M E M O

To: Frank Nearhoof, FDEP
From: Bill Walker & Bob Kadlec
Copies Nick Aumen, DOI & Others
Date: March 1, 2005
Subject: DMSTA Applications to Long-Term Plan PDE Tasks

Following LTP & TOC meetings last week, we discussed potential use of DMSTA in the LTP PDE slots on recovery & predicting downstream impacts of STA discharges. As you requested, here is a brief update on our work & plans. Draft simulations of WCA-2A south of the S10's for the 1978-2003 period are attached. The WCA-2A gradient datasets have been cornerstones for development of DMSTA, as well as its precursors (STA design model & EPGM). Evolution and potential applications of these models are described at www.wwwalker.net/doi/cerp_p_alternatives_march2003.pdf

DMSTA calibrations to S10 transect data are within the range of STA calibrations (northern end similar to emergent cells - southern end similar to non-emergent cells). Responses of water column concentrations at 4, 7, and 10 km to reductions in inflow volume & concentration at the S10's starting roughly in 1995 have been fairly rapid, indicating that reflux from the soils has not been a major factor. The model shows some promise in picking up short-term dynamics associated with pulse loads & depth variations, as well as long-term trends associated with increases & decreases in mean load since 1978. The high spikes in the daily simulations are stagnant periods when marsh depths were as low as 1 cm. These would not have been sampled, but may be approach pore-water concentrations. The dark blue lines and red symbols are quarterly means, weighted by predicted flow. The model was calibrated to 1981-1988 and then run for the entire record. Two pages show entire period (1978-2003) and recovery period (1995-2003). Updated calibrations will be posted later this Spring.

We tried simulating response to a hypothetical reduction in S10 inflow concentration to 10 ppb starting in November 2003 (end of current dataset) & ran it out to 2020. The response of the storage pool (vegetation, litter) is shown. It flatlines about 10 years later. The water column responds sooner. The is probably optimistic because it does not reflect any mining of the soil P by rooted vegetation. This is not “recovery’ as measured by soil P, which would have a longer time scale, especially considering the apparent low rates of net soil P reflux implied in the simulation. Also, there is a need to refine the model to include upflow seepage in the region, as well as floc & soil compartments.

The water column and plant P storage simulations provide a basis for interpreting future monitoring data as the system hopefully continues to improve. At this point, we consider the simulations more as hypotheses for testing against monitoring data than as forecasts for public consumption. Aside from recovery tracking, the model might eventually be useful for evaluating management options, such as fate of the downgradient unimpacted region if the upgradient vegetation were toasted and stored P mobilized.

Our workplan calls for integrating DMSTA with EPGM to provide flow & soil P simulation. We also plan to work with Ken Rutchey & Sue Newman this year to develop publications that integrate these modeling results with their vegetation & soils studies. Applications to STA2 and STA5 downstream transects and to the Refuge are also planned, as well as a test application to CSOP / WCA3B. Both DOI & the Corps have expressed interested in supporting the DMSTA/EPGM integration, but there is no specific schedule right now.

DMSTA/EPGM hydraulics are limited to one-dimensional profiles or branched networks of treatment cells. This is sufficient for simulation of treatment areas and marsh immediately downstream. In the long run, there might be some benefit to building the DMSTA/EPGM P cycling model into one of the regional hydrology models to support systemwide P balance simulations that consider both canal & marsh tansport. We don't know whether any of these has a mass transport capability. A while back, the District imposed the simpler STA design model on the 2x2 hydrology model. The model was called something like the "Everglades Water Quality Model", but we suspect it is now dead since its authors have moved on to other jobs. The scale of 2x2 model is too coarse for this application, anyway. We have no plans or interest in doing this coding, but it might be undertaken by the regional modeling center etc. We are also planning to incorporate the DMSTA cycling algorithm into the hydrology/transport model being developed by DOI for the Refuge.

One rate-limiting step in proceeding further with the DMSTA/EPGM integration is the digestion & interpretation of the "recent" soils data, specifically including consideration of the floc vs. soil distinction, updating correlations between cattail density & soil P, and extending the calibrations to other regions. The EPGM soil calibrations are based upon data collected as of 1991 & it is likely that they can be improved significantly with the data that have been collected since then. The updating exercise will help to identify missing information and focus additional monitoring & research. As mentioned at TOC, there is a need to beef up monitoring at the S10 structures to get better estimates of load going into WCA2A. Because of the intermittent gate operation, grab sampling dates rarely coincide with the discharge periods. Recent S10 transect monitoring data are needed to update the calibrations (current file ends in Oct 2003).

We hope that the State & District will consider this ongoing activity in moving forward with LTP PDE projects associated with recovery & forecasting of downstream impacts.

Phosphorus & Vegetation Gradient in WCA-2A South of S10 Inflow Structures
Slides from SFWMD Presentation to FDEP P Criterion Workshop, Sept 2001

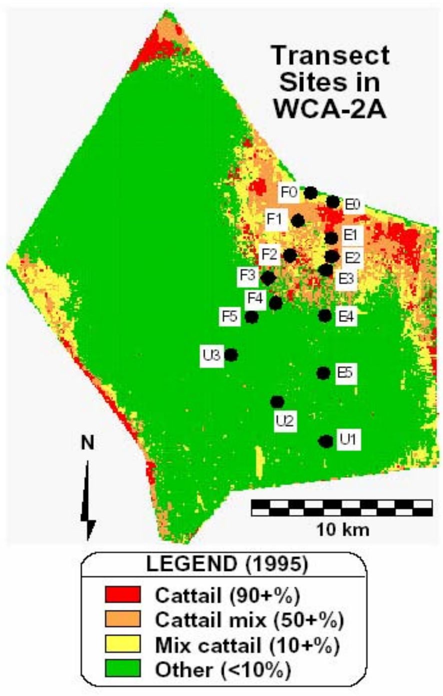
DMSTA Model Zones:

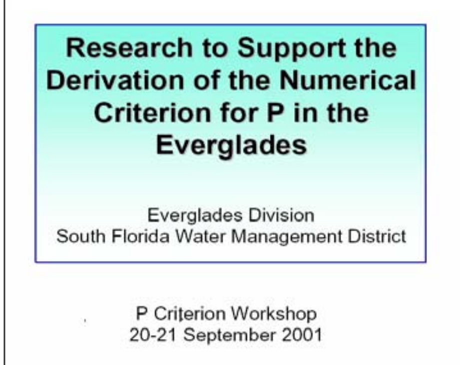
Distance South of Levee (km)		Calibration Transect Sites	Mean Distance South of Levee South of Levee (km)
0 - 4	Emergent	E2, E3, F2	4.5
0 - 7	Emergent --> Open Water	E4, F4, F3	7.4
0 - 10	Emergent --> Open Water	E5, U3 , F5	10.4

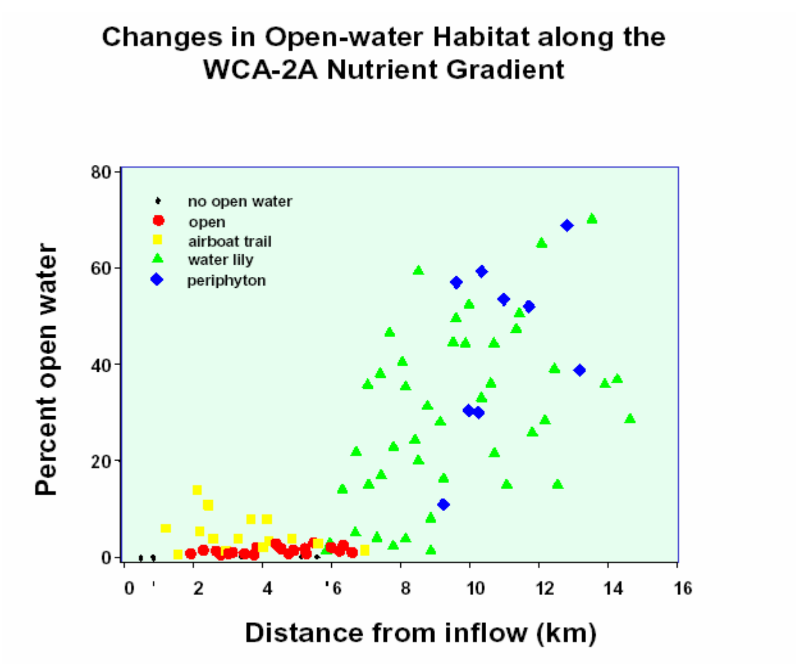
Inflows are the combined inflow through S10 A, C & D

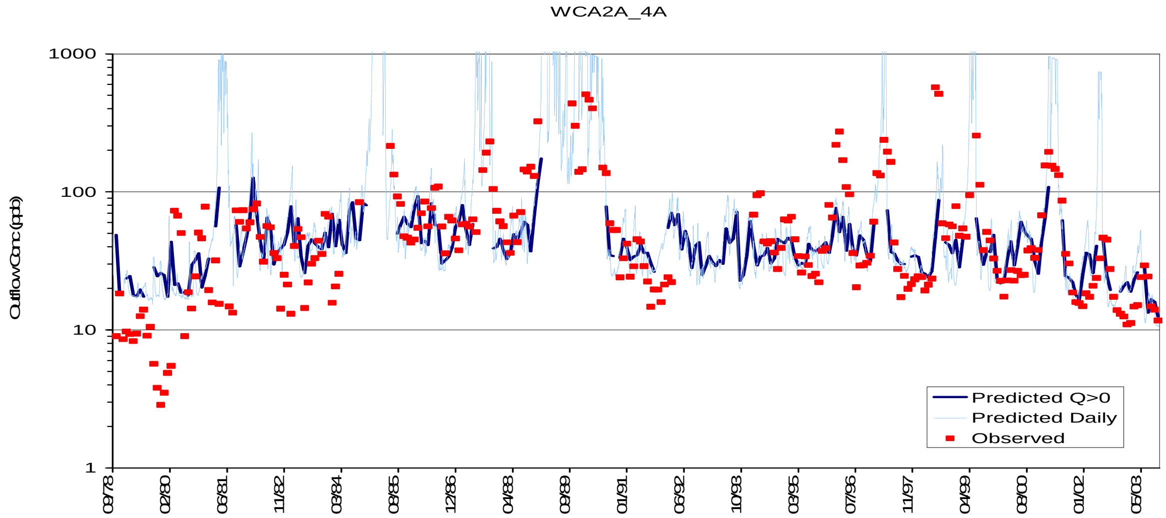
See Walker (1995)

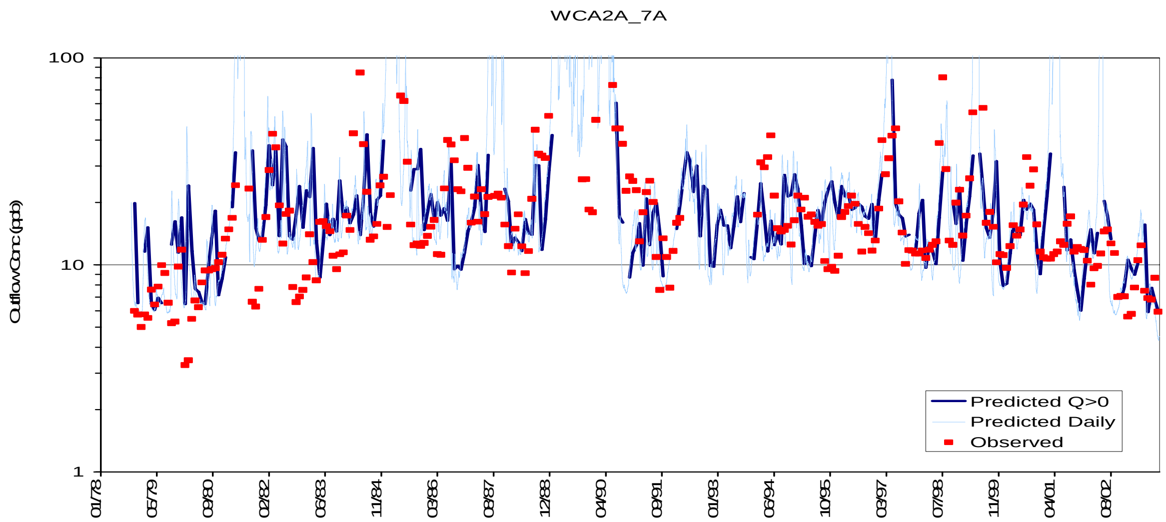
DMSTA coordinates are distance south of the levee
These differ slightly from SFWMD's distance from inflow structure.

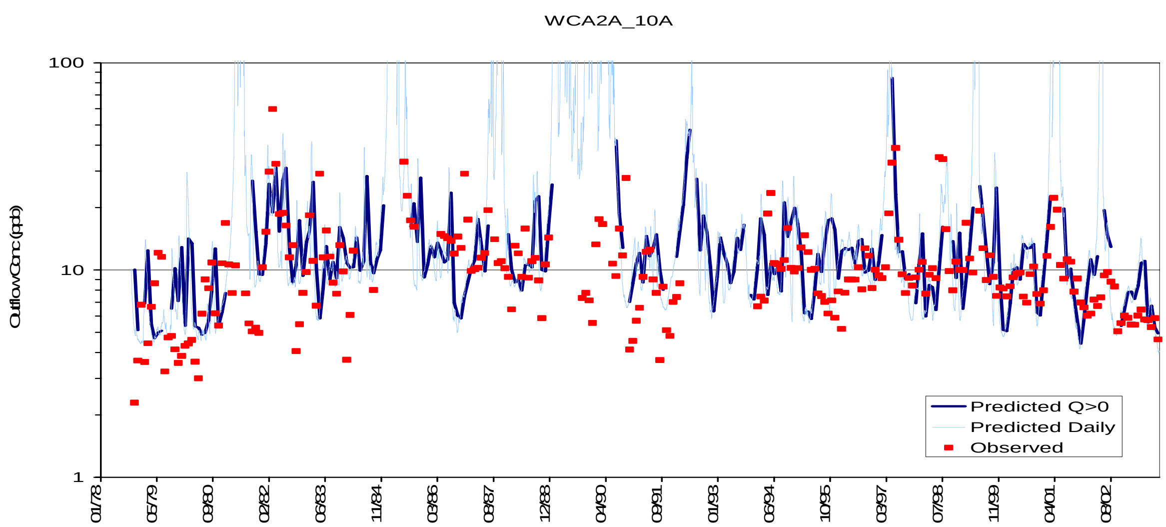










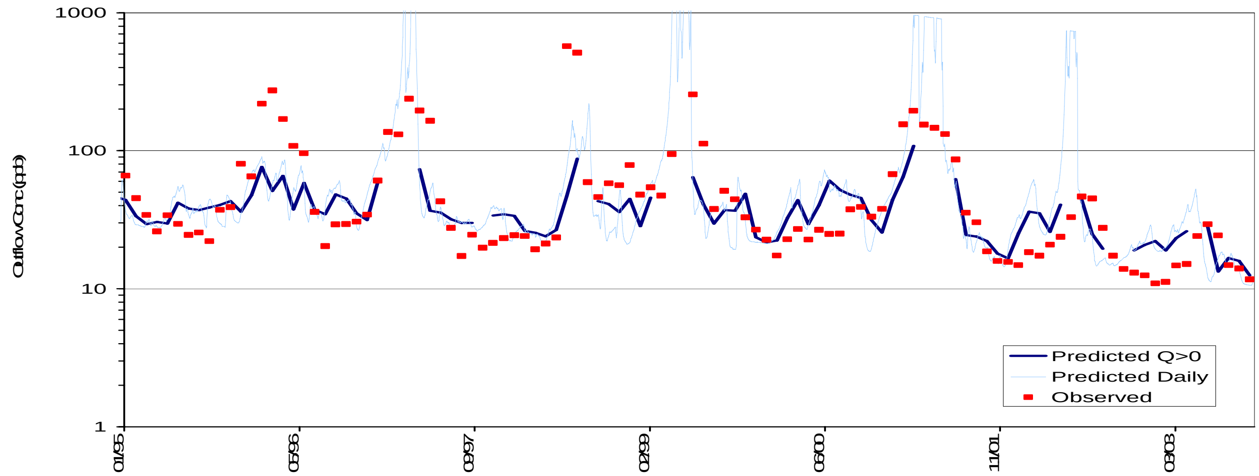


DMSTA Simulations of WCA-2A South of S10's - 1978-2003
Locations: 4, 7, & 10 km south of S10's

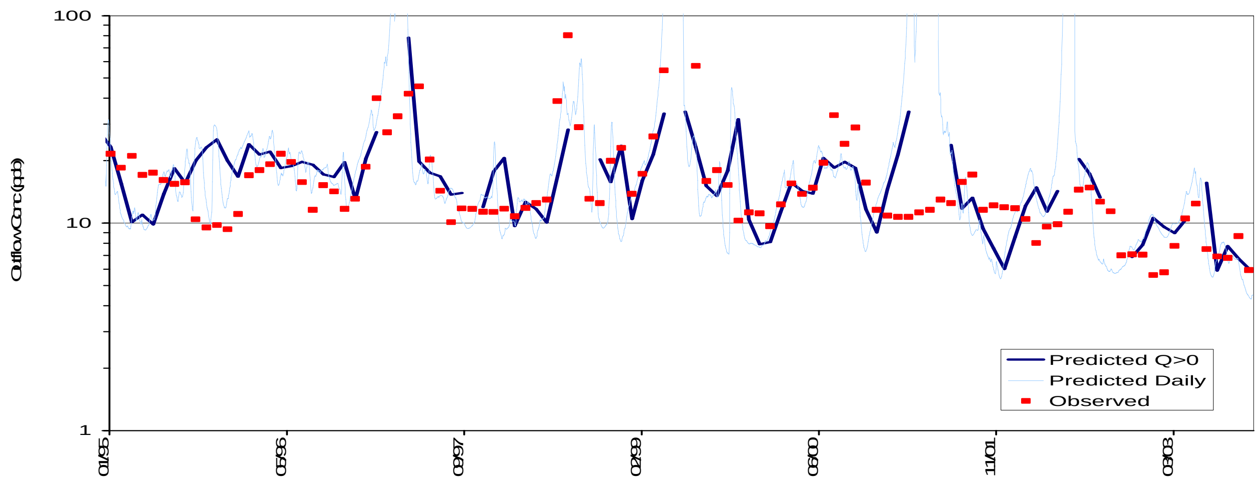
Red Squares =	observed, 90-day composite of regional sites, geomean
Light Blue	daily simulation (including stagnant periods)
Dark Blue	90-day flow-weighted mean (excluding stagnant periods)

WWW DRAFT 2/24/2005

WCA2A_4A



WCA2A_7A



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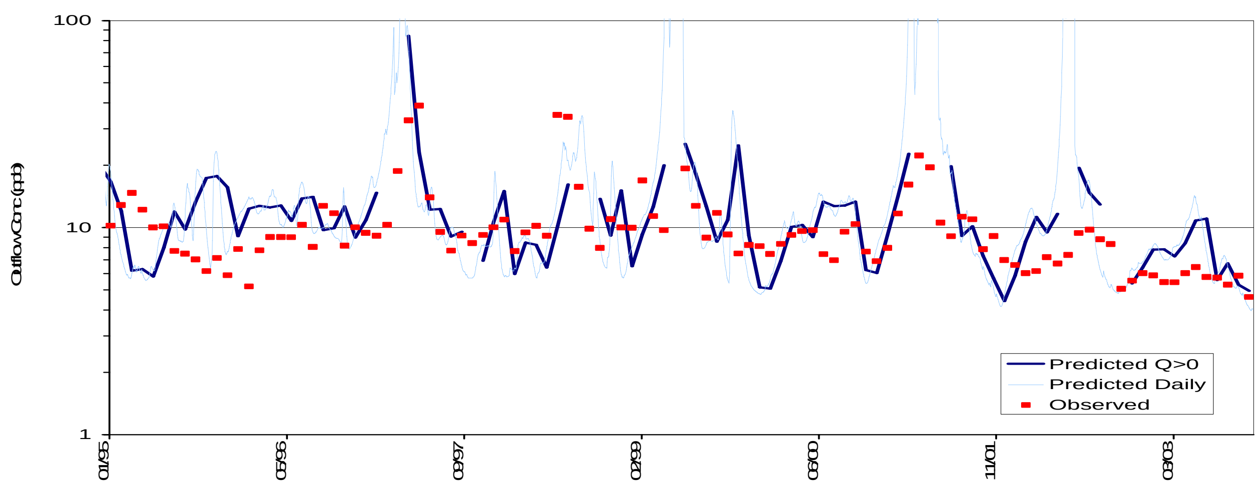


DMSTA Simulations of WCA-2A South of S10's - 1995-2003
Locations: 4, 7, & 10 km south of S10's

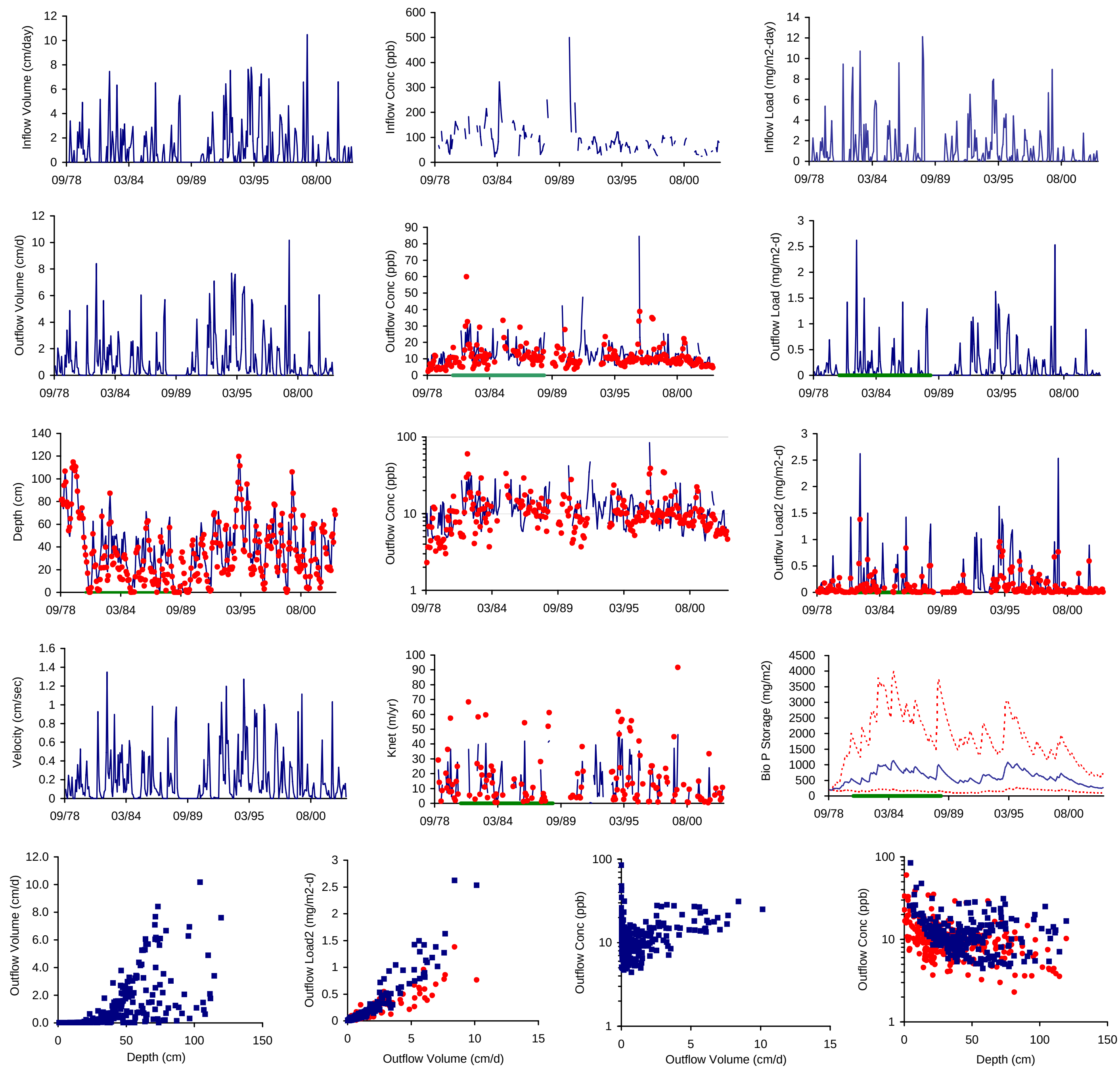
Red Squares = observed, 90-day composite of regional sites, geomean
Light Blue daily simulation (including stagnant periods)
Dark Blue 90-day flow-weighted mean (excluding stagnant periods)

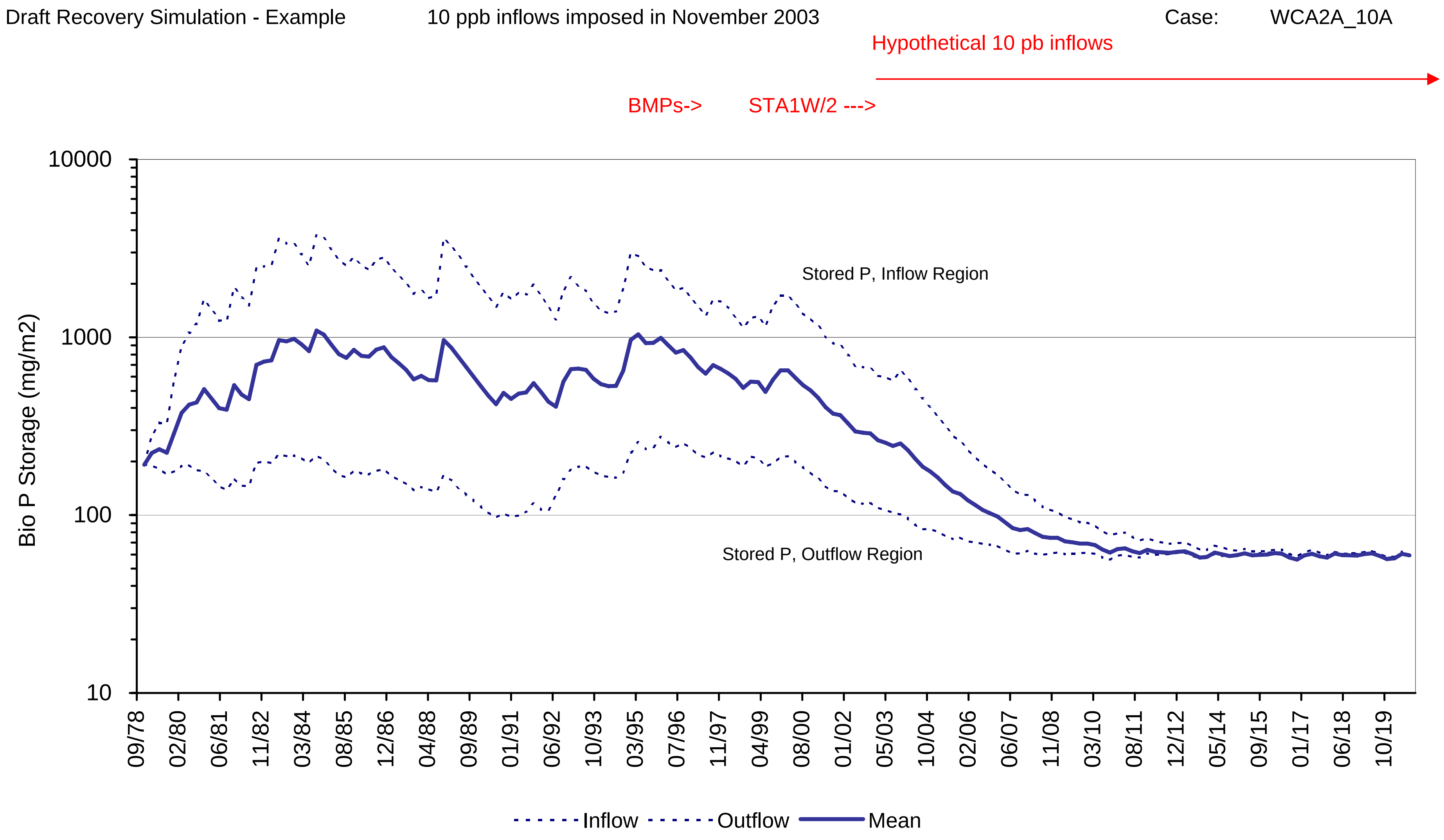
WWW DRAFT 2/24/2005

DMSTA Simulation Results **Case:** **WCA2A_10A** **Period:** **10/01/1978** **to** **10/31/2003**

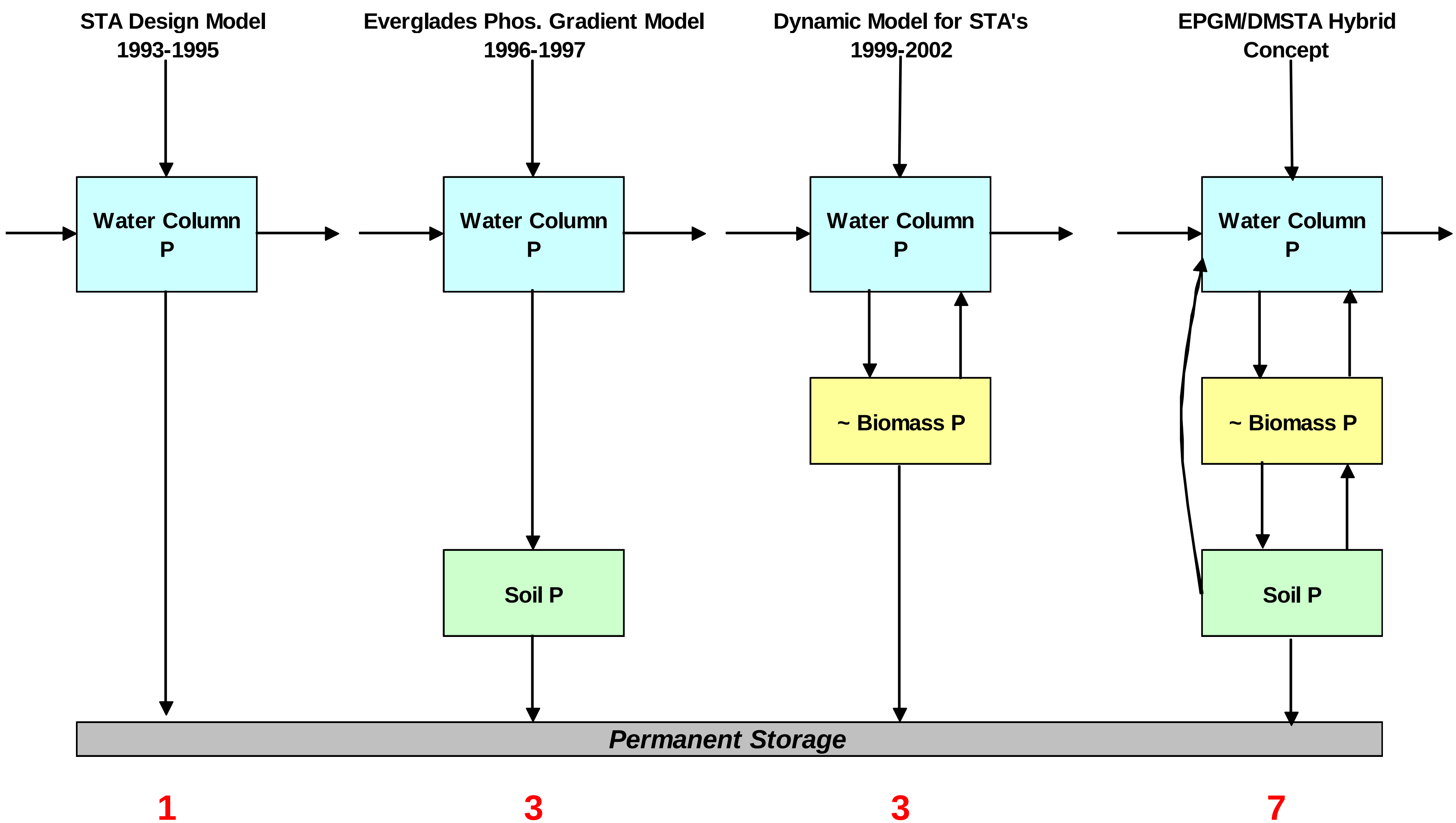
Case: WCA-2A 4.5 km South of L-29; depths forced tro reflect regulation schedule; calib 1981-1988

Input Series	S10ACD_10			Tanks in Series	9.0	Surface Area (km2)	109.2000
Simulation Period	10/01/78	thru	10/31/03	Mean Water Load (cm/d)	1.4	Mean Depth (cm)	39
Output Period	10/01/78	thru	10/31/03	Max Water Load (cm/d)	23.0	Max Depth (cm)	130
Calib Period	01/01/81		12/31/88	Inflow Conc (ppb)	95.2	Freq Depth < 5 cm	10.3%
Startup Interval (days)	823	Iterations	1	Inflow P Load (mg/m2-yr)	377	Load Reduction	84%
Avg Interval (days)	30	Wtr Bal Error	0.0%	Outflow FWM Conc (ppb)	15.3	Conc Reduction	84%
Parameter Set:	None	Mass B Error	1.2%	Outflow C with Bypass	15.3	Time Freq Conc > 10 ppb	37%
K (m/yr)	31.088	Kd (m/yr)	0	95th Percentile (ppb)	25.9	K - SS, C*=4 ppb (m/yr)	10.9
C1 (ppb)	22.0	Weir Depth (cm)	0	Outflow Geo. Mean (ppb)	14.5	Storage Turnover (1/yr)	3.7
C0 (ppb)	4.0	Cont Depth (cm)	0	Outflow GM, Q>0 (ppb)	11.0	Mean Stored P (mg/m2)	613
C2 (ppb)	0	Qout Intercept	3.0	Seepage Loss	0%	Storage Inc/Net Removal	1%
Zx (cm)	60	Qout Exponent	4.0	HRT (days)	36.7	Outfl. Seepage (cm/d/cm)	0




Draft Recovery Simulation - Example
10 ppb inflows imposed in November 2003
Case:
WCA2A_10A
Hypothetical 10 pb inflows
BMPs->
STA1W/2 --->
Stored P, Inflow Region
Stored P, Outflow Region
Bio P Storage (mg/m2)
10000
1000
100
10
09/78
02/80
06/81
11/82
03/84
08/85
12/86
04/88
09/89
01/91
06/92
10/93
03/95
07/96
11/97
04/99
08/00
01/02
05/03
10/04
02/06
06/07
11/08
03/10
08/11
12/12
05/14
09/15
01/17
06/18
10/19
Inflow
Outflow
Mean

Phosphorus Balance Models for Everglades Applications



Number of Calibration Parameters

Phosphorus Mass Balance Models Developed for Everglades Applications

W. W. Walker & R.H. Kadlec for U.S. Department of the Interior

Model	STADM	EPGM	DMSTA	HYBRID
Description	STA Design Model	Everglades Phos. Gradient Model	Dynamic Model for STA's	EPGM/DMSTA Hybrid
Development Dates	1993-1995	1996-1997	1999-2002	Concept
Primary Purposes	Design of Phase I Stormwater Treatment Areas	Impacts of STA Discharges on WCA's	Design of Enhanced Stormwater Treatment Areas - All EPA Basins	Same as EPGM/DMSTA + WCA Recovery + CERP Applications
Applic. to Natural Wetlands	WCA-2A	WCA's	WCA-2A; C111	Everglades
Dynamic Time Scale	Steady State	Years	Days --> Years	Days--> Years
Computational Platform	Any Spreadsheet	Lotus or Excel	Excel / Visual Basic	Excel / Visual Basic
Wetland Trajectory	Steady State	Enrichment	Enrichment	Enrichment or Recovery
Spatial Configuration	Gradient (Plug Flow)	Gradient (Plug Flow)	1-Dim. Branched (Cells in Series, Parallel)	General 1-D Branched or Linked to Existing Hydro Models (NSM Output)
Model Coefficients	1	3	3	7
Calibration Basis	WCA-2A, Treatment Wetlands	WCA-2A	~70 Platforms: Tmt Wetlands, Test Cells, Mesocosms	EPGM/DMSTA; Updated to Include Threshold Research, EPA REMAP; ENP & USGS Research