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Determining What Factors Affect Peoples’ Perceptions of the Use of Reclaimed Water as a Source for Potable Water: A Study within Hillsborough County, Florida

Susana Rebecca Alvarado Tricoche
University of South Florida, salvarad@mail.usf.edu

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Determining What Factors Affect Peoples’ Perceptions of the Use of Reclaimed Water as a Source for Potable Water: A Study within Hillsborough County, Florida

by

Susana R. Alvarado Tricoche

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science School of Geosciences College of Arts and Sciences University of South Florida

Major Professor: Fenda Akiwumi, Ph.D. Joni Downs, Ph.D. E. Christian Wells, Ph.D.

Date of Approval: July 7th, 2014

Keywords: Recycled Water, Wastewater, Risk, Awareness, Trust, Behavior

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DEDICATION

I want to dedicate this thesis to a few individuals whose support has meant the world to me. They have strengthened me and given me the push I needed to complete this degree. To my father, mother and siblings, Jose, Ruth, and Daniel, thank you for believing in me in the hardest of times. Your love and support through my first four years of undergraduate studies allowed me to become a confident young woman and scholar, worthy enough to pursue a higher degree to fulfill my dreams to become an environmental professional. I want to thank my uncle Obed and my aunt Lucy. Their words of encouragement allowed me to continue on to make my entire family proud.

I also want to thank my roommates, Anastasia, Joanna, Raegan and Sarah. Even when I thought I would not make it through one more arduous task, you were always there to encourage me. Your words of support as well as the way you live your lives gave me the strength I needed every day to move forward. And finally, to my spiritual counselor, Erin Saucedo, thank you for the many times you counseled me as I pursued this degree. I am forever grateful.
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To Dr. Joni Downs, thank you for the technical and Geographic Information System’s (GIS) expertise you brought to my research as a committee member. Without your constructive comments and questions, I wouldn’t have questioned my own ideas in developing a sound quantitative methodology for my research. To Dr. Wells, thank you for your feedback as the final committee member to join me. I valued your support and expertise during my undergraduate honors research project. I couldn't have imagined starting my master’s thesis research without your social and anthropological input that served me so well. I also want to thank the staff at Tampa Bay Water for adding to the qualitative portion of my study. I want to thank all of the Homeowner Association leaders and residents who participated in the data collection phase of this research. Your participation was key in making this research extremely successful. Finally, I’d like to thank Ayesha Johnson, a statistician, great friend, and colleague who took her time to review my methods and analysis and gave me invaluable feedback on points to consider so that I could bring clarity to my study.
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ABSTRACT

In response to water supply depletion challenges, countries such as Australia, the United States, and Namibia have implemented technologies that treat wastewater up to the standards permissible to use for irrigation, toilet flushing, and even drinking water. However, many of these countries have been unable to successfully implement some of their ambitious reclaimed water reuse projects due to negative public perceptions of recycling wastewater. The focus of this study was to understand which factors in risk perception theory are the most influential in shaping community perceptions of reclaimed water reuse as a future source of drinking water within Hillsborough County. The research design was comprised of a mixed methodology approach (quantitative and qualitative analyses). The methods for assessing how each of the five main factors played a role in shaping risk perception in each of the communities was comprised of three main analyses, including spatial, statistical (through multiple regression modelling in R), and personal interview data (an HOA leader, one key informant, and a focus group). Residents (n=417) from various neighborhoods were interviewed through surveys which will evaluate factors found in literature that have been shown to have the most effect in shaping risk perception theory.
CHAPTER ONE:  
INTRODUCTION

“Water is …like a diamond, people should pay a higher price for a precious commodity. You can only live three days without water.” – HOA Key Informant Interview

As population continues to grow, water resource managers are faced with the challenge of addressing issues of water supply depletion. Competition for water is increasing and the effects of withdrawing more ground water at a higher rate than rainfall can replenish are evident in water quality decline due to saltwater intrusion, diminished spring flow, dried-out marshes and disappearing lakes. Alternative sources can and are being developed, but at higher cost than traditional sources (Purdum et al., 2002). Without improved water resources management, predictions have shown that water shortages will affect two-thirds of humanity by 2025 (Kemp, Randle, Hurlimann, & Dolnicar, 2012). Wastewater as a source for drinking water is one of the many conservation tools that is available to water resource managers and has been used for many decades. Furthermore, water reclamation and reuse provides a unique and viable opportunity to augment traditional water supplies (Asano, 2002).

Over the last 20 years, the amount of municipal wastewater recovered for reuse has increased throughout the world (Levine & Asano, 2004). This increase in the reuse of wastewater has been triggered due to the worldwide water scarcity trend. A study conducted by Reith and Birkenhead (1998) found that the reuse of wastewater is necessary due to the stress on most of our natural resources from contamination, seawater intrusion and changes in the earth's climate.
The authors noted that the better question is when, and not if the direct use of wastewater as a source of potable water production becomes a reality (Reith & Birkenhead, 1998, pg. 209). Studies such as Sebastian (1974) have highlighted major plants around the world that have implemented technologies to recycle wastewater. In the United States, for example, only 2.3% of wastewater is currently reclaimed (Arrandale, 2002, pg. 54). However, the United States’ Environmental Protection Agency (EPA) has recognized the importance of using reclaimed water as far back as the 1980s, as there is an increase in potable water supply demands combined with climate change (EPA, 2004). The EPA drafted a water reuse document in 1980 titled “Guidelines for Water Reuse,” which was later updated in 1992 and in 2004, to address policies and procedures for implementation of water reuse programs. In the most current update, the U.S. EPA recognized the importance of updating their guidelines to accommodate changes in technologies being implemented to treat wastewater, making it viable for indirect potable water source uses and even direct potable water uses (EPA, 2004). As a result, many cities have started implementing some of these conservation management techniques.

Cities such as El Paso, San Antonio, and Austin in the state of Texas, have expanded reclaimed water systems to meet some of their potable water needs (Arrandale, 2002). In the city of Los Angeles, California, the Irvine Ranch Water District has supplied treated wastewater for many uses including toilet flushing and air conditioning in office complexes (Arrandale, 2002). Another example of reclaimed water reuse can be found in northern Virginia's regional wastewater agency's wastewater reclamation plant. In order to eliminate discharges into nearby bodies of water from several wastewater plants, the reclaimed water plant routes 32 million gallons a day from nearby sewage plants into the Occoquan Reservoir, which supplies water to about one million residents (Arrandale, 2002).
A major consideration with reclaimed water use is the concern over wastewater quality and the health risks posed by its reuse (EPA, 2004). Although technologies have been explored, such as reverse osmosis, to treat the wastewater up to the permissible standards for potable water uses, the concern continues to resurface as a major factor in reclaimed water risk perception (Alcalde Sanz, 2012; McVicar et al., 2012). Although it is sometimes difficult to find the link between environmental contaminants and human disease due the inability to track specific sources of toxic or hazardous pollutants to their source, these concerns continue to grow and are exacerbated by the public’s growing awareness of these contaminants (Cutter, 1993; pg. 39). Furthermore, public perceptions of the human health risks associated will increase as wastewater quality continues to deteriorate (Canter, Nelson, & Everett, 1993). Crook et al. (1998), in assessing the viability of augmenting drinking water supplies with reclaimed water, concluded that concerns can be mitigated by properly treating the water and communicating with the public about the treatment technologies being used. Many studies have evaluated the perception of individuals after they have been presented with reports from professionals in the water resources and water quality field, as well as health officials, to determine how they would perceive their water quality based on water quality reports. The study found that communication did, in fact, change risk perceptions towards a more positive view (Hu, Morton, & Mahler, 2011; Johnson, 2002, 2003). In spite of such existing water reclamation projects, there remain negative perceptions of wastewater use in the minds of the general public that can influence water policy. In California, for example, the city of San Diego abandoned a plan to pipe treated wastewater into a city reservoir due to negative responses from the public (Arrandale, 2002).

Peoples' perceptions of reclaimed water quality have also been shaped over time by factors such as local environmental water quality issues, media, education, and public trust of
local utilities (Carr, Potter, & Nortcliff, 2011; Doria, Pidgeon, & Hunter, 2009; Hartley, 2006; McSpirit & Reid, 2011; Vedachalami & Mancl, 2010; EPA, 2004). Reclaimed water quality risk perceptions among residents in a community are formed by socially constructed risks that are often exacerbated by local issues with water quality, treatment, local government, and utility politics (Masuda & Garvin, 2006). Therefore, public acceptance and perceived risks of reclaimed water use in communities is best formed by the local government’s ability to implement reclaimed water as a viable potable water source in various regions. This need to increase acceptance of wastewater reuse is pertinent to the state of Florida that is currently suffering from water depletion because of environmental issues such as climate change and population growth. Therefore, it is imperative that water management districts in the state of Florida assess the potential risk for water scarcity and drought. Having an understanding of these risks will allow the state to be prepared and have a plan in place to supply communities with clean water.

1.1. Reclaimed Water Use in Florida

Florida has become a leader among states in the reuse of water as an alternative water source to supplement their various sources (Purdum et al., 2002; SWFWMD, 2012). Reclaimed water use programs began in the mid-1960s when the state mostly reused water for agricultural purposes in the city of Tallahassee (Toor & Rainey, 2009; FDEP, 2010). Following the establishment of this program in the state's capital, a statewide development of reclaimed water systems was introduced in several cities. The city of St. Petersburg participated in water reclamation projects in the late 1970s with the introduction of dual water distribution systems and landscape irrigation. Orlando, and other surrounding cities, developed the Water Conserv II project in the mid-1980s. Water utilities in the city of Altamonte Springs and the Loxahatchee
River Environmental Control District began new reclaimed water projects in the 1980s as a result of the development of reclaimed water systems in other cities in Florida (Toor & Rainey, 2009). By 2008, reuse within Florida included 483 systems that reclaimed 667 million gallons of water per day, or about 42% of the state’s total domestic wastewater flow, recycling more water than any other state in the U.S. (FDEP, 2010, pg. 1). Table 1 displays the major steps in the history of reclaimed water system development in the state of Florida.

<table>
<thead>
<tr>
<th>Year</th>
<th>City/Region</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>Tallahassee</td>
<td>Spray irrigation; Crops</td>
</tr>
<tr>
<td>1973</td>
<td>Fiesta Village</td>
<td>Irrigation; Golf courses</td>
</tr>
<tr>
<td>1976</td>
<td>Vero Beach</td>
<td>Industrial; Power plant cooling</td>
</tr>
<tr>
<td>1977</td>
<td>St. Petersburg</td>
<td>Dual water distribution begins; Landscape irrigation</td>
</tr>
<tr>
<td>1977</td>
<td>Gainesville</td>
<td>Groundwater recharge; wastewater injected into Floridan Aquifer</td>
</tr>
<tr>
<td>1978</td>
<td>Loxahatchee River Environmental Control District</td>
<td>Reuse program begins</td>
</tr>
<tr>
<td>1980</td>
<td>Tallahassee</td>
<td>Open Southeast farm</td>
</tr>
<tr>
<td>1986</td>
<td>Orlando/Orange County</td>
<td>Water Conserv II starts; Irrigation of citrus groves and groundwater recharge thru rapid infiltration basins</td>
</tr>
<tr>
<td>1987</td>
<td>Orlando</td>
<td>Wetlands begins; 1640 acres in public park and nature preserve</td>
</tr>
<tr>
<td>1991</td>
<td>Altamonte Springs</td>
<td>Project APRICOT begins; landscape irrigation</td>
</tr>
<tr>
<td>1992</td>
<td>Cape Coral</td>
<td>World’s largest residential irrigation program</td>
</tr>
<tr>
<td>1998</td>
<td>West Palm Beach</td>
<td>Permit issued for indirect potable water reuse</td>
</tr>
<tr>
<td>2001</td>
<td>Hillsborough County NW</td>
<td>Testing of reclaimed water Aquifer Storage and Recovery (ASR) wells.</td>
</tr>
</tbody>
</table>

According to the Florida Department of Environmental Protection (FDEP), 63 out of 67 of the state's counties reclaim wastewater from wastewater treatment plants. Counties in Central Florida (Orlando-Lakeland area), the Tampa Bay area, Southwestern Florida, and a few counties on the Atlantic coast (Palm Beach, Volusia, Brevard) have the largest operations. However, water reuse is limited to landscape irrigation and public access areas which comprises the largest percentage of the current use at 59%, and other general uses such as industrial uses at 14%,

5
agricultural irrigation at 12%, groundwater recharge at 11%, and wetland and riverine recharge at 4% (Toor & Rainey, 2009).

As in other states, however, there has also been some resistance to reclaimed water use in Florida homes. Several local news stories have reported that the "yuck" factor is what affects people's ability to overcome the fear of reusing wastewater as an alternate source of drinking water for the region (See Table 2). The “yuck” factor is simply the negative feelings associated with the use of reclaimed water as a potable water source due to its primary source, recycled wastewater.

<table>
<thead>
<tr>
<th>Title of Article</th>
<th>Published Date</th>
<th>Geographical Location</th>
<th>Brief Article Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reclaimed Riddle</td>
<td>September 25, 2009</td>
<td>Tampa, Florida</td>
<td>It was the “yuck” factor of reclaimed water that got Karyna Rosario thinking to study microbes in reclaimed water and their effect on water quality.</td>
<td><a href="http://news.usf.edu/article/templates/default.aspx?a=1726&amp;template=print-article.htm">http://news.usf.edu/article/templates/default.aspx?a=1726&amp;template=print-article.htm</a></td>
</tr>
<tr>
<td>Tampa Ponders Sweet Sip of (Treated) Sewage</td>
<td>October 21, 2010</td>
<td>Tampa Bay, Florida</td>
<td>Tampa must overcome the “yuck” factor in order to use reclaimed water as an indirect source of potable water; the Florida Potable Reuse Committee is studying these issues.</td>
<td><a href="http://www.angieslist.com/articles/tampa-ponders-sweet-sip-treated-sewage.htm">http://www.angieslist.com/articles/tampa-ponders-sweet-sip-treated-sewage.htm</a></td>
</tr>
<tr>
<td>Getting Past the ’Toilet to Tap’ Concerns</td>
<td>June 21, 2013</td>
<td>Brownwood, Texas</td>
<td>Some residents are having a hard time getting past the “toilet to tap” idea the proposed system would provide, but Harris stated treated water would be cleaner than the water received from the Brownwood lake passing all state and federal standards.</td>
<td><a href="http://www.brownwoodtx.com/news/community/article_88a54d1f2-da44-11e2-a38f-0019b62963f4.html">http://www.brownwoodtx.com/news/community/article_88a54d1f2-da44-11e2-a38f-0019b62963f4.html</a></td>
</tr>
<tr>
<td>Wichita Falls Water Reuse Project Plans Released in Video</td>
<td>June 24, 2013</td>
<td>Wichita Falls, Texas</td>
<td>With plans to begin using reclaimed waste water next year (2014), the city of Wichita Falls is trying to smooth the transition now by answering questions and concerns residents may have.</td>
<td><a href="http://texomashomepage.com/fulltext?nxd_id=286652">http://texomashomepage.com/fulltext?nxd_id=286652</a></td>
</tr>
</tbody>
</table>

1.2. The Study Area – Hillsborough County, Florida

Hillsborough County, Florida, one of three counties in the Tampa Bay region shown in Figure 1, provides a useful case study to investigate public perception of reclaimed water use. The county’s waters, including four broad responsibilities of maintaining water supply, quality,
flooding, and natural system management, is managed by an unique entity, the Southwest Florida Water Management District (SWFWMD). The SWFWMD was established through the 1972 Water Resources Act. The boundaries of this water management district are based on hydrologic boundaries and funded by a tax from the local government. The district is overseen at the state level by the Department of Environmental Protection and is governed by a board appointed by the Governor and approved by the Senate. Although the water management districts are funded by a tax granted to them by the people of Florida in 1976, their budget is closely monitored by the Governor’s Office and by the Legislature (Purdum et al., 2002). On a local level, Tampa Bay Water is Florida’s largest wholesale water provider and supplies potable water to over 2.4 million residents in the Hillsborough-Pasco-Pinellas tri-county area (Tampa Bay Water, 2012). The agency provides water to six Member Government utilities, including the three counties mentioned above and the cities of Tampa, St. Petersburg, and New Port Richey (Tampa Bay Water, 2012).

Water supply in Hillsborough mainly comes from surface water, groundwater, and desalinated sea water. Surface water is a significant component of public supply for the county supplying approximately 33% of the current potable water needs (Purdum et al., 2002). The largest surface water sources come from the Hillsborough River and the Tampa Bypass Canal (Tampa Bay Water, 2014; Purdum et al., 2002). Ground water use is also a major source of potable water for the county at 60% of the overall need (Tampa Bay Water, 2014). However, there are major challenges associated with relying on these sources because of the growing population. Hillsborough County, according to the U.S. Census, covers a land area of 1,020.21 square miles. The county has a population of approximately 1,277,746 as of 2012 (http://quickfacts.census.gov/qfd/states). The county also ranks as the fourth most populated in
the state; it is also projected that Florida’s population will grow to about 21 million in 2020 (Reuse Coordinating Committee and the Water Conservation Initiative Water Reuse Work Group., 2003). With water demands increasing, sinkholes may form as a result of overpumping groundwater. Under natural conditions, sinkholes form slowly and expand by the gradual erosion of subsurface limestone caused by rainwater. Diverting surface water, however, and pumping large amounts of groundwater may result in the abrupt formation sinkholes (Purdum et al., 2002, pg. 56). As a results of these challenges, new sources of water have been explored in the county, specifically reclaimed water.

In 2003, for example, the City of Tampa completed the construction of the South Tampa Area Reclaimed (STAR) project, a $28 million system to extend pipelines carrying treated effluent to residences and businesses. Phase one of the project began in June 2002, with funding assistance from the U.S. EPA and the SWFWMD. The project was met with extensive support from the community, with more than 4,000 customers signing up to participate. The support for the project increased particularly in 2007, with a demand increase from 0.8 MGD (million gallons per day) to 1.4 MGD after the system’s first year. Using recycled water to irrigate grass during the dry season was projected to save two million gallons of potable water a day (Arrandale, 2002; Burney et al., 2008). A Hillsborough County's water resource administrator opined that persuading industrial customers to substitute recycled water for freshwater makes the most sense, since their use stays the same year-round instead of peaking during the summer season (Arrandale, 2002). However, other officials claim the cost of reclaimed water deters many residents from using it in the first place. Moreover, the "yuck" factor mentioned earlier may play a significant role in public acceptance of reclaimed water as an alternative source of drinking water.
In fact, SWFWMD conducted a study of the general public’s willingness to embrace the use of reclaimed water. The qualitative study focused on understanding attitudes towards alternative water sources, with a focus on attitudes toward reclaimed water. The study concluded that over 50% of the Hillsborough County population felt that there was enough water to meet the demand in 10 years (SWFWMD, 2012, pg. 17). SWFWMD relies on alternative water supplies such as reclaimed water to meet existing and future needs, and therefore has attempted to change people’s negative perceptions of it through educational pamphlets to improve program success (See Appendix B). In spite of the opposition faced by the county, many households in the county use reclaimed water for irrigation. According to Tampa Bay Water’s Five Year Water Report for 2011, the county has over 10,000 reclaimed water single family household accounts (Tampa Bay Water, 2012). These connections are strictly for irrigation purposes. Hillsborough County continues to enforce a mandatory water use restriction for all properties within the unincorporated county area, regardless of that property’s water source (Tampa Bay Water, 2012).

The main objective of this research is to further understand the history of Florida’s reclaimed water use as a source of water for the state, and more narrowly, within Hillsborough County. I investigate this history to better understand which factors currently play the most important role in shaping people’s risk perceptions of the use of reclaimed water in this region of Florida. Furthermore, this study also seeks to determine whether greater trust in government water utilities and water officials as compared to health officials had the greatest influence on the public’s risk perception. Finally, the study researched public awareness of local water quality issues related to wastewater.
Figure 1: Study Area, Hillsborough County, FL.
CHAPTER TWO: THEORETICAL FRAMEWORK

My study’s theoretical framework consists of risk theories such as risk perception, risk constructivism versus risk realism, and the Theory of Planned Behavior. Identification of these perceived risks is also important in understanding how they are perpetuated by these various social constructions and societal norms (Cutter, 1993, pg. 67). Moreover, another theory of risk perception relevant to my study is the Gender Difference in Risk Perception Theory. Discussing each of these in depth will enhance the current understanding of risk perception rather than limiting the study to the fields of psychology and behavior analysis.

2.1. Risk Perception Theory

Research has led many social scientists and anthropologists to discover that, although risk perception research traditionally was viewed as individuals being atomized units unconnected to a social system, the new view is that risk is embedded in a variety of social contexts and communities with like-minded individuals will share the same risk perception views (Cutter, 2003; Masuda & Garvin, 2006; Scherer & Cho, 2003). Risk is defined as the possibility of loss or injury; risk analysis refers to the study of risk (Starr & Whipple, 1984). Perception, in a narrower sense, is the actual receipt of the environmental stimuli through one of the five sensory receptors: sight, smell, hearing, taste, and touch (Cutter, 1993, pg. 13). As simple as its definition might be, however, three decades of intense theoretical and methodological debate have produced an abundance of methods which investigate the criticality of social contexts in
understanding risk (Masuda & Garvin, 2006). This new and innovative understanding of risk perception has been embraced by many psychologists, leading to the incorporation of social context into risk perception theory research in psychometrics. This allowed researchers to gain a better understanding of how perceived risk can lead an individual to exhibit certain behaviors towards the perceived threat. An example of these studies will be discussed further to gain a better understanding of risk perception as found in the literature and to establish the theoretical framework for my study within Hillsborough County.

The Kasperson et al. (1988) study focused on the social structures and processes of risk experience, the resulting repercussions on individual and group perceptions, and the effects of these responses on community, society, and economy. Through their study, Kasperson et al. (1988) found several issues in taking a technical approach to the study of risk perception because it focuses narrowly on the probability of events and the magnitude of specific consequences rather than accounting for an individual's ability to perceive risk in a comprehensive way. The authors concluded that, although the technical assessment of risk is essential to decisions about competing designs or materials, this assessment fails to inform societal choices regarding technology. Therefore, this approach lacks depth in understanding the legitimate concerns of risk. Cutter (2003), a pioneer in risk perception research, noted that societal selections of what risks and hazards to emphasize on, or which ones to ignore, often reflected moral, political, and economic choices that were themselves highly influenced by personal values and were socially constructed.

In Metzner’s (2008) study, "Contradictory approaches? On realism and constructivism in the social sciences research on risk, technology and the environment," the author presents two distinct theories of risk, risk realism and risk-constructivism, to understand how they have
shaped the understanding of risk problems in industrial societies. The constructivist approach comprehends "risk" as a construct of societal communication and explains "the increase of environmental and technological risks" through cultural processes of change; in contrast, the "realist" questions the un-reality of risk (Metzner-Szigeth, 2008, pg. 160-161). These contrasting views of risk perception serve as the foundation for understanding how risks are developed within communities which lead to particular behaviors. Furthermore, the risk realism versus risk-constructivism theory offered two additional views of risk perception. The first notes that risk can often be attributed to what reality is or what is "natural" (i.e. hole in the ozone layer, which resulted from the emission of chlorofluorocarbons and other major air pollutants). Risk perception theorists offer a second view, arguing that risk is constructed (Cutter, 1993). Therefore, these theories could serve as a conceptual basis for analyzing and understanding peoples’ perceived risk associated with the use of reclaimed water as a future potable water source.

In Slovic's (1987) study, "Perception of Risk," the author noted that the dominant perception of most Americans is that they face more risk today than in the past and that future risks will be even greater. Understanding these perceptions and what behaviors are linked to them through psychometric paradigm analyses deepens the understanding of perceptions and behaviors by producing quantitative representations, or "cognitive maps" of risk attitudes and perceptions (Slovic, 1987). His study concluded that risk perception studies demonstrated that people’s anxieties are linked to the reality of extensive unfavorable media coverage. A study conducted by Russel and the Army Corp of Engineers (1993) had similar findings. In a study conducted by Nancarrow et al. (2008), titled,"What drives communities' decisions, and behaviors in the reuse of wastewater," social amplifications of risk were studied from the perspective of
the behavior produced by the perceived risk in the individual. Ajzen’s Theory of Planned Behavior proposes that a person’s behavior can be predicted from their behavioral intentions. Factors such as emotion, attitudes, subjective norms, risk perception, knowledge, trust, responsibility, environmental obligation, and intended behavior were all identified as important factors to consider in a model predicting behavior (Nancarrow, 2008, pg. 486). Nancarrow, Leviston, and Tucker's (2009) study confirmed the robustness of the method design used in the Nancarrow et al. 2008 study. Proponents of wastewater recycling schemes believe that this study provides a usable model, which can include these various behavior predicting factors, including the "yuck” factor to facilitate its future application on risk perception assessment of recycling projects within community planning.

In Gustafson’s (1998) "Gender Differences in Risk Perception: Theoretical and Methodological Perspectives," the author noted that although psychological studies have revealed important subjective dimensions in individuals’ perceptions of risk, he proposed that risk perception is not gender neutral. Therefore, regardless of the social context in which a community of men and women live in, women will tend to worry more about certain risks than men. Risk perception is highly influenced by gender roles and how they are established in a community. Therefore, in a community where women are the caregivers, a direct exposure to poor local environmental quality issues would lead to negative risk perceptions towards the use of potable water in their home (Gustafson, 1998, pg. 808). Furthermore, the author found that it is imperative for social researchers to take a qualitative approach in risk perception theory development, which allows gender differences to be accurately represented. Another study, however, conducted by Nurdan and Alkan (2013), had opposite findings. In their study, conducted in Turkey, it was found that both women and men have the same concerns about the
use of wastewater. They concluded that there are no differences in risk perception among genders.

Several case studies worldwide have revealed diverse perceptions of reclaimed water use and identified both factors and behaviors that lead to particular views, corroborating various factors established in the risk perception literature. In Dolnicar and Hurlimann’s (2011) study, “Water Alternatives—Who and What Influences Public Acceptance?,” the authors noted that ignoring public sentiment can prevent water-related initiatives from being implemented, which proved to be true for the San Diego California’s water supply authority. Their water conservation efforts failed, for reasons including negative attitudes by some members of the community and no support from local politicians for the project (Dolnicar & Hurlimann, 2011, pg. 50). This example highlights the power of personal views and interest on public perception (Baggett, Jeffrey, & Jefferson, 2006; Cutter, 1993, pg. 23). In an example from Australia, a potable recycled water scheme was planned in 2005 for Toowoomba in regional Queensland. Immediately after the proposal of this project was communicated to the public, a group of Toowoomba residents formed the action group Community Against Drinking Sewage (CADS). CADS campaigned aggressively against the water recycling plant, using slogans such “Poo-woomba” and “Dunny to tap” (Dolnicar & Hurlimann, 2011, pg. 50). Therefore, Dolnicar and Hurlimann (2011) conducted a study in order to identify which factors of influence were perceived to be the strongest by the general population, determine whether the impact of factors vary across sub-segments of the population, and define segments of the population who differ with respect to what factors influence their water-related behaviors (Dolnicar & Hurlimann, 2011). The research results indicated that the content and source of information regarding alternative water sources, along with an individual’s prior attitude to the alternative water source,
had an impact on the perception of and response to information, a conclusion bolstered by sociologists R. Kasperson and J. Kasperson (1996). The information sources ranged from research findings and water shortage experiences to information provided by politicians. Each of these information sources were ranked by percentage of influence they had on perception (whether positive or negative). Dolnicar and Hurlimann (2011) found that politicians had the least influence at 15%, and research findings had the highest at 88%. Although this study did not explore why people’s perceptions of risk were formed or influenced by trust in the government or other professionals from a social perspective, this study provided a framework for what factors influence risk perception the most. Another study by Dolnicar et al. (2010), which identified awareness as an important factor in risk perception, addressed the issues of public risk perception in Australia. This study found that providing people with simple visual information about recycled water increased their stated likelihood of using this alternative water source (Dolnicar et al., 2010, pg. 1293). A study conducted by Dolnicar and Shafer (2009) surveyed 1000 Australian participants to measure their willingness to accept the use of reclaimed water and desalinated water for a variety of uses, including most indoor potable water uses, such as toilet flushing. This study found that Australians are mainly concerned about health issues that may be associated with the use of water from these alternative sources in their households (Dolnicar & Shafer, 2009, pg. 897). Some of these participants had low levels of factual knowledge about the true health risks associated with desalinated and recycled water. Therefore, health risk is an important factor to consider in risk perception (Nurdan & Alkan, 2013; Dolnicar & Shafer, 2010, pg. 897). The research study also highlighted that periods of intense drought in the country have improved risk perception among Australian residents as long as the barrier of trust could be broken (Dolnicar & Schäfer, 2009, pg. 892). Other researchers have found that risk
perceptions are spatially correlated, as Brody, Highfield, and Peck found in their 2005 case study across two watersheds in San Antonio, Texas. This study used spatial analysis techniques to describe and map the mosaic of perceptions of water quality in Salado and Leon creeks running through the heart of the metropolitan area. One important question this study answered was whether perceptions were spatially correlated or randomly distributed across the watersheds and, to provide an explanation as to why clustering of perceptions occurred in specific locations if autocorrelation was present. Results of this study concluded that environmental perceptions are spatially dependent across the landscape, and that spatial networks of issue-based activism contribute to the formation of localized “hot spots,” which contain similar responses (Brody, Highfield, & Peck 2005). Theories of risk perception and results of empirical studies on risk perception of reclaimed water use could serve as a conceptual basis for analyzing and understanding perception of reclaimed water for potable use in Hillsborough County, Florida. The previously presented risk perception literature indicates that the level of trust is dependent upon the entity providing the information on reclaimed water use quality. Furthermore, gender, as well as socioeconomic factors such as education and awareness, play an important role in shaping these perceptions and can be measured through behavioral-based questions.

My research aims to build on the work of risk perception theorists to understand how social perceptions of risks, whether real or constructed, are shaped by these key factors, which lead to individuals’ predetermined behavioral responses. Through the collection of surveys which measure behavior patterns (positive, negative, or indifferent), degrees of trust, and awareness, my study aims to aid in determining how these factors, along with socioeconomic variables, contribute to the “yuck” factor phenomenon, leading to a positive or negative feeling towards the use of reclaimed water as a future potable water source.
CHAPTER THREE:
RESEARCH DESIGN

3.1. Research Questions

In my research study, I sought to answer the following main research question and sub-questions:

1. What factors currently play the most important role in shaping people’s risk perceptions of the safe use of reclaimed water within Hillsborough County?
2. Which factors have the greatest effect on people who have positive perceptions of reclaimed water reuse for potable water?
3. Which factors have the greatest effect on people who have negative perceptions of reclaimed water reuse for potable water?
4. How important is trust in government water officials as compared to health officials in influencing positive or negative perceptions of the safe use of reclaimed water?
5. Do factors such as socioeconomic status, education (including awareness of local water quality issues), and gender have an effect on risk perception of reclaimed water use?
3.2. Methodology

3.2.1. Data Collection

I used a combination of qualitative and quantitative data collection methods in my study. I conducted surveys using questionnaires, held a focus group, and completed two key informant interviews. I used stratified sampling, convenience sampling and referral or snowball effect sampling. In order to collect a stratified sample, I requested a list of Homeowners Associations (HOAs) from the Hillsborough County Neighborhoods Relation Office. Additionally, I used the Neighborhood Community Atlas to collect socio-economic information for these neighborhoods. My stratified sampling approach involved clustering or grouping the neighborhoods on the basis of socioeconomic status (Acharya et al., 2013). The initial HOAs contacted were evenly split based on geographical location, ensuring that a representative sample was collected.

Convenience sampling is a non-probabilistic method of sampling that allows for a researcher to recruit even more participants to boost a population for a study on the basis of convenience or being at the right place at the right time (Acharya et al., 2013). Stratified sampling involves dividing a sample into various sub-groups or strata; these strata share common characteristics like age, sex, race, income, education, and ethnicity (Acharya et al., 2013). A random sample is taken from each strata allowing for a representation of all groups in the population; this type of sampling, however, can be expensive and time consuming.

All participants were given an informed consent form as well as the flyer of the study. Interested residents were given the link to the online survey by their HOA leader to complete. Further into the process of contacting the neighborhoods, I used referral sampling, or snowball sampling, to increase the number of participants. This method, though non-probabilistic in
nature, allowed for more respondents to participate in the study to reach an optimal sample size (Skowronek & Duerr, 2009).

Referral sampling, or snowball sampling, involves the initial participants forwarding, or sharing, the survey to other neighbors in order to recruit them for participation in a study (Archarya et al., 2013). Although both convenience sampling and snowball sampling are non-probabilistic and do not allow for statistical methods to be generalized to the entire population, resulting in difficulties with interpreting the results, it can serve as a starting method to gain an understanding of the issues posed in a particular field. The issue posed in my study is how to gain a best understanding of what factors shape risk perception in reclaimed water use as a future potable water source.

One HOA or community leader from one of the six regions was surveyed via an interview. I also collected information regarding their perceptions and what type of reclaimed water reuse program they would like to see implemented in their community. I interviewed a water conservation professional as a key informant to the study. The key informant belonged to a major water conservation agency. I interviewed an additional group, structured as an informal focus group, and asked the participants questions about their feelings and suggestions regarding what factors were the most important in informing risk perception. The focus group was comprised of 11 individuals: eight men and three women. During this focus group, I asked the same questions as those used for the online survey. Focus groups are often used to give insight into participants’ perceptions and preferences on a variety of topics (Throupe, 2011). This group is very aware of local water quality issues actively vetting of the county’s management of local surface water bodies issues. The group’s members are voted in by city officials. A multiple regression analysis was conducted requiring a sample size of a total of 50 participants for each
neighborhood/region (n=300; Davenport & Shannon, 2001). This method of analysis was selected because of a recent study conducted in Australia by Chen et al. (2013) titled, “Analysis of Social Attitude to the New End Use of Recycled Water for Household Laundry in Australia by the Regression Models.” This study employed the use of regression analysis to identify key factors in reclaimed water reuse perception and used many of the factors identified in the literature explored for my study’s theoretical framework.

This research is significant because it will aid Tampa Bay Region water management entities in identifying which risk perceptions of water quality are predominant in urban geographies, such as Tampa. Knowing this information can help utility officials identify ways to reshape these risk perceptions to increase public trust via targeted educational pamphlets and/or, water quality reports. This will ensure that water demand remains consistent within Tampa Bay while mitigating watershed impacts internal and external to the region. In addition, an understanding of these risks would allow managers to understand why particular programs, such as reclaimed water reuse programs, are not successful during the implementation phase and are not producing the positive water conservation results they were expecting. This research also has implications on the public’s reaction towards other forms of water resources management in the region, such as the collection of wastewater to recover already used potable water sources, when current water supplies become too scarce because of population growth and increase in demand. Florida’s population is projected to grow from about 16 million in 2000 to about 21 million in 2020, a large increase which has potential of limiting water sources in the Tampa Bay Region (FDEP et al., 2003, pg. 3). Therefore, this study will allow water resource management professionals to incorporate reclaimed water use as a viable alternative to their region’s water demand management programs in order to support potable water sources.
3.2.2. Data Organization

The questionnaire was qualitative in nature and subdivided into the following key sections:

1. Demographics (five questions)
2. Awareness of local environmental issues (10 questions)
3. Behavior/reclaimed water use (four questions)
4. Trust (two questions)
5. Community (one question)

These five categories produced 13 independent variables:

1. Perception.NPW (non-skin contact water quality perception)
2. Awareness
3. Gender
4. Race
5. Income
6. Ethnicity
7. Education
8. Trust in health officials
9. Trust in utilities
10. Trust in media
11. Trust in government
12. Trust in politicians
13. Region

The five demographics questions were used to derive five of the 13 independent variables:
1. Gender (male or female)
2. Race (Black, White, etc.)
3. Ethnicity (non-Hispanic or Hispanic)
4. Income (1 through 4, 1 being lowest income and
5. Education (1 through 6, 1 being the lowest level, 6 being the highest)

The awareness of local environmental issues was used to derive the awareness variable, which was scored out of 100% (the score on the final result was out of 1.0). The four behavior/reclaimed water use questions were used to derive the the non-skin contact reclaimed water use variable (Perception NPW; the scores range from 26 down to -6, see Table 3 for the scoring method).

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you currently use reclaimed water provided by your utility?</td>
<td>If &quot;No&quot; and &quot;I don't know&quot;= 0</td>
</tr>
<tr>
<td>Does your utility provide a connection for reclaimed water use in your community?</td>
<td>If &quot;No&quot; and &quot;Yes&quot;= -1</td>
</tr>
<tr>
<td></td>
<td>If &quot;No&quot; and &quot;No&quot;= 0,</td>
</tr>
<tr>
<td></td>
<td>If &quot;Yes&quot; and &quot;I don't know&quot;= 1</td>
</tr>
<tr>
<td></td>
<td>If “Yes” and “Yes”=1</td>
</tr>
<tr>
<td>Code in excel for values:</td>
<td></td>
</tr>
<tr>
<td>=IF((AND(AZ2=&quot;No&quot;,AV2=&quot;I don't know&quot;)),0,</td>
<td></td>
</tr>
<tr>
<td>IF((AND(AZ2=&quot;No&quot;,AV2=&quot;Yes&quot;)),-1,</td>
<td></td>
</tr>
<tr>
<td>IF((AND(AZ2=&quot;No&quot;,AV2=&quot;No&quot;)),0,</td>
<td></td>
</tr>
<tr>
<td>IF((AND(AZ2=&quot;Yes&quot;,AV2=&quot;I don't know&quot;)),1,1))))</td>
<td></td>
</tr>
<tr>
<td>Do you use rain barrels to collect rainwater for irrigation?</td>
<td>If yes= 1</td>
</tr>
<tr>
<td></td>
<td>If no= -1</td>
</tr>
<tr>
<td>What do you use the reclaimed water for? (check all that apply) - Irrigation of lawn</td>
<td>Code in excel for values:</td>
</tr>
<tr>
<td></td>
<td>=COUNTIFS(BD2,&quot;Irrigation of lawn&quot;)+(COUNTIFS(BE2,&quot;Irrigation of edible garden&quot;))*2+(COUNTIFS(BF2,&quot;Irrigation of ornamental (decorative) garden&quot;)+(COUNTIFS(BG2,&quot;Toilet flushing&quot;)*3)</td>
</tr>
<tr>
<td>What do you use the reclaimed water for? (check all that apply)</td>
<td>Sample for code in excel:</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>- Irrigation of ornamental (decorative) garden</td>
<td>=IF(CC2=&quot;I am in favor (100%)&quot;,3,IF(CC2=&quot;I am in favor with few reservations&quot;,2,IF(CC2=&quot;I am in favor with many reservations&quot;,1,IF(CC2=&quot;Neutral&quot;,0,IF(CC2=&quot;I do not favor&quot;,1.0)))))</td>
</tr>
<tr>
<td>- Toilet flushing</td>
<td></td>
</tr>
<tr>
<td>- I don't use reclaimed water at all</td>
<td></td>
</tr>
<tr>
<td>- Other (please specify)</td>
<td></td>
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<tr>
<td>- Other (please specify)</td>
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</table>

What are your feelings regarding the reuse of reclaimed water for future potable water uses? Rate based on type of water use:
- Irrigation of lawn
- Irrigation of edible garden
- Irrigation of ornamental (decorative) garden
- Toilet flushing
- Please include any additional thoughts you have on the issue.

The two trust questions were used to derive 5 of thirteen independent variables:

1. Trust in utilities
2. Trust in health officials
3. Trust in government officials
4. Trust in media
5. Trust in politicians

The trust score was determined using the respondents’ ranking scores (0 to 1.0, with the latter being the highest rank) of the five experts providing reliable water quality information. The
last independent variable, region, was derived from the community question. Zip codes from nearby communities were grouped and divided into six regions (see Appendix G for a description of the regions’ demographics and population density). The positive or negative perceptions of reclaimed water were determined based on the behavioral/reclaimed water questions regarding their willingness to use reclaimed water for augmentation or as a direct potable water source.

The perception (whether negative or positive) was determined using the scoring method found in Table 4. The points were added and the values categorized as positive, negative, or indifferent. If the value was greater than 0, the participant was considered to have a positive perception. If the value was less than 0, the participant was considered to have a negative perception. This method of scoring was employed to quantify perceptions using negative and positive values and adding them to gauge the level of receptiveness.

See Appendix A for a detailed list of the online questionnaire conducted.
3.2.3. Data Analysis

The statistical software R was used to conduct a multiple regression analysis to determine which of the five primary factors had the highest significance in shaping positive or negative perceptions towards reclaimed water use as a future potable water source. After running the initial regression model, I used a forward function to determine which factors would, if removed, decrease the Akaike’s Information Criterion (AIC), improving model predictability. I ran a correlation function to determine if any of the independent variables were highly correlated to one another. Finally, the regression model results were displayed using the mapping program ArcMap. The datasets were rasterized to understand the variations in perception among all six neighborhoods/regions within Hillsborough County.
CHAPTER FOUR:

RESULTS & DISCUSSION

The total number of participants were 417 residents. Additionally, a water professional was interviewed as well as an HOA leader from one of the six regions represented in the sample size. Finally, one focus group was held, comprised of eight men and three women. The following are the results answering each of the research questions.

4.1. Significant Factors that Affect Positive or Negative Perceptions

The sample size for participants with positive perceptions was 218. The sample size for participants with negative perceptions was 155. The following quantitative and qualitative results and discussion answer the first two sub-research questions that I presented in my research methods:

1. Which factors have the greatest effect on people who have positive perceptions of reclaimed water reuse for potable water?

2. Which factors have the greatest effect on people who have negative perceptions of reclaimed water reuse for potable water?
Figure 2: Percent of perception to reclaimed water reuse as a future potable water source (n=417).

Figure 2 depicts that slightly over half of the participants had a positive perception towards the reuse of the reclaimed water as a future potable water source. Results of the behavior questions showed that residents are more willing to use reclaimed water for sources of non-skin contact water use than for direct drinking water use (see Figures 4 through 8). This variable was moderately correlated with the dependent variable. The correlation coefficient, however, was not significant and its effect on the variable was minimal (see Appendix G, Table G1 for a list of correlation coefficients). The results of the regression analysis depicted this factor to be statistically significant with a 99% confidence interval (see Table 5 and Figure 9).

However, upon disseminating the data by categorizing negative and positive perceptions independently, I found that willingness to use reclaimed water as a future potable water source for non-skin contact water uses was not a significant factor for both positive and negative perceptions. Table 7 depicts that as positive feelings towards non-skin contact water uses of reclaimed water increase, positive perceptions towards the reuse of reclaimed water as a future potable water source also increased (NPW Perception variable with a statistical significance of P= < 0.001****); Figure 10 depicts the effects of this variable in an R effect line plot. Therefore,
for individuals with a positive perception towards reclaimed water use, this variable was a significant factor. These findings corroborate Nancarrow’s 2008 study. Ajzen’s Theory of Planned Behavior, Nancarrow stated, proposed that a person’s behavior can be predicted from their behavioral intentions through factors such as, emotion, attitudes, subjective norms, risk perception, knowledge, trust, responsibility, environmental obligation, and intended behavior.

The findings of my study measured these behaviors and modeled the influence of the independent variables, or factors, on these particular behaviors. My study concluded that positive or negative perceptions can be predicted using these known factors. These findings also corroborate Dolnicar and Hurlimann’s 2011 study which found that an individual’s prior attitude to an alternative water source had an impact on the perception of and response to information, a conclusion which was also bolstered by sociologists R. Kasper and J. Kasper in 1996.

Chen et al.’s (2013) study also found the following results with support my findings:

1. Three of the attitudinal variables (RWAlterDW or recycled water as an alternative source for drinking water, attitude and cost) were found to be key driving forces behind residential water reuse behavior

2. Three of the psychological variables (odor, reading perception from others and adding small unit of drinking water to improve overall water quality) were found to be key driving forces behind residential water reuse behavior.

These results corroborated my study, concluding that non-skin contact reclaimed water use is a significant factor in shaping risk perception. A similar study conducted by Mainali et al. (2013) found that a significantly higher number (70%) of the respondents supported the use of reclaimed water in washing machines. There was also a significant positive correlation between...
the overall support of the new end use and the willingness of the respondents to use this source in washing machines among all groups (Mainali et al., 2013).

On the other hand, this factor was not shown to be significant in the regression analysis for individuals with negative perceptions (see Table 7).

<table>
<thead>
<tr>
<th>Table 5: Regression Model Output in R (n=417)</th>
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<tbody>
<tr>
<td>Coefficients</td>
</tr>
<tr>
<td>TrustU</td>
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<tr>
<td>TrustH</td>
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<tr>
<td>TrustM</td>
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<tr>
<td>TrustG</td>
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<tr>
<td>Trust P</td>
</tr>
<tr>
<td>PerceptionNPW</td>
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<tr>
<td>Education</td>
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<tr>
<td>Region 2</td>
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<td>Region 3</td>
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<td>Region 4</td>
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<td>Region 5</td>
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<tr>
<td>Region 6</td>
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</tbody>
</table>

Residual Standard Error: 2.429 on 405 degrees of freedom; Multiple R Squared: 0.2698; Adjusted R Squared: 0.271; F-statistic: 13.68 on 11 and 405 DF, p-value: < 0.001

*= 90%, **=95-99.0%, ***=99.0-99.9%, ****=99.9-100%

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<thead>
<tr>
<th>Table 6: Regression Model Output in R for Positive Responses (n=218).</th>
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<tr>
<td>Coefficients</td>
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<tr>
<td>TrustH</td>
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<td>TrustM</td>
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<td>Region 2</td>
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<td>Region 3</td>
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<td>Region 4</td>
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<td>Region 5</td>
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<tr>
<td>Region 6</td>
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<td>PerceptionNPW</td>
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Residual standard error: 1.657 on 209 degrees of freedom ; Multiple R-squared:0.277; Adjusted R-squared:0.250

*= 90%, **=95-99.0%, ***=99.0-99.9%, ****=99.9-100%
Table 7: Regression Model Output in R for Negative Responses (n=155).

| Coefficients | Beta Coefficient | Standard Error | Pr(>|t|) |
|--------------|------------------|----------------|---------|
| TrustH       | 0.622            | 0.303          | 0.042** |
| Income       | -0.274           | 0.068          | >0.001**** |
| Awareness    | 1.453            | 0.374          | >0.001**** |
| Education    | 0.180            | 0.059          | 0.003*** |

Residual standard error: 0.825 on 150 degrees of freedom
Multiple R-squared: 0.175, Adjusted R-squared: 0.153
* = 90%, **=95-99.0%, ***=99.0-99.9%, ****=99.9-100%

Figure 3: Reclaimed Water for Irrigation (n=417).

Figure 4: Reclaimed Water for Edible Gardens (n=417).
Figure 5: Reclaimed Water for Ornamental Plants (n=417).

Figure 6: Reclaimed Water for Toilet Flushing (n=417).

Figure 7: Reclaimed Water as a Source for Potable Water (n=417).

Figure 8: Reclaimed Water for Augmenting Surface Water for Potable Water (n=417).
Figure 9: Effect Plot of the Independent Variables on Perception (n=417).
Figure 10: Effect Plot of The Independent Variables on Positive Perceptions (n=218).
Geographic region was also an important factor in informing positive risk perception (refer back to Table 6) at the 90% to 95% confidence interval for regions two and six. Figure 12 also captured the significance of these two regions. For example, as trust in health officials decreased, the receptiveness to the use of reclaimed water as a future potable water source increased. Furthermore, as trust in media increased, the receptiveness to the use of reclaimed water as a future potable water source increase. The results of the spatial analysis of the data collected displayed some patterns across the different neighborhoods/regions surveyed. The data displayed that as respondents with higher education were more trusting of their health officials, the less positive perceptions they displayed. Positive feelings towards reclaimed water were most prominent in populations living closer to the coast. Although I did not use a spatial autocorrelation analysis such as that of Brody et al. (2005), my research found spatial networks upon examination of the thematic maps, supporting their general findings. See Table 8 for a detailed demographic description of Regions 2 and 6.

![Figure 11: The Six Regions of Hillsborough County Represented (n=417).](image-url)
Figure 12: Thematic Map Depicting the Results of Each of the Independent Variables by Region (n=417).
Table 8: Demographic Information of Regions Depicting Significance in the Regression Model for Participants with Positive Perceptions (n=218; Region 1 n= 101, Region 2 n= 34, Region 3 n= 2, Region 4 n= 9, Region 5 n= 25, and Region 6 n= 47).

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4.2. Significance of the Trust Factor in Risk Perception

The following quantitative and qualitative results and discussion answer the third sub-research question that I presented in my research methods:

1. How important is trust in government water officials as compared to health officials in influencing positive or negative perceptions of the safe use of reclaimed water?

The results of the trust section of the study depicted that respondents had a higher level of trust in health officials overall (see Figure 13). The rankings were as follows, with a higher percentage indicating a higher measure of reliability:

1. Health Officials (45.3%)
2. Utilities (25.4%)
3. Government (4.3%)
4. Media (4.3%)
5. Politicians (0.3%)

See Figures 14 through 17 for the ranking of the rest of the entities defined in the survey.
Figure 14: Utilities Quality Information Ranking (n=417).

Figure 15: Media Water Quality Information Ranking (n=417).

Figure 16: Government Water Quality Information Ranking (n=417).

Figure 17: Government Water Quality Information Ranking (n=417).
These results bolster the findings of Dolnicar and Hurlimann (2011), which indicated that trust in health officials and utilities was much higher than trust in politicians and media (Mainali et al., 2013). Both the Chen et al. study (2013) and the Mainali et al. study (2013) corroborated these findings in my study, which discovered that respondents had significant concerns regarding the effects of reclaimed water on health. However, the regression analysis results indicated that for participants with positive perceptions, trust in health officials was significant at the 90% confidence interval. Furthermore, as trust in health officials decreased by -1.02, positive perceptions increased (see Table 9). Although trust in media was not considered statistically significant, it was important in improving model predictability (see Appendix G, Table G2, for correlation values depicting a weak, non-significant, or negative correlation between trust in health officials and trust in media). This finding was corroborated by an interview response from a HOA interviewee:

“I think media could do a better job at informing the public of our water.” – November 2013 (Paraphrased)

In contrast, in participants with negative perceptions, trust in health officials was significant at the 95% confidence interval and the relationship between the variables was negative (see Table 10). In other words, as the trust in health officials increased, negative perceptions also decreased.

| Coefficients | Beta Coefficient | Standard Error | Pr(>|t|)  |
|--------------|-----------------|----------------|----------|
| TrustH       | -1.054          | 0.543          | 0.053*   |
| TrustM       | 0.865           | 0.524          | > 0.010* |

Table 9: Regression model output in R for Positive Responses Highlighting Trust in Health Officials and Trust in Media (n=218).
The trust in health official’s significance corroborated the comments shared by water professional and the HOA leader during the key informant interviews:

“…5 years, more so, endocrine disruptors and other health effects that may come from the water. We do not have data that can assure people that it is safe to drink…There is government mistrust; nothing is taken at face value.” – Water Professional; January 2014 (Paraphrased)

“Health issues are potential problems (i.e. Drug traces and household chemicals).”- Focus Group; February 2014 (Paraphrased)

Participants also shared some of their concerns on health in the online survey. For example:

“We use reclaimed H2O for lawns ... water stinks!!! I know you can clean it up / treat it to make it better ... but this involves treatment plants, more costs, etc. We ONLY trust US EPA when it comes to water ratings ... everything else is suspect!!!!”

“My opposition to using reclaimed water as drinking/potable water lies in the fact that I am unconvinced the current treatment regime will effectively remove pharmaceutical contamination from the water prior to its consumption again. If I could be assured that this can be successfully accomplished, my opinion could shift.”
“I understand that my reluctance to drink recycled cleaned water is perception only. I understand the process used, I understand the practicality of drinking reclaimed water. I just can't get past the fact that source is less than appetizing. Adding reclaimed water back into the aquifer for natural is acceptable. I know it's contrary, but - oh well.”

“Reclaimed water, if treated to make it potable, is cleaner than well water, isn't it? So I'd use it for anything.”

“Want to know levels of treatment - i.e., does it make it all the way to drinking water standards?”

The significance of trust in health officials in the regression analysis also corroborates Dolnicar and Shafer’s 2009 study findings, which found that participants were mainly concerned about health issues that may be related to using water from alternative sources in their households. Having this understanding allows utilities to be able to provide residents with the information needed to increase their trust and support for recycled water programs, as several other studies found; this is important because public perceptions of the human health risks associated will increase as wastewater quality continues to deteriorate (Doria et al., 2009; Canter, Nelson, & Everett, 1993; Hartley, 2006; Johnson, 2003; McSpirit & Reid, 2011; Parag & Roberts, 2009; Vedachalami & Mancl, 2010).

4.3. Significance of Socioeconomic Factors in Risk Perception

The following are the demographic data of the sample population surveyed. The gender distribution of the surveyed population was 67.9% female and 32.1% male (see Figure 18). The income distribution was 73.4% of average household income above $34,000 (see Figure 19). The education data depicted that 87.05% of the population surveyed had at least a bachelor’s degree
The race distribution was majority White at 83.9%, (see Figure 21); the ethnicity distribution was 88.5% non-Hispanic (see Figure 22). The perceived awareness above aware was only slightly over 16% (see Figure 23).

The following results and discussion from quantitative and qualitative data analysis answer the final sub-research questions that I presented in my research methods:

1. Do factors such as socioeconomic status, education (including awareness of local water quality issues), and gender have an effect on risk perception of reclaimed water use?

![Gender of Surveyed Population](image)

*Figure 18: Gender of Surveyed Population (n=417).*
Figure 19: Income of Surveyed Population (n=417).

Figure 20: Education Distribution of Surveyed Population (n=417).
Figure 21: Race Distribution of Surveyed Population (n=417).

Figure 22: Ethnicity Distribution of Surveyed Population (n=417).
When determining which socioeconomic factors played an important role in shaping perception, individuals with negative perceptions to reclaimed water reuse as a future potable water source, two variables were at least 95% significant: income and education (see table 11). These findings validate the results of the the risk perception literature explored by my study, that perceptions are shaped over time by factors such as local environmental water quality issues, media, education, and public trust of local utilities (Carr, Potter, & Nortcliff, 2011; Doria, Pidgeon, & Hunter, 2009; Hartley, 2006; McSpirit & Reid, 2011; Vedachalami & Mancl, 2010). The focus group stated that income was an important factor to consider when determining risk perceptions with one participant stating that:

“Always comes down to money. If we implement reclaimed water, taxes have to be increased.”-February 2014 (Paraphrased)

No socioeconomic factors were significant for individuals with positive perceptions or even the overall regression analysis of the entire population although race and education did play
a role informing other variables in the regression, therefore, they were left in the analysis since their p values were low enough to be considered important.

Awareness of local water quality issues was a variable with more significance in informing negative risk perception (see Figure 24 for the effect plot representation results and Figure 25 for the negative perception effect plot; see Figure 26 and 27 for a comparison of overall awareness and the negative perception group’s awareness). As awareness went up by 1.45 units, the positive perception increased (see Table 11). A moderate correlation between income and awareness was indicated by the correlation function; however, the value was not large enough to affect the model (see Appendix G, Table G3). In the case of individuals with positive perceptions, awareness was normally distributed but the variable was not significant (see Figure 27). The results of this regression analysis corroborate Cutter’s 1993 book, “Living with Risk: The Geography of Technological Hazards,” which found that, although it is difficult to find the link between environmental contaminants and human disease, these concerns continue to grow and are often exacerbated by the growing awareness of environmental issues in individuals (pg. 39). The key informant interviews supported these findings; they all felt that community awareness of local water quality issues was an important factor in shaping perceptions, often using education and awareness interchangeably:

“Education- get it on the golf course.”- Focus Group Interview (February 2014)

“People sometimes don’t know the difference between governmental water agencies (example: the Southwest Florida Water Management District vs. Tampa Bay Water)”-Water Professional Interview; January 2014 (paraphrased)
“There are two things… one is ignorance…lack of knowledge of [what] reclaimed water is… This lack is fueled by the way that we advertise reclaimed water, “the yuck” factor.- Water Professional Interview; January 2014 (paraphrased)

Thus, it is essential that residents are educated on wastewater quality issues and increase awareness of the benefits, which outweigh the initial cost of the technology implementation. Furthermore, it is necessary to educate the public on the importance of water source diversification as resources become depleted. The focus group expressed these feelings as well:

“The need for reclaimed water as an alternative source needs to be made known… as long as we have other sources, people will not be open to using it. Begin using it for non-potable water uses to diminish the use of potable water for non-drinking purposes. For every gallon of groundwater that can be replaced, we can use the potable water for drinking, etc. Other uses of reclaimed water could be:

i. Getting it on the golf course.

ii. Industrial uses

iii. Agricultural uses

iv. Deep well injection.” –February 2014 (Paraphrased)

| Coefficients | Beta Coefficient | Standard Error | Pr(>|t|) |
|--------------|------------------|----------------|---------|
| Income       | -0.274           | 0.068          | > 0.001**** |
| Awareness    | 1.453            | 0.374          | > 0.001**** |
| Education    | 0.180            | 0.059          | 0.003*** |

Residual standard error: 0.825 on 150 degrees of freedom
Multiple R-squared: 0.175, Adjusted R-squared: 0.153
* = 90%, ** = 95–99.0%, *** = 99.0–99.9%, **** = 99.9–100%
Figure 24: Histogram of the Level of Calculated Awareness Among Respondents (n=417).
Figure 25: Effect Plot of The Independent Variables on Negative Perceptions (n=155).
Figure 26: Histogram of the Level Of Calculated Awareness Among Respondents with Negative Perceptions (n=155).
Figure 27: Histogram of the Level of Calculated Awareness Among Respondents with Positive Perceptions (n=218).
CHAPTER FIVE:
CONCLUSION

5.1. Future Research

Future studies should focus on defining each of the variables more concretely. Although human behavior and social variables are difficult to model, defining each variable uniquely reduces high correlation between variables and improves the model predictability. In addition, factors such as cost associated with implementing reclaimed water treatment technologies should be included, as the focus group participants stated. If these new factors are incorporated, limitations of the predictability of the model would be reduced. Finally, actual GPS coordinates should be collected to analyze the data spatially and understand how these perceptions are clustered in the region with a more robust methodology, as employed by Brody, Highfield, and Peck in their 2005 study.

As population continues to grow, water resource managers will be faced with the challenge of addressing issues of water scarcity in the Tampa Bay Region. Therefore, it is imperative that water resource managers understand the history of Florida's reclaimed water use as a source of potable water use for the state and how that has affected risk perceptions associated with its safe use. This study should serve as a guide and a way to expand the understanding of reclaimed water perception within Hillsborough County, Florida. Furthermore, by employing technical analyses, such as multiple regression, students and professionals alike can gain an understanding of which factors are shown to be the most significant in shaping risk
perceptions in their particular communities. The literature review covered four fundamental frameworks for the development of the theoretical framework of this research:

1. Risk Perception
2. Risk Realism vs. Risk Constructivism
3. Theory of Planned Behavior
4. Gender Differences in Risk Perception Theory

Although the analyses did not show gender to be a significant factor in shaping risk perception, it corroborated many of the findings of risk perception theorists. This research will help pioneer risk perception theory and water resources management and planning fields to adopt more socially sensitive policies to manage both the environment and the people to provide enough water for many generations to come.

5.2. Limitations of the Study

The number of participants n=417 resulted in a biased participation for all demographic components. The gender distribution of the surveyed population was 67.9% female and 32.1% male (see Figure 18). The income distribution was biased towards higher income participants, with 73.4% of average household income being above $34,000 (see Figure 19). The education data was also biased with 63.07% of the population surveyed having at least a bachelor’s degree (see Figure 20). The race distribution depicted that the majority of the participants were White, at 83.9%; this race distribution explains why both income and education distribution were biased, favoring higher income and level of education among all participants. The ethnicity distribution in Figure 22 depicts a low percentage of Hispanics. These are important biases with the sample collected for this study.
My study’s participants were predominantly higher-income, well-educated white females. Although this bias can be problematic when attempting to generalize the results to the entire population of Hillsborough County, it nonetheless serves as a foundation for understanding which factors play the most important role in shaping public perception. Furthermore, although the literature explored for this particular study was divided in terms of the significance of differences in gender risk perception, future studies must continue to explore this demographic factor to solidify its significance or non-significance in risk perception theory by diminishing biases in the data collection process of the study (Gustafson, 1998; Nurdan & Alkan, 2013). Additionally, determining peoples’ perceptions using an additive scoring system inherently poses some challenges to the quantifiability of individuals perceptions. However, this scoring method produced results that begin to answer questions regarding the region’s understanding of risk perceptions and behavior relationships.

As the participants of focus group noted, many challenges have to be overcome in order for reclaimed water to become a viable alternative source. For example, building codes for homes would need to change to accommodate the routing of this new water, which can be costly. However, if enough support from the residents and the entire community is garnered, then meaningful policies, ordinances, and codes can be adopted. Therefore, understanding how to educate communities on reclaimed water use as a future potable water source is important. It is through targeted educational efforts that people will begin seeing the long term investment benefits, rather than the short term high cost only. The Melbourne Water authority of the city of Melbourne, Australia faced obstacles when attempting to adopt a challenging target of reclaiming twenty percent of treated effluent from Melbourne’s two major sewerage treatment
plants by 2010 (Arbon & Ireland, 2003). However, this target was successfully adopted in response to key drivers/factors for water recycling in the Melbourne area:

1. Strong support for conserving water resources and protecting marine environments
2. Acknowledgment of recycled water as a valuable resource
3. Greater emphasis on environmental issues and sustainable management principles
4. Opportunities to increase demand for recycled water through effective planning mechanisms (Arbon & Ireland, 2003)

Therefore, policies followed by appropriate legislation, education, policing, technical, and financial measures will lead to the successful implementation of water reclamation and reuse in the future, even during periods of critical water shortages and drought (Lahnsteiner & Lempert, 2007, pg. 441). Reclamation, as Levine and Asano (2004) stated, is a viable potable water source. Communities should therefore perform extensive perception studies to measure risks and behaviors, and then target efforts to shifting the public’s perception about using reclaimed water as a potable water source.
REFERENCES


APPENDICES
Appendix A: Surveys

Did you read the informed consent word document attached to the email with the link to this survey and understand the minimal risk associated with participating in the survey? Note, please read the document before proceeding with this survey; stating no to this answer will automatically invalidate your responses as if you never participated so please read the document before proceeding with the survey if you wish to continue to participate. If you have any questions or need a copy of the informed consent document, feel free to email them at salvarad@mail.usf.edu

General information. If at any point in time during the survey, you do not feel comfortable answering the questions, please exit the survey through the link on the top right corner.

1. What is your gender?
   - Female
   - Male

2. What is your approximate average household income?
   - $0-$14,999
   - $15,000-$24,999
   - $25,000-$34,999
   - $45,000 and above (option was $35,000-$49,999 but combined these two options due to error in survey after data collection).

3. What is your race?
   - White
   - Black or African American
- Asian
- Native Hawaiian or Other Pacific Islander
- American Indian or Alaska Native
- Other (please specify)

4. What is your ethnicity?
- Hispanic
- Non-Hispanic

5. What is the highest level of education you have completed?
- Primary School (Up to 5th Grade)
- Middle School (Up to 8th Grade)
- High School or GED
- Some College
- Associates
- Bachelors
- Masters
- PH.D. or Professional Degree

Please do not use outside sources to answer these questions. This is purely based to determine your awareness of local water quality issues not an aptitude test. General information. If at any point in time during the survey, you do not feel comfortable answering the questions, please exit the survey through the link on the top right corner.

6. What is reclaimed/recycled water?

7. What is Wastewater?
8. What regional agency manages Hillsborough County’s and the surrounding counties in the Tampa Bay Region water quality among other water related policy?

9. What are the sources of water used in Hillsborough County to meet our drinking water needs?

10. What is the major water source for Hillsborough County's drinking water supply?

11. Where does your treated water come from?

12. What happens to your water once you use it for the different activities and task around your home?

13. Select as many main water bodies that are located across the Tampa Bay region?

14. What is the C.W. Bill Young Regional Reservoir and who manages it?

15. How aware are you of local water quality and environmental issues?

Reclaimed water is wastewater treated up to the standards necessary to reuse. With that information in mind, please answer the following questions. General information. If at any point in time during the survey, you do not feel comfortable answering the questions, please exit the survey through the link on the top right corner.

16. Does your utility provide a connection for reclaimed water use in your community?

17. Do you currently use reclaimed water provided by your utility?

18. Do you use rain barrels to collect rainwater for irrigation?

19. What do you use the reclaimed water for? (Check all that apply)

General information. If at any point in time during the survey, you do not feel comfortable answering the questions, please exit the survey through the link on the top right corner. These
questions are meant to help understand your feelings on the issue and will not be used for any other purpose than understand the needs of the community.

20. In your own opinion, rate who has the best information available to the public regarding water quality (5 being the best, 1 being the least best)?

21. What are your feelings regarding the reuse of reclaimed water for future potable water uses? Rate based on type of water use.

If at any point in time during the survey, you do not feel comfortable answering the questions, please exit the survey through the link on the top right corner. This question is meant to help understand your community's overall feeling on the issue and will not be used for any other purpose than understand the needs of the community.

22. Please select which community you are in A through I (The letter that you choose should be in the email that was sent to you with the link to this survey). If you did not get an email with a letter associated with your neighborhood, please select the other option and write in your HOA/Neighborhood name. Please do not include an address or personal information.
Appendix B: Supplemental Documents

Reclaimed Water
A reliable, safe alternative water supply

With constant demands on water resources, the Southwest Florida Water Management District (District) relies on alternative water supplies such as reclaimed water to meet existing and future needs.

Reclaimed water is wastewater that has received at least secondary treatment and is used for beneficial purposes. Reclaimed water is currently used for agricultural irrigation, groundwater recharge, industrial processes, and the irrigation of lawns, landscapes, cemeteries and golf courses. By offsetting demand for ground water and surface water, this alternative, nontraditional water source reduces stress on environmental systems, provides economic benefits by delaying costly water system expansions and eliminates the need to discharge wastewater effluent to surface waters.

Through proper design and efficient use, reclaimed water has become an important, safe and proven alternative water source within the District.

History of Reclaimed Water

For nearly 100 years, highly treated reclaimed water has been used in the United States. In 1912, the first small urban reuse system began with the irrigation of Golden Gate Park in San Francisco. In 1966, Florida entered the reclaimed water arena with the construction of the Tallahassee Reclaimed Water Farm. Since then, reuse within Florida has successfully grown to include more than 440 systems that reclaim 659 million gallons of water per day (mgd) — more water than any other state.

The District and the utilities within its borders have been leaders in the growth of reclaimed water. In 1977, the City of St. Petersburg built the first large urban reuse system in the United States. In addition, as of 2009, the District has developed Florida’s largest and most aggressive reuse development program with 288 projects funded and $298 million in grants budgeted for $862 million in reclaimed water construction.

(See Literature Cited on back)

Figure B1: The SWFWMD Informational Flyer on Reclaimed Water
Appendix C: IRB Approvals and Informed Consent

Good ______ Mr. (Mrs., Ms.) ________

My name is Susana R. Alvarado Tricoche (eIRB#12522) and I am a master’s student at the University of South Florida completing the following research, “Determining what Factors Affect Peoples’ Perception of the Reuse of Reclaimed Water as Source for Potable Water: A Spatial and Statistical Study within Hillsborough County,” for the satisfaction of my thesis requirement. The focus of this research will allow future students and water managers to further understand the history of Florida’s reclaimed water use as a source of water for the state and more narrowly, within Hillsborough County, a county that has successfully implemented reclaimed water programs, how this history has had an effect on risk perceptions associated with the safe use of reclaimed water, and finally, understand which factors play the most important role in shaping those risks. The surveys conducted will only ask for your general demographics and level of education as well as your views of reclaimed water reuse. The final data will portray the regression analysis conducted and the values found for each neighborhood. The identities of these neighborhoods will not be disclosed except that they are in a particular community. The six neighborhoods will essentially represent the perception among the whole county and not linked to a particular neighborhood. Minimal risk involved in this research is the way the information is handled after it is collecting. The security of you as a participant will be ensured through revisions of the draft of the final thesis through the review of advisors and the researchers itself. The collection of the information will be collected through your own personal computer, however, the IP address will not be stored for the analysis for this study. When necessary, pseudonyms will be used to protect your identity. If you have any questions or concerns, do not
hesitate to contact me through the email below or contact the USF IRB and the Department of Health and Human Services, which can review all research records at 813-974-5638.

Researcher Contact Information:

Susana R. Alvarado

Graduate Assistant
Appendix D: Plots for 10 of the 14 Variables Depicting Variability in the Data (n=417).

Figure D1: Perception Dependent Variable Probability (QQ) Plot (n=417).
Figure D2: Non-Skin Contact Perception Independent Variable Probability (QQ) Plot (n=417).
Figure D3: Awareness Independent Variable Probability (QQ) Plot (n=417).
Figure D4: Independent Variable Boxplot Depicting Ranges from $0-14,999 (1) to $45,000 or more (4) Income Level (n=417).
Figure D5: Independent Variable Boxplot Depicting Ranges from High School Diploma (1) to Graduate/Professional (6) Level of Education (n=417).
Figure D6: Ranges of Level of Trust in Utilities Boxplot (n=417).
Figure D7: Ranges of Level of Trust in Health Officials Boxplot (n=417).
Figure D8: Ranges of Level of Trust in Media Boxplot (n=417).
Figure D9: Ranges of Level of Trust in Government Officials Boxplot (n=417).
Figure D10: Ranges of Level of Trust in Politicians Boxplot (n=417).
Appendix E: Plots for 10 of the 14 Variables Depicting Variability in the Data for Positive Perceptions (n=218).

Figure E1: Positive Perception Dependent Variable Probability (QQ) Plot (n=218).
Figure E2: Non-Skin Contact Perception Independent Variable Probability (QQ) Plot for Positive Perception Participants (n=218).
Figure E3: Awareness Independent Variable Probability (QQ) Plot for Positive Perception Participants (n=218).
Figure E4: Independent Variable Boxplot Depicting Ranges from $0-14,999 (1) to $45,000 or more (4) Income Level for Positive Perception Participants (n=218).
Figure E5: Independent Variable Boxplot Depicting Ranges from High School Diploma (1) to Graduate/Professional (6) Level of Education for Positive Perception Participants (n=218).
Figure E6: Ranges of Level of Trust in Utilities Boxplot for Positive Perception Participants (n=218).
Figure E7: Ranges of Level of Trust in Health Officials Boxplot for Positive Perception Participants (n=218).
Figure E8: Ranges of Level of Trust in Media Boxplot for Positive Perception Participants (n=218).
Figure E9: Ranges of Level of Trust in Government Officials Boxplot for Positive Perception Participants (n=218).
Figure E10: Ranges of Level of Trust in Politicians Boxplot for Positive Perception Participants (n=218).
Appendix F: Plots for 10 of the 14 Variables Depicting Variability in the Data for Negative Perception Participants (n=155).

Figure F1: Negative Perception Dependent Variable Probability (QQ) Plot (n=155).
Figure F2: Non-Skin Contact Perception Independent Variable Probability (QQ) Plot for Negative Perception Participants (n=155).
Figure F3: Awareness Independent Variable Probability (QQ) Plot for Negative Perception Participants (n=155).
Figure F4: Independent Variable Boxplot Depicting Ranges from $0-14,999 (1) to $45,000 or more (4) Income Level for Negative Perception Participants (n=155).
Figure F5: Independent Variable Boxplot Depicting Ranges from High School Diploma (1) to Graduate/Professional (6) Level of Education for Negative Perception Participants (n=155).
Figure F6: Ranges of Level of Trust in Utilities Boxplot for Negative Perception Participants (n=155).
Figure F7: Ranges of Level of Trust in Health Officials Boxplot for Negative Perception Participants (n=155).
Figure F8: Ranges of Level of Trust in Media Boxplot for Negative Perception Participants (n=155).
Figure F9: Ranges of Level of Trust in Government Officials Boxplot for Negative Perception Participants (n=155).
Figure F10: Ranges of Level of Trust in Politicians Boxplot for Negative Perception Participants (n=155).
Appendix G: Correlation Coefficient Tables and Regions

### Table G1: Pearson’s Correlation Coefficient Using Bonferroni’s Value (n=417).

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<th>TrustH</th>
<th>TrustM</th>
<th>TrustG</th>
<th>TrustP</th>
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<td>Median Age</td>
<td>% with H.S. Ed and more</td>
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Table G4: Continued

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<th>% with H.S. Ed and more</th>
<th>Median Income ($)</th>
<th>% of Poverty</th>
<th>% of Pop 18 years and over</th>
<th>Cities/Neighborhoods</th>
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