A COMPARISON OF WATER QUALITY IN CREEKS BASED UPON THE LAND-USE IN THEIR WATERSHEDS

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Available literature has suggested that stormwater runoff has a significant impact upon the water quality, and subsequently, the health of the receiving water bodies. The literature also has suggested that impervious surface areas contribute to the volume of stormwater entering receiving water bodies, as well as the quality and velocity of said stormwater. The Brookley complex, located in Mobile, Alabama, is an industrial park anchored by a cargo airport and the land use is primarily industrial. The watershed of Rabby Creek, a sub-unit of Dog River, lies mostly within Brookley. Alternatively, an unnamed creek (also a sub-unit of Dog River), of similar size and watershed area as Rabby Creek, drains a primarily residential area known as Cypress Shores. Water quality, based on measures outlined by Alabama Water Watch, was tested at two locations, one on each creek, and compared. The results showed that the creeks are fundamentally different, but that both are generally healthy.

Keywords: stormwater run-off, industrial complex, water quality, land use

Introduction

Brookley field is a 1,700 acre former Air Force Base and current industrial park located in the City of Mobile. The industrial park is owned by the City of Mobile and managed by the Mobile Airport Authority. It contains a fully operational 9,600 foot runway, and is home to Mobile Aerospace Engineering, Buffalo Rock Distribution, and FedEx, among others (Brookley Complex Website, 2006). Indeed, according to the City of Mobile Zoning Map, the entire complex, save for the airport runway itself, is zoned as an I-2, Heavy Industry District. The site is also the planned location of a multi-billion dollar aircraft assembly plant, contingent upon United States Air Force approvals (Turner 2007). Brookley is located on Mobile Bay, with part of the site draining directly to the bay, via either the end of the runway or through the University of South Alabama Brookley Campus. The other part of the site is located within the Dog River Watershed, Rabby Creek Subwatershed (City of Mobile Planimetric Data, 2003).

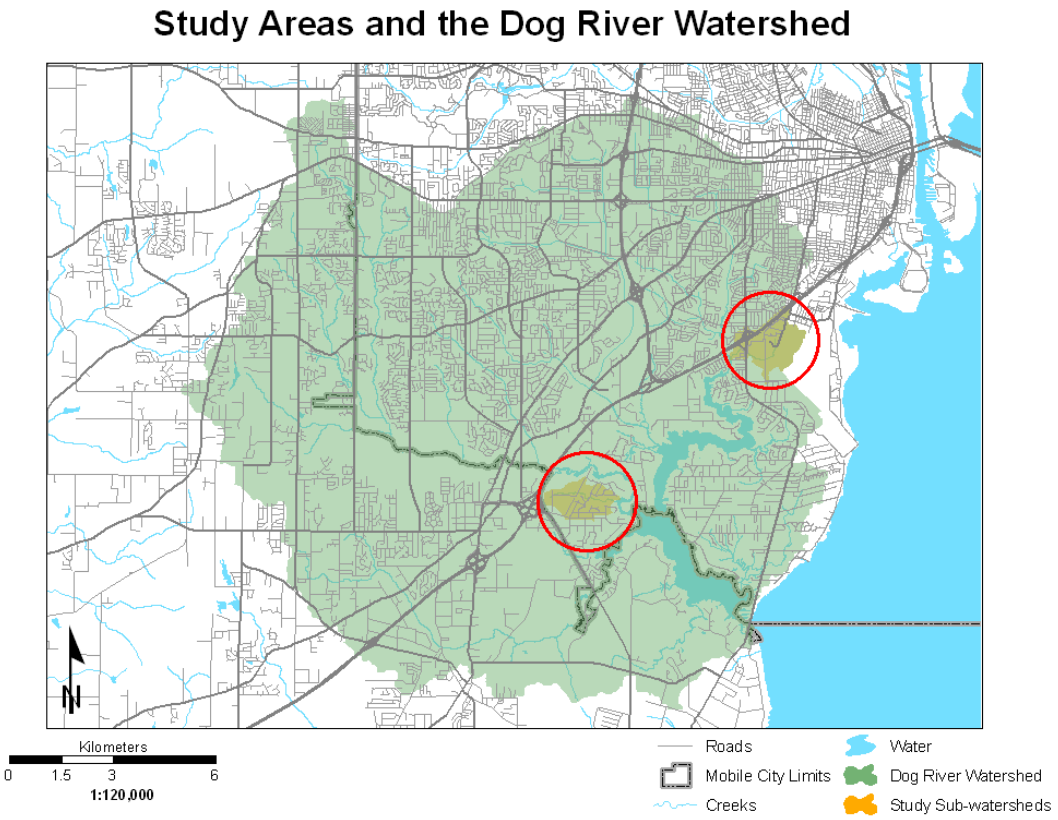

Figure 1: Dog River Watershed with Subject Watersheds

Urban areas are known sources of water pollution due to runoff from impervious surfaces and the very nature of the land use in urban areas. Airports and industrial parks, with their acres and acres of pavement, and their abundance of heavy equipment and industrial activities are perfect examples of the types of facilities that contribute to water quality degradation (D'Ambrosio, 2004).

Because impervious surfaces and land use contribute significantly to decreased water quality (Kreuzer, 2001), I want to determine the health of Rabby Creek because it drains an industrial area and compare it to the health of a comparable creek that drains a less built-up residential area. I chose an unnamed creek (hereafter known as the Cypress Shores creek) which drains a predominantly residential area. The Cypress Shores Creek was chosen due to its length, location near tidally influenced waters, and size of its

watershed. All of these factors were comparable to Rabby Creek. The only significantly different factor between the two creeks is the land use in their respective watersheds. The City of Mobile Zoning Map shows some Light Industrial and Warehouse Business Zoning Districts near the headwaters of the Cypress Shores Creek, however the predominate land use, especially in the testing area, is residential.

Research Question

The goal of this project is to ascertain whether the water quality, as judged by pH, hardness, alkalinity, turbidity, and dissolved oxygen, is worse in Rabby Creek, which drains Brookley Field, rather than in the Cypress Shores Creek, which drains a primarily residential area in the Cypress Shores community.

Methods

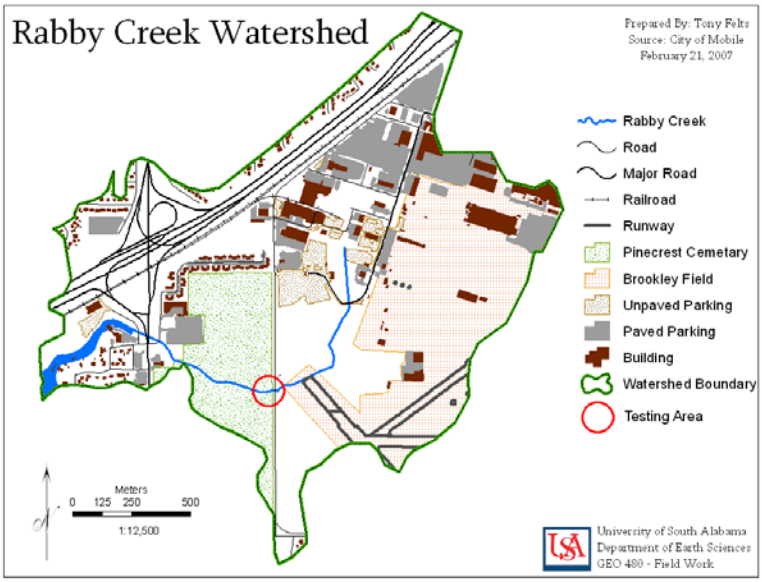

Figure 2: Rabby Creek Subwatershed

Water samples were taken from comparable points at both creeks. The samples were tested using a LaMotte water quality testing kit, the kind used by Alabama Water Watch and available for checkout from Dr. Mimi Fearn. Using standardized procedures outlined in

the Alabama Water Watch Water Chemistry Monitoring Manuel, I tested the samples for pH, hardness, alkalinity, turbidity, and dissolved oxygen. Samples were taken every Sunday from March 4, 2007, to April 8, 2007, between 10:00 a.m. and 2:00 p.m. as per Alabama Water Watch. All of the data was collected and recorded onto a field notebook, and then transferred to a Microsoft Excel spreadsheet for data analysis. Additionally, relevant observations, such as seeing aquatic wildlife, weather conditions, or evidence of water contamination, were noted in the field notebook. The sites in each sub-watershed are comparable and located in an area where the creek is flowing and outside of tidal influence. Water was tested at the site on Rabby Creek because it is the point where the stream exits the Brookley complex, geographically located at 30° 38' 4.58" North and 88° 5' 2.46" West. The site chosen on Cypress Shores Creek was chosen due to its comparable nature to that of the site on Rabby Creek, geographically located at 30° 35' 53.78" North and 88° 8' 11.45" West.

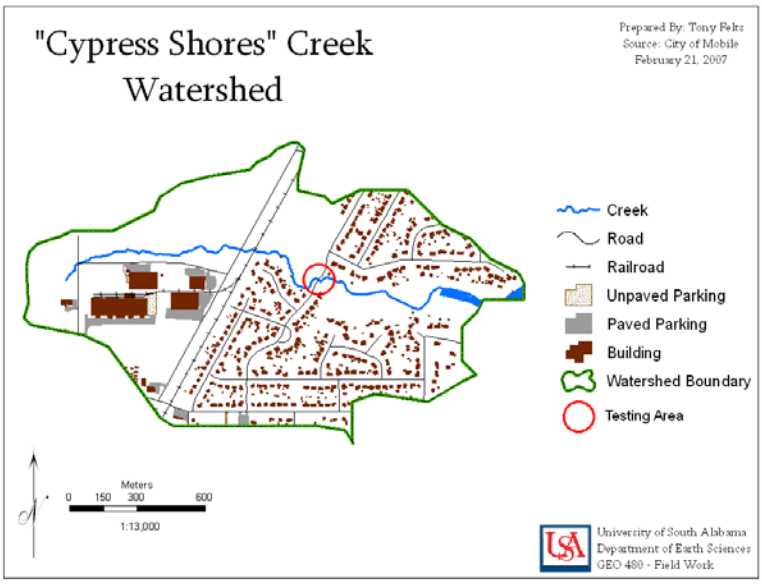

Figure 3: Cypress Shores Creek Subwatershed

Results and Discussion

Dissolved Oxygen

Dissolved oxygen levels were found to be much higher in Rabby Creek than in Cypress Shores Creek. In fact, levels routinely approached or exceeded dissolved oxygen saturation in Rabby Creek. "Oxygen saturation is the dissolved oxygen in a given water sample relative to the maximum amount of dissolved oxygen that could be dissolved in pure water at a similar temperature, elevation, and salinity" (Alabama Water Watch, 2006). Dissolved oxygen saturation levels in Cypress Shores Creek were generally 30-40% lower than those levels observed at Rabby Creek.

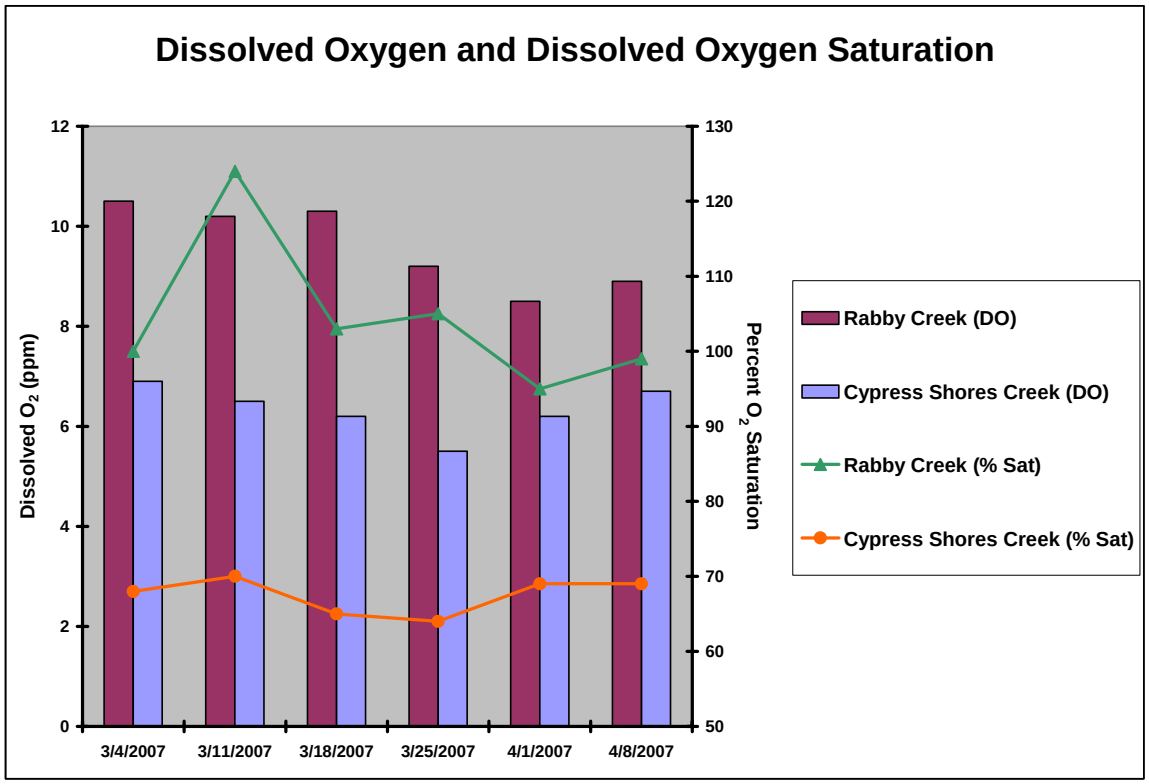

Figure 4: Measured Dissolved Oxygen and Dissolved Oxygen Saturation

There are a few reasons to explain why the dissolved oxygen levels at Rabby Creek were higher than those levels recorded at Cypress Shores Creek. Firstly, Rabby

Creek is significantly shallower than Cypress Shores Creek at the test site. In fact, there is at least a three-foot difference in depth between the two. It is a known fact that the greater the depth, the less dissolved oxygen in the water there is. Further, Rabby Creek, at the test site, has concrete banks and a concrete bottom. Consequently, there is little or no vegetation at the bottom of the creek. At Cypress Shores Creek, on the other hand, there is a large amount of vegetation on the natural banks of the creek, as well as a good deal of aquatic vegetation, the decay of which can deplete dissolved oxygen, and thus deplete the supply. Given these facts, there is evidence to suggest that the levels of dissolved oxygen observed were where they should have been.

pH

The measure of the level of acidity or alkalinity of a substance, or pH, was tested

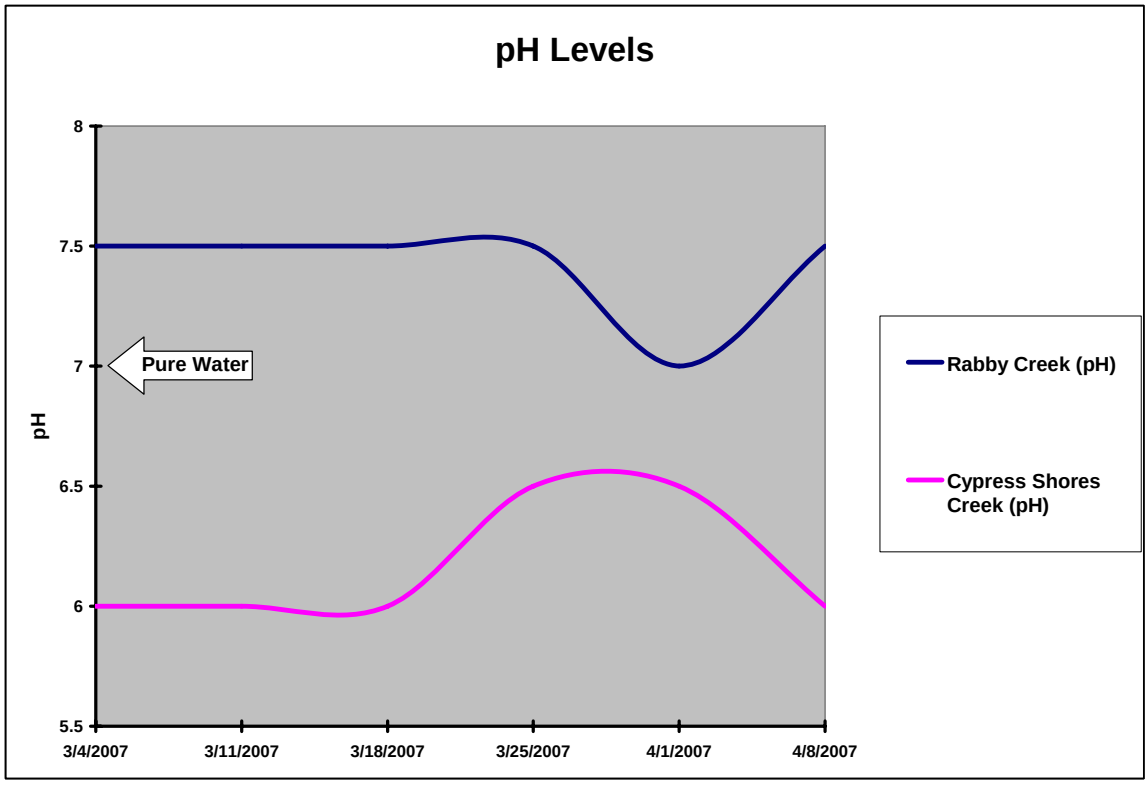

Figure 5: Measured pH Levels

at both sites (Alabama Water Watch, 2006). The pH value recorded at Rabby Creek was almost consistently 7.5, except on April 1, 2007, when the value was 7.0. Values of 6.0 were recorded every week at the Cypress Shores Creek except the week of April 1, 2007, when a value of 6.5 was recorded.

As mentioned earlier, Rabby Creek, at the test site, has concrete banks and a concrete bottom. The presence of this concrete is likely the cause for the higher, very slightly basic pH values recorded there. Likewise, as Cypress Shores Creek's banks and bottom are natural and contain a large variety of plant life, the water there is naturally slightly acidic, thus resulting in the lower pH values which were recorded.

It should be noted that on April 1, 2007, there was a rain event, and it was quite heavily raining at the test site. The readings from that day revealed a value of 7.0, suggesting a dilution (due to rainwater) of the Calcium Carbonate solution which results from the concrete banks and bottom. Likewise, readings on the same day from Cypress Shores Creek suggested a dilution (due to rainwater) of the acidic solution introduced into the creek by the natural vegetation.

Alkalinity

Both creeks recorded moderate levels of alkalinity. According to Alabama Water Watch, alkalinity "is a measure of the buffering capacity of water." Basically, this means that alkalinity provides protection to the water from rapid pH changes. Levels of alkalinity were generally higher at Rabby Creek as opposed to those at the Cypress Shores Creek. On April 1, 2007, the same level of alkalinity was recorded at Rabby

Creek as was recorded at the Cypress Shores Creek. The levels ranged from 0 to 20 mg/L higher at Rabby Creek than at the Cypress Shores Creek.

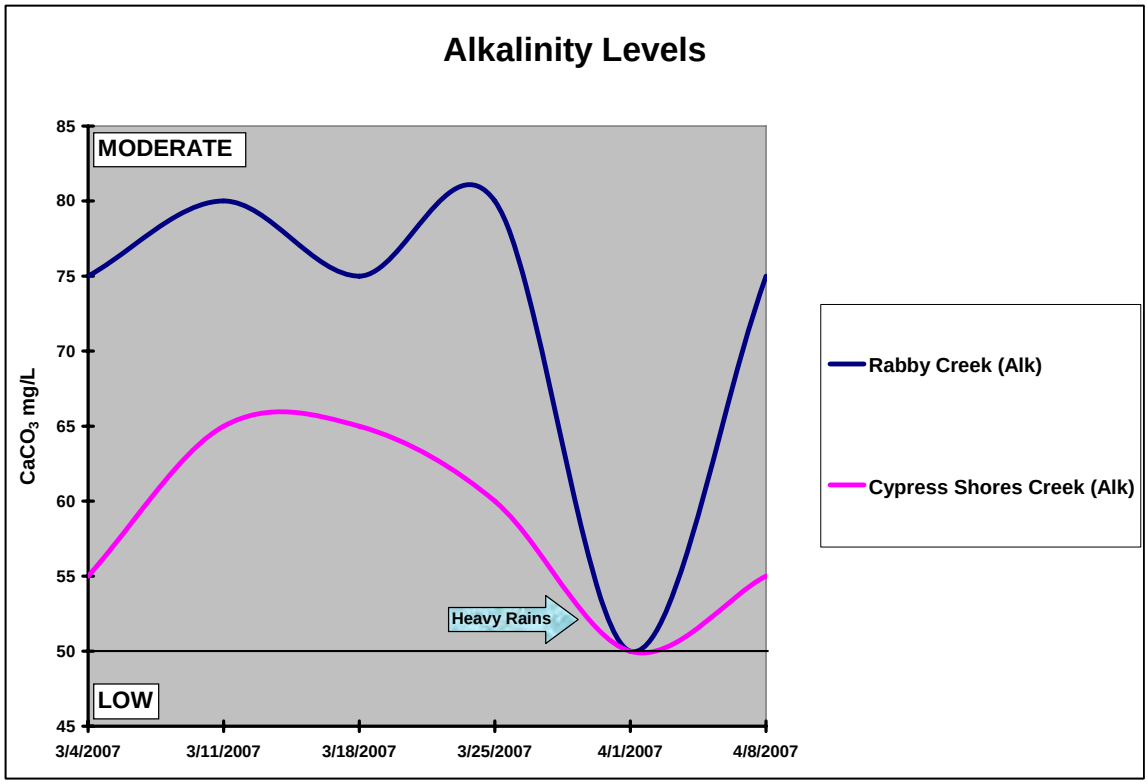

Figure 6: Measured Alkalinity Levels

The concrete banks and bottom of Rabby Creek are again the underlying reason for the higher alkalinity readings observed there, as opposed to those readings recorded at Cypress Shores Creek. The concrete introduces Calcium Carbonate into the water, which results in the higher alkalinity levels. As Cypress Shores Creek does not have concrete banks, a concrete bottom, or any good source of carbonate ions, the levels of alkalinity are naturally lower. The lower readings represent a diminished capacity in the stream to protect itself from pH changes.

It should also be noted that the April 1, 2007, rainfall event which was described in the pH section seems to have diluted that Calcium Carbonate solution in both creeks to

have resulted in notable decreases in alkalinity values. The values returned to the levels which had been noted previously on the next test date, which was April 8, 2007.

Hardness

Hardness, the measure of the amount of dissolved calcium and magnesium in the water, (Alabama Water Watch, 2006) was tested at both sites. Rabby Creek had higher levels of hardness than the Cypress Shores Creek. Rabby Creek's hardness levels were considered "moderately hard" and the Cypress Shores Creek's levels were on the border between "moderately hard" and "moderately soft." Rabby Creek's hardness levels were generally 30 mg/L higher than those at the Cypress Shores Creek.

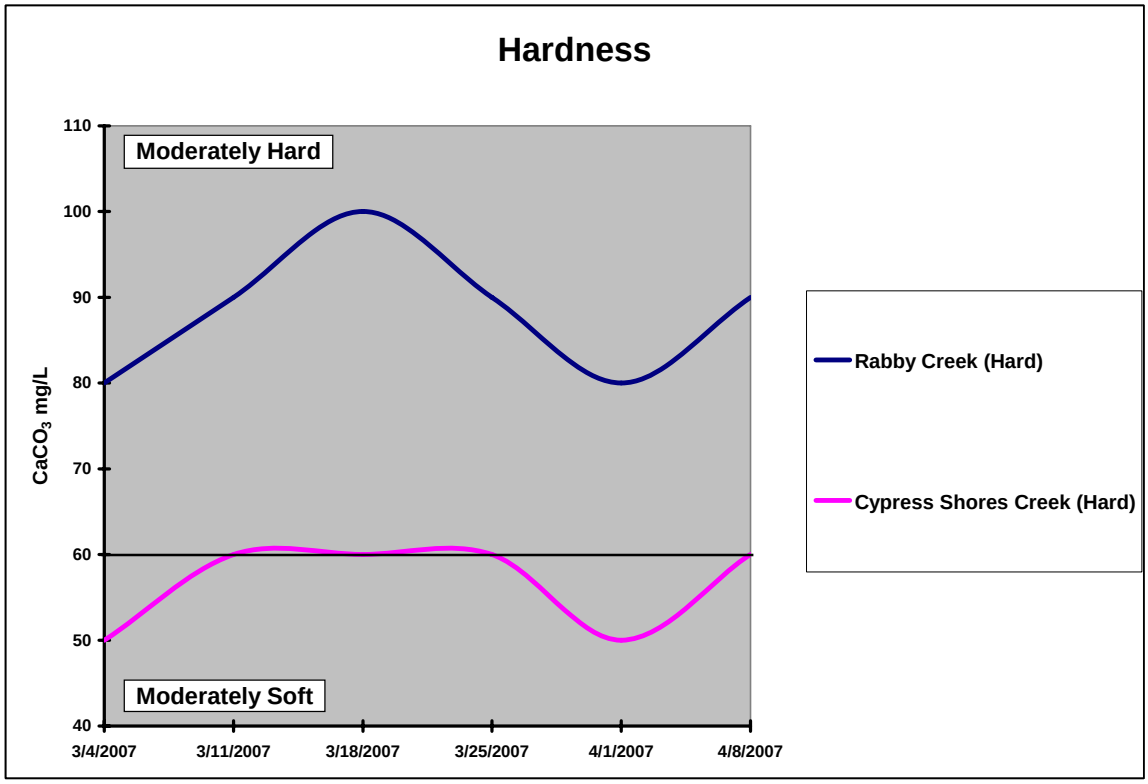

Figure 7: Measured Hardness Levels

As hardness is, by definition, the measure of dissolved calcium and magnesium in the water, and the fact that it is so closely related to alkalinity, the reason for differences between the values observed at Rabby Creek and at Cypress Shores Creek should be clear. Rabby Creek has concrete banks and a concrete bottom, Cypress Shores Creek has both natural banks and a natural bottom. The calcium carbonate solution at Rabby Creek is introduced by the concrete, thus resulting in higher hardness values. Cypress Shores Creek, as mentioned earlier, does not have a good source of Calcium Carbonate ions, and, as such, records lower levels of hardness. The April 1, 2007, rain event that affected alkalinity levels affected hardness levels in the same way, diluting the level of Calcium Carbonate solution in the water and resulting in lowered values than would ordinarily be expected at the site during the testing period.

Turbidity

Turbidity levels, or measurements of water cloudiness from suspended matter in the water (Alabama Water Watch, 2006) at Rabby Creek remained constant at 10 JTU. The cause of this consistency is likely due to the fact that the banks and bottom at the testing site are concrete, and that there are few areas of exposed dirt due to established development and vegetation in the area of the creek. At the Cypress Shores creek, turbidity levels were slightly higher, and varied more after a rain. This was likely due to the lesser amount of development, more exposed dirt from construction activities upstream from the testing location, and lack of an engineered bank or bottom at the test location.

Conclusions and Suggestions

The data suggests that essentially both streams are fairly healthy, as none of the test indicators fell below acceptable levels. Though both streams appear healthy, it is clear that the two creeks have a very different set of circumstances affecting them and their water quality. At both creeks, aquatic wildlife was observed. At Rabby Creek, large numbers of fish were observed in the same area as the test site on every visit. The species of fish could not be positively identified, but the sizes of the fish ranged from fairly small to rather large. Fish were also observed at Cypress Shores Creek, but far less frequently, and in far less quantities. Fish were noted on two visits to the site, and then only one or two fish were ever seen when they were even seen at all.

The data were generally consistent in nature, except for the outlier readings taken on April 1, 2007, which was during a heavy rain event. The fact that all of the data were fairly consistent, given the consistent weather during the test period, leads me to believe that the data collected are an accurate account of the health of the stream based upon Alabama Water Watch standards. As such, based on Alabama Water Watch standards, it is concluded that the initial research question was not sufficiently answered, and that further testing is required to answer the question fully.

It should be noted that I have identified, via photo interpretation, an area that I believe to be a natural retention area located in the restricted area of Brookley Field. Samples taken from this area may yield different results than those from my test site, and it is suggested that, if this project is revisited, permission be obtained from the Mobile Airport Authority to take samples from this area.

It is at this point that I must make a confession. Time was of the essence for this research project. In fact, students only had a few weeks to choose topics, form a hypothesis, and come up with methods of testing said hypotheses. I chose my topic, and without a thorough literature review, I decided to use water quality methods based upon Alabama Water Watch standards.

After completing a literature review, I came to the conclusion that I may be testing for the wrong substances. According to three independent articles by Halm, Kreuzer, and Pitt, the main impact from industrial and airport runoff is in the form of heavy metals contamination. After speaking to my advisor, Dr. Fearn, about this, I learned that we currently did not have ready access to heavy metals monitoring equipment.

It is strongly recommended that this research project be revisited, and that heavy metals testing occur. Samples should be taken from fish, water, and soils, to determine if there, indeed, exists heavy metals contamination at either of the test sites in this project.

Conducting the types of testing described and recommended in this study is extremely important; by investigating the water quality of the Dog River Watershed, the sources of pollution, and the nature of the land in the watershed, a clear picture the overall health of the river system, and indeed the community, emerge. Dog River is an integral part of the Mobile community, and it is worth saving. By identifying critical issues and their sources, and then devising creative and effective solutions to solve and combat those problems, we can preserve our river system and, in doing so, better the entire Mobile community.

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Appendix 1: The Raw Data Numbers

	3/4/2007	3/11/2007	3/18/2007	3/25/2007	4/1/2007	4/8/2007
Rabby Creek (air) °C	12.5	24	17	24	21	11
Cypress Shores Creek (air) °C	16	25	19	27	23	13
Rabby Creek (water) °C	13.5	25	19	22	21	20
Cypress Shores Creek (water) °C	15	19	18	23	21	17
Rabby Creek (DO) ppm	10.5	10.2	10.3	9.2	8.5	8.9
Cypress Shores Creek (DO) ppm	6.9	6.5	6.2	5.5	6.2	6.7
Rabby Creek (% Sat)	100	124	103	105	95	99
Cypress Shores Creek (% Sat)	68	70	65	64	69	69
Rabby Creek (Alk) mg/L CaCO3	75	80	75	80	50	75
Cypress Shores Creek (Alk) mg/L CaCO3	55	65	65	60	50	55
Rabby Creek (Hard) mg/L CaCO3	80	90	100	90	80	90
Cypress Shores Creek (Hard) mg/L CaCO3	50	60	60	60	50	60
Rabby Creek (pH)	7.5	7.5	7.5	7.5	7	7.5
Cypress Shores Creek (pH)	6	6	6	6.5	6.5	6
Rabby Creek (Tur) JTU	10	10	10	10	10	10
Cypress Shores Creek (Tur) JTU	30	15	15	15	15	20