Appendix 4A-7: Report on Expanded Mercury Monitoring at STA-2

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KEY FINDINGS AND OVERALL ASSESSMENT

This document summarizes results from expanded mercury monitoring of STA-2 in accordance with permit No. 0126704 modified on August 9, 2001 (for previous quarterly reports, see correspondence from N. Larson to R. Bray dated September 17, 2001, February 12, 2002, and notes from the April 26, 2002 meeting in Tallahassee, Florida; K. Weaver, May 1, 2002, e-mail).

Key findings are as follows:

1. There were no violations of the Florida Class III numerical Water Quality Standard (WQS) of 12 ng total mercury (THg)/L at the outflow of STA-2 (i.e., G-335); however, outflow from cell 1 reached 12 ng/L during cell drawdown. As such, the project has met the requirements of Section 6.i of the Mercury Monitoring Program of the referenced permits.
2. Results from the expanded monitoring of mercury in surface water and fish tissues strongly indicated that anomalous methylmercury production was restricted to cell 1.
3. A positive gradient was observed in MeHg levels in surface water and fish tissues from the inflow in the north to the outflow in the southern portion of cell 1. Consequently, site C-1A was found not to be representative of conditions within STA-2 cell 1.
4. Further, due to the configuration and design of cell outlets, a single grab sample upstream of the outflow pump at G-335 was found to be unrepresentative of discharge under steady-state flow.
5. The dramatic fluctuations and concentrations of THg and MeHg in the discharge canal decreased following drawdown and reduction in discharge from cell 1.
6. A gradient in cell 1 stage might have resulted in relatively shallow depths in the southern portion of the cell, which might have had an effect on sediment biogeochemistry, particularly redox and mercury methylation.
7. Hg levels in STA-2 fish exhibited spatial patterns consistent with patterns observed in surface water concentrations.
8. Average Hg concentrations in sunfish caught in a swale in cell 1, which was otherwise dry, in April 2002 were twice the basin-wide mean concentration for sunfish.
9. Mercury levels in largemouth bass were also elevated relative to other STAs and downstream sites, with the expected mean concentration in a three-year-old fish from the discharge canal at 1,148 ng/g.

10. While the area of contact and exposure potential was lowered substantially by draining cell 1, fish-eating wildlife remained at some risk of adverse chronic effects from mercury exposure if feeding preferentially at STA-2 in the shallow pools that remained.

BACKGROUND

On September 28, 2000 an interior surface water sample collected during start-up monitoring of STA-2 cell 1 was found to have a methylmercury (MeHg) concentration of 4.8 ng/L. A confirmed concentration of this magnitude had not previously been observed in any interior marsh water sample collected in South Florida by the South Florida Water Management District (SFWMD or District) or the U.S. Geological Survey (USGS). The U.S. Environmental Protection Agency (USEPA) had reported only two higher MeHg values in 663 samples of canal surface water collected in South Florida from 1995 through 1999 (D. Scheidt, personal communication). Consequently, the concentration of MeHg observed in surface water from STA-2 cell 1 was considered anomalously high and was reported to the Florida Department of Environmental Protection (Department or FDEP) immediately following quality assurance validation.

In response to questions raised by the FDEP, the District developed a 90-day modification to the start-up Mercury Monitoring Program. The modification included expanded sampling of surface water, sediment and fish to obtain more information about the nature of this anomalous condition at STA-2. The results of the expanded monitoring program at STA-2 were subsequently submitted to the FDEP in the form of two reports, both of which were published as technical appendices 4A-6 and 4A-7 in the *2002 Everglades Consolidated Report* (2002 ECR).

Based on a review of those documents, the FDEP agreed with the District's conclusions that, (1) an extended period of restricted discharge, which would result in an extended period of shallow, standing water in STA-2 cell 1, was likely to be the worst case for MeHg production, bioaccumulation and ecological risk, and (2) flow-through operation was likely to foster conditions in pore water that would inhibit MeHg production (e.g., redox conditions and sulfide concentrations) as long as the soil and water chemistry conditions were otherwise conducive. Accordingly, on August 9, 2001 the FDEP granted a modification of the mercury start-up condition in the EFA permit for STA-2 to authorize cell 1 flow-through operation. The modified permit included a requirement for followup monitoring that would alert the FDEP to a possible worsening of conditions. This document reports on results of the followup monitoring since the marsh was reflooded and operated under the August 9, 2001 permit modification.

SITE DESCRIPTION

STA-2 is located in western Palm Beach County near the Browns Farm Wildlife Management Area. STA-2 was developed to provide a total effective treatment area of 6,430 acres (cell 1 is 1,990 acres; cells 2 and 3 are each 2,220 acres; for additional details, see SFWMD, 1999a). STA-2 is intended to treat discharges from the S-6/S-2 basin, the S-5A basin, the East Shore Water Control District, 715 farms, and Lake Okeechobee via pump stations S-6 and G-328. S-6 will serve as the primary supply canal pumping station, with G-328 serving as both an irrigation and a "secondary" supply canal source from and to the STA supply canal (**Figure 1**). G-328 serves an approximated 9,980 acres of adjacent agricultural lands. As shown in **Figure 1**, inflows from S-6 and G-328 enter the supply canal and are conveyed southward to the inflow canal, which extends across the STA's northern perimeter. A series of inflow culverts conveys flows from the inflow canal to the respective treatment cells (G-329 A through D into cell 1; G-331 A through G into cell 2; G-333 A through E into cell 3). Water flows southward through the

treatment cells and eventually discharges into the discharge canal via culverts or gated spillways. Cell 1 discharges through five culverts (G-330 A through E) situated along the southern perimeter levee of cell 1, which extends the length of the discharge canal (**Figure 1**). Each culvert consists of a 66-inch-diameter corrugated metal pipe with a weir box and removable slide gate. Under normal operations, weir crest elevations are 12 ft NGVD; inverts are at 9 ft NGVD after slide gate removal. Alternatively, discharge from cell 2 is via a single, gated spillway (G-332) located at the cell's southeast corner and the far west end of the discharge canal (**Figure 1**). G-332 consists of a two-bay, reinforced concrete, U-shaped spillway with two 16-foot-wide vertical lift gates. In automatic operation, G-332 will operate to maintain headwater elevation at or below elevation 12 ft NGVD. Discharge from cell 3 is via a similar-size gated spillway (16-foot-wide vertical lift gates; G-334) situated at the end of a short canal that conveys water from the cell to the west end of the discharge canal (**Figure 1**). Flows then travel eastward in the discharge canal to G-335, the STA-2 outflow pump station, which in turn conveys water to a short stub canal leading to the L-6 borrow canal. Water in the L-6 borrow canal travels north, and then east into WCA-2A through six box culverts (G-336A through F, each with a capacity of 300 cfs, invert at 12 ft) located about three miles south of S-6. The area to receive discharge was previously identified as nutrient-impacted. Under high-flow conditions when stage in the L-6 canal exceeds 14.25 ft, water in the L-6 borrow canal spills into five 72-inch cans and travels south toward S-7. Approximately 0.75 miles north of S-7, the berm has been degraded to an elevation of approximately 12 feet, allowing water to sheetflow into WCA-2A. Again, the area to receive discharge has been previously identified as nutrient-impacted.

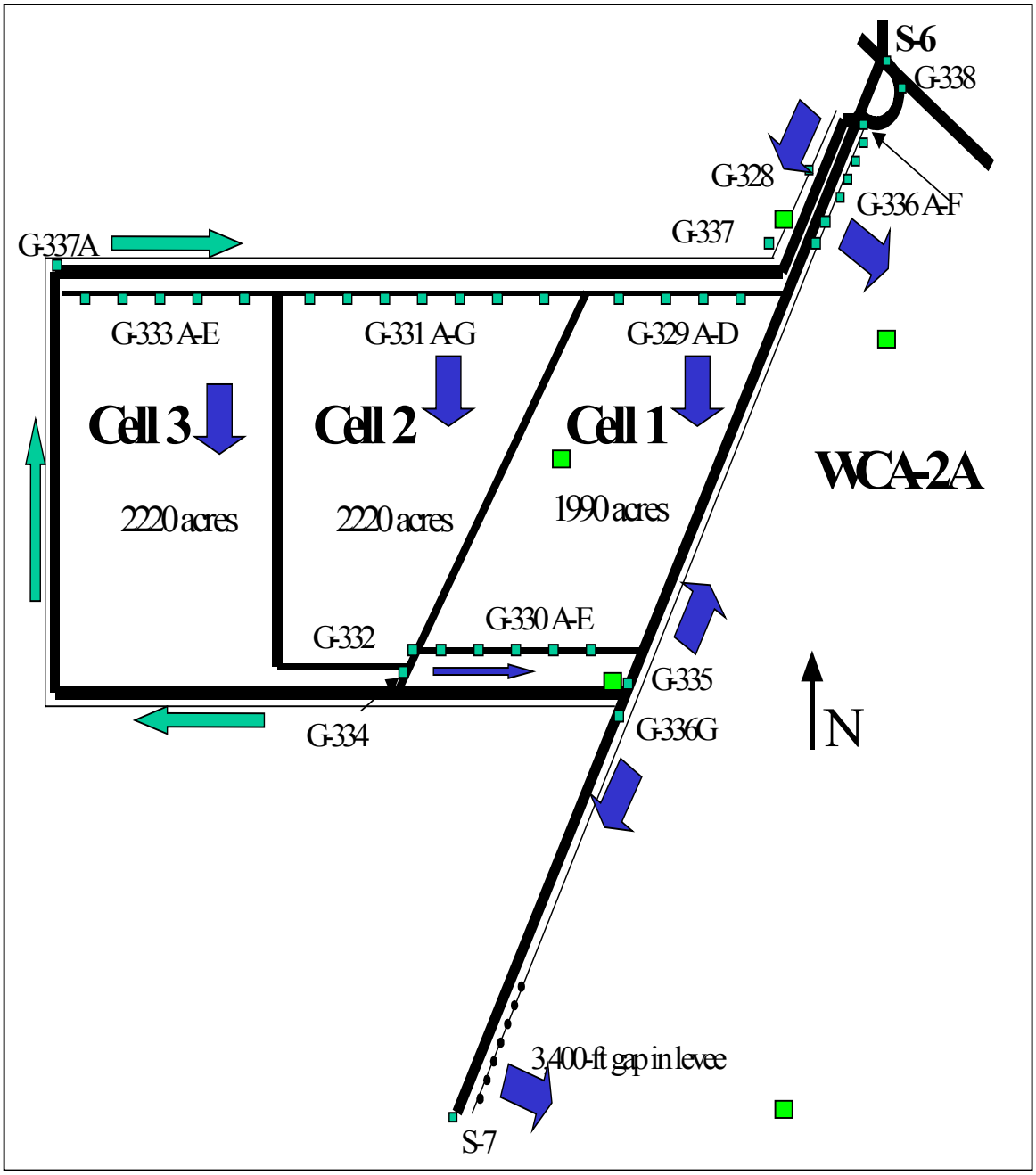

Figure 1. Schematic of STA-2. Note that culverts are labeled from the east to the west, i.e., culvert closest to G-335 is G-330A

RESULTS

SURFACE WATER

Figure 2 summarizes concentrations of total mercury (THg) and methylmercury (MeHg) in unfiltered surface water samples collected at the inflow and outflow of STA-2 from August 9, 2001 through April 30, 2002, or since the District began expanded monitoring under the permit modification. Results of mercury monitoring during the successful start-up of cells 2 and 3 have been reported previously (Rumbold and Fink, 2002). As is evident from **Figure 2**, concentrations of both THg and MeHg fluctuated dramatically in the discharge canal from August through December 2001 and were consistently higher than concentrations in the supply canal. **Figure 2** also shows that the dramatic fluctuations ceased following drawdown and reduction in discharge from cell 1. Furthermore, concentrations in the outflow also declined and approached levels observed in the supply canal. As will be discussed in greater detail, results from the expanded monitoring indicate that anomalous methylmercury production was restricted to cell 1. At no time during the expanded monitoring did THg concentration exceed the Class III Water Quality Standard of 12 ng/L in the outflow.

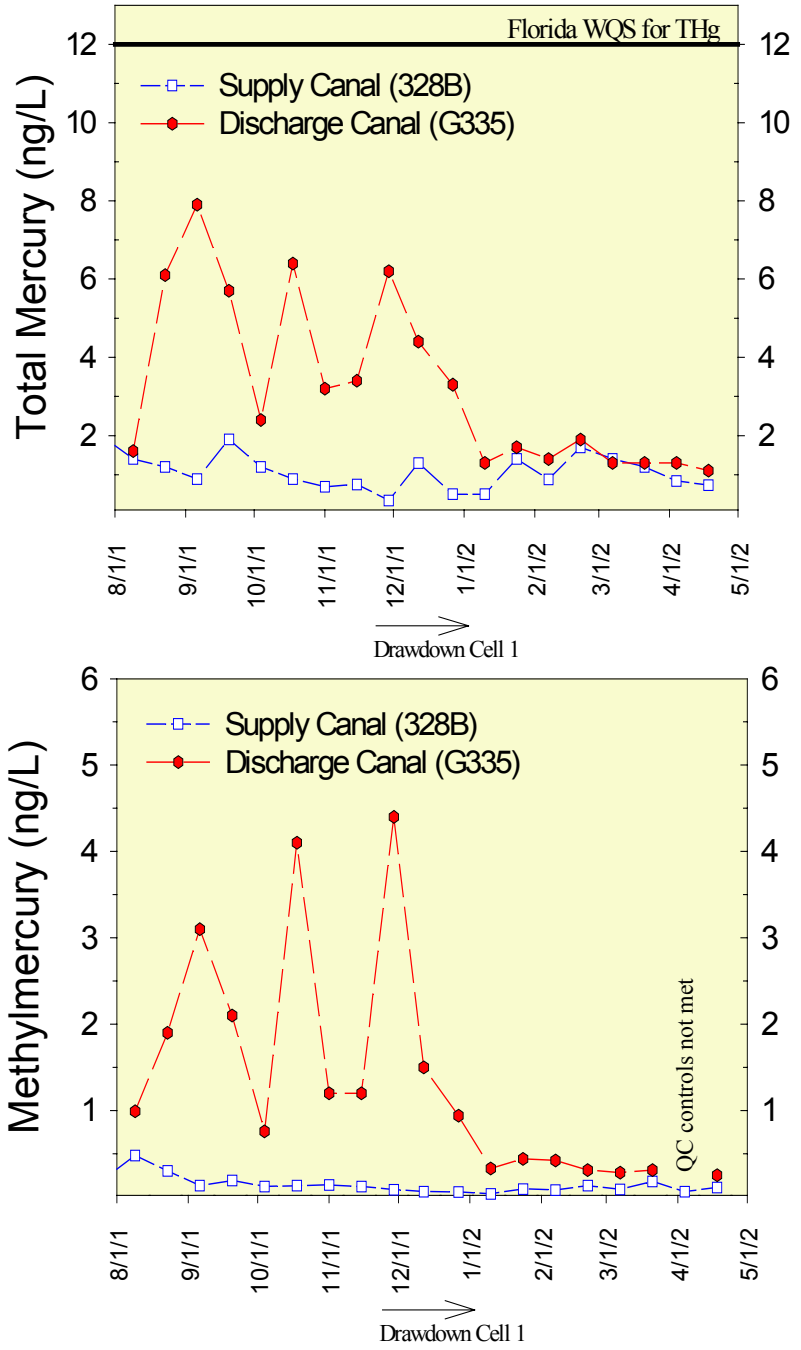

Figure 2. Concentrations of (a) THg and (b) MeHg in unfiltered surface water from supply and discharge canals

REPRESENTATIVENESS OF STA-2 CELL 1-A SITE AND G-335 SAMPLE TO CHARACTERIZE STA-2 CONDITIONS OR DISCHARGE

In accordance with the permit modification, in addition to sampling at the STA-2 supply canal inflow (G-328B) and discharge canal outflow (G-335), THg and MeHg concentrations were also monitored in surface water within the cell 1 marsh (at site C-1A). As is evident from **Figure 3**, concentrations of both THg and MeHg in surface water collected from C-1A decreased dramatically in late August shortly after the marsh was reflooded and they remained relatively low through the end of 2001. This was initially interpreted as a signal that THg processing from atmospheric inputs, sedimentary release, and MeHg production were stabilizing. However, one could not rule out the disproportional influence of inflow water quality on the C-1A site relative to water quality reflective of rainfall contributions of THg as inorganic mercury (Hg(II)), or the internal processing of that Hg(II) to MeHg based on monitoring at one location. More importantly, the low concentrations of THg and MeHg observed at C-1A were inconsistent with the spikes in those constituents that were occurring at the same time in the discharge canal at G-335 (**Figure 2**). This suggested either that cells 2 or 3 had become a significant source of THg and MeHg, or that cell 1 was still the only significant source of THg and MeHg to G-335, but that site C-1A was not representative of cell 1 discharge water quality.

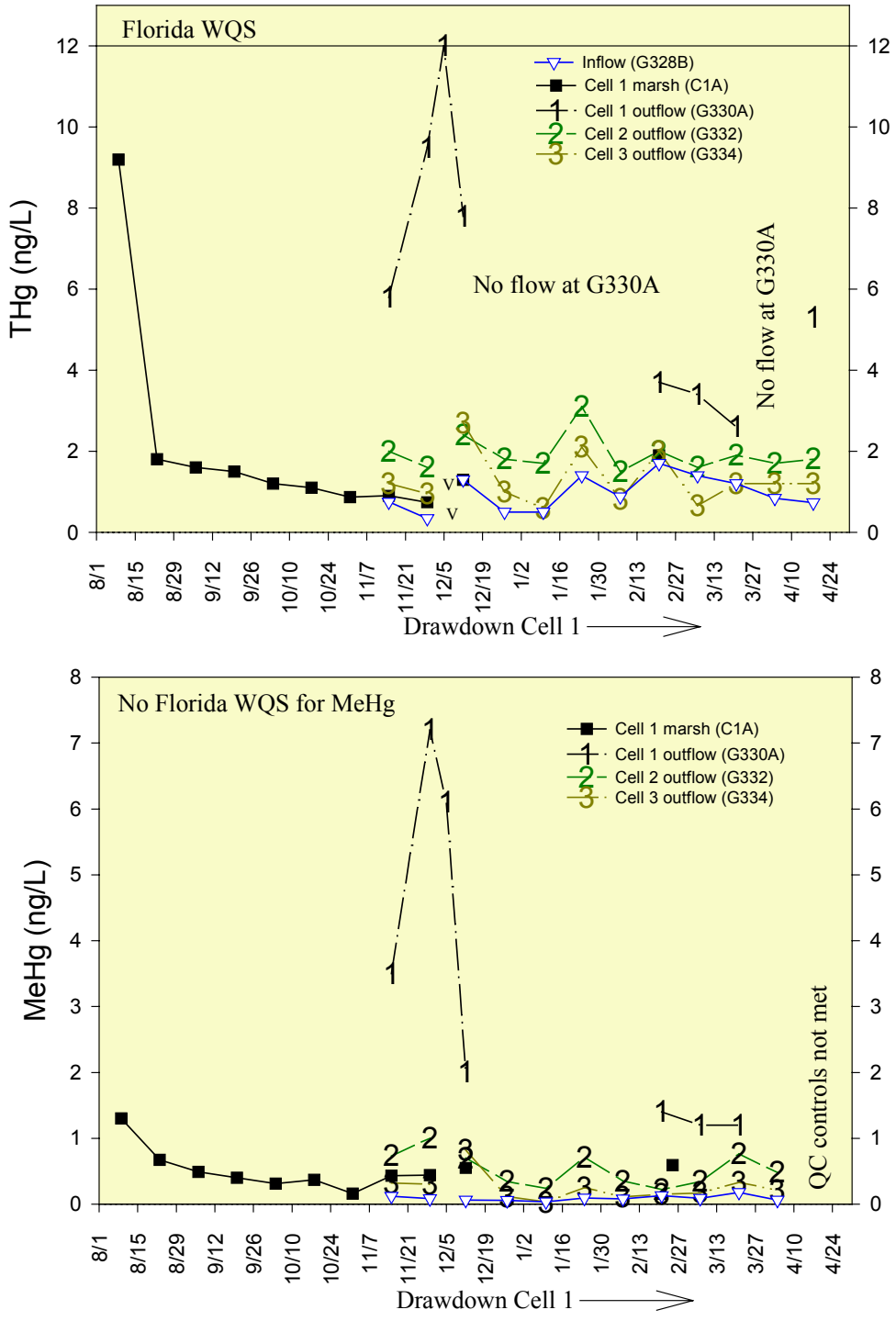

Figure 3. Concentration of (a) THg and (b) MeHg in unfiltered surface water from just upstream of outflows of each STA-2 cell

To identify the source of THg and MeHg in the discharge canal, sample collection was expanded on November 15, 2001 to include sampling upstream of the outflow structures of each of the three cells (i.e., G-334: cell 3; G-332: cell 2; and G-330A: cell 1). As is shown in **Figure 3**, the results of the additional monitoring revealed extremely high concentrations of both THg and MeHg at the outflow of cell 1 relative to the outflows of cells 2 and 3 (standing water in the discharge canal at G-335 and C-1A). During one event, THg concentration reached the state's water quality standard (WQS). These results confirmed that export from cells 2 and 3 was low, and also exposed a positive gradient in cell 1 for both THg and MeHg concentrations in the water column. A positive gradient in THg and MeHg had previously been observed from the inlet to the outlet of cell 1 (Rumbold and Fink, 2002); however, the steepness of the gradient had increased dramatically following initiation of flow-through operation. This further suggested that the interior monitoring site at C-1A might have been strongly influenced by inflow. These results also suggested that the dramatic fluctuations observed in concentrations in the discharge canal from August to December 2001 (**Figure 2**) likely resulted from differences in the relative contribution of source water.

The configuration of the cell outlets (see description above), especially the arrangement of ungated culverts G-330A through E along the length of the discharge canal, had prompted concerns about whether the sample collected from the canal immediately upstream of the G-335 pump station was representative of water quality. Depending on the sequence of events preceding the sample collection (i.e., pump operation, gate opening and closing), the sample upstream of the G-335 pump station may misrepresent the true concentrations and loads exported from STA-2. For example, if the outflow gates from cells 2 or 3 were closed prior to, at the same time, or immediately following G-335 shutdown, the rebound in the stage of the discharge canal (which can be depressed by as much as 6.5 ft in response to a high or extended rate of operation of the G-335 pump station) would be in response to a disproportionate contribution from cell 1 discharge (i.e., flow through ungated culverts G-330A through E) or seepage. Any sample collected prior to the next pump start-up would reflect only the conditions and events surrounding the shutdown and stage increase and not concentrations or load exported. Likewise, a sample collected immediately after G-335 pumps were brought online, but prior to or immediately following the opening of the gates for cells 2 or 3, would not accurately reflect outflow concentrations or loads under conditions approaching steady state. Instead, it would represent flows from cell 1 (i.e., flow through ungated culverts G-330A through E).

As shown in **Figure 3**, this concern focused on whether the grab sample just upstream of the G-335 pump station was valid. Results of the expanded monitoring of surface water outflows of each of the three cells (**Figure 3**) strongly indicated that cell 1 was the source of THg and MeHg.

Because of growing concerns about the suspected positive gradient and the availability of water to maintain the target stage in cell 1 (with the onset of the dry season), after consultation with the FDEP, the District closed the inflows and began drawdown of cell 1 during the final week of November 2001. This drawdown likely played a role in the unprecedented concentrations of THg and MeHg observed at the cell 1 outlet (**Figure 3**). However, as was previously mentioned, the low concentrations of THg and MeHg observed in the discharge canal following drawdown and reduced discharge from cell 1 further confirm that cell 1 was the source of the THg and MeHg (**Figure 2**). Continued monitoring at the outlets of cells 2 and 3, and cell 1 following extreme rain events that occasionally re-wet cells, revealed a persistent pattern of relatively low concentrations in discharges from the other two cells (**Figure 3**).

As will be discussed further, results from monitoring mercury bioaccumulation in mosquitofish, sunfish and bass further confirmed that anomalous MeHg production was limited to cell 1.

EFFORTS TO CHARACTERIZE CONCENTRATIONS OF THg AND MeHg UNDER STEADY-STATE CONDITIONS

Another way to improve the accuracy of loading estimates for STA-2 using existing methods and procedures required timing of sample collection to coincide with steady-state flow conditions under pump operation. Accordingly, sample collection was modified after November 7, 2001 to include a second sample at G-335 at the end of the sampling day, after the pumps had been operating for a few hours. Regrettably, during subsequent collecting events pumps were frequently not operating while field crews were present, and to date, a second sample was collected on just two occasions. This highlights the inherent difficulties associated with attempting to time sample collection to pump operation. On those two occasions (January 24 and February 21) THg remained constant or decreased by 5 percent in the second sample (i.e., 5 percent RPD). MeHg decreased by 15 to 43 percent in the second sample. Additionally, attempts were made to examine the difference between apparent export of THg and MeHg based on monitoring upstream of the G-335 pump station and actual export based on collecting a second sample downstream of the structure. This was done on 11 sampling trips that began in December 2001 and continued through the end of the reporting year. During those trips the concentration of THg upstream and downstream of G-335 differed by an average of just 10 percent, ranging from 0 to 44 percent RPD, with downstream concentrations lower on two out of 11 events. Concentration of MeHg upstream and downstream of G-335 differed on average by 25 percent, ranging from 0 to 113 percent, with lower concentrations occurring in two out of 10 events. In one event, MeHg data were invalidated.

INFLUENCE OF HYDROLOGIC CONDITIONS ON MeHg PRODUCTION IN CELL 1

While the discussion of the potential factors that resulted in the anomalous conditions within cell 1 is left to the accompanying documents in this report, the indirect role of stage on MeHg production cannot be dismissed. From August 9 through November 29, 2001 (i.e., until inlets were closed and the cell was drawn down), the average water depth in cell 1 was 0.88 ft (based on the average stage at G-329B tailwater and G-330A headwater, minus the average ground elevation of 11.82 ft). While the target average depth of 1.0 ft was approached, **Figure 4** shows that cell 1 routinely exhibited a negative gradient in water level, with much lower stages in the southern portion of the cell compared to the northern portion. Obviously, this gradient is a function of the timing and magnitude of operation and inflows from S-6 and G-328, and the operation and outflow of the G-335 pump. The apparent difference in stage within the cell was probably exaggerated by the monitoring locations (i.e., immediately downstream of the inflows and upstream of the outflows). Nevertheless, the persistence of the gradient at certain times suggests the stage may have resulted in relatively shallow depths near the outflow of the cell.

Further, the topography of cell 1 is highly variable, with sloughs and ridges vegetated by plants with both long- and short-hydroperiod requirements. For instance, there appears to be a slight rise in ground elevation from the west to the east. On January 10, 2002 the marsh on the western edge of cell 1 was observed to have 6 in. of standing water that decreased to a depth of 1 in. on the eastern edge, despite having a stage of 2.6 ft below average ground elevation at the bottom of the cell (N. Larson, personal communication). Obviously, the topography would lead to

variable water depths. In addition, topography probably controls and impedes the flow of water across the cell and allows for the development of the observed stage gradients. The resulting gradient in water depths could have an effect on sediment biogeochemistry, in particular redox and mercury methylation.

It should be noted that the District has taken steps to increase the control elevation of the weir boxes for G-330A through E so water depths in the cell-1 marsh would be increased by 1.5 ft. This should also dramatically reduce the influence of pump operation and prevent re-occurrence of the steep gradients in stage within the cell.

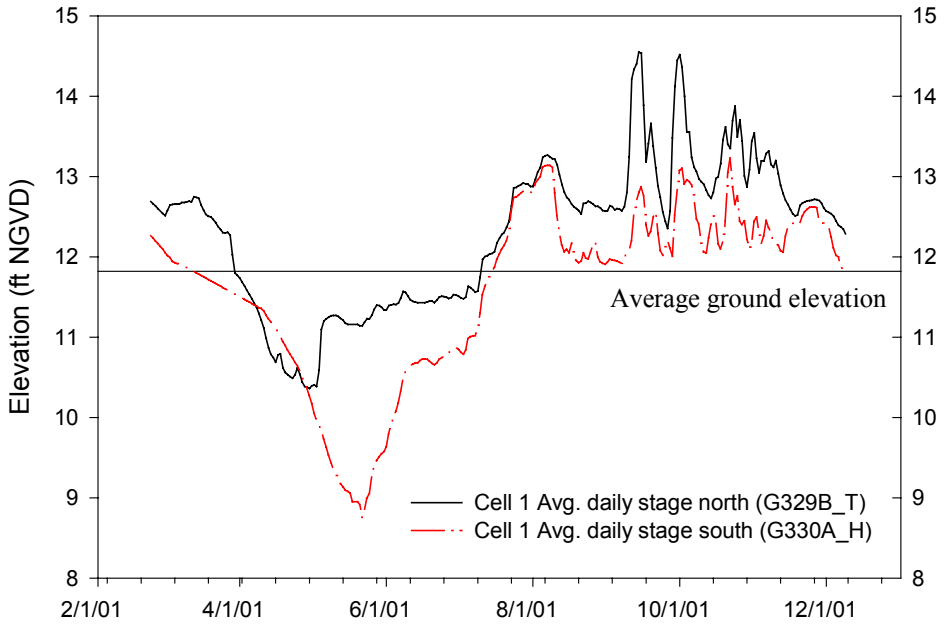

Figure 4. Stage of tailwater and headwater at inflow and outflow culverts, respectively, in STA-2 cell 1

LEVELS OF THg IN FISH

Results from long-term monitoring of THg bioaccumulation in mosquitofish at site C-1A within the cell-1 marsh are summarized in **Figure 5**. It should be noted that while tissue concentrations fluctuated somewhat from August through December, levels exhibited a general decline from previously observed levels. This is consistent with observations in the water column at C-1A. Therefore, as is discussed above, monitoring at C-1A appeared to suggest that MeHg production in the cell-1 marsh had stabilized. However, mosquitofish collected from cell 1 site X, which is located in a swale just upstream of the G-330 culverts, contained a greater Hg concentration in October 2001 and hinted at the continued existence of a positive gradient within the cell. The cell 1X site was added because an earlier reconnaissance of cell 1 indicated that large-bodied fish collections at cell 1A would probably be unsuccessful due to the poor habitat and lack of deeper, open water (T. Lange, FWC, personal communication).

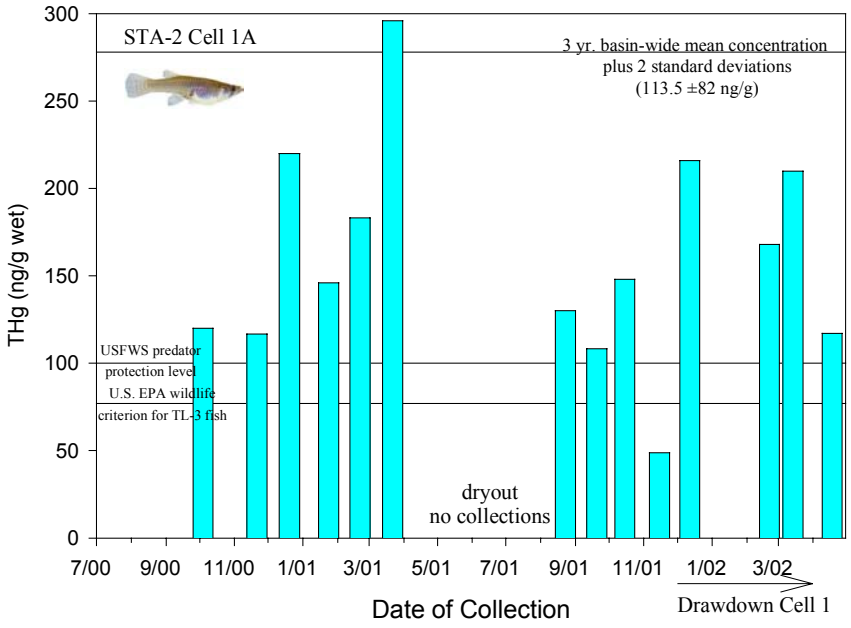

Figure 5. Results of long-term monitoring of THg in mosquitofish caught at STA-2 cell 1, site A

As is evident from **Figure 5**, mosquitofish collected from the other two cells and from the supply and discharge canals also showed spatial patterns consistent with patterns in surface water concentrations, i.e., lower concentration in fish from the supply canal and cell 3, slightly higher concentrations in fish from cell 2 and, concentrations in the discharge canal second only to C-1X. Here again, and similar to surface water, due to the configuration of the G-330 outflow culverts, populations within the discharge canal may reflect a disproportionate contribution of fish overflowing the outflow weirs from cell 1. Regarding fish collected downstream (i.e., at N-4 and Z-4; **Figure 1**), concentrations of THg appeared to be within the range observed during baseline monitoring of mosquitofish in western WCA-2A (i.e., annual collections made from 1998 through 2000). While the target sampling location (WCA-2A7) was the marsh just east of STA-2,

this area was inaccessible, and fish collections were instead made from the L-6 canal in 1998 (115.6 ng/g, 2000 ECR), the L-38E canal in 1999 (282 ng/g, 2001 ECR) and the L-38E canal in 2000 (19 ng/g, 2002 ECR). It should be noted that attempts to collect fish at N-4 failed in January and March 2002, when stage dropped to below ground level in the area. Minimal water was present in January, but insufficient mosquitofish were caught for a composite sample. Because of its influence on mercury biogeochemistry, these drydowns at N-4 (relative to stage at Z-4), if they occur regularly, may also account for the difference in tissue Hg levels observed between the two sizes in October.

While levels of THg in mosquitofish from the supply canal and cells 2 and 3 were about the same in March and April 2002, **Figure 6** shows substantial increases in tissue Hg levels in mosquitofish from cell 1, especially at site C-1X, and the discharge canal. It should be emphasized that cell 1 was not in operation at that time. It had been drawn down in late November, and every effort had been made to dry it out and to maintain it dry; however, this proved to be difficult due to topography and sporadic rainfall and re-wetting. While not representative of the cell's normal operation, fishes were collected to gather information on conditions in the small pools and swales within the cell that would likely be accessible and attractive to wading birds. It was felt this information would be helpful in interpreting results of future monitoring when the cell was reflooded (and some of these fish moved from the swale back to the marsh).

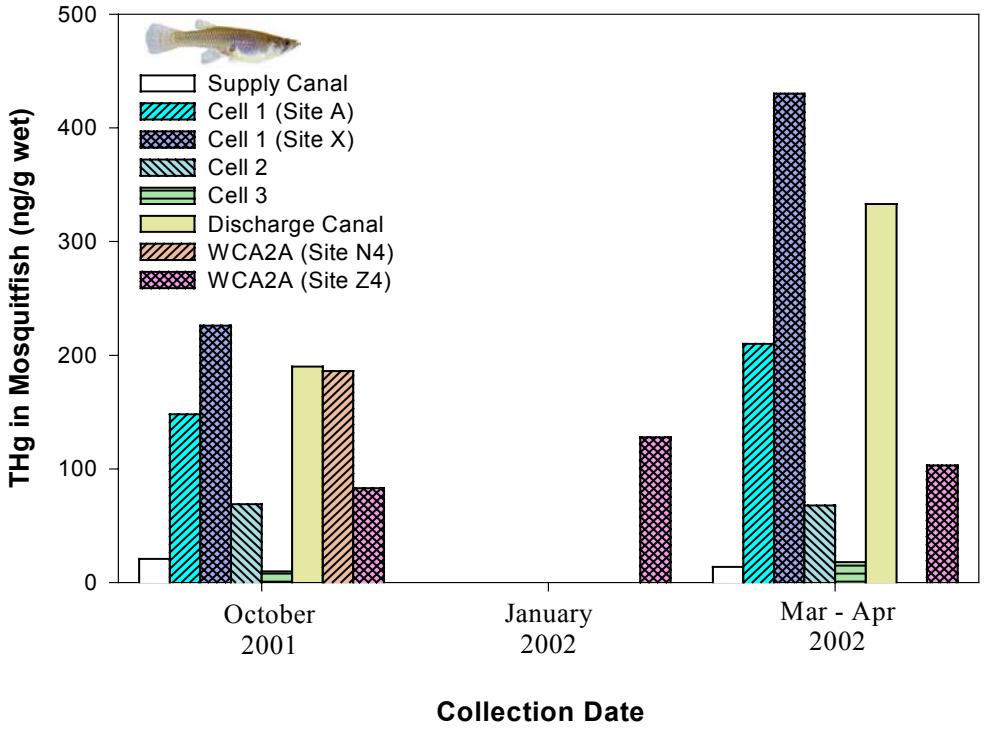

Figure 6. Concentration of THg in mosquitofish from STA-2

Sunfish were also collected from STA-2 and downstream sites in October 2001. As is evident from **Figure 7**, sunfish exhibited statistically significant spatial patterns in tissue Hg (Kruskal-Wallis ANOVA on Ranks; $H = 44.554$, $df = 5$, $p < 0.001$), which were reminiscent of patterns observed in mosquitofish. Fish from cell 1 (i.e., C-1X) contained the highest median concentrations of Hg (155 ng/g) and differed significantly from fish both from cell 3 and from the supply canal (Dunn's Method, $p < 0.05$). Interestingly, levels of Hg in cell 1 fish did not differ significantly from cell 2, the discharge canal, or fish collected at the downstream reference site, Z-4 (**Figure 7**). Fish from Z-4 were noteworthy in that the sampled fish population was significantly smaller than most other fish from STA-2 (ANOVA, $df = 5, 110$; $p < 0.001$; Tukey Test, $p < 0.05$). Because Z-4 sunfish exhibited a significant size/concentration relationship (linear regression; $df = 1,18$; $F = 9.6$; $p = 0.006$), larger fish would have been expected to have had greater concentrations (**Figure 8**). Visual inspection of the size/concentration relationships in sunfish from other sites (none of which were statically significant) supports an idea that sunfish from cell 1 and the discharge canal had recently been exposed to increased ambient Hg concentrations. This is evidenced by the relatively greater concentration in small (and presumably younger) fish compared to larger fish (**Figure 8**, cf. narrow confidence limits and significant regression at the downstream site, Z-4).

In accordance with the permit modification, sunfish were again collected from STA-2 cell 1 in April 2002. It should be re-emphasized that these fish were caught in a swale located just north of the outflow culverts that was partially filled with water that continued to drain and seep from the marsh, most of which was dry (i.e., worst-case conditions that are unrepresentative of normal operation). The sunfish caught from that swale contained an average tissue-Hg concentration of 567 ±194 ng/g wet wt (**Figure 7**). This represented a 215-percent increase over levels observed in October 2001, with the difference between sampling periods being statistically significant ($t = -7.124$, $df = 34$, $p < 0.001$). Note that the size of the populations did not differ between sampling events ($t = -0.03$, $df = 34$, $p = 0.98$). While individually these levels are not unprecedented (Hg concentration has ranged as high as 3,300 ng/g in an individual sunfish from the L-67 stub canal of the ENP), this mean concentration was elevated relative to the basin-wide benchmark Hg concentration for sunfish (i.e., mean $\pm 95^{th}$ percent of all sunfish collected from downstream monitoring sites from 1998 through 2001; see Rumbold and Fink, 2002) of 182 ±15 ng/g ($n = 808$).

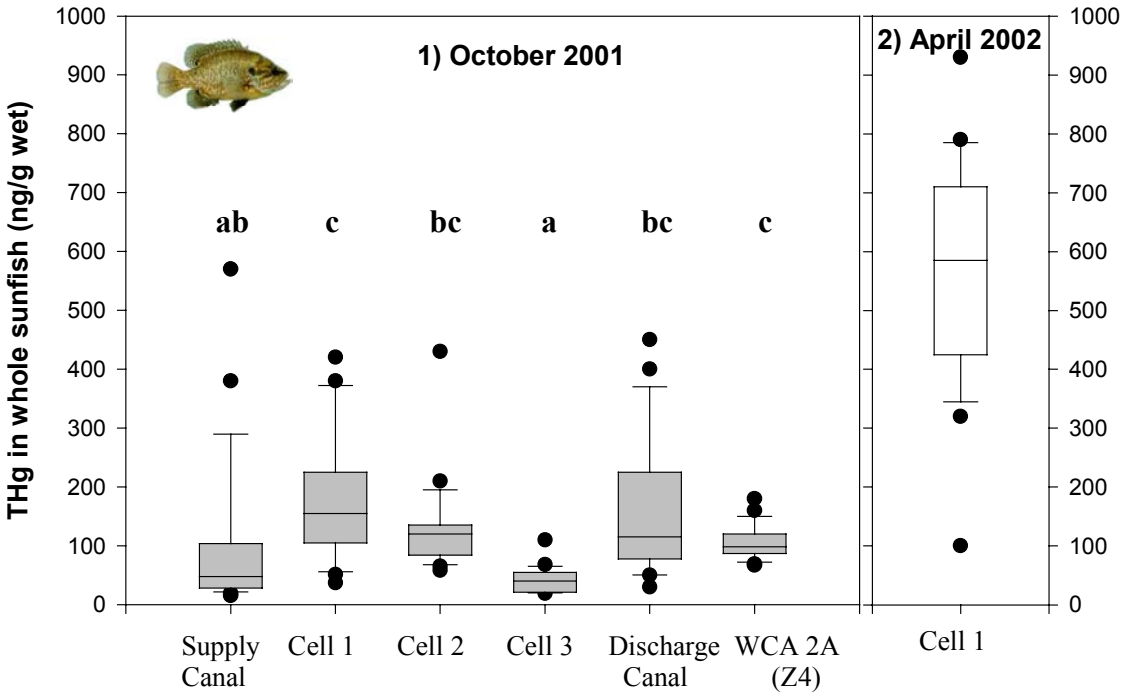

Figure 7. Concentration of THg in sunfish from STA-2 and downstream site. Sites with similar letter designations did not differ significantly

Largemouth bass were also collected from STA-2 in October 2001. Like mosquitofish and sunfish, the bass exhibited significant spatial variability in tissue-Hg concentrations (**Figure 9**; Kruskal-Wallis One Way ANOVA on Ranks; $h = 52.8$, $df = 4$, $p < 0.001$). While the median age of bass was 1.8 yrs for all five sites (statistical analysis excluded the two bass caught at WCA-2A Z-4), mean tissue-Hg concentrations may have differed slightly among sites due to differences in age distributions. Therefore, these results should be interpreted with caution. Further, it should be noted that while sample size was 20 fish at most sites within STA-2, only seven bass were caught from cell 1, and thus the average concentration may have been less representative. Nevertheless, spatial patterns in Hg in bass (**Figure 9**) were similar to patterns observed in sunfish (**Figure 8**), i.e., the concentration of Hg was greater in fish from the discharge canal compared to fish from the supply canal and the cell 3 marsh but did not differ from levels in fish from cells 1 or 2.

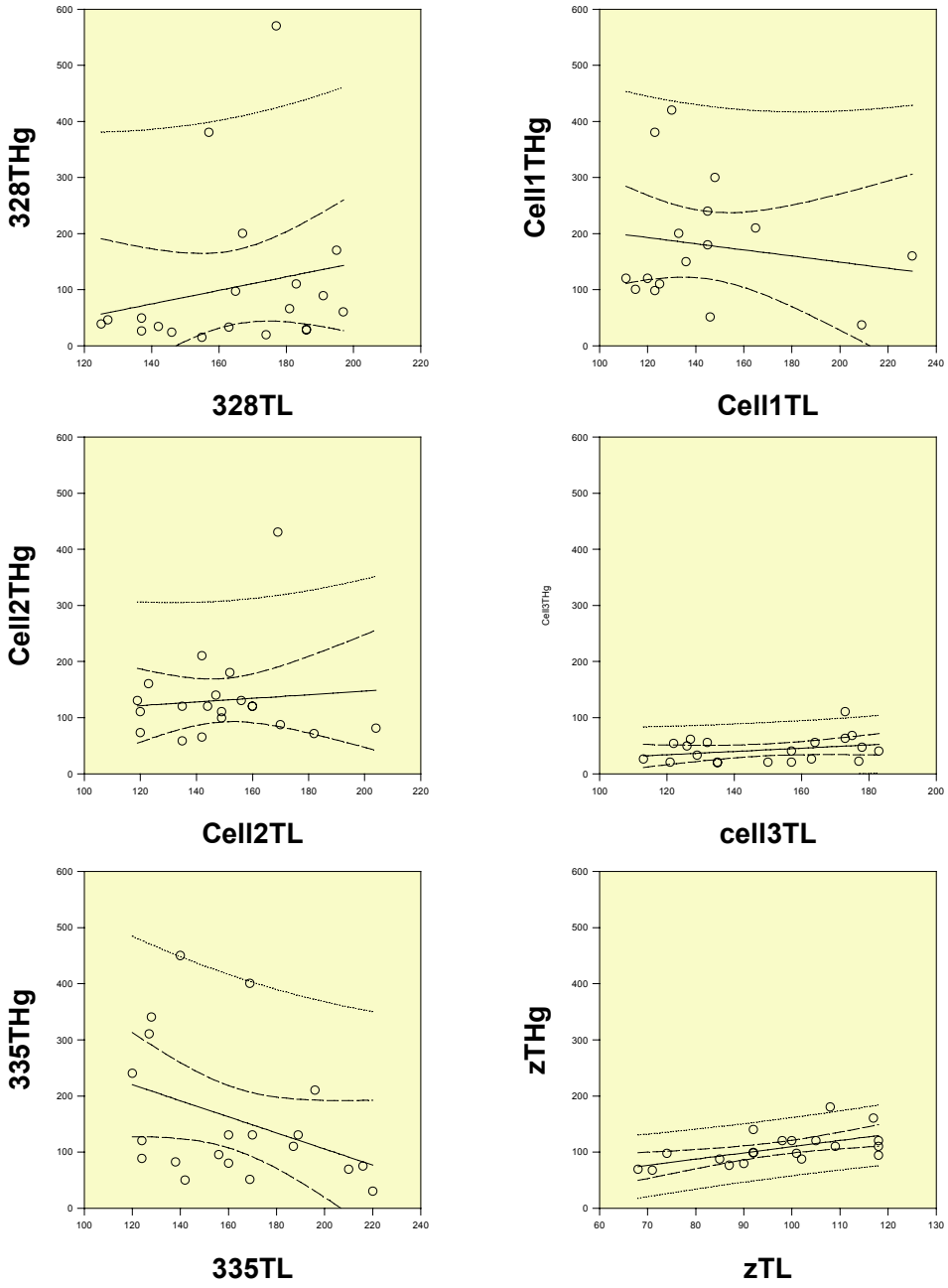

Figure 8. Concentration relationship for sunfish caught at STA-2

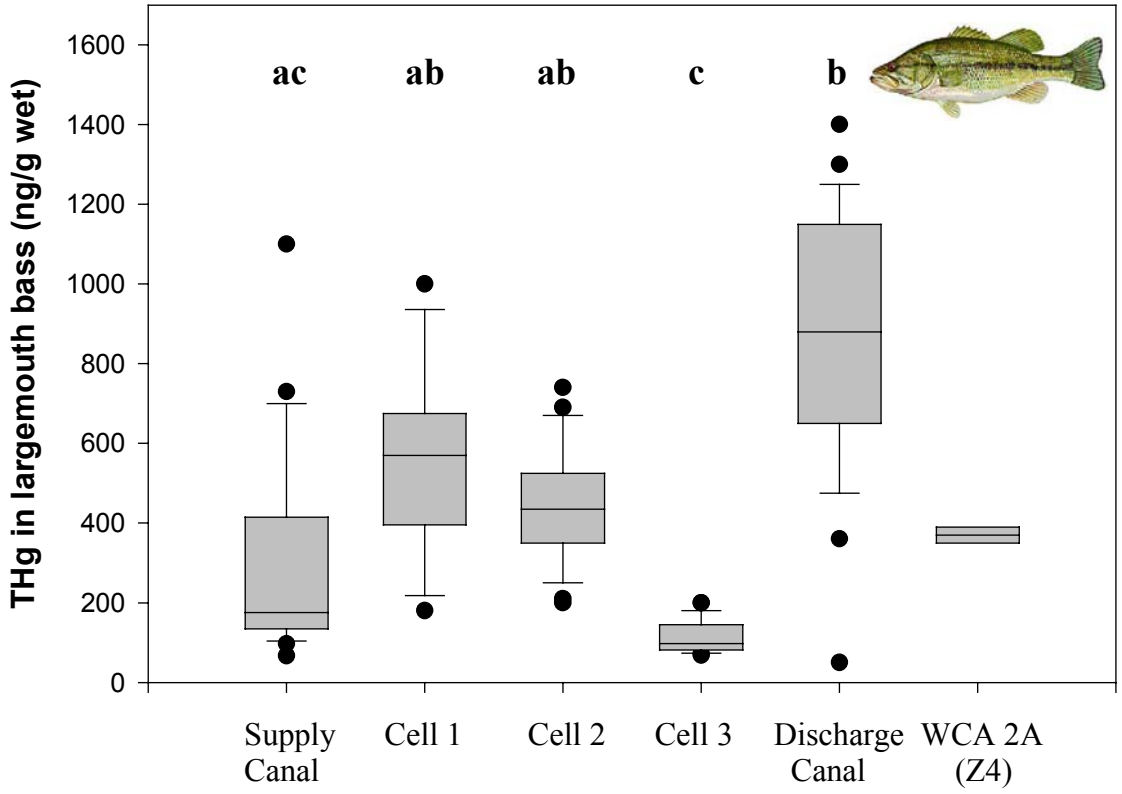

Figure 9. Concentration of THg in largemouth bass caught at STA-2 and downstream site. Sites with similar letter designations did not differ significantly

The discharge canal was the only site in which the age distribution of the sampled population was sufficient to establish a significant age-concentration relationship in the bass. The expected mean concentration for Hg in three-year-old fish (symbolized as EHg3 and calculated by regressing Hg against age; see **Appendix 4A-4** and references therein) at this site was 1,148 ±158 ng/g. This expected mean concentration was greater than EHg3 of bass collected at all but one downstream sites in 2000. The exceptions were bass at P-33 that had an EHg3 of 1,280 ±89 ng/g.

In April 2000, while collecting sunfish in accordance with the modified permit at site C-1X a single bass was caught and retained for analysis. Concentration of Hg in that fish, which was estimated to be 1.5 yrs old, was 2,000 ng/g. When adjusted to the age-class three years standard condition based on an age-length relationship, this exceeds the Florida advisory level for no fish consumption. While sport fishing is not currently allowed in STA-2, consideration is being given to opening up some of the STAs to recreational activities.

RISK TO FISH-EATING WILDLIFE

Levels of mercury in fish tissues can also be put into perspective and evaluated with regard to mercury risk to fish-eating wildlife. The U.S. Fish and Wildlife Service (USFWS) has proposed a predator protection criterion of 100 ng/g THg in prey species (Eisler, 1987). More recently, in its *Mercury Study Report to Congress*, the USEPA proposed a 77 ng/g and a 346 ng/g limit for trophic level (TL) 3 and 4 fish, respectively, for the protection of piscivorous avian and mammalian wildlife (USEPA, 1997). STA-2 mosquitofish (considered to be at TL 2 to 3, depending on age; Loftus et al., 1998) collected from cell 1 and the discharge canal contained Hg at concentrations greater than the USFWS and USEPA criteria, while mosquitofish from the supply canal and cells 2 and 3 did not. STA-2 sunfish, which are at TL 3 (*L. gulosus* at TL 4; Loftus et al., 1998), contained levels of Hg that exceeded both the USEPA and USFWS criteria from all sites except cell 3 in October, especially fish caught from cell 1 in April. Similarly, after adjusting arithmetic mean Hg concentrations in fillets to whole-body concentrations (whole-body THg concentration = 0.69 x fillet THg; Lange et al., 1998), bass from both the discharge canal and cell 1 exceeded the USEPA guidance value for TL 4 fish. Based on these criteria, fish-eating wildlife are at some risk of adverse chronic effects from mercury exposure if feeding preferentially at STA-2. However, as has already been stressed, most of cell 1 was dry, and fish were limited to a few small pools and the swale at the bottom of the cell. Consequently, the area of contact, (the areal extent of contamination for potential exposure) was relatively small.

LITERATURE CITED

Eisler, R. 1987. Mercury hazards to fish, wildlife and invertebrates: a synoptic review. *Biological Report 85 (1.10). Contaminant Hazard Review Report No. 10*. U.S. Department of the Interior, U.S. Fish and Wildlife Service. Laurel, MD.

Lange, T.R., D.A. Richard and H.E. Royals. 1998. *Trophic Relationships of Mercury Bioaccumulation in Fish From the Florida Everglades*. Annual Report. Florida Game and Fresh Water Fish Commission, Fisheries Research Laboratory, Eustis, FL. Prepared for the Florida Department of Environmental Protection, Tallahassee, FL. August.

Rumbold, D.G., L. Fink, K. Laine, F. Matson, S. Niemczyk and P. Rawlik. 2001. Annual permit compliance monitoring report for mercury in Stormwater Treatment Areas and downstream receiving waters of the Everglades Protection Area. Appendix 7-9 in *2001 Everglades Consolidated Report*. South Florida Water Management District, West Palm Beach, FL.

Rumbold, D.G. and L. Fink. 2002. Report on expanded mercury monitoring at Stormwater Treatment Area-2. Appendix 4A-6 in *2002 Everglades Consolidated Report*. South Florida Water Management District, West Palm Beach, FL.