Technical Support Document for the C-139 Basin Performance Measure Assessment Methodology
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1. INTRODUCTION

The South Florida Water Management District (District) is responsible for establishing and managing a phosphorus control program for the C-139 Basin (see **Figure 1-1**). The Everglades Forever Act (Ch. 373.4592(4)f.5., Florida Statutes) established the goal of the C-139 Basin phosphorus control program:

> *Effective immediately, landowners within the C-139 Basin shall not collectively exceed an annual average loading of phosphorus based proportionately on the historical rainfall for the C-139 Basin over the period of October 1, 1978, to September 30, 1988. New surface inflows shall not increase the annual average loading of phosphorus stated above. Provided that the C-139 Basin does not exceed this annual average loading, all landowners within the Basin shall be in compliance for that year. Compliance determinations for individual landowners within the C-139 Basin for remedial action, if the Basin is determined by the district to be out of compliance for that year, shall be based on the landowners' proportional share of the total phosphorus loading. The total phosphorus discharge load shall be determined as set forth in Appendix B2 of Rule 40E-63, Everglades Program, Florida Administrative Code.*

Source control activities for the C-139 Basin consist of mandatory best management practices (BMPs) which have been increased on an annual basis based on achieving compliance with historical, pre-BMP phosphorus levels (Van Horn et al., 2009). Currently, permittees in the basin are required to implement 35 points of BMPs since the basin was not in compliance for four consecutive years prior to Water Year 2007 (WY2007)[3]. As mandated by rule 40E-63 F.A.C., the regulatory program is being revised as necessary to meet the objectives of the EFA. In accordance with the Everglades Long-Term Plan (Burns & McDonnell 2003, as may be amended), the District is conducting supplemental projects to improve the performance of source controls, such as BMP demonstration projects, and enhancing upstream monitoring and analysis of data. The District is conducting exhaustive investigations to understand all factors affecting the basin's ability to reach compliance and not exceed historical phosphorus levels.

This document continues the refinement of the method to assess performance with the goal of the C-139 Basin phosphorus control program. Since the original method was implemented, a change has occurred in the underlying relationship between the annual basin rainfall and the total phosphorus (TP) loads discharged from the basin. This change is likely the result of the interplay of multiple factors, and refinement in the original performance assessment method is proposed to address several of these factors:

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[3] A May 1 – April 30 Water Year is used throughout this document.

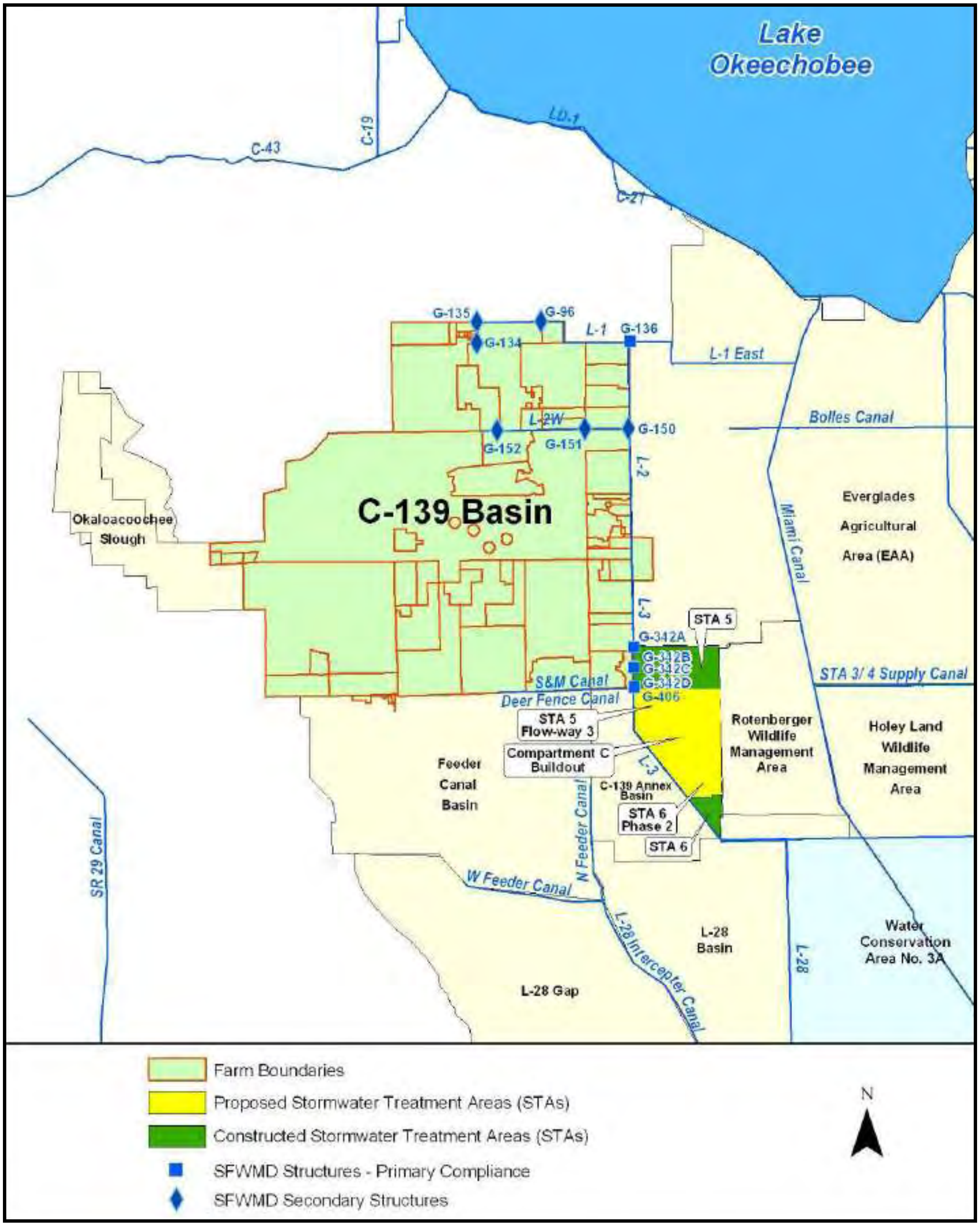


Figure 1-1. Regional Overview of the C-139 and Adjacent Basins (from Van Horn et al. 2009).

1. **Observed differences in the seasonal distribution of C-139 Basin rainfall.**
   - For the period WY2000-WY2009, wet season rainfall has increased by 10% and dry season rainfall has decreased by 38%, compared to WY1980-1988 (**Appendix A**). Overall, the average annual rainfall for WY2000-WY2009 is approximately 2.4 inches (5%) less than the WY1980-1988 period.

   To address this variation in seasonal distribution, the proposed methodology uses a performance measure equation that is based on the monthly rainfall distribution within a water year.

2. **A change in the basin water management practices.**
   - At the regional level, STA-5 began operation in WY2000.
     1. Dry season stages in the eastern portion of the basin south of the G-150 divide structure have been held higher since STA-5 began operation, resulting in a reduction in dry season basin discharges, greater dry season conservation storage, and greater potential for surficial aquifer recharge in the L-2/L-3 system during the dry season (Goforth 2008).
     2. Flood control level of service has improved since STA-5 has been in operation. Storm discharges are occurring within a narrower range in the L-3 stage, i.e., stages are held higher prior to making basin discharges yet peak flow rates are occurring at lower peak stages (Goforth 2008).
   - At the farm level, Water Use permit information indicates a trend of increasing irrigation withdrawal allocations that began prior to STA-5 operation, raising the possibility that increased groundwater withdrawals and associated surface water discharges may be influencing the observed increase in C-139 Basin runoff values (ADA 2006, Goforth 2008). Three major droughts have occurred since the baseline period: during 1990-1991, 2000-2001 and 2007-2008. These droughts highlighted the limited surface storage available in the basin, and increased the reliance on groundwater sources to meet agricultural irrigation demands.
   - C-139 Basin land use data indicate a trend of increasing agricultural land use with a simultaneous decrease of low intensity land uses (e.g., upland forests and wetlands) (Goforth 2008). To the extent that the surface water management of the additional agricultural areas is resulting in higher unit area runoff rates, this regional factor may be influencing C-139 Basin flows and TP loads

   The proposed methodology utilizes the current relationship between basin rainfall and TP loads discharged from the basin, while at the same time maintaining the historical phosphorus loads discharged from the basin. The same average annual TP load as the baseline period (38.2 metric tons/yr[4]) is maintained through scaling of the observed TP load data prior to establishing the relationship between basin rainfall and TP loads.

[4] For reporting purposes, values are reported with one less significant digit than used during data analyses, e.g., the average annual TP load for WY1980-1988 used during calculations was 38.15 mtons

3. **Data uncertainty.**
   - Inherent in any data evaluation process is measurement error and related uncertainties in the data values.
   - Different flow and TP monitoring stations are utilized for assessing basin performance than were used in the measurement of baseline data. Although adjustments were made to account for location, error is inherent to the estimation.
   - Different measurement techniques are utilized for assessing basin performance than were used in the measurement of baseline data. Although adjustments were made to account for many technology improvements, error is inherent to the estimation.

   The proposed methodology uses a performance measure equation that is based on the same flow and TP monitoring locations and methods as the future performance assessment. In addition, the baseline period (WY1980-1988) TP load record was refined based on review and fine-tuning of the original data analysis methods.

The following section describes the adjustment to the baseline period data and the derivation of a revised performance measure assessment method for the C-139 Basin.

2. REFINEMENT OF PHOSPHORUS DISCHARGE RECORD

The method used to initially estimate TP loads during the WY1980-1988 Base Period was described in the draft and final reports *Models for Tracking Runoff & Phosphorus Loads from the C-139 Basin* ("Models Report") through contract with the District (Walker 2000a, 2000b). The following is a summary of that method.

- Flows measured in the L-3 Canal using the historical technique (slope/area equations applied to stage measurements) were calibrated against flows estimated with a more recent ultrasonic velocity meter (UVM).

- TP concentrations in the L-3 Canal measured with the historical technique (grab sampling downstream of the G-88/G-89/G-155 complex) were compared to TP concentrations measured with a more sophisticated technique (composite autosampler at station C139DFC) located just downstream of the intersection of the Deer Fence Canal and the L-3 Canal. This location is closer to the C-139 Basin outlet along the L-3 Canal. An adjustment factor that took into account both the sampling technique and the location was calculated based upon paired samples collected between January 1996 and April 2000. This comparison yielded an adjustment factor of 1.062.

- Missing daily flows for G-136 for the period from July 1, 1982 through May 31, 1983 were estimated.

- Missing TP data at G-136 for the July 1982 – April 1994 period were estimated.

The C-139 Basin TP loads during the Base Period were computed as the sum of the TP loads from L-3 Canal and from the L-1 Canal at structure G-136. Approximately 90% of the basin

TP loads during the WY1980-1988 Base Period were discharged through the L-3 Canal, with the remainder exiting through the L-1 Canal at G-136. In consideration of the fact that eight additional years of data are now available (i.e., WY2001-2009), potential improvements to the previous data analyses based on the extended data set were investigated. The District's examination of the potential extension of the calibration period is presented in Section 2.1 below. As a result of several major changes to the regional water management system since WY2000, recent relationships between TP levels at G-136 and L-3 are unsuitable for use in refinement of historical records. This is further described below in the section titled "Potential Extension of Calibration Period".

The updated analysis is presented herein, and a revised estimate of the C-139 Basin TP load for the WY1980-1988 Base Period is recommended. Refinement of the methods for calculating the Base Period phosphorus discharge record resulted in a revision of average annual load from 36.77 to 38.15 metric tons/yr. Refined Base Period loads are based on the following relatively minor calculation improvements:

- Refinement of the time period used to define the ratio of TP concentrations [C139DFC (ACF[5]) to L3 (Grab sample)] to exclude sporadic data prior to January 1996; and
- Removal of the above mentioned TP concentration ratio from the algorithm used to fill in missing concentration data at G-136 for the period July 1982 through April 1994; the ratio should not have been applied in this algorithm.

2.1 Updated Analysis for the L-3 Canal Phosphorus Discharge Record

Phosphorus concentration data during the Base Period were collected at the L3 station, located approximately eleven miles downstream of the C-139 Basin's southeast outlet. For clarity, throughout this paper, the term "L3" is used when referring to the station "L3", the term "L-3" is used when referring to the C-139 Basin discharge in the L-3 Canal, and the term "L-3 Canal" is used when referring to the physical L-3 Canal. The TP data measured at the L3 station were originally adjusted to represent conditions at the outlet from the C-139 Basin by applying an adjustment ratio; this adjustment ratio was calculated by determining the ratio between TP concentration data at the C139DFC and L3 stations (Walker 2000). There are currently four stations which can potentially be used to extend the period used to calculate an updated adjustment ratio: L3, L3BRS, C139DFC and G-406. **Figure 2-1** shows the relative location of these four stations and **Table 2-1** summarizes the data at these stations. The arrow from the L3 station to the C139DFC station represents in concept the adjustment for both location and sampling technique.

[5] ACF refers to flow-proportion autosampler composite sample

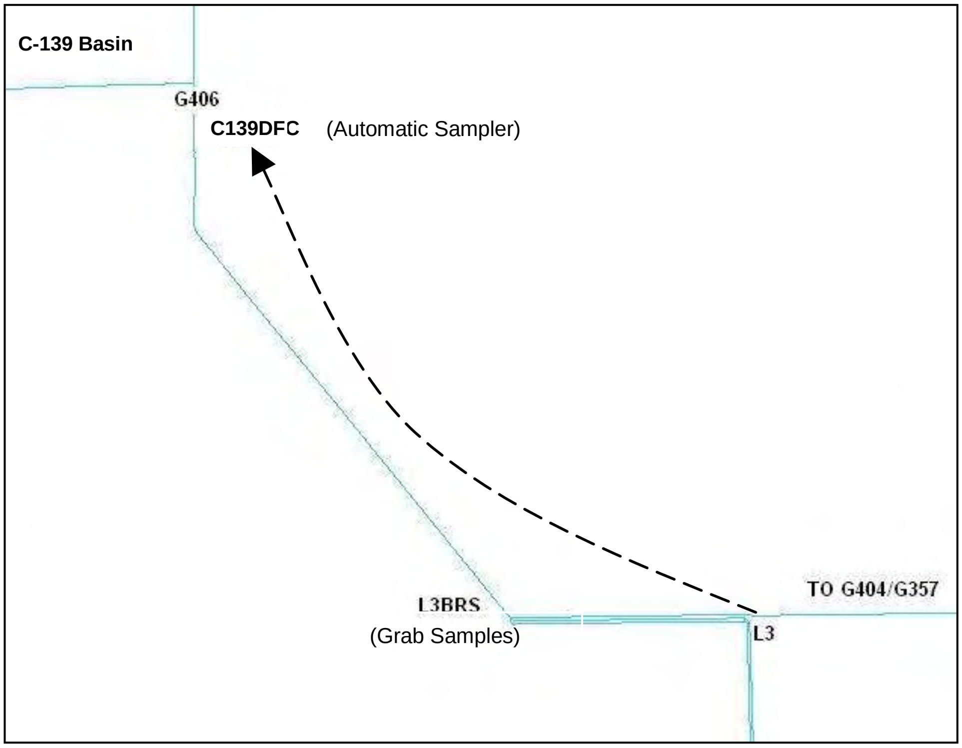


Figure 2-1. Locations of L3, L3BRS, C139DFC and G-406

Table 2-1 Data Available at L3, L3BRS, C139DFC and G-406

Station	Data Range		Note
	Water Quality	Flow	
L3	10/78 – 06/00	10/78 – 06/00 *	Grab only
L3BRS	10/84 - current	10/78 – 06/00 *	No Sample from 08/85 – 04/87
C139DFC	05/95 – 01/02	1/6/96 - 6/26/00	ACF Samples w/UVM
G-406	06/00 - current	06/00 - current	ACF & Grab

* Note: Flow was not measured at the L3 or L3BRS stations, but flow through the L-3 Canal system was combined from several sources for use as the L-3 Canal flow record (Walker 2000a, 2000b).
ACF = flow-proportion autosampler composite
UVM = ultrasonic velocity meter

Analysis of the Adjustment Ratio. The Models Report indicates the 1.062 adjustment ratio between C139DFC and L3 was based on the period from January 1996 through April 2000, however, inspection of the data indicates that the 1.062 adjustment ratio is actually based on the period from May 1995 through April 2000 (Walker 2000). Quality-controlled daily data for the UVM (DBKEY 16243) began on January 6, 1996. Much of the daily flow data in 1995 is missing and therefore estimated, so the quality of flow data triggering the automatic sampler prior to January 1996 at C139DFC is poor. Because of the higher quality of data beginning January 1996, the period January 1996 through April 2000 was used to calculate an updated adjustment ratio of 1.122 between the L3 and C139DCF TP concentration data. With exclusion of the 1995 data, the recalculated adjustment ratio is 1.122 (i.e.,, the L3 grab sample TP concentrations should be adjusted 12.2% upward, instead of the existing 6.2% adjustment) in order to estimate the TP concentration at the southeast outlet of the C-139 Basin.

Potential Extension of Calibration Period (Examined but not applied). Relationships between TP levels at several stations in the L-3 Canal were examined in an attempt to strengthen the C-139 Base Period data set. However, no relationships were found that were appropriate for Base Period adjustments for the L-3 Canal. A summary of the relationships that were examined is presented below.

- *C139DFC and G-406.* Station G-406 is located approximately 865 feet upstream of the location of C139DFC. There was only an eighteen month period (June 2000 to January 2002) of data overlap for stations C139DFC and G-406 (**Table 2-1**). The difference in calculated TP load at these two sites for this period was less than 3%, and this was determined to be not sufficiently significant to warrant extending the data analysis period.

- *L3 and L3BRS.* Stations L3 and L3BRS had an overlapping period of record from May 1987 to June 2000. Cumulative TP loads at L3 were 11% less than at L3BRS during the period of May 1987 to December 1995, while cumulative TP loads at L3 were 4% greater than at L3BRS during the period of January 1996 to June 2000. Since the relationship between L3 and L3BRS was not consistent, it was determined that L3BRS data are not suitable to be used as an extension to the L3 Base Period data set.

- *L3BRS and G-406.* G-406 and L3BRS had an overlapping period of record that started in June 2000 (**Table 2-1**). However, the difference in cumulative TP loads at G-406 and L3BRS is not consistent, and therefore, it was determined that it is not appropriate to use the G-406 data as an extension of the Base Period data set.

There were several major changes to the regional water management system that affected measurement of C-139 Basin discharges after 2000 that help explain the observed relationships described above. The primary receiving water for the C-139 Basin runoff was changed to STA-5, and the L-3 canal south of G-406 became the STA-5 bypass route primarily carrying flows beyond the capacity of the STA as flood protection necessitated. This changed the characteristics of flows and loads downstream of this location to primarily reflect extreme event discharges. In addition, the District began moving water from the Miami Canal to the L-4 Borrow Canal (via G-357 and G-404) in 2000. A 100-ft cut was made in the southern L-4 levee in 2000, allowing mixing of L-4 Borrow Canal water, STA-6 discharges and L-3 Canal water just upstream of the L3 sampling station. In addition, operation commenced in 2001 at the Seminole Big Cypress Reservation water supply pump station G-409, located between G-406 and station L3. These system changes caused mixing of the C-139 Basin discharges with flows from the L-4 Borrow Canal and STA-6, impacting the ability to correlate relationships with the L3 and upstream stations. Therefore, it was determined that an extension of the period of record beyond 2000 for the C-139 Basin Base Period is not appropriate.

2.2 Updated Analysis for the L-1 Canal Phosphorus Discharge Record

Base Period TP load calculations for C-139 Basin discharges through the L-1 Canal via the G-136 structure were based on the method used to estimate missing data for the period of July 1982 through April 1994. The long-term ratio of the flow-weighted TP concentration at G-136 and L3 was computed from paired grab samples collected on common dates during the entire record (1980-2000) when both G-136 and L3 recorded positive flows (Walker 2000b), and weighted based on the G-136 flows to derive an unbiased estimate of the ratio:

$$Ratio_{G\text{-}136:L3} = \Sigma Q_{G\text{-}136}\, C_{G\text{-}G\text{-}136} / \Sigma Q_{G\text{-}136}\, C_{G\text{-}L3} = 0.9145 \qquad \text{Equation 1}$$

where
$Q_{G\text{-}136}$ = Flow at G-136
$C_{G\text{-}G\text{-}136}$ = Grab sample concentration at G-136
$C_{G\text{-}L3}$ = Grab sample concentration at L3 (unadjusted)

Monthly TP loads at G-136 for the period July 1982 through April 1994 were estimated for the January 2002 Rule 40E-63 Appendix B2 methodology by multiplying the monthly flows at G-136 by the monthly flow-weighted mean TP concentration for L-3 (adjusted for location and sampling technique), and further multiplied by the $Ratio_{G\text{-}136:L3}$:

$$Load_{G\text{-}136} = Q_{G\text{-}136} * (Load_{L\text{-}3} / Q_{L\text{-}3}) * Ratio_{G\text{-}136:L3} \qquad \text{Equation 2}$$

where
$Load_{G\text{-}136}$ = Total TP load at G-136
$Load_{L\text{-}3}$ = Total TP load for L-3 (including 6.2% method & location adjustment)
$Q_{L\text{-}3}$ = Flow for L-3

Upon a recent review of this method, it was determined that a slight revision to Equation 2 was necessary for two reasons:

1. the ratio $Ratio_{G\text{-}136:L3}$ was based on the unadjusted grab samples at station L3, and not on the adjusted TP concentration for L-3 as it is used in Equation 2; and
2. to reflect the composite-to-grab ratio calculated for G-136 TP concentrations.

The first reason is demonstrated by the following substitution in Equation 2.

$$\begin{aligned} Load_{G\text{-}136} &= (Q_{G\text{-}136} / Q_{L\text{-}3}) * (Load_{L\text{-}3}) * Ratio_{G\text{-}136:L3} \\ &= (Q_{G\text{-}136} / Q_{L\text{-}3}) * (Q_{L\text{-}3} * C_{ACF\text{-}L\text{-}3}) * Ratio_{G\text{-}136:L3} \\ &= (Q_{G\text{-}136} / Q_{L\text{-}3}) * (Q_{L\text{-}3} * C_{G\text{-}L3} * Ratio_{C/G\text{-}L3}) * Ratio_{G\text{-}136:L3} \qquad \text{Equation 3} \end{aligned}$$

where
$C_{ACF\text{-}L\text{-}3}$ = Composite sample concentration in L-3 (adjusted)
$Ratio_{C/G\text{-}L3}$ = Composite-to-grab sample concentration ratio in L3

Rearranging the terms, Equation 3 can be rewritten as:

$$Load_{G\text{-}136} = Q_{L\text{-}3} * (Q_{G\text{-}136}/Q_{L\text{-}3}) * (C_{G\text{-}L3} * Ratio_{G\text{-}136:L3}) * Ratio_{C/G\text{-}L3} \quad \text{Equation 4}$$

Which is equivalent to:

$$Load_{G\text{-}136} = Q_{G\text{-}136} * C_{G\text{-}G\text{-}136} * Ratio_{C/G\text{-}L3} \quad \text{Equation 5}$$

Equation 5 shows that the missing monthly G-136 concentration values were originally over-estimated by a factor equal to the value of $Ratio_{C/G\text{-}L\text{-}3}$. Hence, the original estimates of the monthly TP load data need to be corrected by dividing by the value of $Ratio_{C/G\text{-}L\text{-}3}$.

In addition, the missing data should be adjusted by the composite-to-grab ratio developed for G-136 (= 0.957). A total adjustment of (0.957/1.122 =) 0.853 will be applied to the loads estimated by multiplying the monthly flows at G-136 by the monthly flow-weighted mean TP concentration for L-3 (adjusted for location and sampling technique) during this missing period.

2.3 Significant Digits of Data Values

The present analysis utilized the following protocol for rounding off data values during calculations:

1. Monthly rainfall values were rounded to the nearest 0.001 inch.
2. Annual rainfall values were calculated as the sum of the monthly values and rounded to the nearest 0.01 inch.
3. Monthly runoff volumes were rounded to the nearest 0.1 acre foot (AF).
4. Annual runoff volumes were calculated as the sum of the monthly values and rounded to the nearest 1 AF.
5. Monthly TP loads were rounded to the nearest 0.1 kg.
6. Annual TP loads were calculated as the sum of the monthly values and rounded to the nearest 1 kg.
7. Monthly TP concentrations were calculated from monthly flow and load values (rounded to the nearest 0.1 AF and 0.1 kg, respectively), and then rounded to the nearest 1 ppb.
8. Annual TP concentrations were calculated from annual flow and load values (rounded to the nearest 1 AF and 1 kg, respectively), and then rounded to the nearest 1 ppb.
9. In order to preserve the above precision, calculations involving log transformation were carried out to the 5th decimal place and regression coefficients were carried out to the fourth decimal place.

2.4 Summary of Updated Data Analysis

The C-139 Basin TP load estimate for the WY1980-1988 Base Period was revised based on the updated data analyses presented above. **Table 2-2** and **Table 2-3** present a comparison of the Base Period TP load estimates based on existing and revised analyses. Compared to the existing analyses, the updated data analyses result in an overall 3.8% increase in the average annual TP load estimate for the WY1980-1988 Base Period. The revised data set will be utilized in derivation of the updated methodology in order to maximize the regression's representation of the C-139 Basin rainfall and discharge relationships. **Table 2-4** compares the annual current and historically reported basin rainfall, flow, TP load, and flow-weighted mean TP concentration (FWMC) for WY1980-2008.

Table 2-2. Comparison of Existing and Revised Base Period Average Load (mtons = metric tons).

	L-3	G-136	C-139 Basin
Existing	32.40 mtons/yr	4.37 mtons/yr	36.77 mtons/yr
Revised	34.22 mtons/yr	3.93 mtons/yr	38.15 mtons/yr
% Difference	5.6%	-10.1%	3.8%

Table 2-3. Comparison of Existing and Revised Base Period Load and Concentration.

Base Period Statistic	Existing	Revised
Mean Annual Load	36.77 mtons/yr	38.15 mtons/yr
Base Period FWMC	227 ppb	235 ppb

Table 2-4. Comparison of New Annual Data with Previous Annual Data

	New Data				Old Data					Differences: New Data minus Old Data				
Water Year	Rainfall in	Runoff AF	TP Load kg	TP Conc ppb	Water Year	Rainfall in	Runoff AF	TP Load kg	TP Conc ppb	Water Year	Rainfall in	Runoff AF	TP Load kg	TP Conc ppb
1980	56.39	171,537	36,618	173	**1980**	56.39	171,537	34,673	164	**1980**	0.00	0	1,945	9
1981	31.06	51,203	4,375	69	**1981**	31.06	51,203	4,143	66	**1981**	0.00	0	232	3
1982	38.61	43,883	6,486	120	**1982**	38.61	43,883	6,141	113	**1982**	0.00	0	345	7
1983	71.98	344,459	154,278	363	**1983**	71.98	344,458	148,059	348	**1983**	0.00	1	6,219	15
1984	47.19	155,622	41,298	215	**1984**	47.19	155,622	40,351	210	**1984**	0.00	0	947	5
1985	46.88	63,107	15,160	195	**1985**	46.88	63,107	14,616	188	**1985**	0.00	0	544	7
1986	46.71	110,301	17,581	129	**1986**	46.71	110,301	17,028	125	**1986**	0.00	0	553	4
1987	60.19	149,284	38,383	208	**1987**	60.19	149,284	37,739	205	**1987**	0.00	0	644	3
1988	47.96	93,914	29,184	252	**1988**	47.96	93,914	28,150	243	**1988**	0.00	0	1,034	9
1989	40.69	72,812	14,655	163	**1989**	40.69	72,812	14,164	158	**1989**	0.00	0	491	5
1990	39.62	45,644	5,757	102	**1990**	39.62	45,644	5,476	97	**1990**	0.00	0	281	5
1991	47.53	45,340	5,221	93	**1991**	47.53	45,340	4,991	89	**1991**	0.00	0	230	4
1992	51.04	99,786	12,801	104	**1992**	51.04	99,786	12,267	100	**1992**	0.00	0	534	4
1993	55.49	137,292	27,407	162	**1993**	55.49	137,292	26,276	155	**1993**	0.00	0	1,131	7
1994	52.03	136,472	22,512	134	**1994**	52.03	136,472	21,750	129	**1994**	0.00	0	762	5
1995	59.85	272,252	65,051	194	**1995**	59.85	272,252	61,891	184	**1995**	0.00	0	3,161	10
1996	60.05	235,759	48,588	167	**1996**	60.24	235,762	48,478	167	**1996**	-0.19	-3	110	0
1997	55.73	164,531	45,860	226	**1997**	55.74	164,535	45,855	226	**1997**	-0.01	-4	5	0
1998	56.58	169,928	35,689	170	**1998**	56.65	169,934	35,576	170	**1998**	-0.07	-6	113	0
1999	51.43	135,793	35,591	212	**1999**	51.92	135,795	35,569	212	**1999**	-0.49	-2	22	0
2000	54.42	201,726	52,371	210	**2000**	54.46	201,733	52,353	210	**2000**	-0.04	-7	18	0
2001	35.55	56,491	17,106	245	**2001**	35.70	56,493	17,143	246	**2001**	-0.15	-2	-37	-1
2002	53.54	199,671	65,923	268	**2002**	54.23	199,675	65,907	268	**2002**	-0.69	-4	16	0.41
2003	54.58	224,419	76,485	276	**2003**	55.40	224,419	72,301	261	**2003**	-0.82	0	4,184	15
2004	49.12	203,934	68,953	274	**2004**	49.90	203,945	69,014	274	**2004**	-0.78	-11	-61	0
2005	49.95	167,454	40,668	197	**2005**	50.68	167,464	40,275	195	**2005**	-0.73	-10	393	2
2006	54.75	333,225	106,892	260	**2006**	53.79	333,235	106,896	260	**2006**	0.96	-10	-4	0
2007	36.20	77,271	29,120	306	**2007**	36.85	77,273	29,123	306	**2007**	-0.65	-2	-3	0
2008	41.63	38,737	5,419	113	**2008**	41.95	38,768	5,419	113	**2008**	-0.32	-31	0	0
Minimum	**31.06**	**38,737**	**4,375**	**69**	**Minimum**	**31.06**	**38,768**	**4,143**	**66**	**Minimum**	**-0.82**	**-31**	**-61**	**-1**
Median	**51.04**	**137,292**	**35,591**	**195**	**Median**	**51.04**	**137,292**	**34,673**	**188**	**Median**	**0.00**	**0**	**345**	**4**
Average	**49.89**	**144,891**	**38,808**	**193**	**Average**	**50.02**	**144,894**	**37,987**	**189**	**Average**	**-0.14**	**-3**	**821**	**4**
Maximum	**71.98**	**344,459**	**154,278**	**363**	**Maximum**	**71.98**	**344,458**	**148,059**	**348**	**Maximum**	**0.96**	**1**	**6,219**	**15**

Differences with previous data can be attributed to the following factors:

1. WY1980-1995 refinements to the L-3 loads based on a revised adjustment ratio of TP concentrations at C139DFC and TP concentrations at station L3; the new adjustment ratio is 1.122.
2. WY1980-1995 refinements to G-136 loads based on revision of the original method used to estimate missing WQ data.
3. WY1996-2008: other refinements in the data resulting from running the C139 model from 1978 to 2008 to update the results from 1996 to 2008 using the latest composite/grab ratios, adjustment rations, and revised DBHYDRO data.
4. WY2006: Correction of rainfall at PAIGE station in June & July 2005; WY2006 rainfall for the C-139 Basin was updated from 53.79 inches to 54.75 inches.
5. WY1980-2009: Consistent application of rounding data values.

Annual data are presented in **Appendix B** and **Appendix C.**

3. DESCRIPTION OF THE REVISED ASSESSMENT METHOD

Since the original method was implemented, a change has occurred in the underlying relationship between the annual basin rainfall and the TP loads discharged from the basin. As discussed in Section 1, this change is likely the result of the interplay of multiple factors, including a shift in the seasonal distribution of C-139 Basin rainfall, data uncertainty, a shift in the basin land use, and a change in the basin water management practices. A refinement in the original performance measure assessment method is proposed to address several of these factors, while at the same time maintaining the historical phosphorus loads discharged from the basin. The following sections describe the derivation of the revised performance measure assessment method.

3.1 Selection of an Appropriate Calibration Period

Several periods were examined for use as the calibration period for the revised assessment methodology. A breakpoint in the relationship between cumulative annual TP loads and measured TP loads occurred in WY2000 (**Figure 3-1**), coinciding with the commencement of STA-5 operation, and that water year was selected as the beginning of the calibration period. Examination of the annual basin rainfall, TP loads and the ratio between runoff volume and rainfall for WY2000 through WY2009 indicated no temporal trends[6], and with one exception, no outliers using the 3-sigma, Hampel Identifier and Maximum Normal Residual outlier detection methods (**Table 3-1**) (Struble 2008, Davies and Gather 1993, Snedecor and Cochran 1989). The annual runoff-to-rainfall ratio was examined because it can be a good indicator of regional water management activities. Using the Hampel Identifier method, the runoff-to-rainfall ratio for WY2001, WY2006 and WY2008 were identified as outliers, however, this outlier detection method is typically applied to sample sizes of ten or more, and the results are questionable for this example with a sample size of just ten. In addition, the Hampel identifier is "Sometimes prone to finding too many outliers" (Struble 2008). In light of the preponderance of evidence, including the results from the more rigorous Maximum Normal Residual outlier detection method, and a strong reluctance to discard data without a clear physical rationale to do so, it was determined that no outliers were present in the annual data set, and WY2009 was selected as the ending water year of the calibration period. Additional details on the outlier detection methods are presented in **Appendix D**.

[6] The presence of a temporal trend was evaluated using a least squares regression of water year versus annual rainfall, TP load, runoff and runoff-to-rainfall ratio. Since the p-values (a measure of randomness) of the slope coefficients ranged from 0.32 to 0.83 it was determined there was no significant temporal trend. If a trend had been present, adjustments to the outlier detection methods would be necessary.

Figure 3-1. Relationship of Predicted TP Loads to Measured TP Loads.

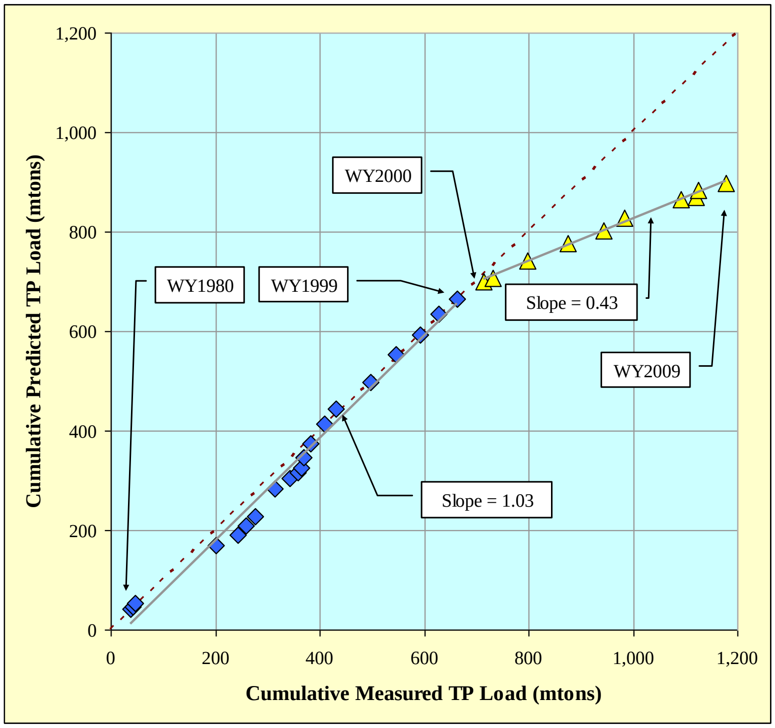


Table 3-1. Summary of Outlier Detection Analyses.

Parameter	Unit	Water Year									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TP Load	mtons	52.371	17.106	65.923	76.485	68.953	40.668	106.892	29.120	5.419	52.307
Rainfall (R)	inches	54.42	35.55	53.54	54.58	49.12	49.95	54.75	36.20	41.63	42.97
Runoff (RO)	inches	14.30	3.99	14.15	15.89	14.43	11.86	23.58	5.46	2.72	11.71
RO: R Ratio		0.263	0.112	0.264	0.291	0.294	0.237	0.431	0.151	0.065	0.273
TP Load Outlier Analysis											
Residual based on mean		0.847	34.418	14.399	24.961	17.429	10.856	55.368	22.404	46.105	0.783
Residual based on median		0.032	35.233	13.584	24.146	16.614	11.671	54.553	23.219	46.920	0.032
3-sigma outlier?		No	No	No	No	No	No	No	No	No	No
Hampel Identifier outlier?		No	No	No	No	No	No	No	No	No	No
Squares of residuals		0.717	1184.626	207.320	623.032	303.756	117.861	3065.571	501.957	2125.708	0.612
MNR outlier?		No	No	No	No	No	No	No	No	No	No
Rainfall Outlier Analysis											
Residual based on mean		7.15	11.72	6.27	7.31	1.85	2.68	7.48	11.07	5.64	4.30
Residual based on median		4.89	13.99	4.01	5.05	0.41	0.42	5.22	13.34	7.90	6.57
3-sigma outlier?		No	No	No	No	No	No	No	No	No	No
Hampel Identifier outlier?		No	No	No	No	No	No	No	No	No	No
Squares of residuals		51.108	137.382	39.300	53.421	3.419	7.177	55.935	122.567	31.821	18.499
MNR outlier?		No	No	No	No	No	No	No	No	No	No
Runoff:Rainfall Ratio Outlier Analysis											
Residual based on mean		0.02	0.13	0.03	0.05	0.06	0.00	0.19	0.09	0.17	0.03
Residual based on median		0.00	0.15	0.00	0.03	0.03	0.03	0.17	0.11	0.20	0.01
3-sigma outlier?		No	No	No	No	No	No	No	No	No	No
Hampel Identifier outlier?		No	Yes	No	No	No	No	Yes	No	Yes	No
Squares of residuals		0.001	0.016	0.001	0.003	0.003	0.000	0.037	0.008	0.030	0.001
MNR outlier?		No	No	No	No	No	No	No	No	No	No

3.2 C-139 Basin Rainfall

Daily rainfall data from 3 area gauges for the period May 1, 1979 – April 30, 2009 (WY1980-2009) were averaged using Thiessen polygon weights for the C-139 Basin (Appendix A). Annual rainfall depths for the C-139 Basin ranged from 31.06 inches to 71.98 inches, with an average of 49.66 inches and a standard deviation of 8.81 inches. The cumulative distribution of the annual values observed for the 30-year period of record is presented in **Figure 3-2**.

The annual rainfall values observed for the WY2000-2009 period ranged from 35.55 inches to 54.76 inches, which represents the 6th percentile and 71st percentile values of the 30-year period of record's cumulative distribution. The WY2000-2009 observed annual rainfall values had an average of 47.27 inches and a standard deviation of 7.61 inches. The annual average value for this 10–yr period was 2.4 inches (5%) lower than the average for the 30-yr period of record, and 2.39 inches (5%) lower than the average for the WY1980-1988 base period.

3.3 C-139 Basin TP Loads

Annual C-139 Basin TP loads are presented in **Figure 3-3**. The annual phosphorus load discharged from the C-139 Basin estimated for the WY1980-1988 baseline period ranged from 4.4 metric tons (mtons) to 154.3 mtons, with an average of 38.2 mtons and a standard deviation of 45.7 mtons. By comparison, the annual phosphorus load discharged from the C-139 Basin estimated for the WY2000-2009 period ranged from 5.4 mtons to 106.9 mtons, with an average of 51.5 mtons and a standard deviation of 30.1 mtons. The annual average value for this ten-year period was 12.3 mtons (31%) higher than the average for the 30-yr period of record, and 13.4 mtons (35%) higher than the WY1980-1988 base period.

Figure 3-2. C-139 Basin Annual Rainfall.

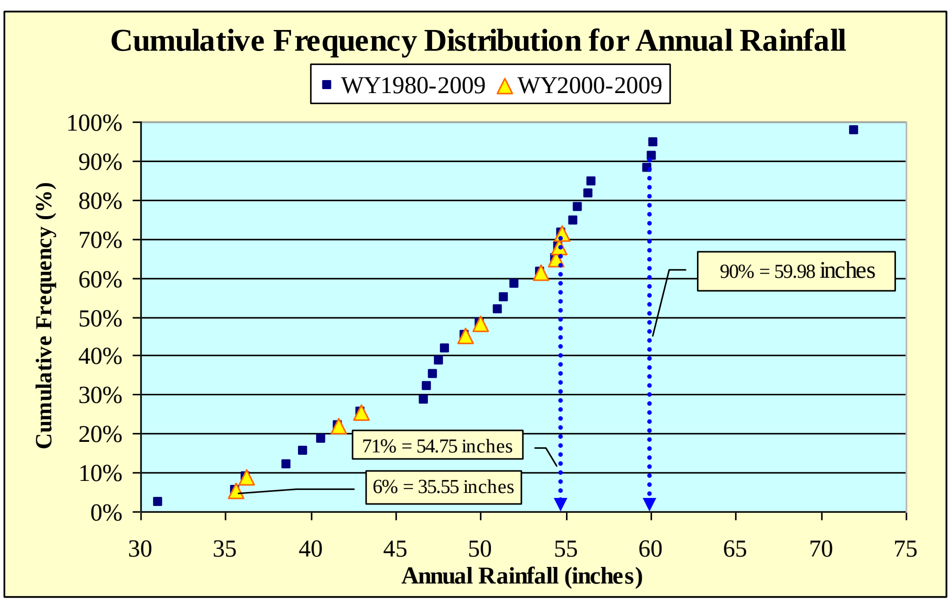
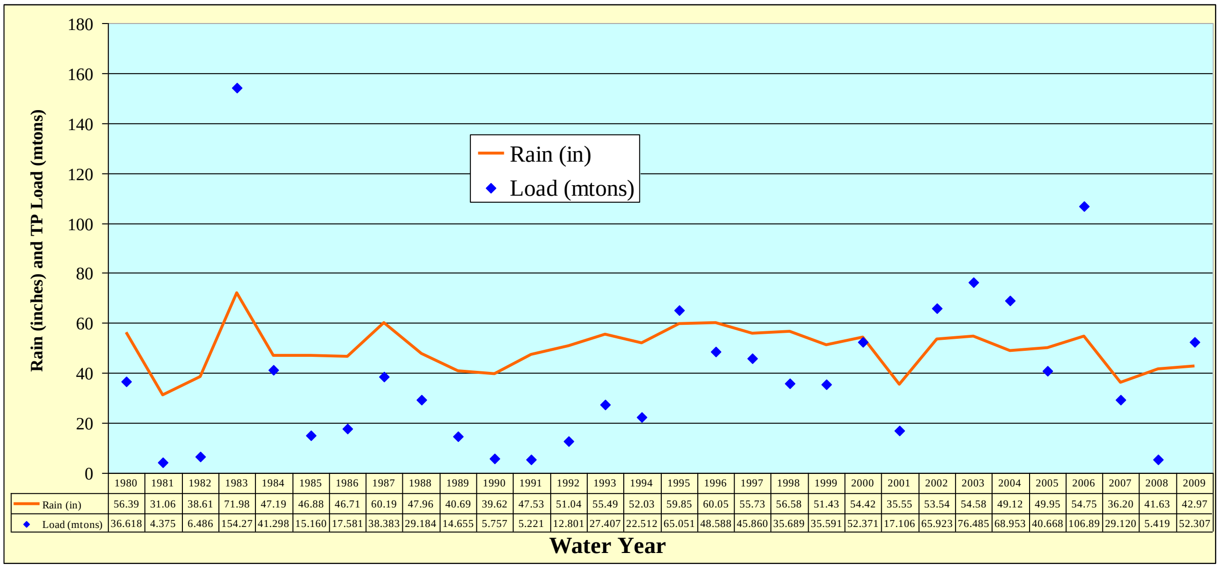


Figure 3-3. C-139 Basin Annual Rainfall and TP Loads.



	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Rain (in)	56.39	31.06	38.61	71.98	47.19	46.88	46.71	60.19	47.96	40.69	39.62	47.53	51.04	55.49	52.03
Load (mtons)	36.618	4.375	6.486	154.27	41.298	15.160	17.581	38.383	29.184	14.655	5.757	5.221	12.801	27.407	22.512

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rain (in)	59.85	60.05	55.73	56.58	51.43	54.42	35.55	53.54	54.58	49.12	49.95	54.75	36.20	41.63	42.97
Load (mtons)	65.051	48.588	45.860	35.689	35.591	52.371	17.106	65.923	76.485	68.953	40.668	106.89	29.120	5.419	52.307

3.4 Calculation of the Annual TP Load Target and Annual TP Load Limit

The existing C-139 Basin assessment methodology consists of an Annual Load Target and an Annual Load Limit, expressed as a function of the annual rainfall to account for hydrologic variability. The expressions for the Target and Limit are based on a regression equation expressing the observed relationship between annual TP loads and annual basin rainfall during the WY1980-1988 base period (Walker 2000a). For the Everglades Agricultural Area (EAA) basin, the TP load assessment method is based on the annual rainfall, but also incorporates the monthly distribution of rainfall (Rule 40E-63, F.A.C.). For the revised assessment method, relationships between basin TP loads and annual rainfall were examined, as in the existing assessment method, and also the relationship with the monthly distribution of rainfall was examined, as in the EAA method. Based on multiple metrics, including a lower standard error and the ability to explain a higher percentage of the variance in the TP load data, it was determined that the relationship based on both the monthly distribution of rainfall and total annual rainfall produced the better regression equation. With the observed shift in intra-annual rainfall since the base period, the use of a relationship including the monthly variability of rainfall is physically justified, in addition having the greater statistical power. For the period WY2000-WY2009, wet season rainfall has increased by 10% and dry season rainfall has decreased by 38%, compared to WY1980-1988 (Appendix A). Overall, the average annual rainfall for WY2000-WY2009 is approximately 2.39 inches (5%) less than the WY1980-1988 period. The following sections describe the derivation of the Annual Target and Annual Limit.

An Annual TP Load Target and an Annual TP Load Limit were derived by initially developing a multiple linear regression equation of the annual C-139 Basin TP load as a function of the annual rainfall and the monthly distribution of rainfall to account for hydrologic variability. The coefficient of variation of the monthly rainfall and the skewness of the monthly rainfall values were utilized in addition to the logarithm of the annual rainfall value as independent variables for the regression equation. The coefficient of variation is a measure of the variability of the monthly rainfall during the water year; a high coefficient of variation indicates high variability in the monthly values, while a low coefficient of variation indicates more uniform distribution of monthly rainfall. The skewness is a measure of the symmetry of the probability distribution of monthly rainfall during the Water Year, with a value of zero if each monthly rainfall value occurs with the same frequency; a positive skew reflects a probability distribution with a mean[7] value that is greater than the median, whereas a negative skew reflects a probability distribution with a mean value that is less than the median.

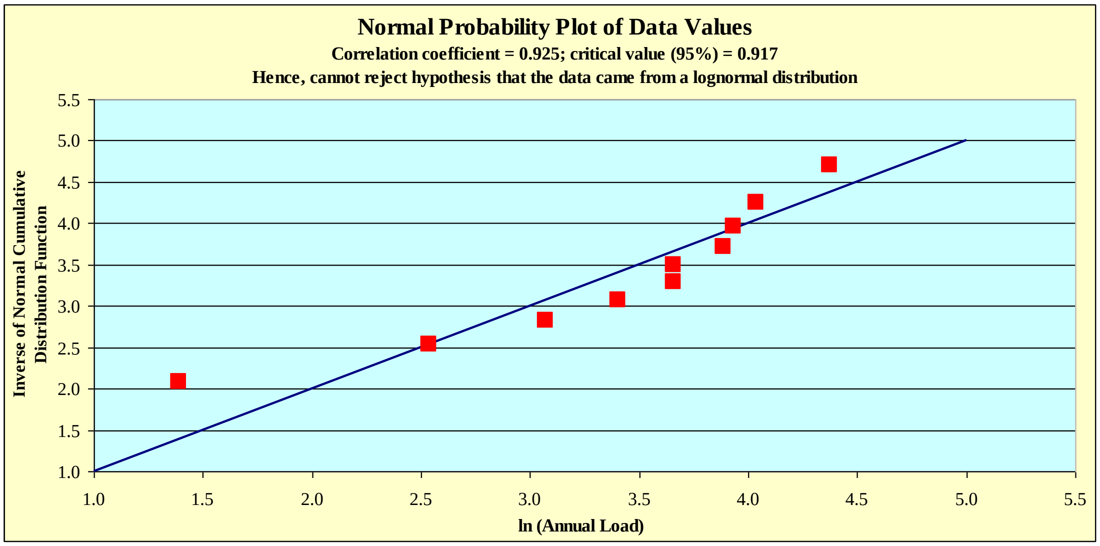
For the calibration period, WY2000-2009, the mean annual TP load was 51.5 mtons. To establish a load target that preserves the goal of the phosphorus control program of the EFA, the WY2000-2009 annual TP loads were scaled by a factor of 74.05%, such that the adjusted mean annual TP load was equivalent to the baseline period mean of 38.2 mtons. For the regression equation, natural logarithm transformations were used for both annual TP load and rainfall, and a May-April Water Year was used. The original and scaled data are presented in **Table 3-2**. **Figure 3-4** presents the normal probability plot for the annual TP loads, and the assumption of a normal distribution was confirmed at the 95% confidence level. The test statistic used in this determination was the correlation coefficient of the points that made up the normal probability plot (NIST/SEMATECH 2006). Since the test statistic was greater than critical value of the normal probability plot correlation coefficient, the null hypothesis that the data came from a population with a normal distribution was not rejected (Filliben 1975 and Devaney 1997).

Table 3-2. Summary of Rainfall and TP Load Data for the WY2000-2009 Calibration Period.

Water Year	Rainfall inches	TP Load mtons	Scaled TP Load mtons
2000	54.42	52.371	38.78
2001	35.55	17.106	12.67
2002	53.54	65.923	48.82
2003	54.58	76.485	56.64
2004	49.12	68.953	51.06
2005	49.95	40.668	30.11
2006	54.75	106.892	79.15
2007	36.20	29.120	21.56
2008	41.63	5.419	4.01
2009	42.97	52.307	38.73
Average	*47.27*	*51.524*	*38.15*

[7] The mean is the arithmetic average of the 12 monthly rainfall values; the median is the monthly rainfall value with 50% of the months having a lower value and 50% of the months having a greater value.

Figure 3-4. Normal Probability Plot for Log-transformed and Scaled Annual C-139 Basin TP Loads.



The resulting regression equation for the Annual TP Load Target is

$$\text{Target} = L_i = \exp\,(a + b_1X_i + b_2C_i + b_3S_i) \tag{1}$$

Predictors (X, C, S) are calculated from the first three moments (m_1, m_2, m_3) of the 12 monthly rainfall totals (r_i, i=1, 12, inches) for the current year:

$$m_1 = \text{Sum}\,[\,r_i\,] / 12$$

$$m_2 = \text{Sum}\,[\,r_i - m_1\,]^2 / 12$$

$$m_3 = \text{Sum}\,[\,r_i - m_1\,]^3 / 12$$

$$X_i = 1\text{n}\,(12\,m_1)$$

$$C_i = [\,(12/11)\,m_2]^{0.5} / m_1$$

$$S_i = (12/11)\,m_3 / (m_2)^{1.5}$$

where, Target_i is the Annual TP Load Target (mtons),

L_i = 12-month load attributed to C-139 Basin Runoff for the WY2000-2009 calibration period, scaled by 74.05% (metric tons),

a = the intercept of the regression line,

X_i = the natural logarithm of the 12-month total rainfall (inches),

C_i = the coefficient of variation calculated from 12 monthly rainfall totals,

S_i = the skewness coefficient calculated from 12 monthly rainfall totals,

b_1 = the regression coefficient for X_i

b_2 = the regression coefficient for C_i

b_3 = the regression coefficient for S_i

The variations in monthly rainfall depths for the WY2000-2009 calibration period that give rise to the values of the coefficient of variation (C) and skewness (S), are presented in **Figure 3-5.** Annual values of rainfall, TP load, C and S are presented in **Figure 3-6**. Applying the coefficients derived using the ordinary least squares method yields the expression for the Annual TP Load Target

$$\text{Annual Load Target} = \exp(-17.0124 + 4.5995\,X + 3.9111\,C - 1.0055\,S) \qquad (2)$$

The coefficient of determination (R^2) for the resulting equation was 0.742, with a standard error of 0.544 on the log-transformed data. While this indicates that factors in addition to the annual rainfall are contributing to the variations in C-139 Basin TP loads, the coefficients of the regression line were all significantly different from zero at the 90% confidence level, with P-values of 0.02, 0.01, 0.05 and 0.10 for the intercept and coefficients b_1, b_2 and b_3, respectively.

The Annual Load Limit was derived as the 90^th^ percentile confidence level above the prediction from Equation (1). The 90^th^ percentile confidence level is equivalent to the upper 80^th^ percentile prediction interval when used as an exceedance criterion, with an associated theoretical Type I error (i.e., false positive) rate of 10%. The Type I error rate is the probability that the assessment will <u>reject</u> the null hypothesis (i.e., a determination that the TP load does not meet the performance measure) when in reality the null hypothesis is true – the annual load meets the performance measure, and is therefore also known as the false positive rate. While this confidence level results in exceedance criteria that are more protective than generally considered in U.S. Environmental Protection Agency (USEPA) guidance methodology, the District and USEPA have established this precedence in permits issued for other discharges in the Everglades region, including the current 40E-63 Rule (USEPA 2002). In deriving the 90% confidence level on the Annual Load Target, the product of the appropriate t-statistic and an expression of the prediction's standard error (SE_p) is multiplied by the Annual Load Target, as expressed below:

$$TP_{i,90\%\,CL} = \text{Target} * \exp[\, t_{\alpha,n-4}\ SE_p \,] \qquad (3)$$

where $TP_{i,90\%CL}$ is the Annual Load Limit corresponding to the 90% confidence level,

Figure 3-5. Monthly Rainfall Distribution for Calibration Period WY2000-2009.

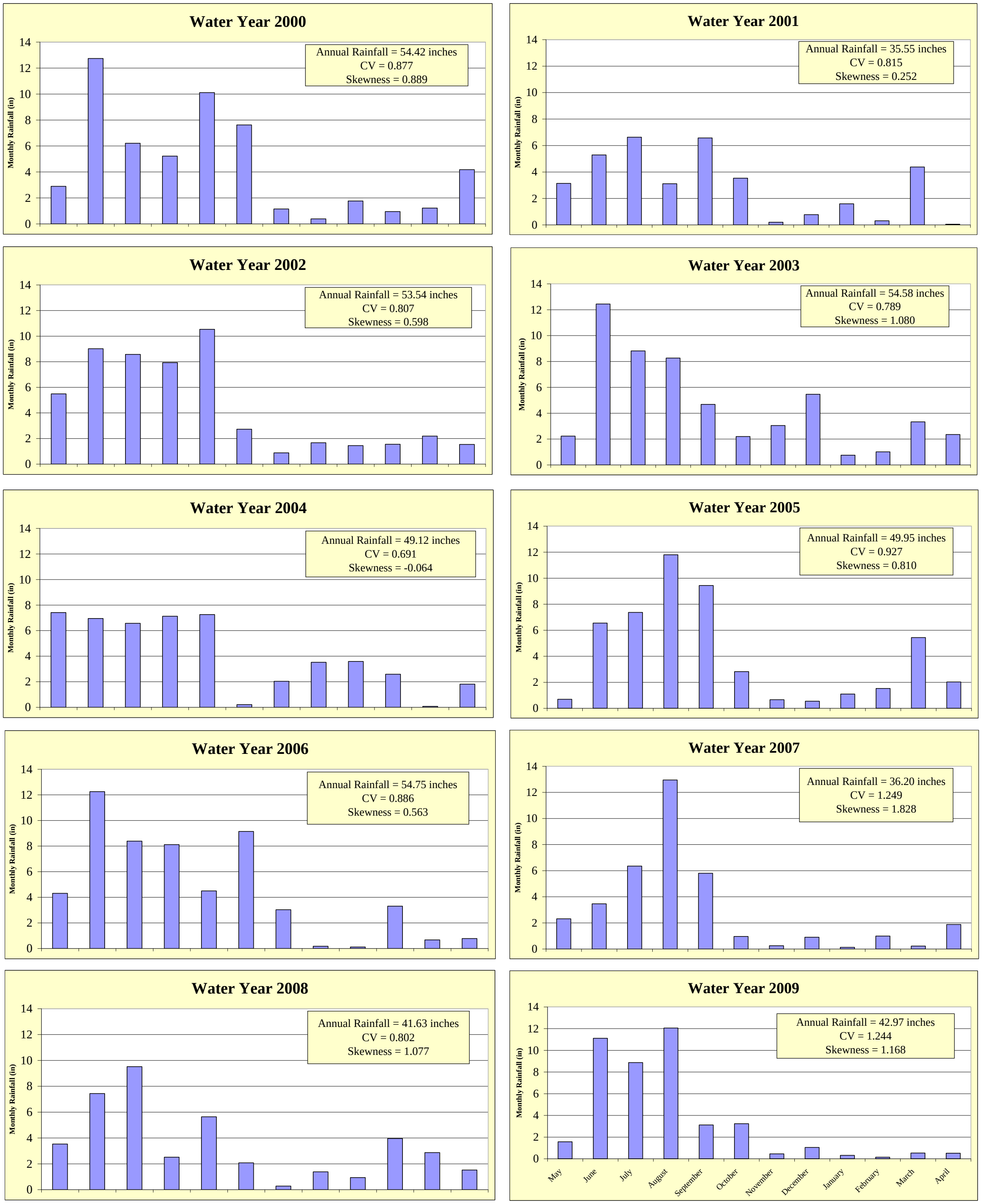
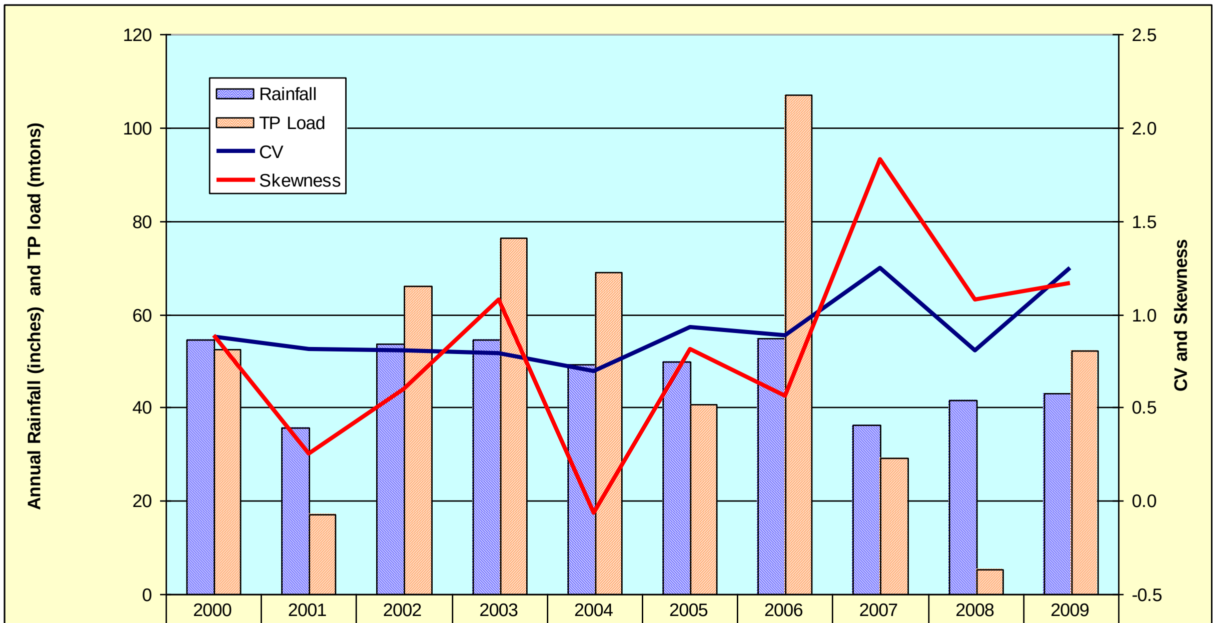


Figure 3-6. Annual Rainfall and TP Loads for Calibration Period WY2000-2009.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Rainfall	54.42	35.55	53.54	54.58	49.12	49.95	54.75	36.20	41.63	42.97
TP Load	52.37	17.11	65.92	76.49	68.95	40.67	106.89	29.12	5.42	52.31
CV	0.877	0.815	0.807	0.789	0.691	0.927	0.886	1.249	0.802	1.244
Skewness	0.889	0.252	0.598	1.080	-0.064	0.810	0.563	1.828	1.076	1.168

$t_{\alpha,n-4}$ is the value of the one-tailed t statistic at significance level α, with n-4 degrees of freedom (for 90% confidence level, α = 0.10), and
n is the number of annual TP loads in the calibration period (= 10)

The standard error of the prediction (SE_p) is comprised of the standard error of the regression equation and the standard error of the predicted mean value, expressed in the equation below (Haan 1977)

$$SE_p = s\left[1 + \frac{1}{n} + \mathrm{var}(b_1)\frac{(X_i - X_m)^2}{s^2} + \mathrm{var}(b_2)\frac{(C_i - C_m)^2}{s^2} + \mathrm{var}(b_3)\frac{(S_i - S_m)^2}{s^2} + 2\,\mathrm{cov}(b_1,b_2)\frac{(X_i - X_m)(C_i - C_m)}{s^2} + 2\,\mathrm{cov}(b_1,b_3)\frac{(X_i - X_m)(S_i - S_m)}{s^2} + 2\,\mathrm{cov}(b_2,b_3)\frac{(C_i - C_m)(S_i - S_m)}{s^2}\right]^{0.5}$$

Equation (4)

where s is the standard error of the regression equation,

$$X_m = \text{average value of the predictor in calibration period} = 3.8434$$

$$C_m = \text{average value of the predictor in calibration period} = 0.9087$$

S_m = average value of the predictor in calibration period = 0.8200

n = 10

$t_{\alpha,n-4}$ = 1.440

s = 0.5440

var(b_1) = 1.4353

var(b_2) = 2.4247

var(b_3) = 0.2737

cov(b_1,b_2) = 0.6800

cov(b_1,b_3) = -0.0536

cov(b_2,b_3) = -0.5926

Collecting terms, Eqn (4) becomes

$$SE_p = 0.5440\ [\ 1 + 1/10 + 4.8500\ (X\text{-}X_m)^2 + 8.1932\ (C\text{–}C_m)^2 + 0.9247\ (S\text{-}S_m)^2 + 4.5950\ (X\text{-}X_m)\ (C\text{–}C_m) – 0.3624\ (X\text{-}X_m)\ (S\text{-}S_m) – 4.0048\ (C\text{-}C_m)\ (S\text{-}S_m)\ ]^{0.5} \qquad (5)$$

The regression results are compared to the scaled annual load data in **Figure 3-7.**

An assumption inherent in the use of Equation (3) is that the residuals of the regression Equation (1) are normally distributed over the observed range of the annual rainfall values. The normality of the regression residuals was confirmed at the 95% confidence level (**Figure 3-8**).

Equations (2) and (3) can be used for each water year to calculate the Annual Load Target and Annual Load Limit as a function of the annual C-139 Basin rainfall that occurred during the water year by substituting the natural logarithm of the 12-month total rainfall for X_i, the coefficient of variation calculated from twelve monthly rainfall totals for C_i, and the skewness coefficient calculated from twelve monthly rainfall totals for S_i. A comparison of the proposed Annual TP Load Target and proposed Annual TP Load Limit for the C-139 Basin for the WY2000-2009 calibration period is presented in **Figure 3-9** and **Table 3-3.**

Figure 3-7. Regression Results for WY2000-2009 Calibration Period, Using Scaled Annual Loads.

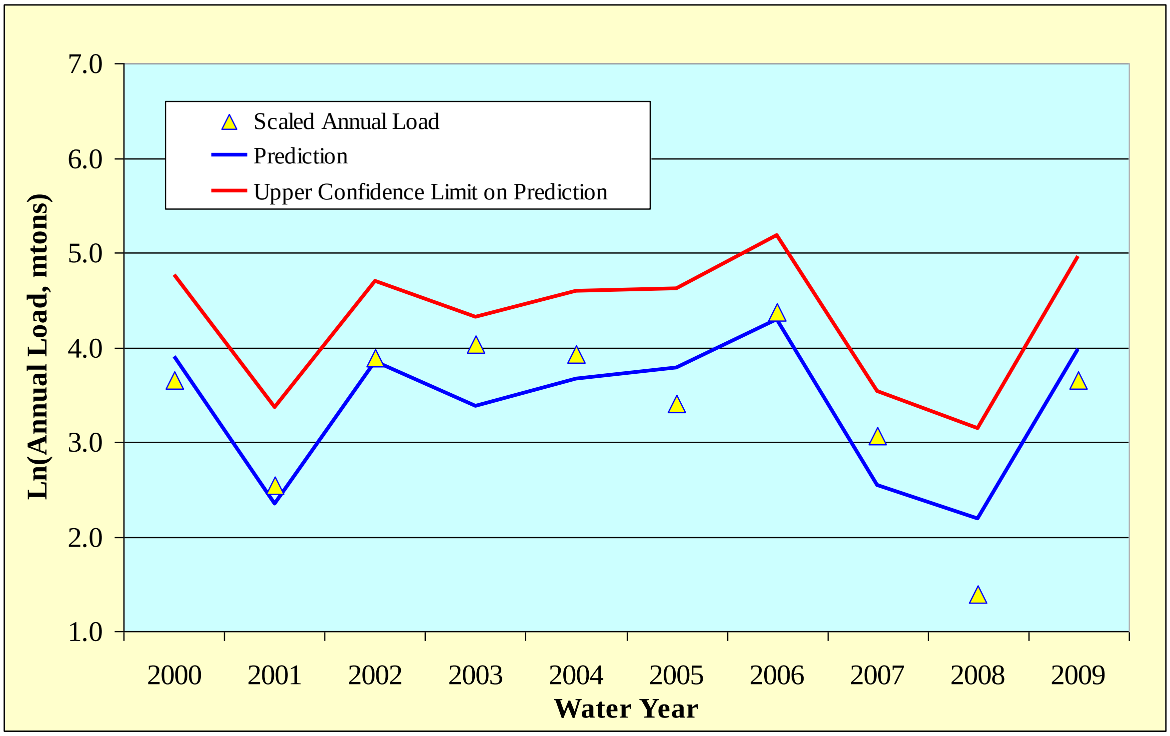
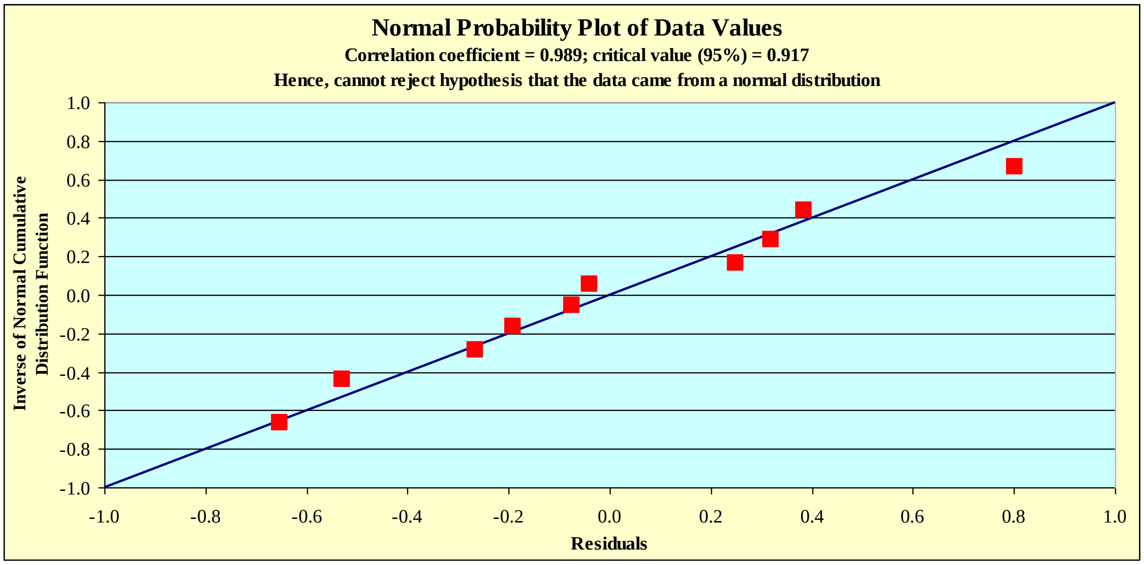


Figure 3-8. Normal Probability Plot of C-139 Basin Regression Residuals.



Assuming that the probability of the annual TP load being above the Annual TP Load Target is 50%, the probability that the C-139 Basin's discharge load is above the Target for three consecutive years is 12.5% (= 0.50 x 0.50 x 0.50). In other words, at an 87.5% confidence level, we can infer that the C-139 Basin is achieving its TP load target if the annual load does not exceed the Annual TP Load Target for three consecutive years. The 3-year assessment cycle approach was used in the existing basin assessment methodology. The use of a three-year cycle for the annual TP Load Target has a theoretical Type I error rate of 12.5%.

Figure 3-9. Comparison of TP Loads For the Calibration Period to the Existing and Proposed Annual Targets and Limits.

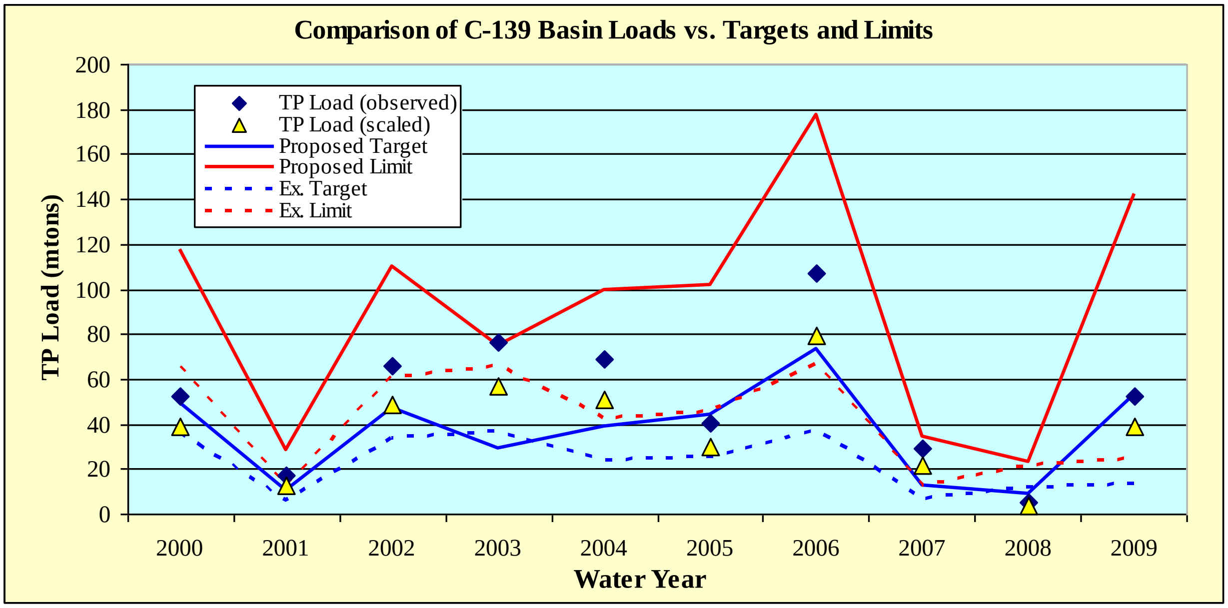


Table 3-3. Summary of Existing and Proposed Annual Targets and Limits.

Water Year	Rainfall inches	Coef. Of Variation CV	Skewness S	Ln(Rain) X	TP Load mtons	Scaled Load mtons	Proposed Target Load mtons	Proposed Limit Load mtons	Existing Target Load mtons	Existing Limit Load mtons
2000	54.42	0.877	0.889	3.997	52.37	38.781	49.74	117.69	36.33	65.18
2001	35.55	0.815	0.252	3.571	17.11	12.667	10.45	28.82	6.27	11.73
2002	53.54	0.807	0.598	3.980	65.92	48.816	47.02	110.02	33.96	60.82
2003	54.58	0.789	1.080	4.000	76.49	56.637	29.49	75.05	36.77	66.00
2004	49.12	0.691	-0.064	3.894	68.95	51.060	39.10	99.38	23.80	42.40
2005	49.95	0.927	0.810	3.911	40.67	30.115	44.15	101.57	25.51	45.45
2006	54.75	0.886	0.563	4.003	106.89	79.154	73.52	177.31	37.24	66.88
2007	36.20	1.249	1.828	3.589	29.12	21.563	12.71	34.48	6.76	12.57
2008	41.63	0.802	1.076	3.729	5.42	4.013	8.96	23.35	12.03	21.68
2009	42.97	1.244	1.168	3.761	52.31	38.733	53.25	142.61	13.71	24.60

3.5 Suspension of Performance Assessment

The performance assessment will be suspended due to extreme rainfall conditions if the discharges do not achieve the Annual TP Load Target described in Section 3.4. Extreme rainfall conditions will be assessed by calculating an adjusted rainfall amount which reflects the cumulative effect of the three variables that comprise the Load Target equation: X, C and S. The adjusted rainfall is the rainfall that would produce the equivalent annual load using the Load

Target equation (2) by setting the values of C and S to their mean values for the calibration period. The derivation of the equation for the adjusted rainfall is provided below.

$$\text{Annual Target Load} = \exp(-17.0124 + 4.5995\,X + 3.9111\,C - 1.0055\,S) \qquad (2)$$

Setting the Annual Target Load equal to the load using the mean values of C and S, and solving for the adjusted rainfall yields

$$\exp(-17.0124 + 4.5995\,X_{adj} + 3.9111\,C_m - 1.0055\,S_m) = \exp(-17.0124 + 4.5995\,X + 3.9111\,C - 1.0055\,S) \qquad (6)$$

$$4.5995\,X_{adj} + 3.9111\,C_m - 1.0055\,S_m = 4.5995\,X + 3.9111\,C - 1.0055\,S \qquad (7)$$

Collecting terms yields

$$4.5995\,X_{adj} - 4.5995\,X = 3.9111\,C - 3.9111\,C_m - 1.0055\,S + 1.0055\,S_m \qquad (8)$$

$$X_{adj} - X = 3.9111/4.5995\,(C - C_m) + (-1.0055/4.5995\,(S - S_m) \qquad (9)$$

Substituting $Ln(Rain_{adj})$ for X_{adj} yields

$$Ln(Rain_{adj}) - X = 0.8503\,(C - C_m) - 0.2186\,(S - S_m) \qquad (10)$$

$$Rain_{adj} = \exp[\,X + 0.8503\,(C - C_m) - 0.2186\,(S - S_m)] \qquad (11)$$

The calculated adjusted rainfall values for the WY1980-2009 period of record are summarized in **Table 3-4** below. The minimum adjusted rainfall of 27.97 inches for WY1981 corresponds to the minimum predicted Annual Target Load of 2.83 mtons. The maximum adjusted rainfall of 66.21 inches for WY1996 corresponds to the maximum predicted Annual Target Load of 148.76 mtons. Hence, the annual performance assessment will be suspended if the adjusted rainfall is outside the range of 27.97 to 66.21 inches and the basin discharge does not achieve the Annual TP Load Target.

3.6 Exceedance Frequency Analyses

The performance assessment methodology for discharges from the C-139 Basin is composed of two parts:

1. an Annual TP Load Target;
2. an Annual TP Load Limit.

The performance assessment will be suspended if the adjusted rainfall for the Water Year is outside the range of 27.97 to 66.21 inches and the actual measured TP loading exceeds the Annual TP Load Target.

Table 3-4. Annual Summary of Adjusted Rainfall.

WY	Rainfall	X = Ln(Rain)	C-Cm	S-Sm	Target Load	$Rain_{adj}$
1980	56.39	4.0323	-0.2667	0.3160	18.23	41.95
1981	31.06	3.4359	-0.1927	-0.2710	2.83	27.97
1982	38.61	3.6535	-0.1087	-0.1110	9.10	36.07
1983	71.98	4.2764	-0.1357	0.2520	99.70	60.70
1984	47.19	3.8542	-0.1397	0.4770	11.23	37.76
1985	46.88	3.8476	-0.0767	-0.4650	35.94	48.62
1986	46.71	3.8440	-0.0727	0.0040	22.40	43.87
1987	60.19	4.0975	-0.0467	0.2610	61.47	54.64
1988	47.96	3.8704	-0.2457	-0.1430	14.91	40.15
1989	40.69	3.7060	0.1363	0.3900	18.24	41.96
1990	39.62	3.6793	-0.1657	-0.4660	11.71	38.10
1991	47.53	3.8614	-0.1417	-0.2130	23.04	44.14
1992	51.04	3.9326	-0.2717	-0.4640	24.76	44.84
1993	55.49	4.0162	0.0273	0.5300	43.10	50.58
1994	52.03	3.9518	-0.3567	-0.6700	23.86	44.48
1995	59.85	4.0918	-0.3827	-0.3610	30.08	46.77
1996	60.05	4.0952	-0.0337	-0.5780	148.76	66.21
1997	55.73	4.0205	-0.1597	-0.6420	68.75	55.98
1998	56.58	4.0357	-0.3857	-0.8310	36.83	48.88
1999	51.43	3.9402	-0.0467	-0.1960	47.21	51.59
2000	54.42	3.9967	-0.0317	0.0690	49.74	52.18
2001	35.55	3.5709	-0.0937	-0.5680	10.45	37.17
2002	53.54	3.9804	-0.1017	-0.2220	47.02	51.55
2003	54.58	3.9997	-0.1197	0.2600	29.49	46.57
2004	49.12	3.8943	-0.2177	-0.8840	39.10	49.52
2005	49.95	3.9110	0.0183	-0.0100	44.15	50.84
2006	54.75	4.0028	-0.0227	-0.2570	73.52	56.81
2007	36.20	3.5891	0.3403	1.0080	12.71	38.79
2008	41.63	3.7288	-0.1067	0.2560	8.96	35.95
2009	42.97	3.7605	0.3353	0.3480	53.25	52.96

The basin is assumed to be in compliance if the following conditions are met

1. The annual TP load is less than or equal to the Annual TP Load Target.

Or if both of the following conditions are met:

1. The annual TP load is less than or equal to the Annual TP Load Limit, and
2. The annual TP load is less than or equal to the Annual TP Load Target at least once in three successive years. Any period(s) for which the performance assessment is suspended due to an adjusted rainfall outside the range of 27.97 to 66.21 inches will be excluded from the determination of whether the Target has been exceeded in three or more consecutive May 1 through April 30 periods.

Since the assessment method contains two components that are applied simultaneously, the cumulative exceedance frequency for the method is greater than the exceedance frequencies of the individual components. An approximation of the cumulative exceedance frequency for the assessment methodology was estimated using a Monte Carlo approach based on the annual rainfall and the annual TP loads of the calibration period (WY2000-2009). A 10,000-year set of annual rainfall data was created that corresponded to the lognormal distribution described by the mean and standard deviation of the rainfall observed during the calibration period.[8] A 10,000-year set of annual rainfall Coefficients of Variation and Skewness values was also created that corresponded to the normal distributions described by the respective mean and standard deviation of those parameters for the calibration period.[9] A 10,000-year set of annual TP load residuals was then created that corresponded to the normal distribution described by the mean and standard deviation of the residuals observed by comparing the loads predicted using regression equation No. (2) and the actual Ln(loads) during the calibration period.[10] Finally, 10,000 years of annual TP load were generated by adding the calculated annual residual to the annual load calculated using regression equation No. (2). The 10,000 years of annual TP loads were then compared to the Annual Load Target and the Annual Load Limit, and the cumulative exceedance frequency was calculated.

Using the 10,000-year synthetic data sets described above, the cumulative exceedance frequency of the assessment methodology was calculated to be 11.0% (**Table 3-5**). Because the TP loads and rainfall from the WY2000-2009 calibration period do not perfectly describe lognormal distributions (e.g., the medians are generally less than the means), and because the random number generator is imperfect, the exceedance frequencies deviate from the theoretical values shown in the second column of **Table 3-5**.

Table 3-5. Exceedance Frequencies for the Proposed Assessment Methodology.

Component of Compliance Assessment	Theoretical Exceedance Fequency	Calculated Exceedance Frequency
Step 1. Annual load > Target Load	50%	49.5%
Step 2. Suspend assessment if Radj is outside the range of 27.97- 66.21 inches and Annual load > Target Load	<5%	3.5%
Step 3. Load > Target for 3 consecutive years	*<12.5%*	10.2%
Step 4. Load > Limit	<5%	1.6%
Cumulative Exceedance Frequency	**<17.5%**	**11.0%**

[8] The Excel random number generator was used to populate the 10,000-year synthetic record of annual rainfall values, with the mean and standard deviation matching the WY2000-2009 calibration period values to within 0.001 units.
[9] The Excel random number generator was used to populate the 10,000-year synthetic record of annual CV and Skewness values, with the mean and standard deviation matching the WY2000-2009 calibration period values to within 0.001 units, and minimum and maximum values matching the calibration period values.
[10] The Excel random number generator was used to populate the 10,000-year synthetic record of annual residuals values, with the mean and standard deviation matching the WY2000-2009 calibration period values to within 0.001 units.

4. ASSESSMENT OF TOTAL PHOSPHORUS LOAD PERFORMANCE MEASURE

Annual C-139 Basin TP loads will be assessed annually against the performance measures established in Section 3.4 and 3.5: the Annual Load Target and the Annual Load Limit. This assessment will be performed using data collected through April 30, a date that corresponds generally with the change from the dry to the wet rainfall seasons. Hydrology, specifically discharge and rainfall, is a dominant factor when computing TP loads. Because rainfall and discharge are subject to large temporal and spatial variation in south Florida, the performance assessment methodology adjusts the TP load for hydrologic variability.

The adjustment for hydrologic variability includes two components:

1. **A model to estimate future TP loads.** The model estimates a future TP load from the C-139 Basin rainfall characteristics by substituting future hydrologic conditions for the conditions that occurred during the calibration period (WY2000-2009), adjusting the observed annual loads by 74.05% so the average annual TP load equals the average annual TP load of the base period (WY1980-1988). The estimation is based on hydrologic data collected for any time period of May 1-April 30 subsequent to the calibration period.

2. **Accommodation for possible statistical error in the model.** Statistical error in the model was accounted for by specifying a required level of statistical confidence in the prediction of the long-term average TP load. The 90th percentile confidence level was selected as reasonable.

Assessment of the C-139 Basin for TP load performance measures will be based upon the following:

1. If the actual measured TP loading from the C-139 Basin in a post-baseline May 1 through April 30 period is less than or equal to the model TP load estimate (Target), then the C-139 Basin will be determined to meet its performance measure, that is, it will have not exceeded the collective average annual phosphorus loading that would have occurred during the baseline period adjusted for hydrologic variability.

2. Suspension of Assessment for Extreme Rainfall
   The performance assessment will be suspended if the adjusted rainfall for the May 1 through April 30 Water Year is outside the range of 27.97 to 66.21 inches and the actual measured TP loading exceeds the Target in any May 1 through April 30 period.

3. If the measured TP loading from the C-139 Basin exceeds the Targets in three or more consecutive May 1 through April 30 periods, and if assessment is not suspended due to extreme rainfall for the May 1 through April 30 Water Year, the C-139 Basin will be determined to have not met its performance measure, that is, it will have exceeded the collective average annual phosphorus loading that would have occurred during the baseline period adjusted for hydrologic variability. Any period(s) for which the performance assessment is suspended will be excluded from the determination of whether

the Target has been exceeded in three or more consecutive May 1 through April 30 periods.

4. If the actual measured TP loading exceeds the Limit in any May 1 through April 30 period, and if assessment is not suspended due to extreme rainfall for the May 1 through April 30 Water Year, the C-139 Basin will be determined to have not met its performance measure, that is, it will have exceeded the collective average annual phosphorus loading that would have occurred during baseline period adjusted for hydrologic variability.

5. The Annual TP Load Target and Annual TP Load Limit will be calculated according to the following equations and explanation.

   Annual Load Target = exp (-17.0124 + 4.5995 X + 3.9111 C – 1.0055 S)

   Explained Variance = 74.2%, Standard Error of Estimate = 0.5440

   Where X_i = the natural logarithm of the twelve-month total rainfall (inches),

   C_i = the coefficient of variation calculated from twelve monthly rainfall totals,

   S_i = the skewness coefficient calculated from twelve monthly rainfall totals,

   Limit = upper 90% confidence limit for Target (metric tons/yr)

   Limit = Target exp (1.440 SE_p)

   SE_p = standard error of predicted ln(Target) for May-April interval

   $$SE_p = 0.5440\ [\ 1 + 1/10 + 4.8500\ (X-X_m)^2 + 8.1932\ (C–C_m)^2 + 0.9247\ (S-S_m)^2 + 4.5950\ (X-X_m)\ (C–C_m) – 0.3624\ (X-X_m)\ (S-S_m) – 4.0048\ (C-C_m)\ (S-S_m)\ ]^{0.5}$$

7. The adjusted rainfall will be calculated according to the following equation and explanation.

   $$Rain_{adj} = \exp\ [X_i + 0.8503\ (C_i - C_m) – 0.2186\ (S_i - S_m)]$$

   Where X_i = the natural logarithm of the twelve-month total rainfall (inches),

   C_i = the coefficient of variation calculated from twelve monthly rainfall totals,

   C_m = the average coefficient of variation of the calibration period (0.9087),

   S_i = the skewness coefficient calculated from twelve monthly rainfall totals, and

   S_m = the average skewness of the calibration period (0.8200).

Upstream monitoring implemented by the District at a sub-basin level is not utilized in determination of compliance of the C-139 Basin. The body of this document supports performance measurement of the basin as a whole and does not provide the technical support for assessment of phosphorus loads at the sub-basin level. **Appendix E** contains annual performance measure computation examples for sub-basins within the C-139 Basin based upon the proposed text of Rule 40E-63 Appendix B3.

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APPENDIX A. C-139 BASIN RAINFALL VALUES

WY	Dry		Wet		Total	
	Load, mton	Rain, in	Load, mton	Rain, in	Load, mton	Rain, in
1980	7.87	21.90	28.75	34.49	36.62	56.39
1981	1.32	8.35	3.05	22.70	4.38	31.06
1982	1.01	13.33	5.47	25.28	6.49	38.61
1983	10.60	19.16	143.68	52.82	154.28	71.98
1984	3.39	14.09	37.91	33.11	41.30	47.19
1985	0.67	13.79	14.49	33.09	15.16	46.88
1986	0.93	11.56	16.65	35.15	17.58	46.71
1987	1.57	15.51	36.82	44.68	38.38	60.19
1988	20.03	18.76	9.15	29.19	29.18	47.96
1989	0.93	12.63	13.73	28.06	14.65	40.69
1990	0.59	7.72	5.17	31.89	5.76	39.62
1991	1.65	17.03	3.57	30.51	5.22	47.53
1992	1.07	14.12	11.73	36.92	12.80	51.04
1993	1.49	15.95	25.92	39.54	27.41	55.49
1994	2.12	15.91	20.39	36.13	22.51	52.03
1995	26.25	21.21	38.81	38.64	65.05	59.85
1996	2.38	9.09	46.21	50.96	48.59	60.05
1997	3.95	12.58	41.91	43.16	45.86	55.73
1998	13.73	23.56	21.96	33.02	35.69	56.58
1999	15.36	16.38	20.23	35.05	35.59	51.43
2000	4.97	9.64	47.40	44.79	52.37	54.42
2001	1.05	7.29	16.05	28.26	17.11	35.55
2002	4.53	9.27	61.39	44.27	65.92	53.54
2003	9.23	15.95	67.25	38.63	76.49	54.58
2004	1.27	13.61	67.69	35.51	68.95	49.12
2005	3.18	11.29	37.49	38.66	40.67	49.95
2006	17.11	8.07	89.78	46.68	106.89	54.75
2007	0.05	4.37	29.07	31.83	29.12	36.20
2008	0.61	10.93	4.81	30.70	5.42	41.63
2009	0.33	3.01	51.98	39.96	52.31	42.97
WY80-09 Ave.	5.31	13.20	33.95	36.46	39.26	49.66
WY80-88 Ave.	5.27	15.16	32.89	34.50	38.15	49.66
WY00-09 Ave.	4.23	9.34	47.29	37.93	51.52	47.27
Difference	-20%	-38%	44%	10%	35%	-5%

APPENDIX B. C-139 BASIN ORIGINAL ANNUAL VALUES

Water Year	Old Data			
	Rainfall in	Runoff AF	TP Load kg	TP Conc ppb
1980	56.39	171,537	34,673	164
1981	31.06	51,203	4,143	66
1982	38.61	43,883	6,141	113
1983	71.98	344,458	148,059	348
1984	47.19	155,622	40,351	210
1985	46.88	63,107	14,616	188
1986	46.71	110,301	17,028	125
1987	60.19	149,284	37,739	205
1988	47.96	93,914	28,150	243
1989	40.69	72,812	14,164	158
1990	39.62	45,644	5,476	97
1991	47.53	45,340	4,991	89
1992	51.04	99,786	12,267	100
1993	55.49	137,292	26,276	155
1994	52.03	136,472	21,750	129
1995	59.85	272,252	61,891	184
1996	60.24	235,762	48,478	167
1997	55.74	164,535	45,855	226
1998	56.65	169,934	35,576	170
1999	51.92	135,795	35,569	212
2000	54.46	201,733	52,353	210
2001	35.70	56,493	17,143	246
2002	54.23	199,675	65,907	268
2003	55.40	224,419	77,271	279
2004	49.90	203,945	69,014	274
2005	50.68	167,464	40,275	195
2006	53.79	333,235	106,896	260
2007	36.85	77,273	29,123	306
2008	41.95	38,768	5,419	113
Minimum	**31.06**	**38,768**	**4,143**	**66**
Median	**51.04**	**137,292**	**34,673**	**188**
Average	**50.02**	**144,894**	**38,158**	**190**
Maximum	**71.98**	**344,458**	**148,059**	**348**

APPENDIX C. C-139 BASIN REVISED ANNUAL VALUES

Water Year	New Data			
	Rainfall in	Runoff AF	TP Load kg	TP Conc ppb
1980	56.39	171,537	36,618	173
1981	31.06	51,203	4,375	69
1982	38.61	43,883	6,486	120
1983	71.98	344,459	154,278	363
1984	47.19	155,622	41,298	215
1985	46.88	63,107	15,160	195
1986	46.71	110,301	17,581	129
1987	60.19	149,284	38,383	208
1988	47.96	93,914	29,184	252
1989	40.69	72,812	14,655	163
1990	39.62	45,644	5,757	102
1991	47.53	45,340	5,221	93
1992	51.04	99,786	12,801	104
1993	55.49	137,292	27,407	162
1994	52.03	136,472	22,512	134
1995	59.85	272,252	65,051	194
1996	60.05	235,759	48,588	167
1997	55.73	164,531	45,860	226
1998	56.58	169,928	35,689	170
1999	51.43	135,793	35,591	212
2000	54.42	201,726	52,371	210
2001	35.55	56,491	17,106	245
2002	53.54	199,671	65,923	268
2003	54.58	224,419	76,485	276
2004	49.12	203,934	68,953	274
2005	49.95	167,454	40,668	197
2006	54.75	333,225	106,892	260
2007	36.20	77,271	29,120	306
2008	41.63	38,737	5,419	113
2009	42.97	165,357	52,307	256
Minimum	**31.06**	**38,737**	**4,375**	**69**
Median	**50.50**	**143,288**	**35,640**	**196**
Average	**49.66**	**145,573**	**39,258**	**195**
Maximum	**71.98**	**344,459**	**154,278**	**363**

APPENDIX D. OUTLIER ANALYSIS

Outlier detection analyses were conducted to assist in determining the appropriate calibration period. Examination of the annual basin rainfall, TP loads and the ratio between runoff volume and rainfall for WY2000 through WY2009 indicated no temporal trends, and with one exception, no outliers using the 3-sigma, Hampel Identifier and Maximum Normal Residual outlier detection methods (Table 3-1) (Struble 2008, Davies and Gather 1993, Snedecor and Cochran 1989). Using the Hampel Identifier method, the runoff-to-rainfall ratio for WY2001, WY2006 and WY2008 were identified as outliers, however, this outlier detection method is typically applied to sample sizes of ten or more, and the results may be questionable for this example with a sample size of just ten. In addition, the Hampel identifier is “Sometimes prone to finding too many outliers” (Struble 2008). In light of the preponderance of evidence, including the results from the more rigorous Maximum Normal Residual outlier detection method, and a strong reluctance to discard data without a clear physical rationale to do so, it was determined that no outliers were present in the annual data set, and WY2009 was selected as the ending water year of the calibration period. A description of each method and the results are presented below.

1. 3-sigma Method (Struble 2008)

This test evaluates whether individual values are outliers by comparison of the residual, defined as the absolute value (mean – value). If (residual) > 3 times the standard deviation, then the value is considered an outlier. However, this test is considered a weak test since both the mean and standard deviation are influenced by the individual values.

2. Hempel Identifier (Davies and Gather 1993 pp. 782-792)

This test evaluates whether individual values are outliers by comparison of the residual, defined as the absolute value (median – value), to the median absolute deviation (mad). A value is considered an outlier if

residual > 5.2 * mad

This test is more robust than the three-sigma test since it uses the median based on rank order, which is not influenced by the extreme values. Typically this test is applied to sample sizes of ten or more, and is applied with caution to this example with a sample size of just ten. However, it is “Sometimes prone to finding too many outliers” (Struble 2008).

3. Maximum Normal Residual, or MNR (Snedecor and Cochran 1989, page 279)

Residual = absolute value (mean – annual value)

MNR = maximum residual / sqrt (sum of square of residuals)

If MNR > critical value, then the year with the maximum residual is an outlier. The critical value is a function of the sample size and the confidence level (= 1- significance level). Table A 15 below contains the critical values (from Snedecor and Cochran 1989).

TABLE A 15
(*i*) SIGNIFICANCE LEVELS OF THE MAXIMUM NORMED RESIDUAL $\max|X - \bar{X}|/\sqrt{\Sigma(X-\bar{X})^2}$ FOR A NORMAL SAMPLE. (*ii*) SIGNIFICANCE LEVELS OF $\max|d|/\sqrt{\Sigma d^2}$, WHERE *d*S ARE NORMAL AND INDEPENDENT

Size of Sample	5% level		1% level	
n	(*i*) MNR	(*ii*) MNR	(*i*) MNR	(*ii*) MNR
5	0.858	0.917	0.882	0.963
6	.844	.884	.882	.940
7	.825	.853	.873	.915
8	.804	.824	.860	.891
9	.783	.799	.844	.869
10	.763	.776	.827	.847
11	.745	.755	.811	.827
12	.727	.736	.795	.808
13	.711	.718	.779	.790
14	.695	.701	.764	.774
15	.681	.686	.750	.758
16	.668	.672	.737	.744
17	.655	.659	.724	.730
18	.643	.647	.711	.717
19	.632	.635	.700	.704
20	.621	.624	.688	.693
22	.602	.604	.668	.671
24	.584	.586	.649	.652
26	.568	.570	.632	.634
28	.554	.555	.616	.618
30	0.540	.541	0.601	.603
35		.512		.564
40		.4.87		.542
60		.417		.464
120		0.316		0.350

Reproduced, with permission, from W. von Türk (formerly Stefansky), *Technometrics* 14 (1972):475–76.

Results of Outlier Detection Analyses

Parameter	Unit	Water Year 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TP Load	mtons	52.371	17.106	65.923	76.485	68.953	40.668	106.892	29.120	5.419	52.307
Rainfall (R)	inches	54.42	35.55	53.54	54.58	49.12	49.95	54.75	36.20	41.63	42.97
Runoff (RO)	inches	14.30	3.99	14.15	15.89	14.43	11.86	23.58	5.46	2.72	11.71
RO: R Ratio		0.263	0.112	0.264	0.291	0.294	0.237	0.431	0.151	0.065	0.273
TP Load Outlier Analysis											
Residual based on mean		0.847	34.418	14.399	24.961	17.429	10.856	55.368	22.404	46.105	0.783
Residual based on median		0.032	35.233	13.584	24.146	16.614	11.671	54.553	23.219	46.920	0.032
3-sigma outlier?		No	No	No	No	No	No	No	No	No	No
Hampel Identifier outlier?		No	No	No	No	No	No	No	No	No	No
Squares of residuals		0.717	1184.626	207.320	623.032	303.756	117.861	3065.571	501.957	2125.708	0.612
MNR outlier?		No	No	No	No	No	No	No	No	No	No
Rainfall Outlier Analysis											
Residual based on mean		7.15	11.72	6.27	7.31	1.85	2.68	7.48	11.07	5.64	4.30
Residual based on median		4.89	13.99	4.01	5.05	0.41	0.42	5.22	13.34	7.90	6.57
3-sigma outlier?		No	No	No	No	No	No	No	No	No	No
Hampel Identifier outlier?		No	No	No	No	No	No	No	No	No	No
Squares of residuals		51.108	137.382	39.300	53.421	3.419	7.177	55.935	122.567	31.821	18.499
MNR outlier?		No	No	No	No	No	No	No	No	No	No
Runoff:Rainfall Ratio Outlier Analysis											
Residual based on mean		0.02	0.13	0.03	0.05	0.06	0.00	0.19	0.09	0.17	0.03
Residual based on median		0.00	0.15	0.00	0.03	0.03	0.03	0.17	0.11	0.20	0.01
3-sigma outlier?		No	No	No	No	No	No	No	No	No	No
Hampel Identifier outlier?		No	Yes	No	No	No	No	Yes	No	Yes	No
Squares of residuals		0.001	0.016	0.001	0.003	0.003	0.000	0.037	0.008	0.030	0.001
MNR outlier?		No	No	No	No	No	No	No	No	No	No

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APPENDIX E.

GUIDANCE DOCUMENT FOR PERFORMANCE MEASURE DETERMINATION IN ACCORDANCE WITH THE PROPOSED AMENDMENTS TO APPENDIX B3 OF PART IV OF40E-63, FLORIDA ADMINISTRATIVE CODE

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Introduction

This document clarifies the procedures for performance measure determination for Sub-basins and permit basins. In particular, it provides examples in response to questions asked at the February 17, 2010, rule development workshop in Clewiston, FL.

The draft amendment to Part IV of 40E-63, F.A.C., expands the Proportional Share assessment from permit basins to District-determined Sub-basins, and provides for a determination of impracticability under which permittees can discharge above their proportional share of the load in accordance with site-specific limits. Accordingly, the procedures for determination of performance measures under these amendments have been revised in Appendix B3, specifically:

- Proportional Share calculation based upon C-139 Basin Target and Limit
- Sub-basin and Permit Basin observed load and unit area load (UAL) calculation
- Adjustment of observed loads and UALs resulting in Assigned UALs
- Evaluation for meeting or exceeding the Proportional Share
- Deferral or % Required Reduction determination

This document provides examples using hypothetical water year results for illustrative purposes only. They do not represent historical or anticipated load levels for the C-139 Basin or its Sub-basins.

C-139 Basin Annual Water Year Evaluation Steps

For each water year, the District shall perform the following steps and report the results:

Step 1: Evaluate C-139 Basin Performance

Step 2: Evaluate Primary Sub-basin Performance

Step 3: Compute Sub-basin Adjustment Factor

Step 4: Compute Secondary Sub-basin Assigned Loads

Step 5: Evaluate Secondary Sub-basin Performance

Step 6: Compute Tertiary Sub-basin Assigned Loads

Step 7: Evaluate Tertiary Sub-basin Performance

Step 8: Compute Permit Basin Assigned Loads

Step 9: Evaluate Permit Basin Performance

Step 10: Compute Percent Required TP Reductions

Steps two through ten will only be conducted when the District determines that the data are valid or sufficiently complete. If data are not, the evaluation of Sub-basin, or Permit Basin performance will not be completed at that level, and the preceding level data will be used (e.g., Primary Sub-basin data will be used if Secondary Sub-basin data are not available.)

C-139 Basin Level Results

If the District determines that the C-139 Basin is out of compliance with its load performance measure, in accordance with the Everglades Forever Act, remedial action is based on the landowners' proportional share of loading.

A new definition introduced in the proposed amendments to determine the landowners' proportional share of the loading is "Assigned UAL". The Assigned UAL is the observed phosphorus load per unit area (lbs/acre) based on a valid or sufficiently complete data set, as adjusted by the District that is assigned to a Sub-basin or Permit Basin. The examples provided in this Guidance Document illustrate how the Assigned UAL is calculated and assigned under different scenarios.

The proportional share of loading for which landowners are evaluated depends on whether the determination was based on the Target and/or Limit results. The Proportional Share Unit Area Load is based on the total C-139 Basin acreage and is assumed to be distributed equally over the entire C-139 Basin.

The water year's annual and monthly rainfall values are used with equations provided in Appendix B2 to compute the annual Target and Limit values for the C-139 Basin.

- If the basin is out of compliance as a result of exceeding the Limit any one year (excluding suspension due to rainfall), the Proportional Share UAL is that year Limit UAL. The Assigned UAL for Sub-basins and Permit basins would be compared to this Proportional share UAL.
- If the basin is out of compliance as a result of exceeding the Target three consecutive years (excluding suspension due to rainfall), the Proportional Share UAL is the average of the three Target UAL values calculated for the three water years. The three-year

average Assigned UAL for Sub-basins and Permit basins would be compared to this Proportional share UAL.

The examples presented in this document, assume that the C-139 Basin is out of compliance based on a single year exceedance of the Limit. The basin level Limit UAL is compared to the single year Assigned UAL at the Sub-basin and Permit Basin levels as described herein.

The following example is based upon a Limit of 92 mtons, which is carried throughout this document.

<u>Example</u>

Step 1: Evaluate C-139 Basin Performance

C-139 Basin Observed Load	=	108 mtons – *out of compliance*
C-139 Basin Limit Load	=	92 mtons
	=	202,200 lbs
C-139 Basin Acres	=	168,450 acres
Proportional Share UAL (Limit UAL in this case)	=	1.20 lbs/acre

If the C-139 Basin collective discharge for the water year is less than or equal to the Limit of 92 mtons, then the basin is in compliance. In this example the C-139 Basin discharge is greater than 92 mtons and the C-139 Basin is out of compliance with its load performance measure. Subsequent analysis is required to determine required action.

Sub-basin Results

Calculations will be made annually to estimate the load attributable to each Sub-basin and Permit Basin within the C-139 Basin. When the C-139 Basin is deemed out of compliance, these computed loads shall be used to determine where additional water quality improvement activities are required.

Permit Basin loads will be used to determine required action, but only if the Primary, Secondary, and Tertiary Sub-Basins are determined to exceed the Proportional Share UAL.

Primary Sub-basins

Primary Sub-basin loads are measured at the C-139 Basin discharge structures and the G-150 structure dividing the L1 and L2 canals. The loads of the Primary Sub-basins will always match the C-139 Basin total load, so no adjustment is made to Primary Sub-basin loads or Observed UAL values.

Example

Step 2: Evaluate Primary Sub-basin Performance

Primary Sub-basin	Observed Load (mtons)	Area (acres)	Observed UAL (lbs/acre)	Proportional Share UAL (lbs/acre) [1]	Meets or Exceeds Proportional Share UAL
L1	10	23,165	0.95	1.20	Meets
L3	98	145,285	1.49	1.20	Exceeds

[1] Proportional Share UAL = 1.20 lbs/acre from Step 1

Secondary Sub-basins

Currently, the L1 Primary Sub-basin has no Secondary or Tertiary Sub-basins. If the L1 did not meet the Proportional Share UAL, then the next evaluation step would be for Permit Basins.

The L3 Primary Sub-basin includes three Secondary Sub-basins: L2, DF, and SM. These Sub-basins are monitored at three stations upstream of the STA5 inflow structures: C139S2 for the L2 Sub-basin, DF02.1TW for the DF Sub-basin, and SM00.2TW for the SM Sub-basin.

If load data for all three secondary stations are available, the District will review if the sum of the phosphorus loading for the three secondary Sub-basin stations (C139S2, DF02.1TW, and SM00.2TW) equals the sum of the phosphorus loading of the L3 Primary Sub-basin stations (G-342 and G-406). If it does not, the calculated loads for stations C139S2, DF02.1TW and SM00.2TW will be adjusted up or down. The Sub-basin Load Adjustment Factor will account for differences that can be expected between the sum of these station loads and the load at the STA inflow stations. Although it is anticipated that the adjustment would typically be downward, it is possible for the adjustment to be upward. If the District determines that accurate water year load cannot be calculated for any one of the three Secondary monitoring stations, then the total load cannot be related to the C-139 Basin load to the STA and south to the L3 Borrow Canal. In such a case, the Observed Loads shall be evaluated without adjustment. Primary Sub-basin Observed UAL values would be applied to the Secondary Sub-basin(s) without successful load monitoring.

Example

Step 3: Compute Sub-basin Adjustment Factor

Monitoring station load upstream of STA5 & L3 south:

C139S2 + DF02.1TW + SM00.2TW = 98 mtons

Monitoring station load into STA5 & L3 south:

G342A + G342B + G342C + G342D + G406 + G508 = 128 mtons

$$\text{Adjustment Factor} = \frac{\textit{Total Load at Secondary Structures upstream of STA5 \& L3}}{\textit{Total Load at Primary Structures to STA5 \& L3}}$$

$$\text{Adjustment Factor} = \frac{98\ mtons}{128\ mtons}$$

$$\text{Adjustment Factor} = 0.77$$

Step 4: Compute Secondary Sub-basin Assigned Loads

Secondary Sub-basin	Observed Load (mtons)	Adjustment Factor	Assigned Load (mtons)	Assigned Load (lbs)
L2	50	0.77	38.5	84,793
DF	43	0.77	33.4	73,531
SM	35	0.77	26.9	59,355

Step 5: Evaluate Secondary Sub-basin Performance

Secondary Sub-basin	Assigned Load (lbs)	Area (acres)	Assigned UAL (lbs/acre)	Proportional Share UAL[1] (lbs/acre)	Meets or Exceeds Proportional Share UAL
L2	84,793	88,673	0.96	1.20	Meets
DF	73,531	36,764	2.00	1.20	Exceeds
SM	59,355	19,288	3.08	1.20	Exceeds

[1] Proportional Share UAL = 1.20 lbs/acre from Step 1

In this hypothetical example, the L2 is the only Secondary Sub-basin to meet the Proportional Share UAL of 1.20 lbs/acre. Both DF and SM Sub-basins exceed the Proportional Share UAL and further evaluation is required to make determinations for permittees within these areas.

Tertiary Sub-basins

The load and UAL shall be calculated annually for all Tertiary Sub-basins, even for those that have already been determined to meet performance measures based upon the previous steps. Therefore, all seven Tertiary Sub-basins were assigned hypothetical loads for this example to demonstrate potential future cases. All Sub-basin loads computed from monitoring data are first adjusted by the Sub-basin Load Adjustment Factor computed from their Secondary Sub-basin analysis, in this example case, 0.77.

<u>Example</u>

Step 6: Compute Tertiary Sub-basin Assigned Loads

Tertiary Sub-basin	Observed Load (mtons)	Adjustment Factor	Assigned Load (mtons)	Assigned Load (lbs)
L2W	15.5	0.77	11.9	26,286
L2E	9.5	0.77	7.3	16,111
L2S	25.0	0.77	19.2	42,397
DFW	18.3	0.77	14.1	31,134
DFE	25.0	0.77	19.2	42,397
SMW	30.0	0.77	23.1	50,876
SME	5.0	0.77	3.8	8,479

Step 7: Evaluate Tertiary Sub-basin Performance

Tertiary Sub-basin	Assigned Load (lbs)	Area (acres)	Assigned UAL (lbs/acre)	Proportional Share UAL[1] (lbs/acre)	Meets or Exceeds Proportional Share UAL
L2W	26,286	19,530	1.35	1.20	Secondary meets
L2E	16,111	20,715	0.78	1.20	Secondary meets
L2S	42,397	48,429	0.88	1.20	Secondary meets
DFW	31,134	25,945	1.20	1.20	Exceeds
DFE	42,397	10,819	3.92	1.20	Exceeds
SMW	50,876	17,525	2.90	1.20	Exceeds
SME	8,479	1,763	4.81	1.20	Exceeds

[1] Proportional Share UAL = 1.20 lbs/acre from Step 1

Even though the L2W Assigned UAL is greater than the Proportional Share UAL, no additional action would be required due to Secondary Sub-basin results. The L2W Sub-basin results may be used in future years for a 3-year Target exceedance.

Permit Basins

Permit Basin discharge monitoring results shall be used to calculate Assigned loads and UALs for the Permit Basins they represent. Permit Basins without discharge monitoring will be evaluated based upon the Assigned UAL for the Sub-basin. In the case that one or more Permit Basins within a Sub-basin are issued a determination of impracticability, the remaining area's UAL shall be adjusted to exclude those Permit Basins with impracticability-required discharge monitoring unless the resulting UAL is greater than the Sub-basin UAL. In such a case the Permit Basins without discharge monitoring will receive an Assigned UAL equal to the lesser of the following two computation methods:

1. the Assigned UAL for the smallest Sub-basin level to which the Permit Basin discharges (as computed by Step 7, 5, or 2), or

2. the resulting UAL of the smallest Sub-basin level Assigned load less the sum of Assigned loads from impracticability-required Permit Basin discharge monitoring within the Sub-basin.

An Assigned UAL will be computed each water year for each Permit Basin, regardless of the results of previous steps. The Sub-basin Load Adjustment Factor will match that applied at the Secondary and Tertiary level, in this example case, 0.77.

Example

Step 8: Compute Permit Basin Assigned Loads

Permit Basin	Observed Load (mtons)	Adjustment Factor	Computed Load (mtons)	Computed Load (lbs)
DFE-0	Not Monitored	0.77	NA	NA
DFE-1	14.0	0.77	10.78	23,766
DFE-2	2.0	0.77	1.54	3,395

Step 9: Evaluate Permit Basin Performance

Impracticability determination exists for DFE-2 and site specific Limit UAL (in this case defining the Proportional Share UAL) of 1.5 lbs/acre.

Permit Basin	Computed Load (lbs)	Area (acres)	Assigned UAL (lbs/acre)	Proportional Share UAL[1] (lbs/acre)	Meets or Exceeds Proportional Share UAL
Permit Basins without Discharge Monitoring					
DFE-0	NA	5,409	3.92 (Sub-basin)	1.20	Exceeds
Permit Basins with Discharge Monitoring					
DFE-1	23,766	2,705	8.79	1.20	Exceeds
DFE-2	3,395	2,705	1.26	*1.50*	Meets

[1] Proportional Share UAL = 1.20 lbs/acre from Step 1

Step 9 shall be repeated for each Tertiary Sub-basin and the L1 Primary Sub-basin. If the District determines that accurate water year load cannot be calculated for a Tertiary Sub-basin, then the procedures within Step 9 shall be applied to the Secondary Sub-basin to which it discharges to compute Assigned UALs for all Permit Basins.

Hypothetical Permit Basins and data were created for each Sub-Basin below to show potential cases for performance results and corresponding required TP reductions. Sub-basin names ending in the number 0 represent the collective Permit Basins without discharge monitoring.

Example

Step 10: Compute Percent Required TP Reductions

Sub-basin or Permit Basin	Assigned UAL (lbs/acre)	Proportional Share UAL[1] (lbs/acre)	Meets or Exceeds Proportional Share UAL	Required TP Reduction (%)
L1	0.95	1.20	Meets	NA
L1-0	0.00	1.20	Primary Meets	NA
L1-1	1.50	1.20	Primary Meets	NA
L1-2	1.30	1.20	Primary Meets	NA
L2W	1.35	1.20	Secondary Meets	NA
L2W-0	1.35	1.20	Secondary Meets	NA
L2E	0.78	1.20	Secondary Meets	NA
L2E-0	0.78	1.20	Secondary Meets	NA
L2S	0.88	1.20	Secondary Meets	NA
L2S-0	0.88	1.20	Secondary Meets	NA
L2S-1	0.60	1.20	Secondary Meets	NA
DFW	1.20	1.20	Meets	NA
DFW-0	1.31	1.20	Tertiary Meets	NA
DFW-1	1.20	1.20	Tertiary Meets	NA
DFE	3.92	1.20	Exceeds	67%
DFE-0	3.92	1.20	Exceeds	47%
DFE-1	8.79	1.20	Exceeds	85%
DFE-2	1.26	1.50[2]	Meets	NA
SMW	2.90	1.20	Exceeds	55%
SMW-0	2.90	1.20	Exceeds	55%
SME	4.81	1.20	Exceeds	73%
SME-0	4.81	1.20	Exceeds	73%

[1] Proportional Share UAL = 1.20 lbs/acre from Step 1

[2] DFE-2 site specific Proportional Share UAL = 1.50 lbs/acre from Step 9

Permit Basin Example Cases

Many potential cases for Permit Basin results were considered in establishing the specific language of the Rule. The following examples are based upon three hypothetical Permit Basins (A, B & C) within a Sub-basin which has an Assigned UAL of 1.50 lb/ac and is over the Proportional Share UAL of 1.20 lb/ac. The following “cases” are presented to help clarify questions regarding the intent of the Rule’s language describing future evaluation of Permit basin Unit Area Loads and, if necessary, load reduction requirements.

No Permit Basins monitor	Case 1
Some Permit Basins monitor	Cases 2a, 2b, 3a, 3b, 5a, 5b
All Permit Basins monitor	Cases 4a, 4b
Permit Basin load adjustment	Cases 3a, 4a, 4b
Impracticability	Cases 5a, 5b

Sub-basin hypothetical data used throughout the Permit Basin Cases:

Sub-basin Load (mton)	Sub-Basin Load Adj.[1] Factor (%)	Sub-basin Adjusted Load (mton)	Sub-basin Assigned UAL (lb/ac)	Limit UAL (lb/ac)	%Reduction
88.4	0.77	68.0	1.50	1.20	20.0%

Permit Basin Areas	A	B	C
Acres	60,000	30,000	10,000
%	60%	30%	10%

Groundrules for assigning Permit Basin UAL and required reduction:

- [1] Adjustment equal to the Sub-basin Load Adjustment Factor has been applied to all monitoring including Permit Basin loads
- Sub-basin monitoring results apply if no Permit Basin Discharge Monitoring Program data exists within Sub-basin
- Permit Basin monitored load is adjusted down if sum of Permit Basin loads exceed the Sub-basin monitored load
- Permit Basin monitored load can be adjusted up to match Sub-basin only if 100% of Sub-basin is monitored at the Permit basin level
- Load data from Permit Basins granted impracticability is subtracted from Sub-basin load data to compute load for remaining area
- Assigned UAL for non-monitored Permit Basins is lesser of Sub-basin Assigned UAL and result of removing Permit Basins with Impracticability
- Assigned UAL is zero if computation results in negative load; Permit Basin monitored annual load cannot be negative

Case 1: No Permit Basins have monitoring

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	No	40.8	1.50	1.50	1.20	20%	Required reduction based on Sub-basin adjusted load.
B	N	No	20.4	1.50	1.50	1.20	20%	Required reduction based on Sub-basin adjusted load.
C	N	No	6.8	1.50	1.50	1.20	20%	Required reduction based on Sub-basin adjusted load.
Total		**0.0**	**68.0**	**1.50**				
		1.00	Permit Basin Load Adjustment Factor					

Result: All Permit Basins' required reduction is based upon Sub-basin data

General notes:

- All cases assume C-139 Basin out of compliance with Limit as tabulated below
- Calculations would apply similarly if out of compliance with Target, but data would represent 3-year averages
- Assigned UAL is computed annually, regardless of C-139 Basin compliance condition
- Limit UAL herein is equivalent to the Proportional Share UAL

Sub-basin hypothetical data used throughout the Permit Basin Cases:

Sub-basin Load (mton)	Sub-Basin Load Adj.[1] Factor (%)	Sub-basin Adjusted Load (mton)	Sub-basin Assigned UAL (lb/ac)	Limit UAL (lb/ac)	%Reduction
88.4	0.77	68.0	1.50	1.20	20.0%

Permit Basin Areas	A	B	C
Acres	60,000	30,000	10,000
%	60%	30%	10%

Groundrules for assigning Permit Basin UAL and required reduction:

- [1] Adjustment equal to the Sub-basin Load Adjustment Factor has been applied to all monitoring including Permit Basin loads
- Sub-basin monitoring results apply if no Permit Basin Discharge Monitoring Program data exists within Sub-basin
- Permit Basin monitored load is adjusted down if sum of Permit Basin loads exceed the Sub-basin monitored load
- Permit Basin monitored load can be adjusted up to match Sub-basin only if 100% of Sub-basin is monitored at the Permit basin level
- Load data from Permit Basins granted impracticability is subtracted from Sub-basin load data to compute load for remaining area
- Assigned UAL for non-monitored Permit Basins is lesser of Sub-basin Assigned UAL and result of removing Permit Basins with Impracticability
- Assigned UAL is zero if computation results in negative load; Permit Basin monitored annual load cannot be negative

Case 2a: Permit Basin monitoring (single) is less than Limit UAL

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	30	30.0	1.10	1.10	1.20	0%	Meets Performance Measure
B	N	No	20.4	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
C	N	No	6.8	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
Total		**30.0**	**57.2**	**1.26**				
		1.00	Permit Basin Load Adjustment Factor					

Result: **Deferral granted for Permit Basin with monitoring**
Other Permit Basins follow Sub-basin results

Case 2b: Permit Basin monitoring (single) is greater than Limit UAL

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	45	45.0	1.65	1.65	1.20	27%	Required reduction based on monitored value.
B	N	No	20.4	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
C	N	No	6.8	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
Total		**45.0**	**72.2**	**1.59**				
		1.00	Permit Basin Load Adjustment Factor					

Result: **Required Reduction for Permit Basin with monitoring based on individual data**
Other Permit Basins follow Sub-basin results

Sub-basin hypothetical data used throughout the Permit Basin Cases:

Sub-basin Load (mton)	Sub-Basin Load Adj.[1] Factor (%)	Sub-basin Adjusted Load (mton)	Sub-basin Assigned UAL (lb/ac)	Limit UAL (lb/ac)	%Reduction
88.4	0.77	68.0	1.50	1.20	20.0%

Permit Basin Areas	A	B	C
Acres	60,000	30,000	10,000
%	60%	30%	10%

Groundrules for assigning Permit Basin UAL and required reduction:

- [1] Adjustment equal to the Sub-basin Load Adjustment Factor has been applied to all monitoring including Permit Basin loads
- Sub-basin monitoring results apply if no Permit Basin Discharge Monitoring Program data exists within Sub-basin
- Permit Basin monitored load is adjusted down if sum of Permit Basin loads exceed the Sub-basin monitored load
- Permit Basin monitored load can be adjusted up to match Sub-basin only if 100% of Sub-basin is monitored at the Permit basin level
- Load data from Permit Basins granted impracticability is subtracted from Sub-basin load data to compute load for remaining area
- Assigned UAL for non-monitored Permit Basins is lesser of Sub-basin Assigned UAL and result of removing Permit Basins with Impracticability
- Assigned UAL is zero if computation results in negative load; Permit Basin monitored annual load cannot be negative

Case 3a: Permit Basin monitoring (single) is greater than Sub-basin load

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	80	68.0	2.50	2.50	1.20	52%	Required reduction based on adjusted monitored value.
B	N	No	20.4	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
C	N	No	6.8	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
Total		**80.0**	**95.3**	**2.10**				
		0.85	Permit Basin Load Adjustment Factor					

Result: **Required Reduction for Permit Basin with monitoring based on individual data adjusted down**
Other Permit Basins follow Sub-basin results
Permit Basin Load Adjustment Factor less than one due to Permit Basin load exceeding Sub-basin load

Case 3b: Permit Basin monitoring (multiple) is less than Sub-basin load

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	No	40.8	1.50	1.50	1.20	20%	Required reduction based on Sub-basin Assigned UAL.
B	N	13	13.0	0.96	0.96	1.20	0%	Meets Performance Measure
C	N	8	8.0	1.76	1.76	1.20	32%	Required reduction based on monitored value.
Total		**21.0**	**61.8**	**1.36**				
		1.00	Permit Basin Load Adjustment Factor					

Result: **Permit Basin without monitoring follows Sub-basin results**
Deferral for one Permit Basin with monitoring based on individual data
Required Reduction for other Permit Basin with monitoring based on individual data

Sub-basin hypothetical data used throughout the Permit Basin Cases:

Sub-basin Load (mton)	Sub-Basin Load Adj.[1] Factor (%)	Sub-basin Adjusted Load (mton)	Sub-basin Assigned UAL (lb/ac)	Limit UAL (lb/ac)	%Reduction
88.4	0.77	68.0	1.50	1.20	20.0%

Permit Basin Areas	A	B	C
Acres	60,000	30,000	10,000
%	60%	30%	10%

Groundrules for assigning Permit Basin UAL and required reduction:

- [1] Adjustment equal to the Sub-basin Load Adjustment Factor has been applied to all monitoring including Permit Basin loads
- Sub-basin monitoring results apply if no Permit Basin Discharge Monitoring Program data exists within Sub-basin
- Permit Basin monitored load is adjusted down if sum of Permit Basin loads exceed the Sub-basin monitored load
- Permit Basin monitored load can be adjusted up to match Sub-basin only if 100% of Sub-basin is monitored at the Permit basin level
- Load data from Permit Basins granted impracticability is subtracted from Sub-basin load data to compute load for remaining area
- Assigned UAL for non-monitored Permit Basins is lesser of Sub-basin Assigned UAL and result of removing Permit Basins with Impracticability
- Assigned UAL is zero if computation results in negative load; Permit Basin monitored annual load cannot be negative

Case 4a: Permit Basin monitoring (all) is greater than Sub-basin load

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	50	44.8	1.64	1.64	1.20	27%	Required reduction based on adjusted monitored value.
B	N	18	16.1	1.18	1.18	1.20	0%	Meets Performance Measure
C	N	8	7.2	1.58	1.58	1.20	24%	Required reduction based on adjusted monitored value.
Total		**76.0**	**68.0**	**1.50**				
		0.90	Permit Basin Load Adjustment Factor					

Result: **Required Reduction based on individual data adjusted down**
Permit Basin Load Adjustment Factor less than one

Case 4b: Permit Basin monitoring (all) is less than Sub-basin load

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	N	40	45.0	1.65	1.65	1.20	27%	Required reduction based on adjusted monitored value.
B	N	18	20.2	1.49	1.49	1.20	19%	Required reduction based on adjusted monitored value.
C	N	2.5	2.8	0.62	0.62	1.20	0%	Meets Performance Measure
Total		**60.5**	**68.0**	**1.50**				
		1.12	Permit Basin Load Adjustment Factor					

Result: **Required Reduction based on individual data adjusted up**
Permit Basin Load Adjustment Factor greater than one

Sub-basin hypothetical data used throughout the Permit Basin Cases:

Sub-basin Load (mton)	Sub-Basin Load Adj.[1] Factor (%)	Sub-basin Adjusted Load (mton)	Sub-basin Assigned UAL (lb/ac)	Limit UAL (lb/ac)	%Reduction
88.4	0.77	68.0	1.50	1.20	20.0%

Permit Basin Areas	A	B	C
Acres	60,000	30,000	10,000
%	60%	30%	10%

Groundrules for assigning Permit Basin UAL and required reduction:

- [1] Adjustment equal to the Sub-basin Load Adjustment Factor has been applied to all monitoring including Permit Basin loads
- Sub-basin monitoring results apply if no Permit Basin Discharge Monitoring Program data exists within Sub-basin
- Permit Basin monitored load is adjusted down if sum of Permit Basin loads exceed the Sub-basin monitored load
- Permit Basin monitored load can be adjusted up to match Sub-basin only if 100% of Sub-basin is monitored at the Permit basin level
- Load data from Permit Basins granted impracticability is subtracted from Sub-basin load data to compute load for remaining area
- Assigned UAL for non-monitored Permit Basins is lesser of Sub-basin Assigned UAL and result of removing Permit Basins with Impracticability
- Assigned UAL is zero if computation results in negative load; Permit Basin monitored annual load cannot be negative

Case 5a: Impracticability required Permit Basin monitoring (single) is greater than *site specific Limit UAL*

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	Y	45	45.0	1.65	1.65	*1.50*	9%	Required reduction based on monitored value and site specific Limit UAL.
B	N	No	17.3	1.27	1.27	1.20	5%	Required reduction is minimum of computed and Sub-basin reduction
C	N	No	5.8	1.27	1.27	1.20	5%	Required reduction is minimum of computed and Sub-basin reduction
Total		**45.0**	**68.0**	**1.50**				
		1.00	Permit Basin Load Adjustment Factor					

Result: Required Reduction for Permit Basin with Impracticability monitoring based on individual data and *site specific Limit UAL*
Other Permit Basins use Sub-basin minus Impracticability monitored load (Reduces % required reduction)

Case 5b: Impracticability required Permit Basin monitoring (single) is greater than *site specific Limit UAL*

Name	Impract? (Y/N)	Adjusted[1] Load (mton)	Computed Load (mton)	Computed UAL (lb/ac)	Assigned UAL (lb/ac)	Limit UAL (lb/ac)	Required Reduction %	Note
A	Y	40	40.0	1.47	1.47	*1.50*	0%	Meets Impacticability approved site specific Limit UAL
B	N	No	21.0	1.55	1.50	1.20	20%	Required reduction is minimum of computed and Sub-basin reduction
C	N	No	7.0	1.55	1.50	1.20	20%	Required reduction is minimum of computed and Sub-basin reduction
Total		**40.0**	**68.0**	**1.50**				
		1.00	Permit Basin Load Adjustment Factor					

Result: Deferral for Permit Basin with Impracticability monitoring based on individual data and *site specific Limit UAL*
Other Permit Basins use Sub-basin results (subtracting Impacticability monitored load would increase UAL and % required reduction)