Comments on the Compliance Report for Shark River Slough Inflow Phosphorus Limits in Water Year 2008

Prepared for

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By

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Introduction

At the February 2009 meeting of the Everglades Technical Oversight Committee, there was considerable discussion of the unusual circumstances and procedures associated with compliance calculations for Long-Term Phosphorus Limits for inflows to Shark River Slough in Water Year 2008 (SFWMD, 2009). Data previously rejected under normal QA/QC protocols were revived and used in the compliance calculations. To my knowledge, flagged data have not been used in previous compliance determinations under the Consent Decree. The unusual procedure resulted in reversal of the initial compliance result, which would have otherwise triggered TOC review of the data to determine whether the excursion resulted from error or extraordinary natural phenomena. The procedure followed in the report essentially short-circuited the two-step process specified under the Consent Decree for compliance determinations by the TOC.

Federal representatives expressed concerns about the justification for the unusual data screening and need for establishing an explicit protocol to handle similar situations in the future. The goals of the latter would be to avoid unnecessary controversy and to ensure that future compliance determinations are accurate and consistent with Consent Decree requirements. It would have been far simpler and less controversial to simply follow the Consent Decree's formula. In my opinion, that formula could have been followed by discussing the data in the report but not changing the bottom line (measured FWM in Table 2 of that report) before discussing the topic at a TOC meeting.

This is the third instance when data used in compliance calculations differed from those passing normal QA/QC tests and provided in a standard retrieval of data from DBHYDRO. To my recollection, federal TOC representatives have neither questioned compliance results based upon data passing QA/QC tests, nor advocated use of data that did not pass those tests. Each of the data reversals initiated by state representatives resulted in favorable compliance determinations. The recent instance involved use of

data that were originally posted in DBHYDRO with flags. The first two instances (May/June 2005 Refuge samples) involved rejection of data that were originally posted in DBHYDRO without flags. After scrutinizing field procedures used in these sampling events, state representatives decided independently to reject the data, regardless of questions raised by federal representatives related to their evaluation of field procedures and regardless of independent evidence that at least some of the deleted data may have reflected actual conditions in the marsh, as opposed to sampling artifacts claimed by state representatives to be responsible for the high phosphorus levels.

The objectives of this report are to summarize and clarify questions raised at the TOC meeting on the procedures followed and contents of the WY 2008 compliance report. Long-term trends in the compliance data are also discussed. It is possible that following the Consent Decree's two-step process would have lead to the same conclusion. The TOC can decide whether further discussion of the WY 2008 compliance determination itself is appropriate.

Regardless of the compliance determination for WY 2008, SRS inflow concentrations in the past few years have been very close to the limits and above the long-term flow-weighted mean of 8 ppb expected to result from compliance with the limits. The compliance determination does not affect my recommendation that TOC begin analyzing and discussing marsh and structure data from WCA-3A in order to develop an understanding of factors contributing to variations in phosphorus concentrations at the SRS inflow structures. This would place the TOC in a better position to make recommendations to the Principals in the event of a future excursion or violation.

Data Screening Protocol

Use of data from sampling events with elevated blank samples is inconsistent with the data quality screening protocol established by FDEP (2004) in developing the Everglades Phosphorus Criterion:

> ***"Blank Contamination -*** *A blank will be considered contaminated if the laboratory result is greater than the MDL (i.e., the parameter was detected). If any analytical result associated with a contaminated blank is less than 5 times the value of the contaminated blank, all the associated samples for that parameter for that sampling event shall be disqualified*"

This protocol was followed by FDEP in rejecting substantial portions of the research data collected by Duke University for use in developing the Phosphorus Criterion. While state TOC representatives indicated that subjective intervention to over-ride QA/QC results was within other guidelines, there is no provision for that type of intervention in the FDEP (2004) document.

The QA/QC procedures are established to minimize unavoidable risk of statistical bias introduced unintentionally by subjective data screening, although there is no basis for discerning whether bias was introduced in this case. Over-riding QA/QC results is a

slippery scientific slope, regardless of how the results are affected and despite the untestable hypothesis cited in the report that the elevated blank sample indicated that the true concentrations at the structures were lower than those reported.

Positive blank samples were recorded for two of the compliance sampling events in the October 2007 thru September 2008 compliance year (April 1, 2008 and September 3, 2008). While not discussed in the report, the former resulted in flagging of 3 samples from the compliance sites, one of which was associated with flow (S12D, TP = 13 ppb, Flow = 68 cfs). The April 1 data were not used in the compliance calculations but are listed in the QA/QC report for April-June 2008 (SFWMD, 2008). Unlike the September 3 event, removing the flags from the April 1 samples would have increased the yearly flow-weighted mean by a small margin. While including the April 1 data would not have affected the ultimate compliance determination, it would have been appropriate to discuss the April 1 flagged samples in the report and subject the data to the same degree of scrutiny as that applied to the September 3 flagged samples.

Implications of Data Screening

The derivation of the Long-Term Limit equation assumed that variance of the data around the concentration vs. flow regression line (i.e., difference between 50^{th} and 90^{th} percentiles) is identical to that calibrated to the historical data. As in the case of Loxahatchee Refuge Marsh TP Levels, it is likely that improvements in sampling and analytical methods have already reduced that variance and thereby increased the probability of compliance even if the long-term mean of the data has not changed. Introducing supplementary data or screening samples after subjecting the data or QA/QC results to scrutiny beyond that applied to the historical data can further reduce variance and weaken the compliance test, particularly if extra scrutiny is triggered by unusually high values but not low ones.

The following hypothetical questions were posed at the TOC meeting and could be further considered in developing a protocol for future compliance determinations:

1. Would the flagged samples have been scrutinized and an Appendix A included in the compliance report, had the results computed directly from DBHYDRO data (without the flagged samples) indicated a flow-weighted mean slightly below the compliance limit?
2. Would the flagged samples have been revived and used in the compliance calculation if supplementary data indicated that they were valid and if their inclusion triggered an excursion, instead of eliminating one?
3. Before publishing compliance reports, are samples with unusually low TP values subject to the same degree of scrutiny as samples with unusually high values?
4. Does the initial QA/QC process include statistical screening criteria for both high and low TP values?
5. Are supplemental data routinely analyzed to verify the compliance determination before issuing the compliance report, regardless of the initial results?

To balance the data-scrutiny process, state TOC representatives suggested that federal representatives routinely perform their own review of unusually low TP values. For example, both an Appendix A and an Appendix B could be attached to each compliance report. Such a process would be time-consuming and adversarial at best, but may be necessary to ensure accurate compliance determinations if the WY 2008 protocol is followed in the future. Following the Consent Decree's two-step process would be far simpler.

Supplementary Data

The TOC can consider the roles of supplementary data in the context of the statistical derivation of the Long-Term Limits and the two-step process for handing excursions prescribed in the Consent Decree. The phosphorus data from the SRS structures stored in DBHYDRO are from at least three monitoring programs (Consent Decree compliance, WCA Inflow/Outflow monitoring, Grab/Composite study), with additional samples in the weeks between the biweekly compliance sampling events that do not appear to be associated with other monitoring projects. These supplementary data are cited in Tables A-1 and A-2 to support use of the September 3 flagged data in the compliance calculations.

In my opinion, supplementary data can be used in the context of compliance measurement to identify sampling or analytical errors, as opposed to random variations, in the compliance data during the second phase of the compliance-determination process conducted jointly by the TOC. If the initial flagging of the September 3 data were interpreted as an error, consideration of this excursion in the second phase would be appropriate. Examples of supplementary data or information demonstrating error would include sample mislabeling, transcription error, problem with the preparation of the blank sample, or a documented contamination event that affected the blank sample but could not have impacted the structure samples.

Utilizing supplementary data in a compliance report creates a risk that they will be misinterpreted as a "second toss of the coin" in the compliance determination. As discussed above, the effects of random variation are already built into the Long-Term Limit equation and assume that there is only one toss of the coin. In my opinion, the demonstration in Table A-2 that results based upon supplementary data are slightly lower than results based upon the compliance data amounts to a second coin toss, as opposed to a demonstration of error.

Supplementary data cited for whatever purpose should be both relevant and complete. Table A-1 (attached here as Table 1 for reference) is deficient in both regards. The table cites results from other sampling programs during August and September to support use of the flagged data collected on September 3rd in the compliance calculations. The listing includes all grab samples collected between August 6 and September 24, as well as 4 daily composites collected in automatic samplers at S12A and S333 on September 2 and September 3. Seven of the S333 samples listed in the table are irrelevant because they were collected on days without flow, unlike the other listed samples. Table A-1 excluded

93 additional composite samples in this period, 66 of which were collected on days with flow (Table 2 attached). None of the composite results were cited in Table A-2, which lists the FWM concentrations for the entire year with different data subsets. While the applicability of the composite sample results is questionable to begin with, citing supplementary data in any context would be appropriate only if all of the data are presented and compared with data from all of the compliance sampling events. The data omission is a concern with respect to protocol, but would not affect the compliance determination if TOC decides that ignoring the flag on the September 3 samples is justified based upon the grab-sample results.

As indicated at the bottom of Table 2, TP concentrations in composite samples tend to exceed concentrations in grab samples (8.0 ppb vs. 6.3 ppb at S12A, 16.7 ppb vs. 11.8 ppb at S333) in August-September 2008. Composite samples are integrated over a 24-hour period and are more likely to capture short-term spikes in concentration that are missed in the grab samples collected once every two weeks. While they cannot be used for compliance determination because of the need to maintain consistency with historical sampling methods, elevated values from the auto-samplers raise the question of whether grab samples are sufficient for computing phosphorus loads entering the Park. It is suggested that this topic be further explored by the TOC. The same issue is relevant to monitoring of TP loads entering the Park in the C111/Taylor Slough Basin.

DBHYDRO Data

The data used in compliance calculations can be inferred from the biweekly frequency, but are not explicitly identified in DBHYDRO. It is recommended that the compliance samples be identified in DBHYDRO to avoid confusion in the event that other parties attempt to reproduce the compliance calculations.

Despite the apparent conclusion that the September 3 structure data were valid, the flag apparently has not been removed from the data stored in DBHYDRO. A retrieval on June 17th did not contain data from April 1 or September 3.

To promote awareness and discussion of all QA/QC issues, it is recommended that any flagged samples or unusual circumstances regarding the data be listed and discussed in each compliance report, as a supplement to the details provided in the associated QA/QC reports that are attached but not discussed at TOC meetings. Given the importance of the October-September data for ENP inflows, it is also recommended that corresponding compliance reports include a listing of all flow and concentration data used or excluded from the calculations, as extracted from the quarterly QA/QC reports.

Additional monitoring sites in the S12/S333 vicinity have been added to DBHYDRO over the past few years in conjunction with compliance monitoring for the Class III Phosphorus Criterion and research activities. It is recommended that TOC discuss the designs and objectives of these new monitoring programs and track the results.

Long-Term Trends

As discussed above, the compliance determination does not influence my interpretation of the data or recommendations to the TOC for further evaluation. The WY 2008 data are consistent with results over the past few years (Figure 1). Even though the Long-Term Limits were not applicable prior to WY 2007, comparing historical data with the limits provides a basis for tracking long-term trends, as opposed to measuring compliance. The limits represent the 90th percentile of TP concentrations in SRS inflows through the S12 structures in 1978-1979. The measured flow-weighted-means tracked close to the limits in WY 2006-2008. If objectives of the limits were achieved, the data would hover around the 50th percentile of the compliance envelope instead of the 90th percentile; i.e., around the center rather than the top of the green bars in Figure 1. Similarly, the long-term flow-weighted-mean concentration would hover around 8.0 ppb (green line in Figure 1), as compared with 9.2 ppb in the most recent 5-year period (WY 2004-2008).

While it is clear that SRS inflow concentrations were above 1978-1979 levels in WY 1999-2008, there are two positive signs in the data (Figure 1):

1. The difference between the 12-month FWM and the 90th percentile decreased in WY 2006-2008 relative to WY 1999-2005 values.

2. In the six 12-month reporting intervals after WY 2008 (October 2008 – March 2009), the 12-month FWM was below 8 ppb for the first time in the past decade, except for a brief period in August 2006. These results are based partially on provisional data.

These apparent improvements may reflect long-term responses to reductions in WCA phosphorus loads resulting from implementation of source controls (BMPs, STAs), short-term responses to decreases in rainfall, and/or random variations. As in the case of Loxahatchee Refuge, continued monitoring over a longer period that includes wet years will provide a basis for distinguishing mechanisms and evaluating the long-term responses of SRS inflow phosphorus concentrations to upstream load reductions.

While higher rainfall has been experienced in the past few months, the 2007-2008 drought caused reductions in inflow loads and WCA stage, as well as altered flow patterns within the WCAs. The system must be operated over a longer time frame with load controls in full operation and a wider range of climatologic conditions to allow rinsing of phosphorus previously accumulated in the water, vegetation, and surface sediments within the impacted areas of the WCAs and resulting flow of cleaner water to the SRS inflow structures.

Since all of the STAs except STA-3/4 are still designated to be in stabilization mode, further load reductions may occur as they enter routine operation. On the other hand, recent performance may be an optimistic estimate of long-term performance because operational periods have not included wet years, which are expected to result in higher

STA inflow loads and outflow concentrations. Increasing trends in STA inflow phosphorus concentrations, particularly in runoff to STA-1W and STA-1E from the S5A basin and in releases from Lake Okeechobee to STA-34, suggest that performance over the past few years may not be representative of long-term conditions with the existing or planned STA designs. Regardless of SRS compliance, continued focus on achieving further reductions in WCA inflow TP concentrations and loads is consistent with objectives to restore and protect impacted marshes in the Refuge, WCA-2A, and WCA-3A that are proximate to the inflows.

To facilitate mechanistic interpretation of compliance data, it is recommended that the TOC begin tracking long-term trends in the mass balances, water balances, and stage of each WCA. In addition, it is recommended that recovery of WCA impacted areas be tracked by periodically reviewing marsh monitoring data from the Phosphorus Rule compliance network and from marsh research and permit transects immediately downstream of STA discharges in each WCA. These activities would at least involve periodic review and discussion of information already summarized in the yearly South Florida Environmental Reports. They would also place TOC in a better position to make recommendations to the Consent Decree Principals in the event of a future excursion or violation of the Long-Term Limits.

References

Florida Department of Environmental Protection, "Data Screening Protocol", 2004.
http://www.dep.state.fl.us/water/wqssp/everglades/docs/DataQualityScreeningProtocol.pdf

South Florida Water Management District, "Quality Assessment Report for Water Quality Monitoring, April-June 2008", prepared for Technical Oversight Committee, August 8, 2008.
https://my.sfwmd.gov/pls/portal/url/ITEM/2B4574D53557E2CDE040E88D49524309

South Florida Water Management District, "Settlement Agreement, July-December 2008 Report" prepared for Technical Oversight Committee, January 26, 2009.
https://my.sfwmd.gov/pls/portal/docs/PAGE/PG_GRP_SFWMD_ERA/PORTLET_ARCHIVES_MEETINGS_SUBTABS/TAB23692216/TOC_DECEMBER2008_SA_REPORT_FINAL_01_26_09.PDF

Table 1 - Table A-1 (SFWMD, 2009) Indicating Dates without Flow

Table A-1. Shark River Slough Grab TP Concentration Data in August and September 2008 and Daily Time Composite Autosampler Data around 9/3/2008

Date	Sample Type	S12A	S12B	S12C	S12D	S333
8/6/2008*	Grab	8	9	15	14	10
8/13/2008	Grab	7	7	9	13	13
8/21/2008*	Grab	6	7	10	14	12
8/27/2008	Grab	6	6	9	12	10
9/2/2008	Daily Autosampler	8				10
9/3/2008*	Grab**	**7**	**6**	**8**	**10**	**13**
9/3/2008	Daily Autosampler	8				11
9/10/2008	Grab	6	6	9	9	8
9/17/2008*	Grab	6	5	8	6	9
9/24/2008	Grab	6	5	6	8	10

* Shaded row indicates compliance data.

** Results for the September 3, 2008 sampling event grabs were qualified based on the District's laboratory protocol for detections in the associated FCEB.

No Flow at S333, August 6, August 19-Sept 15

Table 2 – Phosphorus & Flow Data, August-September 2008

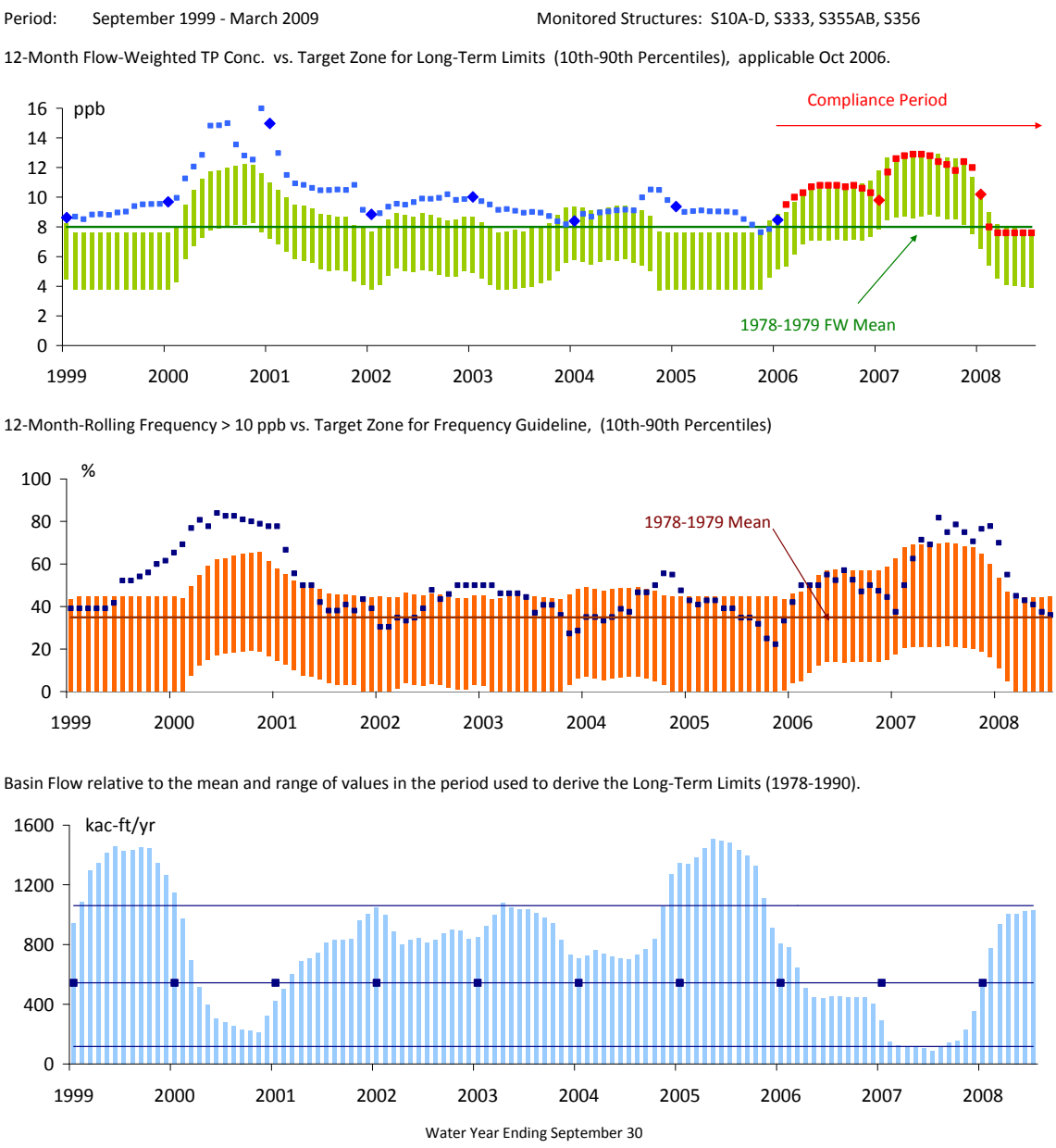
	Sample	Total P Concentration (ppb)						Daily Flow (cfs)					
Date	Type	S12A	S12B	S12C	S12D	S333	FWM	S12A	S12B	S12C	S12D	S333	Total
08/06/08	GRAB	8	9	15	14	*10*	13	228	224	483	502	0	1437
08/06/08	AUTO*	11				*12*	11	228	224	483	502	0	1437
08/07/08	AUTO*	8				*12*	8	228	228	487	510	0	1453
08/08/08	AUTO*	9				19	15	228	228	483	501	314	1754
08/09/08	AUTO*	8				18	15	228	228	480	484	529	1949
08/10/08	AUTO*	8				19	16	228	228	480	486	528	1950
08/11/08	AUTO*	25				17	19	231	228	480	486	524	1949
08/12/08	AUTO*	7				18	15	238	233	483	493	525	1972
08/13/08	GRAB	7	7	9	13	13	11	239	234	488	495	526	1982
08/13/08	AUTO*	7				16	13	239	234	488	495	526	1982
08/14/08	AUTO*	8				14	12	234	234	486	492	523	1969
08/15/08	AUTO*	8				18	15	235	234	485	492	521	1967
08/16/08	AUTO*	9				19	16	234	234	490	502	522	1982
08/17/08	AUTO*	9				17	15	234	234	490	500	522	1980
08/18/08	AUTO*	8				12	10	260	258	527	572	168	1785
08/19/08	AUTO*	9				*11*	9	351	341	636	731	0	2059
08/20/08	AUTO*	9				*12*	9	376	361	666	778	0	2181
08/21/08	GRAB	6	7	10	14	*12*	10	395	375	680	799	0	2249
08/21/08	AUTO*	9				*11*	9	395	375	680	799	0	2249
08/22/08	AUTO*	8				*12*	8	417	383	707	834	0	2341
08/23/08	AUTO*	8				*10*	8	442	398	749	866	0	2455
08/24/08	AUTO*	9				*9*	9	470	420	784	903	0	2577
08/25/08	AUTO*	9				*12*	9	479	427	794	913	0	2613
08/26/08	AUTO*	9				*13*	9	482	427	768	919	0	2596
08/27/08	GRAB	6	6	9	12	*10*	9	490	436	778	949	0	2653
08/27/08	AUTO*	11				*55*	11	490	436	778	949	0	2653
08/28/08	AUTO*	9				*82*	9	501	446	803	969	0	2719
08/29/08	AUTO*	10				*49*	10	501	448	804	954	0	2707
08/30/08	AUTO*	9				*20*	9	504	452	811	993	0	2760
08/31/08	AUTO*	8				*44*	8	574	498	857	1039	0	2968
09/01/08	AUTO*	7				*14*	7	598	527	898	1080	0	3103
09/02/08	AUTO	8				*10*	8	596	528	900	1082	0	3106
09/03/08	GRAB	7	6	8	10	*13*	8	594	528	900	1094	0	3116
09/03/08	AUTO	8				*11*	8	594	528	900	1094	0	3116
09/04/08	AUTO*	8				*12*	8	589	529	900	1104	0	3122
09/05/08	AUTO*	8				*10*	8	586	531	907	1118	0	3142
09/06/08	AUTO*	9				*10*	9	587	529	906	1122	0	3144
09/07/08	AUTO*	8				*14*	8	589	531	908	1127	0	3155
09/08/08	AUTO*	6				*12*	6	591	532	906	1124	0	3153
09/09/08	AUTO*	7					7	599	534	905	1114	0	3152
09/10/08	GRAB	6	6	9	9	*8*	8	612	543	918	1137	0	3210
09/10/08	AUTO*	6				*23*	6	612	543	918	1137	0	3210
09/11/08	AUTO*	7				*11*	7	612	550	924	1155	0	3241
09/12/08	AUTO*	7				*12*	7	616	554	938	1174	0	3282
09/13/08	AUTO*	7				*11*	7	621	562	945	1187	0	3315
09/14/08	AUTO*	13				*11*	13	622	566	948	1196	0	3332
09/15/08	AUTO*	6				*10*	6	623	566	959	1213	0	3361
09/16/08	AUTO*	7				14	8	629	578	970	1229	59	3465
09/17/08	GRAB	6	5	8	6	9	6	632	582	970	1220	125	3529
09/17/08	AUTO*	6				16	8	632	582	970	1220	125	3529
09/18/08	AUTO*	7				16	9	634	585	978	1237	159	3593
09/19/08	AUTO*	6				17	8	646	595	996	1265	169	3671
09/20/08	AUTO*	8				11	9	649	603	1002	1269	147	3670
09/21/08	AUTO*	6				11	7	662	608	1009	1266	106	3651
09/22/08	AUTO*	6				12	7	674	614	1013	1264	159	3724
09/23/08	AUTO*	6				13	7	666	618	1017	1270	170	3741
09/24/08	GRAB	6	5	6	8	10	7	668	626	1025	1288	177	3784

Flow Weighted Means For August-September 2008

Sample Subset	S12A	S12B	S12C	S12D	S333	FWM
Compliance Samples	6.6	6.3	9.6	10.1	9.0	8.7
"", Excluding Sept 3	6.4	6.4	10.2	10.1	9.0	8.9
Listed in Table A-1	6.7	6.0	8.8	10.0	11.8	8.4
* Not Listed in Table A-1	8.0				16.7	9.9
All Grab Samples	6.3	6.0	8.8	10.0	11.8	8.4
All Auto Samples	8.0				16.7	9.8
All Samples	7.8	6.0	8.8	10.0	16.1	9.2

Samples Colected on Days with No Flow (Grey Fo

Figure 1 - Trends in Shark River Slough Inflow TP Concentrations Relative to Long-Term Limits



Top Chart: The Long-Term Limit is the 90th percentile of values for 1978-1979, adjusted for variations in flow (top of green bar). Measured flow-weighted-mean concentrations before and after the LTL compliance period (>= WY 2007) are indicated by blue and red symbols, respectively. The LTLs were designed to reflect the distribution of TP concentrations in SRS inflows through the S12 structures in 1978-1979. If that objective were achieved, we would expect the data to be within the target zone 80% of the time (10-90th percentiles, green bars). The solid green line shows the long-term flow-weighted mean corresponding to 1978-1979 (8 ppb). Comparing the data with the LTLs and target zone prior to WY 2007 is useful for tracking trends, but not relevant for compliance.

Middle Chart**:** Frequency guidelines used for tracking trends vs. 1978-79 conditions.

Bottom Chart: Variations in LTL's reflect variations in Basin Flow, shown relative to range of values in 1978-1990.