APPENDIX 5

Comments
"Total Maximum Daily Load for Total Phosphorus, Lake Okeechobee, Florida" August 2000 Draft

Anthony Federico

Comments are provided on the material presented in the August 2000 draft, which is mostly background information. The report lacks the most critical component: a discussion of the 3 models evaluated (strengths and weaknesses) and a presentation of the rationale for selecting a particular model and load limit. Additional comments on the selection of the TMDL will be provided after the Department presents its rationale and provides the models and documentation.

1. The document has a great deal of background information. However, a key aspect that is missing is a detailed discussion of the trends in the inputs (by tributary) of phosphorus to the lake.

2. pg1 ln11: What is the basis for using a 5-year averaging period? Why not 10 years, etc?

3. pg3 ln15: I don't believe there are significant amounts of peat resuspended in the lake.

4. pg3 ln26: Add the other two major sources of phosphorus – Kissimmee River and S-154 basin.

5. pg7 ln10: There is no support provided for the statement that the regulation of the structures negatively affects the lake's water quality. There were only brief mentions of a stage/phosphorus relationship during the TAC meetings. The issue was never directly discussed. There was no evidence provided that this is a causal relationship. Stage may just be a surrogate for other factors, i.e. loadings, etc.

6. pg7 ln15: Rainfall patterns are the primary driver influencing lake stage. The Hoover Dike and the regulation schedule are secondary factors that can exacerbate the rainfall driven fluctuations.

7. pg8 ln12: I don't believe that the entire lake was affected by the 1986 bloom. Also, to my knowledge, there hasn't been a bloom of that magnitude since then (24 years).

8. pg17 lns 17-19: The report states that the development of seasonal blooms of blue-green algae constitute imbalances. Then on page 9 lines 21 & 22 it is stated that the IAP created conditions more favorable for the proliferation of blue-green algae. A conclusion therefore is that implementation of the IAP has caused an imbalance.

9. pg9 ln 25: I don't recall data being presented that show algal bloom frequencies increasing from 1992 to the present.

10. pg10 ln10: The statement "The total phosphorus concentrations that currently exist in the lake are in excess of the amount needed for a healthy ecosystem" is a key issue. It needs to be supported with data and scientific references.

11. pg10 ln11: This implies that canals and structures are the primary factors contributing to a doubling of the in-lake phosphorus levels, rather than the true cause – phosphorus in runoff.

12. pg11 ln16: The source is more accurately identified as feed, fertilizer and sludge disposal.

13. pg12 ln3: Over what time period has the loads to the lake averaged 570 mtons/yr? This needs to be referenced.

14. pg12 ln 5-7: This doesn't make any sense.

15. pg12 ln11: I believe that the SWIM Act actually called for a plan to be developed and did not directly require a specific load reduction.

16. pg12 ln17: I've never seen data showing sugarcane burning as a significant source of atmospheric phosphorus to the lake. This statement needs a scientific if it is retained.

17. pg12 ln21: Pollman's presentation alone is not sufficient documentation to support these deposition rates. A technical write-up needs to be provided in the appendix.

18. pg17 lns 12-15: This sentence should be struck. It is inaccurate (the COE sets lake schedules) and confusing. What "wetlands" were flooded?

19. pg17 lns 16-17. The sentence "This resulted in an increase of phosphorus in the water column from dead and dying littoral vegetation" should be struck. This is speculation and is inconsistent with the sentence that follows.

20. pg18 ln17: Where is the reference for in-lake concentrations exceeding 1000 ppb? At a minimum this is very misleading.

21. pg19 ln2: Where is it "stated above"? Also, before conclusions are stated with respect to Ca trends, a longer time period needs to be analyzed. The issue of the period of record presented by Pollman was raised at the TAC.

22. pg 20 ln5: The report "Harvey and Havens 1999" is not a technical report and should not be used as a technical reference here and in other locations. The underlying scientific reports need to be referenced.

23. pgs 15 – 26: The section "Factors Affecting Phosphorus Concentrations in Lake Okeechobee" is a mix of physical processes and government processes (i.e. Committees, reports, etc.). These need to be dealt with in separate sections.

24. pg27 ln 12: All the inflows to the lake are not monitored.

25. pg28 ln23: Littoral zone should be changed to near-shore zone.

26. pg30 ln4: The TMDL is expressed as a load and therefore the concept of a flow weighted average does not apply and should be deleted.

27. pg31 lns 3-8: The section "Critical Condition Determination" makes no sense and should be deleted.

28. pg 31 lns22-25: The section on "Seasonal Variation" is incorrect on all its points. If the TMDL was based on Walker's model, it utilized annual data and therefore does not account for seasonal variation. The Lake does experience extreme seasonal variation during periods of extreme rainfall conditions (i.e.). Seasonal variations are not accounted for in the simple use of a multi-year averaging period.

29. pgs 31-33: I agree that the processes involving phosphorus cycling in the lake are difficult to accurately model, especially as load reductions are implemented and the lake recovers. This was one reason I recommended the use of a variable TMDL based on actual future mass-balance data. I therefore agree that the use of a phased TMDL is warranted. However, it appears that the Department, in certain sections of the document, has not proposed a phased TMDL but instead proposes a fixed (135 mtons/yr) TMDL. The TMDL, as proposed in the Executive Summary and on page 30, should be modified to reflect the stated phased approach. I'm also unclear as to how the issue of phosphorus cycling in the watershed bears on the TMDL.

September 18, 2000

Re: Comments on the FDEP draft TMDL for phosphorus for Lake Okeechobee

From: Karl E. Havens (TMDL Technical Advisory Committee member)

General comment:

This document represents a good starting point, synthesizing a large amount of information about a complex resource management issue. However, a number of substantive changes will be required in the revision in order to address factual errors, contradictory statements, and a narrative that does not adequately reflect the conclusions of the TAC membership.

Specific suggestions (page # / paragraph #):

1/2 -- At the end of this paragraph, it would be helpful to tell the reader why point sources are not included. From the existing wording it is not clear whether or not they will be allowed as an additional load that does not fall under this program.

1/3 -- The second to last sentence suggests that Phase II of the plan and compliance with the TMDL will be completed by 2004. I don't think this is correct.

2/3 -- In the last sentence, please note that both the pelagic and littoral zones comprise habitat for fish (reference: Bull, L.A., Fox, D.D., Brown, D.W., Davis, L.J., Miller, S.J. and Wullschleger, J.G. 1995. Fish distribution in limnetic areas of Lake Okeechobee, Florida. Archiv fur Hydrobiologie, Advances in Limnology 45: 333-342).

3/1 -- Please replace this entire paragraph with the following:

> "*Two hundred years ago, a large percentage of the lake bottom in Lake Okeechobee may have been covered with sand, whereas today, much of that area is overlain by organic mud (Brezonik and Engstrom 1997). The upper 10 cm of that mud is estimated to contain over 30,000 metric tons of phosphorus (Olila and Reddy 1993). The rate of mud sediment accumulation and phosphorus deposition both have increased significantly in the last 50 years (Brezonik and Engstrom 1997)."*

3/2 -- In the 4th sentence, omit the words "and peat." Generally it is just mud resuspension that results in high turbidity under typical wind conditions.

3/2 -- About half way into the paragraph, modify the sentence to read as follows:

> "*The edge (near-shore) zone is located in the southern and western portions of the lake, between the littoral and transition zones, and is characterized by lower total phosphorus, higher light availability, and more frequent nutrient limitation than in the other open-water zones (Aldridge et al. 1995)."*

(reference: Aldridge, F.J., Phlips, E.J. and Schelske, C.L. 1995. The use of nutrient enrichment bioassays to test for spatial and temporal distribution of limiting factors affecting phytoplankton dynamics in Lake Okeechobee, Florida. Archiv fur Hydrobiologie, Advances in Limnology 45: 177-190).

3/2 -- Just below that section, please also modify the sentence dealing with the edge zone to read:

> "*The edge zone also is most sensitive to changing lake water levels and nutrient loading, displaying transitions between clear water with macrophyte dominance at low lake stage and turbid water with phytoplankton dominance at high stage (Havens et al. 2000)."*

(reference: Havens, K.E., Hauxwell, J., Tyler, A.C., Thomas, S., McGlathery, K.J., Cebrian, J., Valiela, I., Steinman, A.D. and Hwang, S.J. 2000. Complex interactions between autotrophs in shallow marine and freshwater ecosystems: implications for community responses to nutrient stress. Environmental Pollution, in press).

3/3 -- Near the end of the paragraph, when mentioning light limitation, please cite Phlips et al. (1997), the only study to actually document that phenomenon in the lake. (reference: Phlips, E.J., Cichra, M., Havens, K.E., Hanlon, C., Badylak, S., Rueter, B., Randall, M. and Hansen, P. 1997. Relationships between phytoplankton dynamics and the availability of light and nutrients in a shallow subtropical lake. Journal of Plankton Research 19: 319-342.)

4/1 -- I'd replace the words "inflows" and "outflows" with "inputs" and "outputs" in this paragraph, because they include rainfall and evapotranspiration.

4/1 -- Fisheating Creek doesn't belong in the sentence that mentions "numerous smaller inflows." It is one of the largest sources of surface water inflow to the lake.

4/2 -- The three year time frame refers to the phosphorus residence time. If you calculate a true hydrologic residence time, including ET, the number is closer to 1 yr. Perhaps you can put a caveat in parentheses. In other words, "*The residence time (not including evapotranspiration) of water in the lake is approximately 3 years."*

4/3 -- In the first sentence, please replace "create a water supply" with "*to facilitate greater water storage capacity*."

7/1 -- In the opening sentence, I don't understand how construction of a levee would lower the lake level by 2 feet. I guess you mean that after the levee was constructed, the water was managed in a manner that resulted in a maximum surface elevation of 17 ft instead of 19. Havens et al. 1996a is not the appropriate citation for this statement. Please find the original citation dealing with lake stage regulation.

7/1 -- In the last sentence, it says that the C&SF project "negatively affected the water quality." This merits some kind of explanation.

7/2 -- It is incorrect to say that the USACE designed the schedule to "store water for irrigation." First, the schedule is for flood protection. Second, the water stored in the lake is used for irrigation, urban uses, and deliveries to natural systems.

7/2 -- This paragraph incorrectly implies that management actions were solely responsible for the changes in lake stage. I don't think this is correct. To a very large extent, the regional rainfall patterns determine water levels in the lake (e.g., high rainfall = high stage in 1995-1999).

7/2 -- At the end of this paragraph, it is unclear what is meant by the "1999 schedule."

7 -- Why does figure 3 only include data from 1973 to 1994? This is confusing since the associated text discusses changes in lake stage from the early 1900s to present. Historical hydrographs are readily available.

8/1 -- In the last sentence it says that the 1986 algal bloom moved into the littoral zone. Actually it was the near-shore zone, not the littoral. Also, the bloom did not "affect the entire lake."

9/1 -- The opening paragraph on this page needs a major re-write because it includes statements that are specific to Lake Okeechobee but gives literature citations based on research conducted elsewhere. I'd replace the paragraph with the following text:

> *"Algal blooms in Lake Okeechobee have caused die-offs of macroinvertebrate communities due to toxic by-products of algal decay (Jones 1986), and they could threaten other ecological and societal values of the ecosystem. The algal species that occur during blooms (Anabaena circinalis, Microcystis aeurginosa, and Aphanizomenon flos-aquae) can sometimes produce toxic chemicals that harm fish and wildlife (Carmichael et al. 1985). Dense blooms of algae in a lake also can affect the quality of drinking water by creating taste and odor problems and contributing to high levels of trihalomethane precursors (Heiskary and Walker 1988, Barica 1993)."*

9/2 -- This paragraph contains references that are in error. In particular the paper by Smith and Callopy (1995) deals with wading birds, not algal blooms. Here are the correct citations to use in reference to certain statements:

> Statement: Blue-greens have increased coincident with lower TN:TP ratios (reference: Smith, V.H., Bierman, V.J., Jr., Jones, B.L. and Havens, K.E. 1995. Historical trends in the Lake Okeechobee ecosystem. IV. Nitrogen:phosphorus ratios, cyanobacterial dominance, and nitrogen fixation potential. Archiv fur Hydrobiologie, Supplement 107: 71-88).
>
> Statement: Bloom frequency has increased since the 1970s (reference: Havens, K.E., Hanlon, C. and James, R.T. 1995. Historical trends in the Lake Okeechobee ecosystem V. Algal blooms. Archiv fur Hydrobiologie, Supplement 107: 89-100).

Statement: Blooms are more common in summer (reference: Havens, K.E., Hanlon, C. and James, R.T. 1995. Seasonal and spatial variation in algal bloom frequencies in Lake Okeechobee, Florida, USA. Lake and Reservoir Management 10: 139-148).

9/3 -- The opening sentence says that bloom frequencies "are still increasing." This is not possible because the cited paper was printed in 1996.

9/3 -- At the bottom of the page, Jones (1987) is cited when talking about factors that control blooms. This is not appropriate since that study did not carry out such an assessment. The best citation to address controlling factors is: Havens, K.E., Phlips, E.J., Cichra, M.F. and Li, B.L. 1998. Light availability as a possible regulator of cyanobacteria species composition in a shallow subtropical lake. Freshwater Biology 39: 547-556. This paper includes a conceptual model of algal bloom formation in Lake Okeechobee that is supported in the paper by empirical data.

10/1 -- Please modify the last sentence to read as follows:

"*This is most likely due to lower wind velocities, reduced sediment resuspension, and greater underwater irradiances during summer (Havens et al. 1995)."* The citation refers to the paper in Lake and Reservoir Management mentioned above.

10/2 -- The trend in TP clearly is a non-linear one, with a two-fold increase followed by a plateau. It needs to be described this way in the text. In this same paragraph, it would make more sense to say that in-lake TP doubled as a result of increased inputs from the watershed, and that this input may have been facilitated by the canals. The existing text makes it sound like the canals themselves were primarily responsible.

10/2 -- Near the end of this paragraph, the near-shore zone is confused with the littoral zone. It is very important that the reader understand that there are three distinct regions of the lake: Pelagic (including the north, central, and transition), Edge (or near-shore) and Littoral. Perhaps you can do this by modifying the text in the section that refers to ecological zones earlier in the document. Figure 9 (from Walker and Havens) confuses the terms by calling the near-shore zone "littoral" (sorry about that!). I'd change the labels on this figure.

10 -- On this page there should be a section called "Phosphorus mass balance." In that section, you would tell the reader that by comparing measured P inputs and outputs one can determine the net losses to lake sediments each year from the water column. Those net losses have changed over time relative to loads, in that the lake now assimilates P at about 1/3 of the capacity that it did in the 1970s. This decline in net P sedimentation (Knet) actually was a focal point of three TAC meetings, so I am surprised that it is not highlighted in this document.

10/3 -- The mud did not accumulate since the 1950s. Please look again at Brezonik and Engstrom's paper and use the suggested text provided above in regard to their conclusions. In fact, I would replace this entire paragraph with the text recommended above for the introduction. The reference provided (Havens 1997) is a secondary citation and should be omitted.

11/1 -- Resuspension is NOT responsible for the load that Ramesh refers to when he says (in the 1995 tech pub) that internal loads = external. That load is from diffusive fluxes. The resuspension / settling process is a much larger cycle, and its net result is downward transport of P from the water column to the sediments.

11/2 -- Is there a reference for the statement that P concentrations have increased by 50 to 60-fold "from manure?"

12/1 -- At the end of the opening sentence, add the words "*since 19__*" (I'm actually not sure what time period is being referred to).

12/1 -- The statement about P being added back into the water from sediments is misleading because the sediments are a large net sink for P on a yearly basis. I'd reword this or omit the sentence.

12/1 -- The SWIM Act did not establish loading targets for the contributing basins. That was done in the WOD Rule.

14/3 -- Is there a citation in support of the statement about septic tanks? I thought that the one study done in regard to this showed that it was not a significant source of nutrients to the lake.

15/1 -- Perhaps it should be noted that all of the information being presented in this paragraph is now 8 years old, and that a new watershed P budget is currently being constructed under contract by the SFWMD.

15/1 -- It seems that this same paragraph needs to mention the large inputs of P that come from the Upper Chain-of-Lakes and Lake Istokpoga watersheds.

15/2 -- The second sentence needs to be reworded. I don't know of any evidence that sugar cane burning is the major source of atmospheric P in the region. Also, what is the "bottom line" in this paragraph; i.e., what do we think is a reasonable number for P loading from the atmosphere out over the open lake? The number 18 is mentioned later in the document. It seems like this is the best place to first introduce it to the reader.

17/1 -- The last sentence contains contradictory phrases ("meeting the SWIM target along will not reduce the concentration largely due to sources not controlled under SWIM"). Please reword. Also, the reader gets to the end of this paragraph and wonders what the take home message is supposed to be. How about another sentence to wrap it up?

17/2 -- I don't understand the opening sentence. Will any changes in lake regulation result in eutrophication? Or is it just certain (not specified) changes? The statement needs to be clarified.

17/3 -- The SFWMD did NOT "raise the water level of the lake." The regulation schedule was changed and this happened to coincide with a period of increased rainfall after a relatively long dry period (this can be observed in regional climatological data). I never have been convinced

that the lake stage would have been significantly lower had the schedule not been changed. At a minimum, please say that

> *"lake stages increased dramatically in the late 1970s, coincident with increased rainfall and a modified lake stage regulation schedule adopted by the SFWMD and USACE."*

17/3 -- I'm confused as to what point is being made in the rest of this paragraph. First it says that the littoral zone is flooded, releasing P. Then it says that Dierberg's results (confirmed by others) indicate the P contribution was not significant. Then it says that Canfield and Hoyer found correlations. Where is this going? I'd like to propose a new paragraph to describe the effects of high water levels in the lake:

> *"High water levels in the lake have been documented to exacerbate the symptoms of cultural eutrophication (Canfield and Hoyer 1988, Havens 1997). There is a strong correlation between yearly-average total phosphorus concentrations, near-shore algal bloom frequencies, and water levels. Two ecological processes may interactively explain this phenomenon. First, when water levels are high, there is reduced growth of submerged plants in the near-shore zone, and therefore, less competition for phosphorus between plants and phytoplankton. Phytoplankton sequester nearly all of the available nutrients and give rise to blooms. Second, when water levels are high, there is greater transport of phosphorus-rich water from the mid-lake region into the near-shore area by underwater currents. At low lake stages a shallow rock reef that separates the near-shore area from mid-lake prevents this transport. A third mechanism, that littoral flooding results in internal phosphorus loading from dead vegetation, was shown to be of relatively low importance (Dierberg 1993), who showed that the littoral zone is largely a sink, rather than a source, for phosphorus."*

18/2 -- The correct citation in the first sentence is Olila and Reddy (1993). The amount of phosphorus stored is in excess of 30,000 metric tons, but importantly that is just the upper 10 cm.

18/2 -- A literature citation is needed for the statement about iron solubility.

18/2 -- The correct citation in the 3rd from last sentence is Havens et al. (1995 -- Lake and Reservoir Management, listed above).

18/3 -- I'm not sure why this information is presented. There needs to be some kind of closing statement that says how this relates to the TMDL issue.

18/4 -- One of my MAJOR CONCERNS with the document occurs on page 19. Here there is a presentation of the calcium data, in a manner suggesting that we (the TAC) consider this to be the major explanation for the lake's loss of P assimilation. First, the document has not yet presented the important graph of Knet vs. time around which much of our discussions focused. Second, the Ca hypothesis was just one of many discussed by the TAC. As I recall, we concluded that it might not be a major factor because the system always is super-saturated anyway. I would like to see this document reflect the other in-lake processes that were discussed. This would focus on the concept of sediment binding sites possibly getting saturated with P, and

also the biological factors that might have resulted in a lower Knet (loss of SAV, change in phytoplankton taxonomic composition, increased percentage of P in soluble forms, changes in the invertebrate assemblages, changes in fish community structure). This expanded section could be done using text taken directly from the white papers that Claire Schelske and I presented as handouts to the group. I think it is critical that this be done because most of the biological processes have the potential to reverse their past trends (e.g., diatoms → blue-greens → diatoms). If this occurs, the lake may actually be able to assimilate more than 135 metric tons of P and meet the in-lake goal of 40 ppb. That's something that we would determine in the future when loads start to decline and the lake responds. At that time we also may have modeling tools that include more of the biological processes.

20/3 -- Change "was to report to" to "reported to."

20/3 -- What actions did this result in?

21/1 -- The WOD standard for improved pastures is 350 ppb, not 35 ppb.

21/2 -- In regard to the effects of the Dairy Rule Program, I'd cite the following paper: Havens, K.E., Flaig, E.G., James, R.T., Lostal, S. and Muszick, D. 1996. Results of a program to control phosphorus discharges from dairy operations in south-central Florida, USA. Environmental Management 21: 585-593.

21/3 -- Omit the Harvey and Havens (1999) reference and replace with a more appropriate one (e.g., Anderson and Flaig 1995).

22 -- It is not possible to see the station location on this map.

23/1 -- Insert a reference in the first line, as follows: "The primary focus of the Action Plan *(Harvey and Havens 1999)* was to reduce…" and then omit the reference from the end of the paragraph.

23/3 -- The $38.5 million grant was not part of the Lake Okeechobee Protection Program.

26/3 -- I'm not sure what the final sentence on this page means. Can it be clarified?

27/1 -- The last sentence is in error. The models of Walker and Polman did use data from the eight pelagic stations, but we used data from the near-shore stations to establish the in-lake TP concentration goal of 40 ppb.

27/3 -- The range of TP goals identified in the Havens and James paper was 26 to 92 ppb, not 30 to 50 ppb. Please change this, but also add a sentence that says:

> *"However, on closer inspection of this range, the Lake Okeechobee Issue Team and the TMDL Technical Advisory Committee noted that values towards the mid-point of the range (3o to 30 ppb) were the most appropriate from a scientific standpoint."*

28/3 -- This paragraph does not really explain why the 40 ppb goal is conservative. Perhaps the text could say something like this:

> *"The 40 ppb goal for the entire pelagic region is considered to be a conservative goal that introduces a margin of safety into the TMDL. This reflects the fact that under high lake stage conditions, TP concentrations are relatively homogeneous across the open-water region, but when lake stages are low, the near-shore area displays considerably lower TP than the mid-lake region. Hence if 40 ppb is met at the eight historic stations (which mostly represent the mid-lake) we can expect TP concentrations of below 40 ppb in the near-shore during certain years."*

29 -- I can't make out the stations on this map. The symbols are too small and too numerous. How about showing L001-L008 stations with one kind of symbol, and the near-shore sites used to set the 40 ppb goal with another. The rest of the station symbols could be omitted.

30/1 -- The last sentence refers to appendix 3, which is missing.

30/1 -- I think the main body of text must (at a minimum) provide a generic description of each model (Walker, Polman) and say what the TMDL is based on each model output.

30/1 -- The equation given here is not technically correct. The expression on the right hand side is presented as a sum of loads, but clearly the margin of safety lowers the TMDL rather than raising it (i.e., in an equation the MOS would be a negative).

30/2 -- The rainfall load is not 18 metric tons/yr, it is approximately 35. The number 18 refers to the load in mg/m2 of lake surface.

31/3 -- The first sentence is in error. Many attributes in the lake, including TP, transparency, and blooms, experience strong seasonal variation. Furthermore the statement that there is no seasonal variation "because" the lake has a regulation schedule makes no sense.

32/1 -- Right after the citation for USEPA 1991, please add this sentence:

> *"For example, we may observe a faster recovery of the lake than anticipated, and perhaps an increase in P assimilative capacity, if past biological trends associated with eutrophication (e.g., blue-green and oligochaete dominance) are reversed. This might lead to adjustment of the TMDL."*

32/2 -- Is the design goal 40 ppb for 100% of runoff water (even in 1 in 100 year storms, for example)? That would not be very practical since a RASTA large enough to do this would often be dry.

33/1 -- At the end of the first sentence, add the following: "highest loads of phosphorus to Lake Okeechobee *and they have particularly high concentrations of P in their waters."*

33/3 -- The opening sentence of this paragraph makes it sound like the goal is to reach 40 ppb in the lake by the year 2020. I suspect that this is impossible given the large amounts of residual P in the watershed and lake.

51/1 -- In this model description and the one that Bill Walker is developing, I would avoid saying that the models are "derived from the original Vollenweider model." While this kind of historic information may be OK for journal articles, it only will raise a "red flag" among the public, who know little about modeling, but who know that the existing modified Vollenweider model does not work very well for this lake. Why introduce a possible source of concern where it is not merited?

To: Kimberly Shugar
From: Gary J. Ritter, Supervising Env. Sci. Okeechobee Service Center
Subject: Review Lake Okeechobee Total Phosphorus TMDL

Thank you very much for providing me with the opportunity to review the 09/07/00 draft of the "Total Maximum Daily Load for Total Phosphorus Lake Okeechobee, Florida". This paper is a very good compilation of information regarding the current state of Lake Okeechobee. Please share my comments and questions in regard to this draft document with the committee.

Lines 1-7 Executive Summary Comment… The first statement epitomizes the problem we have had for years with Lake Okeechobee, and that is defining whether we want to manage the Lake as a reservoir or a Lake. It appears that trying to do both, as we have in the past, has contributed to the ecological problems we are currently faced with. I don't see anything in this draft that moves us away from that dual management strategy for Lake Okeechobee. In fact, it appears that in the backgound description of the water body lines 28-31 we define Lake Okeechobee as a reservoir. As such, can we realistically expect to achieve the TMDL for Lake Okeechobee if we continue to manage the lake as a reservoir?

Line 9 Page 2 Introduction… What is CFR?

Page 12, Line 15… Currently, 15 of the 29 basins are currently exceeding… delete 2nd currently.

Page 21, Line 2… Should be 350 ppb.

Page 21, Line 11 … Should be 49 dairies?

Page 30, Line 14… Why will no portion of the TMDL be allocated to point sources?

Florida Department of Agriculture & Consumer Services
BOB CRAWFORD, Commissioner

Please Respond to:
Office of Agricultural Water Policy
3125 Conner Boulevard
Suite C, Mail Stop C-28
Tallahassee, FL 32399-1650

September 27, 2000

Ms. Kim Shugar
Department of Environmental Protection
2600 Blair Stone Road, MS 3525
Tallahassee, FL 32399-2400

Dear Ms. Shugar:

We have completed a review of the Draft document "Total Maximum Daily Load for Total Phosphorus Lake Okeechobee, Florida", and have the following comments for your consideration.

The document contains a lot of background and historical information, but lacks detailed information critical to explaining the derivation of the proposed Lake Okeechobee phosphorus TMDL. Some of the background information appears to be included to justify the use of a 40 ppb phosphorus concentration as the in-lake target, although the reason(s) for choosing 40 from the phosphorus ranges cited is not clearly expressed. The document also does not provide a clear, concise explanation of how the 135 metric ton annual phosphorus load for the lake was derived. Appendix 3 is referenced and may contain some of the missing information, but it has not yet been made available for review. An explanation should also be provided describing how and why the value used for phosphorus load from rainfall varies significantly from that which has previously been accepted and of how the new value was derived

It is unclear what the "Critical Condition Determination" paragraph on page 30 is intended to assert. Can the annual phosphorus load never go over the 135 metric tons, regardless of rainfall amounts? The last sentence is very confusing; the lake's regulation schedule does not prevent "extreme conditions" from occurring, and it does not control flows into the lake.

The "Phase II" paragraph on page 33 is also confusing. The way it is worded, Phase II projects would be completed in 2004 and would achieve the TMDL, while Phase I will be evaluated in 2005, after the TMDL had already been achieved.

We are currently not providing technical comments, but look forward to providing them after we have had the opportunity to review the model(s)and read a complete document that addresses the areas delineated above.

If you have any questions or need clarification please let me know.

Cordially,

BOB CRAWFORD

COMMISSIONER OF AGRICULTURE

John Folks, Environmental Administrator
Office of Agriculture Water Policy
(850) 414-9928

cc: Jerry E. Brooks, FDEP
Chuck Aller, FDACS
Rich Budell, FDACS

Comments on
Total Maximum Daily Load
for Total Phosphorus
Lake Okeechobee, Florida

by Claire L. Schelske
September 24, 2000

Specific comments by page and line

p1,15—be more specific instead of "computer models"

p2,11—changed "limited"— use impaired?

p3, 2 -reference for statement.

p3, 7 –Brezonik and Engstrom (1997) should be cited as well.

p5, 22 –"average" residence time. Should it be noted that RT varies with rainfall, storage in the lake and outflow. The last are also regulated, not natural.

p7, -indicate where appropriate which of the ranges in water levels refer to regulation schedules. Also, indicate why such numbers are different for seasons.

p8,12 –surely, not the entire lake.

p9, 1-7- as written, it would appear that toxic ammonia and other factors listed have been identified as problems in the lake. Some of these studies may not even mention Lake Okeechobee. Also, I suspect the consequence attributed to Jones (1987) is not accurate. Are these only possible or suspected consequences?

p11, 4 –"as large as" 0.7 and 1.1 would be more appropriate (see below).

p11, 7-9, this statement cannot apply to the whole lake. Be much more specific.

p11, 11-13, units for numbers are not useful as presented. Need information on depth integrated.

p12, 5-7 –same comment as above. Also see general comment below (P mass balance).

p17, 8 –reducing "external" phosphorus. . .

p17, 9-10 –I believe this statement depends to a large degree on the time interval selected and on the precision in specifying 40 ppb. This concept should be developed. What are "sources not controlled under SWIM"? I think "phosphorus currently stored in the lake's sediments' is misleading and not stated correctly. The only number given is 30,000 metric tons (see next comment). Some of that is not only "stored" is it permanently buried in the mass balance sense.

p18, 11 –listing 30,000 metric tons of storage is not relevant without a time scale. (also see p10, 28 and P mass balance).

p18 and 19 –the quantitative importance of factors such as "wind effect" and "reduction in Ca" are unknowns relative to the TMDL question (see mass balances).

p31, 7-8 –actually I think we heard and concluded that regulation schedules are an important factor.

p31, 21 –Actually, the appropriate time scale here is Interannual, certainly not Seasonal. All calculations are based on annual averages.

p31, 29-31 –Revise to reflect the approach used. It is not necessary to understand P cycling to use the model proposed.

p31, 31- p32, 2 –Although this statement may be true generally speaking, it would be more appropriate to concentrate on what we know and on how data are used in setting the TMDL. (see sections below).

Possible addition to paragraph beginning on page 8, line 13.

Other studies could be cited to show that Lake Okeechobee has been affected by P enrichment. Phosphorus enrichment is so great that phytoplankton growth is not limited by phosphorus, but by nitrogen (Aldridge). This type of secondary nutrient limitation induced by excessive phosphorus enrichment is a consequence of eutrophication (Schelske 1984). It can be demonstrated in Lake Okeechobee by bioassays (Aldridge, Havens) or from low concentrations of dissolved inorganic nitrogen that control phytoplankton growth (Schelske et al. 1999).

Clarify confusion between short-term P dynamics (Internal Phosphorus Dynamics) and P biogeochemistry (Annual Phosphorus Mass Balance), particularly the relative temporal and spatial scales. Calculations related to TMDL are based on annual means, therefore the relevant time scale is the annual scale. Spatial scales are complex. Reddy's daily estimate of P flux from the sediments, for example is "as large as" for some part of or some station in the mud zone. At the other extreme, Haven's biogeochemical estimate of 30,000 metric tons in the sediments has no time scale and apparently pertains to the mud zone. It does, however, indicate that sedimentary P is a significant phosphorus sink in the biogeochemical sense because the estimate is equivalent to 75 years of storage at a rate of 400 metric tons/yr. (Please note that this type of

storage is SL in the equations listed below). It should be noted that this rate is an estimate of net storage (SL) (see eqs1 and 3). It, also, is large relative to current external loads (MI) and mass balances (indirect calculations of this term in the TMDL mass balance). In fact, from the research standpoint, it is large enough to question whether there are unmeasured inputs.

Annual Internal Phosphorus Dynamics

$$SL = SU - IL \quad \text{(eq 1)}$$

SL = System loss of P (unmeasured losses of P in the lake, including sedimentation and littoral zone storage)

SU = System uptake of P (sum of all biological, chemical and physical processes)

IL = Internal Loading (biological, chemical and physical process including littoral zone releases and sediment flux and resuspension). (Note, this is recycling in the general sense.)

Annual Phosphorus Mass Balance

$$\Delta R = \text{Inputs} - \text{Losses} \quad \text{(eq 2)}$$

$$\Delta R = MI + AI - (SL + OL) \quad \text{(eq 3)}$$

ΔR = Annual change in P reservoir (water mass)

MI = Monitored inputs

AI = Atmospheric inputs

SL = System loss

MO = Monitor outflows

Suggested outline to address the comments above about mass balances. The concept of Knet could be introduced here as well.

The TMDL calculation is based on a mass balance approach with annual means as input variables (eq 3). Three of the five terms (ΔR, MI and OL) can be calculated from the District's monitoring program. An estimate of AI is available from current research (ref). No direct measurements of SL are available for the annual mass balance. Thus, this parameter is calculated by difference. The spatial variability of the lake as shown by the presence of five

ecological zones (Fig. 1) and temporal changes in the lake such as changes in lake level complicate the direct measurement of sediment losses. In addition, this complexity confounds attempts to utilize lake-wide means to assess the lake's trophic state (Schelske 1989, Phlips et al. 1995). The TMDL calculation, however, is valid despite this type of variability. In addition, it does not require data for the lake's internal phosphorus dynamics or recycling (eq. 1). Therefore, neither the spatial complexity of the lake nor short-term phosphorus dynamics must be measured in order to utilize the TMDL calculation.

Sunshine State Milk Producers

Date: 09/20/2000

To: FDEP permitted Dairy Farms in the lower basin

Cc: C. Aller, C. Covington, J. Folks, D.Moore, J.Wright

From: W. Arthur Darling

RE: TMDL for Total Phosphorus, Lake Okeechobee

Included with this memo are 13 selected pages from the 63-page draft TMDL document being developed for Lake Okeechobee. The total document will be the proposal from Florida Department of Environmental Regulation to the U.S. Environmental Protection Agency for restoring the nutrient balance for Lake Okeechobee. For your convenience, I have highlighted in yellow, those passages which you need to be aware of. It should help you to understand the depth of the problem and why you are being asked to do more in the way of phosphorus control.

Page 21, line 16 contains a statement that I believe to be inaccurate based on everything I have been told by the Department and I am challenging that statement. Every dairy is in compliance with their permit, but the desired improvements in exiting water quality have not been achieved. I urge you to take the time to read through the enclosed pages. If you want the full document, contact Missy at the SFWMD office in Okeechobee.

AD

Enc. Selected pages of DRAFT document

Comments on Draft TMDL

General Comments:

Regardless of whether the TMDL is appropriate, attainable, or defensible, I am concerned about the number of technical inaccuracies in this document. I regret that staff at SFWMD were not given the opportunity to review this document before distribution for public comment. I realize that DEP staff had to assimilate a tremendous amount of information on a topic that up until very recently, they had relatively little exposure to. Hence, I appreciate their efforts to synthesize these data. Nonetheless, these inaccuracies, publicized even in a draft version, could result in mistaken assumptions by the public and result in perception problems.

Overall, I was disappointed with the document's approach. Here are the major concerns:

- In my opinion, a disproportionate amount of the document was devoted to background information instead of the TMDL. Very little of the text deals with the TMDL itself, and the justification.
- Allocation is basically ignored.
- I would have liked to have seen more attention paid to upland processes, such as the role of assimilation in streams and wetlands, as well as long-term release of P from the soils that had been loaded by past land use practices. Clearly, these processes influence the P load to the lake, but received relatively little attention.
- What was the purpose of including, almost verbatim, the LO legislation? Why not just highlight the relevant sections?
- If Ca is already close to, or altogether supersaturated in the lake, does the declining concentrations really make a difference?
- Why is not more attention paid to settling coefficients and assimilative capacity?
- Where is Appendix 3? It seems to me that Appendices 2 and 3 are really the meat of the TMDL, yet they are either ignored or treated in an ancillary fashion.

Specific Comments:

p. 2, lines 11-12: This language is confusing; it is not clear what is meant by water quality limited by nutrients (particularly, phosphorus). Standard limnological terminology refers to a limiting nutrient as one that constrains the productivity of the system, and clearly that is not the case for P in Lake Okeechobee. I recommend that the use of "limited" either be defined or that the word be replaced.

p. 3, line 4: I believe that the 30,000 tons refers to P, not mud, and that is just in the upper 10 cm of the sediment, not the entire lake. This needs to be rechecked and revised, if appropriate.

p. 3, line 19: This is a bit of a red herring, since the entire system is underlain by rock, if you dig deep enough. The littoral zone is a mixture of sediment types.

p. 3, line 22: What is the evidence that the edge zone is characterized by severe nutrient limitation? On the contrary, I would argue that over the past few years, light has been much more limiting than nutrients in this region. I refer DEP to the following publications:

Hwang, S-J., Havens, K.E., and Steinman, A.D. 1998. Phosphorus kinetics of planktonic and benthic assemblages in a shallow subtropical lake. Freshwater Biology 40: 729-745.

Steinman, A.D., Meeker, R.H., Rodusky, A.J., Davis, W.P., and S-J. Hwang. 1997. Ecological properties of charophytes in a large, subtropical lake. Journal of the North American Benthological Society 16: 781-793.

p. 3, lines 23-24: Again, what is the evidence that the edge is the most sensitive to water levels and nutrients? One could make a very compelling argument that the littoral zone is more sensitive, as a given change in lake stage will have a much more dramatic impact on littoral zone ecology than in the edge zone. In addition, mesocosm experiments have shown clearly that littoral zone communities are quite sensitive to nutrients. Please read the following publication:

Havens, K. E., T. L. East, A. J. Rodusky, and B. Sharfstein. 1999. Littoral community responses to nitrogen and phosphorus: an experimental study of a subtropical lake. Aquatic Botany 63:267-290.

p. 7 , lines 12-31: Several points here: 1) simply stating mean water levels is potentially misleading because depending on the year, there may have been potential for the high water to flood onto the adjacent wetlands, and in effect, increase the surface area of the lake. However, once the dike was completed, the littoral zone was constrained in size, and high stage had a much more dramatic ecological consequence. This paragraph does not include this context; 2) I have no idea what the "1999 schedule" (line 29) refers to—is that WSE? Run 25? If WSE, this should be stated, and note that it was not implemented until 2000. I also recommend citing the Final EIS by the Corps instead of LORSS. Regardless, this needs to be clarified.

p. 8; Fig. 3: This figure should include data through 1999, at a minimum, and up to the present if at all possible. By only showing data through 1994, the high water levels for much of the later 1990s is totally ignored.

p. 8, line 12: The references I have seen indicated that the bloom only covered 25% of the lake surface area (Jones 1987), not 100%. Again, I would check your references.

p. 9, line 2: Uncritical readers are likely to assume that LO algal blooms result in endotoxins, based on the language here. In fact, only a few cyanobacteria release endotoxins, and this has not historically been a problem in Lake Okeechobee. Given that the lake has plenty of real problems, I see no reason to imply ones that currently do not exist.

p. 9, line 19: change "has" to "have".

p. 10, line 15: You might want to take a look at the following reference, for more detail on the changing hydrography of the system:

Steinman, A.D. and B.H. Rosen. 2000. Lotic-lentic linkages associated with Lake Okeechobee, Florida. Journal of the North American Benthological Society 19: xxx-xxx.

p. 10: It seems to me worthwhile to mention the recent spikes of TP in the system that have occurred post-Hurricane Irene. TP concentrations reached alarming levels, but have come down since the managed recession has begun. Nonetheless, these spikes clearly show the system has the capacity to reach much higher TP concentrations than 100 ppb.

p.10, line 28: This amount refers to the P in the top 10 cm of sediment.

p. 12, line 3: Need to qualify what years this average refers to.

p. 13, Table 1: Several comments on this table: 1) since it is swiped almost verbatim from the Issue Team's Action Plan, an attribution, at a minimum, to that document seems appropriate; 2) It should be made clear in the heading

that these data are based on a 5-yr average; 3) the meaning of the asterisks should be notated; and 4) the distinction between controllable and uncontrollable sources should be clarified. What are referred to as "uncontrollable" are clearly controllable, if adequate resources were expended on those basins. The failure to identify this distinction could lead to public misconceptions regarding the District's regulatory and monitoring programs, which would be unfortunate.

p. 15, line 5: delete "of"

p. 15, lines 2-13: These data are the best we have currently. However, it should be noted that because they are almost 10 years old, there is considerable concern in the community that they do not reflect more recent trends, including the role of septage and biosolids. Although an updated data set will not be available for another 18 months, perhaps it should be stated more explicitly that land use changes may (or may not) render these percentages inaccurate in today's budget.

p. 15, line 26: For an overview of the phosphorus problem in LO, you might want to consult the following reference:

Steinman, A.D., K.E., Havens, N.G. Aumen, R.T. James, K.-R. Jin, J. Zhang, and B. Rosen. 1999. Phosphorus in Lake Okeechobee: sources, sinks, and strategies. Pages 527-544 in: K.R. Reddy, G.A. O'Connor, and C.L. Schelske (editors). Phosphorus Biogeochemistry of Subtropical Ecosystems: Florida as a case example. CRC/Lewis Publ., New York.

p. 18, line 11: see prior comments on P in mud sediments

p. 18, line 12: not sure what is meant by "other organic matter" since calcium is an element.

p. 18, line 18: Recommend stating explicitly what years are being referred to with respect to "decline in external phosphorus loading".

p. 18, line 26: insert "is" after "This".

p. 21, line 2: That should be 350 ppb, not 35 ppb!

p. 23: line 22: The LOPP does not appropriate any money. The Water Advisory Panel funds were a one-time allocation, that was provided separately through a series of 5 grant applications, and there is nothing in the LOPP that explicitly links it to these funds. Linking the LOPP to any dedicated funds is misleading at best.

p. 23, line 29: I know these terms get very confusing, but I think you want the Lake Okeechobee Protection Plan, not Program, here.

p. 24, line 14: It is "Nubbin", not "Nubbins".

p. 27, lines 12-13: Rather than identify chl a and macrophytes, which clearly are a subsample of the biota that have been, or continue to be, monitored in the lake, I recommend simply stating "select biotic communities". Otherwise, there appears to be an intentional disregard for the fish, invertebrate, phytoplankton, and periphyton samples.

p. 27, lines 23-24: Although I do not disagree that 40 ppb chl a is a reasonable standard for bloom conditions, I believe that this document must include the rationale, and documentation, to support that number. At present, that is not included, which seems a big hole to me. At a minimum, cite the journal articles. This standard is less applicable in LO the confounding effects of resuspended sediments often result in light, not nutrient, limitation. Hence, the need for a rationale and defense is even stronger here.

p. 30, lines 14-15: why are no point sources included in the TMDL? I believe an explanation for this decision is warranted.

3 Additional comments were submitted, but are only available in hard copy. Please contact Kim Shugar for copies: kimberly.shugar@dep.state.fl.us, 850-921-9395, 2600 Blairstone Rd., MS 3560, Tallahassee, FL 32399.