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Water-based strategies for making the Small Beverage Industry in New England more sustainable and climate-change resilient

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And accepted on the recommendations of

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ABSTRACT

Water-based strategies for making the Small Beverage Industry in New England more sustainable and climate-change resilient

Michelle Kozminski

Water is a vital resource to the ecosystem, human life, and the economy. However, it is a limited resource that is threatened by a changing climate. The small beverage industry relies on large amounts of high quality water and is therefore at risk due to the uncertainties of climate change. This paper explores how the small beverage industry in New England approaches water to ensure that the industry is sustainable in the long term. A water threatened brewery in California, Sierra Nevada Brewing Company, is used to determine "best practices." Three small beverage companies in New England are examined to represent the local industry.

This paper identifies where the companies fall on Carrol's CSR Pyramid to determine what these companies need to focus on to improve their water approaches. Small beverage companies are successfully thinking about water within their facilities but few companies are thinking about their water impact outside of the facility. To be more climate change resilient, companies need to consider water strategies both inside and outside of their facilities.

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1. Introduction

Water is a vital resource to the ecosystem, human life, and the economy. However, it is a limited resource that has been globally shifting in availability due to climate change (Cooley, et al., 2014, p. 5). Water is a significant input, both in quantity and importance, to many goods and services worldwide. Industries with high water reliance are at risk as water availability becomes less certain. This paper will explore how the small beverage industry in New England, which relies heavily on water, approaches and utilizes water in the production system to ensure that the industry is more sustainable in the long term.

1.1 The Earth's Water

It is estimated that $1.38610^6 km^3$ of available water is in the Earth's hydrosphere, which includes all forms of water on the surface, crust, and atmosphere (Carpenter, Stanley, & Vander Zanden, 2011). 96.5% of the Earth's water is in the ocean and only 2.5% is freshwater (USGS, 2016). Of this freshwater, 68.7% is frozen, 30.1% is groundwater, and the remaining is surface water and miscellaneous freshwater, such as the atmosphere (USGS, 2016). Only 0.026% of liquid freshwater is in lakes, reservoirs, and rivers (Carpenter, Stanley, & Vander Zanden, 2011). Therefore, although it appears that the Earth has a lot of water, very little of the Earth's freshwater is available for use.

1.2 Climate Change and Water

The EPA defines climate change as "any significant change in the measures of climate lasting for an extended period of time" such as "…major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer" (2017). One impact of climate change is global warming, in which there is a "recent and ongoing rise in global warming average temperature near the Earth's surface…caused mostly by increasing concentrations of greenhouse gases in the atmosphere" (EPA, 2017a). These increased greenhouse gases and carbon dioxide levels are mostly a result of human activity such as industrial activity and fossil fuel burning (NASA, 2017).

The Earth's water is at risk due to climate change and global warming. As a "fundamental component of the global climate system," the hydrological cycle and the amount of water moving around is difficult to calculate largely due to the constant fluctuation of freshwater supplies as precipitation patterns change between years (Conway, 2014, p. 80; United Nations, 2012, p. 19; Zeitoun, 2014, p. 12). On top of the variability of precipitation patterns, anthropogenic actions are influencing the Earth's hydrological cycle through climate change and global warming (United Nations, 2012, p. 19). As a result, weather patterns and the water cycle are becoming more unpredictable and intense, "altering water availability, timing, quality, and demand" (Cooley, et al., 2014, p. 5; Michalak, 2016). Temperature, radiation, humidity, and wind speed changes all impact the surface water availability in regions (Conway, 2014, p. 80). This is evident in the

extreme drought that has recently impacted the southeastern United States and the current extreme flooding in southern Thailand (Boonthanom, 2017).

The Earth's water quality is also at risk as these extreme weather events inundate the system with contaminants; for example, heavy rains and flooding can cause nutrient and pesticide runoff in agricultural areas, thus decreasing the quality of the water (Michalak, 2016). Land use changes due to climate change and population growth will also impact the hydrological cycle as consumption practices change and residential areas expand to new areas (Conway, 2014, p. 80). A significant change in freshwater systems will have many impacts on society and the ecosystem, including human health, production systems and industries, and agriculture (Cooley, et al., 2014, p. 5).

1.3 Water is a Global Issue

Water is a global issue; freshwater is impacted by climate change, fluctuates between regions, moves among political boarders, is influenced by a region's actions, and is utilized to create goods and services (United Nations, 2012, p. 9; Cooley, et al., 2014, p. 4). Therefore, collective care for water consumption needs to occur. *Virtual water*, which is defined as the "water used in the production of a good or service," is moved around the world as goods and services are traded (United Nations, 2012, p. 9). A country may use a lot of water in production for a certain product and that product may be nearly exclusively sold to another country.

To illustrate this idea, significant water is used in the production of rice in India. If this rice is exported to the United States, water is indirectly traded, as the United States did not have to utilize any of its water resources to grow the rice, and India bears the water loss. This water trade could be balanced out if the United States exported a similar water intensive product to India.

However, water is rarely considered when making trade decisions (Cooley, et al., 2014, p. 4). According to the World Economic Forum Water Initiative, "…three of the world's top ten food exporters are considered water scarce, and three of the top ten food importers are water rich" (Cooley, et al., 2014, p. 4). To minimize water scarcity risk in local regions and the world, it is important for industries to be mindful of their water footprint in both their supply chain and their production process.

1.4 Water Use in the Small Beverage Industry

This paper focuses on the Small Beverage Industry because the industry operates on a more local scale and utilizes a high amount of water for production. Although a large portion of the water footprint of a beverage can be attributed to the amount of water used to produce the ingredients, this paper focuses on the water used during operations. A sustainable, water constrained, craft brewery in California is used as a case study to compare how the New England small beverage industry is approaching water. The New England small beverage industry is represented by three cases, a soft drinks company and two breweries.

The soft drinks industry has a large water footprint; it is estimated that a 0.5-liter bottle of soda can have a footprint of between 150 and 300 liters (Ercin, Aldaya, & Hoekstra, 2011). While most of that water footprint is due to the water footprint of the ingredients, such as sugar or the fruits used in flavoring, water is still utilized in the production system to keep the process sanitary, to bottle and apply labels, and as a direct input into the product (Ercin, Aldaya, & Hoekstra, 2011). Similarly, breweries utilize high volumes of water directly in their product, in the brewing process, and in the bottling and labeling process.

The water footprint of the beverage industry can be separated into three types of water: green water is when rainwater is utilized in the system, such as in the production of crops for ingredients; blue water is surface water and groundwater, which is utilized directly in the product and in the production system; and gray water, which is the wastewater that is produced during production (Ercin, Aldaya, & Hoekstra, 2011). This paper will focus specifically on blue and gray water as it relates to the small beverage industry.

2. Problem Statement

As climate change is impacting the availability of freshwater, the small beverage industry is facing long term risk due to heavy dependence on water in the production system. This paper will explore if and how the New England small beverage industry is managing their water risks to be more sustainable in the long term by comparing its practice with a case in California that models “best practices”.

2.1 Research Questions

- What are the challenges with collecting data on the small beverage industry?
- What is a progressive craft brewery, Sierra Nevada, doing to be water efficient?
    - Specifically, what is the company's technological approach, their motivations, and do wastewater regulations impact their processes?
- What is the small beverage industry in New England doing to be water efficient?
    - Specifically, what are companies' technological approaches, their motivations, and do wastewater regulations impact their processes?
- What can the small beverage industry in New England learn and implement from Sierra Nevada to become sustainable in the long term, if anything?

3. Background

3.1 Sierra Nevada Brewing Company

Sierra Nevada Brewing Company is an independent craft brewery that opened in Chico, California in 1979. In 2014, Sierra Nevada produced $250 million in revenue selling 1 million barrels of beer (Coffey, 2015). The company opened a second plant in North Carolina in 2015 to increase production capacity and provide easier access to the East Coast. Sierra Nevada's beers are sold all over the United States.

The company prioritizes sustainable practices throughout their production to reduce their environmental impact. According to the company's website, they "…built a deeply felt

belief toward stewardship…" (Sierra Nevada, n.d.). They focus on high quality, sustainable ingredients and even produce some of their hops and barley onsite. Sierra Nevada implements unique brewing processes, such as using open-tank fermenters to let the yeast breathe when producing some of their beers. The company produces half of the electricity it uses on site through solar energy and co-generation hydrogen fuel cells, and recycles and composts 99.8% of their solid waste (Sierra Nevada, n.d.).

3.2 New England Small Beverage Industry

The small beverage industry in New England is the target region discussed in this paper because New England has historically been relatively water rich. However, the area experienced minor drought conditions during the summer of 2016. Therefore, this paper will compare how a beverage company that is in an area that is water scarce, Sierra Nevada Brewery in California, approaches and utilizes water in production as compared to companies in a region of the country that historically hasn't been water constrained but may become more so as the climate changes.

3.2.1. Polar Beverages

Polar Beverages is a private, family run company founded in 1882 in Worcester, Massachusetts, where headquarters remains today (Polar Beverages, n.d.). The company employs around 1,600 people (Corcoran, 2015). Polar Beverages manufactures, bottles, and distributes around 3,000 products comprised mostly of sodas, seltzers, and water (Ba

Tran & Chang, n.d.). The seltzer line is their main focus as the company notes that people are looking for a healthy alternative to soda.

Although they are still bottling in Worcester, Polar Beverages has expanded operations to two additional plants through acquisitions—Adirondack Beverages in Scotia, New York and the Deep South Beverage Manufacturing facility in Fitzgerald, Georgia (Polar Beverages, n.d.). Polar Beverages' plants can bottle 600,000 cases a day with their fastest lines filling at around 400 bottles a minute (Corcoran, 2015; Ba Tran & Chang, n.d.). Can production rates operate around 1200 cans per minute (Ba Tran & Chang, n.d.).

3.2.2. Spencer Brewery

Spencer Brewery is the only Trappist brewery in the United States, founded in 2013 in Spencer, Massachusetts. The brewery was established to help the monks ensure self-reliance and to increase charitable assistance in the future (Spencer Brewery, n.d.). The company's facility is 36,000 square feet and has the capacity to produce 40,000 barrels a year (Dzen, 2014). Although their capacity is large, they are still operating under capacity but plan to increase yearly. Spencer Brewery currently produces 6 types of beer and distributes in 5 states (Spencer Brewery, n.d.; Brewbound, 2016). As part of a monastery, the brewery is planning to stay on location for many years to come and consider themselves as stewards of their land to ensure this longevity.

3.2.3. Wachusett Brewery

Wachusett Brewery is a small, private brewing company founded in 1993 in Westminster, Massachusetts. It is the second largest packaging brewer in Massachusetts, still operating out of their Westminster building. The company currently employs around 50 people and produces around 20 types of beer and a line of hard seltzers, with Blueberry Ale as the current biggest selling beer (Wachusett Brewing Company, 2016). They also produce a special beer for the 99 Restaurant and Pub. Wachusett Brewery distributes to New England, New York, and New Jersey. The company has been increasing in infrastructure by purchasing more building space, brewing equipment, and canning and bottling equipment.

Sales have been increasing each year since production began, but with the craft brewery market becoming saturated, sales have been increasing at a lower rate in recent years. With their new canning line, the company has started contract canning beers for other breweries and produce some beers from start to finish for other breweries as well. Making other breweries' beers is possible because Wachusett Brewery's brewers can adjust the water input to mimic the contracted beer companies' water quality in order to achieve the desired, uniform taste. Also, Wachusett Brewery's system is equipped to produce around 600 barrels per day, enabling production to focus on Wachusett beers and contract beers simultaneously (Furnari, 2015).

3.3 Theoretical Framework: Carrol's CSR Pyramid

According to Carrol's CSR (corporate social responsibility) Pyramid, there is an order of responsibilities that need to be satisfied that dictate when, if at all, a company will engage in sustainable activities. This order is illustrated in Figure 1 below.

Figure 1: Carrol's CSR Pyramid (Carrol, 1991)

Carrol's framework states that economic responsibilities must first be met, followed by meeting legal responsibilities. A company needs to be financially sound and legal before it can take part in any further responsibilities. Only after the company has met both its

economic and legal responsibilities it can (and should) engage in ethical practices, followed by philanthropic responsibilities.

Although this framework is structured in a way that each responsibility must be satisfied before it moves onto the next, it acknowledges that some of these responsibilities will occur simultaneously, as a company may be working on its economic and legal responsibilities at the same time, or ethical and philanthropic responsibilities simultaneously, especially if these activities are embedded in the organization's mission. This framework will be utilized in the paper to determine where on the pyramid small beverage companies discussed in this paper currently fall.

4. Methodology

To answer the questions on how companies in the small beverage industry are approaching and utilizing water in the production system, I first researched potential target companies in the New England area to gather primary data from through phone interviews. One of the challenges I faced immediately, as discussed below, was scheduling meetings or phone calls to talk with industry professionals at the target companies. Thus, in the interest of time, secondary data were collected from company websites, sustainability reports, newspapers, and academic literature to answer the research questions. This secondary research was used to determine if any improvements should be made to production system processes to make the beverage industry in New England more sustainable in the long term.

5. Results and Discussion

5.1 What are the challenges with collecting data for the small beverage industry?

It is difficult to collect primary data from the small beverage industry because employees in the industry are busy, companies are worried about disclosing proprietary information, and companies don't always see the direct benefit of the research. Some of the specific challenges I faced trying to collect primary data through phone conversations with company representatives was that companies would not always respond to the request to talk, some companies did not want to participate in the discussion, and coordinating a meeting time was difficult with varying schedules.

Some of the point of contacts at companies were initially willing and excited to participate but stopped responding to set up a meeting. There was also an instance where a contact responded to me that she/he was willing to talk, but could not be reached upon follow-up. In the interest of time, I could no longer reach out to new companies or follow-up with any companies anymore. Therefore, I switched to secondary data collection. I would recommend anyone doing research with companies in the industry to start data collection long before one would think to do so, as two and a half months was not enough time to secure one interview, even with personal industry contacts.

Note: The companies discussed in this paper were not necessarily the ones that were contacted for interviews.

5.2 What is a progressive craft brewery, Sierra Nevada Brewery, doing to be water efficient?

This section will explore how Sierra Nevada thinks about water in the production system, what the company's motivations for such approach is, and which regulations impact Sierra Nevada's processes and how that impacts their actions, specifically with wastewater.

5.2.1. How is Sierra Nevada thinking about water in the production system?

Sierra Nevada has implemented many technologies to reduce the amount of water utilized throughout their production system. Sierra Nevada has found that the more beer that they produce, the more efficient their systems are and less water is required per barrel of beer. Overall, Sierra Nevada has a zero-waste goal in which they hope to implement cyclical processes that will reuse as much materials as possible, such as water, as illustrated in Figure 2 below. Sierra Nevada has already reduced the amount of water used to produce a barrel of beer by 25% (Sierra Nevada, 2015).

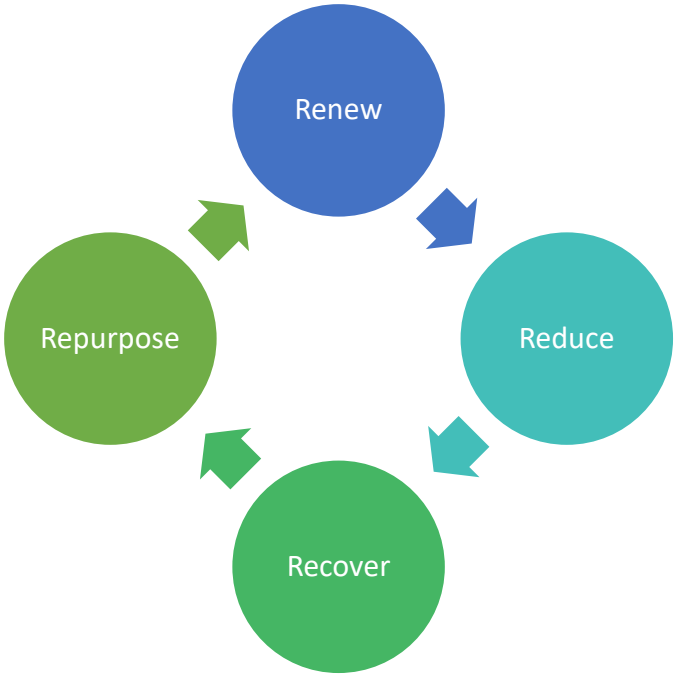

Figure 2: Sierra Nevada's Zero Waste Cyclical Process

The company's facility utilizes on-demand water heaters which reduces the amount of energy used by only heating water when necessary. In their manufacturing process, Sierra Nevada recovers the cool-down water after hot sanitation loops and utilizes this water for other processes in the system. The company has a clean-in-place (CIP) system which maintains cleanliness while using less water. Furthermore, non-water based lubricants are used on the conveyor belts in the packaging plants, reducing the amount of water both used in production and as waste.

The company also has a rainwater collection system attached to their facilities to improve the availability of water for their facilities. The plant in North Carolina has installed twelve 6,500-gallon cisterns on their facility to store rainwater and one 450,000-gallon cistern

below the parking lot. This water is used for irrigation and other processes that do not require high quality water. Also, Drip irrigation is used on the premises, which decreases the amount of water used to keep landscaping and any on-site crop production strong. Also, their plant in North Carolina was designed with bio-swales to slow down the filtration of water into the ground to reduce erosion (Sierra Nevada, 2015). Sierra Nevada is working to decrease the amount of water used throughout their facilities to produce more beer in the future.

5.2.2. What motivates Sierra Nevada's water decisions?

Sierra Nevada notes in their Sustainability Report that the company first utilized water and resource saving techniques because it saved the company money. When the company first started, they could not waste resources because the company was trying to make ends meet to become profitable and successful. Now, as a successful, stable company, Sierra Nevada acknowledges that it is no longer just an economic decision to use resources wisely, but an ethical decision as it is "the right thing to do" (Sierra Nevada, n.d.). Ken Grossman, the owner and founder of Sierra Nevada states that "being a good steward of natural resources, the land, and our communities is the cornerstone of the way we do business" (Sierra Nevada, 2015). The company's mission states that it is "balancing environmental stewardship, social equity, and economic stability" (Sierra Nevada, n.d.). Sierra Nevada's location in California is experiencing U.S. climate change impacts dramatically through drought and extreme rain, which further motivates the company to optimize water use at both facilities.

5.2.3. Do any environmental regulations impact Sierra Nevada's processes, specifically regarding wastewater? If so, how is Sierra Nevada dealing with them?

Federal regulations through the Clean Water Act require facilities that discharge water into waters of the United States to meet water quality standards. Furthermore, states often set stricter standards for facilities to meet. Some facilities emit their water to public treatment plants, which also must meet water quality standards. Due to the large quantity of water that Sierra Nevada's breweries emit and to meet the water quality standards of the public treatment plant, both of Sierra Nevada's breweries operate their own on-site pretreatment wastewater treatment facilities that pretreat the water before it travels to the public treatment plants.

This process not only ensures that the water quality is maintained for the community, but it also allows Sierra Nevada to optimize recycling within their pretreatment process, as illustrated in Figure 3, below. The company first does solid screening on their wastewater. It is then moved to an anaerobic sludge digester where it is treated before moving to an aeration basin that breaks down the remaining solids (Sierra Nevada, 2015). Any solids removed from the process are composted on site for reuse (Sierra Nevada, 2015). Overall, these pretreatment facilities ensure that the company protects the water quality of the community, thus helping their own operations in the long term as the company requires a large input of high quality water in production.

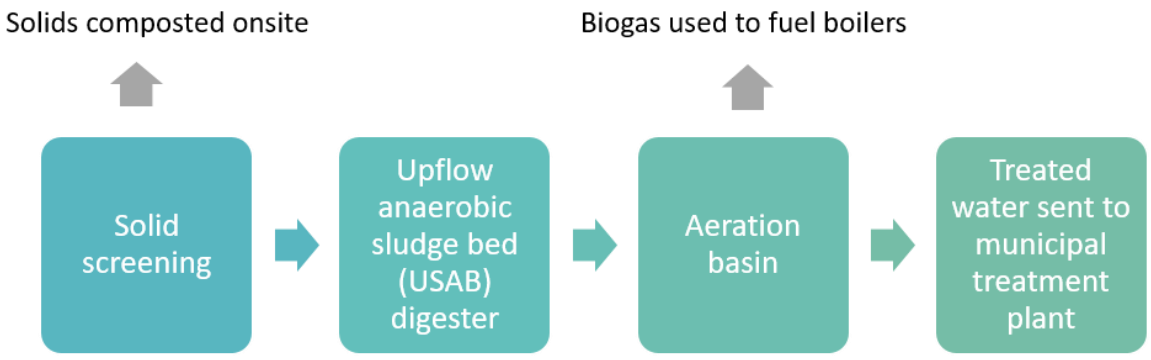

Figure 3: Sierra Nevada's Wastewater Pretreatment Process

5.3 How is the small beverage industry in New England thinking about water in the production system?

This section mirrors section 5.2 but as it relates to the practices and approaches of New England small beverage companies. Specifically, this section will explore how the New England companies think about water in the production system, what the companies' motivations for such approach is, and which regulations impact the companies' processes and how that impacts their actions, specifically with wastewater.

5.3.1. How is the New England Small Beverage industry thinking about water in the production system?

Polar Beverages strives to produce and bottle as efficiently as possible. The company is using technological innovation to reduce water use at all levels of production, thus reducing the cost of their inputs. Some of the technology Polar Beverages has implemented includes a back-wash water recovery system that reduced the amount of

water use and Ionized Air Rinsers that use air instead of water to clean the bottles and cans. Polar Beverages also conducts a water audit annually to check for any water issues and areas to improve. So far, Polar Beverages has seen a 75,000 gallon per day reduction in water use and within the next year, is aiming to reduce another 50,000 gallons per day (Polar Beverages, n.d.).

Spencer Brewery has a clean-in-place (CIP) closed circuit process, where resources such as water used to clean equipment are reused. High efficiency motors and pumps are used in the packaging line to reduce the input of water (Spencer Brewery, n.d.). Spencer Brewery's water comes from a well on their property (Dzen, 2014). To protect their well and their land, water considerations went into the design of the building as a pond was installed nearby to collect run-off from the building. They also installed a swale system on the side of the site that helps slow the movement of water to reduce soil runoff (Spencer Brewery, n.d.).

Wachusett Brewery reuses water in their cleaning process a few times to reduce water consumption. Water is sometimes combined with chemicals to clean out the tanks in between brews, and other times is used on its own to rinse and prepare the equipment for the next batch to brew. Their keg washer has three cycles composing of prewash, wash, and rinse (Bridgewater, Conner, & Slezycki, 2008).

5.3.2. What motivates water decisions for New England small beverage companies?

Polar Beverages notes that their sustainability strategy is “based on balance,” considering economics, social concerns, and environmental responsibility (Polar Beverages, n.d.). The company operates under the understanding that environmental decisions make economic sense. Therefore, Polar Beverages approaches sustainability by reducing inputs and materials, along with technological innovation to increase efficiencies.

Spencer Brewery considers the brewery as a “100-year endeavor” and therefore, wants the land and the brewery to be able to sustain itself. This is evident through their long list of environmental commitments that span from land and habitat management to efficient technologies used to build their brewing building. The brewery is trying to be as resource efficient as possible in order to be successful in their endeavor. Also, it is important to the monks to be good stewards of the land they live on not only to protect their space for living in the future, but to be responsible community members (Spencer Brewery, n.d.).

Wachusett Brewery does not market any sustainability efforts on their website. However, from attending a tour, it is evident that they are working with efficient technologies that complete the processes quickly with few resources. As their company is expanding in size and capacity, they appear to be focused on how to stay competitive and ensure business in the future. This includes producing efficiently.

5.3.3. Do any environmental regulations impact the processes, specifically regarding wastewater, of New England small beverage companies? If so, how are the companies dealing with them?

Companies in the United States that discharge wastewater, or effluent, into surface water must obtain a National Pollutant Discharge Elimination System (NPDES) permit. This permit limits the amount of effluent that can be discharged and often sets parameter criteria to ensure that the discharge is not too polluted. These criteria are set based on the current health of the water body being discharged into to ensure that the health of the waterbody is not negatively impacted by the effluent.

Instead of discharging into surface water, some organizations send their wastewater to publicly owned treatment works (POTWs). POTWs are designed for residential use, and therefore, any industrial water discharged into the plant must meet certain water quality standards to ensure that the plant can properly treat the discharge. Specifically, these standards are set to confirm that the volume and concentration of effluent does not make the POTW exceed their NPDES permit requirements, that solid pollutants in the discharge do not interfere with the flow of the POTW, that the temperature of effluent does not cause the POTW's temperature to exceed 40°C, and that pollutants can be properly treated by the POTW (EPA, 2017b).

Polar Beverages does not list much about their wastewater discharge online. However, through reducing water use, such as with their back-wash water recovery system, the

company notes that it will be minimizing effluent discharge (Polar Beverages, n.d.). Per their National Pollutant Discharge Elimination System (NPDES) permit, the company discharges effluent to the Middle River in Worcester (EPA, 2015). Therefore, if the company can reduce their effluent discharge, they will reduce community environmental impact. The NPDES permit sets parameters requirements that the company must meet, such as the maximum daily flow. If they reduce their flow significantly, Polar Beverages may be able to operate without a NPDES permit, saving time and resources.

Spencer Brewery does not have any information on wastewater posted on their website. There are also no articles online about it. However, a meeting agenda from June 12, 2012 with the Spencer Board of Sewer Commissioners Meeting Agenda lists the abbey's brewery wastewater disposal as a topic (Spencer Board of Sewer Commissioners, 2012). Therefore, it is likely that the discharge is into the town's sewer system to be treated by the Spencer Town Sewer Plant. Because Spencer Brewery is trying to reduce the amount of water used in their production system, they will be reducing the input of wastewater into the town treatment plant.

Currently, Wachusett Brewery's wastewater is sent to a public treatment plant, but goes through a settling tank to pull out any solids before it is transferred to the treatment plant. Therefore, the water must meet the wastewater standards before it leaves the facility. Because it is not pretreated before heading to the treatment plant, the water quality of the wastewater currently meets pretreatment standards mandated by the state and federal governments.

5.4 What can the small beverage industry in New England learn and implement from Sierra Nevada to become more sustainable in the long term, if anything?

Sierra Nevada's business strategy incorporates multiple sustainability actions regarding water to mitigate the company's climate risk and ensure long term success. Sierra Nevada has met its economic responsibilities by providing a steady revenue through increased sales and partaking in water saving techniques to save money, and has also met its legal responsibilities, such as by pretreating wastewater onsite. Sierra Nevada's commitment for water saving practices extends beyond saving money and meeting regulations; the company is committed to these practices because it is the ethical thing to do and because it helps support and protect the surrounding communities. The company also engages in philanthropic activities in order to enhance their communities, such as by donating to local agencies and organizations that focus on clean water, for example (Sierra Nevada, n.d.). Therefore, Sierra Nevada falls at the top of the CSR pyramid, as illustrated in Figure 4 below.

Sierra Nevada's onsite pretreatment of wastewater to meet environmental regulations has improved the efficiency of the company's system. It enhances their closed-circuit system by increasing material reuse, thus decreasing the amount of inputs required. Therefore, Sierra Nevada has improved its systems to meet water quality standards. Overall, the company is in a good position to sustain their business into the future.

Figure 4: Sierra Nevada on Carrol's CSR Pyramid

Polar Beverages has met their economic and legal responsibilities regarding company operations. The company is focused on implementing environmental practices through technological advancements because it improves the efficiency of their processes and reduces the amount of water required. Therefore, Polar Beverages falls in the middle of the CSR pyramid, as seen in Figure 5 below.

To become more risk adverse concerning changes in water supply, Polar Beverages should start to explore their ethical and philanthropic responsibilities related to local water, which would expand their positive impact in the local community. Polar Beverages should reduce their impact on water outside of their facilities, such as by implementing a water capture and reuse system on their facilities. This would prevent surface runoff from both their facilities and the surrounding pavement and provide water to use in

landscaping and facility processes that do not require high quality water as an input. Preventing surface runoff would contribute to protecting the community's water quality, as surface runoff often picks up pollutants such as oil from cars or fertilizers. Because Polar relies on the city's high quality water for their production, this would help ensure the quality water they depend on will be protected for years to come.

Spencer Brewery, like Sierra Nevada, is at the top of the CSR pyramid, as seen in Figure 5 below. As a new brewery, they have not followed the pyramid from a bottom up approach. Instead, they appear to be implementing all the responsibilities at once, considering their ethical responsibility to the environment along with their philanthropic mission in the design of the brewery. However, as a monastery with another business—producing preserves—already in place, St. Joseph's Abbey already had income and business experience to base their brewery on (Spencer Brewery, n.d.). Therefore, they had a solid economic and regulatory foundation from the beginning. Spencer Brewery also spent a few years researching the brewing process and how to make the process efficient without sacrificing the quality of the product (Dzen, 2014).

Spencer Brewery's water saving technologies and biological systems likely had a high upfront cost, but will pay off in the long term, as the quality and supply of their well water will be protected for years to come. Moving forward, Spencer Brewery should implement a water audit at least yearly to make sure their equipment is operating without leaks and to discover any areas that could be improved on through process or technological changes.

Wachusett Brewing Company is also in the middle of the CSR pyramid, as depicted in Figure 5. The company has met their economic and legal responsibilities, and is looking to expand the contract side of their business to continue economic success. Their environmental methods are the result of resource efficiency decisions. Moving forward, Wachusett Brewery could look into new ways to engage in ethical and philanthropic water saving decisions.

Wachusett Brewery has been considering ways to improve their environmental impact through efficiencies since the late 2000s, as apparent by the assessments conducted by Worcester Polytechnic Institute (WPI) students (Bridgewater, Conner, & Slezycki, 2008). Since these assessments are out of date with technological advancements growing rapidly, along with Wachusett Brewery's recent expansion and acquisition of new equipment, Wachusett should conduct new environmental assessments. These assessments will determine where in their production process they can reduce water use and increase efficiencies. Also, now that Wachusett Brewery owns the entire building they are operating in, they should design and implement rainwater capture on their facility. This water could be utilized in their system for processes that do not require potable water and for landscaping uses, thus saving the amount of water inputs required and reducing runoff from the pavement. These actions will help Wachusett Brewery continue operating successfully in the future and provide positive community involvement to protect the water quality of the town's waterways.

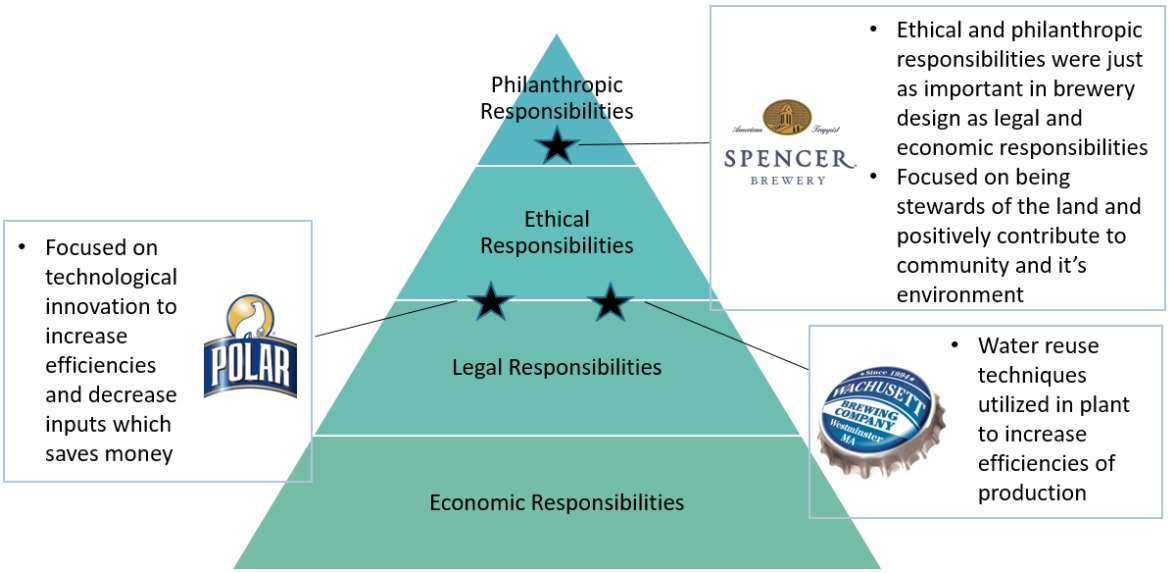

Figure 5: Polar Beverages, Spencer Brewery, and Wachusett Brewery on Carrol's CSR Pyramid

There are some water saving and protecting actions that all the New England Beverage companies explored in this paper, and likely other similar companies in the area, could implement to become sustainable in the long term. It is important for these companies to continually assess their processes to make sure all equipment is operating as it should be to prevent water loss. With this, companies should be thinking about new technological upgrades at all levels of their system, not just inside the factory, to implement in order to improve water efficiencies and decrease water inputs.

Also, companies should become water stewards in their local communities by actively engaging and supporting local organizations focused on protecting water quality, such as watershed alliances. This will ensure that the companies have high quality water for their processes to rely on in the future. It is also recommended that companies work together

to share successful water saving techniques to help each other cut back on total water use in order to ensure the availability of water in the future.

Another consideration companies should make to reduce their water use is to assess how much energy they use and determine how to cut back on energy usage. Energy requires a lot of water for production. Also, heating and cooling systems can also utilize a lot of water. Overall, closed loop systems that reuse water as efficiently and as much as possible will benefit New England small beverage companies and enable them to produce more beverages as the climate changes and water from precipitation becomes more scarce, episodic, and uncertain.

6. Assumptions and Limitations

This research relies on information available online, which limits the depth of analysis and leads to assumptions. This is especially the case since all the companies discussed in this paper are private companies, and therefore are not required to disclose information on their sustainable practices, processes, or financial success. Also, because primary data were not able to be collected by talking with employees involved in the production, assumptions were made on the technologies and approaches utilized in production.

Although all results mentioned above are based on research, recommendations and ratings on the pyramid may be in error by assuming certain practices are not already implemented if they actually have been. Since a few of the data sources were old, and

processes are constantly evolving and the businesses are growing, some of the recommendations could already be implemented.

This paper focuses only on water use in the small beverage industry and how efficient and responsible water use can help businesses be successful in the long term. However, water use is not the only environmental and business factor to consider when assessing how to make a company more climate resilient and sustainable, and it should not be considered in isolation from others like energy consumption and greenhouse gas emissions.

7. Conclusion

The beverage industry requires a large input of high quality water. Without access to this water, beverage companies may have to change their products or may have to cease production. Therefore, it is important for the beverage industry to determine what companies can individually and collectively do to protect the water supply as the climate changes.

Sierra Nevada is focused on implementing sustainability and water saving measures in all aspects of their production system. The company's location in drought-stricken California has required it to be good water stewards for their community. Although they do believe it is the right thing to do for the community, they understand that their company will not exist if the water resources of the area are not protected in terms of both quality and abundance. Therefore, Sierra Nevada has implemented many water saving efficiencies,

also reducing the cost of production as water resources are reused in a cyclical process as much as possible.

Comparing Sierra Nevada's practices to the small beverage industry in New England, where water is not yet considered scarce—though climate change scenarios for the Northeast show water will become more scarce—it is apparent that the New England industry has some room for improvement (National Climate Assessment, 2014). However, regardless of motivations, which often stem from cost savings, the industries in the region are already implementing many techniques to reduce water consumption in their processes. Overall, the limited cases suggest that companies are not thinking about water saving techniques that can occur outside of the walls of their plant, such as through water stewardship and community watershed involvement and rainwater collection systems.

As Figure 6 illustrates, small beverage companies in New England are first looking to meet their economic and legal responsibilities, which appear to occur inside the facility. Related to water saving techniques, these involve technological improvements, innovation, and an increase in efficiencies, which reduces resource inputs. However, the small beverage industry in New England should also look outside of the facility to help meet their ethical and philanthropic responsibilities regarding water. These actions include reducing surface water runoff through green landscaping, utilizing rainwater collection techniques, participating in water stewardship and engaging in community watershed associations. Such actions will contribute to protecting the local watersheds which will help ensure the availability of high quality water for the companies for years to come. Coupling water

saving strategies both inside and outside of the facility will help mitigate the water risk New England small beverage companies will likely face in the future as the climate changes.

Figure 6. Engaging in the CSR Pyramid's Four Responsibilities Involves Reducing Water Both Inside and Outside of the Facility

7.1 Future Work

To continue this research and to further assess how the small beverage industry in New England can become more water risk resilient, interviews with the companies discussed in

this paper and other local companies should be conducted. The interview questions should be refined questions based on the results and findings of the initial company review discussed in this paper. This will allow for a more in depth review of specific technological processes currently used in production and will provide more information on how companies think about water to help them move up on the CSR pyramid.

Also, since it was determined from the analysis above that the small beverage companies in New England should implement water saving techniques outside of their factory walls, it will be effective to develop a guide on rainwater collection systems. This guide could include system options, installation information, water saving potentials, and recommendations on how the water could be used once it is collected.

To help beverage companies in New England become more resilient to climate change in order to protect future business, similar analyses should be completed on other production inputs, such as energy and plastic, that could become scarce or more expensive over time. This analysis would show the most vulnerable aspects for the small beverage industry in New England, thus showing where companies in the industry should prioritize production and process improvements to stay competitive and be successful in the future.

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