Kathy Worley Comments

Comments on PBS&J Report: Clam Bay System Data Collection and Analysis based on a preliminary review. Note an in depth look at this report is put on hold until answers to the questions that are raised in this missive are forthcoming. I apologize for the disjointed nature of these comments – unfortunately I have been dealing with some health issues for the past 3 weeks which have limited review of the report.

Note: Statements that are in red italics are directly from PBS&J report

Executive Summary: Page i section: Review Points 1 and 2:

The FDEP mandate to get data into STORET is important for achieving state-wide water quality goals and initiatives. The County should definitely comply with this mandate, but this is not the main reason to perform water quality monitoring. Water Quality monitoring is one of the methods commonly used to find out what types of pollutants are in the water, can overtime establish any trends, serve as an early warning system for potential developing problems, and can give an indication of their possible source. The information provided by water quality monitoring can help indicate what types of aquatic flora and fauna the estuary could support, given the physical and nutrient water parameter levels present in the water overtime (Note: water quality is not the only thing that dictates what species will reside or use a water body). It seems that there are excessive concerns about getting a negative review by FDEP and triggering an investigation towards a possible TMDL, and while it is nice to head off perceived problems, the TMDL program is just a way to get Counties to address any water quality problems, which is a good thing.

Dissolved Oxygen levels are perceived as a problem regarding State standards in Clam Bay. However in order to trigger a TMDL, dissolved oxygen levels have to be below Standards in concert with causative pollutants. Biological Oxygen Demand, Total Nitrogen and Total Phosphorus also have to exceed State standards. Dissolved oxygen levels recorded in Clam Bay have been below the State standard, typical of a lot of estuarine waterways in the County including Rookery Bay (usually during the summer). This is not unusual and as long as the levels are not constantly below the State standard or at anoxic levels that can precipitate fish kills (given the warm water (d.o and temp have inverse relationship)), these levels are not surprising and can be defended. Rookery Bay is an FDEP reference site (Water Body ID :# 3259M). This site does have dissolved oxygen levels below State standards and Rookery Bay has not triggered a TMDL by FDEP since it does not have a causative pollutant, nor has the Tamiami Canal system (Water Body Id : 3261B).

Water Quality monitoring programs are important and should be implemented for Clam Bay just be sure you know the reason to do so is track water quality trends over time;

what the water quality means to the organisms that live in that water way; and for people who wish to use that waterway for fishing, swimming or other recreational activities.

PBS&J's Critique of other studies

I do not intend to comment extensively on these sections other than to say that it appears that the context and purpose for doing past hydrology and water quality studies were not considered when the review was written. Mr. Humiston's rebuttal to PBS&J's comments concerning their report are valid. Similarly, the critique of the water quality studies done by Pelican Bay and the Conservancy were performed for specific reasons. FYI - the physical parameters collected by the Conservancy do meet the standards for use by FDEP STORET guidelines the data has just never been entered on a regular basis. And as far as the nutrient parameters, it was stated up front by the Conservancy that these data were not performed by a certified lab, but were performed in accordance with acceptable methods, quality controlled with period split samples with a certified lab, and that only a few key parameters were investigated for trends - all of which are standard in most water quality studies. FYI "The most important nutrients in coastal estuaries are dissolved inorganic nitrogen and phosphorus compounds" (Holmboe, et. al., 2001). WHOOPS - Now Iam getting defensive so I'll stop!

Statements from Introduction page 1 paragraphs 1 and 4:
Paragraph 1: "Clam Bay and Moorings Bay are important natural features in Collier County".
Paragraph 4 sentence 3: "In contrast, much of the shoreline of Moorings Bay was significantly altered through dredge and fill activity, such that natural shoreline features in the northern portions of Moorings Bay were mostly absent by the 1950s"

The statement in paragraph 1 contradicts the statement in Paragraph 2 as the entire Moorings Bay today is unnatural. Moorings Bay is not a natural feature. It used to be natural in the 50s' when the mangrove forest extended from Moorings through Vanderbilt. Additionally, although Clam Bay is unarguably the most natural system of mangroves remaining in the urban Naples landscape (discounting Rookery Bay) it is not entirely natural either given the encroaching development and isolated state today.

Source: USGS 1953. Outer (Lower) Clam Bay and Moorings 1953: Undeveloped Natural State

The PBS&J report, intended or not, gives the reader the impression that Moorings Bay is being compared to Clam Bay and Clam Bay is coming off as being perceived as more impaired. These2 systems should not be compared for estuarine health as Moorings Bay is no longer an estuary. Dr. Bauer from the City stated as much at the last meeting. Collier County Pollution Control, Save the Bays, the Conservancy and the City have for decades worked to improve the conditions within Moorings Bay given that this is a hardened structural man-made system. For years all have been pushing for rip-rap when seawalls fail and need to be replaced, fertilizer ordinances, stormwater control, etc and

under Dr. Bauer's guidance some strides have been made in these areas to help improve the conditions of this man-made canal system. The only connection that Moorings Bay and Clam Bay have at this point is the culvert.
Question: In the introduction please define what this report considers the boundaries of the "Clam Bay Watershed" throughout this report to avoid confusion.

Statement from Page 4 last paragraph: "
Instead, the conclusion was reached that die-off was likely due to excessive freshwater input to the system from the adjacent developed uplands and an inadequate dispersion of the increased freshwater input due to severely constricted tidal channels in the mangrove forest. As a result, the mangrove forest became inundated with water levels higher than the tops of the black mangrove pneumatophores. The duration of increased water levels was sufficient to kill the trees by blocking oxygen exchange to the below ground tissues".

While this statement is true it is important to also remember that **impoundment** of excessive freshwater from unusually high rainfall amounts in 1992 and 1995 was the straw that tipped the **Outer Clam Bay Moorings Future Seagate Canals** scales in the northwest corner of the Clam Bay mangrove system and that by all indications was stressed to begin with most likely due to development on the borders of this forest. A lot of emphasis is being placed on improving flushing within the Clam Bay system as a solution to problems that have developed within the mangroves in the past. While flushing is essential to mangrove systems and usually occurs naturally, any excessive anthropogenic freshwater inflows into Clam Bay should be dealt with at the source instead of flushing the excessive freshwater and anthropogenic introduced pollutants to the Gulf. This in itself should be perceived as a problem as in effect we are just contributing to polluting the Gulf and although the levels are probably small in comparison to other inputs it is time we start to address the Gulf instead of treating it like a septic tank throughout the Gulf States. Additionally, improving the flushing of Clam Bay seems to be perceived as some sort of cureall, which is not accurate. Too much flushing is just as much a problem as too little in an estuary, as the habitats and species that use these environments are adapted to shallow, low energy environments. Also, given that estuaries are shallow and the land features typically are at low elevation, very little rise in water levels is needed to flood the mangroves for tidal flushing as long as no impediments that impound the water exist.

Additionally, the usual way to improve flushing is through dredging which can alter the detritusbased system of a mangrove estuary by stirring up and/or removing sediment and disrupting the nutrient sources necessary to the organisms that rely on detritus for food and cover, and can also interfere with the natural decomposition process by bacteria and other organisms. Therefore, dredging to improve flushing should be tempered and used sparingly in order to keep the balance of the system in check.

Statement from Page 5 1.2:
"In response to concerns related to the issues of water quality and circulation in the Clam Bay and Moorings Bay systems, Collier County requested PBS&J prepare a proposal to conduct a circulation and water quality study to determine the following:

• What is the extent and relative health of the natural resources in Clam Bay and Moorings Bay?"

While water quality and hydrology are important components without biological studies it will not be possible to determine the extent and relative health of the natural resources.

•" What do historical data suggest, in terms of status and trends, about the health of Clam Bay and Moorings Bay?"

Historical biological data also needs to be addressed prior to hypothesizing about the health of the system.

• "How do circulation patterns and nutrient delivery interact to create spatial patterns of water quality in Clam Bay and Moorings Bay, and how these patterns affect the estuarine flora and fauna?"

Some inferences can be made from the water quality concerning what species could possibly survive in that particular water but it can't tell you population dynamics and trends.

• "How will changes in circulation within Clam Bay and between Clam Bay and Moorings Bay affect the overall estuary (as defined in Figure 1.5)?"

This will only answer definitively the effect on the hydrology and not the biology.

Question Regarding 2.0 Methods 2.3 page 7

Please specify the number of sediment samples were taken in the system and were any replicates taken? Additionally what were the weather conditions during the 2 day period of sampling?

What method was used to classify the soil conditions based on color? Mullers? Were hue, value and color intensity evaluated? What were the ranges?

Statement from 2.0 Methods 2.4 page 8
"This task consisted of completing a bathymetric survey of a portion of the project area. The bathymetric survey of the project area included Clam Pass (including the ebb shoal complex), Upper, Inner, and Outer Clam Bay, and Moorings Bay".

Please provide the bathymetry map

Regarding Statements from 2.0 Methods page 8 Currents/Water Levels: page 8:
"Current and water level measurements were taken within the project area over a period of 8 days for use in a planning level circulation analysis. This data can also be used for the calibration of a potential hydrodynamic numerical model. Currents and water levels were measured at five and seven locations within the project area, respectively".

And Statements from 7.1
"The data collection effort yielded concurrent water level and flow velocity measurements for a period of 8 days, from August 15 to August 23, 2009. All instruments were successful in collecting data; however, several acts of vandalism"
"It should be noted that the water level data from the Clam Pass gauge is of concern, with a range less than expected and an overall elevation that appears to be too low"

And Statements from Hydrographic Data Analysis 7.3 Current Velocities and Flow Rates page 62:
"The gaps in the South Seagate Dr and Harbour Dr data were due to acts of vandalism during the deployment. After the Harbour Dr gauge was redeployed, the readings appear to be erroneous due to their small magnitude, but no discrepancies can be found in the data files or instrument setup. For the purposes of calculating flow rates at Harbour Dr, only the data before the vandalism occurred was used".

Equipment malfunctions do occur within the field, however not repeating the experiment given the unexpected data; readings that appear erroneous; and only using data prior to incidents given that the period of observation is so short does not give confidence in using these data for model calibration. I have often endured equipment failures that cause the experiment to be repeated otherwise there would have been no confidence in the data. Even when I did some surface water level studies in the past where a gap in the data was caused by equipment vandalism I was able to eliminate this data as I had a year worth of levels and a two week gap was within the realm of acceptable loss. However in this case where the period was 8 days the loss of half the data at some of the sites is too great a percentage to discount. I have a great deal of concern and would not be able to trust any modeling done with the readings that were collected over such a short time span; that were fraught with problems, readings that appeared to be erroneous at Clam Pass (which is one of the focal points hydrologically) and the time frame of only using a "spring tide" where only the extremes and not the norms are used.

Most hydrologic data sets today that are used in conjunction with biological components (which is necessary to develop any sort of management plan that has validity) in estuaries typically rely on a time series water level and velocity for a month covering neap and spring tides. For example, Van Santen, et.al., 2007 collected time series water level, velocity and sediment accumulation for a month covering neap and spring tides in order to ensure that a complete hydrographic picture could be inferred. Ji, et. al., 2001 measured data for tidal calibration that included tidal elevation, salinity, temperature, current velocity at various locations throughout the estuary for 31 days in order to ensure accuracy.

Two independent data sets are required for calibration and subsequent validation of a hydrodynamic model. The observation times should be divided into two separate components 1 month for calibration and 1 month for validation is sufficient and model sensitivity studies are essential (Huang, 2007). Various year's worth of this kind of data

is available from other sources that could be vetted to complete a better hydrologic picture for use in modeling this estuary.
Granted that past hydrologic investigations over the years had different goals, their data is more robust and more suited to model calibration and verification, which at the moment would make these past modeling efforts more useful than an updated more sophisticated model whose calibration and validation is suspect.
"Handling model complexity and reliability is a key area of research today" (Raick, et., al., 2006).

Currently in marine ecosystem modeling the idea is to include an ecological component in conjunction with a general circulation model. What ever strategy is undertaken the key is assessment, as the biology must be linked to the hydrology and physical environment characteristics (Raick, et., al. 2006).

Regarding Statement from the executive summary:
"In order to analyze potential changes to the system to improve circulation and dissolved oxygen
(DO) within the Clam Bay system, a hydrodynamic model will need to be developed to understand the interactions between Clam Bay (Upper, Inner and Outer), Clam Pass, Moorings Bay, and Doctor's Pass"

This statement concludes that there is a need to improve circulation and dissolved oxygen within Clam Bay neither or which has been adequately substantiated or established at this time, particularly in reference to the ecology.

Statement from Hydrographic Data Analysis page 61
"As an unexpected observation, Upper Clam Bay appears to lead Inner Clam Bay by approximately 2 hours. The tidal range is 1 ft, less than 25% of the Gulf tidal range. Both Upper and Inner Bays have a mean tide level about 0.20 ft above the mean Gulf level, likely due to stormwater inflow forcing a head increase".

Given the unexpected results alluded to by the author it is prudent to repeat this experiment to confirm whether the results are an anomaly. Additionally, the time lag could and probably does change during the wet and dry seasons.

Statement from Hydrographic Data Analysis 7.3 Current Velocities and Flow Rates page 62:
It is important to note that the field data was collected during spring tides, where the tidal range is larger than normal (higher highs, lower lows). Also, there were several rainfall events during the study period, which affect water levels in Clam Bay and Moorings Bay due to urban drainage. Evidence of this rainfall can be seen in the water level graphs (Figures 7.2 and 7.3) of Upper and Inner Clam Bay, where it appears the mean water level rises during the week as stormwater enters the system.

What were the extent of the rainfall events and when did the events occur in comparison to when the inflows show up?

The choice of using higher and lower than normal tides can skew the data and should cover an entire spectrum of tides to accurately come up with net values although the time when the readings occurred does give some insight to extreme conditions as stated in the reports conclusion (page 74).

It is important to note that the flow calculations are based on the conditions during the study period and the resultant trends may only be applicable to the study period.

Given the lack of confidence in the data set (data gaps), any results and conclusions about the hydrology would also be suspect and thus any comments on actual values relating to tidal cycles and currents reported in this report would be moot.

In regard to the Water Quality Component of the PBS&J report:

This is part of the report is geared at a review of past data and basically reinforced the basic information that was already apparent such as:

There were erroneous values in the data set from Collier County.

The ends of the Clam Bay system appeared to have more instances lower dissolved oxygen levels and/or nutrient levels which is typical of any system that has deadends – the farther the distance from the pass……

I would have liked to see statistics broken out by season as this is an important driver in water quality and could explain some of the readings that are shown in the graphs. For example, did the instances of low dissolved oxygen occur primarily during the summer months and how does the dissolved oxygen correlate to water temperature values? What were the depths at the various stations in comparison to levels that were reported – is the higher nutrient levels and lower dissolved oxygen recorded in concert with very shallow depths and could sediment resuspension possibly interfered during sampling? Were nutrients and chlorophyll levels higher during the 2005-2007? If so, resuspension of nutrients caused by hurricanes could result in algal blooms as seen in southern estuaries in Florida in 2005. Chlorophyll a levels increased with algal blooms and the majority of regions that Boyer, et. al., 2009 assessed in 2006. CHLA was higher than the median at their sites, but did not appear to indicate negative trends in southern estuaries. Mangrove interfaces with the Gulf had higher chlorophyll a levels in 2006 than in 2005, likely the result of the hurricanes that hit south Florida in 2005 and likely does not indicate long-term trends (Boyer, et. al. 2009)..

Were low dissolved oxygen levels and/or higher nutrient levels persistent over time or just isolated incidents? Were low dissolved oxygen levels primarily between 3 – 4 mg/l or lower and if so how long did the condition last? Any relationship to precipitation events? Were any tables generated that detailed the data and statistics that could clear up some of these questions?

Discounting obvious outliers - are dissolved oxygen or nutrient values that were lower/higher than the ambient levels correlated to weather events such as storm events or episodic algal blooms that appear in the Gulf? (see next paragraphs for the context of this question).

The Gulf coast of Florida receives discharges from a lot of rivers in the northern and central parts of the west coast. Runoff from these rivers affects the chemistry and biology of estuaries with maximum discharges tending to occur in the spring and fall. The southern movement of the waters in the Gulf could affect the southern parts of SWFL waters. An episodic event during the spring occurred when elevated pigment concentrations persisted of 1-6 weeks extending 250 km along the Florida shelf. Plume formation was associated with discharge from local rivers in NW Florida; seasonal changes in height between the shelf and the Gulf of Mexico waters; Loop current circulation and upwellings in the Gulf of Mexico off De Soto; and discharge from the Mississippi and Mobile rivers. On the Florida Shelf in the Gulf of Mexico toxic dinoflagellates have episodic blooms that are suspected of adding to the total nutrient production. These blooms tend to occur in the summer or fall but can occur at any time. The semi-regular occurrences of this bloom indicates that energy levels to higher tropic levels could be seasonal. In May of 1992 a particularly high chlorophyll a bloom occurred (Gilbes, et.al. 1996). Do the high chlorophyll a levels that were found in Clam Bay correspond to the semi regular events in the Gulf shelf particularly in 1992? The impact that nutrients from the Gulf on local estuaries is poorly understood but should be considered as possible explanation of local nutrient and chlorophyll spikes during episodic blooms (Gilbes, et. al. 1996).

In general, from a cursory inspection of the figures presented in the report it is no surprise that the upper regions of the Clam Bay system are higher in nutrients given that the system has been cut off from its natural connections to the north. This is found in both manmade canal systems including Moorings Bay and natural systems that lack river inflows. Additionally, when analyzing the data efforts should be made to explain possible elevated levels such as those discussed above if applicable.

Regarding section 3.2 Dissolved Oxygen page 14 in the report:
"Extremely elevated concentrations of DO were observed between August 2001 and August 2002; these data must have been reported inaccurately, and cannot be representative of the ambient DO readings at that time. To accommodate this data problem, Figure 3.5 was created, where the yaxis was truncated at a more realistic maximum DO level of 10 mg/l".

It would be more appropriate to omit the erroneous data from the set rather that trying to visualize it in truncated form. Suggest including a table of the outliers and stating that these values were not included in analysis of the data set as the values reported were suspect and to include them when making analysis could skew the data set. It is not clear whether or not these suspect values that the authors "truncated" to "10 mg/l" were used in any of the statistics presented in Figure 3.6. If they were they should be removed as given the obvious erroneous level of those values it is not appropriate to include in the statistics and could lead to erroneous conclusion given that there is no way to arbitrarily assign a value to these particular values with any degree of certainty.

Regarding section 3.2 Chlorophyll page 17 in the report:
"Isolated elevated concentrations of chlorophyll a have been observed at the W-6 and W-1 sites, however, the concentration observed on September 1996 at the W-6 site (299 µg/L) is unlikely in the marine waters, and so the data are displayed (Figure 3.8) with a truncated y-axis".

Again, as with the dissolved oxygen, it would be more appropriate to omit the erroneous chlorophyll a data from the set rather that trying to visualize it in truncated form. Suggest including a table of the outliers and stating that these values were not included in analysis of the data set as the values reported were suspect and to include them when making analysis could skew the data set. It is not clear whether or not these suspect values that the authors "truncated" to 50? mg/l" were used in any of the statistics presented in Figure 3.9. If they were they should be removed as given the obvious erroneous level of those values it is not appropriate to include in the statistics and could lead to erroneous conclusion given that there is no way to arbitrarily assign a value to these particular values.

Regarding on Page 20 on the report:

While certain facts presented in the PBS&J's report regarding TMDL's are correct, the interpretation of what actually triggers a TMDL does not appear to be in accordance with FDEP's guidelines.

"*Site W-7 exceeded an annual average Chl-a concentration of 11 µg/L during both 2005 and 2007. Based upon existing criteria from FDEP, Clam Bay would likely be declared verified impaired due to elevated chlorophyll a concentrations"*

According to FDEP's current Impaired Waters Rule 10% of the samples have to exceed annual averages of 11ug/l for the **Water Body**. Given the bar chart values from the Figure 3.9 in the report - it does not appear that 10% of the annual averages for chlorophyll a are impaired as all of the sites would be looked at together. As on the chart only W-7 has instances were the annual average is above 11 ug/l and the rest of the stations appear to be within FDEP's criteria it is unlikely that Clam Bay (WBID) by itself would be classified as verified impaired. Also there are a minimum number of samples needed to put a water body on the Verified list (with at least a 90% confidence). Within the data set (discounting any suspect samples) - How many total samples were there? - And how many were impaired? Were confidence intervals generated for the data?

Regarding the Nutrient Analysis:

When trying to understand and analyze nutrient cycling dynamics it is important to take into account that estuarine wetlands act as a filter as they tend to sequester or recycle nutrients. It is important to remember that mangrove systems are a sink for nutrients and bind large amounts of N and P for production. Ignoring the uptake and release of

nutrients, particularly from minerals that occur naturally in mangrove swamps, can cause errors in determining the nutrient balance necessary to sustain the estuary (Wosten, et. al., 2003). Calculations based entirely on hydrology and water quality which vary considerably in time and space without considering the natural biological and nutrient cycling within the estuary is questionable. While these elements are important relying on them alone for management of the estuary could lead to erroneous conclusions about the estuary dynamics (Wosten, et. al., 2003). The dynamics of an estuary have to be taken into account when evaluating an estuary like Clam Bay versus evaluating a manmade canal system like Moorings. For example: Shallow water estuaries (like Clam Bay) should accumulate substantial amounts of organic matter that becomes incorporated into the benthos where it degrades and is modified by microbes. Microbial communities employ complex anaerobic and aerobic transformations that result in the amount of organic and inorganic nutrients within and above the sediment. Tide and wind indirectly influence microbial communities and thus nutrient concentrations within the sediment through resuspension activity that arise from these forces (Seymour, et. al., 2007). Naturally nutrients could be higher in Clam Bay due to natural interactions, whereas in Moorings Bay there is a lack of natural nutrient cycling due to the lack of detritus buildup which is necessary to an estuary. “Resource management strategies must take into account system-specific factors” (Tomasko, et. al., 2005).

Regarding – Sediment and Biological Health Characteristics

The survey conducted by PBS&J only provides a cursory look at the sediment and any attempt at using this qualitative data to describing redox conditions and benthic communities is fraught with assumptions that could lead to erroneous conclusions. As the visibility in Clam Bay is generally low, any characterizations derived from the survey are anecdotal at best since very little of the surrounding habitats would be visible to the observer. Biological assessments have to encompass the whole spectrum of the food web and not just a visual interpretation of a few of the lower level organisms mentioned in this study, without looking at the community from the top down also. Due to the scope of this study there was no possibility of characterizing the health of the benthic community with any degree of certainty with the methods that this survey employed, as typically indices are used to describe benthic populations.

Regarding Sediments and Redox in Mangrove Estuaries

Mangrove soils have been described as highly anaerobic, sulphidic, reduced inundated muds, whose physicochemical properties vary with elevation and forest type (Alongi and Sasekumar, 1992). The most significant effect of inundation is depletion of soil oxygen. Biological and chemical reactions are largely controlled by oxidation-reduction processes, which are necessary to cycle nutrients within the air, water, and soil. Transformations of nitrogen, sulfur, iron, manganese and carbon occur under anaerobic conditions, where nitrate (NO_3^-), manganese oxide (MnO_2), iron hydroxides ($Fe(OH)_2$), sulfate (SO_4^{-2}), and carbon dioxide (CO_2), in this order, act as electron acceptors in the absence of oxygen (Vespraskas and Faulkner, 2001). Redox potential, expressed and measured as Eh, is a useful indicator of what types of reduced elements one can expect to

find in soil solution It is an electrical measurement that shows the tendency of a soil solution to transfer electrons to or from a reference electrode. From this measurement, estimates can be made to as to whether the soil is aerobic or anaerobic, and whether or not chemical compounds including iron oxides or nitrate have been chemically reduced or are present in their oxidized forms.. Interactions between soil redox potential and availability of essential nutrients are extremely complex (Clough, 1992) and are influenced by a variety of factors including surface water and groundwater inflows, oxygen availability, plankton productivity, pH, and moisture content (Alongi, et. al., 1992).

Color is an obvious cue to soil processes as the color of soil is often determined by the various compounds within it, mineral grains, biological activity, and natural pigments like iron and other oxides. Seasonal variations in precipitation and evapotranspiration rates lead to water table fluctuations causing alternating reduction and oxidation with respect to iron oxides. Mobilization of ferrous iron during periods of reduction can cause segregation in soil zones. However sometimes in areas of high water tables these conditions don't develop leading to anomalous conclusions about color inferences about redox (Rabenhorst and Parikh, 2000). At best in mangrove estuaries color can give a rough idea of the types of minerals that could be present in the substrate, but inference to redox potential of these soils is not recommended. Redox potential should be measured and even then it describes what oxygen-reduction reactions are likely to be occurring in the sediment in that localized area as redox potentials tend to fluctuate. For example, the brown to green color variation in marine sediments marks the depth where nitrate has been reduced to Fe^{3+} to FE^{2+}. The color change can be reversed due to the oxidation properties of iron. The depth to the brown – green transition provides a rapid way to estimate redox conditions in sediments however this depth transition cannot be related to productivity (Rabenhorst and Parikh, 2000).

Thus the *Statement from the executive summary point 6:*
"As a result, Moorings Bay, although subject to extensive urban stormwater runoff, appears to have water ecology conditions better than those found in Clam Bay; this is supported by the results of the Redox layer investigation" should be suspect. Although most mangrove sediments are characterized by negative redox potentials and anoxic conditions that can persist to the surface, some of the surficial sediments near the landward margins are aerobic in nature, possibly due to burrowing fauna. Mangrove sediments near the surface often have highly variable redox, which result in various colors in the soil and rapid changes in redox potential (Eh) over small distances (Clark, et. al., 1998).

Regarding Statements made in the executive summary #2 and #3:
"A fine-grained sediment layer was found in most locations of Outer Clam Bay. This sediment depth was approximately 5 feet in the area of the Seagate canals, was not prevalent in Moorings Bay, and varied in depth in Outer, Inner and Upper Clam Bays'.
"It is not known at this time if the fine-grained sediment layer is naturally occurring, or occurring as a result of man-made changes to the Clam Bay system. It is, however,

known that the sediment layer in the Seagate canals has accumulated since the canals were dug in the 1950s"

.

Fine sediments are not uncommon and occur naturally in mangrove estuaries (Alfaro, 2005; Van Santen, et., al., 2007; Bala Krishna Prasad and Ramanathan, 2005; Alongi, et. al., 2005; Schmid, et., al., 2006) often in the upper reaches of the estuary (Van Santen et., al., 2007). Therefore it is not unusual or even unexpected that the PBS& J found evidences of these types of sediments within the Clam Bay system as there is often an active capture of fine cohesive sediments by mangroves (Van Santen, et., al., 2007). "Mangrove sediment can provide a sink for trace metals since the mangroves create a baffle that promotes the accumulation of fine-grained organic matter-rich sediment which is usually sulphidic due to the presence of sulphate- reducing bacteria in the sediment" (Clark, et. al., 1998).

Sediment accumulation is commonly a by-product of man-made narrow canal systems like Seagate and Aqualane Shores. Additionally, previous investigations by Dr. Aswani Volety (FGCU) that were performed for Save the Bays revealed that in Moorings Bay bottom conditions in Moorings Bay varied from sandy, rock, shell rubble to muddy hypoxic sediments. Rock bottoms particularly in those areas that are dredged would limit any sediment inferences.

Regarding Statement from 3.3 Task 3 – Sediment and Biological Health Characterization General Biological Survey Results page 28

"Redox layers were at or close to the surface (< 20 cm) in both Upper and Outer Clam Bay. In contrast, Redox layers were typically deeper than 20 cm in Inner Clam Bay and Moorings Bay. These data suggest that benthic communities would be expected to be of lower diversity (if not abundance) in both Upper and Outer Clam Bays"

Benthic Communities

Benthic communities are not composed of just seagrass, and macroalgae that are mentioned in this report and given the low sample size (albeit cost driven) and the lack of stringent survey protocols (visual only), and no repetitions overtime, there is no way to quantify the benthic communities. The macrobenthic community alone covers a diverse spectrum of species including but not limited to sponges, mollusks, worms, crabs, lobsters, prawns, etc. (Ellison, 2008) which are not able to be quantified by the cursory inspection performed during this study.

Thus statements such as those made *in the executive summary #6 and 7* reiterated below do not represent the "benthic communities" nor the inferences or comparisons made between the "redox layer" and the diversity of these communities (given the methodology used, limited sampling, and lack of Eh measurements, etc.) in Clam Bay and Moorings Bay

"The shallow Redox layer depths in most of Clam Bay, in combination with the finegrained sediments found in most locations, suggest that benthic (i.e., "bottom-dwelling") communities in Clam Bay would be expected to be less diverse than in

Moorings Bay". " Combined, these results indicate that despite the more modified shoreline and greater pollutant loading potential, Moorings Bay would appear to have a more diverse and healthy benthic ecology than Clam Bay. Differences in the ecological functioning between Clam Bay and Moorings Bay could be due to differences in tidal circulation and residence time".

The relationship between the ecological function and sediment properties in inter-tidal mangrove forests is poorly understood due to the complex interactions between the abiotic and biotic elements (Chapman and Tolhurst, 2004). . Soft sediments are complex, having different physical properties, different degrees of microbes, fauna and trace metals that vary spatially and temporally (Chapman and Tolhurst, 2007). Studies performed by Chapman and Tolhurst (2004) revealed that variation in the benthos did not correlate to bio-dependant properties of the sediment at any scale nor the properties of the sediment relate to any habitat. Their data indicated that properties of the sediment were not related to the properties and processes that drive the benthos, since there was a very large variation in benthos within small sites. These results emphasize the necessity of sampling at a hierarchy of scales to make any definitive statements concerning the benthos as it relates to sediment (Chapman and Tolhurst, 2004).

Biogeomical sediment properties can change depending upon the biota directly through consumption and indirectly by excretion. Benthos can change their local distribution patterns as they move to find food. There is no neat correlation between grain size, sediment color and benthic diversity as patchy distributions are common in soft sediments. Since mangrove forests live in complex environments that have different habitats and substrates with diverse macrobenthic fauna living on the sediment in different abundances it is necessary to examine relationships between the sediment and benthic macrofauna at multiple scales as direct correlations are often inadequate as benthos has differed among the same habitats in multiple mangrove estuaries and even among replicates within the same habitat (Chapman and Tolhurst, 2007). Thus while some sediment properties may be important in determining the structure of macrofauna they are not consistent. Alternatively some organisms may have similar effects upon sediments in different places while the same species may affect the sediment differently from place to place. One problem with many of the studies that compare sediments and benthos is that there is little replication and the need to carry out experiments at multiple scales across multiple habitats, without replication there is a strong possibility that can lead to erroneous conclusions (Chapman and Tolhurst, 2007). The significance of trophic interactions and the mangrove sediments should not be underestimated or ignored in understanding ecosystem health. The unexpected diversity in patterns of resource use in mangrove systems (as described by Bouillon, et.al. 2008) emphasizes the complex and highly dynamic environment of these estuaries which complicates interpretation of trophic interactions necessary to promote faunal health (Bouillon, et., al., 2008). Thus the lack of apparent resources in Moorings Bay might not support a diverse benthic community regardless of the sediment characteristics. Macro and micro benthic organisms vary in scales of cm to km and on temporal scales of minutes to years due to the complex interactions between many biological and physical variables such as tides, erosion, deposition, shore height, nutrients, grazing, settlement, migration and episodic

events like storms and human impacts. Patterns of variation in benthos and the relationship to the sediment begs the question of does the sediment dictate the biota or does the biota dictate the sediment as the biota can alter sediment porosity and grain size, organic content etc. (Chapman and Tolhurst, 2004).
Small scale variation in spatial patterns is not unusual in intertidal environments. Some studies show little variation in the benthos among different habitat relative to the smaller scale variation within habitats. Sediments themselves also can strongly exhibit variations in their properties within sites and within habitats of sites thus compounding the problems of identifying simple relationships and the ability to make judgments on the types of benthos associated with a particular sediment type (Chapman and Tolhurst, 2004). Mangrove areas in particular may differ significantly in their benthic community compositions and interactions. Seagrass areas tend to have higher numbers than mangroves which tend to have lower numbers - although some estuaries have a high degree of macro-invertebrate diversity across habitat. Some estuaries show seasonal variation in faunal assemblages. Higher diversity of benthic habitats were found in Rookery Bay's mangroves than in the adjacent seagrass beds and unvegetated areas, although other areas in Florida this was reversed (Alfaro,. 2005). This begs the question of localized site specific differences and the difficulty in making assumptions about the benthic community based on sediment characteristics and the ephemeral nature of the habitat.

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David Roellig Comments

1. Page1, first paragraph, lst line delete the word “natural”, 3rd line, delete the word “perhaps”. Second paragraph, second line, after the word “inflow”, add “along with sea water by the tides, delete the words, “most likely”, 4th line, delete “Additionally, it was likely that”, 6th line, delete the word, “likely”, 7th line, delete the words “tropical”. The purpose of this comment is to show the need for editing which is a problem throughout this report.“

2. Page 3, last paragraph, 3rd line, delete “ significant modification” and insert “elimination of the mangrove forest and artificial armoring of the shoreline.”.

3. Page 5, 1st paragraph, item 1.,delete the word “retrofitting” and insert the words, “Replaced the culverts under Seagate Drive with three 36’ culverts”

4. The report lacks any information on the existing Seagate culverts such as: number, length, diameter and elevation. It should also be noted that the flap gates on the north side of the culverts were removed some years ago.

5. The report mentions the weather during the data collection period, but includes no information whether weather events had any impact on the collected data.

6. The calculations should be provided to show how the culvert flow rates and speeds were developed.

7. The Seagate flap gates were removed many years ago with the concurrence of FDEP and the City of Naples. At the time, the general opinion was that the flap gates were not providing any real benefits due to lack of significant flow. It is hard to believe now that the flow is ten times greater in the southward direction. The reinstallation of new flap gates or structures should be investigated.

8. Fresh water inflows to Moorings Bay must be investigated with an inventory of outfalls and sources of discharge.

9. Any water quality concerns should be addressed at their source. The impression is given that tidal flushing can solve any possible problems. For more than 50 years, the concept of "Dilution is the Solution to Pollution" has been discredited and will not be an alternative for either Clam or Moorings bays.

10. A primary goal of any model study should be sizing Clam Pass with its tidal prism to maximize the ability of the pass to be self-flushing.

11. The Executive Summary is too long. It should be condensed to a page or two.

Ron Glah Comments

First I have no agenda regarding Hummiston and Moore or others. My issues are the wording and the accuracy of the wording in the executive summary.

In item 1 and 2 they raise the STORET issue and make the lack of reporting sound very onerous.

I thought I remember an earlier discussion that this was not as serious an issue at the time, but all future data collection needed to be in added to the STORET. Again item 4 raises the question of water quality collection by PBSD. Again the wording concerns me vs. just stating the need for additional data collection. Item 5 They state that Clam Bay is Verified Impaired for water quality. Do we really have enough data to make that statement in an executive summary?

Item 7 is comparing apples and oranges, but if you read the beginning you get an impression that Moorings Bay is better maintained! Item 1 on page iii needs to underline the word sufficient.

Item 3 should add " Due to it limited scope that was specified at the time."
-3.2 used very appropriate wording
-I agree with paragraph 2 on page 34

-Paragraph 3 Page 38. I agree with those words. New technology will always improve findings and make prior knowledge seem primitive.
-Para 3 and 4 Page 39 reasonable words that do not find their way into the executive summary –Para 1 page 41 Well stated and better sounding vs. Executive summary
Bottom line: new gauging technology, a more complete study and a better understanding of dat in a grassy estuary requires the need for further testing and comparing the data to other estuaries with similar attributes. Clam bay and Mooring are very different in make up and are not appropriate for comparison.

Also what consultant worth their salt would trash another consultants work and recommend further work!

My objective is to let data identify the problems vs. community emotions.

PBS&J Report
Remarks on Executive Summary and Detail Report
By Linda Roth
10/28/09

Introduction:

The Clam Bay System Data Collection & Analysis Report dated October, 2009 by PBS&J can be easily misinterpreted at first glance. However, if one spends enough time examining it, one will uncover the following points.

The Executive Summary has a number of assertions and omissions that create false impressions of information reported in the Detail Analysis. Furthermore, the Detail Analysis makes a number of statements that are implied as facts, but are just conjectures based on little or no evidence.

Examples are listed below, together with a number of questions about the report itself.

List of Comments:

1. The monitoring equipments used to estimate flow rates and volume exchange were vandalized at two critical locations (one at South Seagate Dr., and the other at Harbour Dr. near Doctor's Pass). Additionally, the data collected at Clam Pass was considered unreliable; it was not used, and substituted with data collected at a location in the Gulf (Gulfside Clam Pass, p. 47). At these locations, 4 days of data were collected instead of 8 days, in August. Even though this equipment for collecting data for water level and flow capacity was broken or deemed unreliable, and only 4 days of data could be used, this data was utilized to estimate flow rates and volume exchange between Clam Bay and

Moorings Bay, and to reach the conclusion that "the net flow is overwhelmingly southerly into Moorings Bay, and Moorings Bay is more affected by conditions in Clam Bay than vice versa" (pp. 44, 45, 62, 76, 77). This scarcity of data is not stated in the Summary.

2. Even if the data collected is assumed accurate, it only applies to conditions present during these 4 days. On page 62, it states "It is important to note that the tide data was collected during "spring tides" where the tidal range is larger than normal (higher highs, lower lows). Also there were several rainfall events during the study period which affect water levels…" It seems that wind directions would also have a significant effect. This is not stated in the Summary.

The report states, "During incoming tides, the south side has a higher water level than the north side, up to 0.25 ft in difference, and leading in phase by about 30 minutes. On the outgoing tide, the south side leads the north by 1.5 hours, with a water level difference of up to 1.5 ft. The result is water flows back and forth between the two bodies, with the majority of flow southward from Clam Bay into Moorings Bay". This is just an interpretation of what happened during these 4 days of data collection. This is not applicable to any other time. (p. 61)

3. The important information, on page 33, that Impaired Water Rules (IWR) guidance on Dissolved Oxygen (DO), and chlorophyll *a* can be locally inappropriate, particularly in subtropical systems, is not stated in the Executive Summary.

4. There is a discrepancy between actual water quality and "anticipated" water quality. The low level of DO is not necessarily indicative of nutrient-enriched water body. This is stated in the Detail report, but <u>not</u> in the Summary. (p. 33)
.

5. In regards to Chlorophyll *a*, the report on page 33 asserts that only Upper Clam Bay would be declared impaired. (This may not be the case if the more recent data of 2008 cited in the references were used instead of leaning on old data. See pages 18-20. The ones in 2008 were all below the median level for Florida estuaries.)

6. The report does not state that the removal in 1997 of the one way flap gates which directed the water flow from Moorings Bay to Clam Bay was due to concerns that the causation of the problems in Clam Bay being largely the result of 27" of additional water which resulted in the drowning of the mangroves. (pp. iv in the Summary & p. 3 in the Report) (City Council Workshop, Aug. 3, 1998)

7. The report does not show the City of Naples having 4 water quality monitoring locations immediately south of Clam Bay as stated in the first sentence on page 7. It shows 4 monitoring stations widely spread throughout Moorings Bay with one station south of Doctors Pass. (p.11)

8. On Pages 40 and 41, doubt is cast about the Tackney & Associates' report as being "theoretical assertions". Then, the PBS&J report proceeds to make its own theoretical assertions about "effective flushing", "water exchange" and "inlet stability".

9. Interestingly, water color is tested, but not fecal coliform which is required by the Florida's TMDL program. (p. 12) Why? There is considerable data on Moorings Bay's water quality collected by "Save the Bay", and other agencies. Why is it not presented in the report?

10. The Water Quality Review and Analysis of 5 stations in Clam Bay were presented. There was none presented for Venetian and Moorings Bay; yet conditions in all 3 Bays are the subject of speculation. (pp. 14-25)

11. The report states there is no seagrass in Moorings Bay, and lots of macroalgae. Are these not indicators of poor water quality from increased nutrients? (p. 32)

12. In Outer Clam Bay, Dr. Tomasko of PBS&J in 2007 reported that there were numerous seagrass beds. This report found only one seagrass bed, and the explanation for this is the ephemeral nature of this species. Could they have been destroyed by motorboat and jet ski traffic? If not, the seagrass should grow back in the near future. (p.29)

13. Adequate DO in sediments cannot be interpreted that Moorings Bay has a more diverse benthic community. Is there not more DO in sediments just offshore? Some of these areas have very limited benthic communities. (p. 29)

14. Clam Bay Estuary is a wetland comprised of "mudflats" at low tides and during dry periods.
Sediment made of mud naturally holds less DO than more porous sediments such as sand. But these mudflats are teeming with micro-organisms and invertebrates that support juvenile fish, birds and other wildlife.

15. The criteria for the locations of an ambient monitoring program are not described. But the report declares that the site locations chosen by PBSD & the Conservancy were inappropriate. (p. 40).

16. The report omits the fact that the Seagate canals & Moorings Bay are no longer a natural estuary. Their shorelines are comprised of man-made canals with cement walls embedded with stormwater run-off drainage pipes emptying into Outer Clam Bay and Moorings Bay. Moorings Bay is not an estuarine habitat.

17. Numerous scientists (Drs. Bauer & Tomasko and others) have stated that the nutrient loading in Clam Bay very likely comes from Moorings Bay and Seagate. All the lawn drainage pipes emptying directly into the water of Outer Clam Bay & Moorings Bay are clear indications of this likelihood. (City Council meetings, May & Sept 2008) (FDER a.k.a. FDEP 1981 report) (Tomasko Seagrass Report, 2007)

18. The water circulation and flushing in Moorings Bay has basically remained the same since the removal of the one way flap gates at the Seagate culverts in 1997. The amount of nutrient loading into Moorings Bay has not decreased, and may have increased due to more housing, boats and docks since 1997. All available data shows that Moorings Bay's water is distressed. These conditions have not changed significantly. Yet, based on this report, we are to believe that the water quality has miraculously become "good".

Conclusion:

As can be seen from the many examples cited above, this report is inconclusive at best. Hence, its assertions, conclusions and recommendations cannot be taken seriously. At worst, it is incompetent and fraudulent; no knowledgeable person should condone or validate it.

The report's Conclusion that "…the net flow is overwhelmingly southerly into Moorings Bay. Moorings Bay is more affected by conditions in Clam Bay than vice versa" is an unsubstantiated assertion. Broken equipments, substitution of data at one location for another, and data collected over a short four-day period during special weather conditions cannot be used to extrapolate what took place or will take place between the two water bodies. Previous scientific studies (with the exception of the 1977 USEPA analysis mentioned by PBS&J), and 11 years of anecdotal and empirical evidence indicate that the exchange of water in the culverts under Seagate Drive goes back and forth depending on the tides, currents, water levels, weather conditions, seasons, etc. In other words, the direction of water flow is inconsistent and controlled by Mother Nature. Unnecessary human interference is dangerous and extremely expensive. The Clam Bay estuary, the Natural Resource Protection Area from Vanderbilt Beach Road to Seagate Drive, is a complex and sensitive ecosystem. This coastal wetland is just like the mangroves, it needs wet and dry periods. When it is continuously inundated with water, unpredictable bad things will happen (e.g., mangrove die-offs). Who will be responsible, and how much more of taxpayers' money will be spent on restoration? Billions of tax dollars are needed to restore the "Field of Grass" in the Everglades because of human misconception.

The report ends by calling for a hydrodynamic model in order to understand and improve circulation and dissolved oxygen (DO) within the Clam Bay system. According to this report, the DO in Moorings Bay is good, and that the low level of DO throughout the Clam Bay system inferred based on Redox depths (dissolved oxygen in sediment), is not necessarily indicative of a nutrient-enriched body (p. 33). Then why is the County wasting our tax dollars, and for whom? Furthermore, a scientific model is something one produces on a computer by in-putting certain parameters. It is not representational of what will happen in reality. It is what one thinks or hopes might happen, and can be influenced by preset agendas.

Finally, in the field of environmental science, there are no definitive approaches. Whether an approach works or not can only be verified by anecdotal and empirical evidence over a long period of time. One can safely say that the approaches used by PBSD, H&M, and the Conservancy have been well tested. The 50 acres of dying mangroves are recovering nicely. The Clam Bay Estuary (mangrove forests, bays and wildlife) is healthy and thriving. It would even be healthier when the Seagate and Moorings communities stop emptying their stormwater run-off into the bays. Our tax dollars and energy should be spent on helping these communities implement Best Management Practices (BMP), as well as oyster, clam, and mangrove restoration programs, instead of trying some costly unproven methods of disturbing the balance of the fragile Clam Pass/Clam Bay ecosystem.