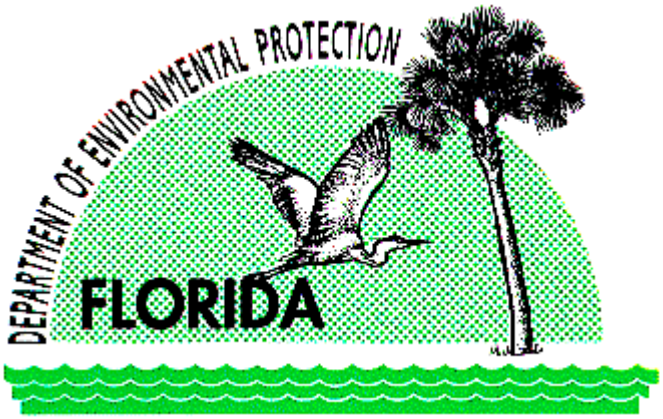


Wakulla Beach Sediment and Water Quality Survey

Wakulla County
Conducted September 2006
Bureau of Laboratories

12 October 2006

Executive Summary

As requested by the DEP Northwest District Office, staff from the DEP Bureau of Laboratories conducted a water quality and sediment survey at Wakulla Beach on September 28 and 30, 2006. This action was prompted by complaints of unusual shoreline sediment.

Thicker than normal deposits of decaying organic matter, averaging 4.3 cm thick, were found to extend for approximately 650 m, at a width of 6 m (approximately 45,000 gallons of material). Laboratory microscopic examination indicated that control (background) and test site samples had similar visual characteristics, with the majority of the material being composed of unidentifiable organic detritus, with decaying seagrass. Nothing that would suggest a human origin of the material (fibers, agricultural seeds, etc.) was observed in the samples. Common benthic (bottom dwelling) diatoms, such as *Amphora* sp. and *Nitzchia* sp. were frequently observed in the material.

Water samples indicated compliance with Class III surface water bacteriological standards (water column bacteria were not detected). Ammonia and nitrate-nitrite, often associated with human activities, were very low or undetected in water from the area.

Coprostanol (a break down product of cholesterol, which in sediments is known as a stable and persistent indicator of human sewage) was not detected in the Wakulla Beach sediment samples, but was abundant in actual sludge samples (taken for comparison) from the City of Tallahassee WWTP. Similarly, metals (*e.g.*, copper, zinc, silver) routinely found in municipal waste sludge were very low or not detected in Wakulla Beach samples, but were much higher in the Tallahassee WWTP sludge. These results suggest that the source of material was not anthropogenically derived waste.

Analyses for sediment caffeine and sediment bacterial indicators were not particularly informative, as caffeine was not found in any sample, and elevated sediment bacterial counts have commonly been found in non-human affected marine sediments.

Results and Discussion

Observations and Aerial Extent

On the afternoon of September 28, 2006, Bureau of Laboratories staff first conducted a visual assessment of the aerial extent of the unusually thick, black sediment, using methods adapted from a recently developed rapid periphyton survey method (located at : http://www.dep.state.fl.us/labs/sop/index.htm). The location of the survey is shown in Figures 1 and 2, and a photo of the survey is shown in Figure 3. The material was observed to be organic matter at a fairly advanced stage of decomposition, with vascular plant tissue (e.g., *Halodule*, *Thallassia*) and fine detritus visible (Figure 4).

When disturbed, the material emitted a strong hydrogen sulfide odor, similar to, but more intense than, background muck in the area. Staff measured the thickness of the material, the width of the material, and the length of shoreline exhibiting this “thicker than normal” organic matter. The evaluation that this material was deposited at “thicker than normal” quantities was the best professional judgment of samplers, who are familiar with *Spartina* marshes and the Wakulla Beach area.

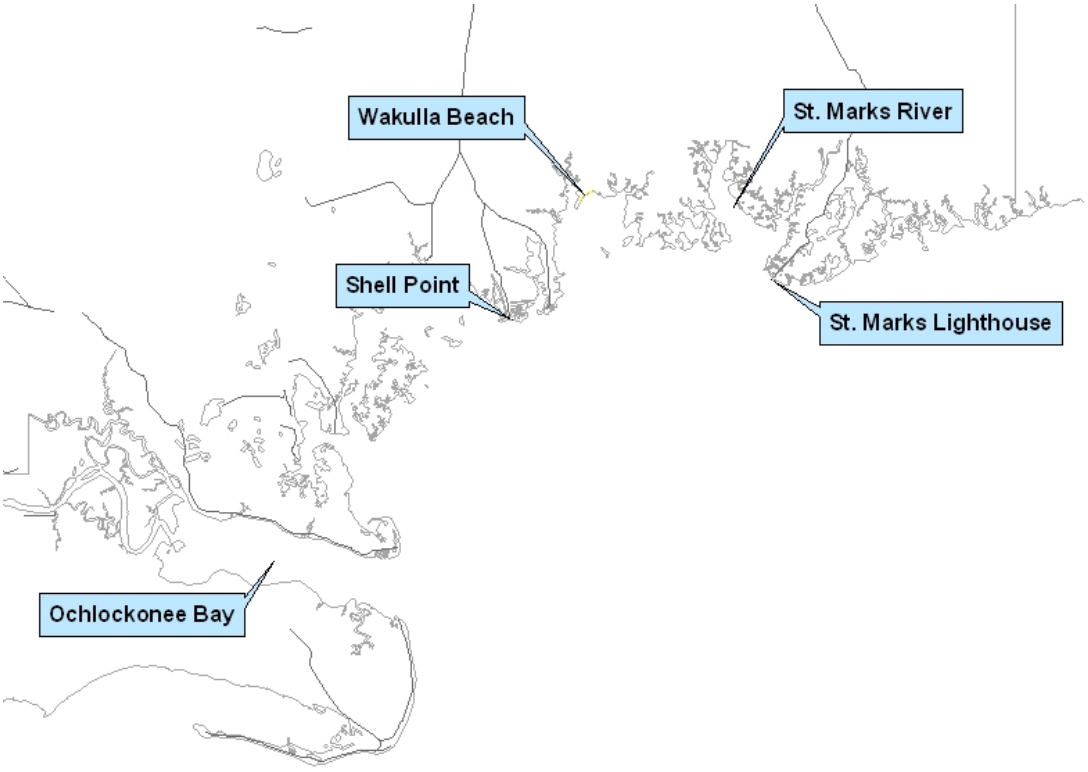


Figure 1. Location of Wakulla Beach, Wakulla County, FL.



Figure 2. 2004 digital aerial photo of Wakulla Beach showing transect locations for determining the aerial extent of the unusual organic sediment.



Figure 3. Measuring the thickness of the material at a sampling transect. Note what appeared to be a thin layer of sulfur-reducing bacteria over the decomposing muck.



Figure 4. Close up of Wakulla Beach sediment during sampling.

The average depth of this organic material observed along the littoral zone was 4.3 cm. Based on Global Positioning System measurements, approximately 652 m of the shoreline had this "thicker than normal" organic material. The average width of this organic layer was 6.1 m. The approximate volume of the organic sediment was 45,170 gallons (0.043m depth x 652 m length x 6.1 m width = 171 m^3). 171 m^3 is equal to 223.7 yd^3, which is equivalent to 45,170 gallons.

Area residents theorized that one potential origin of the material was an illegal discharge from a septic truck. A septic truck filled to capacity carries up to 2,500 gallons. Given the above calculations, it would take approximately 18 trucks, filled to capacity with sludge, to dump the observed volume (45,000 gallons) of organic matter if all the observed material were theorized to be sewage sludge. The fairly equal distribution of the material (about 6 m wide) along the littoral zone is not consistent with allegation that the material was discharged at a single spot near the boat ramp. It is not possible for vehicles to navigate in the surrounding *Spartina* marsh soils to equitably distribute the material. The only tire tracks observed were those leading to the boat ramp.

A different theory regarding the origin of the material was that it had been discharged from a vessel. Wakulla Beach is located at the northern most part of Goose Creek Bay, a system with generally very shallow water depths. While a barge could carry the volume of material observed (approximately 45,000 gallons), the release of the material would likely have had to occur at a distance in excess of 4 miles from Wakulla Beach, due to the shallow waters in Goose Creek Bay. There is a relatively narrow and unmarked natural channel into Goose Creek Bay, but it is insufficient to accommodate a barge or tug given the high potential for grounding. In an offshore discharge scenario, dispersion of the alleged discharge would likely result in much wider shoreline distribution of the matter, probably not confined to the observed 652 m swath.

One additional theory regarding the origin of the organic matter was that it was related to spraying of the herbicide, endothal, on nuisance *Hydrilla* in Wakulla Springs State Park. The most recent application of endothal at the State Park occurred on April, 19 and 20, 2006, approximately 5 months prior to the appearance of the organic muck on Wakulla Beach. Endothall breaks down quickly, with a half-life in water of 4 to 7 days (EXTOXNET), making it extremely unlikely that endothall could currently be detected. The length of time between the two events makes any determination of cause-effect correlation between them difficult to pursue, although any identifiable material associated with the Wakulla Beach organic sediments (benthic diatoms, *Thallassia*) were clearly of marine origin.

Surface Water Quality Results

Surface water was collected for bacteriological analyses on September 28, 2006 from two test sites located east and west of the boat ramp. *Escherichia coli*, *Enterococci*, fecal coliforms, and total coliforms were not detected in either sample, at a detection limit of 2 CFU/100 mL. These results indicate that the presence of material was not contributing to exceedances of water quality standards for bacteria.

During the FDEP sampling on September 28, 2006, a local resident provided information concerning an earlier sampling event at Wakulla Beach (Mr. Jack Rudloe, personal communication). Upon observing the water samples collected by FDEP staff, Mr. Rudloe commented that samples he had assisted in collecting the previous week appeared almost opaque, characterized by excessive black organic matter. It is possible that the earlier samples from the area were sediment/water slurries, rather than actual water samples (see discussion of sediment bacteria below).

Nutrient results from the test site west of the ramp indicated extremely low concentrations of bio-reactive nitrogen (ammonia was less than the practical quantitation limit and nitrate-nitrite was undetected). With such low amounts of total ammonia, the unionized ammonia (a toxic form of nitrogenous waste) would be non-problematic. The TKN (1.7 mg/L) and total phosphorus (0.11 mg/L) were typical of productive tidal marsh estuaries.

Sediment Chemical Results

Sediment samples from control and test sites at Wakulla Beach were analyzed for chemical markers of sewage sludge. These markers included caffeine (which enters waste systems from incomplete digestion of caffeine from beverages), coprostanol (a persistent breakdown product of cholesterol, commonly found in human sewage), and trace metals (elevated metals are generally associated with anthropogenic sludges). Similar analyses were performed on samples of actual sewage sludge obtained from two points in the wastewater treatment plant for the City of Tallahassee. The samples were from the following locations:

Wakulla Beach Samples

East of Ramp Control – a background control sample collected east of the affected zone;
West of Ramp Control – a background control sample collected west of the affected zone;
East of Ramp Test – a composite of samples taken from the access point east to the end of the affected zone;
West of Ramp Test – a composite of samples taken from the access point west to the end of the affected zone;
Test 3 – a discrete grab sample collected at the access point just on the west side of the boat landing area;
Test 4 – a discrete grab sample collected at the access point just on the east side of the boat landing area.

City of Tallahassee Waste Water Treatment Plant (WWTP) Sludge Samples

Undigested Sludge – collected from the process prior to digestor;
Digested Sludge – collected from the process after the digestor.

Caffeine, a typical tracer for human sewage in wastewater, did not prove useful as a marker for the identification of sewage sludge. No caffeine was detected in the sewage sludge obtained from the City of Tallahassee, presumably because it would be soluble in the aqueous fraction (and lost from the sludge during the settling process) and because

the difficult matrix precluded the attainment of sufficiently low detection limits. No caffeine was confirmed in any of the samples collected for this project.

The analyses for coprostanol and trace metals did prove to be useful as indicators of sewage sludge.

Samples were analyzed via a semi-quantitative Gas Chromatography/ Mass Spectrometry technique for coprostanol. High levels of coprostanol were detected in both of the sludge samples obtained from the City of Tallahassee wastewater treatment plant, with an estimated concentration of 490 mg/Kg in the undigested sludge and 610 mg/Kg in the digested sludge (based on dry weight concentrations).

In contrast, no coprostanol was detected in any of the samples collected at Wakulla Beach, suggesting that the origin of the material was not human sewage. Estimated detection limits for coprostanol in the sediment samples from Wakulla Beach were approximately 2 to 7 mg/Kg based on dry weight concentrations.

The trace metal signature for the City of Tallahassee sludge samples was also markedly different from the samples collected at Wakulla Beach, indicating that it is unlikely the material found at Wakulla Beach is associated with municipal sewage sludge. Relevant trace metal signatures for the samples are shown in Figures 5 and 6.

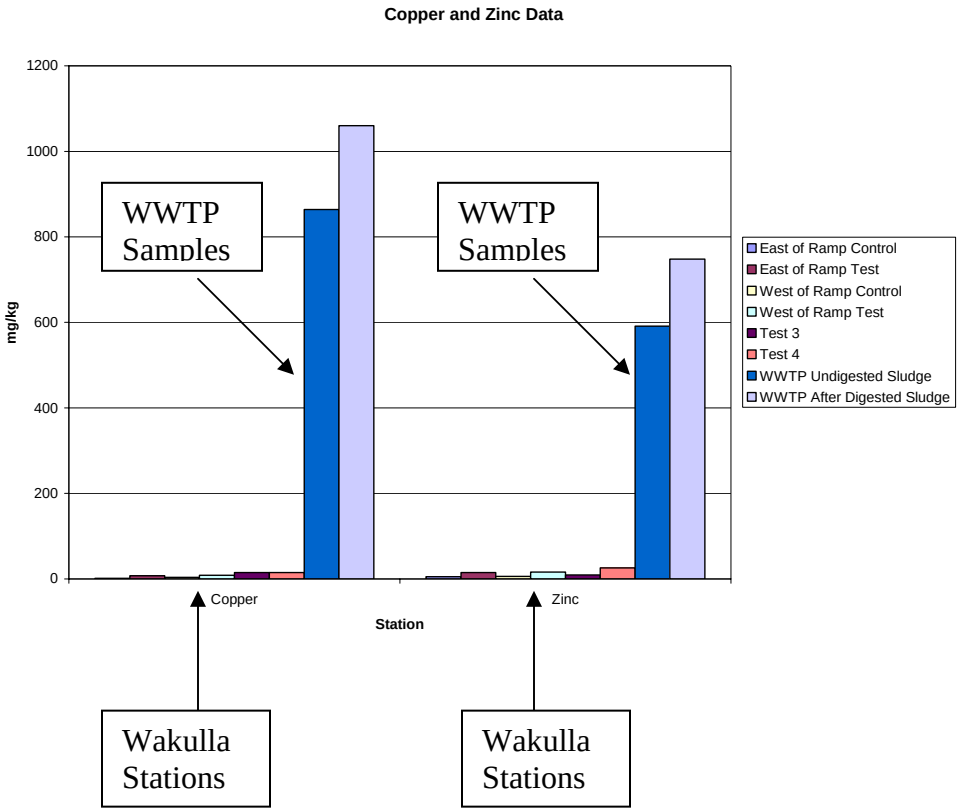


Figure 5. Sediment metals results for copper and zinc.

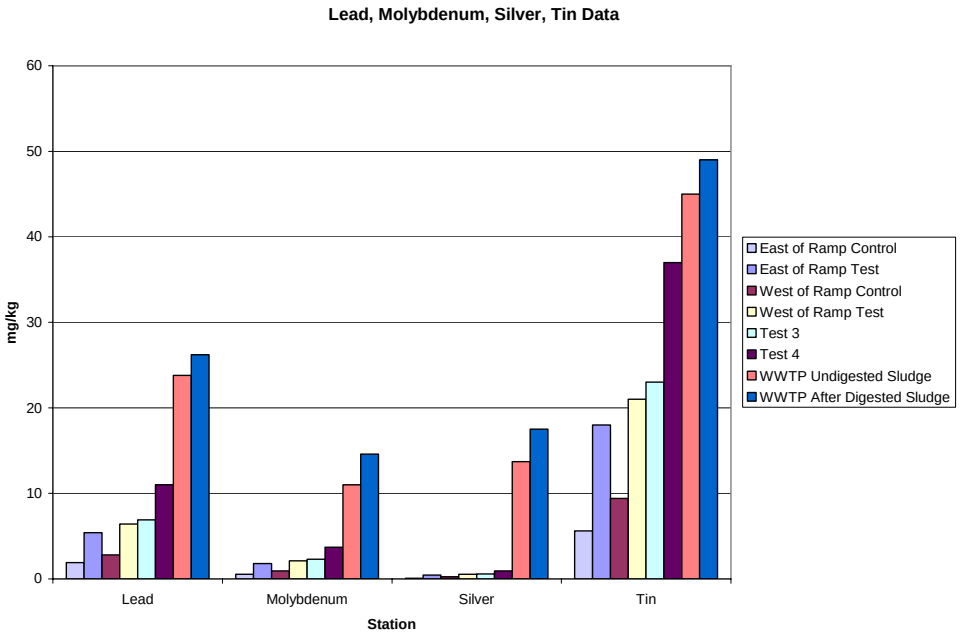


Figure 6. Sediment results for lead, molybdenum, silver, and tin.

For the metals shown, the results were either below quantifiable levels (the Practical Quantification Limit) or below detection limit for all samples collected from Wakulla Beach, control and test stations alike. Where results were below detection, the detection limit was plotted.

Microscopic Examination of Sediment

Sediment samples (Control Sites East and West, and Test Sites East and West) were examined under dissecting and compound microscopes. All samples had similar visual characteristics, with the majority of the material being composed of unidentifiable organic detritus, with decaying seagrass. Nothing that would suggest a human origin of the material (fibers, agricultural seeds, etc.) was observed in the samples.

Benthic (bottom dwelling) diatoms, such as *Amphora* sp. and *Nitzchia* sp. were found to be very common in the samples. Dr. Michael Sullivan, FSU Marine Lab, also examined a sample of the Wakulla Beach sediment he had collected on October 1, 2006. He also observed unidentifiable organic detritus, decomposed seagrass, and benthic diatoms, dominated by *Gyrosigma* sp., *Nitzchia* sp. and *Amphora* sp. (Dr. Michael Sullivan, personal communication). These diatoms are considered to be normal constituents of coastal systems.

Sediment Bacteriological Results

Wakulla Beach test site sediments were found to have greater than 16,000 CFU/100 g of *Enterococci* in both grab samples taken near the boat ramp (Test Sites 3

and 4, collected on September 30, 2006). Sediment fecal coliform concentrations were 16,000 CFU/100 g at Test Site 3 and 13, 000 CFU/100 g at Test Site 4. As there are no ambient standards for bacteria in sediment, and since there is currently ongoing scientific debate concerning the appropriateness of using fecal indicator organisms in marine sediments, additional discussion of these data are warranted.

High numbers of fecal indicator organisms in coastal subtropical marine sediments have been found in areas without human fecal sources. Research performed at University of Miami and other institutions has demonstrated that *E. coli* and *Enterococci*, which originate in warm-blooded animal waste (wildlife and human alike), have the capacity to both persist and reproduce in sediments (Solo-Gabriele *et al.* 2000, Grant *et al.* 2001). The factors that most strongly increase the persistence and re-growth of fecal indicators in marine sediments are periodic wetting and drying of the soil/sediment (as under tidal conditions found in littoral zones), and high percent sediment organic matter. Both of these conditions were characteristic of the Wakulla Beach sediment samples.

A recent study, performed by the University of South Florida, determined that the majority of the *Enterococci* in water from stations at Ochlockonee Bay and Mashes Sands were derived from sediment sources rather than human waste (Harwood, 2005).

A study performed in the non-anthropogenically affected shallow waters of the St. Marks Wildlife Refuge found that the submerged (not littoral zone) sediments contained extremely variable counts of fecal coliform and *Enterococci* levels (FDEP 2004). Fecal coliforms ranged from 23 to greater than 1,609 CFU/100 g and *Enterococci* ranged from 14 to greater than 1,609 CFU/100 g (FDEP 2004). Speciation of the *Enterococci* indicated that the majority of the species isolated from the sediment were from wildlife sources. These St. Marks Refuge sediments were composed of considerably more sand than the Wakulla Beach Test samples, and they were not exposed to air during the tidal cycle, factors which would decrease the *in-situ* reproduction of these bacteria compared to the conditions observed at Wakulla Beach. Even so, greater than 1,609 CFU/100 g of these indicator organisms could be found in natural, non-human affected areas. The actual number of colony forming units per 100 g was not determined because the samples were not diluted enough to achieve a quantifiable range.

Given the above information, the high levels of bacteria in the Wakulla Beach sediments are not particularly informative as an indicator of human sources of the organic material.

Conclusions

On September 28, 2006, thicker than normal deposits of decaying organic matter were observed at Wakulla Beach. These deposits of decaying organic matter, averaging 4.3 cm thick, were found to extend for approximately 650 m, at a width of 6 m (approximately 45,000 gallons of material). Laboratory microscopic examination indicated that control (background) and test site samples had similar visual characteristics, with the majority of the material being composed of unidentifiable organic detritus, with some decaying seagrass. Nothing that would suggest a human origin of the material (fibers, agricultural seeds, etc.) was observed in the samples. Common benthic (bottom dwelling) diatoms, such as *Amphora* sp. and *Nitzchia* sp. were frequently observed in the material.

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