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What's Wrong with the Tap? Examining Perceptions of Tap Water and Bottled Water at Purdue University

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Abstract The environmental impacts of bottled water prompted us to explore drinking water choices at Purdue University, located in West Lafayette, IN. A random sample of 2,045 Purdue University students, staff, and faculty was invited to participate in an online survey. The survey assessed current behaviors as well as perceived barriers and benefits to drinking tap water versus bottled water. 677 surveys were completed for a response rate of 33.1%. We then conducted qualitative interviews with a purposive sample of university undergraduates ($n = 21$) to obtain contextual insights into the survey results and the beliefs of individuals with a variety of drinking water preferences. This study revealed that women drink disproportionately more bottled water then men while undergraduate students drink more than graduate students, staff and faculty. The study also uncovered a widespread belief that recycling eliminates the environmental impacts of bottled water. Important barriers to drinking tap water at Purdue include: perceived risks from tap water and the perceived safety of bottled water, preferring the taste of bottled water, and the convenience of drinking bottled water. The qualitative interviews revealed that drinking water choices can be influenced by several factors—especially whether individuals trust tap water to be clean—but involve varying levels of complexity. The implications of these results for social marketing strategies to promote tap water are discussed.

Keywords Bottled water · Tap water · Social marketing · Risk perceptions

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Introduction

The cumulative environmental impact of millions of seemingly innocuous individual choices can be staggering. This phenomenon is apparent in the mountains of plastic bottles accumulating in landfills around the world. Over the past decade in the United States, public trust in tap water has declined while consumption of bottled water has more than doubled, to a yearly average of almost 30 gallons per person (GAO 2009; Gleick and Cooley 2009). Americans collectively drink between 8 and 9 billion gallons of bottled water annually—making the U.S. the number one consumer of bottled water in the world (Arnold and Larsen 2006, Gleick and Cooley 2009). Purdue University in West Lafayette, Indiana, is no exception to this trend, and, according to the Coordinator of Retail Sales and Marketing for the University Residences, bottled water is the best-selling item in campus mini-marts (Personal communication). Recently there has been a slight decline in consumption of bottled water in the U.S. However, bottled water's share of the beverage market has remained steady as of 2009. The International Bottled Water Association (IBWA) attributes this decline to the economic recession—citing similar declines in consumption of all bottled beverages—rather than an effect of campaigns by environmental groups (IBWA 2010). Regardless of the reasons for the recent decline in consumption, Americans are still

drinking much more bottled water then they were as recently as the early 1990s.

The choice to drink bottled water creates significant environmental impacts that can be avoided by drinking tap water. Bottled water requires large amounts of energy to produce and distribute—much more than the tap water it typically replaces (Gleick and Cooley 2009, Parag and Roberts 2009, Royte 2008). The majority of bottled water is packaged in the plastic polyethylene terephthalate, also known as PET, which is made from fossil fuels (Gleick and Cooley 2009). Refrigerating and transporting the finished product to consumers requires significant amounts of energy as well. Gleick and Cooley (2009) calculated that, in 2007, the 33 billion liters of bottled water consumed in the United States "…required an energy input equivalent of between 32 and 54 million barrels of oil…" (p. 6).

A landfill is the typical "endpoint" in the life cycle of a single-use water bottle, unless it is recycled. However, in the U.S., only about 20% of plastic water bottles are recycled—most end up in landfills where they can take centuries to decompose, or as litter on land, in rivers, and in oceans (GAO 2009; Godwin 2008; Royte 2008). Recycling the plastic water bottles can require significant amounts of additional energy, especially since in 2004 about 40% of PET bottles returned for recycling in the U.S. were processed internationally—often as far away as China (Arnold and Larsen 2006). Since nearly all the energy and materials used to produce and distribute bottled water are derived from oil, the carbon footprint of this product is quite large—especially compared to tap water that is readily available at a significantly lower financial and environmental cost.

Social Marketing

Convincing the public to adopt and maintain sustainable behaviors, such as drinking tap water instead of bottled water, is a challenging task with the potential for significant environmental and social benefits. Social marketing has been used to successfully promote a wide variety of sustainable and healthy behaviors in diverse contexts (Andreasen 1995, Kotler and Lee 2008, McKenzie-Mohr and Smith 1999). Effectively changing behavior through a social marketing campaign requires an in-depth understanding of the target population as well as the current and desired behaviors. Before designing a campaign, it is critical to identify the target population's knowledge and beliefs, their current behaviors, as well as what they perceive to be the important barriers and benefits of engaging in the desired behavior (Andreasen 1995, McKenzie-Mohr and Smith 1999). Rather than relying solely on educating or informing the public, a social marketing campaign strives to decrease the barriers and increase the benefits of the desired behavior (McKenzie-Mohr and Smith 1999, Mckenzie-Mohr &Associates, Inc. 2010).

Little original research has addressed why so many Americans have embraced bottled water (Hurd 1993; Doria 2006), and no published study has addressed how a social marketing approach could be used to discourage bottled water consumption among college students. This study addresses these issues by examining drinking water behaviors at a large university.

Risk Perceptions and Drinking Water Realities

A complex issue related to the consumption of bottled water is the perception of health risks from tap water. The premiums Americans pay for bottled water (as much as 10,000 times more than tap water or about $10 per gallon) indicate that they highly value clean drinking water, and may distrust the quality and safety of tap water (Arnold and Larsen 2006). For example, in a 2002 Gallup poll, the number one reason Americans gave for buying bottled water was "health-related issues" while taste was the second most important factor (United States Government Accountability Office (GAO) 2009).

Perceived risks can play a role in the public's shift away from tap and toward bottled water, especially after contamination events (Parag and Roberts 2009, Anadu and Harding 2000, Jardine 2006, McSpirit and Reid 2011). Media attention on "trust-destroying events", such as outbreaks of illness caused by contaminated tap water, has also weakened public trust in municipal water supplies while falsely inflating confidence in bottled water (Parag and Roberts 2009).

Parag and Roberts (2009), Royte (2008), Gleick (2010), and others have argued that bottled water marketing campaigns have directly and indirectly decreased public trust in tap water. There is little, if any, evidence to support the claim that bottled water is safer than tap—in fact it can be less safe. Under the Environmental Protection Agency (EPA), municipal tap water is subject to more rigorous standards with more frequent monitoring than bottled water, which is regulated as a food product by the Food and Drug Administration (FDA) (GAO 2009; Godwin 2008; Foltz 1999). EPA regulations require fast reporting to the state when a health concern arises within a municipal water supply. Unfortunately there is no such requirement for reporting similar problems with bottled water to the FDA or to the public (Foltz 1999, Royte 2008, Gleick 2010). Additionally, the FDA only has regulatory oversight over products sold in "interstate commerce." Therefore, bottled water that is produced and sold within a state (about 60–70% of all bottled water in the U.S.) is exempt from federal regulation (Gleick 2010, Royte 2008). Limited regulation has allowed the bottled water industry to flourish

without adhering to the same safety standards as municipal water suppliers.

Purpose and Objectives

While a few studies have addressed public perceptions of tap and bottled water, there are still significant gaps in our understanding of how perceptions of risk and environmental impacts interact and influence behavior. The purpose of this research was to assess current behaviors and beliefs about drinking water at Purdue University in Indiana. Through the use of a quantitative survey and mental models interviews, we sought to uncover what factors individuals consider when choosing between tap water and bottled water. Given the limited knowledge of public perceptions of drinking water, this was an exploratory study that addressed the following research questions:

RQ 1 What are the current behaviors of Purdue University students, faculty, and staff in terms of consuming bottled water and/or tap water and using reusable water bottles?

RQ 2 What do Purdue University students, faculty, and staff perceive to be important barriers and benefits to drinking bottled water versus tap water from a reusable water bottle?

RQ 3 What does the Purdue University community believe about the environmental impacts of drinking bottled water?

RQ 4 What role do Purdue University students, faculty, and staff perceptions of health risks from tap water, bottled water, and reusable water bottles play in their decision to drink bottled water or tap water?

Research Design and Methods

We employed a mixed-methods approach, utilizing a quantitative survey followed by qualitative interviews, to assess perceptions of drinking water and to more fully understand the reasoning behind students' drinking water choices. While the survey provided a broad understanding of the current behaviors and attitudes of the university community, we anticipated the need for contextual information about how individuals make the choice to drink bottled water or tap water. Thus, mental models interviews were conducted to more thoroughly understand individuals' decision frameworks regarding drinking water.

The mental model perspective argues that when individuals make a choice, they rely on an array of collected experiences and knowledge to make inferences. Ultimately, they combine these experiences and beliefs to create a decision framework—called a mental model (Morgan and others 2002). The goal of mental models interviews is to capture current beliefs (both correct and incorrect) without influencing or creating beliefs through the wording of the interview questions (Morgan and others 2002). The mental models created through this investigation, and the prominent themes uncovered, can be used to identify concerns and help policymakers and risk communicators know which misconceptions should be addressed, what information lay people need, and what to emphasize when trying to change behavior (Lazo and others 1999, Morgan and others 2002). This paper focuses on the important themes that emerged from the mental models interviews, rather than the models themselves.

Survey Methods

Survey Sampling Procedure

A survey addressing the barriers to, and benefits of, tap water consumption was conducted with a random sample of university students, faculty, and staff to gain insights into their behaviors and perceptions regarding drinking water and the environmental impacts of bottled water. The random sample was drawn from the Purdue University telephone directory, published annually, which includes every student, faculty and staff member who does not choose to opt out. The directory has two separate sections: one for students and one for staff/faculty. We systematically selected six names per page in the student section and nine names per page in the staff/faculty section since there were fewer pages of staff/faculty names, and we oversampled for staff/faculty expecting a lower response rate than from students. For every name selected this way, we used the online directory to retrieve an email address. An online survey was appropriate for this study because of access to and familiarity with the internet in university populations. Using the online survey software, Qualtrics, email invitations including an individual hyperlink to the online questionnaire were sent to 2,045 potential participants on January 19th, 2010, followed by up to three weekly reminder emails. As an incentive, survey respondents had the option of entering a drawing to win one of several $25 cash prizes.

Questionnaire Design

An exploratory survey of students in public areas on the Purdue University West Lafayette campus was conducted to aid in the development of questionnaire items. The results of this preliminary survey were used in conjunction with current literature to develop a draft questionnaire, which was then pre-tested with a subset of faculty, staff, and students at the university, and subsequently revised for

clarity. The final random sample was checked to ensure that no one who had accessed the draft survey was included in the actual study.

The final questionnaire included items about bottled water consumption and use of reusable water bottles, perceived barriers and benefits to drinking tap water from a reusable water bottle versus bottled water, along with demographic characteristics such as gender and political views. Respondents were also asked about their beliefs regarding the environmental impacts of both individual and global consumption of bottled water, using questions adapted from Bratt (1999), as well as their risk perceptions from tap water, bottled water and reusable water bottles (adapted from Bratt 1999). Most items in the questionnaire, including the barriers and benefits, utilized a five-point Likert scale ranging from strong disagreement to strong agreement (coded as 1–5 for analysis).

During construction of the survey in the fall semester of 2009, the Purdue University Administration released information that five buildings on the West Lafayette campus had failed EPA water quality tests for lead several weeks earlier (Purdue University Water Works 2010). The administration assured Purdue students, faculty, and staff that proper action was taken in those buildings to reduce the lead content in the tap water to safe levels. This incident, and what some considered delayed notification by the administration, had the potential to influence attitudes and behavior in terms of drinking tap water on campus. In light of these developments, three questions about the lead incident, "Have you heard about high levels of lead in the water of certain buildings on Purdue's campus?", "How much has the reporting of this event affected your perceptions of the safety of tap water on Purdue's campus?" and the potential barrier, "I don't trust the Purdue administration for accurate and timely information about the safety of tap water on campus" were added to the questionnaire.

Survey Data Analysis

Survey responses were exported from Qualtrics and analyzed using PASW 17 statistical software. Based on the distribution of responses to the question "In the past week, about how many single-serving bottles of water did you drink?" we created an ordinal variable for level of bottled water consumption. This variable categorized respondents into user groups based on how many single-serving bottles of water they reported drinking in the past week (i.e. a response of zero bottles was re-coded as None, 1 or 2 bottles were re-coded as Low, 3 to 7 bottles were re-coded as Moderate, and 8 or more bottles were re-coded as Heavy use). This ordinal variable facilitated comparisons between groups with different levels of bottled water consumption across other variables, including the barriers and benefits they perceived to drinking tap water as opposed to bottled water. Additional analyses included Pearson Chi-squared tests and Spearman's correlations of bottled water usage with perceived barriers and benefits, perceived risks, environmental impact of bottled water, and demographic variables such as position at Purdue University and gender. A between-groups ANOVA was conducted, along with post-hoc Bonferonni tests, to compare the barriers and benefits responses of all four levels of bottled water consumption. These tests revealed that most of the significant differences in agreement were between non-users and heavy users of bottled water, so this article focuses on the differences between these two groups.

Mental Models Interviews Methods

The standardized interview guide was developed based on findings from the online survey and the guidelines proposed by Morgan and others (2002) and addressed current drinking water behaviors (how much bottled water, if they mostly drink tap, bottled, or filtered tap etc.), what factors respondents consider when choosing whether to drink tap or bottled water, and more specific prompts focused on environmental impacts and risk perceptions. According to Morgan and others (2002), mental models interviews should begin with broad questions to avoid introducing the interviewer's ideas, and become more focused later in the interview to ensure all topics of interest are addressed. The interview guide was pre-tested with six individuals with varied backgrounds, drinking water habits, and beliefs about the safety of tap water and bottled water and subsequently revised for clarity and succinctness. One limitation of our interviews was that we did not ask students what proportion of their beverage consumption came from water versus other bottled drinks, such as carbonated soft drinks, juices etc.

Time constraints allowed interviews to be completed with only one of the four respondent categories included in the online survey. Based on the online survey results, Purdue undergraduate students drink significantly more bottled water than the other respondent categories. For this reason, undergraduate students were the target population for these interviews.

Purposive Sampling Procedure

Undergraduate students were purposively sampled by gender and race in order to capture a variety of perspectives. Participants were sampled on different days of the week and at different times of day in late June 2010. Individuals were approached in a common area where students can purchase food and bottled water, and near two

outdoor fountains that are popular gathering places for Purdue students. These locations offered the greatest potential for a variety of perspectives, since students from all colleges and majors tend to gather there. A log of interview respondents was maintained in order to ensure a diverse sample, to track the number of people approached, and to calculate the response rate (Schutt 2009).

Interview Analysis

All interviews were recorded using a digital recorder and transcribed verbatim for analysis. Following transcription, the interviews were coded for relevant themes using QSR NVivo software (QSR International 2007). The themes and connections from each interview facilitated the construction of individual mental models (or concept maps) of drinking water choices.

Results

Survey Respondent Characteristics

A total of 677 questionnaires were completed for a response rate of 33.1%. An additional 52 partially completed questionnaires were included in the analysis. A higher proportion of respondents were female (54.7%) than male (45.3%). Women were more likely to respond to our survey than would be expected based on their proportion (44.5%) of the Purdue University West Lafayette campus (Purdue University Human Resource Services 2010). 84.3% of respondents identified themselves as White/Caucasian, 8.3% as Asian/Pacific Islander, 2.3% as Black/African-American, 2.1% as Hispanic/Latino, and 1.5% as Native American, which is representative of the racial composition of Purdue University (Purdue University Human Resource Services 2010). The mean age of survey respondents was 37 years (SD = 14.9), an accurate reflection of our university population of students and working adults. 45.5% of respondents were staff members, 12% were faculty, 12.4% were graduate students, and 30.1% were undergraduate students.

Interview Themes and Respondent Characteristics

Morgan and others (2002) state that the vast majority of themes and ideas about a particular subject can be obtained with 20 to 30 interviews, a concept referred to as saturation. A total of 25 undergraduate students were approached to be interviewed and 21 agreed to participate (12 males, 9 females) for a response rate of 84%. After 21 interviews, it was determined that saturation of ideas was reached (i.e., no new ideas were emerging with subsequent interviews). Three main recurring themes emerged from these interviews: *Drinking Water Quality and Safety, Trust* (in federal and local governments and Purdue University), and *Environmental Impacts of Bottled Water.*

Most students interviewed were Caucasian, two were African-American, and two were Asian, reflecting Purdue University's undergraduate population. The interviews lasted between five and a half and 17 minutes, with an average length of 9.27 minutes.

Current Behaviors

Survey respondents consumed an average of 4.8 single-serving bottles of water per week, with a range of zero to 56 bottles (Median = 2.0 per week, SD = 7.1). Approximately 62% of respondents reported drinking at least one bottle of water in the past week, while 44% drank three or more bottles of water per week. When it came to using reusable water bottles to drink tap water, a majority of survey respondents had tried using a reusable water bottle, but only 40% used one three or more days per week. These results indicate that overall, members of the Purdue University community more regularly drink bottled water than tap water out of reusable water bottles. One limitation of the focus on reusable water bottles, was that we did not ask respondents about how often they drank tap water from cups or water fountains.

Analysis of the survey results revealed a significant relationship between a respondent's gender and the amount of bottled water they reported drinking (χ^2=10.98, $P < 0.05$). Significantly more women were heavy users of bottled water than would be expected if there was no relationship between gender and the amount of bottled water consumed. Additionally, 45.5% of men reported drinking no bottled water in the past week, while only 33% of women indicated the same.

Significant differences were also found between campus groups—undergraduate students, graduate students, staff, and faculty ($\chi^2 = 42.14$, $P < 0.001$). Undergraduate survey respondents ($n = 200$) consumed an average of 6.9 bottles of water per week (SD = 8.8)—two bottles more than the mean for all respondents. Staff members were the second highest consumers of bottled water, with a mean of 4.5 bottles per week (SD = 6.5), but were also the most diverse in their drinking water choices; 38% of staff were non-users of bottled water, while 24% were moderate users and 20% were heavy users. In contrast, a majority of faculty and graduate students did not drink bottled water, 55% and 54% respectively. In keeping with the differences between groups on Purdue's campus, there was a significant negative relationship between a respondent's age and the amount of bottled water they reported consuming ($r = -0.132$, $P < 0.01$). Therefore, younger respondents

Table 1 Primary drinking water source: interviews

Drinking water source	Gender	
	Male	Female
Bottled water	1	6
Tap water	7	0
Filtered tap water	4	2
Bottled/filtered mix	0	2

tended to drink more bottled water than older respondents. There were no significant differences in bottled water consumption based on a respondent's race or political views.

Among the undergraduates interviewed, the average amount of bottled water consumed was 7.7 bottles per week. Eight interviewees consumed eight or more bottles of water per week, while only four students reported drinking no bottled water in a typical week. Similar to survey respondents, female interviewees consumed more bottled water than males, with means of 12.6 bottles per week and 4 bottles per week respectively. At the beginning of the interview, students were asked if they drink mostly bottled water, mostly tap water, or mostly filtered tap water and the gender differences are apparent in the results displayed in Table 1.

Perceived Barriers to and Benefits of Drinking Tap Water

An ANOVA was conducted to test for significant differences in agreement with barriers and benefits associated with drinking tap water from a reusable water bottle and results are shown in Tables 2 and 3. The ANOVA revealed significant differences in mean agreement with 14 out of 18 potential barriers when comparing the responses of the four groups. The largest differences in mean agreement were between non-users to heavy users of bottled water. Potential barriers that produced the largest disagreement between heavy bottled water users and non-users included preferring the taste of bottled water to tap water, believing that bottled water is safer than tap water, the convenience of bottled water, and feeling that tap water, both on Purdue's campus and in general, is unsafe to drink.

The ANOVA also indicated significant differences between bottled water usage groups in terms of their mean agreement with 16 of 19 potential benefits of drinking tap water. Non-users of bottled water more strongly agreed that the benefits listed would encourage them to drink tap water. Non-users especially agreed with the benefits that involved a reduced environmental impact, with the relative convenience of obtaining tap water and its low cost compared to bottled water. Heavy users of bottled water tended to be more neutral toward potential benefits, but leaned towards agreeing that they would be motivated by the lower cost of tap water, not needing to go to the store regularly to purchase bottled water, and contributing less plastic to landfills. The benefit of tap water that produced the biggest disagreement between non-users and heavy users of bottled water was that, "Bottled water is often the same or similar to tap water."

Differences in Perceived Barriers and Benefits by Gender

Given our finding that women at Purdue are drinking more bottled water than men, we examined responses to the barriers and benefits questions described above to determine if there were gender differences. Chi-square tests revealed statistically significant differences between male and female respondents for several of the barriers and benefits to tap water consumption—especially those that addressed potential health risks. Consistent with the literature about gender and risk perceptions (Finucane and others 2000, Flynn and others 1994), survey results show that women were much more likely than men to be concerned about environmental health risks. For example, women were more likely to strongly agree that the following are barriers to drinking tap water: that tap water in general is unsafe ($\chi^2 = 13.22$, $P = 0.01$), that tap water on Purdue's campus is unsafe ($\chi^2 = 19.22$, $P = 0.001$), and not having access to filtered tap water on campus ($\chi^2 = 13.06$, $P < 0.05$). The interviews revealed similar gender differences in terms of the perceived safety of drinking water. Most bottled water drinkers, the majority being female, found fault with tap water and expressed reservations about the relative safety and cleanliness of tap water on campus and in general compared to bottled water.

Environmental Impacts of Bottled Water

To assess current attitudes at Purdue University concerning the environmental impacts of bottled water, questions regarding the impacts of individual and global behavior were staggered throughout the survey, with global impact questions appearing before individual impact questions. Figures 1 and 2 show the distribution of responses to these four questions.

Figure 1 illustrates that 47.3% of respondents believe that global consumption of bottled water causes some significant environmental damage, and 28.3% believe it causes a lot of damage. A minority of respondents indicated that global consumption of bottled water causes only insignificant environmental damage or none at all. When asked to account for recycling of the bottles, the perceived environmental impact of bottled water decreased

Table 2 Agreement with barriers for non-users and heavy users of bottled water

Barrier[a] (strongly disagree → strongly agree: 1 → 5)	Non-users Mean (*n*)	Heavy users Mean (*n*)	F-test *P*-value
Bottled water is safer to drink than municipal tap water	2.39 (274)	3.4 (155)	0.000
I don't trust our local government to ensure the safety and quality of tap water	2.33 (273)	2.85 (155)	0.000
I don't have access to filtered tap water on campus	2.84 (272)	3.24 (155)	0.000
There aren't enough convenient places to refill a reusable water bottle on campus	2.30 (271)	2.95 (155)	0.000
Reusable water bottles are easy to lose or forget at home	2.93 (273)	3.38 (155)	0.000
Bottled water is more convenient because it is available in many places on campus	2.61 (271)	3.09 (155)	0.000
I feel that tap water on Purdue's campus is unsafe to drink	2.11 (272)	2.99 (154)	0.000
I don't like the taste of tap water as much as bottled water	2.21 (274)	3.53 (155)	0.000
Cleaning a reusable water bottle requires too much time and effort	2.01 (274)	2.69 (155)	0.000
I feel that tap water in general is unsafe to drink	1.73 (273)	2.54 (155)	0.000
I could get sick from germs growing in a reusable water bottle if I don't keep it clean	3.14 (273)	3.58 (155)	0.000
Reusable water bottles are too big to fit in a car cup holder	2.63 (273)	3.1 (155)	0.000
I worry about using a reusable water bottle since it could transfer harmful chemicals (such as BPA) into the water	2.26 (273)	2.68 (155)	0.000
I don't trust the Purdue administration for accurate and timely information about the safety of tap water on campus	2.54 (271)	2.98 (153)	0.001

[a] Barriers that were insignificant at the $P < 0.01$ level are not presented in this table. These barriers are: "A good reusable water bottle is too expensive", "Bottled water is offered for free at events and meetings on campus", "Reusable water bottles are inconvenient to carry around on a daily basis" and "I don't own a reusable water bottle"

Table 3 Agreement with benefits for non-users and heavy users of bottled water

Benefit[a] (strongly disagree → strongly agree: 1 → 5)	Non-users Mean (*n*)	Heavy users Mean (*n*)	F-test *P*-value
Bottled water is much more expensive than tap water	4.46 (263)	3.96 (149)	0.000
I don't have to go to the store to purchase bottled water regularly	4.27 (262)	3.75 (149)	0.000
I am contributing less plastic to landfills	4.24 (263)	3.59 (149)	0.000
I can reduce my consumption of oil used to make plastics	3.9 (260)	3.4 (149)	0.000
I am reducing my personal contribution to global climate change	3.71 (259)	3.21 (149)	0.000
I'm helping to make our campus more sustainable	3.5 (259)	3.14 (148)	0.000
Bottled water is often the same or similar to tap water	3.58 (261)	2.54 (149)	0.000
Reusable water bottles are easy to refill throughout the day	3.81 (261)	3.25 (148)	0.000
Municipal tap water is more regulated, and therefore safer to drink, than bottled water	3.08 (260)	2.6 (149)	0.000
I feel guilty throwing away plastic bottles after only using them once	3.77 (261)	3.32 (149)	0.000
I can filter tap water myself to make it safer to drink	3.71 (259)	3.28 (149)	0.000
A reusable water bottle is convenient because I can always have it with me	3.52 (263)	3.18 (148)	0.001
Recycling single-use bottles takes too much time and/or effort	2.93 (262)	2.71 (148)	0.002
I worry about drinking bottled water because the plastic can transfer harmful chemicals to the water inside	3.04 (260)	2.72 (148)	0.021
Municipal tap water has the benefits of added fluoride, while bottled water does not	3.46 (259)	3.23 (149)	0.038
By using a reusable water bottle, I motivate others to do the same	3.15 (260)	2.91 (149)	0.045

[a] Benefits that were insignificant at the $P < 0.05$ level are not presented here. These benefits are: "Seeing others using reusable water bottles motivates me to do the same", "Reusable water bottles usually hold more water than single-use bottles", and "There aren't enough locations to recycle plastic bottles on campus"

substantially, with 37% of respondents believing it causes some significant damage and just 5.1% indicating that it causes a lot of damage. If the bottles are recycled, a third of respondents believe that the global impact of bottled water is insignificant—24% more than without recycling—and 9.6% believe there is no environmental impact.

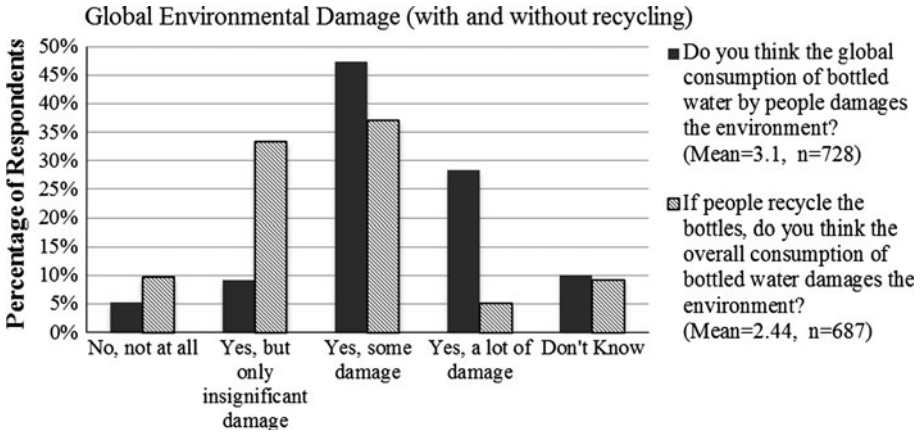

Fig. 1 Perceived global environmental impact of bottled water

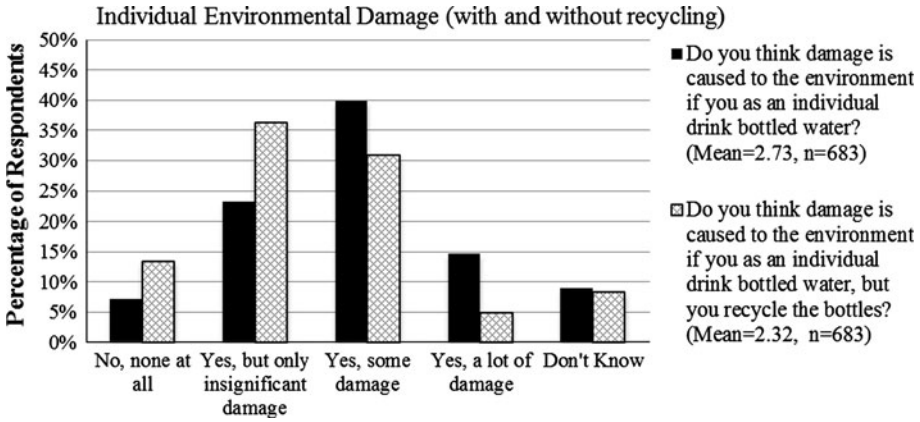

Fig. 2 Perceived individual environmental impact of bottled water

Figure 2 shows respondents' perceptions regarding the environmental impact of the individual choice to drink bottled water. When compared to the global impacts shown in Fig. 1, it is clear that the most common response was that individual use of bottled water causes some significant environmental damage. However, more than twice as many (23.2%) believe their individual behavior causes only insignificant damage and fewer believe individual actions cause a lot of damage (14.7%) than global bottled water consumption. When asked about the effect recycling would have on their personal environmental impact, 36.2% indicated that this behavior would cause only insignificant damage, while 13.3% believed it would have no environmental impact. 30.9% of respondents believed that even if they recycled the bottles there would be some environmental damage, while 4.9% thought they would still be causing a lot of environmental damage.

The undergraduates who were interviewed also seemed to have an incomplete understanding of the environmental implications of bottled water production and consumption. Most of the students interviewed either did not consider environmental impacts when choosing between bottled water and tap water, or believed that recycling the bottles would reduce or eliminate any environmental impacts. Several interviewees did consider environmental impacts of bottled water and came up with a few specific themes, the most common being that "plastic persists in the environment" ($n = 10$) and that "bottled water is a waste of plastic" ($n = 10$). Other themes included "recycling the bottles reduces or eliminates the impacts of bottled water" and "feelings of guilt about environmental impacts." The belief that recycling would reduce or eliminate the impacts of bottled water consumption was tied to the feelings of guilt for several students. If students believe, albeit incorrectly, that recycling the bottles eliminates the environmental impacts of their 'bad habit' they can soothe their guilty conscience without changing their underlying behavior:

Female survey respondents were more likely than men to be motivated to drink tap water by the reduced environmental impact compared to bottled water. Female survey respondents also tended to be more sensitive to the environmental impacts of bottled water. Pearson Chi-square tests indicated that women were statistically more likely than men to believe that the global consumption of bottled water causes a lot of damage or some damage to the environment, while men were more likely to reply that it causes no damage at all, or only an insignificant amount

($\chi^2 = 14.13$, $P < 0.01$). Women were also more likely to reply that if they as an individual drink bottled water, it causes a lot of damage or some damage to the environment ($\chi^2 = 13.57$, $P < 0.01$). There were no statistically significant differences between the attitudes of men and women concerning the environmental impacts of bottled water when the bottles are recycled. In other words, when accounting for recycling, women's perceptions of the environmental impacts of bottled water were the same as men's.

Spearman correlations revealed significant relationships between survey respondents' perceptions of the environmental damage caused by bottled water and the amount of bottled water they reported drinking. Respondents were asked how much environmental damage is caused by individual and global consumption of bottled water, and then the damage when the bottles are recycled. Agreement with each of the environmental damage questions was negatively correlated with bottled water consumption (Global: rho = −0.166, $P < 0.001$; Global Recycling: rho = −0.206, $P < 0.001$; Individual: rho = −0.117, $P < 0.01$; Individual Recycling: rho = −0.237, $P < 0.001$). Therefore, the more environmental damage respondents thought bottled water caused the less bottled water they tended to drink. Regardless of gender, individuals who thought bottled water caused a lot of environmental damage, even when the bottles are recycled, drank less bottled water.

These results demonstrate that the Purdue community has an incomplete understanding of the environmental impacts of bottled water. Respondents tended to link bottled water consumption with inappropriate disposal of plastic bottles, but less with the energy required to produce, transport and refrigerate bottled water. Therefore, they generally believed that recycling the bottles would greatly reduce or eliminate the environmental impacts of this habit.

Drinking Water Risk Perceptions and Consumption of Bottled Water

Table 4 displays survey respondents' perceptions of risk from various sources of drinking water.

Spearman's Rho correlations showed that all six statements were significantly correlated with level of bottled water use. The analysis revealed moderate positive relationships between four of the risk statements and the amount of bottled water consumed, indicating that individuals who believe bottled water is safer than tap water drink significantly more bottled water. There was also a negative correlation between agreement that municipal tap water is more regulated and therefore safer than bottled water and amount of bottled water consumed. In other words, the more a respondent agreed that tap water was safer than bottled water, the less bottled water they tended to drink.

Since women tended to drink more bottled water than men, and have reported higher risk perceptions in previous research (Flynn and others 1994, Finucane and others 2000), Chi-square tests between gender and agreement with the risk perception questions were conducted. Women were significantly more likely than men to agree that, "I am concerned about health risks from water on Purdue's campus" ($\chi^2 = 17.41$, $P < 0.01$). Additionally, there were significant differences between the perceptions of men and women towards certain barriers that addressed potential health risks from drinking tap water. Therefore, higher risk perceptions could be influencing women to drink more bottled water than men.

In addition to the risks above, some potential barriers to drinking tap water that addressed risks were significantly positively correlated with a person's level of bottled water consumption: "Bottled water is safer to drink than municipal tap water" (rho = 0.356, $P < 0.001$), "I feel that tap water in general is unsafe to drink" (rho = 0.302, $P < 0.001$), and "I feel that tap water on Purdue's campus is unsafe to drink" (rho = 0.299, $P < 0.001$). Additional positive correlations exist between the barriers addressing lack of trust in local government to provide safe tap water (rho = 0.197, $P < 0.001$) and lack of trust in the Purdue administration for accurate and timely information about the safety of campus tap water (rho = 0.152, $P < 0.001$) and the amount of bottled water consumed. Therefore, a lack of confidence in the local government and the Purdue administration caused some respondents to drink more bottled water than others who trusted these institutions to provide safe drinking water.

79.9% of respondents had heard about the occurrence of high levels of lead in the drinking water of certain buildings on Purdue's campus, but 64% said they still felt safe drinking tap water on campus. Only 10% reported no longer feeling safe drinking campus tap water after the lead incident, and 13% indicated they already thought campus tap water was unsafe prior to the lead event.

A Pearson Chi-square test was conducted to determine if survey respondents with different perceptions of the lead incident consumed different amounts of bottled water. Respondents with different reactions to the lead event reported prominent differences in the amount of bottled water they consumed ($\chi^2 = 66.27$, $P < 0.001$). 40% of respondents who already thought campus tap water was unsafe to drink reported drinking eight or more bottles of water per week, while just 16.3% drank no bottled water. In contrast, 51% of respondents who reported that the event did not change their perceptions at all, and still felt safe drinking campus tap water, drank no bottled water, while just 15.6% were heavy users. Individuals who thought the

Table 4 Drinking water risk perceptions

Risk statement	Strongly disagree (%) 1	Disagree (%) 2	Neither A nor D (%) 3	Agree (%) 4	Strongly agree (%) 5	Mean (*n*)	Don't know[a]	Corr. with bottled water use (*P*-value)
Bottled water from a natural spring is safer to drink than municipal tap water	6.2	26.9	31.0	13.9	4.0	2.79 (676)	10.8	0.349 (<0.001)
Bottled water that is purified municipal tap water is safer to drink than municipal tap	3.3	16.7	34.8	22.2	4.5	3.10 (674)	10.8	0.257 (<0.001)
I am concerned about health risks from water on Purdue's campus	8.9	30.6	21.5	23.0	7.1	2.88 (674)	1.2	0.197 (<0.001)
Filtering tap water makes it safer to drink	1.9	8.6	22.1	45.3	9.3	3.59 (676)	5.5	0.091 (<0.05)
Bottled water is safer than filtered tap water	6.2	32.1	30.3	9.7	3.0	2.65 (673)	11.0	0.350 (<0.001)
Municipal tap water is more regulated, and therefore safer than bottled water	2.6	22.1	39.8	13.0	3.4	2.91 (676)	11.8	−0.144 (<0.001)

[a] "Don't know" responses are not included in calculation of means

lead event completely changed their perceptions, and no longer felt safe drinking tap water tended to have more diverse drinking water choices—21.5% drank no bottled water and 27.7% were heavy users. Based on these results, this risk event may have had less effect on certain heavy bottled water users who already perceived campus tap water to be unsafe, and tap drinkers who tend to trust tap water. Respondents who reported changed perceptions were somewhat more likely to be heavy users of bottled water.

In keeping with existing research about lay perceptions of water quality (Anadu and Harding 2000, De Franca Doria and others 2005), undergraduate interviewees used aesthetic characteristics—including taste, clarity, and odor—to judge the quality and safety of different sources of drinking water. Most bottled water drinkers, the majority of which were female, and most filtered tap drinkers found fault with tap water and often contrasted these aesthetic problems with positive attributes of bottled water. For example:

> "Well the water here smells, and I feel like that smell comes from something, so I don't really think it's safe."
> "I guess the biggest reason I don't think it's very clean is 'cause sometimes if you get a glass of water from tap, you can see it can be different tints, and have stuff in it, and then when it's bottled water it's completely clear. So, I mean… When it's not clear, it just doesn't look safe to drink."

Many interviewees considered health risks from sources of water when choosing what to drink. Tap drinkers were generally unconcerned with risks, which may contribute to their choice to drink mainly unfiltered tap water. Several bottled water drinkers expressed specific concerns with tap water in general as well as on Purdue's campus. For example:

> "Based off of what's in it. I always think about the bacteria that can be floating in it…Depending on the type of germ you're looking at some people can actually get infections…"
> "I don't want to risk my health by drinking tap water…"

Several bottled water drinkers mentioned that the higher cost of bottled water leads them to believe it is safer than tap water. These interviewees thought they were paying for improved water quality, while in reality the higher cost of bottled water is mainly due to the plastic packaging, transportation, and the company's goal of making a profit. For example:

> "I would think probably bottled water would be safer to drink, maybe, because I guess price affects that with me. I see how much a bottle of water costs and I would think that they'd have to put a lot of time and effort into making sure it's pure."
> "It's in a bottle. It's more expensive. I don't know, just general knowledge, bottle water is just safer than tap water."

Both bottled water drinkers and tap drinkers were concerned about the source of their drinking water. Bottled water drinkers were generally unsure about where their tap water came from, and this contributed to their doubts about the water's quality. For example:

> "I mean I hear people say that the [tap] water is from like, sewage and they filter it. Or it's from the

Wabash River. I hear people talking, so I really don't trust it."

Tap drinkers were generally more knowledgeable about the source and confident in the safety of their tap water. A few tap and filtered tap drinkers correctly pointed out that bottled water companies don't usually disclose the source water on the bottle.

Most tap drinkers and some filtered tap drinkers trusted the government and Purdue to provide safe drinking water through the tap, because of water quality standards in the United States. They also felt strongly that government officials or water providers would be quick to notify the public if there were any issues with the tap water that could result in health problems. For example:

"Just because I primarily use tap water, I kinda think it goes through an inspection, you know, chlorinated, all that stuff, cleaned. Kind of putting trust in someone else that it's gonna be okay."

"Our water at where I'm living now is completely fine. I mean, it seems clean and—I don't know. I mean, I do think about it, but I figure if it was that bad, the city would say something to me, instead of just 'Oh yeah, let 'em keep drinking it.'

… I feel if, like I said, if something was really wrong with the water, the city would say something to me and not just let me keep drinking it."

In contrast, only one bottled water drinker we interviewed described a strong sense of trust in the safety of tap water and the authorities to notify the public if there were any problems.

As might be expected based on the discrepancies in federal regulations for reporting problems with tap water and bottled water, most students interviewed recalled being informed of problems with tap water on campus and in the surrounding area, but only a few had heard about potential health risks from drinking bottled water. A few indicated that hearing about problems with tap water made them more concerned about the potential health risks from drinking tap water, and specifically tap water on Purdue's campus.

Interviewees generally expressed a limited understanding of drinking water regulations in the United States. Only a few students thought tap water was more strictly regulated than bottled water. Many students who drink mostly bottled water and several who drink filtered tap expressed the belief that bottled water is more strictly regulated and safer since it is more processed and is an expensive product rather than a public good. Since a large proportion of bottled water comes from municipal sources, the discrepancy between the perceptions of bottled water drinkers and tap drinkers could indicate that bottled water drinkers are not as informed as non-users about potential sources of bottled water.

Discussion

The results of this study support theories of risk perception that argue for the role of risk perceptions in individual choices, including the Protection Motivation Theory and the Mental Models Approach (Rogers and others 1997, Morgan and others 2002). The significant relationships between risk perceptions and bottled water consumption and the prevalence of risk in many of the interviews indicate that perceptions of risk from drinking water contribute to behavioral choices, and ultimately how much bottled water is consumed. In addition, the differences between the risk perceptions of men and women could help explain the extra bottled water women drink.

As noted by others, municipal tap providers should not dismiss consumers' concerns with aesthetic qualities of tap water. In keeping with previous research, participants in these interviews overwhelmingly judged water quality based on what they see, smell, and taste, and this influenced their decision to drink tap water or bottled water (Anadu and Harding 2000, De Franca Doria and others 2005, Jardine and others 1999).

In their study of tap water perceptions in a coal mining region of West Virginia, McSpirit and Reid (2011) found that along with perceived water quality and saliency of concerns with drinking water, trust in the local water treatment facility strongly and directly predicted whether residents purchased bottled water. Similarly, interviewees in our study who drank tap water generally trusted the federal or local government to ensure that municipal tap was safe to drink. In our survey, lack of trust in the local government and Purdue administration was correlated with increased bottled water consumption. Officials in local governments and at water treatment facilities should try to build and strengthen trust, explain the presence of flavors and odors, and suggest solutions to consumers. Based on the results of this study, officials in government and/or municipal water suppliers need to build or repair trust with bottled water drinkers.

Many undergraduate students expressed concerns and uncertainty about the source of their tap water, especially on Purdue's campus. While no students indicated that they had read a water quality report for Purdue's tap water, several interviewees mentioned hearing the warnings about elevated levels of lead in certain buildings on campus. Most students who described this event saw it as a reason to be concerned about the safety of campus tap water. This perception supports the arguments described above, that

the discrepancy between regulations of tap water and bottled water has increased concerns with the safety of tap water, while creating a false sense of security in bottled water.

Many students did not consider the environmental impacts of their daily drinking water choices—highlighting the disconnect between individual action and environmental consequences. A few bottled water drinkers were aware of some environmental impacts of bottled water, but still drink it. They have obviously learned about the impacts somewhere, and even "felt bad" about drinking bottled water, but they continue to consume it. These results add support to the argument that information campaigns alone are not always effective at changing behavior when other barriers remain (McKenzie-Mohr and Smith 1999).

While most interviewees were aware of some environmental impacts of bottled water, many had an incomplete understanding of the total environmental impact of bottled water production. Most students thought of the large amounts of plastic generated and accumulating in landfills, but only one mentioned the energy required to produce bottled water. Several students expressed the belief that recycling the plastic bottles would greatly reduce or eliminate the environmental impacts of drinking bottled water. Recycling is widely considered to be an environmentally sound decision, but does it really eliminate the impacts of bottled water production and distribution? Many experts would argue that it does not. Given the low levels of bottled water recycling, and that it is shipped all over the world to be recycled, reducing consumption of bottled water is the more sustainable option (Gleick 2010, Royte 2008).

Conclusions and Recommendations

Through this mixed methods study of Purdue University, we have expanded our knowledge of the important factors that contribute to the decision to drink bottled water or tap water. The results of this study can also be used as a barriers and benefits assessment to facilitate the development of a social marketing campaign to discourage consumption of bottled water. The survey revealed relatively widespread bottled water consumption at Purdue University and identified certain groups (undergraduate students and women) who currently drink a disproportionate amount of bottled water. From the results of the survey, we also know to focus on certain barriers and benefits that heavy users thought were most important. The behaviors, perceptions, barriers and benefits revealed by this survey of Purdue are likely to be generalizable to other large public universities in the Midwestern U.S. where no major campaigns against bottled water have been implemented.

Behavior change research has revealed that campaigns that only provide information are rarely effective, and that campaigns should address significant barriers and benefits through appropriate tools in addition to communicating information (McKenzie-Mohr and Smith 1999, Mckenzie-Mohr &Associates, Inc. 2010). In his book, *Fostering Sustainable Behavior,* Doug McKenzie-Mohr emphasizes that certain tools have been effective at addressing different types of barriers, and that social marketers should combine the appropriate tools as cohesive strategies for successful campaigns (McKenzie-Mohr and Smith 1999). Table 5 summarizes general categories of barriers and the recommended tools, followed by Table 6, which outlines specific strategies to promote tap water based on the barriers and benefits our study uncovered.

A campaign to promote tap water must address the Purdue community's concerns with the quality and safety of tap water, especially on campus. Based on the interviews, the preference for bottled water typically stems from interconnected concerns with the aesthetic qualities and safety of tap water. In other words, the perception that tap water tastes or smells "bad" was linked to perceptions of risk from tap water. Given the significant barriers and benefits our study uncovered, a blind taste-test paired with the distribution of information about U.S. regulations for tap water could challenge existing beliefs and ease concerns about the safety of tap water in general and on Purdue's campus in particular. If an individual cannot tell the difference between the tap and bottled water, his/her perceptions of the taste and quality of tap water could be changed. Commitments could be incorporated into the taste-test, by having participants sign their name pledging to drink less bottled water or to give it up completely. By posting the names of those who made the commitment in their residence hall where everyone can see it, these public commitments could increase social pressure and motivate students who are aware of the environmental impacts of bottled water, but need an extra incentive to change their behavior (McKenzie-Mohr and Smith 1999).

In both the survey and interviews, respondents generally believed that the environmental impact of their individual behavior wouldn't be as significant as the global impact of

Table 5 Types of barriers and recommended tools

Barriers	Tools
Lack of motivation	If they have intention to act: commitments
	If they need convincing: norms, incentives
Forgetting	Prompts
Lack of social pressure	Norms
Lack of knowledge	Communication, social diffusion
Inconvenience	Structural changes

Table 6 Developing strategies to promote tap and discourage bottled water

Barriers and benefits	Tools	Strategies
Barriers		
I don't like the taste of tap water as much as bottled water (lack of motivation, lack of knowledge)	Commitments, communication	Blind taste test, incorporate commitment to drink less bottled water/more tap water
Bottled water is safer than municipal tap water; Concern about safety of tap water on Purdue's campus (lack of knowledge)	Communication	Inform about regulations, safety of tap water & deception by bottled water companies
Concern with germs in reusable water bottles (lack of knowledge)	Communication	Inform about simple ways to keep the bottle clean, Provide dishwasher-safe reusable water bottle
Perceived lack of access to filtered tap water on campus (inconvenience, lack of knowledge)	Communication, structural changes	Inform: Filtered water is already available in Purdue Memorial Union; several newer water fountains on campus include filters. Increase availability of filtered tap water on campus and advertise.
Reusable water bottles are easy to lose or forget at home (forgetting)	Prompts	Distribute eye-catching refrigerator magnets and/or signs for doors, "Don't forget your reusable water bottle"
Bottled water is offered for free at events and meetings on campus, Bottled water is more convenient since it's available in many places on campus (inconvenience)	Structural changes	Purdue University policy changes: providing tap water at events instead of bottled. Improving the tap water infrastructure on campus, followed by a campus-wide ban on bottled water.
Benefits		
Saving money because tap water is much cheaper than bottled water (provides motivation)	Communication, incentive	Inform/persuade: You're wasting money and resources on bottled water!
Don't have to go to a store regularly to purchase bottled water, A reusable bottle holds more water (convenience, provides motivation)	Communication	You're wasting time and money buying bottled water. Using a reusable bottle means you don't have to buy several bottles of water per day.
It's better for the environment, Less plastic in landfills, less waste of oil (Have intention, lack motivation)	Commitments, communication	Stop throwing away money, and plastic bottles! Drink tap. Use commitments to motivate those who are aware of impacts but still drink bottled water.
Bottled water is often the same or similar to tap water (motivation, knowledge)	Norms, communication	Inform about bottled municipal tap water. In blind taste tests, most people can't tell which is tap or bottled

bottled water consumption. Therefore, students, faculty, and staff may be underestimating their individual contributions to the overall impacts of bottled water. A tap water campaign should emphasize how each individual's behavior adds to the global environmental impact of bottled water. Highlighting the bottled water life cycle and emphasizing that reducing consumption is more effective than recycling, should be key components of a tap water campaign at Purdue University. The campaign should also account for the fact that women at Purdue currently drink more bottled water than men, and were more concerned about the environmental impacts of drinking bottled water. A campaign that urges behavior change based on the environmental impacts of bottled water would be more persuasive to women than men at Purdue.

As shown in Table 6, many of the significant barriers would be addressed most effectively through structural changes by the university. Purdue University could prioritize tap water quality on the West Lafayette campus and build trust in the safety of tap water on campus. The university could invest in updating and improving the tap water infrastructure across campus, especially in older buildings where they may have degraded to the point of causing contamination or unpleasant tastes and odors. Purdue could provide filtered tap water in more places on campus and effectively advertise this option. The university could also promote sustainability and save money if it stopped offering bottled water for free at campus events and meetings, and switching to pitchers of tap water. Once trust in campus tap water is repaired, and the infrastructure is updated, Purdue University could make a strong statement in favor of sustainability—following the example of other universities such as Washington University in St. Louis and Brown University—by ending the sale of bottled water on campus. For this policy to be effective, it would be crucial to build the support of Purdue students, faculty, and staff, as well as the dining services, and consider their input when implementing such a ban.

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