A SURVEY OF PUBLIC PERCEPTION AND ATTITUDES ABOUT WATER RESOURCES IN TEXAS

A Dissertation

by

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ABSTRACT

This study examines the results of a random sample survey of Texans to evaluate citizen awareness, attitudes and willingness to act on water issues. This study investigates changes in public attitudes following one of the most intense one-year droughts in Texas by evaluating public perception of water availability, assessing Texans' attitudes and perceptions regarding drought conditions, and comparing the number of Texans adopting practices to conserve water before and after the drought of 2011. Almost 70% felt that the likelihood of their area suffering from a prolonged drought was increasing. More than 61% of respondents have changed the way their yard is landscaped and 62% have also adopted new technologies in an effort to conserve water. Overall, responses indicate that Texans are concerned with water availability after experiencing in 2011 the worst one-year drought on record and that the majority of respondents are taking personal action in an effort to conserve water for the future.

Furthermore, the study assesses outreach effectiveness for particular populations and audiences' media preferences for learning about water issues and examines preferences for additional information on particular water resource topics, including possible trends in information sources related to socio-demographic changes from 2008 to 2014. City and municipal water districts reached the greatest number of people with 68.2% of the total population and 73.9% of respondents living within city limits ($p < .0001$) receiving water information from these sources. Protecting drinking water

supplies (57.4%) and water management for home and garden landscaping (55.8%) were the water resource topics of greatest interests to respondents.

Finally, this study evaluates Texans' perceptions of drinking water quality as related to their drinking water source. Overall, almost a quarter of the respondents (23.5%) indicated that bottled water is their primary drinking water source. A large majority (81.3%) of those primarily receiving their drinking water from private supplies believed groundwater in their area to be of good or excellent quality and only 3.1% did not know or did not have an opinion regarding local groundwater quality.

DEDICATION

I dedicate this work to my wife, Heather, and to our children, Sam and Kate. Your unconditional love, encouragement, and support have meant the world to me.

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the help of many people. First, I would like to thank my committee chair, Dr. Diane Boellstorff, for her guidance, support, and encouragement throughout the course of this research. Thank you for seeing potential in me and for the encouragement to pursue my Ph.D. I would also like to thank Dr. Boellstorff, as my supervisor, for allowing time to attend class and to juggle both my full time responsibilities and my research. Thank you for your trust; without your guidance and mentorship, none of this would have been possible.

I would also like to thank my committee members, Dr. Scott Cummings, Dr. Monty Dozier, and Dr. Kevin Wagner, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and the Soil and Crop Sciences department faculty and staff for their constant encouragement and for making my time at the office enjoyable.

Thank you to the Texas State Soil and Water Conservation Board, the United States Environmental Protection Agency and the United States Department of Agriculture for their generous support of my research.

I would also like you thank each recipient who responded to the survey. Thank you for your participation; without you I could not have completed my research.

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CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a dissertation committee consisting of Dr. Diane Boellstorff [advisor], Dr. Kevin Wagner, and Dr. Monty Dozier of the Department of Soil and Crop Sciences and Dr. Scott Cummings of the Department of Agricultural Leadership, Education, and Communications.

All work for the dissertation was completed independently by the student.

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NOMENCLATURE

ANOVA	Analysis of Variance
LGI	Land Grant Institutions
SDWA	Safe Drinking Water Act
SPSS	Statistical Package for Social Science
TCEQ	Texas Commission on Environmental Quality
TWDB	Texas Water Development Board
TWRI	Texas Water Resource Institute

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CHAPTER I

INTRODUCTION

Rationale and Background

Texas faces many challenges to ensure clean and adequate water supplies for the future. The Texas Water Development Texas Water Development Board (2017) estimates the Texas population will increase more than 70 percent resulting in a 17 percent increase in water demand between 2020 and 2070. In addition to rapid population growth, periodic and extreme droughts, such that in 2011, have and will continue to cause issues for water suppliers. Droughts are nothing new, and especially for Texas. In 1950, a seven year drought devastated many Texas ranches and farms. The multi-year drought grabbed the attention of all Texans, where the legislature created the Texas Water Development Board (TWDB), as well as many river authorities where many new reservoirs began construction. In 2011, Texas experienced its worst single-year drought (Nielsen-Gammon, 2012), lowering both aquifer and reservoir levels that were depended on for drinking water, and causing economic hardship. Droughts can also capture the attention of the public as they face the reality that adequate water supplies are not always ensured (Adams et al., 2013; Evans et al., 2015).

In addition to water supply concerns, water quality issues are also important. The *2014 Texas Integrated Report* (Texas Commission on Environmental Quality, 2014) developed by the Texas Commission on Environmental Quality (TCEQ) confirms that the most frequent parameter resulting in impairment of Texas waterbodies is bacteria

(pathogens), only 26.3% of respondents believed or suspected that pathogens were a pollutant of concern and 73.7% indicated they don't know, or know suspected pathogens are not a problem. As many watershed protection plan and Total Maximum Daily Load efforts in Texas aim to address bacteria loads and impairments at least partially through public engagement and the adoption of appropriate best management practices, it is important for the public to be informed about the impact of pathogens on water quality.

Evaluating public opinion regarding water quality issues aids government agencies, universities, and Extension with watershed planning, prioritizing restoration, and educating the public on water quality issues relevant for them (Borisova, 2012). Public attitudes and perceptions of water quality can vary based on where one lives (Hu and Morton, 2011).

As water managers, government agencies, and scientists work to resolve water supply and water quality concerns, it is important to produce and reach the public with water resource information. Boellstorff et al. (2013) reported preferences in the southern region of the United States for sources, topics and delivery of water resource information. It is increasingly critical to determine how the public perceives water resource needs and management and to evaluate attitude changes that may occur with a growing population.

Materials and Methods

A statewide survey was developed to assess Texans' perceptions and attitudes about water resources in the state. The questionnaire is one of the survey components comprising the National Integrated Water Quality Program Needs Assessment Survey project initiated in 2002. The present survey is based on the 2002 template developed by water quality coordinators in the Pacific Northwest Region with input from other participating Land Grant Institution water quality coordinators for the Southern, Mid-Atlantic, Northwest, Northeast and Caribbean Island Regional Water Programs (Mahler, 2010). The initial survey was sent to 1,275 randomly selected Texas residents in August, 2008 following methods described in Boellstorff et al. (2010); 419 surveys (33%) were completed and returned. In 2014, minor modifications were made to the template survey to adapt it to Texas' water management agencies and organizations, and to modernize particular questions before the survey was re-issued. The survey questionnaire included 59 questions addressing water resource, water quality, and other environmental issues. The study population consisted of the adult residents of Texas.

In April of 2014, the questionnaire was mailed to 1,800 randomly selected residences in Texas following the tailored survey design method (Dillman, 2000). As in 2008, individuals were mailed a paper copy of the survey instrument; a cover letter; and a self-addressed, stamped envelope. Twenty days later, individuals were sent a reminder postcard. Twenty days after the reminder postcard was sent, another survey instrument; cover letter; and self-addressed, stamped envelope were mailed. Twenty days later, a final reminder postcard was mailed to participants. Individuals returning the evaluation

or indicating that they did not want to participate in the study were removed from the mailing list so that they were not re-contacted. Taking into account the number of 1) surveys "returned to sender for incorrect address," 2) recipients requesting to not participate, and 3) recipient death, the effective number of mailed questionnaires in 2014 was 1,655 and the return rate for the completed survey questionnaires was 29%. Survey responses were coded and entered into a spreadsheet. Missing data were excluded from analyses. Three dissertation chapters representing three manuscripts for submission to peer-reviewed journals will be developed as follows:

A Survey of Public Perceptions and Attitudes about Water Availability Following Exceptional Drought in Texas

This study investigates the relationship of water quantity perceptions to water conservation actions. Responses to the following five questions in both 2008 and 2014 and effect of socio-demographics (age, gender, length of Texas residency, education, community size, and residence location) are the focus of this article:

1) **Do you regard water quantity (having enough water) as a problem in the area where you live?** (Mark one answer) Answer choices ranged from definitely not to definitely yes.

2) **The likelihood of your area suffering from a prolonged drought is:** Answer choices were increasing, decreasing, staying the same or no opinion.

3) **The likelihood of your area having enough water resources to meet all of its needs 10 years from now is:** Answer choices were high (likely enough water), medium, low (likely not enough water) or no opinion.

4) **Have you or someone in your household done any of the following as part of an individual or community effort to conserve water or preserve water quality?** (Mark all that apply) Answers choices included five types of water conservation or water quality protection activities.

5) **Do you think that the amount of rainfall in your area will change as a result of global warming?** Answer choices included: yes (a significant increase in rainfall), yes (a slight increase in rainfall), no (no change in rainfall), yes (a slight decrease in rainfall), yes (a significant decrease in rainfall) or I don't know.

Learning Preferences for Water Resource Information from Extension and Other Sources

This manuscript focuses on Texans' preferences for receiving water resource information. Responses to the following questions along with demographic information requested by the survey were analyzed in this paper.

Have you received water resource information from the following sources? Eleven potential sources were listed requesting the respondent indicate "yes" or "no" for each source.

Would you like to learn more about any of the following water quality issue areas? (Mark all that interest you). Sixteen topics were offered as answer choices.

If you had the following kinds of learning opportunities to learn more about water issues, which would you be most likely to take advantage of? (Mark up to 3 items). Thirteen learning opportunities were offered as answer choices.

Consumer Water Quality Evaluation of Private and Public Drinking Water Sources

This paper focuses on Texans' perception of the quality of their drinking water with an emphasis on private well owners and how they compare to respondents receiving their water from public supplies and those who purchase bottled water. This study examines public perceptions of drinking water and groundwater quality, and possible actions citizens have adopted to safeguard their drinking water. Furthermore, the study analyzes factors influencing the likelihood of well owners having their water wells tested. Responses to the following questions were analyzed:

Where do you primarily get your drinking water? (Mark only one answer) Answer choices included: Private supply, Public supply-municipal, Public supply-rural water district, Purchase bottled water, and I don't know.

Do you feel that your home tap drinking water is safe to drink? (Yes or No)

Do you have your home drinking water tested? (Yes or No)

In your opinion, what is the quality of groundwater (sources of well water) in your area? Answer choices were Good or excellent; Good, and improving; Good, but deteriorating; Fair; Poor, but improving; Poor; and No opinion/don't know.

Do you know of or suspect that any of the following pollutants affect either surface or groundwater quality in your area? A list of twelve pollutants (Pathogens,

Fertilizer/ Nitrates, Fertilizer/Phosphates, Heavy metals, Minerals, Pesticides, Salinity, Pharmaceuticals, Petroleum products, Algae, Product and waste from mining, and Septic systems) was provided with answer choices including: Know it is NOT a problem; Suspect it is NOT a problem; Don't Know; Suspect it IS a problem; and Know it IS a problem.

Data Analysis

Water Supply

The Statistical Package for Social Sciences (SPSS) Version 23 was used for data analyses. The null hypotheses that the response frequencies are the same for the various answer options and socio-demographic variables were tested using Pearson's chi-squared and logistic regression analyses. Descriptive summary statistics were calculated for socio-demographic variables. A logistic regression analysis was used to predict the likelihood of adopting water conserving actions such as: changing yard landscaping, changing lawn watering, and adopting water conserving technologies using demographic variables. Further, the potential differences in the influence of water availability perception on water management behaviors before (2008 survey) and after (2014 survey) the exceptional drought of 2011 was evaluated. Pearson's chi-squared test ($p<0.05$) was applied to determine significant differences in responses before and after the 2011 Texas drought and for demographic variables.

Water Resource Information Preferences

The Statistical Package for Social Sciences (SPSS) Version 23 was used for data analyses. Descriptive summary statistics were calculated for socio-demographic variables. The null hypotheses that the response frequencies are the same for the various answer options and socio-demographic variables were tested using Pearson's chi-squared and logistic regression analyses. For example, logistic regression analyses were used to determine if socio-demographic variables such as, residence, age, or location or education level predict preferences for receiving information on water resources.

Water Quality

To conduct analyses, the Statistical Package for Social Sciences (SPSS) Version 23 was used. Descriptive summary statistics were calculated for socio-demographic variables. Chi-square analyses as well as descriptive statistics were used to evaluate differences among respondents and residence locations potentially affecting treatment of home drinking water systems, acquiring water tests, and the perceived quality of groundwater and surface water. The null hypothesis is that the response frequencies are the same for the various answer options and socio-demographic variables. Analyses of Variance (ANOVA) were conducted to determine any differences among residence location and suspected pollutants affecting respondent drinking water supplies. All tests of statistical significance were conducted using an *a priori* alpha of .05.

CHAPTER II

A SURVEY OF PUBLIC PERCEPTIONS AND ATTITUDES ABOUT WATER AVAILABILITY FOLLOWING EXCEPTIONAL DROUGHT IN TEXAS

Introduction

Texas experienced its worst single-year drought on record in 2011 (Nielsen-Gammon, 2012), affecting people in many ways. While farmers may have been more directly affected by drought, city dwellers also were impacted by expectations for compliance with municipal drought contingency plans and water restrictions. For some citizens, public supplies came within days of running out of water and a few systems were supplied by neighboring utilities. Reservoir levels dropped and reached record lows for storage, while aquifer levels also dropped and some wells went dry. The 2011 drought caused a record loss of $7.62 billion to Texas agriculture (Fannin, 2012). Most water supply systems implemented mandatory and eventually challenging restrictions. The severity of the drought captured the attention of 26 million Texans from all regions of the state.

In addition to the pressures of periodic, extreme drought, the Texas Water Development Board (2017) estimates that the Texas population will increase more than 70 percent from 2020 to 2070, and water demand will increase by 17 percent. Texas' rapidly growing urban areas will lead water consumption for the state. By 2070, 30 percent of the total water volume included in management strategies proposed in the State Water Plan will involve demand management to reduce needs for additional water

through water conservation and drought management (Texas Water Development Board, 2017).

Public perceptions and attitudes toward water issues will play an important role in whether Texans choose to adopt water conservation practices. Water conservation by Texas residents will play a pivotal role in meeting water supply demands the state will face in the future. Previous research links attitudes and perceptions to water use behaviors (Campbell et al., 2004; Clarke and Brown, 2006; Jorgensen et al., 2009; Willis et al., 2011). The public's attitudes regarding water supply also can be linked to experiences in longer term drought conditions (Adams et al., 2013; Casagrande et al., 2007; Delorme et al., 2003; Evans et al., 2015).

Texas A&M AgriLife Extension Service in conjunction with a national needs assessment project initiated through the Pacific Northwest Regional Water Program has facilitated two random sample surveys of Texans to evaluate citizen awareness, attitudes and willingness to act on water issues (Mahler et al., 2013). The first survey was conducted in 2008 at the beginning of a relatively mild drought. The drought intensified through 2009-2012 when much of the state was categorized as enduring exceptional drought. The original survey was re-issued to another random sample of Texans in 2014 and represents an opportunity to investigate changes in public attitudes following exposure to one of the most intense one-year droughts in Texas. The objectives of this study are to:

1. Evaluate the public's perception of water availability
2. Evaluate Texans' attitudes and perceptions regarding drought conditions

3. Compare the number of Texans adopting practices to conserve water before and after the drought of 2011.

Materials and Methods

A state-wide survey was developed to assess Texans' perceptions and attitudes about water resources within the state. The questionnaire is one of the survey components comprising the National Integrated Water Quality Program Needs Assessment Survey project initiated in 2002. The present survey is based on the 2002 template developed by water quality coordinators in the Pacific Northwest region with input from other participating Land Grant Institution (LGI) water quality coordinators for the Southern, Mid-Atlantic, Northwest, Northeast and Caribbean Island Regional Water Programs (Mahler, 2010). The survey was sent to 1,275 randomly selected Texas residents in August, 2008 following methods described in Boellstorff et al. (2010); 419 surveys (33%) were completed and returned. Minor modifications were made to the template survey to adapt it to Texas' water management agencies and organizations, and to modernize particular questions before the survey was re-issued in 2014. The survey questionnaire included 59 questions addressing water resource, water quality, and other environmental issues. The study population consisted of the adult residents of Texas.

In April of 2014, the questionnaire was sent via direct mail survey to 1,800 randomly selected residences in Texas following the tailored survey design method (Dillman, 2000). As in 2008, individuals were mailed a paper copy of the survey instrument; a cover letter; and a self-addressed, stamped envelope. Twenty days later,

individuals were sent a reminder postcard. Twenty days after the reminder postcard was sent, another survey instrument; cover letter; and self-addressed, stamped envelope were mailed. Twenty days later, a final reminder postcard was mailed to participants.

Individuals returning the evaluation or indicating that they did not want to participate in the study were removed from the mailing list so that they were not re-contacted. Taking into account the number of 1) surveys "returned to sender for incorrect address," 2) recipients requesting to not participate, and 3) recipient death, the effective number of mailed questionnaires in 2014 was 1,655 and the return rate for the completed survey questionnaires was 29%. Survey responses were coded and entered into a spreadsheet. Missing data were excluded from analyses.

This study investigated the relationship of water quantity perceptions to water conservation actions. Responses to the following five questions in both 2008 and 2014 along with socio-demographic information requested by the survey were the focus of this article:

1) **Do you regard water quantity (having enough water) as a problem in the area where you live?** (Mark one answer) Five answer choices ranged from definitely not to definitely yes.

2) **The likelihood of your area suffering from a prolonged drought is:** Answer choices were increasing, decreasing, staying the same or no opinion.

3) **The likelihood of your area having enough water resources to meet all of its needs 10 years from now is:** Answer choices were high (likely enough water), medium, low (likely not enough water) or no opinion.

4) **Have you or someone in your household done any of the following as part of an individual or community effort to conserve water or preserve water quality?** (Mark all that apply) Answers choices included five types of water conservation or water quality protection activities.

5) **Do you think that the amount of rainfall in your area will change as a result of global warming?** Answer choices included: yes (a significant increase in rainfall), yes (a slight increase in rainfall), no (no change in rainfall), yes (a slight decrease in rainfall), yes (a significant decrease in rainfall) or I don't know.

The Statistical Package for Social Sciences (SPSS) Version 23 was used for data analyses. The null hypothesis that the response frequencies are the same for the various answer options and socio-demographic variables was tested using Pearson's chi-squared and logistic regression analyses. A logistic regression analysis was used to predict the likelihood of adopting water conserving actions such as: changing yard landscaping, changing lawn watering, and adopting water conserving technologies. Descriptive summary statistics were calculated for socio-demographic variables. Further, the potential differences in the influence of water availability perception on water management behaviors before the exceptional drought (2008 survey) and responses after the exceptional drought (2014 survey) were evaluated. Pearson's chi-squared test ($p<0.05$) was applied to determine significant differences in responses before or after the 2011 Texas drought and for demographic variables.

Results

The 2014 water issues survey achieved a response rate of 29.4% (491 out of 1,671 surveys) with 327 respondents coming from the first mailing, and 164 from the second. Demographic characteristics regarding residence for 2008 and 2014 were not significantly different. As shown in Table 1, 48.1 and 53.5% of survey respondents lived in communities of more than 100,000 in 2008 and 2014, respectively. In addition, 73.5% of survey respondents in 2008 and 72.8% in 2014 lived inside city limits in 2008 and 2014. A total of 71% of respondents from both surveys resided in communities of 25,000 or more people. Twenty-nine percent lived in small communities of 7,000 people or fewer, respectively. A large majority, more than 90%, of respondents for both surveys had lived in Texas for more than 10 years or for all their lives.

Respondent gender differed between the 2008 and 2014 surveys; with 2014 more closely reflecting the actual demographics of the state: 48.7% male, and 51.3% female ($p<.0001$). Respondents of both surveys were somewhat better educated and older than the general Texas population (U.S. Census Bureau, 2013; 2015).

Table 1. Demographics of respondents for surveys conducted in 2008 and 2014

Category		Year	
		2008	**2014**
		% (n)	% (n)
Gender	Male	63.9 (262)	48.7 (185)
	Female	36.1 (148)	51.3 (195)
Years lived in Texas	All my life	47.9 (197)	46.6 (180)
	More than 10 years	40.6 (167)	45.6 (176)
	5 to 9 years	7.1 (29)	4.4 (17)
	Less than 5 years	4.4 (18)	3.4 (13)
Size of residence community	> 100,000	48.1 (190)	53.5 (238)
	25,000 to 100,000	21.3 (84)	19.6 (87)
	7,000 to 25,000	12.2 (48)	11.2 (50)
	3,500 to 7,000	8.6 (34)	5.8 (26)
	<3,500	9.9 (39)	9.9 (44)
Education	Less than or some high school	5.4 (22)	3.5 (16)
	High school graduate	16.4 (67)	12.6 (58)
	Some college	31.5 (129)	27.9 (129)
	College graduate	25.4 (104)	33.5 (155)
	Advanced college degree	21.3 (87)	22.5 (104)
Age	18 - 24	1.2 (5)	0.5 (2)
	25 - 34	6.9 (29)	4.2 (16)
	35 - 49	25.3 (106)	18.9 (72)
	50 - 64	28.4 (119)	40.8 (155)
	65 years old or older	38.2 (160)	35.5 (135)
Residence location	Inside city limits	73.5 (302)	72.8 (337)
	Outside city limits, not farming	22.6 (93)	22.7 (105)
	Outside city limits, farming	3.9 (16)	4.5 (21)

Water Quantity

Respondents were asked "Do you regard water quantity (having enough water) as a problem in the area where you live? (Mark one answer)." From the response set, respondents could choose: definitely not, probably not, I don't know, probably, or definitely yes. In 2008, 22.5% of respondents believed water quantity to be a problem where they lived (Figure 1) and a sum of 47.9% believed that water quantity definitely or probably was a problem in their area. In comparison, 37.2% from the 2014 survey responded that water quantity is a problem where they live (likelihood ratio test, $p<.0001$), and a sum of 61.6% believed water quantity definitely or probably was a problem in their area. Furthermore in 2008, 15.1% of the respondents agreed that water quantity was definitely not a problem where they lived, while only 6.8% agreed water quantity was definitely not a problem in the 2014 survey ($p<.0001$). A combined 44.2% of respondents indicated that there was definitely not or probably not a water quantity problem in their area, and that fell to only 28.2% in 2014. Multinomial logistic regression analysis of responses from the 2014 survey indicated no statistical significance with socio-demographic variables of gender, community size, age, residence location, years in Texas, and education.

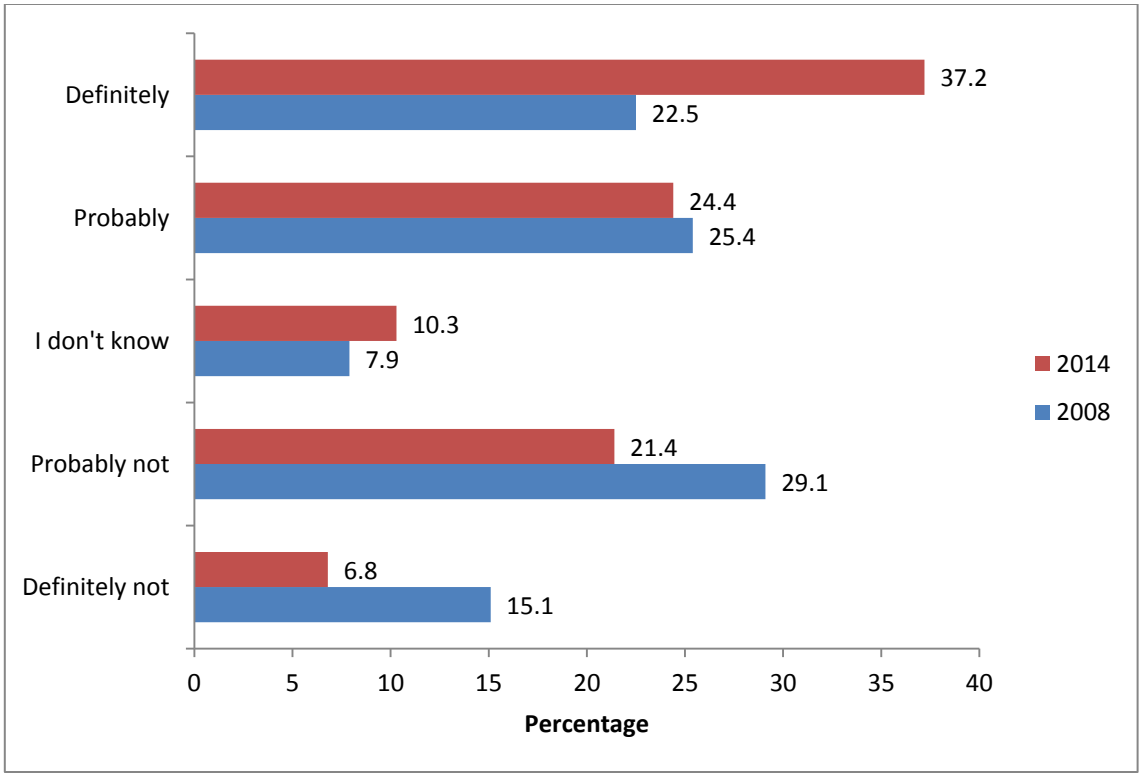

Figure 1. Is water quantity a problem where you live?

Likelihood of Prolonged Drought

Similar responses were given when survey respondents were asked to evaluate the likelihood of their area suffering from a prolonged drought. In 2008, 51.6% of respondents believed that the chance of a prolonged drought in their area was increasing, while in 2014, 69.2% responded that the chances of a prolonged drought in their area was increasing ($p<.0001$). The number of Texans responding that the likelihood of a prolonged drought in their area staying the same decreased from 37.9% in 2008 to 22.1% in 2014 ($p<.05$; Table 2). Fewer responses in the "staying the same" category were likely the result of about 40% of Texas experiencing some level of drought in

August 2008, while about 66% of Texas was in a drought in April 2014 when the survey was re-issued. In April of 2014 more than 16 million Texans lived in areas categorized as in moderate or more extreme categories of drought (U.S. Drought Monitor Map Archive, Fuchs, 2014). Multinomial logistic regression analysis of responses from the 2014 survey indicated no statistical significance with socio-demographic variables of gender, community size, age, residence location, years in Texas, and education.

Table 2. The likelihood of your area suffering from a prolonged drought is:

		2008	2014	Percentage Point Change
		% Respondents		
Prolonged drought affecting your area	Increasing	51.6[a]	69.2[b]	17.6
	Staying the same	37.9[a]	22.1[b]	-15.8
	Decreasing	2.4[a]	2.1[a]	-0.3
	No opinion	8.1[a]	6.6[a]	-1.5

Superscript indicates significance at the .05 level.

Likelihood of Enough Water to Meet Area Needs

Respondents were asked to evaluate the likelihood of their area having enough water to meet its needs 10 years from now. In 2008, 30.2% of the survey respondents believed that there would not be enough water in their area to meet all of its needs in 10 years (Figure 2). In 2014, the responses for low likelihood (likely not enough water) increased to 52.8% ($p<.0001$). Additionally, 20.0% of survey respondents in 2008 replied that the likelihood of enough water in their area was high (likely enough water) to meet needs in 10 years, compared to only 7.1% in 2014. Multinomial regression analysis of the responses for the 2014 survey indicated respondents having more education ($p<.001$) were more likely to believe that there would not be enough water in their area to meet needs in 10 years. Other socio-demographic variables showed no significant differences.

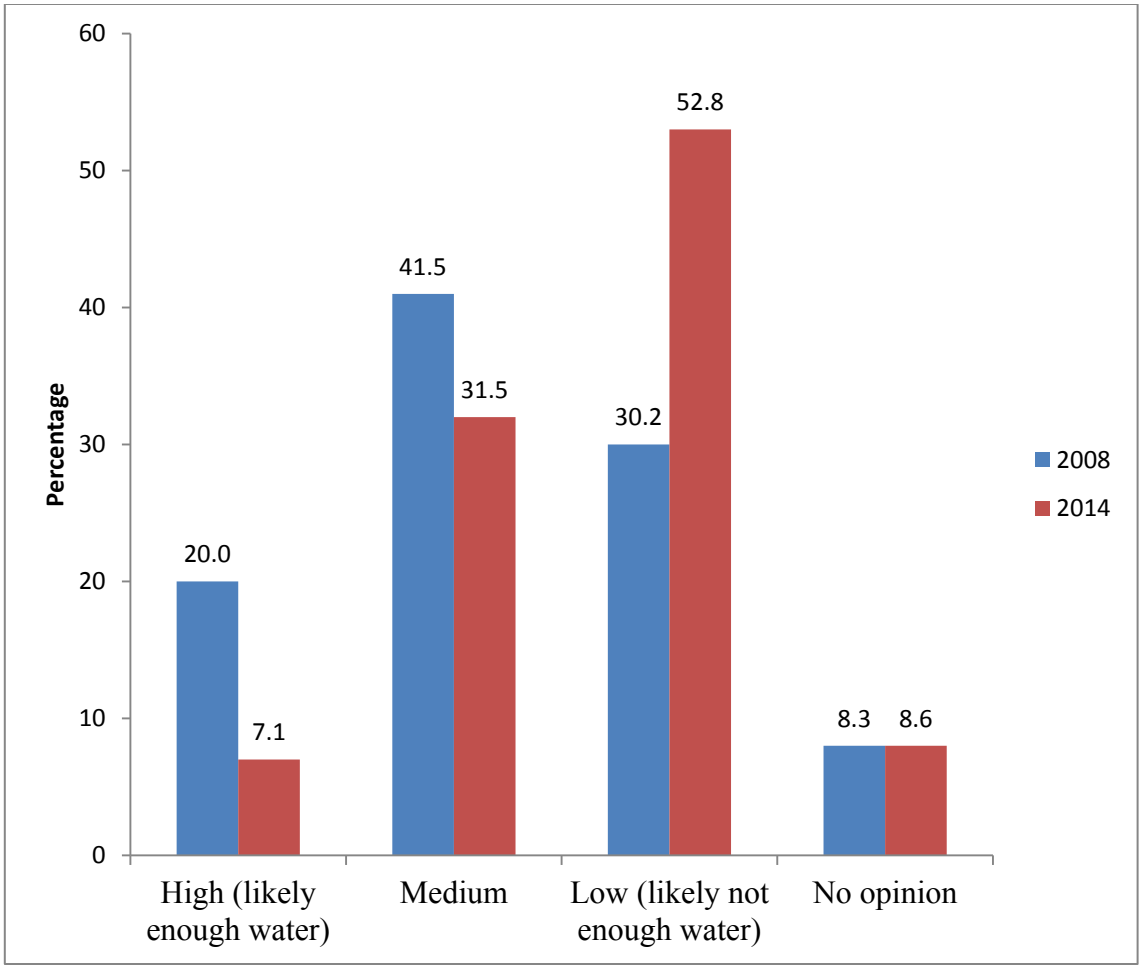

Figure 2. The likelihood of your area having enough water resources to meet all of its needs 10 years from now is:

Behavior Changes Protecting Water Quality or Water Quantity

Landscaping

As shown in Figure 3, respondents from the 2014 survey were more likely to have changed the way they have landscaped their yard than 2008 survey respondents ($p<.001$). Multinomial logistic regression analyses of the 2014 responses with socio-demographic variables indicated gender played a significant ($p<.05$) role in predicting

whether respondents had changed their landscaping. Female respondents were more likely than males to have changed the way they landscape their yard.

Watering

Surprisingly, there was no significant difference between 2008 and 2014 respondents regarding whether home owners had changed how often they watered their yards, perhaps because municipal drought restrictions had already been commonly imposed during the drought in 2008. For 2014, gender ($p<.05$) and number of years lived in Texas ($p<.05$) were significant regarding whether respondents had changed how often they watered their yard. Females and respondents living in Texas longer were more likely to have changed the way they watered their yard.

Adopt New Technologies

Respondents in 2014 were more likely than those in 2008 to have adopted new technologies to conserve water quantity or quality (chi-square, $p=.001$). Furthermore, again gender was the only significant predictor for adopting new technologies in an effort to conserve water (multinomial logistic regression $p<.006$). Females were more likely to adopt new technologies in an effort to conserve water than males.

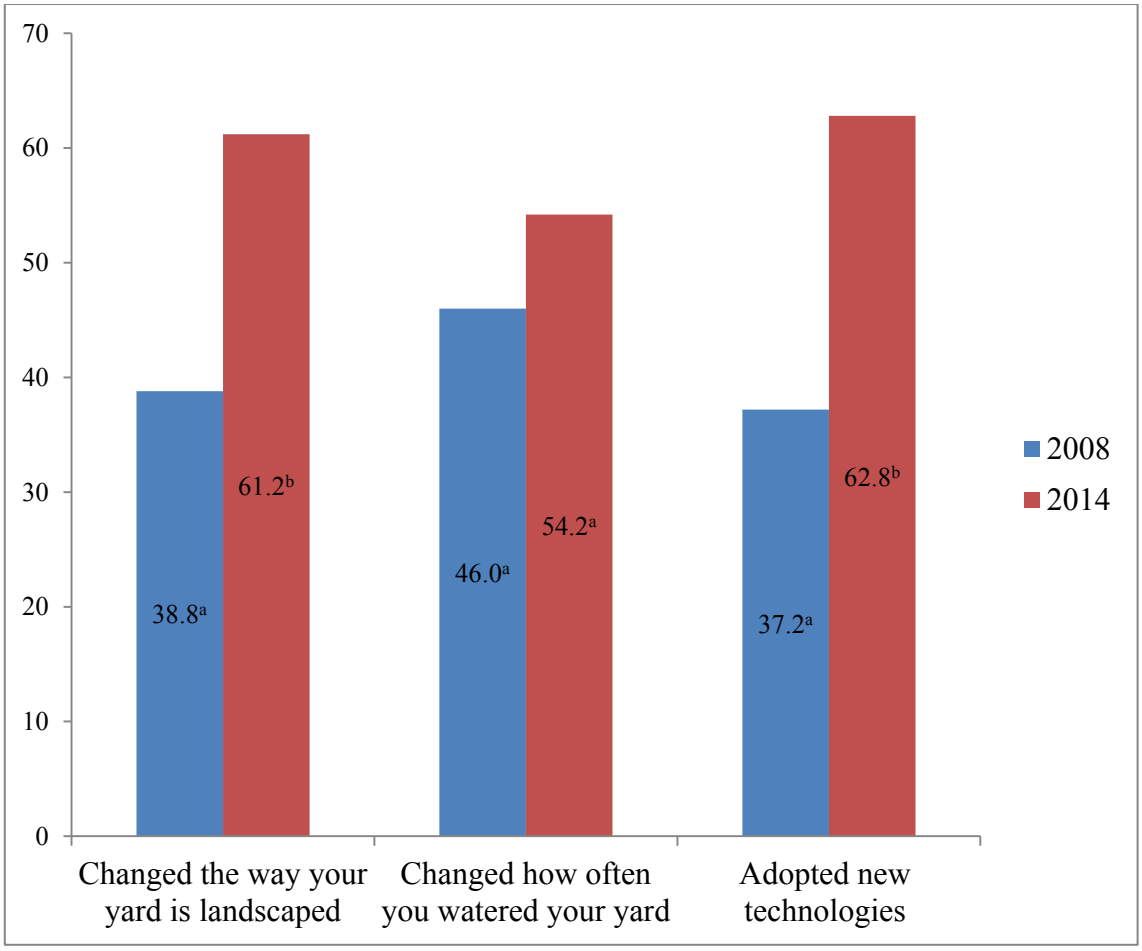

Figure 3. Have you or someone in your household done any of the following as part of an individual or community effort to conserve water or preserve water quality?

Rainfall Change as a Result of Global Warming

Responses to the question, "Do you think that the amount of rainfall in your area will change as a result of global warming?" significantly differed between survey years (chi-square, ($p<.001$). From the 2008 to the 2014 survey, an increased percentage of respondents (+12.4%) believed that rainfall would decrease significantly (Table 3);

however, approximately one-third of respondents for both the 2008 and 2014 surveys answered that they do not know if the amount of rainfall in their area will change.

Table 3. Do you think that the amount of rainfall in your area will change as a result of global warming?

		Year		
		2008 % (n)	2014 % (n)	Percentage Point Change
Do you think that the amount of rainfall in your area will change as a result of global warming?	Yes, increase significantly	6.0 (24)	2.7 (12)	-3.3
	Yes, increase slightly	7.2 (29)	2.9 (13)	-4.3
	No change	26.3 (106)	17.8 (80)	-8.5
	Yes, decrease slightly	17.1 (69)	17.3 (78)	.2
	Yes, decrease significantly	13.2 (53)	25.6 (115)	12.4
	I don't know	30.3 (122)	33.8 (152)	3.5

Multinomial logistic regression of socio-demographic variables indicated that education plays a role in the perception of rainfall changes that might occur as a result of global warming (p=.001) More education reduces the likelihood of responding that rainfall will increase as a result of global warming.

Discussion

Using data from surveys administered in 2008 and 2014, this study assesses public attitudes and perceptions regarding water resources and actions taken to conserve water. The questionnaire is a component of the National Integrated Water Quality Program Needs Assessment Survey project initiated in 2002 (Mahler et al., 2005). The focus of this study was on the year of the survey (before or after a historical drought) and responses to questions related to current water availability issues and Texans' perceptions of future water availability. Additionally, adoption of water saving practices was assessed regarding survey year and associated socio-demographics. The results of this study indicate that recent drought experience strongly influences public perception of current water quantity issues as well as perception of future water availability. Evans et al. (2015) similarly reported that perceptions of local drought conditions significantly affected public attitudes and awareness regarding water supply. Specifically, the public is more concerned about water resources and climate change during periods of extreme drought. Evans et al. (2015) also showed that length of residency significantly affected the perception of water availability, with respondents living in the state longer less likely to be concerned with water supply. Length of residency was not statistically significant in the present study perhaps because the drought was exceptional and extended. Additionally, few respondents had lived in Texas for less than 10 years. News coverage of drought will typically increase when drought intensifies, which enhances awareness of extreme drought (Dow, 2010).

As shown in Figure 1 and Table 2, perception of future water availability shifted significantly following the period of extended exceptional drought at its worst in 2011, with respondents in 2014 indicating more concern than 2008 respondents. Texans have become more concerned with having enough water within 10 years to meet their needs, with 53% believing supply will not be adequate. Almost 70% felt that the likelihood of their area suffering from a prolonged drought was increasing. More than 61% of respondents have changed the way their yard is landscaped in efforts to conserve water. Furthermore, more than 62% have also adopted new technologies in an effort to conserve water.

Perceived importance of water resources is a significant factor that drives water conservation (Adams et al., 2013). Efforts initiated during drought periods to conserve water by changing the way a yard is landscaped or adopting new technology (low flow showerheads, high efficiency appliances, etc.), can become long-term behavior changes. Adoptions of more permanent changes, rather than temporary or short-lived actions, represent positive behavior modification likely to be continued even during normal rainfall periods. Additionally, intensifying public concern regarding water supplies during drought conditions creates unique opportunities for Extension and other water resource management organizations to deliver timely and valued water conservation information.

Perception that the amount of rainfall in their area will change as a result of global warming increased from 2008 to 2014 with a jump (+12.4 percentage points) in respondents believing rainfall will significantly decrease. However, despite frequent

media reports regarding climate change, respondents indicating that they did not know what rainfall changes would occur increased slightly from 30.3 to 33.8%. Udayakumara et al. (2010) reported that environmental awareness is influenced by education. Similarly, the present study found that increased education influenced perception that rainfall would decrease as a result of global warming. Kleinberg and Colby (2014) and Leiserowitz (2005) also reported that some citizens believe that climate change will not affect an individual or their community, but is rather more a global or national problem. The findings of these studies may support the contention that further climate change research is necessary before more of the public feels they can draw an informed conclusion.

Overall, responses indicate that Texans are concerned with water availability and believe that there are concerns for water resources in the future after experiencing in 2011 the worst one-year drought on record. Results also indicate that with citizen concern, the majority of respondents are taking personal action in an effort to conserve water for the future.

This study provides useful information in support of water conservation outreach programs. Texans tend to be more concerned with water availability during and after droughts providing a timely opportunity to highlight drought conditions and appropriate responses and actions for citizens through outlets such as state agencies, Extension services, news outlets, and groundwater and utility districts. It may also be effective to remind the public of extreme droughts they have experienced when conducting an outreach program. Because Texans are more willing to make time-consuming, possibly

expensive, but lasting changes to their landscape during and after droughts, outreach programs with information including best management practices for lawn irrigation, drought tolerant landscapes, and new water conservation technologies should be made available through appropriate sources. Investment in education during critical environmental events when audiences are seeking information frequently results in permanent behavior changes that continue to conserve water resources when more typical weather returns (Cohen et al., 2006).

Regional and state-wide surveys are important tools for assessing public perception and attitudes regarding water availability issues. Survey evaluations can document changes in perception and adoption of best management practices, as well as identify opportunities for expanded outreach and research efforts.

CHAPTER III

LEARNING PREFERENCES FOR WATER RESOURCE INFORMATION FROM EXTENSION AND OTHER SOURCES

Introduction

The Land Grant Institutions' (LGI) mission is unique in higher education as LGIs are responsible for formally educating students, conducting research, and extending outreach of new information to the public, primarily via the LGI's Extension service. Originally, Extension outreach focused primarily on agricultural resources associated with rural areas; however, outreach topics currently have broadened and include natural resource management and environmental stewardship relevant to urban, suburban and rural areas.

LGI Extension services efforts to extend outreach regarding natural resource management and environmental stewardship information can play an important role in states' ability to more effectively address water issues. The importance of reaching all areas of the state with water resource education is becoming increasingly important in Texas, as it wrestles with water resource challenges related to extreme drought or floods. Undoubtedly, water quantity issues will be increasingly important as Texas continues to experience rapid growth, especially in urban areas. Texas Water Development Board (2017) projects the Texas population to increase 70% between 2020 to 2070, to 51 million people. Over half of the growth is expected to occur in the state's largest urban areas, Dallas and Houston. Furthermore, water quality impairments, drinking water

quality concerns and water management practices addressing climate change will continue to challenge water managers, communities and citizens.

Texas residents will play a pivotal role in addressing state water supply needs in the future, as well as challenges of uncertain climate change impacts and environmental sustainability. Previous research links attitudes and perceptions to water use behaviors (Campbell et al., 2004; Clarke and Brown, 2006; Willis et al., 2011); Jorgensen et al. (2009) suggest that lack of trust of the water supplier can decrease the likelihood of participating in a water conservation plan. Thus, education, transparency and contact with residents regarding evaluation of current conditions and planning for future water needs is needed to help citizens make informed water use decisions.

Population growth in urban centers, as well as in the rural-urban interface, requires that Extension recognize the importance of reaching urban and rural non-farming sector populations. Milburn et al. (2010) recommends that Extension address the changing rural population by re-training Extension experts, and developing Extension generalists that focus on teaching fundamentals to non-farming, new landowners. Extension must include strategies to address the interest areas of non-farming, rural landowners. Research evaluating preferences for water resource information in the southern region of the United States in 2008 (Boellstorff et al., 2013) indicated that older respondents and those living in smaller cities were more likely to receive water resource information from Extension. In addition, Boellstorff et al. (2013) reported that overall, respondents preferred to receive water resource information through printed factsheets, watching television coverage, reading the newspaper, and visiting websites.

Texas A&M AgriLife Extension Service in conjunction with a national needs assessment project initiated through the Pacific Northwest Regional Water Program facilitated a random sample survey of Texans to evaluate citizen awareness, attitudes and willingness to act on water issues (Mahler et al., 2013) in 2008. The survey was re-issued to a random sample of Texans in 2014. This study focused on the impact of population growth centered in urban areas and the acceptance of available changes in technology since the 2008 survey. The study also assessed outreach effectiveness to particular populations, audiences' media preferences for learning about water issues, and preferences for additional information on particular water resource topics. In addition, this study examined possible trends in information sources related to socio-demographic changes from 2008 to 2014.

Materials and Methods

A state-wide survey was developed to assess Texans' perceptions and attitudes about water resources within the state. The questionnaire is one of the survey components comprising the National Integrated Water Quality Program Needs Assessment Survey project initiated in 2002. The present survey is based on the 2002 template developed by water quality coordinators in the Pacific Northwest Region with input from other participating Land Grant Institution water quality coordinators for the Southern, Mid-Atlantic, Northwest, Northeast and Caribbean Island Regional Water Programs (Mahler, 2010). The survey was sent to 1,275 randomly selected Texas residents in August, 2008 following methods described in Boellstorff et al. (2010); 419

surveys (33%) were completed and returned. Minor modifications were made to the template survey to adapt it to Texas' water management agencies and organizations, and to modernize particular questions before the survey was re-issued in 2014. The survey questionnaire included 59 questions addressing water resource, water quality, and other environmental issues. The study population consisted of the adult residents of Texas.

In April of 2014, the questionnaire was sent via direct mail survey to 1,800 randomly selected residences in Texas following the tailored survey design method (Dillman, 2000). As in 2008, individuals were mailed a paper copy of the survey instrument; a cover letter; and a self-addressed, stamped envelope. Twenty days later, individuals were sent a reminder postcard. Twenty days after the reminder postcard was sent, another survey instrument; cover letter; and self-addressed, stamped envelope were mailed. Twenty days later, a final reminder postcard was mailed to participants. Individuals returning the evaluation or indicating that they did not want to participate in the study were removed from the mailing list so that they were not re-contacted. Taking into account the number of 1) surveys "returned to sender for incorrect address," 2) recipients requesting to not participate, and 3) recipient death, the effective number of mailed questionnaires in 2014 was 1,655 and the return rate for the completed survey questionnaires was 29%. Survey responses were coded and entered into a spreadsheet. Missing data were excluded from analyses.

This study focuses on Texan's preferences for receiving water resource information. Responses to the following questions along with demographic information requested by the survey were analyzed in this paper.

Have you received water resource information from the following sources? Eleven potential sources were listed requesting the respondent indicate "yes" or "no" for each source.

Would you like to learn more about any of the following water quality issue areas? (Mark all that interest you). Sixteen topics were offered as answer choices.

If you had the following kinds of learning opportunities to learn more about water issues, which would you be most likely to take advantage of? (Mark up to 3 items). Thirteen learning opportunities were offered as answer choices.

The Statistical Package for Social Sciences (SPSS) Version 23 was used for data analyses. The null hypothesis that the response frequencies are the same for the various answer options and socio-demographic variables was tested using Pearson's chi-squared and logistic regression analyses. For example, logistic regression analyses were used to determine if residence location or education level predict preferences for receiving information on water resources. Descriptive summary statistics were calculated for socio-demographic variables.

Results

The 2014 water issues in Texas survey achieved a response rate of 29.4% (491out of 1,671 surveys) with 327 respondents coming from the first mailing, and 164 from the second. As shown in Table 4, 53.5% of survey respondents lived in communities of more than 100,000 people. In addition, 72.8% in 2014 lived inside city limits. A total of 73.1% of respondents resided in communities of 25,000 or more

people. Twenty-nine percent lived in small communities of 7,000 people or fewer. A large majority, more than 90%, had lived in Texas for more than 10 years or for all their lives. Respondents of both surveys were somewhat better educated and older than the general Texas population (U.S. Census Bureau, 2013; 2015). More than 76% of the respondents were 50 years old or older.

Table 4. Demographics of respondents for surveys conducted in 2014

Category		**2014** % (n)
Gender	Male	48.7 (185)
	Female	51.3 (195)
Years lived in Texas	All my life	46.6 (180)
	More than 10 years	45.6 (176)
	5 to 9 years	4.4 (17)
	Less than 5 years	3.4 (13)
Size of residence community	> 100,000	53.5 (238)
	25,000 to 100,000	19.6 (87)
	7,000 to 25,000	11.2 (50)
	3,500 to 7,000	5.8 (26)
	<3,500	9.9 (44)
Education	Less than or some high school	3.5 (16)
	High school graduate	12.6 (58)
	Some college	27.9 (129)
	College graduate	33.5 (155)
	Advanced college degree	22.5 (104)
Age	18 - 34	4.7 (18)
	35 - 49	18.9 (72)
	50 - 64	40.8 (155)
	65 years old or older	35.5 (135)
Residence location	Inside city limits	72.8 (337)
	Outside city limits, not farming	22.7 (105)
	Outside city limits, farming	4.5 (21)

Sources of Water Resource Information

Respondents were asked to identify if they had received water resource information from a list of 11 choices by marking "yes" or "no" beside each source. As expected, mass media reached a large portion of the respondents: 63.9% of respondents indicated they had received water resource information from newspapers and magazines, and 56.9% received information from television (Table 5.) Respondents residing in the city were more likely to receive information from television than rural residents (likelihood ratio test, $p = .015$). Surprisingly, city and municipal water districts reached the greatest number of people with 68.2% of the total population and 73.9% of respondents living in the city (likelihood ratio test, $p < .0001$) receiving water information from these sources. One-third of respondents living outside the city and engaged in farming received water resource information from Extension. Remarkably, 20.2% of respondents living outside city limits and not engaged in farming had received water resource information they could identify as being made available through Extension and 10% of respondents living in the city (likelihood ratio test, $p = .006$) recognized receiving water resource information through Extension. Although 10% of respondents living within city limits indicated they had received water resource information from Extension, frequently mass media (television, newspapers/magazines, radio), environmental groups and environmental agencies rely on and transfer information developed by Extension and universities. The three types of organizations that predominantly provide outreach programs for water resources information were consistently recognized by respondents living outside city limits and not engaged with

farming: 23.9% indicated environmental agencies, 22.4% indicated environmental groups, and 20.2% recognized Extension outreach. Fifteen percent of respondents received water resources information from universities. The overall response that 13.4% have received water resource information from Extension corresponds to over 2.7 million adult residents. In addition, the percentage of respondents from urban areas of more than 100,000 people receiving water resource information that they could identify as being from Extension increased from 7.9% in 2008 to 10.6% in 2014 possibly indicating effective expansion of Extension outreach for urban audiences.

Preferred water resource information sources were similar for age groups with the exception of newspapers and magazines ($p < .015$). More than 71.3% of the 65 years and older group responded that they receive water resource information from newspapers and magazines, compared to 65.0% for 50 - 64 years old, and 49.4% for 49 years and younger. There were no significant differences found regarding water resource information source preferences between the 2008 and 2014 surveys.

Table 5. Water resource information sources and respondent residence location. †

Information sources	Overall % (n)	Inside city limits % (n)	Outside city limits, not engaged in farming % (n)	Outside city limits, currently engaged in farming % (n)
Extension	13.4 (52)	10.2 (29)	20.2 (17)	33.3 (6)
Television	56.9 (242)	61.1 (190)	46.8 (44)	40 (8)
Newspapers and magazines	63.9 (266)	65.6 (200)	58.7 (54)	63.2 (12)
City /Municipal water districts	68.2 (296)	73.9 (238)	57 (53)	26.3 (5)
Environmental groups	31.9 (126)	35.4 (103)	22.4 (19)	21.1 (4)
Environmental agencies	31.4 (126)	34 (100)	23.9 (21)	26.3 (5)
Universities	15.2 (60)	15.5 (45)	12.9 (11)	22.2 (4)

† Residence groups are defined based on their response to the survey question: Where do you live? Missing responses were dropped from category totals. Information sources selected by less than 30% of respondents were not reported.

Water Resource Topics

Preferred water resource topics are shown in rank in Figure 4. Protecting drinking water supplies (57.4%) and water management for home and garden landscaping (55.8%) were of greatest interests to respondents (N=371). Comparing 2008 and 2014 surveys, there was a significant increase in the interest in water management for home and garden landscaping (34.1% vs. 55.8%; likelihood ratio $p < .003$). Also, Boellstorff et al. (2013) reported that in 2006-2010, only 40% of respondents in a survey of 16 states in the Southern, Mid-Atlantic, and Northeast regions of the United States were interested in learning about water management for home and garden landscaping.

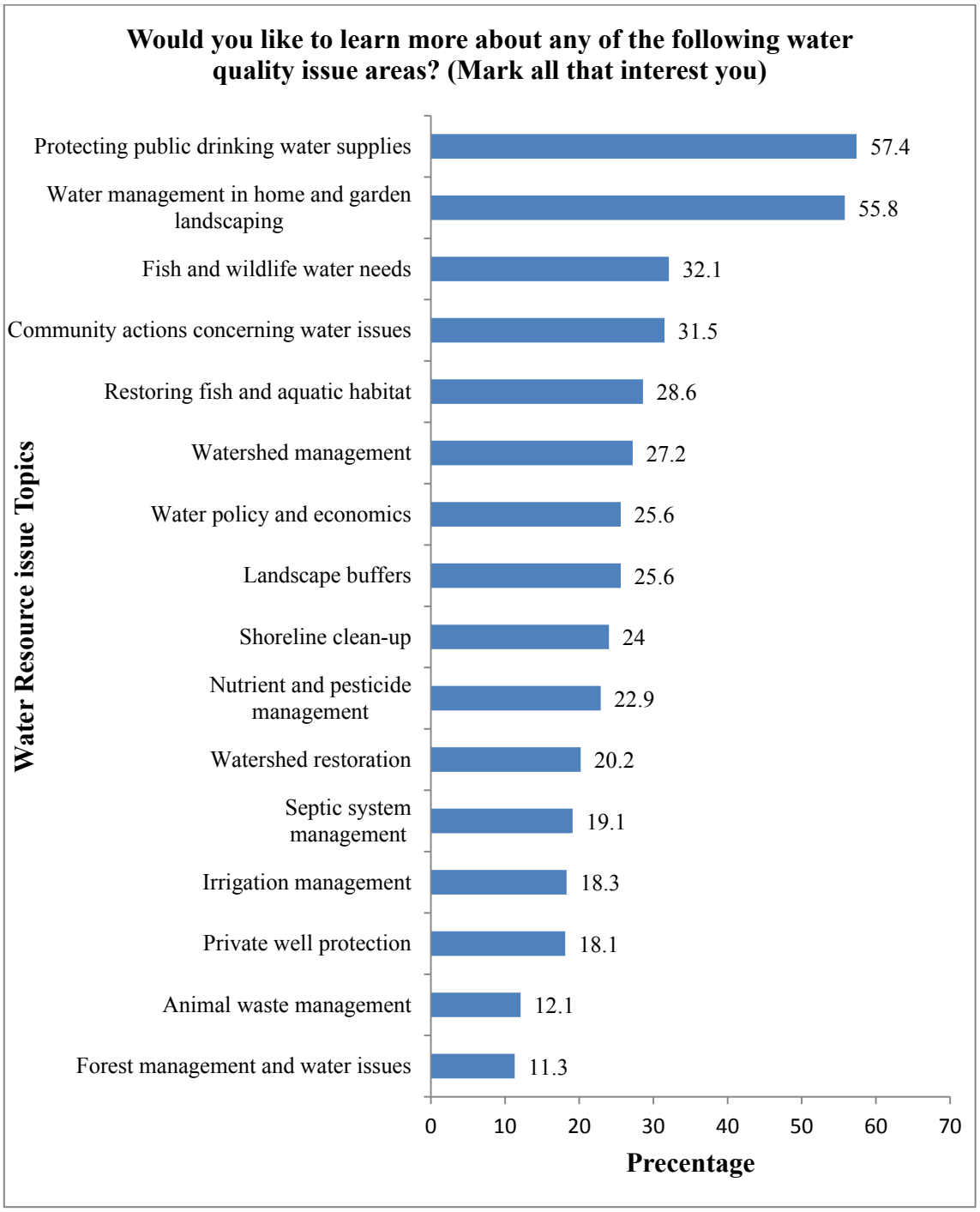

Figure 4. Respondent preferences for additional information on water resource topics. Records without responses marked for any of the learning opportunities were removed from the analysis.

Binary logistic regression analyses of the two topics of greatest interest, those that more than 50% of respondents indicated they would like to learn more about, were analyzed with the socio-demographic responses shown in Table 4. Females ($p < .01$) and respondents having lived a shorter amount of time in Texas ($p < .012$) were more likely to want to learn about water management for home and garden landscaping. No significant differences in demographic characteristics were found for respondents inidcating that they would like to learn more about protecting public drinking water supplies, with the exception that respondents living within city limits ($p < .005$) were more interested in learning more about protecting public drinking water.

Table 6. Preferences with ≥35% interest for more information on water resource issues and residence location.

Water Resource Topic	Residence Location		
	Inside city limits (n=266)	**Outside city limits, not farming (n=79)**	**Outside city limits, farming (n=18)**
Protecting Public Drinking Water Supplies	63.2%	41.8%	
Septic System Management		39.2%	
Private Well Protection		35.4%	55.6%
Watershed Management			44.4%
Fish and Wildlife Water Needs			38.9%
Water Management for Home and Garden Landscaping	59.4%	51.9%	
Watershed and Stream Restoration			44.4%

Four topics with at least 35% interest for more information were indicated for respondents living outside city limits and currently engaged in farming (Table 6). Private well protection was the sole, common topic for both outside city limits engaged in farming and not farming. Respondents living inside city limits had only two topics, protecting public drinking water (63.2%) and water management for home and garden landscaping (59.4%) at or above the 35% interested threshold. Interest in both topics was shared with respondents living outside of the city limits and not engaged in farming. Similar to the results for inside city limits residence locations, for cities with populations greater than 100,000, the topics most frequently chosen were 1) protecting public

drinking water supplies (50.4%), and 2) water management for home and garden landscaping (46.6%).

Preferred Learning Opportunities

As shown in Figure 5, respondents would visit a website (53.5%); read printed fact sheets, bulletins, or brochures (51.2%); watch television (44.5%); or read a newspaper article (38.5%) to learn more about water issues. Although it was not a significant difference, visiting a website moved from the fourth most frequently selected opportunity for learning in a 2008 regional survey (Boellstorff et al., 2013) to the most popular method for learning in the 2014 survey, increasing from 42.0 to 53.5%.

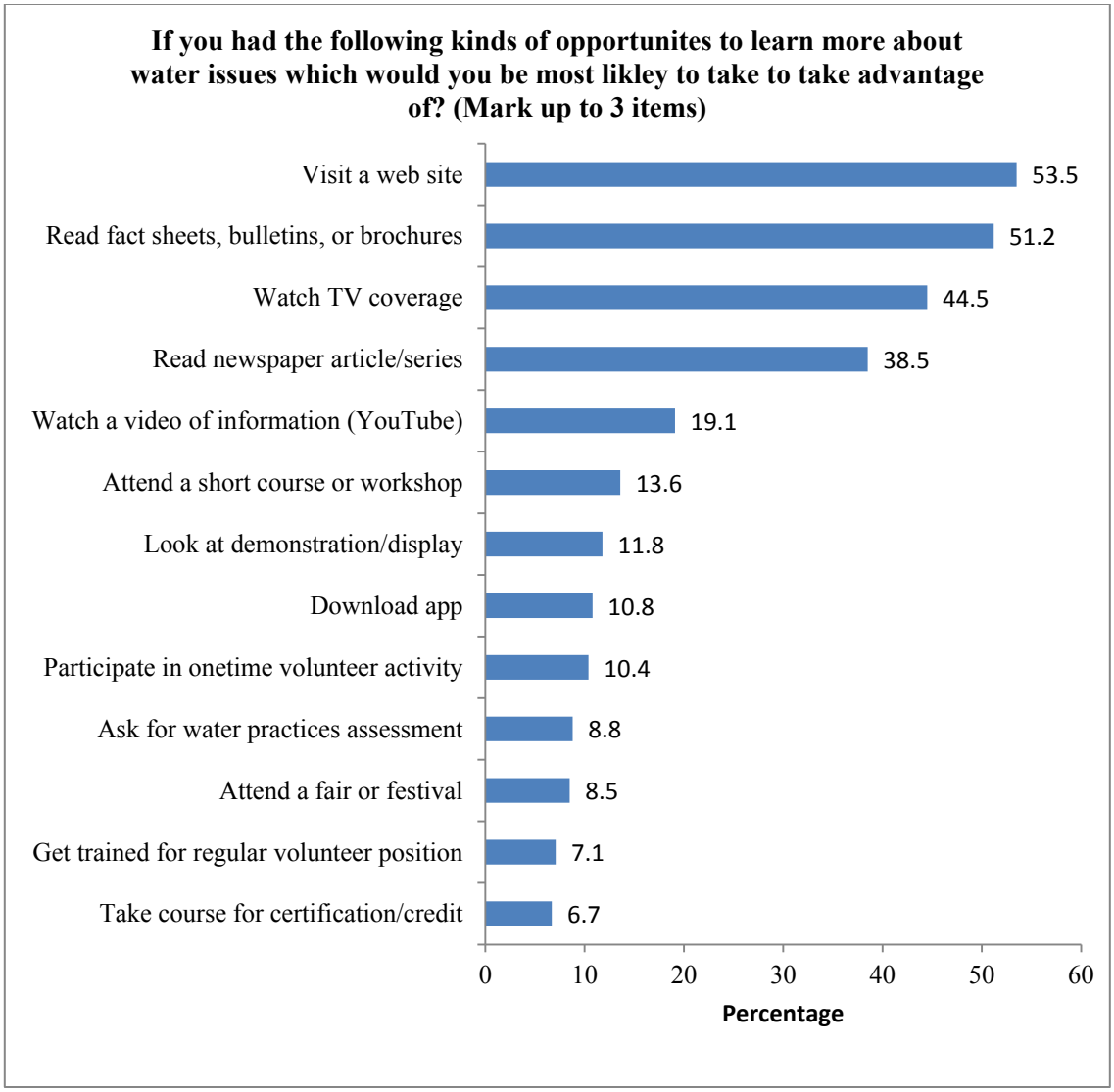

Figure 5. Preferred learning opportunities for all respondents.

The most popular methods for learning were analyzed regarding age of the respondent. As shown in Table 7, there were significant differences among age groups for likelihood to take advantage of each learning opportunity, except for watching TV coverage. Each method showed a clear trend, with younger respondents more likely to

visit a website or watch a short video. Conversely, older respondents were more likely to prefer to read factsheets, bulletins, or brochures or to read a newspaper article/series.

Table 7. Preferred learning opportunities and respondent age.

	Age Groups			
Learning Method	**18 - 34 (n=18)**	**35 - 49 (n=72)**	**50 - 64 (n=155)**	**65 and Older (n=135)**
Visit a website***	55.6%	56.9%	58.7%	36.3%
Read fact sheets, bulletins, or brochures*	33.3%	37.5%	45.2%	57.0%
Watch TV coverage	33.3%	30.6%	36.1%	48.1%
Read newspaper article/series*	27.8%	25.0%	32.9%	44.4%
Watch a video of information (YouTube)*	33.3%	19.4%	18.7%	10.4%

* Probability level of 0.05.
*** Probability level of 0.001.

Binary logistic regression analyses of the responses regarding preferred learning opportunities for respondents against socio-demographic information indicated that, with the exception of watching TV coverage, age was a significant predictor for all methods regarding preferences for different learning opportunities. In addition, respondents with more education ($p<.015$) were more likely to visit a website for water resource

information. Those having lived in Texas fewer than 5 years ($p<.035$) were less likely to watch TV coverage for their water resource information.

Discussion

This study assessed outreach effectiveness, audiences' media preferences for learning about water issues and preferences for additional information on particular water resource topics. In addition, this study evaluates possible trends in preferences for information sources related to socio-demographic variables, and compares results to those for a similar survey administered in 2008 and reported by Boellstorff et al. (2010). Mass media sources such as newspapers, magazines, and television were ranked very high by respondents for receiving water resources information, similar to results from 2008. The highest ranked source of information was city and municipal water districts for 68.2% of all respondents, and 73.9% of those living within city limits. This new response option was added to the 2014 survey, and highlights respondents' recognition of the information their districts provide. During 2011, Texas experienced the worst single-year drought on record (Nielsen-Gammon, 2012). During and after the drought, city and other water suppliers implemented drought contingency plans usually including water restrictions for homeowners. Presumably, city dwellers noted the mail outs and other methods of direct contact water suppliers employed to reach water users regarding restrictions, conservation, and/or current water availability. For Extension, partnering with municipalities and water districts to develop fact sheets to be included in mail outs

may serve as an excellent method to provide more citizens with timely water resource and water conservation information.

One–third of Extension's more traditional audience, those residing outside of city limits and engaged in farming, indicated they have received water resource information that they could identify as being from Extension. More than 20% of those living outside city limits and not engaged in farming have received water resource information through Extension. The percentage of respondents residing in large cities of more than 100,000 people and receiving water resource information that they could identify as being from Extension increased from 7.9% in 2008 to 10.6% in 2014, an exceptional increase for urban areas not traditionally targeted by Extension outreach programs. Recent efforts to bring relevant water resource outreach programs to large cities and metropolitan areas have been well-received. Additionally, considering the growth that occurred between 2008 and 2014 and which continues, particularly in the larger cities in Texas, increasing numbers of individuals will be reached through programs delivered in urban areas.

Future efforts for Extension to reach more urban, suburban and rural populations could include partnering with city or district water suppliers to develop effective materials to be included in utility bill mail-outs. Overall, 13.4% of the adult population in Texas in 2014, or roughly 1 of 8 Texans, responded that they received water resource information specifically from Extension, corresponding to more than 2.7 million adult respondents potentially affecting the 7.7 million people in their Texas households (average Texas household size was 2.84 people in 2011-2015, U.S. Census Bureau, 2015b) . These findings are similar to those reported for 2008 by Boellstorff et al. (2013)

indicating that households with 4.3 million individuals received water resource information from Texas A&M AgriLife Extension Service.

The overall analysis for water resource topics of interest indicated that protecting public drinking water supplies and water management for home and garden landscaping are markedly the most popular topics of interest (Figure 4). Interest in the home and garden landscaping topic increased from 34.1% in 2008 to almost 60% in 2014. Perhaps the interest can be attributed to the exceptional drought the area had recently experienced and increased water restrictions causing Texans to consider more drought-tolerant landscaping choices and practices. Gholson (2017b) reported that following a period of extended, exceptional drought, 61.1% of Texans indicated they had changed the way their yard is landscaped in an effort to conserve water. The interest in learning more about water management for home and garden landscaping that Texans, and specifically urban Texans (Table 6) expressed, presumably corresponded with actions taken to conserve water. Developing programs to address drinking water protection and also home and garden landscaping would address public educational needs, as well as potentially expand the Extension urban audience.

As shown in Figure 5 and Table 7, visiting a website, reading fact sheets, and watching television are most preferred by respondents. Age was a significant predictor for most learning opportunities. Younger respondents were more likely to visit a website or watch a short video, while older respondents were more likely to prefer fact sheets, bulletins, or brochures, and to read a newspaper article/series. As younger respondents age, it is anticipated that they will continue to utilize websites and increase the overall

percentage of respondents visiting websites for water resource information. This trend is already evident as visiting a website moved from the fourth most frequently selected opportunity for learning in a 2008 regional survey (Boellstorff et al., 2013) to the most popular method for learning in the 2014 survey, increasing from 42.0 to 53.5%. While it will remain important to produce printed materials to reach a broad audience, developing short educational videos or transferring fact sheets to websites will be important for reaching younger audiences.

State- and nationwide surveys are valuable tools for evaluating impacts and reach of outreach and education programs. Results reported in Boellstorff et al. (2010) established a baseline assessment of Texans' perceptions and attitudes regarding water beginning in 2008 and this survey and future surveys are important for evaluating changes over time. Such surveys with minor modifications updates should continue to be re-issued at 5-year intervals to additional random samples of Texans, with the next planned survey anticipated for release in 2019.

The present study reports water resource topical areas of greatest interest and preferred methods for reaching various demographic groups, including the growing urban sector. This information is critically important to financially-limited organizations disseminating water resource information, including Extension, environmental agencies and groups, and cities and water districts, as they seek to efficiently encourage the public to adopt appropriate water resource management and water conservation practices. Future supplemental studies could focus on specific issues such as water conservation or

drinking water quality, and those factors possibly influencing how these water resource topics are perceived by Texans.

CHAPTER IV

CONSUMER WATER QUALITY EVALUATION OF PRIVATE AND PUBLIC DRINKING WATER SOURCES

Introduction

Through the regulatory framework established by the U.S. Safe Drinking Water Act (SDWA) in 1974, citizens are assured safe drinking water from public drinking water suppliers. In Texas and throughout the United States, private water wells are not regulated under the Safe Drinking Water Act or any other rule and are not required to be tested to ensure that drinking water meets water quality standards for public water supplies. Management and protection of private water wells are under the control of the landowner, and therefore, depend primarily on education rather than regulation. Public attitudes and perceptions of water quality can vary based on where one lives. Hu and Morton (2011) reported that those residing in rural areas perceive their water to be of better quality than do those living in urban areas. Typically, people living in more rural areas receive their water from a rural public water supply system or a private well. Overall, cases of drinking water disease outbreaks have decreased for public water supply systems since the 1980s, while there has been an increase in the annual proportion of outbreaks reported for private systems (Craun et al., 2010).

Texas A&M AgriLife Extension Service in conjunction with a national needs assessment project initiated through the Pacific Northwest Regional Water Program has facilitated two random sample surveys of Texans to evaluate citizen awareness, attitudes

and willingness to act on water issues (Mahler et al., 2013). The first survey was conducted in 2008. The original survey was re-issued to another random sample of Texans in 2014 as a follow up to the 2008 survey.

This study examines differences in the perception of water quality based on an individual's primary drinking water source. The questions of interest are: Where do you primarily get your drinking water? Possible responses to this question included: Public supply - municipal, Public supply – rural water district, Private supply, and Purchase bottled water. Private supply was assumed to be water from a private water well and not from a river, pond, or lake. Past research indicates that individuals who buy bottled water are more likely to believe their drinking water is unsafe, and also likely to regularly buy bottled water when they have a view that local groundwater is of low quality (Hu et al., 2011). However, factors potentially influencing perception have not been evaluated with the focus on respondents who primarily receive their drinking water from private supplies.

This evaluation of Texans' perceptions of water quality will aim to answer questions such as: Do public drinking water customers trust the quality of their water supply more than private well owners trust the quality of the water they drink? Are private well owners satisfied with their drinking water, and do they believe it is safe to drink? Is a difference in perception of local groundwater quality reflected by the respondent's primary drinking water source? Furthermore, this study will examine whether there is a relationship between choice of primary drinking water source and perceptions of types of potential pollutants in drinking water that could affect health.

Materials and Methods

A state-wide survey was developed to assess Texans' perceptions and attitudes about water resources within the state. The questionnaire is one of the survey components comprising the National Integrated Water Quality Program Needs Assessment Survey project initiated in 2002 and is based on the 2002 template developed by water quality coordinators in the Pacific Northwest region with input from other participating Land Grant Institution (LGI) water quality coordinators for the Southern, Mid-Atlantic, Northwest, Northeast and Caribbean Island Regional Water Programs (Mahler, 2010). The survey was sent to 1,275 randomly selected Texas residents in August, 2008 following methods described in Boellstorff et al. (2010); 419 surveys (33%) were completed and returned. Minor modifications were made to the template survey to adapt it to Texas' water management agencies and organizations, and to modernize particular questions before the survey was re-issued in 2014. The survey questionnaire included 59 questions addressing water resource, water quality, and other environmental issues. The study population consisted of the adult residents of Texas.

In April of 2014, the questionnaire was sent via direct mail survey to 1,800 randomly selected residences in Texas following the tailored survey design method (Dillman, 2000). As in 2008, individuals were mailed a paper copy of the survey instrument; a cover letter; and a self-addressed, stamped envelope. Twenty days later, individuals were sent a reminder postcard. Twenty days after the reminder postcard was sent, another survey instrument; cover letter; and self-addressed, stamped envelope were mailed. Twenty days later, a final reminder postcard was mailed to participants.

Individuals returning the evaluation or indicating that they did not want to participate in the study were removed from the mailing list so that they were not re-contacted. Taking into account the number of 1) surveys "returned to sender for incorrect address," 2) recipients requesting to not participate, and 3) recipient death, the effective number of mailed questionnaires in 2014 was 1,655 and the return rate for the completed survey questionnaires was 29%. Survey responses were coded and entered into a database. Missing data were excluded from analyses.

This study focused on Texans' perception of the quality of their drinking water with an emphasis on private well owners and how they compare to respondents receiving their water from public supplies or purchasing bottled water. This study examined public perceptions of drinking water and groundwater quality, and possible actions citizens may have adopted to safeguard their drinking water. Furthermore, the study analyzed factors influencing the likelihood of well owners having their water wells tested. Because 2008 and 2014 responses were not significantly different for the questions examined for this article, the data for both years were combined for this study. Responses to the following questions were analyzed.

Where do you primarily get your drinking water? (Mark only one answer) Answer choices included: Private supply, Public supply-municipal, Public supply-rural water district, Purchase bottled water, and I don't know.

Do you feel that your home tap drinking water is safe to drink? (Yes or No)

Do you have your home drinking water tested? (Yes or No)

In your opinion, what is the quality of groundwater (sources of well water) in your area? Answer choices were Good or excellent; Good, and improving; Good, but deteriorating; Fair; Poor, but improving; Poor; and No opinion/don't know.

Do you know of or suspect that any of the following pollutants affect either surface or groundwater quality in your area? A list of twelve pollutants was provided with answer choices including: Know it is NOT a problem; Suspect it is NOT a problem; Don't Know; Suspect it IS a problem; and Know it IS a problem.

Please check all of the boxes that apply to your home drinking water system. Answer options included: I have a water treatment system (softener, etc.); I have water filter; I purchase 5 gallon containers of drinking water; I often use bottled water for drinking purposes; I never buy bottled water; I am satisfied with my drinking water (piped in house); and My drinking water is separate from my water supply system.

The Statistical Package for Social Sciences (SPSS) Version 23 was used for data analyses. Descriptive summary statistics were calculated for socio-demographic variables. Chi-square analyses as well as descriptive statistics were used to evaluate differences among respondents and residence locations potentially affecting treatment of home drinking water systems, acquiring water tests, and the perceived quality of groundwater and surface water. Analyses of Variance (ANOVA) were conducted to determine any differences among residence location and suspected pollutants affecting respondent drinking water supplies. All tests of statistical significance were conducted using an *a priori* alpha of 0.05. The null hypothesis is that the response frequencies are the same for the various answer options.

Results

The 2014 survey achieved a response rate of 29.4% (491 out of 1,671 surveys) with 327 respondents coming from the first mailing, and 164 from the second. Socio-demographic characteristics regarding residence for 2008 and 2014 were not significantly different other than for gender; with 2014 more closely reflecting the actual demographics of the state: 48.7% male, and 51.3% female ($p<.0001$). Because 2008 and 2014 responses were not significantly different for the questions examined for this article, the data for both years were combined for this study. For the question of "Where do you primarily get your drinking water?" the response of "I don't know" was excluded from the analysis. (Answer choices had included: Private supply, Public supply-municipal, Public supply-rural water district, Purchase bottled water, and I don't know.) As shown in Table 8, 51.0% of survey respondents lived in communities of more than 100,000. In addition, 73.1% of survey respondents lived inside city limits. A total of 71.4% of respondents resided in communities of 25,000 or more people, while 17.0% of respondents lived in or associated with small communities of 7,000 people or fewer. A large majority, more than 90%, of respondents had lived in Texas for more than 10 years or for all their lives. Respondents were somewhat better educated and older than the general Texas population (U.S. Census Bureau, 2013; 2015). Seven percent of all respondents had less than a high school education, 14.4% were high school graduates, 29.6% had some college or vocational training, 29.7% were college graduates, and 21.9% had advanced degrees.

Respondents were asked where they primarily get their drinking water, and 57.1% indicated they received their water from public supplies – municipal. Unexpectedly, the next highest percentage was bottled water, with almost a quarter (23.5%) of Texans indicating they receive their primary drinking water from bottled water. Almost 8% of the respondents indicated they received their primary drinking water from private supplies (private wells).

Table 8. Demographics of respondents.

Category		% (n)
Primary drinking water source†	Private Supply	7.6 (64)
	Public supply - municipal	57.1 (480)
	Public supply – rural water district	11.8 (99)
	Purchase bottled water	23.5 (198)
Gender	Male	56.6 (447)
	Female	43.4 (343)
Years lived in Texas	All my life	47.3 (377)
	More than 10 years	43.0 (343)
	5 to 9 years	5.8 (46)
	Less than 5 years	3.9 (31)
Size of residence community	> 100,000	51.0 (428)
	25,000 to 100,000	20.4 (171)
	7,000 to 25,000	11.7 (98)
	3,500 to 7,000	7.1 (60)
	<3,500	9.9 (83)

Table 8. Continued

Category		% (n)
Education	Less than or some high school	4.4 (38)
	High school graduate	14.4 (125)
	Some college	29.6 (258)
	College graduate	29.7 (259)
	Advanced college degree	21.9 (191)
Age	18 – 24	0.9 (7)
	25 – 34	5.6 (45)
	35 – 49	22.3 (178)
	50 – 64	34.3 (274)
	65 years old or older	36.9 (295)
Residence location	Inside city limits	73.1 (639)
	Outside city limits, not farming	22.7 (198)
	Outside city limits, farming	4.2 (37)

†Responses of "I don't know" were excluded from the analyses.

Tap Water Safety

Respondents were asked, "Do you feel that your home tap drinking water is safe to drink?" Overall, 81.4% responded that they felt their tap water was safe. As shown in Table 9, 92.1% of respondents who primarily get their drinking water from private supplies felt their drinking water was safe. Conversely, only 57.0% ($p<.0001$) of respondents purchasing bottled water for their primary drinking water felt their tap drinking water was safe. Respondents who primarily get their drinking water from public

suppliers were very similar and felt their water to be safe, with confidence in municipal suppliers slightly higher (88.8%) than for rural water districts (85.6%).

Males (84.1%) were more likely to feel that their drinking water was safe than were females (78.4%, $p<.05$). Also, respondents 65 and older were more likely to feel their water was safe (88.2%) compared to those 35-49 (77.1%) and 50-64 (76.4%) years of age, and surprisingly similar to those 18-34 years old (84.3%). Community size or location of residence did not affect whether respondents felt that their water was safe to drink.

Table 9. Comparisons of beliefs on safety of drinking water by source.

Variable	Do you feel your home tap drinking water is safe to drink?	
	Yes	**No**
Primary drinking water source* **	**Percentage of Respondents**	
Private Supply	92.1	7.9
Public supply – municipal	88.8	11.2
Public supply – rural water district	85.6	14.4
Purchase bottled water	57.0	43.0
Gender*		
Male	84.1	15.9
Female	78.4	21.6
Residence Location		
Inside city limits	82.3	17.7
Outside city limits, farming	79.2	20.8
Outside city limits, engaged in farming	83.8	16.2

Table 9. Continued

Variable	Do you feel your home tap drinking water is safe to drink?	
	Yes	**No**
Education		
Less than high school	76.3	23.7
High school graduate	82.5	17.5
Some college or vocational	80.4	19.6
College graduate	83.1	16.9
Advanced degree	81.2	18.8
Age**		
18 – 34	84.3	15.7
35 – 49	77.1	22.9
50 – 64	76.3	23.7
65 and older	88.2	11.8

*Significant at the .05 level
**Significant at the .001 level
***Significant at the .0001 level

Home Drinking Water Systems

Respondents were asked to check all that apply to their home drinking water systems from the following choices: I have a water treatment system (softener, etc.), I have a water filter, I purchase 5 gallon containers of drinking water, I often use bottled water for drinking purposes, I never buy bottled water, I am satisfied with my drinking water (piped in house), and my drinking water is separate from my water supply system. As expected, responses regarding home drinking water treatment for those purchasing

bottled water as their primary water source were significantly different for all response options except for having a water treatment system (softener, etc.). Those receiving their water from private supplies were also more likely to have a water treatment system for their home drinking water than those receiving their water from public supplies - municipal ($p<.0001$), public supplies – rural water district ($p<.01$), or purchasing bottled water ($p<.0001$).

Interestingly, those receiving their primary source of drinking water through private supplies did not differ from those receiving water from any other sources (public – municipal, public – rural water district or bottled water) regarding whether a water filter was installed on their home drinking water system. The same analysis was performed regarding residence location. Responses from those living inside city limits, those living outside city limits and farming, and those living outside city limits and not farming were significantly different for "I never buy bottled water" and "I am satisfied with my drinking water (piped in house)." Those living outside city limits and engaged in farming were significantly ($p<.05$) more satisfied with their drinking water than respondents living inside city limits. Furthermore, respondents living outside city limits and farming were more likely to never buy bottled water than those living within city limits and those living outside city limits and not farming ($p <.01$). Responses regarding the five other options for this question (I have a water treatment system (softener, etc.)), I have a water filter, I purchase 5 gallon containers of drinking water, I often use bottled water for drinking purposes, and my drinking water is separate from my water supply system) were not significantly different for residence location or community size.

Testing Home Drinking Water

Respondents were asked if they tested their home drinking water. Those receiving their water primarily from private supplies were significantly more likely than those obtaining their primary drinking water from other sources to test their home drinking water ($p<.0001$). As shown in Table 10, about a third of those primarily receiving their drinking water from private supplies responded that their water had been tested.

Table 10. Do you have your home drinking water tested?

Drinking Water Source	Test your Drinking Water	
	Yes	**No**
Private Supply	34.4%	65.6%
Public supply - municipal	10.7%	89.3%
Public supply - rural water district	14.3%	85.7%
Purchase bottled water	10.7%	89.3%

Perceptions of Water Quality

Respondents were asked to evaluate both their local surface and groundwater quality. For this analysis, the seven possible responses (Good or excellent; Good, and improving; Good, but deteriorating; Fair; Poor, but improving; Poor; and No

opinion/don't know) were grouped into four categories, 1 = good/excellent, 2 = Fair (also includes Good, but deteriorating), 3 = Poor, and 4 = No opinion/I don't know. As shown in Figure 5, 81.3% of residents who get their drinking water from private supplies (typically groundwater wells) view the groundwater in their area as good or excellent, and only 7.8% perceive groundwater quality to be poor. Respondents getting their drinking water from public – municipal supplies were more likely than those with drinking water from private supplies (42.9% vs. 3.1%) to not know or have no opinion of the quality of the groundwater ($p<.0001$). Bottled water consumers had the lowest rating for good or excellent (27.8%). About the same percentages of respondents receiving drinking water from the various sources had the opinion that their groundwater quality was poor. There was no difference in perception of surface water quality among those receiving their primary drinking water from the various drinking water sources.

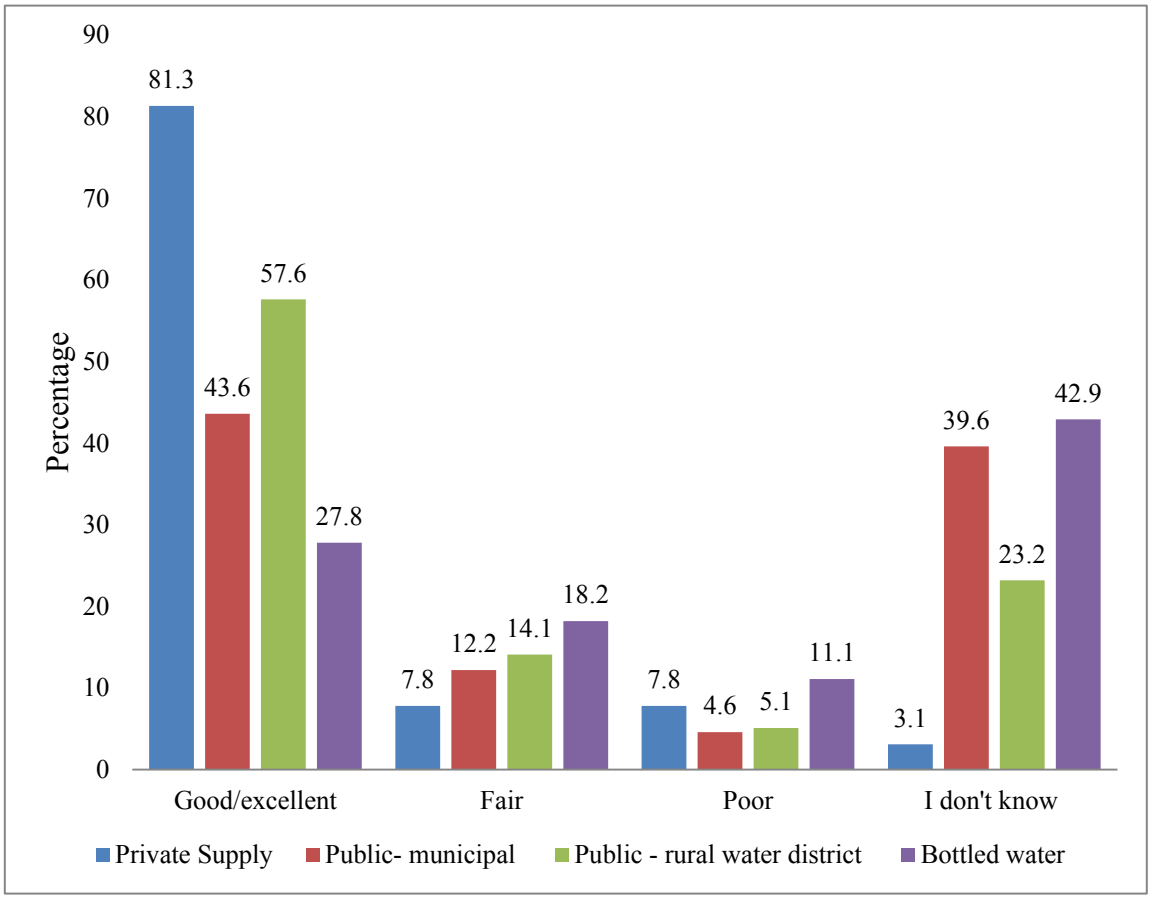

Figure 6. Quality of groundwater in your area.

Perceptions of Sources of Pollutants

Respondents were given a list of twelve pollutants and asked if they knew of or suspected that the pollutants affected the quality of the surface or groundwater in their area. For this analysis, responses (1= Know it is NOT a problem, 2= Suspect it is NOT a problem, 3= Don't know, 4= Suspect it IS a problem, 5= Know it IS a problem) were

recoded into the following three categories: (1 = Is NOT a problem, 2 = Don't know, 3 = IS a problem). Analysis of variance was used to determine any differences in perception of possible pollutants related to respondents' primary drinking water sources. Perceptions of possible pollutants reported by those receiving their primary drinking water from private supplies, public supplies - municipal, public supplies – rural water district, and those purchasing bottled water significantly differed for six potential pollutants (Table 11).

Overall, those receiving their primary drinking water from bottled water were more frequently likely to suspect/know a pollutant was a problem. The next most frequent group to believe surface water or groundwater in their area was affected by the same pollutants (in some cases) were respondents who receive their primary drinking water from public supplies - municipal sources. The highest rated concerns for those who get their primary drinking water from bottled water were Fertilizer/Nitrates (2.36), Fertilizer/Phosphates (2.35) and Pesticides (2.33). These three highest rated concerns for those drinking bottled water as their primary source are frequently associated with agriculture, but are also commonly used by to manage lawns and gardens within city limits.

Those who received their drinking water from public supplies - municipal were similarly concerned about Fertilizer/Nitrates (2.32), Fertilizer/Phosphates (2.33) and Pesticides (2.33). There was no difference in perceptions of pollutants potentially affecting surface and groundwater for those receiving their drinking water from private supplies or public supplies - rural water districts. Pathogens (bacteria, viruses, germs)

were generally viewed as a low threat to water quality; however, those receiving their drinking water primarily from public supplies - rural water districts believed that pathogens were significantly less of a problem for surface or groundwater quality in their area than those who used bottled water. Both those who get their primary drinking water from public supplies - municipal or bottled water were more likely to be concerned with pharmaceuticals (antibiotics, personal care products) affecting local surface or groundwater than those receiving their drinking water from private supplies. Those who received their drinking water from bottled water (2.19) were more concerned with petroleum products affecting the water quality in their area than those receiving their drinking water from private supplies (1.76).

The greatest differences in perceptions of pollutants affecting water quality are between those who obtain their drinking water from private supplies and those drinking bottled water and their perception of potential pollution by product and waste water from mining (Cohen's d = .72) and salinity (Cohen's d =.70).

Table 11. Do you know of or suspect that any of the following pollutants affect either surface or groundwater quality in your area?

Pollutant	Primary drinking water source	N	Mean	S.D.	F-value	Bonferroni post hoc[1] (Cohen's d)[2]
Pathogens (bacteria, viruses, germs)	Private supply	32	1.94	0.72	3.069	Bottled water (.50)
	Public supply- municipal	254	2.06	0.66		
	Public supply- rural water district	43	1.86	0.68		
	Bottled water	103	2.19	0.64		
Fertilizer/Nitrates	Private supply	33	2.09	0.80	2.269	No significant differences
	Public supply- municipal	256	2.32	0.66		
	Public supply- rural water district	43	2.14	0.74		
	Bottled water	105	2.36	0.61		
Fertilizer/Phosphates	Private supply	33	2.06	0.79	2.8532	No significant differences
	Public supply- municipal	254	2.33	0.66		
	Public supply- rural water district	44	2.11	0.72		
	Bottled water	103	2.35	0.61		

Table 11. Continued

Pollutant	Primary drinking water source	N	Mean	S.D.	F-value	Bonferroni post hoc[1] (Cohen's d)[2]
Heavy Metals (lead, arsenic, mercury)	Private supply	32	1.84	0.63	1.253	No significant differences
	Public supply- municipal	256	2.03	0.68		
	Public supply- rural water district	45	1.96	0.67		
	Bottled water	105	2.09	0.64		
Minerals (iron, manganese, calcium)	Private supply	33	2.09	0.72	.401	No significant differences
	Public supply- municipal	255	2.12	0.67		
	Public supply- rural water district	44	2.14	0.70		
	Bottled water	105	2.20	0.66		
Pesticides	Private supply	33	2.09	0.77	4.100	
	Public supply- municipal	252	2.33	0.67		
	Public supply- rural water district	45	2.00	0.74		Public supply - municipal (.48); Bottled water (.50)
	Bottled water	105	2.33	0.61		
Salinity (water too salty)	Private supply	33	1.42	0.50	3.873	Bottled water (.70)
	Public supply- municipal	255	1.71	0.70		
	Public supply- rural water district	45	1.69	0.73		
	Bottled water	104	1.88	0.69		

Table 11. Continued

Pollutant	Primary drinking water source	N	Mean	S.D.	F-value	Bonferroni post hoc[1] (Cohen's d)[2]
Pharmaceuticals (antibiotics, personal care products)	Private supply	33	1.73	0.67	4.223	Public supply - municipal (.50); Bottled water (.56)
	Public supply- municipal	254	2.08	0.69		
	Public supply- rural water district	45	1.84	0.64		
	Bottled water	105	2.10	0.65		
Petroleum products	Private supply	33	1.76	0.71	4.530	Bottled water (.64)
	Public supply- municipal	256	2.05	0.69		
	Public supply- rural water district	45	1.87	0.66		
	Bottled water	106	2.19	0.66		
Algae	Private supply	33	1.82	0.77	3.105	No significant differences
	Public supply- municipal	255	2.13	0.70		
	Public supply- rural water district	45	1.91	0.67		
	Bottled water	105	2.11	0.64		
Product and waste water from mining	Private supply	33	1.39	0.61	4.893	Bottled water (.72)
	Public supply- municipal	252	1.69	0.61		
	Public supply- rural water district	46	1.61	0.68		
	Bottled water	105	1.85	0.65		

Table 11. Continued

Pollutant	Primary drinking water source	N	Mean	S.D.	F-value	Bonferroni post hoc[1] (Cohen's d)[2]
Septic systems	Private supply	33	1.73	0.80	.779	No significant differences
	Public supply-municipal	255	1.86	0.67		
	Public supply- rural water district	45	1.93	0.75		
	Bottled water	105	1.91	0.64		

[1]As in Hu and Morton (2011), the categories shown below are the ones that show significant differences (at 0.05 level) from the group being considered.

[2]Cohen's d shows effect size for the difference between two means. In general, the value is calculated by dividing the difference between the two means with the standard deviation (or pooled standard deviation). Usually a Cohen's d of 0.20 means small effect, 0.50 is moderate effect, and 0.80 is large effect. Practically, a Cohen's d falling between 0.25 and 0.50 is considered significant (Cohen, 1988; Hu and Morton, 2011).

Discussion

Using data from surveys administered in 2008 and 2014, this manuscript assesses public attitudes and perceptions regarding drinking water. Most respondents reported that they believe their drinking water is of high quality, with 81.4% responding that they believe their tap water is safe to drink. An even larger number, 92.1%, of those receiving their water from private sources believe their tap water is safe. Conversely, only 57.0% of respondents who consume bottled water as their primary source of drinking water believe their tap water is safe to drink. Both municipal and rural water district public water systems are regulated, maintained, and under rigorous monitoring and testing

requirements. Private water wells have no requirements to be tested or monitored to ensure safe drinking water quality, and yet those receiving their primary drinking water from private supplies are more frequently confident that their tap drinking water is safe.

Kreutzwiser et al. (2011) found that complacency was a significant barrier for well owners testing their water, and that experiencing problems was what motivated well owners to test. As expected, fewer of those receiving their drinking water primarily from bottled water believe their tap water is safe. Furthermore, research has shown that perceived risk of unsafe drinking water is what drives consumers to buy bottled water as their primary drinking water source (Anadu and Harding, 2000; Hu et al., 2011). However, studies have shown that the common belief that bottled water is safer than tap water may not be accurate (Lalumandier and Ayers, 2000; Raj, 2005). Overall, almost a quarter of the respondents (23.5%) indicated that bottled water is their primary drinking water source. Results indicated that females (78.4%) were less likely to feel their drinking water was safe than were males (84.1%), and those 65 years and older were the age group most likely to respond that their water was safe (88.2%). Perhaps experience of drinking water from private supplies for many years with no noticeable health issues results in the older group perceiving their water to be safer than it may be, as Craun et al. (2010) reported that drinking water disease outbreaks have increased for private water sources.

Those receiving their primary drinking water from private supplies are consuming the least regulated water and yet are the most certain that their water is safe to drink. Several factors that may influence this perception are those indicating their

primary source of drinking water was private supply were much more likely to have a water treatment system for their home than those receiving their primary drinking water from public supplies - municipal ($p < .0001$) and public supplies – rural water district ($p < .01$) sources. Having a water treatment system could give private well owners a false sense of security. For example, water softeners are a common treatment system for private water wells users, but do not address the bacteriological issues that can occur for up to one-third of private well owners (DeSimone and Hamilton, 2009) and also do not address other potential contaminants that may be of concern. Private water supplies should be tested regularly, at least annually for fecal coliform or *Escherichia coli*. According to the results of the present survey, more than 65% of Texans receiving their primary drinking water from private supplies (usually their private water well) have never had their water supply tested. This figure is substantially lower than other studies where 65% (Hexemer et al., 2008) and 75% (Kreutzwiser et al., 2011)of private well owners responded that they tested their water annually

As expected, those receiving their primary drinking water from private supplies tested their water significantly more (34.4%, $p < .0001$) than those receiving their primary drinking water from public sources. Respondents who received their primary drinking water from public water supplies may not have personally initiated testing the tap water in their home, but because regular testing is required for public water systems; their water was being regularly tested by the supplier.

As shown in Figure 5, few respondents (4.6% to 11.1%) perceived groundwater quality to be poor in their area. A large majority (81.3%) of those primarily receiving

their drinking water from private supplies believed groundwater in their area to be of good or excellent quality and only 3.1% did not know or did not have an opinion regarding local groundwater quality. These findings are in agreement with Benham et al. (2016) who reported the most common reason for no action taken by private well owners to protect their water supply was due to perceptions of no problems with their water system. In contrast, those receiving their primary source of drinking water from public supplies – municipal (43.6%) and public supplies - rural water districts (57.6%) believed area groundwater to be of good or excellent quality, and almost 40% of those receiving their primary drinking water from public supplies – municipal sources had no opinion or did not know the quality of groundwater in the area. As also suggested by Boellstorff et al. (2013) for the southern region of the United States, the results of the present survey indicate a significant need for expanded water resource education and outreach programs for the Texas urban sector including information regarding groundwater quality and local drinking water sources. As Gholson (2017a) reports that the water resource topic of greatest interest to Texans living within city limits was "Protecting Public Drinking Water Supplies," this type of water resource educational programming should be well-received by urban audiences. In addition, although the *2014 Texas Integrated Report* developed by the Texas Commission on Environmental Quality(TCEQ) (Texas Commission on Environmental Quality, 2014) confirms that the most frequent parameter resulting in impairment of Texas waterbodies is bacteria (pathogens), only 26.3% of respondents believed or suspected that pathogens were a pollutant of concern and 73.7% indicated they don't know, or know suspected pathogens are not a problem. As many

watershed protection plans and Total Maximum Daily Load efforts in Texas aim to address bacteria loads and impairments at least partially through public engagement and the adoption of appropriate best management practices, it is important for the public to be informed about the impact of pathogens on water quality.

Further analysis of perceptions of pollutants potentially affecting drinking water quality indicated that those who get their primary drinking supply from bottled water or from public supplies - municipal were more likely to believe that pollution had occurred than those who get their drinking water from private or public supplies - rural water districts. These results were similar to those reported by Hu and Morton (2011) and Borisova et al. (2013) comparing perceptions of water quality expressed by urban and rural residents. In particular, those living in urban areas were more likely than those living outside city limits to believe that agriculturally-related potential pollutants such as Pesticides, Fertilizer/Nitrates, and Fertilizer/Phosphates could be negatively affecting water quality. It is unclear if city dwellers believe the sources of these pollutants are agricultural, or whether they also attribute them to pesticide and fertilizer uses within urban areas. To address residential uses, outreach programs targeting audiences concerned with lawn and turf management, as well as proper irrigation of lawns should reduce excess run-off and pollutant transport to water supplies. Gholson (2017a) reported that water management for home and garden landscaping is of interest to almost 60% of those living within city limits.

Although elevated *E. coli* concentrations are the most common reason for streams to be considered impaired in Texas (Texas Commission on Environmental

Quality, 2014), generally Texans did not perceive "pathogens (bacteria, viruses, germs)" to affect water quality in their area. In addition, industrial activities such as mining and oil and gas operations that are associated with petroleum production and waste water from mining usually occurring in more rural areas, did not affect the level of concern for respondents who receive their drinking water from public supplies - rural water districts or private supplies. Although concerns regarding unconventional oil and gas operations impacting groundwater supplies have been reported in the popular press, pollutants associated with these activities did not appear to be of concern to rural residents typically in these production areas.

Gholson (2017b) also reported that for well owners, typically those living outside city limits and engaged in farming, the water resource topic of greatest interest was private well protection. Because private well owners believe they have knowledge regarding the quality of their drinking water supply (groundwater) and feel more in control of the management of their water supply, they will frequently participate in outreach programs that encourage well testing and proper well maintenance, if made available (Texas Water Resource Institute, 2014). As Hu et al. (2011) suggest, as well owners are more involved in the management of their water supply, they have greater trust in the quality and safety of the water, even though Craun et al. (2010) report that drinking water disease outbreaks associated with private wells are increasing as outbreaks associated with public systems decrease.

Regional and state-wide surveys are important tools for evaluating public perceptions and attitudes regarding water resources. Such evaluations identify

knowledge gaps, topics of interest and target audiences. For example, Morris et al. (2016) emphasized the importance of understanding the barriers private well owners may have to implementing best management practices so that effective outreach programs may be developed. In the future, further study of the characteristics of those receiving their primary drinking water from private supplies that focuses on perceptions, barriers and factors influencing the likelihood of well owners testing their water and properly managing their private water well system would yield insights beneficial for developing appropriate programs encouraging water testing.

CHAPTER V

SUMMARY

This study evaluated public perception and attitudes about water resources in Texas by examining perceptions regarding water availability following exceptional drought, learning preferences for water resource information, and consumer evaluation of private and public drinking water sources.

A Survey of Public Perceptions and Attitudes about Water Availability Following Exceptional Drought in Texas

The results of this study indicate that recent drought experience strongly influences public perception of current water quantity issues as well as perception of future water availability, as was the case for a similar study. Evans et al. (2015) reported that perceptions of local drought conditions significantly affected public attitudes and awareness regarding water supply. Specifically, the public is more concerned about water resources and climate change during periods of extreme drought. Evans et al. (2015) also showed that length of residency significantly affected the perception of water availability, with respondents living in the state longer less likely to be concerned with water supply.

As shown in Figure 1 and Table 2, perception of future water availability has shifted significantly following the period of extended exceptional drought at its worst in 2011, with respondents in 2014 indicating more concern than 2008 respondents. Texans

have become more concerned with having enough water within 10 years to meet their needs, with 53% believing supply will not be adequate. Almost 70% felt that the likelihood of their area suffering from a prolonged drought was increasing. More than 61% of respondents have changed the way their yard is landscaped in efforts to conserve water. Furthermore, more than 62% have also adopted new technologies in an effort to conserve water.

Perceived importance of water resources is a significant factor that drives water conservation (Adams et al., 2013). Efforts initiated during drought periods to conserve water by changing the way a yard is landscaped or adopting new technology (low flow showerheads, high efficiency appliances, etc.), can become long-term behavior changes. Adoptions of more permanent changes, rather than temporary or short-lived actions, represent positive behavior modification likely to be continued even during normal rainfall periods. Additionally, intensifying public concern regarding water supplies during drought conditions creates unique opportunities for Extension and other water resource management organizations to deliver timely and valued water conservation information.

Perception that the amount of rainfall in their area will change as a result of global warming increased from 2008 to 2014 with a jump (+12.4%) in respondents believing rainfall will significantly decrease. However, despite frequent media reports regarding climate change, respondents indicating that they did not know what rainfall changes would occur increased slightly from 30.3 to 33.8%. Udayakumara et al. (2010) reported that environmental awareness is influenced by education. Similarly for this

study, results indicated that increased education influenced perception that rainfall would decrease as a result of global warming. (Kleinberg and Colby, 2014; Leiserowitz, 2005) also reported that some citizens believe that climate change will not affect an individual or their community, but is rather more a global or national problem. The findings of these studies may support the contention that further climate change research is necessary before more of the public feels they can draw an informed conclusion.

Overall, responses indicate that Texans are concerned with water availability and believe that there are concerns for water resources in the future after experiencing in 2011 the worst one-year drought on record. Results also indicate that with citizen concern, the majority of respondents are taking personal action in an effort to conserve water for the future.

This study provides useful information in support of water conservation outreach programs. Texans tend to be more concerned with water availability during and after droughts providing a timely opportunity to highlight drought conditions and appropriate responses and actions for citizens through outlets such as state agencies, Extension services, news outlets, and groundwater and utility districts. It may also be effective to remind the public of extreme droughts they have experienced when conducting an outreach program. Because Texans are more willing to make time-consuming, possibly expensive, but lasting changes to their landscape during and after droughts, outreach programs with information including best management practices for lawn irrigation, drought tolerant landscapes, and new water conservation technologies should be made available through appropriate sources. Investment in education during critical

environmental events when audiences are seeking information frequently results in permanent behavior changes that continue to conserve water resources when more typical weather returns (Cohen et al., 2006).

Learning Preferences for Water Resource Information from Extension and Other Sources

Mass media sources such as newspapers, magazines, and television were ranked very high by respondents for receiving water resources information, similar to results from 2008. The highest ranked source of information was city and municipal water districts for 68.2% of all respondents, and 73.9% of those living within city limits. This new response option was added to the 2014 survey, and highlights respondents' recognition of the information their districts provide. During 2011, Texas experienced the worst single-year drought on record (Nielsen-Gammon, 2012). During and after the drought, city and other water suppliers implemented drought contingency plans usually including water restrictions for homeowners. Presumably, city dwellers noted the mail outs and other methods of direct contact water suppliers employed to reach water users regarding restrictions, conservation, and/or current water availability. For Extension, partnering with municipalities and water districts to develop fact sheets to be included in mail outs may serve as an excellent method to provide more citizens with timely water resource and water conservation information.

One–third of Extension's more traditional audience, those residing outside of city limits and engaged in farming, indicated they have received water resource information

that they could identify as being from Extension. More than 20% of those living outside city limits and not engaged in farming have received water resource information through Extension. The percentage of respondents residing in large cities of more than 100,000 people and receiving water resource information that they could identify as being from Extension increased from 7.9% in 2008 to 10.6% in 2014, an exceptional increase for urban areas not traditionally targeted by Extension outreach programs. Recent efforts to bring relevant water resource outreach programs to large cities and metropolitan areas have been well-received. Additionally, considering the growth that occurred between 2008 and 2014 and which continues particularly in the larger cities in Texas, increasing numbers of individuals will be reached through programs delivered in urban areas.

Future efforts for Extension to reach more urban, suburban and rural populations could include partnering with city or district water suppliers to develop effective materials to be included in utility bill mail-outs. Overall, 13.4% of the adult population in Texas, or roughly 1 of 8 Texans, in 2014 responded that they received water resource information specifically from Extension, corresponding to more than 2.7 million adult respondents potentially affecting the 7.7 million people in their Texas households (average Texas household size was 2.84 people in 2011-2015, U.S. Census Bureau, 2015b) . These findings are similar to those reported for 2008 by Boellstorff et al. (2013) indicating that households with 4.3 million individuals received water resource information from Texas A&M AgriLife Extension Service.

The overall analysis for water resource topics of interest indicated that protecting public drinking water supplies and water management for home and garden landscaping

are markedly the most popular topics of interest (Figure 4). Interest in the home and garden landscaping topic increased from 34.1% in 2008 to almost 60% in 2014. Perhaps the interest can be attributed to the exceptional drought the area had recently experienced and increased water restrictions causing Texans to consider more drought-tolerant landscaping choices and practices. Gholson (2017b) reported that following a period of extended, exceptional drought, 61.1% of Texans indicated they had changed the way their yard is landscaped in an effort to conserve water. The interest in learning more about water management for home and garden landscaping that Texans, and specifically urban Texans (Table 6) expressed, presumably corresponded with actions taken to conserve water. Developing programs to address drinking water protection and also home and garden landscaping would address public educational needs, as well as potentially expand the Extension urban audience.

As shown in Figure 5 and Table 7, visiting a website, reading fact sheets, and watching television are most preferred by respondents. Age was a significant predictor for most learning opportunities. Younger respondents were more likely to visit a website or watch a short video, while older respondents were more likely to prefer fact sheets, bulletins, or brochures, and to read a newspaper article/series. As younger respondents age, we anticipate that they will continue to utilize websites and increase the overall percentage of respondents visiting websites for water resource information. This trend is already evident as visiting a website moved from the fourth most frequently selected opportunity for learning in a 2008 regional survey (Boellstorff et al., 2013) to the most popular method for learning in the 2014 survey, increasing from 42.0 to 53.5%. While it

will remain important to produce printed materials to reach a broad audience, developing short educational videos or transferring fact sheets to websites will be important for reaching younger audiences.

State- and nationwide surveys are valuable tools for evaluating impacts and reach of outreach and education programs. Results reported in Boellstorff et al. (2010) established a baseline assessment of Texans' perceptions and attitudes regarding water beginning in 2008 and this survey and future surveys are important for evaluating changes over time. We anticipate that the survey with minor modifications will continue to be re-issued at 5-year intervals to additional random samples of Texans, with the next survey planned for release in 2019.

The present study reports water resource topical areas of greatest interest and preferred methods for reaching various demographic groups, including the growing urban sector. This information is critically important to financially-limited organizations disseminating water resource information, including Extension, environmental agencies and groups, and cities and water districts, as they seek to efficiently encourage the public to adopt appropriate water resource management and water conservation practices. Future supplemental studies could focus on specific issues such as water conservation or drinking water quality, and those factors possibly influencing how these water resource topics are perceived by Texans.

Consumer Water Quality Evaluation of Private and Public Drinking Water Sources

Most respondents reported that they believe their drinking water is of high quality, with 81.4% responding that they believe their tap water is safe to drink. An even larger number, 92.1%, of those receiving their water from private sources believe their tap water is safe. Conversely, only 57.0% of respondents who consume bottled water as their primary source of drinking water believe their tap water is safe to drink. Both municipal and rural water district public water systems are regulated, maintained, and under rigorous monitoring and testing requirements. Private water wells have no requirements to be tested or monitored to ensure safe drinking water quality, and yet those receiving their primary drinking water from private supplies are more frequently confident that their tap drinking water is safe. Kreutzwiser et al. (2011) found that complacency was a significant barrier for well owners testing their water, and that experiencing problems was what motivated well owners to test. As expected, fewer of those receiving their drinking water primarily from bottled water believe their tap water is safe. Furthermore, research has shown that perceived risk of unsafe drinking water is what drives consumers to buy bottled water as their primary drinking water source (Anadu and Harding, 2000; Hu et al., 2011). However, studies have shown that the common belief that bottled water is safer than tap water may not be accurate (Lalumandier and Ayers, 2000; Raj, 2005). Overall, almost a quarter of the respondents (23.5%) indicated that bottled water is their primary drinking water source. Results indicated that females (78.4%) were less likely to feel their drinking water was safe than

were males (84.1%), and those 65 years and older were the age group most likely to respond that their water was safe (88.2%). Perhaps experience of drinking water from private supplies for many years with no noticeable health issues results in the older group perceiving their water to be safer than it may be, as Craun et al. (2010) reported that drinking water disease outbreaks have increased for private water sources.

Those receiving their primary drinking water from private supplies are consuming the least regulated water and yet are the most certain that their water is safe to drink. Several factors that may influence this perception are that those indicating their primary source of drinking water was private supply were much more likely to have a water treatment system for their home than those receiving their primary drinking water from public supplies - municipal ($p < .0001$) and public supplies – rural water district ($p < .01$) sources. Having a water treatment system could give private well owners a false sense of security. For example, water softeners are a common treatment system for private water wells users, but do not address the bacteriological issues that can occur for up to one-third of private well owners (DeSimone and Hamilton, 2009) and also do not address other potential contaminants that may be of concern. Private water supplies should be tested regularly, at least annually for fecal coliform or *Escherichia coli*. According to the results of the present survey, more than 65% of Texans receiving their primary drinking water from private supplies (usually their private water well) have never had their water supply tested. This figure is substantially lower than other studies where 65% (Hexemer et al., 2008) and 75% (Kreutzwiser et al., 2011) of private well owners responded that they tested their water annually

As expected, those receiving their primary drinking water from private supplies tested their water significantly more (34.4%, $p<.0001$) than those receiving their primary drinking water from public sources. Respondents who received their primary drinking water from public water supplies may not have personally initiated testing the tap water in their home, but because regular testing is required for public water systems; their water was being regularly tested by the supplier.

As shown in Figure 5, few respondents (4.6% to 11.1%) perceived groundwater quality to be poor in their area. A large majority (81.3%) of those primarily receiving their drinking water from private supplies believed groundwater in their area to be of good or excellent quality and only 3.1% did not know or did not have an opinion regarding local groundwater quality. These findings are in agreement with Benham et al. (2016) who reported the most common reason for no action taken by private well owners to protect their water supply was due to perceptions of no problems with their water system. In contrast, those receiving their primary source of drinking water from public supplies – municipal (43.6%) and public supplies - rural water districts (57.6%) believed area groundwater to be of good or excellent quality, and almost 40% of those receiving their primary drinking water from public supplies – municipal sources had no opinion or did not know the quality of groundwater in the area. As also suggested by Boellstorff et al. (2013) for the southern region of the United States, the results of the present survey indicate a significant need for expanded water resource education and outreach programs for the Texas urban sector including information regarding groundwater quality and local drinking water sources. As Gholson (2017a) reports that the water resource topic of

greatest interest to Texans living within city limits was "Protecting Public Drinking Water Supplies," this type of water resource educational programming should be well-received by urban audiences. In addition, although the *2014 Texas Integrated Report* developed by the Texas Commission on Environmental Quality (Texas Commission on Environmental Quality, 2014) confirms that the most frequent parameter resulting in impairment of Texas waterbodies is bacteria (pathogens), only 26.3% of respondents believed or suspected that pathogens were a pollutant of concern and 73.7% indicated they don't know, or know suspected pathogens are not a problem. As many watershed protection plan and Total Maximum Daily Load efforts in Texas aim to address bacteria loads and impairments at least partially through public engagement and the adoption of appropriate best management practices, it is important for the public to be informed about the impact of pathogens on water quality.

Further analysis of perceptions of pollutants potentially affecting drinking water quality indicated that those who get their primary drinking supply from bottled water or from public supplies - municipal were more likely to believe that pollution had occurred than those who get their drinking water from private or public supplies - rural water districts. These results were similar to those reported by Hu & Morton (2011) and Borisova et al. (2013) comparing perceptions of water quality expressed by urban and rural residents. In particular, those living in urban areas were more likely than those living outside city limits to believe that agriculturally-related potential pollutants such as Pesticides, Fertilizer/Nitrates, and Fertilizer/Phosphates could be negatively affecting water quality. It is unclear if city dwellers believe the sources of these pollutants are

agricultural, or whether they also attribute them to pesticide and fertilizer uses within urban areas. To address residential uses, outreach programs targeting audiences concerned with lawn and turf management, as well as proper irrigation of lawns will reduce excess run-off and pollutant transport to water supplies. Gholson (2017a) reported that water management for home and garden landscaping is of interest to almost 60% of those living within city limits.

Although elevated *E. coli* concentrations are the most common reason for streams to be considered impaired in Texas (Texas Commission on Environmental Quality, 2014), generally Texans did not perceive "pathogens (bacteria, viruses, germs)" to affect water quality in their area. In addition, industrial activities such as mining and oil and gas operations that are associated with petroleum production and waste water from mining usually occurring in more rural areas, did not affect the level of concern for respondents who receive their drinking water from public supplies - rural water districts or private supplies. Although concerns regarding unconventional oil and gas operations impacting groundwater supplies have been reported in the popular press, pollutants associated with these activities did not appear to be of concern to rural residents typically in these production areas.

Gholson (2017) also reported that for well owners, typically those living outside city limits and engaged in farming, the water resource topic of greatest interest was private well protection. Because private well owners believe they have knowledge regarding the quality of their drinking water supply (groundwater) and feel more in control of the management of their water supply, they will frequently participate in

outreach programs that encourage well testing and proper well maintenance, if programs are made available (Texas Water Resource Institute, 2014). As Hu et al. (2011) suggest, as well owners are more involved in the management of their water supply, they have greater trust in the quality and safety of the water, even though Craun et al. (2010) report that drinking water disease outbreaks associated with private wells are increasing as outbreaks associated with public systems decrease.

Regional and state-wide surveys are important tools for evaluating public perceptions and attitudes regarding water resources. Such evaluations identify knowledge gaps, topics of interest and target audiences. For example, Morris et al. (2016) emphasized the importance of understanding the barriers private well owners may have to implementing best management practices so that effective outreach programs may be developed. In the future, further study of the characteristics of those receiving their primary drinking water from private supplies that focuses on perceptions, barriers and factors influencing the likelihood of well owners testing their water and properly managing their private water well system would yield insights beneficial for developing appropriate programs encouraging water testing.

Recommendations

This study indicates several recommendations that Extension, education outreach programs, and agencies should consider.

A Survey of Public Perceptions and Attitudes about Water Availability Following Exceptional Drought in Texas

- Survey evaluations can document changes in perception and adoption of best management practices, as well as identify opportunities for expanded outreach and research efforts. Continue to conduct follow-up surveys at least every five years.
- Texans tend to be more concerned with water availability during and after droughts, providing a timely opportunity to highlight drought conditions and appropriate responses and actions for citizens through outlets such as state agencies, Extension services, news outlets, and groundwater and utility districts.
- Texans are more willing to make time-consuming, possibly expensive, but lasting changes to their landscape during and after droughts. Outreach programs with information including best management practices for lawn irrigation, drought tolerant landscapes, and new water conservation technologies should be made available through appropriate sources. Investment in education during severe environmental events when audiences are seeking information is critical.

Learning Preferences for Water Resource Information from Extension and Other Sources

- Extension should partner with municipalities and water districts to share or develop fact sheets to be included in utility district mail outs, an excellent method for providing more citizens with timely water resource and water conservation information.
- Develop or deliver existing programs regarding 1) drinking water protection and 2) home and garden landscaping to address identified public educational interests and to expand the Extension urban audience (Figure 4).
- Develop short educational videos or transfer fact sheets to websites to more effectively reach younger audiences.
- Continue to develop and distribute fact sheets, brochures and other paper copies to support learning preferences for older audiences.

Consumer Water Quality Evaluation of Private and Public Drinking Water Sources

- Education regarding water quality issues for both urban and rural Texans should be expanded, but it is important to understand that these audiences view pollution concerns differently.
- Outreach programs for urban areas should emphasize lawn and turf management, as well as proper irrigation of lawns to reduce excess run-off and pollutant transport to water supplies.

- Further study of the characteristics of those receiving their primary drinking water from private supplies that focuses on perceptions, barriers and factors influencing the likelihood of well owners testing their water and properly managing their private water well system would yield insights beneficial for developing appropriate programs encouraging water testing.

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APPENDIX A

COVER LETTER AND INFORMATION SHEET FOR SURVEY INSTRUMENT

Survey Letter of Introduction

TEXAS A&M AGRILIFE EXTENSION
349 Soil and Crop Sciences, TAMU, College Station, Texas 77845

May 7, 2014

Dear Texas Resident,

Texas A&M University is concerned with water issues and how these issues affect our businesses and daily lives. Your views and the views of other citizens about a wide range of water issues as provided in the enclosed survey are crucial to guide the University's research and educational efforts in Texas.

Your response to this survey is very important. You are one of 1,800 residents of Texas who are being asked for their views on water issues. Your responses will represent the more than 26 million residents of the state. Would you please complete this questionnaire and return it in the stamped business envelope supplied with this mailing? The questionnaire should only take about 12 minutes to complete. All results of this survey will be available to the general public.

Your response will be completely confidential. This questionnaire has an identification number in ink in the top right hand corner for mailing purposes only. This is so that we may check your name off the mailing list when your completed survey is returned. Your name will never be placed on the questionnaire itself.

My name is Diane Boellstorff and I have been conducting water resource surveys in Texas through Texas A&M AgriLife Extension Service for the past six years. To ensure this survey's integrity, I am working with another water resource and evaluation contact at Texas A&M University, Dr. Scott Cummings, to develop the survey and process your input. If you have any questions, we would be happy to answer them. Our email addresses are dboellstorff@tamu.edu and s-cummings@tamu.edu. Please return only the survey in the stamped business envelope.

Thank you for your assistance.

Sincerely,

Diane E. Boellstorff

Scott R. Cummings

Dr. Diane E. Boellstorff
Assistant Professor and Extension Specialist
Texas A&M AgriLife Extension Service
Texas A&M University System

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Study Information Sheet

Information Sheet
Texas Water Perceptions and Attitudes Survey

Introduction
The purpose of this form is to provide you information that may affect your decision as to whether or not to participate in this research study. If you decide to participate in this study, this form will also be used to provide you with relevant information about the study.

You are being asked to participate in a research project studying Texas residents' perceptions and attitudes about water in Texas. The purpose of this study is to better understand how Texans perceive the issue of water in Texas. You were chosen for this survey based on a random sample of all Texas residents.

What will I be asked to do?
If you agree to participate in this study, you will be asked to complete the attached survey in which we will ask you questions about your perceptions and attitudes associated with water in Texas. This study will take 15 - 20 minutes to complete.

What are the risks involved in this study?
The risks associated in this study are minimal, and are not greater than risks ordinarily encountered in daily life.

What are the possible benefits of this study?
You will receive no direct benefit from participating in this study; however, developing best practices for dealing with our state's water situation could benefit all citizens in Texas.

Do I have to participate?
No. Your participation is voluntary. You may decide not to participate or to withdraw at any time without your current or future relations with Texas A&M University, your employer, or city/county being affected.

Who will know about my participation in this research study?
This study is confidential. The records for this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only research personnel will have access to the records.

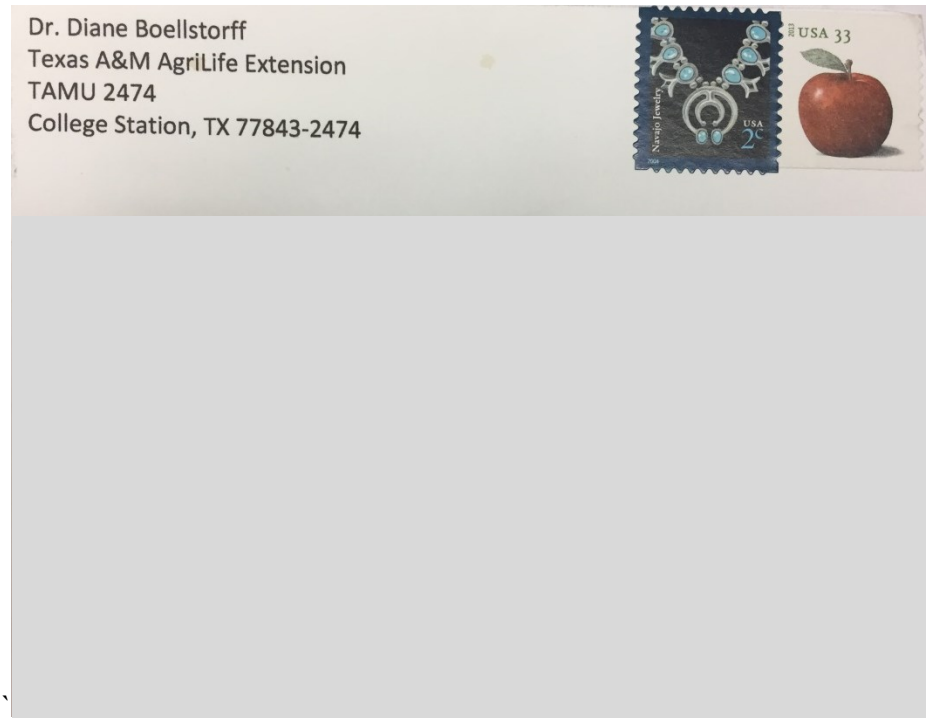
Whom do I contact with questions about the research?
If you have questions regarding this study, you may contact Dr. Scott R. Cummings at 979-847-9388 or s-cummings@tamu.edu.

Whom do I contact about my rights as a research participant?
This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979) 458-4067 or irb@tamu.edu.

APPENDIX B

REMINDER POST CARD

Reminder Post Card



Dear Texas Water Survey Recipient,

This postcard is a friendly reminder to complete and return the *Water Issues in Texas* survey that you received 10 days ago. Your response is very important as you are one of 1,800 Texans representing our state of 26 million people.

Would you please return the questionnaire in its accompanying stamped business envelope supplied with the survey? The questionnaire will take only about 12 minutes to complete and your response will be completely confidential.

If you have any questions, we would be happy to answer them. Our email addresses are dboellstorff@tamu.edu and s-cummings@tamu.edu. Thank you very much for your assistance.

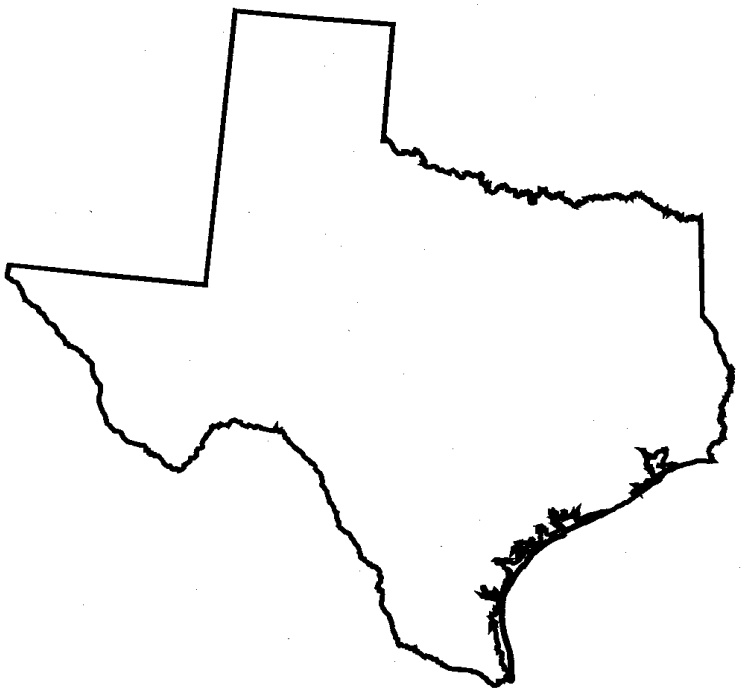
Diane Boellstorff and Scott Cummings, Texas A&M AgriLife Extension

APPENDIX C

2008 AND 2014 SURVEY INSTRUMENTS

Survey Instrument – 2008

WATER ISSUES IN TEXAS



A survey of public attitudes in Texas

Sponsored by:
Southern Region
Texas A&M University
Prairie View A&M University
University of Idaho

August 2008

HOW DO YOU FEEL ABOUT THE ENVIRONMENT?

How important are each of the following water issues to you? (Circle **one** answer per question)

	Issue	Not important	Somewhat important	No opinion	Important	Very important
1.	Clean rivers and lakes	N	S	O	I	V
2.	Clean marine water	N	S	O	I	V
3.	Clean bays and estuaries	N	S	O	I	V
4.	Clean water for shellfishing	N	S	O	I	V
5.	Clean beaches	N	S	O	I	V
6.	Clean drinking water	N	S	O	I	V
7.	Clean groundwater	N	S	O	I	V
8.	Water for commerce/ industry/power generation	N	S	O	I	V
9.	Water for household landscapes	N	S	O	I	V
10.	Water for agriculture	N	S	O	I	V
11.	Water for aquatic habitat	N	S	O	I	V
12.	Water for recreation	N	S	O	I	V
13.	Water for municipal use	N	S	O	I	V
14.	Interstate transfer/sale of water rights	N	S	O	I	V
15.	Within state transfer/sale of water rights	N	S	O	I	V
16.	Hypoxia (Gulf dead zone)	N	S	O	I	V

How important are the following actions in protecting our water resources? (Circle **one** answer per question)

	Issue	Not important	Somewhat important	No opinion	Important	Very important
17.	Treating stormwater runoff	N	S	O	I	V
18.	Improving wastewater treatment	N	S	O	I	V
19.	Residential water conservation	N	S	O	I	V
20.	Building new water storage structures (dams, reservoirs)	N	S	O	I	V
21.	Improving home and garden practices	N	S	O	I	V
22.	Preserving & restoring buffer zones & wetlands	N	S	O	I	V
23.	Improving agricultural practices	N	S	O	I	V
24.	Preserving agricultural land & open space	N	S	O	I	V
25.	Better management of recreational activities (boating, fishing, ATVs)	N	S	O	I	V
26.	Better management of shoreline access to prevent erosion	N	S	O	I	V
27.	Improving water quality monitoring to detect pollution	N	S	O	I	V
28.	Making water quality and quantity data available to public	N	S	O	I	V
29.	Educating municipal officials	N	S	O	I	V

DRINKING WATER ISSUES

30. Where do you primarily get your drinking water? (Circle **one** answer)

a. Private supply (private well, river, pond, lake)
b. Public supply – municipal
c. Public supply – rural water district
d. Purchase bottled water
e. I don't know

31. Please **check all** of the boxes that apply to your home drinking water system.

☐ I have a water treatment system (softener, etc.)
☐ I have a water filter
☐ I purchase 5 gallon containers of drinking water
☐ I often use bottled water for drinking purposes
☐ I never buy bottled water
☐ I am satisfied with my drinking water (piped in house)
☐ I am not satisfied with my current drinking water (piped in house)
☐ My drinking water is separate from my water supply system

32. Do you feel that your home tap drinking water is safe to drink?

a. Yes
b. No

33. Do you have your home drinking water tested?

a. Yes
b. No

PROTECTING AND PRESERVING WATER RESOURCES

34. In your opinion, what is the quality of groundwater (sources of well water) in your area?

a. Good or excellent
b. Good, and improving
c. Good, but deteriorating
d. Fair
e. Poor, but improving
f. Poor
g. No opinion / don't know

35. In your opinion, what is the quality of surface waters (rivers, streams, lakes, channels, and wetlands) where you live?
    a. Good or excellent
    b. Good, and improving
    c. Good, but deteriorating
    d. Fair
    e. Poor, but improving
    f. Poor
    g. No opinion / don't know

36. Do you regard water **quantity** (having enough water) as a problem in the area where you live? (Circle **one** answer)
    a. Definitely not
    b. Probably not
    c. I don't know
    d. Probably
    e. Definitely yes

37. Do you know of or suspect that any of the following pollutants affect either surface or groundwater quality in your area?

Pollutant	Know it is NOT a problem	Suspect it is NOT a problem	Don't know	Suspect it IS a problem	Know it IS a problem
a. Pathogens (bacteria, viruses, germs)	1	2	3	4	5
b. Fertilizer/Nitrates	1	2	3	4	5
c. Fertilizer/Phosphates	1	2	3	4	5
d. Heavy metals (lead, arsenic, mercury)	1	2	3	4	5
e. Minerals (iron, manganese, calcium)	1	2	3	4	5
f. Pesticides	1	2	3	4	5
g. Salinity (water too salty)	1	2	3	4	5
h. Pharmaceuticals (antibiotics, personal care products)	1	2	3	4	5
i. Petroleum products	1	2	3	4	5
j. Algae	1	2	3	4	5
k. Product and waste water from mining	1	2	3	4	5
l. Septic systems	1	2	3	4	5

38. In your opinion, what is the quality of ocean waters off the coast of the Southern states?

a. Good or excellent
b. Good, and improving
c. Good, but deteriorating
d. Fair
e. Poor, but improving
f. Poor
g. No opinion / don't know

39. In your opinion, which of the following are most responsible for the existing pollution problems in rivers and lakes in your state? (Ckeck up to **3** answers)

☐ Forestry (wood harvesting)
☐ Agriculture – crops
☐ Agriculture – animals
☐ Erosion from roads and/or construction, repair
☐ Industry
☐ Military bases
☐ Septic systems
☐ Runoff from home landscapes
☐ Stormwater runoff
☐ Landfills
☐ Wastewater treatment plants
☐ New suburban development
☐ Oil wells and mining

40. Do you know what a watershed is? (Check **one** box)

☐ Yes
☐ No

41. How well do you feel each one of these groups is fulfilling their responsibility for protecting water resources in your community? (Circle **one** answer per group)

Group	Very well	Moderately well	Don't know	Somewhat poorly	Very poorly
a. Federal government	1	2	3	4	5
b. State government	1	2	3	4	5
c. Your county, city, or town	1	2	3	4	5
d. Individual citizens	1	2	3	4	5

42. The likelihood of your area suffering from a prolonged drought is:

a. Increasing
b. Decreasing
c. Staying the same
d. No opinion

43. The likelihood of your area having enough water resources to meet all of its needs 10 years from now is:

a. High (likely enough water)
b. Medium
c. Low (likely not enough water)
d. No opinion

44. Have you or someone in your household done any of the following as part of an individual or community effort to conserve water or preserve water quality? (Check **all** that apply)

☐ Changed the way your yard is landscaped
☐ Changed how often you water your yard
☐ Changed your use of pesticides, fertilizers, or other chemicals
☐ Pumped your septic system (if you have one)
☐ Adopted new technologies (low flow faucets, etc.)

45. Have you received water resources information from the following sources? (Check **one** box per source)

	Yes	**No**
a. Cable television	☐	☐
b. Network television	☐	☐
c. Public television	☐	☐
d. Local newspapers	☐	☐
e. Major newspapers	☐	☐
f. Extension	☐	☐
g. Universities	☐	☐
h. Schools	☐	☐
i. Environmental agencies	☐	☐
j. Environmental groups	☐	☐
k. Magazines	☐	☐
l. Radio	☐	☐
m. Friends and family	☐	☐

46. Please place an X on the line below to indicate how you see yourself on environmental issues:

FOR TOTAL NATURAL RESOURCE USE	EQUAL BALANCE BETWEEN USE AND PROTECTION	FOR TOTAL ENVIRONMENTAL PROTECTION

47. Have you participated in any of the following activities? (Circle **all** that apply)

a. Master Gardener program
b. Volunteer water quality monitoring
c. Lake, river, bay, wetland, or watershed protection groups
d. County, municipal, township or tribal commission meetings

48. Would you like to learn more about any of the following water quality issue areas? (Check **all** that interest you)

☐ Watershed management
☐ Watershed restoration
☐ Forest management and water issues
☐ Irrigation management
☐ Animal waste management
☐ Nutrient and pesticide management
☐ Private well protection
☐ Septic system management
☐ Protecting public drinking water supplies
☐ Water policy and economics
☐ Community actions concerning water issues
☐ Fish and wildlife water needs
☐ Home and garden landscaping
☐ Restoring fish and aquatic habitat
☐ Landscape buffers
☐ Shoreline clean-up

49. If you had the following kinds of learning opportunities to learn more about water issues, which would you be most likely to take advantage of? (Check up to **3** items)

- ☐ Read printed fact sheets, bulletins, or brochures
- ☐ Visit a web site
- ☐ Attend a short course or workshop
- ☐ Look at a demonstration or display
- ☐ Read a newspaper article or series
- ☐ Watch TV coverage
- ☐ Watch a video of information
- ☐ Take part in a onetime volunteer activity (for example, water monitoring, streamside restoration, or education)
- ☐ Take a course for certification or credit
- ☐ Get trained for a regular volunteer position (for example, as a watershed steward or a water quality monitor)
- ☐ Learn how to conduct a home, farm, or workplace water practices assessment
- ☐ Attend a fair or festival

50. Have you ever changed your mind about an environmental issue as a result of: (Check **all** that apply)

- ☐ News coverage (TV, newspapers, Internet, etc.)
- ☐ Conversations with other people
- ☐ Attending public meetings or participating in volunteer activities
- ☐ Classes or presentations
- ☐ Speech by an elected official
- ☐ Firsthand observation (field trips, etc.)
- ☐ Financial considerations

51. Do you think that the amount of rainfall in your area will change as a result of global warming?

a. Yes, a significant increase in rainfall
b. Yes, a slight increase in rainfall
c. No, no change in rainfall
d. Yes, a slight decrease in rainfall
e. Yes, a significant decrease in rainfall
f. I don't know

PLEASE ANSWER THE FOLLOWING AS THEY PERTAIN TO YOU

52. Where do you live?
   a. Inside city limits
   b. Outside city limits, not engaged in farming
   c. Outside city limits, currently engaged in farming

53. The population of the city/town in which you live is:
   a. More than 100,000 people
   b. 25,000 to 100,000 people
   c. 7,000 to 25,000 people
   d. 3,500 to 7,000 people
   e. Less than 3,500 people

54. What is your zip code?

   ZIP CODE _____

55. How long have you lived in Texas?
   a. All my life
   b. More than 10 years, but not all my life
   c. 5 to 9 years
   d. Less than 5 years

56. What is your gender?
   a. Male
   b. Female

57. What is your age?

   _____ years old

58. What is the highest level of education you have completed?
   a. Less than high school or some high school
   b. High school graduate
   c. Some college or vocational training
   d. College graduate
   e. Advanced college or other professional degree

59. Where do you normally get your news? (Check **all** that apply)

- ☐ Local newspapers
- ☐ Major newspapers
- ☐ Radio
- ☐ Internet
- ☐ Local television
- ☐ National television
- ☐ Cable television
- ☐ Public television
- ☐ Magazines or newsletters

THANK YOU FOR YOUR HELP

Survey Instrument – 2014

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ⊘ ⊘ ⊘
Either pencil or pen may be used

Water Issues in Texas

Your views on the quality and effectiveness of Extension programs are extremely important. Please take a few minutes to tell us about your experience with this activity. Your answers to the following questions will help us better meet your needs. Either pencil or pen may be used to complete the survey. Please do not write your name on this form so that your responses are anonymous. Thank you!

HOW DO YOU FEEL ABOUT THE ENVIRONMENT?

How important are each of the following water issues to you? (Mark one answer per question)

Issue	Not Important	Somewhat Important	No Opinion	Important	Very Important
1. Clean rivers and lakes	O	O	O	O	O
2. Clean marine water	O	O	O	O	O
3. Clean bays and estuaries	O	O	O	O	O
4. Clean water for shell fishing	O	O	O	O	O
5. Clean beaches	O	O	O	O	O
6. Clean drinking water	O	O	O	O	O
7. Clean groundwater	O	O	O	O	O
8. Water for commerce/ industry/power	O	O	O	O	O
9. Water for household landscapes	O	O	O	O	O
10. Water for agriculture	O	O	O	O	O
11. Water for aquatic habitat	O	O	O	O	O
12. Water for recreation	O	O	O	O	O
13. Water for municipal use	O	O	O	O	O
14. Interstate transfer/sale of water rights	O	O	O	O	O
15. Within state transfer/sale of water rights	O	O	O	O	O
16. Hypoxia (Gulf dead zone)	O	O	O	O	O

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Please continue on the other side

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ⊘ ⊘ ⊘
Either pencil or pen may be used

How important are the following actions in protecting our water resources? (Mark one answer per question)

Issue	Not Important	Somewhat Important	No Opinion	Important	Very Important
17. Treating storm water runoff	O	O	O	O	O
18. Improving wastewater treatment	O	O	O	O	O
19. Residential water conservation	O	O	O	O	O
20. Building new water storage structures (dams, reservoirs)	O	O	O	O	O
21. Improving home and garden practices	O	O	O	O	O
22. Preserving & restoring buffer zones & wetlands	O	O	O	O	O
23. Improving agricultural practices	O	O	O	O	O
24. Preserving agricultural land & open space	O	O	O	O	O
25. Better management of recreational activities (boating, fishing, ATVs)	O	O	O	O	O
26. Better management of shoreline access to prevent erosion	O	O	O	O	O
27. Improving water quality monitoring to detect pollution	O	O	O	O	O
28. Making water quality and quantity data available to public	O	O	O	O	O
29. Educating municipal officials	O	O	O	O	O

DRINKING WATER ISSUES

30. Where do you primarily get your drinking water? (Mark only one answer)

- O Private supply (private well, river, pond, lake)
- O Public supply - municipal
- O Public supply - rural water district
- O Purchase bottled water
- O I don't know

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Please continue on the other side

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ⊘ ⊘ ⊘
Either pencil or pen may be used

31. Please check all of the boxes that apply to your home drinking water system.

- ○ I have a water treatment system (softener, etc.)
- ○ I have a water filter
- ○ I purchase 5 gallon containers of drinking water
- ○ I often use bottled water for drinking purposes
- ○ I never buy bottled water
- ○ I am satisfied with my drinking water (piped in house)
- ○ My drinking water is separate from my water supply system

32. Do you feel that your home tap drinking water is safe to drink?

○ Yes ○ No

33. Do you have your home drinking water tested?

○ Yes ○ No

PROTECTING AND PRESERVING WATER RESOURCES

34. In your opinion, what is the quality of groundwater (sources of well water) in your area?

- ○ Good or excellent
- ○ Good, and improving
- ○ Good, but deteriorating
- ○ Fair
- ○ Poor, but improving
- ○ Poor
- ○ No opinion / don't know

35. In your opinion, what is the quality of surface waters (rivers, streams, lakes, channels, and wetlands) where you live?

- ○ Good or excellent
- ○ Good, and improving
- ○ Good, but deteriorating
- ○ Fair
- ○ Poor, but improving
- ○ Poor
- ○ No opinion / don't know

36. Do you regard water quantity (having enough water) as a problem in the area where you live? (Mark one answer)

○ Definitely not ○ Probably not ○ I don't know ○ Probably ○ Definitely yes

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Please continue on the other side

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ⊘ ⊘ ⊘
Either pencil or pen may be used

37. Do you know of or suspect that any of the following pollutants affect either surface or groundwater quality in your area?

Pollutant	Know it is NOT a problem	Suspect it is NOT a problem	Don't know	Suspect it IS a problem	Know it IS a problem
a. Pathogens (bacteria. viruses, germs)	O	O	O	O	O
b. Fertilizer/Nitrates	O	O	O	O	O
c. Fertilizer/Phosphates	O	O	O	O	O
d. Heavy metals (lead, arsenic, mercury)	O	O	O	O	O
e. Minerals (iron. manganese, calcium)	O	O	O	O	O
f. Pesticides	O	O	O	O	O
g. Salinity (water too salty)	O	O	O	O	O
h. Pharmaceuticals (antibiotics, personal care products)	O	O	O	O	O
i. Petroleum products	O	O	O	O	O
j. Algae	O	O	O	O	O
k. Product and waste water from mining	O	O	O	O	O
l. Septic systems	O	O	O	O	O

38. In your opinion, what is the quality of ocean waters off the coast of the Southern states?

- O Good or excellent
- O Good, and improving
- O Good, but deteriorating
- O Fair
- O Poor, but improving
- O Poor
- O No opinion / don't know

39. In your opinion, which of the following are most responsible for the existing pollution problems in rivers and lakes in your state? (Mark up to 3 answers)

- O Forestry (wood harvesting)
- O Agriculture - crops
- O Agriculture - animals
- O Erosion from roads and/or construction, repair
- O Industry
- O Military bases
- O Septic systems
- O Runoff from home landscapes
- O Storm water runoff
- O Landfills
- O Wastewater treatment plants
- O New suburban development
- O Oil wells and mining

40. Do you know what a watershed is? (Check one box)

O Yes O No

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Please continue on the other side

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ✓ ◒ ◔
Either pencil or pen may be used

41. How well do you feel each one of these groups is fulfilling their responsibility for protecting water resources in your community? (Mark one answer per group)

Group	Very well	Moderately well	Don't know	Somewhat poorly	Very Poorly
a. Federal government	O	O	O	O	O
b. State government	O	O	O	O	O
c. River Authority	O	O	O	O	O
d. Groundwater Conservation District	O	O	O	O	O
e. Your county, city, or town	O	O	O	O	O
f. Individual citizens	O	O	O	O	O

42. The likelihood of your area suffering from a prolonged drought is:

O Increasing O Decreasing O Staying the same O No opinion

43. The likelihood of your area having enough water resources to meet all of its needs 10 years from now is:

O High (likely enough water) O Medium O Low (likely not enough water) O No opinion

44. Have you or someone in your household done any of the following as part of an individual or community effort to conserve water or preserve water quality? (Mark all that apply)

O Changed the way your yard is landscaped

O Changed how often you water your yard

O Changed your use of pesticides, fertilizers, or other chemicals

O Pumped your septic system (if you have one)

O Adopted new technologies (low flow showerheads, high-efficiency washing machines and dishwashers, etc.)

45. Have you received water resources information from the following sources? (Mark one box per source)

Source	Yes	No	Source	Yes	No
a. Television	O	O	g. Environmental groups	O	O
b. Newspapers and magazines	O	O	h. Radio	O	O
c. Extension	O	O	i. City/Municipal water district	O	O
d. Universities	O	O	j. River Authority	O	O
e. Schools	O	O	k. Groundwater Conservation District	O	O
f. Environmental agencies	O	O			

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Please continue on the other side

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ⊘ ⊘ ⊘
Either pencil or pen may be used

46. Please mark the number on the line below to indicate how you see yourself on environmental issues:

Average American Adult

1	2	3	4	5	6	7	8	9	10
FOR TOTAL NATURAL RESOURCE USE				*EQUAL BALANCE BETWEEN USE AND PROTECTION*					*FOR TOTAL ENVIRONMENTAL PROTECTION*

47. Have you participated in any of the following activities? (Mark all that apply)

- Master Gardener Program
- Volunteer water quality monitoring
- Lake, river, bay, wetland, or watershed protection groups
- County, municipal, water district, or township meetings
- Extension educational programs involving water

48. Would you like to learn more about any of the following water quality issue areas? (Mark all that interest you)

- Watershed management
- Stream restoration
- Forest management and water issues
- Irrigation management
- Animal waste management
- Nutrient and pesticide management
- Private well protection
- Septic system management
- Protecting public drinking water supplies
- Water policy and economics
- Community actions concerning water issues
- Fish and wildlife water needs
- Home and garden landscaping
- Restoring fish and aquatic habitat
- Landscape buffers
- Shoreline clean-up

49. If you had the following kinds of leaning opportunities to learn more about water issues, which would you be most likely to take advantage of? (Mark up to 3 items)

- Read printed fact sheets, bulletins, or brochures
- Visit a web site
- Attend a short course or workshop
- Look at a demonstration or display
- Read a newspaper article or series
- Watch TV coverage
- Watch a video of information (YouTube or longer videos)
- Take part in a onetime volunteer activity (for example, water monitoring, stream side restoration, or education)
- Take a course for certification or credit
- Get trained for a regular volunteer position (for example, as a watershed steward or a water quality monitor)
- Learn how to conduct a home, farm, or workplace water practices assessment
- Attend a fair or festival
- Download an app

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Please continue on the other side

TEXAS A&M AGRILIFE EXTENSION

MARKING INSTRUCTIONS
CORRECT: ■ INCORRECT: ⊘ ✓ ◒ ◔
Either pencil or pen may be used

50. Have you ever changed your mind about an environmental issue as a result of: (Mark all that apply)

- O News coverage (TV, newspapers, Internet, etc.)
- O Conversations with other people
- O Attending public meetings or participating in volunteer activities
- O Classes or presentations
- O Speech by an elected official
- O Firsthand observation (field trips, etc.)
- O Financial considerations

51. Do you think that the amount of rainfall in your area will change as a result of global warming?

- O Yes, a significant increase in rainfall
- O Yes, a slight increase in rainfall
- O No, no change in rainfall
- O Yes, a slight decrease in rainfall
- O Yes, a significant decrease in rainfall
- O I don't know

PLEASE ANSWER THE FOLLOWING AS THEY PERTAIN TO YOU

52. Where do you live?

- O Inside city limits
- O Outside city limits, not engaged in farming
- O Outside city limits, currently engaged in farming

53. The population of the city/town in which you live is:

- O More than 100,000 people
- O 25,000 to 100,000 people
- O 7,000 to 25,000 people
- O 3,500 to 7,000 people
- O Less than 3,500 people

54. What is your zip code? ☐☐☐☐☐

55. How long have you lived in Texas?

- O All my life
- O More than 10 years, but not all my life
- O 5 to 9 years
- O Less than 5 years

56. What is your gender?

- O Male
- O Female

57. What is your age?

☐☐ years old

58. What is the highest level of education you have completed?

- O Less than high school or some high school
- O High school graduate
- O Some college or vocational training
- O College graduate
- O Advanced college or other professional degree

59. Where do you normally get your news? (Mark all that apply)

- O Newspapers
- O Internet
- O Magazines or newsletters
- O Radio
- O Television

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Thank You For Your Help!

You comments will be appreciated, either here or in a separate envelope.

Please return your completed questionnaire in the enclosed envelope to:

Scott R. Cummings, Dr.P.H.
Associate Head for Extension and Program Leader|Organizational Development
Associate Professor and Extension Specialist|Department of Agricultural
Leadership, Education, and Communications
Texas A&M AgriLife Extension Service
128C AGLS
2116 TAMU| College Station, TX 77843-3187

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APPENDIX D

IRB APPROVAL LETTER

DIVISION OF RESEARCH
Research Compliance and Biosafety

TEXAS A&M UNIVERSITY

DATE: February 25, 2014

MEMORANDUM

TO: Scott Cummings
ALRSRCH - Agrilife Research - Ag Leadership, Education & Communication

FROM: Human Subjects Protection Program
Institutional Review Board

SUBJECT: Initial Review Submission Form Approval

Study Number: IRB2014-0070

Title: Texas Water Perceptions and Attitudes Survey

Review Type: Expedite

Approval Date: 02/25/2014

Continuing Review Due: 01/15/2015

Expiration Date: 02/15/2015

Documents Reviewed and Approved: Water Study Information Sheet (English) (Version 1.0);
Draft Water Survey (Version 1.0)

Document of Consent: Waiver approved under 45 CFR 46.117 (c) 1 or 2/ 21 CFR 56.109 (c)1

This research project has been approved. As principal investigator, you assume the following responsibilities:

1. **Continuing Review:** The protocol must be renewed by the expiration date in order to continue with the research project. A Continuing Review application along with required documents must be submitted by the continuing review deadline. Failure to do so may result in processing delays, study termination, and/or loss of funding.
2. **Completion Report:** Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB.
3. **Unanticipated Problems and Adverse Events:** Unanticipated problems and adverse events must be reported to the IRB immediately.
4. **Reports of Potential Non-compliance:** Potential non-compliance, including deviations from protocol and violations, must be reported to the IRB office immediately.
5. **Amendments:** Changes to the protocol must be requested by submitting an Amendment to the IRB for review. The Amendment must be approved by the IRB before being implemented.
6. **Consent Forms:** When using a consent form or information sheet, you must use the IRB stamped approved version. Please log into iRIS to download your stamped approved version of the consenting instruments. If you are unable to locate the stamped version in iRIS, please contact the office.
7. **Audit:** Your protocol may be subject to audit by the Human Subjects Post Approval Monitor. During the life of the study please review and document study progress using the PI self-assessment found on the RCB website as a method of preparation for the potential audit. Investigators are responsible for

750 Agronomy Road, Suite 2701
1186 TAMU
College Station, TX 77843-1186
Tel. 979.458.1467 Fax. 979.862.3176
http://rcb.tamu.edu

maintaining complete and accurate study records and making them available for inspection. Investigators are encouraged to request a pre-initiation site visit with the Post Approval Monitor. These visits are designed to help ensure that all necessary documents are approved and in order prior to initiating the study and to help investigators maintain compliance.

8. **Recruitment:** All approved recruitment materials will be stamped electronically by the HSPP staff and available for download from iRIS. These IRB-stamped approved documents from iRIS must be used for recruitment. For materials that are distributed to potential participants electronically and for which you can only feasibly use the approved text rather than the stamped document, the study's IRB Protocol number, approval date, and expiration dates must be included in the following format: TAMU IRB#20XX-XXXX Approved: XX/XX/XXXX Expiration Date: XX/XX/XXXX.
1. **FERPA and PPRA:** Investigators conducting research with students must have appropriate approvals from the FERPA administrator at the institution where the research will be conducted in accordance with the Family Education Rights and Privacy Act (FERPA). The Protection of Pupil Rights Amendment (PPRA) protects the rights of parents in students ensuring that written parental consent is required for participation in surveys, analysis, or evaluation that ask questions falling into categories of protected information.
2. **Food:** Any use of food in the conduct of human subjects research must follow Texas A&M University Standard Administrative Procedure 24.01.01.M4.02.
3. **Payments:** Any use of payments to human subjects must follow Texas A&M University Standard Administrative Procedure 21.01.99.M0.03.

This electronic document provides notification of the review results by the Institutional Review Board.