Biscayne Bay Southeastern Everglades Ecosystem Restoration
(WQ Subteam)

DRAFT - Water Quality Planning Targets

Paul Julian, Ph.D. | December 21, 2020 (Updated: May 10, 2021)

Objective

- Evaluate the potential for developing planning level water quality targets from project areas to downstream OFW

Approach

- Rescale existing water quality at discharge locations to established downstream Numeric Nutrient Criteria (62-302.532 FAC).
- Similar approach to Everglades Stormwater Treatment Area WQBEL (Technical Support Document).

Biscayne Bay Numeric Nutrient Criteria

As acknowledged in the NNC technical support document watershed development has led to adverse effects in Biscayne Bay including:

- hypersalinity
- algal blooms
- benthic community (seagrass and coral) loss
- loss of some fish species.

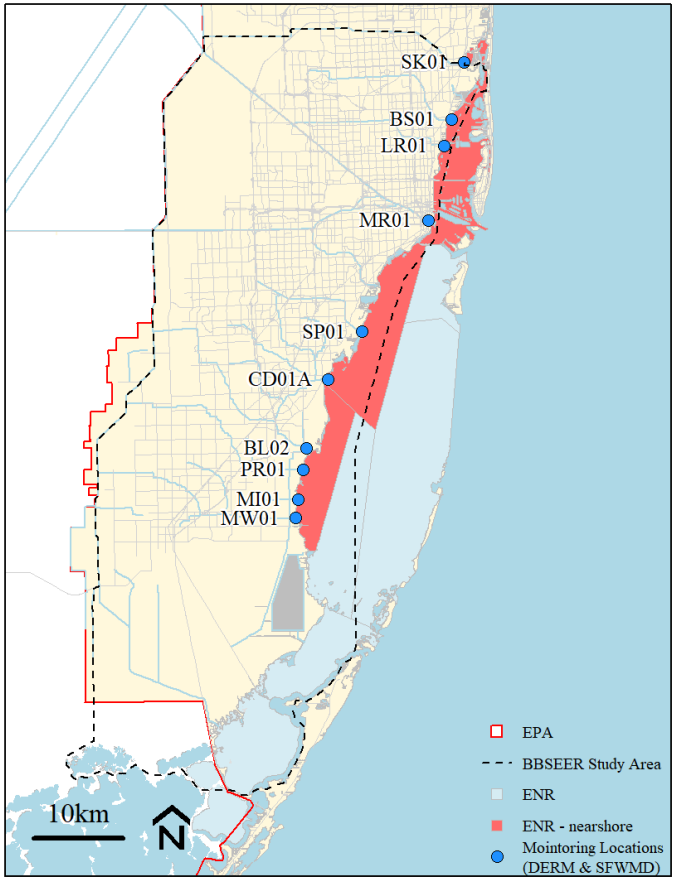
Water Quality is related to land use and differs among North, Central and South regions

Nutrients exhibits a declining gradient from land to open water.

The established NNC is based on a *"maintain existing conditions"* approach using water quality monitoring data collected from 1995 to 2009.

- For the *"maintain existing conditions"* approach, it must be concluded that the observed nutrient regime was inherently protective of the system under the conditions unique to that system.

Estuary-Specific Numeric Interpretations of the Narrative Nutrient Criterion



62-302.532(1) FAC. Estuary-Specific Numeric Interpretations of the Narrative Nutrient Criterion.

Estuary	Segement	Total Phosphorus (mg L^{-1}) [A]	Total Nitrogen (mg L^{-1}) [A]	Chlorophyll-a (µg L^{-1}) [A]
(h) Biscayne	1. Card Sound	0.008	0.33	0.5
Bay	2. Manatee Bay - Barnes Sound	0.007	0.58	0.4
	3. North Central Inshore	0.007	0.31	0.5
	4. North Central Outer-Bay	0.008	0.28	0.7
	5. Northern North Bay	0.012	0.30	1.7
	6. South Central Inshore	0.007	0.48	0.4
	7. South Central Mid-Bay	0.007	0.35	0.2
	8. South Central Outer-Bay	0.006	0.24	0.2
	9. Southern North Bay	0.010	0.29	1.1

[A] Criteria expressed as annual geometric means (AGM) are not to be exceeded more than once in a three year period.

STA WQBEL

Table 4. Derivation of the WQBEL for TP in discharges to the EPA.

Parameter	Value	Description
Number of STAs	6	*k*
Number of STA Years	38	*N*
Degrees of Freedom	32	*df = N-k*
LTFWM for LTGM = 10	12.8	*Average rescaled LTFWM across STAs and years equivalent to GM =10 ppb*
Standard Error of LTFWM	0.6	*Standard error of rescaled LTFWM across STAs and years*
Annual Ln Mean FWM	2.48	*m = mean (Ln rescaled FWM)*
Annual Ln Standard Deviation FWM	0.325	*std = standard deviation (Ln rescaled FWM)*
Annual Pooled Ln Standard Deviation FWM	0.350	*s = pooled standard deviation (Ln rescaled FWM)*
Assumed Tail Probability	0.1	$p_{0.1}$ *= probability for 90% prediction*
Students-t	1.31	$t_{0.1} = (p_{0.1}, DOF)$, *1-tailed*
Annual Maximum FWM Limit (AWFM)	18.9	$Limit = exp(m + s*t_{0.1})$
Mean Ratio FWM/GM	1.25	*Mean of FWM/GM*

Everglades WQBEL

- 13 µg L^{-1} as an annual FWM in more than three out of five years and;
- 19 µg L^{-1} as an annual FWM.

(Source)

Methods

Data Sources

- Water quality data was retrieved from FDEP STORET [1], WIN [2] and SFWMD DBHYDRO [3].
- Daily discharge data retrieved from SFWMD DBHYDRO [3].
- Period of record considered May 1999 - May 2019 (Florida WY2000 - 2020).

Data Handling

- Fatally qualified data were removed prior to analysis.
- Values reported less than the minimum detection limit (MDL) were set to $\frac{1}{2}$ the MDL.
- Annual (Florida WY) geometric mean (GM) concentrations were computed on days of flow with greater than four samples per year and atleast one in the dry and wet season.
- Flow-weighted mean (FWM) concentrations were calculated using paired WQ and flow data.

[1] STORET; [2] WIN; [3] DBHYDRO

Methods

Data Rescaling

$$RF = \frac{NNC}{\overline{\overline{GM}}}$$

$$\overline{\overline{GM}} = \frac{\sum_{i=1}^{n} GM}{n}$$

$$FWM_{RF} = FWM \times RF$$

Where,

NNC = long-term numeric nutrient criterion limit for specific region

GM = geometric mean for each year at each station

$\overline{\overline{GM}}$ = arithmetic mean of geometric mean at each station for n years

n = number of years per site

FWM = annual FWM calculated for each site

Statistical Analysis

$$y_{ij} = ln(C_{ij})$$

$$m = \frac{\sum_{i=1}^{k} \sum_{i=1}^{n_i} y_{ij}}{N}$$

$$S_y = \sqrt{\frac{\sum_{i=1}^{k} \left[\sum_{j=1}^{n_i} \left(y_{ij} - \bar{y}_i \right)^2 \right]}{N - k}}$$

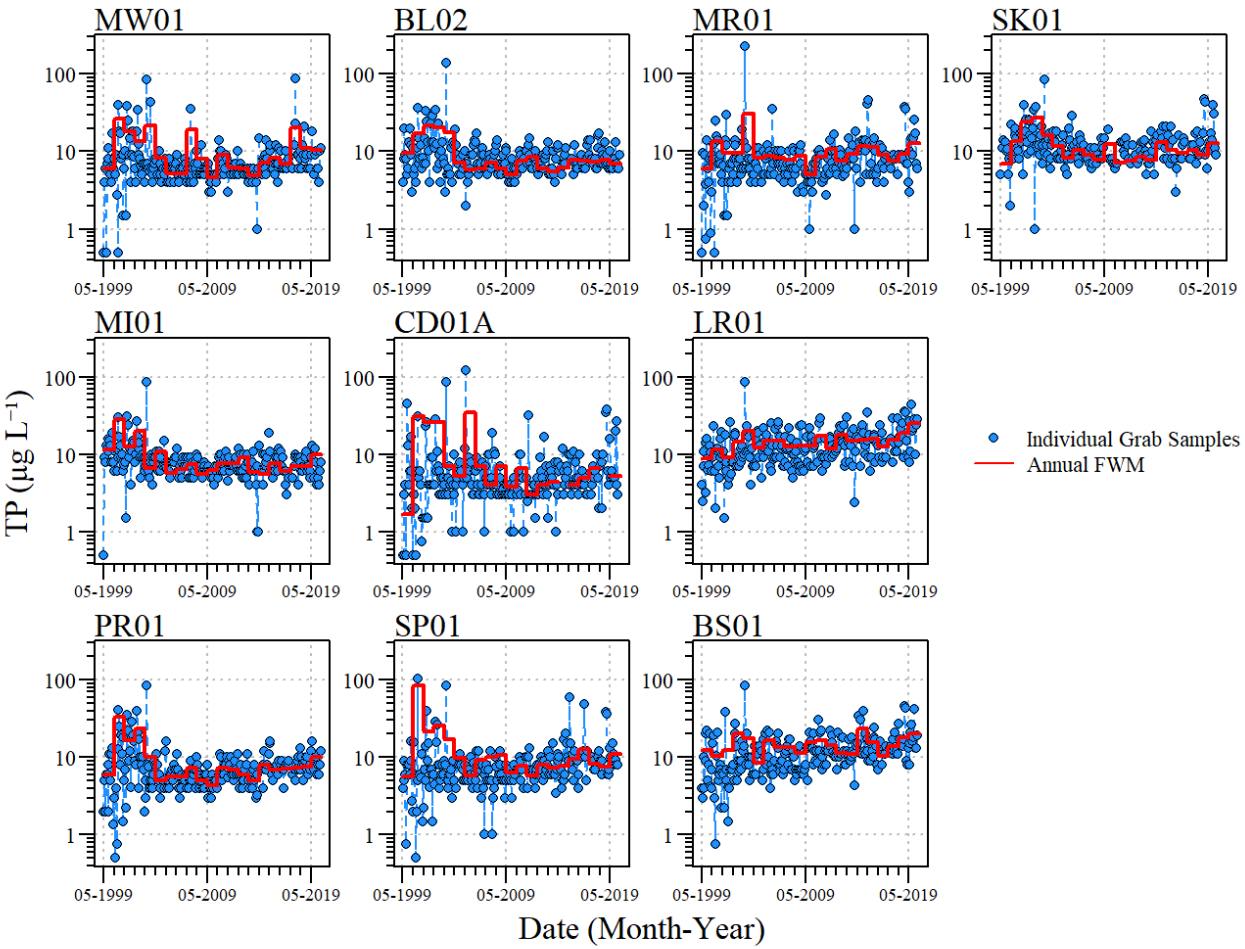
$$df = N - k$$

$$L_\rho = \frac{m + S_y \times t_\rho}{\sqrt{N}}$$

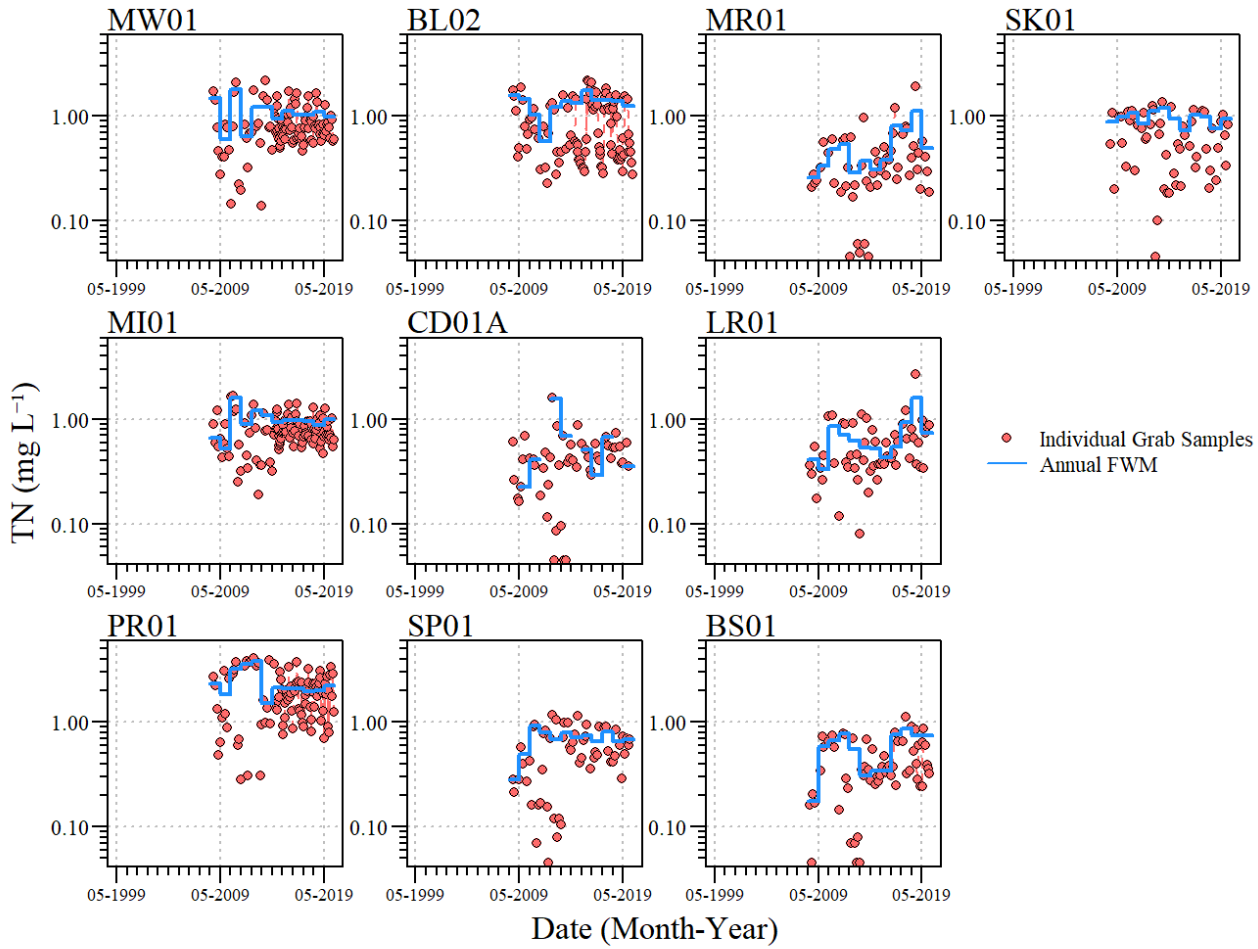
Where,

C_{ij} = FWM for year j and site i, rescaled to NNC
$\bar{y}_i$ = mean ln(FWM) for site i across years
N = total number of site years
k = number of sites
m = mean of log nutrient data across sites and years (rescaled FWM)
S_y = pooled year-to-year standard deviation
df = degrees of freedom in s
L_p = long-term limit FWM concentration with exceedance probability ρ
t_p = 1-tailed t-statistic, significance level ρ and df

Total Phosphorus

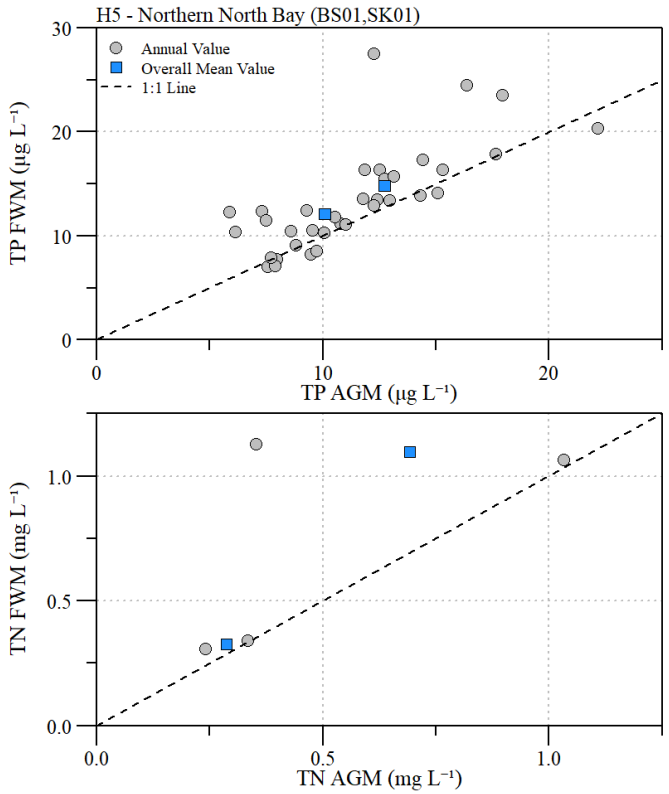


Total Nitrogen



ENRH5 Northern North Bay

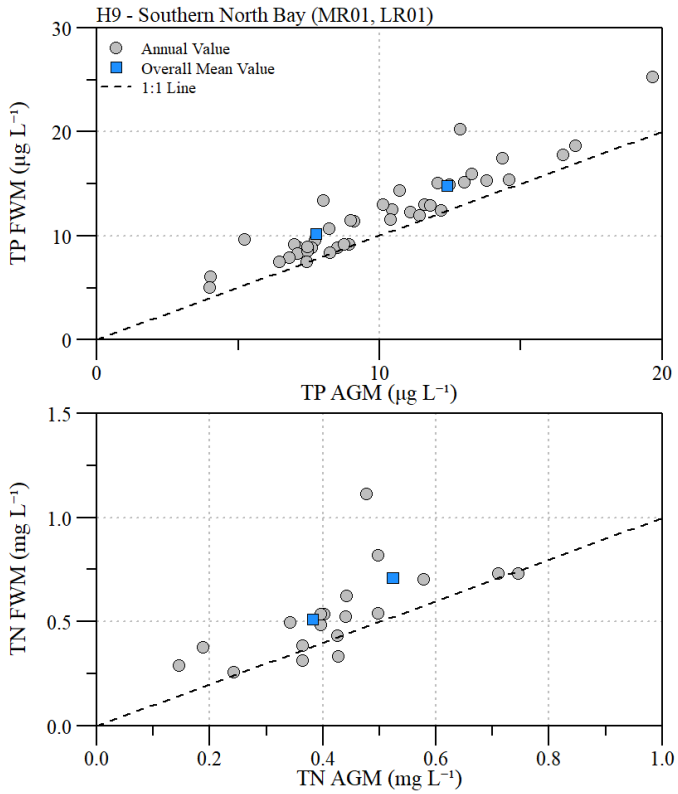
	Total Phosphorus (µg L⁻¹)	Total Nitrogen (mg L⁻¹)
Parameter	**Value**	**Value**
Downstream NNC	12	0.30
Number of Sites; k	2	2
Number of Site Years; N	35	4
Degree of Freedom; df	33	2
Mean Rescaled FWM; LTFWM	14.20	0.41
SE of Rescaled FWM; SE LTFWM	0.90	0.04
Annual Ln Mean FWM; m	2.60	-0.91
Annual Ln SD FWM; std	0.316	0.200
Pooled Ln SD FWM; s	0.056	0.041
Assumed Probability; p	0.1	0.1
Students-t; Tp	1.31	1.89
Long Term FWM Limit	14	0.45



LIMITED TN DATA

ENRH9 Southern North Bay

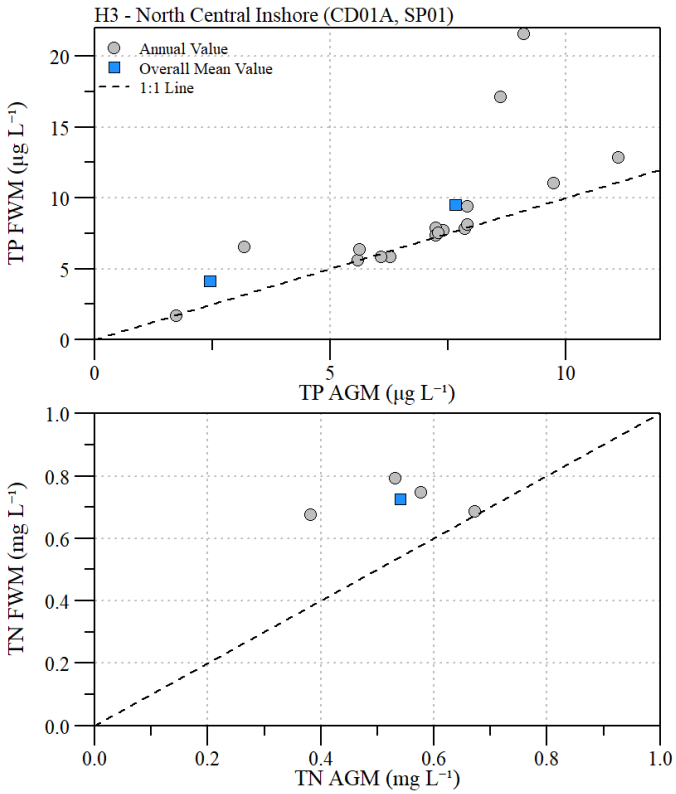
	Total Phosphorus (µg L^{-1})	Total Nitrogen (mg L^{-1})
Parameter	**Value**	**Value**
Downstream NNC	10	0.29
Number of Sites; k	2	2
Number of Site Years; N	42	20
Degree of Freedom; df	40	18
Mean Rescaled FWM; LTFWM	12.56	0.39
SE of Rescaled FWM; SE LTFWM	0.79	0.04
Annual Ln Mean FWM; m	2.48	-1.03
Annual Ln SD FWM; std	0.302	0.419
Pooled Ln SD FWM; s	0.048	0.101
Assumed Probability; p	0.1	0.1
Students-t; Tp	1.30	1.33
Long Term FWM Limit	13	0.42



ENRH3 North Central Inshore

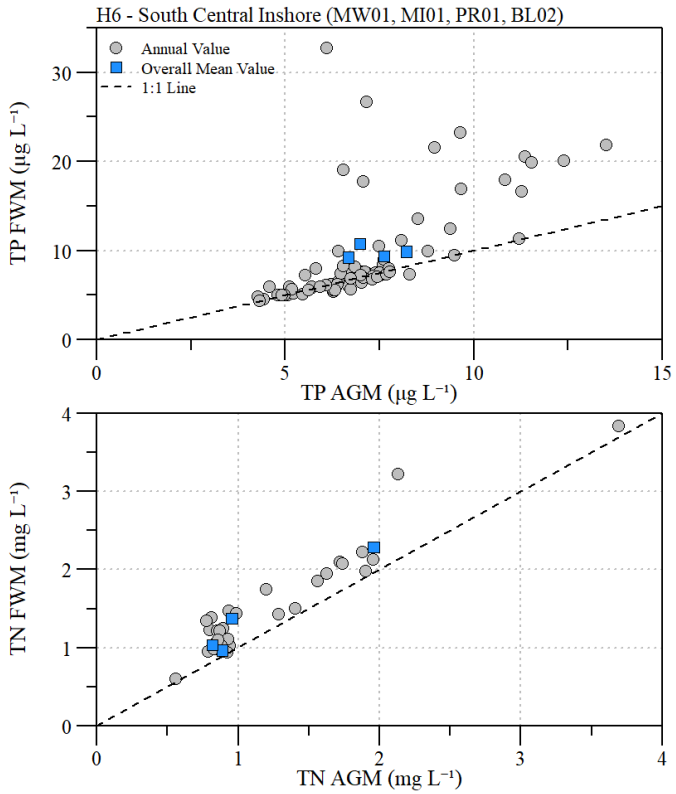
	Total Phosphorus (µg L⁻¹)	Total Nitrogen (mg L⁻¹)
Parameter	**Value**	**Value**
Downstream NNC	7	0.31
Number of Sites; k	2	1
Number of Site Years; N	17	4
Degree of Freedom; df	15	3
Mean Rescaled FWM; LTFWM	9.05	0.42
SE of Rescaled FWM; SE LTFWM	1.14	0.02
Annual Ln Mean FWM; m	2.10	-0.88
Annual Ln SD FWM; std	0.445	0.074
Pooled Ln SD FWM; s	0.118	0.043
Assumed Probability; p	0.1	0.1
Students-t; Tp	1.34	1.64
Long Term FWM Limit	9	0.45

LIMITED TN DATA



ENRH6 South Central Inshore

Parameter	Total Phosphorus (µg L⁻¹) Value	Total Nitrogen (mg L⁻¹) Value
Downstream NNC	7	0.48
Number of Sites; k	4	4
Number of Site Years; N	76	30
Degree of Freedom; df	72	26
Mean Rescaled FWM; LTFWM	9.49	0.61
SE of Rescaled FWM; SE LTFWM	0.70	0.02
Annual Ln Mean FWM; m	2.10	-0.52
Annual Ln SD FWM; std	0.502	0.226
Pooled Ln SD FWM; s	0.059	0.042
Assumed Probability; p	0.1	0.1
Students-t; Tp	1.29	1.31
Long Term FWM Limit	9	0.62



Inital Thoughts

- Structure/canal specific water quality planning limits based on downstream NNC
- Total Nitrogen data limitations
  - ENRH5 and ENRH3
  - Alternate sites for Snake Creek, Biscayne Canal, Snapper Creek and Cutler Drain?

Acknowledgements

Data

South Florida Water Management District (DBHYDRO)

Miami-Dade Department of Environmental Resources Management via FDEP STORET/WIN

Slides

- Slide deck - HTML | PDF |
- RMarkdown Source

Draft Work Product
In support of BBSEER planning