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Honors Option

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Water in Milledgeville

Water is one of the most essential resources for not only humans, but all living things. It makes up to 71 percent of Earth's surface and up to 60 percent of the human body. Every living creature, from small insects to huge mammals, use water, yet many of us are unaware of the impacts local water has on our daily lives. Our bodies require the intake of water every day, however, we often do not know where our water comes from, how it is processed, or how it gets into our faucets. Hydroelectricity, or electricity generated by water passing through hydroelectric dams, accounted for 16 percent of global electricity generation in 2011, yet many are unaware of the effects hydropower has on our daily electricity usage (Moller, 2012). Ecosystems and their services also rely heavily on water; the pH and concentration of dissolved oxygen (DO) specifically can alter aquatic ecosystems greatly. While water is so important to our survival, power usage, and ecosystems, it often times goes unnoticed as to how important it is.

Having a steady and dependable source of clean drinking water is one of the most important resources humans can have access to. Almost all of the major systems present in the body require water to operate proving how necessary it is (Functions of Water in the Body). Most notable roles water plays in the body are the regulation of temperature and dissolving of nutrients. Blood, which is largely composed of water, uses the high specific heat of water to help warm up or cool off both internal organs and the body as a whole (Silbajoris, 2018). For water

soluble vitamins and minerals, water is able to dissolve them so that the body is able to absorb the necessary nutrients without having to digest them directly; some of these nutrients include vitamins B and C (Vitamins and Minerals, 2018).

Water is only beneficial when it is clean and pollutant free, otherwise it can lead to many water-borne diseases. Often times, those in undeveloped countries do not have access to clean drinking water or proper sanitation and hygiene facilities. This leads to many people drinking polluted and unsafe water. This water may be contaminated with human and animal feces, road runoff, pesticides, other organic material, or harmful bacteria and can lead to illnesses like cholera, e. coli, giardia, all of which lead to diarrhea, nausea, and abdominal pain (Spring Run-off, 2015; Waterborne Diseases). It is estimated that over three million people die every year due to not having access to clean drinking water (Deaths from Dirty Water, 2019). Diseases such as these show how important clean water and proper sanitation and hygiene facilities are so maintaining our health.

Many different sources of fresh water exist, some of which are safer to drink than others. These can be divided between surface and ground sources. Surface water includes lakes, rivers, and wetlands; these sources are easily contaminated with feces, pesticides, and organic material such as leaves and other plants (Spring Run-off, 2015). Ground sources are often aquifers located beneath the Earth's surface and are refilled through the seeping of water into the ground. Because surface water recharges ground water, ground water may also contain the same pollutants found in the surface water. However, due to the water seeping between layers of rock, sand, and clay, a majority of the contaminants are filtered out so only trace amounts of pollutants remain (Spring Run-off, 2015). While ground water is more difficult and expensive to access, it

is generally safer for humans to drink with little to no processing (Groundwater Pollution VS Surface, 2018).

Residents in Milledgeville, Georgia primarily uses surface water sources due to the large reservoirs of Lake Sinclair and the Oconee River in close proximity. These water sources are located in the Oconee Watershed, draining a total of 5,330 square miles allowing any rain or runoff in this area to eventually flow into Lake Sinclair or the Oconee River before draining into the ocean (Meyer, Judith, and Gretchen Loeffler, 2009). Lake Sinclair is a man-made lake created in 1953 (Lake Sinclair History and Information). It was originally created as a source of electricity for residents and is operated by Georgia Power (Lake Sinclair). The Oconee River is a natural river that flows for 160 miles, not including Lakes Oconee and Sinclair which were created by damming the river (Oconee River).

Water from these freshwater surface sources are processed by two water treatment plants in Milledgeville: the Lamar F. Ham Water Treatment Plant and the James E. Baugh Water Treatment Plant (Pelt). Both plants are owned and operated by the city of Milledgeville's Water and Sewer Department (Pelt). Once water has been drawn into the plant, it is pumped into large sedimentation basins used to remove large particles and to disinfect (Annual Water Quality Report). Next it is mixed with a coagulant which causes smaller particles to group together for easy removal; it goes through a final filtration to catch the smallest particles before a final disinfection (Annual Water Quality Report).

Water from Lake Sinclair and the Oconee River that is not processed and sent to homes for consumption and use may be sent through the Sinclair Dam which separates the lake from the Oconee River. Sinclair Dam houses a 45,000-kilowatt capacity generating facility which provides power to the greater Milledgeville area (Lake Sinclair Dam; Lake Sinclair History and

Information). Hydropower is just one of the ways humans can generate electricity; other ways can be divided into renewable and nonrenewable sources. Renewable energy comes from sources that replenish themselves naturally but are restricted to the amount of energy in a unit of time (Renewable Energy Explained, 2018). These sources include solar, wind, hydroelectric, biomass, and geothermal (Renewable Energy). Each source has its own specific pros and cons as well as collection and conversion methods. For example, hydropower is greatly beneficial since water is a renewable, domestic resource granting price stability; it is also very clean in comparison to other energy sources (Jensen, 2018). Cons of hydropower are the environmental impacts damming a river has on its ecosystem; this includes both terrestrial and aquatic ecosystems (Jensen, 2018). Not only is the body of water changed from a flowing river to a still lake, but the land surrounding the river is flooded, causing many changes to the local environment.

However, various kinds of hydropower exist that limit the cons dams cause. These include storage, pumped-storage, and run-of-the-river (Mutiti, Christine, and Kalina Manoylov, 2018). Storage hydropower is the most common; it uses dams to create a reservoir to hold water that is to be later released through the dam (Types of Hydropower). Pumped-storage also stores but instead uses two reservoirs. One of these reservoirs is located at a higher elevation than the other, allowing the water to be pulled through a turbine by gravity (Pumped-Storage Hydropower). Run-of-the-river hydropower is the least harmful to the environment; it does not dam rivers or use reservoirs but instead uses the naturally occurring flowing water to turn turbines (Helston, Charlotte, and Andrew Farris, 2017).

All of these types of hydropower, as well as most renewable and nonrenewable sources of power, use turbines to produce electricity. As water, steam, or wind push the propellers on a turbine, it spins. This turns a shaft in a generator, spins a motor, which produces electricity (Can

You Make Electricity with Water?). Solar power is one of the only sources of energy that does not use turbines in the formation of electricity (Mutiti, Christine, and Kalina Manoylov, 2018).

Nonrenewable sources are defined by not being able to be replenished in a short amount of time that will make them readily available for human use; these include coal, oil, natural gas, and nuclear energy (Nonrenewable Energy Explained). While all of these sources have a higher energy yield and are more efficient than renewable sources, they all have major set-backs on the environment (McDermott). Coal is one of the biggest sources of energy and electricity in the world; according to the World Coal Association, 38 percent of the world currently uses coal for electricity production, and it is often higher per country (Coal and Electricity, 2013). Both the mining and burning of coal has significant impacts on the environment. Mining coal often removes all vegetation and topsoil in an area, completely eradicating the ecosystem and leading to severe erosion (Negative Effects of Coal Mining, 2014). After it is mined, it is burned for electricity generation. Burning coal releases sulfur dioxide, nitrogen oxides, and carbon dioxide, all of which are greenhouse gases that increase overall warming of the Earth (Mutiti, Christine, and Kalina Manoylov, 2018). Oil, natural gas, and nuclear energy all have their own pros and cons that each effect the environment individually.

Water is not only beneficial in terms of our bodies and electricity, it is immensely important to our ecosystems, in which humans also benefit from. Some of the utilities water provides us includes “nutrient enrichment of agricultural lands, support of fisheries, transportation, wastewater flushing, prevention of salt water intrusion in coastal systems, and support of biological productivity” (Parker). These are referred to as ecosystem services, or contributions of ecosystems to human well-being, and extend past just what water is able to do

for us (Ecosystem Services). Water alone enables us to grow and harvest food, get from one place to another, and to maintain healthy lifestyles.

In Milledgeville, the two primary sources of water, Lake Sinclair and the Oconee River, provide residents with water for drinking and hygiene, transportation, recreation, and many other habitat and regulation services. Most notable habitat service is that of Lake Sinclair itself providing an aquatic habitat for many fish, invertebrate, and plant species (Felsher, 2018). The lake also provides steady rainfall throughout the year due to an increase in precipitation; this allows for the regulation of pollen accumulation and of temperatures relative to the lake (Proximity to Water Bodies).

The many ecosystem services show how important not only water is to our daily lives and the ecosystems around us, but also the quality of that water. Water quality refers to both that of drinking water and water found in lakes and streams; of course, both sources have different requirements due to what they are used for. Drinking water from taps is regulated by the Environmental Protection Agency (EPA) (Water Quality & Testing, 2009). The EPA distinguishes six categories of contaminants for drinking water: microorganisms, disinfectants, disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides (National Primary Drinking Water Regulations, 2018). Each category contains many specific contaminants, each with varying amounts that indicate safe levels for drinking.

The tests to indicate good quality for non-drinking water, such as in lakes or rivers, are similar to those provided by the EPA, but not as strict. Tests determining water quality for un-drinkable water include temperature, conductivity, pH, dissolved oxygen, turbidity, odor, bacterial count, or dissolved minerals. While drinking water regulations are strict, there is not a

specific set of amounts to indicate if a lake or river is considered healthy; this is instead done by analyzing results from several tests (How Do We Determine Water Quality?).

For the water samples taken from both Lake Sinclair and the Oconee River, only temperature, conductivity, pH, dissolved oxygen, and physical characters were tested for due to time and available materials. Each of these tests were repeated twice, about a week apart, for a total of five weeks. This allowed for a wide range of weather and air temperatures to be present for sample taking providing an average of the water quality for each site.

Temperature and dissolved oxygen are related because colder water is able to hold more dissolved oxygen (Dissolved Oxygen). Dissolved oxygen (DO) is free oxygen, O_2, that has been dissolved in water, much like sugar is dissolved, allowing aquatic creatures to use it in respiration (Dissolved Oxygen). This is why temperature and DO are both important to aquatic ecosystems. Conductivity also is affected by temperature; "the warmer the water, the higher the conductivity" (Indicators: Conductivity, 2016). Conductivity measures how well water can carry an electrical current; it can indicate discharge of a pollutant has entered the water source since salts and other inorganic chemicals can carry current (Indicators: Conductivity, 2016). Varying levels of conductivity can harm aquatic life because many are adapted to live in a specific range (What is Conductivity?). pH is another test that indicates levels of dissolved metals or other pollutants in water. Water with good quality ranges from a pH of six to nine, out of 14, lower indicating more acidic water (Water Quality: pH, Alkalinity, and Conductivity, 2011).

Lastly, physical characteristics include color, clarity, odor, and height of water. Color and clarity are referred to as turbidity, which measures the clarity or amount of light scattered by suspended material in the water (Turbidity and Water). While this can be measured with devices that read how much light is scattered, but in this case, it was simply recorded as clear or muddy

(Turbidity and Water). Odor was recorded in the same manner; if a smell was discernable during testing, it was recorded. Odor may indicate if any harmful pollutants, such as sewage or gasoline, have been deposited into the water. Height of water, especially for Lake Sinclair and the Oconee River, can be attributed to Sinclair Dam which releases water from Sinclair to Oconee.

For the results of testing, both Lake Sinclair and the Oconee River have good water quality. Conductivity and pH were stable and constant throughout the five weeks, indicating little to no outside pollutants were added (Figure 1). This also shows how both sites were healthy enough to naturally regulate any small fluctuations.

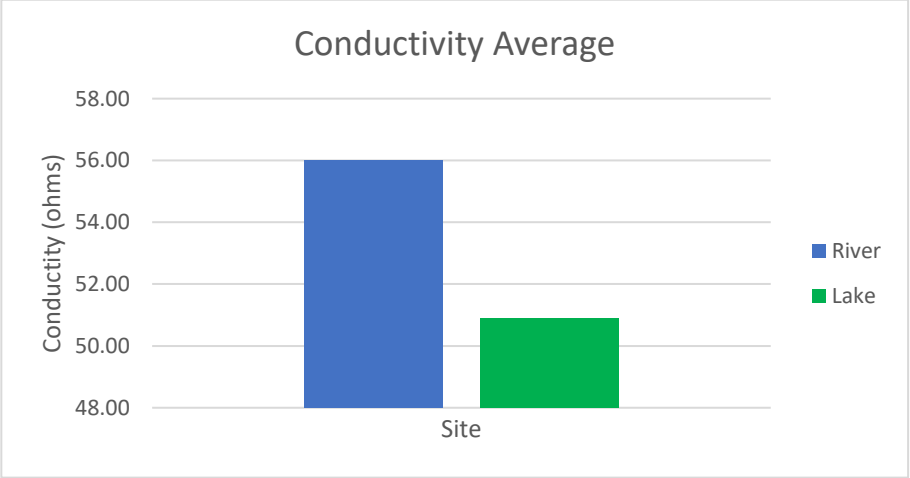

Figure 1: Shows conductivity averages between both sites.

Temperature of the water was almost always colder than temperature of the air due to the high specific heat of water, allowing so that more heat is required to warm up water than air (Figure 2 & Figure 3). This also helps explain why DO levels were constantly high but did decrease as the air warmed up (Figure 4).

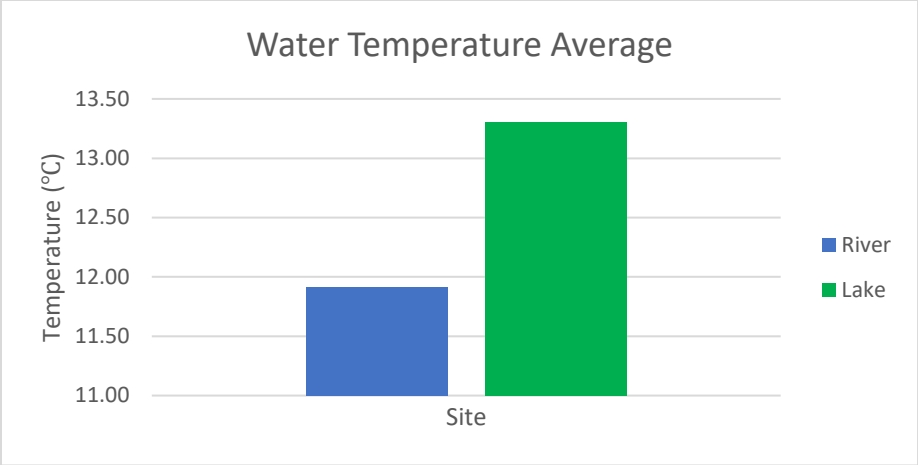

Figure 2: Shows water temperature averages between the two sites.

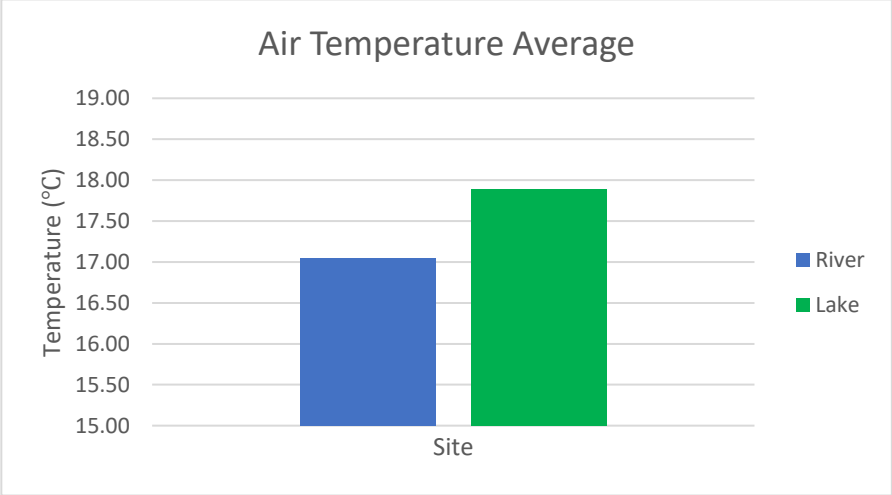

Figure 3: Shows air temperature averages between the two sites.

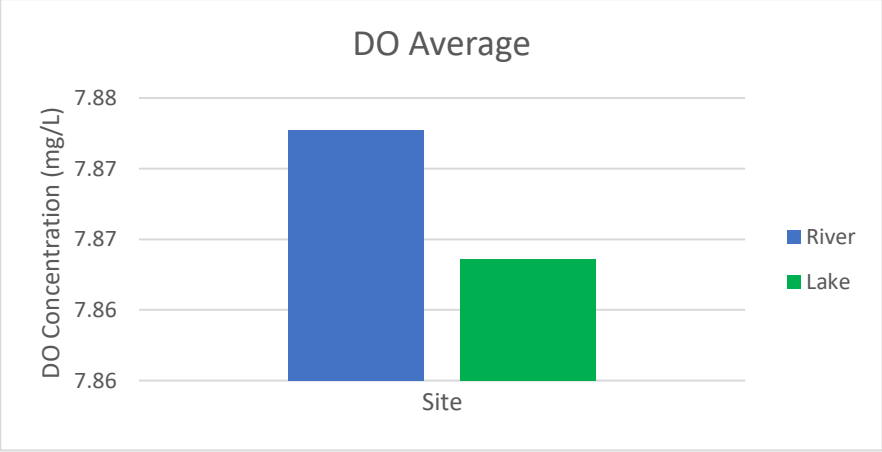

Figure 4: Shows dissolved oxygen concentration averages between the two sites.

All physical characteristics that were recorded were also in the ranges of indicating healthy water (Table 1). While there were many times when muddy or cloudy water was observed, it was due to rainfall the previous day. This also accounts for varying levels of flow between each source, as well as the dam releasing varied amounts of water each week.

Table 1: Shows recorded physical characteristics for each site and number of collection.

Collection Number	Site	Physical Characteristics
1	Oconee River	High flow, turbid, muddy water, natural smell
1	Lake Sinclair	Normal flow, some rain, turbid, muddy water, natural smell
2	Oconee River	Normal flow, turbid, muddy water, natural smell
2	Lake Sinclair	Normal flow, very rainy, turbid, muddy water, natural smell
3	Oconee River	Normal flow, clear water, natural smell
3	Lake Sinclair	Normal flow, low turbidity, clear water, natural smell
4	Oconee River	Low flow, low turbidity, clear water, natural smell
4	Lake Sinclair	Normal flow, low turbidity, clear water, natural smell
5	Oconee River	Low flow, low turbidity, clear water, natural smell
5	Lake Sinclair	Low flow, low turbidity, clear water, natural smell, high concentration floating particulates (pollen)

Water has many uses and is beneficial for all living organisms, from providing us with electricity to being the source of life for many aquatic species. However, many of us are unaware of not only everything water does for us on a daily basis, but also the quality of that water and how it can be measured and understood. From the gathered data, the running water of the Oconee River increased the DO and lowers the temperature on average but has a higher conductivity. This may indicate slightly better water quality of the river, but overall both Lake Sinclair and the

Oconee River have very high quality, which is beneficial to both the human population and ecosystems in Milledgeville.

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