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MEMORANDUM

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SUBJECT: 1965-2000 BMP Replacement Water Time series Estimation for the Initial CERP Update

This memorandum summarizes the methodology used to compute 1965-2000 daily time series of replacement (a.k.a. makeup) water deliveries associated with the implementation of Best Management Practices (BMP) in the Everglades Agricultural Area (EAA). The derived time series will be used in the South Florida Water Management Model (SFWMM) simulations for the Initial CERP Update (ICU).

Introduction:

As part of the Everglades Forever Act (Florida Statutes, Chapter 373.4592, 1994) requirements, Best Management Practices (BMPs) have been implemented in the Everglades Agricultural Area (EAA). The objective of BMP implementation in the EAA is to improve water quality in the Everglades Protection Area (EPA) by reducing phosphorous loads. Partial BMP implementation in the EAA commenced in water year 1989 with full implementation in place by the end of 1995.

Due to expected runoff reduction from the EAA as a result of BMP implementation, the Everglades Forever Act required that the District develop a model to quantify the amount of water to be replaced from Lake Okeechobee to the EPA. District Rule Chapter 40E-63, F.A.C., Part II adopted on October, 1995, established the model for the quantification of runoff reduction during a water year and replacement water to be delivered from the Lake to the EPA from October to February of the next water year. Actual replacement water deliveries may be lower than the target given by the Rule due to canal conveyance limitations or the Water Conservation Areas (WCAs) exceeding their regulation schedules. In addition, makeup water deliveries may be suspended when the Lake is under supply-side management. BMP replacement water deliveries from Lake Okeechobee to the EPA commenced in water year 1996 based on the model established in Chapter 40E-63, F.A.C.

Extensive testing conducted with data collected since 1995 has failed to show a statistically significant reduction in EAA runoff. Therefore, EAA runoff reduction will not be incorporated

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in the 2000 Base ICU simulation. However, since makeup water deliveries from Lake Okeechobee to the EPA are an established operational practice since water year 1996, replacement water will be incorporated in the 2000 Base ICU simulation.

Methodology:

The SFWMM 2000 Base ICU simulation describes how the regional system would behave under “current” operations (circa December 2000) subject to the historical (1965-2000) range of climatic conditions. Since BMP replacement water deliveries are function of rainfall, time series of BMP replacement water spanning the period of simulation (1965-2000) are required. Makeup water deliveries from Lake Okeechobee to the EPA commenced in water year 1996. Due to the lack of historical data spanning the 1965-2000 period of simulation, a rainfall-based approach has been used to estimate BMP replacement water time series for the entire period of simulation.

The method is based on the strong ($R^2=0.97$) logarithmic relationship between EAA average rainfall for water years 1995-2000 and the historical replacement water target for water years 1996-2001 (Figure 1). EAA average rainfall is a weighted-average of rainfall at 9 District monitoring stations defined in Rule Chapter 40E-63 (Table 1).

For implementing the method, rainfall for 9 SFWMM grid cells (Table 1), representing the 9 District monitoring stations, was extracted from the SFWMM v5.0 input rainfall binary file. EAA 9-cell average rainfall was calculated based on the Thiessen weights defined in Rule Chapter 40E-63, which are listed in Table 1. Figures 2 and 3 show that the EAA 9-cell average rainfall for water years 1979-2000 very closely matches the EAA 9-station average rainfall ($R^2=0.99$) as expected.

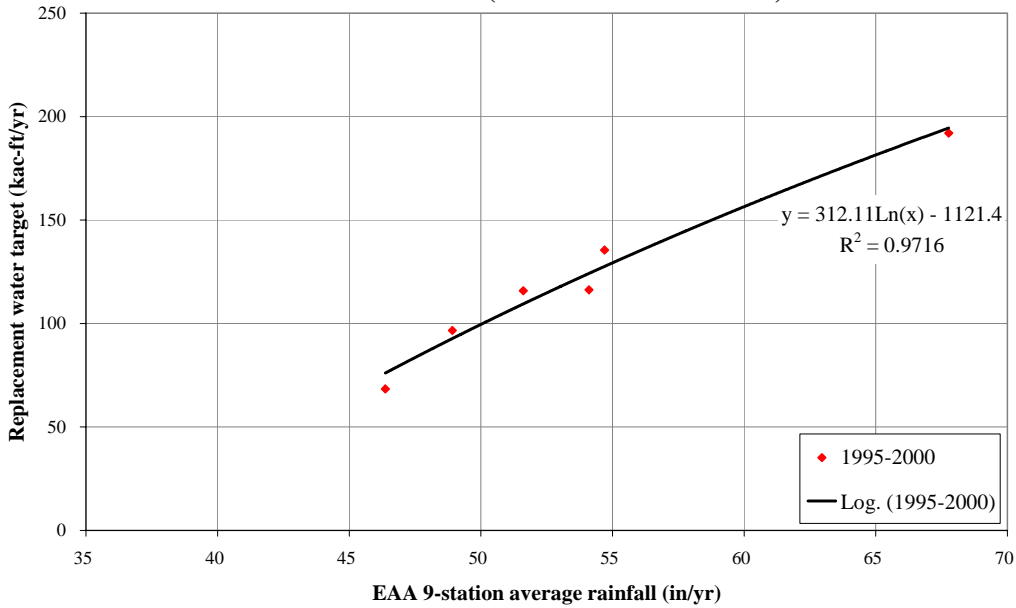
Based on the logarithmic relationship shown in Figure 1, the EAA average rainfall obtained from the SFWMM v5.0 rainfall binary file for water years 1965-2000 was used to estimate target replacement water deliveries for the next water year (Table 2, Figure 3).

There are two main reasons for the selection of water years 1995-2000 to assemble the model used here: (1) the 2000 Base simulation should reflect full BMP implementation which was completed around 1995, and (2) water years 2001 and 2002 were excluded due to the extreme drought conditions and water shortages affecting South Florida.

Rule Chapter 40E-63 defines fixed monthly percentages of the target replacement water to be delivered to the EPA during October to February of the next water year (Table 3). These monthly factors were applied to the estimated target replacement water deliveries for a water year to obtain monthly target deliveries. January-February, 1965 and October-December, 2000 target deliveries were estimated circularly based on the estimated target replacement water deliveries for water years 2000 and 1965, respectively. For creating the daily time series of replacement water, monthly target deliveries were uniformly distributed throughout the month.

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**Comparison of Replacement Water Target (Water Years 1996-2001)
versus Rainfall (Water Years 1995-2000)**



Water Year	EAA 9-Station Average Rainfall (in/yr)	Replacement Water Target for Next Water Year (Oct-Feb) (kac-ft/yr)
1995	67.77	192.0
1996	54.70	135.5
1997	51.61	115.8
1998	48.92	96.7
1999	54.11	116.3
2000	46.37	68.4

Figure 1. Logarithmic relationship between EAA 9-station average rainfall for water years 1995-2000 and replacement water target from BMP Rule for water years 1996-2001. Source of data is October 14, 2002 internal District memorandum from Wossenu Abteu to Ron Mierau.

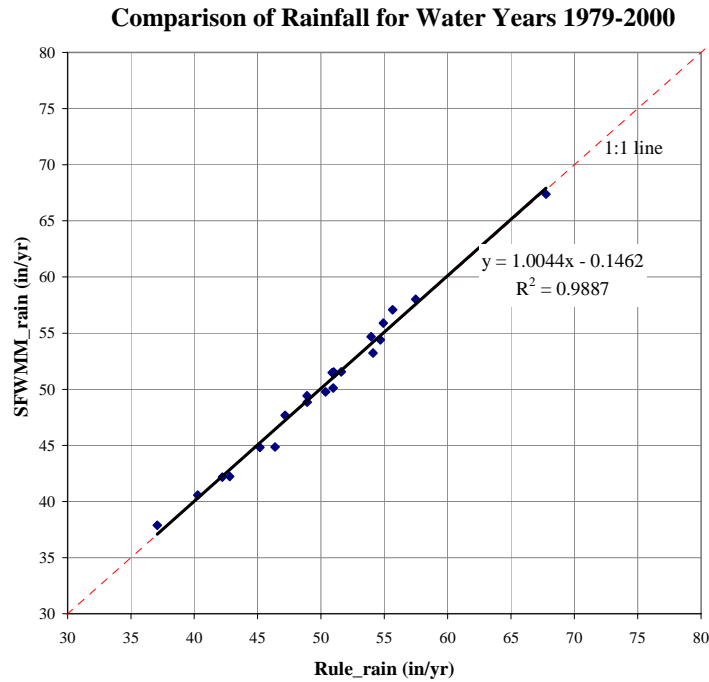


Figure 2. Comparison of EAA average rainfall for water years 1979-2000.

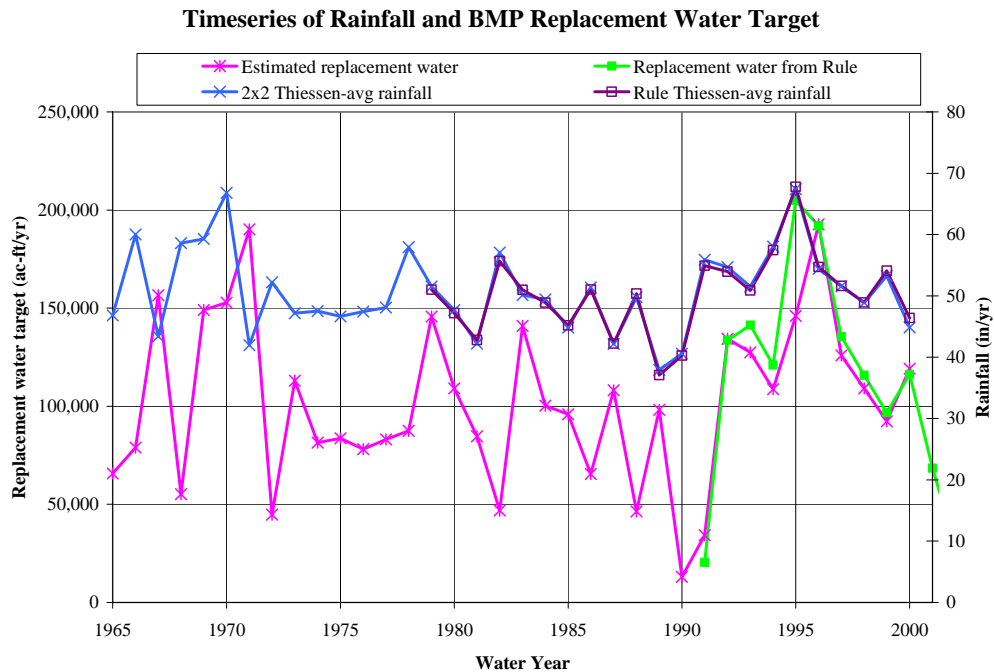


Figure 3. Annual time series of EAA 9-station average rainfall from BMP Rule, EAA 9-cell average rainfall from SFWMM rainfall binary, replacement water from BMP Rule and estimated replacement water for SFWMM. Note the one year lag between rainfall and BMP replacement water.

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Table 1. District’s rainfall monitoring stations in the EAA used in BMP replacement water calculations.

STATION	Thiessen Weight	DBKEY	XCORD	YCORD	SFWMM cell (Row, Col)
ALICO	0.0974	15197	662050.191	792096.255	(48,11)
BELLE-GLADE	0.1617	15200	777082.691	844670.746	(53,22)
MIAMI LOCK_R	0.1076	15198	719458.180	853630.902	(54,17)
PAHOKEE1_R	0.1438	15201	798481.181	901482.752	(58,24)
S5A_R	0.0989	15202	862679.587	855002.715	(54,30)
S6_R	0.0763	15203	837525.021	777745.664	(46,28)
S7_R	0.0592	15204	807896.812	728054.542	(42,25)
S8_R	0.1743	15205	730112.505	726534.776	(42,18)
SOUTH BAY_R	0.0844	15199	753759.327	847537.884	(53,20)

Table 2. Statistics of the estimated BMP replacement water target time series by water year.

Water Year	Water Year Rainfall (in/yr)	Estimated BMP Replacement Water Target (ac-ft/yr)
1965	46.8	65,747
1966	60.0	78,942
1967	43.4	156,480
1968	58.6	55,167
1969	59.3	149,082
1970	66.8	152,755
1971	41.9	190,077
1972	52.2	44,743
1973	47.2	112,976
1974	47.5	81,451
1975	46.7	83,625
1976	47.4	78,034
1977	48.1	83,043
1978	58.0	87,492
1979	51.5	145,702
1980	47.7	109,023
1981	42.2	84,694
1982	57.1	46,860
1983	50.1	140,917
1984	49.4	100,290
1985	44.8	95,910
1986	51.4	65,409
1987	42.2	108,120
1988	49.8	46,430
1989	<i>Min: 37.9</i>	98,161
1990	40.6	<i>Min: 13,058</i>

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1991	55.9	34,296
1992	54.7	134,301
1993	51.5	127,463
1994	58.0	108,723
1995	<i>Max: 67.4</i>	145,978
1996	54.4	<i>Max: 192,673</i>
1997	51.5	125,889
1998	48.9	109,099
1999	53.2	92,337
2000	44.9	119,143
Average for base period (water years 1979-1988)	48.6	89,581
Average for 36-yr period of simulation (1965-2000)	50.8	101,780

Note: The base period includes water years 1979-1988 prior to BMP implementation. The BMP Replacement Water Rule was developed based on observations for the base period. Note the one year lag between rainfall and BMP replacement water. For example, rainfall for water year 1981 includes rainfall from October, 1980 to September, 1981. Rainfall for water year 1981 is used to estimate BMP replacement water target for delivery from October to February of the next water year (water year 1982: October, 1981-February, 1982).

Table 3. Monthly distribution target for BMP makeup water deliveries.

Month of water year	Target percentage
October	28.7%
November	22.8%
December	26.5%
January	14.9%
February	7.1%

MI/mi

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