Notes for the Loxahatchee River Reasonable Assurance Plan Workshop on 24-AUG-17

Rainfall Sources:

1. *SFWMD DBHydro*: There are three rain gauges within the vicinity of the Loxahatchee River RAP
    a. JDWX – Jonathan Dickinson State Park from 12-SEP-97 to CURRENT – 20 years POR
    b. SIRG – South Indian River in Jupiter Farms from 28-OCT-93 to 13-JUL-16 – 23 years POR
    c. S46_R – Structure 46 SW Fork of Loxahatchee River, North of Indiantown Road from 18-MAR-97 to CURRENT – 20 years POR

2. *St Lucie BMAP*: There are six (6) sub-basins within the BMAP with the South Fork Basin being the closest to the Loxahatchee River RAP

	Basin	Inches
a.	South Fork	57.7 – Closest to Loxahatchee River RAP
b.	North Fork	50.8
c.	Basin 4 / 5 / 6	53.9
d.	C-44	49.3
e.	C-24	53.6
f.	C-23	49.9

3. *Existing Report*: There are two existing reports that can be utilized and evaluated for rainfall
    a. *Evaluation of Water Quality Stormwater Regulations for Martin County*, dated May 2000 prepared by Environmental Research & Design (ERD), Harper, Herr & Baker.

        This report preformed, "….a detailed hydrologic evaluation which utilized hourly rainfall records from the National Climatic Data Center for St. Lucie Canal Lock from 1942 to 1993"

        This is a POR of 51 years, that provided an Total Average Annual Rainfall Amount = 52.33"

    b. *Evaluation of Current Stormwater Design Criteria within the State of Florida, Final Report*, dated June 2007, prepared by Environmental Research & Design (ERD), Harper & Baker.

        This report conducted a continues simulation hydrologic model which evaluates rainfall/runoff relationships over an extended period of time. A list of the 45 monitoring stations in the report are provided in *Table 4-19: Listing of NCDC Hourly Precipitation Monitoring Stations in Florida*

        The closest station was St. Lucie New Lock 1 (7859) with the following information:

i.	No. of Years:	35
ii.	No. of Events:	4688
iii.	Mean Annual Rainfall:	54.82 inches
iv.	Maximum Event:	10.66 inches
v.	Mean Event:	0.41 inches

Event Mean Concentrations:

A comparison of Event Mean Concentrations (EMC) between those values in the Loxahatchee RAP and the St Lucie Estuary BMAP was completed. To understand the comparison, you need to know where and how the EMCs were derived in the St Lucie BMAP.

The majority of the "*Base"* EMCs from the BMAP are consistent with the values given in Table 4-17: Summary of Literature-Based Runoff Characterized Data for General Land Use Categories in Florida, from the report *Evaluation of Current Stormwater Design Criteria within the State of Florida*, June 2007, Harper & Baker. This report utilized a number of stormwater characterization studies from around the State to derive a mean value for a given land use type.

The St Lucie BMAP utilizes these values as the *Base* EMCs, and then a *Factor* is applied to derive the EMCs used in the BMAP. This factor is, [assuming], applied to better represent the EMC's in this part of Florida.

The below table represents the EMC values in the RAP and BMAP. Both the "Base" and "Factor" values are given from the BMAP. The Delta comparison is the difference between the RAP EMC value compared to the BMAP value, a red value indicates that the BMAP EMC is higher than the RAP EMC, a green value indicates that the BMAP EMC is lower than the RAP EMC. The green shaded values represent those values consistent with the *Evaluation of Current Stormwater Design Criteria within the State of Florida*, report, whereas the green cross hatched values are inconsistent with the report.

Comparison of EMCs Between Loxahatchee River RAP and the St Lucie Estuary BMAP

				St Luce BMAP				Delta			
		LOX RAP		Base		w/ Factor		Base		w/ Factor	
						0.6012	0.6520			0.6012	0.6520
FLUCC	Land Use Category	TN (mg/l)	TP (mg/l)	TN (mg/l)	TP (mg/l)	TN (mg/l)	TP (mg/l)	TN (mg/l)	TP (mg/l)	TN (mg/l)	TP (mg/l)
1100	Low Density Residential	1.51	0.178	1.61	0.191	0.97	0.125	-0.10	-0.013	0.54	0.053
1200	Single Family	1.87	0.301	2.07	0.327	1.24	0.213	-0.20	-0.026	0.63	0.088
1300	High Density Residential	2.10	0.497	2.32	0.520	1.39	0.339	-0.22	-0.023	0.71	0.158
1800	Low Intensity Commercial	1.07	0.179	1.18	0.179	0.71	0.117	-0.11	0.000	0.36	0.062
1400	High Intensity Commercial	2.20	0.248	2.40	0.345	1.44	0.225	-0.20	-0.097	0.76	0.023
1500	Industrial	1.19	0.213	1.20	0.260	0.72	0.170	-0.01	-0.047	0.47	0.043
1600	Mining	1.18	0.150	1.18	0.150	0.71	0.098	0.00	0.000	0.47	0.052
1900	Urban Open Land	1.15	0.055	1.15	0.055	0.69	0.036	0.00	0.000	0.46	0.019
2000	General Agriculture	2.79	0.431	2.79	0.750	1.68	0.489	0.00	-0.319	1.11	-0.058
2100	Pasture	3.30	0.621	3.35	0.440	2.01	0.287	-0.05	0.181	1.29	0.334
2140	Row Crops	2.46	0.489	2.90	0.890	1.74	0.580	-0.44	-0.401	0.72	-0.091
2210	Citrus	2.07	0.152	2.24	0.420	1.35	0.274	-0.17	-0.268	0.72	-0.122
3000	Rangeland	1.15	0.055	1.15	0.055	0.69	0.036	0.00	0.000	0.46	0.019
4000	Upland Forrest	1.15	0.055	1.15	0.055	0.69	0.036	0.00	0.000	0.46	0.019
5000	Water	1.60	0.067	0.84	0.105	0.51	0.068	0.76	-0.038	1.09	-0.001
6000	Wetlands	1.01	0.090	1.01	0.050	0.61	0.033	0.00	0.040	0.40	0.057
7000	Barren Land	1.15	0.055	1.18	0.150	0.71	0.098	-0.03	-0.095	0.44	-0.043
8000	Transportation, Communication and Utilities	1.37	0.167	1.64	0.220	0.99	0.143	-0.27	-0.053	0.38	0.024

= Values consistant with the report, *Evaluation o Current Stormwater Design Criteria within the State of Florida* , June 2007, Harper & Baker

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Runoff Coefficients:

Runoff coefficients (ROC) are a function of soil types and soil storage, directly connected impervious area (DCIA), and Curve Numbers. In the Lox River RAP model, the ROCs used are directly from the St Lucie BMAP. I do not know where or how these ROCs were determined, however, I suspect that they were scrutinized during the BMAP process. Similar with the EMCs, there is a "*Base*" values given for each land use, and soil type. This *Base* is multiplied by a *Factor* (0.8628) to obtain the ROC value used in the model. I do not know what the *Factor* represents and why it is applied. It's also important to note that the ROCs in the St Lucie BMAP, for each Land Use given are the same for each Soil Type. This is something that should be considered in the Next iteration of the BMAP.

An alternative would be the use of the ROCs in the *Evaluation of Current Stormwater Design Criteria within the State of Florida*, June 2007, Harper & Baker, given in Table 4-24: Summary of Mean Runoff Coefficients for Each Cluster as a Function of Land Use and Hydrologic Soil Group. The issue with using this table is, there are limited Land Uses given, and some assumptions would need to be made, or, additionally in the same report, Appendix C, Zone 5, Mean Annual Runoff Coefficients (C values) as a Function of DCIA Percentage and Non-DCIA Curve Number (CN) can be utilized. However, additional calculations and assumptions would need to be made to determine the Directly Connected Impervious Area (DCIA) and Curve Numbers for the pervious areas. By using the Appendix C table, the ROCs would be open to interpretation and the consistency of the ROCs would be lost.

The Spreadsheet Model – How it Works

The spreadsheet model determines the *Existing Condition Loads* to the waterbody. Below is the East Fork Creek calculations from the St Lucie BMAP, given as an example. The input data that needs to be determined once the total watershed area has been identified are the Land Use Types and Soil Types. From this information the area of each Land Use type per Soil Type needs to be determined. This information is highlighted in green and is input under Column B, Land Use; Column D, Hydrologic Soil Type, and Column K, Acres. Then given the Land Use Type the corresponding TN EMC and TP EMC is input in Columns H and I, respectively, and given the Soil Type, the corresponding ROC is input in Column J. This information is

highlighted below in orange. The Rainfall amount in Column F, is predetermined and in this example is in the South Fork basin of the BMAP and the value is 57.7 inches, highlighted in red. Columns A and C are informational data to identify the name of the project and the WBID. Columns E and G are included in the BMAP to account for additional TP and Base flows, if needed. In this example there is additional TP account for, but no additional base flow. The spreadsheet calculates the Runoff volume, in Acre-Feet, by the following formula…

Runoff (ac-ft) = (Rainfall (F) * Runoff Coefficient (J) * Acres (K) / 12) + (Baseflow (G) * Acres (K))

Once the volume of Runoff is calculated, then the Existing Conditions Nutrient Loadings for TN and TP are calculated by the following formulas….

TN (lbs/yr) = (2.721 * TN EMC (H) * Runoff (L))
TP (lbs/yr) = (2.721 * TP EMC (I) * Runoff (L))

Whereas, 2.721 is the conversion factor from mg/l to lbs/ac-ft.

For this example, for the 2,325 acre basin, the annual runoff volume is 2,997.03 Ac-ft, which produces a nutrient load of 9,346.1 pounds of TN per year and 1,953.9 pounds of TP per year.

EAST FORK CREEK Example

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Name	LAND_COVER	LOXRAP_WBID	HYDGRP	TP_Add	Rain_in	Baseflw_ft	TN_EMC	TP_EMC	ROC	Acres	Runoff Ac-ft	TN lbs/yr	TP lbs/yr
East Fork Creek	1310	COASTAL	A	0.1900	57.7000	0.0000	1.240	0.213	0.393	40.00	75.59	255	51.4
East Fork Creek	1310	COASTAL	B/D	0.1900	57.7000	0.0000	1.240	0.213	0.393	230.00	434.63	1466.4	295.6
East Fork Creek	1310	COASTAL	C	0.1900	57.7000	0.0000	1.240	0.213	0.393	40.00	75.59	255	51.4
East Fork Creek	1310	COASTAL	D	0.1900	57.7000	0.0000	1.240	0.213	0.393	85.25	161.09	543.5	109.6
East Fork Creek	1320	COASTAL	A	0.1900	57.7000	0.0000	1.390	0.339	0.393	114.00	215.42	814.8	220.4
East Fork Creek	1320	COASTAL	C	0.1900	57.7000	0.0000	1.390	0.339	0.393	211.50	399.67	1511.6	408.8
East Fork Creek	1400	COASTAL	B/D	0.1900	57.7000	0.0000	0.710	0.117	0.431	46.50	96.37	186.2	39.5
East Fork Creek	1700	COASTAL	B/D	0.1900	57.7000	0.0000	0.970	0.125	0.341	14.87	24.38	64.4	11.1
East Fork Creek	1700	COASTAL	D	0.1900	57.7000	0.0000	0.970	0.125	0.341	20.00	32.79	86.6	15
East Fork Creek	1820	COASTAL	A	0.1900	57.7000	0.0000	2.010	0.287	0.289	25.00	34.74	190	31.9
East Fork Creek	1820	COASTAL	B/D	0.1900	57.7000	0.0000	2.010	0.287	0.289	170.75	237.28	1297.7	217.7
East Fork Creek	1820	COASTAL	C	0.1900	57.7000	0.0000	2.010	0.287	0.289	30.00	41.69	228	38.3
East Fork Creek	1820	COASTAL	D	0.1900	57.7000	0.0000	2.010	0.287	0.209	30.00	30.13	164.8	29.2
East Fork Creek	1920	COASTAL	D	0.1900	57.7000	0.0000	0.690	0.036	0.288	232.50	321.97	604.5	75.7
East Fork Creek	3200	COASTAL	A	0.1900	57.7000	0.0000	0.690	0.036	0.262	186.00	234.32	439.9	58.3
East Fork Creek	4130	COASTAL	B/D	0.1900	57.7000	0.0000	0.690	0.036	0.262	82.00	103.30	193.9	25.7
East Fork Creek	4130	COASTAL	D	0.1900	57.7000	0.0000	0.690	0.036	0.262	80.75	101.73	191	25.3
East Fork Creek	5200	COASTAL	B/D	0.1900	57.7000	0.0000	0.510	0.068	0.053	80.75	20.58	28.6	19.2
East Fork Creek	5200	COASTAL	D	0.1900	57.7000	0.0000	0.510	0.068	0.053	82.00	20.90	29	19.4
East Fork Creek	5250	COASTAL	D	0.1900	57.7000	0.0000	0.510	0.068	0.053	267.38	68.14	94.6	63.4
East Fork Creek	6250	COASTAL	B/D	0.1900	57.7000	0.0000	0.610	0.033	0.026	69.75	8.72	14.5	14
East Fork Creek	6250	COASTAL	D	0.1900	57.7000	0.0000	0.610	0.033	0.026	69.75	8.72	14.5	14
East Fork Creek	8100	COASTAL	A	0.1900	57.7000	0.0000	0.990	0.143	0.446	46.50	99.72	268.6	47.6
East Fork Creek	8100	COASTAL	C	0.1900	57.7000	0.0000	0.990	0.143	0.446	6.00	12.87	34.7	6.1
East Fork Creek	8100	COASTAL	B/D	0.1900	57.7000	0.0000	0.990	0.143	0.446	63.75	136.71	368.3	65.3
										2325.00	2997.03	9346.10	1953.90

LAND USES				
1310	High Density - SFR	395.25	17.0%	
1320	High Density - Mobil Home	325.50	14.0%	
1400	Commercial & Services	46.50	2.0%	
1700	Institutional	34.88	1.5%	
1820	Golf courses	255.75	11.0%	
1920	Inactive Land with Street Patterns	232.50	10.0%	
3200	Upland Shrub and Brush Land	186.00	8.0%	
4130	Sand Pine	162.75	7.0%	
5200	Lakes	162.75	7.0%	
5250	Marshy Lake	267.38	11.5%	
6250	Wet Pineland - Hydric Pine	139.50	6.0%	
8100	Transportation	116.25	5.0%	
		2325.00	100%	
		2325.00		

SOIL TYPES		
2	Lawnwood Fine Sand	B/D
4	Waveland Sand	B/D
5	Waveland Sand, Depressiona	D
6	Paola Sand	A
7	St Lucie Sand	A
10	Basinger Fine sand, depressi	B/D
12	St John Variant sand	D
13	Placid sand	B/D
14	Satellite Variant sand	C
21	Pineda sand	D
35	Salerno Sand	B/D
40	Sanibel muck	D
41	Jonathan sand	B
56	wabasso sand	D
64	Eau Gallie Fine sand	D
65	Tuscawilla sand	D