UCLA IoES
Corporate Partners Program

Watering the Tech Industry

How major tech companies are approaching water sustainability

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Introduction

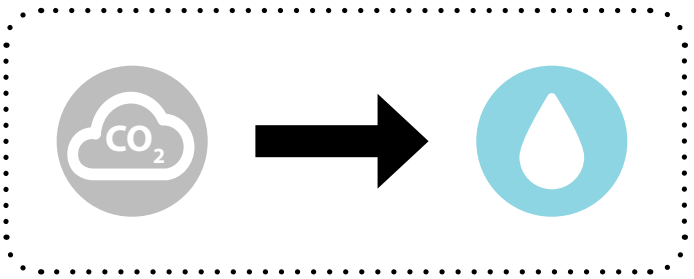
Tech giants today are ever-present in our society, dominating in their own industry and influencing the community around them. They produce products that we use in our daily, if not hourly, lives and are constantly modernizing and expanding the scope of their work, supporting the needs of a technology-based 21st century. The ubiquitous presence of these companies is a result of their global business success. The revenue generated by tech corporations is staggering -- the top ten U.S. tech firms reported over 1 trillion dollars in collective revenue in 2018 [1]. The significance of these companies to the global economy makes them more visible to the consumer and subsequently more impactful [2]. Companies like Apple, IBM, and Google, just to name a few, have all single-handedly steered the human population into a tech-savvy era of efficiency, ease, and innovation. And with the immense pull these companies have on our society, they have the potential to play a critical role in shaping the future of not only their consumer products and services, but of large-scale global issues we face today including the environment.

> *"The top 10 US tech firms reported over 1 trillion dollars in collective revenue in 2018"*

Growing concern over climate change presents a need for sustainable action. Companies, especially those in the tech industry, have begun to identify their contributions to the problem and evolve into more environmentally-conscious bodies. These companies are redesigning their operations to achieve greener goals through reducing natural resource consumption, recycling waste, and developing cutting-edge technologies that apply the same efficiency and ease that their products provide.

The involvement of companies in sustainability has become nearly universal in the last few years. Notably, this trend is acknowledged and even championed by Larry Fink, CEO and Founder of BlackRock, the largest investment management firm in the country. Larry Fink's 2019 annual message to CEOs of firms that his company invests in urges them to recognize their role in the well-being of global society [3]. He tells these corporate heads that "the world needs [their] leadership" to create solutions for their consumers and the communities in which they operate [3]. Pressure for companies to be green also comes from the bottom-up; consumers are speaking with their wallets, buying more products from and investing in companies with demonstrated sustainability leadership [4]. The demand for social change and responsibility has pushed corporate sustainability to become an integral part of a company's business model.

Carbon and energy emissions have been the focal point of the environmental cause since the mid-1960's when the concept of environmental quality first came into existence. When companies initially started transitioning to greener operations, lowering carbon emissions was the easiest, most cost-effective first step. This meant that companies predominantly focused their efforts on initiatives that reduced energy usage. As they achieved the low hanging fruit in the energy sector, efforts have shifted towards water needs and usage [5].



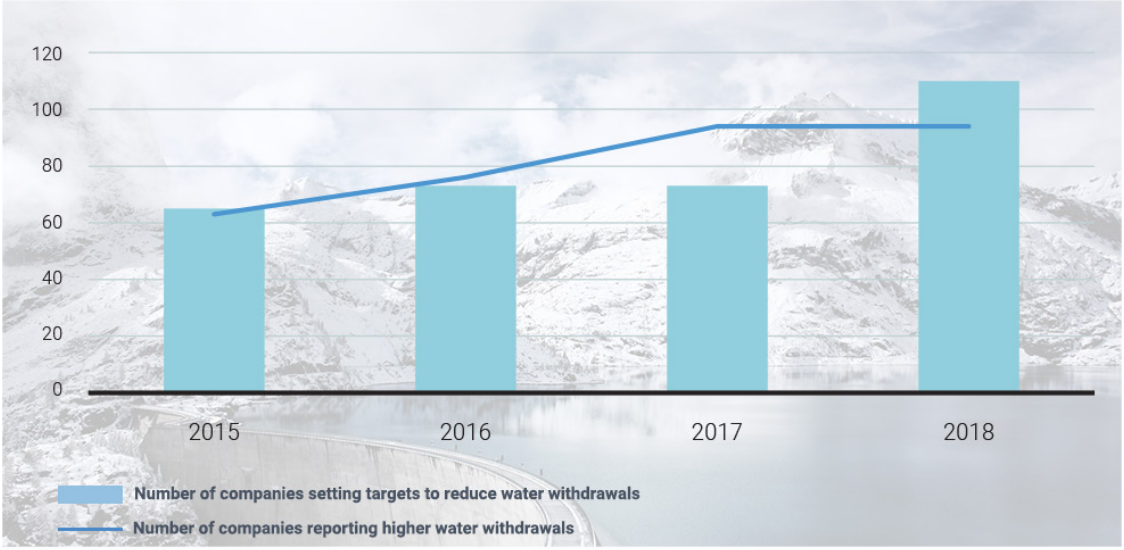


Figure 1. *CDP Water Reporting. In the last 4 years there has been a steady increase in companies reporting to the CDP that they have set water reduction targets. However, the chart also shows companies are still generally using more water each year, instead of reducing usage. [6]*

This transition came later because water in most locations is much more affordable than energy; its pricing does not reflect its true value [7, 8]. Consequently, efforts to reduce consumption impact a company's bottom line less. However, as climate change increases the frequency and duration of drought [9, 10], water conservation has captured more attention and will continue to do so [11].

Since the beginning of the decade, water sustainability has increasingly become a major point of corporate environmental concern [5]. Companies now submit water data to well-known corporate sustainability rating indexes such as the CDP, or the Carbon Disclosure Project, who grade a company on its level of disclosure of environmental data. These ranking systems make the hidden water use among tech companies more obvious, in particular highlighting the tech industry's need for ultra-pure water in the manufacturing process and large amounts of water for cooling in data centers.

Stakeholders and consumers today demand that companies become more environmentally conscious throughout all aspects of their supply chain. As a result, green supply chain management (GSCM) is increasingly promoted within publicly traded companies. Water sustainability is a key component of a GSCM as water scarcity both affects manufacturing and is a human rights concern. Companies, therefore, look down their supply chains to understand collective water use of their products and work reduce their overall footprint. They are especially conscious of water in areas where it is limited, such as deserts or other drought-prone regions. This issue will be discussed further in the Trends section.

Very few if any sources collate information about the new and evolving practices within the field of corporate water sustainability-- especially not with a specific focus on the tech industry. We were interested to know if tech companies were leading sustainability in this field, in the same way that they have within the field of energy and emissions. This research project aims is to synthesize and report on the water sustainability programs at major tech companies, including how they report on water and make decisions internally.

Research Methodology

To start, we created our own definition for companies that we consider "tech giants". Working with our faculty advisor, we decided they must both be one of the Fortune 500 as well as ranked on Barron's List of the 100 Most Sustainable Companies by Calvert Research and Management [12, 13]. This generated a list of 16 companies, which was too many for us to interview. When we narrowed the list down by companies which produce hardware, instead of software products, we achieved a manageable list of 12 companies (see chart on page 6).

We built an interview framework that we tailored to each company based on the information they share publicly through annual reports, CDP reports and CSR websites. The four main points of inquiry in the questionnaire were:

We reached out to sustainability leads at each company via phone or email to conduct an interview; six responded. Interviews were conducted over the phone and lasted from 30 minutes to an hour. The identities of interviewees have been left anonymous in this report, and if requested, they have been allowed to review a draft for accuracy before we finalized it.

In this report, we synthesized key trends from the interviews, supplemented by research we conducted on the six other companies online-only. We attempted to capture how the tech industry as a whole approaches water conservation; however our biggest finding was that all of the companies we interviewed function uniquely. Each company's physical structure, business hierarchy, and goals varied widely. Accordingly, we provide a summary profile of each company to give more details about how they address water use in their context. These profiles are not meant to be comprehensive and detail all activities or practices related to water but rather to highlight innovative or special approaches a given company has used.

1. How was water measured, tracked, and reported and associated tools or software used?
2. What standards does the company holds their suppliers to?
3. How is data collected from water relayed within the internal chain of command and incorporated into decision-making?
4. What initiatives or programs were put in place as a result of the water data collected?

Trends

Our review of the twelve companies highlights multiple trends in how tech companies address water conservation, reporting, and decision making. Tables 1 and 2 capture some of the key attributes across the 12 companies while the below synthesis delves into deeper analysis of the apparent trends. Additionally, to provide context for our synthesis, we have written in-depth case studies, provided following the Trends section.

Table 1: Companies that were interviewed

Company	Water-reporting software	Frequency of reporting	How data are used to influence decisions	Supply chain involvement
	WRI Aqueduct	Varies; data centers and regions of interest can be monthly or daily, office buildings are 2x a year	Water is looked at within the sustainability department and data center department; sustainability department makes decisions.	Yes, see Clean Water Program
	WRI Aqueduct Tool; third-party software system	Quarterly to COO; more regularly at locations with sub-meters	Quarterly meetings with COO to propose water initiatives and present data	Yes, implementation of water sustainability plans in water stressed region
	WRI Aqueduct and internal company methods	Varies; yearly for most structures and more often for structures in Water Stressed Regions	Water initiatives are sponsored by the C-Suite	Yes; implementation of recycled water treatment plants specifically in water stressed regions
	Billing statements and internal software	Utilities are collected monthly, corporate roll-up is quarterly	Director of sustainability makes decisions but shares it with corporate heads if necessary; C-suite is included in "10 year water goals"	Did not discuss supply chain with us
	Ecolab Water Risk Monetizer and WRI Aqueduct	Quarterly; monthly for some high water risk regions	Company segregated into 3 parts, depends within each part, but the decisions stop at sustainability department.	Yes; Ecolab Water Risk Monetizer and implementation of water sustainability plans in water stressed regions
	Excel	2x a year at corporate level, quarterly for manufacturing	Water data sharing with sustainability department only	No; due to outsourcing of other parts of supply chains to other companies

Table 2: Companies that were researched through publicly available materials only

Company	Water-reporting software	Frequency of reporting	How data are used to influence decisions	Supply chain involvement
AT&T	World Business Council for Sustainable Development (WBCSD) Global Water Tool	At least once a year	Public Policy and Corporate Reputation Committee reports to the Chief Sustainability Officer	No, but it conducts risk assessments for its facilities
CenturyLink	Not Specified	Not Specified	Not Specified	Not Specified
CISCO	World Business Council for Sustainable Development (WBCSD) Global Water Tool	Annually	Corporate Responsibility Committee (CRC) reports to the Sustainability Executive Team (SET) whose COO reports to the Board of Directors	Partial
MOTOROLA SOLUTIONS	Internal company methods	Quarterly	Annual with the Chief Administrative Officer	Yes, included Tier 1 suppliers within water risk assessments.
TEXAS INSTRUMENTS	WRI Aqueduct Tool and internal company methods	Not specified	Annually, CFO meets with Board	Not specifiied
Western Digital	WRI Aqueduct Tool and internal company methods	Yearly	Not specified	Yes, includes some Tier 1 within audits of water use within the company

This review made apparent two key considerations that shape how water is reported:

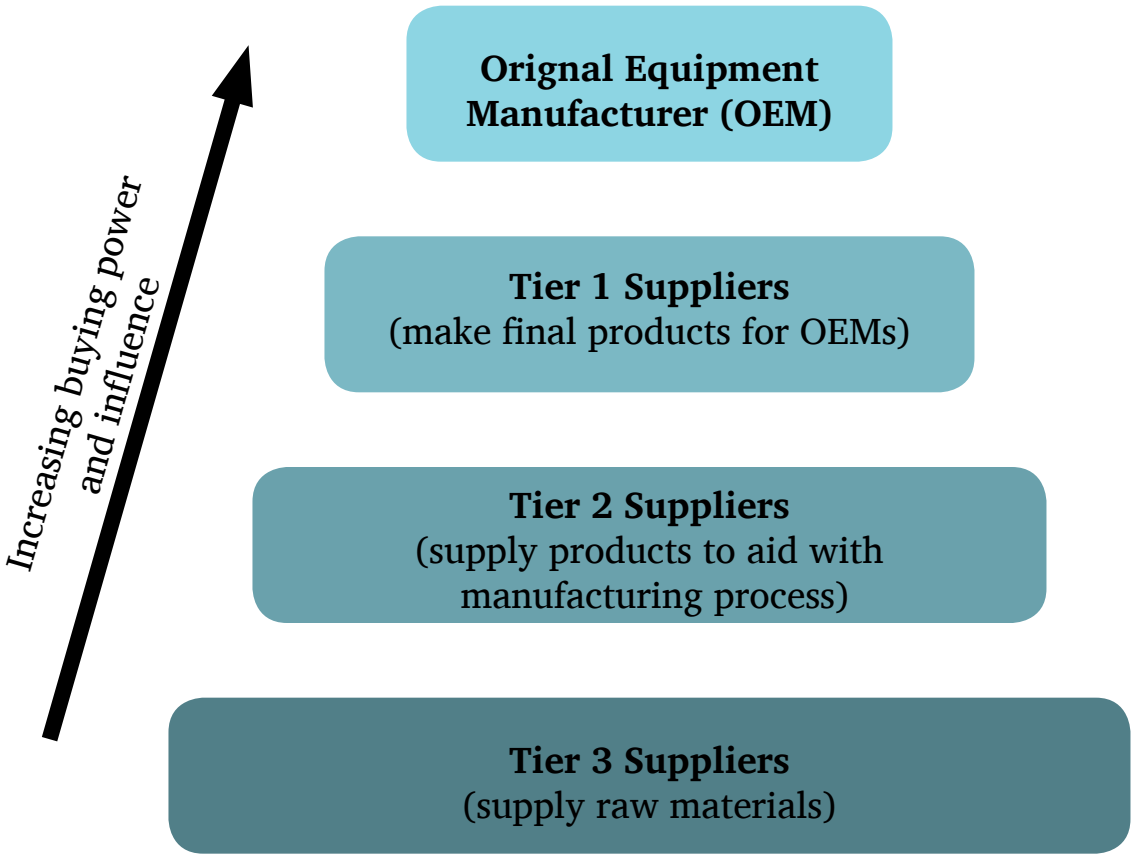
First, we were most surprised by the limitation in water reporting. This was not due to unwillingness by parent companies, but by the lack of robust technologies that would provide effective water conservation and documentation throughout a company's supply chain. This lack of technology has inspired companies to create and collaborate together to provide a more efficient and comprehensive approach towards water monitoring.

Second, nearly all the companies tailored their water conservation activity to geography, with drought-prone areas receiving the most attention and highest level of intervention. Water accessibility and scarcity is a significant risk component in the 21st century, as global climate change and environmental whiplashes have made water supplies highly volatile. As a result, water availability is an important component of risk analysis for companies within supply chain management.

Trend 1: A company's water reporting rarely goes beyond its direct contractors (Tier 1 suppliers)

Supply chains can be broken down generally into four divisions within the tech industry: the original equipment manufacturer (OEM), Tier 1 suppliers, Tier 2 suppliers, and Tier 3 suppliers. The companies we interviewed qualify as OEMs and they hold direct contracts with only their Tier 1 suppliers. Tier 1 suppliers make final products for the OEMs. However, Tier 1 suppliers need products to aid with their manufacturing processes. This necessity contributes to the creation of the Tier 2 supplier within the supply chain. Tier 1 suppliers hold contracts with their Tier 2 suppliers. Additionally, Tier 2 suppliers receive their raw materials, such as metals and plastics, from Tier 3 suppliers in which they hold contracts with [1].

It is important to highlight OEMs, or parent companies, only have contracts with Tier 1 suppliers. As the OEM delves further into a product's supply chain, there is less transparency in the processes that occur. With a contract they can require an audit or request that a company participates in a CDP report. Without a contract, as is the case with Tier 2 and 3 suppliers, they do not have this ability or transparency. This makes it increasingly difficult for OEMs to report on and provide transparency beyond the first tier in their supply chains. This was reflected in our research as we found that water stewardship is generally limited to Tier 1 facilities. Of the 12 companies we research, we not able to find evidence that any of the companies performed audits on or provided water conservation technologies beyond their Tier 1 facilities.



Trend 2: Strong demand for better water accounting and reporting tools

Effective reporting on water necessitates robust technology systems. These include: systems for monitoring use rates, data collecting software, and human analysis. Furthermore, for these systems to be truly inclusive of a supply chain's water footprint, they must be able to collect data from multiple tiers and suppliers within the supply chain to send to the OEM. Based on our interviews and literature reviews, it is apparent that there is room to grow in each arena.

Technology to enable supply chain reporting of water metrics is extremely limited in its extent and feasibility of accessibility. Typically an audit of direct suppliers' water use analyzes two components: the facility and the manufacturing processes. Through the course of our interviews, respondents pointed out that water savings within their Tier 1 facilities predominantly reside within the building engineering and not within the manufacturing processes themselves. Water conservation within a production facility primarily results from transitions to high efficiency hygienic technologies, like low flush toilets, and modified irrigation techniques [1]. These improvements within a production facility are relatively easy to implement compared to modification within the product manufacturing process. Due to the emphasis on building water reductions, the most notable data collection process is utility billing. Each company that we interviewed explicitly mentioned its use of utility billing as the main data collection resource. This is a simple method to collect water use data and predominantly resides within the real estate department of a company's headquarters.

A major limitation of this form of data is that it typically records a single volume of water use for an entire building or even an entire campus. This can be a problem, particularly when a company, or one of its suppliers, occupies only one floor of a building. It dramatically limits the ability to assess which steps within manufacturing processes are using too much water and where a technology solution could be implemented. An obvious solution is submetering or higher resolution water usage data collection, mentioned by many of the companies we interviewed. Real time water data reporting from submeters can also help identify leaks and avoid costly water damage [2].

Tools for Improving Water Accounting and Reporting

Ecolab's Water Risk Monetizer Tool

Submeters

Policy changes are helping companies to address this challenge. Starting in 2013 the state of California, where many of the tech companies have facilities, requires newly constructed or renovated commercial facilities larger than 50,000 square feet to submeter water through Title 24 [2]. This type of policy will likely become more uniform in the coming decades as other states follow suit.

An additional constraint many of our companies faced was how to roll-up and analyze all the data from their facilities. Most companies create their own data management system, which is often based within Excel. They lamented how this makes data synthesis and sharing an arduous process, and discussed how forecasting forthcoming changes or risk to upper management was challenging. Microsoft, in partnership with EcoLab, has taken steps to fill this gap. Together they have built the Water Risk Monetizer, which allows companies to calculate water risk and the associated financial risk under different expansion scenarios (see Microsoft's case study on page 19 for further details) [3].

Trend 3: Risk to water supply motivates innovation at data centers

Technology companies are increasing expanding and relying on cloud-based technologies, or data centers. By 2020, the United States will require approximately 4,000 more data centers to remain optimally functional with projected cloud-usage growth [1]. A hidden sustainability challenge of this growth is water consumption. Data centers need to maintain a consistent cool temperature. This requires air conditioning, which is either an energy or water intensive technology [2].

Impact of Data Centers

Data centers across the globe utilize in total more electricity than the country of Iran [3].

In 2014 data centers in the US consumed 165 billion gallons of water, comparable to a week of water use for Washington state [4,5].

The two most common forms of data center cooling are liquid cooling or air cooling [6]. Liquid cooling is water-intensive; water runs behind a barrier near data storage units to absorb the heat created by the processors and other electronics [6]. Air cooling on the other hand is electricity-intensive; it utilizes electricity to power air conditioning systems which separate the cool and warm air from each other [6]. Often times the hot air is released into the environment, which can cause a localized warming effect [7]. Liquid cooling is a much more efficient cooling method than air as this process can be maintained in a closed looped system and water can be recycled and reused for further cooling [7]. Additionally, water has the added benefit of being more affordable than electricity and produces less greenhouse gases [7]. This combination of benefits has caused data centers to favor water-intensive cooling methods over electricity-based ones.

This choice can present a problem when data centers are located in water-stressed regions. Water stressed regions are identified within the industry with the assistance of programming software, the most notable being WRI Aqueduct [8]. This tool combines indicators ranging from drought severity to media coverage of water issues into an overall water risk score for locations around the world (see Figure 2 for map of US). Companies are adapting their water conservation and management strategies to have more stringent conservation standards in these risk-prone areas.

They are motivated by two factors. First, companies are concerned about the continued availability of water for future operations. Water risk is a key concern given the volatility of the climate due to global scale climate change. Additionally, data centers are facilities of immense financial investment and would have devastating impacts if deemed inoperable for potentially millions of cloud users. From a stakeholder perspective, data centers and their management are of increasing concern and necessitate stability.

Secondly, companies are conscious about the impact that their activities have on neighboring communities. The water that data centers use using often comes from the same source as drinking water. Therefore, if a company depletes water resources, its workers and neighbors will also be directly negatively impacted. Companies do not want that publicity fall-out. During our review we found that seven out of the 12 companies researched have expressed explicit concern for community prosperity connected to water use.

The remaining companies have mentioned implicitly their concern for human rights issues. This concern is exemplified in the alignment of company water goals to the United Nations Sustainable Development Goals (SDGs). The SDGs call upon businesses to perform as good actors with consideration for human rights; which includes how water use is affecting the surrounding communities [9]. Industry response is expressed through the multitude of community partnerships and groundwater recharge programs that companies establish within water-stressed regions as a form of mitigation. Their engagement tends to be implemented directly in the geography of extraction, benefiting communities that might otherwise be negatively impacted by the company facilities. Thus, the company is providing water stewardship in addition to employment opportunities in the region. See the Microsoft and IBM case studies for examples of how two tech companies have factored this concern into their decision-making.

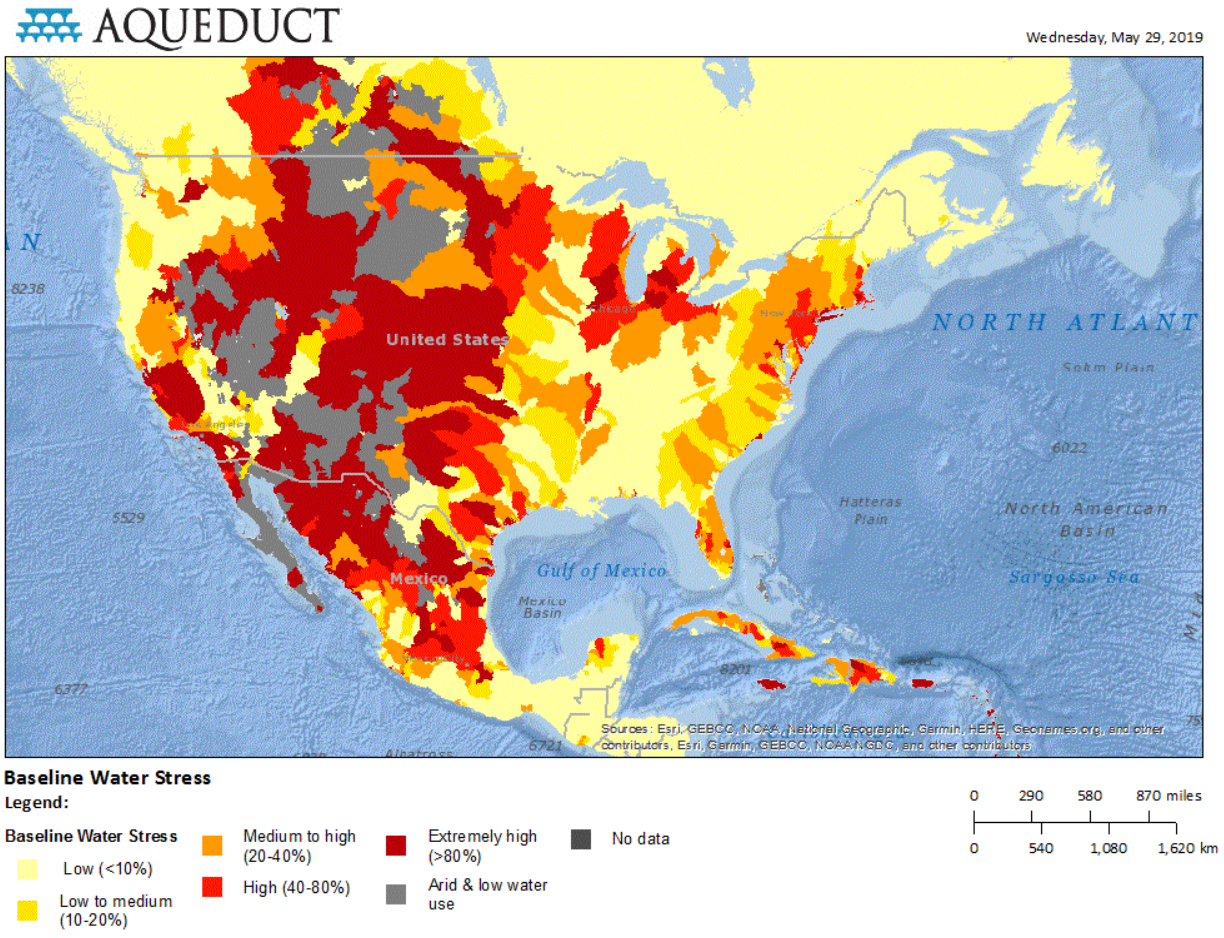


Figure 2. *WRI Aqueduct Baseline Water Stress map of the US [8].*

Trend 4: Water data is collected monthly but only reviewed annually by top leadership

Throughout all of the companies we interviewed, we found that water data is collected at minimum monthly. However, the interval that this information is reported up the management chain is far longer. For several companies we interviewed it was only once a year.

Sustainability departments are typically composed of a team of people that report to a managing sustainability officer or director. For companies with a large sustainability portfolio, that team might be broken into other subteams which specialize in a particular issue like water. Water usage data is typically received by this team (or subteam) and reviewed monthly, or more frequently if collection methods support that. For larger companies with multiple manufacturing facilities a real estate team is often involved as a middle-man. They are the ones that receive the billing information, which they share with the sustainability team. The sustainability team then reviews the information within their direct influence quarterly, while water data within Tier 1 facilities is reviewed more often- on a monthly rather than quarterly interval. Because usage data comes from municipal billing, the real estate team receives the water data first and then shares the data with the sustainability department. The data is compiled and analyzed by the sustainability department and from there certain metrics would be shared with the C-suite of a company.

It is not uncommon for the information to only stay within the sustainability department. The sustainability department may make small changes, like telling the building manager of a particular facility that they likely have a leak when usage rates go abnormally high, but rarely will they synthesize the data and take it to executive members of their company. That type of information sharing typically happens only once a year.

When the executives review the data they have typically been rolled up across all facilities and operations. They do not see raw data and do not make decisions on a building by building basis. Instead the data are translated into metrics that demonstrate progress towards company CSR goals, which have been outlined in a publicly available document. The objective of their review is to determine if any big, large-scale strategy changes need to be made. The executives are ultimately responsible for ensuring the company delivers on its sustainability promises. As sustainability grows in popularity, executives have even started to have their compensation tied to the company's sustainability performance, much like had already existed for financial performance [1].

The intention of this review is good, but the frequency of information sharing could present a problem since it only allows for major course correction once a year, which may be too infrequent. Regular progress reports and decision-making are necessary to evolve water sustainability within a company to reach internal goals and maintain efforts to combat global water scarcity. As discussed under Trend 2, we are likely to see an increase in submetering which will result in a shorter interval of water usage reporting. It will be interesting to see if this will translate to a more frequent interval of reporting up the management chain.

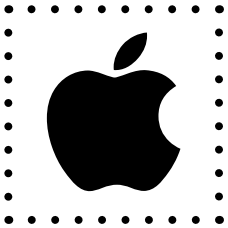
Apple

Apple is one of the most valuable technology companies in the world, topping almost every list from net worth to brand loyalty. The company's sustainability performance is similairly impressive, and can be attributed to its ambitious environmental goals and the high standards that it holds itself to. The company is comfortably ahead in achieving its sustainability targets, recently reaching its 100% renewable energy goal in 2018 [1].

Apple's supportive groundwork for innovative strategies has allowed for major accomplishments by its water department such as its water recycling program, the Clean Water Program. Initiated in 2013, the Clean Water Program was devised as a method for Apple's suppliers to be more responsible for how they discharge water [2]. Within this program, Apple mandates risk assessments and analyzes water withdrawls by its suppliers' facilities with the WRI Aqueduct Tool to determine areas where water could be more sustainably used. This information allows Apple to help suppliers not only meet local regulations, but comply with Apple's sustainability standards as well. With an increase of 51% in audits within the first year of the program, Apple has reported that between 75% and 99% of all of its suppliers are in compliance with its water standards [2]. Its annual Supplier Responsibility progress report outlines the details of these audits in addition to other supply chain components -- a report just as expansive as its yearly CSR.

75-99% of Apple's suppliers are in compliance with its water standards

Apple's water reporting sheds light on third party sources of water usage and has set an exemplary model for supplier responsibility among other tech corporations. The Clean Water Program has enabled Apple to reduce the water input for the lifecycle of its products as well as to improve the water footprint of other companies its suppliers service. By its own high expectations for water consumption, Apple has set a prime



example for other companies to take greater responsibility for their water and other environmental footprints.

However, Apple has acknowledged that the location of many of it supply chain facilities outside of the U.S. makes the management and tracking process more challenging. Often times, Apple must rely on its supplier's self-reported data. Despite Apple's efforts to be as integrated into its suppliers data as possible, disclosure of water use data is ultimately up to the suppliers' discretion. This means in order to spare itself any unwanted press, suppliers may limit the transparency of their operations to big companies like Apple.

Apple uses third party companies and the WRI Aqueduct Tool to collect data on both its supply chain as well as its own corporate water use. These tools not only record data but help Apple forecast and allow them to better plan future facilities and initiatives that tackle potential areas of concern. As an example of this, Apple consults the water risk maps prior to locating new facilities to better inform these decisions, and mitigate water impacts for those sited in drought-prone areas. This proactive and deliberate planning helps Apple lower its water footprint in all three classifications of its water consumption: data centers, retail, and corporate.

The deliberate and thoughtful approach to water planning is witnessed in the steps Apple has taken in its retail stores as well. Often water usage data for retail locations is limited, so instead Apple uses the square footage of the stores as a proxy to estimate usage. The company wants to improve the accuracy of this facet of its water use accounting, so they now require all new retail stores to include submeters that actively record data to receive more definite measurements of water use. Submeters have allowed Apple to more accurately predict the necessary amount of water that its facilities require and lower facility water footprints. The frequency of this data collection is generally dependent on the location, but is typically once a month.

Apple's attitude towards water consumption and its strong business foundation has allowed it to set and reach high standards of achievement. It has seen extremely positive results and been commended for the environmental impact and role modeling of its environmental department. As we are beginning to see other companies take responsibility in their roles as large technology companies, Apple's sustainability visions continue to expand and influence others to cultivate greener ways of life.

Hewlett-Packard

Hewlett-Packard Company, or HP, was founded in 1939 and is a leader in providing technology and solutions to personal and commercial consumers related to printing and imaging [3]. In 2018, they were awarded countless sustainability awards such as Corporate Responsibility's 100 Best Corporate Citizens, an award that recognizes companies that are the most transparent and successful in social environmental responsibility, and Energy Star Partner of the Year for its green and energy-efficient programs [4]. Sustainability is deeply rooted in the company's daily operations and is a major component of its mission.

Like many other major tech companies, HP uses a third-party software to collect water usage data for all of its utilities. And like many other tech companies, the method of collection varies depending on the type of facility. It strives to reduce its footprint in all facilities by requiring LEED certification for new buildings and renovations, installing low flow water fixtures, utilizing sustainable landscaping, installing smart water meters, and capturing rainwater [3].

HP uses the WRI Aqueduct Tool to identify and rank risk level of facilities located in water-stressed regions. This type of information is used to identify where water efficiency projects would have the greatest impact and is a big motivator to increase the use of recycled water. Its system of water reporting also includes the use of artificial intelligence that detects leaks to avoid water waste, a perfect example of how HP is investing in advanced technologies to reduce water consumption.

HP is proactive in integrating the data that is gathered by its operations and the WRI Aqueduct Tool to create programs for its facilities in high risk areas. Singapore, where one of HP's largest manufacturers of its ink cartridges is located, has been identified as a facility in a water-stressed region that also consumes a vast amount of water [4]. In an effort to counteract this, systems of rainwater capture for cooling towers were implemented and additional water meters were installed that better track water usage at the facility.

Internally, water data is delivered through quarterly reports to its Chief Operating Officer, the President of Strategy Business Management, where the sustainability program team presents the data in a way that exhibits the company's need to endorse water initiatives. This is done by creating program blueprints for the executives to sign off on that meet both economic and sustainability needs.

IBM

IBM has revolutionized how society relies and depends upon technology since 1911. Currently, it is a cognitive solutions and cloud platform company and its global capabilities include services, software, systems, and fundamental research and financing. IBM is listed as number 38 on the Fortune 500 list and has generated $79.6 billion in the 2018 fiscal year [5]. IBM is a leading performer in corporate water sustainability practices within not just its internal operations, but in its technological innovations to assist other companies engaged in sustainability practices, to enable understanding and preserving of water resources, and to improve access to water. These innovations leverage leading technologies such as artificial intelligence, internet of things (IoT), analytics, and blockchain, and are all delivered through IBM's cloud platform [6].

Within its own operations, IBM has focused on its footprint in water-stressed locations. It has utilized the World Resources Institute's Aqueduct Water Risk Atlas to identify those of its 45 facilities that are located in high risk areas and develop annual reduction goals for each [6]. Since 2016, water use by these facilities has decreased annually with a 6.6% reduction in 2016 and a 2.9% reduction in 2017 [6]. Further, all wastewater generated by these facilities is treated to meet local regulatory and IBM's requirements, whichever is more stringent, before being discharged into the receiving water systems from local municipality suppliers [7].

IBM also sets environmental requirements for its suppliers. Among those requirements are:

1. Establishing an environmental management system
2. Identifying the suppliers' own significant environmental intersections including energy consumption, greenhouse gas emissions, waste generation and water consumption
3. Setting goals, measuring progress towards them and publicly disclosing results

These requirements reflect IBM's belief and interest in helping its suppliers build capabilities and expertise to manage their own environmental responsibilities--the benefits of which then transfer onto their other business partners. To ensure this, IBM also requires its first tier suppliers to cascade the requirements to their suppliers who perform work that is material to the products, parts and/or services supplied to IBM.

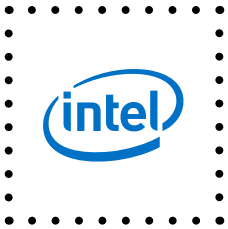
IBM boasts one of the largest research divisions in the private sector. This unique entity enables IBM to continually invent, innovate and disseminate technological advancements and know-how -- including those addressing sustainable development goals -- to assist its clients and society-at-large in becoming more efficient and reducing impacts on the environment. These technologies range from a precision irrigation system that helps clients reduce water consumption while improving crop yield, to using Watson cognitive capabilities to turn satellite imagery into actionable efforts in drought areas [6].

One example in more detail is the Jefferson Project [6]. This is collaborative project undertaken by IBM, Rensselaer Polytechnic Institute and The FUND for Lake George to model Lake George in New York — its depths and shoreline — to get a holistic and accurate view of everything happening in and around one of the United States' pristine lakes [6]. The goals of the project are multifold and include understanding and managing the complex factors impacting the lake from invasive species, pollution and other factors, as well as developing a template to use in other freshwater bodies around the globe.

Increasing irrigation efficiency

Using imagery from drought areas

Studying impacted lake systems



Intel

Intel specializes in making microchip processors and in data management to power cloud-based technologies. It is listed as 46 on the Fortune 500 with over $9.6 billion in revenue [8]. Water is a key component in its manufacturing process and has thus become a pillar within its sustainability programs. It launched an initiative in 2017 to restore 100% of its global water use by 2025 [9]. Intel plans on doing this through a combination of: conservation of water use, recycled treatment facilities on-site of manufacturing facilities, implementation of water conservator appliances within its facilities, and collaborations with the local community and shared watershed [10].

Intel has constructed wastewater treatment facilities at its manufacturing sites to reduce single use water. The company sends treated water for reuse within its facilities either as part of the manufacturing process or for irrigation. The remaining water is reintroduced to the local community's water management systems for non-potable uses.Intel returns approximately 80% of water withdrawals to their communities for reuse or to the local watershed [9]. The remaining 20% of water is returned to the global watershed through collaborations with other water intensive industries, such as agriculture, through the creation and implementation of technologies that would aid in water conservation [9]. The water users of these technologies save is projected to total the 20% Intel cannot directly restore to the global watershed [9]. The new projects initiated by Intel save approximately 1.3 billion gallons a year in the U.S.; this is in addition to the 3.5 billion gallons saved per year globally as a result of its recycling and conservation efforts [9]. The company has also seen cost savings with this initiative. Approximately $3 million has been invested into water projects which has resulted in $6 million in projected savings [9].

Furthermore, Intel has initiated water transparency throughout its supply chain. Intel may have a smaller supply chain than the other tech companies included in this report, since it often is a Tier 1 supplier itself, however that has not stopped it improving transparency in its own supply chain. As a result of its 2017 Program to Accelerate Supplier Sustainability, Intel requires CDP auditing throughout its supply chain [9]. It uses the WRI Aqueduct tool to identify suppliers located in a water-stressed region and then has them to answer the CDP questionnaire [10]. Recently 47 suppliers received the questionnaire, of which 44 completed the questionnaire [10].

Microsoft

Microsoft is a global technological innovator that revolutionized the interaction between humans and electronics. In 2018 Microsoft had $89.95 billion in revenue, placing it 30th on the Fortune 500 list [11]. Microsoft is a sustainability leader within the tech industry with its initiatives to reduce its carbon footprint by 75%, reduce energy usage at data centers, and integrate sustainability practices within its growth [12].

In regards specifically to water monitoring and conservation, it is a good performer within its industry. Microsoft monitors water usage throughout its Tier 1 suppliers and focuses on reducing single use water at data centers. However, its most notable contribution to water sustainability within the technology industry is its collaboration with EcoLab and Trucost to create the Water Risk Monetizer [12]. Established in 2014, this tool is an open-source and publicly available application that allows companies to calculate water risk and the associated financial risk under different expansion scenarios [13]. In creating this tool and allowing everyone else to use it free of charge, Microsoft has advanced the field of water sustainability far beyond its own footprint.

Microsoft has many water sustainability targets, and like many companies of similar caliber within the technology sector, the targets are aligned to the UN Sustainable Development Goals. Its targets highlight water sustainability, watershed management and stewardship, and reduction of effluent runoff and water contamination [12]. Its water initiatives promote conservation within three water intensive sectors: data centers, manufacturing processing, and real estate. Each of these sectors experiences unique difficulties with water conservation.

To reduce water use in its corporate buildings, Microsoft has created a stormwater capture program at its Silicon Valley campus, yielding net-zero water usage [14]. This is a first for the tech industry.

In its product manufacturing, Microsoft focuses on engaging its supply chain. It is well-known for being a good performer when it comes to auditing its Tier 1 manufacturers. Resultantly, two thirds of Tier 1 facilities contracted under Microsoft have replied to water surveys [15]. Furthermore, it requires that 95% of its Tier 1 facilities provide a CDP report regarding water use [14].

However, the most notable initiative towards water conservation is at Microsoft's data centers. It is using a systems-based approach which combines many inputs for more progressive water savings. Microsoft uses multiple auditing systems, such as the WRI Aqueduct as well as the Water Risk Monetizer it co-created [15]. These programs enable it to determine if the data center is in a water stressed region (WRI Aqueduct) and then calculate the risks and financial cost of water scarcity (Water Risk Monetizer). This knowledge then leads to informed decisions on how to promote the longevity of its data centers and the protection of the surrounding water basin. Combined with daily water use date, Microsoft is able to determine water risk on a frequent basis.

Xerox

Founded in 1906, Xerox has maintained its reputable name and place at the top of its field in providing printing and digital services to its consumers. Today, Xerox is a comparatively smaller tech giant, with only five operating facilities worldwide. The structural differences among Xerox's facilities create uniquely different habits of water reporting compared to the larger tech giants it competes with. Despite this size difference, Xerox has created green initiatives and major sustainable goals for its company based on the same principles as its competition.

The bulk of Xerox's water consumption is located in its Rochester, NY location, where a third-party data collection system records water usage. Most of the other Xerox facilities gather water data through metering and submetering for localized water improvement. This data is reviewed twice a year on a corporate level and quarterly among staff at the manufacturing facilities. These quarterly meetings with manufacturers promote follow-up from the data collection at its sites and on the goals the individual manufacturers and Xerox have set for themselves. As this operational component of Xerox contains the bulk of its water consumption, Xerox does not report on water consumption in its supply chain [16].

Each of Xerox's five locations analyzes its own data for its operations and often does not share it with the other facilities. Thus each location is fundamentally independent from the others in a sustainability sense and initiatives to lower water footprint are established by and implemented at individual facilities. In general, facilities in water-stressed areas have more advanced conservation targets; outside of these areas conservation efforts focus on energy. Xerox's overall objective is to take action where they can make the biggest change. Environmental Operations Managers at each location compile data to be shared with headquarters and reported on as a whole using the Global Reporting Initiative (GRI) standards, and shared with entities such as the Dow Jones Industrial Sustainability Index.

Clean water is essential to Xerox's operation as it is used in its manufacturing processes and for cooling those facilities [16].

A modernized, environmental switch Xerox manufacturers have made is from its legacy toner to its modern toner. The modern toner business makes the product through Emulsion Aggregation (EA). EA toner produces small, uniform toner particles that are then filtered through an aqueous process [17]. This is a water-intensive process, more than the previous production method which relied more heavily on energy. To counter the spike in water consumption of the switch, Xerox's aqueous process reuses water in a closed-loop system, saving a significant amount of water. Xerox also uses OIT to closely monitor and adjust cooling towers at its manufacturing facilities, which reduces water use and helps offset the increase in water consumption by the transition to the EA toner process.

Xerox's transition to a water-based toner business is an example of the trade-offs between environmental commodities that companies must choose to make. Energy and water are closely interlinked; both resources are often used in different manners to achieve the same outcome. For Xerox, saving energy means using more water in the toner process. Trade-offs at each company are inherently different; they are dependent on the goals, the available resources, and the corporate and consumer benefits.

AT&T

Unlike the other companies included in this report, a large part of AT&T's sustainability initiatives are centered around its advanced technology and how the company can apply that technology in the community around it. AT&T has earned great praise in not only areas of sustainability, but also for its volunteerism, philanthropy, and diversity in the workplace [18]. Its sustainability goals for the next decade are ambitious. For example, the company has a target to save the world 10 times the amount of their annual carbon footprint by 2025 through increasing the efficiency of its networks and helping its consumers reduce their own carbon footprint [19]. The advanced solutions that AT&T has developed for its consumers to lower their environmental footprint as well as its own is a new and original concept to combat water scarcity everywhere.

"the company has a target to save the world 10 times the amount of their annual carbon footprint by 2025"

AT&T identifies its areas of concern through the World Business Council for Sustainable Development, or WBCSD, Global Water Tool. It uses this data in addition to the information it collects from its facilities to improve water withdrawals in drought-prone areas [20]. The Smart Watering system is one approach that alleviates the stress in these regions. The objective of AT&T's Smart Watering system is to purposefully use water in agriculture. Farmers with a Smart Watering and Smart Irrigation system installed can reduce their water usage without physically tending to their crops by a device developed by PrecisionKing [19]. These devices water crops based on the needs of that plant in real time [19]. Farmers Jim and Sam Whittaker in Arkansas have lowered their water usage by up to 60% using PrecisionKing, saving them a significant amount of money everyday [19]. AT&T's collaboration with the Global Environmental Management Institute (GEMI) and the Environmental Defense Fund (EDF) provides AT&T consumers a service similar to that of PrecisionKing but on a broader level. WaterMAPP is a set of tools designed for consumers to be able to construct sustainability models of their own including branding and auditing [21]. And to show the quality of the services that they are providing for its customers, AT&T employs these services within its own company.

CenturyLink

CenturyLink is a global telecommunications provider and is ranked 132 on the Fortune 500 list with approximately $23 billion in revenue for the 2018 fiscal year [22].

CenturyLink is the second largest telecommunications provider in the world and has the capability to serve approximately 50 million people with internet service in the United States alone [23]. CenturyLink is ranked 64 in Barron's List of the 100 Most Sustainable Companies by Calvert Research and Management [24]. Given the expansive nature of its company and high sustainability rank, the lack of transparency CenturyLink provides in regards to its sustainability initiatives and processes is shocking. In its 2017 and 2018 CSR Reports, among the only publicly accessible sustainability reports by CenturyLink, no water management or conservation policies within the company are publicized [25, 26]. Additionally, CenturyLink has not disclosed a CDP Water report and within the CDP Supply Chain reports, it has opted to decline to disclose information regarding to its water use within its supply chain. This is a sharp contrast to the other telecommunication companies we researched for this report including AT&T, Cisco Systems and Motorola Solutions.

One location where CenturyLink excels in sustainability is its CenturyLink Field in Seattle, Washington [27]. Intense water conservation measures have been established there such as high efficiency hygienic appliances and reclaimed water for irrigation of the field [28]. It is commendable that CenturyLink is promoting water sustainability practices and establishing a industry norm within sport fields.

Century Link Field

Cisco Systems

Cisco Systems is a networking hardware company that develops telecommunication products and services. Its impressive rank on Barron's 100 Most Sustainable Companies as the top technology company for the second year in a row speaks to its environmental sustainability goals. Despite the eager nature of the company to improve efficiency and sustainability in all areas, they have reported year-to-year increases in water consumption since FY14 [28]. This likely indicates a growth in production. The company has instituted a number of water conservation initiatives to counteract this such as using irrigation controllers, using reclaimed water in cooling and landscaping, and implementing drip irrigation to increase efficiency [28].

Cisco is ranked as the #1 technology company by Barrons 100 Most Sustainable Companies

Water is primarily reported through the World Business Council for Sustainable Development (WBCSD) Global Water Tool. Similar to the WRI Aqueduct Tool, this is a tool that works to highlight areas at risk. 70% of Cisco's facilities are categorized as high or extremely high water consumers. This is compounded by the fact that its two largest facilities, located in Bangalore, Singapore and San Jose, California, are both geographies of "extremely high" baseline water stress (defined as when withdrawls are 40-80% of total annually available blue water in an area) [28]. These facilities account for 65% of its water use. Cisco holds water consumption at these facilities to a higher standard, however the company's water footprint is still struggling to match its goals [28].

Sustainability information at the company is maintained by the Sustainability Executive Team (SET). The SET acts as Cisco's environmental department, collecting relevant environmental data and relaying it to the company's Board of Directors through the COO, a "sponsor" of the SET [29]. The COO also meets quarterly with the Corporate Responsibility Committee (CRC), which is tasked with enforcing water initiatives and regulating water risk within Cisco. The CRC handles the majority of the research, synthesis of data collected from suppliers and manufactures, and addresses inquiries and concerns from stakeholders [29]. Collectively, the SET and CRC bring together the necessary components of Cisco's water consumption data to push the initiatives that we see implemented today.

Motorola Solutions

Motorola Solutions is a telecommunications company which placed 416 on the Fortune 500 list and generated revenues of $7.3 billion in the 2018 fiscal year [30]. From its online documentation it seems that the company is in the early stages of its sustainability journey. This may be because its facilities are predominantly located in regions that are not undergoing water stress. Motorola only began its water initiatives in 2015, but has already seen withdrawals reduced by 49%, with 25% of that occurring within the 2017 fiscal year [31]. This reduction was a result of a targeted approach by the real estate team to LEED certify its facilities and promote water-saving sanitation technologies [32].

The company uses contract suppliers for most of its manufacturing so its water use and challenges are different from many other companies profiled in this report. It does requires its Tier 1 suppliers to complete audits to analyze their general environmental and water stewardship. Its latest environmental risk assessment had 182 responses which contributes to approximately 83% of its supply chain spend [31].

Texas Instruments

Texas Instruments (TI) is a global semiconductor company that serves manufacturers. TI upholds the environmental responsibility of the tech industry in its company through the strategic design of its products, making its consumers' manufacturing processes greener, too. One of its primary water concerns is water quality; manufacturing semiconductors requires deionized water, a very pure form [33]. TI has taken this as an opportunity to design more efficient water purifying technology to use at its facilities. It has first focused its efforts on lowering consumption and then on reuse and recycling [33, 34]. This policy has extended beyond manufacturing to landscaping, where the company uses xeriscaping and native or drought tolerant plants [34].

For risk assessment and forecasting, TI uses the WRI Aqueduct Tool along with its own internal company methods of reporting water data and reports through the CDP [33]. Although TI recognizes that it has facilities that are located in drought-prone regions, it does not take special actions to mitigate the water consumption in those regions [35]. However it states that close monitoring of the evolving water needs allow it to accurately predict and prepare to supply the sufficient water requirements of TI manufacturers and better construct programs to continue lowering water usage.

Western Digital

Western Digital Corporation is a technology-focused company that manufactures storage and cloud-based systems like data centers. Western Digital places 152 on the Fortune 500 list with revenues of approximately $20 billion in the 2018 fiscal year [36]. Western Digital was chosen for this company spotlight due to its similarities in technological services offered all the while having contrasting approaches towards water sustainability.

It is important to mention the lack of publicly shared reports on the sustainability practices and measures Western Digital has taken within its company. Western Digital does not disclose a public CSR report and the literature of focus for this company spotlight is its CDP Water 2018 report. From the literature review conducted for Western Digital, it became evident that this company was on the pathway towards the industry norm for sustainability practices.

The practices that the company employs are:

- Utilizing the WRI Aqueduct to analyze the water risk for its facilities; it has determined three of its facilities are susceptible to water risk.
- Utilizing 20.5% recycled water within its supply chain processes.
- Decreasing water withdrawals by 8.5%.
- Implementing a Resource Conservation Program which addresses the risks associated with water use in scarce regions. This program has initiated targets to reduce water use by 1% from the previous year. However, it is important to note that this target has not been reached [37].

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