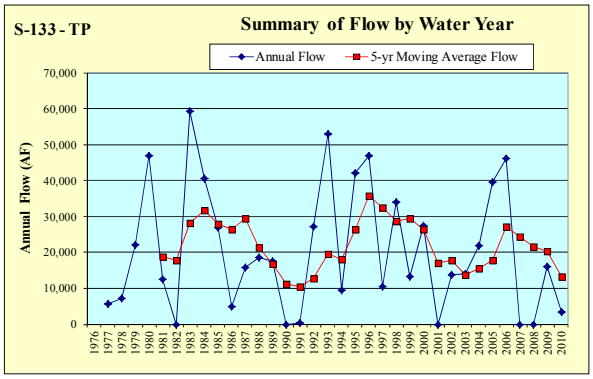
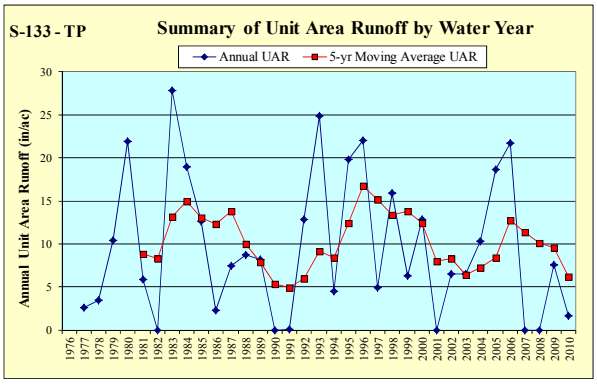
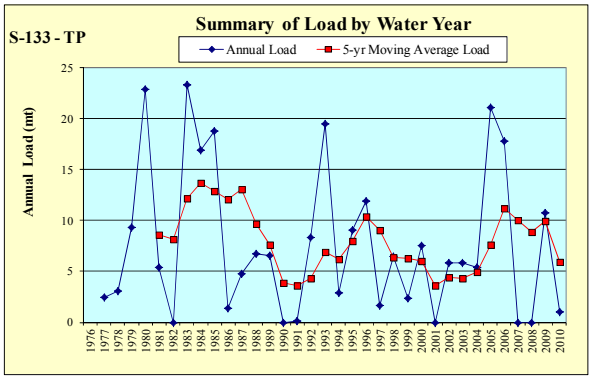
APPENDIX A - SUPPLEMENTAL INFORMATION FOR THE DERIVATION OF THE PERFORMANCE MEASURE METHODOLOGIES FOR THE LAKE OKEECHOBEE WATERSHED

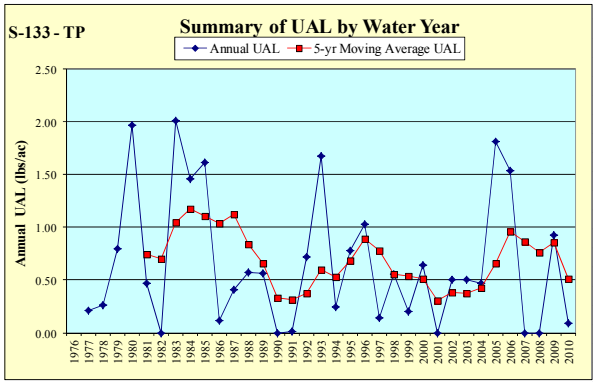
TAYLOR CREEK-NUBBIN SLOUGH SUB-WATERSHED

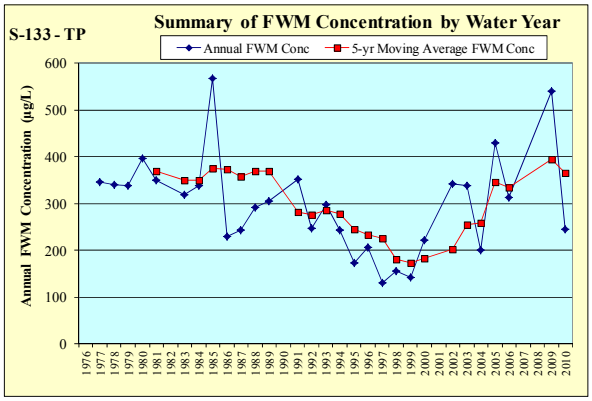
Summary of annual flow, TP and rainfall for S-133 Summary Basin

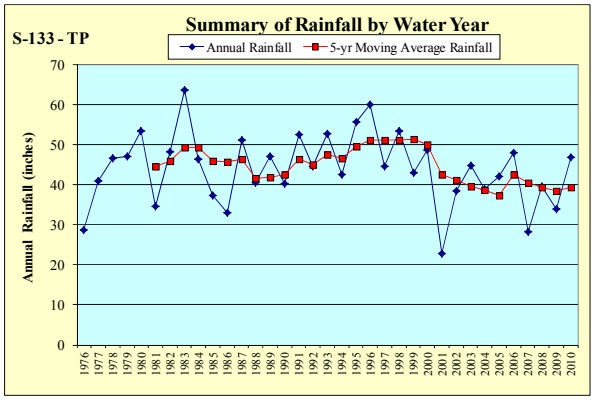




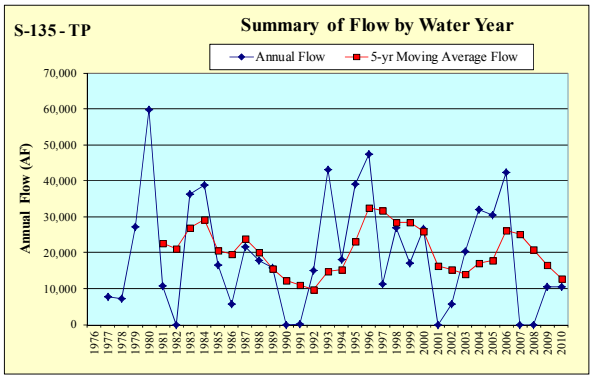


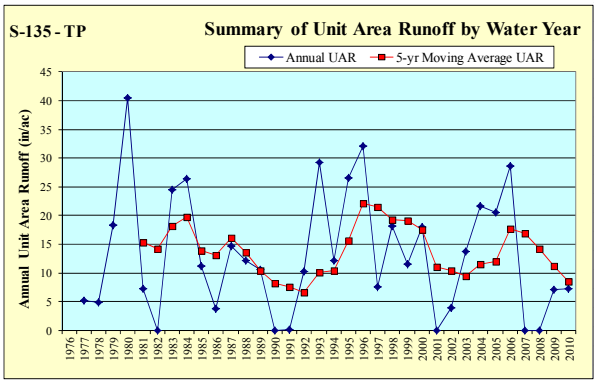


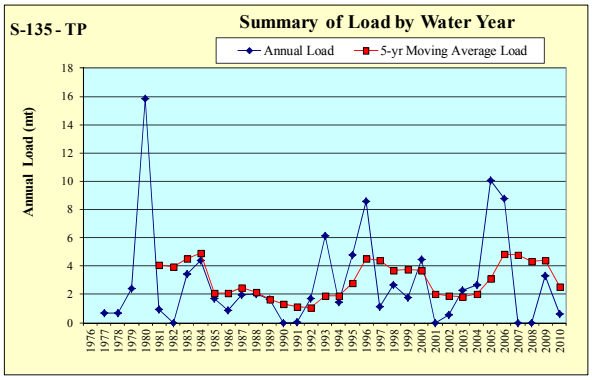


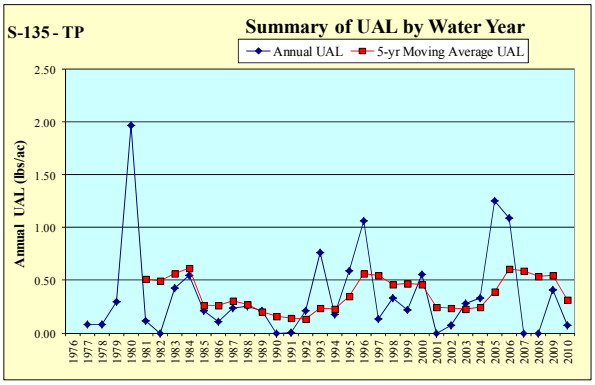


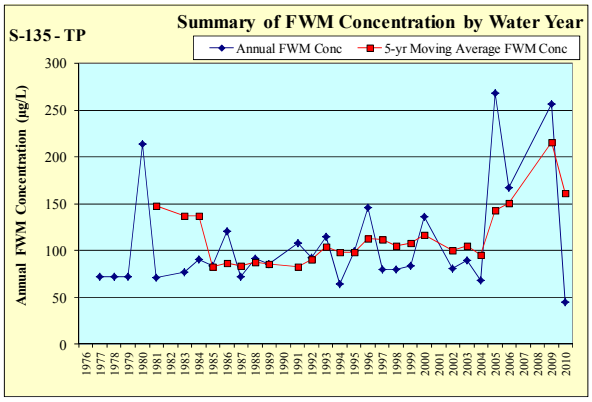
Summary of annual flow, TP and rainfall for S-135 Summary Basin

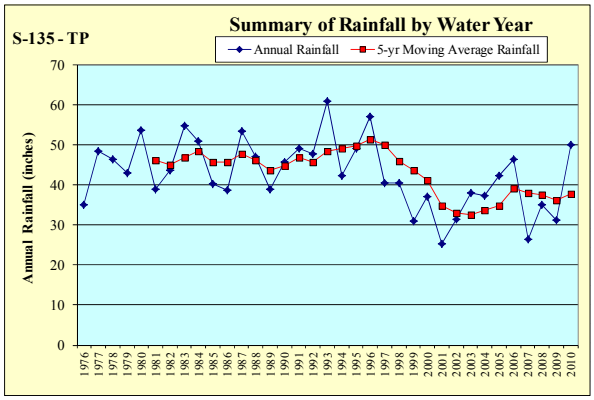












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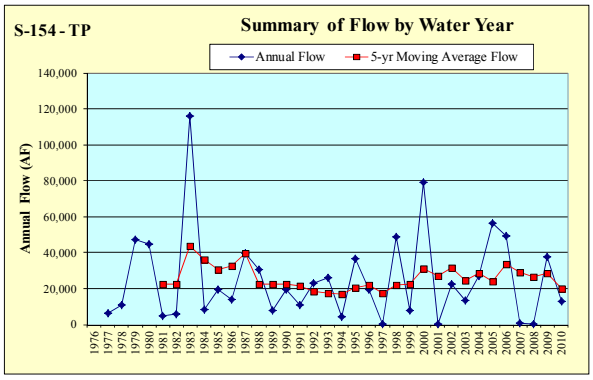
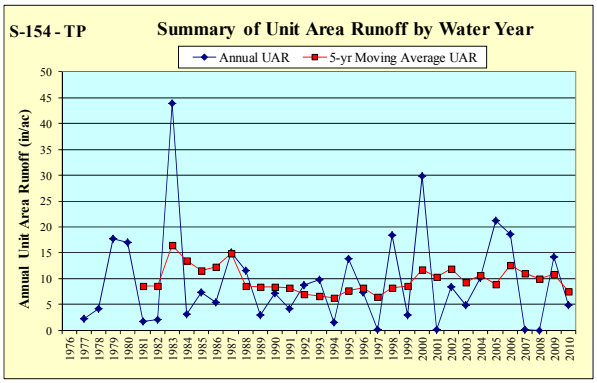
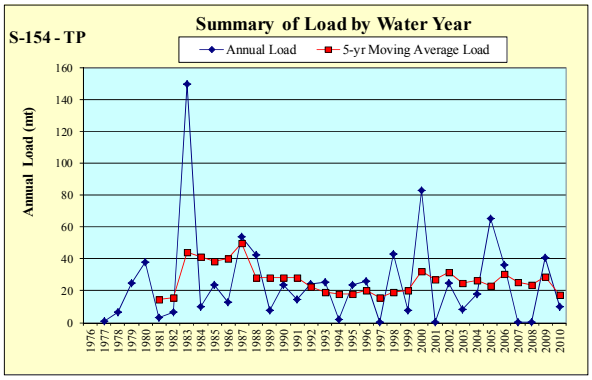
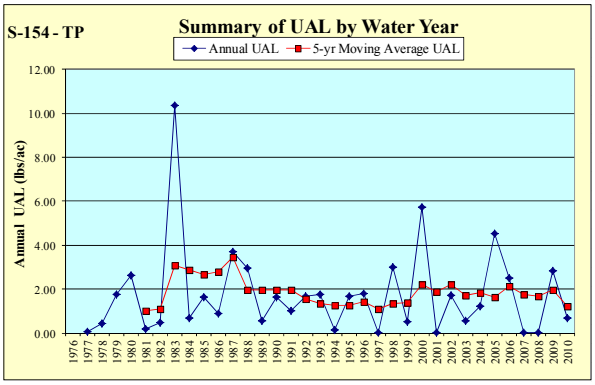
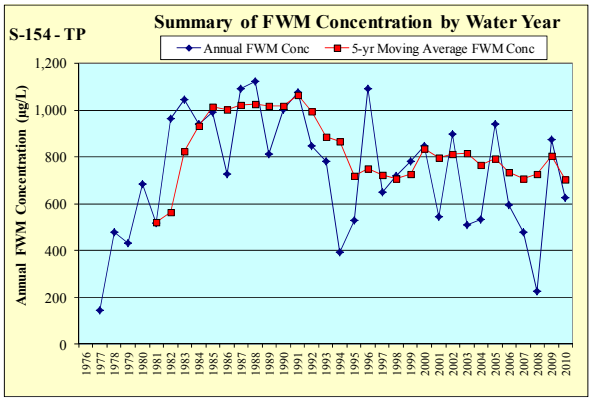
Summary of annual flow, TP and rainfall for S-154 Summary Basin

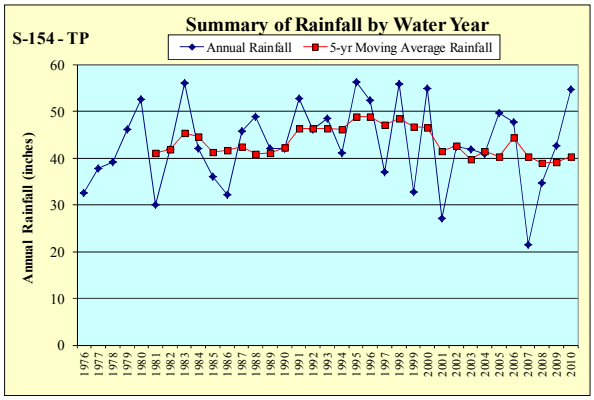












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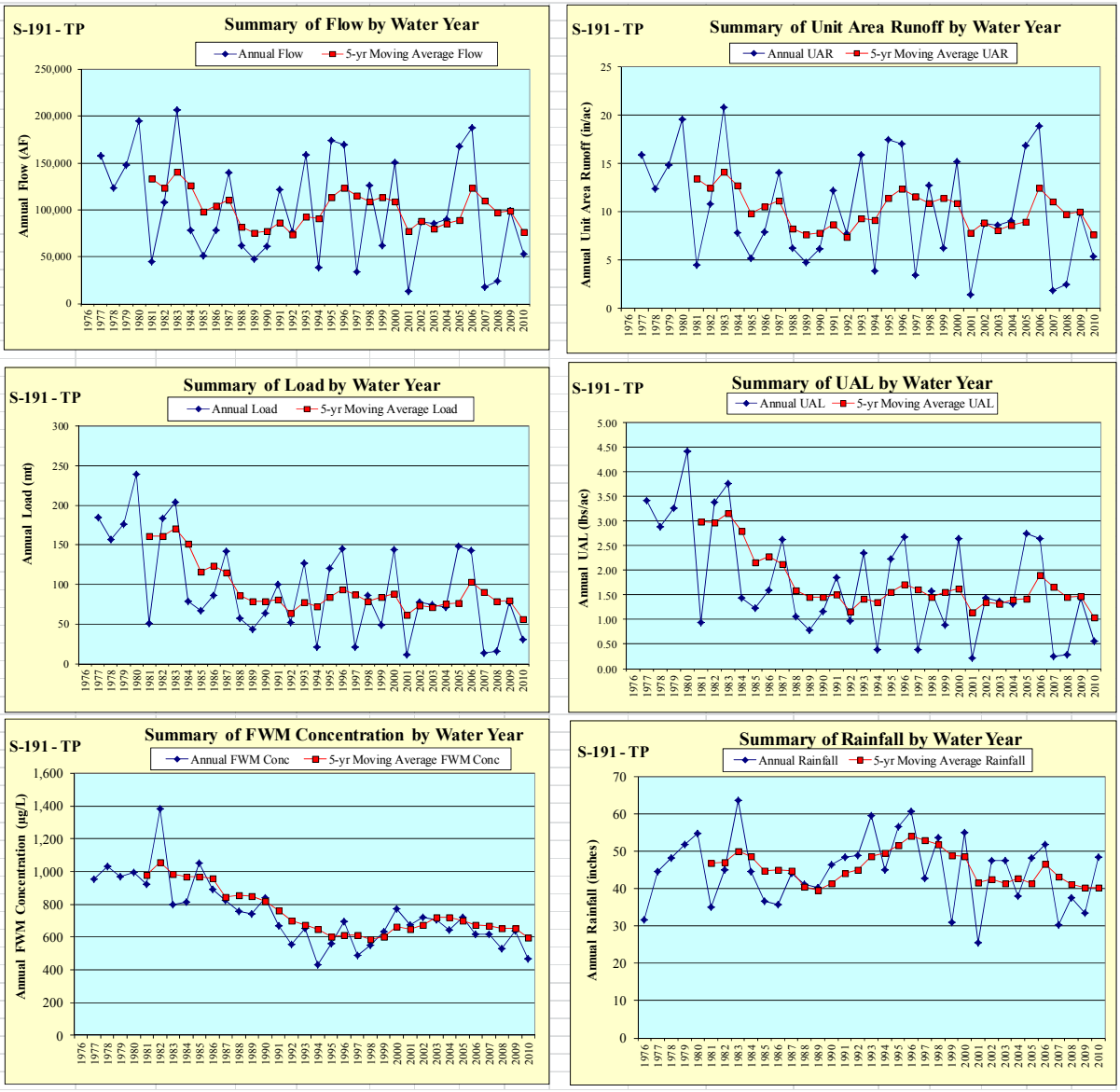
Summary of annual flow, TP and rainfall for S-191 Summary Basin



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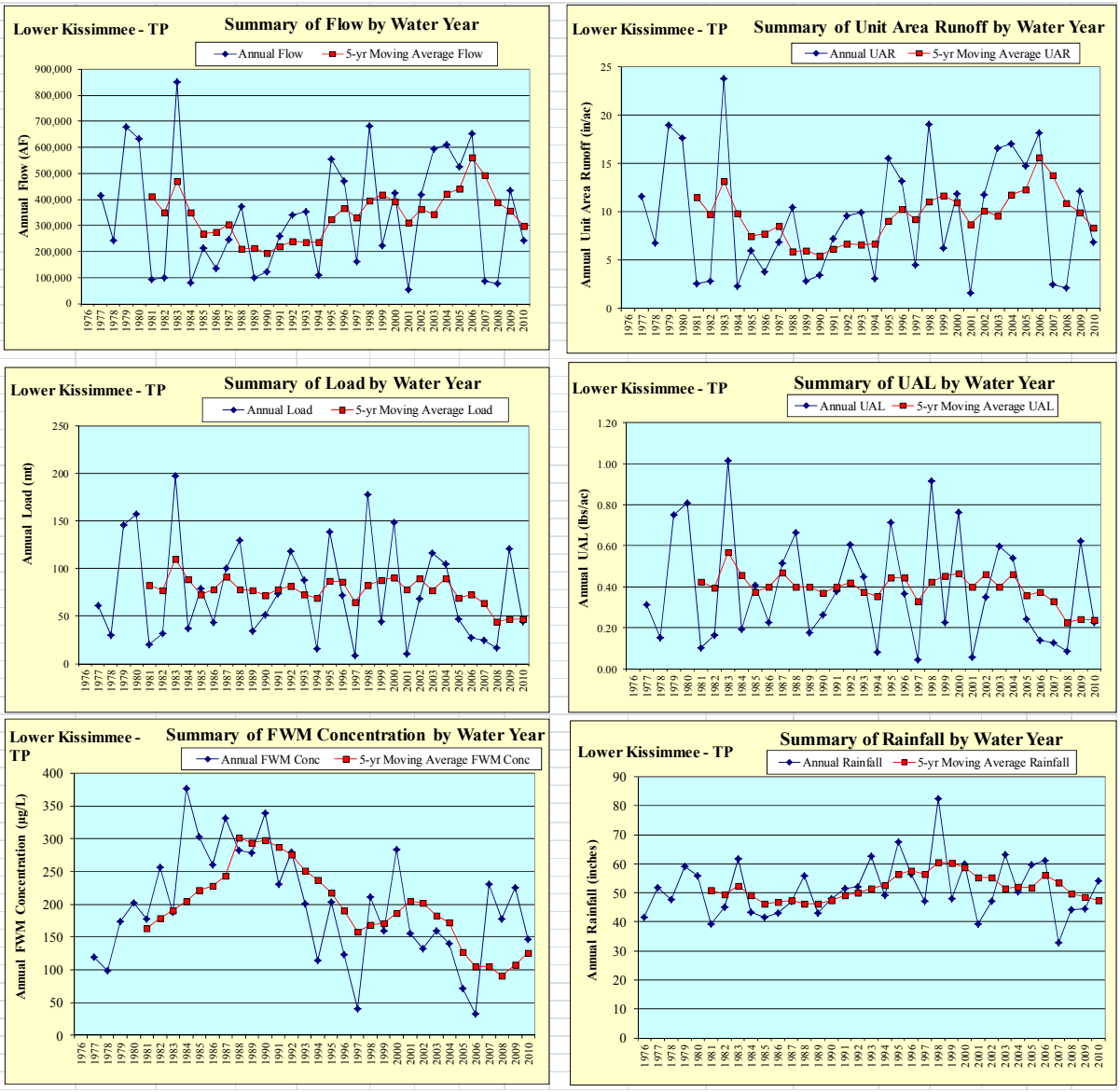
Summary of annual flow, TP and rainfall for the Lower Kissimmee Sub-watershed



Calculation of Net Basin TP Loads for the Lower Kissimmee Sub-watershed

The Lower Kissimmee Sub-watershed receives surface inflows from the Upper Kissimmee Sub-watershed at S-65 and discharges to Lake Okeechobee at S-65E. Some of the inflows from the Upper Kissimmee are retained in the Lower Kissimmee Sub-watershed as a result of evapotranspiration, water supply withdrawals, groundwater recharge, increased storage, etc. The portion of the total inflow from S-65 that is "passed through" the Lower Kissimmee and discharged to Lake Okeechobee is not considered in this evaluation. Only basin flows that are the result of local rainfall and runoff from the Lower Kissimmee Sub-watershed are evaluated in this analysis. (Note: Inflows from Lake Istokpoga via G-85 are limited to leakage through closed culvert stop logs and are considered insignificant.) Basin flows are calculated on a daily basis as follows:

I_{LK} = Total Inflow to the Lower Kissimmee Sub-watershed
= Q_{S-65} = S-65 discharge
O_{LK} = Total Outflow from the Lower Kissimmee Sub-watershed
= Q_{S-65E} = S-65E discharge
PT_{LK} = Pass-through flow
= the portion of S-65 inflow that is passed through the Lower Kissimmee Sub-watershed
= minimum (I_{LK} , O_{LK})
B_{LK} = net basin flow produced by local rainfall and runoff
= $O_{LK} - PT_{LK}$

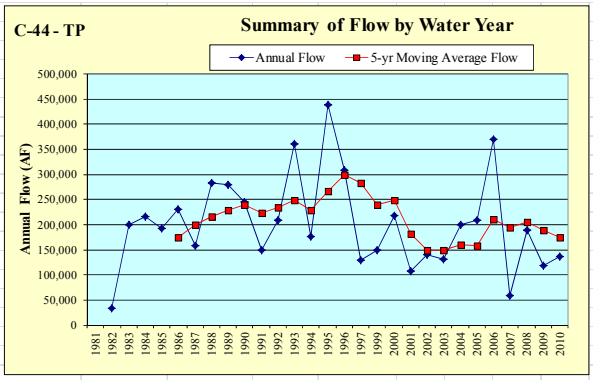
TP loading from the Lower Kissimmee Sub-watershed is the result of direct rainfall and runoff from within the sub-watershed and does not include external TP loading from the Upper Kissimmee Sub-watershed. Lower Kissimmee Sub-watershed basin loading is calculated using the following equations.

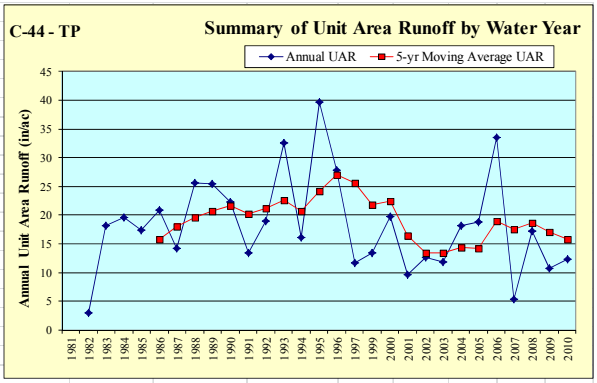
C_{S-65} = S-65 TP concentration
PTL_{LK} = pass through TP load = the portion of S-65 TP load that is passed through the Lower Kissimmee Sub-watershed
= $PT_{LK} * C_{S-65}$
C_{S-65E} = S-65E TP concentration
BL_{LK} = net basin TP loads produced by local rainfall and runoff
= $(Q_{S-65E} * C_{S-65E}) - PTL_{LK}$

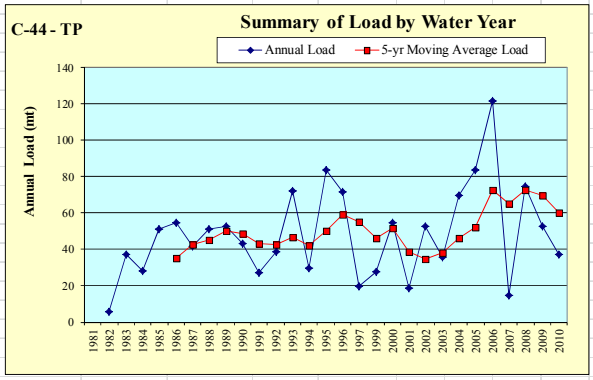
These calculations were performed on a daily time-step and the results were summed to monthly and annual totals.

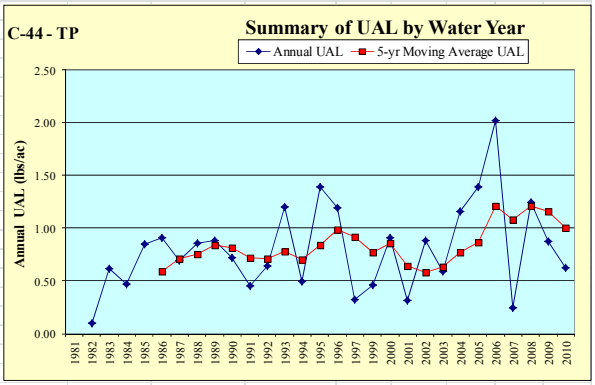
EAST LAKE OKEECHOBEE SUB-WATERSHED

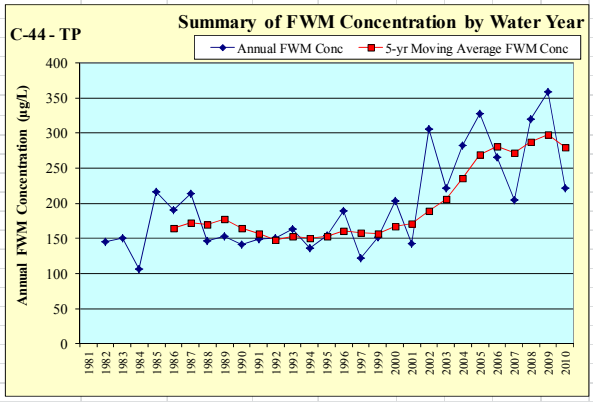
C-44 Hydrologic Unit

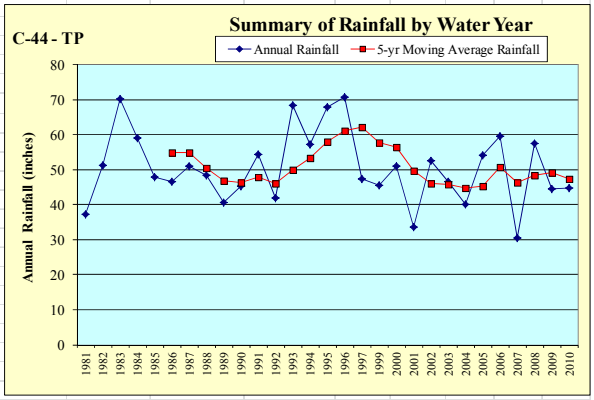












Calculation of Net Basin TP Loads for the C-44 Hydrologic Unit

C-44 Hydrologic Unit Flows

$Q_{S\text{-}308In}$ = S-308 discharges from Lake Okeechobee to C-44
$Q_{S\text{-}308Out}$ = S-308 discharges C-44 to Lake Okeechobee
$Q_{S\text{-}80}$ = S-80 discharges from C-44 to St. Lucie Estuary
$I_{C\text{-}44}$ = total inflow to C-44
= $Q_{S\text{-}308In}$
$O_{C\text{-}44}$ = total outflow from C-44
= $Q_{S\text{-}308Out} + Q_{S\text{-}80}$
$PT_{C\text{-}44}$ = pass-through flow for C-44
= minimum ($I_{C\text{-}44}$, $O_{C\text{-}44}$)
$B_{C\text{-}44}$ = net basin flow produced by local rainfall and runoff
= $O_{C\text{-}44} - PT_{C\text{-}44}$

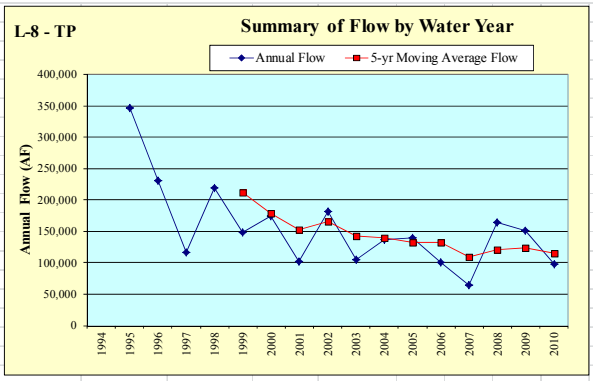
C-44 Hydrologic Unit Loads

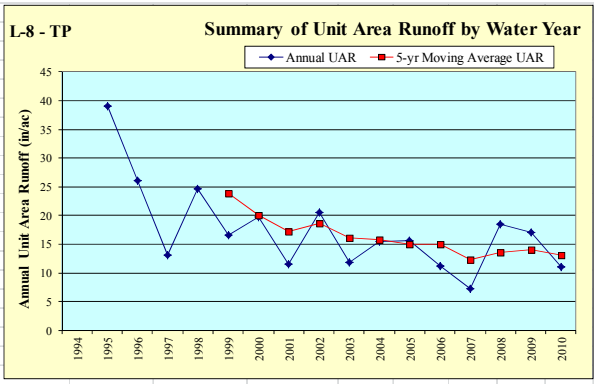
C_{In} = total inflow concentration
= total inflow load to C-44 / total inflow to C-44
= $(Q_{S\text{-}308In} * C_{S\text{-}308In}) / I_{C\text{-}44}$
$PTL_{C\text{-}44}$ = pass-through load for C-44
= $PT_{C\text{-}44} * C_{In}$
$C_{S\text{-}80}$ = S-80 concentration
$C_{S\text{-}308}$ = S-308 concentration
$OL_{C\text{-}44}$ = total outflow load from C-44
= $(Q_{S\text{-}80} * C_{S\text{-}80}) + (Q_{S\text{-}308Out} * C_{S\text{-}308})$
$BL_{C\text{-}44}$ = net basin load produced by local rainfall and runoff
= $OL_{C\text{-}44} - PTL_{C\text{-}44}$

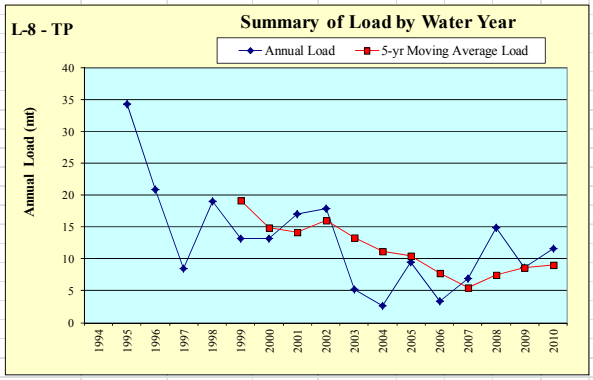
Comments:

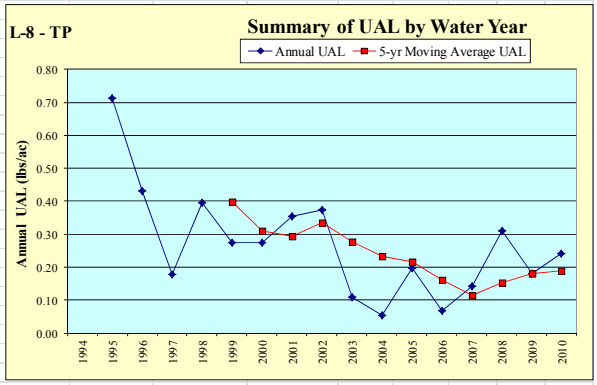
- The outflow concentration at S-308 to Lake Okeechobee ($C_{\mathbf{S\text{-}308}}$) should be the grab concentrations at S-308C, as these reflect discharges from the C-44 into the lake.
- However, the inflow concentrations at S-308 from Lake Okeechobee into the C-44 are the autosampler concentrations at S308C based on meeting with Cheol Mo on August 27, 2010.

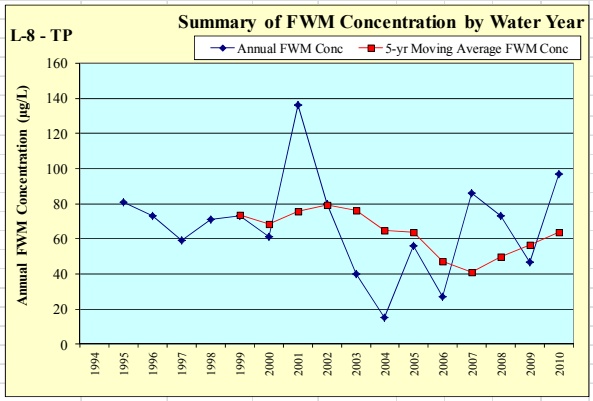
L-8 Summary Basin

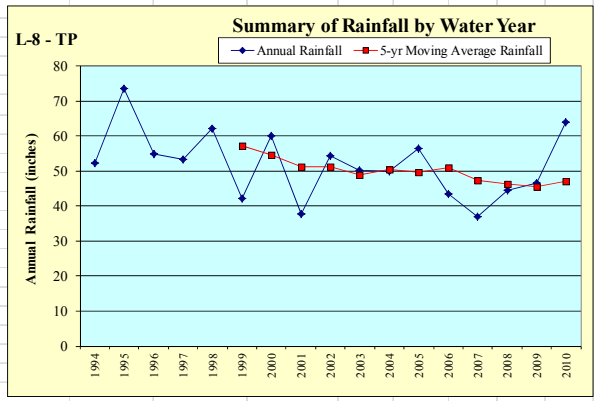












Calculation of Net Basin TP Loads for the L-8 Summary Basin

A combination of stormwater runoff and water supply deliveries are discharged from the L-8 Canal to multiple receiving waters: to Lake Okeechobee at C-10A, to the City of West Palm Beach's water catchment system at Control No. 2, to the EAA at S-5AW, to the WCA-1 at S-5AS, and to the C-51W Canal at S-5AE. The L-8 Summary Basin receives inflows from Lake Okeechobee at C-10A, from WCA-1 at S-5AS, from the C-51W Canal at S-5AE, and from the West Palm Beach Canal in the EAA at S-5AW. Some of the inflows are retained in the basin as a result of evapotranspiration, water supply withdrawals, groundwater recharge, increased storage, etc. The portion of the total inflow that is "passed through" the L-8 Summary Basin and discharged to adjacent waters is not considered basin flow in the evaluation of historical data analyses for the purpose of developing performance measures. Only basin flows that are the result of local rainfall and runoff from the L-8 Summary Basin are considered basin flow in the evaluation of historical data analyses. Following the standard District algorithm, L-8 Summary Basin flows were calculated on a daily basis by initially estimating the pass through volumes as follows:

I_{L-8} = total inflow to the L-8 Summary Basin
= sum [$Q_{S-5AEIn} + Q_{S-5AWIn} + Q_{S-5ASIn} + Q_{C-10AIn}$]
$Q_{S-5AEIn}$ = flow at structure S-5AE into the L-8 Summary Basin
$Q_{S-5AWIn}$ = flow at structure S-5AW into the L-8 Summary Basin
$Q_{S-5ASIn}$ = flow at structure S-5AS into the L-8 Summary Basin
$Q_{C-10AIn}$ = flow at structure C-10A into the L-8 Summary Basin

O_{L-8} = total outflow from the L-8 Summary Basin
= sum [$Q_{S-5AEOut} + Q_{S-5AWOut} + Q_{S-5ASOut} + Q_{C-10AOut} + Q_{WPB2}$]
$Q_{S-5AEOut}$ = flow at structure S-5AE out of the L-8 Summary Basin
$Q_{S-5AWOut}$ = flow at structure S-5AW out of the L-8 Summary Basin
$Q_{S-5ASOut}$ = flow at structure S-5AS out of the L-8 Summary Basin
$Q_{C-10AOut}$ = flow at structure C-10A out of the L-8 Summary Basin
Q_{WPB2} = flow at City of West Palm Beach pump No. 2

PT_{L-8} = pass-through flow
= minimum [I_{L-8} , O_{L-8}]
B_{L-8} = net basin flow produced by local rainfall and runoff
= O_{L-8} - PT_{L-8}

These calculations were performed on a daily basis and the results were summed to monthly and annual totals. Daily flow and TP data were provided by the District. Flow data for the City of West Palm Beach's Control No. 2 was only available beginning May 1994, hence the historical data analysis for the L-8 Summary Basin began at this point in time.

Net Basin TP loading from the L-8 Summary Basin is the result of direct rainfall and runoff from within the summary basin and does not include external TP loading from surrounding basins. Following the standard District algorithm for calculating pass-through loads, the L-8 Summary Basin loading was calculated on a daily basis for each boundary structure using the following algorithms.

PTL_{L-8} = PT_{L-8} * cumulative flow-weighted mean inflow concentration measured at S-5AE, S-5AW, S-5AS and C-10A

C_{L-8In} = [(Q_{S5ASIn} * C_{S5ASIn} + Q_{S5AEIn} * C_{S5AEIn} + Q_{S5AWIn} * C_{S5AWIn} + Q_{C10AIn} * C_{C10AIn}) / I_{L-8}]

PTL_{L-8} = PT_{L-8} * C_{L-8In}

C_{S5ASIn} = S-5AS TP inflow concentration

C_{S5AEIn} = S-5AE TP inflow concentration

C_{S5AWIn} = S-5AW TP inflow concentration

C_{C10AIn} = C-10A TP inflow concentration

O_{L-8} = total outflow load from the L-8 Summary Basin

= $Q_{S5ASOut}$ * $C_{S5ASOut}$ + $Q_{S5AEOut}$ * $C_{S5AEOut}$ + $Q_{S5AWOut}$ * $C_{S5AWOut}$ + $Q_{C10AOut}$ * $C_{C10AOut}$ + Q_{WPB2} * C_{WPB2}

$C_{S5ASOut}$ = S-5AS TP outflow concentration

$C_{S5AEOut}$ = S-5AE TP outflow concentration

$C_{S5AWOut}$ = S-5AW TP outflow concentration

$C_{C10AIOut}$ = C-10A TP outflow concentration

C_{WPB2} = estimated concentration at City of West Palm Beach pump No. 2

= estimated as the cumulative flow-weighted mean inflow concentration measured at S-5AE, S-5AW, S-5AS and C-10A

= C_{L-8In}

BL_{L-8} = net basin TP loads produced by local rainfall and runoff

= OL_{L-8} - PT_{L-8}

These calculations were performed on a daily time-step and the results were summed to monthly and annual total loads.

Algorithm for Estimating TP Loads Discharged from the Southern L-8 Canal Structures (S-5AW, S-5AS, S-5AE): Deriving a Common Daily Time Series of TP Concentrations

1. Using the District's LOAD Program for the period WY1995-2011, daily, monthly and annual flow weighted mean (FWM) TP concentrations for discharges through the S-5AW, S-5AS and S-5AE[23] exhibited considerable heterogeneity, with annual coefficients of variation (standard deviation / mean) ranging up to 1.02 (see **Table A-1** and **Figure A-1**).

2. For structures located as close together as these three, it was expected that there would be a closer range of FWM concentrations[24]. However, the LOAD Program looks only at the specific station in question in establishing an appropriate concentration to apply to the flow, and does not look at adjacent stations. As a result, TP concentrations from grab samples were applied to flow values up to 2,229 days (i.e., more than six years) distant from the date of flow in estimating load (see **Table A-2**).

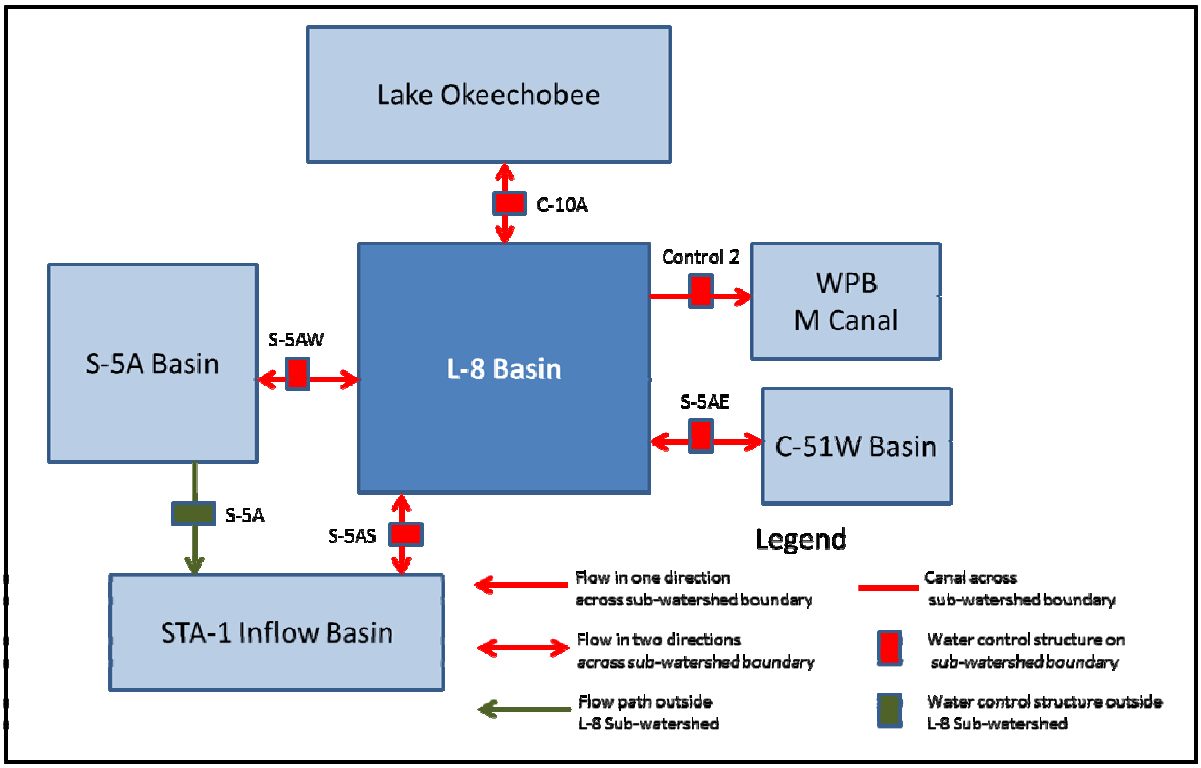
3. An alternative algorithm was investigated to reduce the heterogeneity between the concentrations at these structures, utilizing a common concentration time series for the southern terminus of the L-8 Canal. The time series was derived according to the following procedure.
    a. TP concentrations collected on days when flow occurred at each structure, with the following criteria
        i. S-5AW:
            1. Priority was given to grab samples collected at S-5AW on days with flow.
            2. If a grab sample was not collected at S-5AW on the day with flow, a concurrent grab sample at S-5A was used if the flow at S-5A was less than or equal to the flow from S-5AW, in order to minimize the influence of EAA water quality on the S-5A sample.

[23] Discharge through S-5AW from east to west (to the S-5A Basin); discharge through S-5AS from north to south (to the STA 1 Inflow and Distribution Works); discharge through S-5AE from west to east (to the C-51 West Basin).
[24] A recent decision by the District to eliminate sampling at S-5AS and S-5AW and use samples taken at S-5AE was based on analyses that bear out this expectation.

ii. S-5AE:

1. Within a 14-day window, priority was given to autosampler composite concentrations over grab sample concentration, consistent with the LOAD Program algorithm using the 14-day window option.

Figure A-1. Flow diagram for the L-8 Summary Basin



b. A single daily time series was compiled from the concentrations at the three structures.

i. If values were available at all three stations, an arithmetic average was calculated for that day (note: this concurrent sample collection never occurred).

ii. If values were available for only two structures, an arithmetic average was calculated for that day (note: this occurred 16 days during of the period of record)

iii. If only one value was available, that value was used for that day (note: this occurred 758 days during the period of record).

iv. Concentrations on days prior to the first value were set to the first value.
v. Concentrations on days after the last value were set to the last value.
vi. Concentrations for days with no value were estimated from linear interpolation.

c. The resulting time series was then applied to the daily flow for each structure to calculate a daily TP load.
d. The heterogeneity of daily, monthly and annual FWM TP concentrations was reduced in 13 of the 17 years of record (**Table A-3** and **Figure A-2**).
e. The net effect was to decrease the estimated total TP loads discharged out of the L-8 Canal (see **Table A-4**). Ninety-six (96) percent of the net change in TP loads occurred in WY1995, with most of that (97%) attributed to a revision in the TP loads estimated leaving through S-5AW.
i. S-5AW: a net reduction of 28.848 mt (1.697 mt/yr)
ii. S-5AS: a net reduction of 4.594 mt (0.270 mt/yr)
iii. S-5AE: a net *increase* of 3.593 mt (0.211 mt/yr)

4. The updated data sets for the L-8 Basin utilized this alternative algorithm for estimating TP loads from these three structures.

Calculations are contained in the spreadsheet:
"L-8 Southern Concentrations – 1 5 2012.xlsx" and
"L-8 Basin Flows and Loads – 1 5 2012.xlsx"

Table A-1. Annual FWM TP Concentrations at the Southern L-8 Canal Structures.

Water Year	S-5AW Conc, ppb	S-5AS Conc, ppb	S-5AE Conc, ppb	Total Conc, ppb	Coef. Of Variation
1995	323	84	76	132	0.87
1996	97	109	76	84	0.18
1997	30	0	62	56	1.02
1998	24	145	64	62	0.80
1999	49	171	76	82	0.65
2000	105	184	108	119	0.34
2001	51	49	117	73	0.54
2002	37	59	50	50	0.23
2003	88	137	113	112	0.21
2004	56	169	98	99	0.53
2005	169	180	183	181	0.04
2006	178	181	142	143	0.13
2007	119	0	97	102	0.88
2008	66	181	83	69	0.56
2009	105	0	126	125	0.88
2010	80	181	124	122	0.39
2011	75	0	99	99	0.89
Total	***133***	***127***	***103***	***109***	

Figure A-1. Annual FWM Concentrations Using Standard LOAD Program Algorithm.

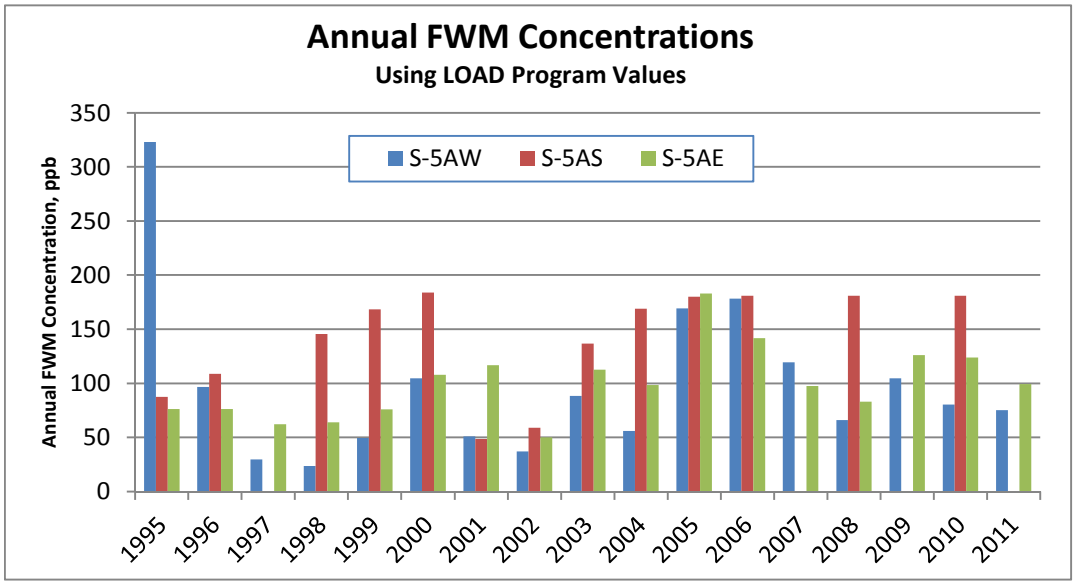


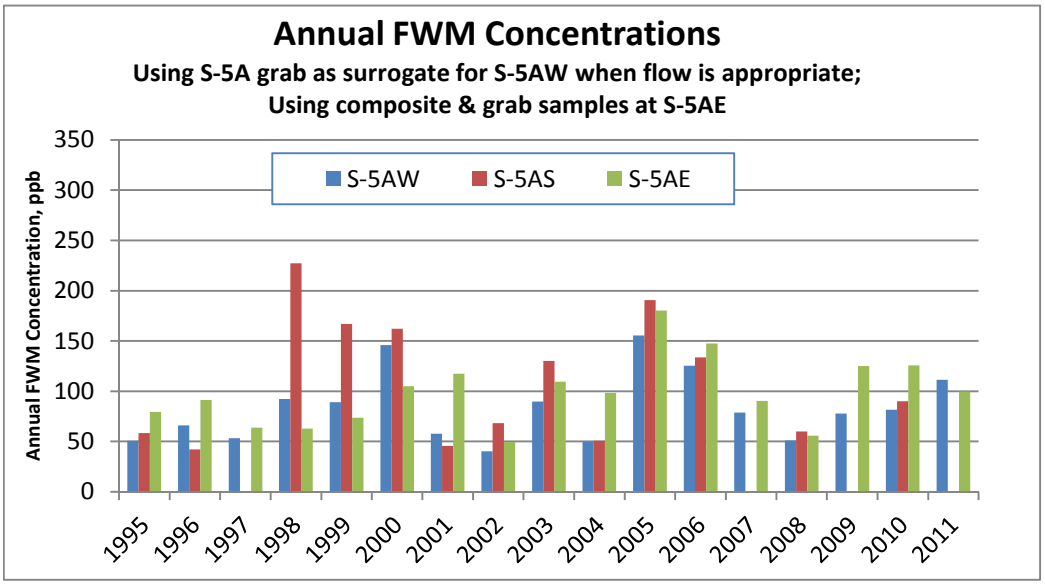
Table A-2. Summary Statistics for Southern L-8 Canal Structures During WY1995-2011.

Station	Days with Flow days	Days with Flow % of POR	Number of grab samples	# of grab samples on days with flow	% of days with flow that have grab samples	% of grab samples on days with flow	Maximum # of days between grab samples on days with flow
S-5AW	729	12%	93	29	4%	31%	602
S-5AS	309	5%	166	6	2%	4%	2294
S-5AE	3669	59%	425	293	8%	69%	532

Table A-3. Annual FWM TP Concentrations at the Southern L-8 Canal Structures, Using Common Time Series of Concentrations.

Water Year	S-5AW Conc, ppb	S-5AS Conc, ppb	S-5AE Conc, ppb	Total Conc, ppb	Coef. Of Variation
1995	51	59	79	70	0.24
1996	66	42	91	81	0.37
1997	53	0	64	62	0.88
1998	92	227	63	66	0.69
1999	89	167	74	84	0.46
2000	146	162	105	121	0.21
2001	58	46	117	76	0.52
2002	40	68	50	51	0.27
2003	90	130	109	109	0.18
2004	50	51	98	97	0.42
2005	155	191	180	177	0.10
2006	125	134	148	147	0.08
2007	79	0	90	88	0.87
2008	51	60	56	52	0.08
2009	78	0	125	122	0.93
2010	82	90	126	124	0.24
2011	111	0	99	100	0.87
Total	***78***	***107***	***104***	***101***	

Figure A-2. Annual FWM Concentrations Using Alternative Algorithm.



5182 **Table A-4. Comparison of Annual TP Loads.**
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Water Year	Original				Using a Composite Daily Time Series			
	S-5AW Load, kg	S-5AS Load, kg	S-5AE Load, kg	Total Load, kg	S-5AW Load, kg	S-5AS Load, kg	S-5AE Load, kg	Total Load, kg
1995	32,759	5,926	21,703	60,388	5,141	4,121	22,526	31,789
1996	12,489	1,402	19,142	33,033	8,520	541	22,858	31,919
1997	721	0	5,879	6,600	1,293	0	6,037	7,330
1998	403	308	14,676	15,386	1,566	481	14,383	16,429
1999	858	2,709	10,586	14,153	1,546	2,645	10,249	14,441
2000	5,120	7,889	20,906	33,915	7,145	6,955	20,364	34,464
2001	1,354	585	2,340	4,280	1,533	549	2,353	4,434
2002	475	888	3,487	4,850	517	1,027	3,451	4,996
2003	1,777	1,529	27,187	30,493	1,803	1,451	26,399	29,653
2004	371	1,096	31,242	32,709	331	329	31,237	31,897
2005	6,748	4,301	35,118	46,167	6,190	4,557	34,574	45,321
2006	256	1,344	40,925	42,525	180	993	42,579	43,751
2007	992	0	3,113	4,105	652	0	2,889	3,541
2008	3,250	197	256	3,703	2,518	65	172	2,755
2009	1,116	0	18,901	20,018	832	0	18,694	19,525
2010	533	0	21,714	22,247	541	0	21,993	22,534
2011	137	0	14,491	14,628	204	0	14,501	14,705
Total	***69,359***	***28,174***	***291,666***	***389,199***	***40,511***	***23,714***	***295,259***	***359,484***
Average	***4,080***	***1,657***	***17,157***	***22,894***	***2,383***	***1,395***	***17,368***	***21,146***
Change from Original				***Total***	***-28,848***	***-4,460***	***3,593***	***-29,715***
				Average	***-1,697***	***-262***	***211***	***-1,748***
Percent Change from Original				***Total***	***-42%***	***-16%***	***1%***	***-8%***
				Average	***-42%***	***-16%***	***1%***	***-8%***

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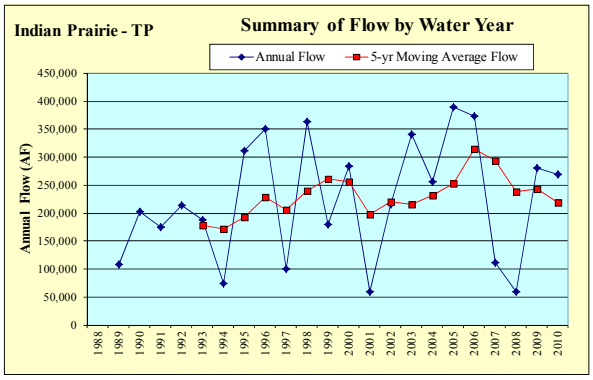
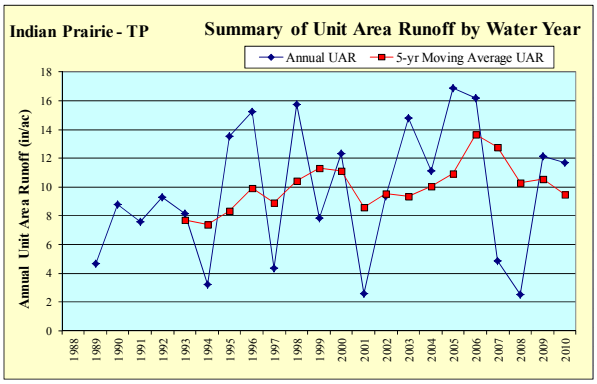
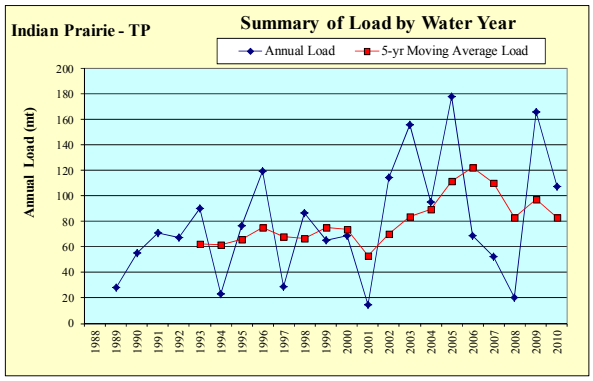
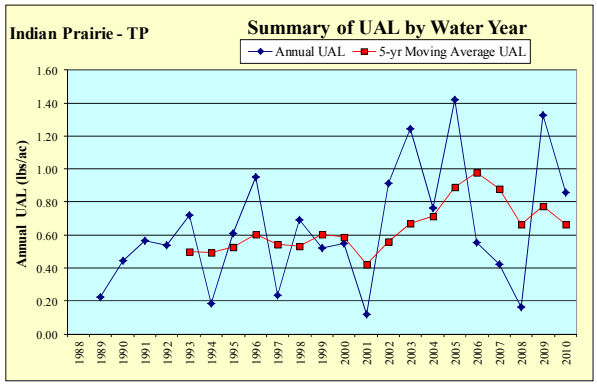
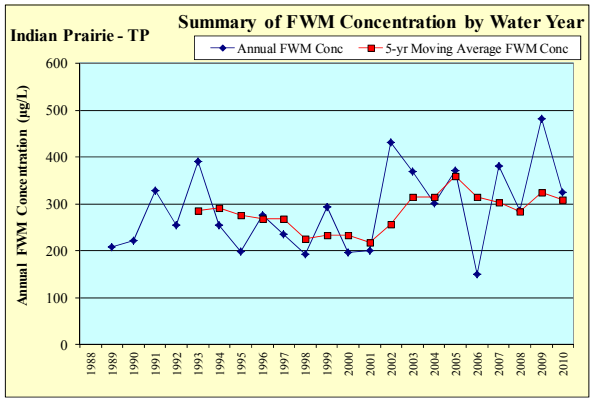
INDIAN PRAIRIE SUB-WATERSHED

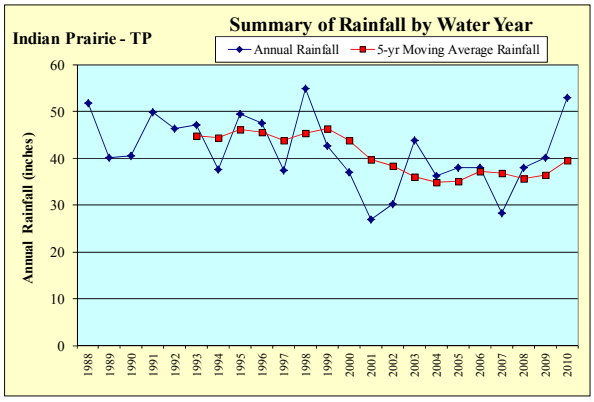












Calculation of Net Basin TP Loads for the Indian Prairie Sub-watershed

I_{IP} = total inflow to the Indian Prairie Sub-watershed
= Q_{S-68}
Q_{S68} = flow at S-68

O_{IP} = total outflow from the Indian Prairie Sub-watershed
= $Q_{S131} + Q_{S71} + Q_{S72} + Q_{S129} + Q_{S127} + Q_{S84} + Q_{LCanal}$
Q_{S131} = flow at S-131
Q_{S71} = flow at S-71
Q_{S72} = flow at S-72
Q_{S129} = flow at S-129[25]
Q_{S127} = flow at S-127
Q_{S84} = flow at S-84
Q_{LCanal} = total flow at L-59E, L-59W, L-60E, L-60W, L-61E, and L-61W

PT_{IP} = pass-through flow
= minimum (I_{IP} , O_{IP})
B_{IP} = net basin flow produced by local rainfall and runoff
= O_{IP} - PT_{IP}

OL_{IP} = total outflow TP load from the Indian Prairie Sub-watershed
= $Q_{S131} * C_{S131} + Q_{S71} * C_{S71} + Q_{S72} * C_{S72} + Q_{S129} * C_{S129} +$
$Q_{S127} * C_{S127} + Q_{S84} * C_{S84} + Q_{LCanal} * C_{LCanal}$
C_{S131} = TP concentration at S-131
C_{S71} = TP concentration at S-71
C_{S72} = TP concentration at S-72
C_{S129} = TP concentration at S-129
C_{S127} = TP concentration at S-127
C_{S84} = TP concentration at S-84

PTL_{IP} = pass through TP load
= $PT_{IP} * C_{S68}$
C_{S68} = TP concentration at S-68

BL_{IP} = net basin load produced by local rainfall and runoff
= $OL_{IP} - PTL_{IP}$

[25] After a review of the S-129 spillway data, it was determined that the negative flows were not reliable, and therefore, they were omitted from the analyses.

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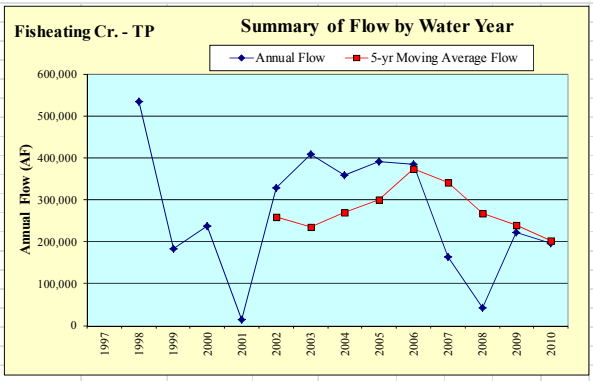
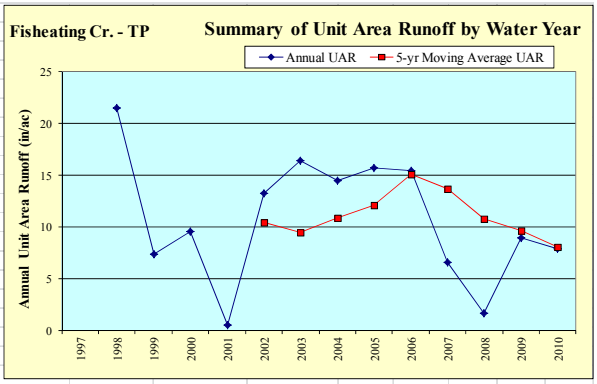
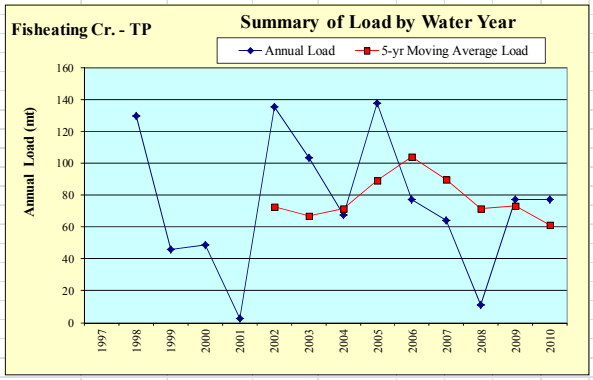
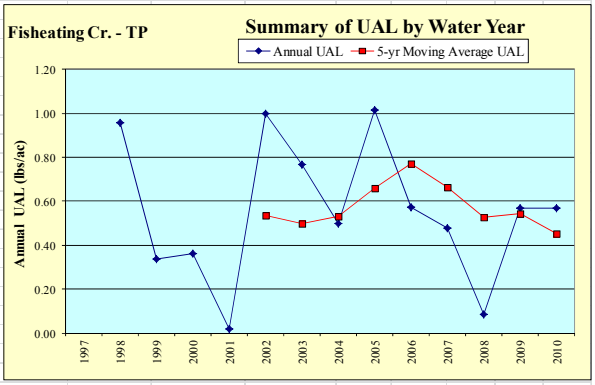
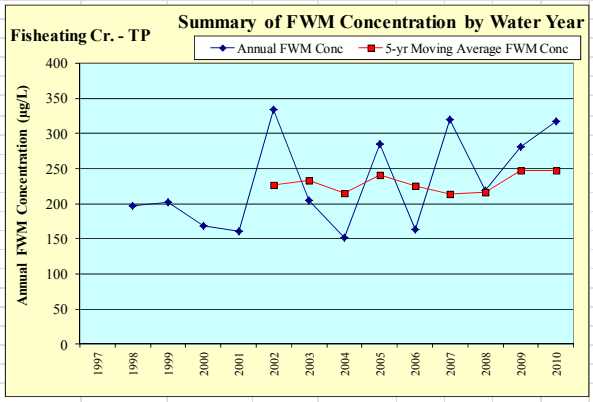
Fisheating Creek Summary Basin

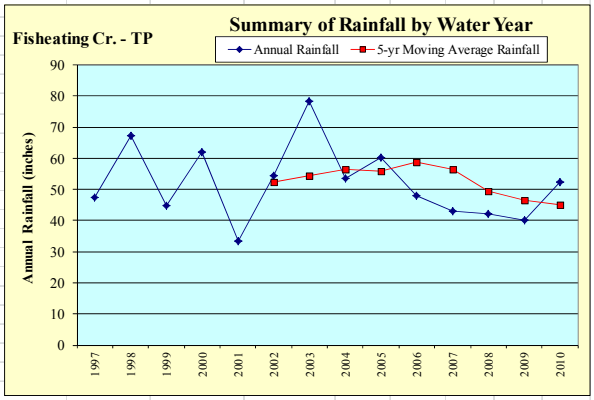












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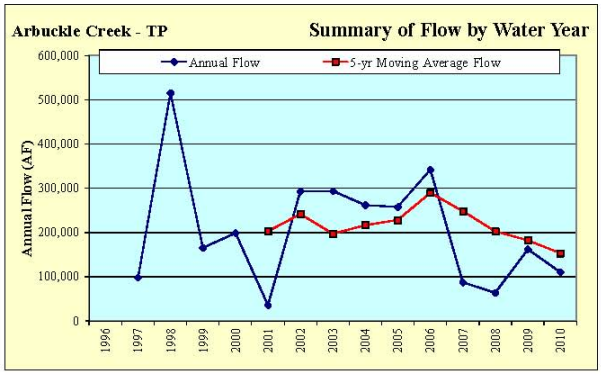
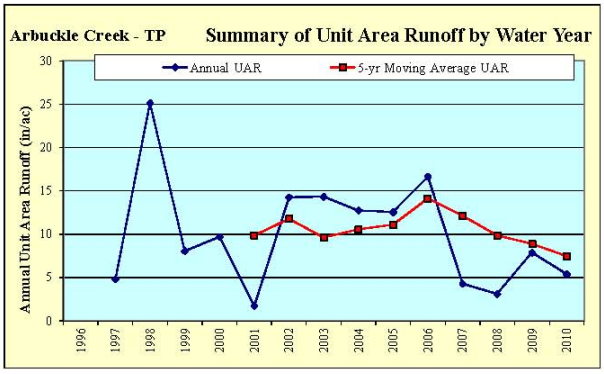
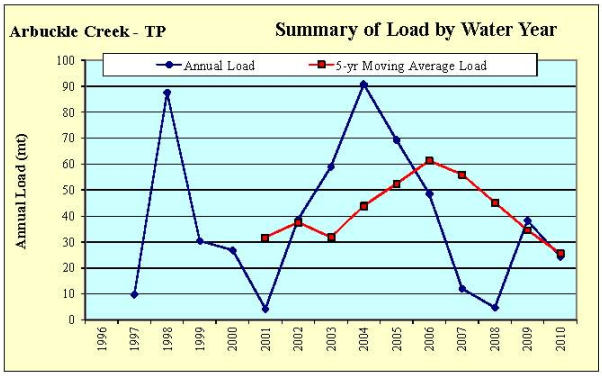
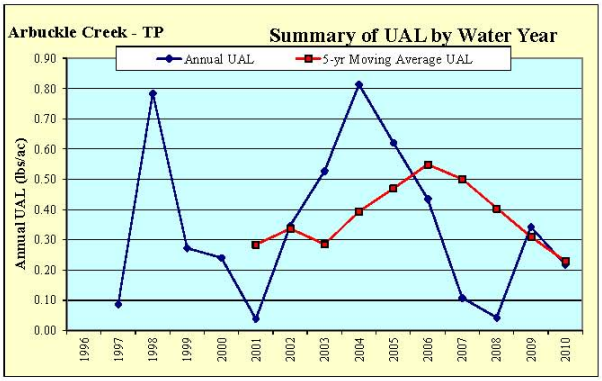
LAKE ISTOKPOGA SUB-WATERSHED

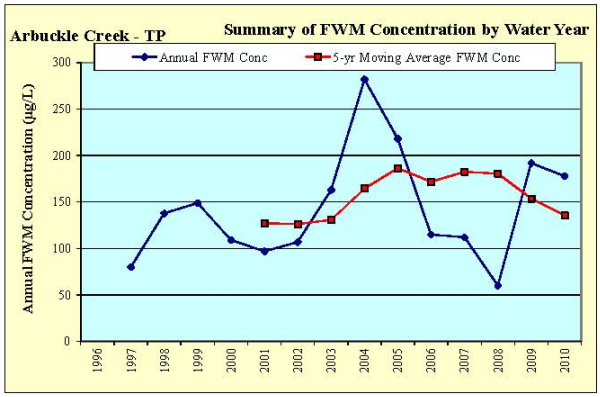
Summary of annual flow, TP and rainfall for Arbuckle Creek

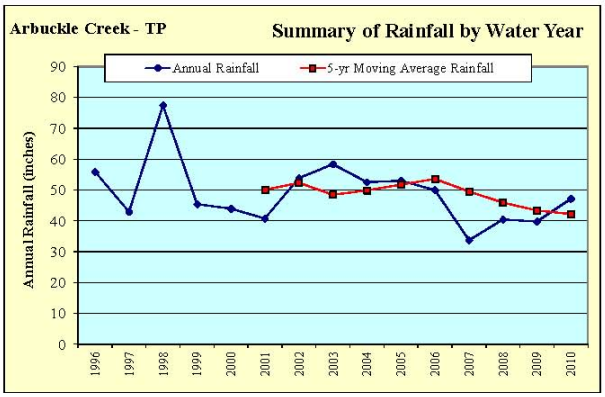




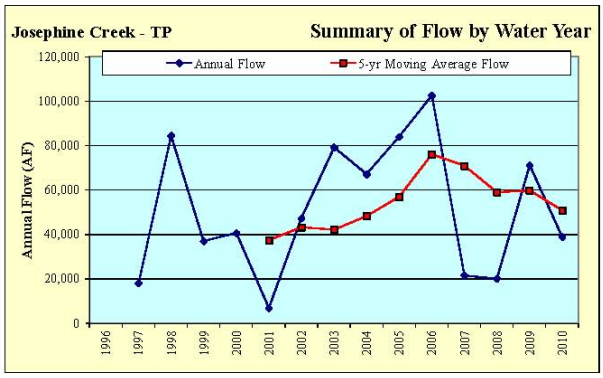


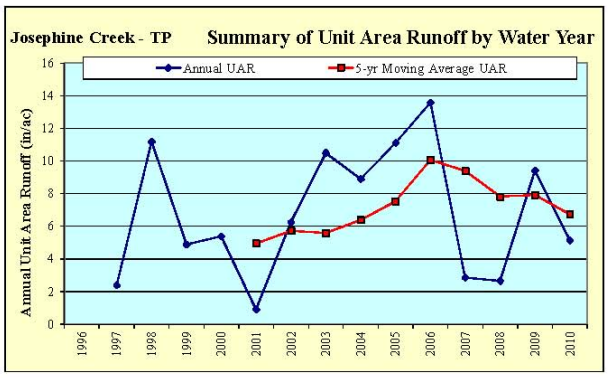


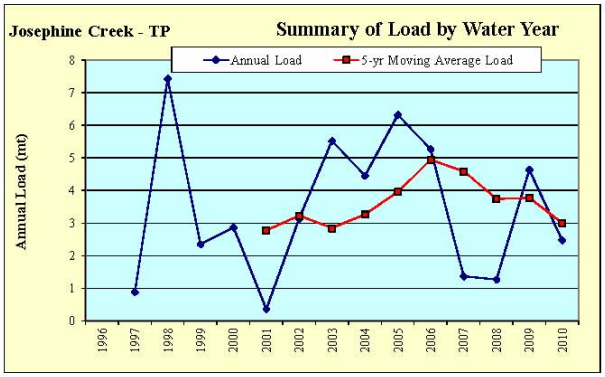


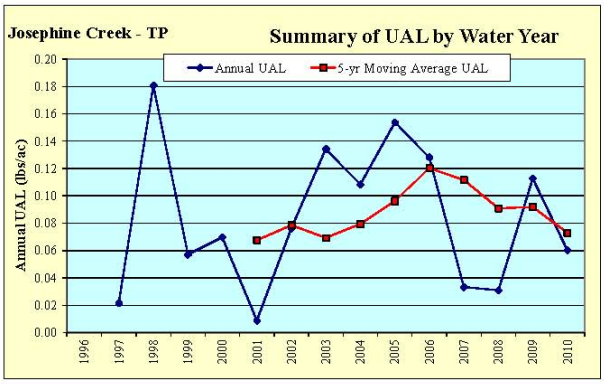


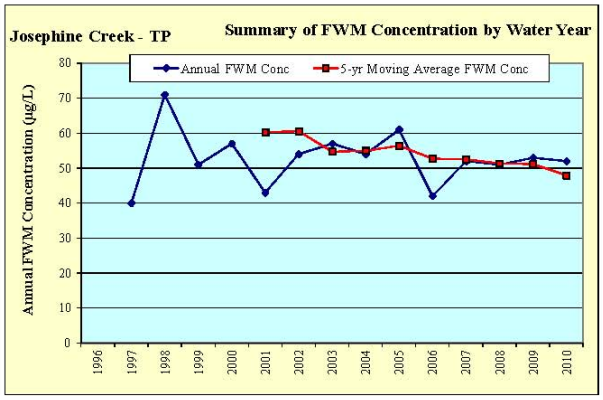
Summary of annual flow, TP and rainfall for Josephine Creek

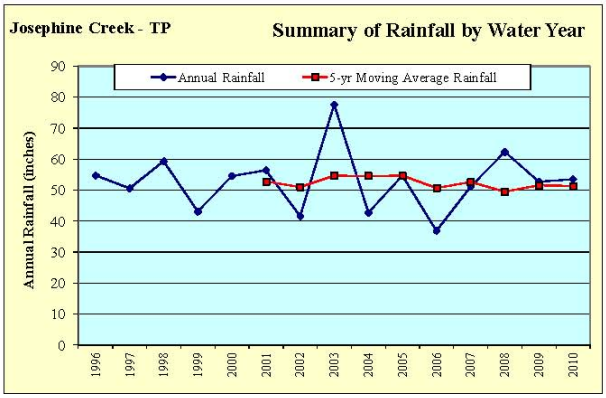






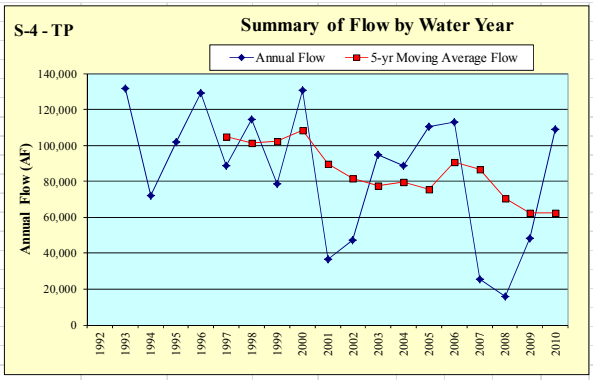


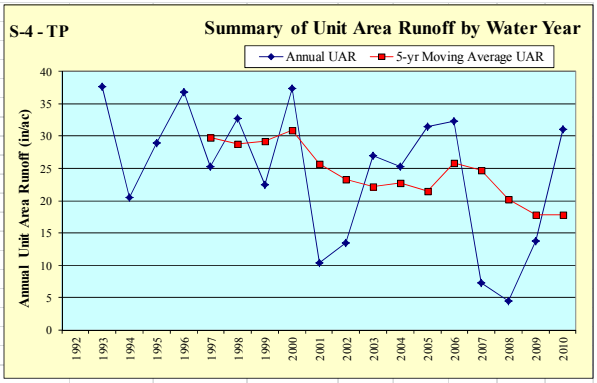


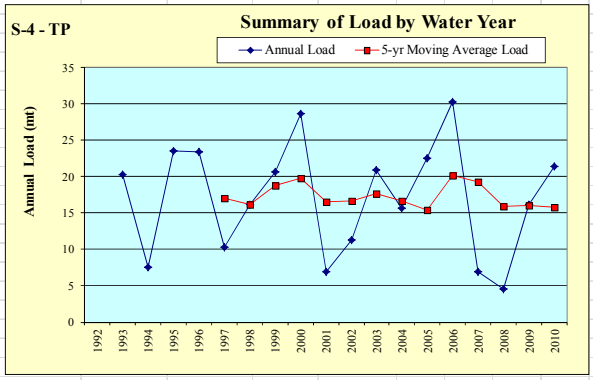


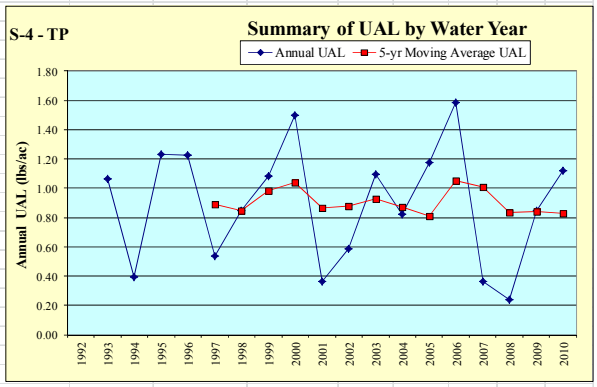
WEST CALOOSAHATCHEE SUB-WATERSHED

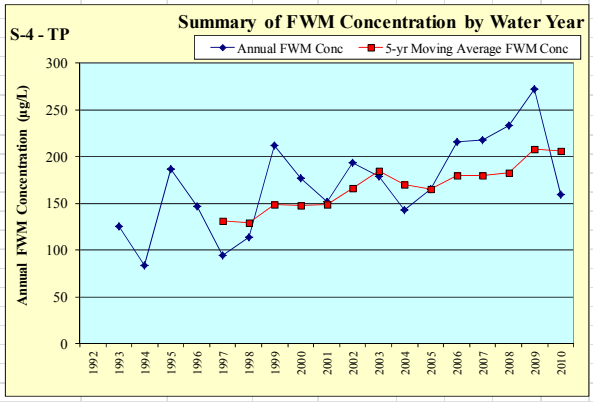
S-4/Industrial Canal Hydrologic Unit

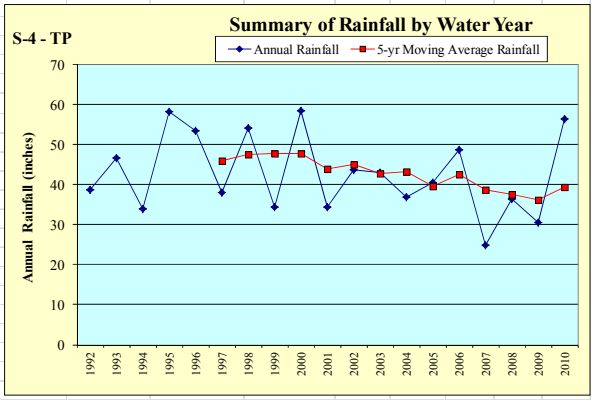












Calculation of Net Basin TP Loads for the S-4/Industrial Canal Hydrologic Unit

The S-4/Industrial Canal Hydrologic Unit receives inflows from Lake Okeechobee, the East Caloosahatchee Hydrologic Unit, and from Unit 5 of the South Florida Conservancy District (EPD-07 of the SFCD). The S-4/Industrial Canal Hydrologic Unit discharges to Lake Okeechobee and the East Caloosahatchee Hydrologic Unit. Some or all of the total inflows to the S-4/Industrial Canal Hydrologic Unit may be retained in the basin as a result of meeting agricultural and urban water supply demands, evapotranspiration, groundwater infiltration, or increasing internal storage. Pass-through flows and loads are the portion of the total inflows that are discharged from the hydrologic unit. Because S-169 controls flow between the S-4 Sub-basin and the Industrial Canal Sub-basin, flow through S-169 must be considered in the calculation of the hydrologic unit's pass-through flows and loads. Failure to do so will result in overestimates of pass through, e.g., on days when S-169 is closed, inflows to the hydrologic unit through S-310 cannot physically reach S-235 and therefore, cannot contribute to pass through at that structure. Basin flows and loads result from rainfall and runoff from the hydrologic unit and do not include pass-through flows and loads.

In order to properly account for the S-169 operations, it's necessary to make a minor modification to the standard algorithm for calculating pass-through flows and loads. Pass-through flows are calculated using applicable algorithms for four operational conditions:

1. On days when the total inflows or total outflows are zero;
2. On days when the total inflows and total outflows are nonzero and S-169 is closed;
3. On days when the total inflows and total outflows are nonzero and S-169 is discharging from the Industrial Canal Sub-basin to the S-4 Sub-basin (positive flow values in DBHYDRO);
4. On days when the total inflows and total outflows are nonzero and S-169 is discharging from the S-4 Sub-basin to the Industrial Canal Sub-basin (negative flow values in DBHYDRO);

The following equations describe how pass-through flows are calculated for each of these conditions.

1. If

$$\text{Total Inflow} = Q_{S310In} + Q_{EPD07} + Q_{S235In} = 0$$

or

$$\text{Total Outflow} = Q_{S310Out} + Q_{S4} + Q_{S235Out} = 0$$

then

$$PT_{S4IC} = \text{pass-through flow} = 0$$

where Q_{S310In} = Discharges at S-310 from Lake Okeechobee to the Industrial Canal
$Q_{S310Out}$ = Discharges at S-310 from the Industrial Canal to Lake Okeechobee
Q_{S235In} = Discharges at S-235 from the East Caloosahatchee Hydrologic Unit to the S-4 Sub-basin

$Q_{S235Out}$ = Discharges at S-235 from the S-4 Sub-basin to the East Caloosahatchee Hydrologic Unit
Q_{EPD07} = Discharges at pump station EPD-07 from SFCD to the Industrial Canal
Q_{S4} = Discharges at S-4 from the S-4 Sub-basin to Lake Okeechobee
PT_{S4IC} = Portion of the total inflow to the S-4/Industrial Canal Hydrologic Unit that is discharged from the hydrologic unit
Notes: $Q_{S4}$is unidirectional out of the hydrologic unit
Q_{EPD07} is unidirectional into the hydrologic unit

2. If

$$\text{Total Inflow} > 0$$

and

$$\text{Total Outflow} > 0$$

and

$$Q_{S169West} = 0$$

and

$$Q_{S169East} = 0$$

then

$$PT_{S4} = \text{minimum}\ (Q_{S235In}\ ,\ Q_{S4})$$
$$PT_{IC} = \text{minimum}\ (Q_{EPD07},\ Q_{S310Out})$$
$$PT_{S4IC} = PT_{S4} + PT_{IC}$$

where $Q_{S169West}$ = Discharges at S-169 from the Industrial Canal to the S-4 Sub-basin
$Q_{S169East}$ = Discharges at S-169 from the S-4 Sub-basin to the Industrial Canal Sub-basin
PT_{S4} = Portion of the total inflow to the S-4 Sub-basin that is discharged from the Sub-basin
PT_{IC} = Portion of the total inflow to the Industrial Canal Sub-basin that is discharged from the Sub-basin

3. If

$$\text{Total Inflow} > 0$$

and

$$\text{Total Outflow} > 0$$

and

$$Q_{S169West} > 0$$

then

$$PT_{IC} = \text{minimum}\ (Q_{S310In} + Q_{EPD07}\ ,\ Q_{S310Out})$$
$$PT_{S4} = \text{minimum}\ (Q_{S235In} + \text{minimum}\ (Q_{S169West}\ ,\ (Q_{S310In} + Q_{EPD07} - PT_{IC}))\ ,\ (Q_{S4} + Q_{S235Out}))$$
$$PT_{S4IC} = PT_{S4} + PT_{IC}$$

4. If

$$\text{Total Inflow} > 0$$

and

$$\text{Total Outflow} > 0$$

and

$$Q_{S169East} > 0$$

then

$$PT_{S4} = \text{minimum}\ (Q_{S235In}\ ,\ Q_{S4} + Q_{S235Out}\ )$$

$$PT_{IC} = \text{minimum}\ (Q_{S310In} + Q_{EPD07} + \text{minimum}\ (Q_{S169East}\ ,\ (Q_{S235In} - PT_{S4}), Q_{S310Out})$$

$$PT_{S4IC} = PT_{S4} + PT_{IC}$$

For all conditions,

B_{S4IC} = net basin flow produced by local rainfall and runoff
= $O_{S4IC} - PT_{S4IC}$

All calculations were performed on a daily time step and then summed to monthly and annual totals.

Pass through TP loads are calculated using the appropriate hydrologic unit flow weighted inflow concentrations, based on the applicable algorithms for the following three S-169 flow conditions:

1. On days when S-169 is closed;
2. On days when S-169 discharges to the west, from the Industrial Canal to the S-4 Sub-basin; and
3. On days when S-169 discharges to the east, from the S-4 Sub-basin to the Industrial Canal.

The following algorithms are used for the three conditions described above:

1. If

$$Q_{S169West} = Q_{S169East} = 0$$

Then

$$PTL_{IC} = PT_{IC} * C_{EPD07}$$

$$PTL_{S4} = PT_{S4} * C_{S235In}$$

$$PTL_{S4IC} = PTL_{IC} + PTL_{S4}$$

where PTL_{IC} = Portion of the total inflow load to the Industrial Canal Sub-basin that is discharged from the Sub-basin
C_{EPD07} = Concentration of discharges at pump station EPD-07
PTL_{S4} = Portion of the total inflow load to the S-4 Sub-basin that is discharged from the Sub-basin
C_{S235In} = Concentration of S-235 discharges from the East Caloosahatchee Hydrologic Unit to the S-4 Sub-basin
PTL_{S4IC} = Portion of the total inflow load to the S-4/Industrial Canal Hydrologic Unit that is discharged from the Hydrologic Unit

2. If

$$Q_{S169West} > 0$$

Then

$$PTL_{IC} = PT_{IC} * C_{EPD07}$$

$$PTC_{S4} = (Q_{S235In} * C_{S235In} + Q_{EPD07} * C_{EPD07} + Q_{S310In} * C_{S310In}) / (Q_{S235In} + Q_{EPD07} + Q_{S310In})$$

$$PTL_{S4} = PT_{S4} * PTC_{S4}$$

$$PTL_{S4IC} = PTL_{IC} + PTL_{S4}$$

where PTC_{S4} = Flow weighted inflow concentration of S-4 Sub-basin

C_{S235In} = Concentration of flows at S-235 from East Caloosahatchee Hydrologic Unit to the S-4 Sub-basin

C_{EPDO7} = Concentration discharged at pump station EPD-07 into the Industrial Canal Sub-basin

C_{S310In} = Concentration discharged at S-310 from Lake Okeechobee into the Industrial Canal Sub-basin

3. If

$$Q_{S169East} > 0$$

Then

$$PTL_{IC}=PT_{IC} * (Q_{S235In} * C_{S235In} + Q_{EPD07} * C_{EPD07}) / (Q_{S235In} + Q_{EPD07})$$

$$PTL_{S4} = PT_{S4} * C_{S235In}$$

$$PTL_{S4IC} = PTL_{IC} + PTL_{S4}$$

Once the pass-through loads are calculated, the hydrologic unit's net basin loads are calculated by subtracting pass-through loads from the total outflow loads as follows:

BL_{S4IC} = net basin load produced by local rainfall and runoff
= $OL_{S4IC} - PTL_{S4IC}$

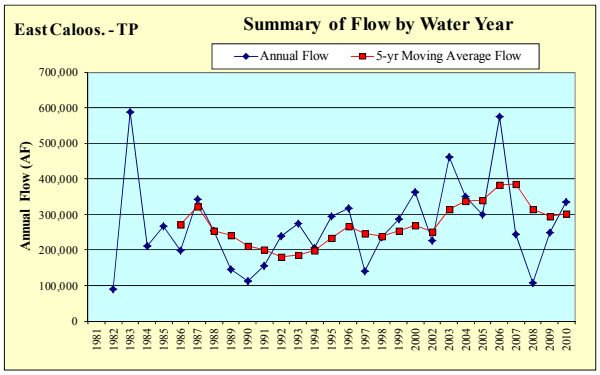
OL_{S4IC} = $OL_{S235} + OL_{S4} + OL_{S310Out}$

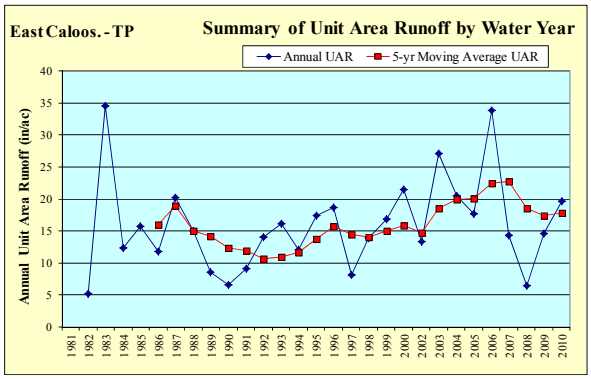
OL_{S235} = load discharged at S-235 to the East Caloosahatchee Hydrologic Unit

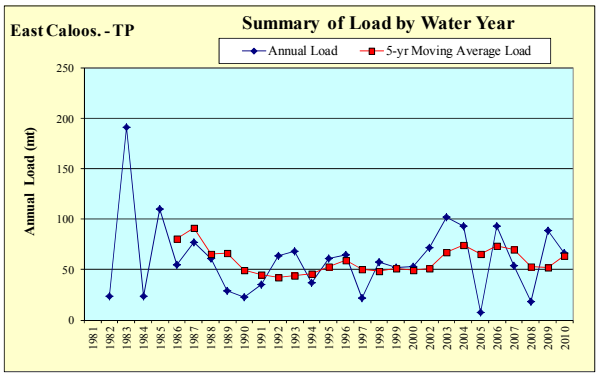
OL_{S4} = load discharged at S-4 to Lake Okeechobee

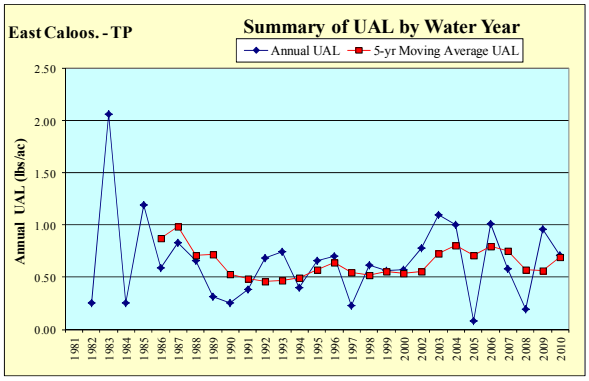
$OL_{S310Out}$ = load discharged at S-310 to Lake Okeechobee

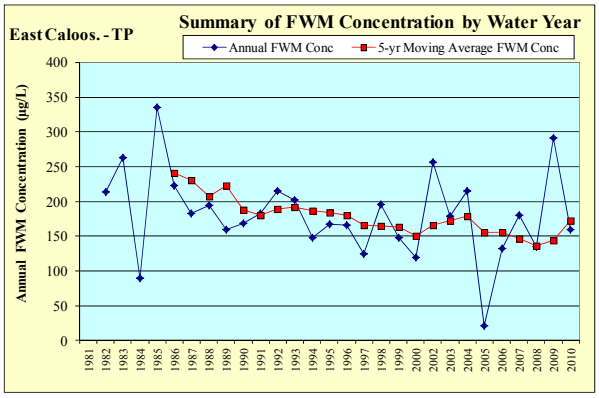
East Caloosahatchee Hydrologic Unit

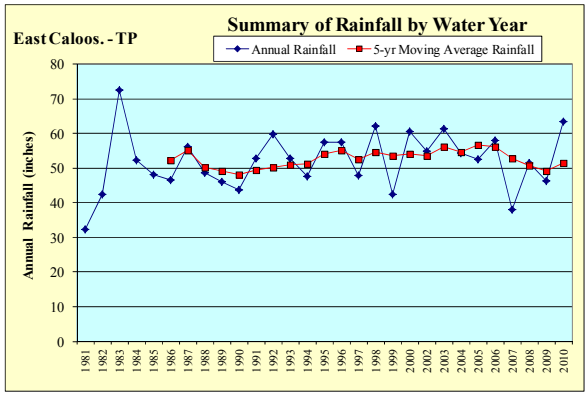












Calculation of Net Basin TP Loads for the East Caloosahatchee Hydrologic Unit

East Caloosahatchee Hydrologic Unit Flows

I_{EC} = total inflow to the East Caloosahatchee Hydrologic Unit
= $Q_{S77In} + Q_{S235In}$
$QS77_{In}$ = S-77 discharges from Lake Okeechobee into C-43
$QS235_{In}$ = S-235 discharges from the L-D3 Canal into C-43

O_{EC} = total outflow from the East Caloosahatchee Hydrologic Unit
= $Q_{S77Out} + Q_{S235Out} + Q_{S78}$
Q_{S77Out} = S-77 discharges from C-43 into Lake Okeechobee
$Q_{S235Out}$ = S-235 discharges from C-43 into the L-D3 Canal
Q_{S78} = S-78 discharges

PT_{EC} = pass through flow
= minimum (I_{EC} , O_{EC})

B_{EC} = net basin flow produced by local rainfall and runoff
= O_{EC} - PT_{EC}

East Caloosahatchee Hydrologic Unit Loads

OL_{EC} = total outflow TP load
= $Q_{S77Out} * C_{S77Out} + Q_{S235Out} * C_{S235Out} + Q_{S78} * C_{S78}$
C_{S77Out} = S-77 TP outflow concentration
$C_{S235Out}$ = S-235 TP outflow concentration
C_{S78} = S-78 TP concentration

PTL_{EC} = pass through TP load
= $PT_{EC} * C_{In}$
C_{In} = cumulative flow weighted mean inflow concentration
= ($Q_{S77In} * C_{S77In} + Q_{S235In} * C_{S235In}$) / I_{EC}

BL_{EC} = net basin load produced by local rainfall and runoff
= OL_{EC} - PTL_{EC}
C_{S77In} = S-77 TP inflow concentration
C_{S235In} = S-235 TP inflow concentration

5454 **UPPER KISSIMMEE SUB-WATERSHED**

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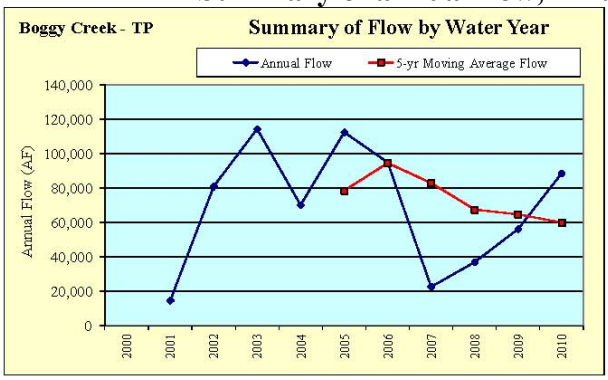
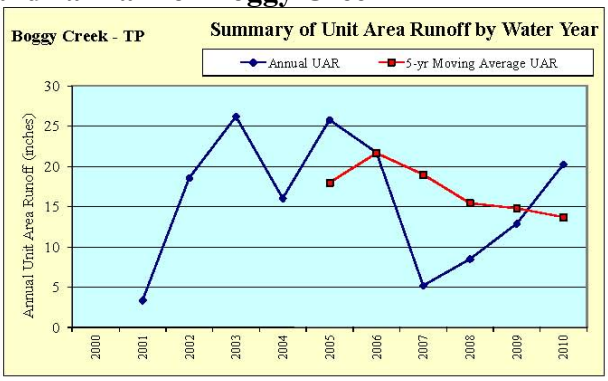
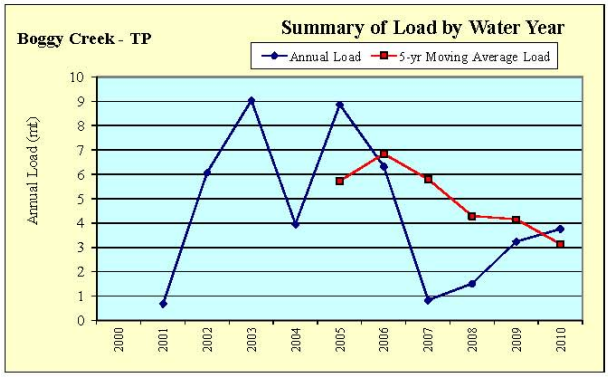
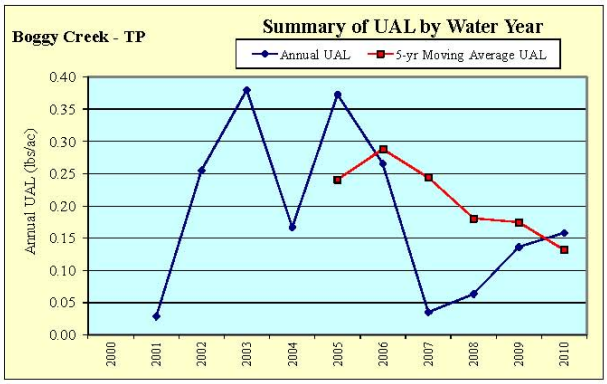
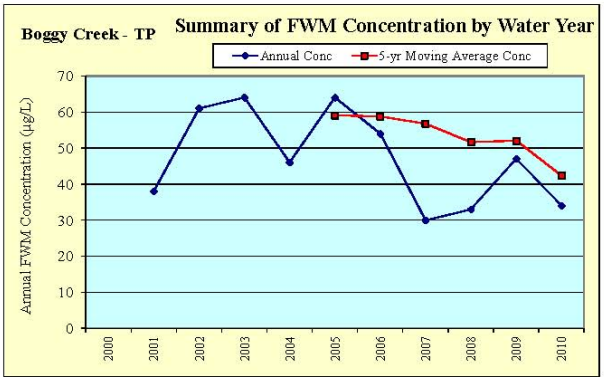
5456 **Summary of annual flow, TP and rainfall for Boggy Creek**

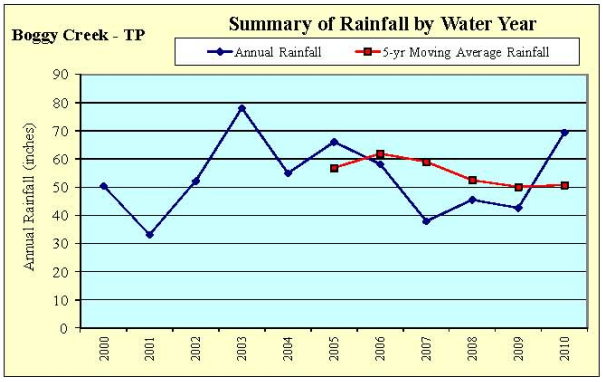












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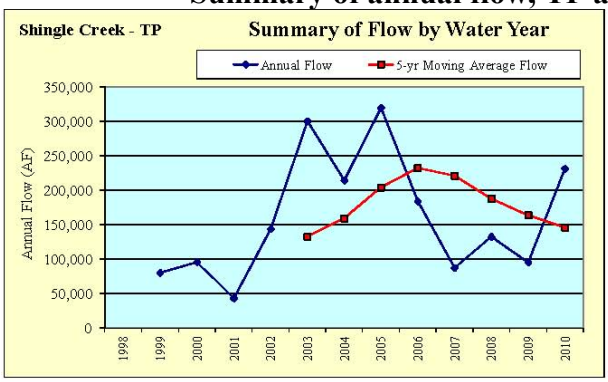
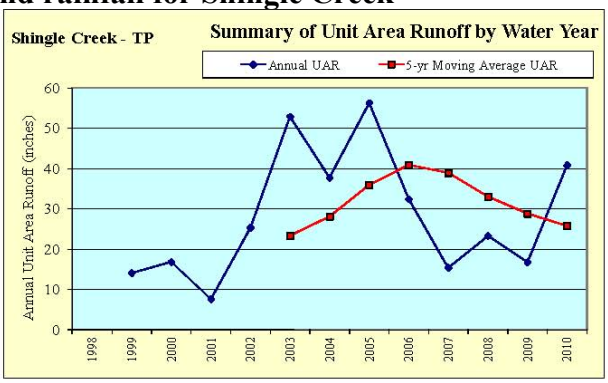
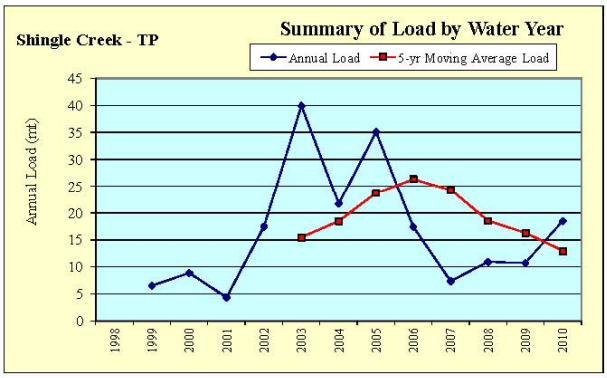
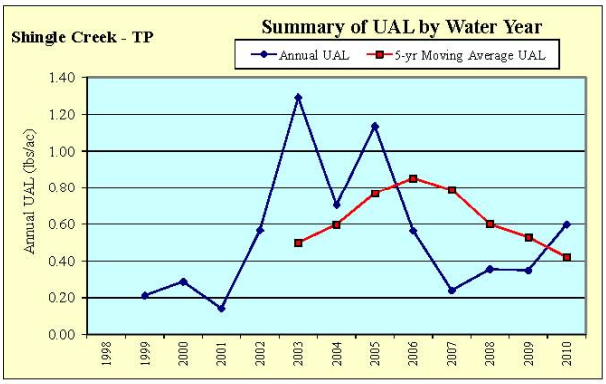
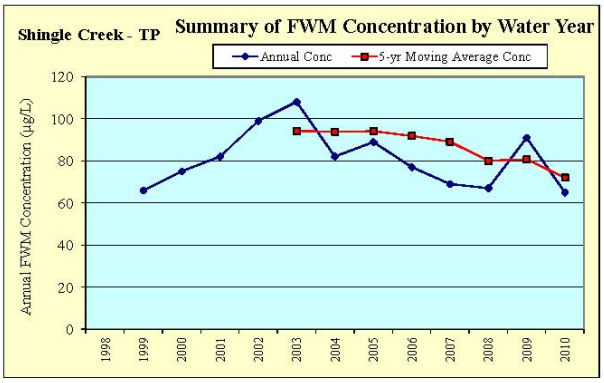
5459 **Summary of annual flow, TP and rainfall for Shingle Creek**

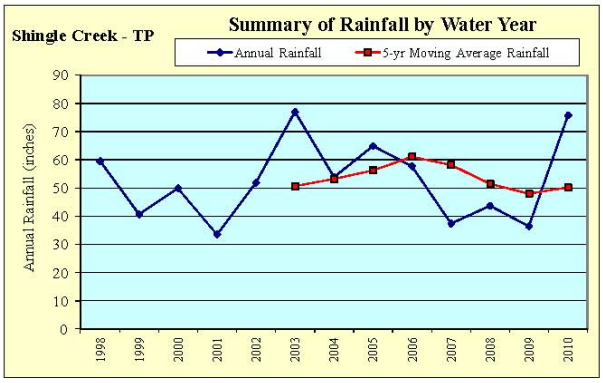












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