A Study of Water Consumption at Brookhaven National Laboratory

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I. **Abstract**

Many people have the impression that bottled water is safer to consume than tap water. This sentiment has been upheld by employees at Brookhaven National Laboratory (BNL) and as a result many employees choose to drink bottled water as opposed to the potable water supplied by the Lab. In most cases the bottled water comes in the form of bottled water dispensers (coolers), purchased using laboratory funding. The Safety & Health Services Division's Environmental Safety and Health guidance states bottled water purchases should first be reviewed and approved by the Environmental Protection Division (EPD). Without a lab-level policy there is no apparent consequence for not following the guidance and no leverage for the EPD to deny a purchase request. This dynamic has raised a number of concerns from the Lab and the EPD. Cost burden is one of the main concerns of EPD right now. Because bottled water is purchased to supply buildings that already have viable options for potable water, the Lab is essentially paying for an extra source of drinking water in some cases. Another area of concern is employee health. Due to the lack of information EPD has on the bottled water and dispensers being purchased, there is no way to ensure they are all receiving adequate maintenance. Inadequate maintenance of the bottles or the dispensers can expose employees to a number of contamination sources. The last major area of concern is the environmental footprint of the current bottled water use and delivery.

EPD's goal is to reduce the overall use of bottled water on site and increase the use of bottle filling stations. To accomplish this the EPD needs more leverage in the regulation of bottled water and coolers. The goal of this project was to communicate the need for a policy that gives EPD the ability to do this. This was accomplished by: investigating the history of the

stigma surrounding tap water, presenting accurate information stating the actual difference in quality between bottled water and tap water, evaluating the current economic burdens of supplying both sources of water, and lastly evaluating the saving potential of transitioning from water cooler to filling station. This project provided me with valuable research experience. It improved my writing ability as well as my ability to critically analyze research papers and other literature.

II. **Introduction**

The general public has long had the impression that bottled water is safer to consume than tap water. This sentiment has been upheld by employees at Brookhaven National Lab (BNL) and as a result many employees choose to drink bottled water as opposed to the potable water supplied by the Lab via fountains, bottle filling stations, and faucets. In some cases this is in the form of single-use bottles purchased by individual employees. But in most cases the bottled water comes in the form of water cooler jugs purchased using laboratory funding. There are instances where bottled water purchases are warranted. In work areas where potable water is not readily accessible; in buildings where potable water is not accessible within 200-feet of a work area; and in buildings where testing shows potable water does not meet drinking water standards, bottled water must be supplied. That being said, bottled water purchased with BNL funds is currently supplied and consumed outside of these constraints. The Safety & Health Service Division's Environmental Safety and Health guidance states bottled water dispenser purchases should first be reviewed and approved by the Environmental Protection Division (EPD). Without a lab-level policy there is no apparent consequence for not following the guidance and no leverage for the EPD to deny a purchase request. This dynamic has raised a number of concerns from the Lab and the EPD:

Monetary concerns

Currently there is a large amount of spending associated with the Lab's efforts to supply drinking water to its employees. Because bottled water is purchased to supply buildings that already have viable options for potable water consumption, the Lab is essentially paying for an extra source of drinking water cases. That being said, this "extra source" is very expensive in comparison to supplying tap water.

Health concerns

There is currently no formal policy or process that determines who is responsible for monitoring and recording the stock of bottled water and bottled water dispenser units being purchased. Because of this there is no way for BNL to ensure they are all receiving adequate maintenance. Inadequate maintenance of the bottles of the dispensers can expose employees to a number of contamination sources. That being said, the Lab is planning on outsourcing a cleaning service but it will be financed by the respective budgets of departments that wish to have coolers in their buildings.

Environmental Concerns

From a sustainability perspective the consumption of tap water is the better option. It reduces the level of plastic pollution tied to bottled water use as well as the resources required to deliver bottled water across the Lab the way that it is now.

The EPD's current goal with regard to this issue is to reduce the overall use of bottled water on site and increase the use of bottle filling stations. To accomplish this the EPD needs more leverage in the regulation of bottled water and coolers. The goal of this project is to communicate the need for a policy that gives EPD the ability to regulate the purchase of bottled water across the Lab and the installment of bottle filling stations. This will be accomplished by: investigating the history of the stigma surrounding tap water, presenting accurate information that explains the actual difference in quality between bottled water and tap water, evaluating the current economic burdens of supplying both sources of water, and lastly evaluating the saving potential of transitioning from water cooler to filling station.

III. **Background**

<u>Drinking Water At BNL</u>

BNL's Water Treatment Facility (WTF) was created in 1963 to remove iron and manganese from the groundwater and has undergone a series of upgrades over the years, the most recent taking place in 1995-96.[13] It now supplies potable water across the Lab's entire property. Much of the lore surrounding the tap water supplied by the Lab is derived from past instances of contamination. Some surveys in recent years have found contaminants in the water.[2] But, BNL's sampling process and ability to use multiple wells for drinking water alleviates any contamination issues with its supply to lab employees. Even so, it is still important to understand the history in order to understand what can be done to alleviate employees' concerns.

The most commonly mentioned contamination is from the High Flux Beam Reactor (HFBR). The HFBR operated from 1965 to 1996, which was used for scientific research. The

High Flux Beam reactor was shut down in 1996 for routine maintenance but in 1997 high levels of tritium (above state and federal drinking standards) were found in the groundwater south of the HFBR. The Lab was swift in addressing the contamination but as a result the Department of Energy shut down the HFBR in November 1999. This contamination was swiftly dealt with but while it had no lasting effects on the quality of the water on site it did influence the perception of it. In addition to tritium a common contaminant of concern has historically been lead. Many of the buildings on BNL's site were constructed before 1985. As a result these buildings have a higher chance of drinking water containing residual lead and copper due to typical plumbing corrosion. To address the possibility of contamination, testing for lead and copper is performed over a sample group of buildings and respective occupants are informed of any test results above the regulatory maximum contaminant level (MCL) provided by the Environmental Protection Agency (EPA).[1] Excluding apartments and recreation areas, there have been no lead or copper MCL exceedances as far back as 2015.

Water Quality

The Lab's continuous efforts to uphold drinking water quality are not the only factors that make drinking water just as compliant with regulations as bottled water. The criteria for water quality and testing that BNL follows is established by the EPA. This also goes for publicly supplied tap water outside of the Lab.[6] Unlike tap water, bottled water regulations are mandated by the FDA. The FDA has six main classifications for bottled water.[3] Artesian Water – water under pressure that rises from an aquifer. Distilled Water – water that has undergone the distillation process of being boiled and condensed back into a liquid in a separate container. Mineral Water – water from underground sources that contains a concentration of minerals and trace elements and contains 2250 milligrams per liter of total dissolved solids. Sparkling Water – water from any source that contains the same amount of carbon dioxide as it did when it emerged from the source. Spring Water – water from underground that naturally flows to the surface or through a bore hole. And lastly, Purified Water – water from any source, including tap water, that has been treated and meets the standard of purified water defined by the United States Pharmacopeia definition of "purified water". The classification of purified water is a point of interest as it means bottled water can be marketed as "higher quality" than tap water but its source water can still be tap water. On top of that the pharmacopeia states "there is a potential for microbial contamination and other quality changes of this bulk packaged non-sterile water to occur. Therefore, this form of *purified water* should be prepared and stored in such a fashion that limits microbial growth and/or simply used in a timely fashion before microbial proliferation renders it unsuitable for its intended use. Also…there could be extractable compounds leaching into the water from packaging."[10]

Not only does the standard for quality stray from what is commonly assumed for bottled water, but also testing requirements. Having two separate organizations creates different criteria for water quality and in most cases the EPA has more rigorous requirements for testing. Currently the FDA requires testing for 90 compounds. The EPA-,and in turn BNL, tests for 170+ compounds in its tap water. Out of the compounds that are tested for one of the most common points of concern are PFAS. PFAS are a group of man-made chemicals that includes PFOA, PFOS, GenX, and many other chemicals. PFAS have been manufactured and used in a variety of industries around the globe, including in the United States, since the 1940s (not bottled water companies).[9] PFOA and PFOS have been the most extensively produced and studied of these chemicals. Both chemicals are very persistent in the environment and in the human body—meaning they don't break down and can accumulate over time. There is evidence that exposure to PFAS can lead to adverse human health effects such as kidney cancer and kidney failure. Currently, there are no U.S. Food and Drug Administration (FDA) Standards of Quality (SOQs) or testing requirements for per- and polyfluoroalkyl substances (PFAS) in bottled water. That being said, while not mandated by law, the International Bottled Water Association (IBWA) requires its members to test their bottled water products annually for PFAS. Even so, there are still popular water bottle brands that do not belong to the IBWA and therefore do not test for PFAS. Notable examples include Dasani, Glaceau Smartwater, and Fiji Water. Unlike the FDA, the EPA does require testing for PFAS. In recent years the EPA has continued to delve deeper into research on PFAS and broaden our basis of knowledge. Their current method of testing measures PFAS in drinking water using solid phase extraction and LC/MS/MS at low ng/L concentrations.[8] Not only that but they also provide the public with information on PFAS and update what is available as new developments are made. The EPA provides access to the Drinking Water Treatability Database (TDB), a comprehensive resource offering up-to-date details on over 30 treatment methods and more than 120 regulated and unregulated contaminants. Among these are 26 PFAS chemicals. The database contains information sourced from numerous literature outlets, such as peer-reviewed journals, conferences, research reports, theses, and dissertations. The data collected includes studies conducted at bench, pilot, and full-scale levels, involving surface, ground, and laboratory water samples.

Based on this information it is clear that tap water has more stringent sampling & reporting requirements than bottled water. If more people were aware of this information, it is likely that they would choose tap water over bottled water.

IV. **Economic considerations of bottled versus tap**

Costs of Bottled Water Delivery and Dispensers

In 2022 the Lab spent about $133,044.00 on bottled water deliveries for water coolers. These were delivered to 126 delivery points across the Lab.[7] This cost does not account for the purchase of new cooler units; it only represents the cost of the 5 gallon jugs that supply them. Because there are no accurate records kept that show purchase information for coolers it is difficult to estimate the yearly expenditure. That being said, it is still important to note that the average cost for a heating and cooling water dispenser is about $250 in the current market.[4] In addition to paying for the bottled water delivery, there is a cost associated with cleaning water dispenser units regularly and replacing them when needed. Because water reservoirs, spigots and other internal components of water dispensers are prone to microbe growth, proper cleaning techniques must be followed to prevent contamination and possible illness. In the past departments have been responsible for funding Facilities & Operations (F&O) staff to clean water dispensers as needed. It would take about two hours to fully clean each individual unit at a rate of $125 an hour. On top of this F&O would only provide this service as requested but only after all other work priorities are complete, which has resulted in water dispensers not being cleaned in a timely manner. To maintain an appropriate cleaning schedule in the future, contracting the bottled water delivery service provider to clean water dispensers is expected to become the norm. Though the Lab has not settled on a provider yet, the estimated cleaning cost EPD has received is $95 per unit.

Costs of tap water

The estimated potable water rate for FY23 was $4.24 per thousand gallons.[5] This amount was calculated factoring in the costs of sampling, filtration, system flushing, and water treatment plant operation. While this rate accounts for the water supply it doesn't represent other costs associated with providing tap water across the Lab. For example, more filters and bottle filling units will have to be purchased and installed in buildings across the Lab in order to promote tap water consumption. This is mainly because additional layers of filtration along with filling stations reduce stubborn chlorine taste in water and alleviate stigma associated with regular tap.

The cost of installing a new bottle filling station depends on the unit being purchased and the installation requirements for each respective unit. Because some buildings on site are old, infrastructural changes must be made to retrofit new stations. For example in some cases additional electrical wiring or updated local plumbing fixtures may be required. According to one of BNL's Facility Project Managers, the total cost for installing a new bottle filling station in building 490 in 2021 was $2,565.70. The total cost for labor was $1,511.88 and the cost of the actual unit was $1,053.82. These costs can be used as the average estimated cost for new filling stations in the future as this example was a standard single unit station and didn't require extensive infrastructural changes. The cost for individual filter replacements is about $30 per filter and about $65 for the installation labor. These filters should be replaced every 3,000 gallons or once a year depending on which comes first.

Saving potential

Last year a study was carried out that surveyed 46 buildings on BNL's campus.[11] Data was gathered on the various water units on site including kitchen faucets, water fountains, water bottle filling stations, bottled water dispensers and bottled water storage areas. These water units were individually evaluated for their conditions, model and components (when applicable) , the amount of use they received, and other unit information. In addition, the location of each of these units was recorded. This information along with the cost estimates discussed in the last section can be used to simulate the potential savings that could result from transitioning bottled water dispensers to bottle filling stations when applicable.

Fig 1. Simulated saving potential of using tap over bottled water in a BNL building with adequate access to quality potable water.

Cost factors	Bottled water	Cost Factors	Filling station
Dispenser units	$1,178.857	Units	$1,053.82
Bottled water delivery (5 gallon jugs)	$2,442.12	Potable water	$3.985
Cleaning (twice a year)	$760	Installation	$1,511.88
-	-	Filter replacements	$95
Total expense	$4,380.98	Total expense	$5,139.37
Total expense after 2 years	$7,583.10	Total expense after 2 years	$5,234.37
Saving potential per year	-	Saving potential per year	$2,348.73

For this example building 901/901A was used. The 2022 survey showed that the space contains two Elkay brand single unit water fountains and four bottled water dispensers. Three of the dispensers are Primo brand and the other was unmarked. For consistency and accuracy the price of this dispenser was estimated at a price equal to the others. The price for the bottled water dispenser units was calculated by averaging the price of all bottom loaded hot and cold dispensers Primo offers. The delivery cost for the water bottles was calculated using data gathered by EPD.[7] The data provides a monthly breakdown of delivery costs to various sites at the Lab from May 2022 to October 2022. For this example the data was annualized to produce a more comprehensive comparison between bottled and tap water costs. According to the data the delivery cost for bottles delivered to 901/901A totaled at $2,442.12. As stated earlier the lowest quote received for a cleaning fee is $95 per unit. To properly maintain units and avoid contamination Primo suggests their units be cleaned at least twice a year.[12] With four units in the space the cleaning fee was projected at $760 a year. The price of water bottle filling units was estimated using the cost data provided by the Facility Project Manager. To accurately compare the two drinking water options the price of potable water was calculated based on the number that would be used in a year through bottled water consumption. The price per water bottle is $12.99. When computed against the yearly spending the total number of bottles purchased comes out to 188 5-gallon bottles per year and in turn 940 gallons. It was already determined that the potable water rate at the Lab is currently $4.24 per 1,000 gallons which in turn means that it would be $.00424 dollars per gallon and cost $3.985 to supply 940 gallons of potable water. F&O estimates installations at $1,511.88 for standard units assuming additional costs for retrofitting aren't required. Lastly in a two-year period the filter would have to be replaced once at a cost of about $95. While initially the bottle filling stations would incur a greater cost the purpose of this example was to look at overall saving potential. If we use these same values to estimate the spending for the following years we see that the use of the filling stations would save $2,348.73 per year in this example. It is important to note that this saving potential only represents 3 out of 126 delivery sites, meaning that if bottle filling station use replaced that of bottled water use, where applicable, across the Lab a great deal of money could be saved. Another important consideration is market fluctuation. Because the price of bottled water delivery is more volatile than that of lab-provided potable water, the filling stations are a more reliable option from a financial standpoint.

V. **Discussion**

In conclusion, the comparison between bottled and tap water use at Brookhaven National Lab (BNL) highlights the pressing need for a comprehensive policy to more effectively regulate lab spending on bottled water. From an economic standpoint, the potential for substantial cost savings by transitioning to bottle filling stations is evident. The simulated analysis has shown that BNL could save a large sum of money by replacing bottled water dispensers with bottle filling stations where applicable. Moreover, considering the volatile nature of the bottled water market, the long-term financial stability offered by tap water use and bottle filling stations becomes even more appealing. Beyond economic considerations, environmental concerns underscore the urgency of implementing a policy favoring tap water use. The transition to bottle filling stations would significantly reduce plastic waste, aligning with sustainability goals and reducing the Lab's environmental footprint. Moreover, tap water quality at BNL is thoroughly monitored and adheres to strict EPA regulations, while the quality of bottled water is regulated by the FDA, with less stringent testing requirements. The evidence indicates that tap water is equally regulated, if not more, than bottled water.

By enacting a policy that empowers the Environmental Protection Division (EPD) to regulate the purchase of bottled water and promote the installation of bottle filling stations, BNL can address the economic, environmental, and health concerns associated with bottled water use. Such a policy would encourage responsible water consumption, reduce unnecessary expenses, and reinforce the Lab's commitment to sustainability and employee well-being. In conclusion, implementing a policy that promotes the use of tap water and bottle filling stations at BNL is a crucial step toward optimizing water supply practices and reducing financial and environmental burdens. By encouraging employees to embrace tap water and fostering a culture of sustainability, BNL can set an example for other institutions and contribute to a greener, more cost-effective future. It is clear that the time has come for BNL to take proactive measures and adopt a policy that will lead the way in responsible water usage and resource management.

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