APPENDIX 1
Public and Peer Review Panel Comments

Appendix 1-3
Authors Responses to Comments

Appendix 1-3h
Author's Response to Comments on Chapter 8

Chapter 8: Advanced Treatment Technologies for Treating Stormwater Discharges into the Everglades Protection Area

Responses to Public and Peer Review Comments

Comment: As with Chapter 6, ATT investigators are to be commended for collecting an enormous quantity of data. However, dimensions of experimental units, influent flow rates, and hydraulic residence times are frequently omitted. It is understood that most of this information is available in other documents. It is disappointing that analysis of the various unit processes investigated was not done more along the lines of the way an Environmental Engineer would analyze the situation: model the reactor using basic mass balance and reaction kinetics/stoichiometry principles.

Response: To address the public's comments that more detail should be provided about the experiments, an increased level of detail, including dimensions of experimental units, influent flow rates, and hydraulic residence times have been added to the chapter where appropriate. Unfortunately, extremely detailed discussion of each experiment of each advanced treatment technology was beyond the scope this report. The number of variables tested within each technology at each site makes detailed discussion impracticable. Additionally, many of the experiments are ongoing and P mass balances will be calculated at the end of the study. The purpose of this report is to provide an overview of the research to date for the water year ending April 30, 2000. Results and developments after the end of the water year will be discussed in next year's Everglades Consolidated Report. Please note that all quarterly reports, interim and final reports are public documents and are available during normal business operating hours. Efforts are currently underway to provide a web page with access to all Advanced Treatment Technology reports.

Comment: It is significant that some of the ATTs can reduce TP to less than 0.010 mg/L, but it is critical that cost estimates be made so that the screening process can begin. Preliminary cost estimates will provide data that can be used to eliminate some of the options being considered and allow more resource to be devoted to the evaluation of the viable options.

Response: Several comments were received that indicated that preliminary cost estimates will provide data that can be used to eliminate some of the options being considered. Initial cost estimates for full-scale implementation of the ATTs were provided by the Desktop Evaluation conducted by PEER Consultants P.C./Brown and Caldwell in 1996. However, these costs were extremely preliminary and were not based on data derived from tests with EAA waters. The initial estimates were also based on a number of assumptions that have since proved to be incorrect. The Supplemental Technology Standard of Comparison evaluation methodology is the venue in which cost scale-up will be compared. Currently, many of the ATTs are only just completing the small scale mesocosm and test cell experiments and the larger scale field scale studies are just beginning. It is our opinion that estimates of operation, maintenance and scale-up costs cannot not be accurately determined from these small scale experiments as they do not accurately represent full scale construction or operational situations. Therefore, although we recognize the need to add cost analysis to the discussion, we feel that any cost estimates produced at this time would be imprudent.

Comment: **Advanced treatment technologies under investigation:** The introductory paragraphs provide an excellent summary of the activities, descriptions of the forms of phosphorus and problems facing the District. Were any of the effluents introduced into an environment similar to that expected after treatment? Is it possible that the treated effluent will return to a minimum sustainable concentration of TP (perhaps 0.030 mg/L)? What was the influent TP fractionation in Phase I studies? It is indicated that phosphorus was analyzed for PP, TDP, and SRP, but these data were not shown. How did the fractionation change seasonally and was performance of the reactors affected? Why were the results from [PSTA] Phase II not shown in Figure 8-3 or in a separate graph?

Response: The immediate objective and mission of this Department is to research other technologies that may be used to optimize the STAs performance to attain the planning target 10 ppb P, therefore introduction of effluent to an [Everglades Protection Area] environment is not addressed in the current research of the ATTs. The Managed Wetlands Treatment Technology (MWTS) may address this question indirectly. The MWTS treats (chemically) surface waters down to a phosphorus level of approximately 10 ppb and subsequently discharges to a Typha spp. wetland. Sustainable concentrations of TP in this type of wetland may be observable.

Additional data on PP, TDP, and SRP has been added to the Chapter. Fractionation does not vary significantly with seasons.

[PSTA] Phase II experiments had only been operating for a month at the time of this report and therefore, the data were not included.

Comment: One of the important aspects of these treatment processes is how they will behave in response to events such as storm flows. Are experiments planned or have any been conducted in mesocosms or test cells where the systems are subjected to transients in inflow rate or phosphorus concentrations and types?

Response: Almost every technology will be examining a “pulse” type flow regime typical of storm events. The results will be reported in the water year during which such studies occur.

Comment: It would be helpful to see the results of individual treatments as a minimum in terms of percent phosphorus removal. With this information readers could draw their own conclusions, and it would facilitate analysis of the removal efficiency under different treatment conditions. A simple mass balance model including processes involving water-substrate interactions of phosphorus could be produced that would be useful for evaluation and design purposes.

Response: Additional detail has been added to the Chapter to show phosphorus removal. Percent phosphorus removal can be misleading without understanding inflow phosphorus concentrations. Additionally, the objective of each experiment was to reach a phosphorus concentration of approximately10 ppb (planning goal).

Comment: There apparently was some replication of some treatments in the PSTAS mesocosms, and it would be helpful to see the variability. This is very important in evaluating the reliability of the process.

Response: Extremely detailed discussion of each experiment of each advanced treatment technology was beyond the scope this report. The number of variables tested within each technology at each site makes detailed discussion impracticable. Additionally, all data is preliminary and statistical comparison will be made for the final reports.

Comment: In the peat based system it is possible that shading of the attached algae reduced growth rates and consequently reduced phosphorus removal. It would be interesting to know what impact the macrophyte growth had on the hydraulic characteristics of the systems. The hydraulic characteristics of the PSTAs will vary with the amount of plant cover, and as plant cover increases light penetration decreases having a significant effect on algae *growth*.

Response: Dye tracer studies were performed and will be reported in next year's document. The hydraulic characteristics will be compared. However, it was also noted that a wall effect did exist in the mesocosms and increased algae growth was noted along the sides of these systems that may have biased the uptake rates.

Comment: Mesocosm tanks producing lower mean TP outflow concentrations than the test cells is probably attributable to all of the factors mentioned on page 8-11, but another factor is the possibility for greater short circuiting in the test cells. A careful analysis of the hydraulic characteristics of the two types of tanks may yield significant results.

Response: Dye tracer studies were performed and will be reported in next year's document. The hydraulic characteristics will be compared.

Comment: It would be interesting to have an explanation of how the mesocosms were operated to obtain the different velocity in Phase 2. The velocity is a function of flow rate entering the mesocosm and the cross sectional area of the mesocosm; therefore, if recycle is used to control the velocity through the system, the HLR will increase and there will be an increase in the mass of TP entering the system. If the influent flow rate is decreased to compensate for the recycle, there is a corresponding decrease in the concentration of TP entering the mesocosm. The overall HLR cannot be constant without varying the flow rate or the surface area. How was the experiment conducted?

Response: An explanation has been added to the chapter.

Comment: Another factor that will affect the velocity in the mesocosms (as well as the Test Cells) is the volume of plants in the cross-sectional area. Are the studies designed to account for the effects of plant growth on the hydraulics of the systems?

Response: PSTA wetland systems with similar or greater emergent macrophyte cover typically have void fractions greater than 90 to 95 percent, resulting in little detectable effect on residence time or performance.

Comment: The field-scale PSTA experiments should yield interesting and useful results. It is good to see the third-point sampling stations. Too many wetland experiments and evaluations without intermediate data have been conducted and have yielded data subject to misinterpretation. Examples of this error are many of the early constructed wetlands systems and multiple cell wastewater treatment lagoon systems. Data from the influent and effluent to these systems have been used to design systems that have resulted in over-designs.

We suggest that one of the two unbaffled field scale units be constructed with a baffle covering about 2/3 of the cross-sectional area of the basin at the 1/3 points (at the sampling boardwalks) beginning on opposite sides. Research on large models has shown significant improvement in the hydraulic performance with such a simple modification in a straight-through flow pattern. Such a modification could be accomplished by attaching a baffle to the first sampling boardwalk and repositioning the second boardwalk to start on the opposite side from the first boardwalk and attach a baffle. A simple plastic sheet or boards would accomplish the desired effect. A copy of the material in the fourth reference is being sent, and other results of the research on baffling can be found in the following:

1. Mangelson, K. A. 1971. Hydraulics of Waste Stabilization Ponds and Its Influence on Treatment Efficiency. Ph.D. dissertation. Utah State University, Logan, Utah.

2. George, R. L. 1973. Two-dimensional Wind-generated Flow Patterns. Diffusion and Mixing in a Shallow Stratified Pond. Ph.D. dissertation. Utah State University, Logan, Utah.

3. Mangelson, K. A. and G. Z. Watters. 1972. Treatment Efficiency of Waste Stabilization Ponds. ASCE San. Eng. J., 98 (SA2), April.

4. Middlebrooks, E. J., et al. 1982. Wastewater Stabilization Lagoon Design, Performance and Upgrading. Macmillan Publishing Co., Inc. New York, NY.

Response: We have requested and received these references and will consider this option. The references are listed here for the interested reader.

Comment: Submerged Aquatic Vegetation/Limerock: Were the volumes or masses of vegetation the same in the reactors operating at HRT of 1.5, 3.5, and 7.0 days? It is very likely that one of the dominant factors in the performance of the SAV/LR is the growth attached to the vegetation.

Response: As these are natural systems it is very likely that there were plant biomass differences across the various mesocosms. Plant biomass was sampled during the experiment, but this data has not yet been analyzed.

Comment: The SAV/LR were analyzed only in terms of HRT. This assumes that the P removal process is a volumetric removal within the water column rather than an interfacial mass transfer to the bottom substrate. Has this been confirmed? An educated guess would be that the latter is more significant; therefore, overflow rate is the controlling parameter. If depth were the same in all reactors, then the same relationship between percent removal and HRT would exist for the percent removal and HLR, assuming that you know the actual HRT.

Response: SAV/LR results were reported in terms of HRT for comparability. Flow rates (HLR) were varied keeping depth constant.

Comment: It is interesting that TP removal did not increase when the HRT was increased from 3.5 to 7.0 days, particularly since the concentration of TP appeared to be adequate to sustain the growth of attached algae. Were the actual hydraulic characteristics of the mesocosms essentially the same or were there sidewall effects or differences in vegetation that could account for the lack of an increase? There are similarities between the biological components of the PSTA and the SAV/LR. Were the HRTs in the PSTAs similar to the HRTs in the SAV/LRs? One significant difference was the influent TP concentration. It would be interesting to see a comparison of the two biological components taking into account differences in influent TP concentrations, HRT, and vegetation.

Response: In all tanks, depth was held constant and flow was varied. Vegetation biomass was analyzed. In both the 3.5 and 7.0-day HRT mesocosms, average SRP levels were reduced to below detection limit The HLRs and depths between SAV/LR and PSTA were not the same. However, comparisons of results between the PSTA and SAV/LR systems will be addressed after the experiments are concluded.

Comment: Were statistical comparisons of the mean effluent TP concentrations conducted to determine if they differed?

Response: All data is preliminary and statistical comparison will be made for the final reports.

Comment: Were dye studies conducted to determine the actual HRT in the mesocosms? (See the discussion of hydraulics in the review of Chapter 6.) There are large differences in the nominal HRT and actual HRT (AHRT), and it is likely that many of the differences observed can be better explained if the AHRT were known.

Response: Dye studies were performed in all test cells and some mesocosms. Greater discussion of tracer studies has been added to the chapter.

Comment: Were the first year results from varying water depth less because of greater plant growth resulting in less light penetration, reducing the attached growth contribution to TP removal? It would be desirable to show the influent TP concentrations on Figure 8-8.

Response: Plant growth can always be a factor and attempts will be made to correlate biomass to results. Influent concentrations have been added to Figure 8-8.

Comment: Harvesting of the plants in the SAV probably reduced the surface area available for attached microorganisms to grow. Long term effects without harvesting and allowing biomass to accumulate might increase TP concentrations by feedback to the water. It would be good to show pre- and post-harvesting and recovery data in Figure 8-8. Identifying dates when changes in operating procedures occurred would make it easier to understand Figure 8-8.

Response: Some mesocosms were not harvested and at this point have not shown any negative long-term effects associated with not harvesting. Figure 8-8 on p. 8-21 is a duplicate and is not associated with SAV harvesting effects, but depth affects, Table 8-4 is referred to in the section on harvesting.

Comment: In the Effects of Substrate Types experiments the more vigorous growth of plants was an obvious factor in TP removal, but it is equally likely that the increase in plant growth also provided a home for the attached organisms resulting in additional TP removal.

Response: Acknowledged.

Comment: Is it possible that the wide variation in the influent TP concentrations had an effect on the Chara spp. in the Sequential SAV/LR treatment system? About the time that TP concentrations became erratic there was a significant drop in influent TP followed by a significant increase that was followed by a rapid decline and then rather erratic input after that. Is it known why the senescence of Chara spp. occurred?

Response: This is of course a possibility and it is not known why the Chara senesced.

Comment: It would be helpful in interpreting the results of the Shallow Raceway (SR) experiments if the velocity, HRT and complete dimensions of the system were provided. It is difficult to compare the size of the SR that would be required to accomplish the same results as those obtained with the other ATTs. If the size of a SR system is not prohibitive, it appears to offer great promise as a biological solution to the phosphorus problem in the Everglades. Initial results after doubling the velocity and HLR indicate that the optimum velocity and HLR were selected during the first experiments.

Response: HRT and dimensions of the SR systems will be provided. These are extremely shallow, 9 cm, and therefore land availability and cost needed to run a large-scale system at 9 cm would be prohibitive. The original intent of these systems was to provide information on pH in periyphyton systems and not as a study in periphyton effectiveness. Additionally, higher outflow P concentrations may be related to increased inflow concentrations, which occurred at the same time, and not the doubling of velocity.

Comment: The evaluation of STA 1-West Cell 4 is conducted in both Chapter 6 and Chapter 8. Are the same results presented in both chapters? Although somewhat redundant, it would be convenient to readers to have the results in both chapters.

Response: Chapter 6 encapsulates the results presented in this chapter.

Comment: Results in Table 8-6 appear to support lowering the HLR to 0.11 cm/day; however, additional information is needed to reach such a conclusion. It would be helpful to include the influent TP concentration in Table 8-6.

Response: Influent TP levels have been added to numerous tables and figures.

Comment: More detail about the dynamic simulation model would be interesting such as the basic form of the equation and variables to be considered.

Response: The dynamic model is not being developed nor funded by the District, but we will provide the website of where you can obtain more information on this model.

Comment: Are hydraulic characterization studies planned for the future? Many of the results of the extensive research effort being conducted in the Everglades will be subject to considerable question if hydraulic characterization studies are not conducted. Very few variables are as critical as the hydraulics of an engineered system.

Response: Dye studies were performed for several of the technologies at several scales and this data is currently being analyzed and will be presented in next year's report.

Comment: Are efforts being made to assess the "sustainability of long-term treatment?" Will there come a point when P buildup in the bottom substrate is enough to provide a P recycle feedback that will effectively reduce the efficiency of the treatment system, requiring some form of maintenance to restore its utility?

Response: Research is on-going. The Everglades Nutrient Removal Project (now STA 1-West) has been operating nearly five years without an observable P feedback. It is anticipated that these systems can operate decades without any maintenance.

Comment: Chemical Treatment-Solids Separation: The pH value and alkalinity can have a pronounced effect on algae growth. Bioassay result will give some indication of what impact might occur, but has any thought been given to what impact the discharge of the treated water to a natural environment might have on periphyton, plants, etc.? With increases in sulfur concentrations is there a potential for blooms of sulfur bacteria and an impact on the production of methyl mercury from the deposits of particulate mercury?

Response: The District concurs that bioassay results are limited. The District is currently evaluating the Managed Wetlands Treatment System technology which discharges directly to a wetland. Additionally, since the completion of the CTSS study, the District has switched from aluminum sulfate to aluminum chloride to avoid the potential of mercury methylation due to increased sulfur.

Comment: Low Intensity Chemical Dosing: Figure 8-14 would be improved by adding the influent TP concentration. The decision to discontinue the LICD appears to be appropriate.

Response: TP concentration is provided in the Unwalled Control data on the figure. Clarification has been provided in the caption and chapter text.

Comment: Managed Wetlands: What were the statistical relationships between the control test cells and the treatment test cells during Phase 1 Test Cells studies?

Response: This was a paired watershed analysis and a detailed description of the data analysis is out of scope of this chapter.

Comment: It is doubtful that the attempt to simulate sludge contact by recirculating sludge to the top of the flow stream in the test cells was a very realistic simulation. If the ability of the Managed Wetlands to remove TP is to be adequately evaluated, a typical system should be utilized as it appears will be the case at the Big Cypress Reservation. What operational adjustments were made to overcome the episodic floc overflow? On page 8-38 it is stated that TP and TPP concentrations in wetland outflow are lower when compared to the control. How much lower?

Response: Noted. Operational adjustments and reduction data have been added to the chapter.

Comment: Conclusions. As mentioned in the opening paragraph, enormous quantities of data have been collected in the ATT studies, and the investigators are to be commended for their efforts. The Findings section is a good summary of the results from the various ATT studies, and it may be more appropriate that this section appear at the beginning of the chapter in the summary section and change the title to Summary and Findings. Such a rearrangement would make it much easier for the reader seeking the bottom line without wading through the detail.

Response: Findings have been moved to the beginning of the chapter.

Recommendations (Addressed in the above panel comments and listed here for the interested reader.)

1. It is strongly recommended that the analysis of the various unit processes investigated be done more along the lines of the way an Environmental Engineer would analyze the situation: model the reactor using basic mass balance and reaction kinetics/stoichiometry principles.

2. It is strongly recommended that the hydraulic characteristics of all of the ATTs be evaluated. Design information is not complete without good hydraulic information.
3. Cost estimates should be made as soon as possible so that the screening process for the ATTs can begin.
4. Analyses of the data should be conducted to determine the influence of the influent TP fractionation on performance of the ATTs.
5. Experiments should be conducted in mesocosms or test cells where the systems are subjected to transients in inflow rate or phosphorus concentrations and types.
6. Efforts should be made to assess the "sustainability of long-term treatment."

Comments from United States Department of the Interior,

- **NATIONAL PARK SERVICE and FISH AND WILDLIFE SERVICE, Everglades Program Team**

Comment: In Chapter 8, it is apparent that the SFWMD is proceeding with CTSS research at a large scale and high expense, despite overwhelming consensus that such a technology employed at the full scale would not be acceptable to any of the agencies or entities involved in Everglades restoration. We believe that the initial phases of the research have been high quality and informative, and have produced sufficient information to make initial determinations of the lack of feasibility. We believe the technology has several fatal flaws if employed at the large-scale level, including: potential increases in Hg methylation rates due to sulfate enrichment; concerns regarding effluent marsh readiness; and the economic and ecological impacts associated with chemical transport, and sludge transport and disposal. CTSS research at the present scale diverts critical resources away from expanded research on other, more acceptable passive technologies. This finding is supported by the efforts of the Florida Department of Environmental Protection and the National Park Service to find supplemental funds to augment critical passive technology research efforts that the SFWMD has not funded.

Response: The Everglades Forever Act establishes a default criteria of 10 ppb total phosphorus. At this time, two advanced treatment technology demonstration projects have demonstrated an ability to achieve that criterion - Chemical Treatment/High Rate Clarification and Chemical Treatment/Filtration. Both demonstration projects were conducted as small-scale studies and warrant additional study as long as a phosphorus criterion remains unset. To address the potential for methylation of mercury, all research projects employing chemicals have switched to chloride compounds.

We believe that sufficient levels of cost estimates are available, particularly for CTSS, for preliminary presentation and assessment as part of the Consolidated Report. It is recognized that these estimates would be refined as new research and engineering information becomes available, but we believe strongly that initial estimates should be provided for public review. On pages 8-39 through 40, it is indicated that Phase 3 of the STSOC, "Development of cost estimates," is completed, and we believe this information, even in draft form, should be included at this time.

Response: As indicated previously, cost estimates have not been developed for each of the technologies. The discussion of Phase 3 of the STSOC has been reworded to more accurately reflect the "development of standard costs". These standardized costs will be used by all demonstration project teams to develop cost estimates after the completion of their studies.

Chapter 8: Advanced Treatment Technologies for Treating Stormwater Discharges into the Everglades Protection Area

Responses to Public and Peer Review Comments

USDOI National Park Service & Fish and Wildlife Service Everglades Program Team Comments and Authors' Responses

Comments Specifically from Nick Aumen

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Response (DEP, Atkeson & Parks; SFWMD, Fink): See William Green, Esq., Sugar Cane Growers Cooperative of Florida, Comments and Author's Responses above. Because DEP is pursuing a primary strategy of control of air emissions of mercury it has not addressed questions about whether sulfate control could alleviate the Everglades mercury problem. However, sulfate enrichment has not been ruled out as a potentially controllable factor contributing to the Everglades mercury problem. The significance of the effects of sulfate from Chemical Treatment Solids Separation (CTSS) cannot be stated at this time, but will be considered prior to investing in this technology. The District has a Section 319 Grant from USEPA Region 4 via DEP to evaluate ATTs, including CTSS, for potential mercury problems during the demonstration phase. We believe these screening studies will alert the DEP to a potential mercury problem before a technology is scaled up for the next phase of testing. This work will continue through FY '02.