Implementation and Verification of BMPs to Reduce EAA Farm P Loads: Floating Aquatic Vegetation Impact on Farm P Load Master Permit for BMP Research SOW

7th Annual Public Meeting on the Long-Term Plan for Achieving Water Quality Goals for the Everglades Protection Area Tributary Basins

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MASTER PREMIT FOR BMP RESEARCH, TESTING, IMPLEMNTATION SCOPE OF WORK- RELATIVE TO CHAPTER 40E-63, FAC, PART III

- Final SOW submitted to SFWMD September 17, 2009
- Public workshop conducted on November 18, 2009
- Master permit SOW approval- 15 January 2010

Presentation Outline

- EAA basin performance
- Previous IFAS BMP research
- BMP research SOW
  - Justification
  - Objectives
  - Methods
  - Expected Outcomes
  - Timeline
- Current priorities

Table 3 – Best Management Practices Summary and "BMP Equivalent" Points

BMP	PTS	DESCRIPTION
WATER DETENTION ½ Inch Detained 1 Inch Detained	5 10	• water table management by controlling levels in canals, field ditches, soil profile, fallow fields, aquatic cover crop fields, prolonged crop flood; • measured on a per event basis – rainfall vs. runoff
FERTILIZER APPLICATION CONTROL	2 ½	uniform and controlled boundary fertilizer application (e.g. direct application to plant roots by banding or side-dressing; pneumatic controlled-edge application such as AIRMAX)
FERTILIZER CONTENT CONTROLS		
Fertilizer Spill Prevention	2 ½	• formal spill prevention protocols (handling and transfer) • side-throw broadcast spreading near ditch banks
Soil Testing	5	avoid excess application by determining P levels needed
Plant Tissue Analysis	2 ½	avoid excess application by determining P levels needed
Split P Application	5	apply small P portions at various times during the growing season vs. entire application at beginning to prevent excess P from washing into canals (rarely used on cane in EAA)
Slow Release P Fertilizer	5	avoid flushing excess P from soil by using specially treated fertilizer which breaks down slowly thus releasing P to the plant over time (rarely used in EAA)
SEDIMENT CONTROLS		EACH SEDIMENT CONTROL MUST BE CONSISTENTLY IMPLEMENTED OVER THE ENTIRE ACREAGE
Any 2 Any 4 Any 6	2 ½ 5 10	• leveling fields • cover crops • ditch bank berm • raised culvert bottoms • sediment sump in canal • veg. on ditch banks • strong canal cleaning program • other BMP • field ditch drainage sump • slow field ditch drainage near pumps • sump upstream of drainage pump intake
OTHER Pasture Management	5	reduce cattle waste nutrients in surface water runoff by "hot spot" fencing, provide watering holes, low cattle density, shade, pasture rotation, feed & supplement rotation, etc.
Improved Infrastructure	5	uniform drainage by increased on-farm control structures
Urban Xeriscape	5	lower runoff & P by using plants that require less of each
Det. Pond Littoral Zone	5	vegetative filtering area for property stormwater runoff
Other BMP Proposed	TBD	proposed by permittee and accepted by SFWMD

EAA BMP Table

- Minimum 25 points
- EAA basin P loads have an average yearly reduction of nearly 50%
- Typical BMP farm permit includes:
  -water detention
  -fertilizer spill prevention
  -fertilizer app control
  -sediment controls
- Sediment controls not as well defined/understood; high potential for improvement

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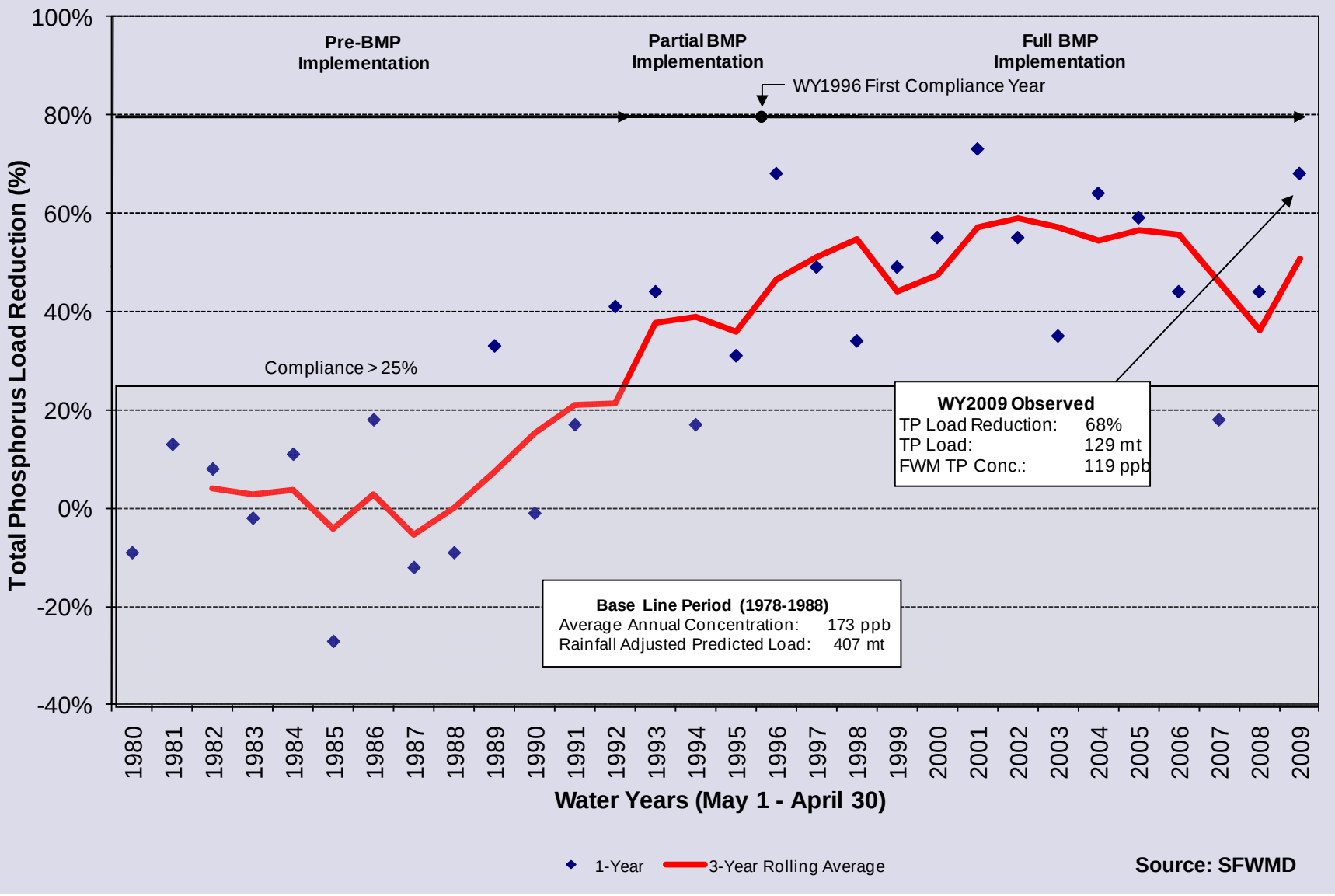
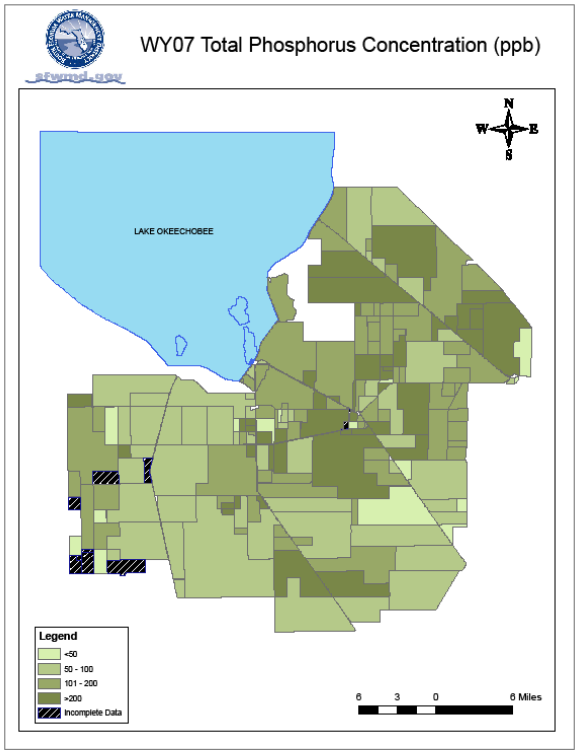
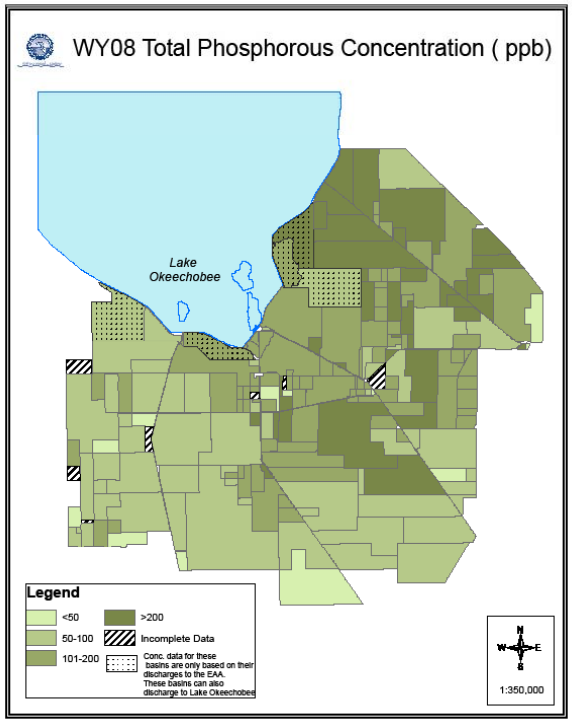
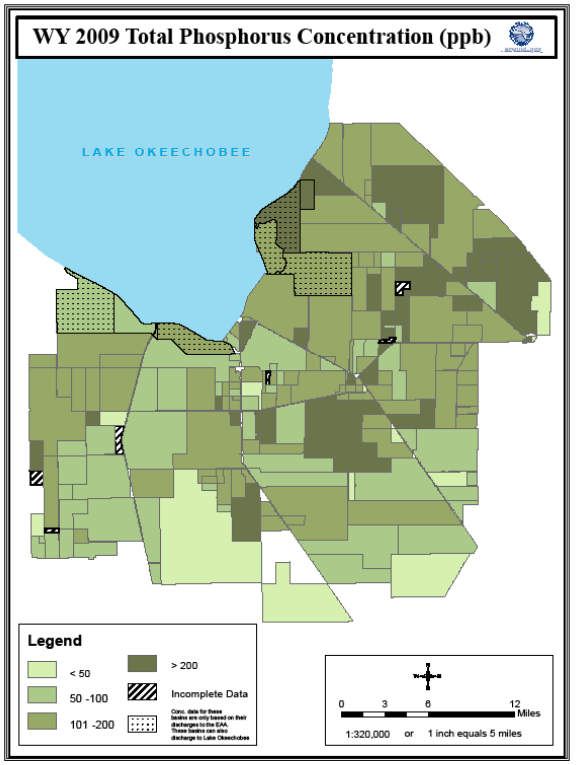
EAA Basin Performance



EAA Basin Performance

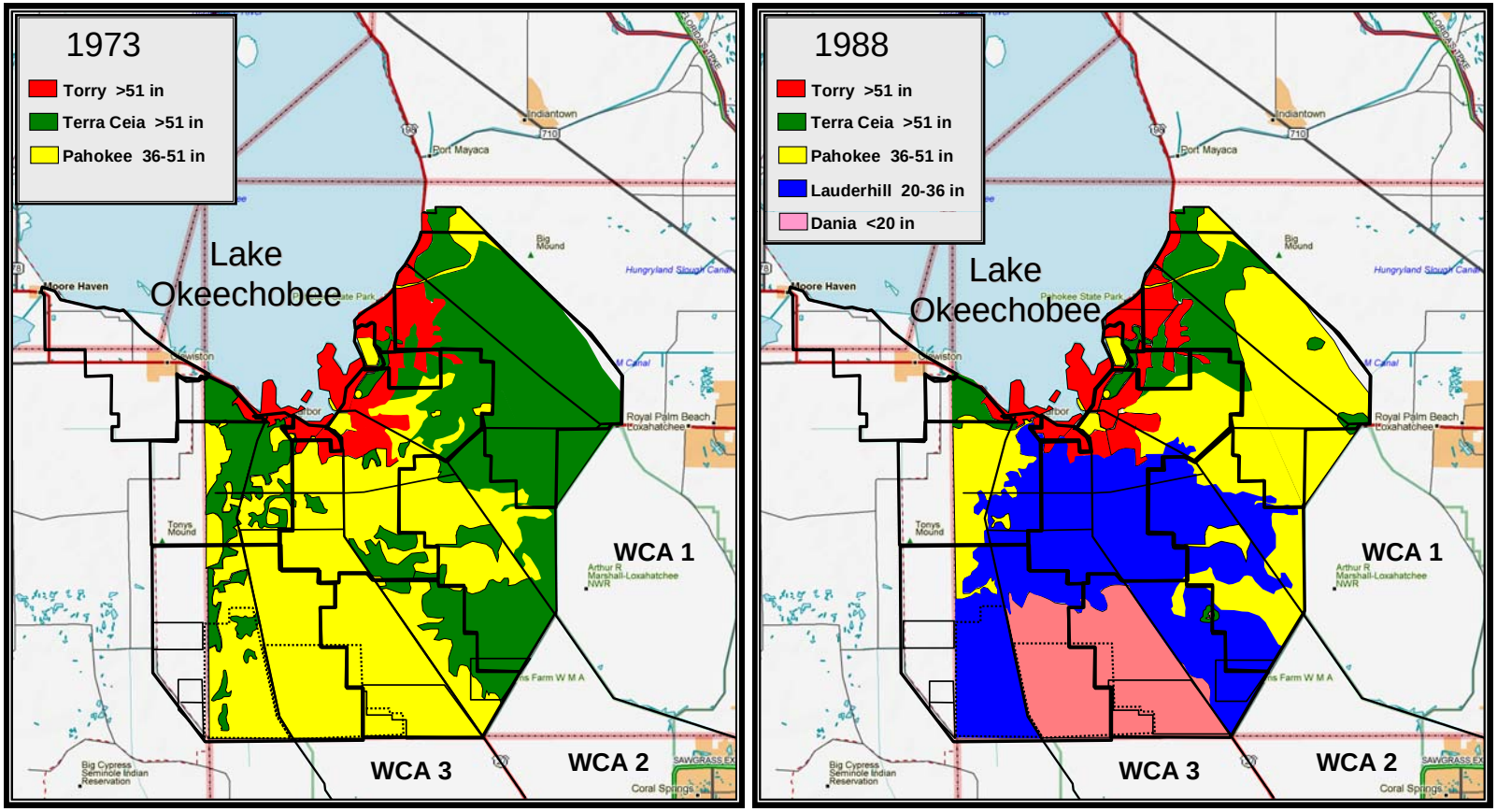






Source: SFWMD

EAA Soil Depth



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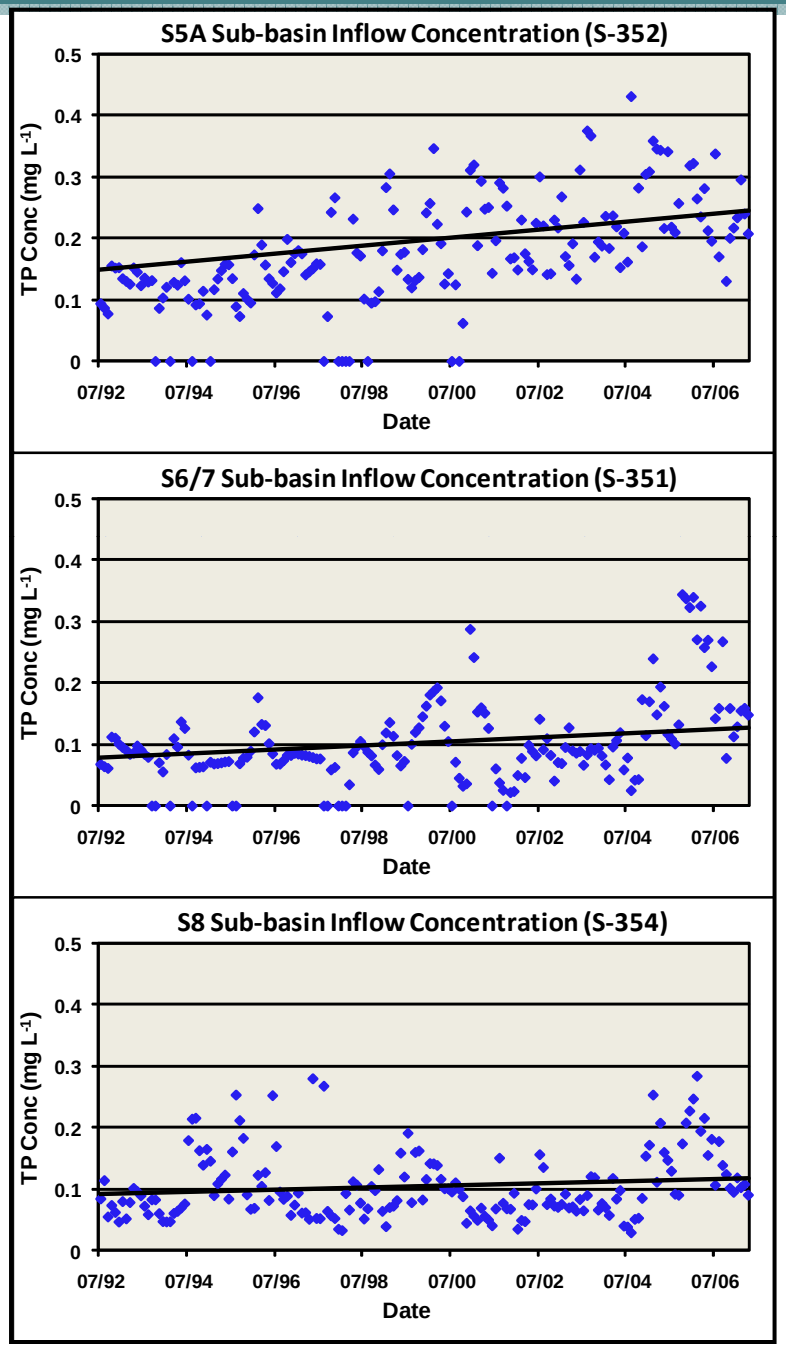

EAA Irrigation Water

- Water delivered from three structures: S2, S3, and S-352
- Increasing P trend in Lake O irrigation waters at all three locations
- Greatest P increase is for WPB canal
- Hurricanes of 2004 and 2005 elevated Lake P concentrations by suspending P-enriched sediments
- EAA Inflow P levels did not recover as quickly at S-352 as S-2 and S-3

?Higher P loads into WPB canal may influence farm P loads

? Sediments in conveyance canals may be a source of P to irrigation waters/STAs

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Previous EAA-BMP Studies*

1. BMP efficacy (92-02)
2. Sedimentation basin effectiveness (98-00)
3. Particulate and dissolved P (98-02)
4. Particulate P source and transport (00-04)
5. Aerial survey of FAV (00-02)
6. BMP demonstration farm (03-04)
7. Statistical analysis of factors affecting BMP performance (06-08)

*Studies by UF/IFAS with EAA-EPD and/or FDEP funding

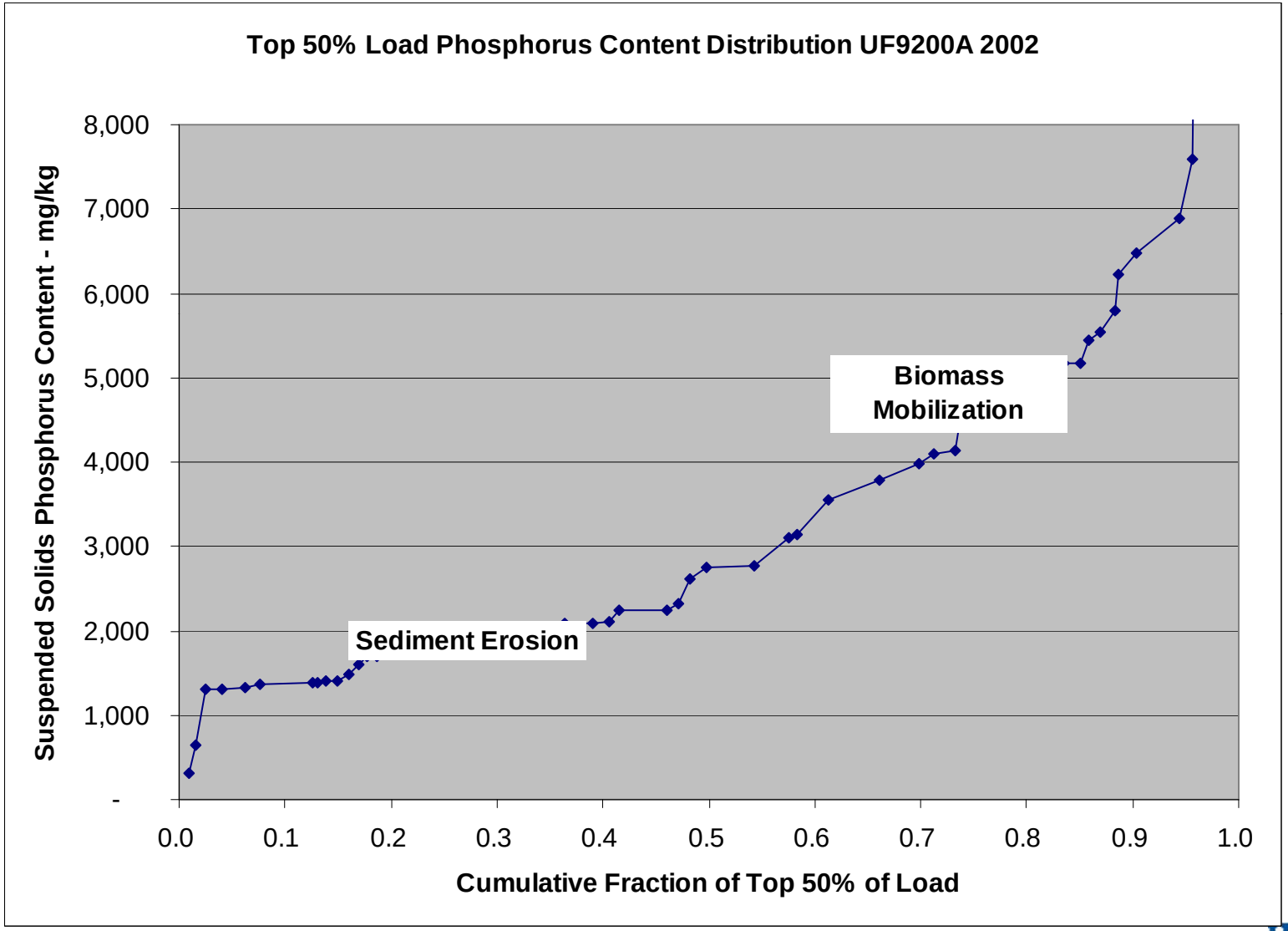
BMP Research SOW

Justification

- 40-60% of farm P load is in particulate form
- Exported particulate P has canal origins
- Recently deposited P readily transported
- Floating Aquatic Vegetation (FAV) is a source of exported particulates

Particulate and Dissolved P Study 1998-2002
Particulate P Source and Transport Study 2000-2004
Survey of FAV on Two EAA Farms 2000-2002
BMP Demonstration Farm 2002-2003

Particulate P Sources and Transport



BMP Research SOW

What happens when FAV is controlled?

Co-precipitation of P with $CaCO_3$ in aquatic systems with high pH will lead to denser, less labile inorganic sediments (Murphy et al., 1983; Reddy et al., 1987; Danen-Louwerse et al., 1995)

↓ Less production of mobile particulates
↓ Reduce flux of P from canal sediments
Δ Change canal water P speciation
? Reduce overall farm P loads

EAA-BMP Research SOW 2009-2014

Objectives

1. Evaluate FAV management practices in EAA farm canals for impact on farm drainage P load and particulate P physico-chemical properties
2. Use the results to develop a BMP for managing FAV and reducing farm P loads.

Hypothesis

FAV-free farm canals generate denser, less-labile, less transportable sediments than canals that do not control FAV growth

BMP Research SOW

Experimental Design

Paired-farms study (4 pairs)

- Two farm pairs each in S5A and S-6 sub basins
- Calibration and treatment time periods
- Measure changes after initiation of practices
- Improved vs. typical FAV control practices

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BMP Research SOW

Experimental Design

Typical FAV control

- Typical FAV control during calibration period.
- Grower keeps same typical control practices during treatment period

Improved FAV control

- Typical FAV control during calibration period.
- Initial mechanical harvesting of FAV; Chemical spot spraying to control FAV during treatment period

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BMP Research SOW

Experimental Design

Advantages of the paired-farm basins approach:

- Climate and hydrologic differences from year to year are statistically controlled
- Farm basins need not be identical
- Water quality change can be attributed to the treatment alone rather than farm basin differences
- Using paired event data, rather than monthly values, calibration may be achieved in shorter time

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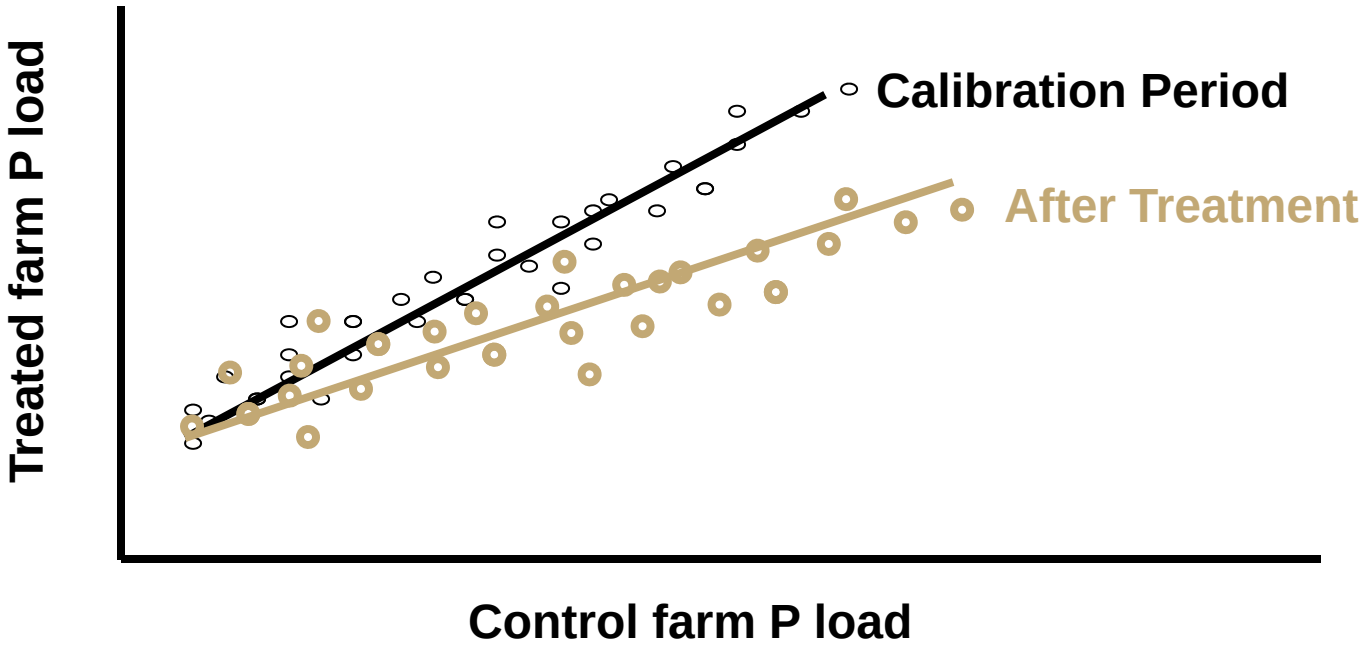
BMP Research SOW

Paired-Farm Basin Study Design

$$Treated_i = b_0 + b_1 (Control_i) + e$$



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BMP Research SOW

Methodology

A. Initial survey of EAA farms will be conducted to provide researchers a representative range of farm canal characteristics and FAV biomass for farms within a sub-basin.

B. Data for drainage water P concentrations, drainage flow, and pumping to rainfall ratio will be obtained from SFWMD's BMP permit database. Data will be statistically analyzed to observe trends and relationships among the farms.

BMP Research SOW

Methodology

C. Two pairs of farms will be chosen in each of the S5A and S6 sub basins. Farm selection criteria:

1. Farm size between 640 to 1280 acres with a single exit pump station
2. Similar dimensions of main farm canals
3. Similar land use and cropping history.
4. Significant P load regression relationship of the paired farms
5. Same irrigation source canal
6. Willingness of the grower to cooperate for ~5 years

BMP Research SOW

Methodology

D. Site survey of eight selected study farms

- Canal system configuration
- Cropping history
- BMP plan and implementation
- Soil depth and variation
- Sediment characterization and depth
- Ambient canal water P speciation
- Estimated canal velocities for recent water years
- Check pump calibrations
- FAV management practices

BMP Research SOW

Methodology

E. Monitoring of farms

- Levels of inflow and outflow farm canals
- Pump RPMs of drainage pumps
- Drainage flow via data loggers using pump calibration equations, RPMs, and canal levels
- Estimated velocity by data loggers from drainage flows and canal levels
- Rainfall by tipping bucket rain gauge
- Drainage flow samples composited by auto-samplers triggered by data logger
- Flow composite samples held in refrigerated containers on-site until sample collection

BMP Research SOW

Methodology

F. Sample collection

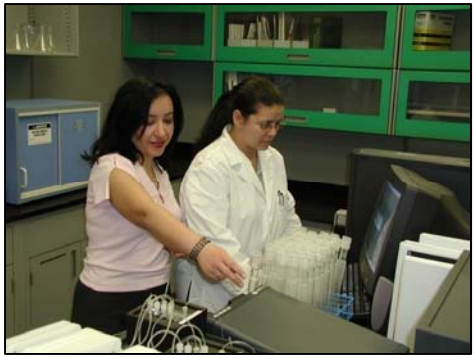
- Drainage water - 24 hours in refrigerated container
- Ambient farm canal water - twice monthly
- Sediment – depth measured and sampled 2X year
- FAV biomass – collected every two months

BMP Research SOW

Methodology

G. Analyses

- Water samples - TP, TDP, PP, SRP, DOP, TSS, pH, and Ca
- Canal sediments - TP, ash content, pH and bulk density
- Solids may be analyzed further for mineralogy using solid state assessment, e.g., x-ray diffraction
- FAV samples - biomass, species composition,& TP



BMP Research SOW

Methodology

H. Statistical Analyses

- Analysis using SAS ANCOVA model
- Paired watershed study design with repeated measures
- Potential covariates: flow, canal level, velocity, rainfall
- Covariates included to increase precision
- Bivariate plots will be presented w/equations
- Estimates of percentage change will be estimated
- Data may also be pooled and analyzed by sub-basin

BMP Research SOW

Expected Outcome

Development of a BMP for managing farm canals to produce denser, less mobile sediments, thus providing growers with an additional tool in their efforts to reduce off-farm P loading.

One year prior to completion of data collection of project, sediment data will be analyzed. A meeting with EAA-EPD will be arranged for a discussion on temporal trends of sediment accumulation and disappearance from farm canals.

The analysis and discussion will determine if there is justification to consider an additional Scope of Work to research sediment transport.

BMP Research SOW- Timeline

Tasks and Activities	Timeline
1.00 Approval of SOW	Month 0
1.01 EAA farm canal survey	Month 1-2
1.02 Site selection of eight study farms	Month 3
1.03 Installation of monitoring equipment	Month 4-5
1.04 Begin calibration period	Month 6
1.05 Begin treatment period	Month 30
1.06 Progress report	July 2010
1.07 Annual report 2011	July 2011
1.08 Annual report 2012	July 2012
1.09 Annual report 2013	July 2013
1.10 Annual report 2014	July 2014
1.11 End of sampling	Month 66
1.12 Draft Final Report	Month 72
1.13 Final Report	Month 74

Current Priorities

Initial survey of EAA farms will be conducted to provide researchers a representative range of farm canal characteristics and FAV biomass for farms within a sub-basin.

Eight or more farms in each sub-basin will be surveyed.

- canal dimensions and layout
- estimated average and maximum flow velocities
- prevalent FAV species coverage, management strategies
- sediment depths; visual observations of sediments
- canal cleaning schedules
- average farm soil depth and cropping history

Current Priorities

Finalize farm selection

- BMP advisory Committee- meeting held end of Jan.
- Meet with farm cooperators/personnel
- Present selections to SFMWD
- Collect cooperator farm data

Monitoring equipment installation

- Sensors: Canal levels, pump RPMs, rainfall
- Drainage water auto-samplers w/refrigeration
- Solar panels, data loggers, radio telemetry

Current Priorities

Initiate baseline monitoring

- Sediment depth measurements and cores
- Biweekly ambient canal waters
- Daily composited, refrigerated, drainage waters
- Bimonthly FAV biomass samples

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