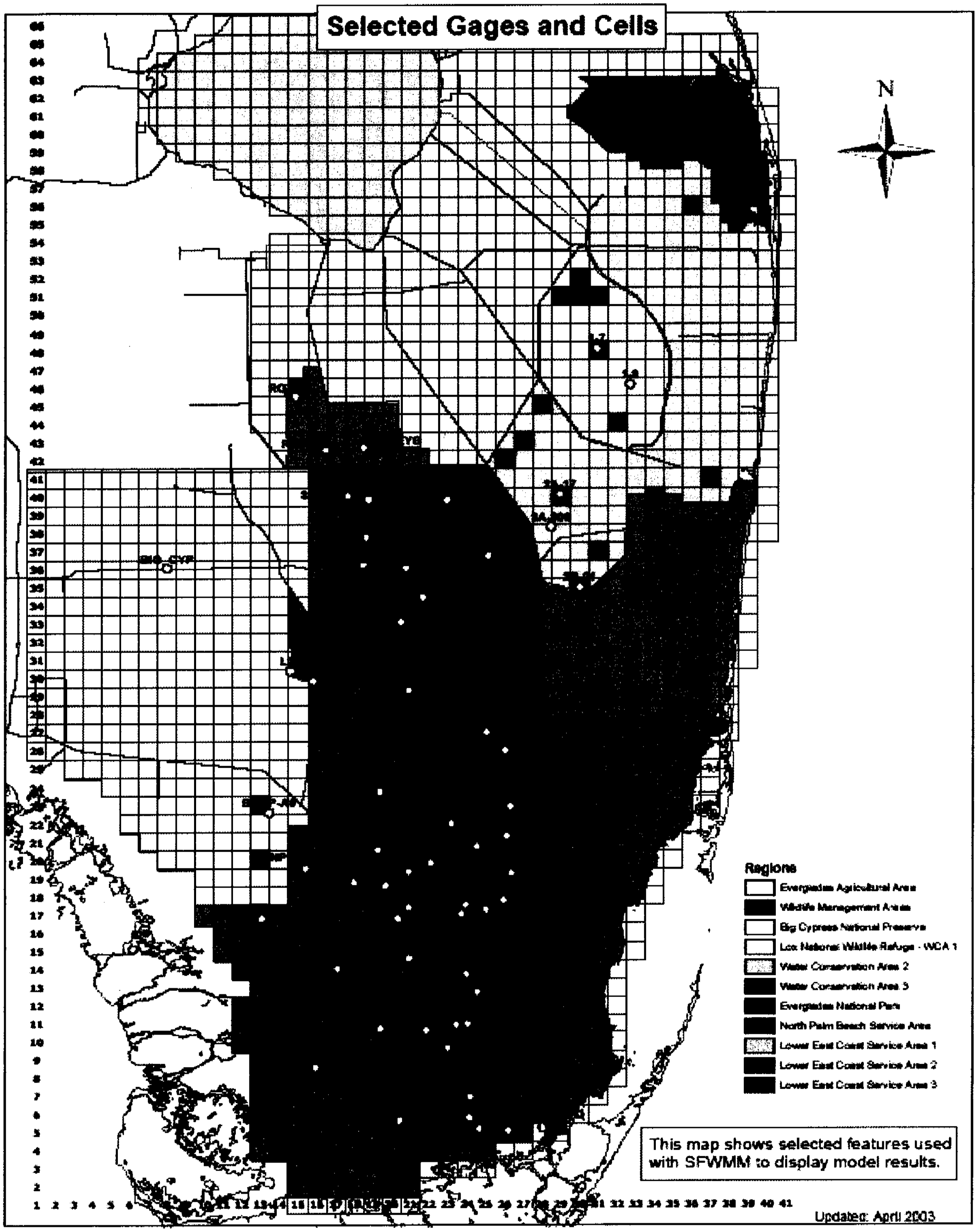


FIGURE B-2: GAGE AND MONITORING POINT LOCATIONS REPORTED BY THE SFWMM

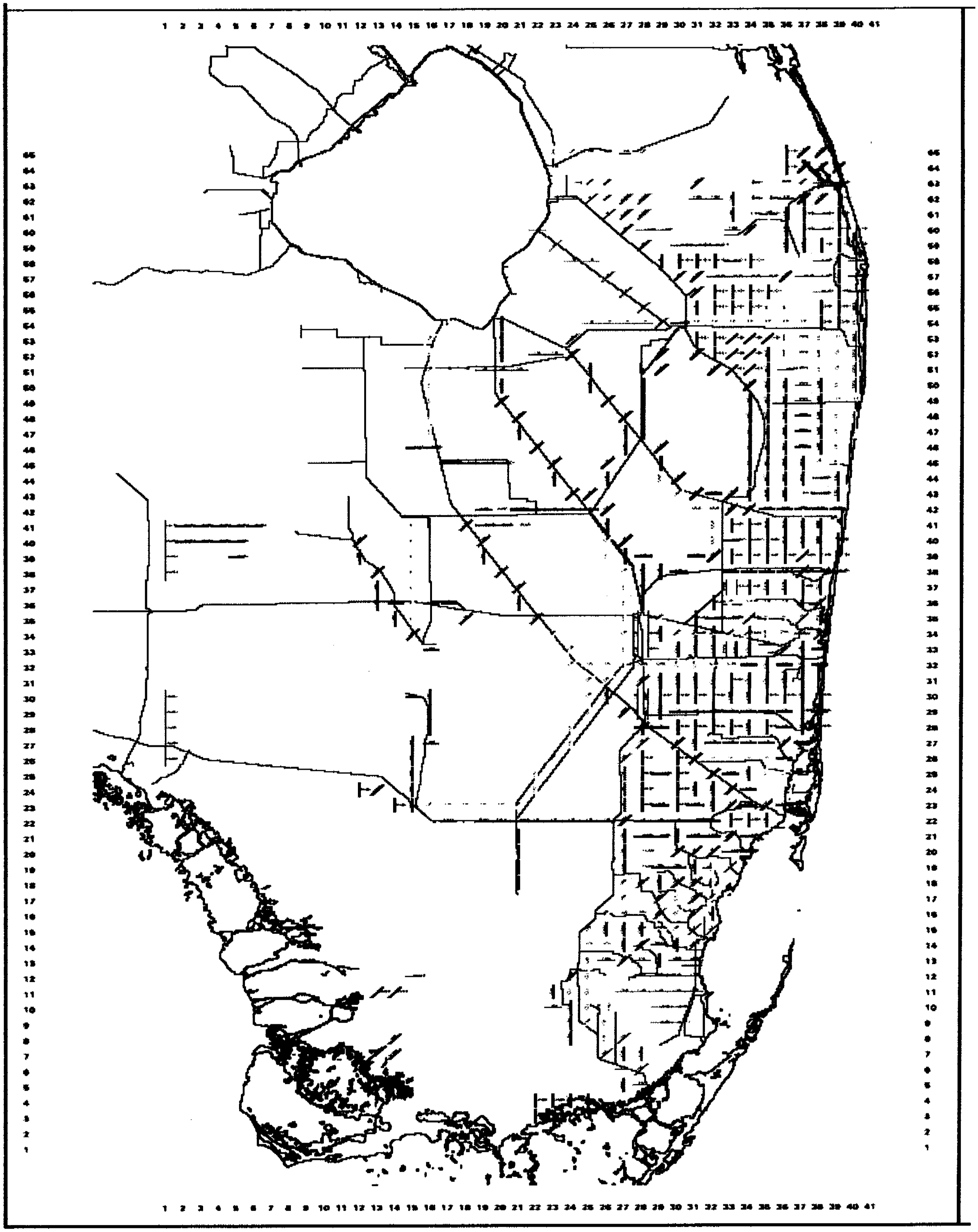


FIGURE B-3: SFWMM CANAL NETWORK (VERSION 5.0)

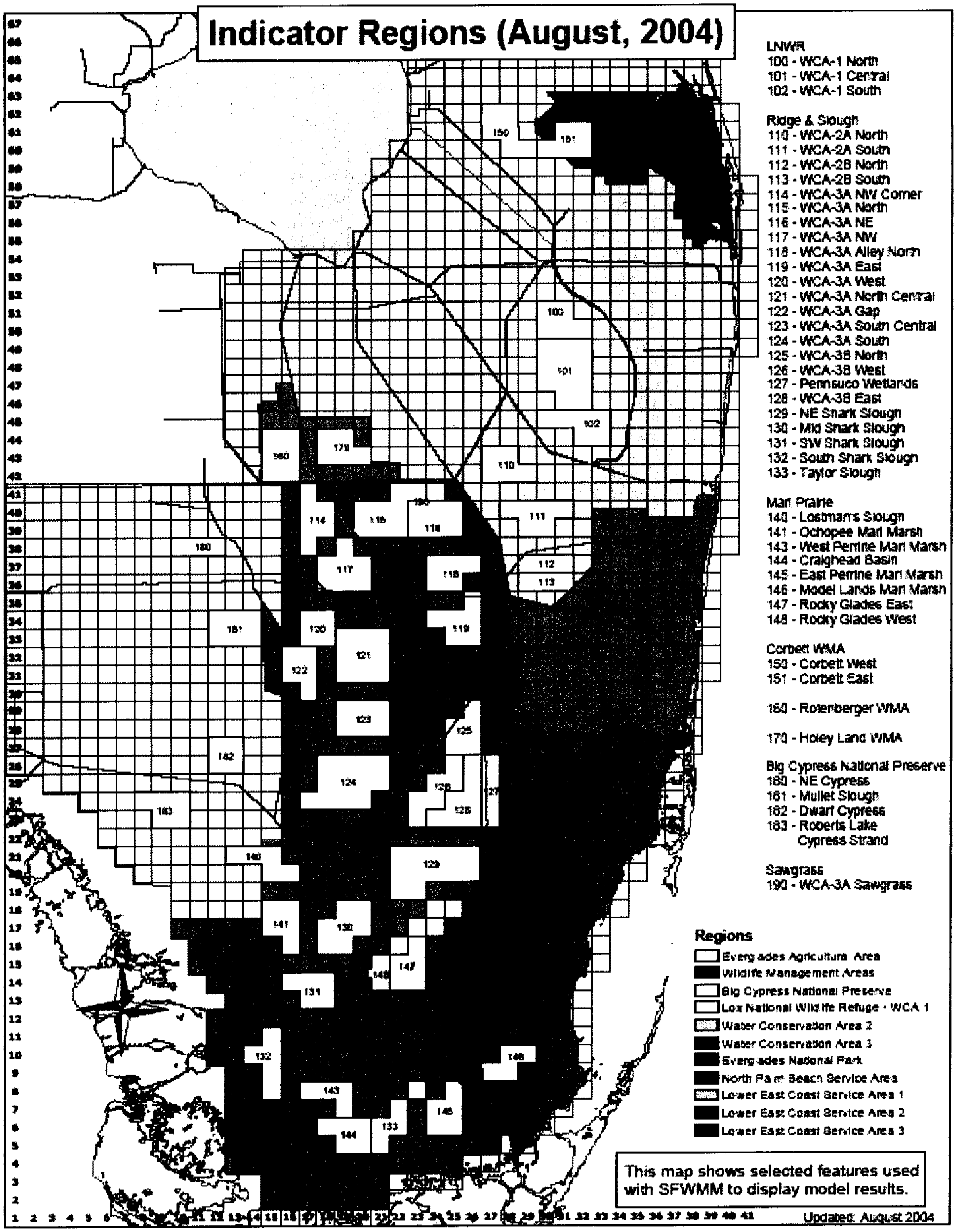


FIGURE B-4: SFWMM INDICATOR REGIONS (VERSION 5.0)

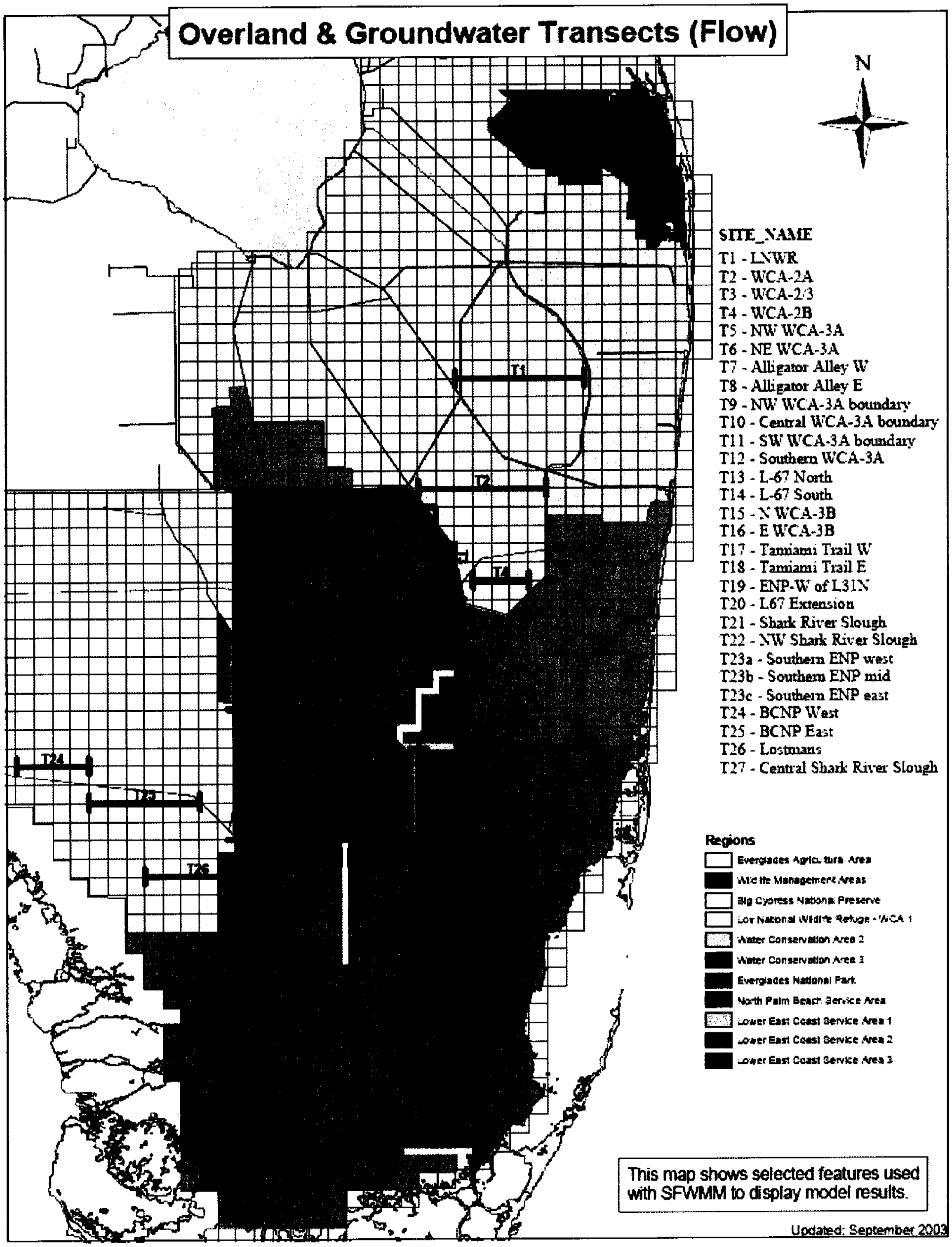


FIGURE B-5: SFWMM OVERLAND FLOW TRANSECTS

ATTACHMENT C

Selected Performance Measures and Indicators: 2007 LORSS SEIS (TSP Refinements)

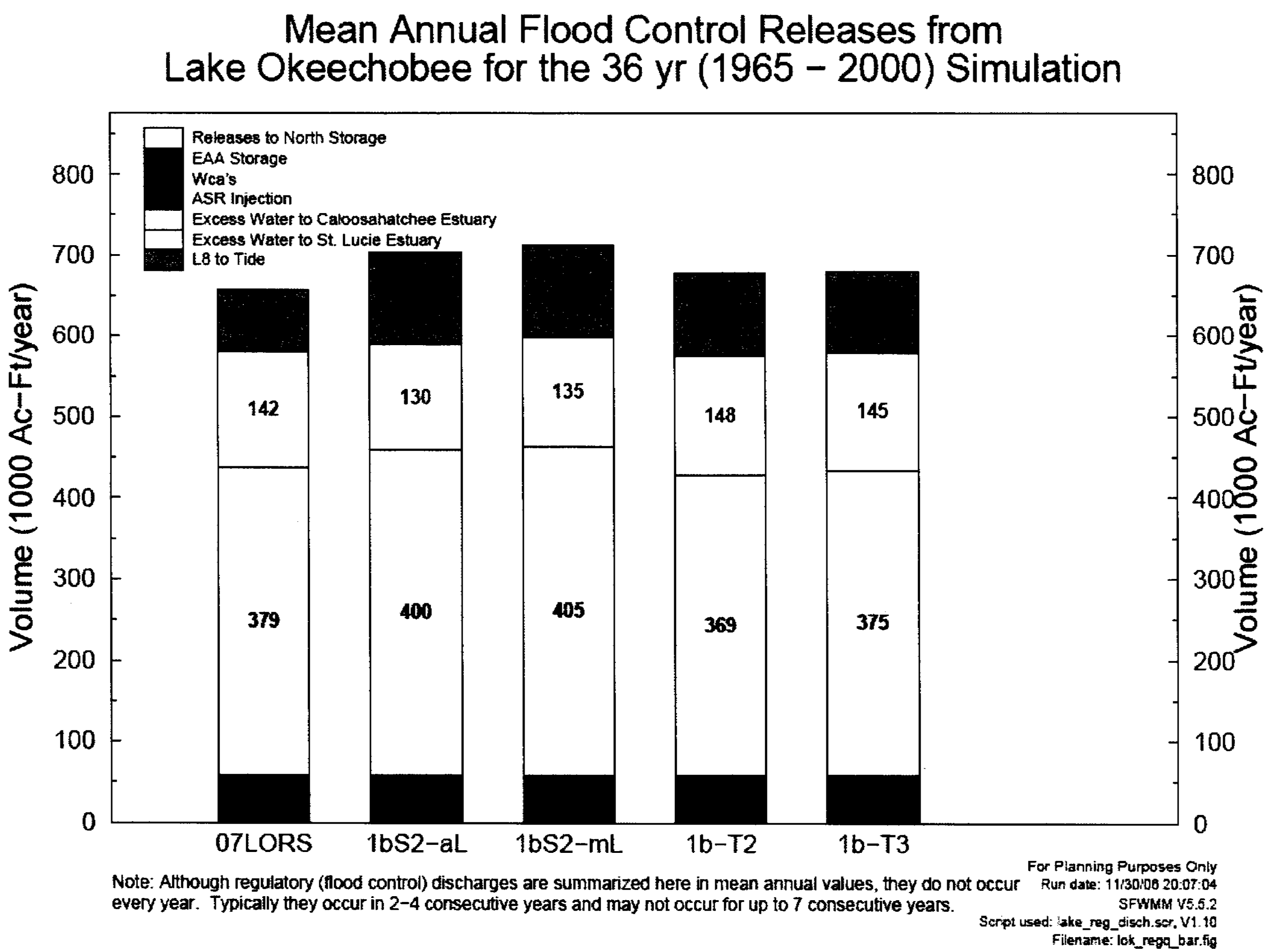


FIGURE C-1: MEAN ANNUAL FLOOD CONTROL RELEASES FROM LAKE OKEECHOBEE (1)

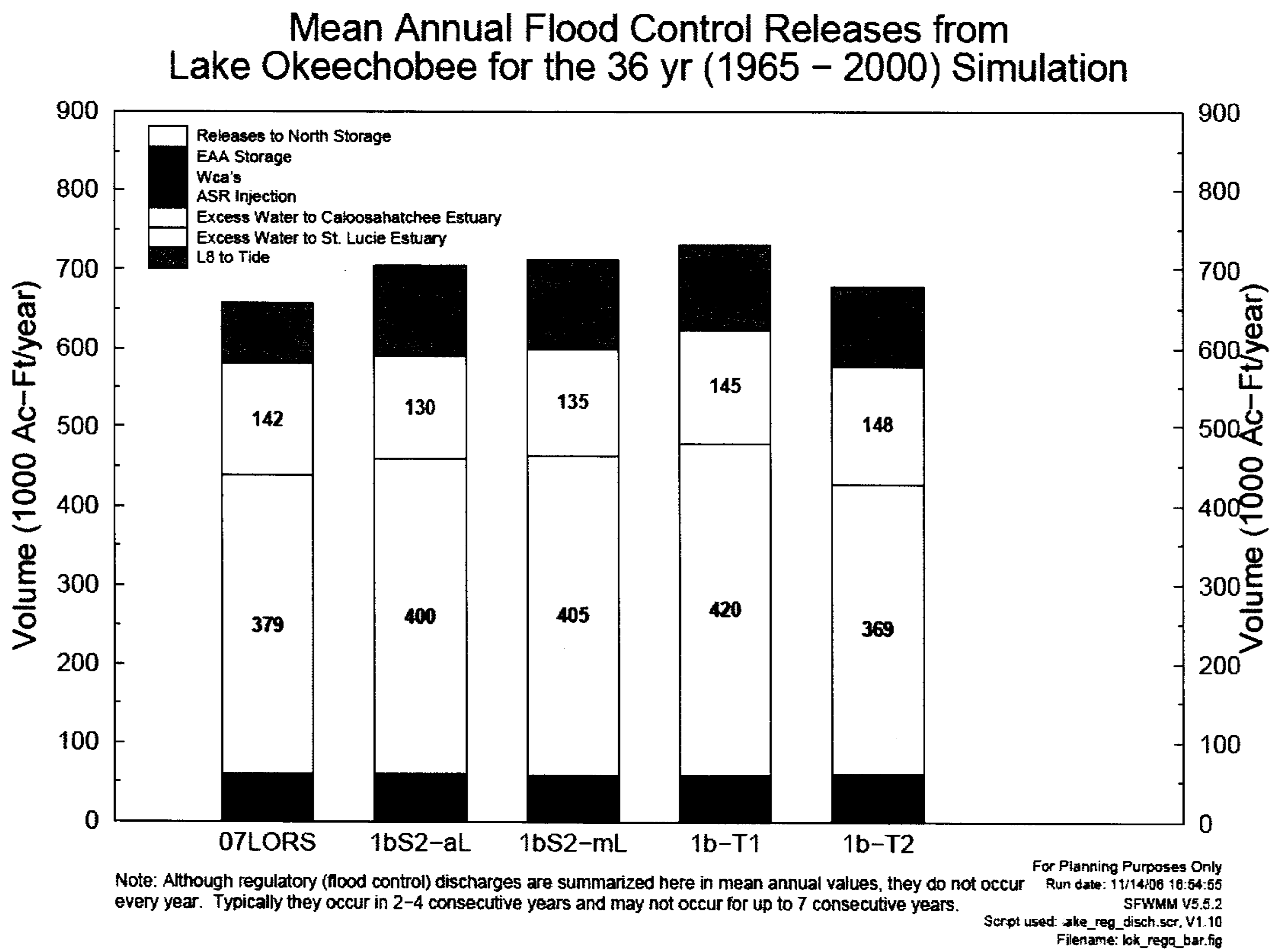


FIGURE C-2: MEAN ANNUAL FLOOD CONTROL RELEASES FROM LAKE OKEECHOBEE (2)

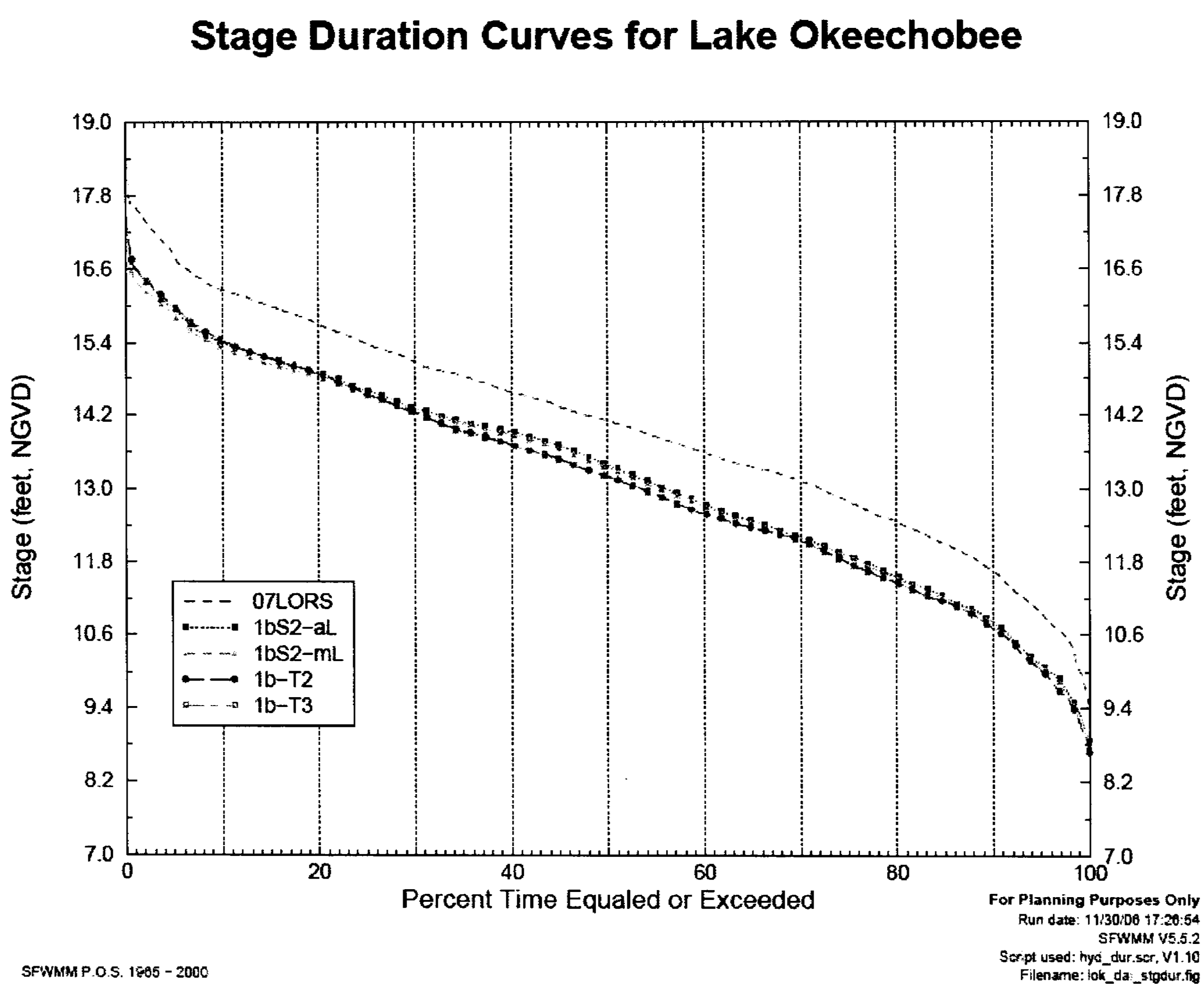


FIGURE C-3: LAKE OKEECHOBEE STAGE DURATION CURVES (1)

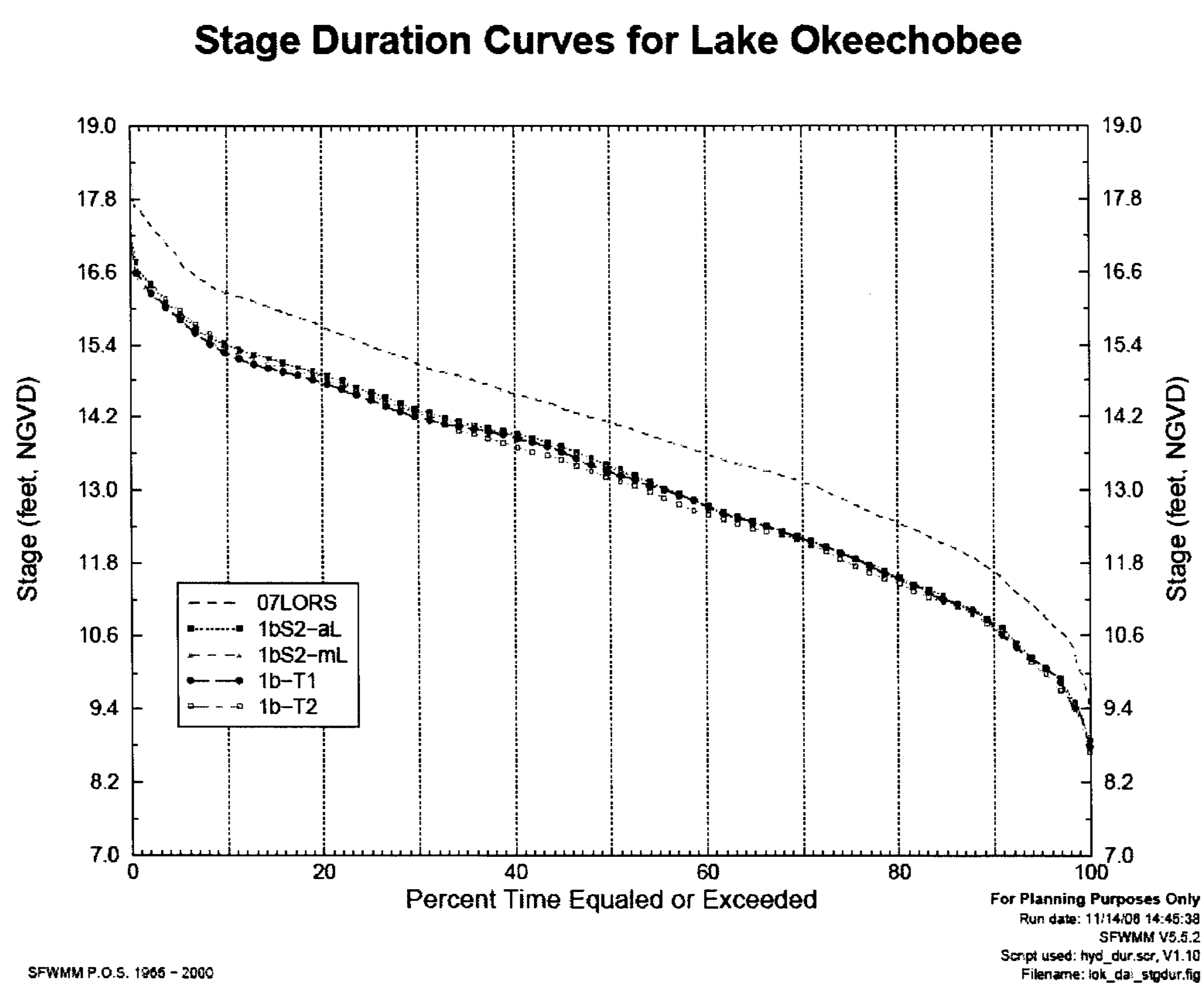
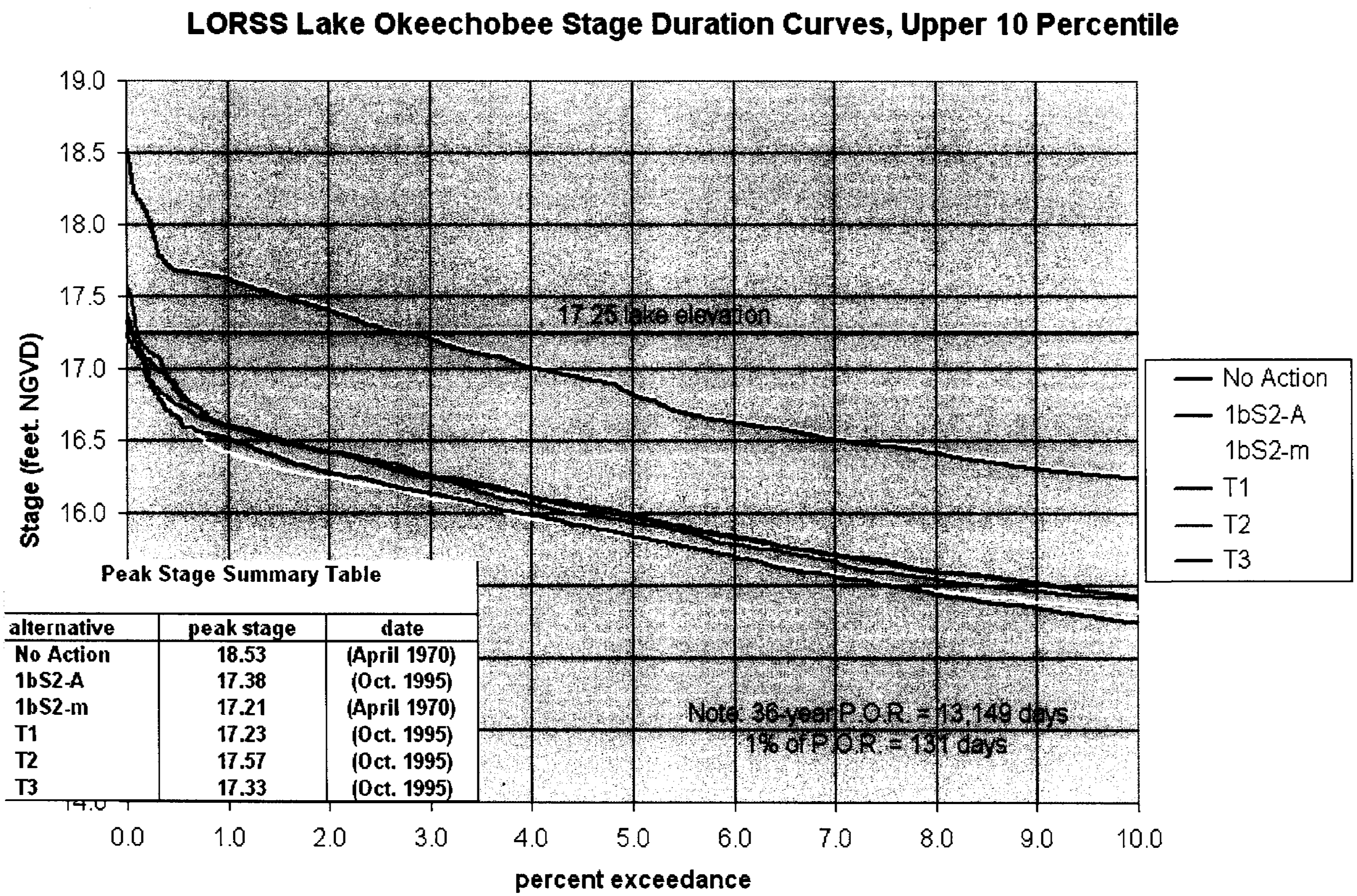


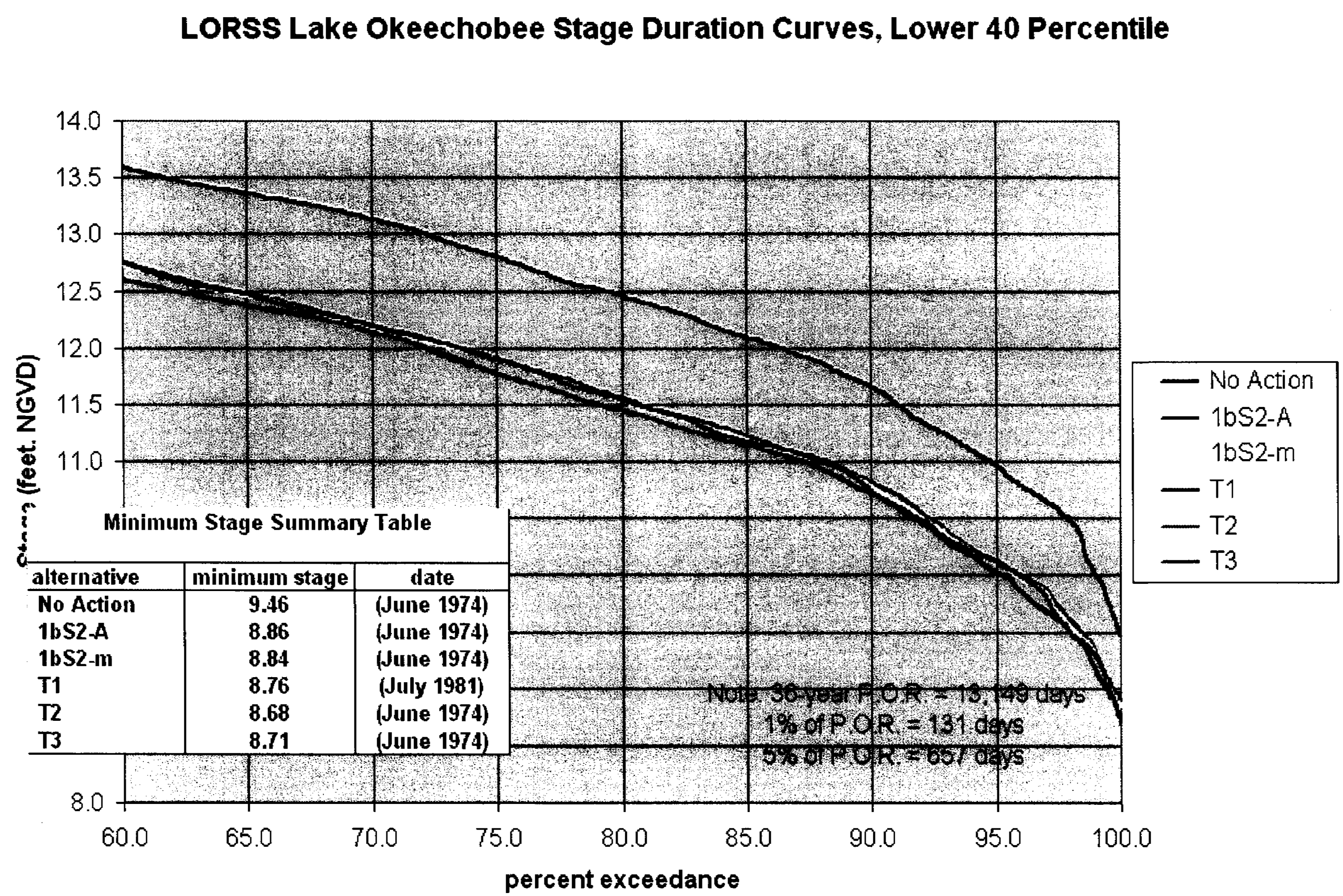
FIGURE C-4: LAKE OKEECHOBEE STAGE DURATION CURVES (2)



Peak Stage Summary Table

alternative	peak stage	date
No Action	18.53	(April 1970)
1bS2-A	17.38	(Oct. 1995)
1bS2-m	17.21	(April 1970)
T1	17.23	(Oct. 1995)
T2	17.57	(Oct. 1995)
T3	17.33	(Oct. 1995)

FIGURE C-5: LAKE OKEECHOBEE STAGE DURATION CURVES, UPPER 10 PERCENTILE



alternative	minimum stage	date
No Action	9.46	(June 1974)
1bS2-A	8.86	(June 1974)
1bS2-m	8.84	(June 1974)
T1	8.76	(July 1981)
T2	8.68	(June 1974)
T3	8.71	(June 1974)

FIGURE C-6: LAKE OKEECHOBEE STAGE DURATION CURVES LOWER 40 PERCENTILE

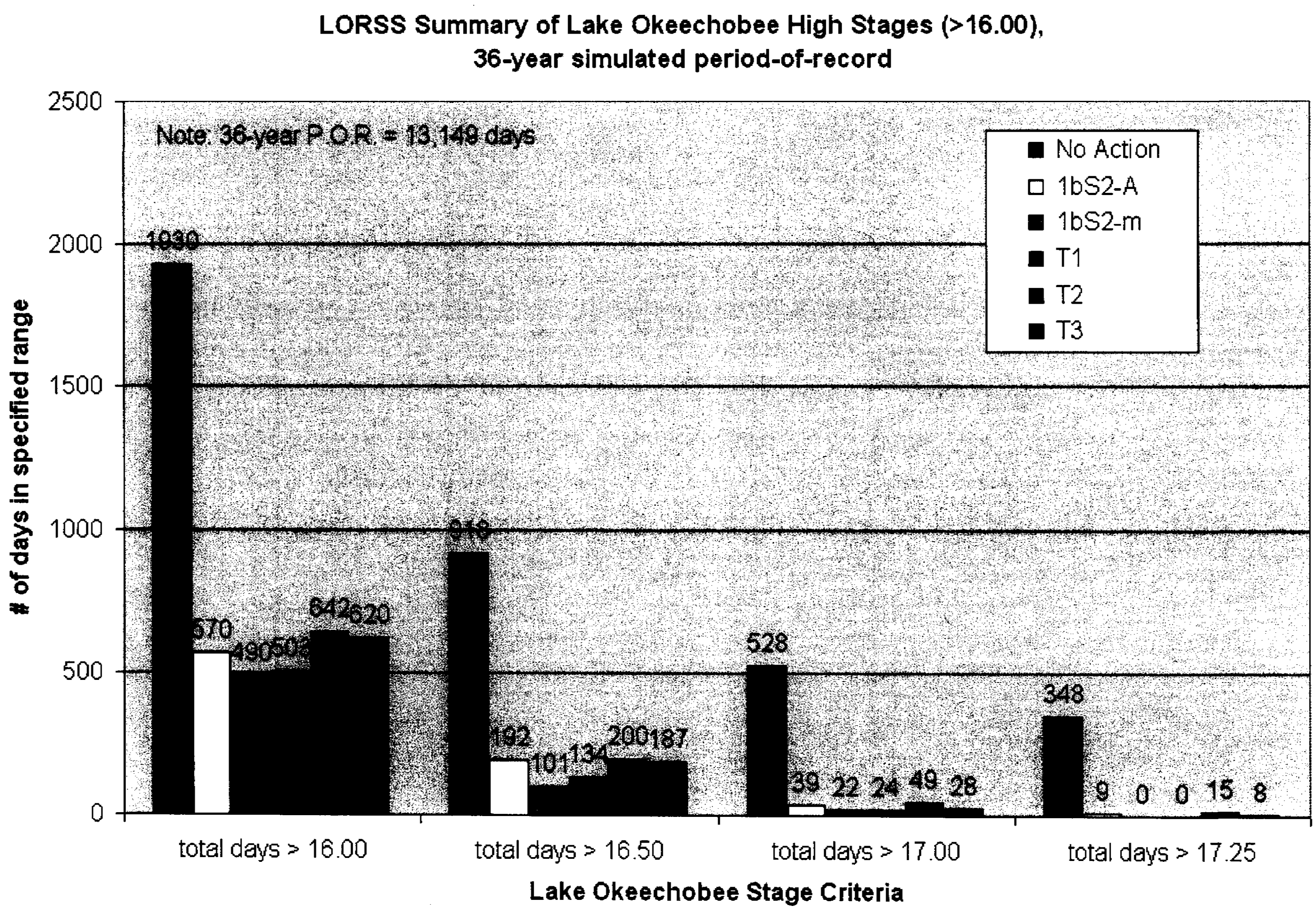


FIGURE C-7: OCCURRENCE FREQUENCY OF LAKE OKEECHOBEE HIGH STAGES

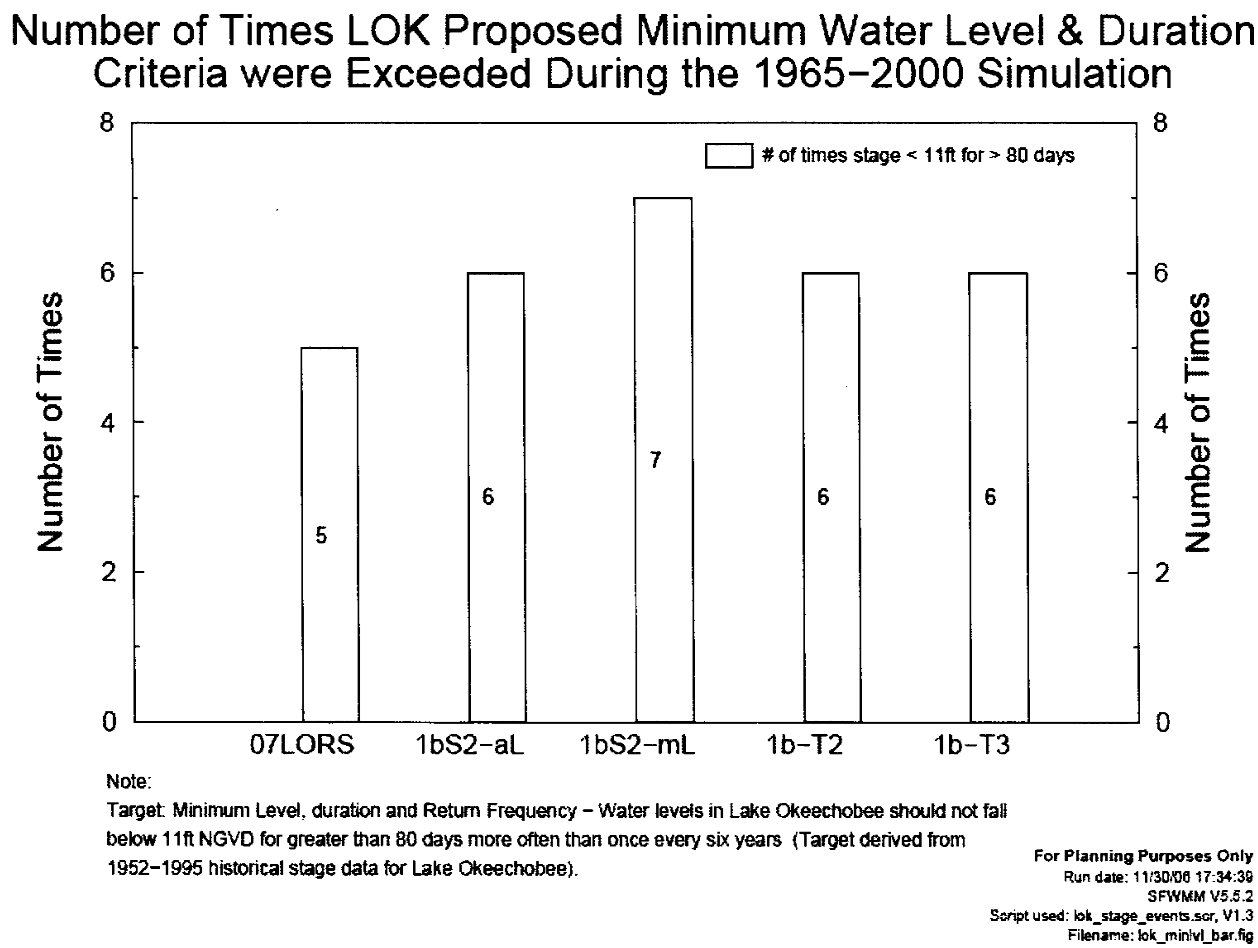


FIGURE C-8: NUMBER OF TIMES LAKE OKEECHOBEE MINIMUM WATER LEVEL AND DURATION CRITERIA WERE EXCEEDED DURING THE 1965-2000 SIMULATION (1)

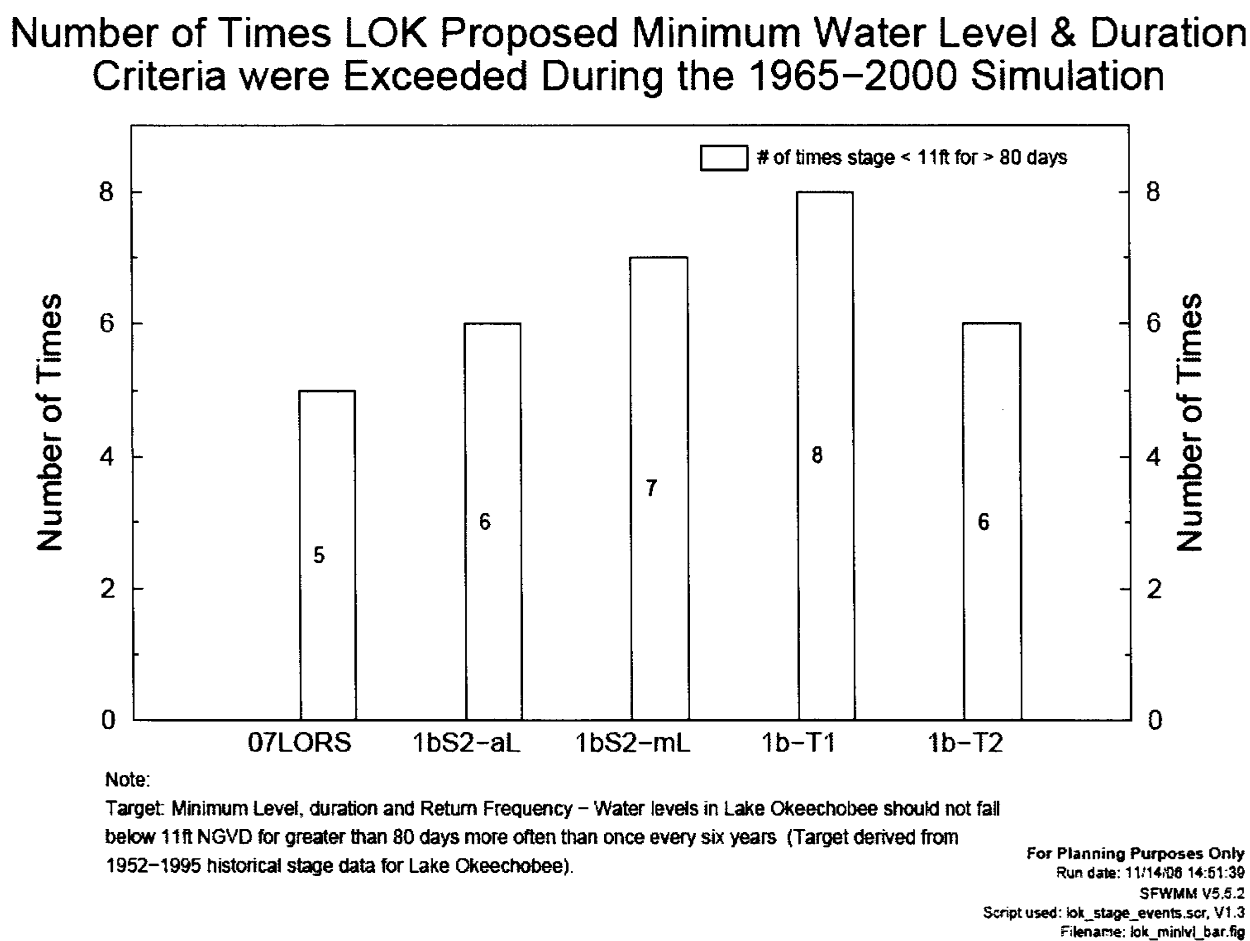


FIGURE C-9: NUMBER OF TIMES LAKE OKEECHOBEE MINIMUM WATER LEVEL AND DURATION CRITERIA WERE EXCEEDED DURING THE 1965-2000 SIMULATION (2)

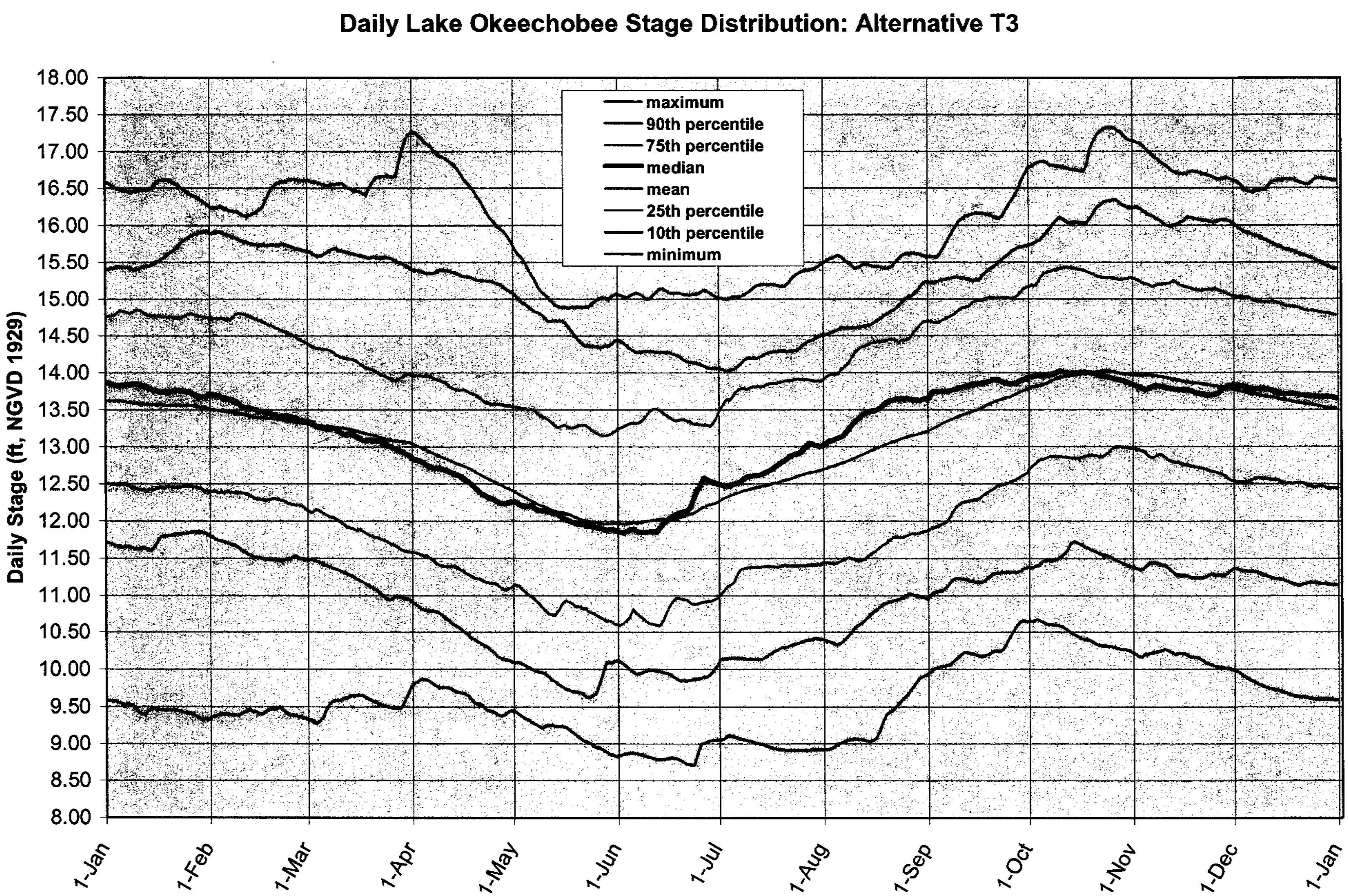


FIGURE C-10: LAKE OKEECHOBEE DAILY STAGE EXCEEDANCE CURVES FOR ALTERNATIVE T3

Month

Stage	J	F	M	A	M	J	J	A	S	O	N	D	
19	3.5	4	4.5	5	6	6.5	6.5	6	5	4	3.5	3.5	
18.5	3	3.5	4	4.5	5.5	6	6	5.5	4.5	3.5	3	3	
18	2.5	3	3.5	4	5	5.5	5.5	5	4	3	2.5	2.5	
17.5	2	2.5	3	3.5	4.5	5	5	4.5	3.5	2.5	2	2	
17	1.5	2	2.5	3	4	4.5	4.5	4	3	2	1.5	1.5	A
16.5	1	1.5	2	2.5	3.5	4	4	3.5	2.5	1.5	1	1	
16	0.5	1	1.5	2	3	3.5	3.5	3	2	1	0.5	0.5	B
15.5	0	0.5	1	1.5	2.5	3	3	2.5	1.5	0.5	0	0	
15	0	0	0.5	1	2	2.5	2.5	2	1	0	0	0	
14.5	0	0	0	0.5	1.5	2	2	1.5	0.5	0	0	0	
14	0.5	0	0	0	1	1.5	1.5	1	0	0	0.5	0.5	
13.5	1	0.5	0	0	0.5	1	2	0.5	0	0	1	1	
13	1.5	1	0.5	0	0	0.5	0.5	0	0	0.5	1.5	1.5	
12.5	2	1.5	1	0.5	0	0	0	0	0	1	2	2	
12	2.5	2	1.5	1	0	0	0	0	0.5	1.5	2.5	2.5	
11.5	3	2.5	2	1.5	0.5	0.5	0.5	0.5	1	2	3	3	
11	3.5	3	2.5	2	1	1	1	1	1.5	2.5	3.5	3.5	C
10.5	4	3.5	3	2.5	1.5	1.6	1.5	1.5	2	3	4	4	
10	4.5	4	3.5	3	2	2	2	2	2.5	3.5	4.5	4.5	
9.5	5	4.5	4	3.5	2.5	2.5	2.5	2.5	3	4	5	5	
9	5.5	5	4.5	4	3	3	3	3	3.5	4.5	5.5	5.5	
8.5	6	5.5	5	4.5	3.5	3.5	3.5	3.5	4	5	6	6	
8	5.6	6	5.5	5	4	4	4	4	4.5	5.5	5.6	5.6	
7.5	7	6.5	6	5.5	4.5	4.5	4.5	4.5	5	6	7	7	

FIGURE C-11: CONCEPTUALIZATION OF LAKE OKEECHOBEE STAGE ENVELOPE PERFORMANCE MEASURE

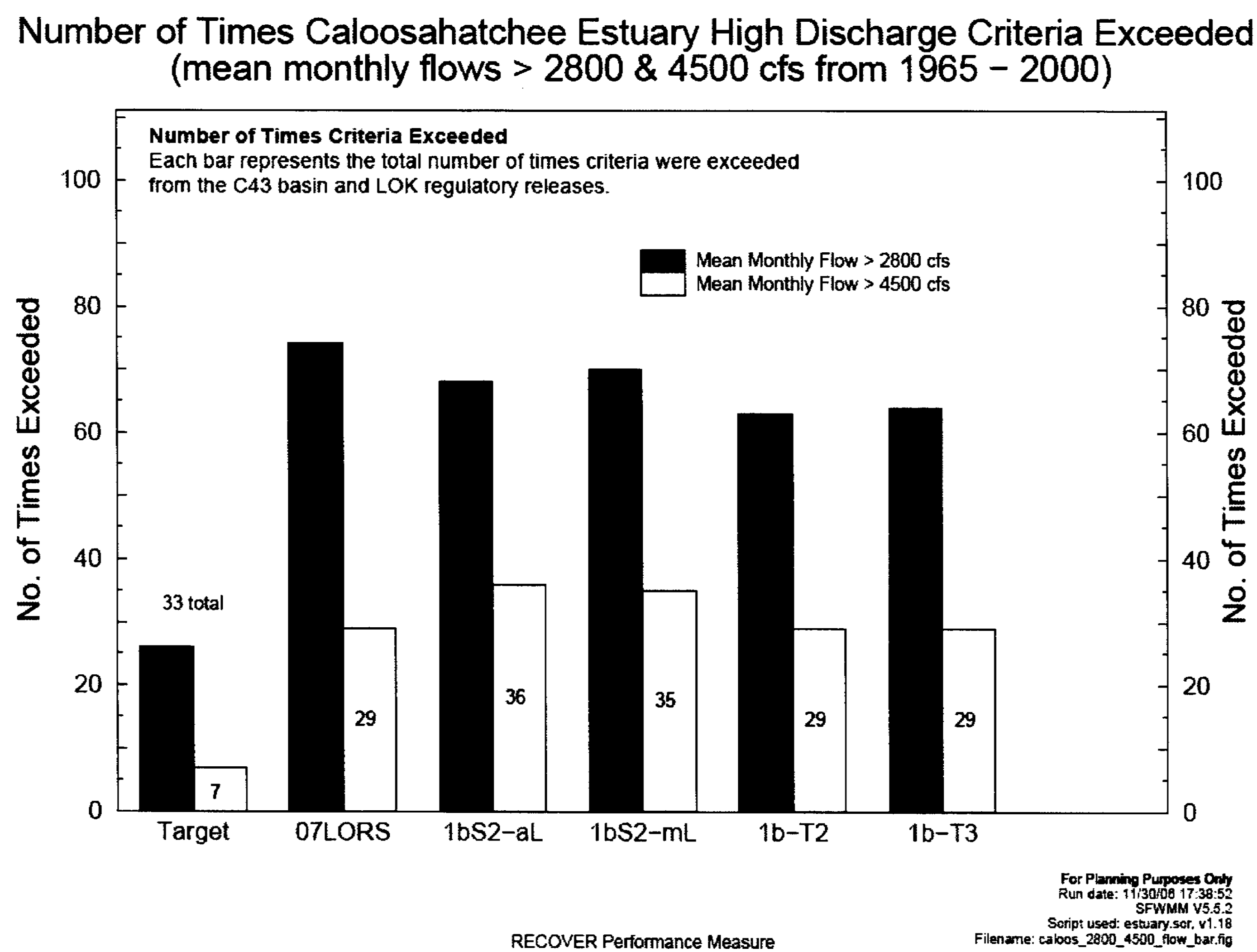


FIGURE C-12: CALOOSAHATCHEE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (1)

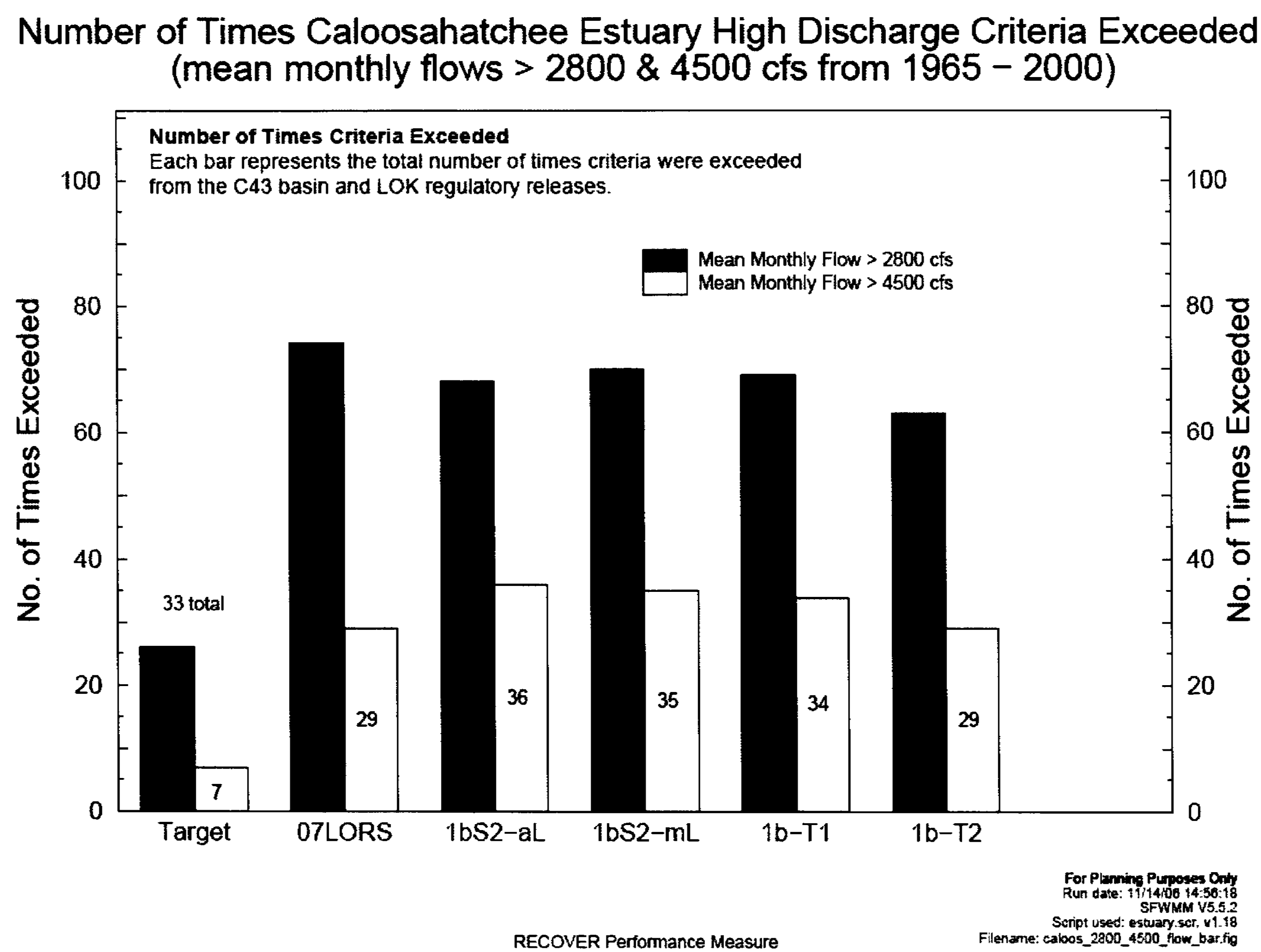


FIGURE C-13: CALOOSAHATCHEE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (2)

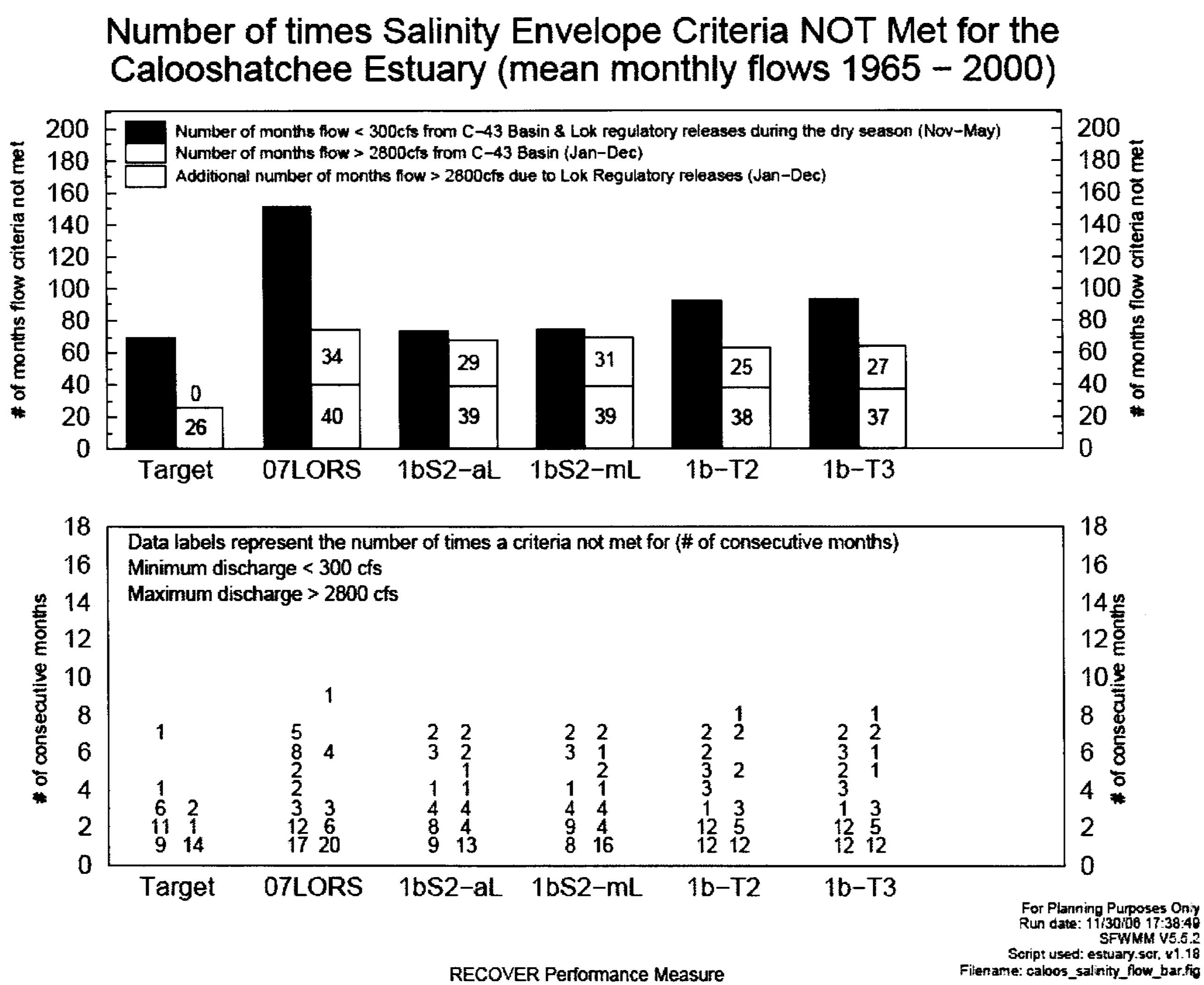


FIGURE C-14: CALOOSAHATCHEE ESTUARY SALINITY ENVELOPE CRITERIA (1)

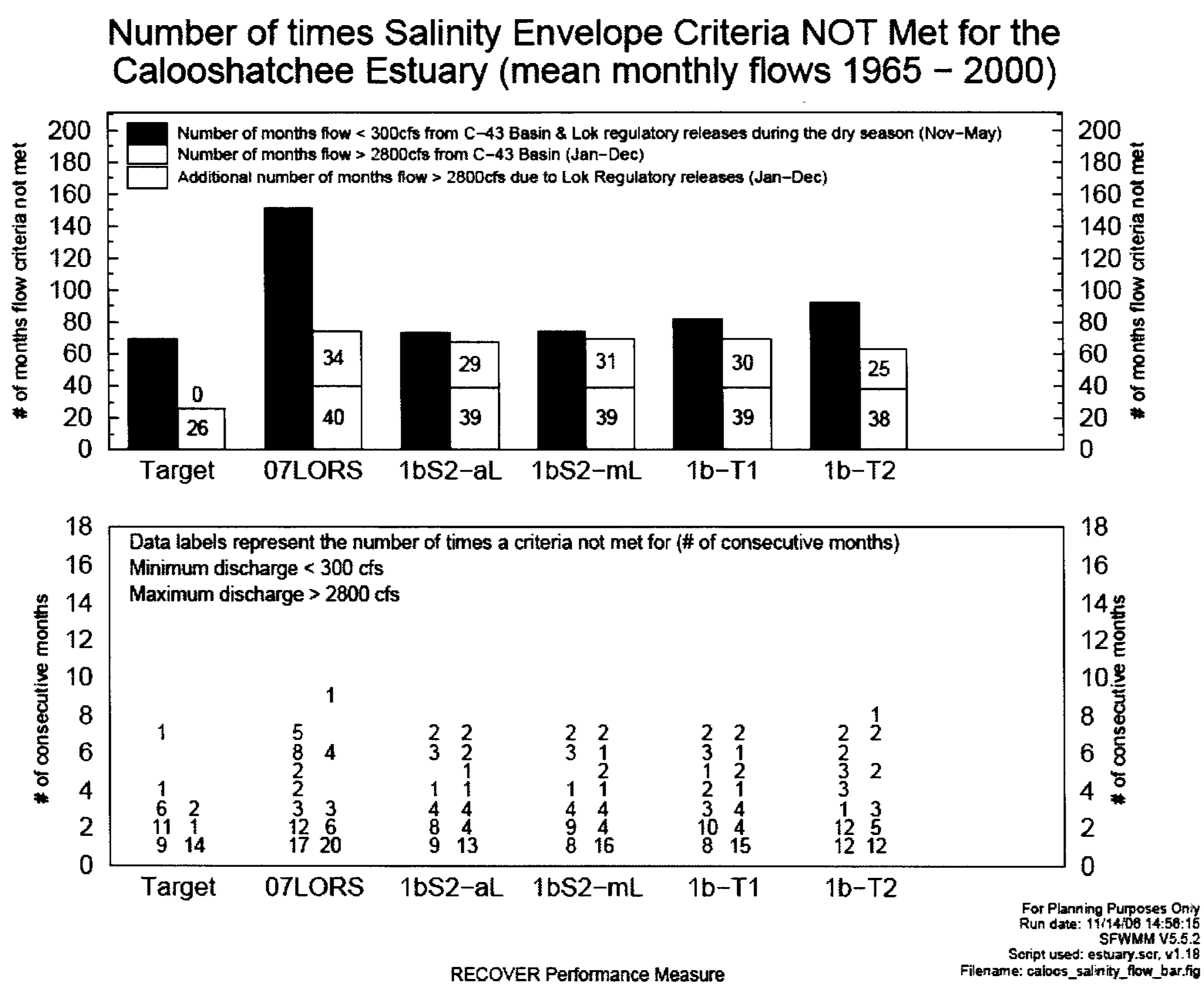


FIGURE C-15: CALOOSAHATCHEE ESTUARY SALINITY ENVELOPE CRITERIA (2)

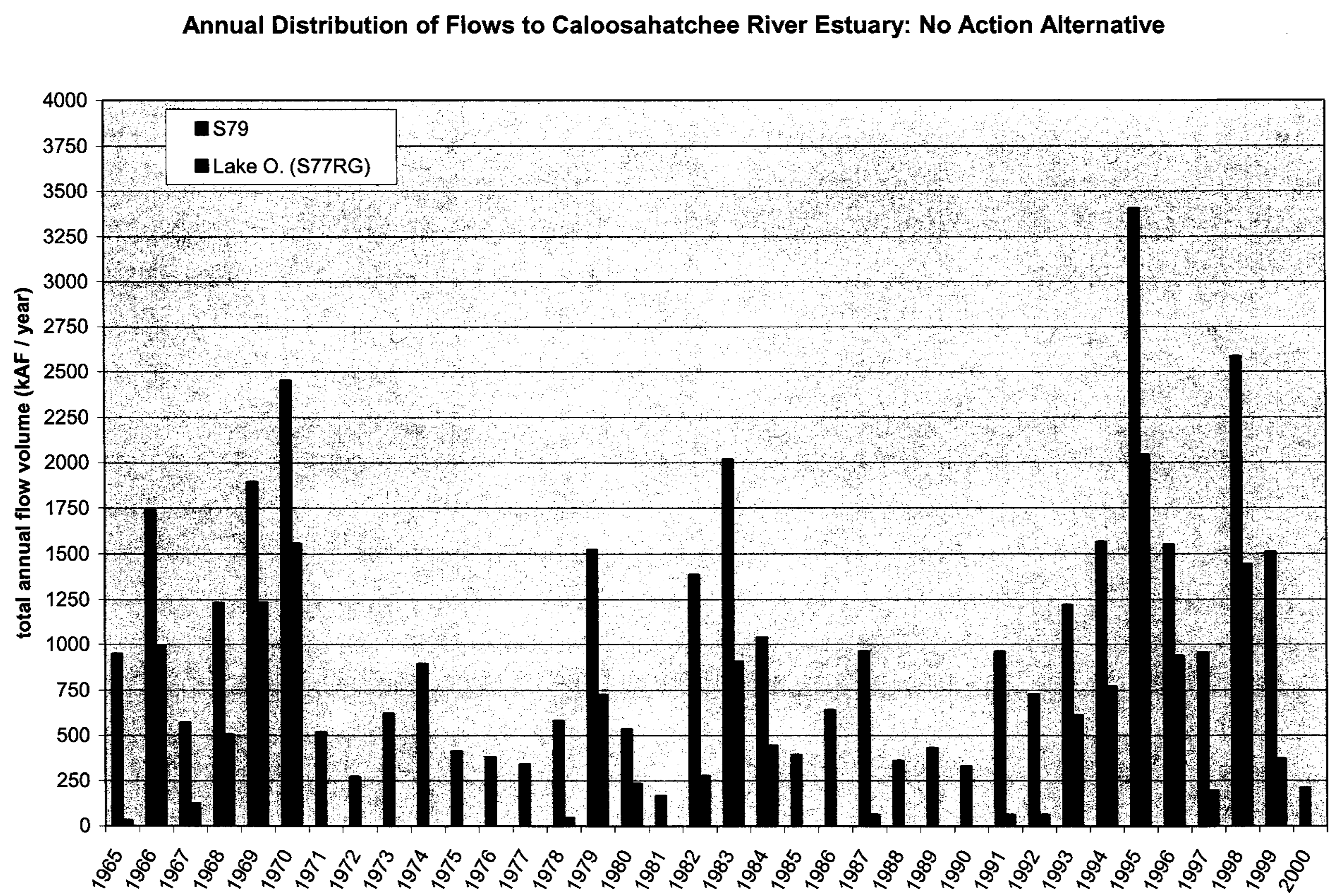


FIGURE C-16: ANNUAL DISTRIBUTION OF FLOWS TO THE CALOOSAHATCHEE ESTUARY, NO ACTION ALTERNATIVE

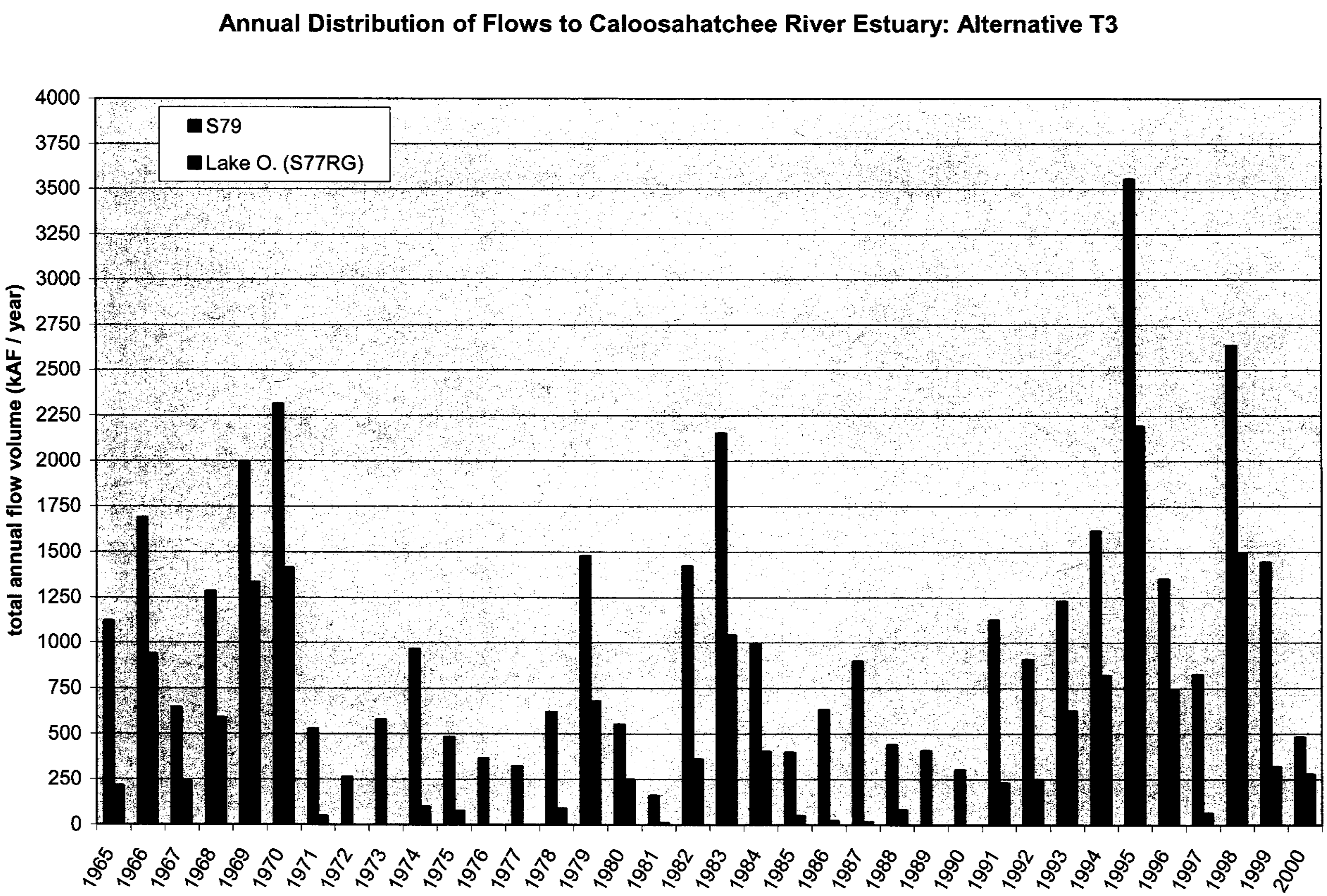


FIGURE C-17: ANNUAL DISTRIBUTION OF FLOWS TO THE CALOOSAHATCHEE ESTUARY, ALTERNATIVE T3

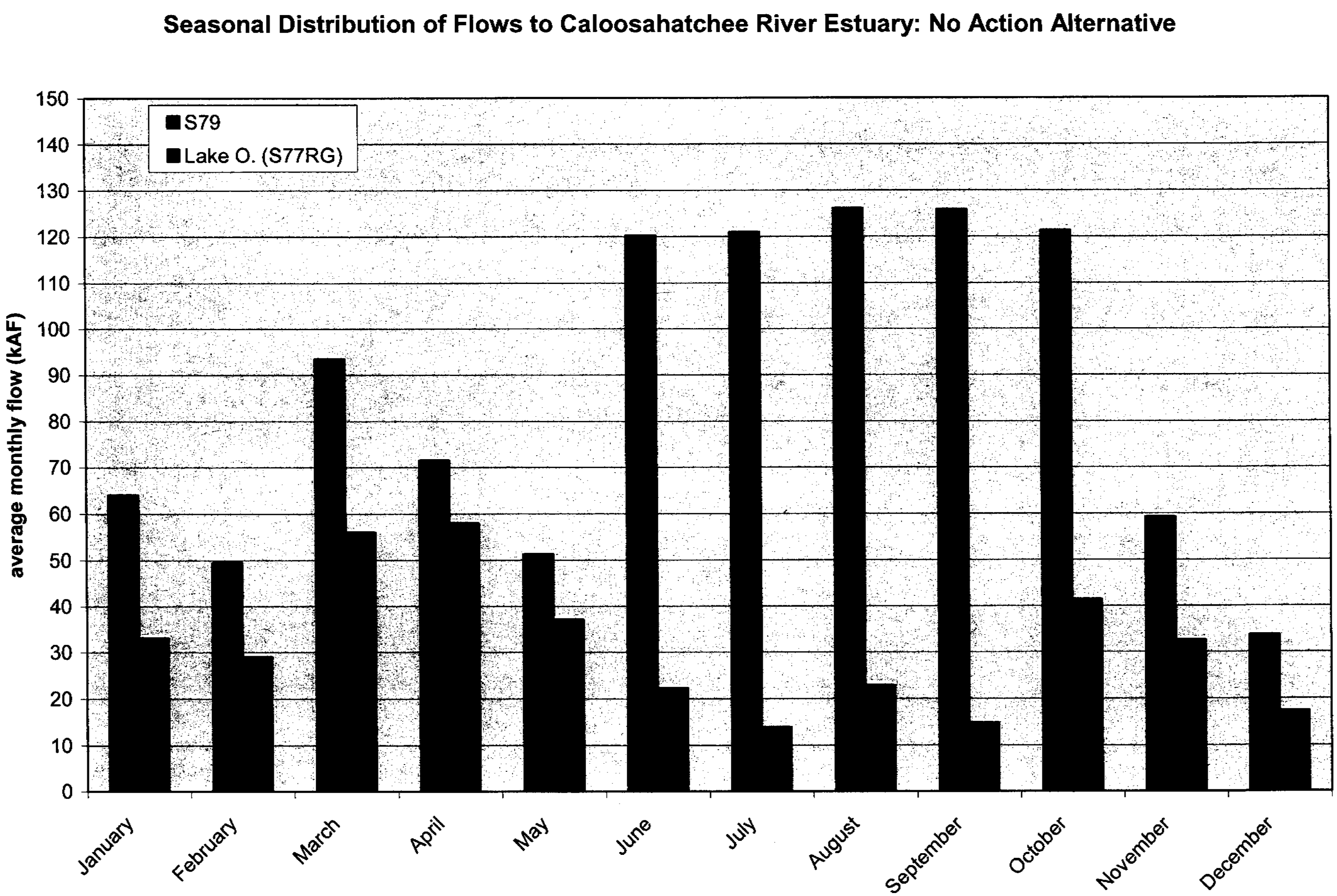


FIGURE C-18: SEASONAL DISTRIBUTION OF FLOWS TO THE CALOOSAHATCHEE ESTUARY, NO ACTION ALTERNATIVE

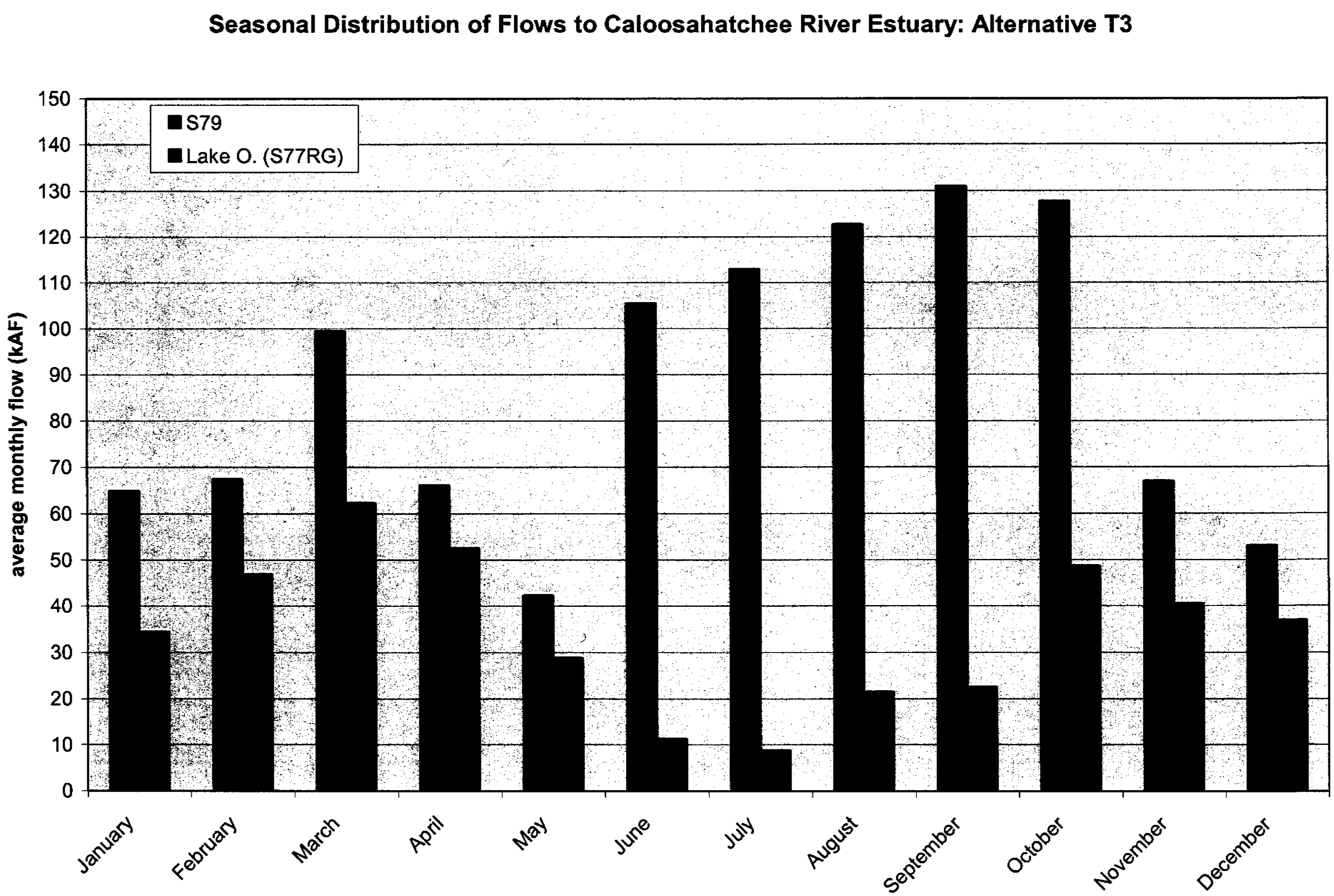


FIGURE C-19: SEASONAL DISTRIBUTION OF FLOWS TO THE CALOOSAHATCHEE ESTUARY, ALTERNATIVE T3

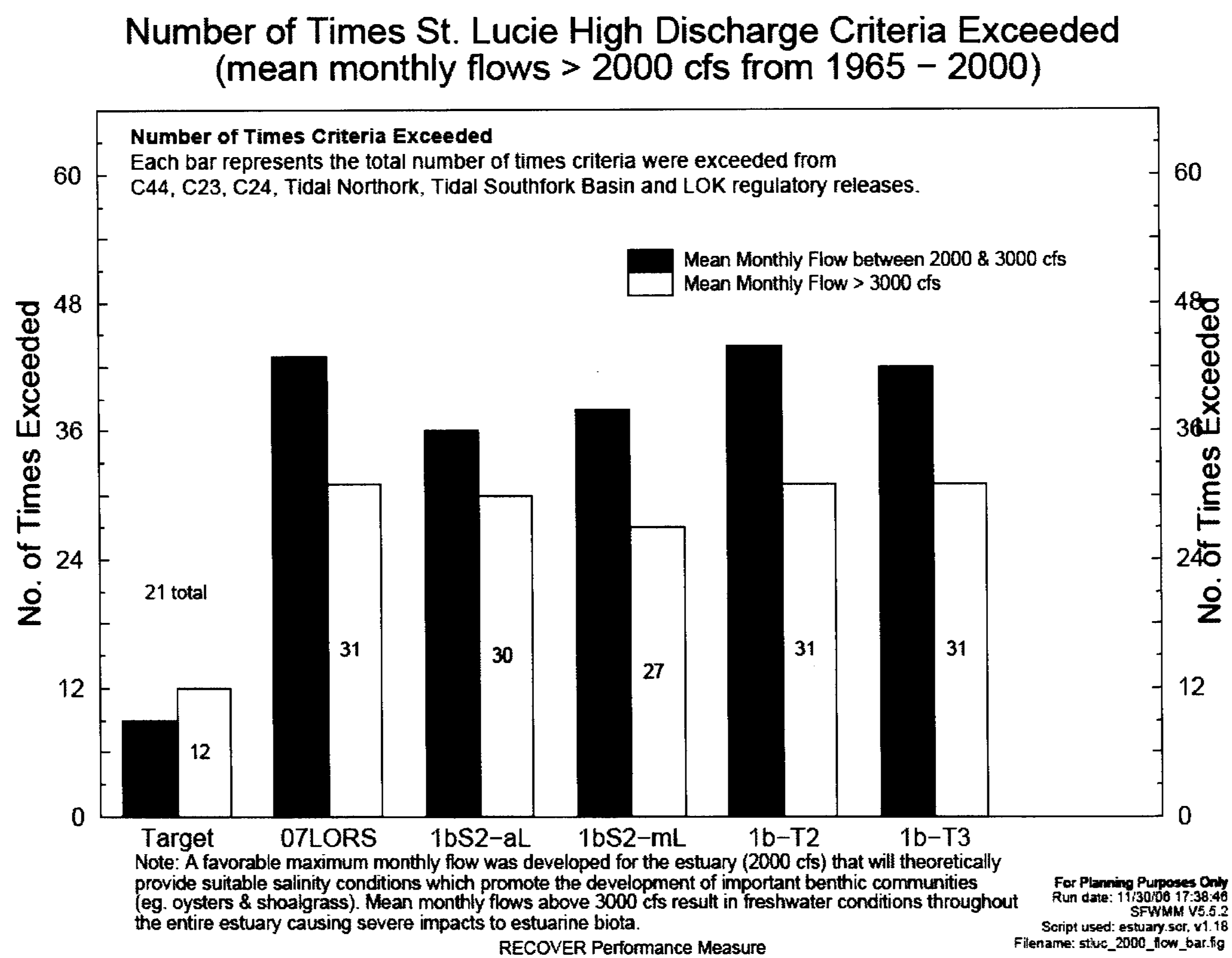


FIGURE C-20: ST. LUCIE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (1)

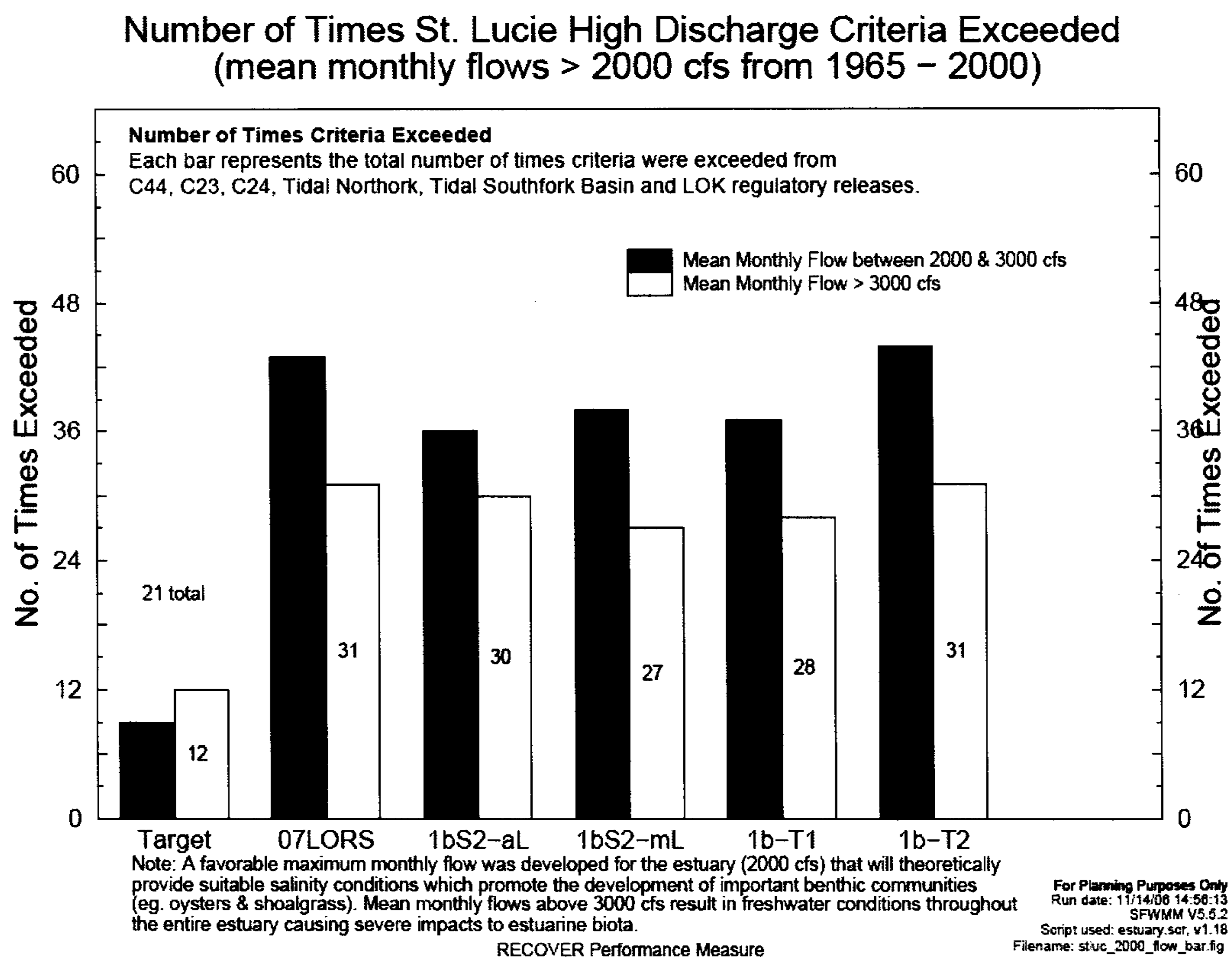


FIGURE C-21: ST. LUCIE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (2)

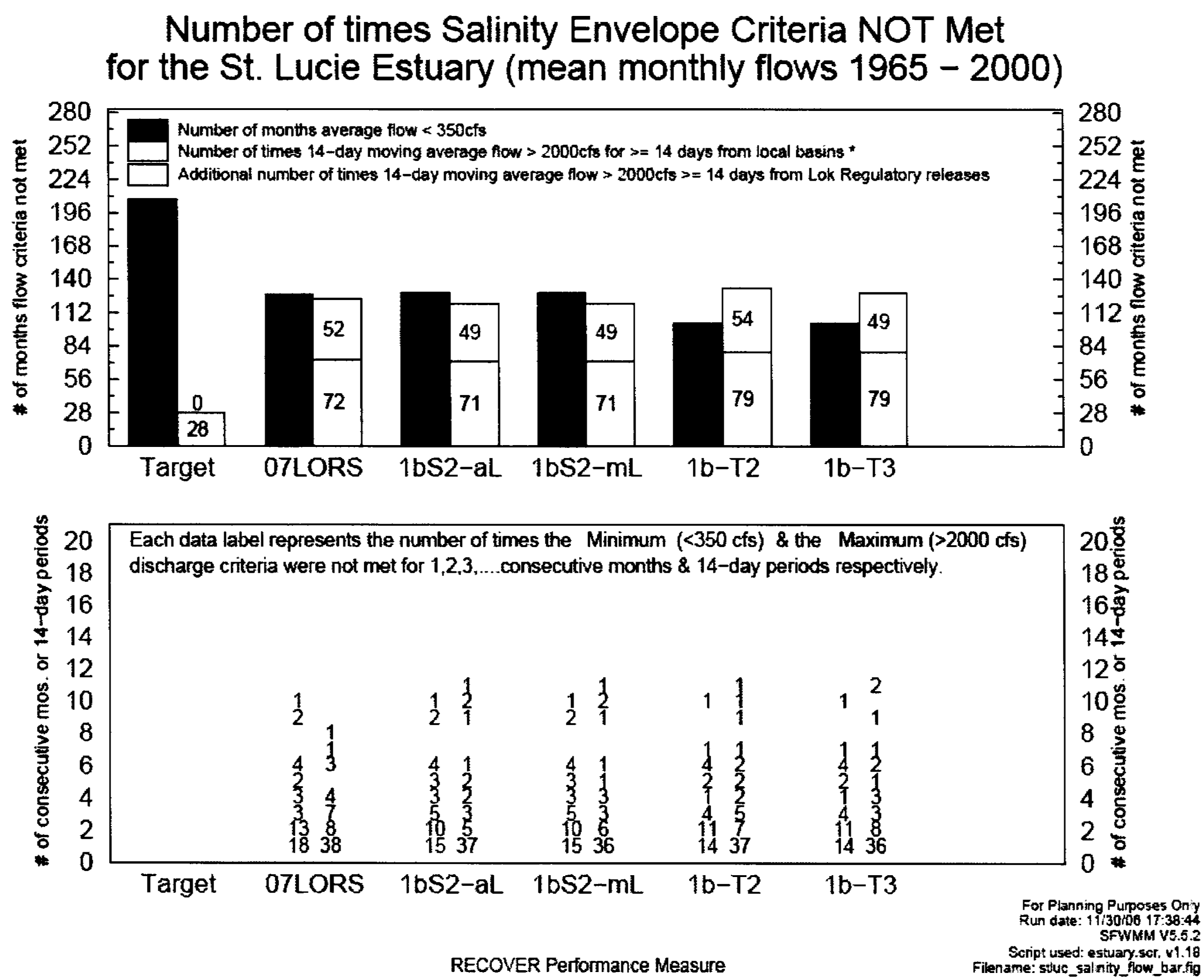


FIGURE C-22: ST. LUCIE ESTUARY SALINITY ENVELOPE CRITERIA (1)

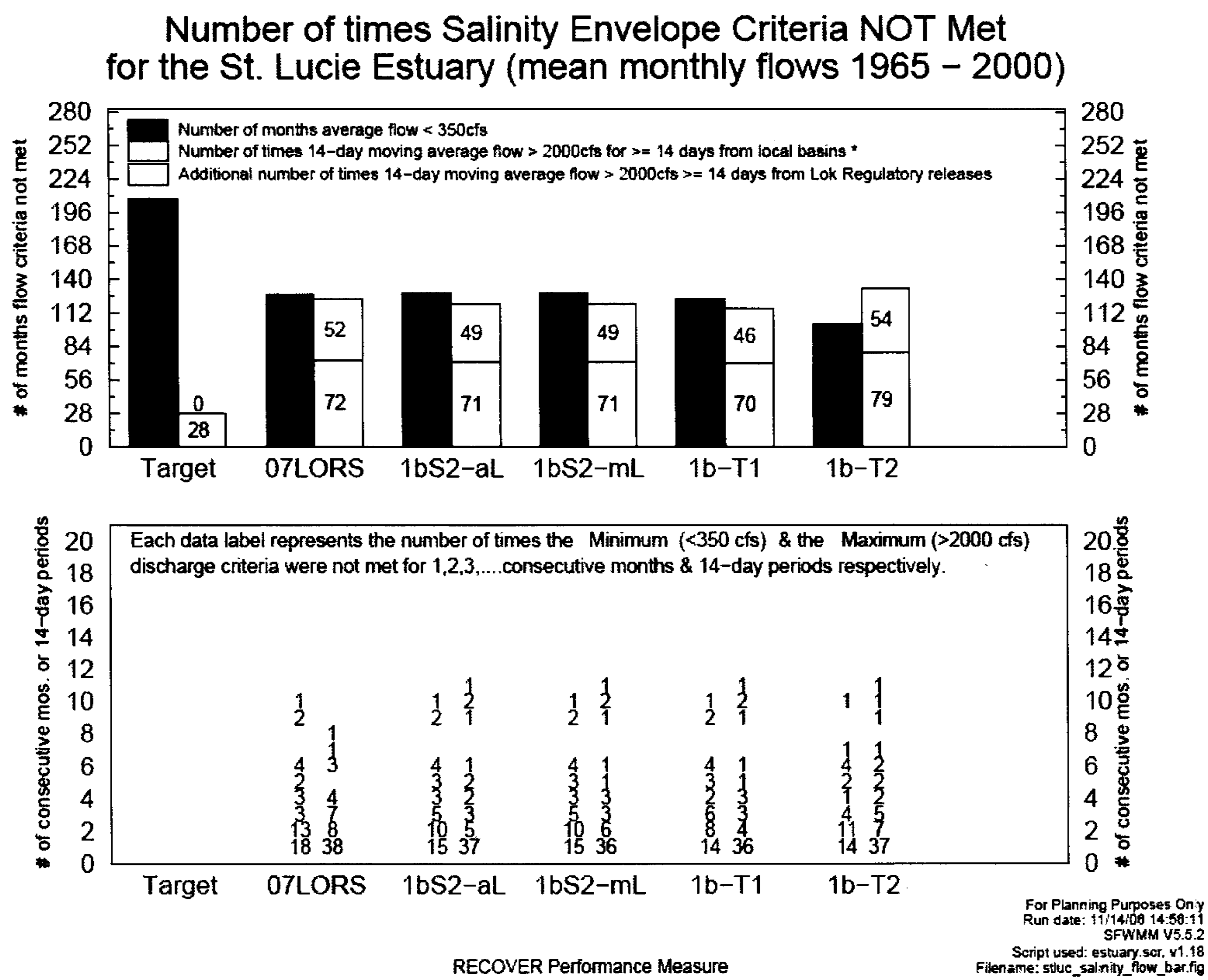


FIGURE C-23: ST. LUCIE ESTUARY SALINITY ENVELOPE CRITERIA (2)

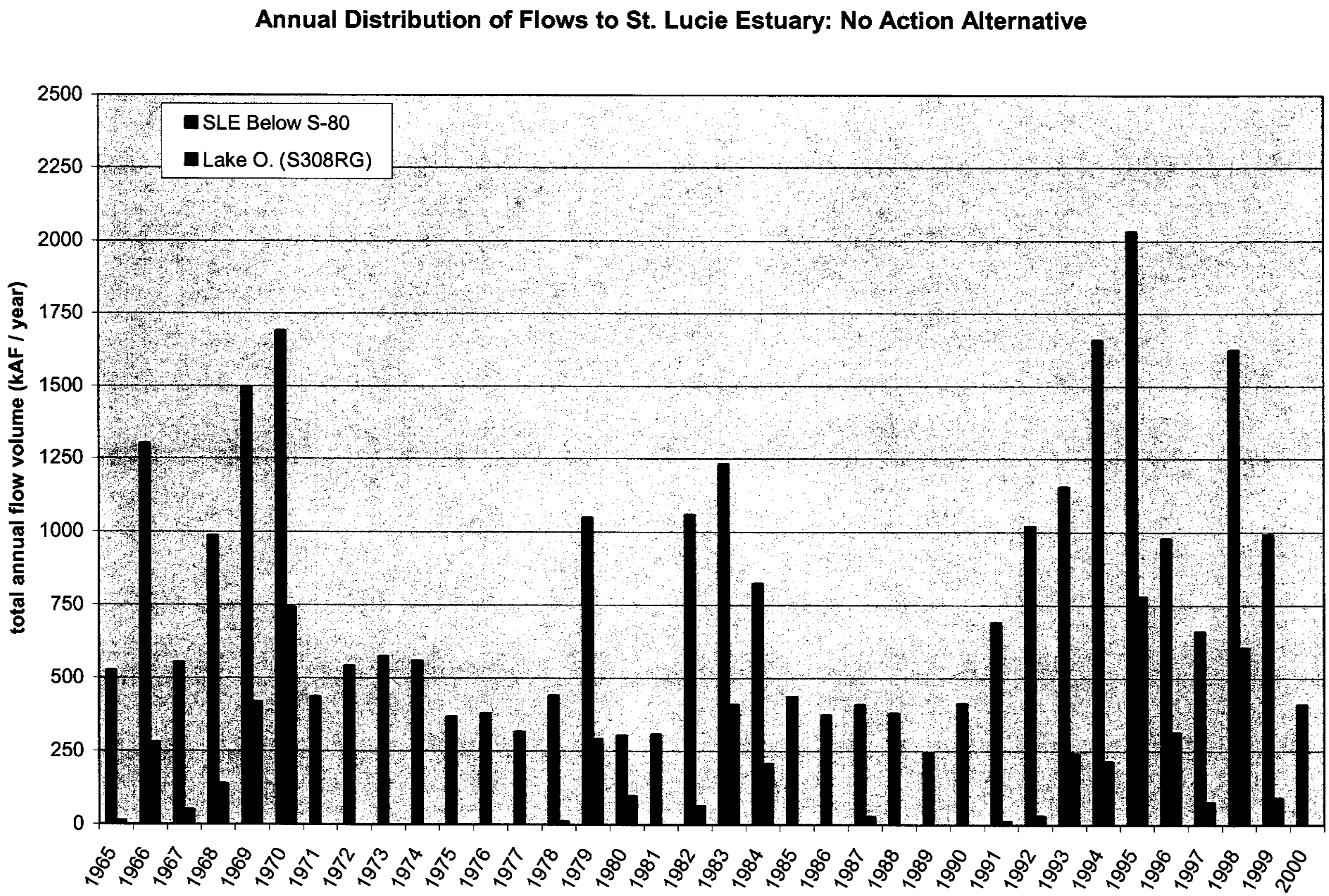


FIGURE C-24: ANNUAL DISTRIBUTION OF FLOWS TO THE ST. LUCIE ESTUARY, NO ACTION ALTERNATIVE

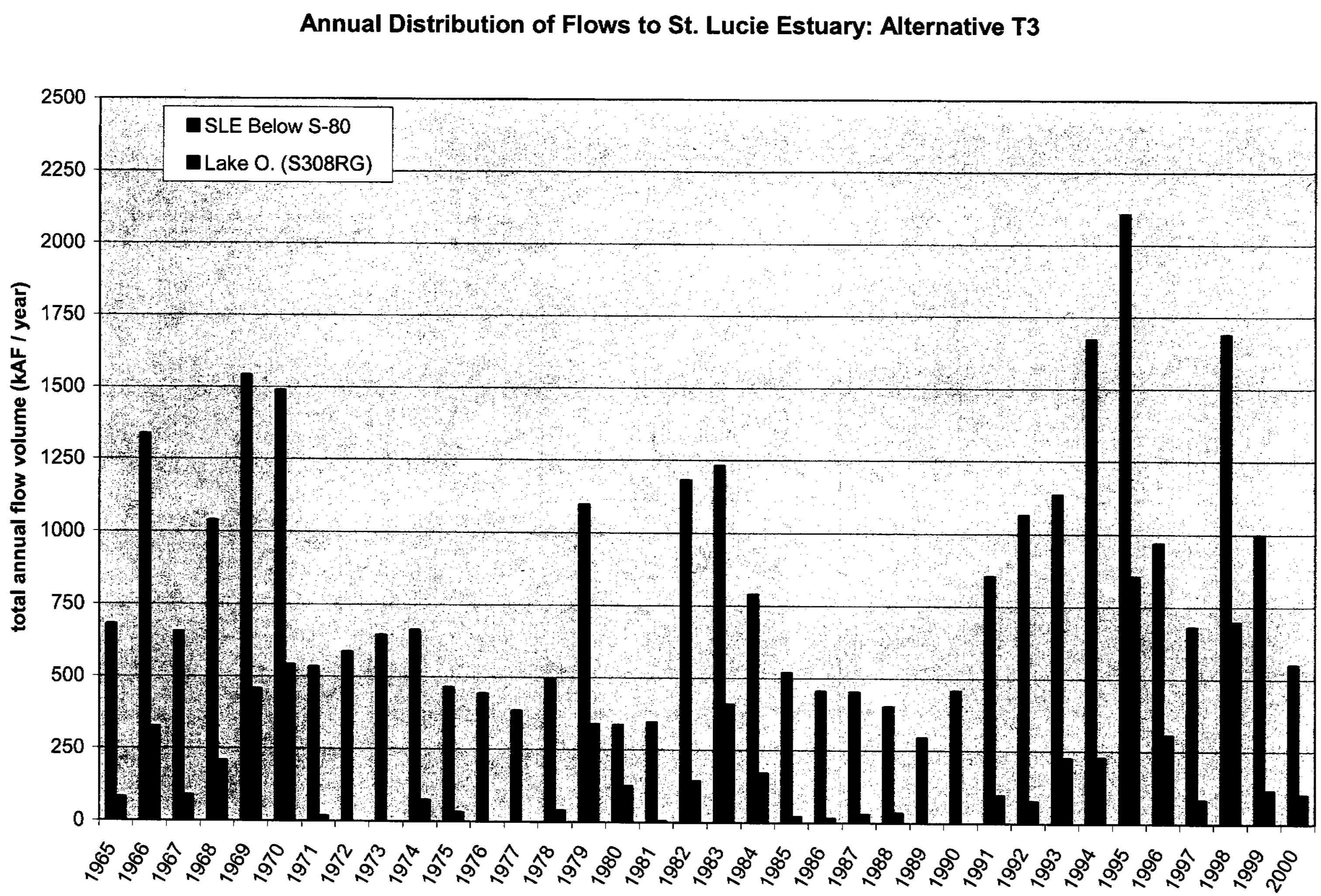


FIGURE C-25: ANNUAL DISTRIBUTION OF FLOWS TO THE ST. LUCIE ESTUARY, ALTERNATIVE T3

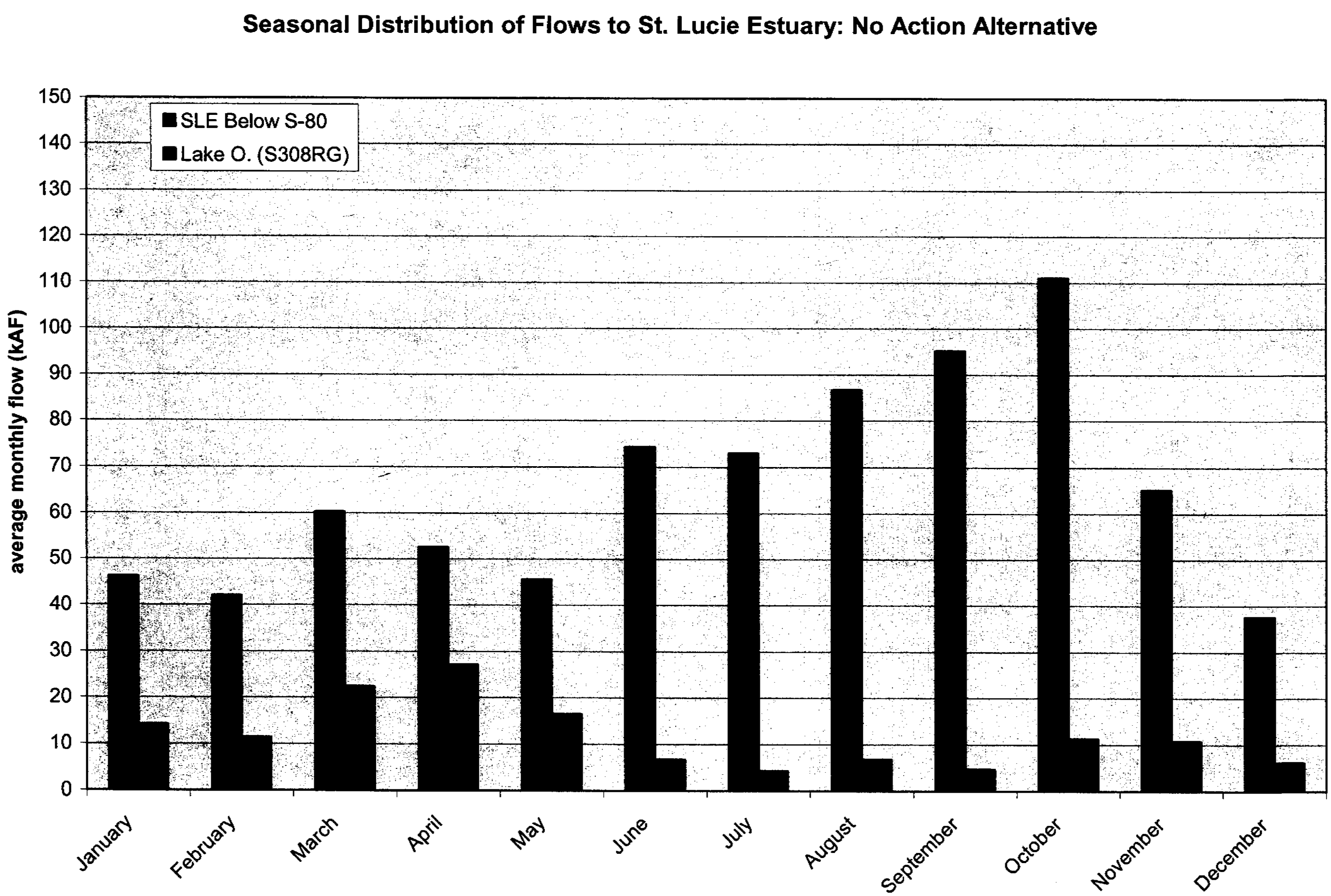


FIGURE C-26: SEASONAL DISTRIBUTION OF FLOWS TO THE ST. LUCIE ESTUARY, NO ACTION ALTERNATIVE

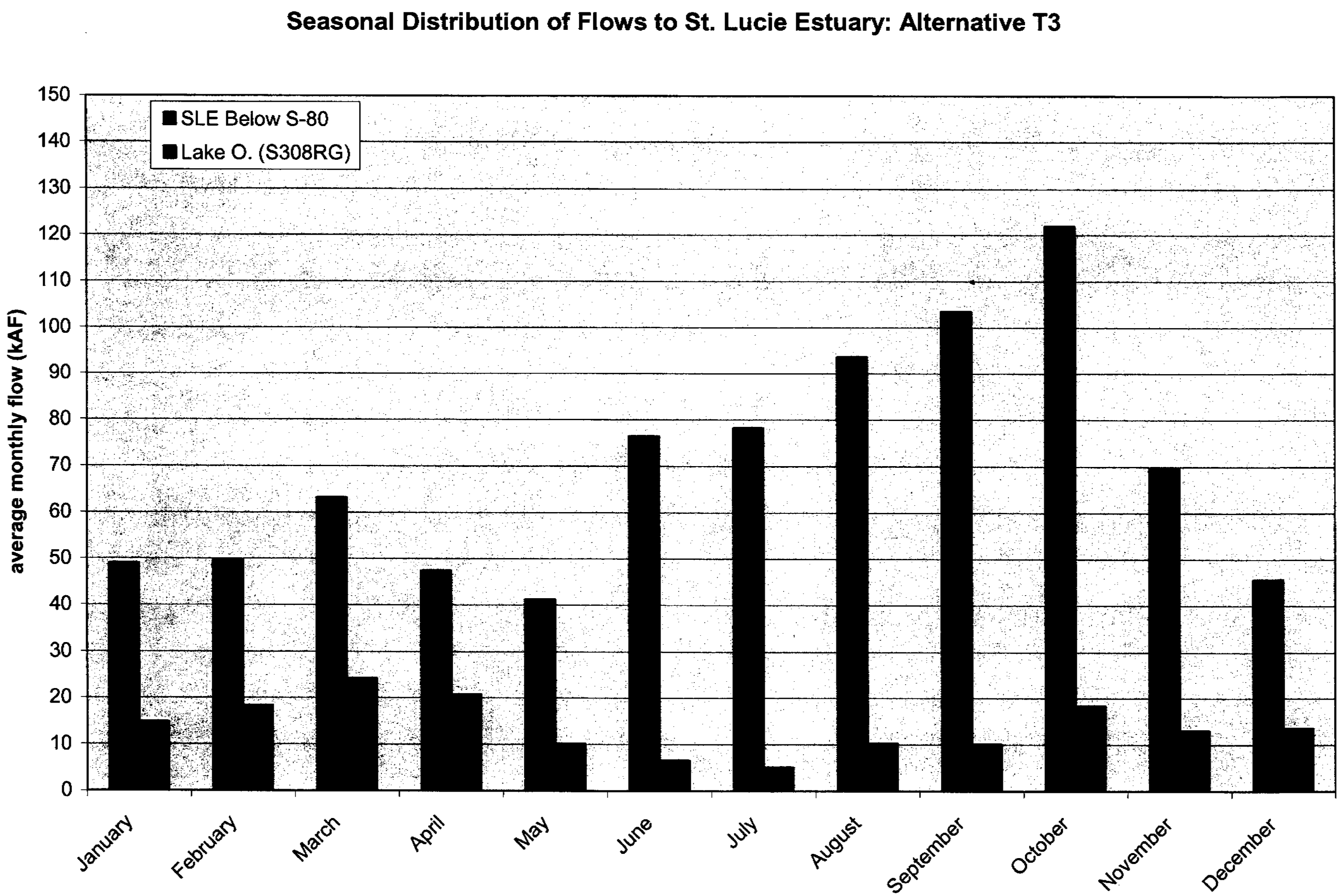


FIGURE C-27: SEASONAL DISTRIBUTION OF FLOWS TO THE ST. LUCIE ESTUARY, ALTERNATIVE T3

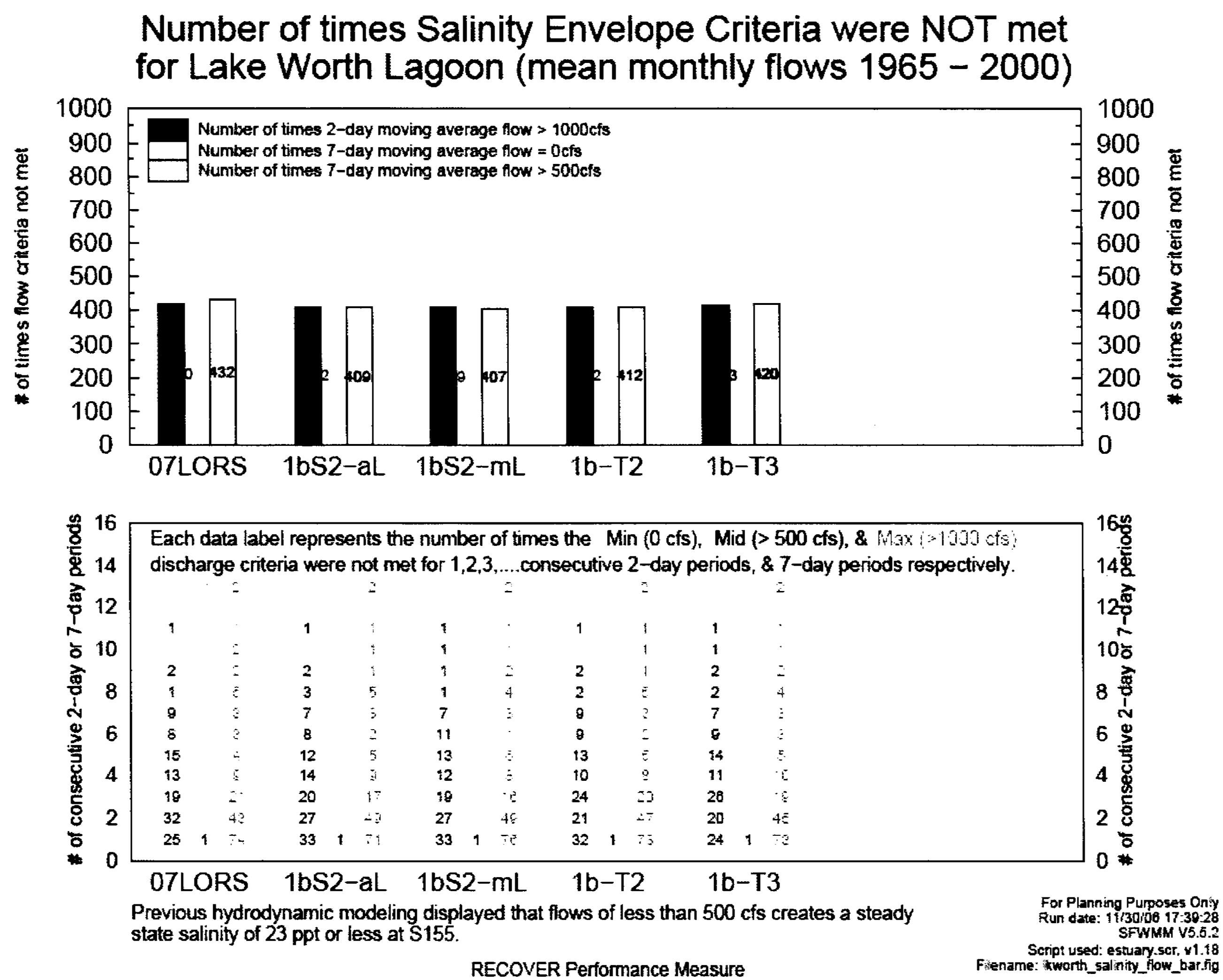


FIGURE C-28: LAKE WORTH LAGOON SALINITY ENVELOPE CRITERIA (1)

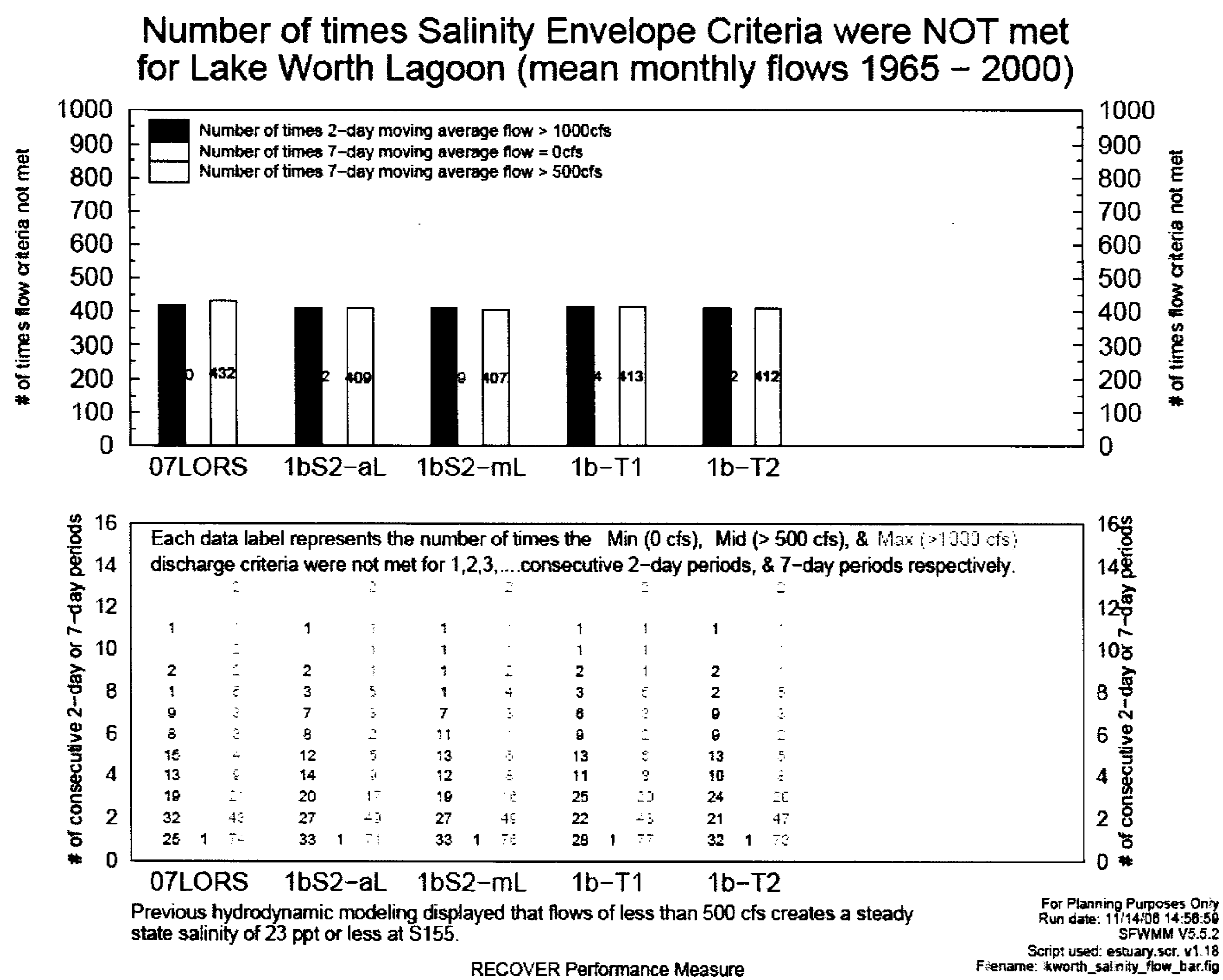


FIGURE C-29: LAKE WORTH LAGOON SALINITY ENVELOPE CRITERIA (2)

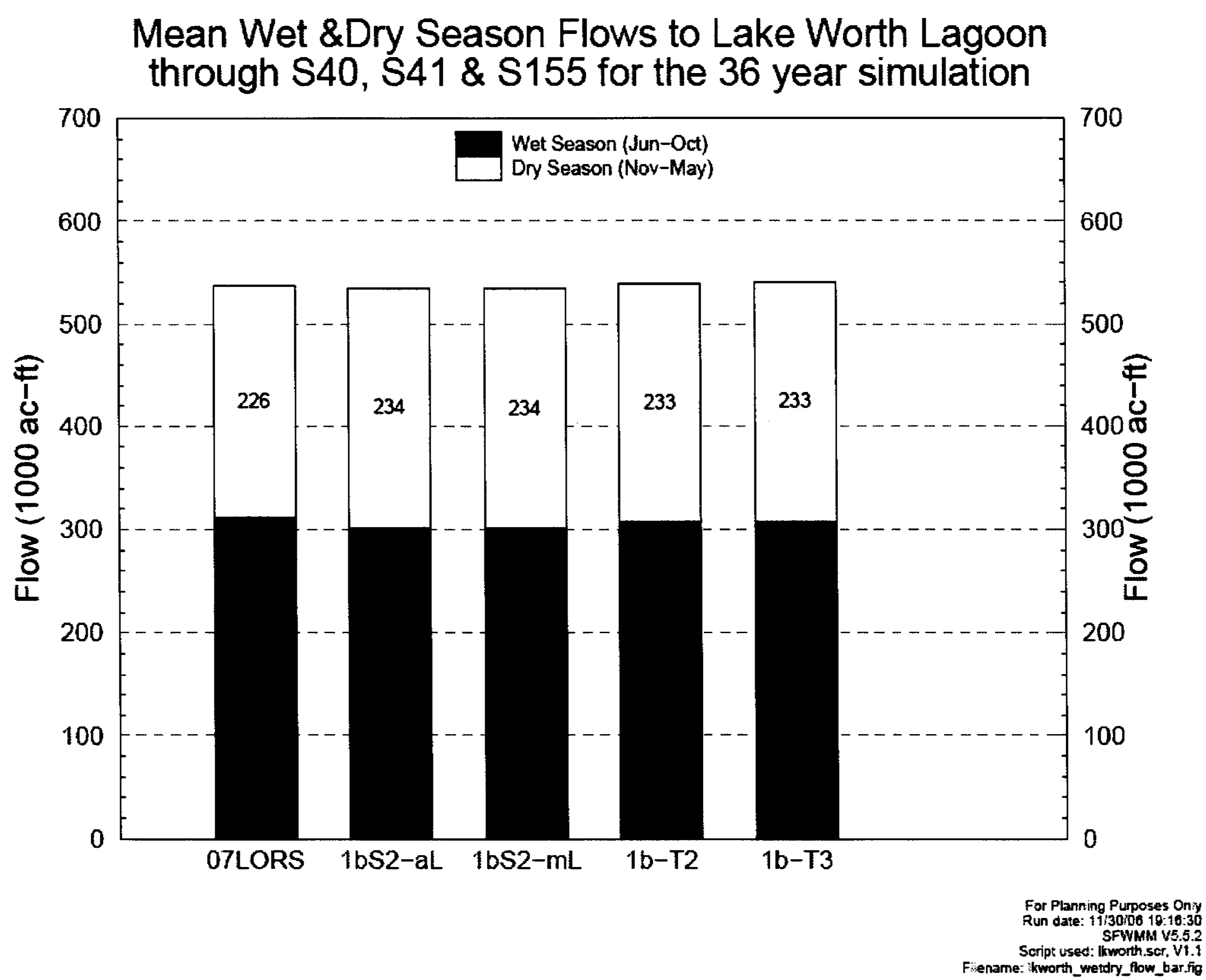


FIGURE C-30: LAKE WORTH LAGOON, MEAN WET AND DRY SEASON FLOWS (1)

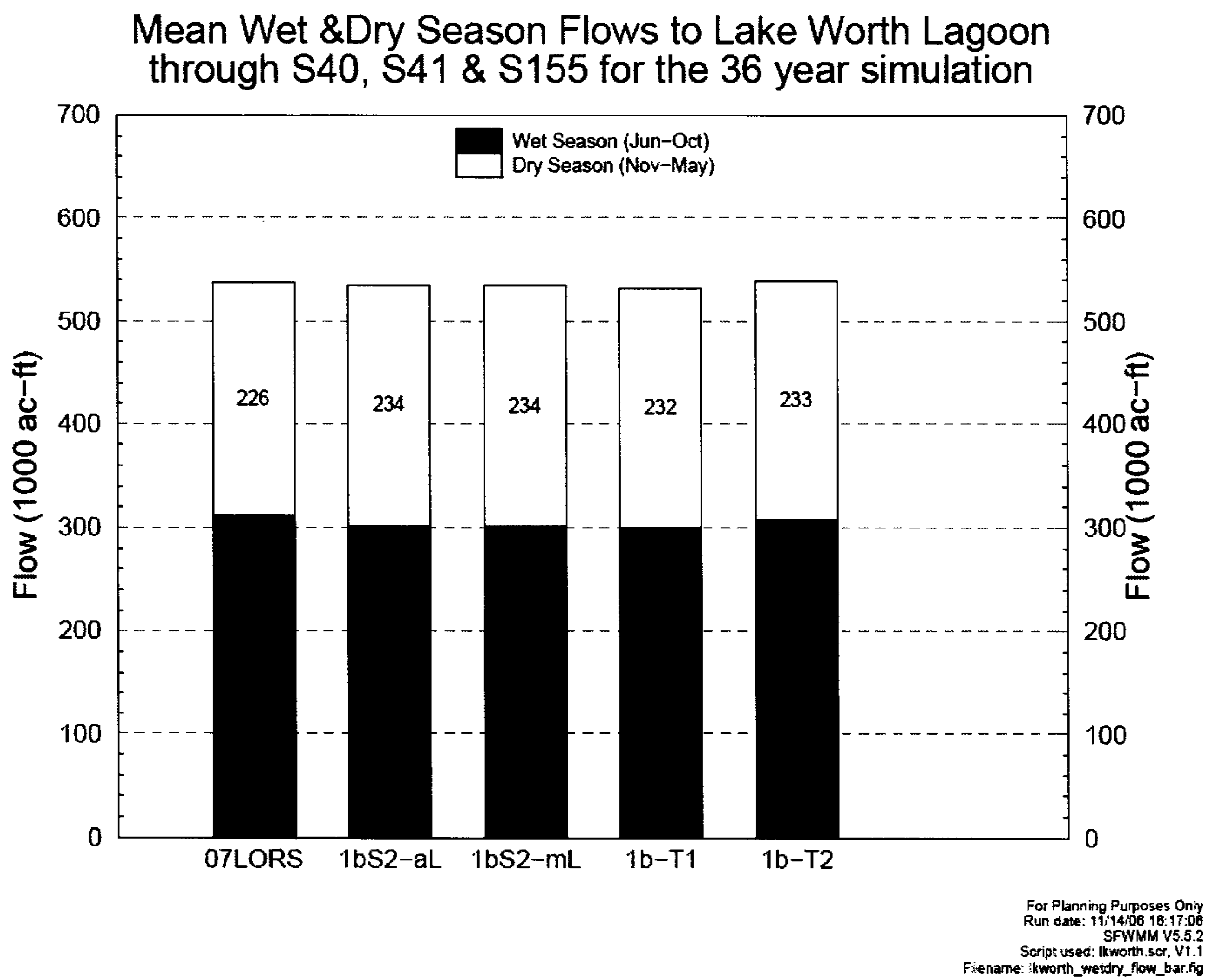


FIGURE C-31: LAKE WORTH LAGOON, MEAN WET AND DRY SEASON FLOWS (2)

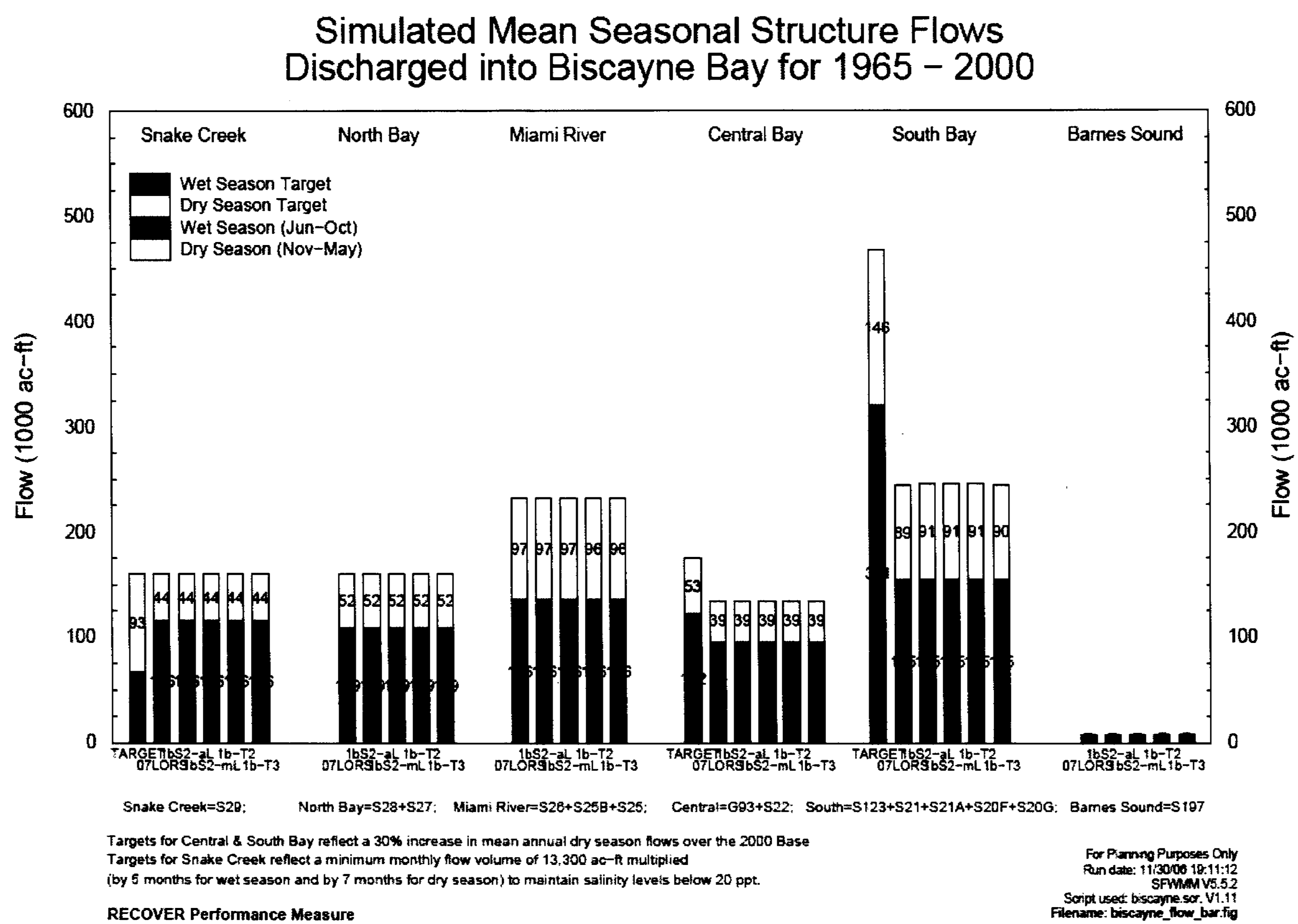


FIGURE C-32: BISCAYNE BAY, MEAN SEASONAL STRUCTURE INFLOWS (1)

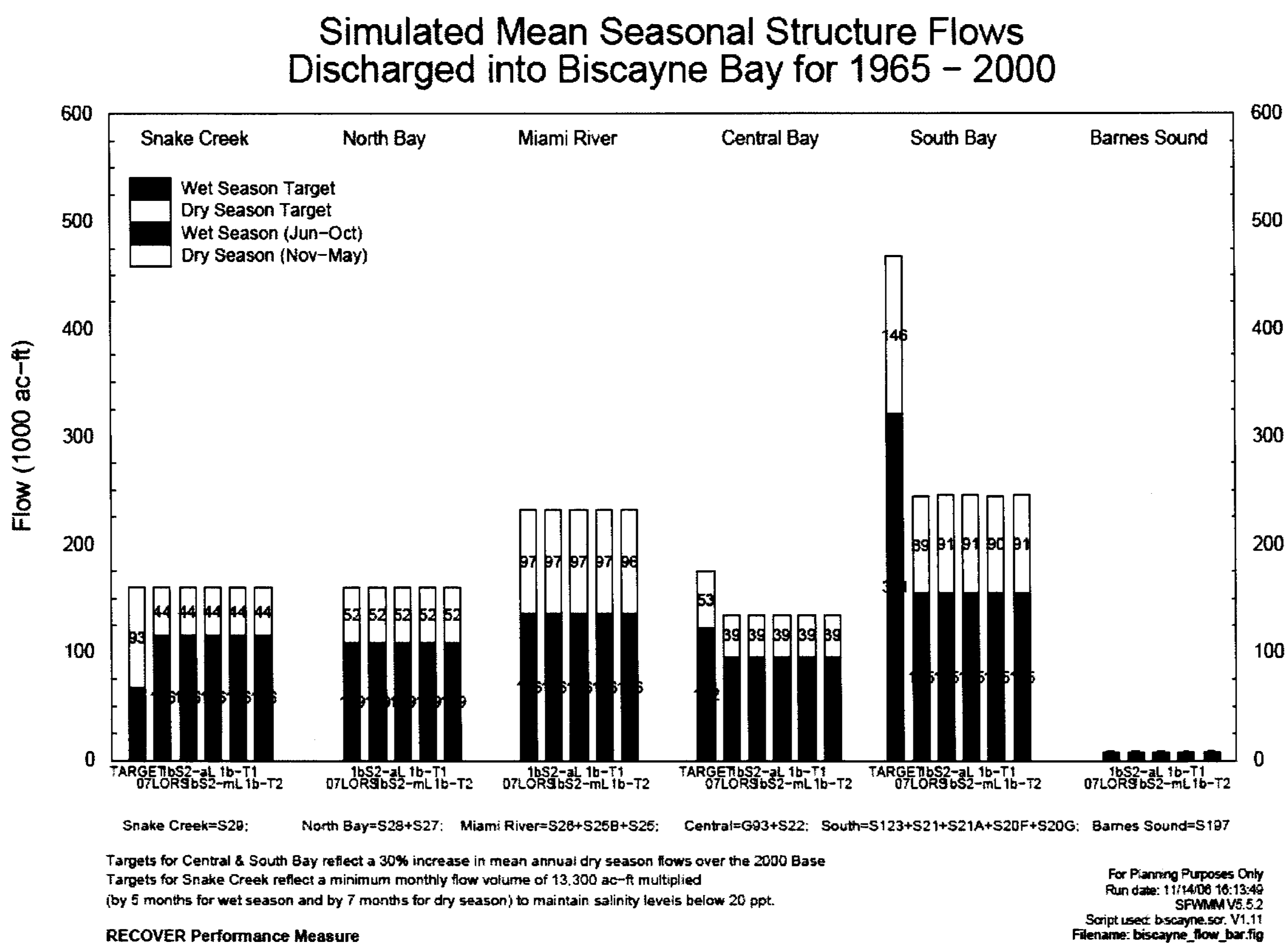


FIGURE C-33: BISCAYNE BAY, MEAN SEASONAL STRUCTURE INFLOWS (2)

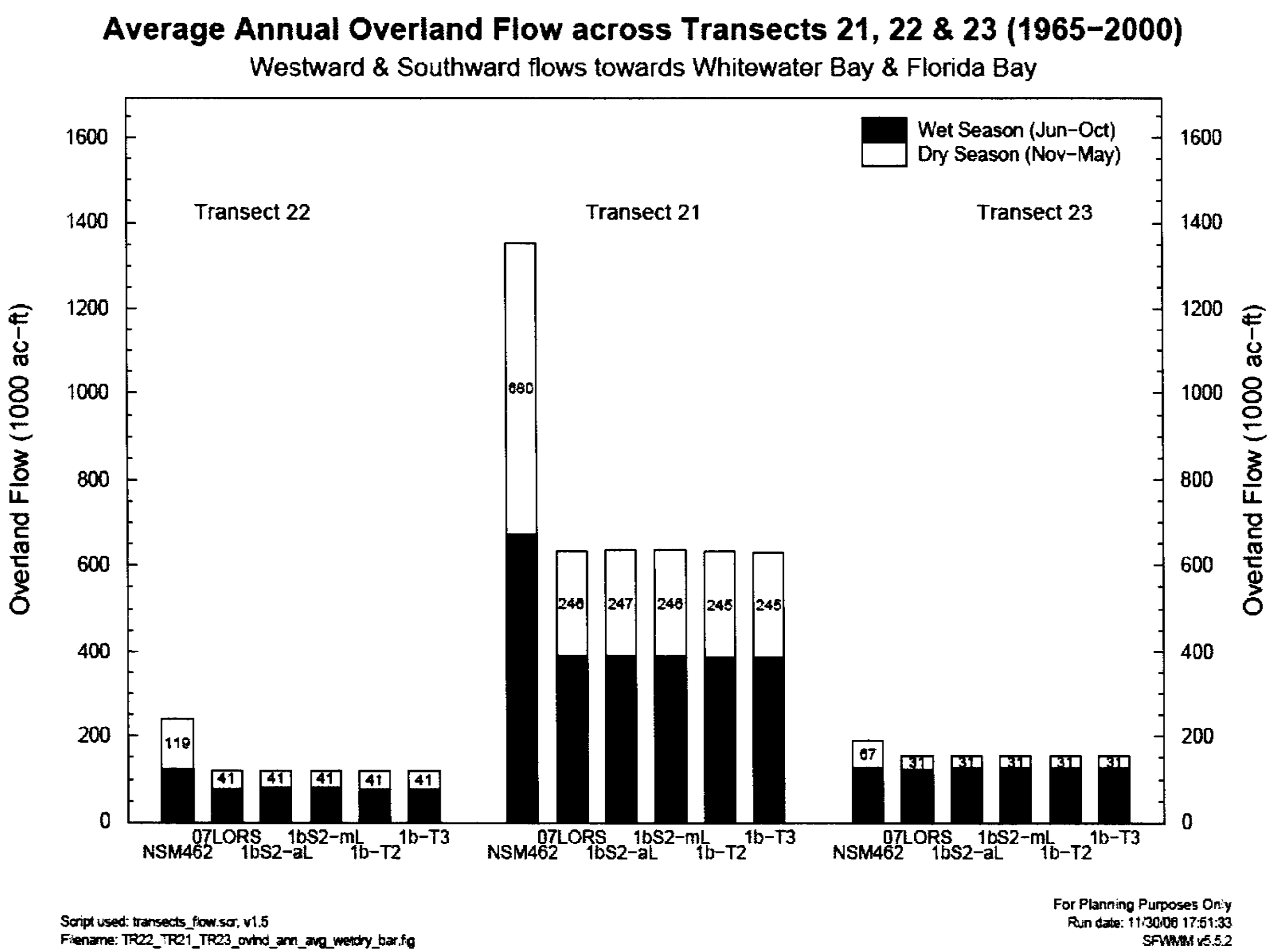


FIGURE C-34: AVERAGE ANNUAL OVERLAND FLOWS TOWARDS WHITEWATER BAY AND FLORIDA BAY (1)

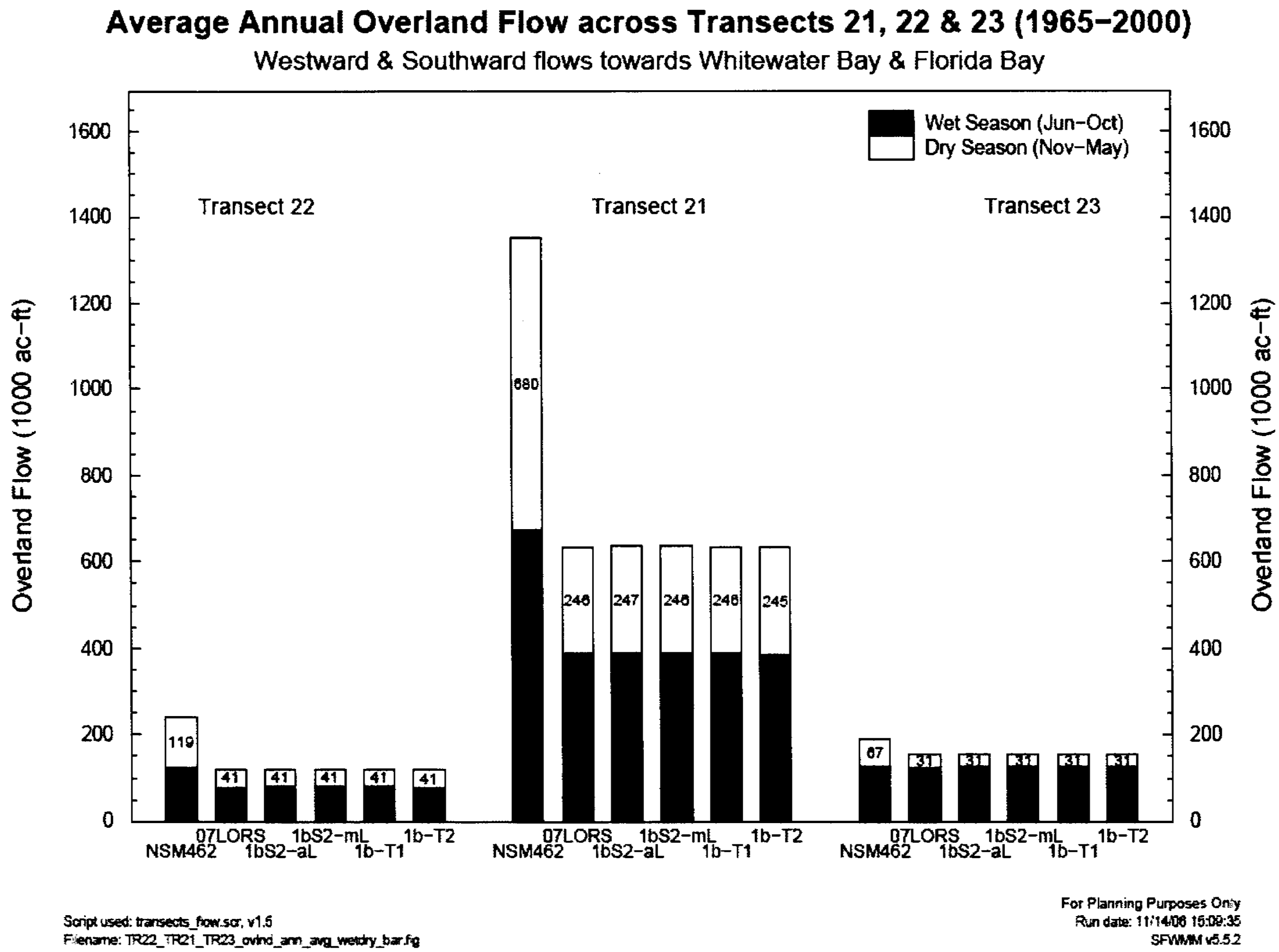


FIGURE C-35: AVERAGE ANNUAL OVERLAND FLOWS TOWARDS WHITEWATER BAY AND FLORIDA BAY (2)

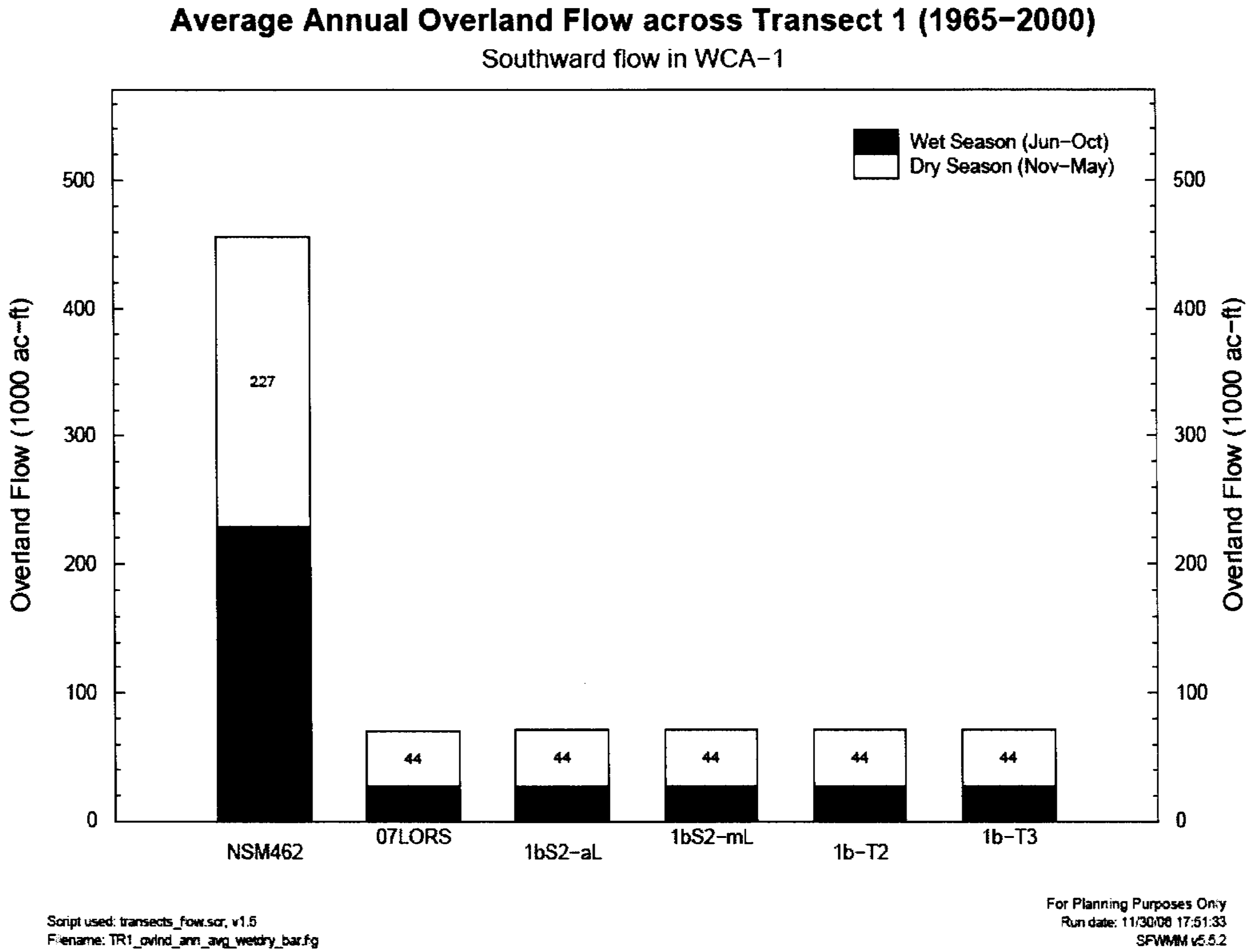


FIGURE C-36: AVERAGE ANNUAL OVERLAND FLOW ACROSS TRANSECT 1, WCA-1 (1)

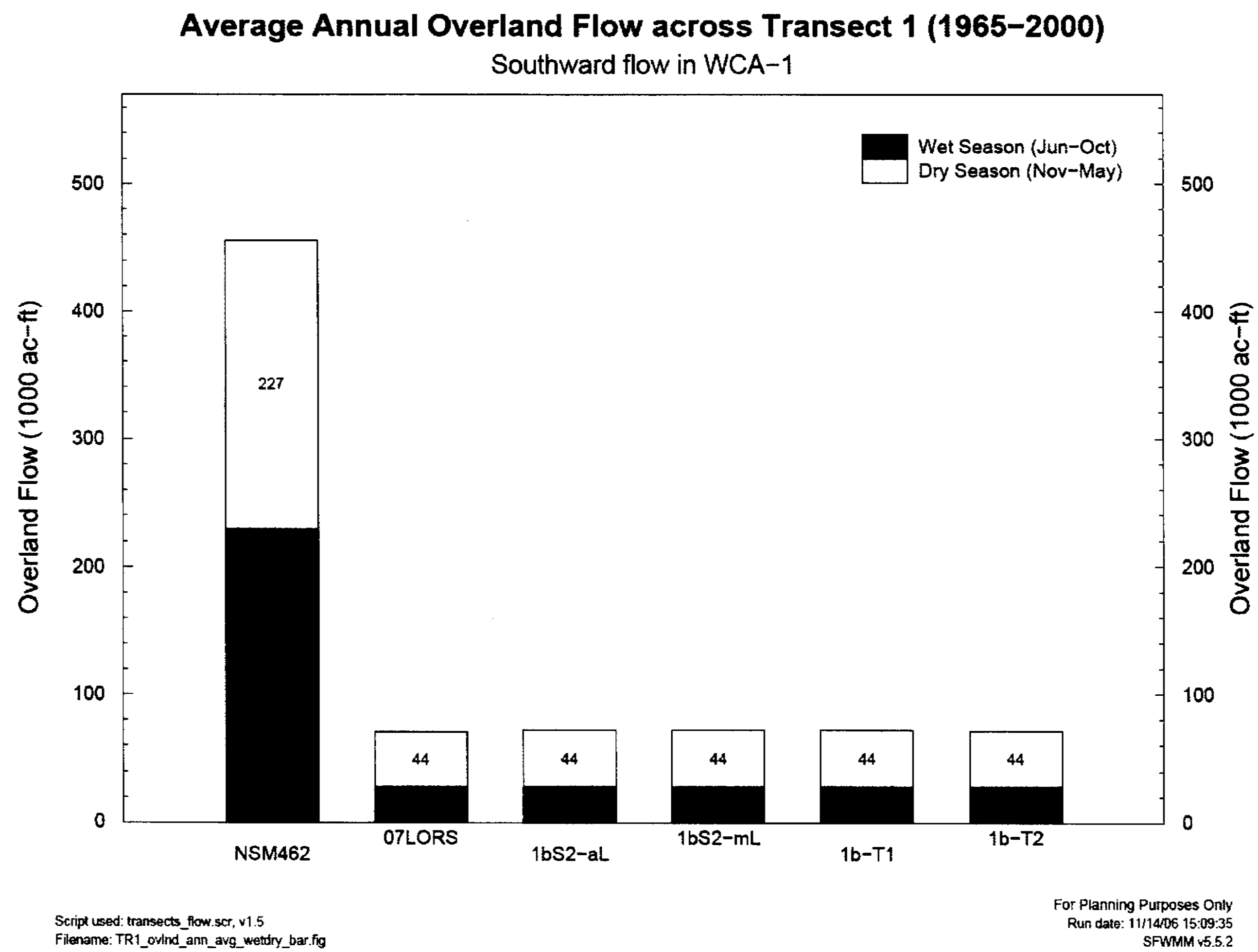


FIGURE C-37: AVERAGE ANNUAL OVERLAND FLOW ACROSS TRANSECT 1, WCA-1 (2)

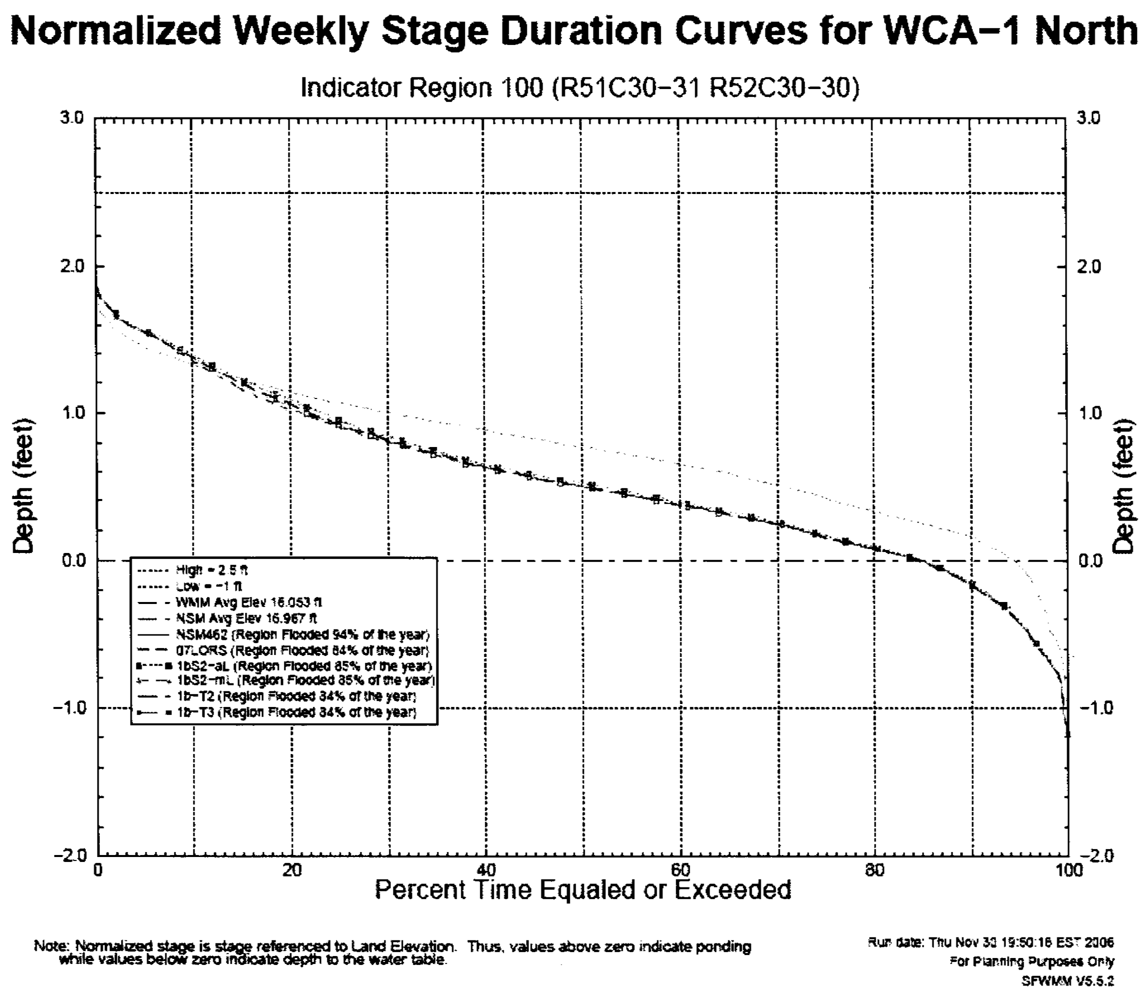


FIGURE C-38: STAGE DURATION CURVES FOR INDICATOR REGION 100, WCA-1 NORTH (1)

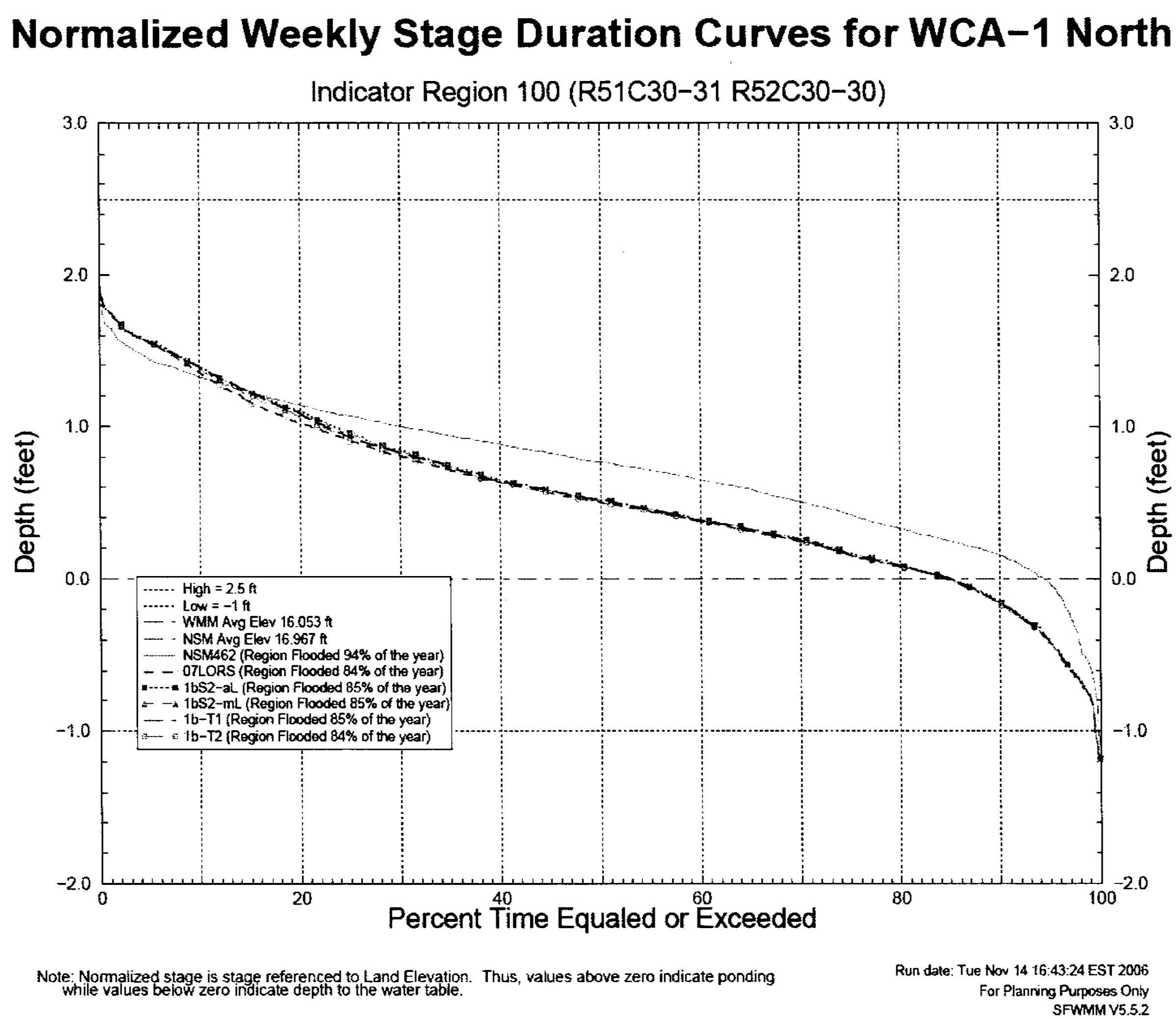


FIGURE C-39: STAGE DURATION CURVES FOR INDICATOR REGION 100, WCA-1 NORTH (2)

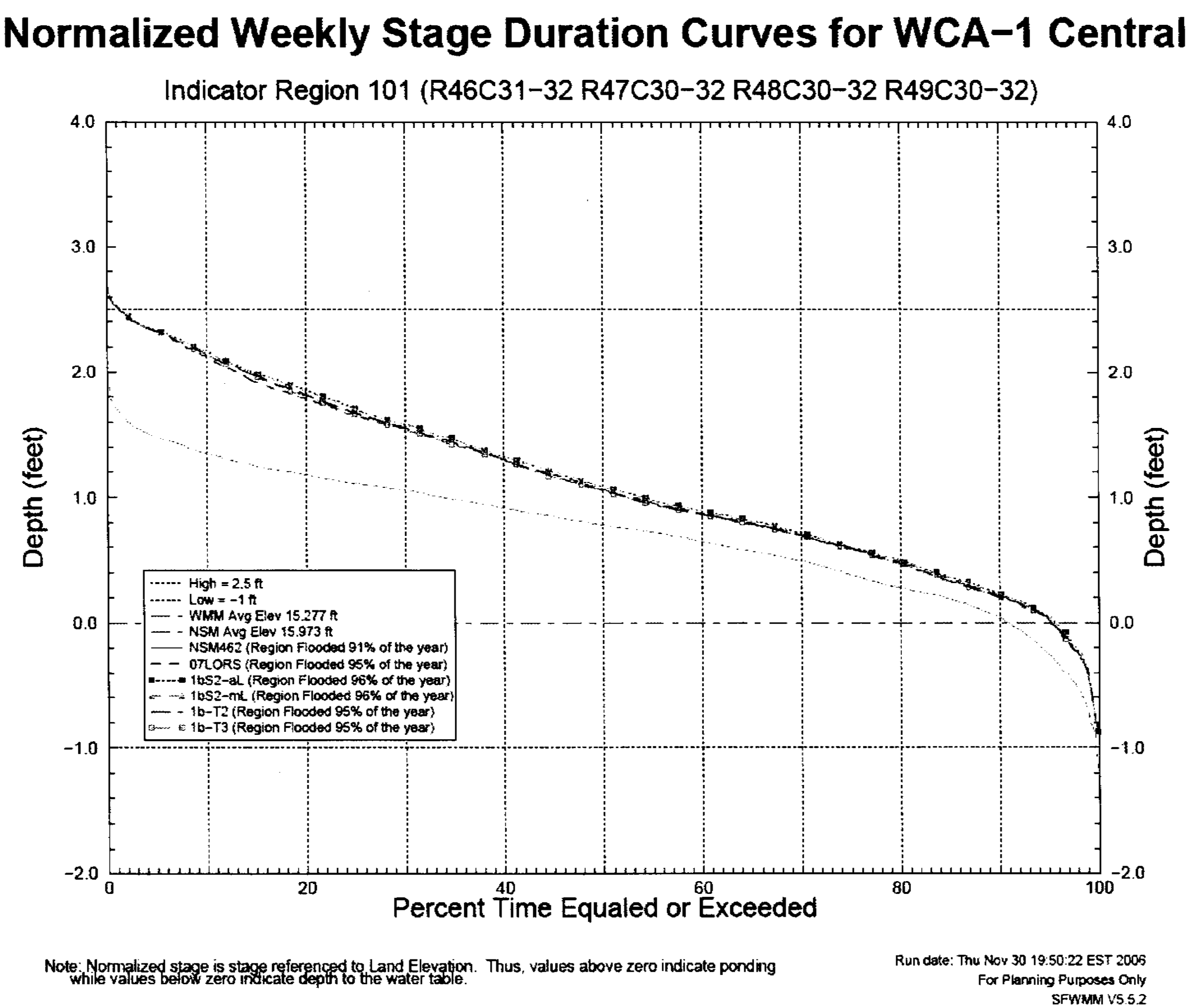


FIGURE C-40: STAGE DURATION CURVES FOR INDICATOR REGION 101, WCA-1 CENTRAL (1)

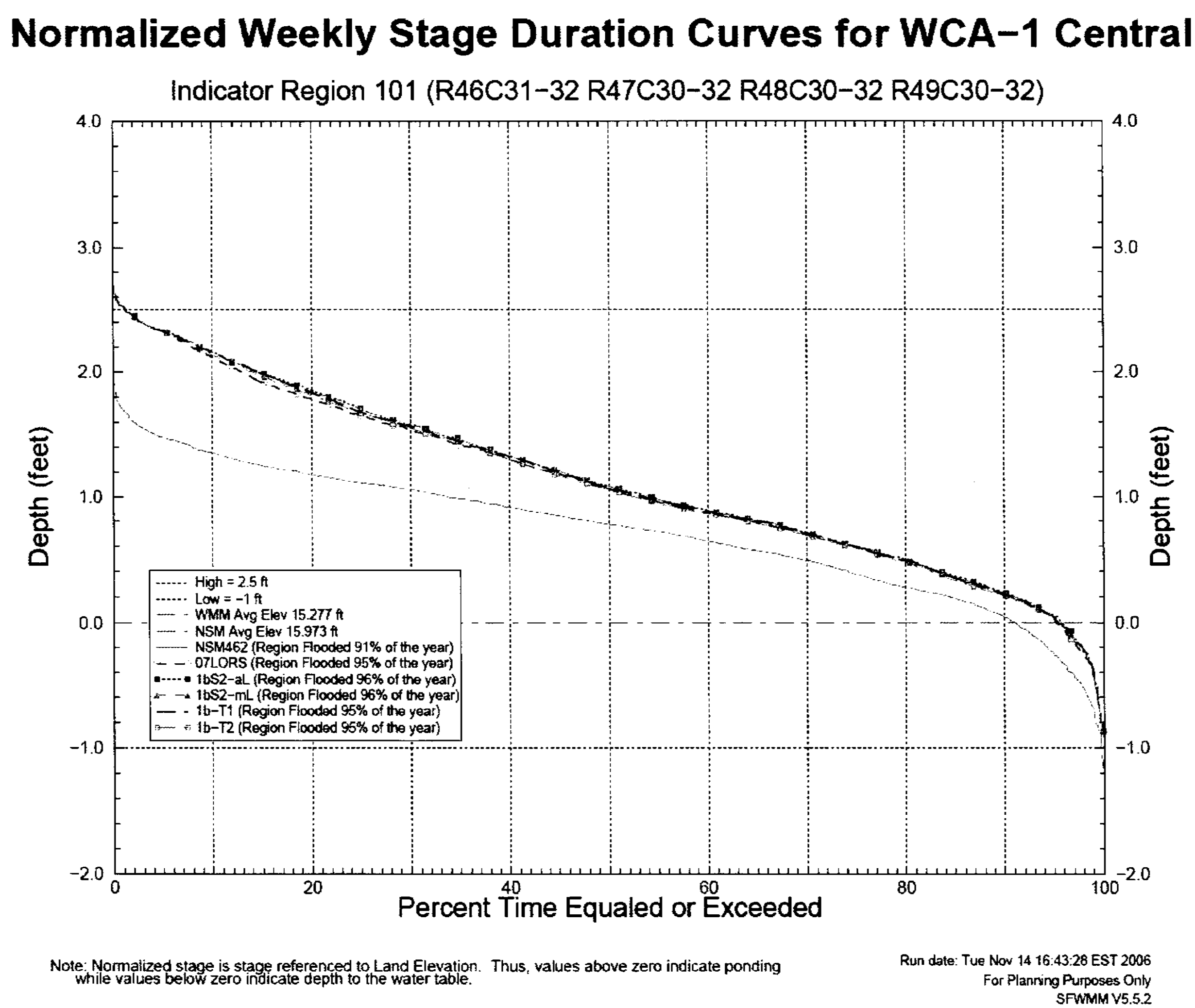


FIGURE C-41: STAGE DURATION CURVES FOR INDICATOR REGION 101, WCA-1 CENTRAL (2)

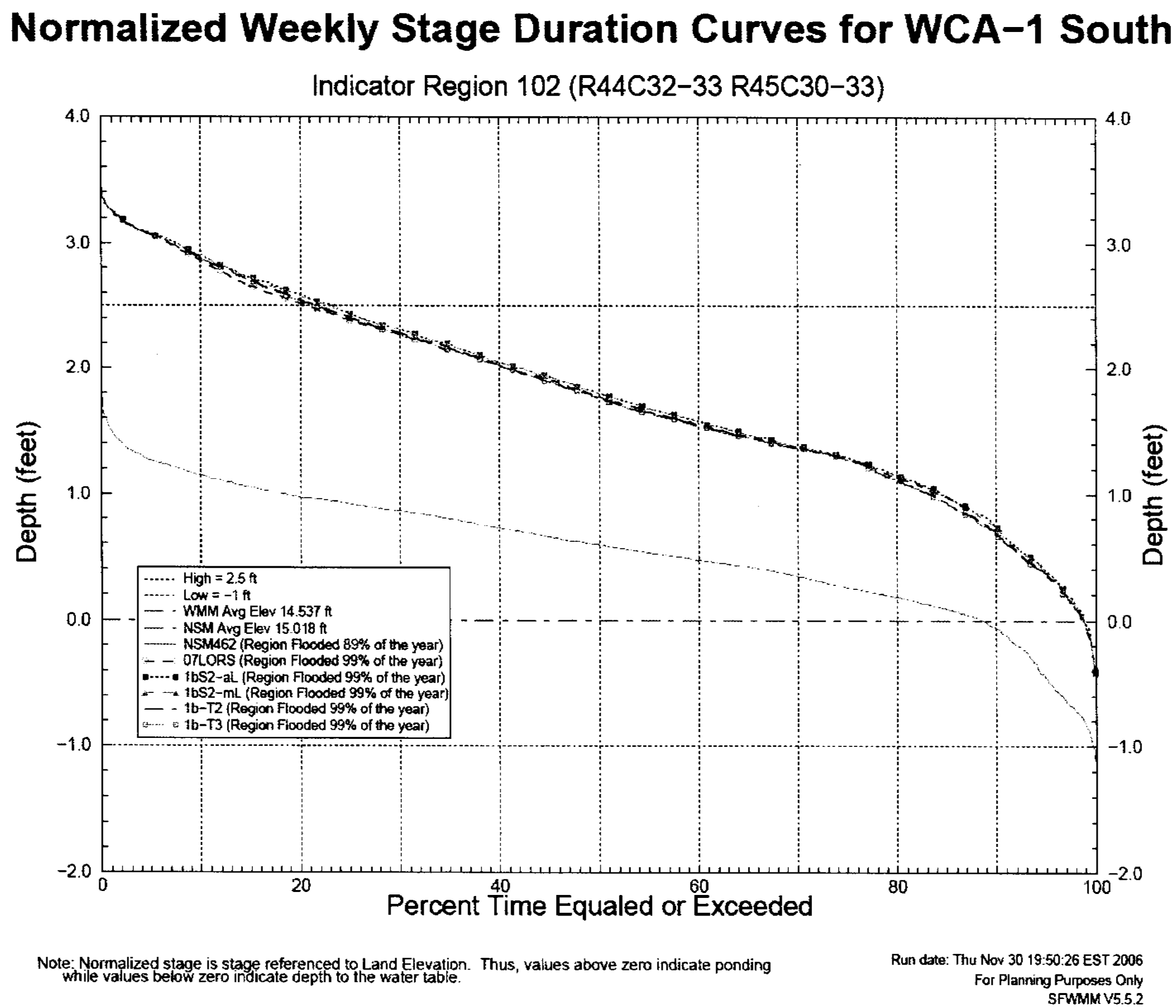


FIGURE C-42: STAGE DURATION CURVES FOR INDICATOR REGION 102, WCA-1 SOUTH (1)

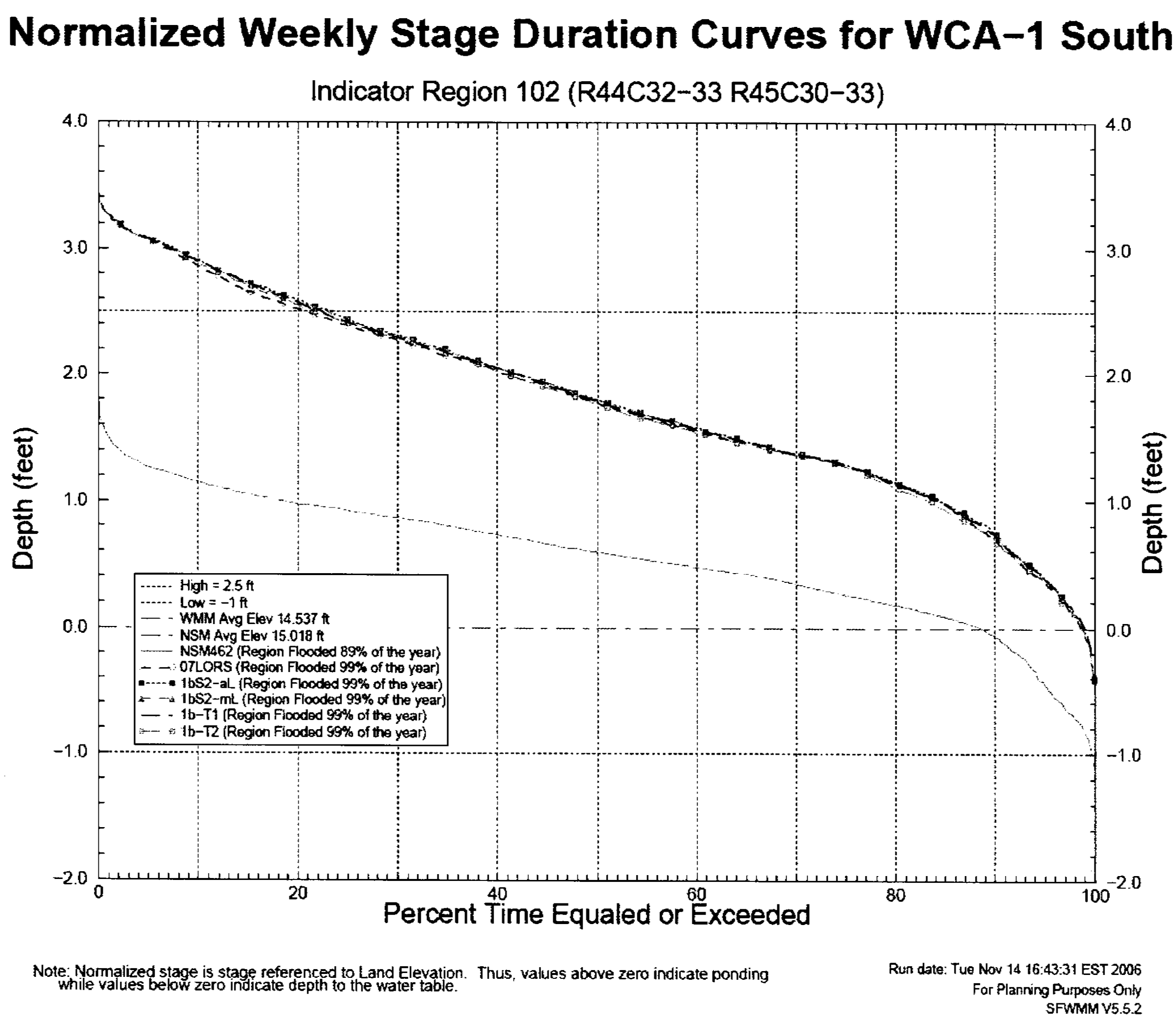


FIGURE C-43: STAGE DURATION CURVES FOR INDICATOR REGION 102, WCA-1 SOUTH (2)

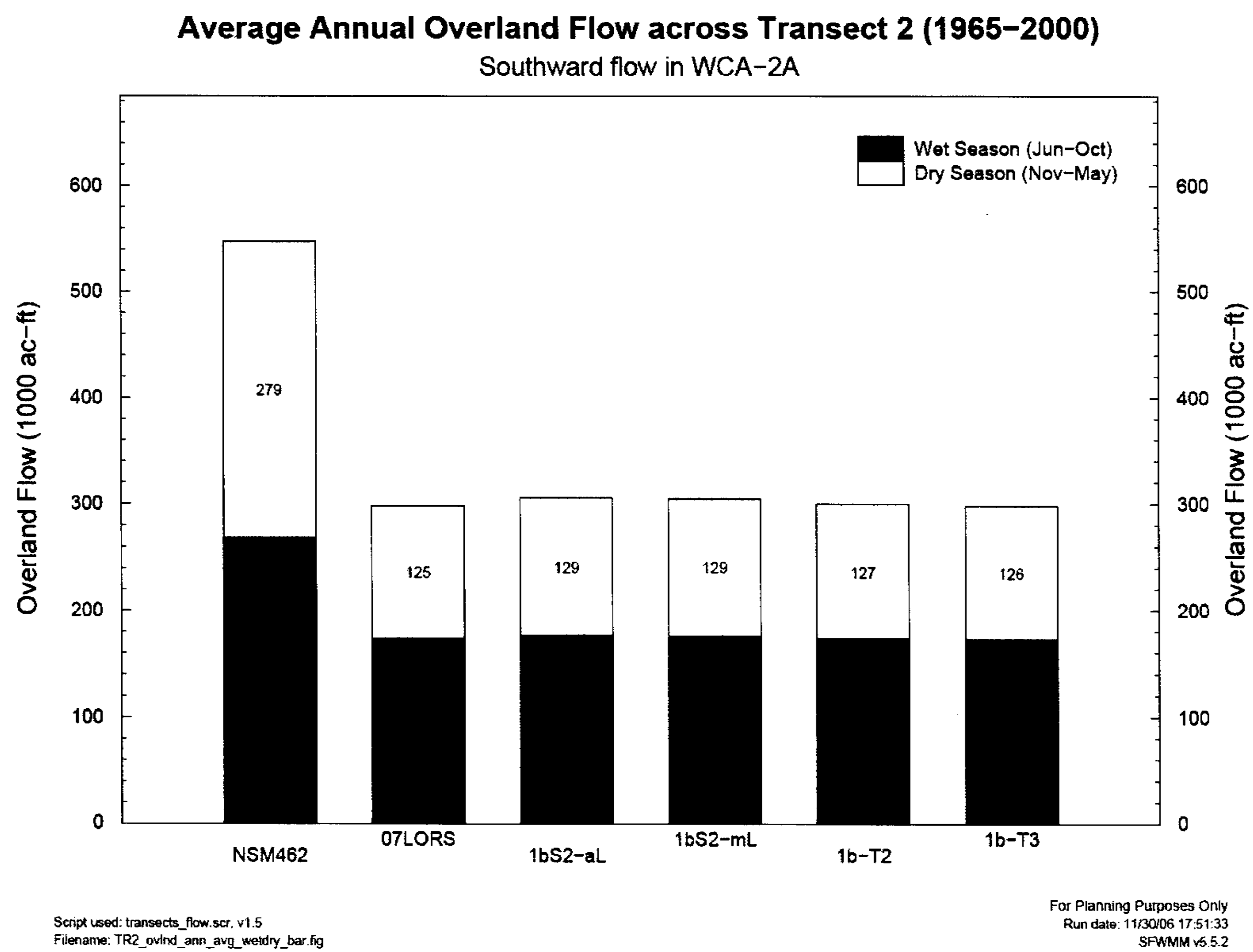


FIGURE C-44: AVERAGE ANNUAL OVERLAND FLOW ACROSS TRANSECT 2, WCA-2A (1)

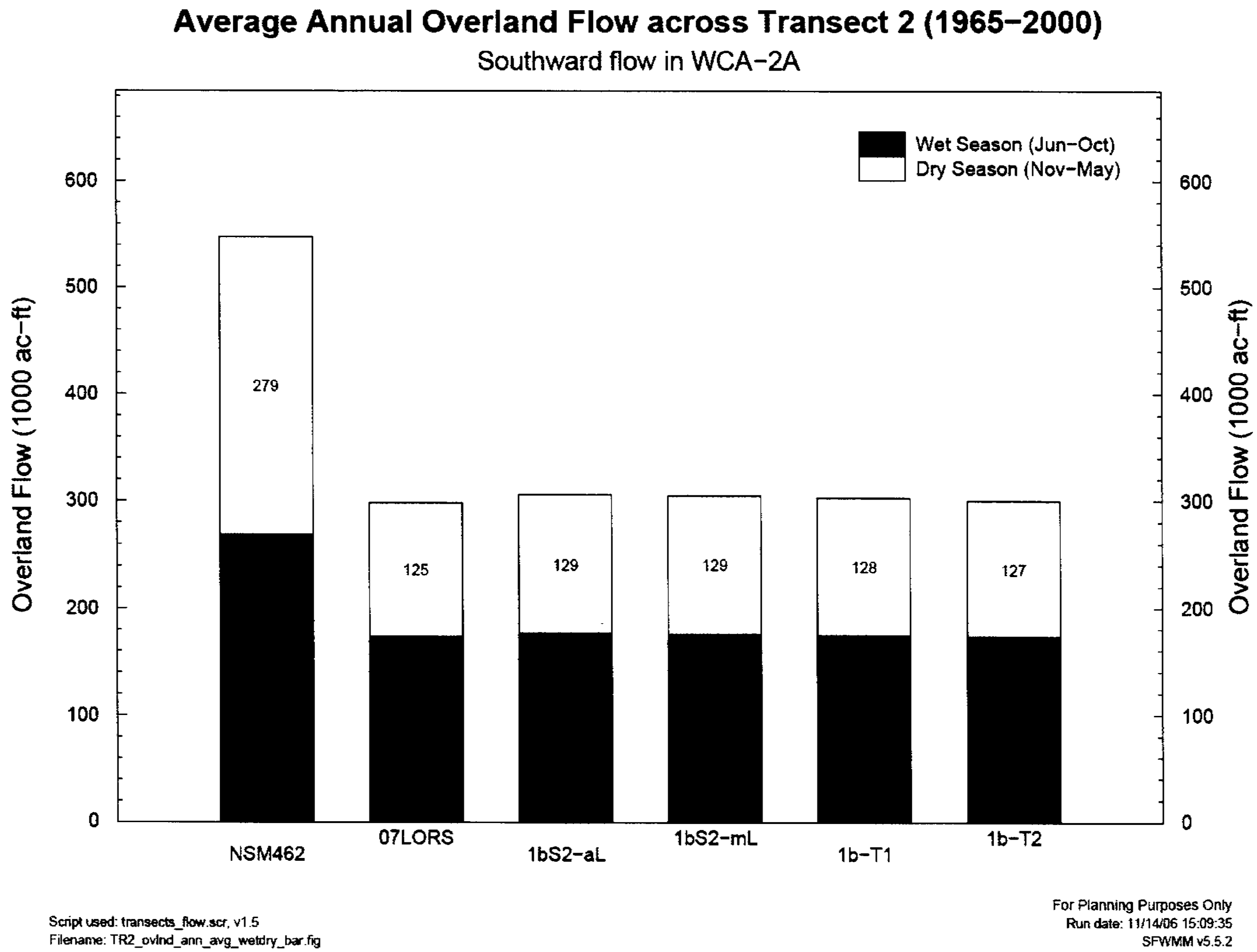


FIGURE C-45: AVERAGE ANNUAL OVERLAND FLOW ACROSS TRANSECT 2, WCA-2A (2)

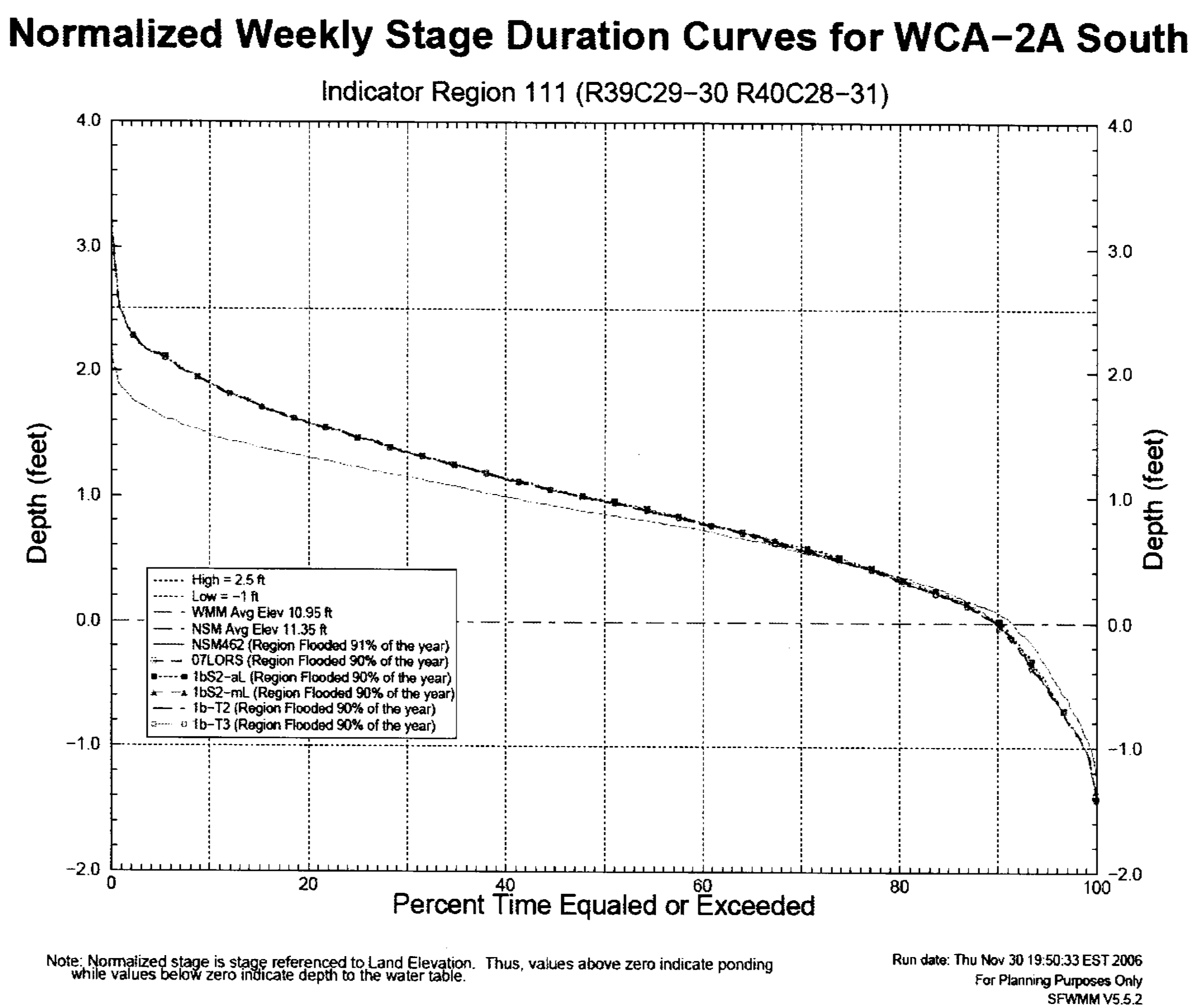


FIGURE C-46: STAGE DURATION CURVES FOR INDICATOR REGION 111, WCA-2A SOUTH (1)

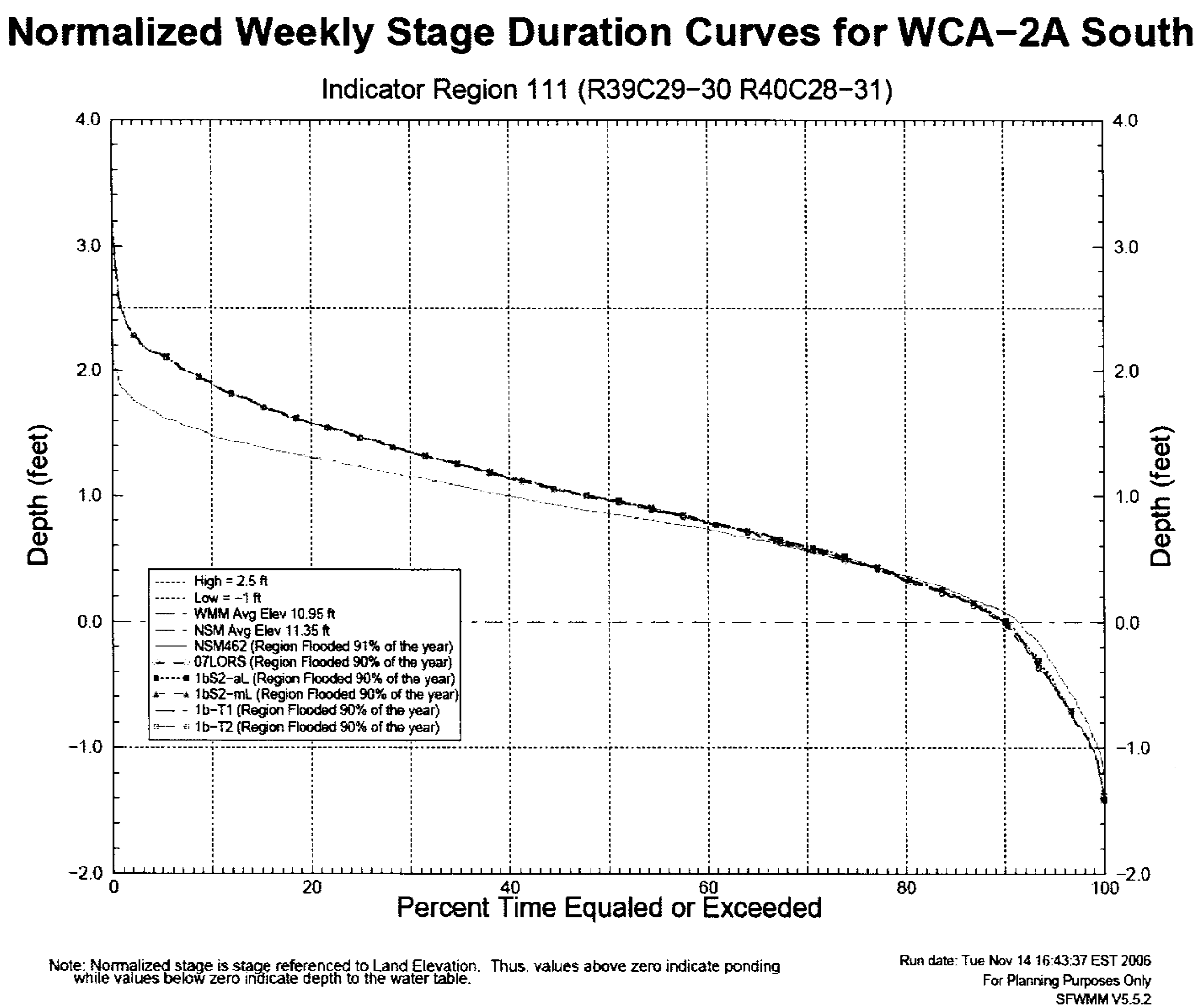


FIGURE C-47: STAGE DURATION CURVES FOR INDICATOR REGION 111, WCA-2A SOUTH (2)

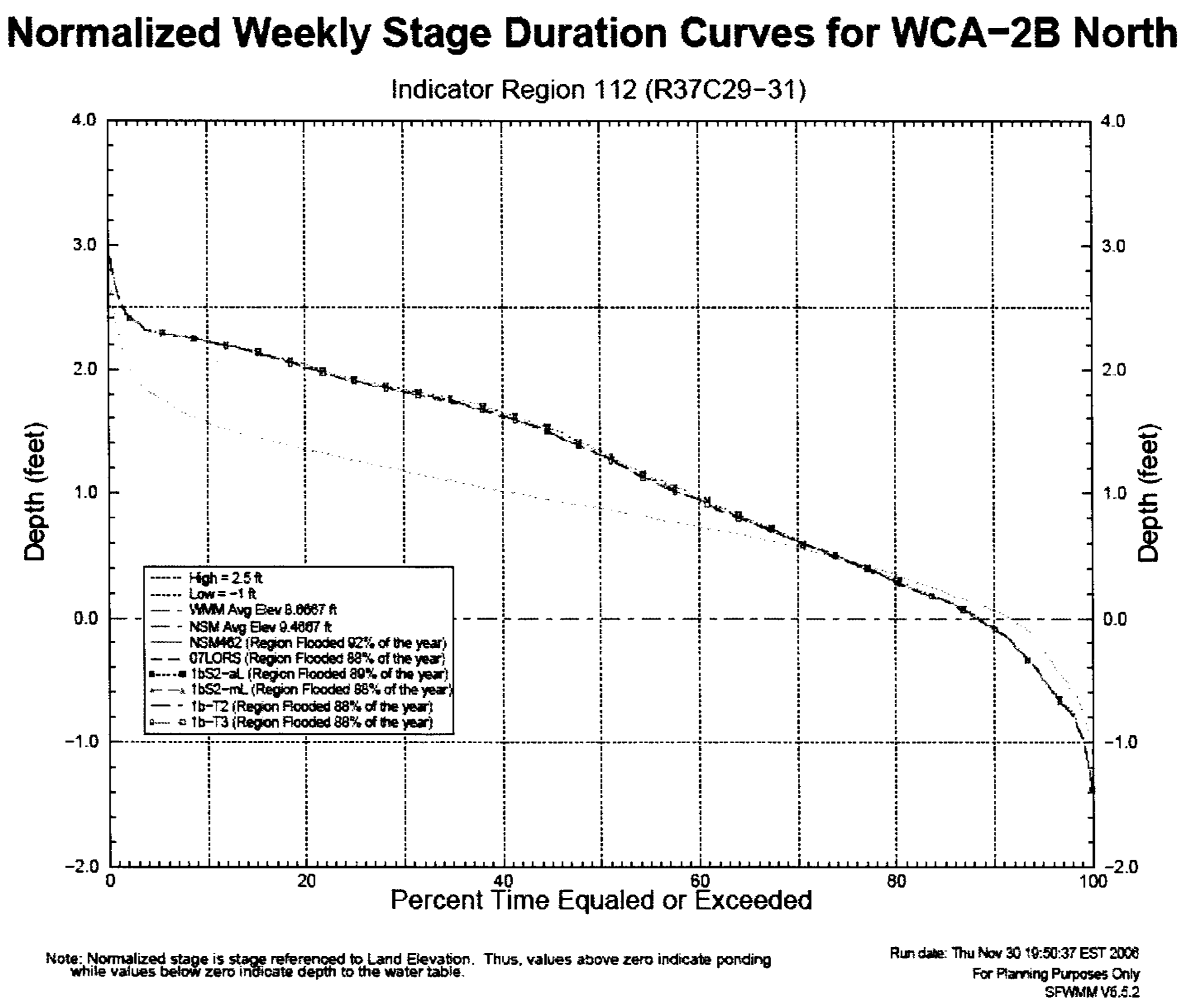


FIGURE C-48: STAGE DURATION CURVES FOR INDICATOR REGION 112, WCA-2B NORTH (1)

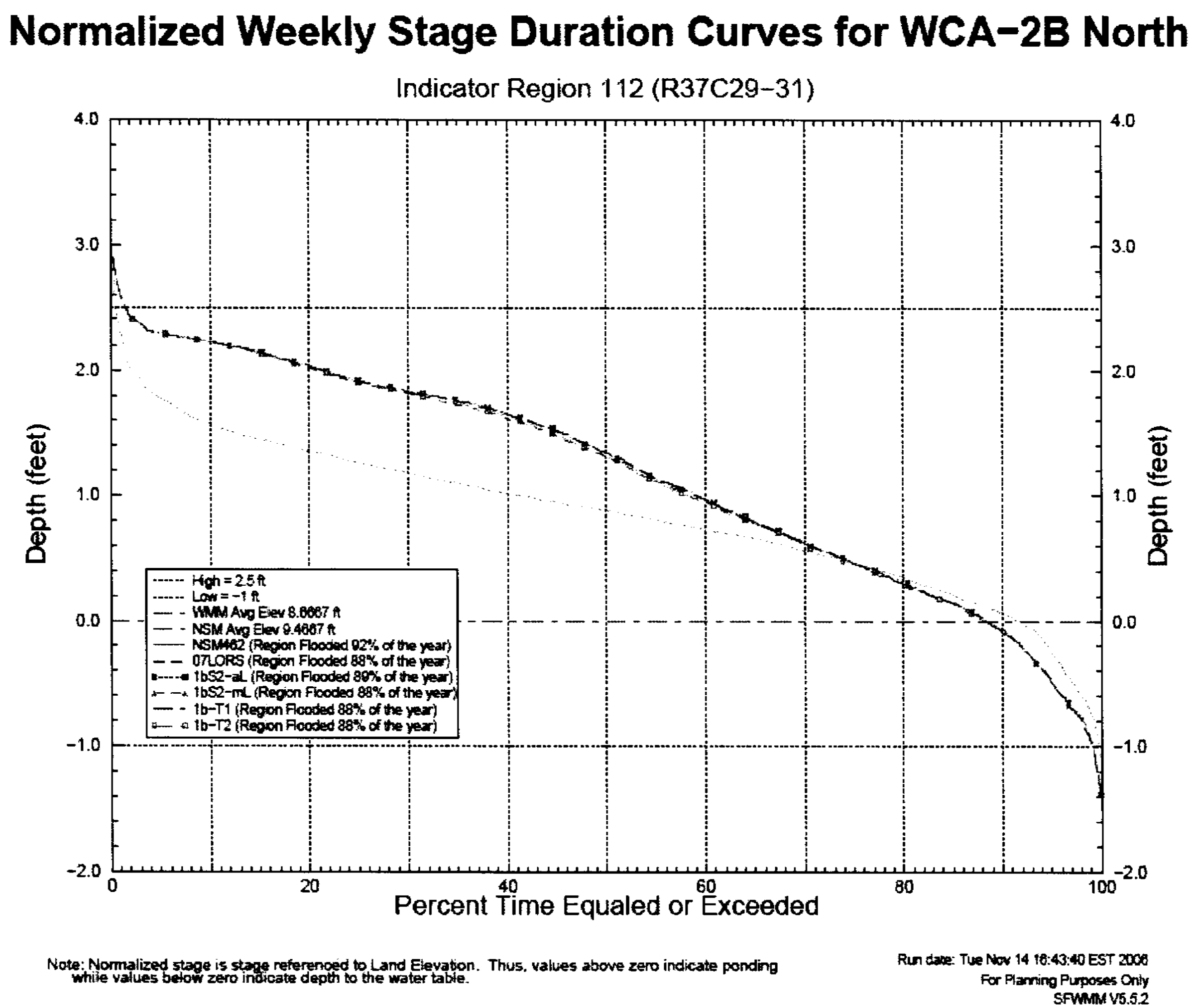


FIGURE C-49: STAGE DURATION CURVES FOR INDICATOR REGION 112, WCA-2B NORTH (2)

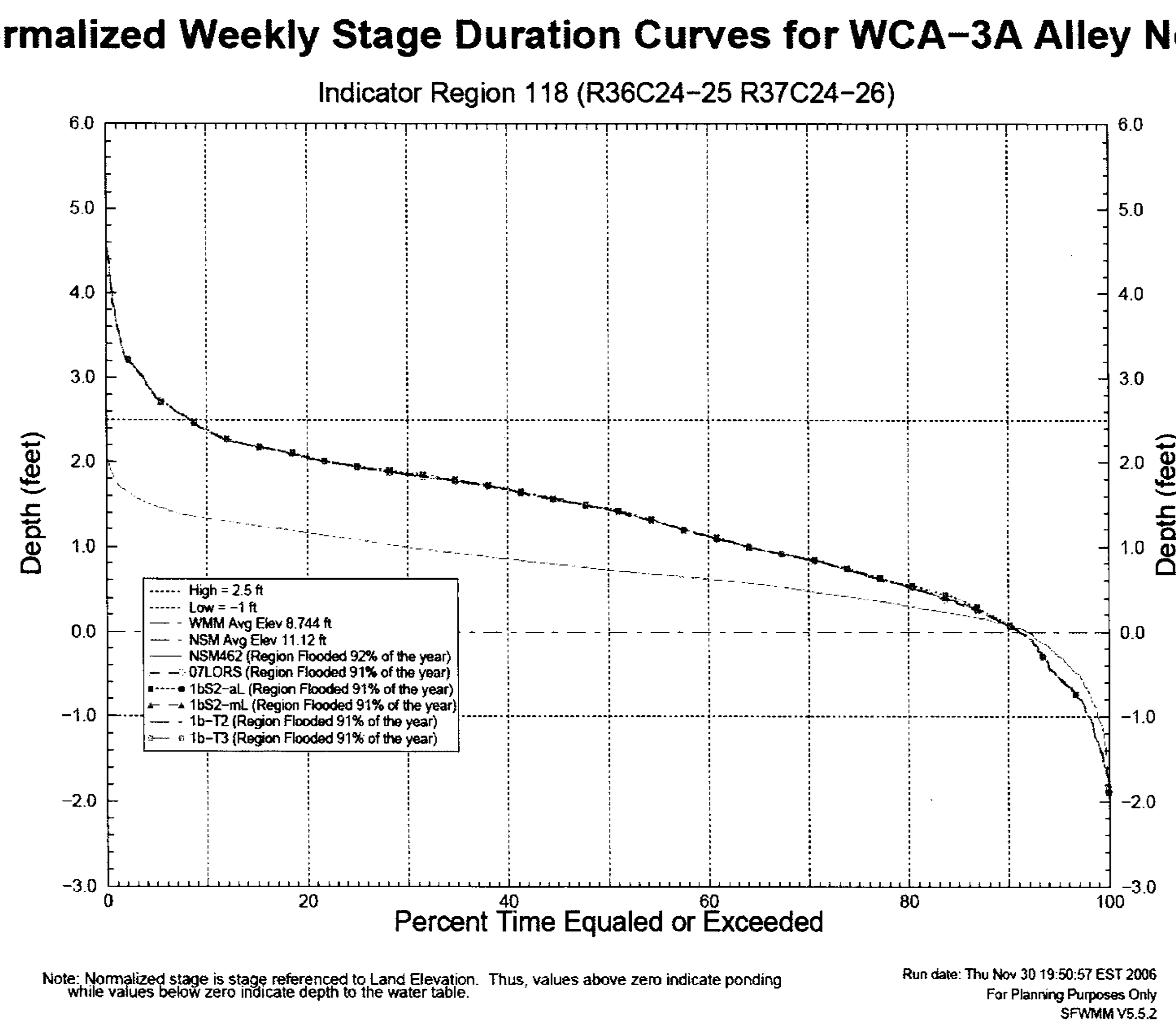


FIGURE C-50: STAGE DURATION CURVES FOR INDICATOR REGION 118, WCA-3A ALLEY NORTH (1)

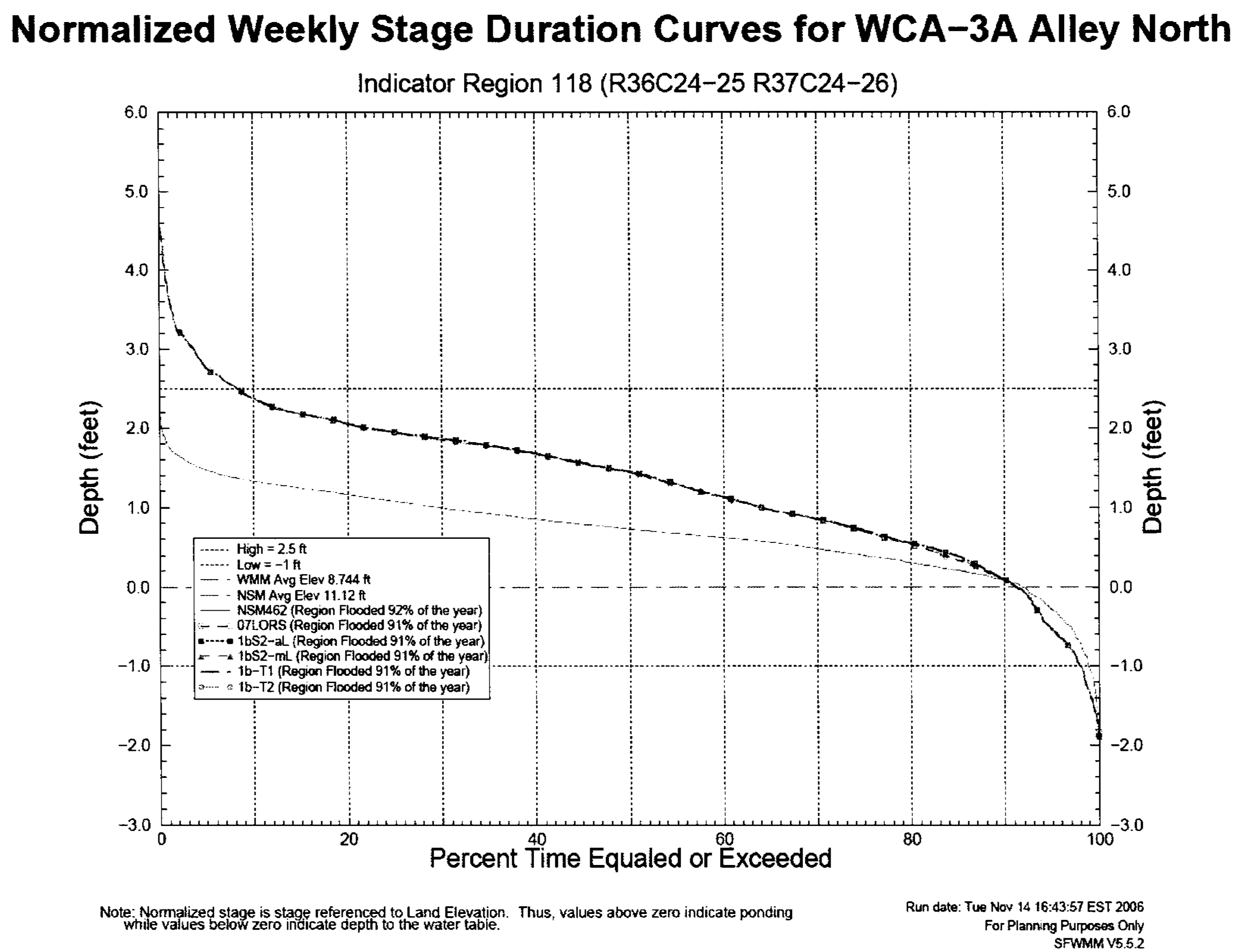


FIGURE C-51: STAGE DURATION CURVES FOR INDICATOR REGION 118, WCA-3A ALLEY NORTH (2)

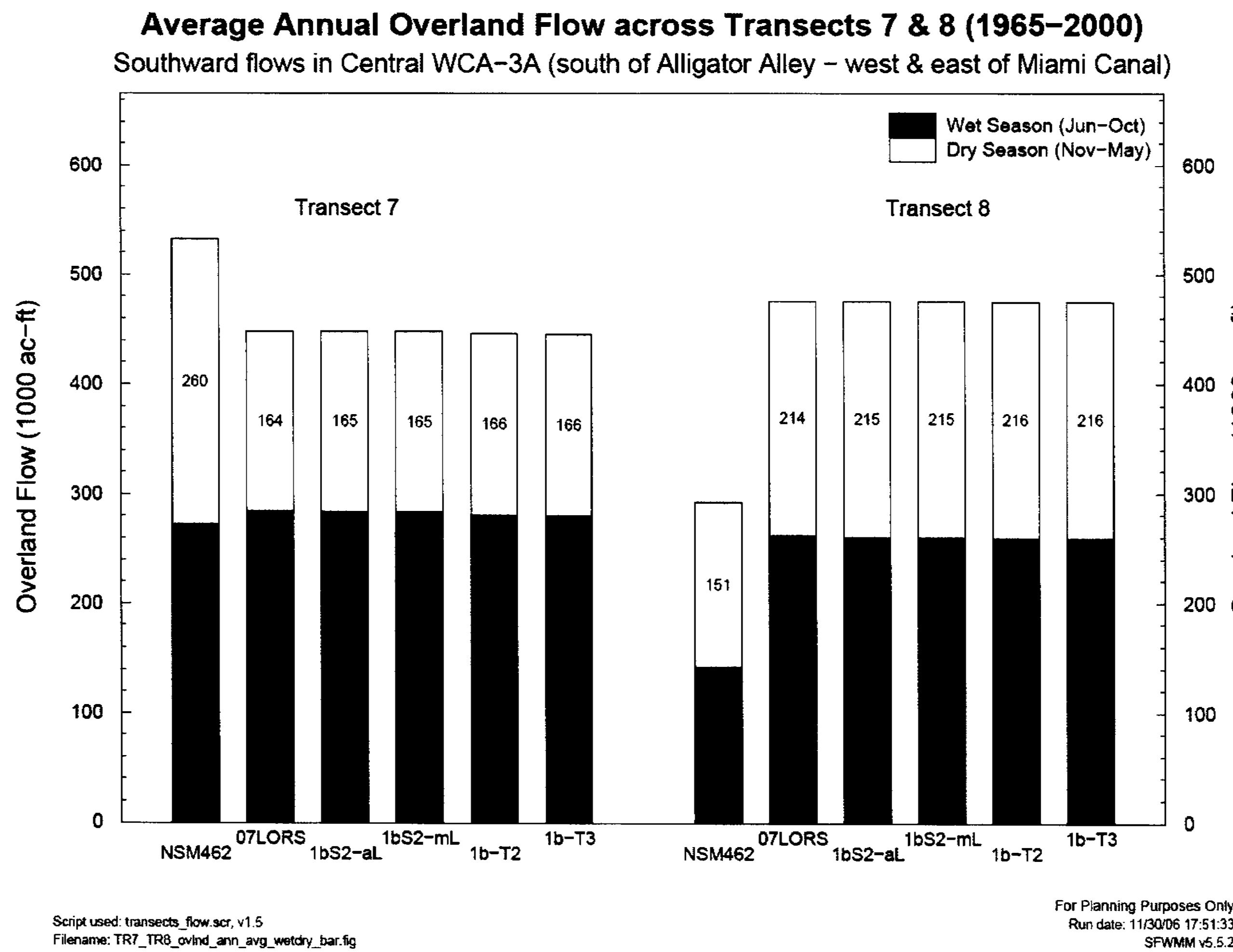


FIGURE C-52: AVERAGE ANNUAL OVERLAND FLOW ACROSS TRANSECTS 7 AND 8, CENTRAL WCA-3A (1)

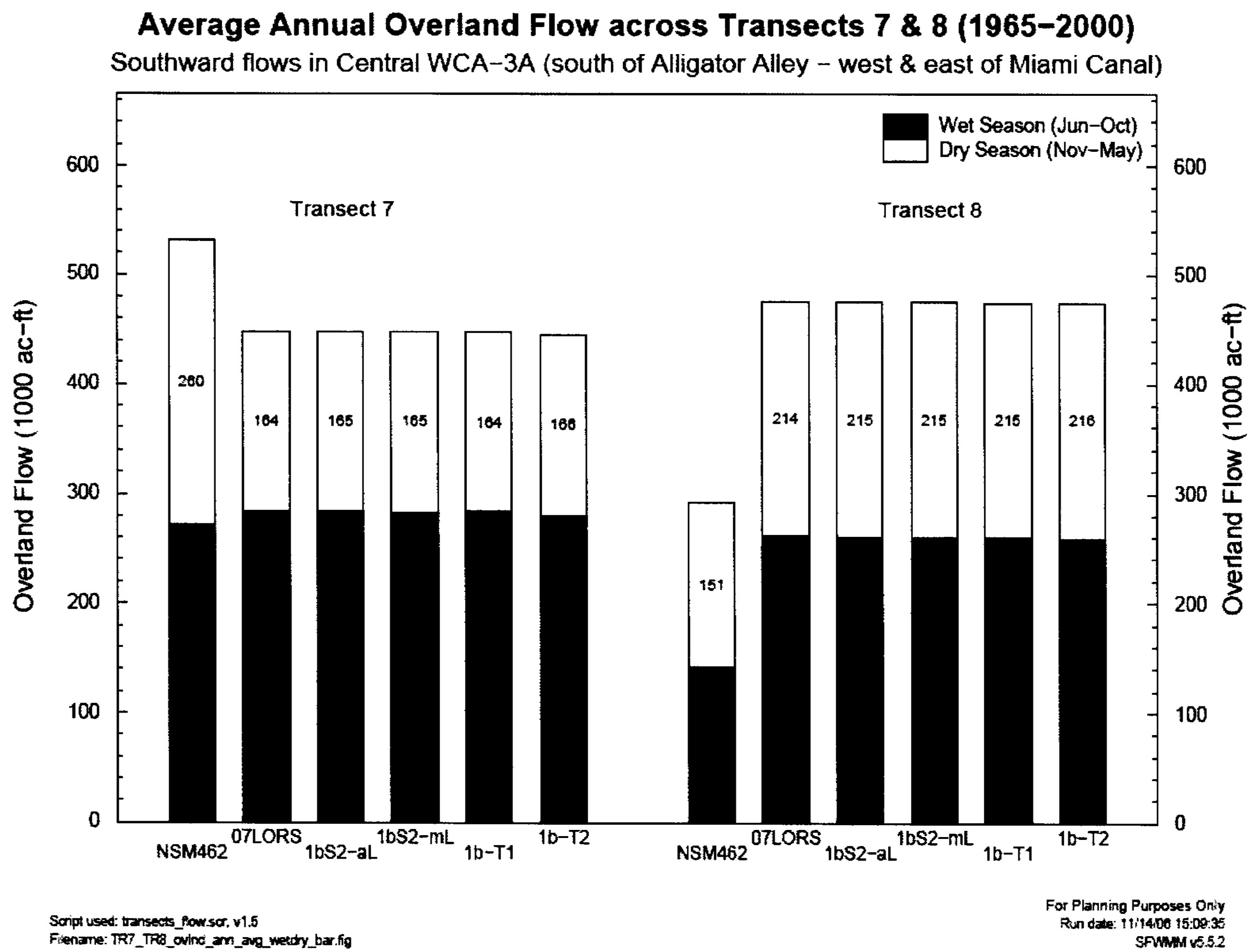


FIGURE C-53: AVERAGE ANNUAL OVERLAND FLOW ACROSS TRANSECTS 7 AND 8, CENTRAL WCA-3A (2)

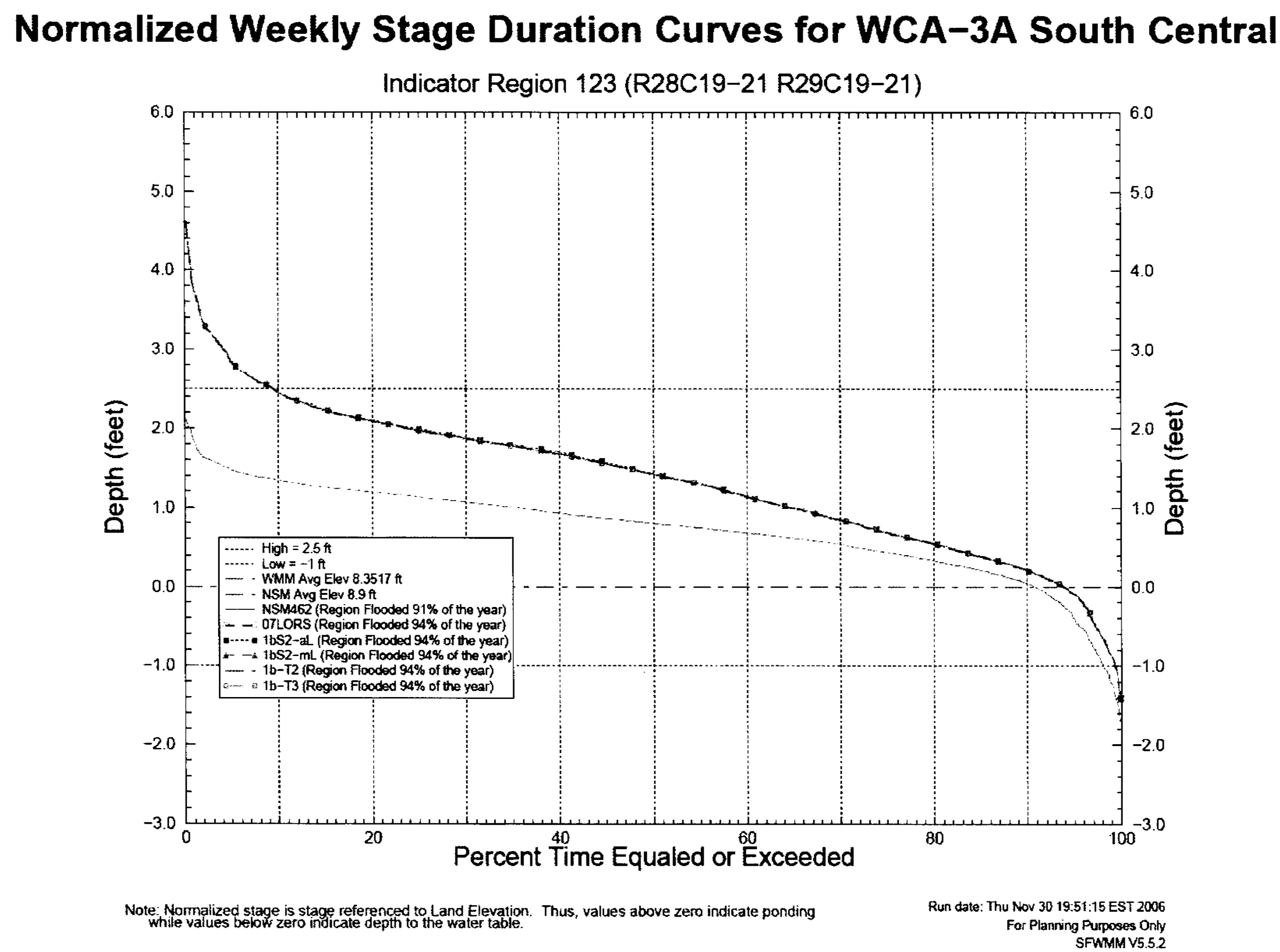


FIGURE C-54: STAGE DURATION CURVES FOR INDICATOR REGION 123, WCA-3A SOUTH CENTRAL (1)

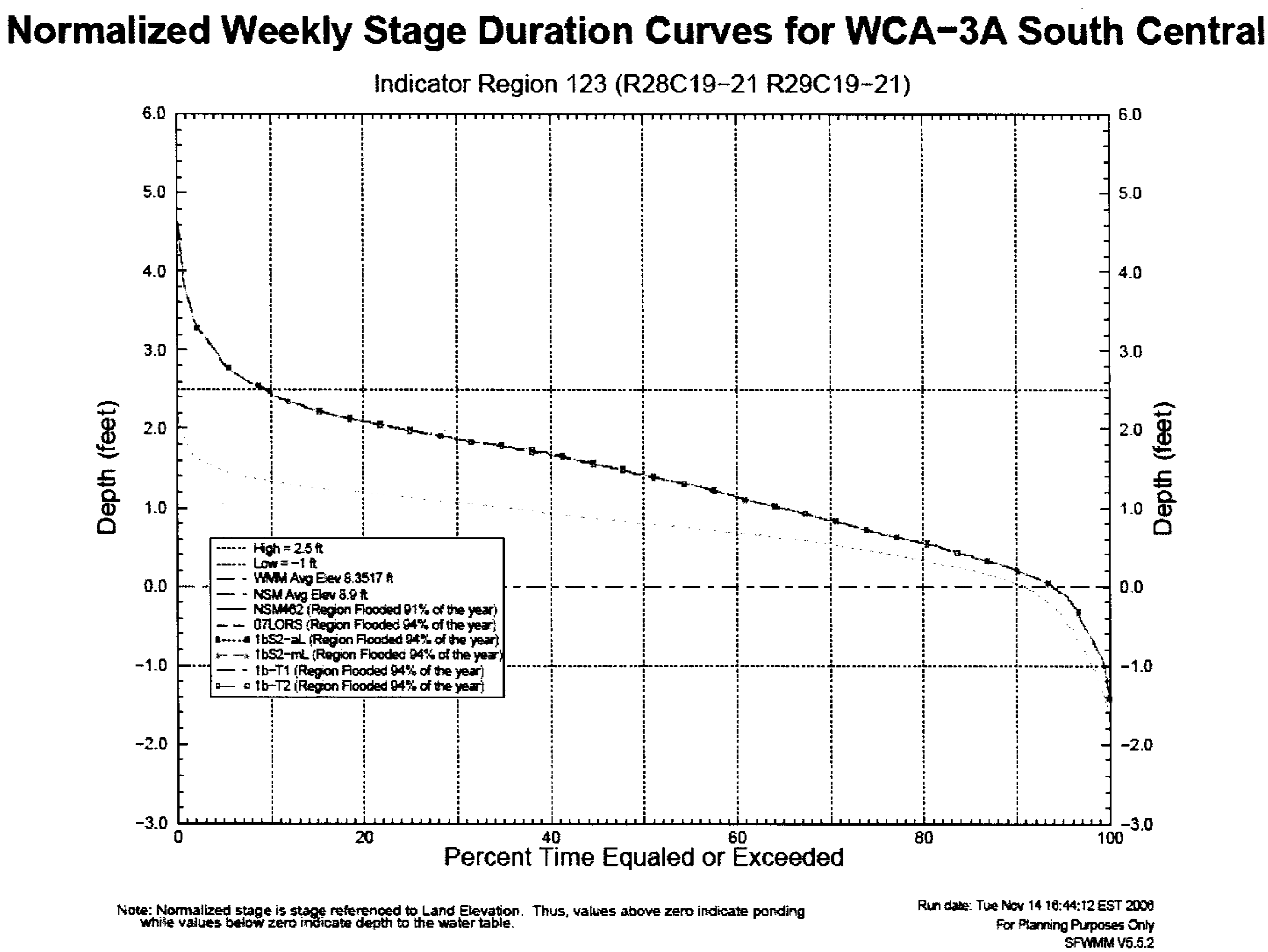


FIGURE C-55: STAGE DURATION CURVES FOR INDICATOR REGION 123, WCA-3A SOUTH CENTRAL (2)

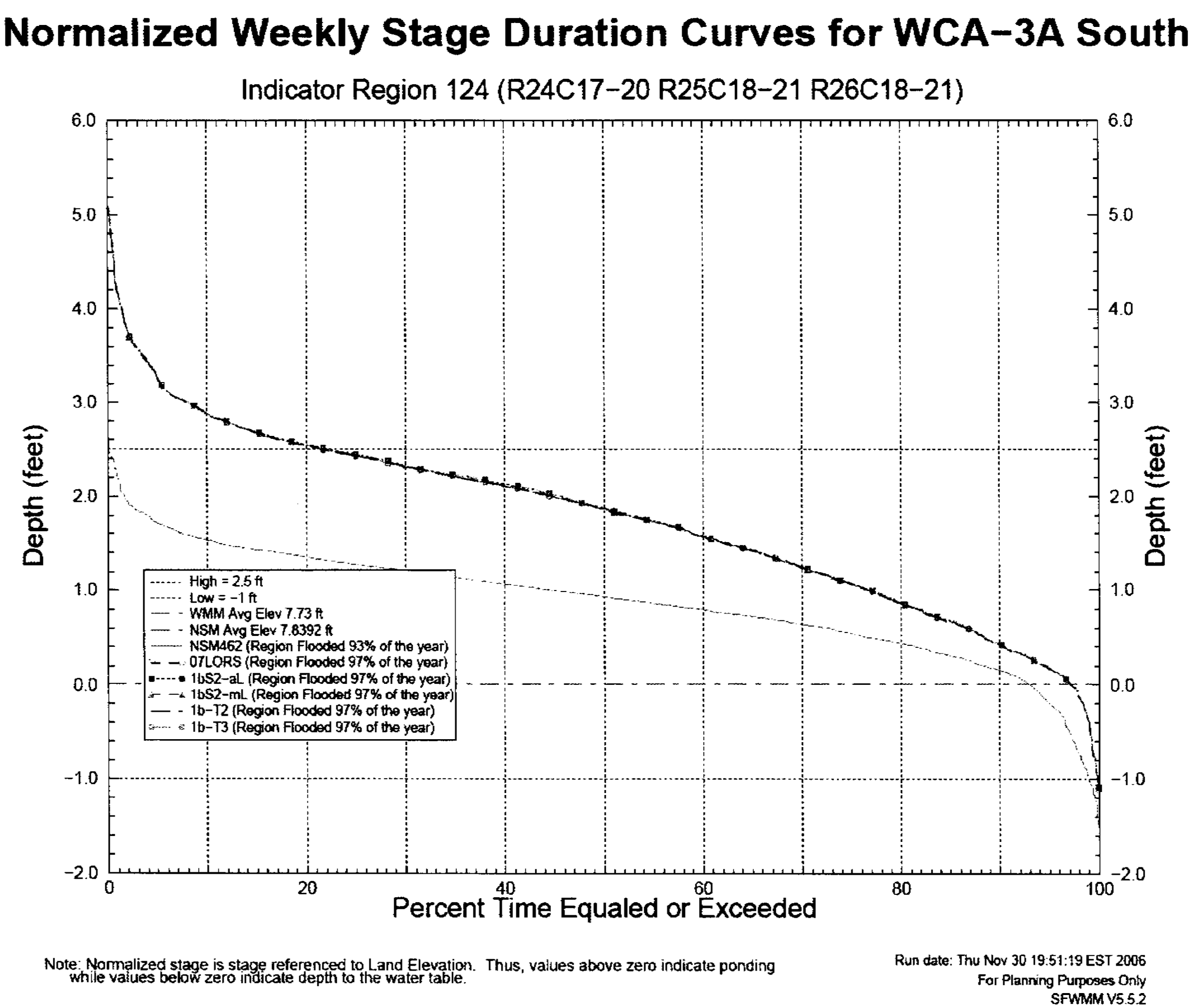


FIGURE C-56: STAGE DURATION CURVES FOR INDICATOR REGION 124, WCA-3A SOUTH (1)

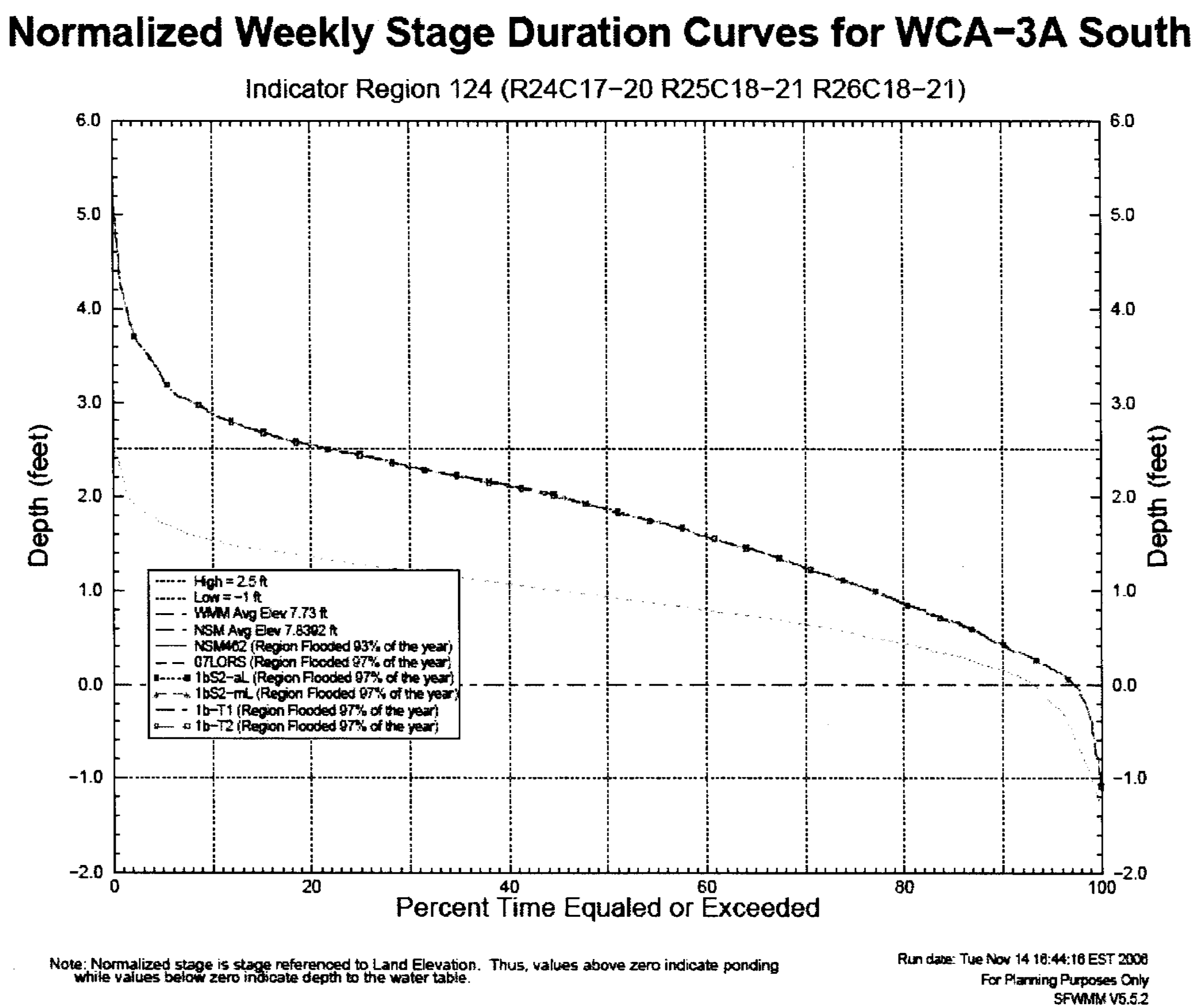


FIGURE C-57: STAGE DURATION CURVES FOR INDICATOR REGION 124, WCA-3A SOUTH (2)

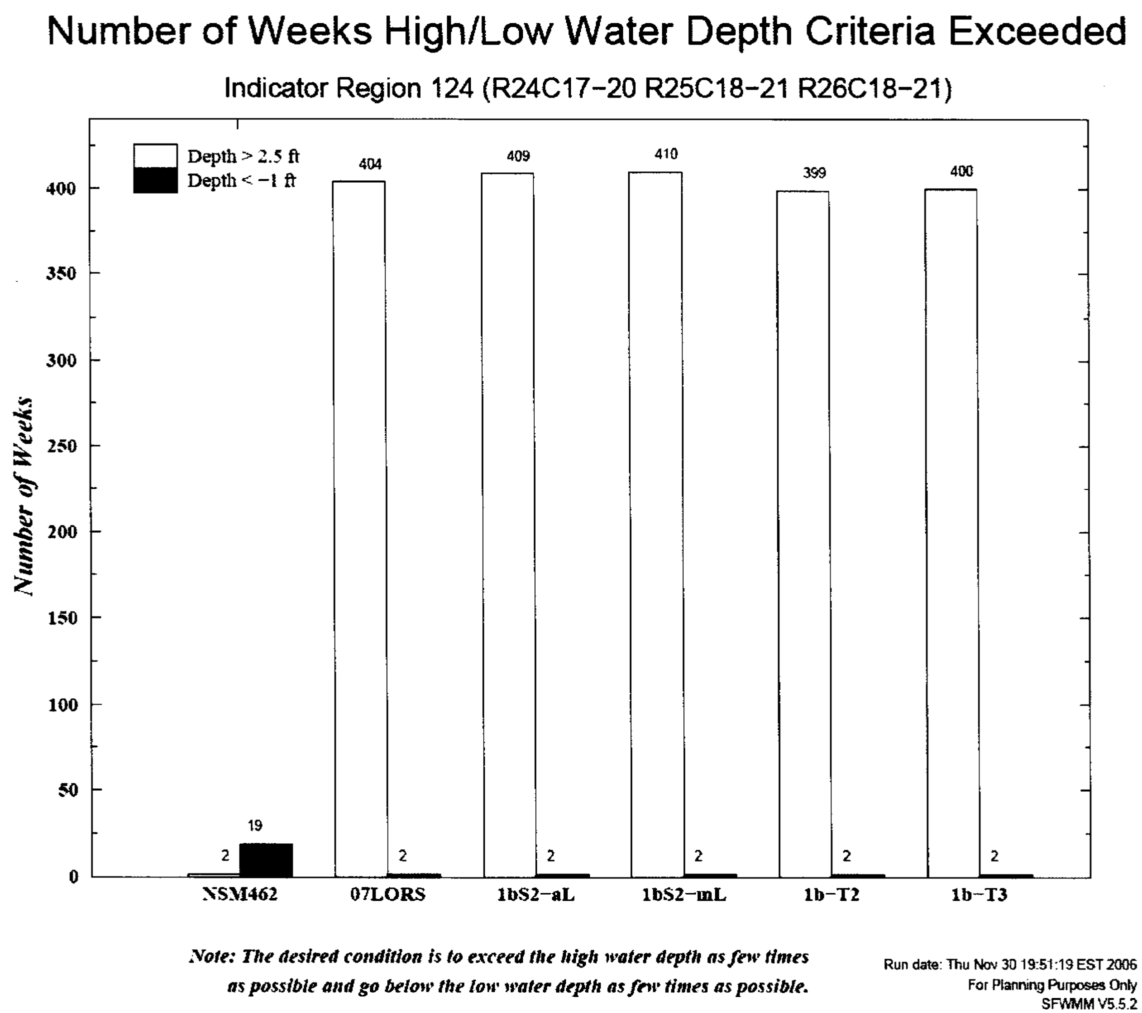


FIGURE C-58: HIGH AND LOW WATER DEPTH CRITERIA FOR INDICATOR REGION 124, WCA-3A SOUTH (1)

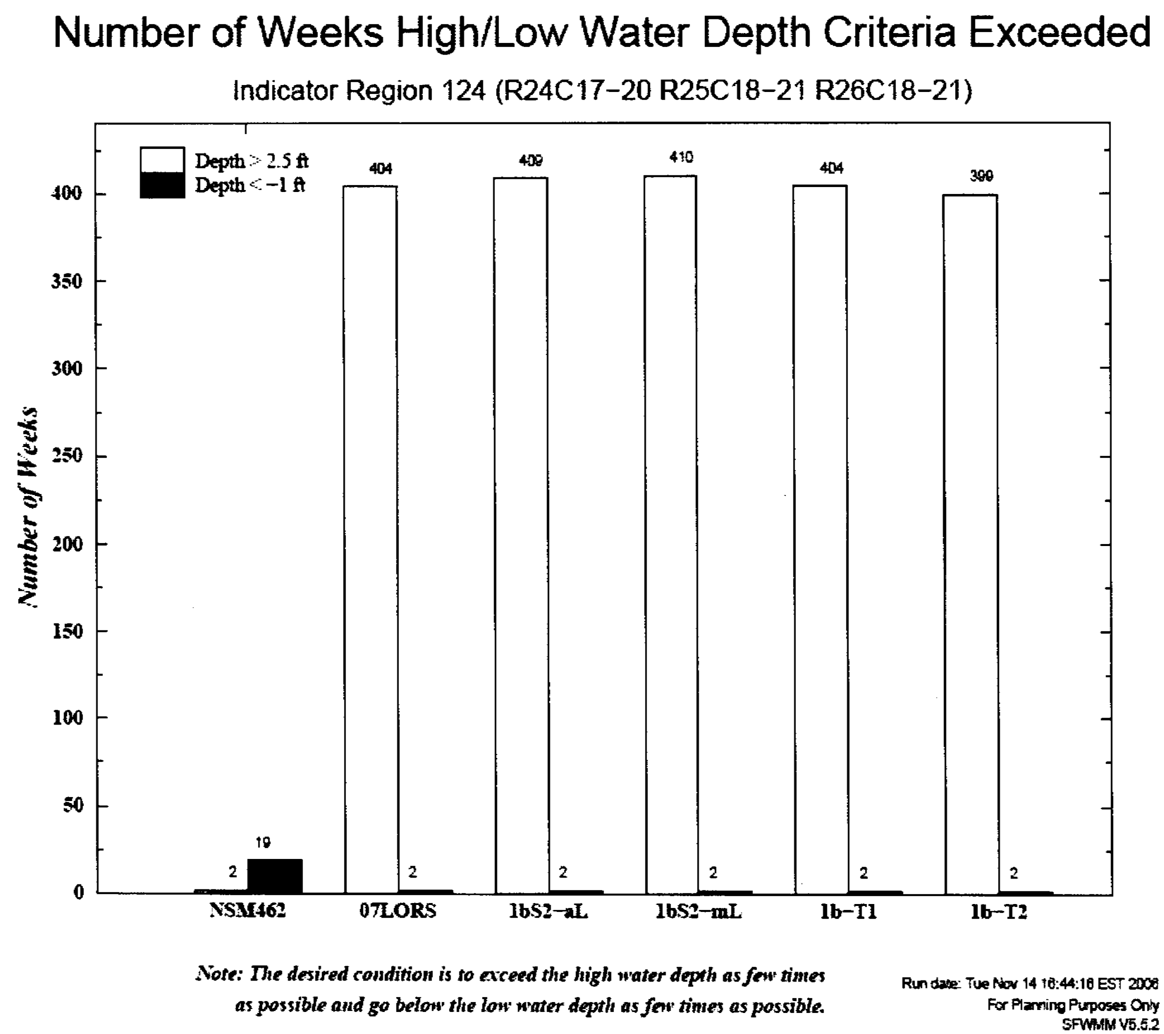


FIGURE C-59: HIGH AND LOW WATER DEPTH CRITERIA FOR INDICATOR REGION 124, WCA-3A SOUTH (2)

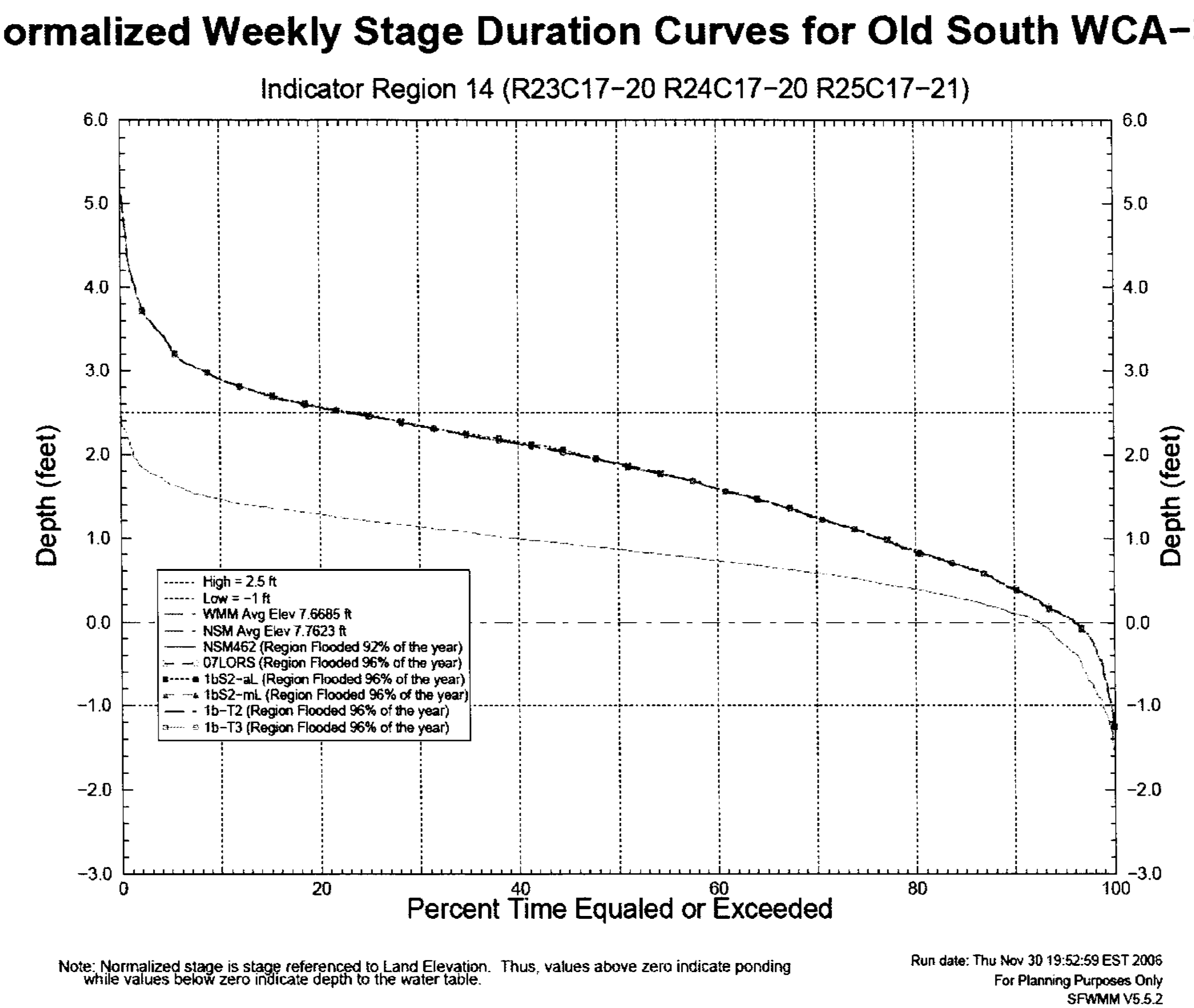


FIGURE C-60: STAGE DURATION CURVES FOR RESTUDY INDICATOR REGION 14, WCA-3A SOUTH (1)

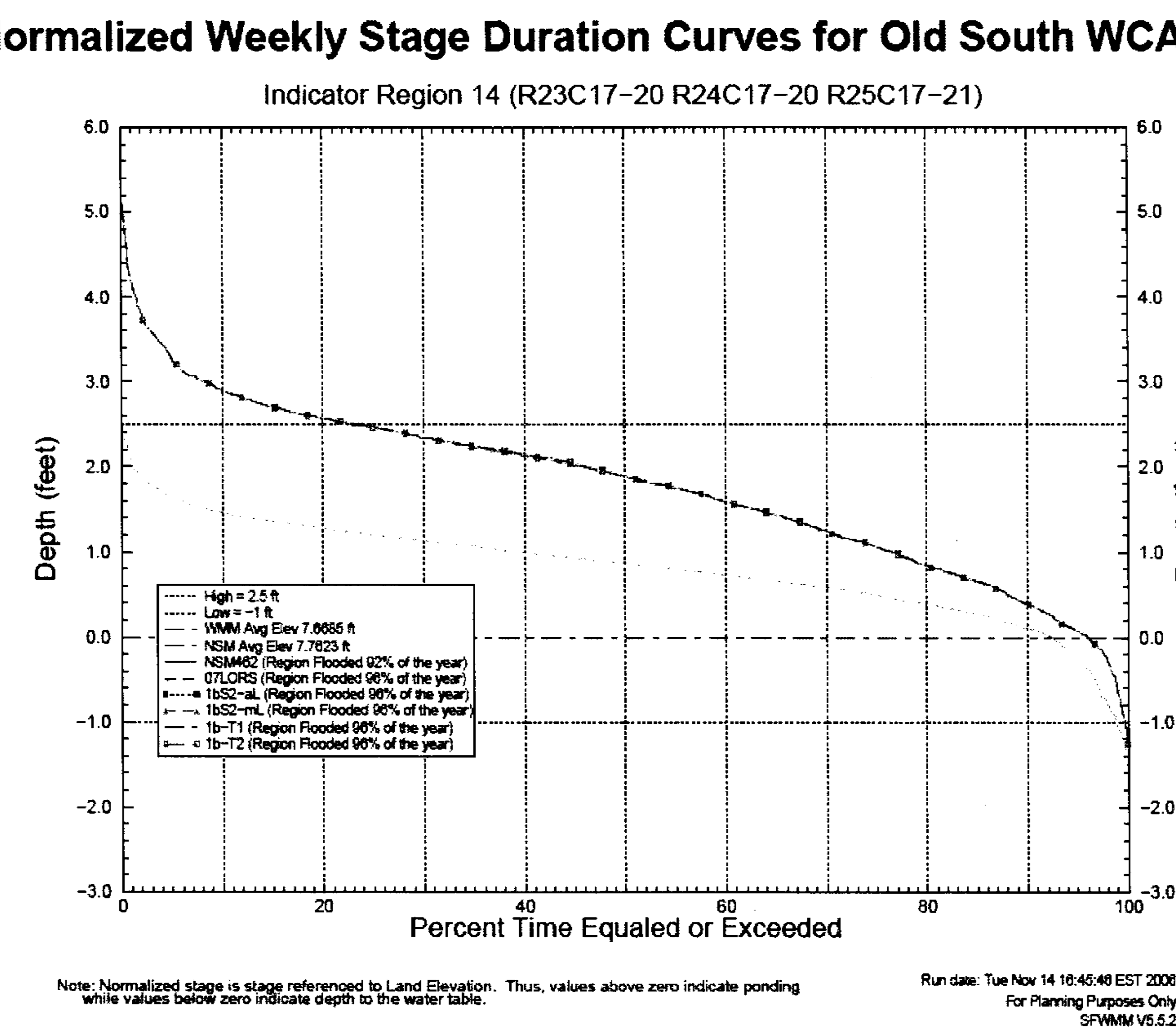


FIGURE C-61: STAGE DURATION CURVES FOR RESTUDY INDICATOR REGION 14, WCA-3A SOUTH (2)

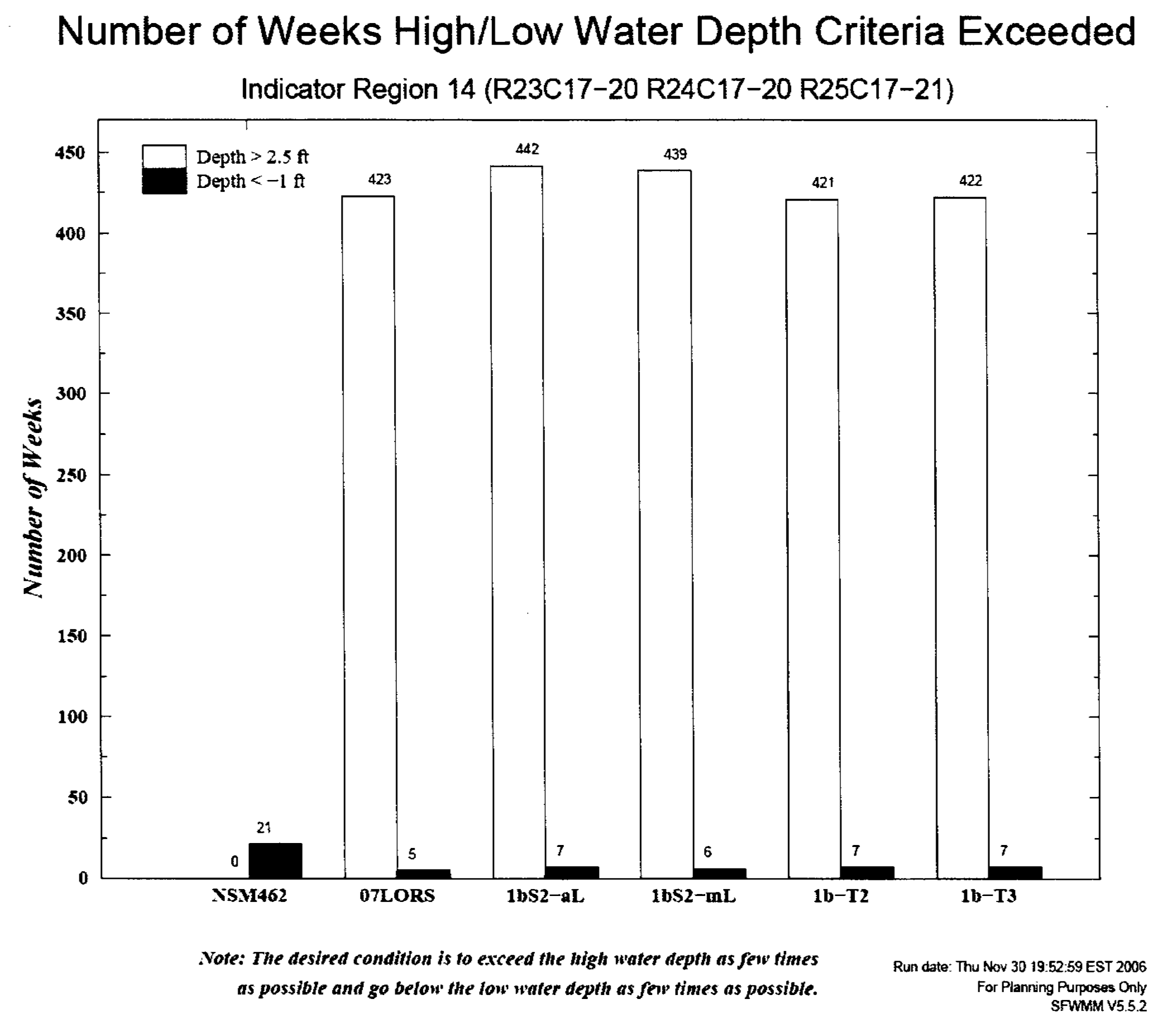


FIGURE C-62: HIGH AND LOW WATER DEPTH CRITERIA FOR RESTUDY INDICATOR REGION 14, WCA-3A SOUTH (1)

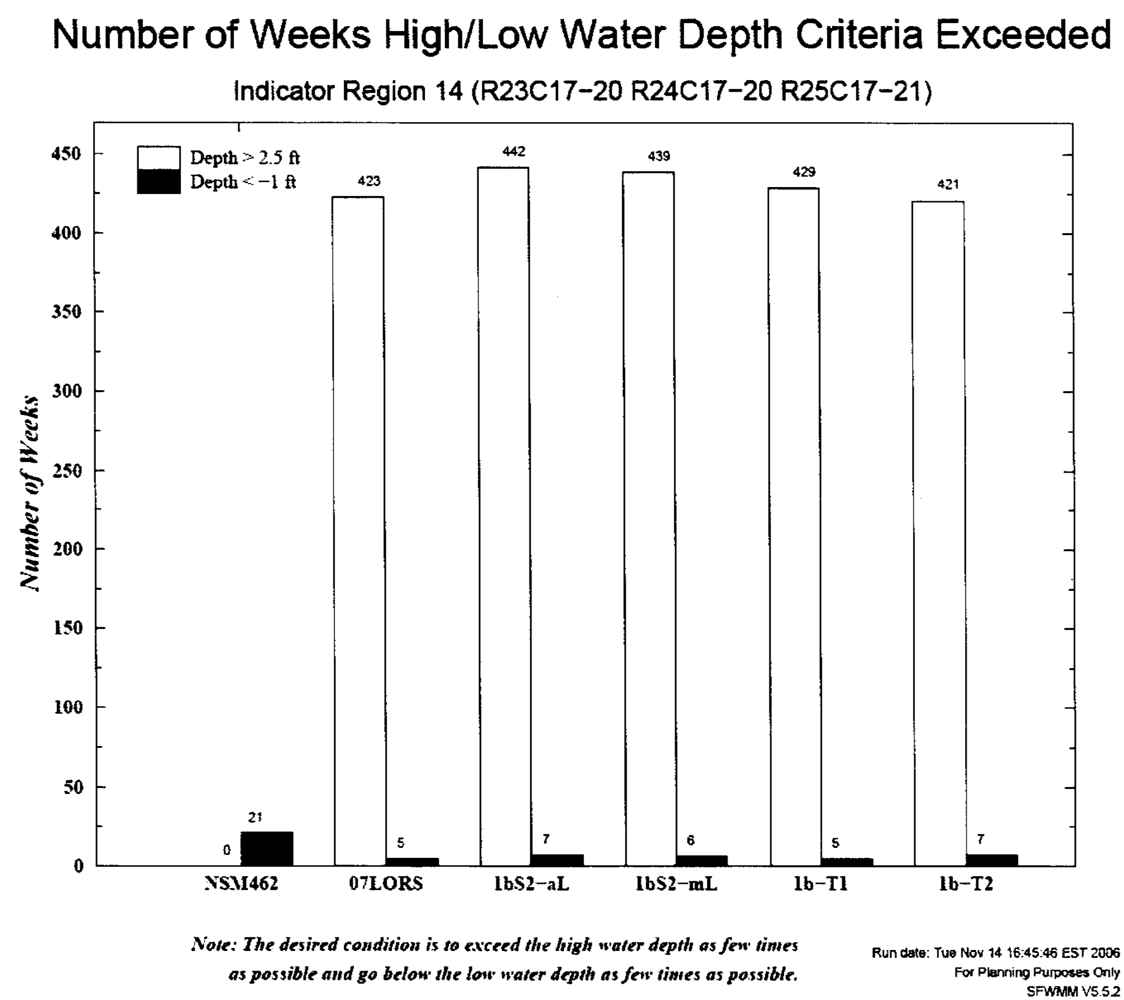


FIGURE C-63: HIGH AND LOW WATER DEPTH CRITERIA FOR RESTUDY INDICATOR REGION 14, WCA-3A SOUTH (2)

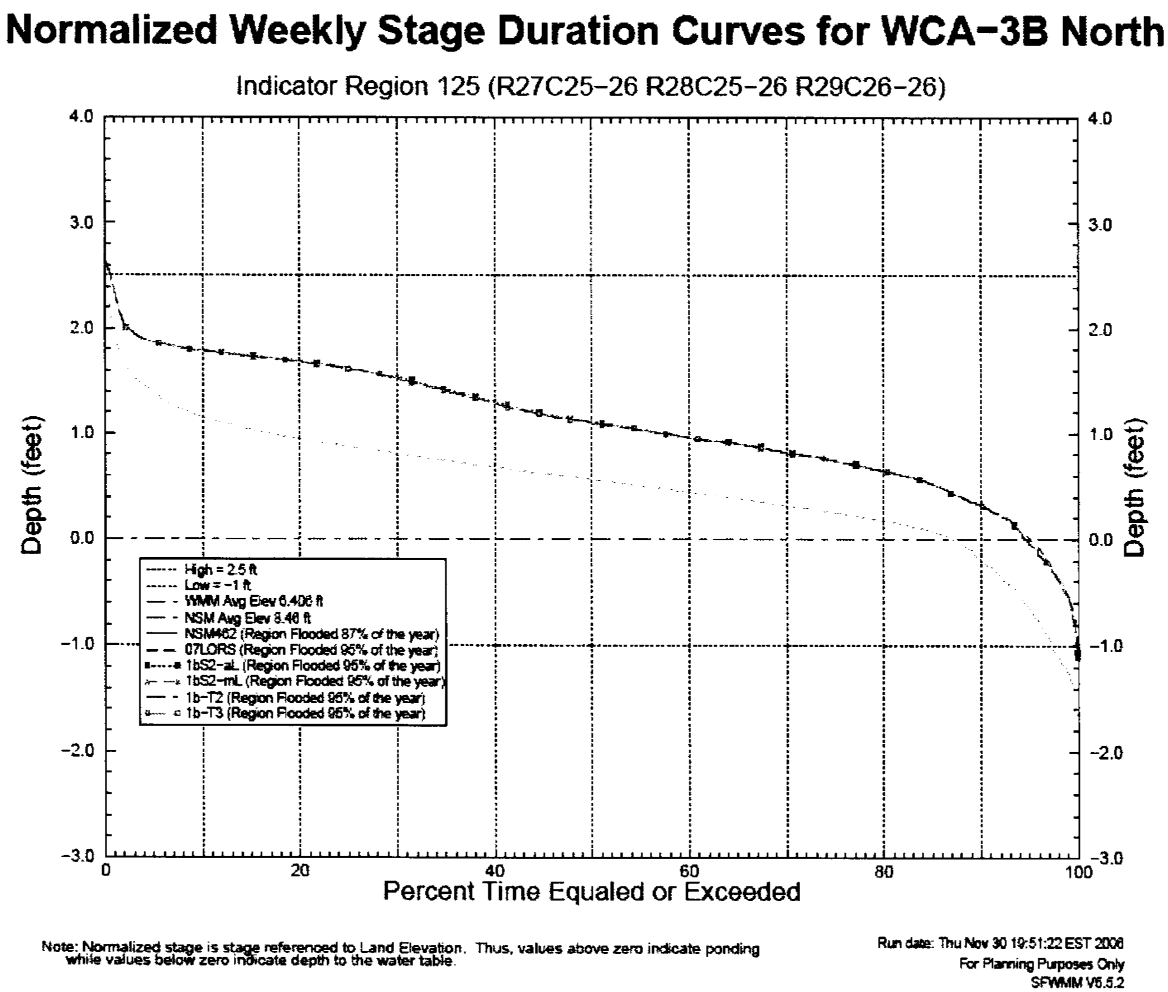


FIGURE C-64: STAGE DURATION CURVES FOR INDICATOR REGION 125, WCA-3B NORTH (1)

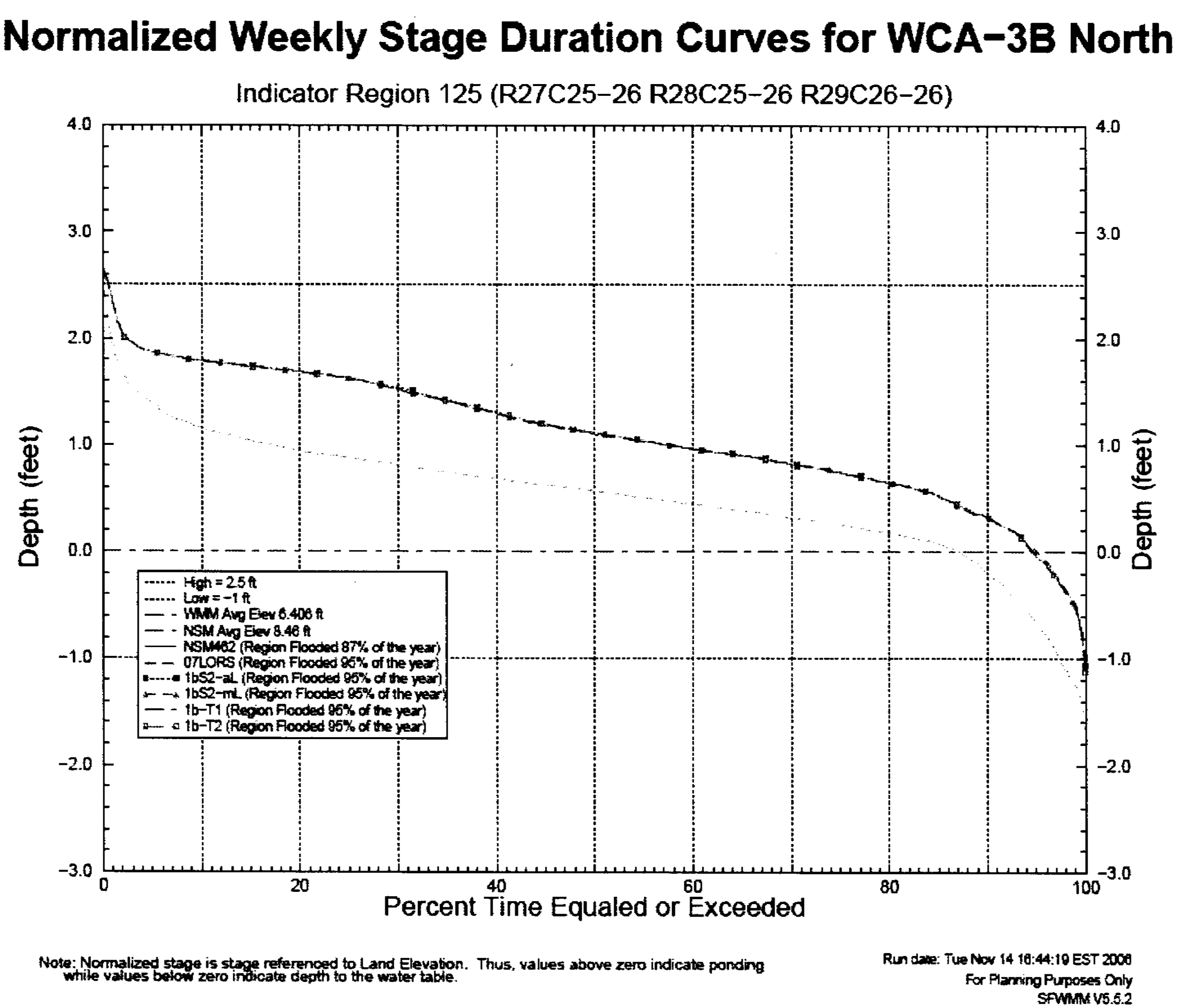


FIGURE C-65: STAGE DURATION CURVES FOR INDICATOR REGION 125, WCA-3B NORTH (2)

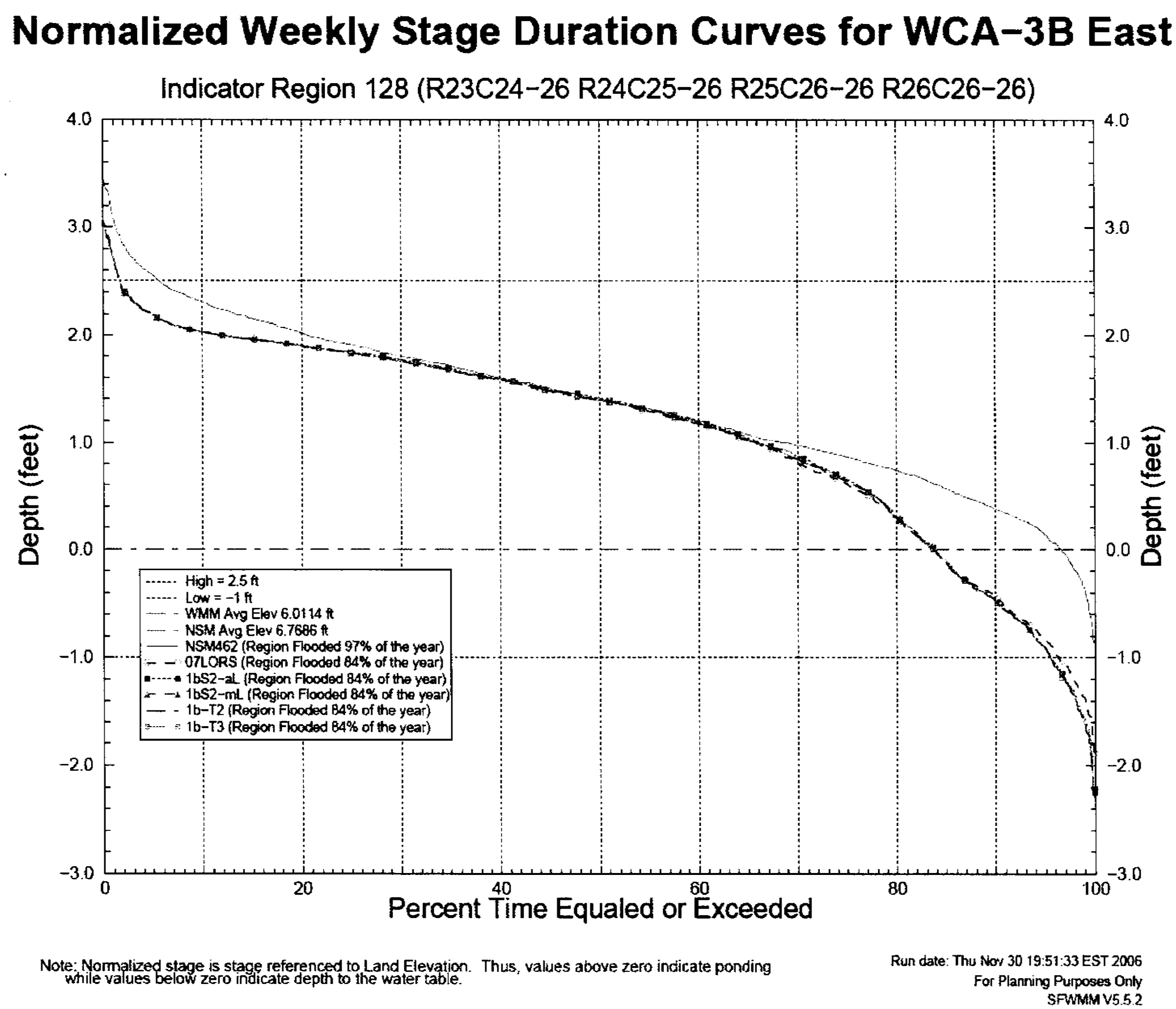


FIGURE C-66: STAGE DURATION CURVES FOR INDICATOR REGION 128, WCA-3B EAST (1)

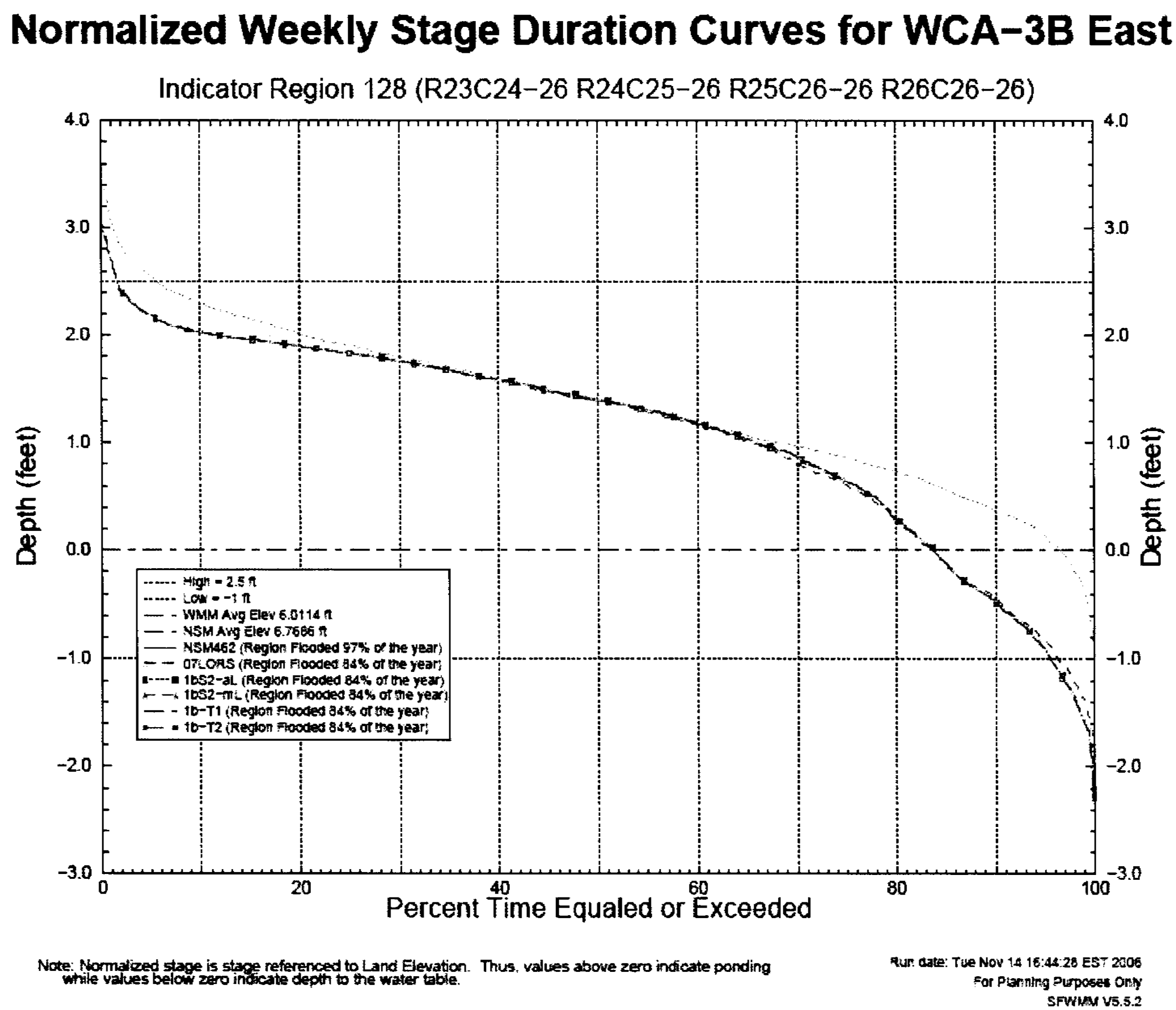


FIGURE C-67: STAGE DURATION CURVES FOR INDICATOR REGION 128, WCA-3B EAST (2)

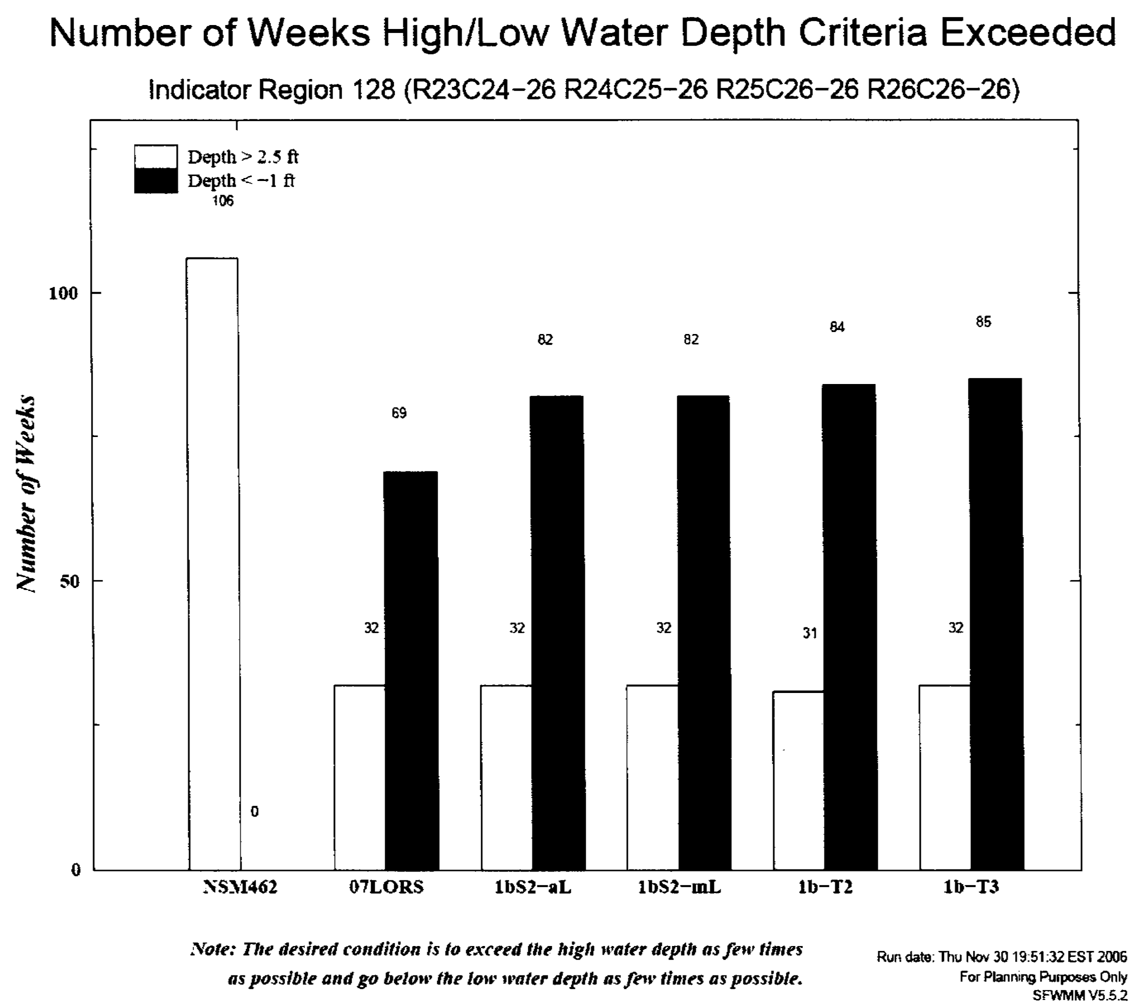


FIGURE C-68: HIGH AND LOW WATER DEPTH CRITERIA FOR INDICATOR REGION 128, WCA-3B EAST (1)

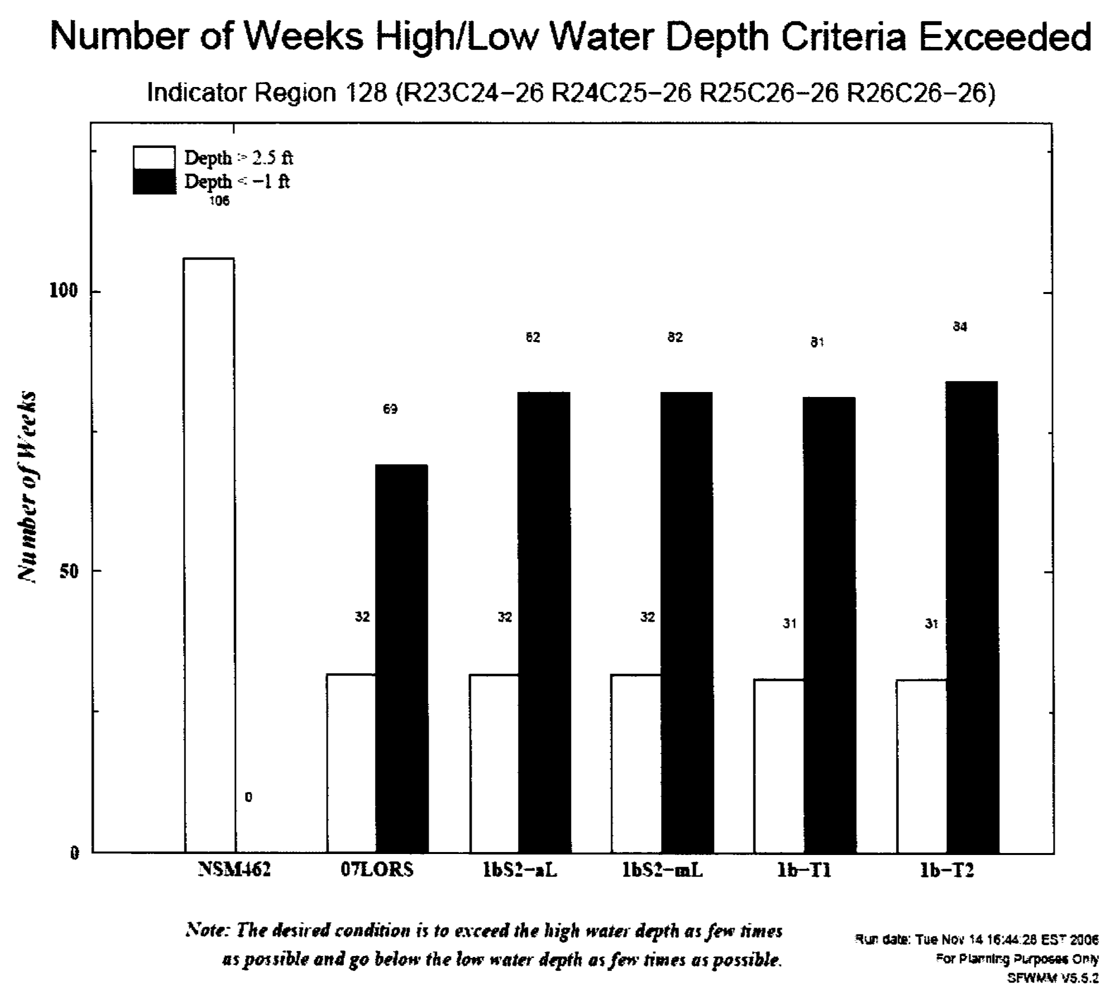


FIGURE C-69: HIGH AND LOW WATER DEPTH CRITERIA FOR INDICATOR REGION 128, WCA-3B EAST (2)

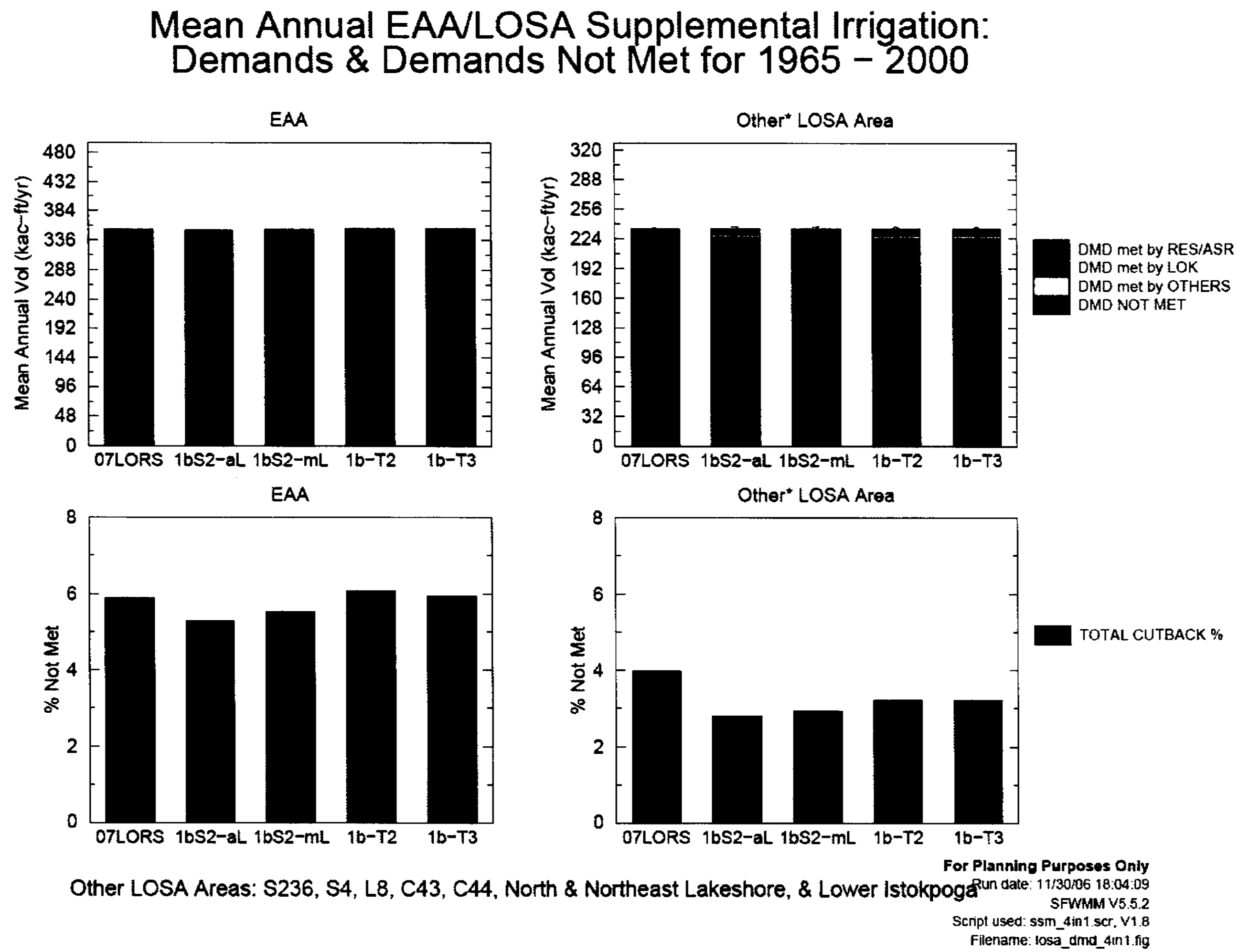


FIGURE C-70: MEAN ANNUAL EAA AND LOSA SUPPLEMENTAL IRRIGATION DEMANDS AND DEMANDS NOT MET, 1965-2000 (1)

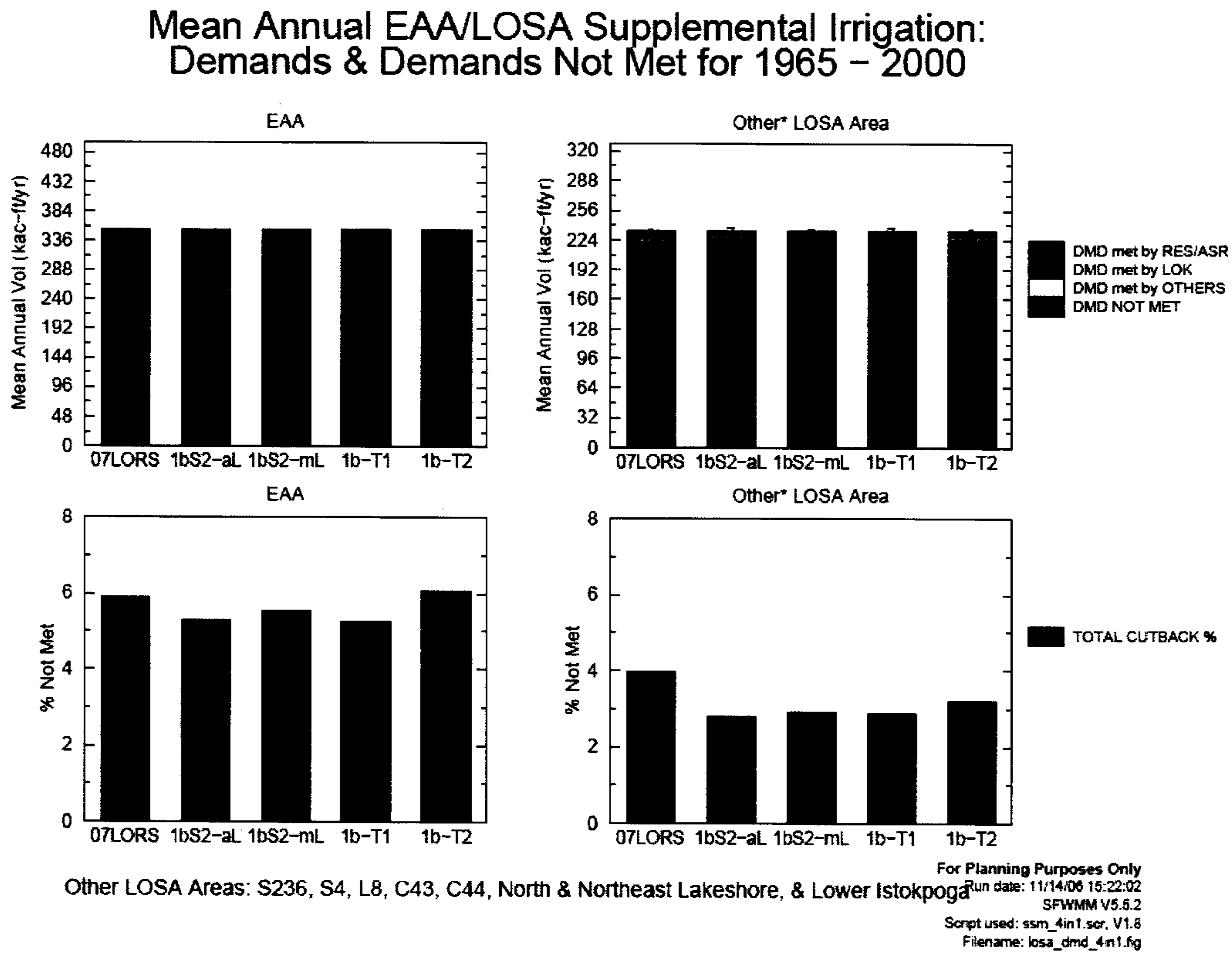
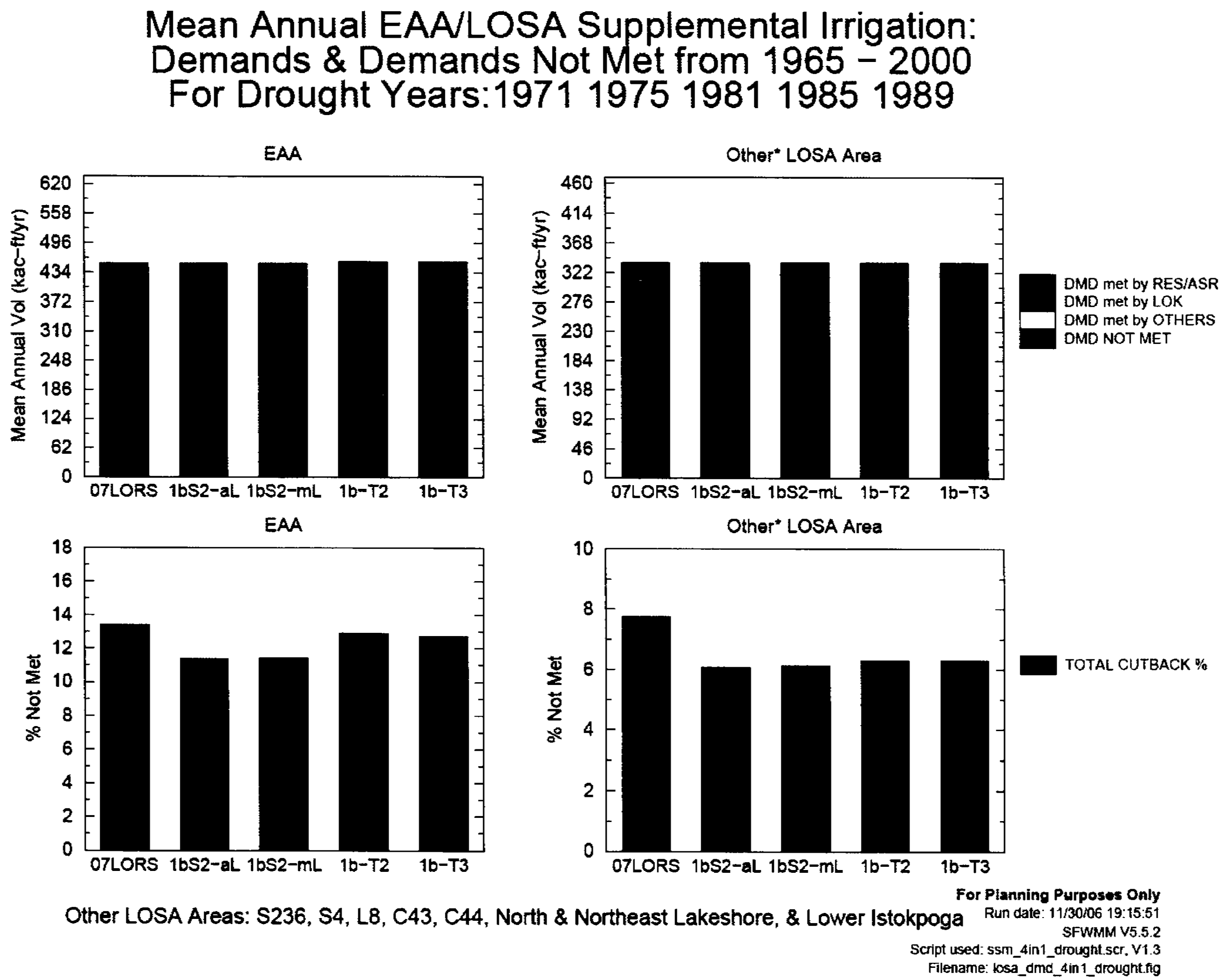


FIGURE C-71: MEAN ANNUAL EAA AND LOSA SUPPLEMENTAL IRRIGATION DEMANDS AND DEMANDS NOT MET, 1965-2000 (2)



Other LOSA Areas: S236, S4, L8, C43, C44, North & Northeast Lakeshore, & Lower Istokpoga

FIGURE C-72: MEAN ANNUAL EAA AND LOSA SUPPLEMENTAL IRRIGATION DEMANDS AND DEMANDS NOT MET, 1965-2000 DROUGHT YEARS (1)

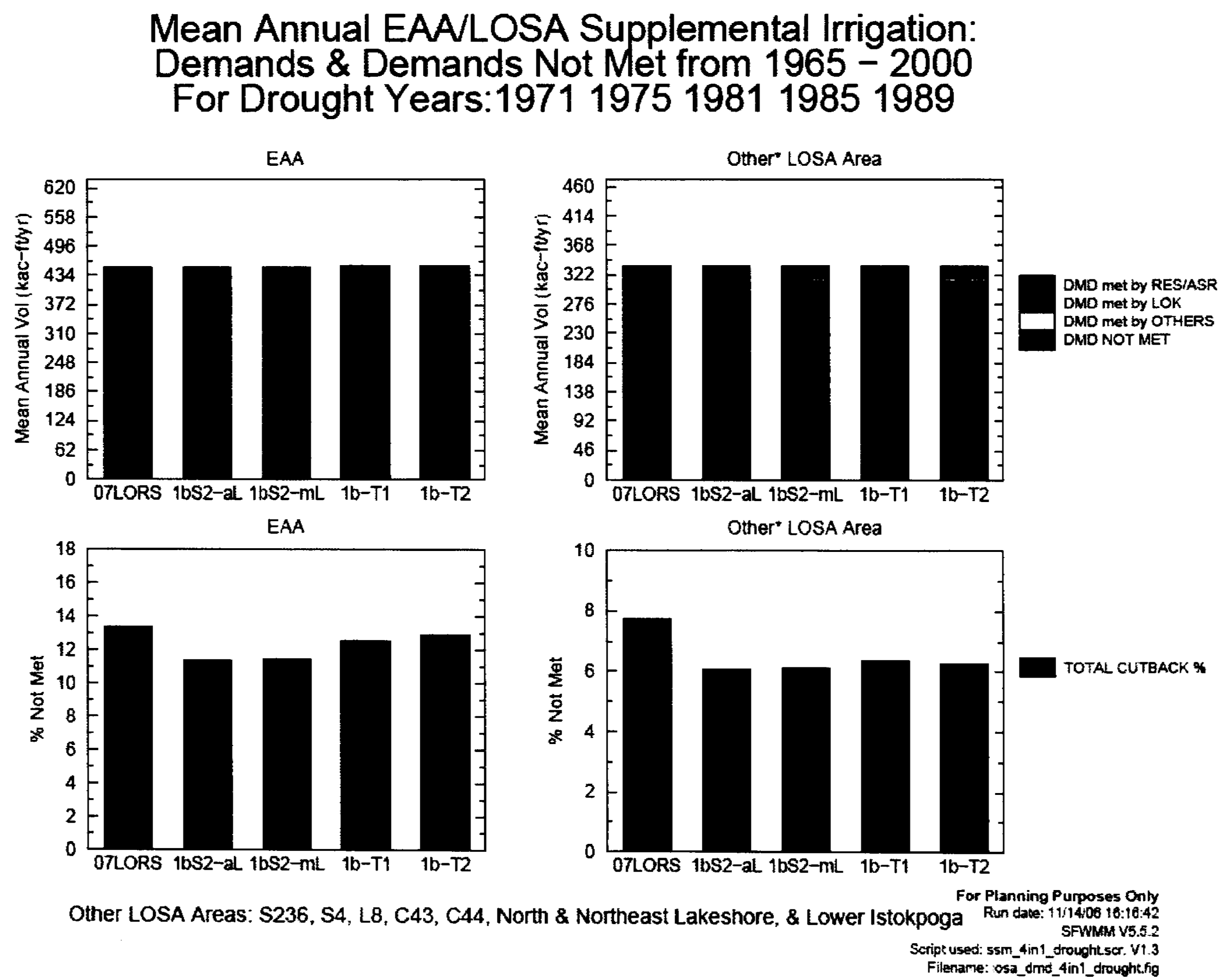


FIGURE C-73: MEAN ANNUAL EAA AND LOSA SUPPLEMENTAL IRRIGATION DEMANDS AND DEMANDS NOT MET, 1965-2000 DROUGHT YEARS (2)

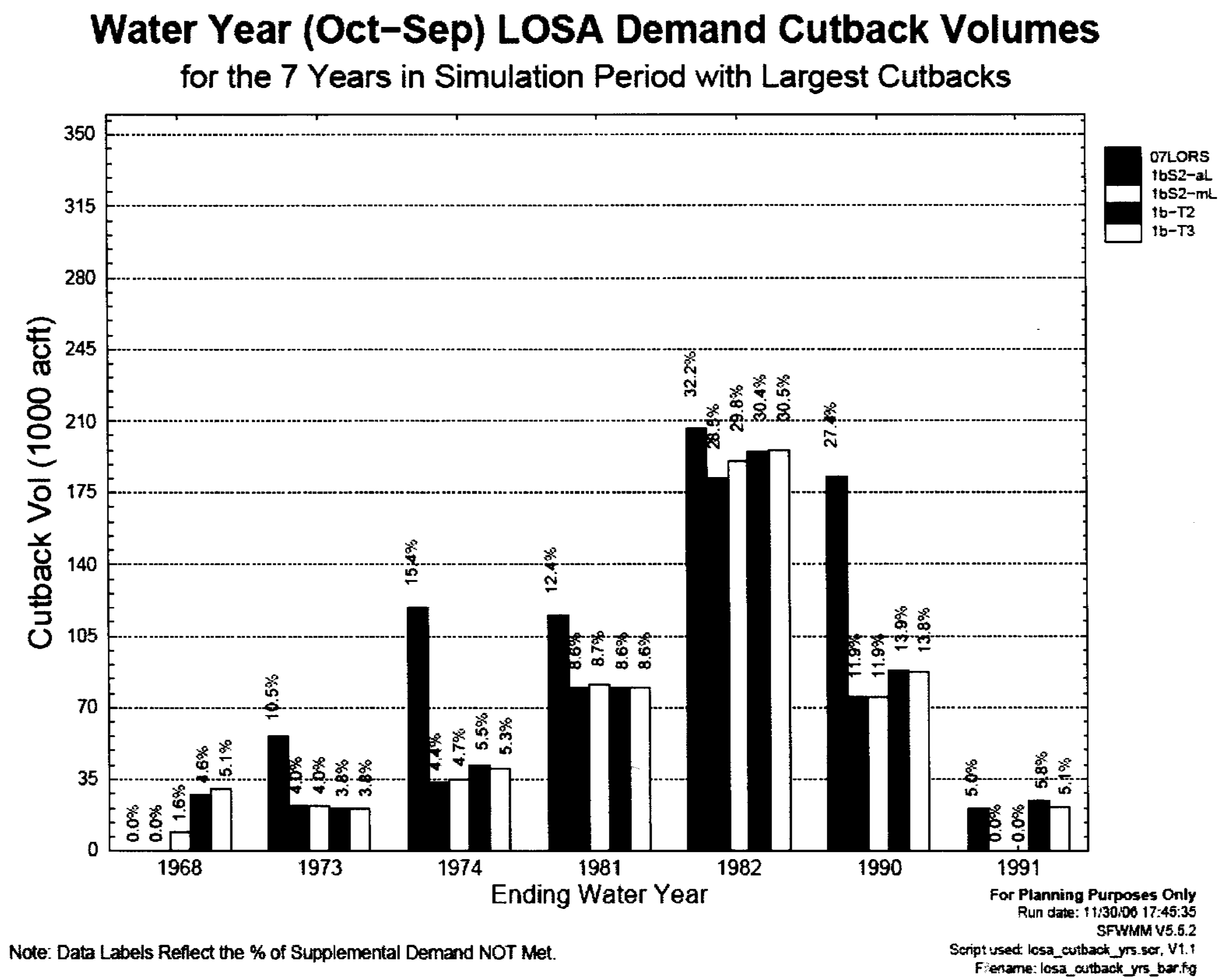


FIGURE C-74: WATER YEAR LOSA DEMAND CUTBACK VOLUMES, 7 DROUGHT YEARS (1)

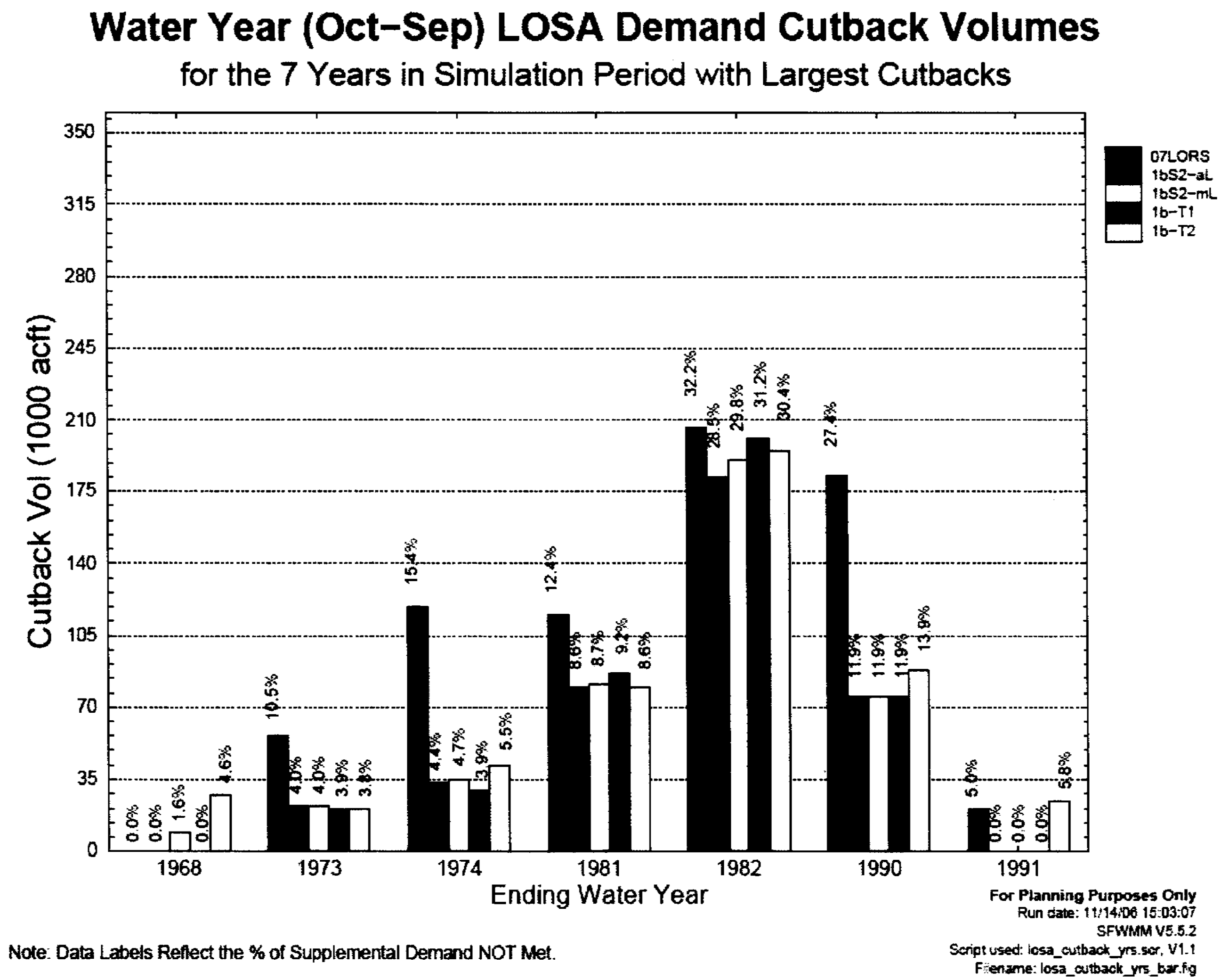


FIGURE C-75: WATER YEAR LOSA DEMAND CUTBACK VOLUMES, 7 DROUGHT YEARS (2)

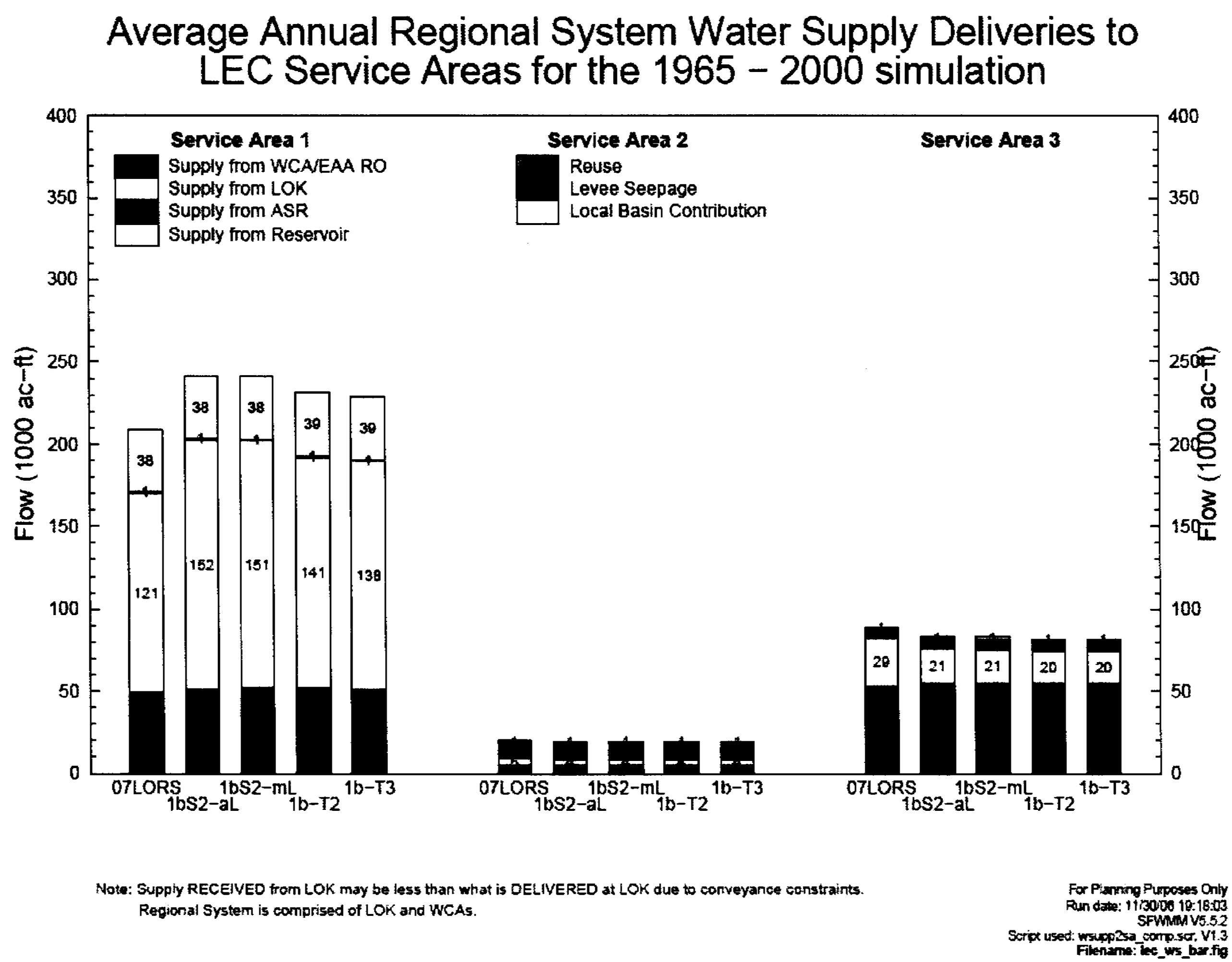


FIGURE C-76: AVERAGE ANNUAL REGIONAL WATER SUPPLY DELIVERIES TO LOWER EAST COAST SERVICE AREAS, 1965-2000 (1)

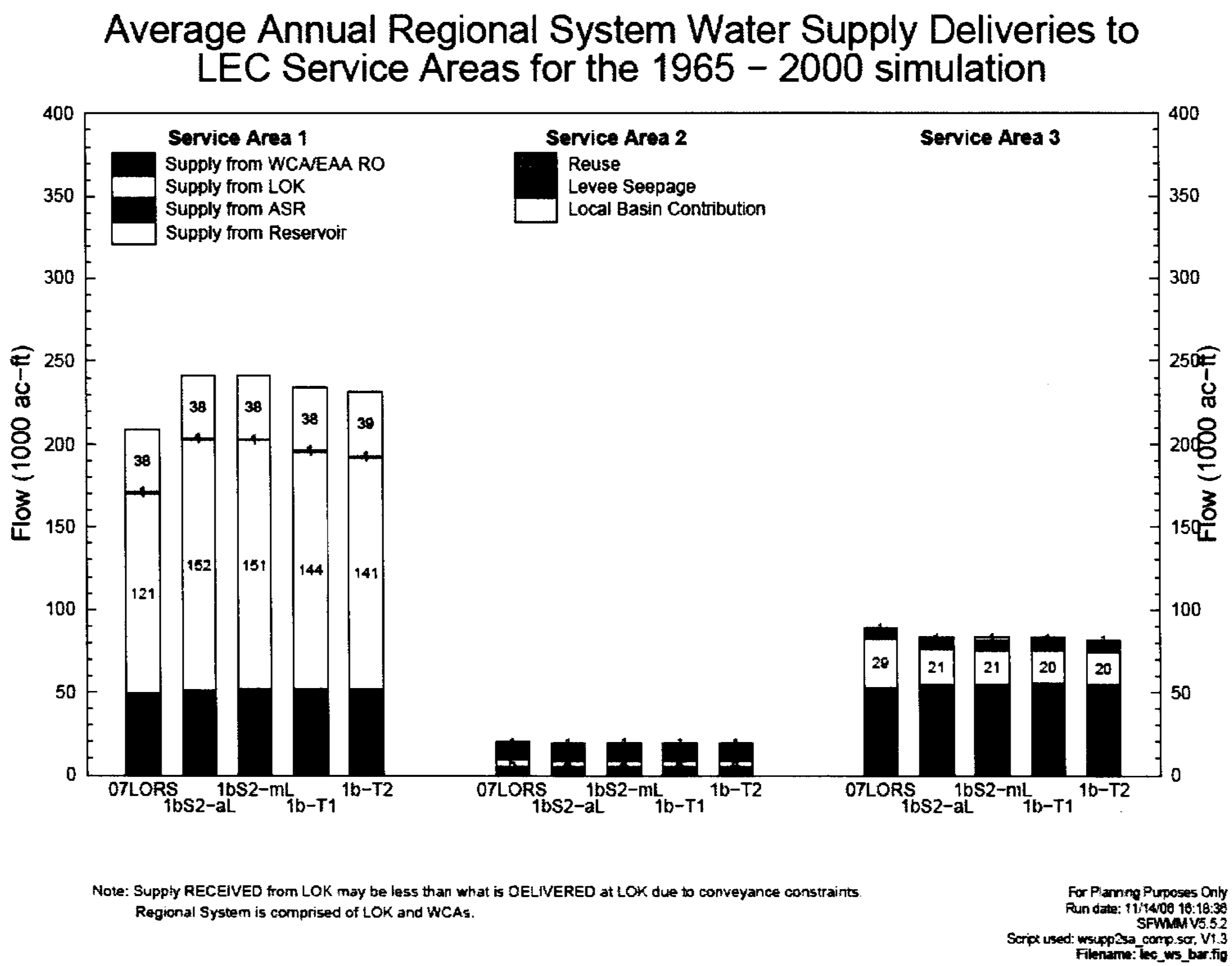


FIGURE C-77: AVERAGE ANNUAL REGIONAL WATER SUPPLY DELIVERIES TO LOWER EAST COAST SERVICE AREAS, 1965-2000 (2)

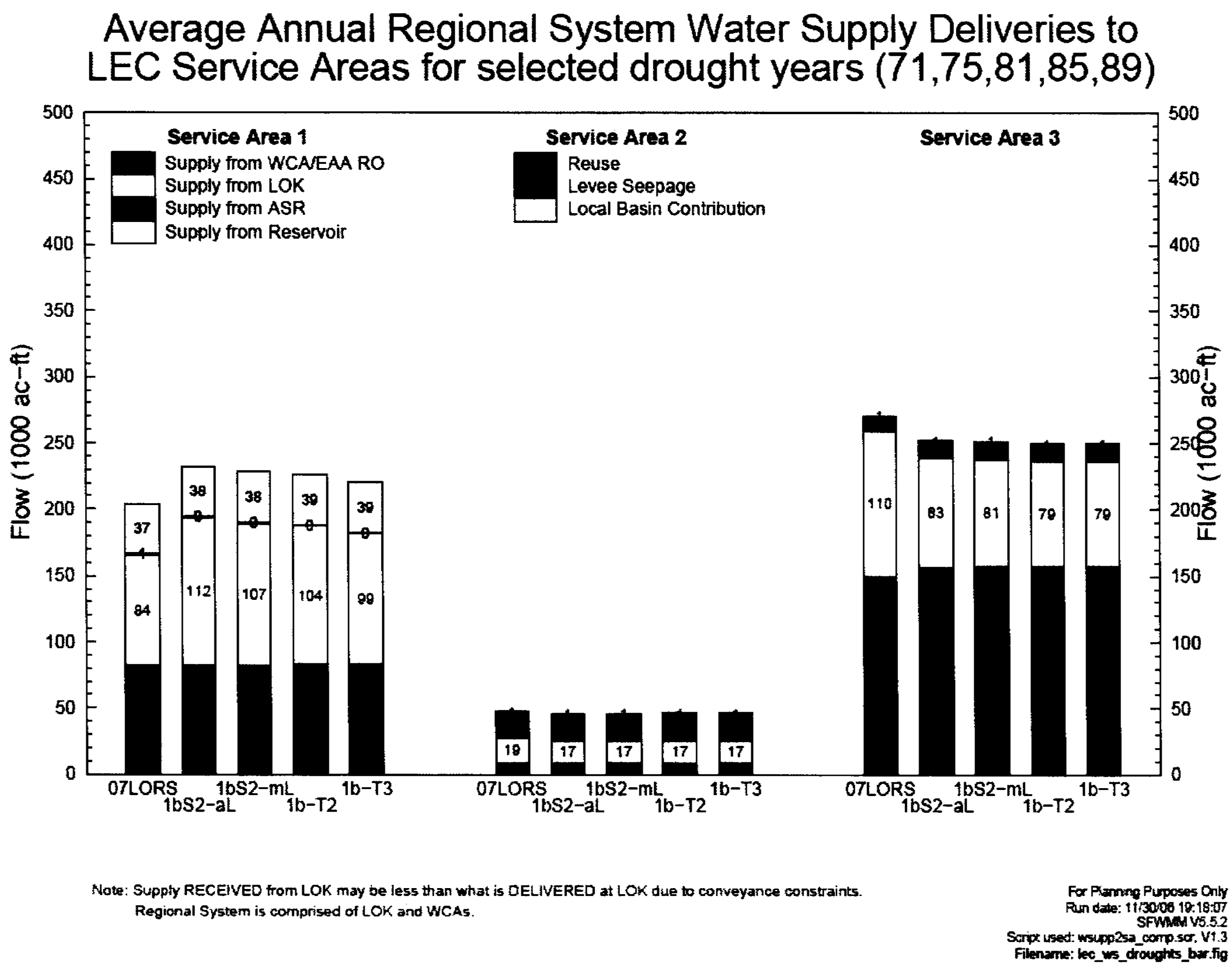


FIGURE C-78: AVERAGE ANNUAL REGIONAL WATER SUPPLY DELIVERIES TO LOWER EAST COAST SERVICE AREAS, 1965-2000 DROUGHT YEARS (1)

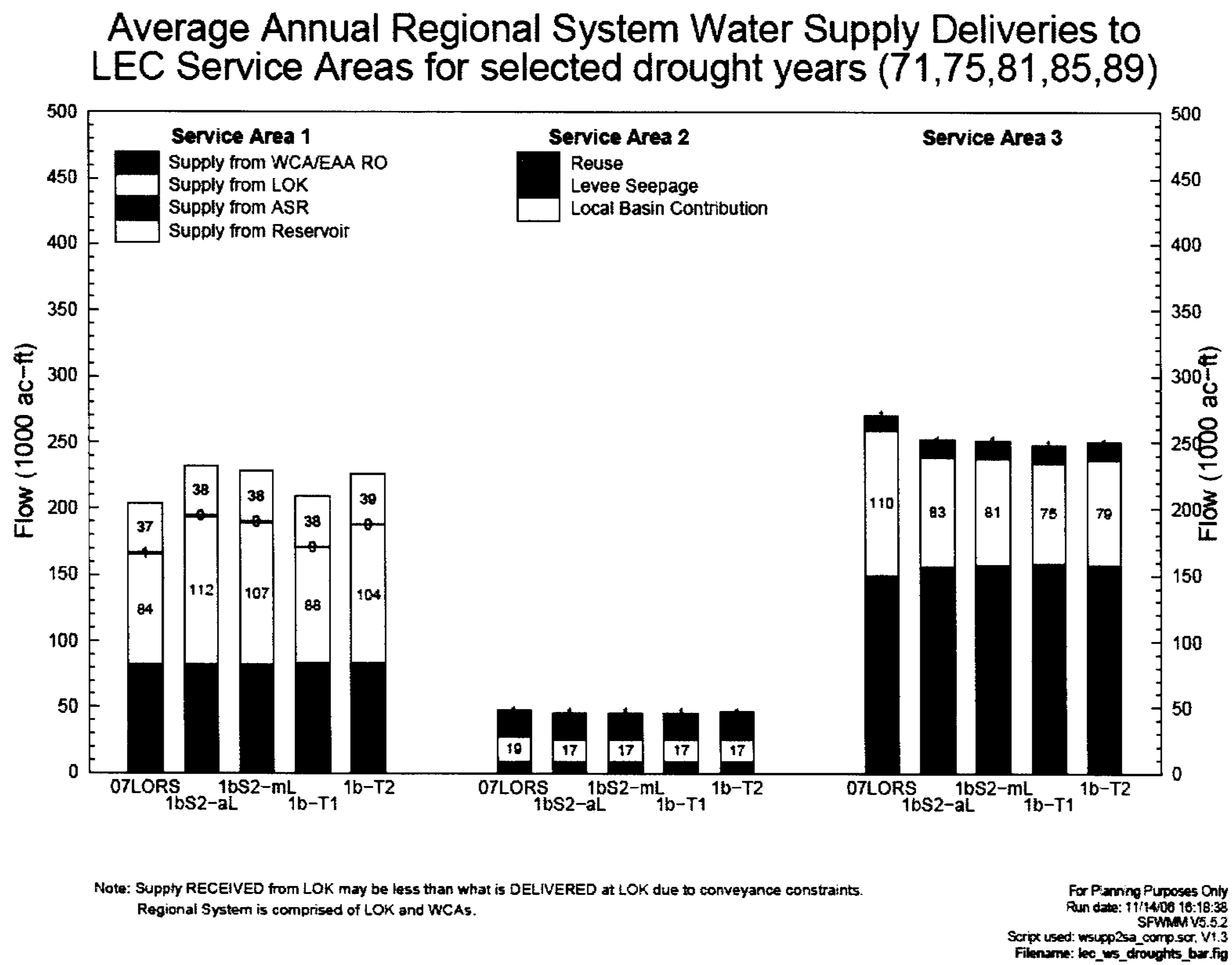


FIGURE C-79: AVERAGE ANNUAL REGIONAL WATER SUPPLY DELIVERIES TO LOWER EAST COAST SERVICE AREAS, 1965-2000 DROUGHT YEARS (2)

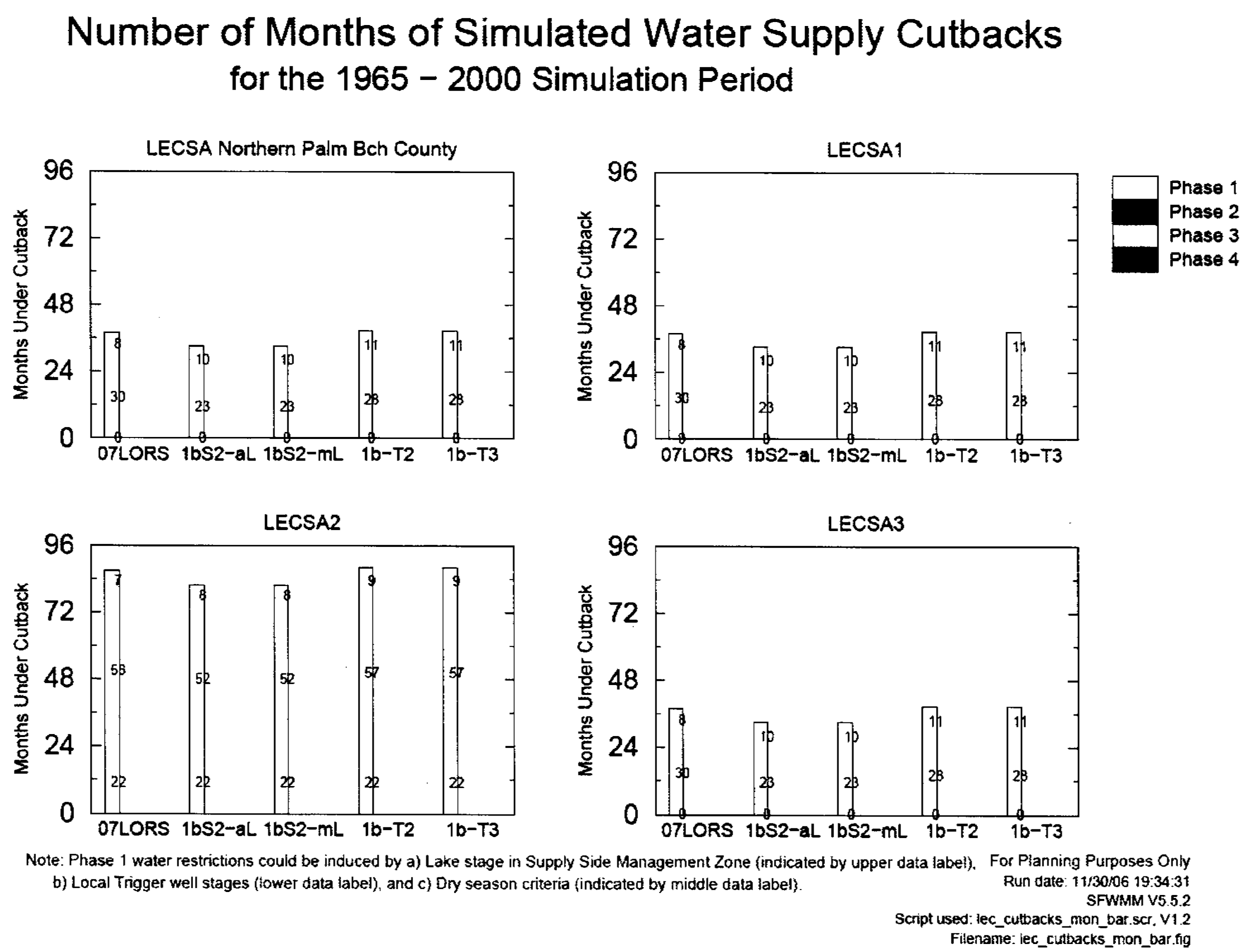


FIGURE C-80: MONTHS OF SIMULATED WATER SUPPLY CUTBACKS FOR LOWER EAST COAST SERVICE AREAS (1)

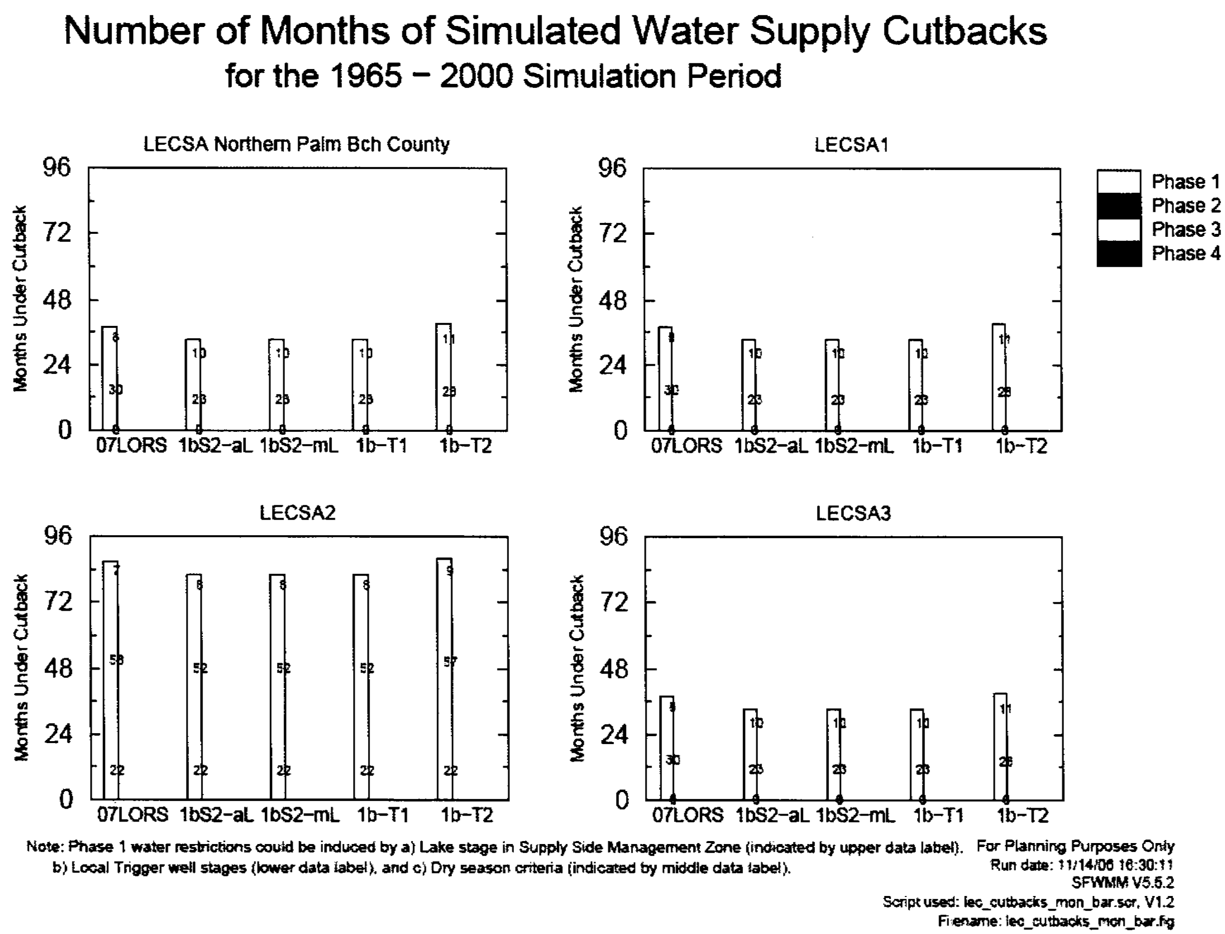


FIGURE C-81: MONTHS OF SIMULATED WATER SUPPLY CUTBACKS FOR LOWER EAST COAST SERVICE AREAS (2)

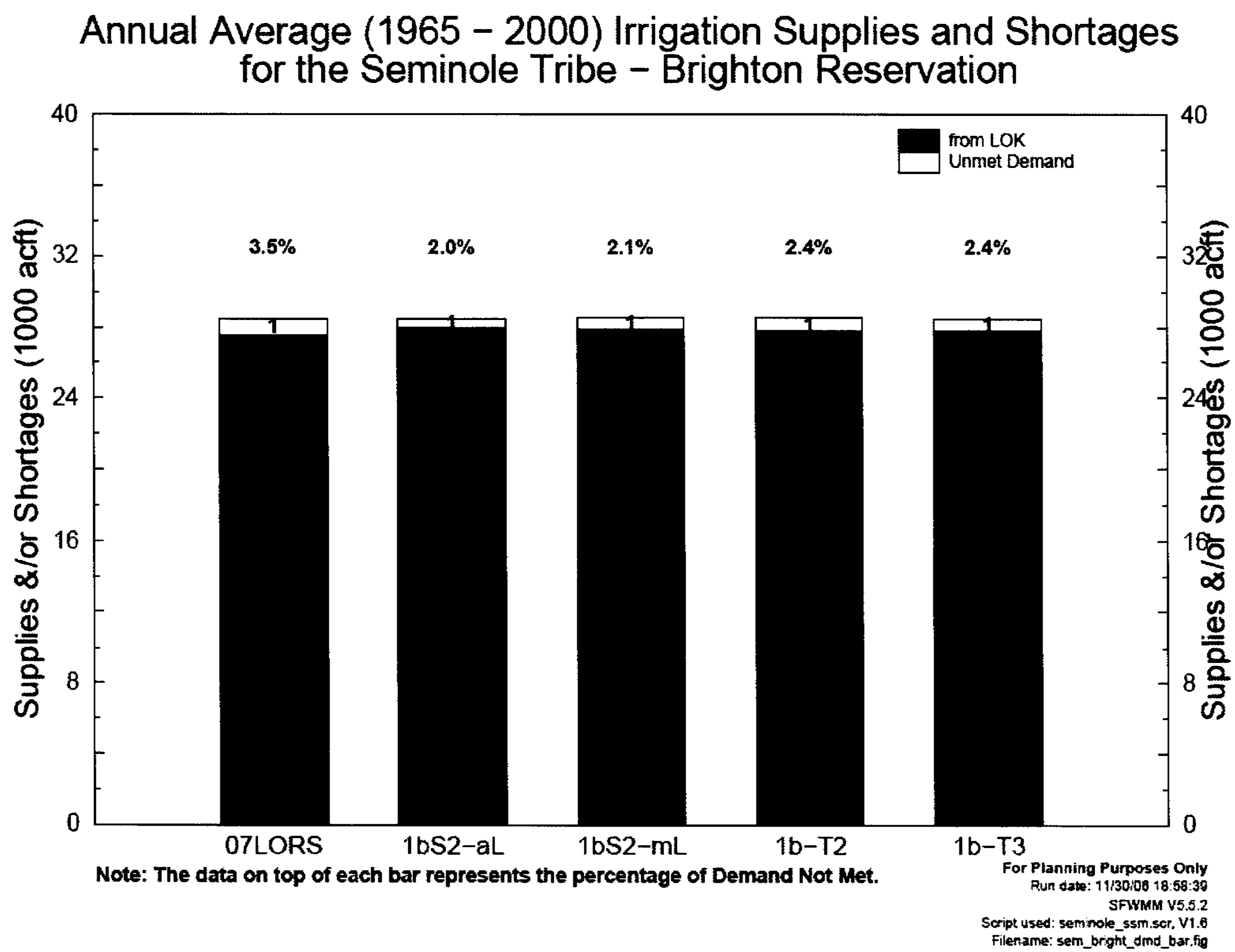


FIGURE C-82: AVERAGE ANNUAL SIMULATED IRRIGATION SUPPLIES AND SHORTAGES FOR THE SEMINOLE TRIBE – BRIGHTON RESERVATION (1)

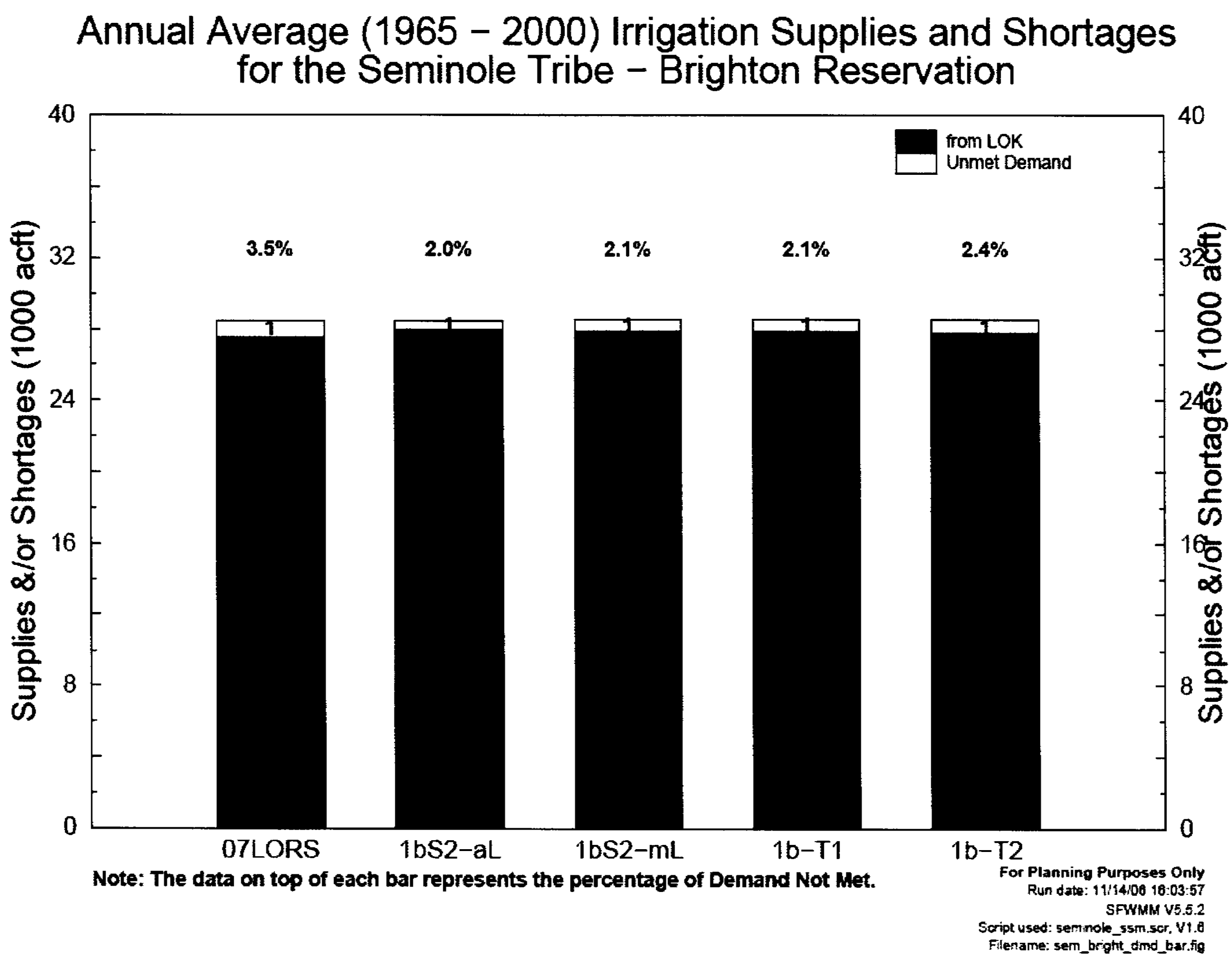


FIGURE C-83: AVERAGE ANNUAL SIMULATED IRRIGATION SUPPLIES AND SHORTAGES FOR THE SEMINOLE TRIBE – BRIGHTON RESERVATION (2)

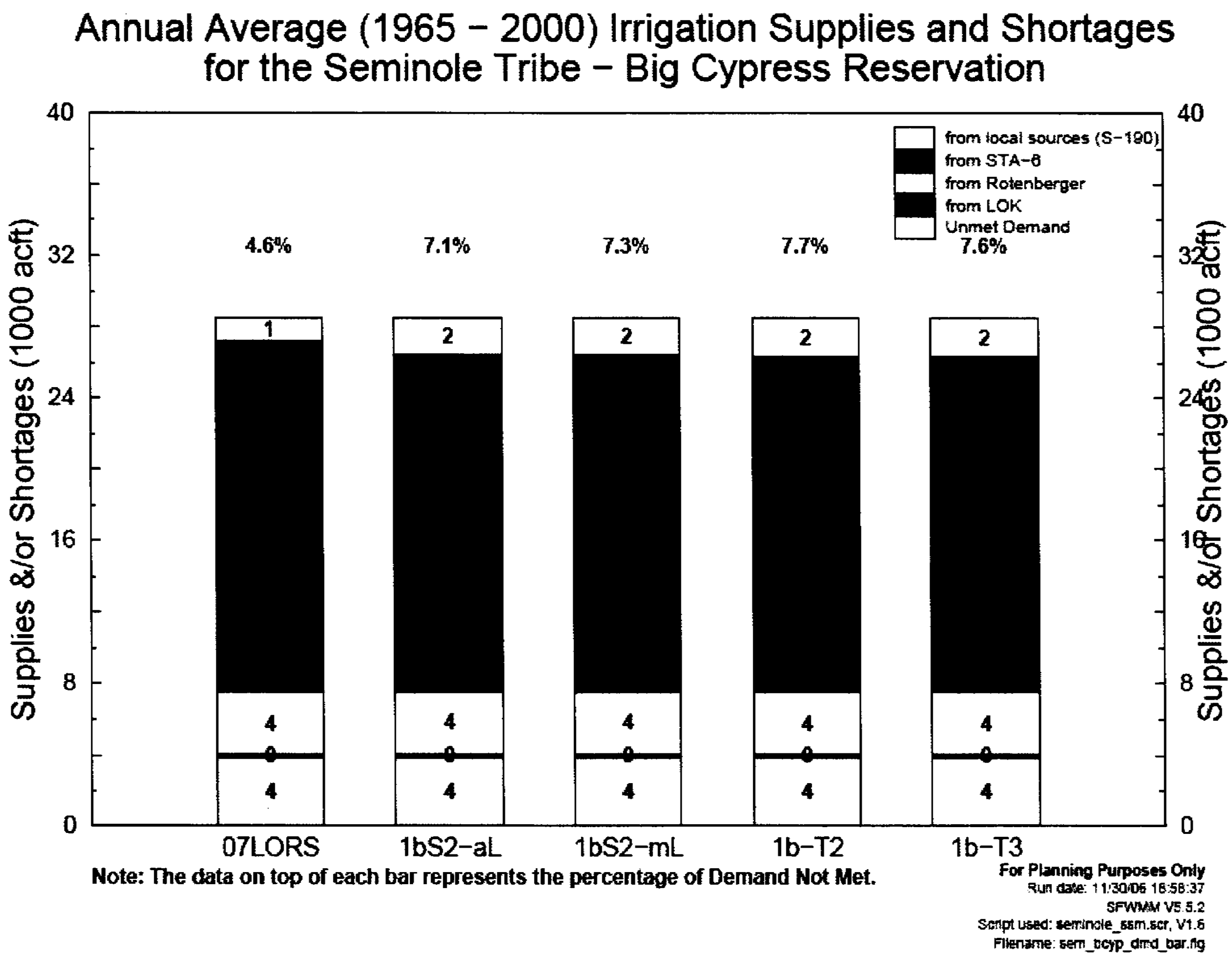


FIGURE C-84: AVERAGE ANNUAL SIMULATED IRRIGATION SUPPLIES AND SHORTAGES FOR THE SEMINOLE TRIBE – BIG CYPRESS RESERVATION (1)

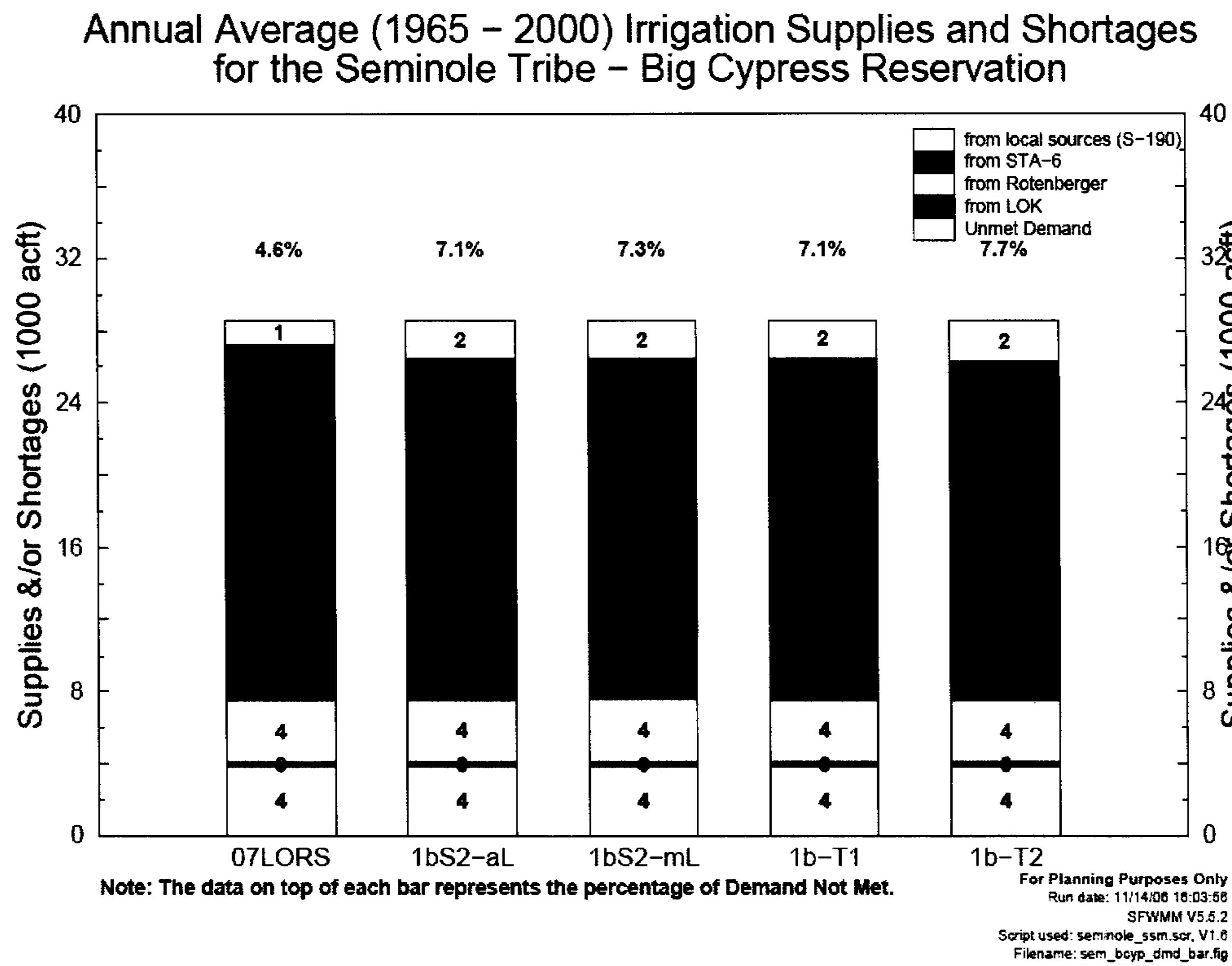


FIGURE C-85: AVERAGE ANNUAL SIMULATED IRRIGATION SUPPLIES AND SHORTAGES FOR THE SEMINOLE TRIBE – BIG CYPRESS RESERVATION (2)

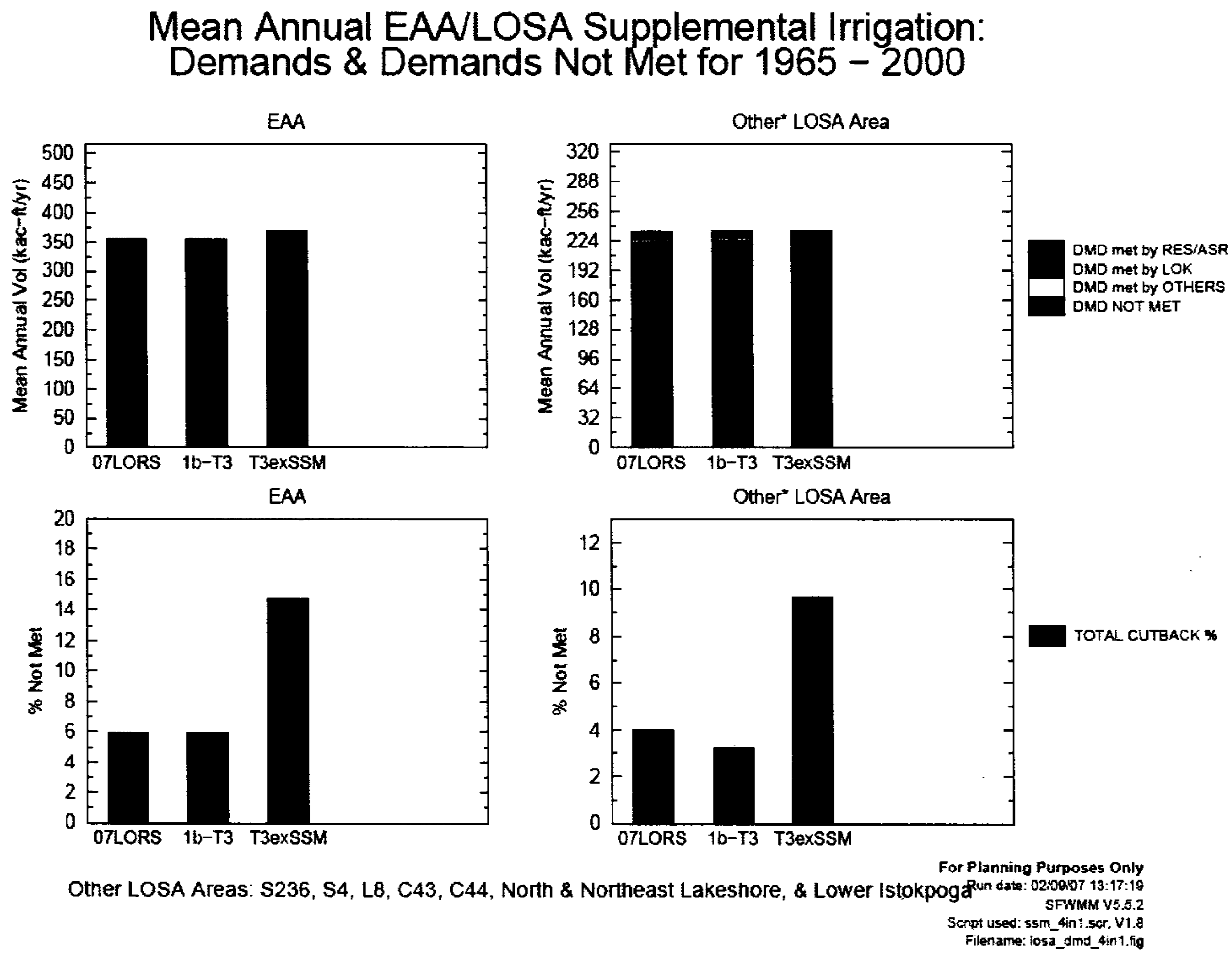


FIGURE C-86: MEAN ANNUAL EAA AND LOSA SUPPLEMENTAL IRRIGATION DEMANDS AND DEMANDS NOT MET, 1965-2000 (SSM SENSITIVITY SIMULATION)

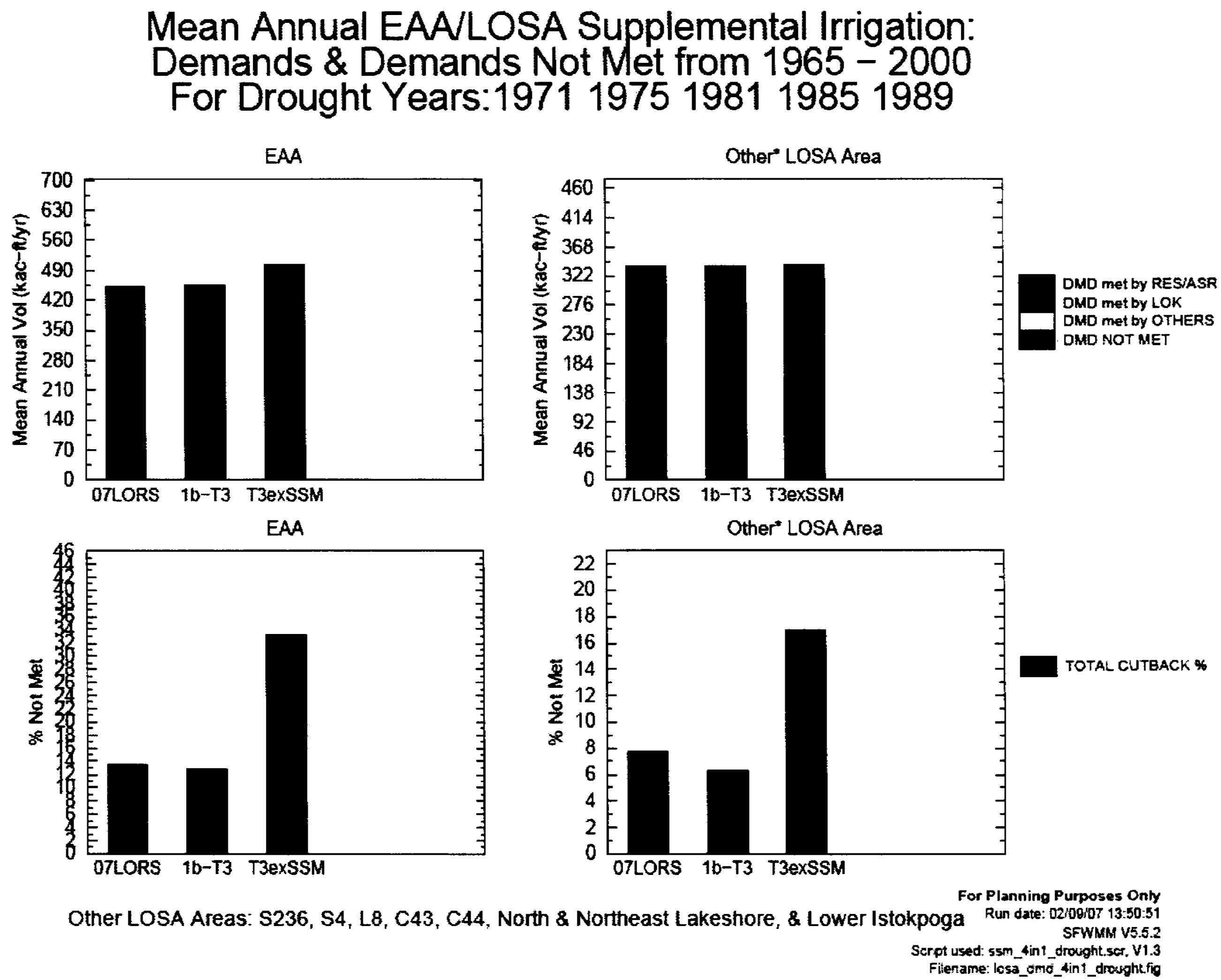


FIGURE C-87: MEAN ANNUAL EAA AND LOSA SUPPLEMENTAL IRRIGATION DEMANDS AND DEMANDS NOT MET, 1965-2000 DROUGHT YEARS (SSM SENSITIVITY SIMULATION)

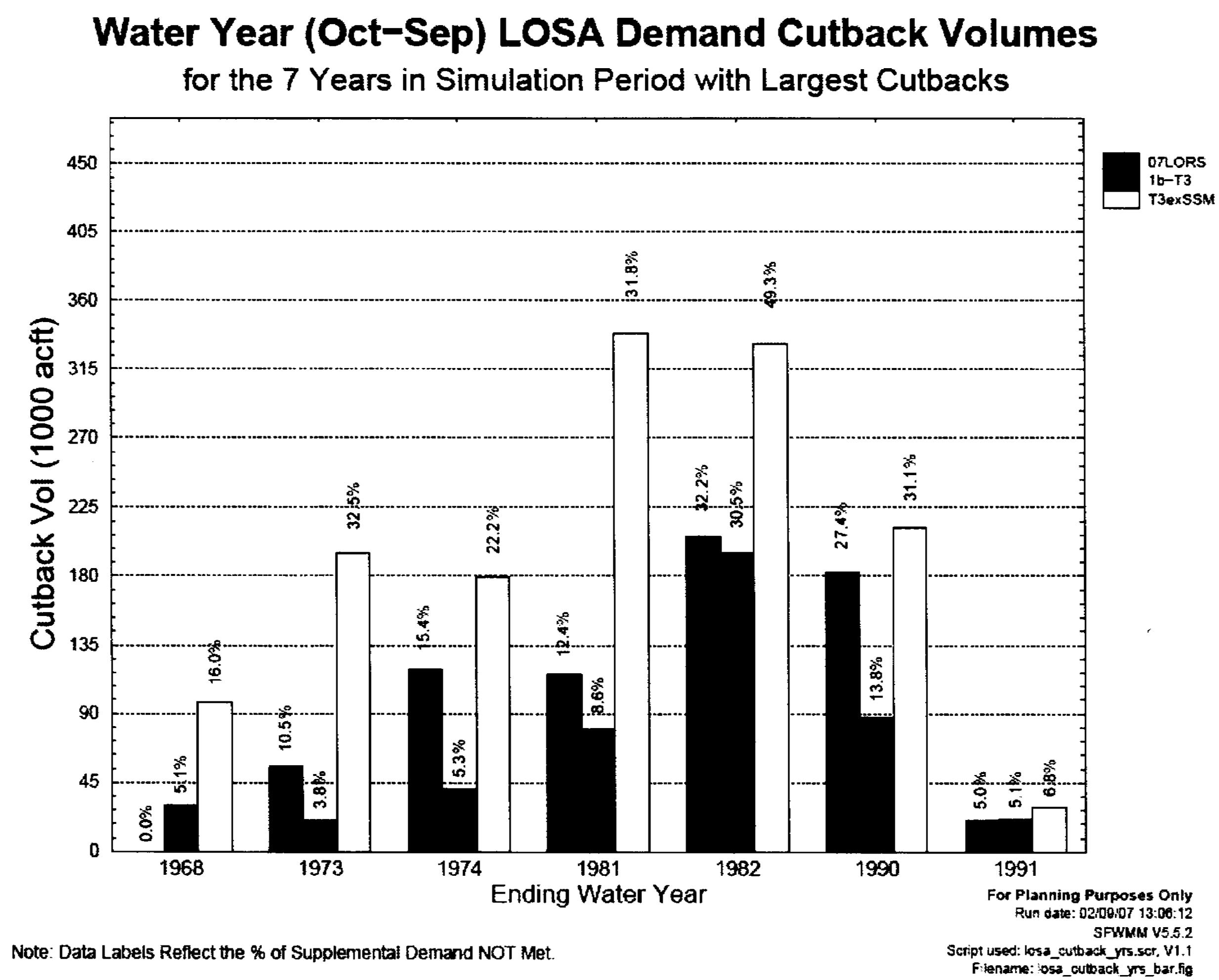


FIGURE C-88: WATER YEAR LOSA DEMAND CUTBACK VOLUMES, 7 DROUGHT YEARS (SSM SENSITIVITY SIMULATION)

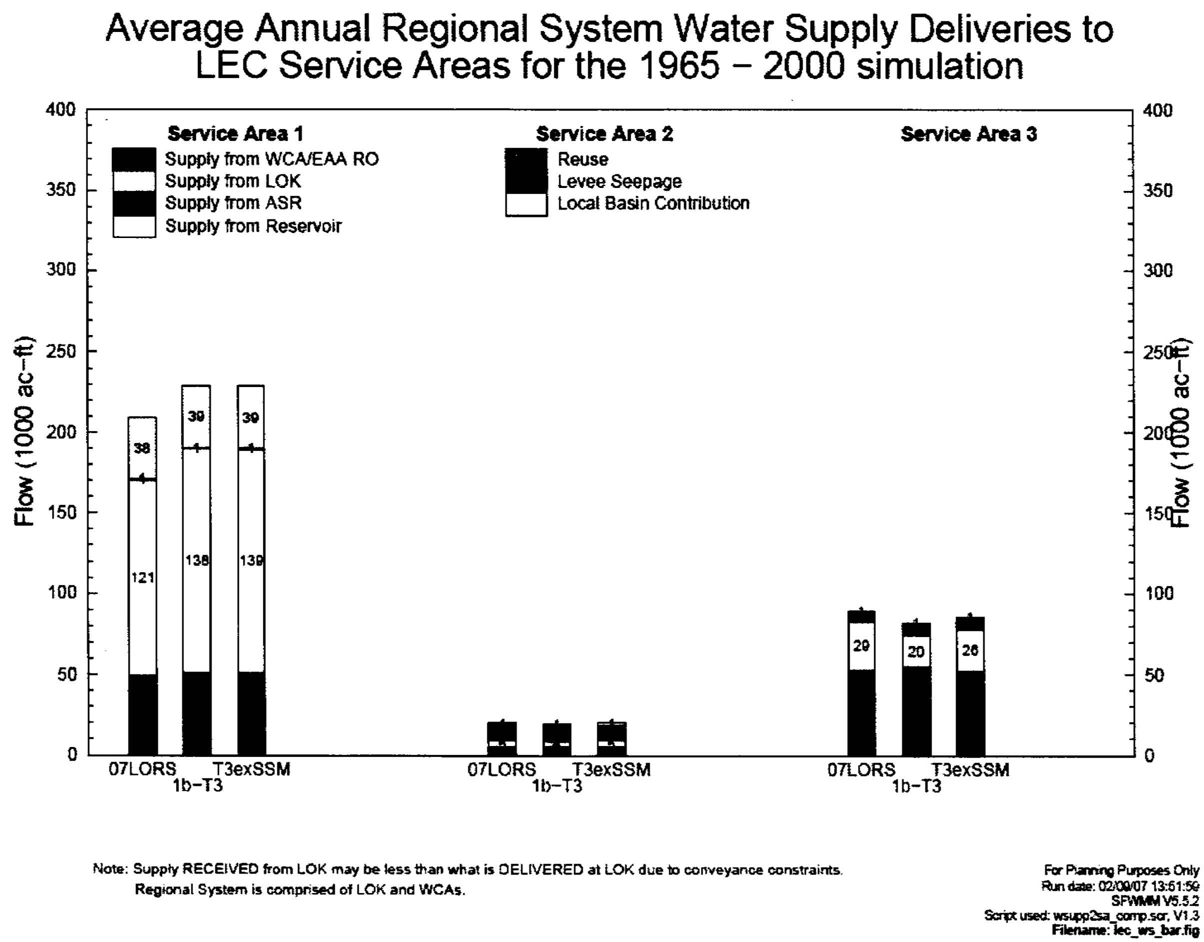


FIGURE C-89: AVERAGE ANNUAL REGIONAL WATER SUPPLY DELIVERIES TO LOWER EAST COAST SERVICE AREAS, 1965-2000 (SSM SENSITIVITY SIMULATION)

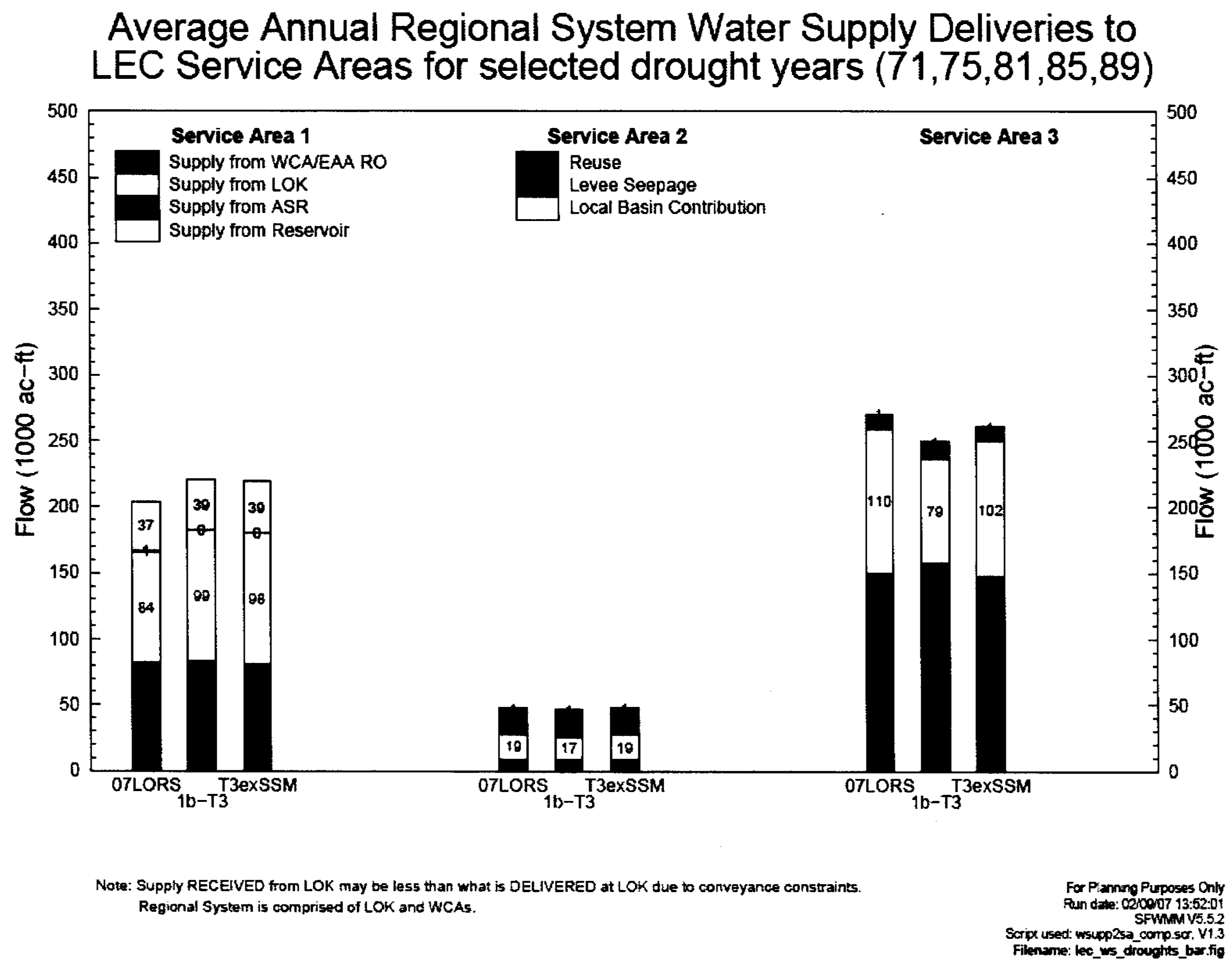


FIGURE C-90: AVERAGE ANNUAL REGIONAL WATER SUPPLY DELIVERIES TO LOWER EAST COAST SERVICE AREAS, 1965-2000 DROUGHT YEARS (SSM SENSITIVITY SIMULATION)

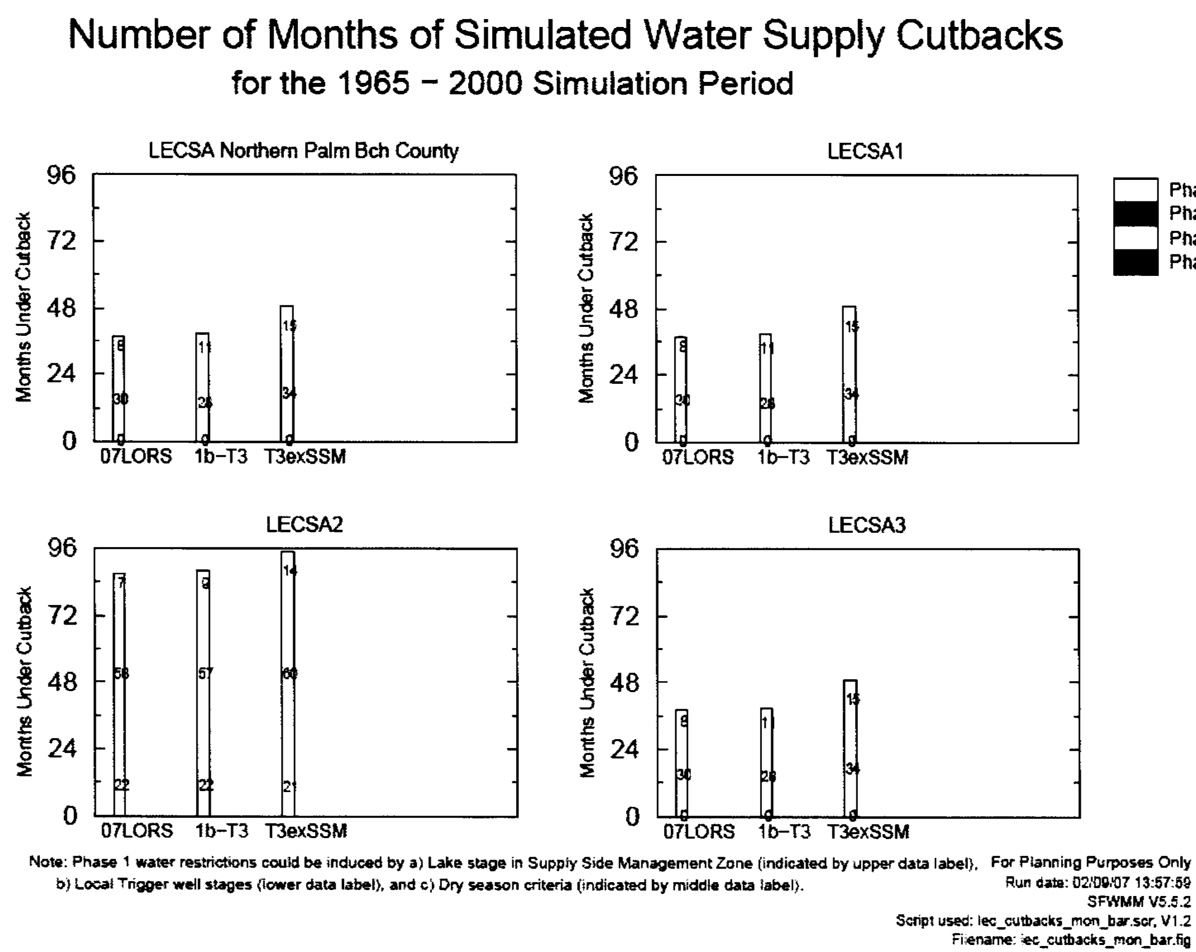


FIGURE C-91: MONTHS OF SIMULATED WATER SUPPLY CUTBACKS FOR LOWER EAST COAST SERVICE AREAS (SSM SENSITIVITY SIMULATION)

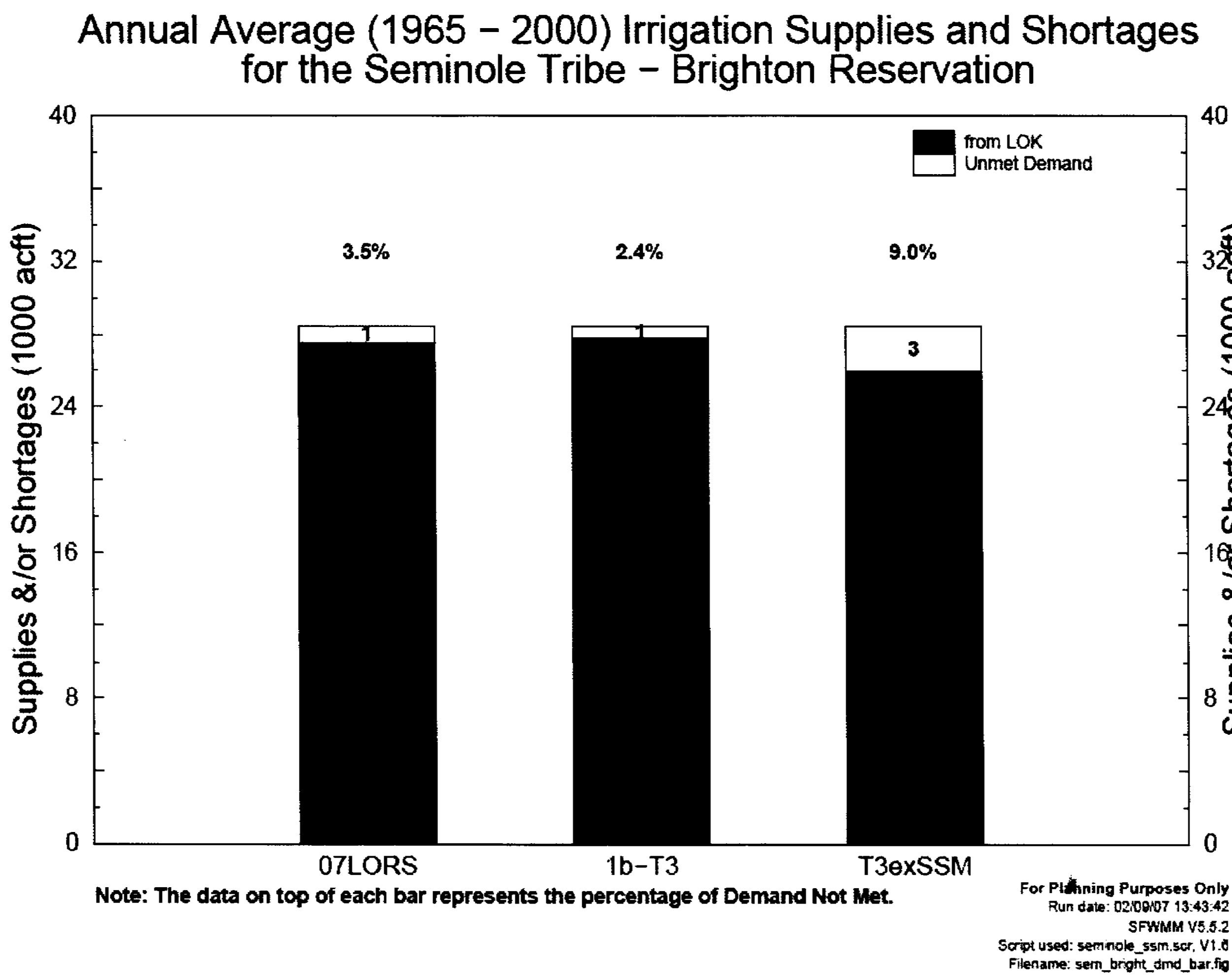


FIGURE C-92: AVERAGE ANNUAL SIMULATED IRRIGATION SUPPLIES AND SHORTAGES FOR THE SEMINOLE TRIBE – BRIGHTON RESERVATION (SSM SENSITIVITY SIMULATION)

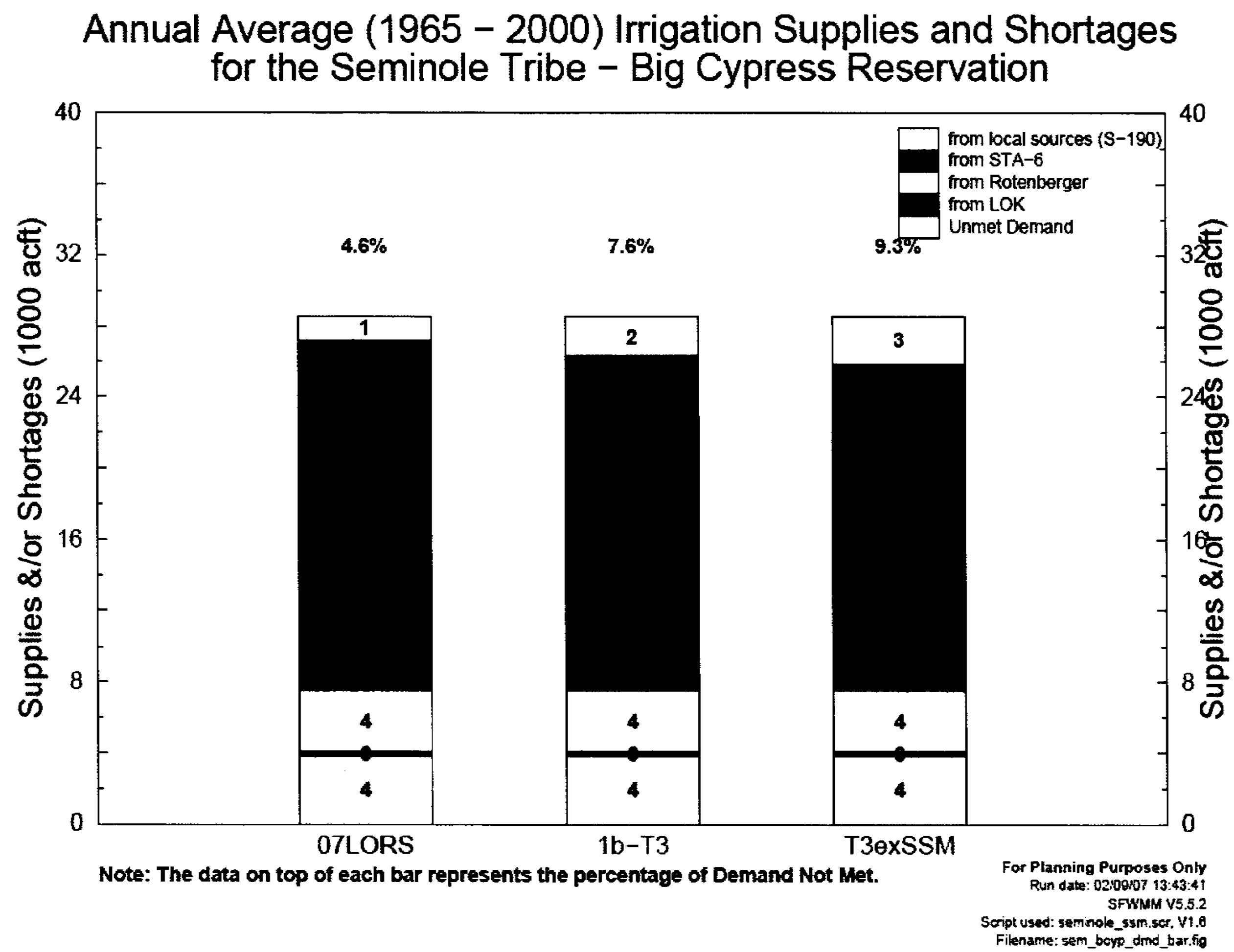


FIGURE C-93: AVERAGE ANNUAL SIMULATED IRRIGATION SUPPLIES AND SHORTAGES FOR THE SEMINOLE TRIBE – BIG CYPRESS RESERVATION (SSM SENSITIVITY SIMULATION)

End of Month Stage Duration Curves for Cell Row 40 Col 34 in the LEC

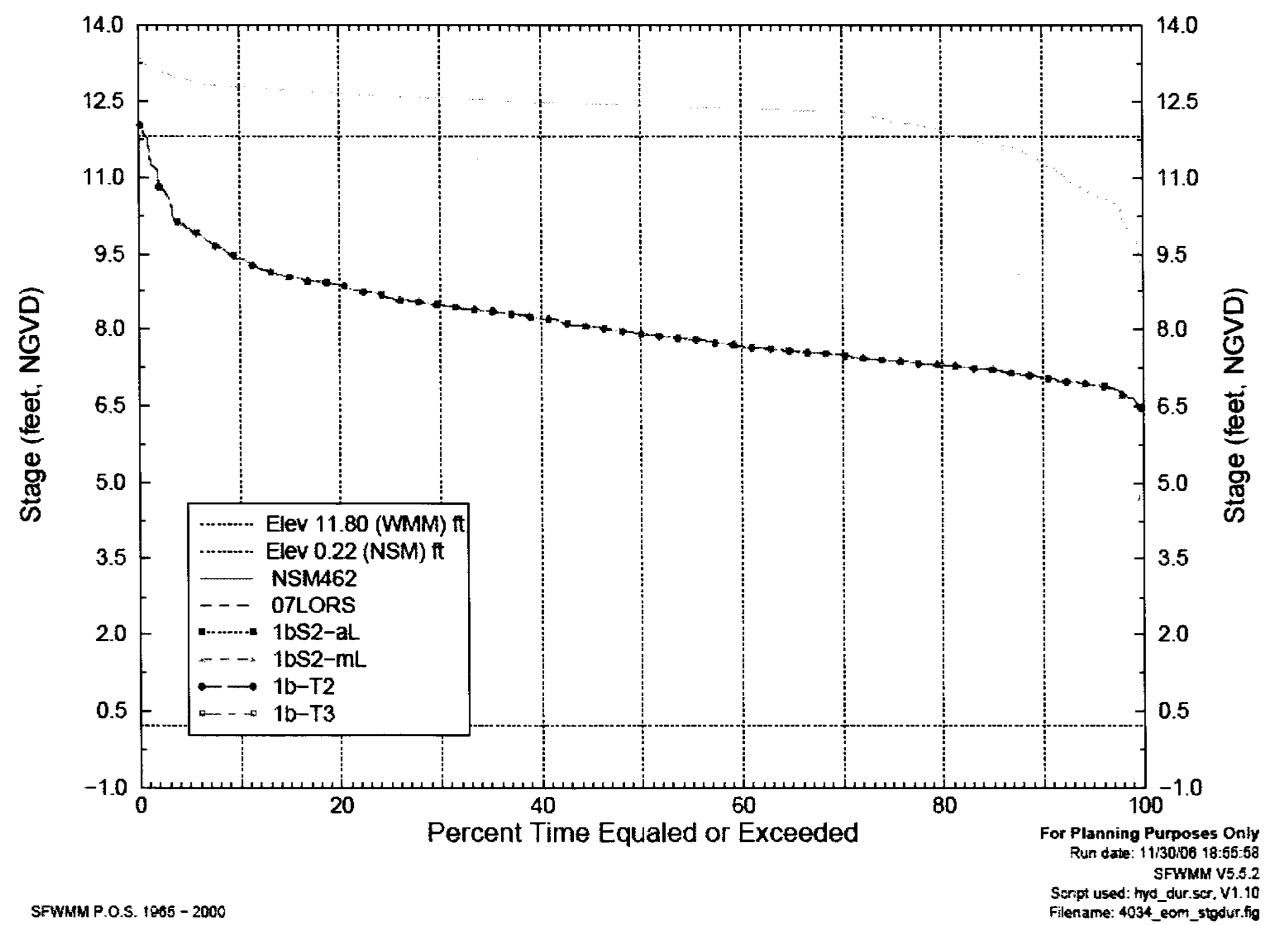


FIGURE C-94: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 40 COLUMN 34 (1)

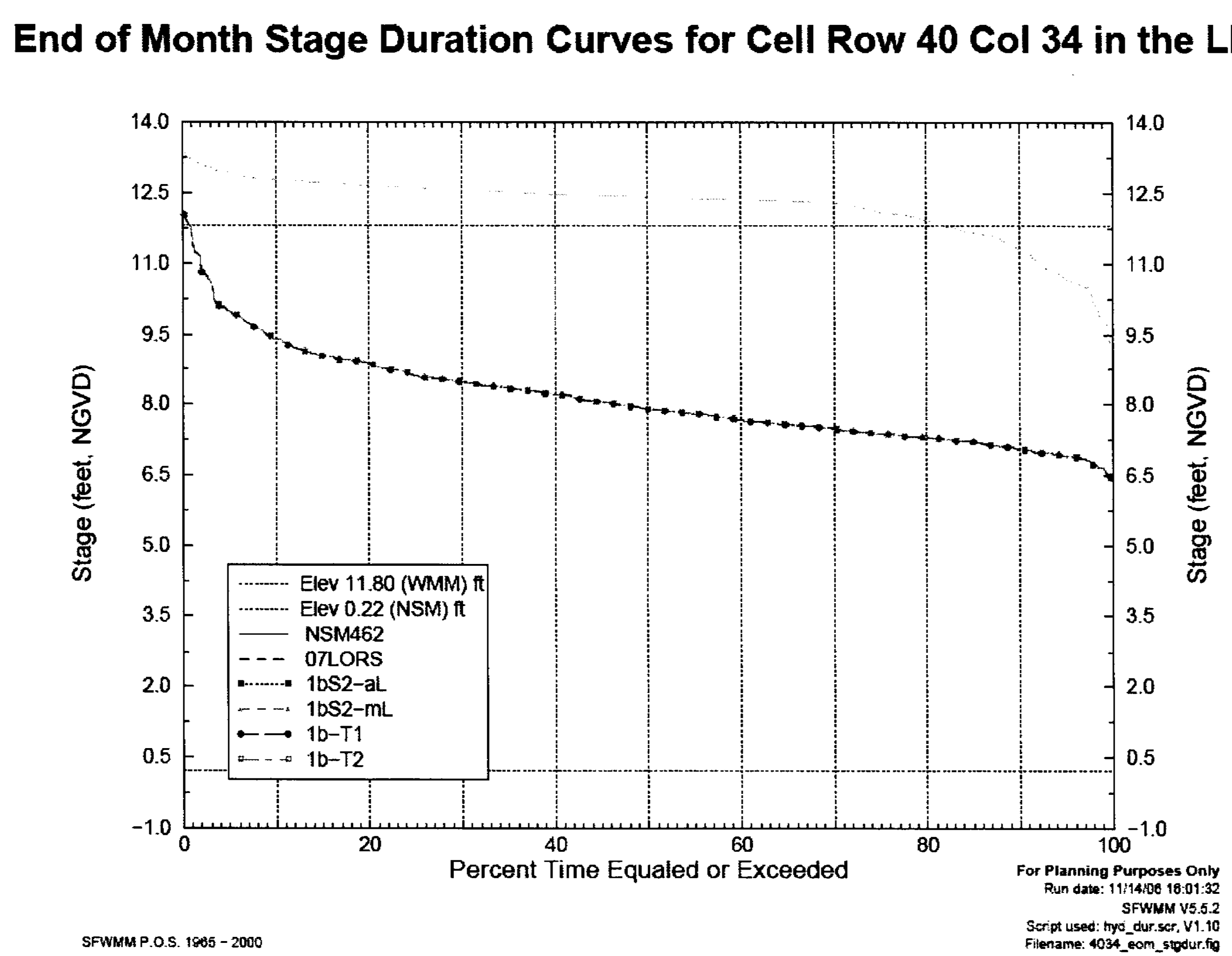


FIGURE C-95: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 40 COLUMN 34 (2)

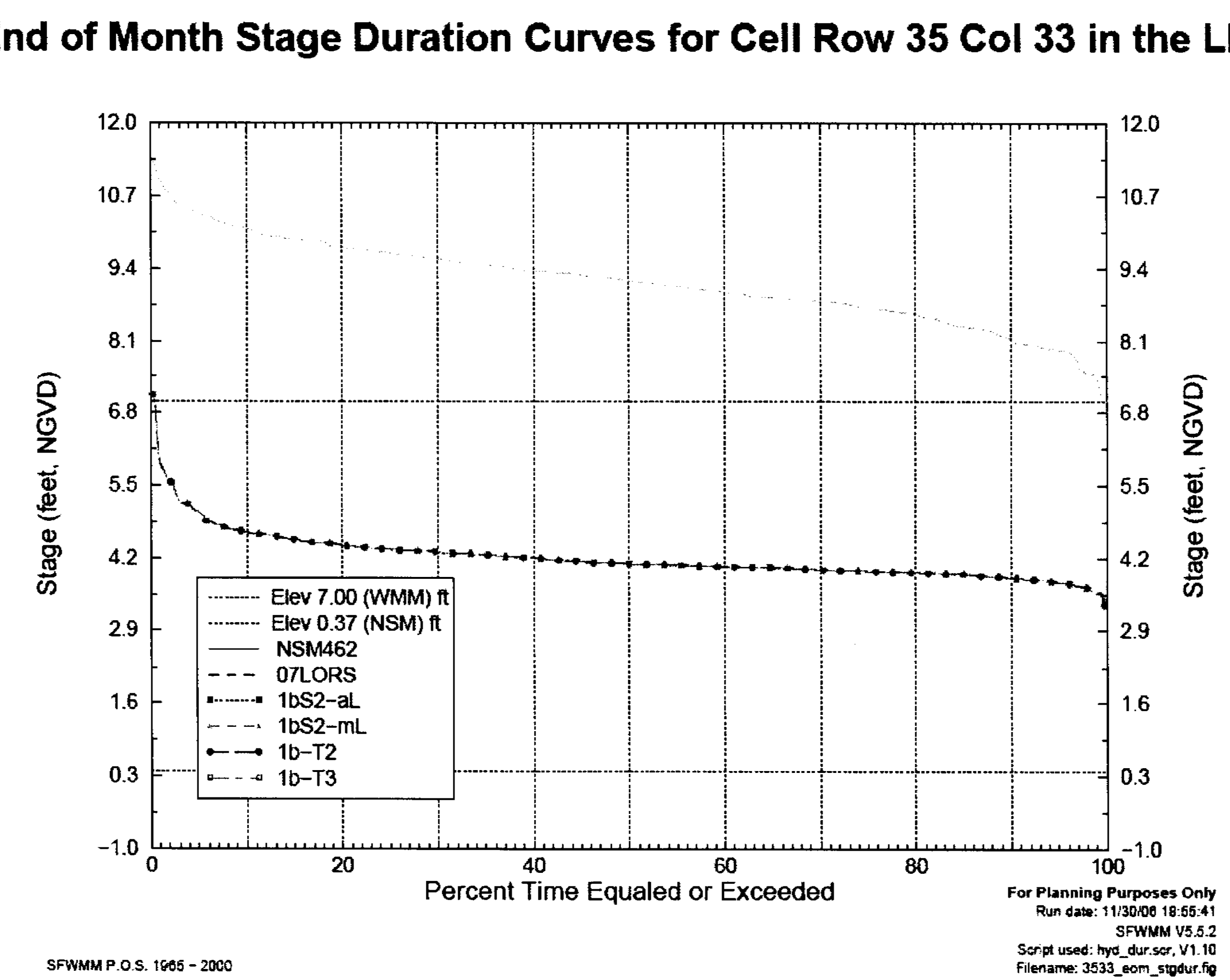


FIGURE C-96: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 35 COLUMN 33 (1)

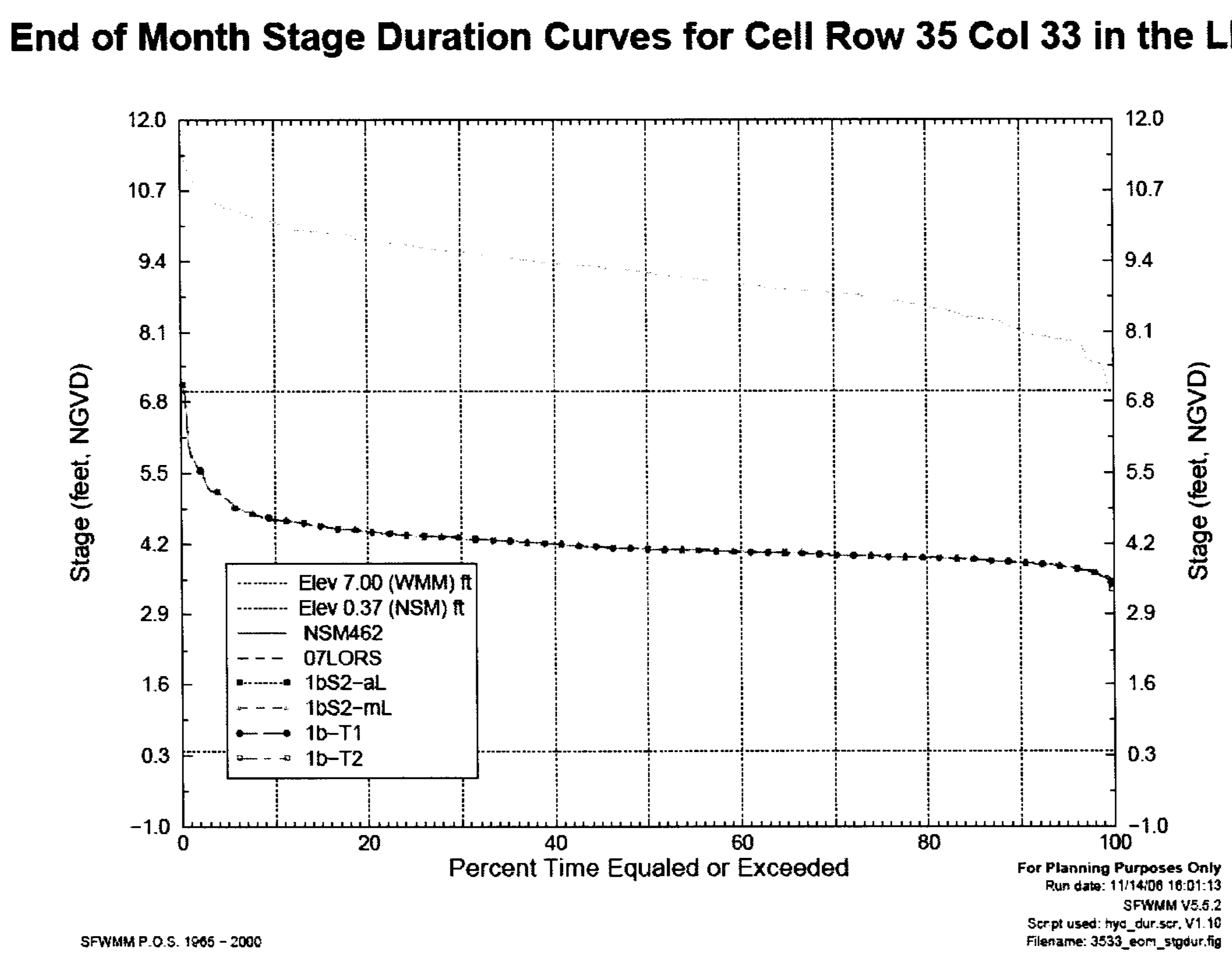


FIGURE C-97: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 35 COLUMN 33 (2)

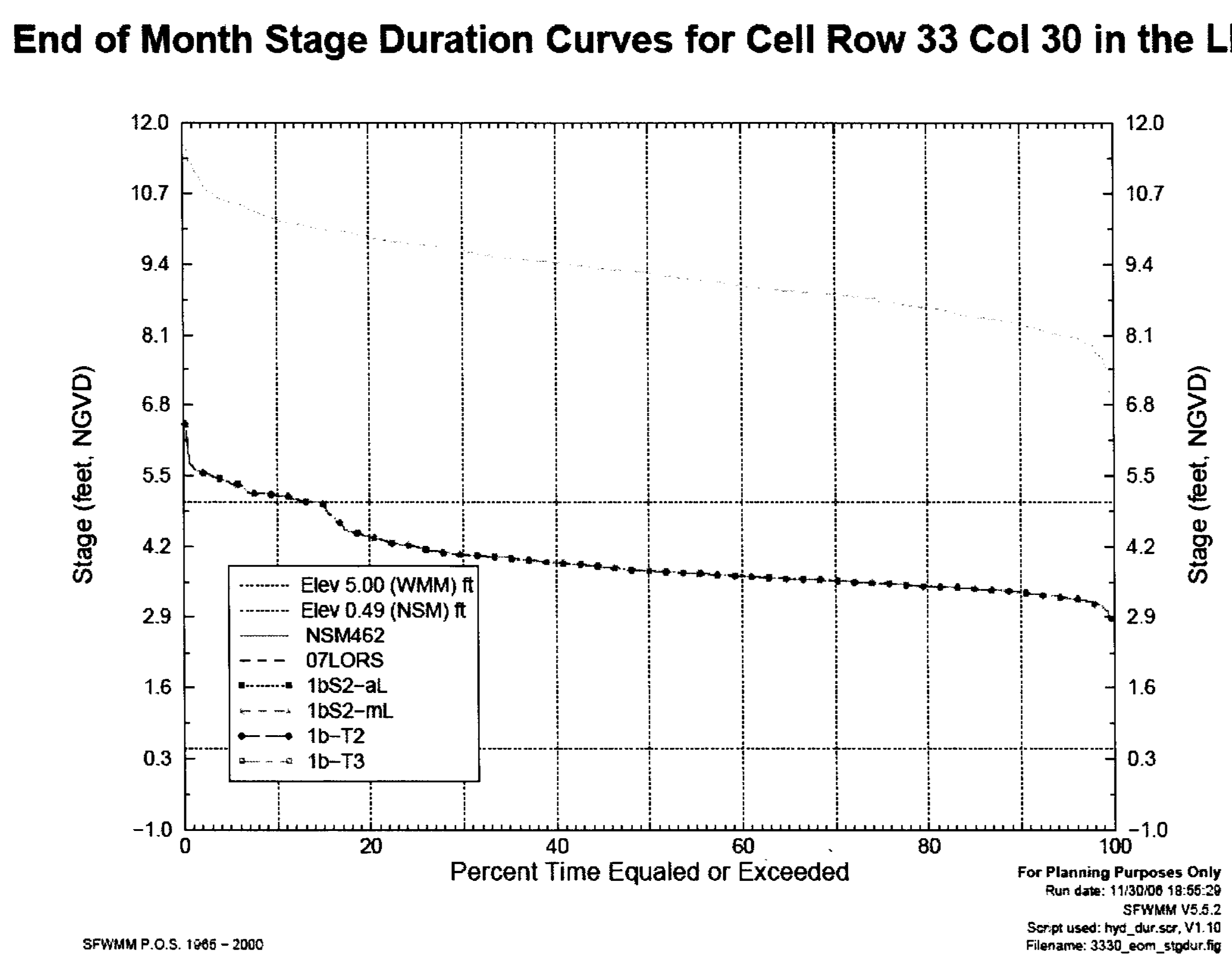


FIGURE C-98: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 33 COLUMN 30 (1)

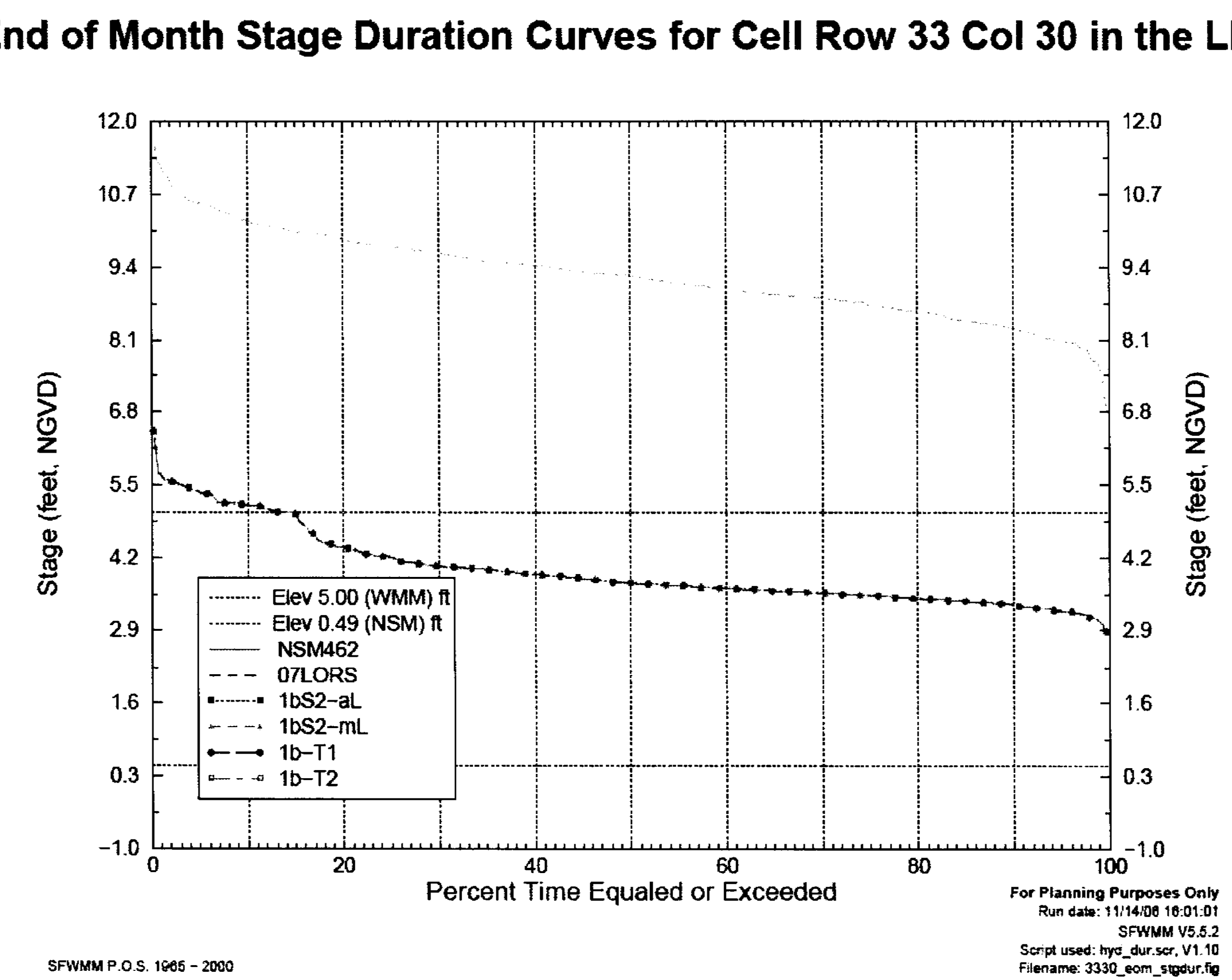


FIGURE C-99: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 33 COLUMN 30 (2)

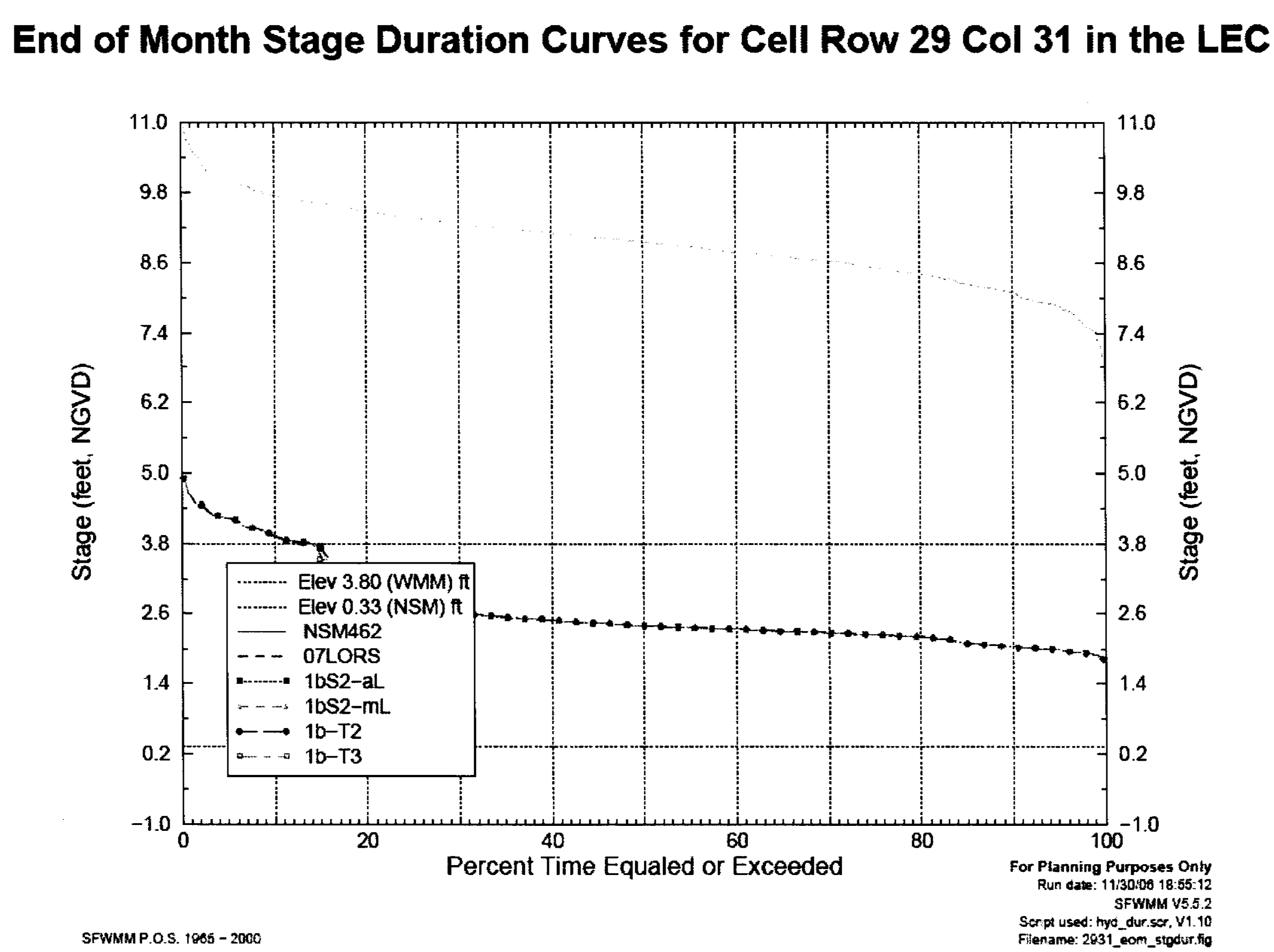


FIGURE C-100: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 29 COLUMN 31 (1)

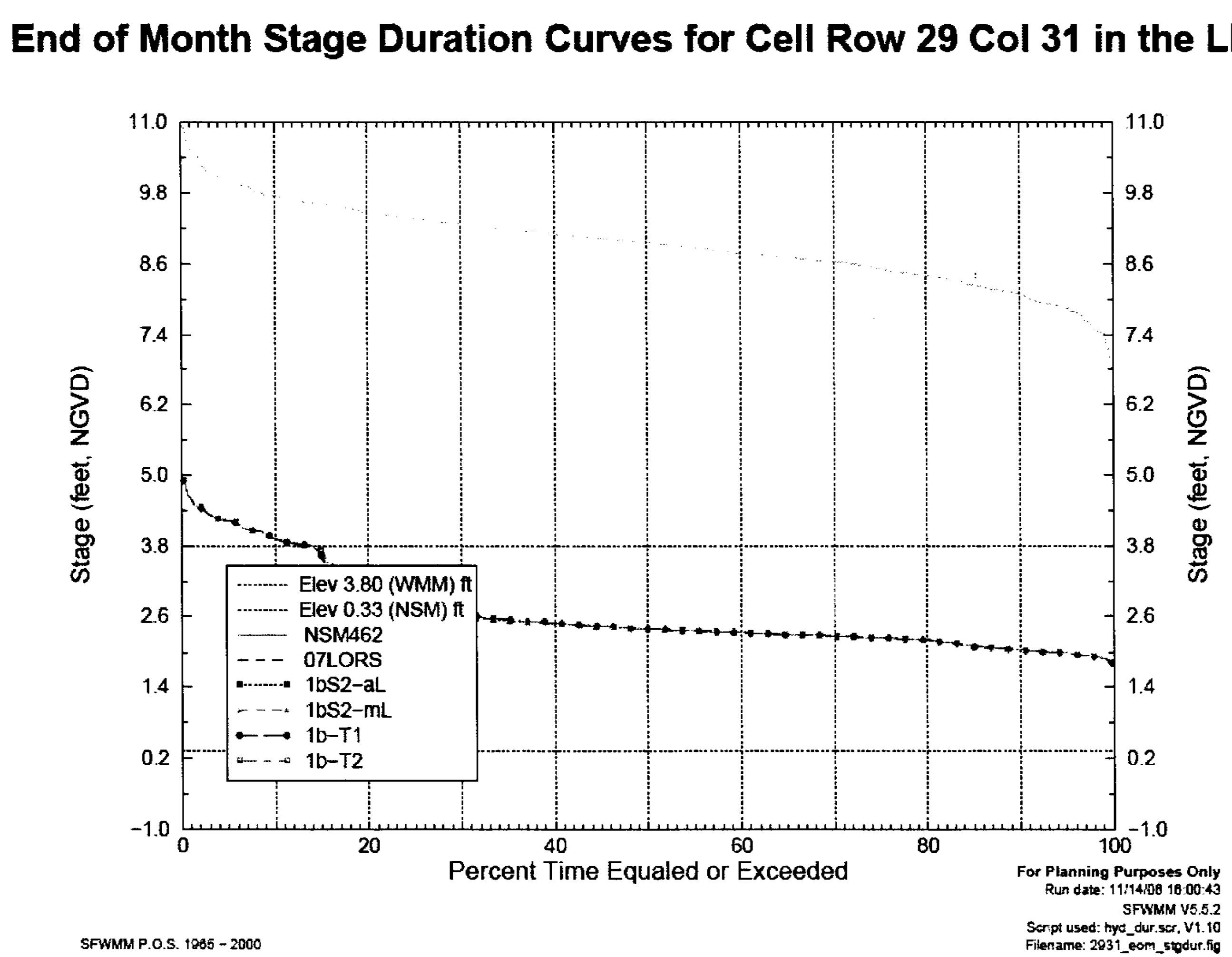


FIGURE C-101: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 29 COLUMN 31 (2)

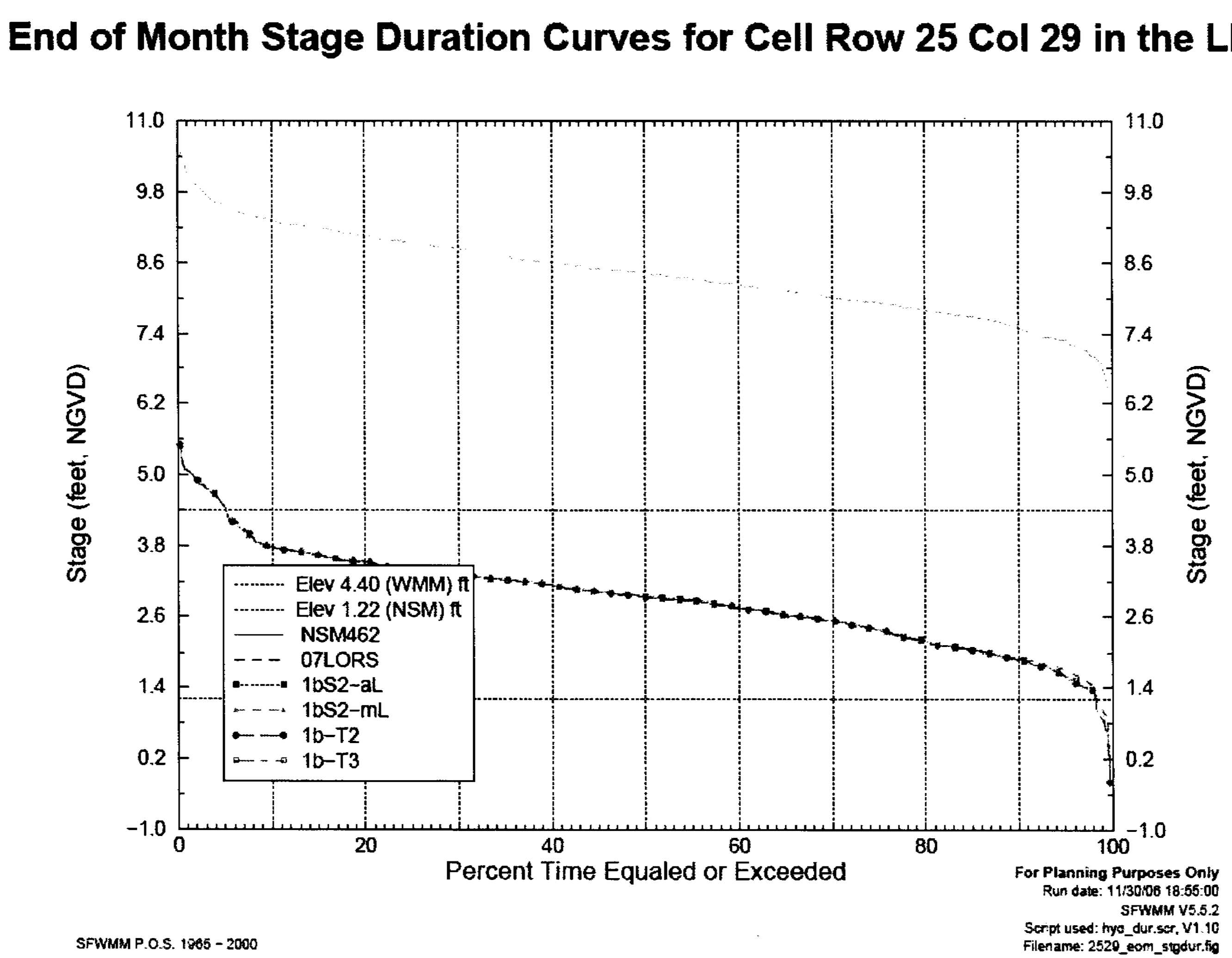


FIGURE C-102: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 25 COLUMN 29 (1)

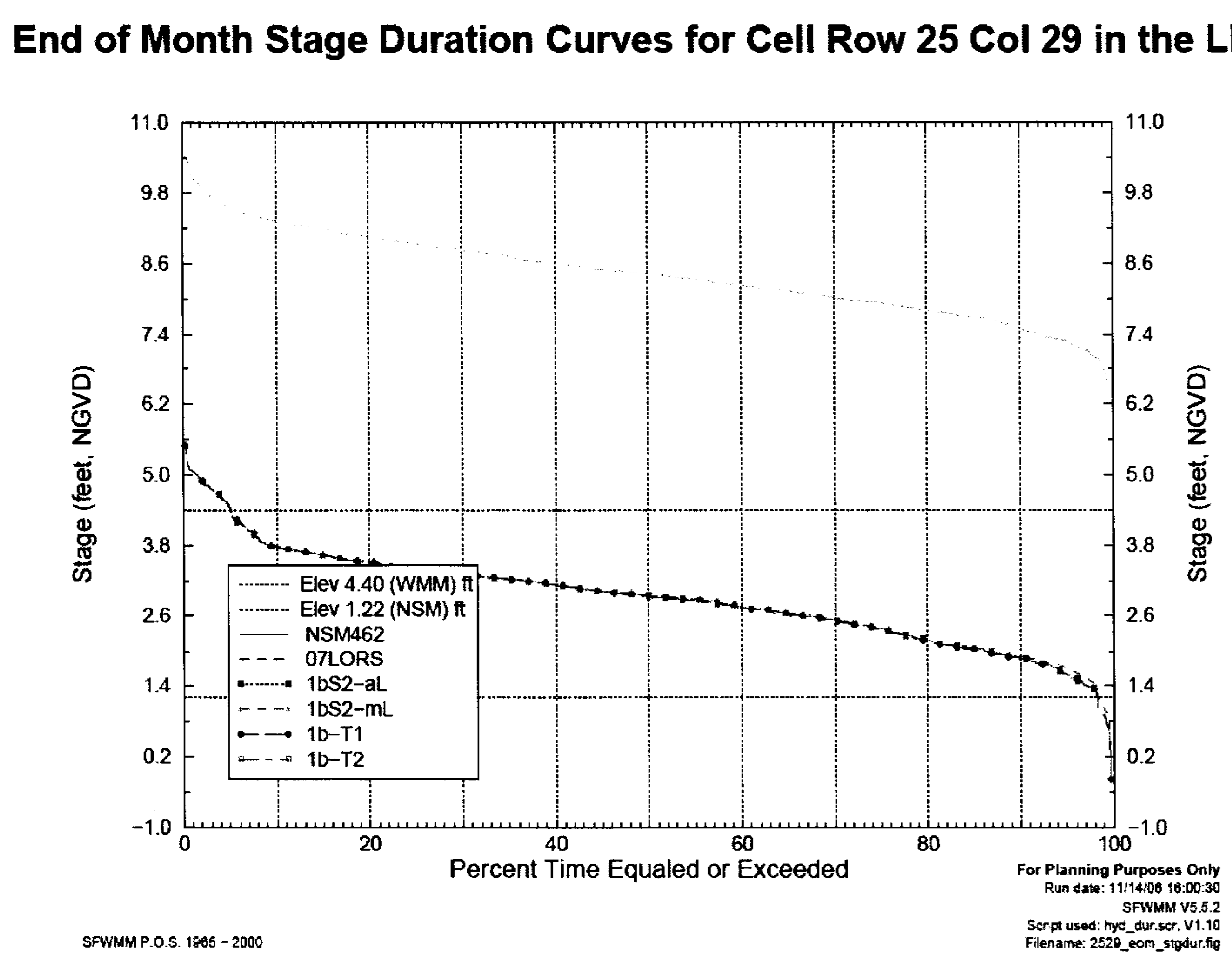


FIGURE C-103: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 25 COLUMN 29 (2)

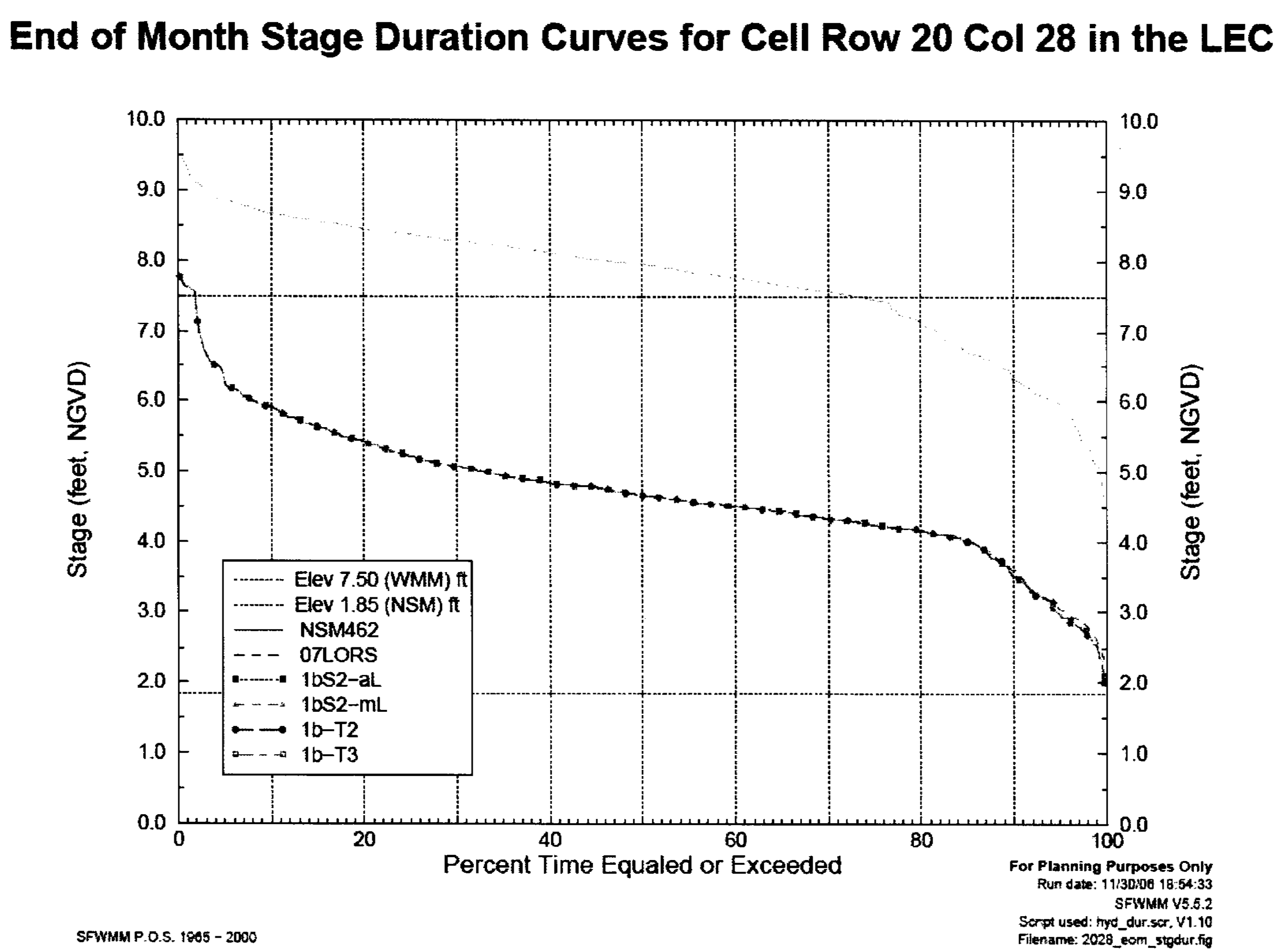


FIGURE C-104: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 20 COLUMN 28 (1)

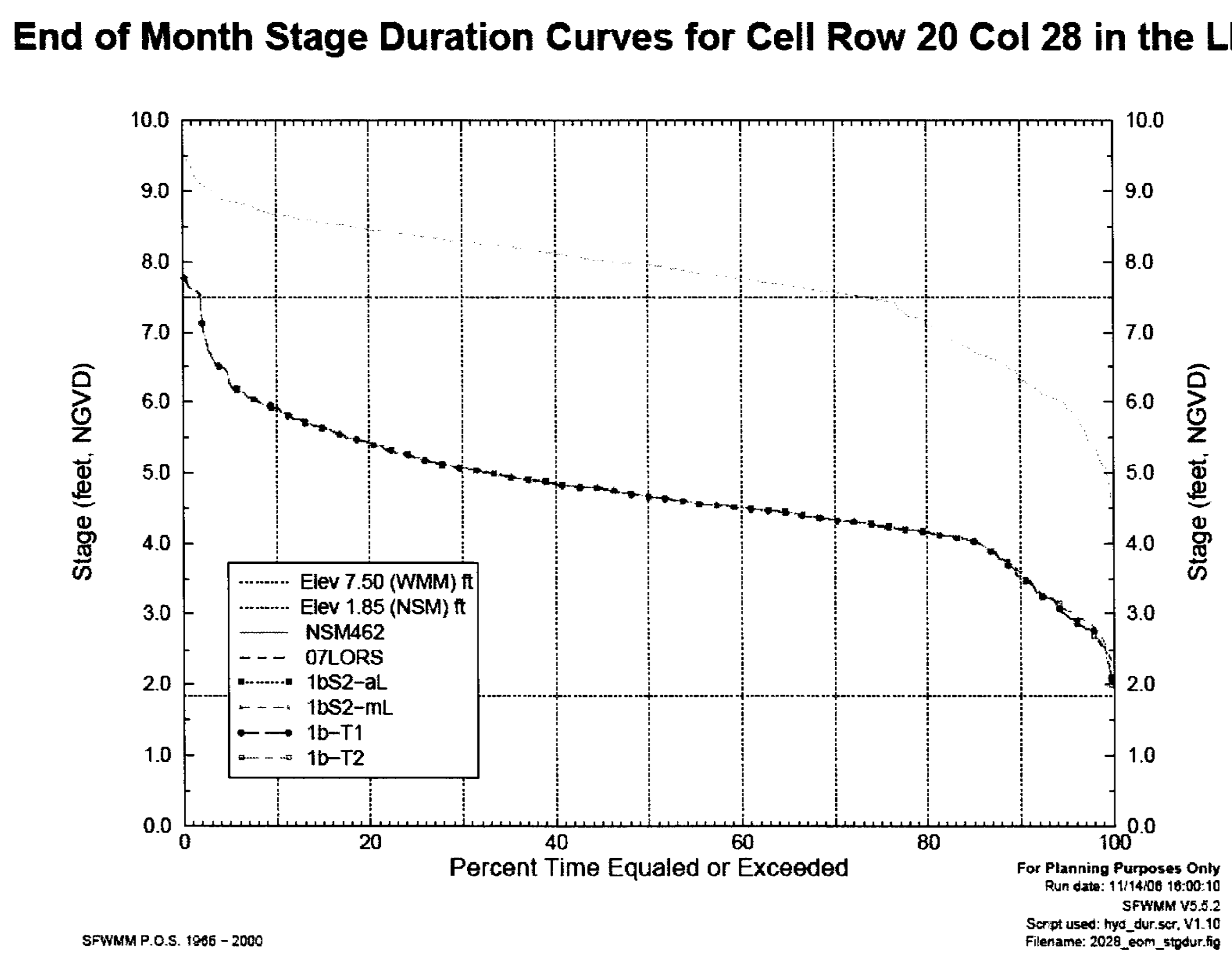


FIGURE C-105: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 20 COLUMN 28 (2)

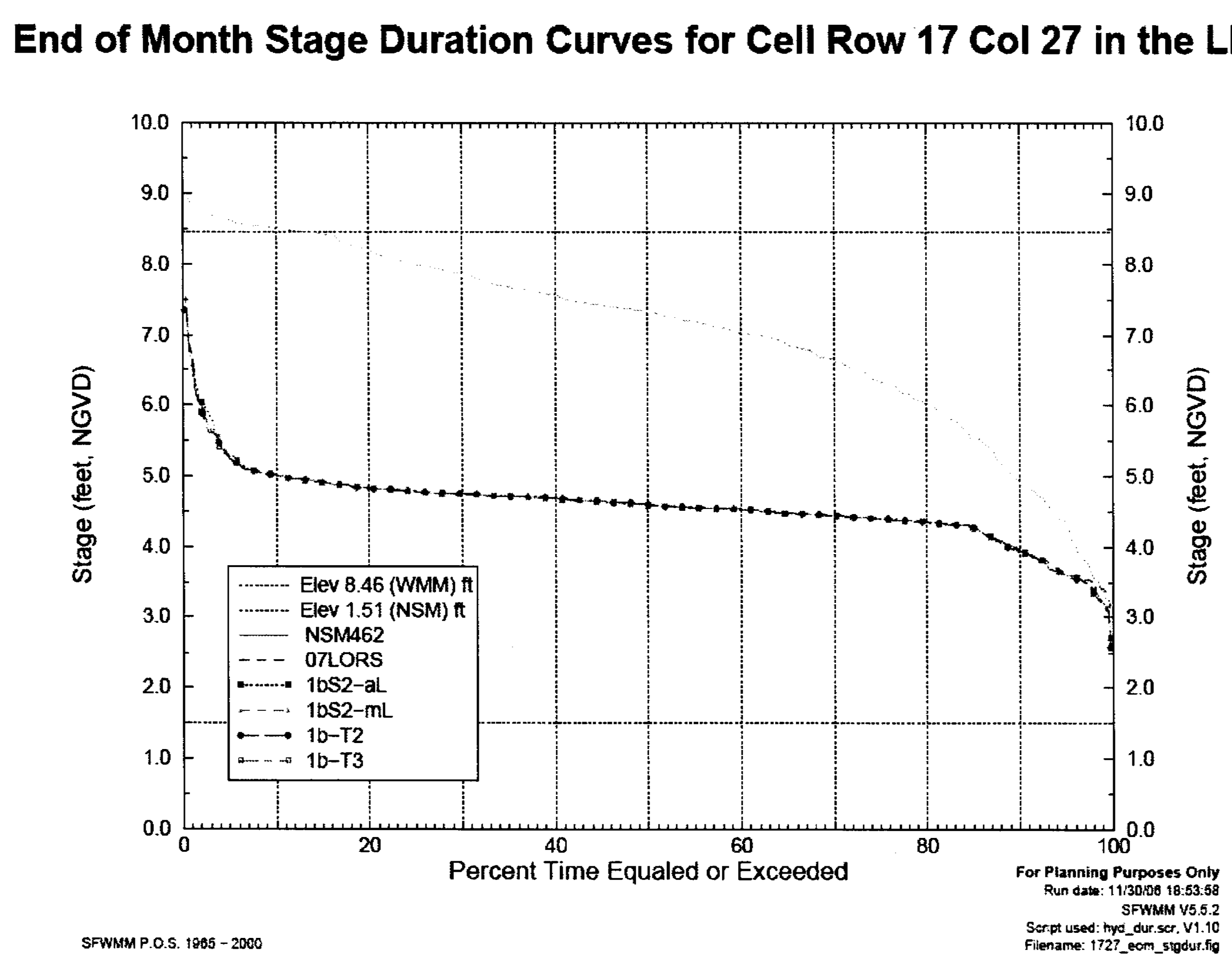


FIGURE C-106: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 17 COLUMN 27 (1)

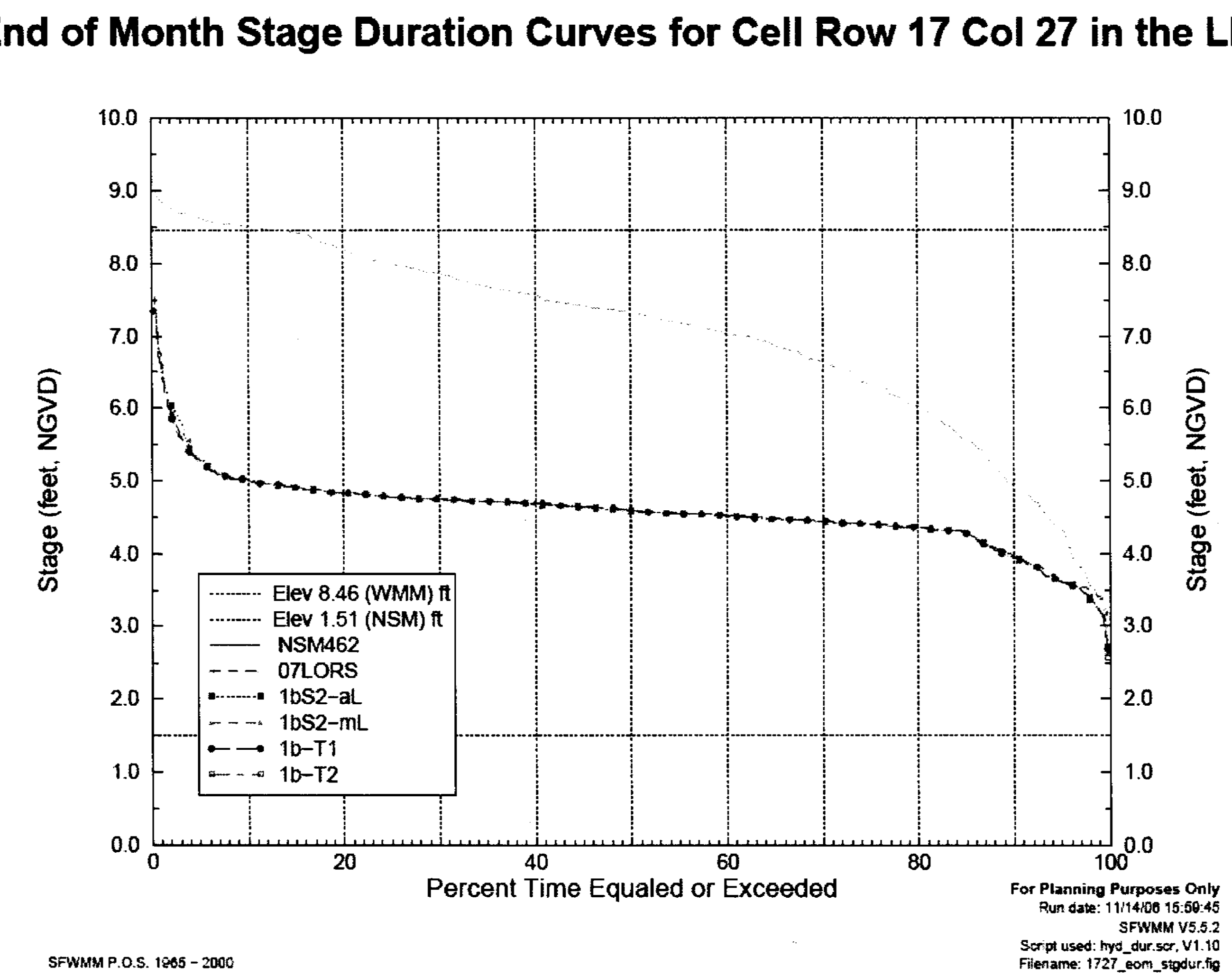


FIGURE C-107: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 17 COLUMN 27 (2)

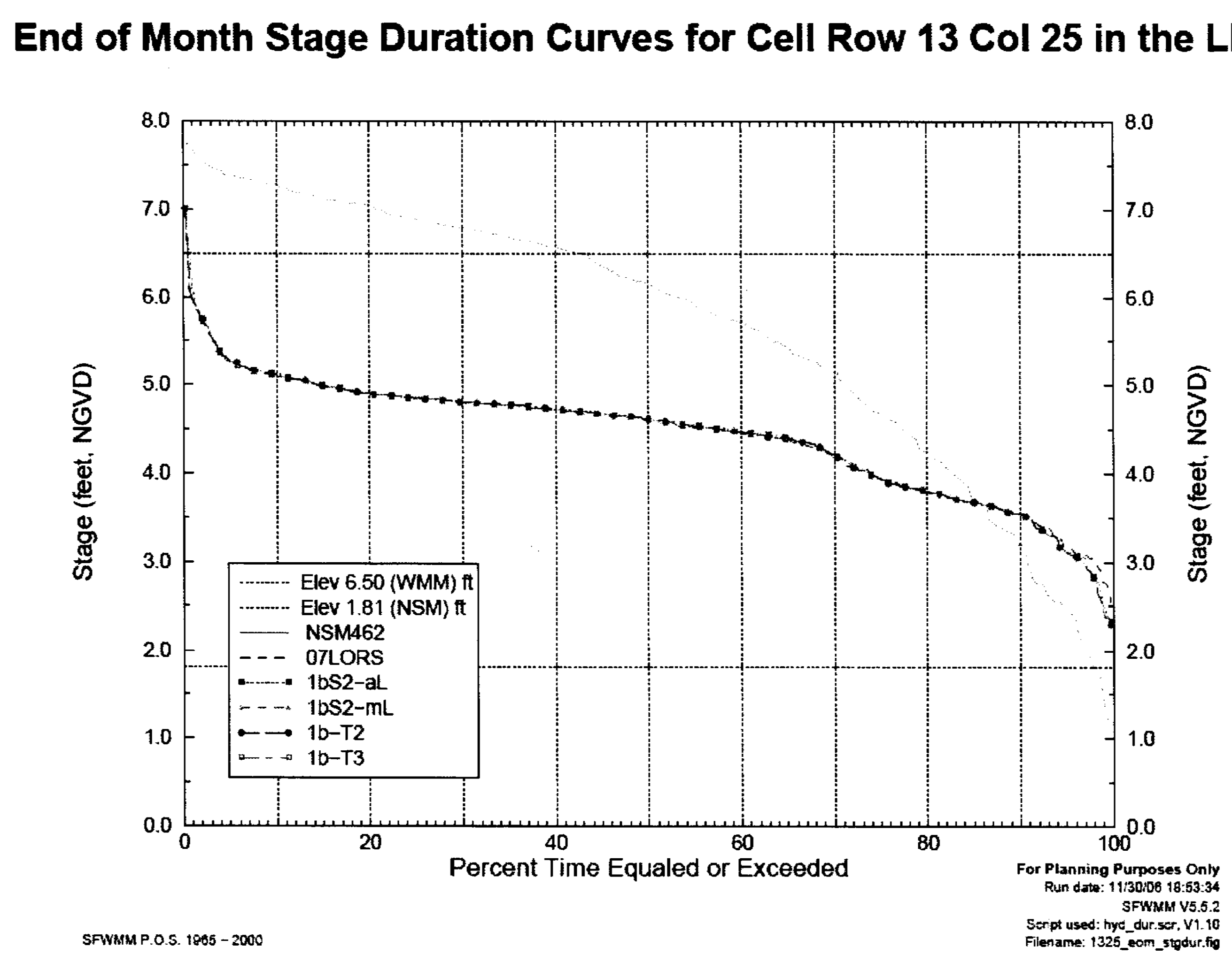


FIGURE C-108: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 13 COLUMN 25 (1)

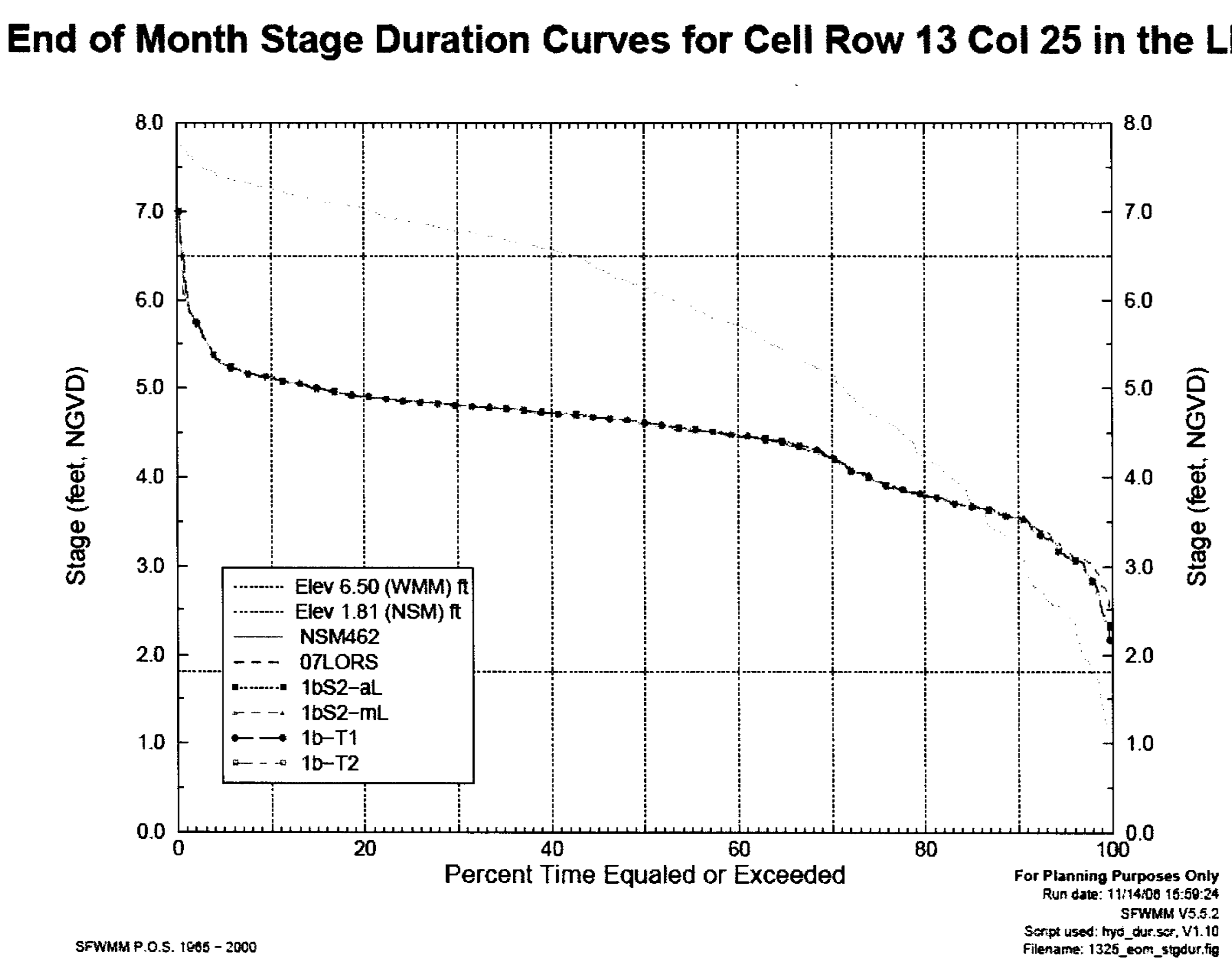


FIGURE C-109: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 13 COLUMN 25 (2)

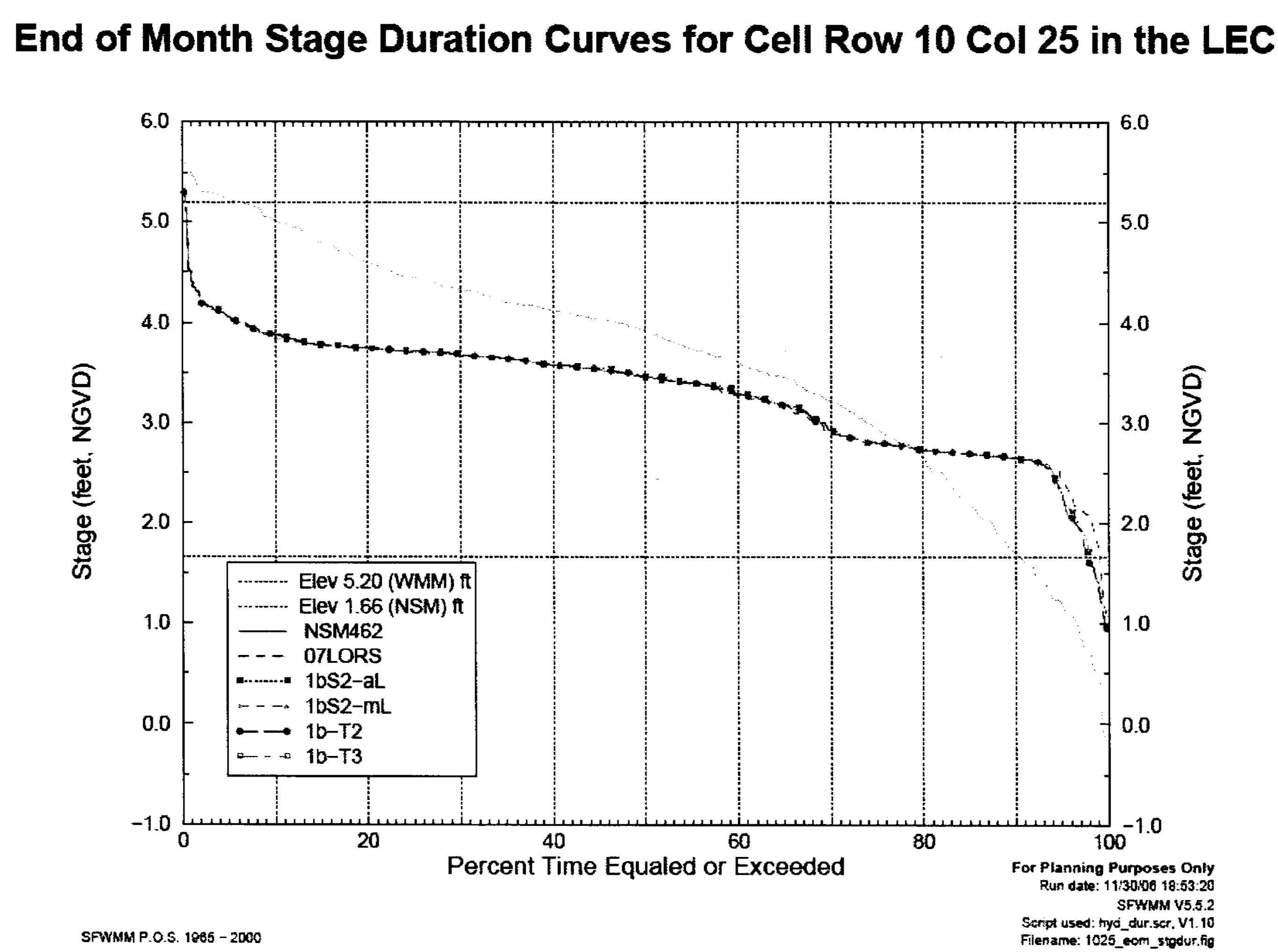


FIGURE C-110: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 10 COLUMN 25 (1)

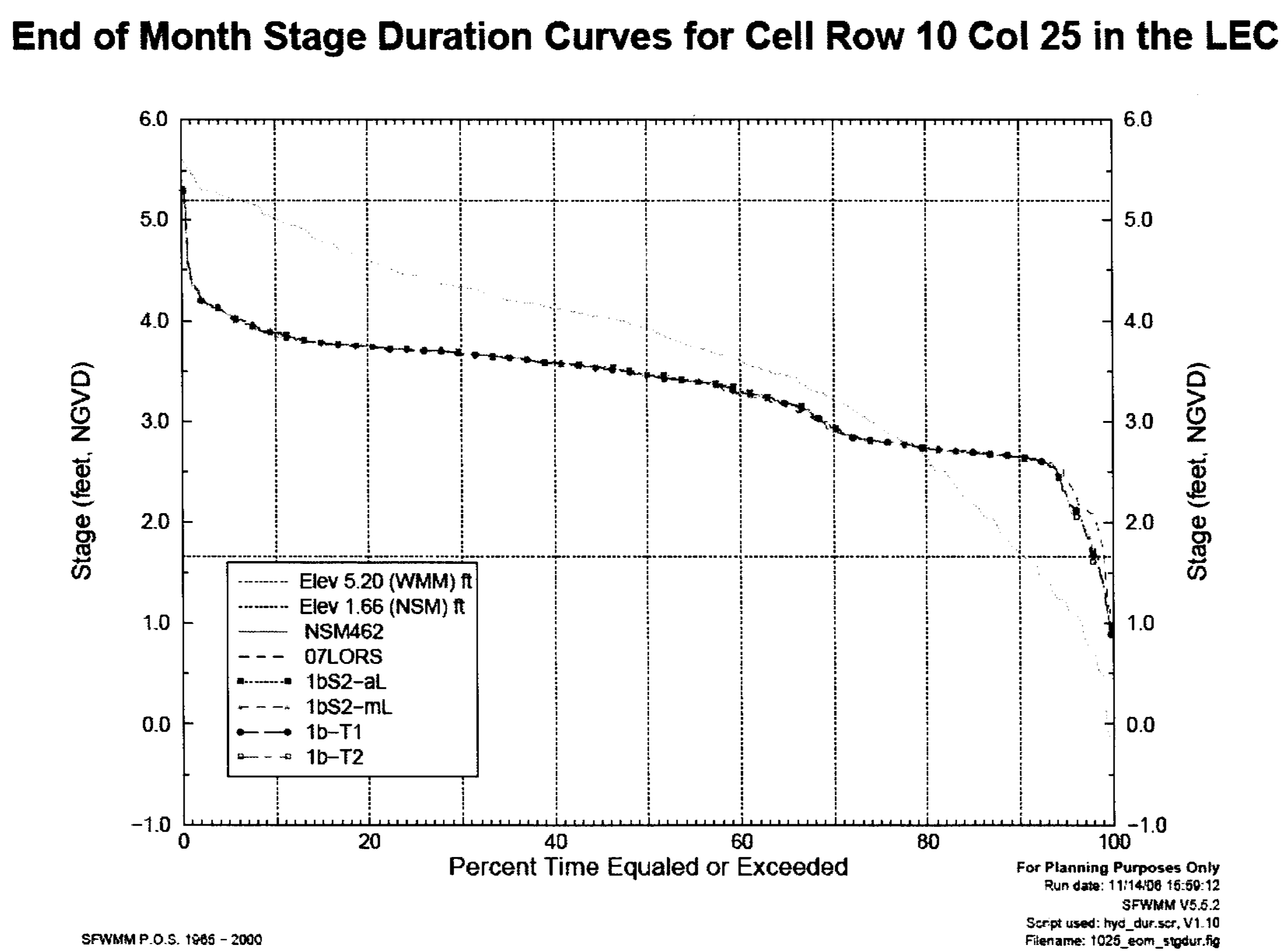


FIGURE C-111: STAGE DURATION CURVES FOR LOWER EAST COAST GRID CELL, ROW 10 COLUMN 25 (2)

Set 1: Initial stages on 01-Jan-2001 pick up where LORSS SFWMM simulations ended (07LORS=12.04', TSP3=10.53'); Represents a continuation of the 36yr simulations to 41yrs.

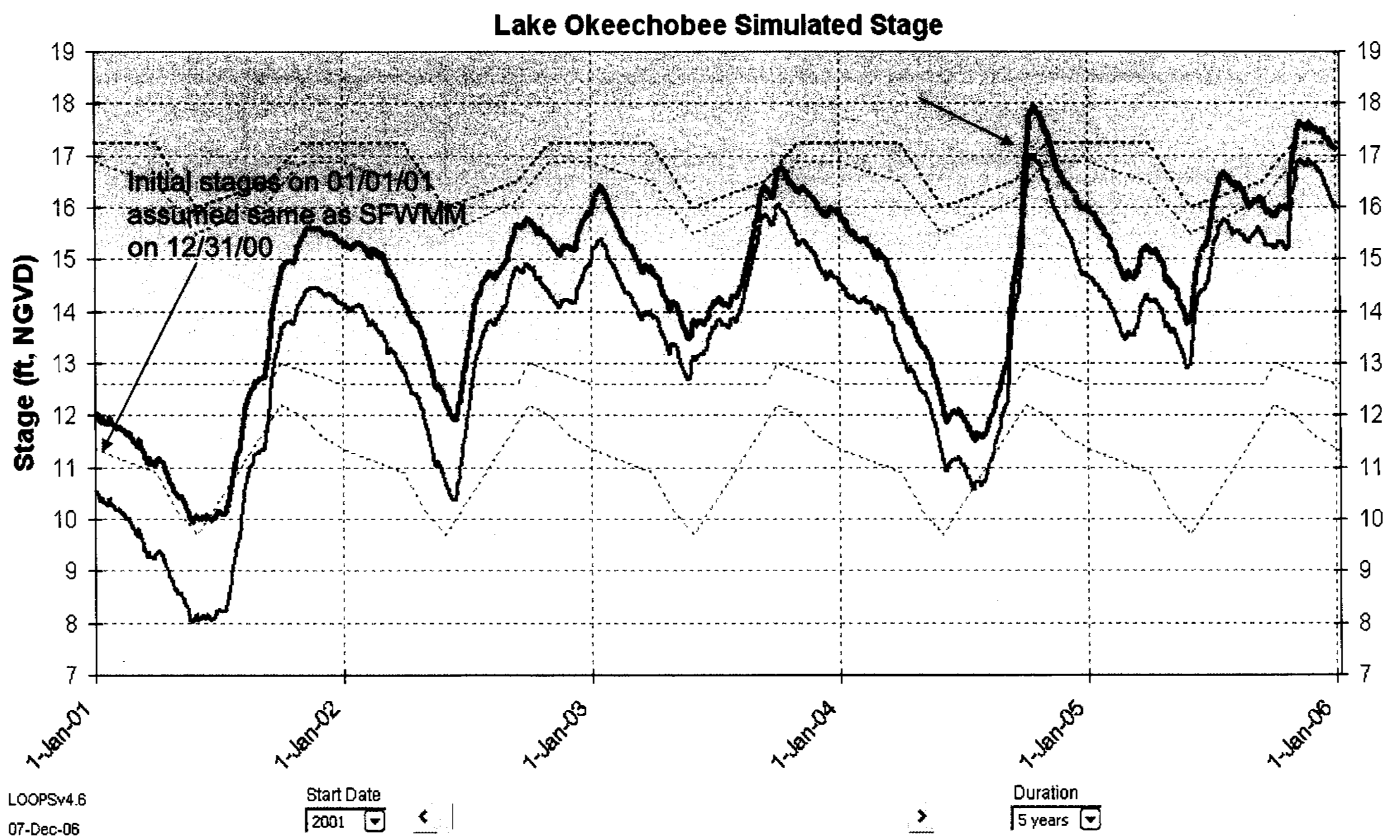


FIGURE C-112: 2001-2005 LAKE OKEECHOBEE SIMULATED STAGE HYDROGAPH FROM LAKE OKEECHOBEE OPERATIONS SCREENING MODEL (LOOPS), ASSUMING INITIAL STAGE FROM SFWMM

Set 2: Initial stages on 01-Jan-2001 assumed same as historical (07LORS = TSP3 = 11.11')
Represents what-if the TSP-3 were implemented on 01-Jan-2001.

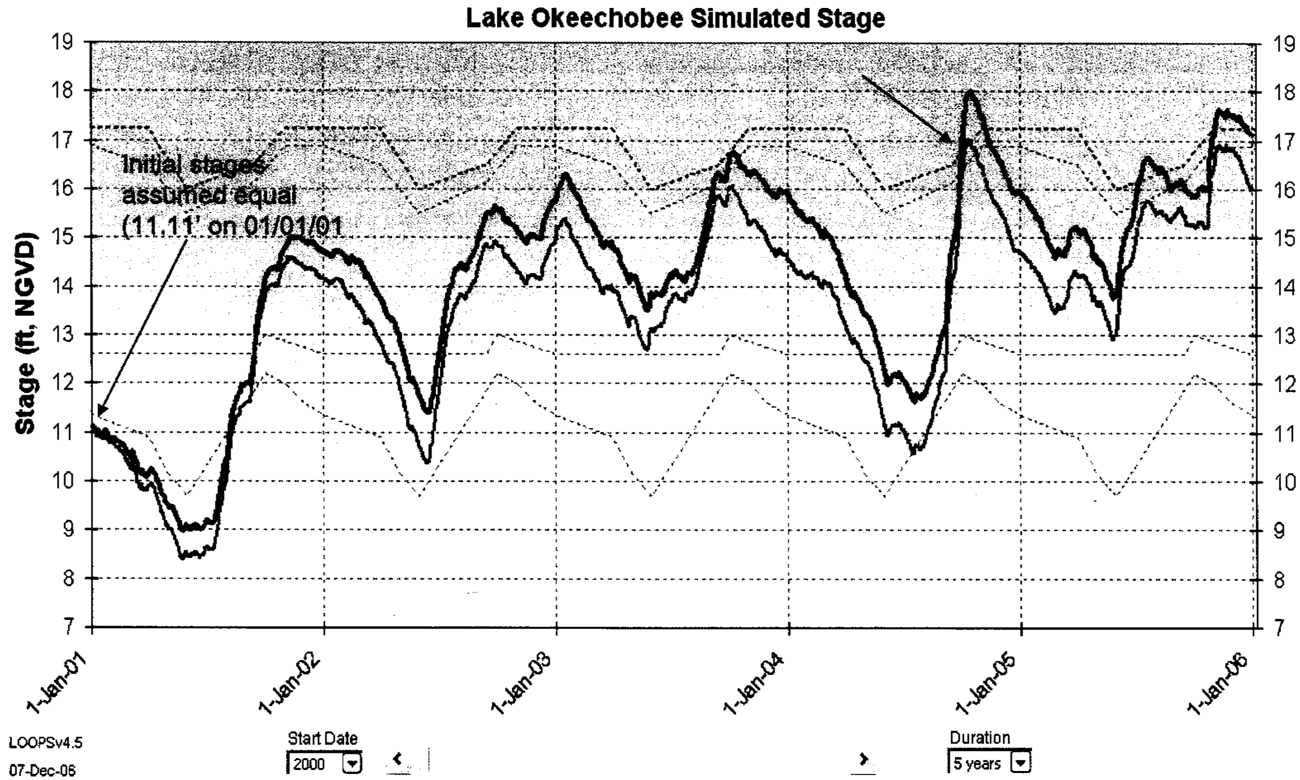


FIGURE C-113: 2001-2005 LAKE OKEECHOBEE SIMULATED STAGE HYDROGAPH FROM LAKE OKEECHOBEE OPERATIONS SCREENING MODEL (LOOPS), ASSUMING INITIAL STAGE TO MATCH HISTORICAL STAGE

ATTACHMENT D

Selected Performance Measures and Indicators: 2006 LORSS SEIS

SIMULATION RESULTS

An enormous amount of output is generated from each SFWMM simulation and post-processed Performance Measures and Indicatiors. Selected graphical summaries of the performance of each of the 2006 LORSS SEIS alternatives evaluated are presented and discussed in this attachment. The complete set of performance measure output for all alternatives evaluated under this study is available on the COE web page for LORS Modeling, at the following web address: http://hpm.sfrestore.org/loweb/sfwmm/. Simulation results for the 2006 LORSS SEIS alternatives are available under the informational runs link on this page. The alternative overviews provided in this section have not been modified from the appendix presented within the 2006 LORSS SEIS draft report; requests for additional information from public comments to the 2006 LORSS SEIS draft report have been incorporated into the presentation of the 2007 LORSS SEIS alternatives, where applicable.

The best hydrologic performance measures are those which provide a quantitative indication of how well (or poorly) an alternative meets a specific objective. These hydrologic performance measures are useful surrogates for ecosystem benefits and impacts. Although not presented herein, further evaluations of the results from water quality, ecological, and economic perspectives will be performed as part of the LORSS. Because it was not possible to include all seven alternatives (plus the No Action Alternative) into one graphical plot, three plots having the same performance measures are generated to show the appropriate comparisons. Simulation results for all alternatives, compared to the No Action Alternative, are summarized for the following regions: Lake Okeechobee, Estuaries and Bays (includes Caloosahatchee and St. Lucie estuaries), WCAs and ENP Flows, and Water Supply. Table D-1 summarizes the naming convention used to display the performance measures for each alternative, as names are limited to six to eight characters.

TABLE D-1: PERFORMANCE MEASURE LABELS FOR ALTERNATIVES

Alternative	PM data label
no action alternative	07LORS
LORS-FWO alternative	lors-fwo
alternative 1bS2-A17.25	a1bS2-A
alternative 1bS2-m	a1bS2-m
alternative 2a-B	alt2a-B
alternative 2a-m	alt2a-m
alternative 3-B	alt3-B
alternative 4-A17.25	alt4-A

Lake Okeechobee

A review of the simulation output for Lake Okeechobee requires consideration of a wide range of performance metrics including flood protection, lake ecology, and navigation. Figures D-1 through D-8 are examples of the modeling results as related to the following discussion. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. Regulatory Releases

An overview of the trends of alternative performance is captured from a review of the performance measure showing average annual flood control releases from Lake Okeechobee and the associated distribution to tidewater through the L-8 canal, the SLE through S-308, the Caloosahatchee Estuary through S-77, and south to the WCAs through S-351 (to the Hillsborough and North New River Canals) and S-354 (to the Miami River Canal), which are shown in Figures D-1 through D-3. Ranking the alternatives with respect to average annual flood control discharge to the SLE, the following trend is observed (highest to lowest): Alternative 2a-m; Alternative 2a-B; Alternative 4-A17.25; Alternative 3-B; No Action Alternative (labeled as 07LORS in all performance measure graphics); LORS-FWO and Alternative 1bS2-m; and lastly Alternative 1bS2-A17.25. Ranking the alternatives with respect to average annual flood control discharge to the Caloosahatchee Estuary, the following trend is observed (highest to lowest): Alternative 2a-m; Alternative 4-A17.25; Alternative 2a-B; Alternative 1bS2-m; Alternative 1bS2-A17.25; No Action Alternative; LORS-FWO; and lastly Alternative 3-B. Generally, the alternatives that most significantly lower the lake stages result in the most significant increase in discharge volume to the estuaries. This point is emphasized by the assumption of the treatment capacity constraint for STA-3/4, which is utilized to limit the average annual volume of lake regulatory releases passed south to STA-3/4 from S-351 and S-354 to a comparable volume for the no action condition and all evaluated LORSS Alternatives. Potential changes in flows to the estuaries will be later discussed in this section.

B. Stage Duration Curves: Flood Protection and Navigation

The stage duration curve for Lake Okeechobee is a key indicator of relative alternative performance (Figures D-4 through D-6). Two alternatives, LORS-FWO and Alternative 3-B, demonstrate a trend to reduce lake stages by approximately 0.1 to 0.5 feet compared to the current WSE regulation schedule (the No Action Alternative). Three alternatives, Alternative 1bS2-A17.25, Alternative 1bS2-m, and Alternative 4-A17.25, demonstrate a trend to reduce lake stages by approximately 1.0 to 1.2 feet. Two alternatives, Alternative 2a-B and Alternative 2a-m, demonstate a trend to reduce lake stage by greater than 1.2 feet, up to approximately 1.5 feet. Peak stages for the No Action Alternative and the other alternatives are summarized as follows: 18.50 ft, NGVD for the No Action Alternative; 18.03 ft for Alternative LORS-FWO; 17.48 ft for Alternative 1bS2-A17.25; 17.23 ft for Alternative 1bS2-m; 17.13 ft for Alternative 2a-B; 17.05 ft for Alternative 2a-m; 18.04 ft for Alternative 3-B; and 17.22 ft for Alternative 4-A17.25. Three of the alternatives plus the No Action Alternative show simulated stages above 17.25 ft, NGVD: 331 days for the No Action Alternative; 59 days for LORS-FWO; 12 days for Alternative 1bS2-A17.25; and 107 days for Alternative 3 (note: 13,149 days in the SFWMM 36-year POR). Aviodance of the 17.25 feet elevation offers additional protection for public safety and the HHD. Extreme high lake stages have also been documented to adversely impact the plant and animal communities, through processes which include the following: physical uprooting of emergent and submerged plants; reduced light levels in the water column due to increased suspended sediment; and littoral zone exposure to increased nutrient levels from the water column. The frequency of occurence for lake stages above 16.0 feet, 16.5 feet, 17.0 feet, and 17.25 feet are summarized in Figure D-7.

Alternatives observed to most significantly reduce the extreme high water stages for Lake Okeechobee (upper ten percent of the stage duration curve) also show the most significant reduction in lake stages during dry conditions (bottom ten percent of the stage duration curve). Increased fequency of low water conditions can adversely impact the health of the Lake Okeechobee littoral zone through increased susceptibility to fire and drought conditions, habitat loss, expansion of exotic and invasive vegetation, and oxidation of organic soils. The minimum simulated stages for Lake Okeechobee are summarized as follows: 9.61 feet for the No Action Alternative; 9.11 feet for LORS-FWO; 8.88 feet for Alternative 1bS2-A17.25; 8.82 feet for Alternative 1bS2-m; 8.36 feet for Alternative 2a-B; 8.27 feet for Alternative 2a-m; 9.07 feet for Alternative 3-B; and 8.42 feet for Alternative 4-A17.25. Increased frequency of low water conditions may also potentially impact recreational and commercial navigation and availability of lake supply for water supply needs. The number of days below 12.56 feet elevation is stated in the following summary: 2577 days for the No Action Alternative; 3336 days LORS-FWO; 4809 for Alternative 1bS2-A17.25; 4842 days for Alternative 1bS2-m; 5141 days for Alternative 2a-B; 5776 days for Alternative 2a-m; 3260 days for Alternative 3-B; and 4841 days for Alternative 4-A17.25.

C. Lake Okeechobee Ecology: Extreme High Stage, Extreme Low Stage, Stage Envelope

RECOVER is an arm of the CERP responsible for linking science and the tools of science to a set of system-wide planning, evaluation and assessment tasks. The most current (as of March 2006) RECOVER performance measures for Lake Okeechobee: extreme low lake stage, Lake Okeechobee extreme high lake stage, and Lake Okeechobee stage envelope, were utilized to evaluate the alternatives of the LORSS effort. In-depth documentation and rationale for these performance measures is available through the RECOVER performance measure documentation in the draft RECOVER CERP System-wide Performance Measures report (RECOVER, 2006), at the following web address: www.evergladesplan.org/pm/recover/eval_team_perf_measures.cfm. Extreme low and extreme high lake stage are evaluated with response curves. For extreme low lake stage, zero weeks below 10 ft, elevation NGVD responds to a score of 100, and 540 weeks or greater with stages below 10 ft responds to a worst case situation (15 weeks per year over 36 year simulation period), with scores linearly varied between the two extremes. For extreme high lake stage, zero weeks above 17 ft elevation responds to a score of 100 and 396 weeks or greater with stages above 17 weeks responds to the assumed worst case situation (11 weeks per year), with scores linearly varied between the two extremes. The resultant standard scores for extreme low and high lake stage are summarized as follows, with low score followed by high score: 99/83 for the No Action Alternative; 95/90 for LORS-FWO; 87/99 for Alternative 1bS2-A17.25; 87/99 for Alternative 1bS2-m; 83/100 (rounded up) for Alternative 2a-B; 78/100 (rounded up) for Alternative 2a-m; 92/85 for Alternative 3-B; and 85/99 for Alternative 4-A17.25.

The stage envelope performance measure similarly documents the benefits of seasonally-variable water levels within the range of 12.5 feet (June-July low) and 15.5 feet (November-January high) on the plant and animal communities of Lake Okeechobee. The conceptualization of the optimal stage envelope seasonal variation is shown in Figure D-8. The comparison actually utilizes smoothed boundaries for the upper and lower envelope); in simplified terms, penalty points are assigned to each alternative based on deviations outside of the envelope, with increased penalty points with increased distance away from the optimal envelope. The worst case scenario for variability above the stage envelope is assumed to be one where the lake stage hydrograph is always in the poor zone (one foot outside of the stage envelope), which equates to a total score of 1872 foot-weeks; the response curve is a line between 0 (target, score of 100) and 1872 foot-weeks (score of 0). For deviation of lake stage below the envelope, the target is 192 weeks. This is the score that would be obtained if all years had hydrographs within the optimal zone, except for once per decade the stage falling to just below 11 feet elevation for an average of three months. The response curve is a line between 192 (192 foot-weeks or less receives a score of 100) and 1872 foot-weeks (worst case scenario receives a score of zero). The resultant standard scores for lake daily stage (RECOVER performance measure specified weekly stage, but only daily stage comparisons are available within the LORSS evaluation timeframe) above and below the stage envelope are summarized as follows, with the above score followed by the below score: 75/56 for the No Action Alternative; 63/62 for LORS-FWO; 34/80 for Alternative 1bS2-A17.25; 33/82 for Alternative 1bS2-m; 24/90 for Alternative 2a-B; 9/94 for Alternative 2a-m; 60/53 for Alternative 3-B; and 28/86 for Alternative 4-A17.25. The percentage of time within the stage envelope was also identified for all alternatives as comparable, ranging within a narrow band from 25 percent (Alternative 3) to 32 percent (Alternative 2a-B) of the 36-yearPOR. Given the similiarity of time within the stage envelope band, additional focus was placed on the deviation of stages when outside the stage envelope band; alternatives observed to most significantly reduce the extreme high water stages for the lake will score better for the stage envelope above and tend to score lower for the stage envelope below.

Estuaries and Bays

One of the objectives for managing Lake Okeechobee levels was to reduce the number of high regulatory discharges to the Caloosahatchee and St. Lucie estuaries. Recognizing the need to lower the high lake levels, a strategy was incorporated into the alternatives to make more low-level (environmentally friendly) releases to avoid the high-level regulatory releases. Figures D-9 through D-23 are examples of the modeling results as related to the following discussion. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. Caloosahatchee Estuary

For all the alternatives, the mean monthly flows between 2800 and 4500 cfs were essentially the same or decreased. For mean monthly flows greater than 4500 cfs, only two alternatives had the same or less events: LORS-FWO and Alternative 3-B. The rest of the alternatives had an increase of two to three events of high flow with the exception of Alternative 2a-B which had an increase of seven events of high flow. The base condition and all alternatives were about five times greater than the target for high flows.

In addition to the number of mean monthly flows, the duration of high-flow releases (consecutive months of >4500 cfs) are of concern. All of the alternatives showed significant differences in the duration of mean monthly high-flow events. A discussion of the longest duration of the total estuary high-flow will be presented in this attachment. The worst case for No Action Alternative (base run) was 24 periods of two to three months duration of high-flow. The worst case for LORS-FWO was 23 periods of two to three months duration of high-flow. The worst case for Alternative 1bS2-A17.25 was seven periods of six to seven months duration of high-flow. The worst case for Alternative 1bS2-m was four periods of four to five months duration of high-flow. The worst case for Alternative 2a-B was seven periods of six to seven months duration of high-flow. The worst case for Alternative 2a-m was four periods of four to five months duration of high-flow. The worst case for Alternative 3-B was seven periods of six to seven months duration of high-flow. The worst case for Alternative 4-A17.25 was seven periods of six to seven months duration of high-flow.

For the mean monthly flows less than 300 cfs, all the alternatives significantly reduced the number of events (by almost half the number). Alternative 2a-B, Alternative 2a-m and Alternative 4-A17.25 showed the least improvement.

B. St. Lucie Estuary

For all the alternatives, the mean monthly flows between 2000 and 3000 cfs were nearly the same or decreased. For mean monthly flows greater than 3000 cfs, the alternatives had mixed results. For LORS-FWO, Alternative 1bS2-A17.25, Alternative 1bS2-m, Alternative 3-B, and Alternative 4-A17.25 there was a slight reduction of high-flow events. Only Alternative 2a-B and Alternative 2a-m had a greater number of flow events greater than 3000 cfs. The base condition and all alternatives were two to three times greater than the target for high flows.

In addition to the number of mean monthly flows, the duration of high-flow releases (consecutive months of >3000 cfs) are of concern. All of the alternatives showed differences in the duration of mean monthly high-flow events. A discussion of the longest duration of the total estuary high-flow will be presented in this attachment. The worst case for No Action Alternative (base run) was six periods of six to seven months duration of high-flow. The worst case for LORS-FWO was nine periods of four to five months duration of high-flow. The worst case for Alternative 1bs2-A17.25 was eight periods of four to five months duration of high-flow. The worst case for Alternative 1bS2-m was seven periods of six to seven months duration of high-flow. The worst case for Alternative 2a-B was seven periods of six to seven months duration of high-flow. The worst case for Alternative 2-m was seven periods of six to seven months duration of high-flow. The worst case for Alternative 3-B was seven periods of six to seven months duration of high-flow. The worst case for Alternative 4-A17.25 was eight periods of four to five months duration of high-flow.

For the mean monthly flows less than 350 cfs, the minimum flow needs were generally thought to be met by intervening flows (including groundwater flows). With regard to releases from S-80, most alternatives had essentially the same number of low-flow months as the base case. There were three notable differences: Alternative 2a-B and Alternative 3-B had more low-flow months while Alternative 2a-m had fewer low-flow events.

C. Lake Worth Lagoon

For all the alternatives, the number of times the two-day moving average flow was greater than 1000 cfs decreased. The number of times the seven-day moving average flow was greater than 500 cfs were nearly the same except for slight increase in LORS-FWO, Alternative 2a-B and

Alternative 2a-m. The number of times the seven-day moving average flow was equal to zero remained unchanged for all alternatives.

D. Biscayne Bay

Flows to Biscayne Bays were essentially unchanged (± 1 to 2 kAF/yr) in all the alternatives.

E. Whitewater Bay

For most alternatives, there was less than a 3 kAF/yr reduction in overland flow. However, Alternative 4-A17.25 and Alternative 2a-m had a 4 and 5 kAF/yr reduction in overland flow, respectively.

F. Florida Bay

Flows to Biscayne Bays were essentially unchanged (+ 1 kAF/yr at most) in all the alternatives.

WCA and ENP Flows

The flow changes, as related to the various alternatives, in the WCAs and ENP are discussed in this section. Generally, the flow changes (as indicated by the transect flows) in these areas are relatively small. As a result of greater-than-normal lake mixing from recent hurricanes, the STA-3/4 flow constraint of approximately 63,000 acre-feet/yr reduces the amount of flow from Lake Okeechobee that normally goes directly to WCA 3A; this is because of the increased loading that could occur due to an increased suspension of nutrients in Lake Okeechobee. The STA-3/4 flow constraint is included in all the alternatives as well as in the No Action Alternative base condition. Figures D-24 through D-26 are examples of the modeling results as related to the following discussion. All of the figures can be reviewed at: http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. WCA 1

Flows across Transect T1 show little variation (± 1 kAF/yr) in all the alternatives.

B. WCA 2A

Flows across Transect T2 show some variation in the alternatives. Alternative 1bS2-A17.25 and Alternative 1bS2-m show an increase of about 6 kAF/yr; LORS-FWO, Alternative 2a-B and Alternative 3-B show little change (-1 or -2 kAF/yr); and Alternative 2a-m and Alternative 4-A17.25 show a decrease in flow (-5 and -6 kAF/yr).

C. WCA 3A

Flows across central WCA 3A (Transects T6 and T7) show slight variations between alternatives. Alternatives LORS-FWO, 1bS2-A17.25, 1bS2-m, 2a-B and 3-B show overland flow differences of about ± 3 kAF/yr. Alternative 2a-m and Alternative 4-A17.25 show decreases of -13 kAF/yr and -7 kAF/yr.

D. ENP

Overland flows into ENP are shown as Transects T17 and T18. LORS-FWO decreases flow (-4 kAF/yr); Alternative 1bS2-A17.25 increases flow (2 kAF/yr); Alternative 1bS2-m shows no change; Alternative 2a-B decreases flow (-6 kAF/yr); Alternative 2a-m decreases flow (-13 kAF/yr); Alternative 3-B decreases flow (-4 kAF/yr); Alternative 4-A17.25 decreases flow (-9 kAF/yr).

Water Supply

All alternatives evaluated, including the No Action Alternative, assume operation of the SFWMD temporary forward pumps for water supply at S-354 (400 cfs), S-351 (600 cfs), and S-352 (400 cfs). Based on preliminary operational guidance from the SFWMD, the pumps are simulated to trigger on for water supply demands if Lake Okeechobee stage falls below 10.2 feet; the pumps are assumed triggered off when Lake Okeechobee stage recovers to 11.2 feet. The No Action Alternative assumes the existing SSM line (set by the SFWMD) to be in place. Based on guidance from the SFWMD, a modified SSM line and operations are anticipated to be implemented in advance of any new regulation schedule resultant from LORSS; all alternatives, therefore, assume a one foot lowering of the existing SSM line as a surrogate for the anticipated SSM changes by the SFWMD (this assumption is based on a recommendation from the SFWMD). The No Action Alternative is the only alternative to utilize the existing SSM line. In order to provide additional data related to the assumed lowering of the SSM line, a sensitivity model run was completed for the Preferred Alternative with the SSM line returned to the existing (same as the No Action Alternative) level.

Three performance measures are presented to compare the potential water supply impacts of the alternatives. Particular emphasis is given to water supply impacts under the most significant drought conditions experienced within the simulation POR, as water supply needs under drought conditions are highly susceptible given the observed lowering of Lake Okeechobee stages under the alternatives. Figures D-27 through D-32 are examples of the modeling results as related to the following discussion. All of the figures can be reviewed at:
http://hpm.saj.usace.army.mil/loweb/sfwmm.

A. Everglades Agricultural Area

Simulated water supply effects to the EAA are shown based on the performance measure for mean annual EAA Supplemental Irrigation, demands and demands not met. The alternatives are ranked in order of the mean annual volume of demands not met during the drought years of 1971, 1975, 1981, 1985, and 1989, with increased demand not met indicative of higher potential impacts to EAA water supply: 27,000 acre-feet of demand not met for LORS-FWO (6% of total demand is not met); 37,000 acre-feet for Alternative 3-B (8% not met); 44,000 acre-feet for the No Action Alternative (10% not met); 67,000 acre-feet for Alternative 1bS2-A17.25 (15% not met); 73,000 acre-feet for Alternative 1bS2-m (16% not met); 84,000 acre-feet for Alternative

4_A17.25 (18% not met); 103,000 acre-feet for Alternative 2a-B (22% not met); and the highest of 134,000 acre-feet for Alternative 2a-m (27% not met).

B. Lake Okeechobee Service Area

Simulated water supply effects to the LOSA are shown based on the performance measure for mean annual LOSA Supplemental Irrigation, demands and demands not met. The alternatives are ranked in order of the mean annual volume of demands not met during the drought years of 1971, 1975, 1981, 1985, and 1989, with increased demands not met indicative of higher potential impacts to LOSA water supply: 15,000 acre-feet of demand not met for LORS-FWO (5% of total demand is not met); 18,000 acre-feet for Alternative 3-B (5% not met); 24,000 acre-feet for the No Action Alternative (7% not met); 28,000 acre-feet for Alternative 1bS2-A17.25 (8% not met); 30,000 acre-feet for Alternative 1bS2-m (9% not met); 39,000 acre-feet for Alternative 4-A17.25 (11% not met); 45,000 acre-feet for Alternative 2a-B (13% not met); and the highest of 56,000 acre-feet for Alternative 2a-m (17% not met).

C. Lower East Coast

Simulated water supply effects to the Lower East Coast are shown based on the number of months of water supply cutbacks for the 36-year POR. The performance measure graphics selected show the number of months under cutback (all cutbacks are phase 1 cutbacks for the LORSS Alternatives) for each of the following LECSA: Northern Palm Beach County, LECSA1, LECSA2, and LECSA3. Phase 1 cutbacks can be induced by one of three triggers: Lake stage in SSM Zone (indicated by upper label on figures D-30 through D-32), local trigger well stages (lower data label; as expected, this changes minimally for the regulation schedule alternatives), or dry season criteria (indicated by the middle data label; phase 1 restrictions remain in place until the end of the dry season if water restrictions from the Lake or local groundwater triggers occurred anytime during the dry season). For LECSA Northern Palm Beach County, the No Action Alternative shows 31 months of simulated cutbacks; slight increases to 33 months are observed in the simulation results for Alternative 1bS2-A17.25, Alternative 1bS2-m, Alternative 2a-B, Alternative 2a-m, and Alternative 4-A17.25; significant reduction of cutback months are observed with 16 months under cutback for the LORS-FWO alternative and Alternative 3-B. The same trend is observed in the simulation results for LECSA1, LECSA2, and LECSA3. The No Action Alternative simulation results show 31 cutback months for LECSA1, 80 cutback months for LECSA2, and 31 cutback months for LECSA3. Alternatives 1bS2-A17.25, 1bS2-m, a2a-B, 2a-m, and Alternative 4-A17.25 slight increases to 33 cutback months for LECSA1, 82 cutback months for LECSA2, and 33 cutback months for LECSA3. Alternative LORS-FWO and Alternative 3-B show a significant reduction to 16 cutback months for LECSA1, 71 cutback months for LECSA2, and 16 cutback months in LECSA3.

D. SSM Sensitivity Simulation

The above general overview of water supply performance measure trends is dependent on the assumption for the SSM line. As previously summarized, modified SSM line and operations are anticipated to be implemented in advance of any new regulation schedule resultant from LORSS;

all alternatives (with the exception of the No Action baseline alternative), therefore, assume a one foot lowering of the existing SSM line as a surrogate for the anticipated SSM changes by the SFWMD. Generally, the inclusion of the temporary forward pumps allows for the assumption of the lowered SSM line, meaning that water supply restrictions would be initiated at lower lake stages than currently in practice. Additional data is available for the evaluation of the Preferred Alternative (Alternative 1bS2-m) through a sensitivity model simulation with the existing SSM line assumed in place (consistent with the No Action Alternative). The assumed lowering of the SSM line does alter the performance of the Preferred Alternative. With the existing SSM line assumed in place with the operational rules of Alternative 1bS2-m, the simulation results show mean annual EAA supplemental demands not met to increase from an average annual volume of 22,000 acre-feet and average drought year (1971, 1975, 1981, 1985, and 1989) volume of 73,000 acre-feet under Alternative 1bS2-m to an average annual volume of 42,000 acre-feet and average drought year volume of 114,000 acre-feet; the percentage of demands not met for the EAA is increased from six to 12 percent for the average year and 16 to 24 percent during the drought years. With the existing SSM line assumed in place with the operational rules of Alternative 1bS2-m, the simulation results show mean annual LOSA supplemental demands not met to increase from an average annual volume of 10,000 acre-feet and average drought year volume of 30,000 acre-feet under Alternative 1bS2-m to an average annual volume of 23,000 acre-feet and average drought year volume of 56,000 acre-feet; the percentage of demands not met for the LOSA is increased from four to ten percent for the average year and nine to 17 percent during the drought years. The number of months of simulated water supply cutbacks for the four LECSAs also show increased cutback months for the Preferred Alternative without the assumption of a lowered SSM line: 33 to 49 months for Northern Palm Beach County; 33 to 49 months for LECSA1; 82 to 95 months for LECSA2; and 33 to 49 months for LECSA3. Select performance measures have been summarized; the complete performance measure set is available on the study web page previously cited (the performance measure set includes "alt1bS2-m-exSSM" in the title and the abbreviation of "mexSSM" on the performance measure set graphics). The SSM Line is set by the SFWMD. Modified SSM rules and a modified SSM line are under development by the SFWMD; these efforts are anticipated to be completed prior to implementation of any new regulatory schedule for Lake Okeechobee, and the efforts will be able to consider the additional data provided from the Preferred Alternative for LORSS. The water supply effects of the alternatives, as shown by a review of the performance measures, must be evaluated with consideration of this parallel and ongoing effort by the SFWMD. The performance measure output is dependent on the SSM line assumption; modification of the SSM line or existing SSM rules (as assumed in place under all alternatives evaluated) will affect the simulated performance, and the nature of the changes will determine the significance of the observed improvement or potential additional impact seen in the simulation results.

SUMMARY

The No Action Alternative, along with seven other alternatives, were modeled using the SFWMM. The modeling intent and differences of the alternatives were presented. Model output and post-processed products were used in the selection of the 2006 LORSS SEIS TSP. Selected examples of the model output and performance measures are included as part of this attachment (Figures D-1 through D-32).

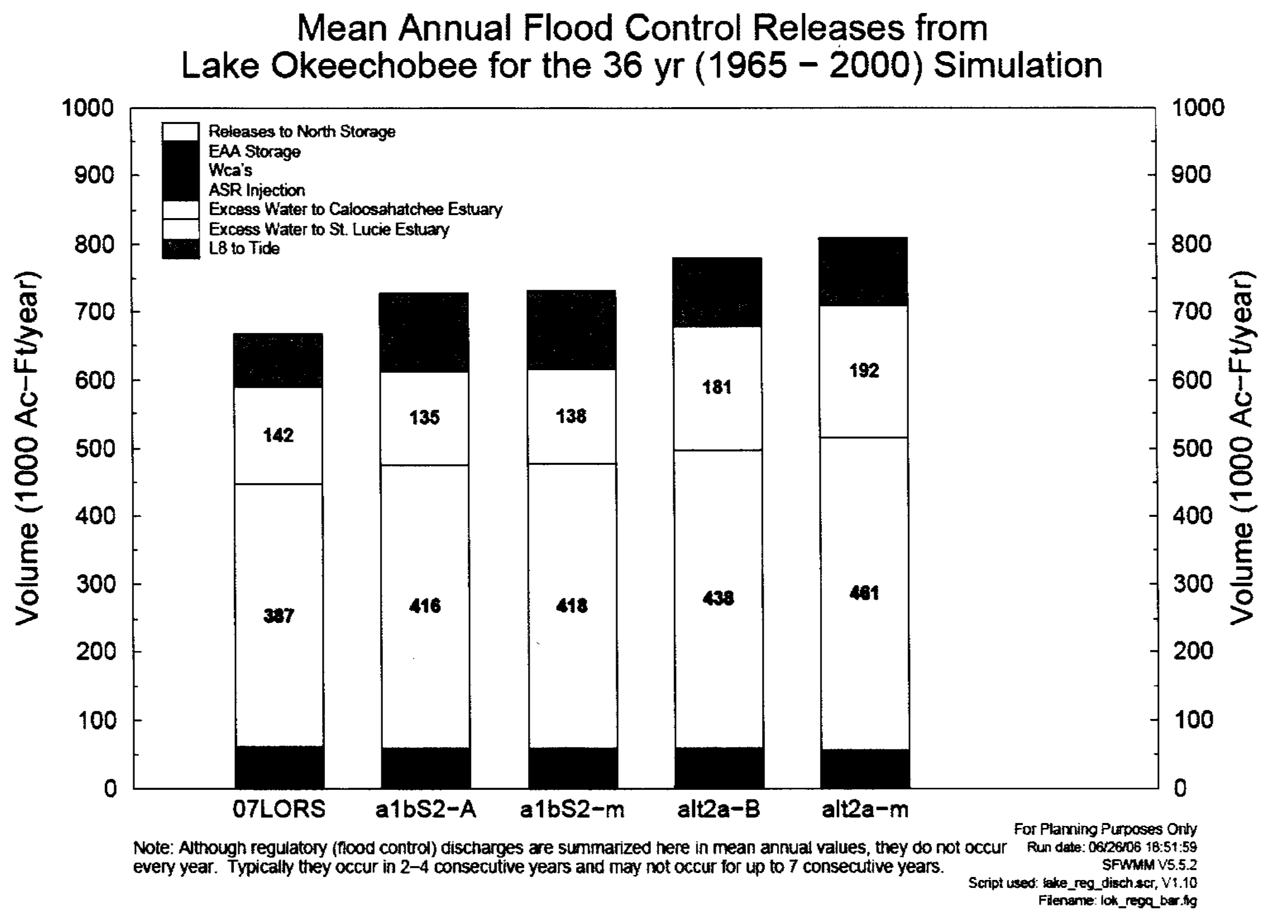
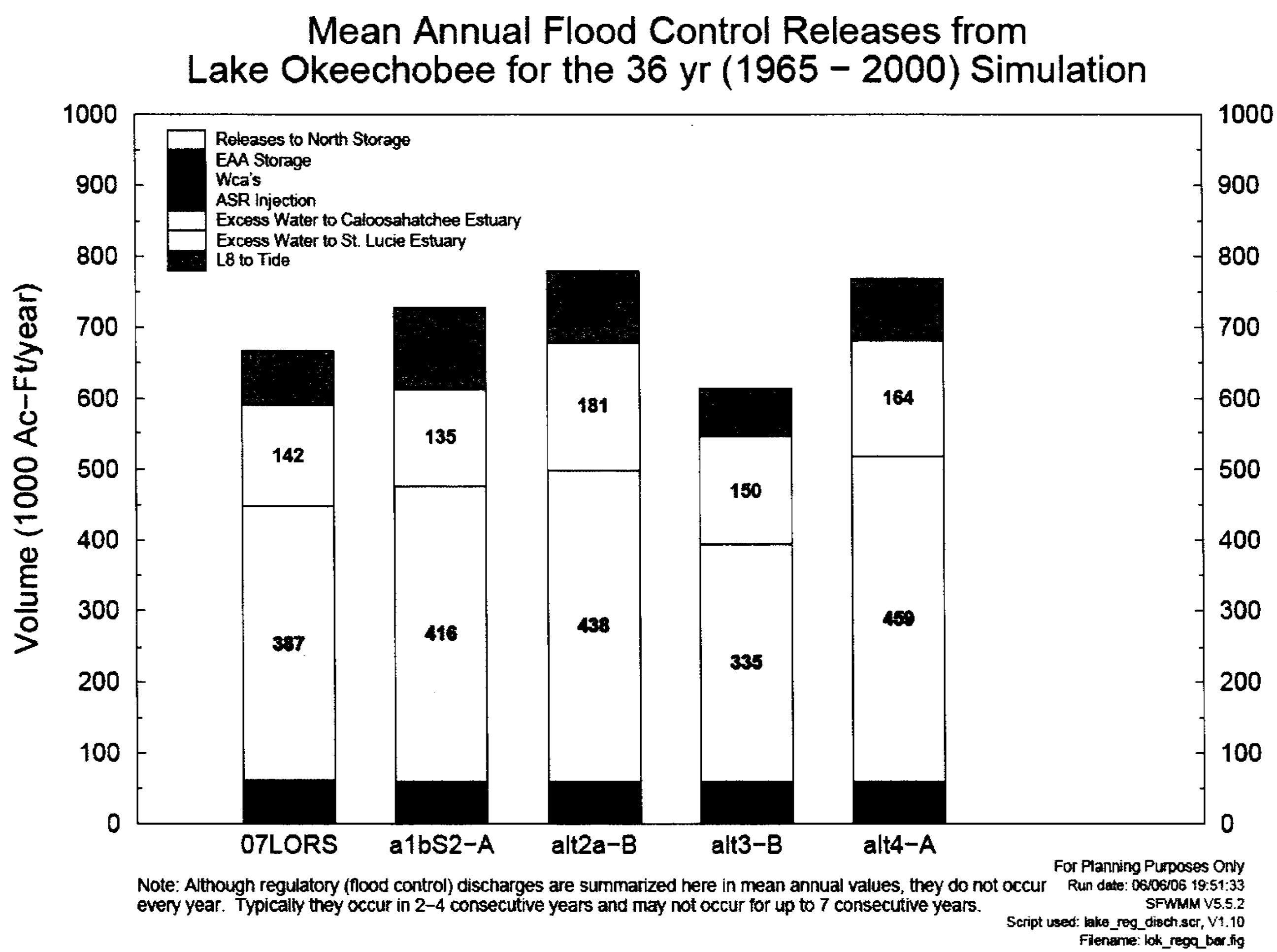


FIGURE D-1: MEAN ANNUAL FLOOD CONTROL RELEASES FROM LAKE OKEECHOBEE (1)



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.

FIGURE D-2: MEAN ANNUAL FLOOD CONTROL RELEASES FROM LAKE OKEECHOBEE (2)

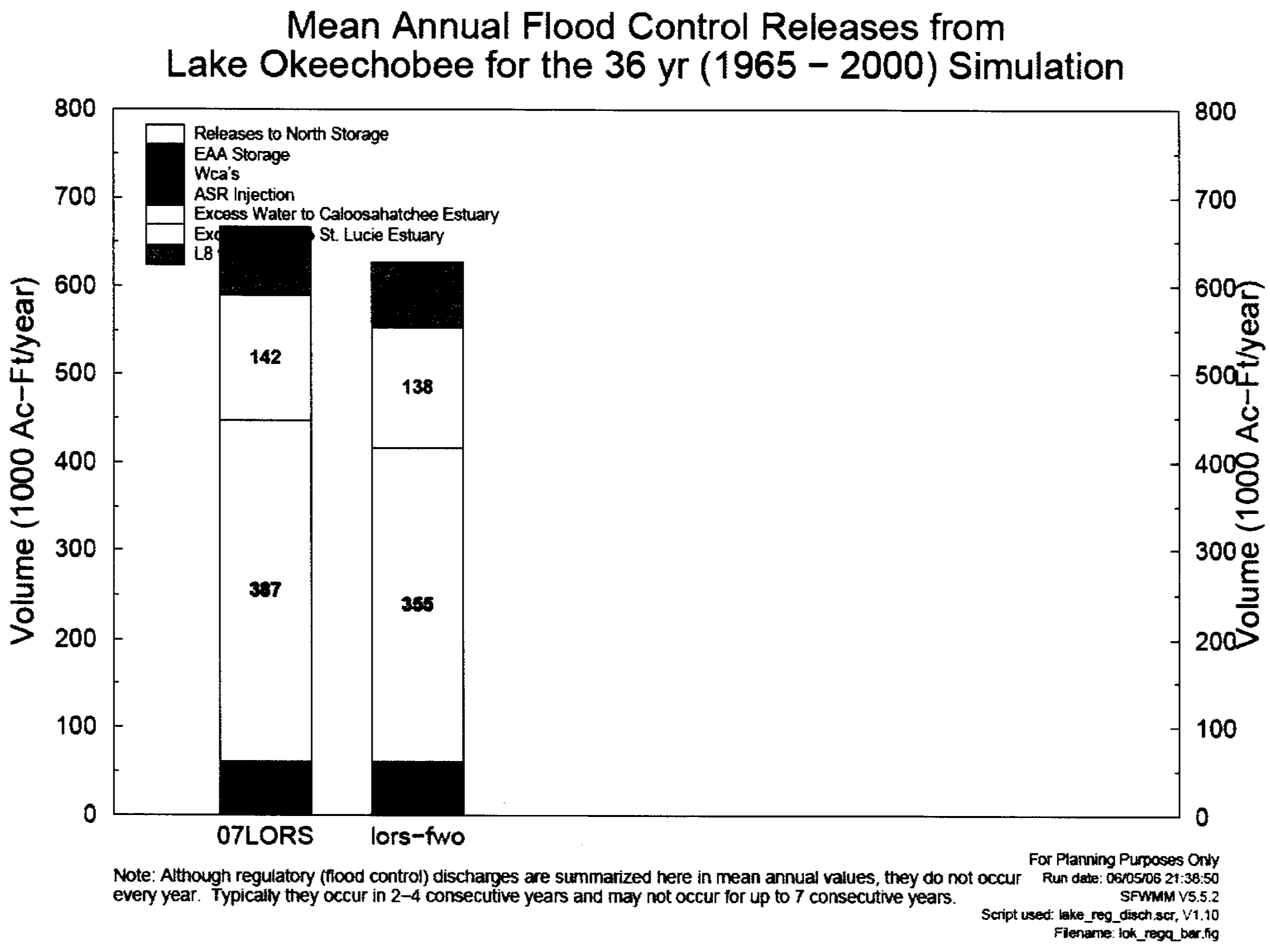


FIGURE D-3: MEAN ANNUAL FLOOD CONTROL RELEASES RROM LAKE OKEECHOBEE (3)

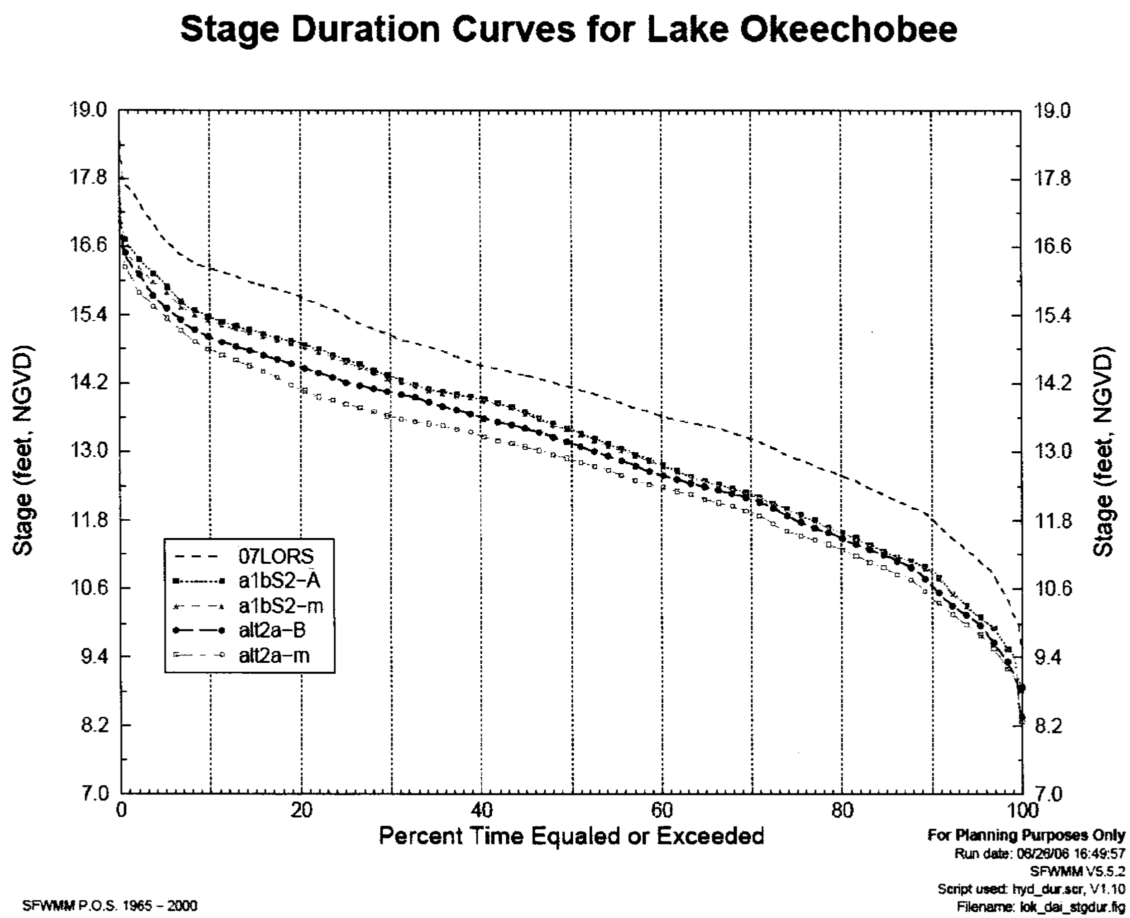


FIGURE D-4: LAKE OKEECHOBEE STAGE DURATION CURVES (1)

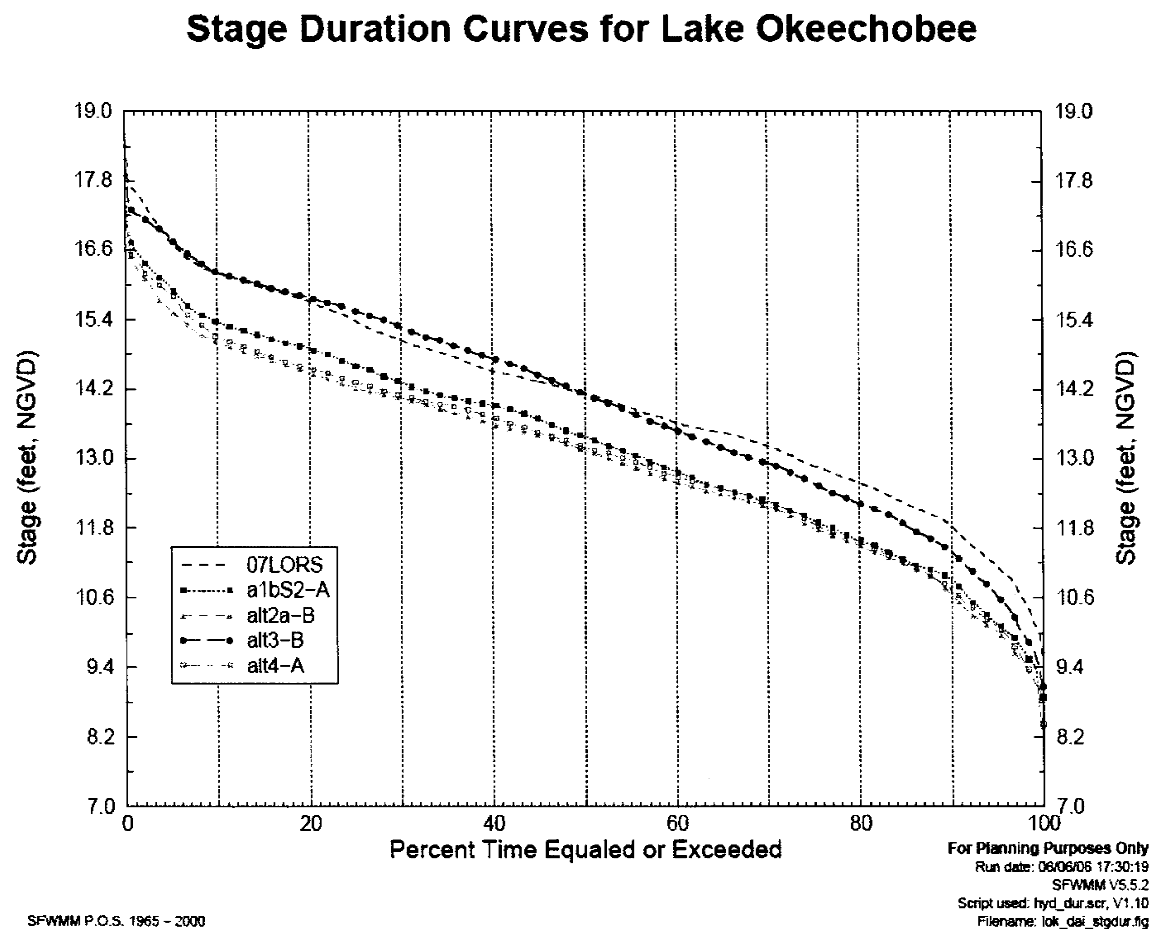


FIGURE D-5: LAKE OKEECHOBEE STAGE DURATION CURVES (2)

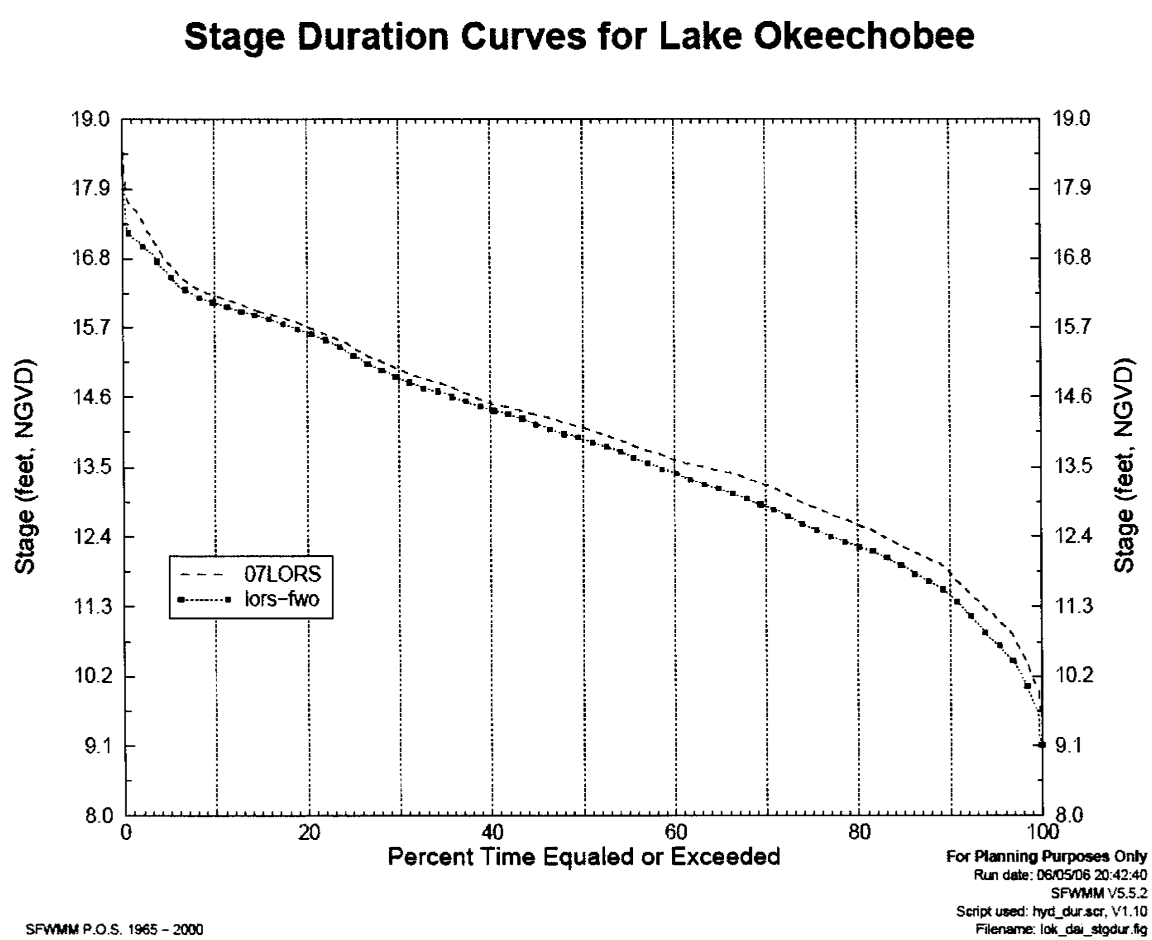


FIGURE D-6: LAKE OKEECHOBEE STAGE DURATION CURVES (3)

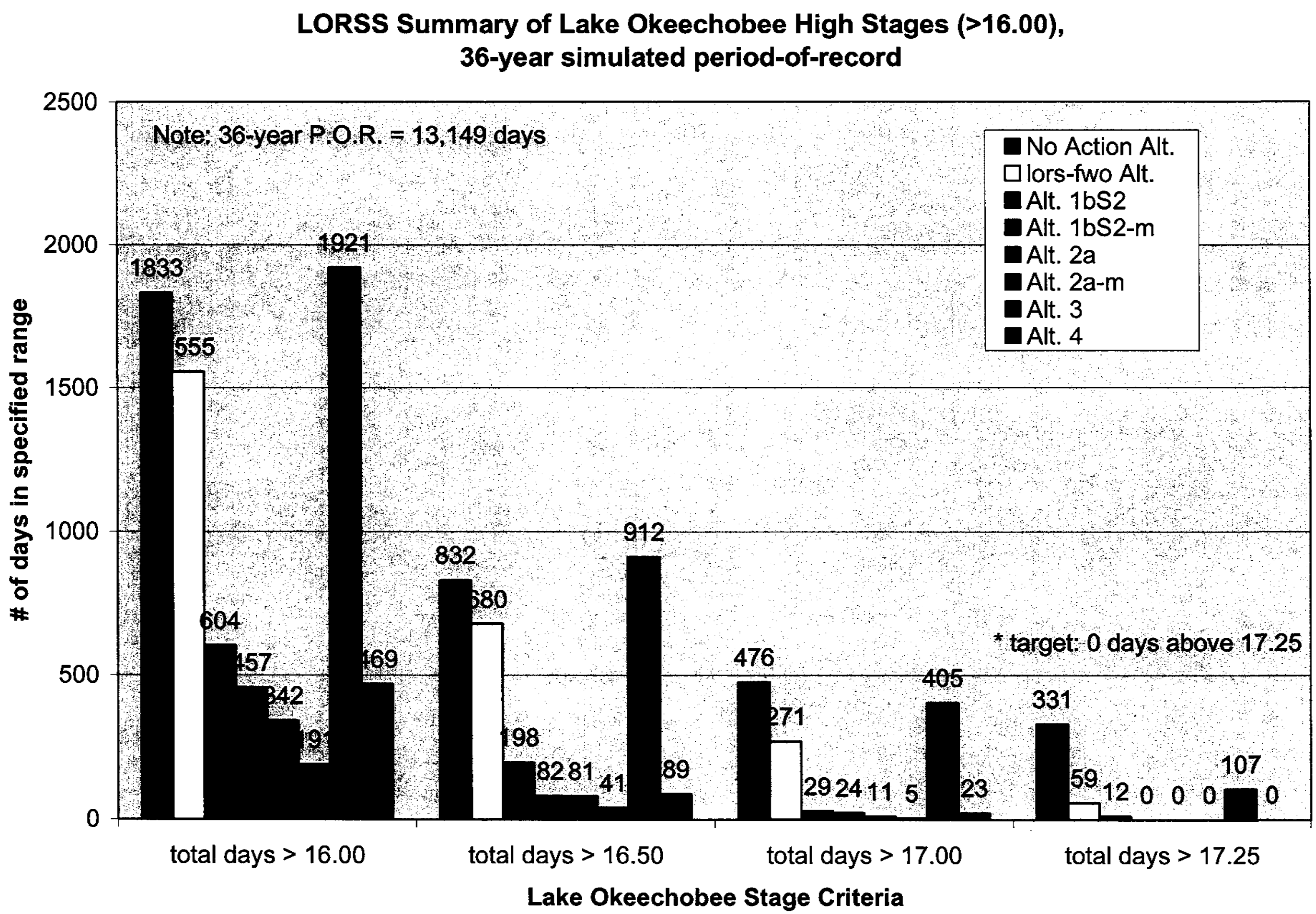


FIGURE D-7: OCCURRENCE FREQUENCY OF LAKE OKEECHOBEE HIGH STAGES

Month

Stage	J	F	M	A	M	J	J	A	S	O	N	D	
19	3.5	4	4.5	5	6	6.5	6.5	6	5	4	3.5	3.5	
18.5	3	3.5	4	4.5	5.5	6	6	5.5	4.5	3.5	3	3	
18	2.5	3	3.5	4	5	5.5	5.5	5	4	3	2.5	2.5	
17.5	2	2.5	3	3.5	4.5	5	5	4.5	3.5	2.5	2	2	
17	1.5	2	2.5	3	4	4.5	4.5	4	3	2	1.5	1.5	A
16.5	1	1.5	2	2.5	3.5	4	4	3.5	2.5	1.5	1	1	
16	0.5	1	1.5	2	3	3.5	3.5	3	2	1	0.5	0.5	B
15.5	0	0.5	1	1.5	2.5	3	3	2.5	1.5	0.5	0	0	
15	0	0	0.5	1	2	2.5	2.5	2	1	0	0	0	
14.5	0	0	0	0.5	1.5	2	2	1.5	0.5	0	0	0	
14	0.5	0	0	0	1	1.5	1.5	1	0	0	0.5	0.5	
13.5	1	0.5	0	0	0.5	1	2	0.5	0	0	1	1	
13	1.5	1	0.5	0	0	0.5	0.5	0	0	0.5	1.5	1.5	
12.5	2	1.5	1	0.5	0	0	0	0	0	1	2	2	
12	2.5	2	1.5	1	0	0	0	0	0.5	1.5	2.5	2.5	
11.5	3	2.5	2	1.5	0.5	0.5	0.5	0.5	1	2	3	3	
11	3.5	3	2.5	2	1	1	1	1	1.5	2.5	3.5	3.5	C
10.5	4	3.5	3	2.5	1.5	1.5	1.5	1.5	2	3	4	4	
10	4.5	4	3.5	3	2	2	2	2	2.5	3.5	4.5	4.5	
9.5	5	4.5	4	3.5	2.5	2.5	2.5	2.5	3	4	5	5	
9	5.5	5	4.5	4	3	3	3	3	3.5	4.5	5.5	5.5	
8.5	6	5.5	5	4.5	3.5	3.5	3.5	3.5	4	5	6	6	
8	5.6	6	5.5	5	4	4	4	4	4.5	5.5	5.6	5.6	
7.5	7	6.5	6	5.5	4.5	4.5	4.5	4.5	5	6	7	7	

FIGURE D-8: CONCEPTUALIZATION OF LAKE OKEECHOBEE STAGE ENVELOPE PERFORMANCE MEASURE

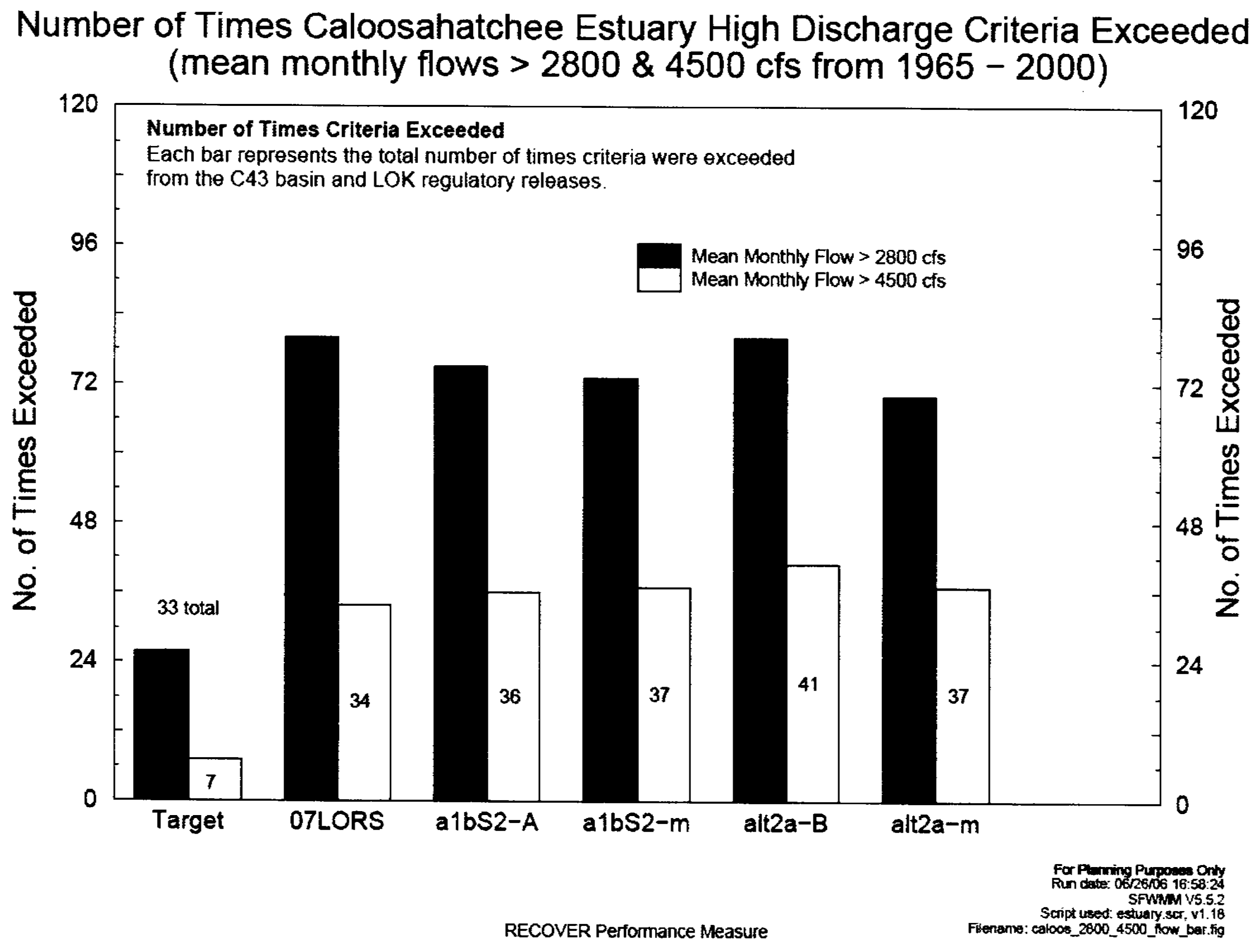


FIGURE D-9: CALOOSAHATCHEE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (1)

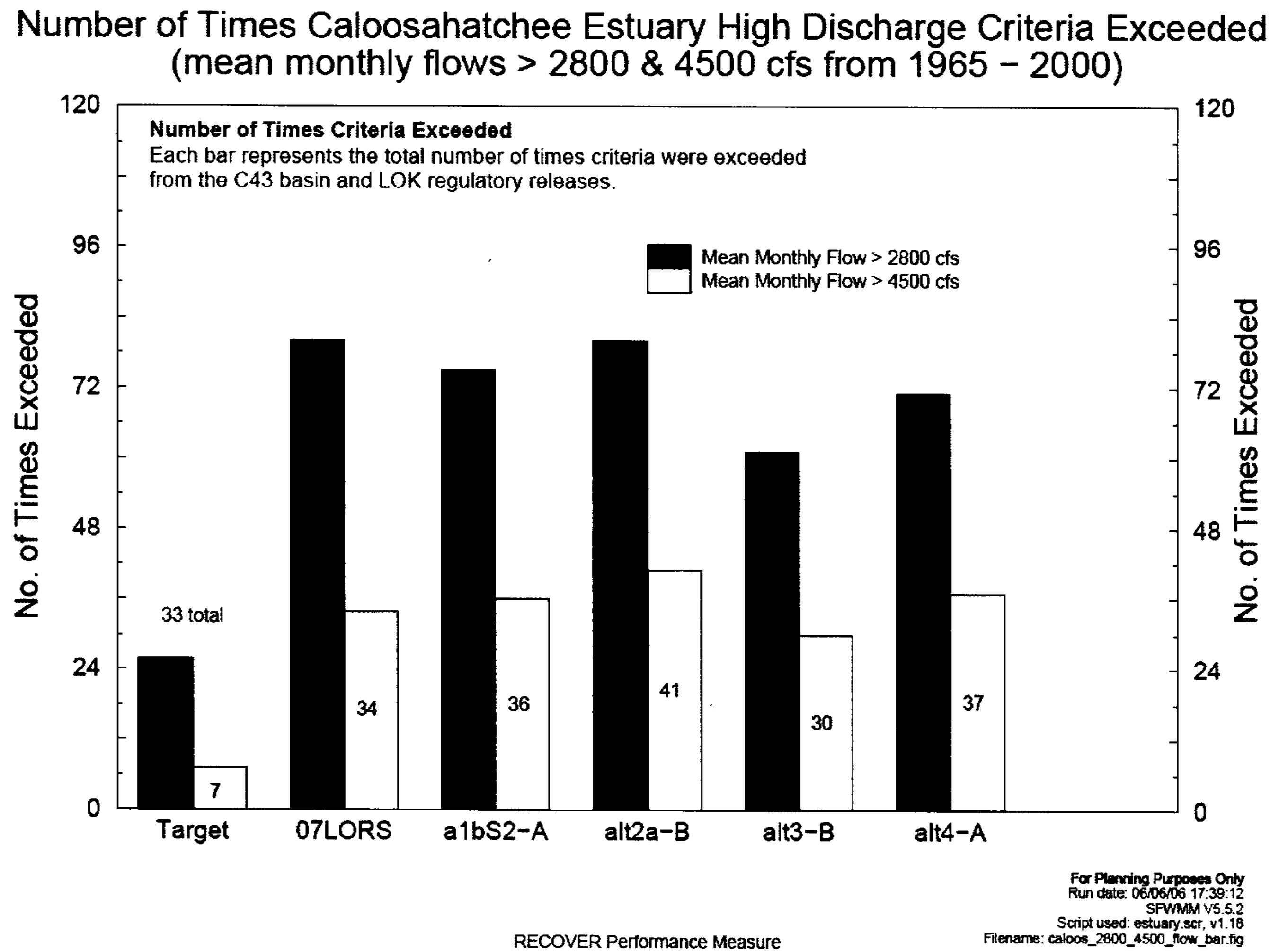


FIGURE D-10: CALOOSAHATCHEE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (2)

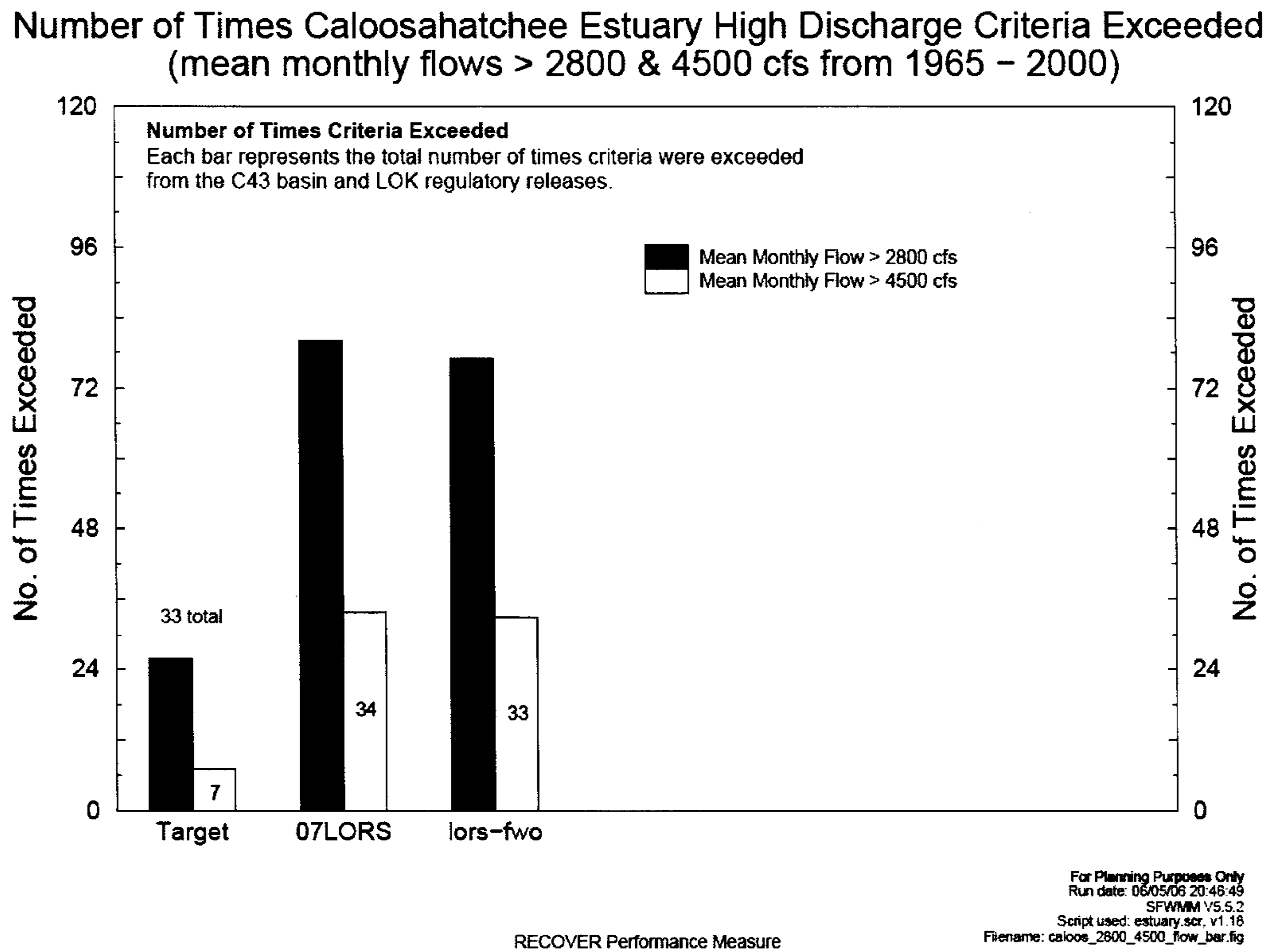


FIGURE D-11: CALOOSAHATCHEE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (3)

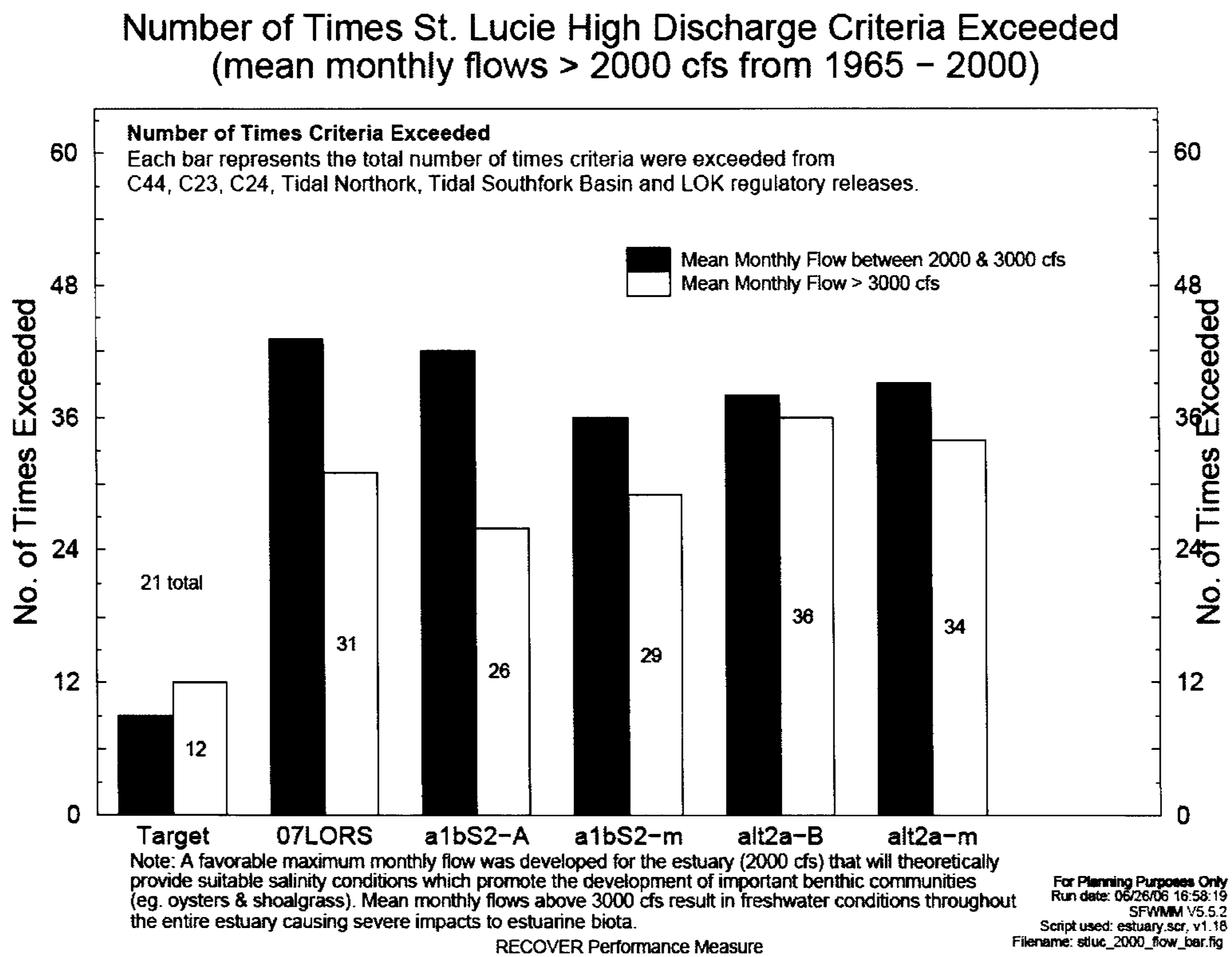


FIGURE D-12: ST. LUCIE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (1)

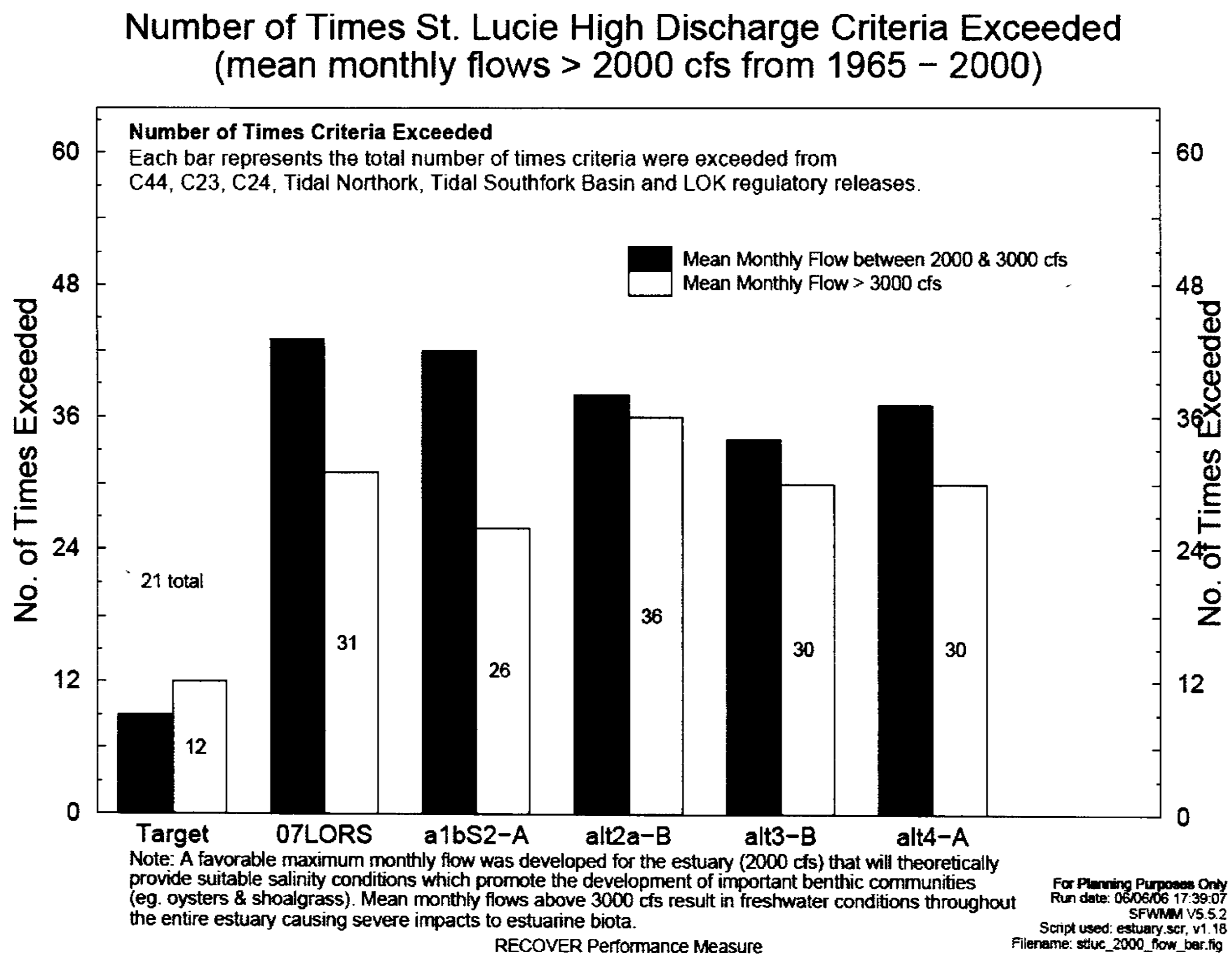


FIGURE D-13: ST. LUCIE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (2)

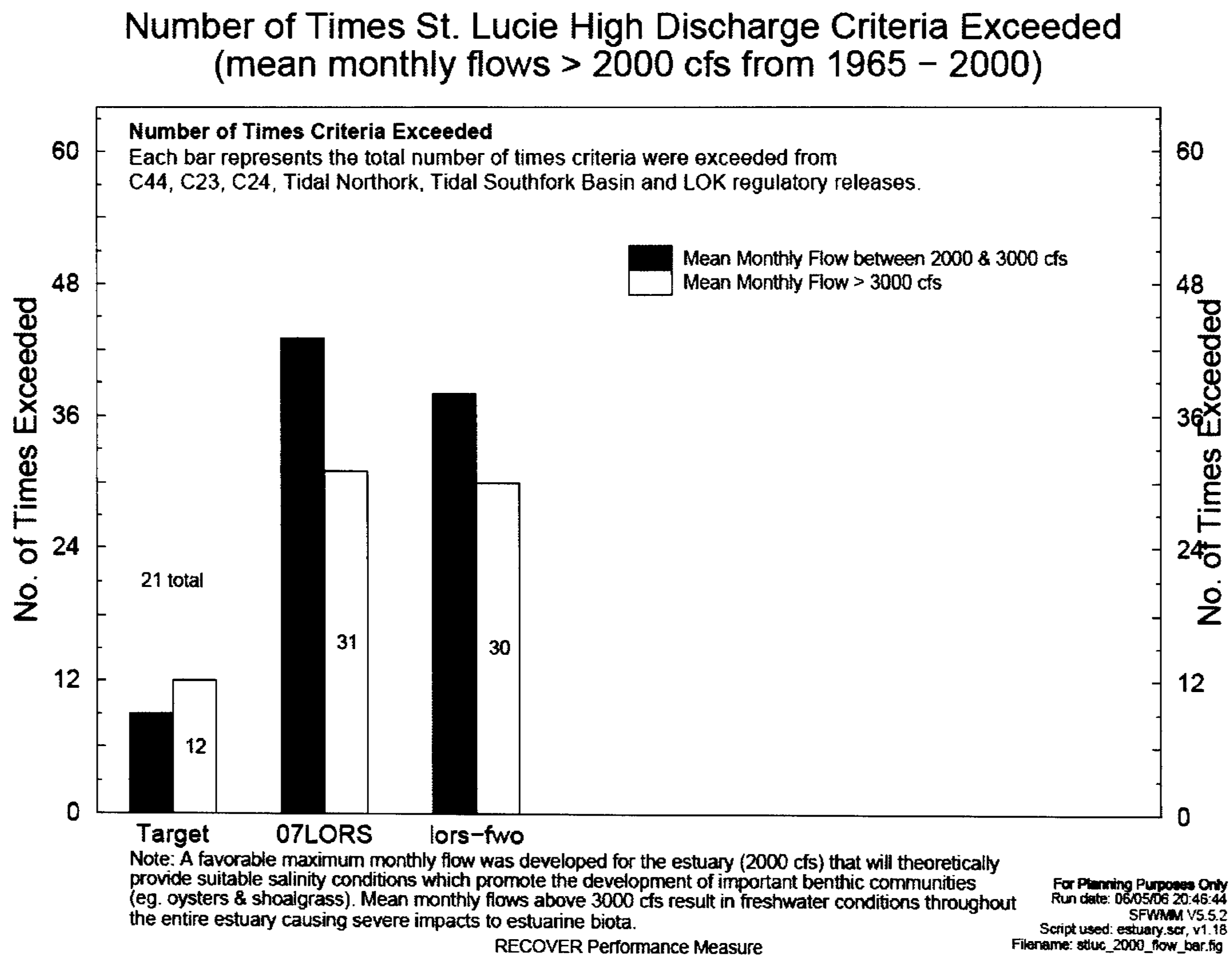


FIGURE D-14: ST. LUCIE ESTUARY HIGH DISCHARGE CRITERIA EXCEEDED (3)

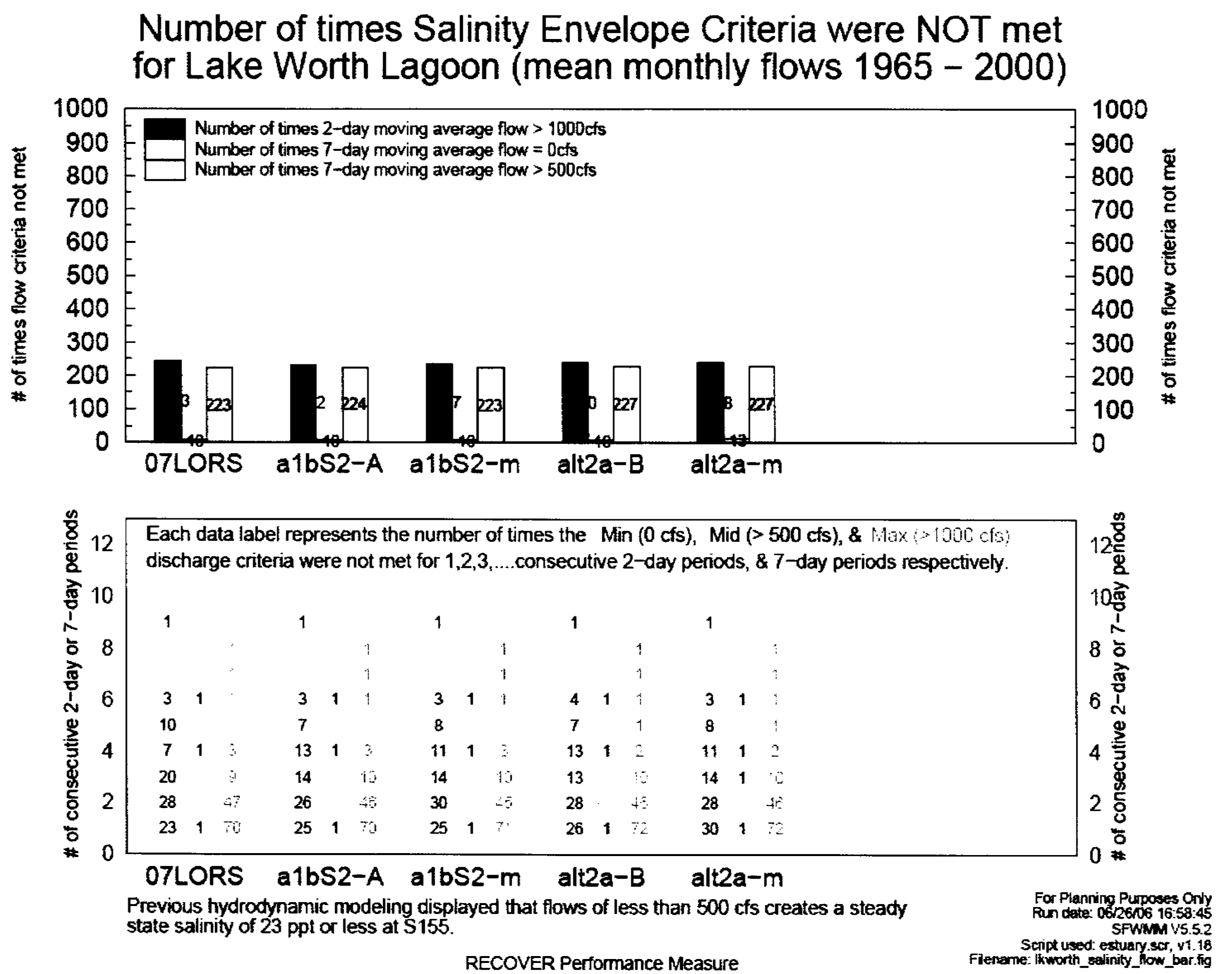


FIGURE D-15: LAKE WORTH LAGOON SALINITY ENVELOPE (1)

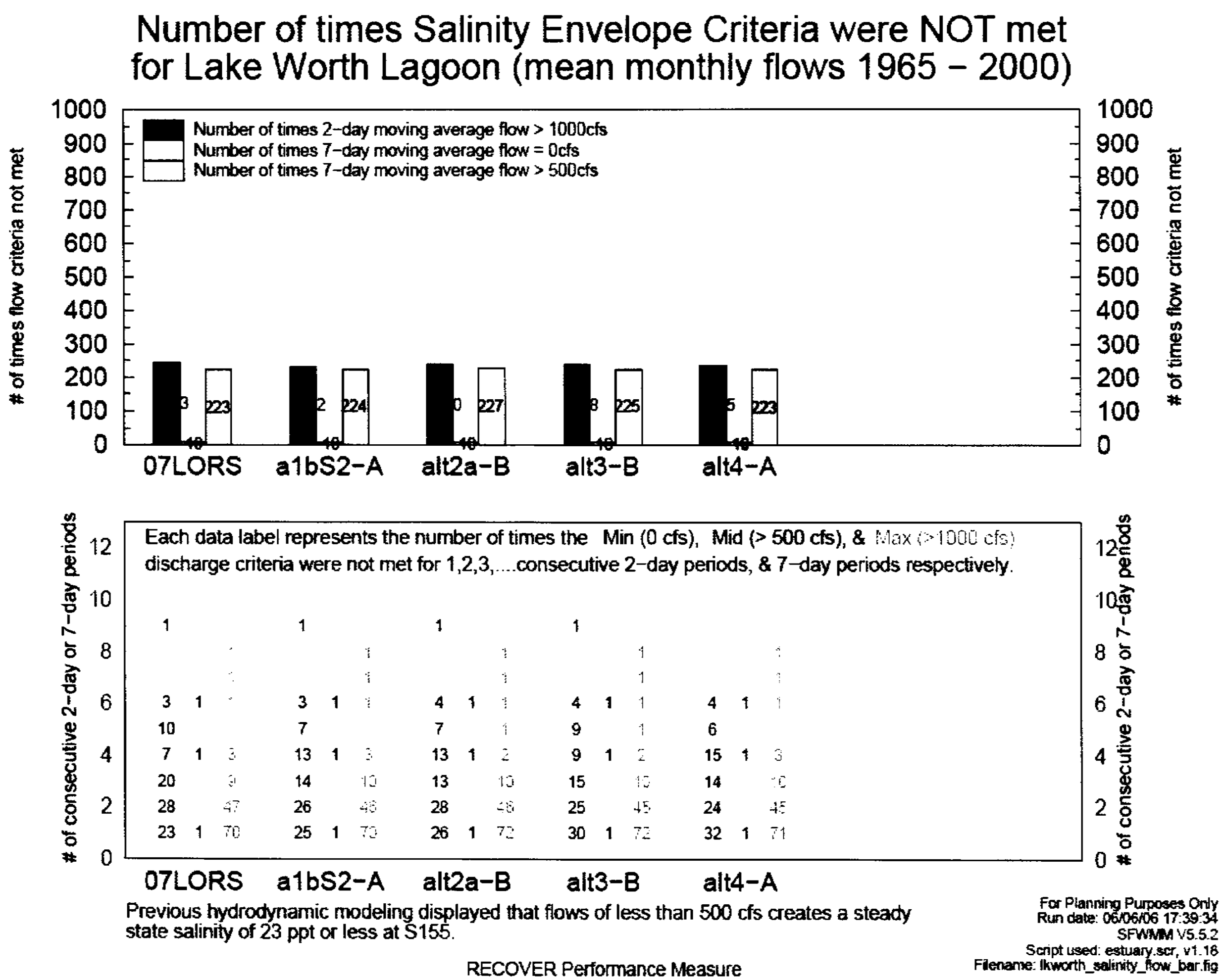


FIGURE D-16: LAKE WORTH LAGOON SALINITY ENVELOPE (2)

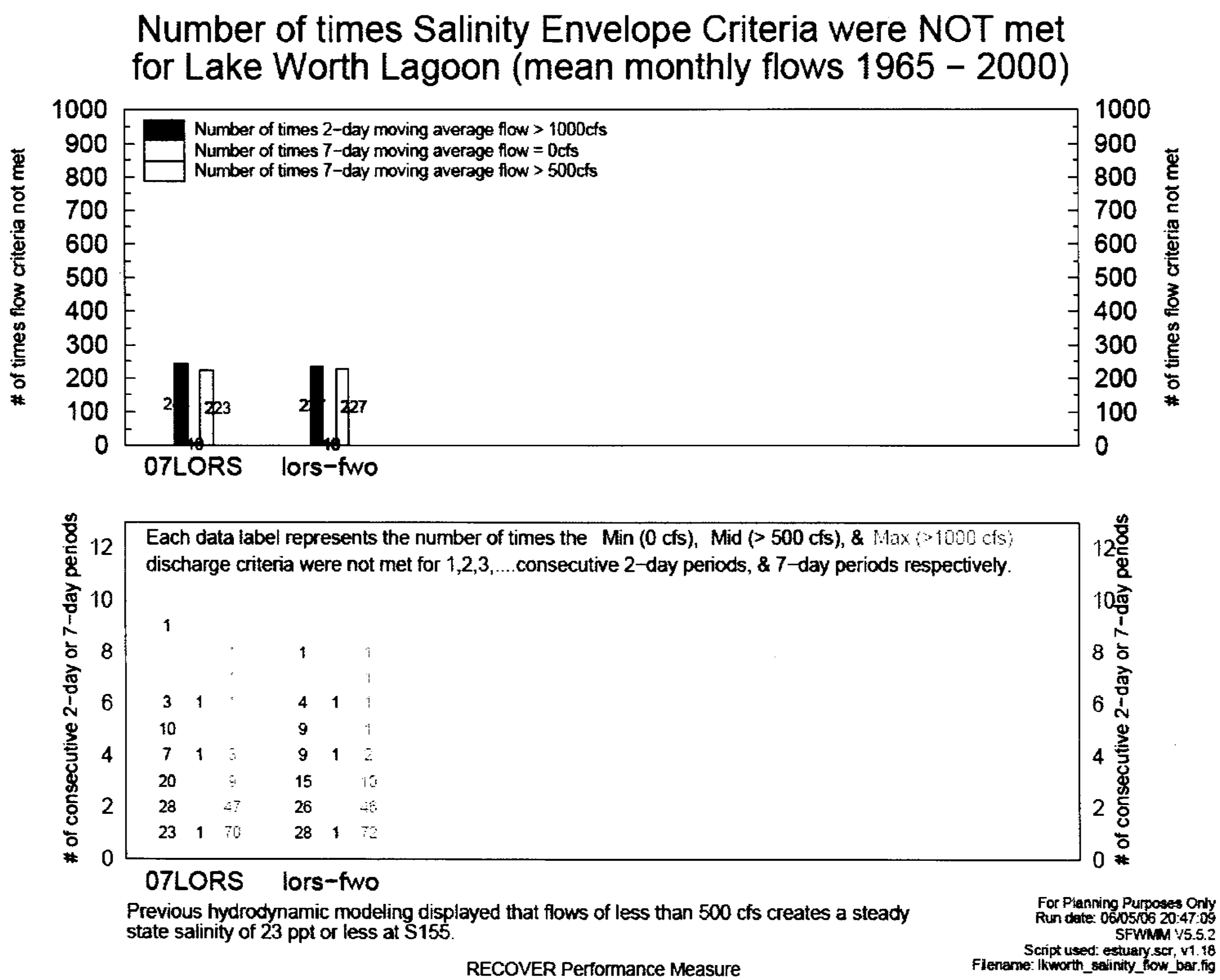


FIGURE D-17: LAKE WORTH LAGOON SALINITY ENVELOPE (3)

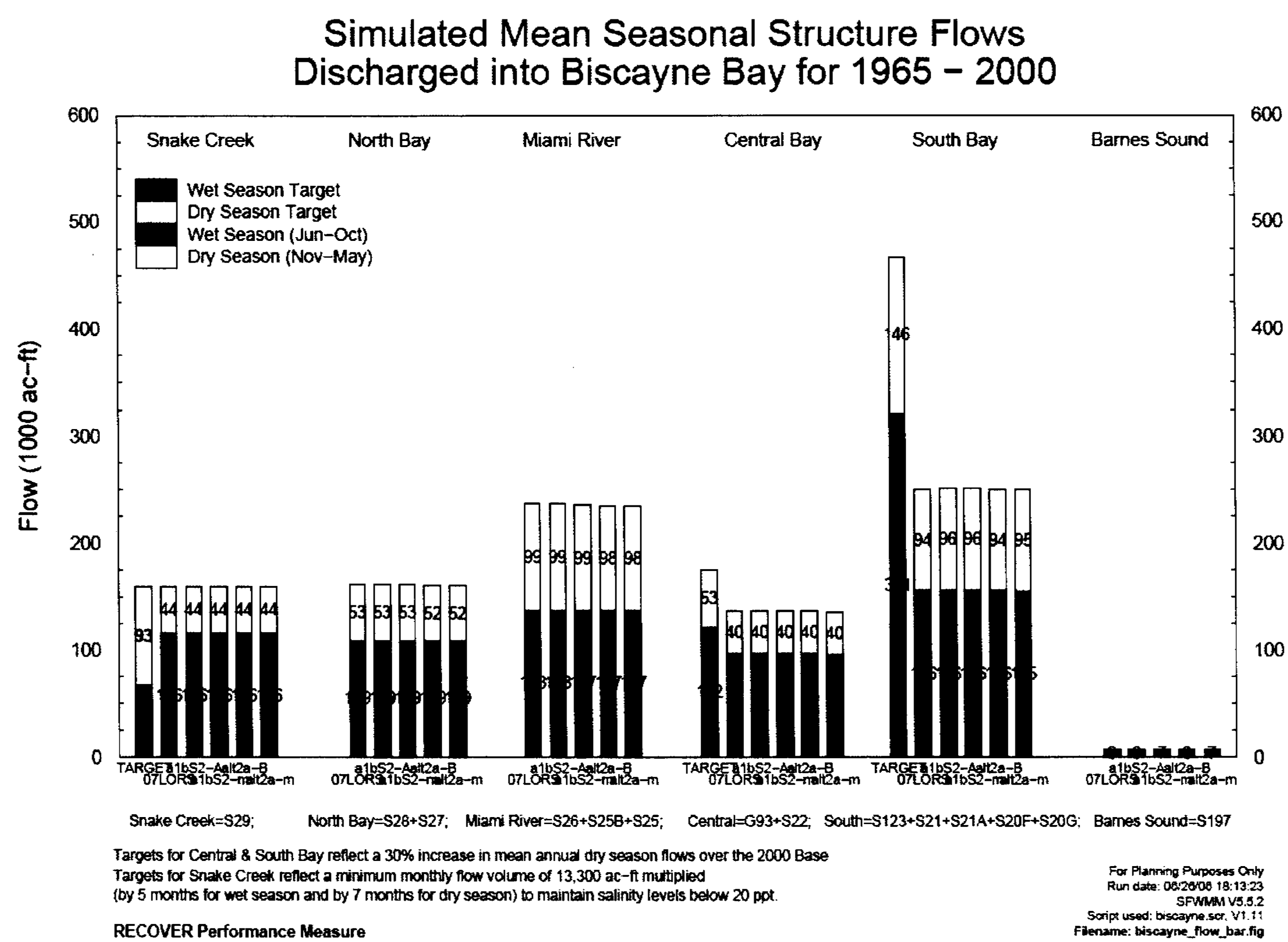


FIGURE D-18: MEAN SEASONAL STRUCTURE FLOWS DISCHARGED TO BISCAYNE BAY (1)

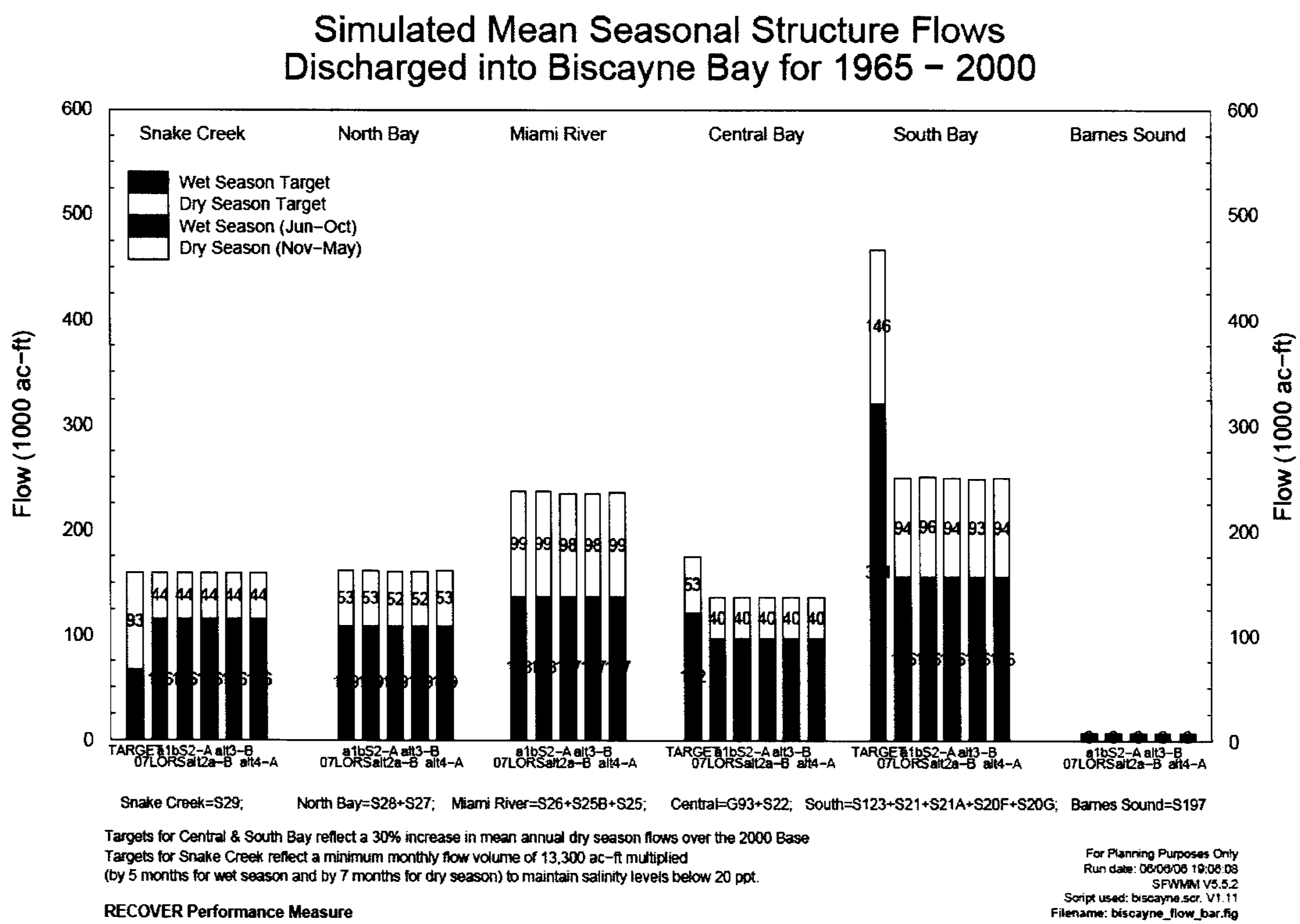


FIGURE D-19: MEAN SEASONAL STRUCTURE FLOWS DISCHARGED TO BISCAYNE BAY (2)

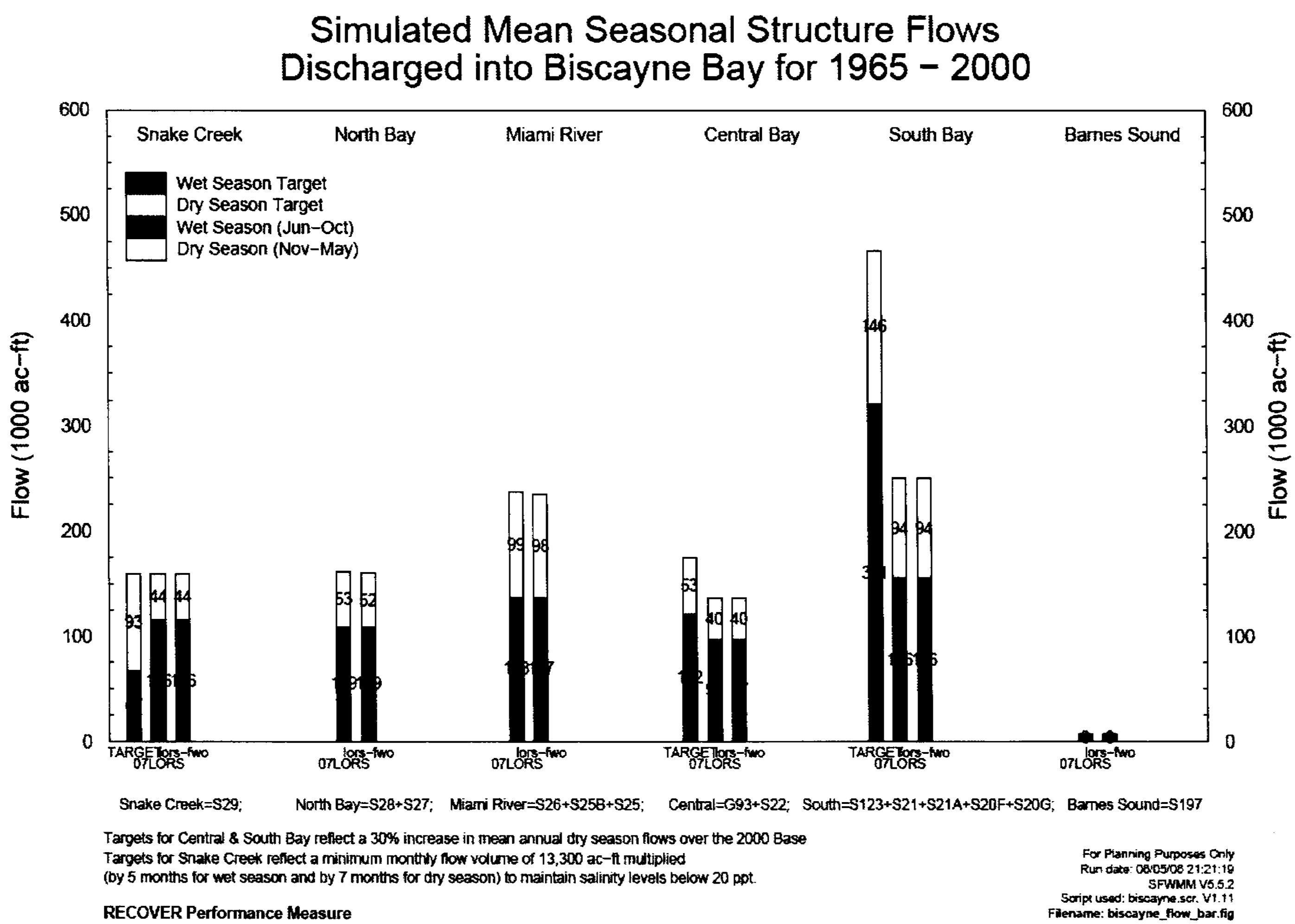


FIGURE D-20: MEAN SEASONAL STRUCTURE FLOWS DISCHARGED TO BISCAYNE BAY (3)

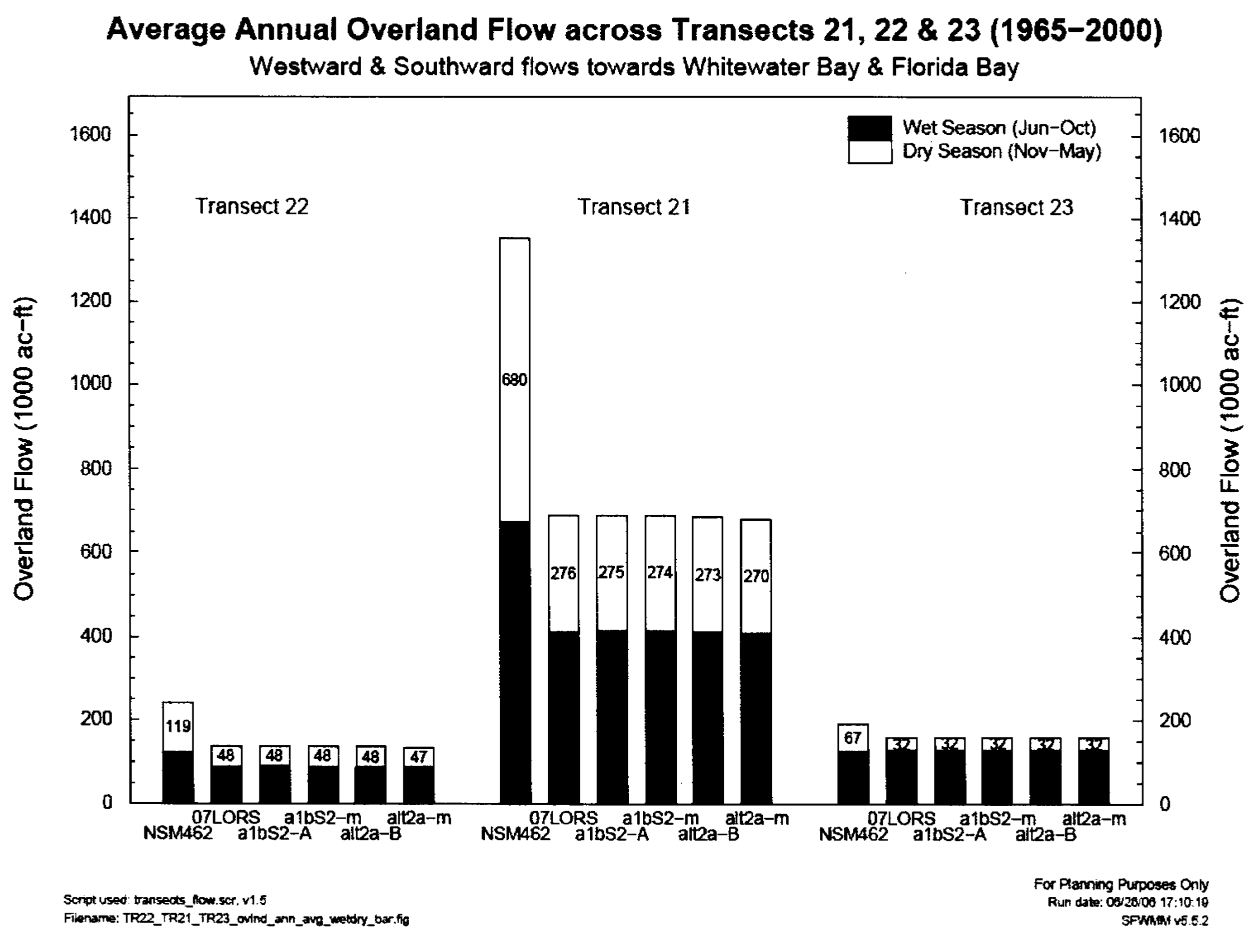


FIGURE D-21: AVERAGE ANNUAL OVERLAND FLOWS TOWARDS WHITEWATER BAY AND FLORIDA BAY (1)

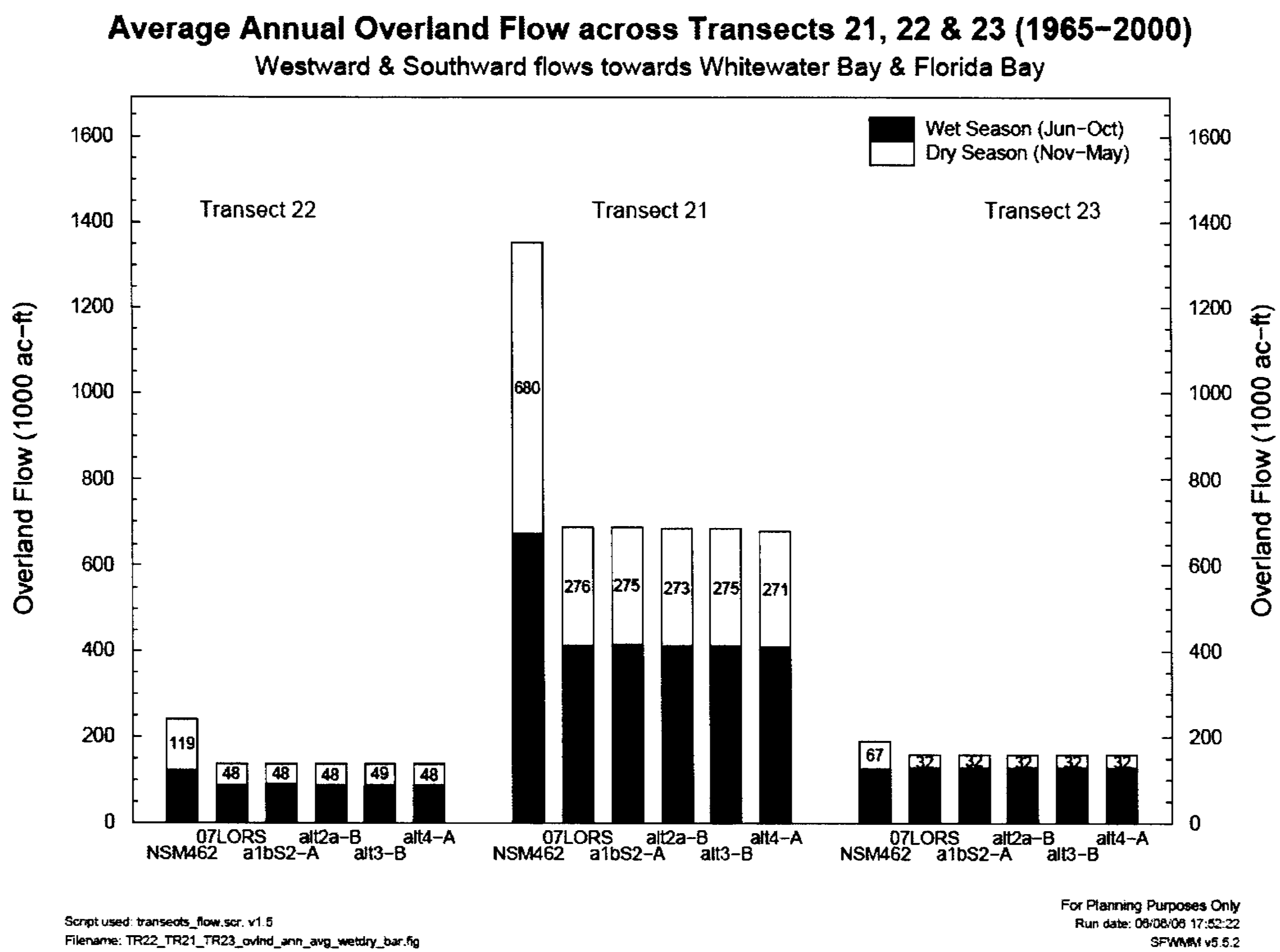


FIGURE D-22: AVERAGE ANNUAL OVERLAND FLOWS TOWARDS WHITEWATER BAY AND FLORIDA BAY (2)

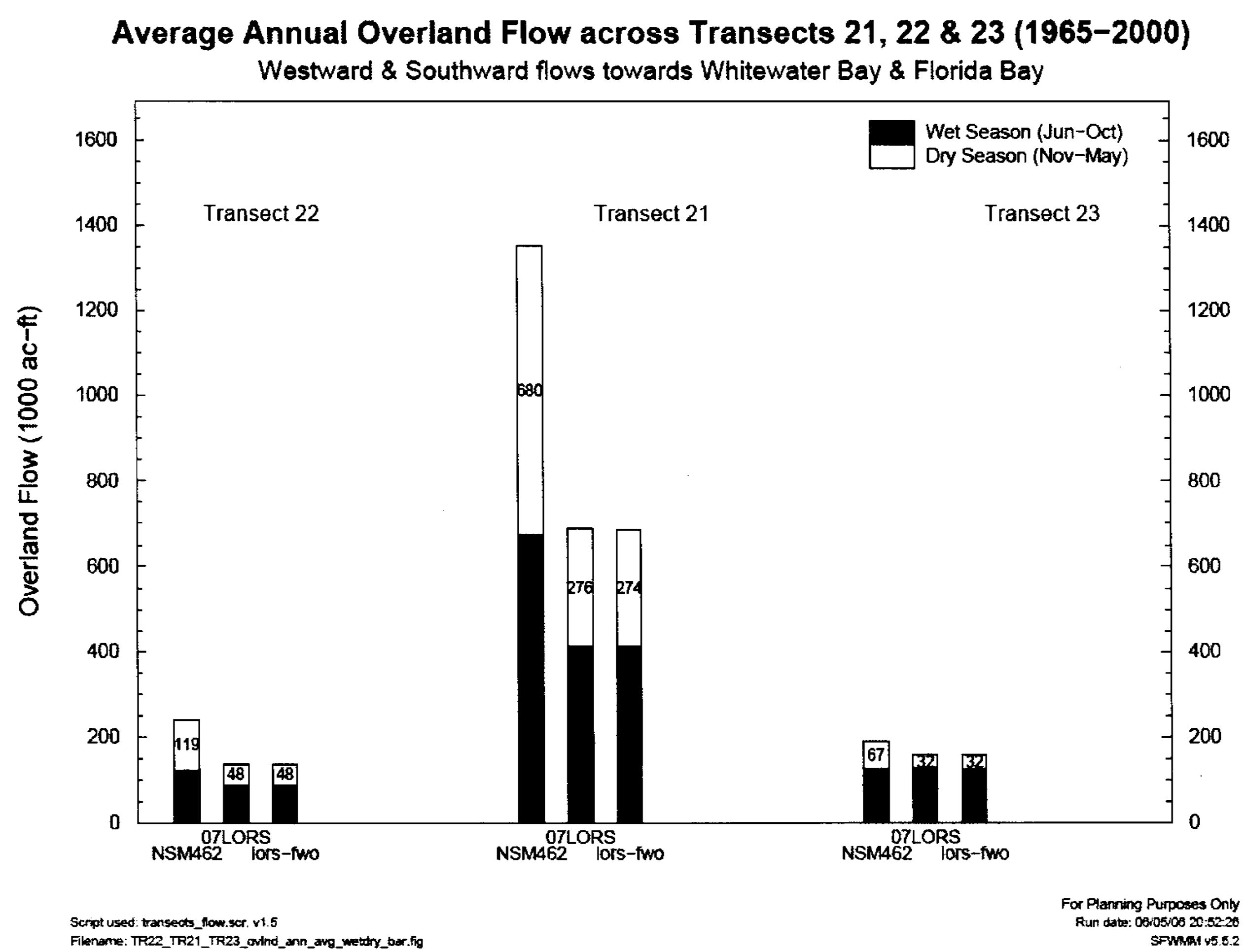


FIGURE D-23: AVERAGE ANNUAL OVERLAND FLOWS TOWARDS WHITEWATER BAY AND FLORIDA BAY (3)

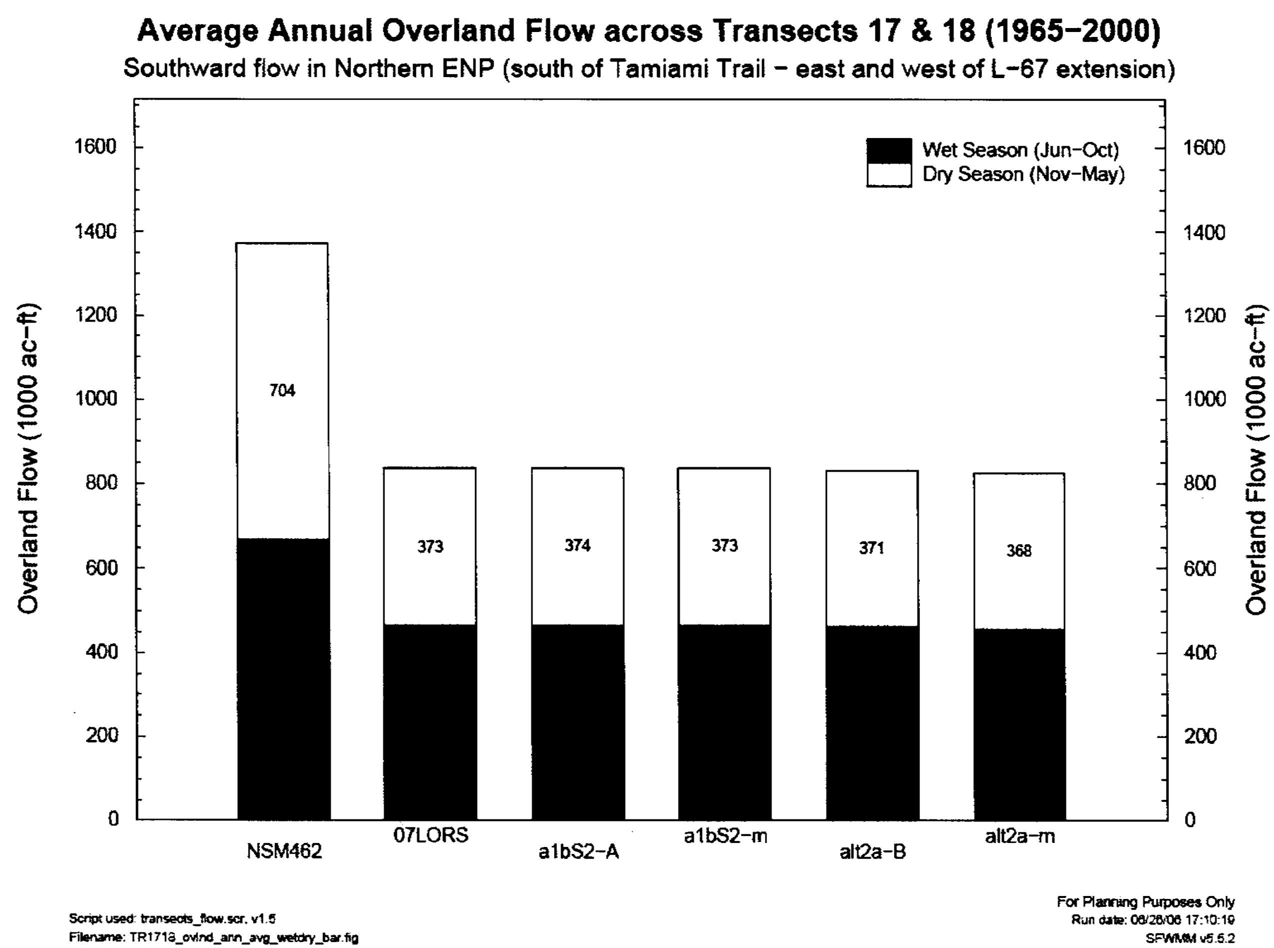


FIGURE D-24: AVERAGE ANNUAL OVERLAND FLOWS TO NORTHERN ENP (1)

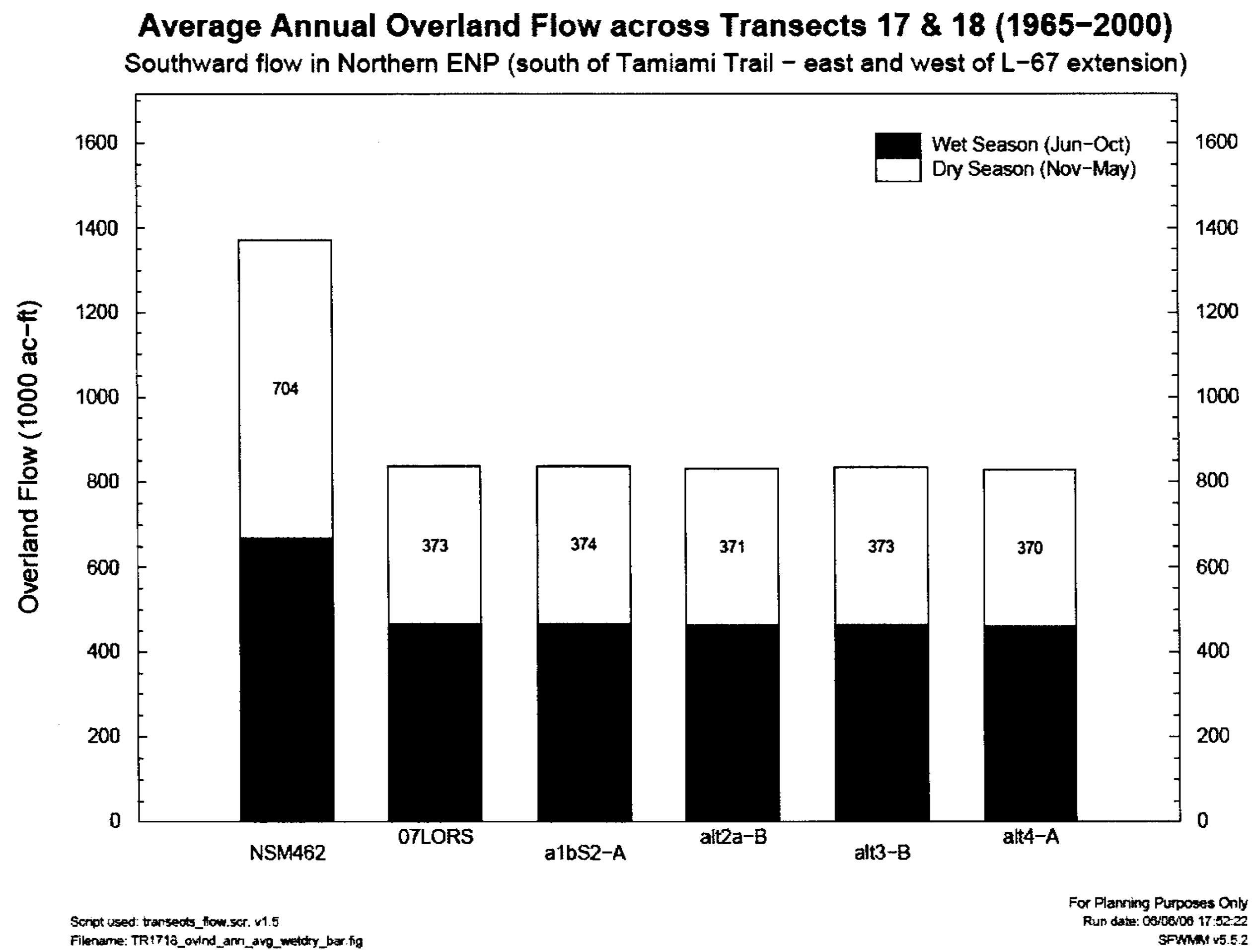


FIGURE D-25: AVERAGE ANNUAL OVERLAND FLOWS TO NORTHERN ENP (2)

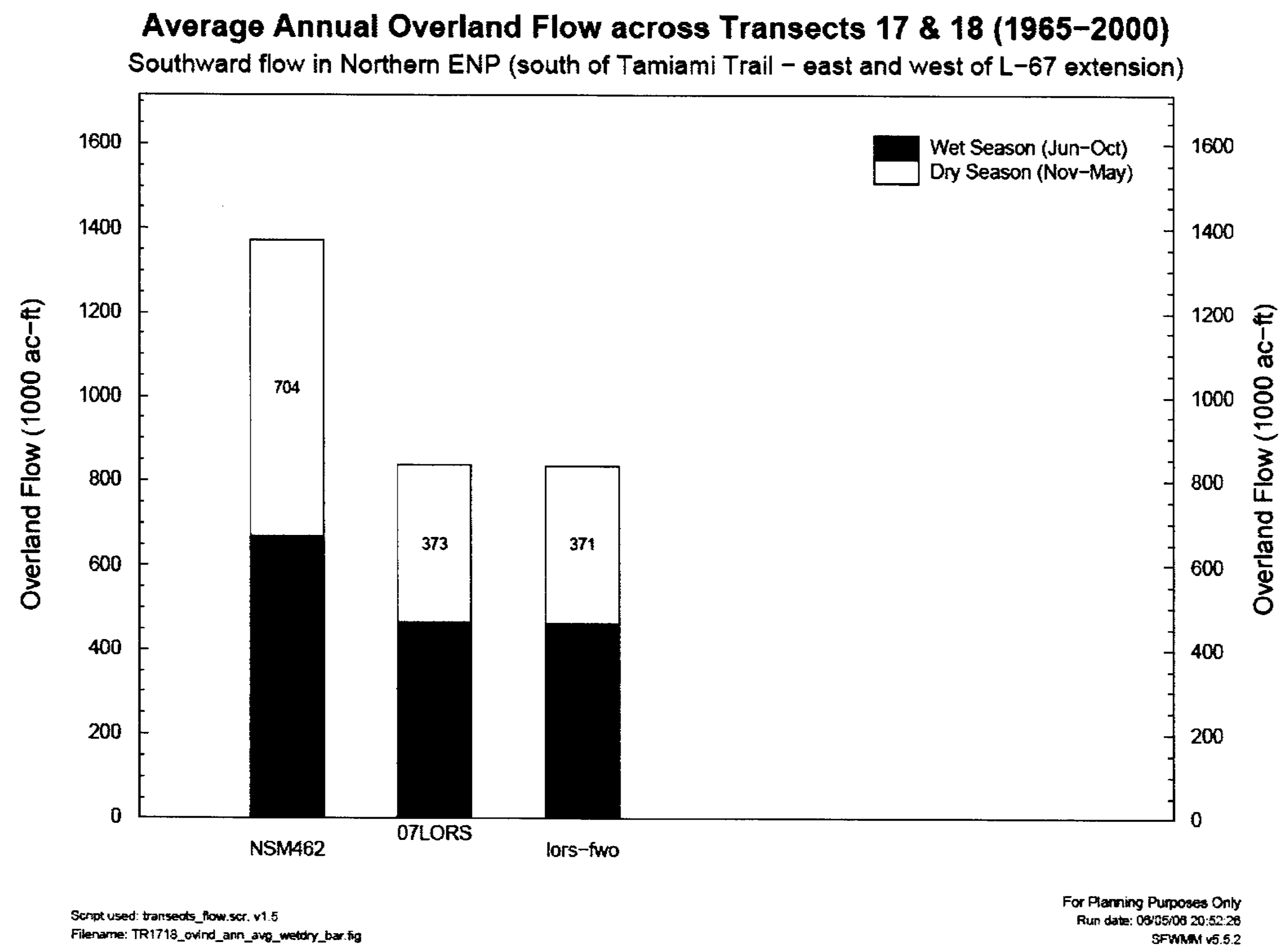


FIGURE D-26: AVERAGE ANNUAL OVERLAND FLOWS TO NORTHERN ENP (3)

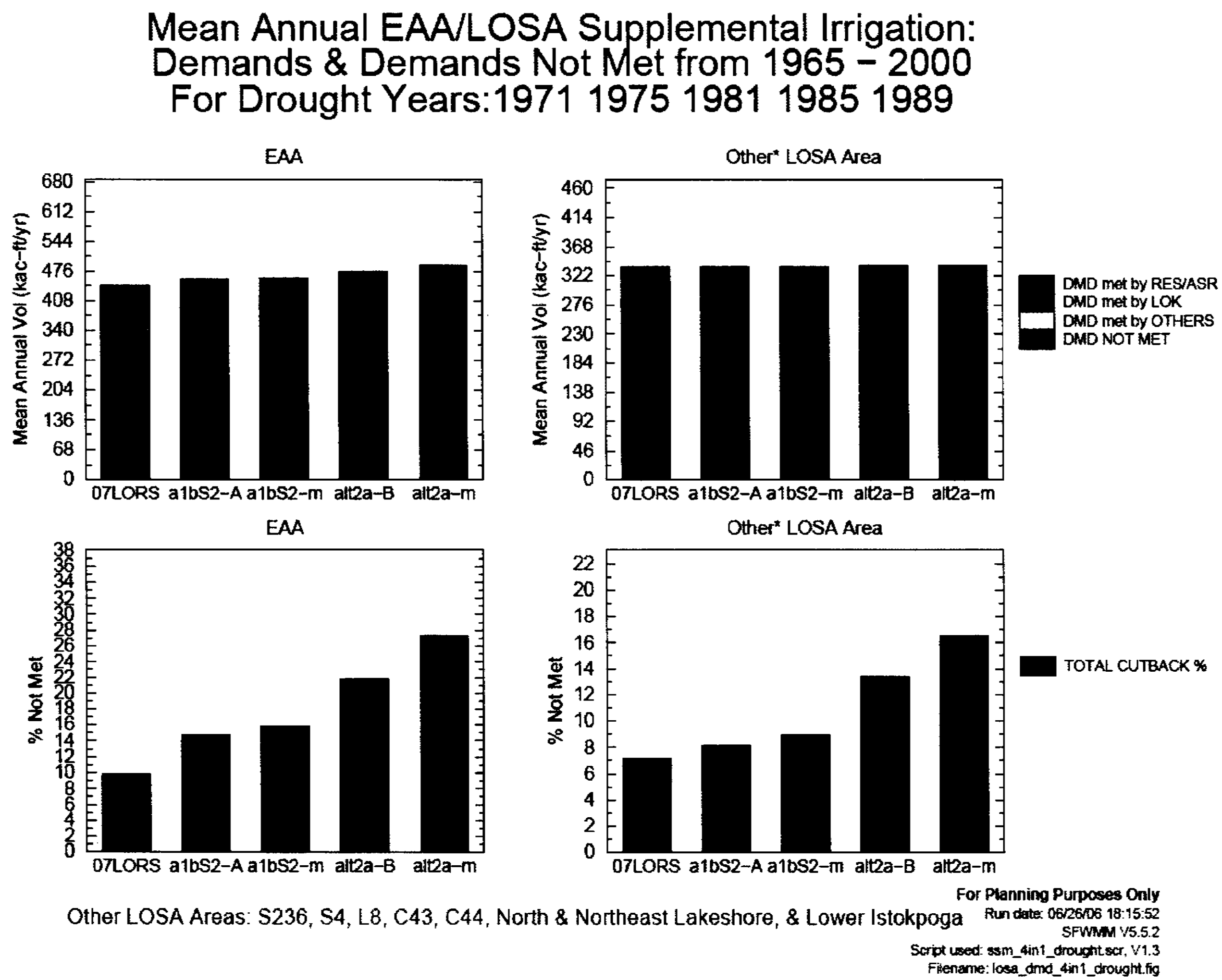


FIGURE D-27: MEAN ANNUAL EAA/LOSA SUPPLEMENTAL IRRIGATION FOR DROUGHT YEARS (1)

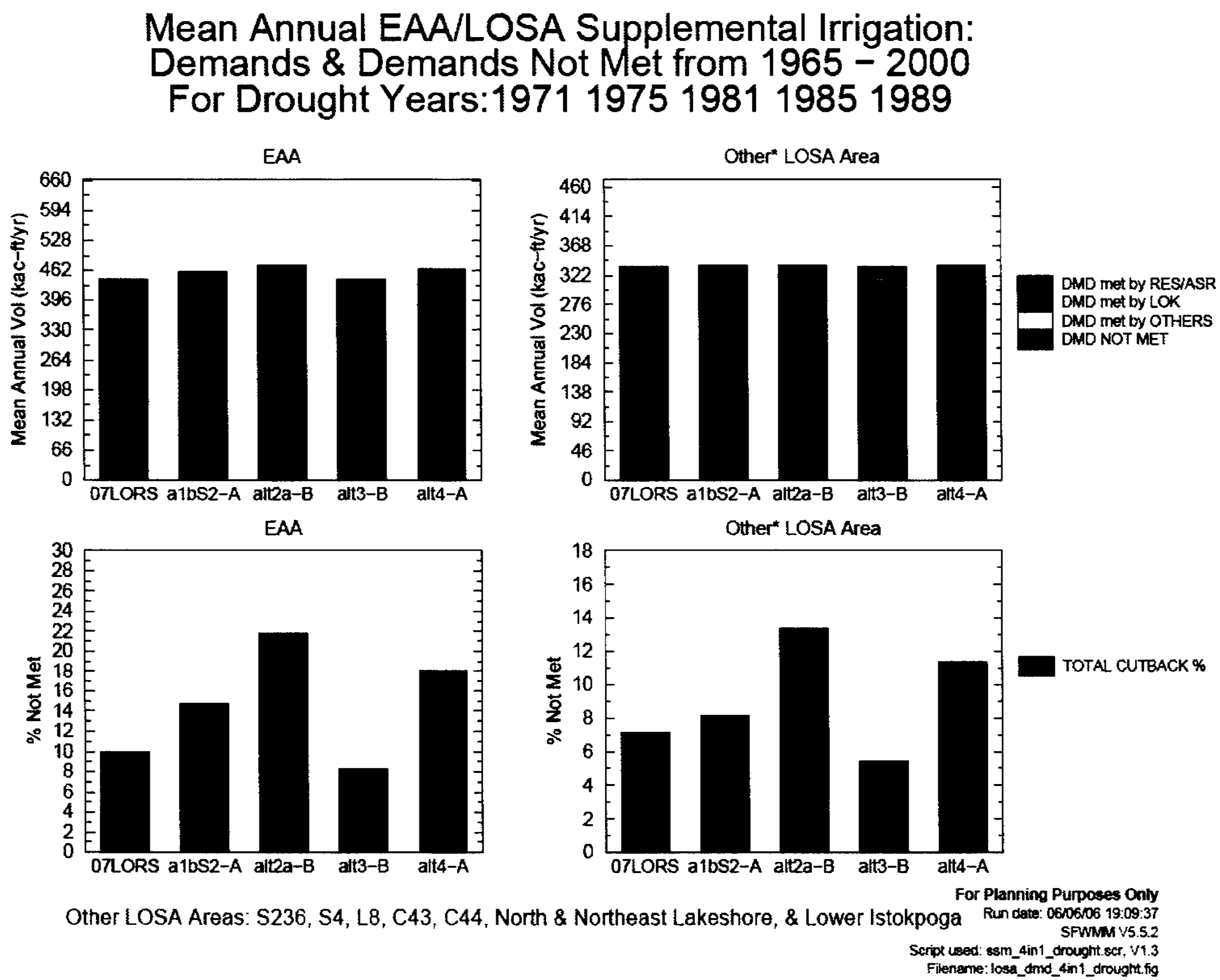


FIGURE D-28: MEAN ANNUAL EAA/LOSA SUPPLEMENTAL IRRIGATION FOR DROUGHT YEARS (2)

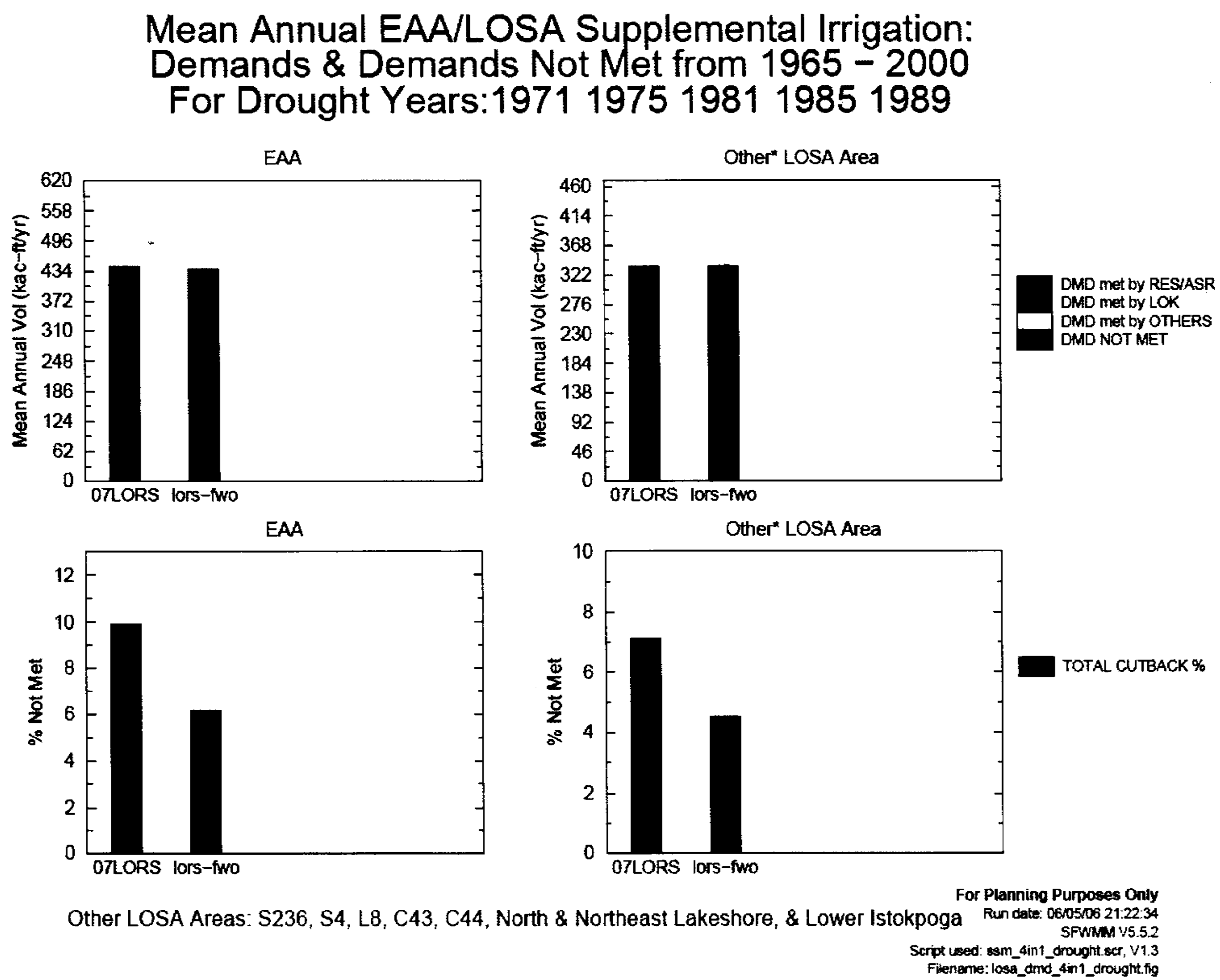


FIGURE D-29: MEAN ANNUAL EAA/LOSA SUPPLEMENTAL IRRIGATION FOR DROUGHT YEARS (3)

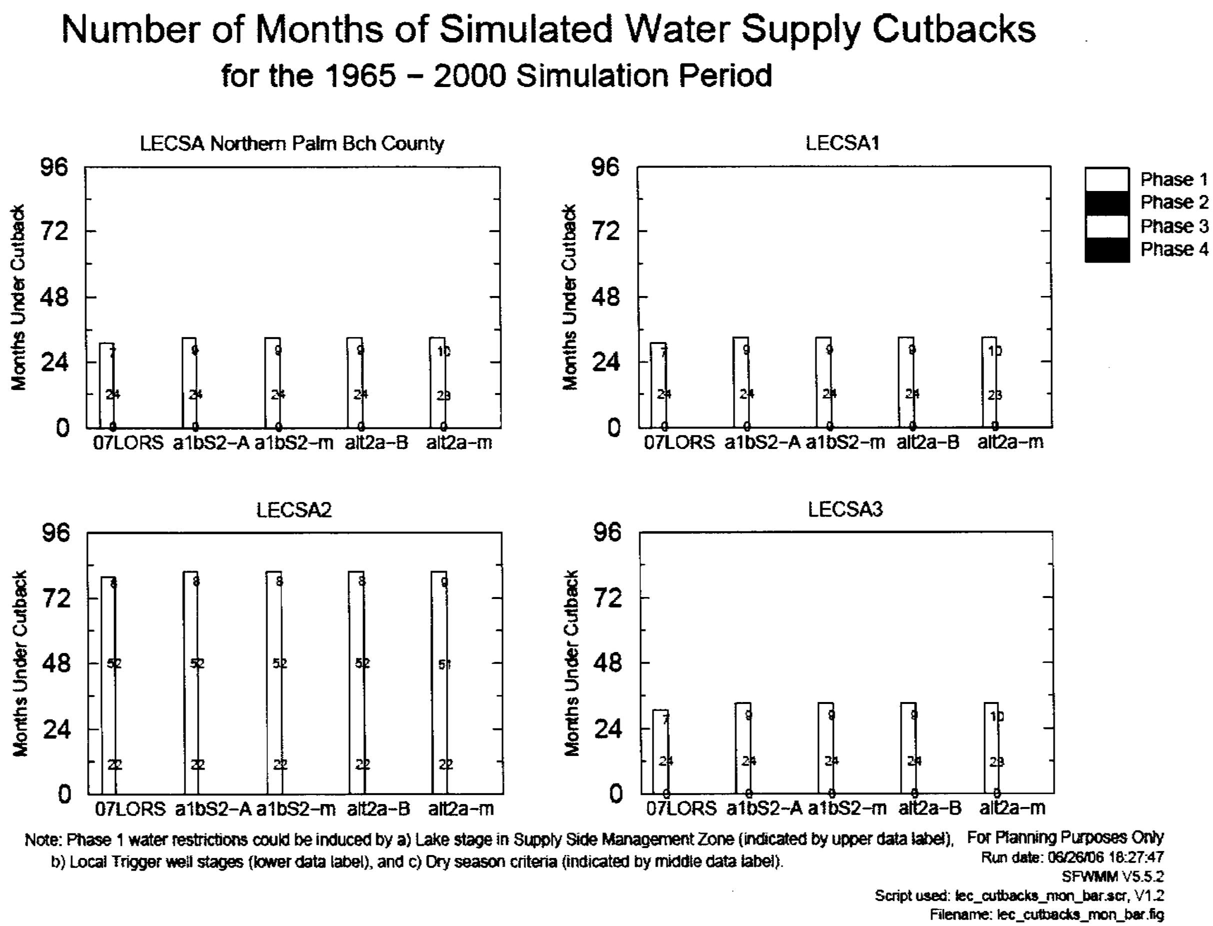


FIGURE D-30: LOWER EAST COAST SIMULATED WATER SUPPLY CUTBACKS (1)

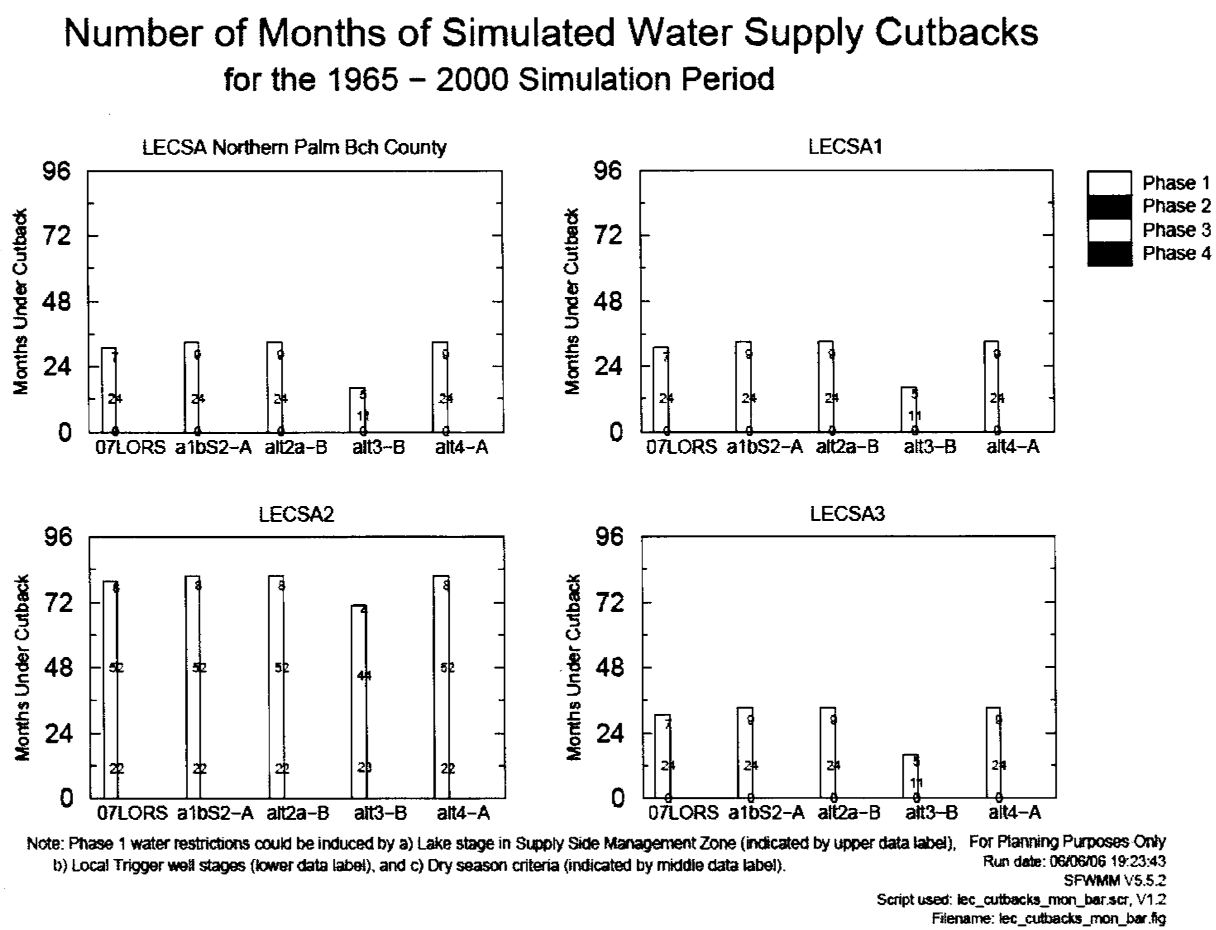


FIGURE D-31: LOWER EAST COAST SIMULATED WATER SUPPLY CUTBACKS (2)

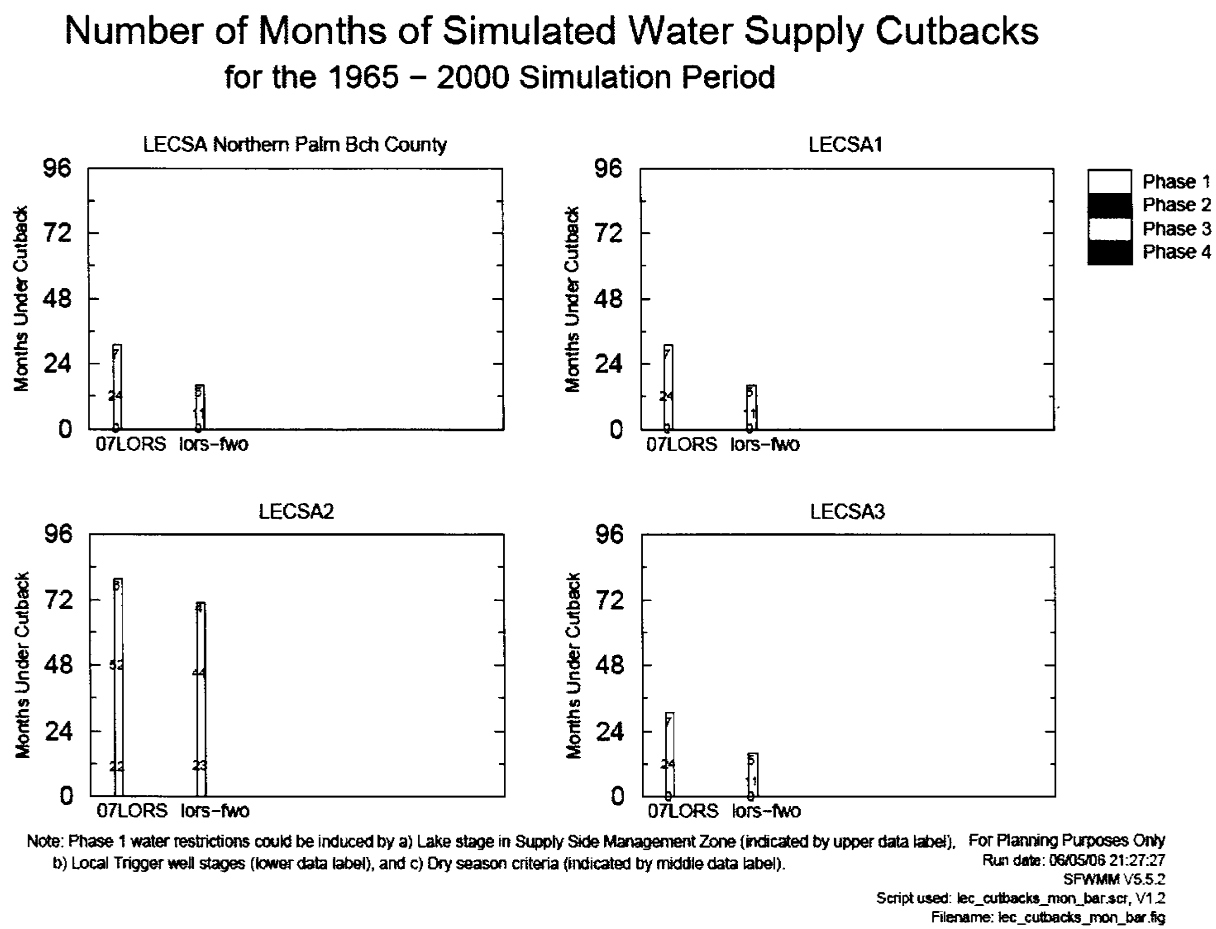


FIGURE D-32: LOWER EAST COAST SIMULATED WATER SUPPLY CUTBACKS (3)

ATTACHMENT E

Summary of Assumptions used for LORSS Baseline (No Action Alternative)

LORSS 2005 Base Condition
SFWMM Model Assumptions Table
(Based on SFWMD LEC2005 Base Condition)

Feature	Assumptions
Regional Input Data	
Climate	• The climatic period of record is from 1965 to 2000. • Rainfall estimates have been revised and updated for 1965-2000. • Revised evapotranspiration methods have been used for 1965-2000.
Topography	Updated November 2001 and September 2003 using latest available information (in NGVD 29 datum). November 2001 update includes: • U.S. Geological Survey (USGS) High Accuracy Elevation data from helicopter surveys collected 1999-2000 for Everglades National Park and WCA 3 south of Alligator Alley • USGS Lidar data (May 1999) for WCA 3A north of Alligator Alley • Lindahl, Browning, Ferrari & Helstrom 1999 survey for Rotenberger Wildlife Management Area. • Storm water Treatment Area surveys from 1990s • Aerometric Corp. 1986 survey of the 8-1/2 square mile area • Includes estimate of Everglades Agricultural Area subsidence • Other data as in SFWMM v3.7 • Florida Fish and Wildlife Commission (FWC) survey 1992 for Holey Land Wildlife Management Area. September 2003 update includes: • Reverting to FWC 1992 survey data for Rotenberger Wildlife Management Area. • DHI gridded data from Kimley–Horn contracted survey of EAA, 2002-2003. Regridded to 2x2 scale for EAA outside of STAs and WMAs.
Sea Level	• Sea level data from six long-term National Oceanic and Atmospheric Association (NOAA) stations were used to generate a historic record to use as sea level boundary conditions for the 1965 to 2000 evaluation period.

Feature	Assumptions
Land Use	• All land use has been updated using most recent Florida Land Use /Land Cover Classification System (FLUCCS) data (1995), modified in the Lower East Coast urban areas using 2000 aerial photography (2x2 scale).
Natural Area Land Cover (Vegetation)	Vegetation classes and their spatial distribution in the natural areas comes from the following data: • Walsh 1995 aerial photography in Everglades National Park • Rutchey 1995 classification in WCA 3B, WCA 3A north of Alligator Alley and the Miami Canal, WCA 2A and 2B • Richardson 1990 data for Loxahatchee National Wildlife Refuge • FLUCCS 1995 for Big Cypress National Preserve, Holey Land and Rotenberger Wildlife Management Areas, and WCA 3A south of Alligator Alley and Miami Canal.
Lake Okeechobee Service Area	
LOSA Basins	• Lower Istopoga, S-4, North Lake Shore and Northeast Lake Shore demands and runoff based on AFSIRS modeling.
Lake Okeechobee	• Lake Okeechobee Regulation Schedule WSE according to WSE decision trees, with pulse releases in Zone D modeled as Level III pulse in upper third of the zone, Level II pulse in middle third of the zone, and Level I pulse in the lower third of the zone, when the decision tree calls for regulatory releases to the estuaries in that zone. • WSE thresholds according to the Class Limit Adjustment (CLA) for WSE: Increase the frequency of Pulse Releases in Zone D of WSE. • WSE regulatory discharges south, at times when the decision tree calls for such releases, include maximal use of discharge pathway L8 → C51 → tide, to reflect ongoing lake operations. • Lake Okeechobee Supply Side management policy for Lake Okeechobee Service Area water restriction cutbacks as per rule 40E-21 and 40E-22. • Emergency flood control back pumping to Lake Okeechobee from the Everglades Agricultural Area.

Feature	Assumptions
	• Kissimmee River inflows based on interim schedule for Kissimmee Chain of Lakes using the UKISS model. • Flood control releases south of Lake Okeechobee are constrained by WCA regulation schedules • Only STA-3/4 would be used to treat Lake Okeechobee regulatory releases to the south
Caloosahatchee River Basin and S-4 Basins	• Caloosahatchee River Basin irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage. • Public water supply daily intake from the river is included in the analysis.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS method based on existing planted acreage. • Basin demands include the Florida Power & Light reservoir at Indiantown.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage in a manner consistent with that applied to other basins not in the distributed mesh of the SFWMM. • The 2 in 10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons/month). AFSIRS modeled 2 in 10 demands equaled 2,383 MGM. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved. • SSM applies to this agreement.
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage in a manner consistent with that applied to other basins not in the distributed mesh of the SFWMM. • The 2 in 10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM. AFSIRS modeled 2 in 10 demands equaled 2,659 MGM. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per the District's Final Order and Tribe's Resolution establishing the Big Cypress

Feature	Assumptions
	Reservation entitlement, tribal rights to these quantities are preserved. • Supply-side Management SSM applies to this agreement
Seminole Hollywood Reservation	• Hollywood Reservation demands are set forth under VI. C of the Tribal Rights Compact. • Tribal sources of water supply include various bulk sale agreements with municipal service suppliers.
Everglades Agricultural Area	• Everglades Agricultural Area irrigation demands are simulated using climatic data for the 36 year period of record and a soil moisture accounting algorithm, with parameters calibrated to match historical regional supplemental deliveries from Lake Okeechobee. • SFWMM EAA runoff and irrigation demand response to rainfall was calibrated for 1984-95 and verified for 1979-1983/1996-2000. No runoff reduction adjustment was necessary to account for Best Management Practices (BMPs). • EAA cells in the Miami Canal Basin between STA5 and STA6 are not production cells (shrub Land Use). Then, no irrigation demands are required in this area. Runoff from this area is part of the Miami Canal Basin.
Everglades Construction Project Stormwater Treatment Areas	• Storm water Treatment Area 2 is connected to the regional system and operational. STA-2 all three cells operational (6,430 acres on line) • STA 1E is built and in place, but not operational. • STA-1W is partially operational with approximately 5,371 acres on line • STA-5 is partially operational with approximately 2,890 acres on line • STA-6 Section 1 operational with 897 acres on line • STA-3/4 is partially operational with approximately 11,000 acres on line • Operation of Storm water Treatment Areas assumes maintenance of a 6" minimum depth.
Holey Land Wildlife WMA	• As per Memorandum of Agreement between the FWC and the South Florida Water Management District.

Feature	Assumptions
Rotenberger Wildlife WMA	• Interim Operational Schedule as defined in the Operation Plan for Rotenberger, 2001.
Water Conservation Areas	
WCA 1 (Arthur R Mitchell [ARM] Loxahatchee National Wildlife Refuge)	• Current Central and Southern Florida (C&SF) Regulation Schedule. Includes regulatory releases to tide through LEC canals. • No net outflow to maintain minimum stages in the LECSA canals (salinity control), if water levels are less than minimum operating criteria of 14 feet. The bottom floor of the schedule (Zone C) is the area below 14 feet. Any water supply releases below the floor will be matched by an equivalent volume of inflow from Lake Okeechobee.
WCA 2 A&B	• Current C&SF regulation schedule. Includes regulatory releases to tide through LEC canals. • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels in WCA 2A are less than minimum operating criteria of 10.5 feet. Any water supply releases below the floor will be matched by an equivalent volume of inflow from Lake Okeechobee.
WCA 3 A&B	• Current C&SF regulation schedule for WCA 3A, as per WCP–IOP for protection of the Cape Sable seaside sparrow-C&SF Project for Flood Control and other Purposes, 2002. • Includes regulatory releases to tide through LEC canals. Documented inWCP, 2002. • No net outflow to maintain minimum stages in the LECSA canals (salinity control), if water levels are less than minimum operating criteria of 7.5 feet in WCA 3A. Any water supply releases below the floor will be matched by an equivalent volume of inflow from Lake Okeechobee.
Lower East Coast Service Areas	
Public Water Supply and Irrigation	• Public water supply wellfield pumpages and locations are based on actual pumpage data for calendar year 2004. • Irrigation demands are based upon existing land use (updated through 2000) and calculated using AFSIRS, reduced to account for landscape and golf course areas irrigated using reuse water and landscape areas

Feature	Assumptions
	irrigated using public water supply.
Other Natural Areas	• For the Northwest Fork of the Loxahatchee River, the District operates the G-92 structure and associated structures to provide approximately 50 cfs over Lainhart Dam to the Northwest Fork, when sufficient water is available in C-18 Canal. • Flows to Pond Apple Slough through S-13A are adjusted in the model to approximate measured flows at the structure. • Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay.
Coastal Basin Canal Facilities and Operations	• C&SF system and operating rules in effect in 2005. • Includes operations to meet control elevations in the primary coastal canals for the prevention of saltwater intrusion. • Includes existing secondary drainage/water supply system. • C-4 Flood Mitigation Project • C-11 Water Quality Treatment Critical Project (S-381 and S-9A) • Releases from WCA 3A to ENP and the South Dade Conveyance System (SDCS) will follow the IOP: o Decreased S-12 flood control discharges and increased flood control discharges to SDCS o Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 o Structure S-12B is closed Jan. 1 to July 15. o Structure S-12C is closed Feb. 1 to July 15. o South Dade Conveyance System operations will follow IOP for protection of the Cape Sable seaside sparrow
Western Basins and Big Cypress National Preserve	
Western Basins	• Estimated and updated historical inflows from western basins at two locations: G-136 and G-406. The G-406 location represents potential inflow from the C-139 Basin into STA 5. Data for the period 1978-2000

Feature	Assumptions
	is the same as the data used for the C-139 Basin Rule development.
Big Cypress National Preserve	• Simulated demands in excess of historical demands are partially supply by basin flows. Any remaining excess water is directed to S-190. • Tamiami Trail culverts are not modeled in SFWMM due to the coarse (2x2 mile) model resolution
Everglades National Park and Florida Bay	
Everglades National Park	• Water deliveries to Everglades National Park are based upon the IOP. • When stages in WCA 3A fall in Zone E1 of the regulation schedule and the stage at G-3273 is below the critical threshold, S-333 flows are directed to ENP, a fraction of which is released through S334. This simulation is consistent with IOP ALT7RP2.
Region-wide Water Management and Related Operations	
Water Shortage Rules	• The existing condition reflects the existing water shortage policies in 2005 as reflected in SFWMD Chapters 40E-21 and 40E-22, FAC