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M E M O

To: Everglades Technical Oversight Committee

Date: January 30, 2001

Subject: Proposed Amendments to the BMP Replacement Water Rule

This memo provides TOC members with background for discussion of the above topic at the TOC meeting February 9. I believe that there are technical flaws in proposed changes to the EAA Regulatory Rule that could have long-term impacts on delivery of BMP replacement water to the Everglades, as required under the Consent Decree. I urge the TOC to consider these points along with other submitted opinions in deciding whether to support the proposed amendments. This is a matter of some urgency, since the amendments are slated for adoption at the Governing Board meeting on February 15.

The State/Federal Consent Decree requires implementation of Best Management Practices (BMP's) to reduce phosphorus loads from the Everglades Agricultural Area (EAA) and provision of additional flow to offset any reductions in runoff volume attributed to BMP's. The SFWMD developed and implemented the EAA Regulatory Rule (40-E-63) in part to meet these requirements. Over the past several years, the efforts by the Industry and District have been successful in achieving phosphorus load reductions of ~50%, while providing additional releases from Lake Okeechobee to offset the ~10% reduction in EAA runoff volume measured after BMP implementation. Estimates of phosphorus load reduction and runoff volume reduction are based upon correlations with annual rainfall calibrated to a 10-year period prior to BMP implementation (October 1978 – September 1988). These estimation procedures were developed in two long series of public workshops and subsequently embedded in the Rule.

Several amendments to the EAA Regulatory Rule are slated for adoption at the February Governing Board meeting. Most of these changes are adjustments to phosphorus load monitoring points and calculations to account for new inflows to and outflows from the EAA associated with ECP implementation. These changes are necessary in order to measure future BMP performance.

The issue of concern is the proposed change in the methodology for estimating runoff volume reductions and corresponding BMP replacement water (a.k.a. makeup water) requirements. Volume reductions are estimated by comparing recent observed runoff volumes with predictions of a regression model that represents the EAA rainfall/runoff response during the 1979-1988 pre-BMP period. The proposed amendment involves changing the model time step from yearly to monthly. Specific reasons for the change are not stated in the modified rule text (see attached).

Over the past several years, I have worked for SFWMD and DOI on a variety of issues pertaining to their common interests and responsibilities under the Consent Decree. Under the SFWMD's Expert Assistance program, I developed the existing methodology and participated in a series of public workshops that led to the initiation of the replacement water portion of the Regulatory Rule in 1995. Under contract with SFWMD Everglades Regulation, I was asked to review Rule changes proposed by MFL, Inc. in 1998-1999 and raised concerns similar to those expressed below. Until very recently, I was unaware that the proposal was still being considered, but in a different venue. Apparently, the topic was discussed in a series of workshops held involving MFL and SFWMD staff over the past several months.

My concerns about the proposed Rule amendment are in the following categories:

1. Poor Data Fit Relative to the Existing Model
2. Inconsistency with Phosphorus Load Tracking Procedure
3. Confidence Intervals / Burden of Proof
4. Implications for Water-Supply Planning

These points are discussed below with reference to model results and data shown in Figures 1-3. In the interest of expediency, these figures use readily available monthly runoff and phosphorus load data derived from the load tracking procedure, updated through September 2000. The replacement water model uses a slightly different method for computing the "observed" runoff on any day based upon flow measurements at individual structures. Additional effort would be required to update the analysis using this alternative procedure. The differences are inconsequential in the context of the graphs, comparisons, and conclusions discussed below.

1. Poor Data Fit Relative to the Existing Model

Under the proposed Rule amendment, the difference between the observed and predicted monthly runoff values is summed over the October-September Water Year and used to compute the replacement water volume. Thus, the ability of the model to predict the total runoff for the Water Year is critical. The proposed model does not fit data from the WY 1979-1988 baseline period ($r^2 = 0.58$) as well as the existing model ($r^2 = 0.83$), as indicated by the scatter plots at the top of Figure 1. In addition, the monthly model does not track the peaks & valleys of the 12-month-rolling average time series as well as the yearly model (second panel of Figure 1).

The 5-year, rolling-average time series is used to smooth out random variations and track the long-term signal (bottom of Figure 1). The signal from the yearly model has been fairly consistent, indicating an average runoff reduction of 2-4 inches/year after 1993. The signal from the monthly model has been erratic, indicating runoff reductions of 2-3 inches/yr in 5-year periods ending in 1993-1994, runoff increases (negative reductions) of 1–3 inches/yr in 1995-1999, and a runoff reductions of ~1 inch/yr in 2000. Aside from the relatively poor fit of data from the baseline period, the erratic signal is another indication that the monthly model is inferior.

2. Inconsistency with Phosphorus Load Tracking Procedure

Because they are based upon the same datasets and are attempting to track signals from the same activity (BMP's), models for tracking load and volume reductions should operate on the same time step. It would be inconsistent to change the runoff model from a yearly to a monthly time step without making an analogous change to the phosphorus load model. Comparisons of yearly and monthly phosphorus load tracking models are shown in Figure 2. Figure 3 shows 5-year-rolling-average percentage reductions in runoff and load computed using models operating at each time step.

Implications of changing the time step in either or both tracking procedures are summarized below:

Model Time Step	Runoff	Load
Base Period Variance Explained (R^2, WY 1979-1988)		
Monthly	58%	74%
Yearly (Existing)	83%	94%
5-Yr Average Reductions (Oct 1993 - Sept 1998)		
Monthly	-7%	35%
Yearly (Existing)	10%	44%
5-Yr Average Reductions (Oct 1995 - Sept 2000)		
Monthly	4%	42%
Yearly (Existing)	9%	53%

Compared with monthly models, yearly models explain a higher percentage of the data variance and predict higher percentage runoff and load reductions. With a consistent change from yearly to monthly models, the estimated reduction in runoff volume would decrease from 9% to 4% for the most-recent 5-year period and the estimated reduction in load would decrease from 53% to 42%.

Considering the data and experience that have accumulated since 1992-1995, it is likely that models currently used for tracking load and runoff reductions under the Rule could be improved. Such improvements could conceivably involve a shorter time step, as well as other adjustments to the data reduction procedures. Based upon the relatively low r^2 values and erratic tracking behavior of the monthly models, however, the existing yearly models still provide the best available estimates of runoff and load reduction.

3. Confidence Intervals / Burden of Proof

Even with a change to the new rainfall/runoff model, it is possible that the tracking procedure would indicate a net decrease in EAA runoff during a particular year. Under the amendment, a corresponding amount of replacement water would be delivered only if the decrease in runoff were found to be statistically significant at the 90% confidence level. The attachment of a confidence interval requirement is entirely new to this portion of the Rule. Replacement water is currently delivered regardless of uncertainty associated with the runoff reduction estimate (subject to Governing Board discretion).

Under the Regulatory Rule, the EAA is assumed to be in compliance with the 25% load reduction requirement unless the computed load reduction is significantly below the target at the 90% confidence interval. In other words, the Industry is given the benefit of the doubt until non-compliance is "proven" beyond the uncertainty band associated with the data and tracking model.

Under the proposed amendment, the resource is not given the benefit of the doubt. Replacement water would not be delivered unless the computed runoff reduction is significantly greater than zero at the 90% confidence level. Essentially, the burden of proof is placed on the resource. The relatively poor fit of the proposed model increases the width of the uncertainty band, increases the burden of proof, and decreases the likelihood that replacement water will be delivered in any given year.

4. Implications for Water-Supply Planning

Partially as a consequence of runoff reductions estimated using the proposed new model, it is my understanding that future water-supply planning for South Florida is now being done with the assumption that no BMP replacement water will be required. I question the validity and wisdom of this assumption, particularly in the face of runoff volume reductions in the range of 4-9% over the last 5 years, regardless of which model is used. Furthermore, the 4-9% observed range is strongly influenced by data from a relatively wet period. Runoff reductions associated with BMP's may be more significant during extended dry periods, when the whole issue becomes more critical.

Without an initial claim to water specifically allocated in the planning process, it may be more difficult to protect the resource's interest in times of water-supply crisis, even if a (largely toothless, as proposed) framework remains for allocating replacement water on an annual basis. Considering post-BMP data, changing the assumed runoff reduction

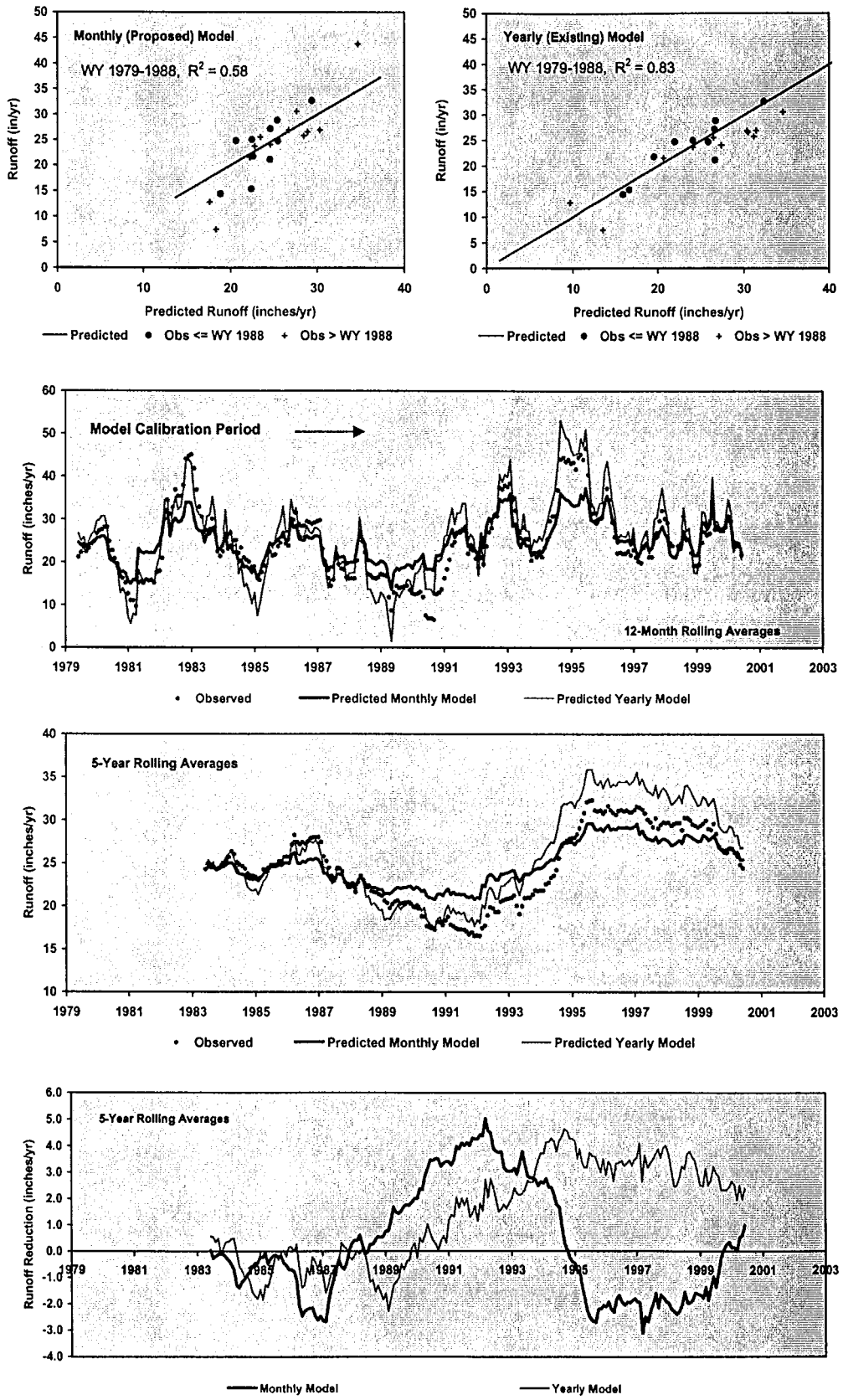
from 20% to 10% would not be unreasonable for planning purposes (i.e. modeling future water-management scenarios). Changing the planning assumption can be done without changing the Rule. Assuming that there will be no need for replacement water in modeling future water management scenarios is not technically defensible and seems inconsistent with restoration goals.

List of Figures:

Attachment:

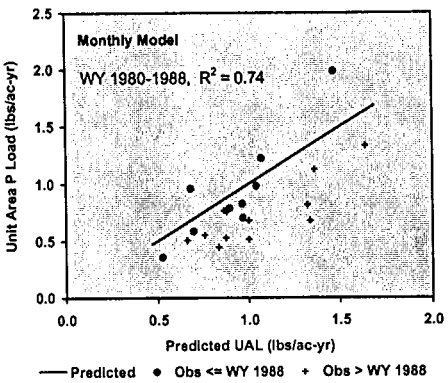
Relevant Portions of Proposed Rule Amendment

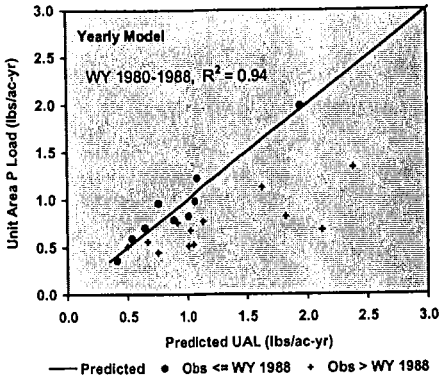
Figure 1
Comparison of Monthly & Yearly Models for EAA Runoff Volume

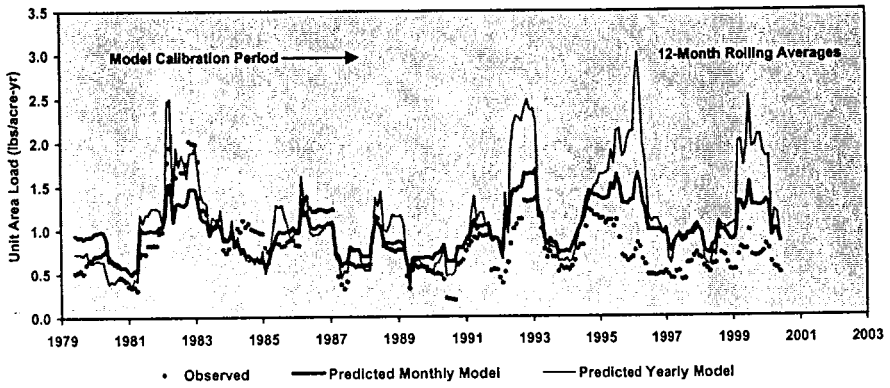


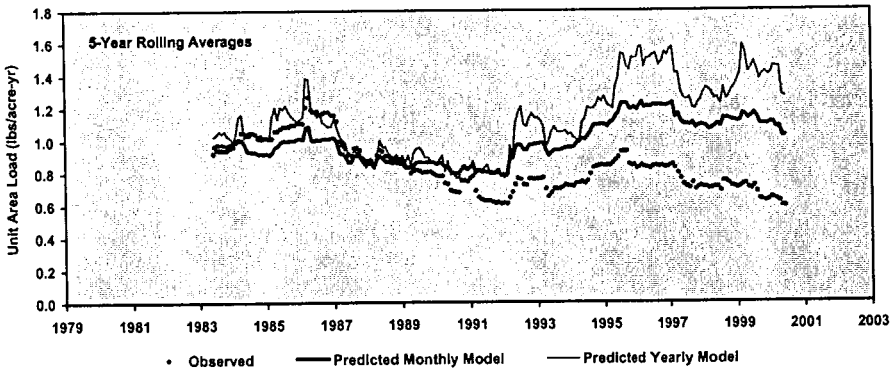
Yearly Model: Existing Model for Calculating Replacement Water
Monthly Model: Proposed New Model for Calculating Replacement Water

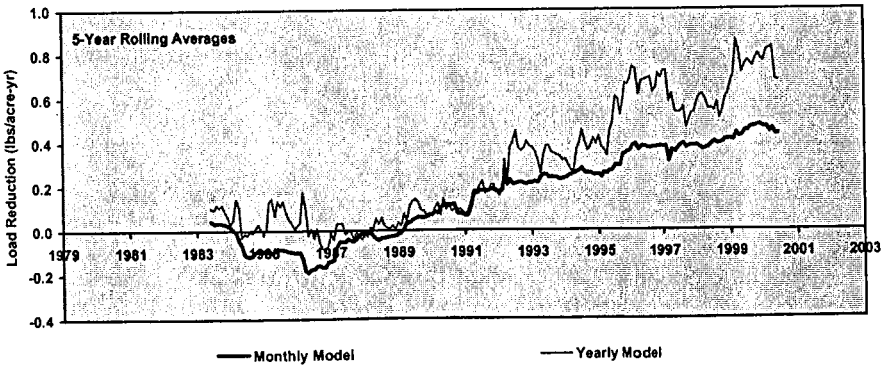
Figure 2
Comparison of Monthly & Yearly Models for EAA Phosphorus Load





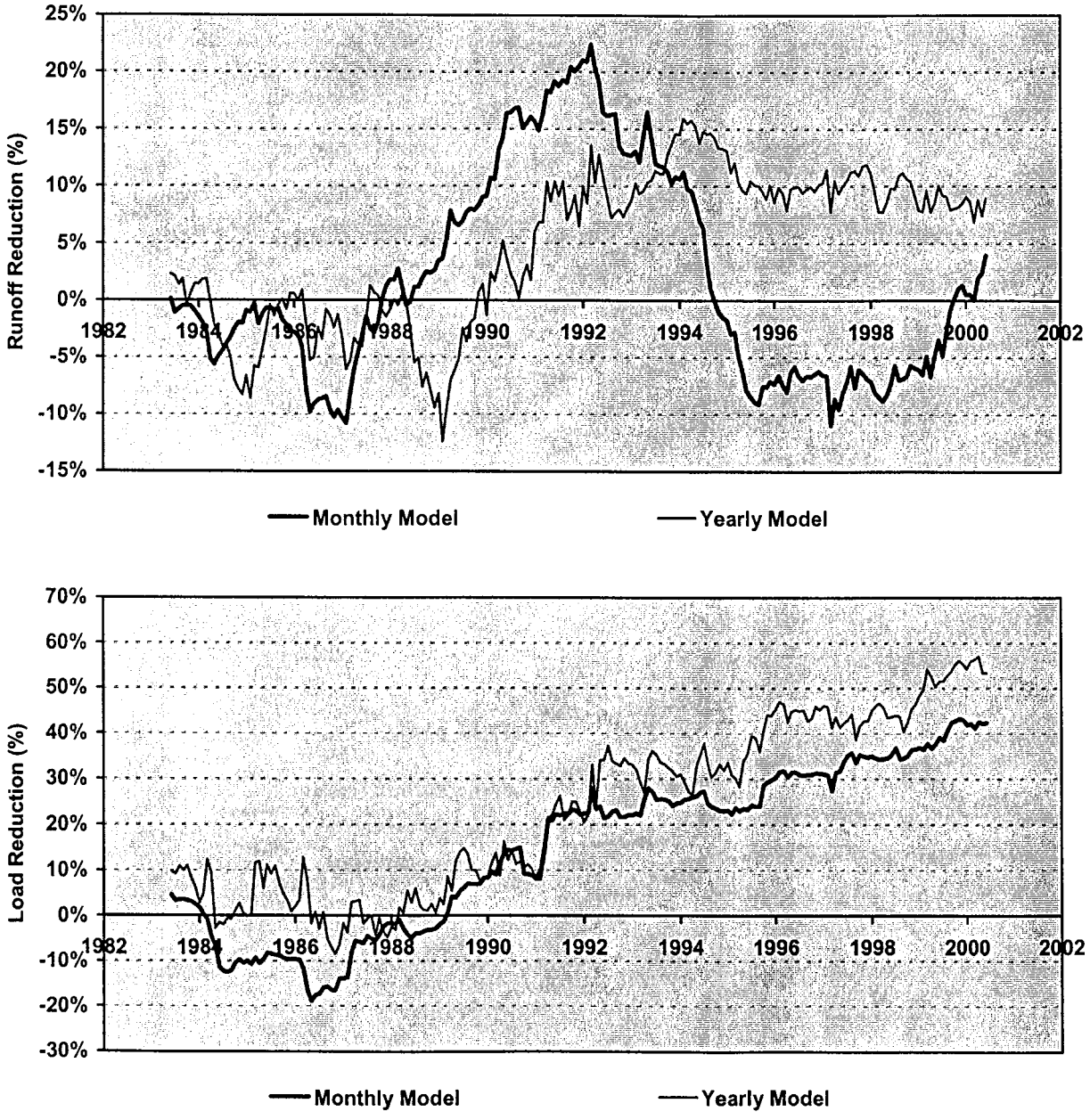






Yearly Model: Existing Model for Calculating Load Reduction
Monthly Model: Proposed New Model for Computing Replacement Water Applied to P Load Data

Figure 3
Percentage Reductions in Runoff & P Loads Estimated by Each Model
Five-Year Rolling Averages



Yearly Model	Existing Models for Calculating Replacement Water & Load Reductions
Monthly Model	Proposed Change to Replacement Water Model with Analogous Change to Load Model

Subpart A BMP Replacement Water

40E-63.211 — Purpose.

This Subpart implements the Everglades Forever Act requirements that the District develop a model to quantify the amount of water to be replaced as a result of reductions of flow to the Everglades Protection Area from BMP implementation and publish a notice of rulemaking on the model no later than July 1, 1995. The timing and distribution of the replaced water is to be directed to maximize the natural balance of the Everglades Protection Area. This Subpart is based on the best information available at the present time. Amendments to incorporate new methodology or to coordinate better with other programs, plans or rules can be expected and shall be made in accordance with Ch. 120, F.S.

Specific Authority 373.044, 373.113, 373.4592 FS. Law Implemented 373.4592(4)(b) FS.History — New 11-26-95.

40E-63.212 — Definitions.

(1) "Averaging period" means the current water year and the four preceding water years, i.e., the five water years prior to the beginning of a release period on October 1.

(2) "Base period" means the 10 year period from October 1978 — September 1988.

(3) "Current water year" means the year beginning October 1 and ending September 30 for which a replacement water allocation is quantified.

(4) "Release period" means the five months immediately following a current water year during which the replacement water allocation calculated for that year is released. The release period begins on October 1.

Specific Authority 373.044, 373.113, 373.4592 FS.
Law Implemented 373.4592(4)(b) FS.
History — New 11-26-95.

40E-63.223 — Model to Quantify Annual Allocation of Replacement Water.

(1) This section outlines the model to be used to calculate the volume of water needed to compensate for reductions in runoff from the EAA resulting from implementation of BMPs pursuant to Ch-apter 40E-63, F.A.C. Replacement water volumes refer to flows reaching the Water Conservation Areas or Stormwater Treatment Areas. Replacement water volumes do not include any flows released for urban water supply or agricultural water supply.

(2) The model is based upon hydrologic data collected during the base period. Procedures for calculating EAA runoff and rainfall are as follows:

(a) Total EAA Runoff is calculated from daily flow measurements obtained from the District's data base. The data base identifiers are listed in the following table:

BMP REPLACEMENT WATER
TABLE 1 – RUNOFF

STRUCTURE	DBKEY	STRUCTURE	DBKEY	STRUCTURE	DBKEY	STRUCTURE	DBKEY
HGS5	15068	S150	15041	G344C	J0721	G402A	LX264
S2	15021	G136	15195	G344D	J0722	G402B	LX265
S3	15018	G200	15736	G349B	JA353	G402C	LX266
S5A5AW	15031	G600	GG955	G350B	JA352	G402D	LX267
S6	15034	EBPS	LX274	G344A	J0719	G404	LX269
S7	15037	ESPS	LX273	G344B	J0720	G410	LX270
S8	15040			G328	J0718	G357	LX263

1. The EAA Runoff equation is:

Runoff = - Minimum (0, S3 + ~~G88~~ + G136 +G344A + G344B + G344C + G344D + G402A + G402B + G402C + G402D - S8 - G200 – G349B – G350B – G357 – G404 – G410 – G600)

- Minimum (0, S2 - S6 - S7 - S150 – G328 + ESPS)
- Minimum (0, HGS5 - S5A5AW ~~– G250 –~~ + 0.82 EBPS)

2. The volume of EAA Runoff discharged to the South (Water Conservation Areas) is calculated from daily flow measurements using the following equation:

Runoff to South = Runoff + Minimum (0, S3) + Minimum (0, S2) + Minimum (0, HGS5)

3. The data used in the above equations will be adjusted by the District to account for any new inflows or outflows from the EAA developed in the future in order to ensure that replacement water volume is not affected by future reductions in the EAA contributing watershed area, including those changes caused by the construction of Stormwater Treatment Areas.

(b) EAA Rainfall is calculated from measurements obtained from the District's data base. It is calculated as the weighted sum of daily rainfall measurements at 9 rainfall monitoring stations. The data base identifiers for rainfall stations and station weights are listed on the following table:

BMP REPLACEMENT WATER
TABLE 2 – RAINFALL STATIONS

DBKEY	THEISSEN WEIGHT	DBKEY	THEISSEN WEIGHT
15197	0.0974	15202	0.0989
15198	0.1076	15203	0.0763
15199	0.0844	15204	0.0592
15200	0.1617	15205	0.1743
15201	0.1438		

(3) The ~~model calculates~~ methodology to calculate the annual replacement water volume is based upon:

(a) volume of runoff from the EAA under base-period conditions, adjusted for variations in ~~annual~~ monthly rainfall;

(b) observed runoff reduction for the averaging period;

(c) percentage of EAA runoff which was discharged to the Water Conservation Areas during the averaging period;

(d) future reductions in EAA contributing watershed area, including those due to construction of Stormwater Treatment Areas.

(1) The ~~equations~~ method for calculating the annual replacement water volume (1000 acre-ft) ~~are~~ is based on a two step process:

Step 1. A statistical test is used to determine if the monthly rainfall/runoff relationship observed during the Averaging Period is statistically similar to the monthly rainfall runoff relationship observed during the Base Period. If the statistical test demonstrates similarity in the runoff response to rainfall at a 90% confidence level between the Base Period and the Averaging Period, no Replacement Water deliveries will be made.

The test is conducted utilizing the 120 months of data from the Base Period and the 60 months of data from the Averaging period. An F-Test is then performed to determine whether the regression coefficients for the two time periods are significantly different.

Step 2. If the test in Step 1 fails to demonstrate similarity, then the Replacement Volume will be computed as the greater of zero (0.0) and the Replacement Volume as computed based on the following:

Replacement Volume = ~~Predicted Runoff ×~~ Runoff Reduction × Area Factor × Fraction South

~~Predicted Runoff = Total Runoff for Current Water Year Predicted from Base Period Rainfall / Runoff Regression (1000 acre-ft)~~

	=	~~-1585.6 + 53.87 × Rainfall~~
Runoff reduction	=	Sum of the twelve monthly values calculated by taking the difference between the runoff predicted for each month of the Current Water Year using the Base Period Equation, and the runoff predicted for the same months using the Averaging Period Equation. (1000 acre-ft)
Base Period Equation	=	$1.2091*Rainfall^2+13,764*Rainfall+2.6$
Avg. Period Equation	=	This equation is calculated each year by computing the second order regression between the monthly rainfall and monthly runoff for the five years of data collected during the Averaging Period.
Rainfall	=	Total EAA Rainfall for each month of the Current Water Year (inches)
Area Factor	=	Factor to Account for Change in Watershed Contributing Area
	=	Average Area in Current Water Year/Average Area in Base Period
Average Area for Base Period	=	523,791 acres (Everglades Protection Project, Conceptual Design, February 15, 1994)
~~Runoff Reduction~~	~~=~~	~~Measured Runoff Reduction for Averaging Period~~
	~~=~~	~~1 - Σ (Observed EAA Runoff) / Σ (Predicted Runoff × Area Factor)~~
~~Σ~~	~~=~~	~~Sum over Averaging Period~~
Fraction South	=	Fraction of Total Runoff Discharged to South During Averaging Period
	=	Σ (EAA Runoff to South) / Σ (EAA Total Runoff)
Σ	=	Sum over Averaging Period

(5) If measurements required to calculate the annual replacement water volume are not available due to delays in data processing, recorder malfunction, etc., values will be estimated based upon best available methods. Measurements of rainfall and runoff volume required for the above computations shall be available within 75 days of data collection.

Specific Authority 373.044, 373.113, 373.4592 FS. Law Implemented 373.4592(4)(b) FS.
History — New 11-26-95.

40E-63.225 — Delivery of Average Annual Allocation of Replacement Water.

(1) The average annual allocation will be delivered each year in accordance with s. 373.4592(4)(b), F.S.

(2) Under typical hydrological conditions, the average annual allocation will be delivered during the replacement period according to the following fixed percentages, which are designed to produce future flows (runoff + makeup) characteristic of the seasonal distribution of flows from the EAA under more natural conditions: October 28.7%; November 22.8%; December 26.5%; January 14.9%; February 7.1%.

(3) Replacement water deliveries will be made to the Water Conservation Areas before the Stormwater Treatment Areas (STAs) are operational. Replacement water deliveries will be made to the STAs after they are operational, except when the delivery is likely to cause hydraulic bypass around an STA or otherwise hinder its performance.

(4) Replacement water deliveries will not be made when delivery is infeasible due to conveyance constraints south of Lake Okeechobee, when individual Water Conservation Areas (or their upstream Stormwater Treatment Areas) exceed regulation schedule, or during a Level 1 Alert.

(5) Under extreme hydrological conditions, the replacement water delivery schedule shall be submitted to the Governing Board for consideration under Section 373.4592(4)(b), F.S. Extreme conditions include those under which:

(a) the replacement water allocation is likely to be discharged as a regulatory release from the Water Conservation Areas to tidewater or to cause detrimental flows to Everglades National Park; or

(b) the water level in Lake Okeechobee is at a warning stage or lower as defined in the Lake Okeechobee Water Supply Management Plan.

(6) Differences between the allocated and delivered volumes will not be carried forward from one month to the next.

(7) Replacement water will be delivered on a monthly basis before any other flows are released to the Water Conservation Areas or Stormwater Treatment Areas for environmental purposes.

Specific Authority 373.044, 373.113, 373.4592 FS. Law Implemented 373.4592(4)(b) FS.
History — New 11-26-95.