APPENDIX 1
Public and Peer Review Panel Comments

Appendix 1-3
Authors Responses to Comments

Appendix 1-3e
Author's Response to Comments on Chapter 5

Chapter 5: Effectiveness of Best Management of Practices

Responses to Public and Peer Review Panel Comments

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Peer Review Panel Comments and Author's Responses

Comment: While it is apparent that the EAA is a major source of TP, it is not clear whether most of the phosphorus originates from subsidence and mineralization of organic matter or from application of inorganic fertilizers. It would be useful to quantify the source of phosphorus as optimization of BMPs based on water or nutrient management requires this information. Another question centers around the issue of nutrient budgets and flows within the EAA. It would be useful on the long run to maintain a phosphorus budget for the EAA. This budget should include the amount of phosphorus entering the area as fertilizer and the amount leaving the area in the harvested crop. A large net gain of phosphorus in the area now may have serious consequences in later years.

Response: Phosphorus exists in the EAA drainage water in both dissolved- and particulate- phases. Particulate P originates primarily from fine soil particles eroded from the field and detritus materials of aquatic vegetation. Dissolved P in drainage water comes mainly from leaching of soil profiles. Fertilization and soil mineralization are the two major sources of P in soils. Recommended fertilization rates vary with crops and soil conditions. A typical fertilization rate would be about 100 lbs P/ac/y for vegetables and 25 lbs P/ac/y for sugarcane (Coale, 1994; Schueneman and Sanchez, 1994). The difference explains why P concentrations in vegetable drainage water are much higher than from sugarcane fields (CH2M-Hill, 1979). Mineralization of organic matter is a natural process which is influenced by the water table (aerobic or anaerobic conditions), the soil temperature (the decomposition rate constant), and the quantity of substrate (soil depth and organic P content). Given the complex soil environment in the EAA, the mineralization rate varies significantly from one farm to another. Reported soil mineralization rate ranges from about 20 to 150 lbs P/ac/y (Reddy, 1983; and Reddy and Rao, 1983; Sanchez and Porter, 1994). Fertilization recommendations are based partly on the amount of P that soil mineralization can provide. In another word, the higher the soil mineralization rate, the less the fertilizer is required. Other sources of P entering the EAA include rainfall and irrigation water. The flux of these contributions (<2 lbs P/ac/y) is relatively small compared with that from soil fertilization and soil mineralization (Stuck, 1996).

Please note that only part of the P supplied by fertilization and soil mineralization is released into drainage water. Fertilization typically provides high concentrations of P in soil solution during a short period of time, which is more prone to leaching with rainfall and drainage. Soil mineralization releases P year-round at a much slower rate. The major sinks of P are biological uptake and transformation into inorganic forms in soils. The rate of biological uptake varies with crops, varieties, and the growth condition. A typical biological uptake rate is about 50 lbs P/ac/y for sugarcane and only about 25 lbs P/ac/y for vegetables (Coale, 1994; Schueneman and Sanchez, 1994). Part of the P uptaken by plants is returned into the field, and the amount depends partly on practices such as burning canes in the field and disposal of water and wastes from the sugar mill. Fertilization history also influences P concentration in soil solution. Given the same condition, drainage water from a site with a longer cultivation history tends to have higher P concentrations since soil P sorption sites are more saturated under a longer period of fertilization (CH2M-Hill, 1979).

The overall implication of the above discussion is that soil minerlization and fertilization both are significant P sources for the EAA, and their relative contribution depends largely on crops and soil conditions. A P budget for the entire EAA would require detailed information about P fluxes of fertilization, soil mineralization, biological uptake and yield of each crop planted, harvested biomass, irrigation, rainfall, and other contributions such as burning of canes in each of the EAA farms. Due to the fact that some of the information is confidential or not readily available, such an effort would be extremely difficult if not impossible. An early attempt by Morris (1975) concluded that about 18% of P input into the EAA were from fertilizers and the remainder coming from soil mineralization and rainfall/irrigation water. However, he readily pointed out that this estimation was subject to large variability.

The bottom line is that Everglades BMPs integrate available practices to control these processes involved. Nutrient management BMPs are specifically developed to control over or improper fertilization practices. High P water from vegetable fields can be properly routed or recycled in sugarcane fields with water management BMPs. Maintaining an appropriate water table in the field through water management BMPs will reduce the mineralization process. In addition, proper pumping to avoid over drainage of fields (drainage uniformity) will also minimize leaching of dissolved P out of soil profiles or reduce sediment transport. We concur with the panel that conservation tillage should be used as an important BMP to control the soil mineralization process. A new section entitled “Phosphorus sources in the EAA” was added in the chapter to describe the major sources of P in the EAA including the mineralization of organic soils, fertilization, rainfall, and irrigation.

<u>Comment</u>: In 1998, Hurricane Georges produced large phosphorus spikes (figure 5-6, page 5-18) and may have contributed to the highest annual TP load in the 1996-2000 period. The spikes were primarily due to large increases in particulate P concentration (presumably caused by turbulence). Since hurricanes are not anthropogenic events, the Panel wonders whether effects of hurricanes are taken into account in computing the annual baseline TP load.

<u>Response</u>: The compliance TP load model to adjust rainfall for a given year is a statistical model developed with data of the base periods (1979 to 1988) when BMPs were not implemented. The model is used to predict the TP load for a given water year based on three rainfall parameters: the total annual rainfall, the coefficient of variation of monthly rainfall during the water year, and the skewness of monthly rainfall during the water year. The three rainfall parameters reflect not only the quantity of the rainfall but the distribution or the intensity of rainfall. Thus for a given year with hurricanes, the spiking effect of rainfall on TP load will be implicitly reflected by the three parameters. During the base period, seven hurricanes and three tropical storms directly or indirectly influenced the pumping and drainage in the EAA. Validation of the model using data from Water Year 89 to 92 indicated that the predicted TP load matched the measured TP load reasonably well. However, the model doest not have the capacity to to predict event-based loads such as that presented in Table 5-6. Note that the 1998 Hurricane George did not actually hit south Florida, and the pumping in anticipation of the event contributed significantly to the TP load for that particular year.

<u>Comment</u>: A new and emerging issue is the biogeochemical relationship between mercury and sulfur. The Panel has learned that sulfur is applied as a soil amendment to increase the availability of other essential micronutrients when soil pH is high. Given this situation, the District and the growers may need to think seriously about whether the use of sulfur-bearing fertilizers and soil amendments should be considered in the BMPs.

<u>Response</u>: In the EAA, sulfur deficiency is unlikely to occur on organic soils due to their high S content (Sanchez, 1990). Microorganisms are capable of oxidizing elemental S and organic S compounds to the plant available sulfate form. Sulfur is also available from the atmosphere as sulfur dioxide and sulfur trioxide. Sulfur is recommended for increasing micronutrient availability when the soil pH is more

than 6.6 (Sanchez, 1990). Since most organic soils are buffered against pH reductions (Beverly and Anderson, 1986), a significant amount of sulfur is required to achieve the desired pH reduction of Histosols (Burdine and Guzman, 1965; Schueneman and Sanchez, 1994) and this may not be economically feasible. An alternative of applying sulfur to correct micro-nutrients deficiency would be to apply the micro-nutrient needed along with an acid-producing P fertilizer (Schueneman and Sanchez, 1994).

While current nutrient management BMPs in the EAA are focused only on P fertilization, we believe that water management BMPs and sediment control BMPs should be fundamentally effective for all constituents in drainage water, both in dissolved phase and in particulate phase. For example, the reduced soil mineralization rate, leaching, and discharge volume from water management BMPs should also reduce sulfate release from the soil and the overall quantity of sulfur output from a farm. Moreover, sediment control BMPs may reduce sulfur attached to particulate originated from soil erosion and aquatic vegetation in farm canals. An analysis of the sulfur concentration and load from the EAA over the past 20 years will help to confirm this point.

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