WATER EXPLORATORY TO INFORM THE NEXT SUSTAINABILITY PLAN

PREPARED FOR

Jessica Prata and Helen Bielak

Environmental Stewardship, Columbia University

PREPARED BY

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Workshop for Sustainable Development

Table of Contents

DEC 18, 2019

Jessica Prata and Helen L. Bielak
Environmental Stewardship Office

423 W. 120 Street, Suite 7
New York, NY 10027

Dear Jessica Prata and Helen L. Bielak,

Re: Water Exploratory Final Proposal

Please find enclosed our detailed final proposal for your kind consideration.

Following our final presentation on the 3rd of December, 2019, we would like to present a final report summarizing our conclusions and recommendations for the 2020 Sustainability Plan.

We cover an in-depth literature review about water conservation efforts currently being conducted at other American universities, Columbia's current efforts to reduce water waste and increase water conservation efforts alongside the Year of Water, and an audit of two Columbia buildings to assess our current water use. We also include a comprehensive report on plastic water bottle use, including a literature review on drinking water habits across America and in other universities, and data on Columbia students' drinking water preferences. We include a list of plastic bottle alternatives, and recommendations on marketing initiatives to promote reusable bottle use.

Please find the recording of our final presentation in this link:
https://youtu.be/D9caGh0LHIQ

Finally, we want to thank you in advance for your time spent reviewing our proposal. It has been a tremendous pleasure working with you all throughout the entirety of the semester.

Yours Truly,

Gigi Bat-Erdene, Sangwoo Jeon, Maya Matthews, Carolina Rabbat and Amber Swinarski

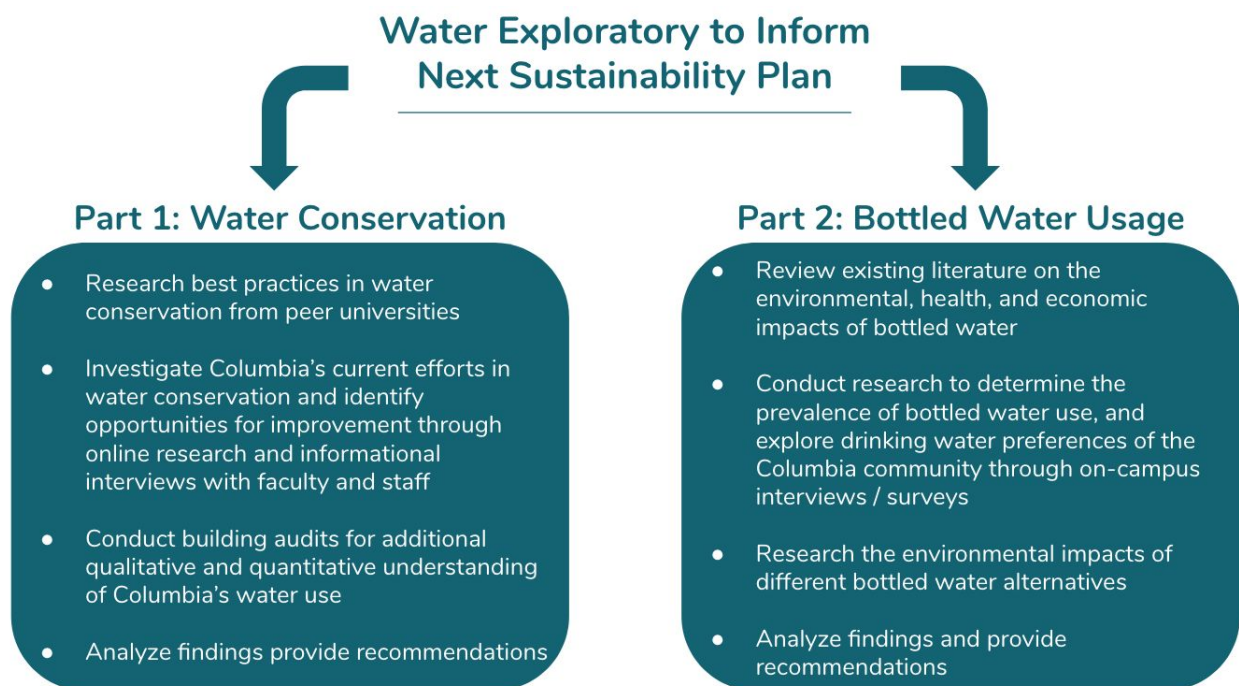Carolina

PROJECT OVERVIEW

The overall goal of this project is to inform key decision-making processes regarding water on campus.

The following objectives were established to accomplish this:

- **Determine best practices for water conservation in the university setting and how Columbia can best improve upon its current efforts.**

- **Provide recommendations for movement away from bottled water use on campus.**

- **Establish potential goals to inform the 2020 University Sustainability Plan and offer ideas and methods for implementation.**

In order to provide informed recommendations, the group utilized a variety of tools to gather information. Methods included collecting background research, conducting surveys and interviews, gathering quantitative and qualitative observations, and participating in water-related events.

To best make sense of our broad goals and varied research methods, the project was split into two workstreams:

Water Exploratory to Inform Next Sustainability Plan

Part 1: Water Conservation

- Research best practices in water conservation from peer universities

- Investigate Columbia's current efforts in water conservation and identify opportunities for improvement through online research and informational interviews with faculty and staff

- Conduct building audits for additional qualitative and quantitative understanding of Columbia's water use

- Analyze findings provide recommendations

Part 2: Bottled Water Usage

- Review existing literature on the environmental, health, and economic impacts of bottled water

- Conduct research to determine the prevalence of bottled water use, and explore drinking water preferences of the Columbia community through on-campus interviews / surveys

- Research the environmental impacts of different bottled water alternatives

- Analyze findings and provide recommendations

The final section of the project seeks to highlight high-level recommendations that are not specific to either workstream and provide guidance for next steps.

PART 1: WATER CONSERVATION
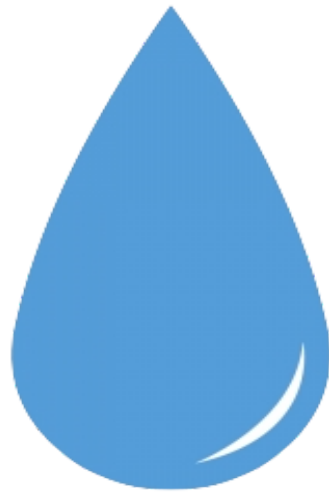
This section aims to establish a baseline for Columbia's current water use and conservation efforts in order to identify areas for improvement. Qualitative and quantitative information was gathered to learn more about what water use and water conservation looks like at Columbia, and how this compares to the work of its peer institutions. Findings and recommendations are provided at the end of this section to determine the areas Columbia should focus its future efforts in water conservation and outline what the next steps could look like.

Amber

ROADMAP

PART 1: WATER CONSERVATION

Determine best practices in water conservation in the university setting:

- Research on Practices of Peer Institutions

Understand current water use and water conservation efforts at Columbia:

- Research of Columbia's Water Conservation Efforts
- Interviews with Faculty and Staff
- Building Audits

Analyze results and provide guidance for next steps:

- Findings and Recommendations

Research on Practices of Peer Institutions:

The objective here was to research best practices in water conservation in the university setting and answer the following questions:

- What does Columbia do well compared to other institutions?
- Considering what peer institutions do well compared to Columbia, what opportunities does Columbia have to improve and explore?

Selection of peer universities: Peer universities in the US were selected for study based on a number of factors including proximity to Columbia, awards / recognition in water conservation practices, and similar challenges to those of Columbia. The starting point for determining which universities to look at was the overall ratings as well as the rankings within the "Water" category from the Sustainability Tracking, Assessment, and Rating System, also known as STARS. STARS is a system created by the Association for the Advancement of Sustainability in Higher Education (AASHE) and has compiled sustainability reports of nearly 1000 institutions. The universities selected for study consisted of Stanford, University of New Hampshire, University of Connecticut, Harvard, Princeton, and NYU.

Research criteria: During research, the areas explored include but were not limited to measurement and effectiveness of water conservation efforts, education and outreach efforts, and implementation of innovative ideas. Key findings are summarized in **Appendix A** and best practices are listed below.

Best practices:

- **Safe, reliable, and readily available drinking water supply**
    - Campus water supply is high-quality and campus users understand it as such
    - Water refilling stations are easily accessible
- **Upgrade to water-efficient facilities**, including toilets, showerheads, and washing machines
- **Emphasis on marketing, education, and engagement**
    - Sustainability goals are clear and progress is made publicly available
    - Sustainability website contains relevant and user-friendly information
    - Relevant faculty research and efforts of students groups are promoted
- **Water use is measured and made publicly available**
    - Allows institutions to track progress towards goals and be recognized by rating systems like STARS
    - Demonstrates transparency to the public and the campus community
- **Pursuit of greywater reuse efforts**

Amber

Research on Columbia's Water Conservation Efforts:

Current efforts:

- Upgrades to water-efficient facilities and installation of water refill stations in many residence halls and academic building
- Trayless dining in dining halls
- Reusable water bottles supplied to new undergraduate and graduate students during Columbia's orientation week
- Buildings on the new Manhattanville campus are LEED certified and individually metered, allowing for more efficient water use and easier tracking

Areas for improvement:

- Lack of resources surrounding water conservation on Columbia's sustainability website
- Language surrounding leak reporting ties into mold prevention but fails to mention water conservation as a reason to report known leaks
- Lack of transparency surrounding Columbia's water use data and insufficient reporting / recognition of current efforts on STARS
- Columbia is not currently pursuing any known greywater reuse projects

Current challenges:

- Much of Columbia's water data on the Morningside campus is manually recorded due to old infrastructure and a lack of individual meters which make it difficult to measure / track water use associated with specific buildings

Amber

Interviews with Faculty and Staff:

Interviews among faculty and staff were scheduled to further inform us as we entered the process of building and enacting a qualitative and quantitative measurement of water usage on campus. Conducting an audit would be the most practical method of achieving such measurements of water usage at Columbia, but two interviews with Columbia University faculty members: Dr. Upmanu Lall and Mr. Peter Michaelides enabled us to understand what the future of water may look like at Columbia, juxtaposed with the current manner of water usage and distribution on campus and in the larger metropolitan city of New York.

Interview with Dr. Upmanu Lall:

Dr. Upmanu Lall enlightened us with information regarding the Water Center's role in shaping water use around the world, as well as Columbia's significant contribution to water related research. Professor Lall seemed immediately intrigued by the prospects of our planned audit, and offered advice on how best to conduct meaningful analyses of Columbia's water usage and conservation efforts. He also made several salient suggestions regarding how internal research can help shape water conservation at a metropolitan level in New York City.

One of his suggestions for the university at large in terms of shaping external water conservation and distribution tactics coincided with current areas of focus for the Water Center's research. An in-depth comparative case-study analysis of some of the major water systems in metropolitan cities across the United States would reveal that the US is a leader in water services around the world, but improvements can still be made. Like Columbia's water system, the infrastructure in place for the distribution of clean water across vast areas, especially in metropolitan cities, have aged tremendously since their first implementation. However, given the costliness of replacing aging infrastructure, cities, organizations, and institutions looking to reform water conservation and distribution methods should look to **technology** as a major cost-effective way to enact the change they wish to see.

Examples of such technological innovations included

- sensors installed in the faucets themselves to give readings of data in real-time
- cyberinfrastructure for water distribution and quality that enables a synthesis of data into predictions and models treated by variable scenarios
- innovations in water collection and treatment that could be performed more locally, in a more distributed fashion
- utilities that could integrate rainwater harvesting, local groundwater usage, point-of-use treatment, and water reclamation and reuse

The priority for institutions like Columbia, as Professor Lall mentioned, should be the **data**. The audit conducted in this project should therefore be a commentary on the data available, alongside how to increase the speed of data available regarding water usage of different

Maya

categories of buildings (residential, multi-purpose, academic, athletic, etc.). In the future, the university's decision making and implementation processes regarding water should all be driven by data, or at the very least, the desire to collect as much data as possible to inform the university as it makes strides to become a leader in water conservation and sustainability.

As such, the audit took shape from a desire to collect various forms of data about Columbia affiliates' relationship with water. Inspired by Professor Lall and the Water Center's research methods around the world, we conducted a basic census of the buildings we selected for the audit – capacity, number of faucets, showerheads, toilets, washing machines, dryers, profile of the usage of water in the building, typical user profiles, etc. We sought to collect data on average water usage in the building over the last year, identifying trends in water usage such as seasonality. We utilized hard quantitative data from Columbia University Facilities & Operations and paired it with our qualitative findings from interviews and water taste tests to paint a holistic picture of water usage across campus.

Interview with Peter Michaelides:

Mr. Peter Michaelides focused on the structural nature of water distribution at Columbia. The Columbia Morningside Campus has maintained a water system with antique infrastructure; the pipes, on average, were installed circa World War I, making it a very costly feat to replace the pipes on campus as a whole (see: *Interview with Professor Lall*). Furthermore, the Morningside campus' water infrastructure was created to distribute water around campus to residential and academic buildings on a continuous loop, such that there are only a few select buildings that are individually metered for instantaneous fluctuations in water consumption. For this reason, when the data around water usage reflects something like a broken toilet, Mr. Michaelides and his team rely on users in the building to report issues and document where exactly they are located within an online system. If they go unreported, individuals in facilities and operations scour the Morningside campus in search of what can occasionally be a singular, malfunctioning toilet.

In conducting cost-benefit analyses regarding changes that could provide significant benefits to water conservation on campus, Mr. Michaelides and his team have found a combination of low hanging fruit solutions, as well as longer term, large scale solutions. Like Professor Lall, Mr. Michaelides has found that **data-driven decision making** will be the best way to address these challenges and has already begun looking to technological innovations to drive the change the university wishes to see in this regard.

One way Mr. Michaelides has gone about utilizing technological innovation and data-driven decision making is through the newly created **Energy Management Information System,** a technological tool that connects people and institutions to actionable insights that project to measurable fiscal and environmental returns. The EMIS tools, which went live in November, include advanced energy information systems, benchmarking and utility tracking tools, equipment-specific fault detection and diagnostic systems, automated system optimization, and building-automation systems -- all of which have cloud-based accessibility. Because all water meters have been entered into the EMIS system already, Mr. Michaelides and his team will be

Maya

able to do more benchmarking by square footage, and draw comparisons to other benchmarking outside the Columbia University portfolio of 240 buildings to buildings of similar density, structure and purpose in the greater New York City and tri-state area.

Mr. Michaelides aided our team in the process of building our audit by identifying three residential buildings on the Morningside Campus that are individually metered: Furnald Hall, River Hall, and the 600 West 113th Street Brownstone. He also suggested some metrics that would potentially provide insights, such as building density, information about the nature of usage that is more in-depth than typical nomenclature (i.e. "residential," "multi-purpose," etc.) the number of water efficient devices within the buildings, and a general profile of tenants of the building – who they are, how much water they typically use, the qualitative characteristics of their water usage, and other similar metrics.

The audit that emerged from this interview was influenced by an inherently qualitative perspective. There are 19 undergraduate residential buildings on Columbia University's campus, each having very different profiles based upon the tenants that live there. What impact does the purpose and tenant profile have on the consumption of water in the building and the aggregate campus consumption of water for the entire campus? We built such questions into the methodology of the audit, integrating an analysis of usage of water in Lenfest Center for the Arts, a non-residential building, as well as multiple interview studies, a water taste test, and a Water Footprint Calculator survey (specific to residents of Furnald Hall) in order to address some of these questions.

Building Audits:

The building audits were utilized as a research tool to gain a better qualitative and quantitative understanding of how water is used around campus. Two buildings were selected for audits: Furnald Hall and Lenfest Center for the Arts.

Furnald Hall:

Selection: Furnald was selected for audit because it is one of the only buildings on Columbia's Morningside campus that is individually metered, meaning that data on water use in this specific building would be available for analysis. Additionally, Furnald is a residential building, which would therefore provide a snapshot of how water is used among Columbia undergraduate students who live on campus.

About Furnald:

- Undergraduate residence hall
- Mainly houses first and second year students
- Total occupancy: 246 (190 singles rooms and 28 doubles)
- 10 residential floors with communal bathrooms and kitchens
- Laundry room located in basement

Facilities: Furnald's facilities include water-efficient sinks (97), showerheads (53), toilets (53), and washing machines (6). There are also water bottle faucets (10) in sinks located throughout the building, in addition to two water refill stations.

Quantitative Analysis - Furnald Water Meter: Due to Furnald's individual water meter, data on specific metrics, such as total indoor water use per month, was able to be accessed. Looking at how water use changed as students went home for breaks, it was observed that Furnald's water use decreased dramatically when students were not on campus. It could be then assumed that nearly 100% of Furnald's water use is attributed to residents. Additionally, it was observed that water use in Furnald is used at a relatively constant rate and does not vary seasonally during the academic school year. For visuals, see **Appendix B**.

It was therefore appropriate to divide total monthly water use by the number of residents to determine water use per resident.

Water Meter Findings:

Total monthly indoor water use in Furnald Hall:

~ 238,000 Gallons

Average indoor water use per resident per day in Furnald Hall:

~ 32 Gallons

According to Furnald's water meter, the average resident uses ~32 gallons of indoor water each day. Indoor water is water used for cooking, cleaning, bathing, laundry, etc.

Average indoor water use per resident per day in Furnald Hall:

~ 32 Gallons

VS.

Average indoor water use per person per day in America:

60 Gallons

This is significantly less than the average American, who uses approximately 60 gallons of indoor water each day. In interpreting these results, however, it was important to note that this likely paints an incomplete picture due to the fact that many first and second year undergraduates utilize Columbia's meal plan. This means that cooking and cleaning dishes would not be counted under Furnald's meter and would instead be counted at a dining hall.

Aside from this, additional reasons behind the lower water usage in Furnald could be attributed to Furnald's newer facilities. These facilities are more water-efficient than many American homes. Moreover, the small rooms inside Furnald require little cleaning.

Water Footprint Calculator: To give additional color to the quantitative analysis on Furnald's water meter data, Furnald students were also asked to fill out a survey that would estimate and break down their water use based on the answers they provide. The

WATER FOOTPRINT®
CALCULATOR

Water Footprint Calculator (watercalculator.org) provides a snapshot of how a person's daily activities and routines impact their water use. The results, reported as a water footprint, are meant to be an estimate that can help people better understand how their habits and behaviors contribute to their overall water use. The Water Footprint Calculator also allows users to compare their water use in each category to the average American. While the tool separates water use into "Indoor," "Outdoor," and "Virtual," our analysis focused only on indoor water use.

Water Footprint Calculator Methodology, Findings, and Comparison to Meter Data:

37 students were sampled, entering their own estimations of average water usage (e.g. shower length, frequency, etc.). Findings are summarized below:

Average Student's Water Footprint Profile

Indoor Water	Student Gallons per day[1]	US Avg Gallons per day[2]
Shower	20	12
Bathtub	0	1
Bathroom Sink	12	4
Toilet	5	19
Kitchen Sink	6	7
Dishes	0	1
Laundry	8	15
Total	51	59
Actual	32	59

1) **"Student gallons per day" are based on the Water Footprint Calculator estimations, with the exception of the last row, showing Actual Water Use, which is based on data collected from the Furnald water meter.**
2) **All "US avg. gallons per day" are based on findings from the Water Research Foundation.**

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According to the results of the Water Footprint Calculator, the average Furnald resident uses 51 gallons of water per day. Students who took the survey did not note any water use for cooking or dishes, meaning the categories of water use correspond between the two methods for analysis. This makes a comparison between the water meter and the Water Footprint Calculator appropriate.

When comparing the meter and the Water Footprint Calculator, it was revealed that the average Furnald resident overestimated their actual water usage by 19 gallons per day. Several potential explanations for this include access to highly-efficient facilities and students overestimating the frequency in which they do their laundry.

Lenfest Center for the Arts:

Selection: The LEED-certified Lenfest Center for the Arts was selected for Audit because it is one of the newly designed buildings on the Manhattanville campus, and as such, is currently individually metered. The building is also equipped with diverse multi-purpose facilities; this generates a very unique tenant profile in terms of users of the building and its facilities, as well as the usage of water within the building. Lenfest, a building of specific importance to Columbia University's Graduate School of the Arts, is the host of much of the school's programming for the Year of Water. Its events and programming have implemented and maintained prototype planning efforts that aim to conserve water and mitigate overall consumption.
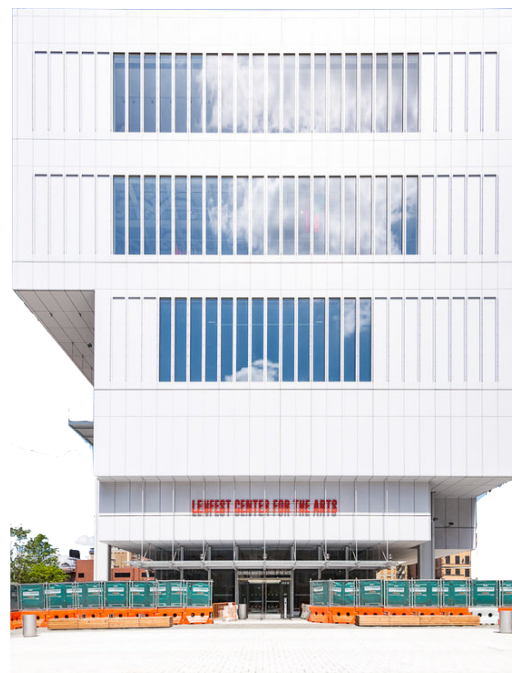
About Lenfest Center for the Arts:

Columbia University School of the Arts' Lenfest Center is a dynamic new hub for cultural and civic engagement on the new Manhattanville Campus in Harlem on 129th street. Equipped with four flexible venues (The Katharina Otto-Bernstein Screening Room, Flexible Performance Space, the Miriam & Ira D. Wallach Art Gallery, and The Lantern) and a public plaza, this new state-of-the-art facility offers innovative opportunities for the presentation and generation of contemporary art across various disciplines -- readings, installations, performances, screenings and symposia are just a few of the activities at the Lenfest Center that highlight contemporary scholarship, global perspectives, and strong local partnerships.

Quantitative Analysis:

After meeting with Mr. Brendan Regimbal, the Director of Production and Operations at the Lenfest Center for the Arts, we learned that a quantitative analysis of the building would not be reflective of the building's actual water usage, nor its tenants, due to the fact that the building is not yet operating at its fullest planned capacity. At this point in time, building use is restricted to students who attend the few classes scheduled within the building, as well as those who attend specific events within the building, which, again, are not reflective of the number of expected occupancy in the near future when operations expand.

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Qualitative Analysis:

Water usage in Lenfest Center for the Arts is very diverse, as one might expect. The building is equipped with two sets of washing and drying machines for costume design and preparation, kitchens with large sinks and heavy duty faucets for events as well as show production (props, etc.), and there are bathrooms located on every other floor in the building, loaded with the newest energy-efficient utilities. The tenants of Lenfest are professors, students, and curious residents of New York looking for interesting exhibits and productions. The density of the building oscillates drastically over the course of a typical 9AM to 5PM work day. Nevertheless, despite there being little to no data on water usage for the building at this point in time, Lenfest is already interested in paving the way for Columbia to make decisions driven by goals for water conservation. For events, performances, gallery openings, symposia, and any event hosted within the building, Columbia University Production and Operations place drinking water dispensary stations across the room, carefully monitoring consumption to ensure water is always in the tanks in an effort to curb water bottle usage by their guests for the night. Always refusing plastic water bottle cases, the Lenfest Center for the Arts ensures that all the programming they are doing for the Year of Water is not trivialized by the routine operations of the building. Mr. Regimbal's team is currently searching for more ways to ensure that all of its operations, facilities and events abide by the utmost standard for water conservation, informed by some of the most salient and recent research conducted by scholars in hydrology, water conservation and management.

Findings and Recommendations:

Findings:

The group set out to answer the following questions:

- What does Columbia do well compared to other institutions?
- Considering what peer institutions do well compared to Columbia, what opportunities does Columbia have to improve and explore?

To answer the first question, the areas where the group found Columbia to perform well in comparison to its peer institutions included:

- **Provision of reliable, safe, and healthy drinking water:** While this point may seem very basic, it is essential, as it lays the groundwork for creating a sense of trust between the Columbia community and facilities, and enables the success of efforts to reduce the use of plastic water bottles.
- **Reusable water bottles provided to new students upon arrival:** This initiative not only makes it possible for all students to practice sustainability water use, but it also prioritizes sustainable decision-making among students from the moment they step foot on campus.
- **Upgrades to water-efficient facilities:** A large part of the low water use per person that was uncovered during the building audits was attributed to the installation of water-efficient facilities, which are prevalent across campus.

Obstacles and Opportunities:

While gathering information relating to water use and conservation efforts on Columbia's campus, the team encountered several obstacles:

- **Lack of publicly available information:** While it was apparent that many of Columbia's peer institutions report water use and publicly outline their sustainability plans and progress, it was much more difficult to uncover this information for Columbia. Instead, the group relied heavily on internal water use data, observations, and interviews with Columbia affiliates including students, faculty, and staff.
- **Obstacles to measuring water use on Columbia's Morningside campus:** Due to the age and infrastructure of Columbia's Morningside campus, the current "water loop" system and lack of individually metered buildings make measurement of Columbia's water use challenging. The process is largely manual, making it difficult to attribute water use to specific buildings and track it over time.
- **Difficulty finding materials related to outreach and education:** Unlike many peer institutions, Columbia's sustainability website had few resources related to education on best practices in sustainable water use.

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- **Working in silos:** It was also observed that Columbia's sustainability site did not link to campus events, outreach efforts by student groups, or related research being conducted by students and faculty. Upon speaking with members of the Columbia community, it became apparent that there is a lack of communication and information sharing between stakeholders in water conservation efforts at Columbia.

We believe these obstacles represent opportunities for Columbia to improve upon its current efforts in water conservation, and sustainability more generally. For this reason, many of them tie in directly to our recommendations.

Recommendations:

After reviewing the findings from Part 1: Water Conservation, the group would like to recommend the following actions as opportunities for Columbia to improve in the area of water conservation:

- **Overcome obstacles related to accurate measurement of water use on campus:** Accurate measurement will allow for identification of problem areas, a quicker diagnosis of abnormalities, and the ability to track progress towards conservation goals. Columbia should begin working towards this goal by installing individual water meters on all buildings and transitioning to a more automated data tracking system.
- **Gradually upgrade to water-efficient facilities in all residential and academic buildings:** Replacing outdated facilities, such as faucets, with more water-efficient replacements will build upon past efforts and allow continued progress in reducing water use across campus.
- **Consult researchers involved in the Year of Water and Columbia's Water Center:** Utilizing Columbia's existing network will allow campus sustainability to overcome the issue of working in silos and access some of the top thought leaders in the world to offer guidance on how water conservation should be pursued moving forward. It is therefore recommended that Columbia maintain the connections it has created with faculty during the Year of Water and provide this network with regular updates and requests for feedback as new water-related projects and goals are established.
- **Explore opportunities in greywater reuse:** This is the one area that Columbia lags far behind its peer institutions. Greywater reuse represents an opportunity to significantly reduce water use with an innovative solution. While it is not clear what greywater reuse would look like on our campus, Columbia can start by connecting with peer institutions who excel here, including UConn and Princeton whose efforts are detailed **Appendix A**.
- **Promote ongoing education and engagement surrounding water safety and conservation:** Update Columbia's sustainability website with educational material, bulletins for upcoming sustainability events, information relating to water research and projects, and a directory of partners and Columbia stakeholders that can be accessed. There should be a major focus on usability. This will both promote education and enable action. See the following page for an example of what this could look like in the context of leak reporting:

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Example Education & Engagement Opportunity - Leak Reporting:

The accessibility of information and the way in which material is presented can be utilized to encourage Columbia affiliates to follow best practices.

Problem: Leaks can make significant contributions to water use, especially when they are able to persist over long periods of time. Currently, finding and fixing leaks at Columbia is a manual process, making leak reporting is an extremely helpful step in assisting facilities to identify leaks.

Leak Reporting at Columbia:

- Report leaks through an online maintenance system unless they are urgent
- Existing information regarding leak reporting at Columbia is extremely limited and fails to relate leaks to water conservation, instead only warning that leaks can pose a mold threat
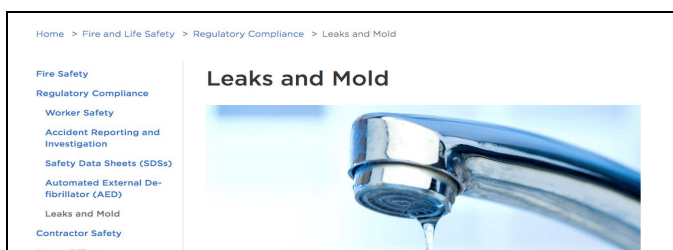
Leak Reporting at Peer Institutions - Stanford and UConn:


Stanford

- Hotline for leak reporting
- Participation in EPA's Fix a Leak Week to educate students/faculty

UConn

- Online leak reporting system, similar to Columbia, supplemented with Stop the Drop educational campaign

Recommendation: Simply educating the Columbia community on the importance of leak reporting and highlighting its relationship with water conservation is low cost and could encourage greater participation in leak reporting.

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PART 2: BOTTLED WATER USAGE
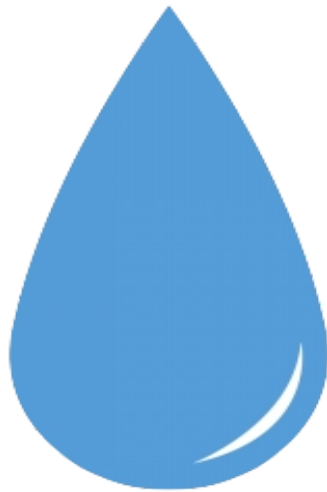
Similar to how the first section explores Columbia's water usage, this section explores Columbia's bottled water usage. Part 2 aims to determine the environmental, health, and economic impacts of bottled water usage and provide recommendations for movement away from bottled water use on campus. A variety of research methods were utilized to determine the prevalence of and reasons for bottled water usage at Columbia. Findings and recommendations are provided at the end of this section based on these results and an analysis of the pros and cons of bottled water alternatives.

ROADMAP

PART 2: BOTTLED WATER USAGE

Conduct a literature review to determine the impact of bottled water and the prevalence of its use:

- Research on Environmental, Health, and Economic Impacts of Bottled Water Usage
- Research on Drinking Water Preferences

Gather additional information to determine what drives bottled water use at Columbia:

- Water Taste Test and Accompanying Interviews

Research alternatives to bottled water, comparing environmental impact to that of bottled water and considering the feasibility of implementation:

- Alternatives to Bottled Water
- Recycling in NYC

Analyze results and provide guidance for next steps:

- Findings and Recommendations

Literature Review on Environmental, Health, and Economic Impacts of Bottled Water Usage:

Despite initiatives around the world to reduce plastic waste, bottled water consumption continues to grow. With increasing usage of bottled water, the bottled water industry has steadily expanded over the last few decades. Bottled water has been used in place of tap water for its convenience, better taste, and perceived purity. However, the research below offers statistics on bottled water usage in the United States and New York City contrary to these commonly held beliefs. It also indicates the environmental, health, and economic impacts of a single-use plastic water bottles.
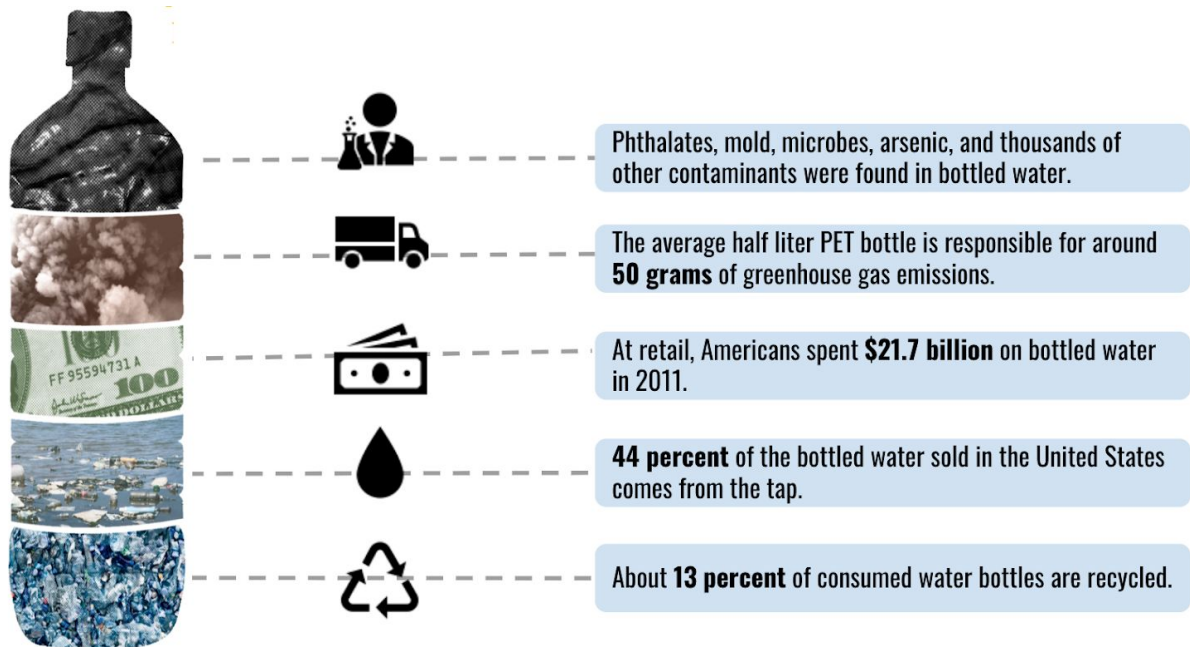
Bottled Water Usage in the United States

- It takes 2,000 times more energy to produce bottled water than tap water (Hanlon, 2015).
- 68 billion plastic bottles are thrown away annually in the United States (Department of Environmental Conservation).
- Annually, 76 million barrels of oil are required to produce, transport, store, and dispose of the plastic bottles used in the United States, which is enough oil to fuel 4.3 million cars for a year (Hugh, 2019).

Bottled Water Usage in New York City

- New Yorkers use 800 million plastic bottles per year (Mayor's Office of Sustainability).
- New Yorkers throw away 1,579,600 pounds of plastic bottles and jugs every week (GrowNYC).
- 15,134 plastic bottles and jugs are trashed every day by New Yorkers (GrowNYC).
- New York City residents currently recycle only about 17% of their total waste — half of what they could be recycling under the current program (NYCdata).

In the Life of A Single Plastic Water Bottle

Phthalates, mold, microbes, arsenic, and thousands of other contaminants were found in bottled water.

The average half liter PET bottle is responsible for around **50 grams** of greenhouse gas emissions.

At retail, Americans spent **$21.7 billion** on bottled water in 2011.

44 percent of the bottled water sold in the United States comes from the tap.

About **13 percent** of consumed water bottles are recycled.

- Tap water, when drank at the recommended amount of eight glasses a day, equals $0.49 per year, while drinking this amount of water from water bottles equals $1,400 each year (Newair, 2018).
- 167 water bottles were used in the past year by the average person, only 38 of those were recycled (Newair, 2018).
- It takes over 50 million barrels of oil to pump, process, transport, and refrigerate bottled water every year (Tort, 2017).
- 3,800 tons of transport-related pollution were released throughout shipment of bottled water from Western Europe to New York City (Deziel, 2019).
- It takes approximately 400 years to decompose plastic bottles in a landfill.
- It takes 17,200 to 31,950 watt-hours to produce 1 kilogram of plastics from crude oil (Low-Tech Magazine).

Research on Drinking Water Preferences

Understanding why people choose to drink bottled water is key in order to reduce plastic bottle waste. In order to aid the Environmental Stewardship Office in its plastic waste reduction efforts, we conducted an in-depth literature review about drinking water preferences. Approximately 90% of Columbia University's students are American, so this review considers studies done on drinking water preferences in the United States. It also looks at recent research done at American universities, which have a similar demographic to Columbia. The results of our review are summarized below chronologically according to their date published.

Nationwide:

Mackey et al. (2004) found that **tap water drinkers were more satisfied than bottled water consumers with the overall quality of their water**. Participants who cited a preference for tap water perceived it to be safe, have an agreeable taste or odor, and believed it to be healthy. Those who **preferred bottled water** cited **taste, healthiness and safety** as reasons behind their choice. However, the report is over fifteen years old, and it may not be reflective of consumption preferences today.

Authors Hu et al. (2011) focused on answering why consumers may choose to drink bottled water over tap. They found that participants who perceived their drinking supply to be **unsafe were more likely to choose bottled water** as their primary water source. Safety of tap water was defined as perceived contamination of taste or odor as well as media reports.

University Setting:

Cunningham et al. (2010) sought to discover where students at the University of Michigan sourced their drinking water. They found that **tap was the primary water source for 45% of the participants, while filtered tap water accounted for another 39% of interviewees**. Those who primarily drank bottled water cited convenience followed by taste and health concerns as their main reasons for their choice.

Saylor et al. (2011) investigated why students at Purdue University prefer tap or bottled water. The researchers found that a **perceived health risk from tap water was the main barrier to the adoption of tap water as a primary drinking source**. They also reported that students **believed bottled water to be safer for their health. Participants also referred to a preferred taste and convenience of bottled water**. Most students stated that they do not consider the environmental impacts of their daily drinking water choices.

King et al. (2014) found similar results. The authors found that tap was the preferred drinking water source. **The report indicated that cost, convenience and environmental concerns were the main reasons for selecting tap. The 31% of participants who prefer bottled water mentioned convenience, taste, and perceived healthiness, safety and cleanliness as their main reasons for their preference.**

According to Güngör-Demirci et al. (2016), **the consumption of bottled water in the United States has increased fourfold in the past twenty years despite American tap water being lauded as one of the safest in the world.** In their peer reviewed study at San José State University, the researchers found that **62.5% prefer to go to a water fountain than a convenience store to purchase bottled water**. Students also indicated that their main reason for choosing to drink **tap water is cost, while citing health impacts followed by taste or odor as the motive for choosing bottled water**.

Liu et al. (2016) found results consistent to Güngör-Demirci et al.'s work. The group of graduate students at Michigan State University conducted a behavioral study on drinking water sources for students, staff and faculty on campus. Like the first group, they found a little over a third of participants preferred bottled water — **37% claimed they like and consume bottled water more** (Liu et al., 2016). However, **unlike the researchers at San José, 37% of participants reported drinking mainly tap water**. This may be because they included an option for **consuming both tap and bottled water in their questionnaire, which included 24.3% of people**. Furthermore, **around 39% of participants also claimed to use filtered water filling stations on campus,** whereas the rest either did not know about them or did not use them.

Water Taste Test and Accompanying Interviews:

We sought to build upon the results observed in our literature review by conducting our own qualitative experiment at Columbia. We wanted to get an indication of the drinking water preferences of Columbia students and affiliates. We used a combination of data collection methods to triangulate our results and obtain data saturation, including interviews, participant observation and questionnaires (summarized in the Methodology section below). While the scope of the project did not allow us to survey a large enough sample for statistically significant results, we hope our findings will give a suggestion of how and why students choose their drinking water, and where the University should focus its efforts to reduce plastic bottle waste. We found that the majority of students drink primarily tap water (72%), and those who choose bottled cited safety and convenience as the reasons behind their choice. This **highlights the importance of widely available refilling stations, accessibility to refillable water bottles, and the necessity of campaigns that explain the high quality and safety of New York tap water.**

Methodology:

- We distributed a survey to **47 Columbia University undergraduate students and affiliates**.
    - 66% undergrads, 6.3% grads, 10.6% staff.
    - The survey was conducted in person inside Lerner Hall, which houses one of the two dining halls on campus.
    - Convenience sampling was used, as the site is a popular hub for students.
    - The questionnaire featured nine questions, including seven multiple-choice questions about how students primarily get their drinking water, their reasons for choosing that source, and a rating scale for how often they use a reusable bottle or how often they drink bottled water.
    - Each multiple-choice question included the possibility of jotting in their response outside of the given choices, but only two students used that option.
- To supplement and triangulate the study's research methods, f**ive semi-structured interviews were conducted.**
    - 5 semi-structured interviews with 4 seniors and one 1st year undergraduate student.
- A participant observation event using **a blind water taste test** was also done.
    - The taste test featured bottled water (from the brand DASANI®), tap water, and tap water filtered using a standard Brita® filter.
    - Each type of water was placed in three identical plastic bottles and served to passersby in disposable plastic cups.
    - **Two separate tastings were done**, one used room temperature water, where 17 people were surveyed, and the other cooled the water down in the same fridge, where another 30 were surveyed.

- ■ This was done to ensure there was no difference in palatability due to the water's temperature.
  - ○ Individuals were asked to report what cup of water they preferred and to guess where the different waters were sourced.
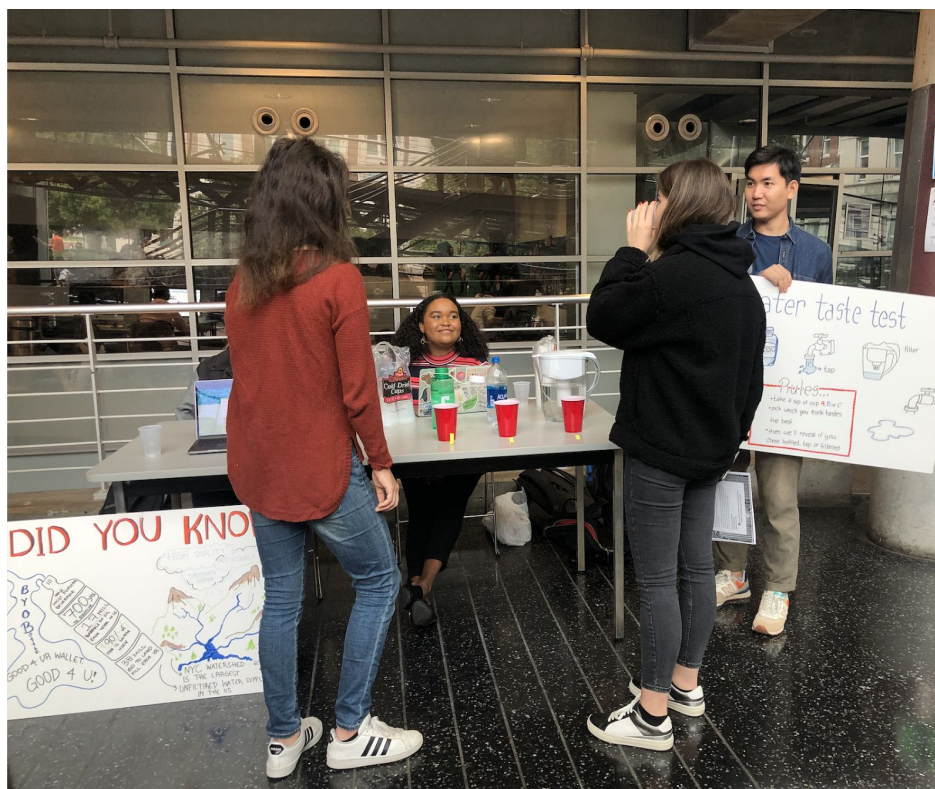
Photograph taken of the taste test being conducted inside Lerner Hall.

Findings:

The survey's data demonstrate that tap and filtered tap water is how 71.8% of respondents get their drinking water. Of the remaining 28.3%, 17.4% drink exclusively bottled water, and 10.8% drink a combination of bottled water and tap or filtered tap water (Figure 1). All 47 respondents answered the question of how they primarily source their drinking water. The interviews reflected this finding — four out of the five students interviewed also drink predominantly tap water.

Reasons for Choosing Tap Water:

41 students responded to the survey question that asked them why they choose to drink tap water. From the five multiple-choice options, 59% of students indicated that they drink tap because of convenience, 22% do it for environmental reasons, 15% claim it is because of price, 2% drink tap because of its taste, and 2% choose tap water because they perceive it to be healthier than other alternatives (Figure 2). Below, we enumerate (in no particular order) the

main reasons students mentioned as reasons for choosing to drink tap water. We summarize the key takeaways, as well as general observations we found during data collection. We also mention reasons we assumed would be important to students (such as the taste of tap water) based upon the literature review, but which turned out to not be a major reason why students choose tap.

1. Taste

Participant observation during the water taste test demonstrated that 44% of students preferred the taste of bottled water in a blind test. 41% enjoyed the taste of filtered water best, and 15% selected tap as their favorite of the three (Figure 3). Eleven participants expressed surprise at their choice, claiming they drink primarily tap water and never noticed a difference before. One student commented that the tap water "tasted too fresh," which was a characteristic that was off-putting to him. Another student asked where the tap water was sourced, citing concern that the quality of Columbia's pipes may be the reason why so many participants did not enjoy the unfiltered tap water. The tap water, including the tap water that was filtered using a Brita® filter, was taken from a sink from the bathrooms on the first floor of Lerner Hall. Three students claimed they noticed no difference in the flavor of the water whatsoever, one of which chose to repeat the blind test. The temperature of the water may have had some impact on its palatability, but it seemed to be minimal: 2 out 17 chose tap water as their favorite when it was at room temperature, whereas 5 out of 30 chose it as their favorite when tap was cooled in the fridge.

The taste of tap water seemed to have little impact on students' choice between tap and bottled. While students tended to prefer the taste of bottled water (Figure 3), no student said taste alone was the reason they did not drink tap water in both the participant observation event and during interviews. One student interviewed mentioned he mitigated his dislike for the taste of tap water by using a filter, and he believes that is more cost effective than purchasing bottled water. The blind taste test supports the idea that filtered water seems to remove any unpleasant flavor of tap water, since it was a close second in popularity.

2. Access to Reusable Water Bottles

It is possible that having a reusable bottle promotes the use of tap water, since all students who indicated they use a reusable bottle every day (shown as the rating "5" on Figure 4) or most days (shown as the rating "4" on Figure 4) also indicated they primarily drink tap water.

While the survey revealed that all 47 participants use a reusable water bottle at least rarely (a "2" on the rating scale, defined as less than once a week) (Figure 4), the participant observation demonstrated that several students expressed frustration about losing their water bottle. They explained they would resort to purchasing disposable bottles instead, since reusable bottles are costlier. An interview with one student revealed similar findings: she resorted to purchasing large plastic bottles of water because she would regularly misplace her more expensive reusable bottle. She claimed social pressures — going to her classes and seeing other students using reusable bottles, particularly in classes related to sustainability — made her purchase another

Carolina

reusable water bottle, but she explained she resorted to drinking only bottled water for half of a semester because she would lose her reusable bottles.

3. Convenience

Survey data demonstrated that convenience was the main reason why students choose tap water as their primary drinking source. Interviews supported this claim, as convenience was the second most mentioned reason for choosing to drink tap water (Figure 5). Students saw tap water as more readily accessible than bottled water, mentioning both in interviews and in the water taste test that they could source it from sinks in their dorms and hydration stations around campus. One student mentioned that having a hydration station, which provides cool filtered water, on every floor of her building last year incentivized her to drink less bottled water than now, where she lives in a dorm where the only accessible hydration station is in the lobby of her building. Also, students complained in both interviews and during the taste test that continually having to restock on plastic water bottles from a store is a troublesome endeavor.

Having a reusable bottle seemed to play a part in the convenience of tap water. As one student put it during her interview, "bottled water is maybe slightly more convenient, because you can buy it wherever, but as long as I just fill up my water bottle and bring it around with me, it's fine." Having a vessel to transport your water is a major component in students' perception of convenience.

4. Price

Students also mentioned price was a major incentive for drinking tap water (Figure 5). Coding the interviews revealed that the fact that tap water is free on campus was mentioned 18 times total during the five interviews. Students claimed they are often on a budget and being expected to purchase bottled water could cost "thousands of dollars."

However, during the participant observation and interviews, students mentioned that if they perceived the tap water quality to be unsafe, they would purchase bottled water. One student explained that he did not know America's tap water was safe when he first moved to New York from Korea, so he spent money on bottled water. So, the price is a factor for students to choose tap, but they need to perceive that tap water is high-quality.

5. Environment

Both interview and survey data demonstrate that the environmental impact is a reason for students to choose to drink tap water. However, interviews and comments from students during the taste test revealed that environmental concerns are secondary to price and convenience. One student expressed this general sentiment through her comment: "I would [...] say more so convenience and money and then it's just [...] a double whammy that it happens to be environmentally friendly." Students enjoy that their choice is environmentally friendly, but they don't seem to make that choice with the environment as their major concern.

Yet, a few students expressed feeling judged by others when they brought a plastic water bottle to class, and this was echoed during the interviews as well. Some students claimed others saw them as less environmentally conscious if they had plastic water bottles. One student who was interviewed was a Sustainable Development major, and she claimed she felt her consumer choices needed to reflect her values, as she believed bottled water to have a negative impact on the environment.

6. Culture and Safety

The high quality of American tap water was also frequently mentioned (coded as "America"). Four out of five students interviewed mentioned that New York's tap water was seen as high quality. Students also mentioned that tap water was "safe" six times (coded as "safety").

American students interviewed seemed more confident about New York City's tap water quality than international students. Students seemed less confident about the quality of tap water abroad (coded as "International"). However, the two foreign students interviewed explained that friends told them New York tap water was safe, so they eventually adopted tap water as their primary water source.

7. Health

Similar to the survey, the idea that tap water is healthier than other alternatives was rarely mentioned in the questionnaire responses. When health was cited, it was phrased in terms of tap allowing students to drink more water throughout the day. As one student explained, "I can reuse [a reusable water bottle] and refill it constantly, so I can drink more water throughout the day." Another student explained that having a hydration station on every floor of her building had her drinking more water. One student mentioned that her family provides a filter for tap water at home, which she found incentivized her to drink more tap water. The accessibility of tap water helped students make choices they felt were healthier.

Reasons for Choosing Bottled Water:

The questionnaire data shows that 17.4% of students drink primarily bottled water, and another 10.8% drink a combination of bottled and tap (Figure 1). Convenience and the perception that bottled water is a healthier or safer alternative to tap water were the main reasons students choose to drink bottled water (Figure 6 and Figure 7). Two students indicated that their parents make them drink bottled water out of safety concerns. We summarize the main reasons why students choose bottled water in no particular order below.

1. Culture and Safety

Cultural backgrounds played a role in students' opinions about tap water. During interviews, students who lived abroad had generally poor opinions about international tap water quality (coded as "International" in Figure 7) and solely drank bottled water in their home countries.

While all students interviewed claimed to drink tap water in the US, several expressed that their loved ones or themselves experience fear that American tap water is contaminated: the idea that tap water in America is more exposed to environmental pollution than bottled spring water was mentioned.

One student from California mentioned she didn't know New York's tap water was safe when she first arrived in the city, since she had been told that the tap water in Napa Valley, California was unsafe. She drank primarily bottled water when she arrived on campus. During the taste test, a student from New Jersey and a couple students from the Midwest claimed they thought tap water was unsafe.

Two students interviewed had grown up abroad, and they claimed that they were unaware that they were able to drink tap water in New York when they first arrived in The City. One student resorted to drinking only bottled water until he was told the tap water was safe to drink.

It seems that foreign students who distrust the water quality in their home country are more likely to drink bottled water when arriving at Columbia. Similarly, students who distrust the water quality in their hometown in America were also more likely to drink only bottled water.

2. Health

Similarly, the idea that bottled water is "healthier" than tap water was discussed seven times throughout the interviews. It was also the second most popular choice as a reason for choosing to drink bottled water. The interviews seem to suggest that participants believe bottled water to have minerals added to make it healthier, and that the springs are more readily monitored by federal authorities, so it is "purer" than the reservoirs for tap water. Participants claim it is possible to trace the source of bottled water and check for its quality, whereas tap water was believed to be sourced from much larger reservoirs so checking its quality at home was seen as less intuitive.

3. Taste

Students partaking in the water taste test preferred the taste of bottled water over tap (Figure 3). The interviewees supported the idea that bottled or filtered water tended to be tastiest. However, taste alone did not seem to stop students from drinking tap water. As the survey data demonstrates, no student indicated they drink bottled water because it is tastier than other alternatives.

4. Family

If bottles were readily available at home, participants were more likely to choose to drink bottled water. Similarly, two of the students surveyed indicated that their parents make them drink bottled water. During the participant observation event, a student mentioned that they did not drink tap water because their parents are concerned that tap water could be unsafe.

During the interviews, one student mentioned that her mother only drank bottled water, concerned over tap water quality. She drinks tap water, and she has gotten into arguments with her mother about their different opinions on tap versus bottled water. She believes it would be impossible to convince her mom that tap water is as safe as bottled water.

If families drank bottled water, students interviewed were more likely to bottled water at home. But it was relatively unusual for parents to force their children to only drink a type of water.

5. Convenience

The majority of people surveyed indicated that they drank bottled water because it is convenient. During the interviews, one student believed bottled water to be convenient because it could be purchased "wherever you go." However, another student cited that bottled water could be less convenient than tap because one has to constantly repurchase the bottles.

Conclusions

While this project cannot give a conclusive reason for why Columbia students drink either tap or bottled water, it does offer some indication of where future research could focus on. The study supports previous literature, indicating that Columbia students who participated in the project choose to drink predominantly tap water. Those who drink primarily bottled water claimed convenience, concerns about the safety of tap, and health were the main reasons for their decision. Taste, one's family's habits, and one's cultural background — specifically, being an international student or having lived abroad — also seemed to make students favor bottled water. From these results, we deem it would be important to explain to students how safe New York City's tap water is, and we also suggest exploring ways to make tap water more accessible — such as installing more hydration stations throughout the campus.

Alternatives to Bottled Water:

The literature review, water taste test, and interviews indicated that even though some students choose to drink bottled water because they believe that drinking bottled water is more convenient, safe, and healthy than drinking tap water, many Columbia students also prefer drinking tap water to bottled water. As New York City has some of the best water in the world, drinking tap water would be the most sustainable way to reduce bottled water usage. However, it is not possible to force people to drink only tap water instead of bottled water. Therefore, to reduce waste and protect the environment, alternatives to bottled water should be discussed.

The objective was to research best alternatives to bottled water and answer the following questions:

- What are the most "popular" bottled water alternatives that can be used at Columbia University?
- What are the pros and cons of the alternatives?

In order to reduce bottled water usage at Columbia University, the university needs to consider alternatives to bottled water. Every manufactured beverage package has a much larger environmental impact than tap water. However, since different water packaging is associated with different amounts of environmental impact, analyzing the pros and cons of bottled water alternatives is essential. Canned water, boxed water (cartons), and water filling stations are suggested as alternatives to bottled water.

Featured below are the primary alternatives to bottled water:

Facts about Canned Water:

Transportation / Greenhouse Gas Emission

- "A 2016 study by ICF International found that the combined greenhouse gas (GHG) emissions associated with the transportation and refrigeration of beverages in

Sangwoo

aluminum cans are lower than those associated with beverages in glass or plastic bottles under the same conditions" (The Aluminum Association, 2016).
- Refrigeration for aluminum cans due to space efficiency emits lower GHG emissions compared to both glass bottles and plastic bottles (The Aluminum Association, 2016).

Recycling/Decomposition

- Aluminum is one of the most valuable recyclable materials because there is no limit to how many times it can be recycled. In fact, it is estimated that more than two-thirds of all the aluminum that has ever been produced is still being used today (McCoy, 2018).
- In terms of recyclability, aluminium has the best value compared to bottled and boxed water in New York City because aluminum has a high capture rate (the percentage of trash that is recycled) as well as a high deposit rate. Aluminum cans are included in container deposit laws in New York (Interview with Bridget Anderson from DSNY, 2019).
- "In 2017, the total recycling rate of aluminum containers and packaging, which includes beverage containers, food containers, foil and other aluminum packaging, was 32.8 percent" (EPA, 2019).
- Within this number, the most recycled category of aluminum was beer and soft drink cans, at 49.2 percent (0.6 million tons) (EPA, 2019).
- Aluminium cans might take 10 to 100 years to decompose in landfill sites (TAPP WATER, 2019).

Energy Costs of Making and Recycling the Aluminum Cans

- It takes 63,000 to 95,000 watt-hours to produce 1 kilogram of aluminum from bauxite ore (Low-Tech Magazine).
- Even though the production of aluminium from bauxite ore is an incredibly energy intensive process, recycling an aluminum can saves 95% of the energy needed to make aluminum from bauxite ore (One Earth Company).
- Recycling one pound of aluminum (33 cans) saves about 7 kilowatt-hours (kWh) of electricity. 20 recycled cans can be made with the energy needed to produce one can using virgin ore (West, 2019).

Facts about Boxed Water:

Transportation / Greenhouse Gas Emission

- During the production process, cartons result in only 8 grams of greenhouse gas emissions (per liter container) while the average half liter PET (Polyethylene terephthalate) bottle is responsible for around 50 grams of greenhouse gas emissions (Paster, 2018).
- Boxed Water trucks empty cartons to its filling stations packed flat, fitting 26 trucks worth of containers into a single truck (Paster, 2018).

Recycling/Decomposition

- About three-quarters of each box is made of fully recyclable paper – which is free of BPAs and phthalates, and sourced from well-managed forests (74% paper, 20% plastic, and 6% aluminum) (Davidson, 2018).
- In terms of recyclability, carton has the lowest value because it is not included in container deposit laws in New York and has low capture rate (Interview with Bridget Anderson from DSNY, 2019).
- Boxed water (carton) might take 100 to 400 years to decompose in landfills (Davidson, 2018).

Energy Costs of Making and Recycling Cardboard (Paper)

- It takes 6,950 to 13,900 watt-hours to produce 1 kilogram of paper from standing timber (Low-Tech Magazine).
- Recycling cardboard only takes 75% of the energy needed to make new cardboard (Davidson, 2018).
- Recycling just one tonne of cardboard saves 46 gallons of oil and 4000kWh of electricity (One Earth Company).

Comparison of Bottled Water and Primary Alternatives

	Bottled Water	Canned Water	Boxed Water (Carton)
Carbon Footprint Reduction*	30%	96%	No data available
How many times can it be recycled?	Bottled water can be recycled about 1-2 times.	Canned water can be recycled infinitely.	Boxed water can be recycled about 4-5 times.
% Recovered for Recycling	9.5%	45%	70%
Time to Decompose	400 years	10-100 years	100-400 years
Decomposition Residue	Microplastics	Metal scrap	Some microplastics
Impact on Nature/Animals	Very high	Low	Medium
Capture Rate in New York City	High	Medium	Low
Electricity Costs of Production Per 1 Kg	17,200 to 31,950 watt-hours	63,000 to 95,000 watt-hours	6,950 to 13,900 watt-hours

* If, for example, aluminium cans are made of 100% recycled material, the carbon footprint will be 96% less than it would be if the product was only used once. However, since only 45% of cans are recovered for recycling (in the US), the real carbon footprint would be much higher.

An Innovative Alternative to Plastic Bottled Water: Ooho

In addition to providing information about the primary plastic bottle alternatives, canned water and boxed water, we also wanted to mention the emergence of new and innovative alternatives such as Ooho, which provides a solution to unsustainable production and disposal of plastic bottles through an edible water bottle people can safely eat and drink.

Ooho is an edible membrane, made from 100% seaweed and plant, that can encapsulate water, soft drinks, or alcohol (Villaluz, 2018). The ingredients used in an Ooho membrane is biodegradable within four to six weeks which means it does not contribute to pollution and is highly sustainable (Villaluz, 2018). Furthermore, since Ooho's ingredients are considered to be significantly cheaper than plastic, they can potentially fully replace plastic bottles in the future.

Ooho can be a great alternative to plastic bottles at sporting events. It can replace plastic cups and bottles for running events, races and other sporting events where numerous plastic bottles are thrown away. To remove plastic waste, it can be used at Columbia University sporting events instead of bottled water. Also, it can be used at festivals. People can use Oohos to drink juices, water, or even alcoholic cocktails at festivals or private events as an alternative to plastic bottles.

The Best Alternative to Plastic Bottled Water:

Filtered Water Bottle Filling Stations

Although canned water and boxed water could be alternatives to bottled water, the best alternative to plastic bottled water is filtered water bottle filling stations. Water bottle filling stations encourages students and faculty to use reusable water bottles. Columbia University has installed water filling stations in each building and is planning to build more water filling stations. There are several benefits of water filling station usage as an alternative to plastic bottled water.

Benefits of Filling Stations

- **Safe Drinking Water:** A main benefit of filtered water bottle filling stations for Columbia University is their ability to provide safe drinking water. The majority of stations use high-performance filters that remove common contaminants such as chlorine and lead. "Elkay, one of the leading water bottle filling station manufacturers, offers filtered water bottle filling stations that remove, on average, 99.3 percent of lead from drinking water" (Zoundi, 2017). Furthermore, water bottle filling stations indicate the status of the filter quality, so that users can be aware of the quality of water they drink.

- **Better Tasting Water:** As described in our literature review and water taste test, taste is a significant factor in people's decision to choose tap versus bottled water. Filtered water bottle filling stations are equipped with high-performance filters and cooling systems by making them capable of removing the usual culprits of unpleasant tasting water: chlorine and particulates (Zoundi, 2017).

- **Reduced Waste**: By using reusable water bottles to drink water at filtered water filling stations, Columbia University can reduce bottle water use. Also, the 'Exclusive Green Ticker' located on the filling station itself informs users of the number of 16-ounce plastic bottles saved from landfills just by choosing filtered water over bottled.

Recycling in NYC:

While considering switching away from plastic bottles, it is important to ascertain how potential alternatives detailed earlier — cartons or aluminum cans — are recycled in New York City, and how they compare to the ease of recycling a standard plastic (PET) water bottle. We interviewed Bridget Anderson from the NYC Department of Sanitation (DSNY), who explained the recycling process for the typical carton, plastic bottle and aluminum can in New York City.

Our research indicates that **plastic and aluminum have a high capture rate** (the percentage of trash that is recycled) as well as a **high deposit rate**. Soda, water, beer, and other liquid containers carry a deposit weight. If you return a number of containers, you can you get around 5 cents back for your help in recovering those materials. Communities of canners scavenge for deposit containers. **Cartons, on the other hand, have a very low deposit rate,** so there is little incentive to collect cartons that were not initially thrown in the recycling pile. Similarly, cartons are lined with a plastic resin, so they cannot be recycled as mixed paper. Their **capture rate is consequently quite low**. From the standpoint of recycling — whether the material is easy to recycle and also whether there is a high percentage chance that it will be recycled — we found that aluminum and plastic are better alternatives than cartons, simply because there is still a low capture and deposit rate for plastic lined cartons. If an event requires water from containers, there is a greater chance aluminum or plastic containers will be recycled. Our findings are further explained below.

Deposit and Capture Rate:

We found that aluminum cans have the greatest value for canners, followed by PET bottles. This means that when canners bring recaptured material to redemption centers, they will receive **more money** for the total weight of cans brought in than for an equivalent weight of plastic bottles. Therefore, there is a greater incentive for canners to collect aluminum than plastic. Presently however, PET bottles have a higher capture rate in New York City than aluminum cans. There is also a very large deposit market for plastic bottles.

Cartons, on the other hand, offer **very little in terms of compensation from redemption centers**. This is because cartons are not included in deposit container laws, which help ensure compensation for bringing reclaimed material to redemption centers. Additionally, there are few buyers for the recycled material from cartons. **For now, the capture and deposit rate for plastic lined cartons are both very low.**

New York City Specific:

New York City recycles approximately 650,000 tons of material yearly. It has a sophisticated recovery system, so it is able to source all of its recycled material from the waste produced in New York City. Consequently, New York's recycling firms do not need to rely on an import market for waste.

Carolina

Is there a life cycle benefit for aluminum versus plastic?

Aluminum is more easily turned into another aluminum can, while bottles are often turned into fiber for clothing. Columbia's commencement gowns, for instance, are made from recycled plastic. As discussed earlier, an entire aluminum can will not yield a new recycled can. A percentage of mined aluminum is required to recycle the aluminum can.

Cartons are recycled to make ceiling tiles. Cartons are a low value commodity, and there are fewer buyers for material made from recycled cartons. Anderson explained that it is not always possible to find buyers for the material. Furthermore, the lower deposit and capture rates result in less product being available for recycling. Finally, because they are multilayer and laminated products, they need to be recycled at specialty recycling firms.

Other Potential Alternatives - Paper Cups:

If Columbia were to adopt sealable paper cups instead of bottled water for events like commencement, they should not be lined with plastic resin found in commercial boxed waters. That way, they can be placed into mixed paper recycling bins. Anderson does explain, however, that the capture rate for single use products is generally very low. Yet, because paper cups are lighter in weight, they will also have a smaller impact on trash generation and storage in terms of the total weight of waste generated. Anderson mentions that, in her experience, most paper cups end up in landfill-destined trash rather than recycling bins.

Ideas to Maximize Trash Recovery for Recycling During Events on Campus:

In order to maximize recycling during campus events, we suggest marketing to student groups. **Students can make around 5 cents per PET bottle they deliver to a reclaiming center, so they can fundraise money for their student groups**. Students can assign bin monitors to ensure guests at events like Commencement dispose of their bottles in bags, which they can bring to a reclaiming center and profit from.

Another potential solution is to invite the Eco-Reps group and assign them as a litter patrol. They can be stationed by bins on campus to ensure guests dispose of their waste into the appropriate recycling bin. Eco-Reps are offered extended housing for volunteering in the program, so they would already be on campus during Commencement.

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Findings and Recommendations:

Findings:

- **Canned water is the best primary alternative to bottled water:** Due to its high capture and deposit rate, and because it can be recycled an infinite number of times, aluminum is the best alternative to plastic in NYC.
- **The majority of Columbia students drink tap water:** The majority of Columbia students we surveyed drink primarily tap water, and those who choose to drink bottled cited safety and convenience as the reasons behind their choice.
- **Much of the Columbia community is uninformed about the quality and safety of NYC tap water:** The surveys and interviews we conducted showed that many people were surprised to learn about the quality and safety of NYC tap water, regardless of what their drinking water preferences were. This is largely due to the fact that people on Columbia's campus come from all over the country and the world, and many people do not enjoy the same water quality where they are originally from.

Recommendations:

After reviewing the findings from Part 2: Bottled Water Usage, the group would like to recommend the following actions as opportunities for Columbia to reduce the prevalence of single-use plastic bottles on campus:

- **Recommended alternative to bottled water at Commencement:** Graduates and guests should be encouraged to bring their own reusable bottles or use compostable cups at either water filling stations or 5-gallon glass dispensers during commencement. Columbia University could encourage students and guests to bring their own reusable water bottles via messaging on commencement tickets or email.

Amber / Sangwoo / Carolina / Gigi

- **Recommended alternative to bottled water at small events:** Columbia University can encourage attendees to bring their own reusable water bottle or mug in advance. It should provide tap or filtered water in pitchers / dispensers along with reusable or compostable cups (e.g. Butterfly cup).

- **Install additional water refilling stations:** In an effort to reduce the environmental impact of plastic water bottles and encourage the use of reusable containers, Columbia University should install more water filling stations, especially in dorms and academic buildings.
- **Educate the Columbia community on the safety and quality of NYC tap water:** Our data showed that Columbia students are often unaware about the safety of New York City tap water. Campaigns divulging its origin, sourcing and quality should be conducted, particularly to freshmen and new students. We recommend placing information posters on Columbia's QuickFill stations and distribute relevant pamphlets when giving out reusable water bottles.
- **Minimize barriers related to obtaining reusable water bottles:** We found that having a reusable water bottle greatly improves the chance of a student utilizing the QuickFill stations instead of reaching for bottled water. Ensuring students have a cheap, accessible source of reusable water bottles is key. We recommend offering a discount to reusable bottles the the Columbia Bookstore every year, so students who have lost their bottle have the chance to replace it.
- **Engage with student groups to aid in recycling efforts:** Since students are able to profit for every bottle they return to a redemption center, they can fundraise money for their clubs by stationing themselves as litter collectors during large campus events. Eco-Reps could also be involved, playing the role of bin monitors to ensure bottles and cans are placed in the correct recycling bin during large events.

Amber / Sangwoo / Carolina / Gigi

Example Engagement Opportunity: Find My Hydration Station

The best way to navigate away from plastic bottle usage is to install more hydration stations, but we acknowledge this can be costly and time intensive. As of now, there is undoubtedly an inconsistent number of hydration stations available throughout campus. Some buildings have 4, while others only have 1. When students or faculty enter new buildings, chances are that they don't know where the hydration station is, or even whether there is one to begin with. "Find My Hydration Station" is a low-cost digital app idea that can be made available for any iOS device. The app informs the user where the nearest hydration stations are located and shows the most efficient route to get there. The goal is to incentivize students to refill their reusable water bottles, instead of purchasing a plastic water bottle at a store. All you have to do is scan the QR code with the camera of your iOS device, and you are automatically taken to a map. For the sake of simplicity and convenience, the code can come in the form of a sticker. These stickers can be distributed independently to returning students, as well as to incoming students at orientation paired with the free Sustainable Columbia water bottles. Below, we have included a visual prototype of what this could look like.

Find My Hydration Station

PART 3: KEY TAKEAWAYS AND RECOMMENDED NEXT STEPS
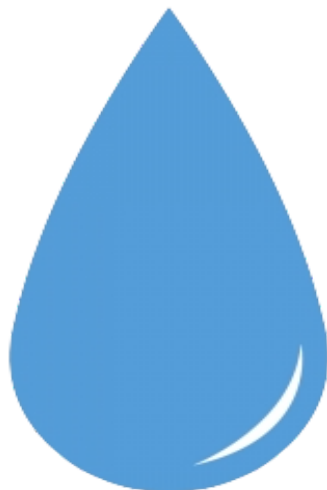
While Part 1 and Part 2 contain more detailed recommendations that are specific to the topics of water conservation and bottled water use, this final section aims to give a high-level summary of the project and touch on recommended next steps that are not specific to either of the previous sections. As a result, the recommendations included in this section are predominantly related to general marketing and engagement strategies.

Amber

KEY TAKEAWAYS: PART 1 & PART 2

Below, the key takeaways from Part 1 and Part 2 are framed as questions Columbia should use to guide future efforts. Each question is then answered with broad recommendations that were determined to be both high-impact and feasible to implement in the near future.

Key Takeaways from Part 1: Water Conservation

How to educate students, faculty, and staff on best water conservation practices?

Inform new and returning students about New York's safe and clean water supply	Educate students and faculty on how to report leaks and why this is important for water conservation	Encourage water conservation in residence halls with reminders in bathrooms and kitchens, similar to existing reminders to save electricity located near light switches

Key Takeaways from Part 2: Bottled Water Usage

How to navigate away from plastic bottle use on campus?

Encourage the Columbia community to use reusable water bottles as the best alternative to bottled water	Install more water filling stations on campus, both indoors and outdoors	Use gallon(s) glass dispenser when possible at events

KEY TAKEAWAY: OVERALL RESEARCH PROCESS

Additionally, throughout the research process, the topic of engagement and marketing continued to emerge as an area that Columbia could utilize to achieve deeper engagement across campus and with the public. Although this did not represent an initial area of focus for this project and therefore does not naturally fit into either of the two previous sections, we believe that increasing efforts related to engagement and marketing represents an opportunity to amplify the impact of our previously stated recommendations relating to water conservation and reducing bottled water use. Key takeaways on this topic are summarized below, and recommended next steps are provided on the following page.

Key Takeaways from Overall Research Process		
How to continue and expand efforts in engagement and marketing?		
Utilize art and public events to capture an audience that Columbia Sustainability may not usually reach	Ensure marketing of water conservation continues after the Year of Water ends and expand the original initiative beyond the School of the Arts	Engage with the Columbia community and the public with social media and user-friendly online information

Next Steps in Marketing and Engagement

*"Columbia is not just theorizing, not just doing research on water. Columbia is doing research that's leading to **action**. How do you make that visible?"*

– Carol Becker, Dean of the School of the Arts, Columbia University

Columbia is a leader in cutting-edge research-related areas such as climate change, sustainability, and water rights. Not only that, but we are translating such research into action with measurable impacts. But how can we improve the visibility and dissemination of our efforts within Columbia University and beyond?

Based on the interviews with the members involved in the Year of Water, communication was mentioned as one of the biggest challenges. Communication plays a fundamental role in all facets of organizational structure and it's going to be central to the water related initiatives. Therefore, this section proposes internal and external communication strategies, which aim at continuing the efforts of water conservation as a whole by engaging the Columbia community and beyond.

Types of Engagement

The events surrounding the Year of Water have proved to be effective means of engaging a wide range of people. A diverse range of events utilizing art, theatre, discussions, and film enable Columbia Sustainability to capture an audience they might not usually reach. These events are able to bring students, faculty, and the public from all disciplines together, thus creating a dialogue — one that includes, provokes, and questions our relationship with water from multiple perspectives. The continuation of such events, paired with successful marketing strategies, will be an important step in expanding the initiative beyond the School of the Arts, and even Columbia University. Below, we have proposed ways to use technology to do just this. We recognize that the strategies chosen will depend on a range of factors, but the ideas we have provided below can be considered in general as best practices. The first half will focus on external communication efforts with a specific focus on digital marketing. The second half will be centered on internal communication to ensure there is less of working in silos. The conclusion briefly discusses components future Workshop for Sustainable Development classes could work on.

1. Digital Marketing

Marketing Strategies on Instagram

The marketing strategies will largely focus on Instagram; visuals can have an enormous impact on the success of your content marketing and media campaigns. Our brain only needs 1/10 of a second to process an image, compared to reading in which 200 words take an average of 60 seconds. Moreover, people remember visual information much better than information they have read or heard. We therefore encourage the use of visuals across all your social media channels; Twitter, Facebook, and even LinkedIn posts with images generate a much higher engagement than those without images.

How to Develop a Successful Brand Online

- **Constant theme:** Since Instagram is an entirely visual medium, creating a visually consistent feed can work to promote the mission of Sustainable Development. A brand aesthetic has helped a number of businesses increase engagement and drive traffic to the profile. If a person clicks on the account, the first thing they are going to see is the design; so we want them to stay and hit that "follow" button. Creating a theme can be really simple! Anything from color, font, or medium can contribute to a professional and aesthetic Instagram profile.
- **Scheduled Posts:** Spend one to two hours on one day to schedule Instagram posts for the next two weeks. Carefully craft your posts to ensure engagement and suit your social media strategies. With apps like Later (formerly Latergramme), you can schedule up to 30 posts per month for free with the mobile app or through the web browser. Post during evenings to guarantee more engagement.
- **Diverse media:** Use a variety of image types and formats. Use Canva to turn facts and statistics into fun graphs and illustrations. Canva is a user-friendly design tool used by non-designers and professionals alike; the services can be accessed through this link https://www.canva.com. Post pictures of products or initiatives, with an appropriate caption. When you can, share these images and videos across all your social media channels. Share content with link posts that can take students straight to the source. Add videos and tutorials on how to recycle or navigate through the Sustainable Development website.
- **Use of hashtags:** Consistent use of hashtags work to integrate Twitter, Facebook, and Instagram accounts.

The Livestream Feature

The livestream feature on Instagram and Facebook is one of the newest additions. It's a medium that can connect water experts or Year of Water representatives directly in touch with other people in real time. The livestream as a platform engages a wider range of audience in a more intimate and genuine setting. Remain open to feedback; you never

know what types of valuable insights the student body or even the public might have to offer. Promote the Live video in advance to maximize viewer attendance via email lists, social media posts, calendars, and any other public announcements. Done right, Sustainable Columbia will be able to attract massive engagement from followers and further build their brand. Instructions on starting a Livestream can be found under **Appendix D** as **Figure 8**.

Instagram Livestream Marketing Ideas:

Live events: This is suitable for any water related events like Waterlicht or a Climate Change Town Hall. Consider assigning an attendee with the task of setting up a mobile device at the event so that followers who aren't able to attend can still be part of the action.

Website exposure: The Sustainable Columbia website offers a wide array of tools that can benefit students, faculty, and the public to adopt healthy, sustainable lifestyle habits. From reporting leaks to determining whether a building is suitable for a hydration station installation, you want to make sure people know about this great website. Show off the website's features, do a virtual tour of the interface, highlight key sections of the Sustainability Plan – the possibilities are endless.

Q&A: After establishing an engaged follower base, there is a lot of value in hosting a short Live video where they can ask questions in real time. You can also ask for questions beforehand on other social networks and answer them Live. This is perfect to stir a dialogue on New York City tap water, for instance. A researcher or a professor can go online for 30 minutes to answer any questions the public has on whether the water is safe to drink and demystify any false preconceptions.

An instructional or educational stream: This directly ties into efforts to broaden the culture of sustainability both inside and outside classrooms. Teach people directly how they can make a difference through instructions on recycling. Moreover, many classes within Sustainable Development and Environmental Studies feature guest speakers via Skype. It is often in the form of a lecture, with only a little time for questions at the end. If classrooms were to utilize the Livestream feature instead, the students can directly ask their questions or make comments whilst inside the classroom, thereby actively indicating collective interest in certain topics and promoting an organic two way dialogue. In today's increasingly digitized world, the scholarly community is beginning to turn its attention to the use of social media and other online platforms. In recent years academics have shown a growing interest in non-traditional methods of evaluating their scholarly 'impact,' and Sustainable Columbia should too!

2. Public Engagement

Engagement with the Student Body: Water Ambassador Program

Water Ambassador Program is a leadership opportunity for students who are dedicated to the efforts to conserve water and create a more sustainable campus. This program integrates the student body to the larger objectives; students are a great tool for marketing. You might want to consider creating groups, where one group is responsible for creating marketing content, such as infographics and flyers and another is responsible for social media management, thereby posting at the right times. Some can be asked to go around campus and hang flyers up. Some can be asked to repost #YearofWater related content on their accounts. With the help of students, there are many ways Sustainable Columbia's efforts could be made known throughout campus. Given the presence of sustainability on campus, students will be eager to join and learn more about how their school is tackling such urgent issues. Compensating student ambassadors will ensure the program can stay around for the long haul. Compensation may come in the form of money, mentorship programs, or workshops to improve specific skills. We would urge the faculty to be directly involved and showcase their investment in students involved in water campaigns.

Engagement with Key Stakeholders Related to the Year of Water

- **Newsletter**: Regular newsletters can include periodic updates, news, and events related to the Year of Water. By sending a newsletter out twice a month, the efforts of Sustainable Columbia will be made more visible to the rest of the campus. This is useful in getting attention from different departments, offices, and students whilst strengthening ongoing connections. You could consider using the newsletter to bring certain features of the new website into spotlight and / or determine which building is conserving water best, etc.

Bi-Monthly Newsletters to the Columbia Community

- **Internal platform**: Based on the interviews, working in silos was mentioned as one of the biggest problems facing the Year of Water. This got us thinking about the value of building internal technology platform centered around the Year of Water. Faculty members can share their ideas, knowledge, and expertise directly onto the platform and receive immediate feedback. It can encourage experimentation, collaboration, and lead to overall organizational changes moving forward. If done well, this can be a great tool for defining goals, metrics, and road maps that reach far beyond the Sustainability Plan.

Internal Platform

No more working in silos!
Share ideas, suggestions,
and updates with your
community

Potential Areas of Focus in the Future

New York City Branding and Tap Water

New York tap water is safe to drink, but not everyone knows that. Students and faculty that come from foreign countries where the tap water is not safe to drink are likely to assume the same thing about New York water. Implementing city branding that showcases how New York City has some of the best tap water in the world might prove to be a professional and legitimate way to encourage people to drink water from the tap. For instance, we have discussed generating posters backed up by the municipality of NYC as opposed to just Sustainable Columbia. Looking into how parks, public schools, and other cities do this can provide some useful reference points.

Performance Indicators

Establishing performance indicators will be important to measure effectiveness levels across topical areas. It can provide insight into what is working and what is not, enabling us to change work plans and / or targets accordingly. Given the limited time and scope of our project, we did not have the opportunity to delve further into developing a system of indicators. However, we acknowledge the importance of measuring value, in order to clearly assess whether or not the proposals in Water Exploratory to Inform the Next Sustainability Plan are achieving its project objectives. If the next cohort of Workshop for Sustainable Development students were to continue this project, we suggest this to be one of the focus areas they can look into.
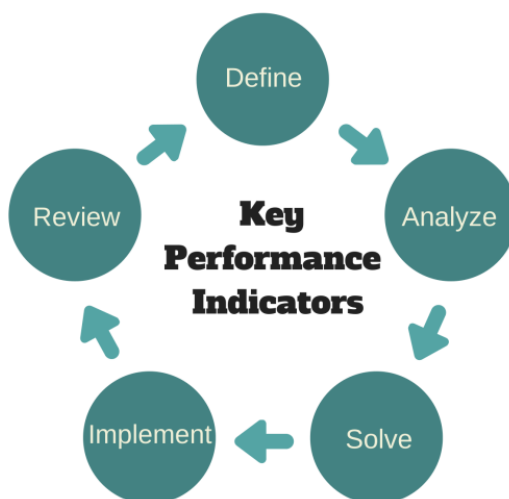
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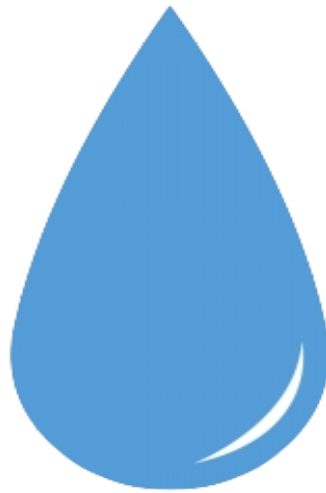
APPENDICES

The following appendices are included to provide additional information for research findings referenced throughout the report:

- **Appendix A:** details the water conservation efforts of Columbia's peer institutions and explains why each institution was selected for study
- **Appendix B:** analyzes data from Furnald Hall's water meter
- **Appendix C:** provides an overview of the findings from the water taste test, including figures, surveys, and interviews
- **Appendix D:** includes additional information related to engagement and marketing strategies

Appendix A: Practices of Peer Universities

	Reason for Selection	Conservation Efforts	Education and Outreach	Areas of Innovation
Stanford				
	Holds the top overall score in STARS, a sustainability tracking framework for universities, and ranks 4th in the "Water" category	Upgrades to water-efficient facilities in ~90% of student housing and academic buildings	Clear, distinct, and publicly available goals	Greywater use in toilets and irrigation
		Installation of real-time water metering devices	User friendly sustainability site which includes plans, project overviews, fact sheets: sustainable.stanford.edu	Hotline to report leaks
		Measures total water use and potable water use + total and potable water use per weighted campus user on STARS... metrics tracked over time	Website dedicated to water resources: suwater.stanford.edu	Stanford Energy System Innovations Project (SESI) features an energy efficient heat recovery system, reducing emissions and potable water use
			Participation in national Flx a Leak Week	
University of New Hampshire				
	Of the five schools with the highest STARS rating category (Platinum), this is the only one located in the northeastern United States	Upgrades to water-efficient facilities where economically feasible	Educational campaign and outreach for reducing use of bottled water and installation of water refill stations	Greywater use in toilets
		Banned distribution of bottled water in dining halls	Water page on sustainability website is not very user friendly and appears outdated: sustainableunh.unh.edu/water	
		Measures total water use and potable water use + total and potable water use per weighted campus user on STARS... metrics tracked over time		
University of Connecticut				
	Of the three schools tied for first place in the STARS "Water" category, this is the only one located in the northeastern United States	LEED-Silver renovation of a 100 year old administrative building reduced the building's water use by 30% and serves as an example of a whole-scale water-efficiency retrofit	Highly transparent: clear goals and areas of focus, water use is publicly available, and website has a clear focus on stakeholder engagement: https://ecohusky.uconn.edu/water-conservation/#	Reclaimed Water Facility treats non-potable water for use in heating / cooling, irrigation, etc. This project has resulted in multiple awards including an Engineering Excellence Award and the Water Reuse Association's 2011 Institution of the Year award
		All residence halls have been retrofitted for water-efficient showerheads and sinks	Stop the Drop educational campaign to encourage leak reporting	
		Rainwater collection and irrigation pond lowers pumping required for irrigation	Website lists sites of water refilling stations and allows users to request installation of additional units using departmental funds	
		Measures total water use and potable water use + total and potable water use per weighted campus user on STARS... metrics tracked over time	EcoMadness competition in which dorms compete to reduce water and electricity consumption over an entire month	

	Reason for Selection	Conservation Efforts	Education and Outreach	Areas of Innovation
Harvard				
	Similarities with Columbia as an Ivy League Institution in an urban setting in addition to publicized efforts to reduction to reduce bottled water use on campus	Dining halls and Faculty Club eliminated plastic bottles. 5 gallon water containers used in place of plastic bottles at commencement	User-friendly and engaging website that also highlights water research and student initiatives: https://green.harvard.edu/	Support stormwater reduction and passive filtration in campus design which includes green roofs
		Goal: reduce university-wide water use 30% by 2020 from 2006 baseline, including process, irrigation, and potable water usage However, water use metrics are not publicly available through STARS	Water bottle reduction (Beyond the Bottle) educational campaign around campus and participation in city-wide sticker campaign (Cambridge in Motion) to promotion use of tap water. Water refill stations installed and maps created to show their locations	Environmental Passive Integrated Chamber System (EPIC) to capture stormwater and supply it for uptake by trees
Princeton				
	Similarities with Columbia as an Ivy League Institution in addition to publicized efforts to reduce plastic use on campus	Office of Sustainability provides free usable water bottles and dining halls switched to boxed water last year as part of a larger effort to cut back on plastic use on campus However, students have expressed concern over the Princeon's tap water quality	Clear goals and user-friendly website that highlights upcoming events and student efforts	24,000 gallons of capacity for rainwater harvesting systems which collect rainwater for reuse in toilet flushing, while one system also collects and reuses condensate from mechanical systems
		Upgrades to water-efficient facilities and trayless dining Goal: reduce university-wide water use 26% by 2046 from 2008 baseline Measures total water use and potable water use + total and potable water use per weighted campus user on STARS... metrics tracked over time	Informational signage in bathroom stalls to encourage proper use and raise awareness about water conservation efforts	
NYU				
	Similarities with Columbia as a prominent university located in Manhattan in addition to publicized efforts to reduce bottled water use on campus	Commitment to stop purchasing plastic water bottles beginning in 2020	Difficulty accessing information regarding water use and conservation efforts online	

Appendix B: Graphs from Furnald Audit
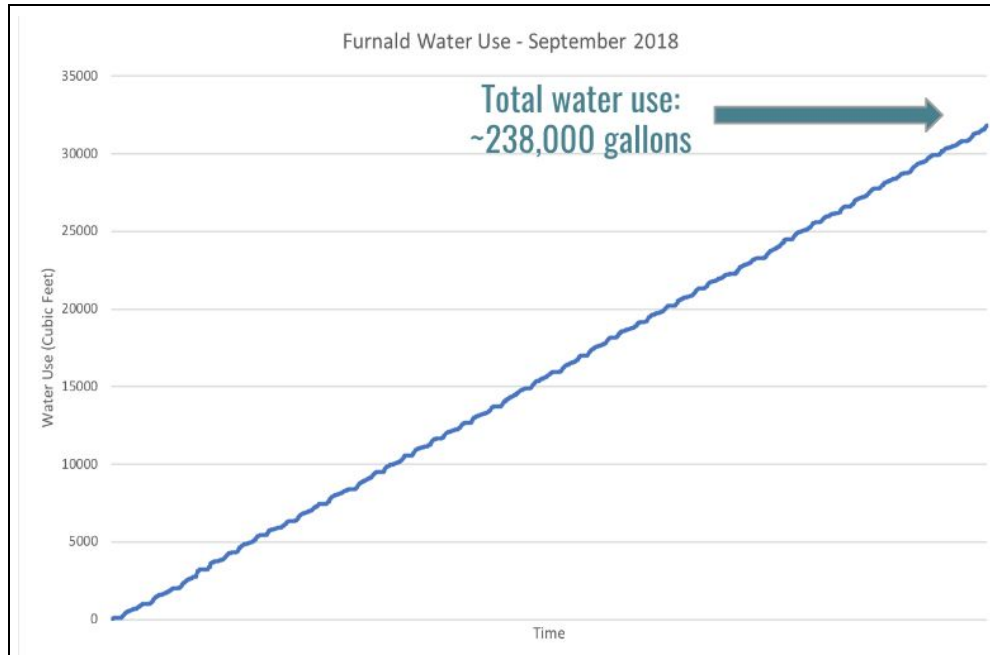
Water usage in Furnald increases at a relatively constant rate. While the figure above contains data from September 2018, indoor water usage in Furnald does not vary seasonally throughout the academic school year. Therefore, this data is representative of a "typical month" in Furnald.
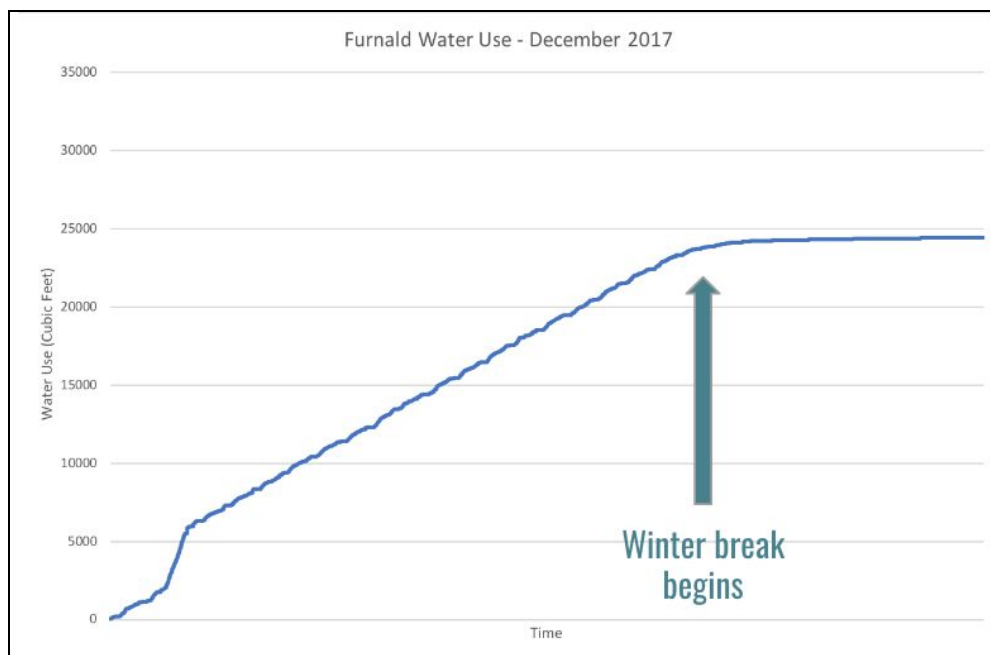
The month of December demonstrates that when students leave for break, water use abruptly changes, becoming negligible for the remainder of the month. In other words, when there are very few residents present, water use is almost non-existent. It can then be assumed that indoor water use in Furnald can be nearly 100% attributed to residents.

Appendix C: Water Taste Test - Figures, Surveys, and Interviews

HOW DO PARTICIPANTS PRIMARILY GET THEIR DRINKING WATER

■ Percentage of Participants

Bottle and Tap	6.5
Bottle and Filter	4.3
Bottle	17.4
Tap	43.5
Filter	28.3
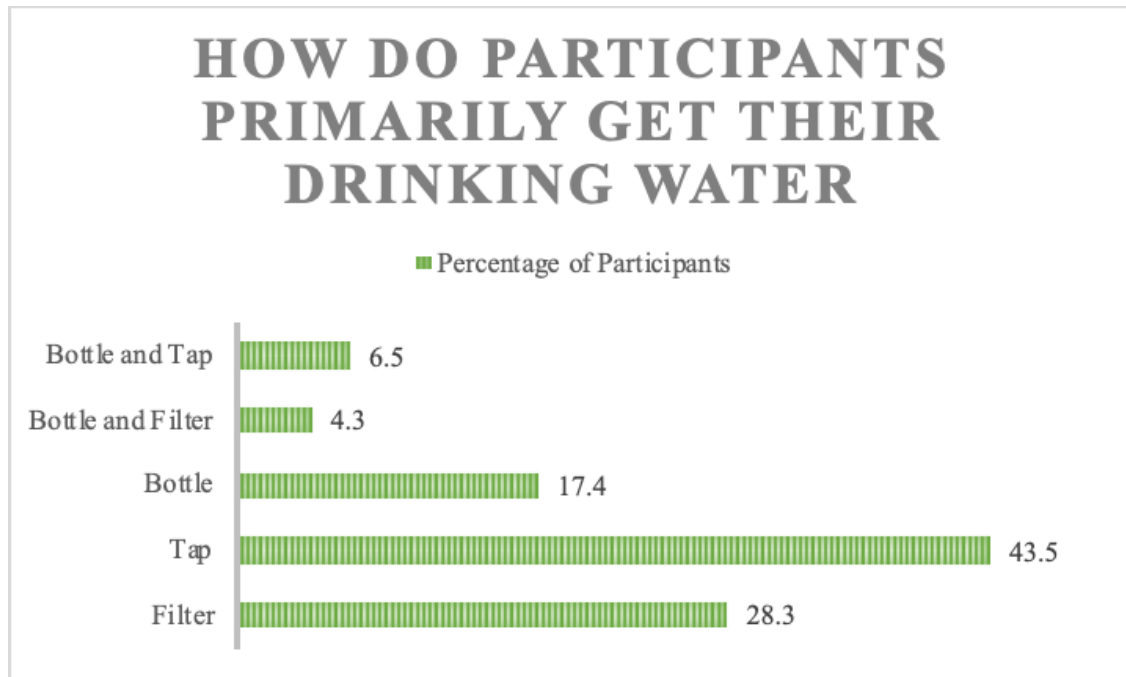
Figure 1 – Plot of survey data on how participants primarily source their drinking water. All 47 participants responded to this question.

REASON FOR CHOOSING TO DRINK TAP WATER

Taste 2%
Healthier 2%
Price 15%
Convenience 59%
Environmental 22%
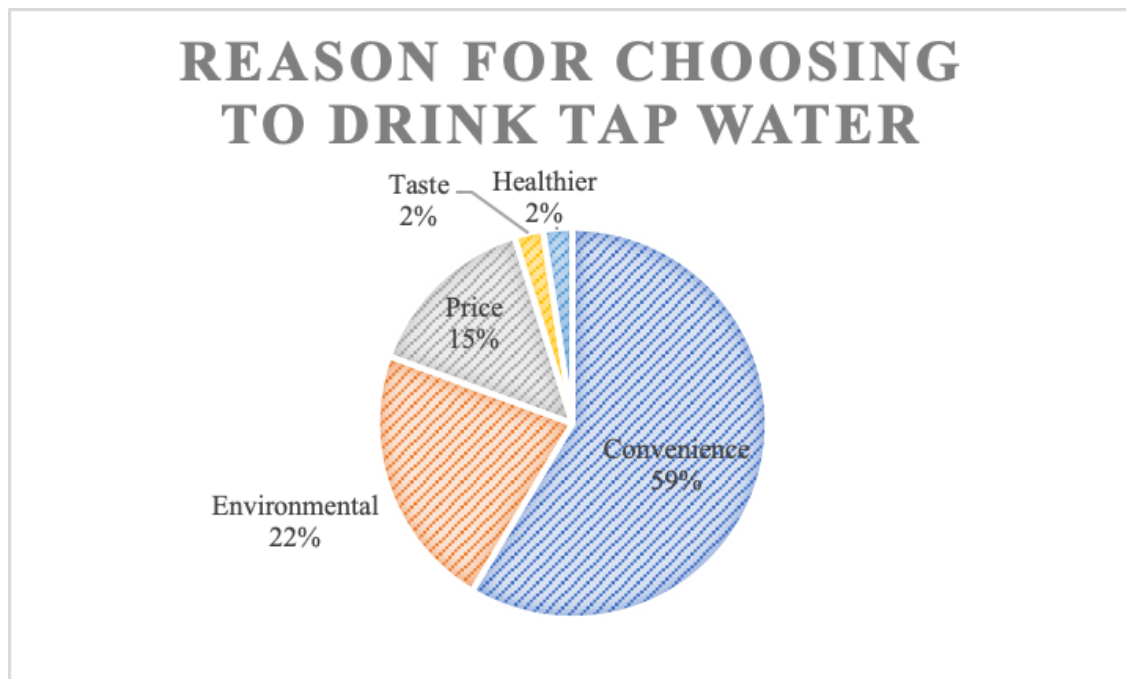
Figure 2 – Graph showing survey data about why participants choose to drink tap water. Multiple choice list with convenience, price, health, taste, environment and other (with the option to jot in a response) were offered.
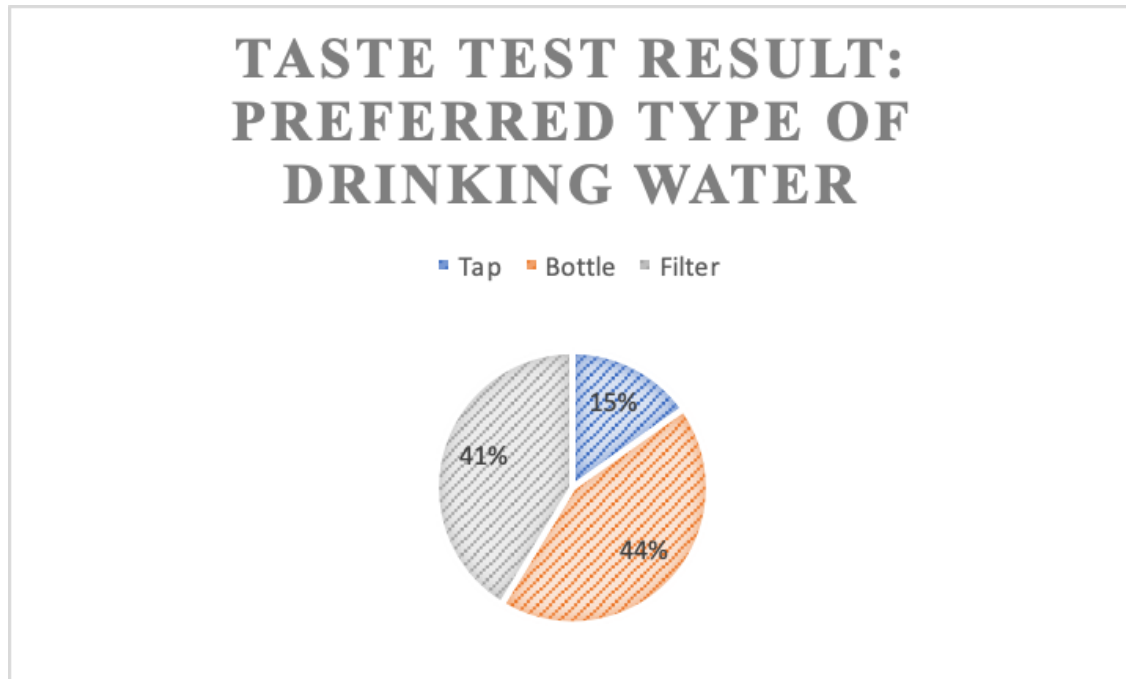
Figure 3 – Graph showing what flavor of water (bottled, tap or filtered tap) students preferred when trying them side by side in a blind taste test.
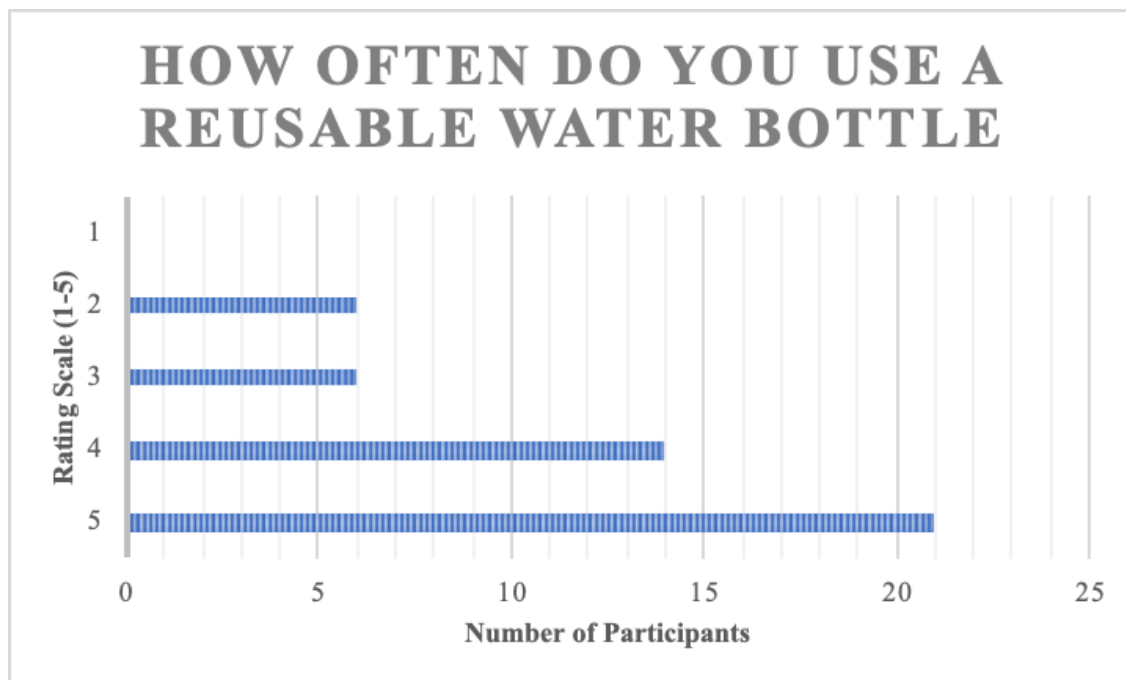
Figure 4 – Survey data plotting rating scale of how often participants use a reusable water bottle. Range defined as Never = 1, Rarely (less than once a week) = 2, Sometimes (1-3 times a week) = 3, Often (every other day or so) = 4, Always (everyday) = 5)
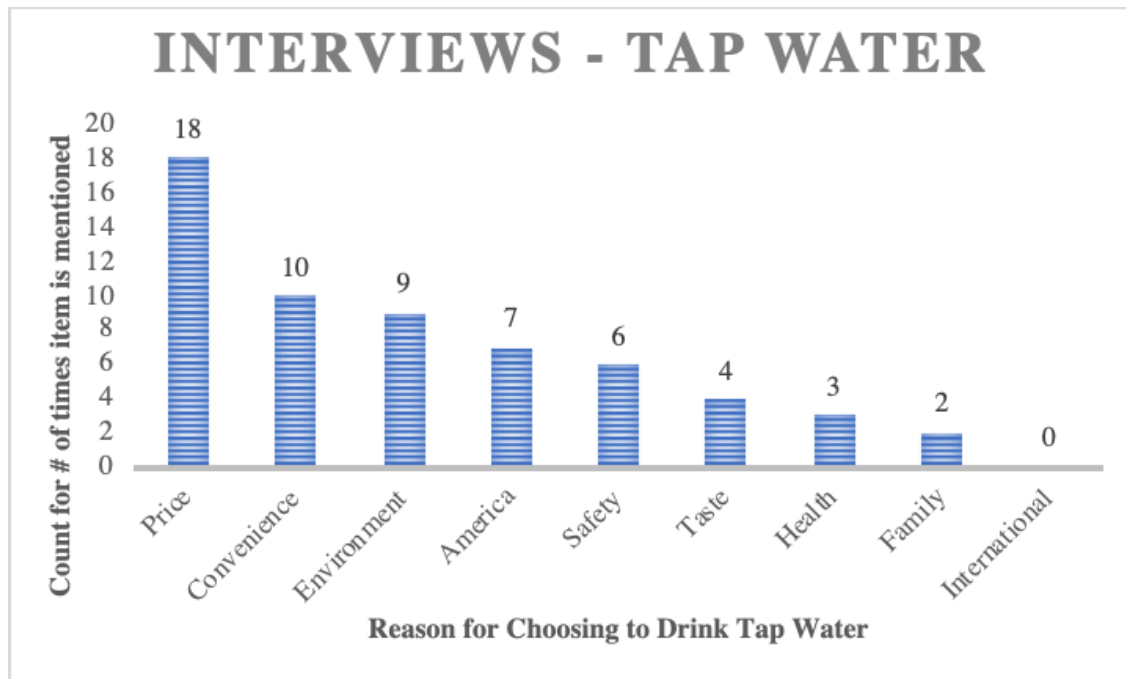
Figure 5 – Interview data coded to show the number of times a particular reason is mentioned why interviewees drink tap water.
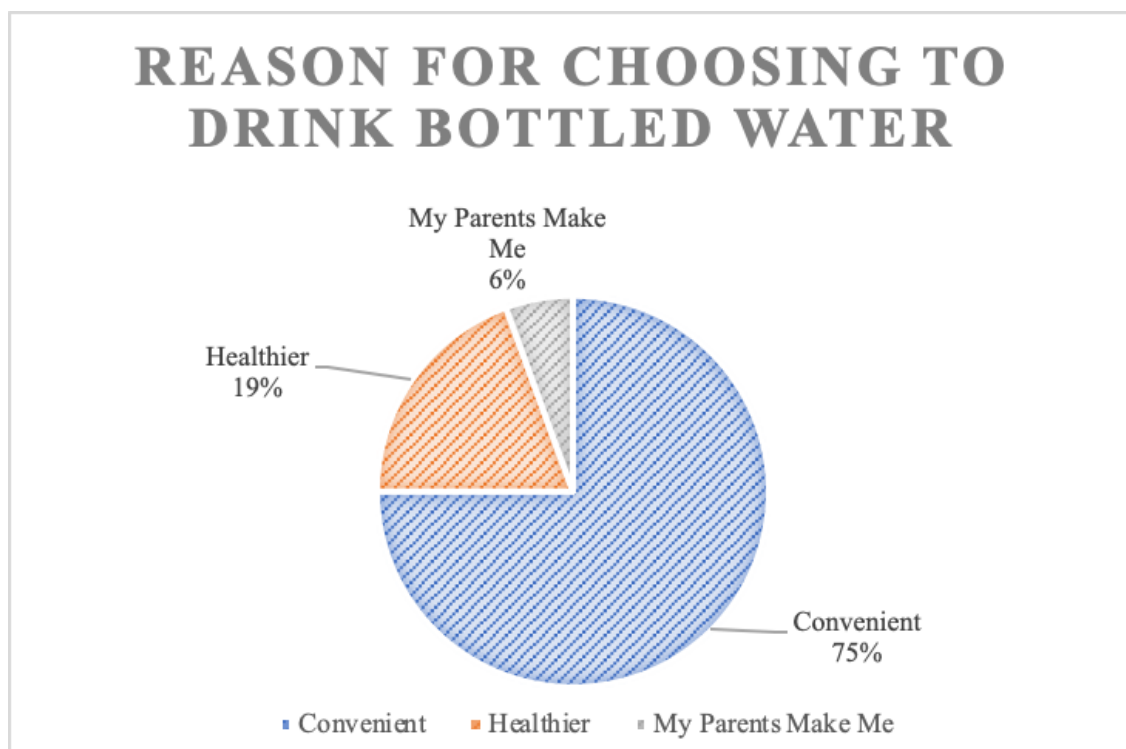
Figure 6 – Survey data plotting reason why people choose to drink tap water. Options were "Convenience," "Health" "Taste," and an option to jot in one's response.
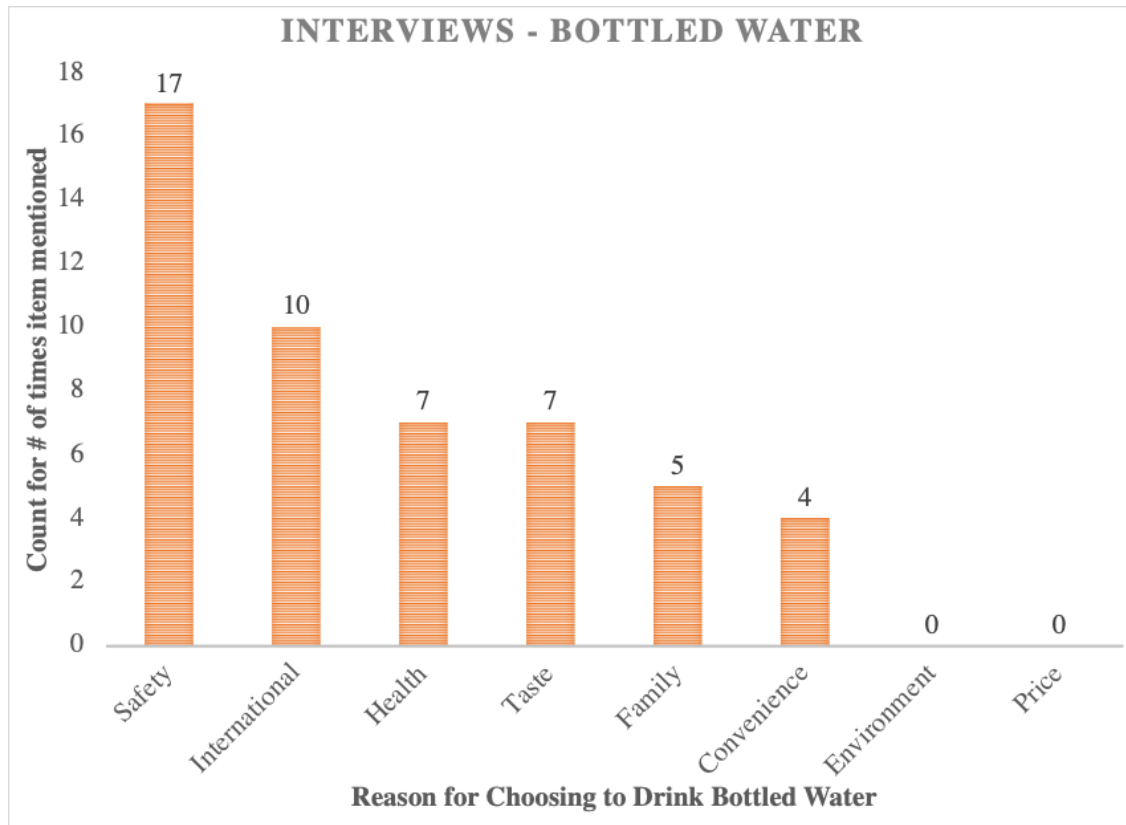
Figure 7 – Interview data coded to show the number of times a particular reason is mentioned why interviewees drink bottled water.

Appendix D: Additional Information on Engagement and Marketing

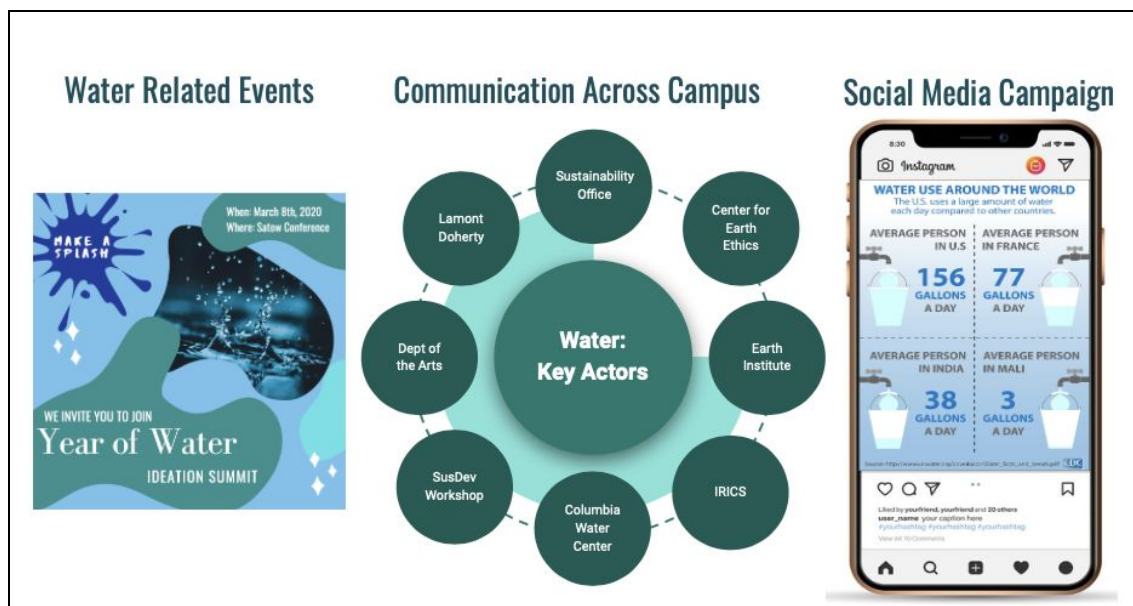Figure 8 - Instructions on starting a Live video on Instagram.

Figure 9 - Examples of how communication strategies could be improved through the usage of infographics, internal newsletters, and social media campaigns.