Public Acceptance & Water Reuse: An Assessment of the Water Reuse Program Operating in San Marcos, Texas

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Abstract

Purpose: The purpose of this research is three-fold. First this applied research project develops an exploratory model to assess a water reuse program. Second, this applied research project uses the exploratory model to evaluate a water reuse program in San Marcos, TX. Third, based on the evaluation of the water-reclaiming program, recommendations for improvement are developed.

Method: The methodology used in this research is a case study. This methodology is an analysis of a single unit, the water reuse program operating in San Marcos, TX, and aims to generalize across a larger set of units, an exploratory model. Case study methodology in this research gains understanding by review and analysis of documents and conducting interviews through the development and testing of working hypothesis. The selection of this particular unit supports the research purpose by hosting interviews and focusing on organizational documents, which includes websites and literature (signage, public notifications, annual reports, etc.) produced by the water reuse program operating in San Marcos, TX.

Findings: The results demonstrate the application of communication and policies and practices to encourage public acceptance of water reuse. The criteria regarding public health concerns were not demonstrated by document analysis but did appear during the structured interviews. Specifically, document analysis regarding the maintenance of a water reuse inventory failed to yield evidence. The presence of support in the interviews suggests that the inventory is in place but not presented to the public via the Internet. As interviews demonstrated support for all of the criteria, increasing the volume of published information for the public would improve the water reuse program. Not increasing the available information for the public will limit the understanding of the intricacies associated with the water reuse program and may result in a decline of public support.

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Chapter I – Introduction and Research Purpose

Currently Texas is facing a water crisis (TWDB, 2011). Leading scholars attribute the crisis to the state's historical approach to capturing and managing its' water resources[1]. Texas has a history of implementing reactive policy to address water supply issues. The action results from one or a combination of three reoccurring themes: drought, population growth, and infrastructure development (Bath, 1999). Implementing reactive policy serves as a quick fix, or a treatment rather than a cure to the problems. While infrastructure development may create jobs, stimulate an economy, or temporarily offer a solution to an issue concerning the water supply, most do not address the big issue of long-term water security in the state (US EPA, 2012).

Texas droughts directly resulted in the construction of dams and water reservoirs. These were early attempts to store water. Beginning in 1920, Texas had 11 dams and by the 50's the number had grown to 66 dams. By the end of 1960, there were a total of 105 dams. The United States Federal Emergency Management Agency (FEMA) suggests a life expectancy of 50 years for a dam. (Hershaw, 2011). "Texas currently lists 7,126 non-federal dams including 1,046 high hazard (probable loss of life) and 725 significant hazard dams (potential loss of life). An average of four dams fail in Texas each year." (Texas - Dams, 2014). The maintenance of damming water has recently proven to require large sums of money. The dry weather in Texas causes cracks in the dams and now most work regarding these structures is directed to repair and maintenance. The state of Texas currently holds an infrastructure rating of D- for its dams (Texas - Dams, 2014). The low

[1] See Bath, (1999); Bagwell & Personett, (1997); Blanchard-Boehm, et al., (2008); Bumgarner & Thompson, (2012); Chaudhuri & Ale, (2014); Crawford, (2010); Weinheimer, et al., (2013).

rating is due to the lack of adequate inspection, maintenance, and repair. (Hershaw, 2011). Since 1990, the water level in Texas reservoirs has decreased approximately 30% (TWBD, 2011).

In addition to climate and development, population growth has contributed to the water security concerns in Texas. In 2013, Texas ranked as the second most populous state in the U.S. with 26.45 million residents (United States Census Bureau, 2013). The literature also reveals that between July 2012 and 2013, Texas gained more than 387,000 residents. This gain in population is an increase of more than 1.3 million people with a current rate of growth at 5.2% since the last U.S. Census in 2010 (Young, 2013).

One answer to Texas' problem is conservation and efficient water management[2]. The supply for the most part is a finite one and should be treated as so. With efforts geared towards conservation, Texas should be better equipped to manage the plaguing problems surrounding the states' water supply (TWBD, 2011).

Resourceful approaches would focus policy and direct projects toward water conservation and innovative water techniques (TWBD, 2011; US EPA, 2012). The Texas Water Development Board (TWDB) is the chief agency tasked with managing water techniques practiced in the state of Texas with a goal of ensuring future water supplies for Texans. The TWDB has defined a few practices as "innovative water technologies" as these practices aid in maintaining and replenishing water supplies (TWBD, 2011). The TWDB aims to tackle the water crisis by researching, funding, and implementing policy advancing "innovative water technologies" including: Aquifer Storage and Recovery,

[2] See Alan Plummer Associates, Inc., (2010); Buscher, (2015); Guest, et al., (2009); Hartley, (2006); Khan & Gerrard, (2005); TWBD, (2011); US EPA, (2012).

Brackish Resources Aquifer Characterization System (BRACS), Desalination, Rainwater Harvesting and Water Reuse technologies (TWBD, 2011).

Specifically, this research examines one of the innovative technologies identified by the TWDB. Essentially, water reuse is recycling already used water to use again for a constructive purpose (TWBD, 2011). At the local level, wastewater from homes and businesses is collected and then purified at a wastewater treatment facility to a water quality level suitable for its intended use (TWBD, 2011). Reclaimed water is local and typically utilized in five different ways: 1) irrigation of golf courses, park, and athletic fields, 2) cooling water for power generation facilities, 3) natural gas drilling operations, 4) decorative fountains or ponds, and 5) augmentation of potable water supplies through indirect reuse (TWBD, 2011). The primary benefit to water reuse is that, in most cases, the whole process remains local (TWBD, 2011). Wastewater is produced locally and is then treated nearby and repurposed to serve that community. Water reuse acts as an alternative to capturing new, distant, water sources and the associated infrastructure development meant to transfer water to the community (TWBD, 2011).

Research Purpose

The purpose of this research is three-fold. First this applied research project develops an exploratory model to assess a water reuse program. Second, this applied research project uses the exploratory model to evaluate a water reuse program in San Marcos, TX. Third, based on the evaluation of the water-reclaiming program, recommendations for improvement are developed.

San Marcos, Texas

The city of San Marcos is located in Central Texas on the Interstate 35 corridor between Austin (north of San Marcos) and San Antonio (south of San Marcos). The county seat for the city resides in Hays County but the city limits extend into Caldwell and Guadalupe Counties. The U.S. Census Bureau recorded the population of San Marcos at 44,894 in 2010 (U.S. Census Bureau). The City was named the "fastest growing city in the U.S." for the years 2013 - 2015 with a growth rate of approximately 7.9% (Zillman, 2015). The growth is expected to continue as San Marcos is home to Texas State University (approximately 35,500 students in 2013) and centrally located between two large employment hubs, Austin and San Antonio.

San Marcos is home to the San Marcos River, a natural spring fed river (Hendricks & Greene; San Marcos River Foundation). The Spanish were among the first to colonize the region in the mid to late 18th century (Hendricks & Greene). In addition to supplying water to the community, the San Marcos River serves as a tourist attraction. The water temperature of the San Marcos River remains at around 72°F year round and is known for its' clarity (San Marcos River Foundation). Popular recreational river activities include: glass boat tours, floating, kayaking, and fishing. San Marcos is also home to the San Marcos Premium and Tanger Outlet malls. The malls combined have approximately 350 stores and cover over 1 million square feet (San Marcos Convention & VIsitor Bureau).

Growth is one reason "innovative" water management strategies, such as water reuse, should be employed. An efficient water reuse program can effectively supplement a water supply by substituting reused water for applicable purposes (i.e. irrigation,

industrial cooling, fountains). San Marcos' Waste Water Treatment Plant (WWTP) is located in the southeast corner of town and involves direct non-potable reuse. The WWTP holds four industrial contracts; its first was with a gas-fired power plant in 2000. The San Marcos WWTP also holds contracts with a cement plant, golf course, and university. In 2005, the City Council of San Marcos granted a ten-year contract to CH2MHill to operate and maintain the City's WWTP. The fund associated with the WWTP accounts for approximately $32 million of the City of San Marcos' annual budget. The WWTP is permitted to receive an average daily flow (ADF) of 9 million gallons per day (MGD) under a TCEQ Texas Pollutant Discharge Elimination System (TPDES) permit.

Figure 1.1 – City of San Marcos WWTP

Figure 1.2 – City of San Marcos WWTP

Chapter Summaries

Chapter one provides an introduction to issues surrounding the water supply in Texas. This chapter also states the research purpose and presents some information on the setting of the case study. A brief introduction to the City of San Marcos and chapter summaries are also provided.

Chapter two reveals the historic influences on water supply and demand. The historical context answers the question, "How did we get here?" The historical context describes the major factors that created the current situation regarding water supply and demand.

Chapter three reviews the literature used in the development of the criteria that formulates the exploratory conceptual framework. The criteria are developed from the literature using working hypotheses as a mechanism for evaluation. The Working Hypothesis Framework is broken into the following overarching components: Communication, Public Health, and Policies & Practices.

Chapter four discusses the research methodology used in this study. This research is a case study, supported by document analysis and interviews while the conceptual framework is operationalized.

Chapter five provides the results from the document analysis and interviews used to assess water reuse programs. The results indicate all three criteria are incorporated into the water reuse program in considerable amounts. However, some specific facets of the three criteria are only included in limited amounts (i.e. coordination between/within agencies, public perception, reuse inventory).

Chapter six provides recommendations and conclusions based on the water reuse program case study. The results indicate that communication, public health, and policies and practices are applied in various degrees by the water reuse program operating in San Marcos. This chapter also provides information on suggestions for future research.

Chapter II – Historic Influences on Water Supply & Demand

Chapter Purpose

Chapter Two develops the historical context of influences on water supplies and demands and provides a definition of its features. The historical context is necessary to understand the development of the "water crisis" and suggest water reuse as a preferred alternative of water management.

Climate

The temperature, humidity, and annual rainfall present in a region influences the water supply. A major concern for most of the world is annual droughts (Dascher et al., 2014). The literature suggests most water use occurs during the warmer seasons, which are also growing seasons for most crops. The cooler seasons allow for water supplies to recharge and these are typically the wetter periods of the year regarding rainfall. Recharge rates also vary, as seasonal rainfall rates are not constant (Sun, et al., 2008).

While climate may be somewhat predictable in short sight, long-term uncertainty causes concern regarding the water supplies. Studies suggest that there has been a gradual increase in global temperatures since the beginning of the Industrial Revolution (1760's)[3]. Climactic variability influences and complicates predictions regarding water supplies around the world. Warmer temperatures generally result in a reduced water supply due to evaporation and evapotranspiration (Dascher, et al., 2014). Climate is only one of the influences on the supply and demand of water and it should be taken into consideration with all other influences while employing water management practices

[3] See Dascher, et al., (2014); Sun, et al., (2008); TWBD, (2011); US EPA, (2012).

(Dascher, et al., 2014). As climate is subject to variability, water managers are forced to rely on the conclusions revealed by historic and projected trends.

Population Growth

Population growth is occurring on all levels, local, state, and global[4]. Studies focusing on the correlation of population growth and the effect on a water supply have been conducted by examining average household water consumption, historical trends, and projected gains in regional populations. As of 2013, Texas has a population of 26.45 million ranking 2nd in the United States among states with the highest population. Texas is also home to the fastest growing city in the nation. As of 2013, San Marcos, TX has a population of 54,076 and has been growing at a rate of 8% (Blanchard-Boehm, et al. 2008). A growing population effects water supplies as larger a population requires more water for use. Common water uses to consider relating to this population growth include municipal, domestic, and recreational utilizations (Vogl 2011). Along with a reduction of the water supply, a growing population also means an increase in water demand. An increase in the practices linked with providing services such as clean water and wastewater treatment require additional resources (i.e. money & water) (Vogl 2011). A growing population is also related to urban sprawl. Urban areas are associated with impervious surfaces and higher temperatures with the concentration of infrastructure (Vogl 2011).

The major unknown regarding the impact on water supply and population growth involves advancement in technology. Projections suggest shortages by 2060 but there is

[4] See Damodaram & Zechman, (2013); Uddameri, et al., (2014); Vogl, et al., (2011).

no way to consider possible technological advancements enhancing the ability to secure/produce/conserve water supplies (TWBD, 2011; US EPA, 2012).

Population growth is an issue being dealt with on multiple communal levels. If trends continue as projected, something drastic must happen for water supplies to meet demands (TWBD, 2011; US EPA, 2012). The most practical change would be technological advancements regarding water management (TWBD, 2011; US EPA, 2012). Nonetheless, a growing population will require more water.

Land Cover & Use

In addition to the three reoccurring themes, land coverage and use has a positive or negative impact on a water supply depending on the landscaping and practices carried out on it[5]. Reasearchers based their findings on historcal, cultural, and regional trends, as well as considering technological advancements regarding land use. Land cover and use is subject to regional specificity. In most cases, land cover such as trees and grasses enhance a water supply as they slow runoff and increase infiltration (Bumgarner, et al. 2012). However, some species of flora (the Cedar tree in Texas) have the opposite effect as they absorb large amounts of water through their leaves and root systems (Banta, et al. 2011).

Land use, specifically agriculture, has a large impact on a water supply (Weinheimer, et al., 2013). Besides using the water to grow crops, agriculture also impacts the water supply through soil quality. Annual agriculture practices carried out on the same plot of land reduce soil quality, which in turn increases surface runoff (Chaudhuri, et al., 2014). Surface runoff can result in an increase of turbidity and

[5] See Banta & Slattery, (2011); Bumgarner & Thompson, (2012); Chaudhuri & Ale, (2014); Nagy C. R., et al., (2011); Strickland, (2009); Weinheimer, et al., (2013).

contaminants found in a water supply (i.e. pesticides & herbicides). Livestock is another example of land use in which the water supply may be negatively affected (Nagy, et al., 2011).

As with the other influences, future technological progressions regarding land uses make projections unclear (TWBD, 2011; US EPA, 2012). Technological advancements in agriculture could result in crops that use less water and/or reduce the impacts of current practices on a water supply.

Infrastructure Development/Technology

Infrastructure development can have positive or negative impacts depending on a stakeholder's relative location to the project[6]. The research is based on studies that involved historical practices and the current status of those practices. Dams, for example, can have a positive impact for stakeholders able to utilize the water captured by the structure but a negative impact for stakeholders located downstream as their supply would now be restricted (Blanchard-Boehm, et al., 2008). Researchers have also considered potential advancements in technology as a way to improve water supplies.

For the most part, technology (i.e. water reuse) enhances a water supply. Current and future technologies should allow for more efficient practices, monitoring abilities, and treatments such as desalination and wastewater. Water reuse enhances a water supply by supplementing it. Water is needed for various purposes (i.e. drinking, toilet flushing, industrial cooling, irrigation). In some cases (toilet flushing, industrial cooling, irrigation) reclaimed water can be used. This enhances a water supply by substituting the type of water used for these purposes. Desalination is another aspects in which reclaiming

[6] See Clayton, et al., (2014); Crawford, (2010); Damodaram & Zechman, (2013); Strickland, (2009); Sunshine, (2008); Vergara, et al., (2013).

water can supplement a potable water supply. Technology allows water reuse programs to desalinate salt water to be repurposed for potable uses. This would also enhance a water supply, as the desalinated product would be used instead of potable water in appropriate applications.

Desalination has proven to be an expensive process that has deterred adoption in many areas. However, as history suggests, as new technologies are developed, the cost of older technologies drops. Therefore, with time, desalination will become a common practice as newer technologies are developed. Water reuse is sure to be an important development as regions across the U.S. and World deal with changes in weather patterns, droughts, and population increases.

As technology develops over time, so will the purposes in which the reclaimed water can be used. Most water reuse programs produce Type II water, which is not suitable for public contact. However, this is likely not to be the case in the near future. With the development of technology, the methods in which wastewater is processed will follow. Technology change should result in reclaimed water suitable for purposes previously forbidden (i.e. dishwashing, laundry, bathing, drinking).

Policy

Water policy regarding the rights to its use is a complex issue with vague definitions and multiple administrative levels[7]. Research discussing the topic usually analyzes historical and current water policy and the apparent impacts on a water supply[8]. Authorities include the Environment Protection Agency (EPA), Texas Commission on

[7] See Bath, (1999); Damodaram & Zechman, (2013); Reisner, (1993); Vergara, et al., (2013); Wells, (2014).
[8] See Bath, (1999); Damodaram & Zechman, (2013); Reisner, (1993); Vergara, et al., (2013); Wells, (2014).

Environmental Quality (Texas specific), the Texas Water Development Board (Texas specific), watermasters, water conservation districts, ground water management authorities, and municipalities. These complicate jurisdiction, overlapping boundaries are mostly defined by county lines instead of the more logical watershed boundaries. This practice sometimes results in conflicts of interests (Bath 1999).

As suggested by the literature[9], water policy is a complex issue that has been under scrutiny for some time and a fundamental change must take place regarding the rights to water use. Current policy causes confusion and does a poor job of regulating and monitoring water use. Notions such as "use it or lose it," in agricultural practices discourage conservation as unused water rights may be lost the next season as the rights would be viewed as unneeded.

In conclusion, the literature reveals that all of the mentioned influences (climate, population growth, land cover & use, infrastructure development/technology, and policy) have an impact on a water supply. Therefore, water management practices should take into account all of the influences on the water supply when considering water management strategies. Also, ideal water management practices are subject to regional specificity. A state a large as Texas possesses variations in influences regarding water supply differing from the west to the east coast. To properly address the issues regarding the water supply and future demands in Texas, the state must adopt an approach to water management that considers all of the influences on the water supply, regional specificity, conservation, and efficient use. Ultimately, technological advancements and conservation efforts (water reuse) will be the key to meeting projected water demands.

[9] See Bath, (1999); Damodaram & Zechman, (2013); Reisner, (1993); Vergara, et al., (2013); Wells, (2014); TWBD, (2011); US EPA, (2012).

Chapter Summary

This chapter reveals historic influences on water supply and demand. The historical context answers the question, “How did we get here?” The historical context describes the major factors that created the current situation regarding water supply and demand.

Chapter III – Literature Review and Conceptual Framework

Chapter Purpose

From the literature, a conceptual framework is developed to organize the criteria used to provide a preliminary evaluation of the water reuse program operating in San Marcos, TX. The criteria are developed from the literature using working hypotheses as a mechanism for evaluation. The working hypotheses aim to test whether the water reuse program operating in San Marcos, TX adequately addresses issues of public acceptance regarding water reclamation and its' associated practices. The Working Hypothesis Framework is broken into the following overarching components: Communication, Public Health, and Policies & Practices.

Communication (Working Hypothesis 1)

"Communication is a complex process that takes place between two or more parties, whereby information is delivered, received, interpreted and responded to. To be successful, water reuse organizations must communicate effectively with their stakeholders." (Khan & Gerrard, 2005, p. 355) Stakeholders include all individuals and organizations effected by the water reuse programs (Khan & Gerrard, 2005). Stakeholders in a water reuse program can involve all levels of public agencies, property-owners, special interest groups, clients, potential clients and the community surrounding the water reuse program (Khan & Gerrard, 2005). Literature regarding the topic suggests the lack of communication between the water reuse programs and communities has directly resulted in the failure of the programs[10].

[10] See Hartley, (2006); Ingram, et al., (2005); Khan & Gerrard, (2005).

Identifying the leadership of a water reuse program involves recognizing those who are responsible for the practices associated with the water reuse program (Hartley, 2006). Recognizing the management enables the public to make judgments regarding their confidence in the leadership of the water reuse programs (Russell & Hampton, 2005). Public confidence in the leadership may be based on the leaderships' track record, knowledge and responses to the public (Russell & Hampton, 2005).

Effective communication also addresses public acceptance concerns through education and public outreach (Khan & Gerrard, 2005). Education and public outreach informs the public and stakeholders and promotes a water reuse community in order to strengthen communal confidence (Baker & McKenzie, 2008; Khan & Gerrard, 2005).

Coordinating communications within water reuse programs and between other agencies (drinking water programs, wastewater programs, department of health, etc.) encourages public acceptance (US EPA, 2012). Communications within and between agencies should be cohesive to avoid competing narratives and public confusion. Communications should build public confidence and encourage public acceptance of water reuse programs (Ingram, et al., 2005).

If the water reuse programs operating in San Marcos, TX identify the leadership, practice public education and outreach, and coordinate between/within agencies, one would expect:

WH1: Effective water reuse programs achieve public acceptance of water reuse through communication.

Identify the Leadership (WH1a)

"A knowledgeable and dedicated leader of the water reuse program who develops and maintains relationships with all water programs and other agencies should be designated." (US EPA, 2012, p. 4-2) Advancing technology, changes in weather patterns and population growth have all contributed to the complexity of the relationships between human and environmental needs (Janosova, et al., 2005). The technical aspects of the relationships and lack of technical expertise by the general community members, requires societies to have a competent authority(ies) to engage in daily operations and management (Janosova, et al., 2005).

Decades of studying leadership have yet to yield a definite meaning. The inconsistency makes the ability to assess leadership skills across-jobs challenging (Hurt & Homan, 2013). Robert Hamlin (2004) suggests that there are leadership behaviors that are universal[11]. Hamlin's model of universal leadership effectiveness determined that there were eight positive (effective) and six negative (ineffective) universal leadership behaviors (Table 3.1). Furthermore, the United States Department of Labor created the Occupational Information Network (O*NET). "The O*NET is a comprehensive occupational information system that coalesces the last 60 years of psychological and industrial research in organizational studies. The O*NET consists of a job content model with over 400 variables used to define a job and an active online database of over 1000 jobs profiled using the model." (Hurt & Homan, 2013, p. 19) From the 400 variables, the O*NET developed 42 Generalized Work Activities (GWAs) to describe work behaviors. Evaluating common leadership behaviors, such as Hamlin's and GWAs, allows for

[11] See Hamlin, (2004); Hamlin, (2005); Hamlin, et al., (2006).

across-job comparisons and a universal definition of leadership for various organizations to consider.

Table 3.1 – Hamlin's Model of Universal Leadership Effectiveness	
Positive (Effective) Universal Leadership Behaviors	**Negative (Ineffective) Universal Leadership Behaviors**
1. Good planning and organizing, and proactive execution, monitoring and control.	1. Inappropriate autocratic, dictatorial, authoritarian and non-consultative, non-listening managerial approach.
2. Active supportive management and leadership.	2. Unfair, inconsiderate, inconsistent, and/or selfish, manipulative, self-serving behavior.
3. Delegation and empowerment.	3. Active intimidating and/or undermining behavior.
4. Shows care and concern for staff and other people.	4. Slack management, procrastination in decision-making, ignoring problems and/or avoiding/abdicating from responsibilities.
5. Actively addresses and attends to the learning and development needs of their staff.	5. Depriving and/or withholding behavior.
6. Open, personal and trusting managerial approach.	6. Exhibits parochial behavior, a closed mind and/or a negative approach.
7. Involves and includes staff in planning, decision-making and problem solving.	
8. Communicates regularly and well with staff, and keeps them informed.	
Source: Hamlin, In Support of Universalistic Models of Managerial and Leadership Effectiveness: Implications for HRD Research and Practice, 2004	

Water reuse programs publicly recognizing the leadership tasked with managing the water reuse facilities and practices enables the public to make a judgment regarding their level of confidence in the programs' leadership. (Khan & Gerrard, 2005). "Success of water reuse projects will largely depend on the credibility of the supplier of information. The credibility of the water reuse organization and its senior managers is as important to the success of the projects as the quality of the project itself" (Khan & Gerrard, 2005, p. 358). Information, knowledge and public perception all play a role in shaping the communal confidence in water reuse programs (Hartley, 2006). Public confidence in leadership is developed from the relationships between the public and the organization (Hon & Grunig, 1999). There are six key elements of the relationships that can determine levels of public confidence in leadership (Table 3.2).

Table 3.2 - PR Relationship Measurement Scale
1. Control Mutuality - The degree to which parties agree on who has the rightful power to influence one another. Although some imbalance is natural, stable relationships require that organizations and publics each have some control over the other.
2. Trust - One party's level of confidence in and willingness to open oneself to the other party. There are three dimensions to trust: integrity: the belief that an organization is fair and just … dependability: the belief that an organization will do what it says it will do … and, competence: the belief that an organization has the ability to do what it says it will do.
3. Satisfaction - The extent to which each party feels favorably toward the other because positive expectations about the relationship are reinforced. A satisfying relationship is one in which the benefits outweigh the costs.
4. Commitment - The extent to which each party believes and feels that the relationship is worth spending energy to maintain and promote. Two dimensions of commitment are continuance commitment, which refers to a certain line of action, and affective commitment, which is an emotional orientation.
5. Exchange Relationship - In an exchange relationship, one party gives benefits to the other only because the other has provided benefits in the past or is expected to do so in the future.
6. Communal Relationship - In a communal relationship, both parties provide benefits to the other because they are concerned for the welfare of the other -- even when they get nothing in return. For most public relations activities, developing communal relationships with key constituencies is much more important to achieve than would be developing exchange relationships.
Source: Hon & Grunig, 1999

If the water reuse program operating in San Marcos, TX aims to encourage public acceptance through communication, one would expect:

WH1a: Water reuse programs should identify the program leadership.

Education & Public Outreach (WH1b)

Education and public outreach provide a mechanism by which water reuse programs can inform the public of the intricacies involved with reclaiming water (Baker & McKenzie, 2008). The general public lacks technical knowledge and an in-depth understanding of the activities associated with water reclamation (Janosova, et al., 2005). "Education and outreach is generally perceived as critical to advancing water recycling, not only to encourage its use, but also to overcome any public concerns about the safety and quality of recycled water" (Baker & McKenzie, 2008, p. 2). Education is associated with formal learning in a classroom setting for the purpose of professional development

(NASA, 2012). Education outcomes are evaluated and tested in the field before being utilized for educational purposes. Public outreach refers to an organizations' contact with the public (NASA, 2012). Public outreach can inform the public through the media, TV, radio, and the Internet.

Public education and outreach also provide a platform upon which water reuse programs can notify the public of programmatic goals (Hartley, 2006). "In most circumstances, a successful communications program will contain strategies that allow stakeholders to study the evidence and draw their own conclusions about water reuse. Stakeholders should view both the decision-making process and the decisions themselves as transparent and fair (Khan & Gerrard, 2005, p. 360)." It is key that water reuse facilities practice education and engage in public outreach in order for the public to exercise judgment, only then will the foundation of public acceptance be sound (Khan & Gerrard, 2005).

If the water reuse program operating in San Marcos, TX aims to encourage public acceptance through communication, one would expect:

WH1b: Water reuse programs should engage in education and public outreach.

Coordination Between/Within Agencies (WH1c)

A multitude of agencies, organizations and individuals can lay claim to public knowledge and opinion about aspects and practices related to water reclamation (US EPA, 2012). While debate about the merits of water reuse should be encouraged, it can lead to competing narratives regarding water reclamation. Coordination among agencies

that focuses on finding a common narrative should be practiced to determine a preferred tactic to address future water supplies and avoid divides in communal support (Coutts, 2005). "In many cases, it can be useful to remind the community that there are two major water management issues to be addressed. One is to overcome impending shortages of supply. The other is to limit the environmental implications of continuing to dump ever-increasing volumes of treated sewage into the world's rivers and oceans. Only water reuse can meet these challenges simultaneously" (Khan & Gerrard, 2005, p. 365). Publicizing a unified message amongst multiple outlets that encourages and supports water reuse programs avoids public confusion, recognizes water reuse as the preferred option, and encourages communal confidence in water reuse programs (Guest, et al., 2009; Ingram, et al., 2005).

If the water reuse program operating in San Marcos, TX aims to encourage public acceptance through communication, one would expect:

WH1c: Water reuse programs should coordinate between/within agencies.

Public Health (Working Hypothesis 2)

Public health concerns regarding the practices associated with water reuse programs influence public acceptance[12]. Public health concerns arise from the fact that water reuse programs reclaim water that has already been once used. Implementing a water reuse program without taking into consideration public health concerns can lead to community abandonment of support (Hurlimann & McKay, 2005). The literature

[12] See Hartley, (2006); Hon & Grunig, (1999); Hurlimann & McKay, (2005); TWBD, (2011); US EPA, (2012).

suggests that public health concerns can be addressed through appeasing the public perception of water reuse, adopting and implementing health and safety rules or guidelines governing water reuse, and maintaining a reuse inventory to provide program credibility[13].

Appeasing the public perception of water reuse encourages public acceptance of water reuse programs by providing communities with reassurance regarding the safety of the water reuse program practices. Water reuse programs can appease the public perception through aesthetic wastewater treatment, conducting research, and producing literature[14].

Adopting and implementing health and safety rules governing water reuse confirms that the environment, and the public residing in the environment, is protected. People tend to favor water reuse programs that offer environmental safeguards (Hartley, 2006). The rules should also be adaptable to evolving industry standards and technology (US EPA, 2012).

"Surveys indicate that water and sewerage authorities typically command the least degree of community trust" (Khan & Gerrard, 2005, p. 358). A reuse inventory mitigates this problem by building communal trust and promoting transparency in water reuse practices. Community trust is essential to the public acceptance of a water reuse programs[15]. A programs' inventory legitimizes the organization by recording its' operations and revealing compliance with rules and regulations (US EPA, 2012).

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[13] See Hartley, (2006); Hon & Grunig, (1999); Hurlimann & McKay, (2005).
[14] See Hartley, (2006); Hon & Grunig, (1999); NASA, (2012).
[15] See Hartley, (2006); Khan & Gerrard, (2005); Russell & Hampton, (2005); US EPA, (2012).

If the water reuse programs operating in San Marcos, TX ensure the safety of water reuse, adopt and implement health and safety guidelines governing water reuse, and maintain a water reuse program, one would expect:

WH2: Water reuse programs adequately address public health concerns regarding public acceptance.

Appease Public Perception of Water Reuse (WH2a)

Water reuse programs can appease the public's perception of water reuse through aesthetic wastewater treatments (TWBD, 2011). The general public lacks the technical capacity to assess wastewater quality based on contaminants, therefore, they may base their judgments on different values than the experts (Friend & Coutts, 2005). Lay people generally judge the quality of reclaimed water using sensorial analysis, specifically the color and the smell of the repurposed water (Zarra, et al., 2008). "Even though a real toxicological-sanitary risk is hardly ever associated with the odor impact from sources connected to the activities of wastewater management, due to the rarely dangerous nature of the smells as well as the generally very low concentration, the collective imagination often associates the bad smell to conditions of 'non healthy' air" or water. (Zarra, et al., 2008, p. 89).

Water reuse programs can also satisfy the public's discernment of water reuse by conducting research and producing literature (US EPA, 2012). Ongoing research and subsequent publication demonstrates a commitment to the analyses of water reuse, which in turn demonstrates the safety of a water reuse program (Khan & Gerrard, 2005). As previously mentioned, lay people lack the technical expertise to fully comprehend all of

the intricacies associated with water reuse programs (Friend & Coutts, 2005). Therefore, water reuse programs should conduct research and produce literature, revealing the safety of water reuse, as they possess the capacity to assess and analyze the practices (Baker & McKenzie, 2008).

If the water reuse program operating in San Marcos, TX aims to address public health concerns to encourage public acceptance, one would expect:

WH2a: Water reuse programs should appease public perception of water reuse.

Adopt and Implement Health & Safety Rules (WH2b)

Health and safety rules implemented and adopted for governing water reuse should be comprehensive and detailed to reassure environmental safety and address public health concerns (Coutts, 2005). Rules refer to enacted regulations that have been developed, and can be enforced, by governmental agencies (Friend & Coutts, 2005). The federal government and state agencies jointly regulate public waterways in the United States. The ultimate authority for reclaimed water in the U.S. is The Clean Water Act (CWA), 1972. "The 1972 CWA assigned the federal government and states specific responsibilities for water quality management designed to make all surface waters 'fishable and swimmable.'" (US EPA, 2012, p. 4-5) Fundamental components of a water reuse regulatory framework are described in the EPA's 2012 Guidelines for Water Reuse (Table 3.3).

Table 3.3 EPA's Fundamental Components of a Water Reuse Regulatory Framework for States	
Category	**Comment**
Purpose and/or goal statement	• Frame the state's purpose for developing the rule or regulation (e.g., to satisfy a need or fulfill a statutory requirement), and describe the ultimate vision for the water reuse program. The process to authorize, develop, and implement rules or changes to rules is time consuming and costly. After adoption, rules are difficult to change, which limits the ability to accommodate new technologies and information.
Definitions	• Define type of use and other water reuse-related terms used within the body of the rule or regulation.
Scope and applicability	• Define type of use and other water reuse-related terms used within the body of the rule or regulation. • Include grandfathering or transitioning provisions for existing facilities, systems, or activities not regulated prior to the adoption of the rules or regulations.
Variance	• Describe procedures for variances to design, construction, operation, and/or maintenance requirements of the regulation for hardships that outweigh the benefit of a project, and the variance, if granted, would not adversely impact human health, other beneficial uses, or the environment. These variance procedures give regulators flexibility to consider projects that may deviate only minimally from the requirements with no significant adverse impact or opportunities that are not anticipated during initial development of a regulation. Since variances need to be based on sound, justifiable reasons for change, regulatory programs should develop guidance on how to develop adequate justification that can be relied upon as precedence setting for future regulatory decisions and actions.
Permitting requirements	• Describe the permitting framework for water reuse. Indicate whether the water reuse rule or regulation will serve as the permitting mechanism for water reuse projects or identify other regulations through which the water reuse rule or regulation will be implemented and projects permitted. • Describe if or how end users of reclaimed water will be permitted, and rights of end user to refuse reclaimed water if not demanded. • Describe permit application requirements and procedures. Specify all information that the applicant must provide in order to appropriately evaluate and permit the water reuse projects.
Define or refine control and access to reclaimed water	Determine the rights to and limits of access and control over reclaimed water for subsequent use and the relationship between the underlying water right, wastewater collection system ownership, reclamation plant ownership, and downstream water users who have demonstrated good-faith reliance on the return of the wastewater effluent into a receiving stream within the limits and requirements of the state's water rights statutory and regulatory requirements.
Relationship to other rules	• Describe relationship between water reuse rule or regulation and, for example, water and wastewater regulations, environmental flow requirements, solid waste or hazardous waste rules, groundwater protection, required water management plans, and relevant health and safety codes for housing, plumbing, and building.
Relationship to stakeholders	• Identify regulatory or non-regulatory stakeholders from various sectors (e.g., water, wastewater, housing, planning, irrigation, parks, ecology, public health, etc.) that have a role or duty in the statewide reuse program.
Relationship to regulations or guidelines for uses of other non-	• Describe other rules or regulations that exist for graywater recycle and stormwater or rainwater harvesting and use. • Some states may choose to develop a more comprehensive approach that encompasses rules or regulations for all non-conventional water sources,

conventional water sources	including water reuse, within one set of rules or regulations.
Reclaimed water standards	• Include a provision to evaluate and allow standards to be developed on a case-by-case basis for less common uses of reclaimed water that are not listed. • Require points of compliance to be established to verify compliance with standards.
Treatment technology requirements	• In addition to reclaimed water standards, some states specify treatment technologies for specific reuse applications.
Monitoring requirements	• Describe methods and frequency for monitoring all standards listed in the rules or regulations.
Criteria or standards for design, siting, and construction	• Describe criteria or standards of engineering design, siting, and construction for water reuse facilities and systems that typically include, but are not limited to, facilities or systems to treat/reclaim, distribute, and store water for reuse. • Develop requirements for dual plumbed distributions systems (separate distribution of potable and nonpotable water) that are co-located. • Describe requirements for the transfer of reclaimed water and its alternative disposal if unsuitable or not required by target user (e.g., during wet seasons).
Construction requirements	• Describe requirements for engineering reports, pilot studies, and certificates required to construct and to operate.
Operations and maintenance (O&M)	• Describe minimum requirements for the submission and content of O&M manual. The scope and content of an O&M manual will be determined by the type and complexity of the system(s) described by the manual.
Management of pollutants from significant industrial users as source water protection	• Where facilities or systems with inputs from significant industrial users are proposing to generate reclaimed water suitable for human contact or potable reuse, describe programs that must be implemented to manage pollutant of concern from significant industrial users. • Pretreatment programs of combined publicly owned treatment works and reclamation systems may satisfy program requirements. • Develop program requirements for satellite reclamation systems also affected by inputs from significant industrial users. • Such pretreatment programs should develop discharge limits that are intended to protect source water, rather than wastewater treatment and sewer system integrity.
Access control and use area requirements	• Describe requirements to control access to sites where reclaimed water will be generated, or in some cases, stored or utilized. • Describe requirements for advisory sign placement, message, and size. • Describe requirements for proper use of reclaimed water by end users to ensure protection of the environment and human health (e.g., setbacks, physical barriers or practices to prevent reclaimed water from leaving the site of use, etc.).
Education and notification	• Include requirements for generators or providers of reclaimed water to educate end users of appropriate handling and use of the water, and to provide notification to end users regarding the discharges of substandard water to reuse and loss of service for planned or unplanned cause.
Operational flow requirements	• Requirements for maintaining flow within design capacity of treatment system or planning for additional treatment capacity as needed.
Contingency plan	• Include a requirement for a contingency plan that describes how system failures, unauthorized discharges, or upsets will be remedied or addressed.
Recordkeeping	• Describe what operating records must be maintained, the location where they are retained, and the minimum period of retention.

Reporting	• Describe what items must be reported, the frequency of reporting, and to whom they are reported.
Stakeholder participation	• Requirements on public notice, involvement, and decision-making. This will apply where the water reuse rule or regulation is used as the vehicle to permit water reuse projects.
Financial assistance	• Describe state, local, or federal funding or financing sources.
Source: US EPA, 2012	

It is also fundamental that these rules have the capacity to adapt to industry changes arising from technological advances (US EPA, 2012). Research regarding water reuse has increased over the years due to the growing need to supplement water supplies (TWBD, 2011). The increase in water reuse research has resulted in evolving technologies that better equip water reuse programs to manage and administer reclaimed water (Alan Plummer Associates, Inc., 2010). Technological advancements increase opportunities for the use of reclaimed water (Alan Plummer Associates, Inc., 2010). Therefore, rules must be updated accordingly to regulate the new avenues created technological advancements.

If the water reuse program operating in San Marcos, TX aims to address public health concerns to encourage public acceptance, one would expect:

WH2b: Water reuse programs should adopt and implement health and safety rules governing water reuse.

Maintain a Reuse Inventory (WH2c)

Maintaining a water reuse inventory provides the program with legitimacy. The credibility of the water reuse organization is a factor that greatly influences the success of the water reuse programs (Ingram et al., 2005) and, "recent observations suggest that

wastewater utilities may be suffering from a general decline in community trust and confidence… (Khan & Gerrard, 2005, p. 358).” This is generally a common trend for all public agencies and officials in the United States (Hartley, 2006). A good reputation is the firmest case for communal trust because it is built over time (Khan & Gerrard, 2005). “The water reuse organization should seek to remind the community of past circumstances, or an on-going history, where trust placed in it has proved warranted (Khan & Gerrard, 2005, p. 362).” The history of water reuse programs is recorded in its’ inventory.

A water reuse inventory records the programs operations and interactions with customers and the public. The inventory records disinfections levels, permitted capacities and average flows for the programs reuse activities (Cunliffe et al., 2005). Activities refer to the purpose of the water reuse and include landscaping, agriculture, ground water recharge, and industrial uses (US EPA, 2012). A programs’ inventory also includes the publics’ access to reuse systems by reporting the number of residents, golf courses, schools and any unique uses of reclaimed water by the program (Cunliffe et al., 2005). Customer charges are also recorded in a water reuse programs inventory.

If the water reuse program operating in San Marcos, TX aims to address public health concerns to encourage public acceptance, one would expect:

WH2c: Water reuse programs should maintain a reuse inventory.

Policies & Practices (Working Hypothesis 3)

Policies and practices are established to regulate the activities associated with reclaiming water to ensure the safety of the practices (Cunliffe, et al., 2005; TWBD, 2011). Policies and practices differ from rules based on the water reuse programs' relationship with each. Rules are developed, enforced and developed by regulatory agencies for water reuse programs by which the programs must comply. Policies and practices refer to the programs interpretations of the rules and are developed by the program to engage with the public (US EPA, 2012).

Specific policies and practices that facilitate public acceptance of water reuse programs include: establishing reclaimed water standards; clarifying the intended use for the recycled water; and mitigating the effects on the community[16]. If not the state, the locality in which water reuse programs operate should have in place expected standards regarding the quality of the final product produced from the facilities (Bagwell & Personett, 1997). Policies and practices may also be in place to encourage cooperation amongst locales and/or various levels of government (Bagwell & Personett, 1997; TWBD, 2011).

Multiple researchers suggest that the disapproval of water reuse programs strongly correlates with the intended use of the repurposed water[17]. Literature reveals that the two significant factors influencing public acceptance include the intended purpose of the

[16] See Bagwell & Personett, (1997); Cunliffe et al., (2005); Harshman & Barnette, (2000); Khan & Gerrard, (2000); Munoz, et al., (2010); TWBD, (2011); Zarra et al., (2008).
[17] See Cotruvo & Bell, (2014); Cunliffe et al., (2005); Hurlimann & McKay, (2005); Khan & Gerrard, (2005).

reclaimed water and the likelihood of public contact with the recycled water[18]. The higher likelihood of public contact with the repurposed water resulted in lower public acceptance of the practice. One study found an acceptance rate of over 90% for water reused for the purpose of maintaining recreational parks and golf courses, uses that involve a lower possibility of human contact (Khan & Gerrard, 2005). As the likelihood for human contact rose, the likelihood of public acceptance dropped. The study reported variances of 70% to 90% in the approval of repurposed water used for toilet flushing and washing clothes and a 30% to 60% variance in the approval for uses such as cooking and drinking (Khan & Gerrard, 2005).

Years of population growth and urban sprawl have led to water reuse facilities operating in close proximity to communities (Zarra, et al., 2008). Lay people within communities tend to exercise sensorial judgments to determine the quality of reclaimed water (Munoz, et al., 2010; Zarra, et al., 2008). The smell and the color of the recycled water is the most common way people lacking technical expertise determine water quality (Munoz, et al., 2010; Zarra, et al., 2008). Various states and locales enact policies and regulations to address these concerns by requiring buffer zones and odor abatement tactics[19].

[18] See Cotruvo & Bell, (2014); Cunliffe et al., (2005); Hurlimann & McKay, (2005); Khan & Gerrard, (2005); TWBD, (2011).
[19] See Munoz, et al., (2010); TWBD, (2011); Zarra et al., (2008).

If the water reuse program operating in San Marcos, TX meets the requirements laid out in the TAC, one would expect:

WH3: Water reuse programs adequately address the issues of public acceptance through policies and practices consistent with community, state and environmental norms.

Establish Reclaimed Water Standards (WH3a)

Standards set expectations for both the producer and consumer of products (Khan & Gerrard, 2005). Consumer concerns are either legitimized or extinguished by recalling standards set in place by the water reuse programs (Khan & Gerrard, 2005). Not adhering to standards can result in the termination of operations and discourages public confidence in the entity tasked with maintaining operations of the facilities (TWBD, 2011). Reclaimed water standards should be assessed on a case-by-case basis to accommodate for regional specificity (US EPA, 2012). Standards regarding water reuse programs revolve around communicating risks associated with reclaimed water to the public (US EPA, 2012). "Risk communication is a process; one that generally composed of the behaviors of hearing, understanding, perceiving, believing, confirming, and then responding to a warning message" (Blanchard-Boehm, et al., 2008, p. 299). Risk communication consists of two categories: (1) emergency warnings, or public understandings and reactions to communications about risks in the near future (flash floods, natural disasters); and (2) pre emergency, low-key warning, which addresses public analyses and replies to communications regarding possible long-term threats (future water supplies)(Blanchard-Boehm, et al., 2008).

Regional water planning for water reuse allows for a "bottom-up" approach to water planning (TWBD, 2011). "The primary problem we face is not the availability of technology for resource recovery, but the lack of a socio-technological planning and design methodology to identify and deploy the most sustainable solution in a given geographic and cultural context" (Guest, et al., 2009, p. 6127). Regional planning for water reuse is necessary as local water needs vary. The size of Texas suggests that regional planning be implemented and the notion is supported with the enacting of Senate Bill 1 in the Texas Legislature during 1997 (Buscher, 2015). A water reuse program should equally consider environmental, economic, and social impacts of regional planning across spatial and temporal scales identified by stakeholders (US EPA, 2012). Stakeholders are broadly defined to include utility manager, operators, regulators, local government officials, public interest groups and all others impacted by the program (Guest, et al., 2009).

If the water reuse program associated with reclaiming water for reuse in San Marcos, TX aims to be accepted by the public…

WH3a: Water reuse programs should establish reclaimed water standards.

Clarify Intended Use for the Recycled Water (WH3b)

The literature suggests that the likelihood of public contact with water reuse operations is important in determining public acceptance[20]. Therefore, it is important for the water reuse programs to clarify which type of reclaimed water use will be

[20] See Cotruvo & Bell, (2014); Cunliffe et al., (2005); Hurlimann & McKay, (2005); Khan & Gerrard, (2005); TWBD, (2011).

implemented. Purposes for reclaimed water can be broken down to two different types, potable (suitable for drinking) and non-potable (suitable for uses other than drinking), and four categories: direct potable reuse, indirect potable reuse, direct non-potable reuse, and indirect non-potable reuse (see table 3.4) (TWBD, 2011; US EPA, 2012).

Table 3.4 – Categories of Water Reuse
Direct potable reuse – refers to the use of reclaimed water that is piped directly from a wastewater treatment facility to a drinking water treatment and distribution center. (The TCEQ has not yet developed a rule for implementing direct potable reuse in Texas.)
Indirect potable reuse – refers to the use of reclaimed water to augment drinking water supplies by discharging to a water body that is subsequently treated for potable consumption.
Direct non-potable reuse – refers to the use of reclaimed water that is piped directly from a wastewater treatment facility to a site for non-potable beneficial uses such as landscape irrigation, power plant cooling, and manufacturing.
Indirect non-potable reuse – refers to the use of reclaimed water for non-potable purposes by discharging to a water body that is a supply source for non-potable uses, such as golf course irrigation.
Source: US EPA, 2012

Each category of reclaimed water involves a different level of likeliness of public contact. Studies found a greater public acceptance of non-potable uses rather than potable as the likeliness of ingesting reclaimed water is associated with potable uses[21]. Signage, public meetings, and media announcements (TV commercial, radio, email service) are ways of communicating the intended use and the type of reclaimed water to be utilized (TWBD, 2011; US EPA, 2012). Communicating the intended use and type of reclaimed water to be utilized informs the public on how they should interact with the repurposed water (Cotruvo & Bell, 2014; Hurlimann & McKay, 2005).

If the water reuse program associated with reclaiming water for reuse in San Marcos, TX aims to be accepted by the public…

WH3b: Water reuse programs should clarify the intended use for the recycled water.

[21] See Cotruvo & Bell, (2014); Cunliffe et al., (2005); Hurlimann & McKay, (2005); Khan & Gerrard, (2005); TWBD, (2011).

Mitigate the Effects on the Community (WH3c)

"Any place or process in which wastewater is collected, conveyed or treated has the potential to generate and release nuisance odors to the surrounding area" (Harshman & Barnette, 2000, p. 34). This is becoming an increasing issue with water reuse programs due to recent trends in population growth and urban sprawl (Zarra, et al., 2008). Where applicable, water reuse facilities operate within buffer zones designated by various policies present in the region (TWBD, 2011). Buffer zones establish a barrier between the facilities and communities in order to shield the public from unpleasant effects of the production of recycled water (Zarra, et al., 2008). Water reuse program can also address issues of nuisance odors through odor abatement tactics (Munoz, et al., 2010). These tactics capture the toxins released into the air that cause the unpleasant smells resulting from the water reclamations processes (Munoz, et al., 2010). Mitigating the effects on the community through established buffer zones and odor abatement is critical to the public acceptance of water reuse as nuisance odors produced by water reuse facilities are considered the most common complaint amongst the exposed community (Munoz, et al., 2010; Zarra, et al., 2008).

If the water reuse program associated with reclaiming water for reuse in San Marcos, TX aims to be accepted by the public…

WH3c: Water reuse programs should mitigate the effects on the community.

Summary of the Conceptual Framework

A conceptual framework is developed to organize the criteria used to provide a preliminary evaluation of the water reuse program operating in San Marcos, TX. Based on findings in the literature, working hypothesis are developed in order to assess the water reuse program operating in San Marcos, TX. The exploratory conceptual framework table elucidates the preliminary conceptual framework by including the working hypothesis, sub-hypothesis and the supporting scholarly literature utilized to develop the criteria to evaluate water reuse programs.

Table 3.5 Conceptual Framework

Title: Public Acceptance & Water Reuse: An assessment of the Current Water Reuse Program Operating in San Marcos, Texas **Purpose:** The purpose of this research is three-fold. First this applied research project develops an exploratory model to assess a water reuse program. Second, this applied research project uses the exploratory model to evaluate a water reuse program in San Marcos, TX. Third, based on the evaluation of the water-reclaiming program, recommendations for improvement are developed.	
Working Hypothesis	**Supporting Literature**
Working Hypothesis 1: Water reuse programs adequately address public acceptance regarding the practice of water reuse through **communication.**	
WH1a: Water reuse programs should **identify the leadership.**	(Hamlin, 2004)(Hamlin, 2005)(Hamlin, 2006) (Hartley, 2006) (Hon & Grunig, 1999) (Hurt & Homan, 2013) (Janosova, et al., 2005) (Khan & Gerrard, 2005) (US EPA, 2012)
WH1b: Water reuse programs should **engage in education & public outreach.**	(Baker & McKenzie, 2008) (Hartley, 2006) (Janosova, et al., 2005) (Khan & Gerrard, 2005) (NASA, 2012)
WH1c: Water reuse programs should **coordinate between/within agencies.**	(Coutts, 2005) (Guest, et al., 2009) (Ingram, et al., 2005) (Khan & Gerrard, 2005) (US EPA, 2012)
Working Hypothesis 2: Water reuse programs adequately address **public health** concerns regarding public acceptance.	
WH2a: Water reuse programs should **appease public perception of water reuse.**	(Baker & McKenzie, 2008) (Friend & Coutts, 2005) (Khan & Gerrard, 2005) (TWBD, 2011) (US EPA, 2012) (Zarra, et al., 2008)
WH2b: Water reuse programs should **adopt and implement health and safety rules governing water reuse.**	(Alan Plummer Associates, Inc., 2010) (Coutts, 2005) (Friend & Coutts, 2005) (TWBD, 2011) (US EPA, 2012)
WH2c: Water reuse programs should **maintain a reuse inventory.**	(Cunliffe, et al., 2005) (Hartley, 2006) (Ingram, et al., 2005) (Khan & Gerrard, 2005)
Working Hypothesis 3: Water reuse programs adequately address the issues of public acceptance through **policies and practices** consistent with community, state and environmental norms.	
WH3a: Water reuse programs should **establish reclaimed water standards.**	(Bagwell & Personett, 1997) (Blanchard-Boehm, et al., 2008) (Buscher, 2015) (Guest, et al., 2009) (Khan & Gerrard, 2005) (TWBD, 2011) (US EPA, 2012)
WH3b: Water reuse programs should **clarify the intended use for the recycled water.**	(Cotruvo & Bell, 2014) (Cunliffe, et al., 2005) (Hurlimann & McKay, 2005) (Khan & Gerrard, 2005) (TWBD, 2011) (US EPA, 2012)
WH3c: Water reuse programs should **mitigate the effects on the community.**	(Harshman & Barnette, 2000) (Munoz, et al., 2010) (TWBD, 2011) (Zarra, et al., 2008)

Chapter Summary

This chapter reviews the literature used in the development of the criteria that formulates the exploratory conceptual framework. The criteria are developed from the literature using working hypotheses as a mechanism for evaluation. The Working Hypothesis Framework is broken into the following overarching components: Communication, Public Health, and Policies & Practices.

Chapter IV – Research Methodology

Chapter Purpose

Chapter Four describes the research techniques used to assess the water reuse program operating in San Marcos, TX focusing on the characteristics of the exploratory model developed in the previous chapter. This chapter follows the collection and assessment of material that define a water reuse program as part of the exploratory model.

Research Method

The methodology used in this research is a case study. This proves appropriate as a case study, "investigates a contemporary phenomenon (the "case") in depth and within its real-world context" (Yin, 2014, p. 16). A case study permits researchers to comprehend various characteristics of organizations, such as, the water reuse program operating in San Marcos, TX (Shields & Rangarajan, 2013; Yin, 2014). This methodology is an analysis of a single unit, the water reuse program operating in San Marcos, TX, and aims to generalize across a larger set of units, the exploratory model developed in chapter three. Case study methodology in this research gains understanding by review and analysis of documents and conducting interviews through the development and testing of working hypothesis (Shields & Rangarajan, 2013).

The unit of analysis of this study is the water reuse program operating in San Marcos, TX. The selection of this particular unit supports the research purpose by hosting interviews and focusing on organizational documents, which includes websites and literature (signage, public notifications, annual reports, etc.) produced by the water reuse program operating in San Marcos, TX.

Operationalization of the Conceptual Framework

The working hypotheses and corresponding sub-hypotheses were operationalized through the use of document analysis and interviews (Shields & Tajalli, 2006). Table 4.1 outlines the source of evidence (historical documents & interviews) used to test the working hypotheses and the questions that shape the analyses of the historical documents and interviews operationalization of the conceptual framework. The conceptual framework is divided into three sections, each with an operationalization of the corresponding working hypotheses. Each section of the table contains three columns. The first column numbers the working sub-hypotheses. The second column lists the document sources evaluated. The third column identifies the questions evaluated. For example, WH1a identifying leadership is tested using document analysis (City of San Marcos and Guadalupe-Blanco River Authority websites). If these websites post information on the water reuse program leaders, the evidence would support WH1a. The interviews are applied in the same manner. For example, WH1b education and public outreach is tested with structured interviews (along with document analysis). If these interviews reveal information on the water reuse programs' approach to education and public outreach, the evidence would support WH1b.

Table 4.1 – Operationalization Table

Title: Public Acceptance & Water Reuse: An assessment of the Current Water Reuse Program Operating in San Marcos, Texas **Purpose:** The purpose of this research is three-fold. First this applied research project develops an exploratory model to assess a water reuse program. Second, this applied research project uses the exploratory model to evaluate a water reuse program in San Marcos, TX. Third, based on the evaluation of the water-reclaiming program, recommendations for improvement are developed.		
Working Hypothesis 1: Water reuse programs adequately address public acceptance regarding the practice of water reuse through **communication.**		
Sub-hypothesis	**Method of data collection**	**Evidence**
WH1a: Water reuse programs should **identify the leadership.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos identifies the leadership. I-1: How does a water reuse program choose the leadership? I-2: How does the water reuse leadership interact with the public?

WH1b: Water reuse programs should **engage in education & public outreach.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos engages in education & public outreach. I-3: Why does a water reuse program engage in education & public outreach? I-4: How does a water reuse program engage in education & public outreach?
WH1c: Water reuse programs should **coordinate between/within agencies.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos coordinates between/within agencies. I-5: How does a water reuse program promote a water reuse community? I-6: How does a water reuse program coordinate between/within agencies?

Working Hypothesis 2: Water reuse programs adequately address **public health** concerns regarding public acceptance.		
WH2a: Water reuse programs should **appease public perception of water reuse.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos appeases the public perception of water reuse. I-7: How does a water reuse program appease the public perception of water reuse?
WH2b: Water reuse programs should **adopt and implement health and safety rules.**	**Document Analysis:** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority **Interview Question – (I)** City of San Marcos Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos adopts and implement health and safety rules. I-8: How does a water reuse program achieve balance between human and environmental needs? I-9: How does a water reuse program adapt to new technologies?

WH2c: Water reuse programs should **maintain a reuse inventory.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos maintains a reuse inventory. I-10: Why do water reuse programs maintain a reuse inventory? I-11: How does a water reuse program maintain a reuse inventory?
Working Hypothesis 3: Water reuse programs adequately address the issues of public acceptance through **policies and practices** consistent with community, state and environmental norms.		
WH3a: Water reuse programs should **establish reclaimed water standards.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos produce a product that meets state & local reclaimed water quality standards. I-12: How does a water reuse program communicate the risks associated with water reuse (emergency and pre-emergency)?

WH3b: Water reuse programs should **clarify the intended use for the recycled water.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos clarify the intended use for the recycled water. I-13: How does a water reuse program clarify the intended use for the recycled water?
WH3c: Water reuse programs should **mitigate the effects on the community.**	**Document Analysis:** City of San Marcos (Website) Guadalupe-Blanco River Authority (Website) **Interview Question – (I)** City of San Marcos (Director of Water/Wastewater Department) Guadalupe-Blanco River Authority (Director of Hays County)	The documents should reveal that the water reuse program operating in San Marcos mitigate the effects on the community. I-13: How does the water reuse program mitigate the effects on the community?

Support Criteria

The collected evidence is gauged on a four-level scale based on the water reuse programs' demonstration of the criteria developed by the exploratory model. The four levels of the scale include: no support, weak support, sufficient support, and exceptional support. Evidence assigned a no support level indicates that the criteria developed by the exploratory model were not present in the document analysis or interviews. This indicates that none of the reviewed documents or structured interviews mentioned the criteria developed by the exploratory model.

Evidence assigned a weak support level indicates that the criteria developed by the exploratory model were present in either the document analysis or interviews, but not enough to reach to sufficient level. This indicates that a small number of the reviewed documents and structured interviews mentioned the criteria developed by the exploratory model. The main difference between weak and sufficient is frequency and depth. If an element of the exploratory model is mentioned in only one set of documents or only interviews, then it is assigned a weak level of support. A weak level of support can also be assigned if an element of the exploratory criteria is mentioned but lacks a sufficient explanation or depth.

Evidence assigned a sufficient support level indicates that the criteria developed by the exploratory model were present in a majority of the document analysis and interviews. A sufficient support level indicates that an acceptable amount of the exploratory model is present in the water reuse program. This indicates that a portion of the reviewed documents and interviews mentioned the criteria developed by the exploratory model. The main difference between sufficient and exceptional is an expectation of findings. A level of exceptional support frequently verifies expectations while they are verified less frequently with a sufficient level of support. If an element of the exploratory model is mentioned in both sets of documents or a combination of a single set of documents and interviews, then it is assigned a sufficient level of support.

Evidence assigned an exceptional support level indicates that the criteria developed by the exploratory model were present in both the document analysis and interviews. This indicates that a large portion of the reviewed documents and structured interviews mentioned the criteria developed by the exploratory model. If an element of

the exploratory model is mentioned in both sets of documents and interviews, then it is assigned an exceptional level of support.

Document Analysis

Document analysis is one of the data collection tools used in this study. Analyzing documents provides useful facts about the water reuse program. This in turn facilitates an understanding of the program's capacity to support working hypotheses on their own. Document analysis also provides for exactness, and the ability to repeatedly review. Weaknesses include content familiarity, difficulties in obtaining documents, and bias selectivity (Shields & Rangarajan, 2013; Yin, 2014). Document analysis is used to test all of the working hypotheses within the conceptual framework.

The document analysis of the water reuse program operating in San Marcos, TX was affected by availability. Not all of the websites are maintained in the same fashion. For example, some websites (i.e. City of San Marcos) has not updated its website to describe the current capacity of production permitted for the water reuse program. The documents analyzed in this study are based on electronic availability. Table 4.1, the Operationalization Table mentions the documents reviewed in this study.

Interviews

Interviews are another mode of data collection used in this study. Interviews aim to describe central themes in a real world setting and reveal what those themes mean to the subjects. The exploratory framework develops the themes for this topic. Weaknesses include response bias, inaccuracies due to poor recall, and reflexivity (interviewee says what interviewer wants to hear) (Shields & Rangarajan, 2013; Yin, 2014). The interviews are used to verify the categorical features of the exploratory model. The interviews lasted

an average of 45 minutes with the longest at 75 minutest and the shortest 30 minutes. Interviews are used to assess all of the working hypotheses under the conceptual framework.

The interviews of the subjects related to the water reuse program operating in San Marcos, TX was affected by number of participants. Five out of the eight possible candidates were unwilling to participate due to time constraints and nature of the discussion. Even though anonymity was ensured, some participants were unwilling to discuss the relevant topics.

This study uses human subjects in its structured interviews. The primary concerns associated with this research include voluntary participation and participant anonymity. To address the issues of voluntary participation and anonymity, a consent form was provided to all participants. Consent to participate included disclosure of all information pertaining to this study except for participants' names. The interviews were conducted in the offices of the participants'. Participants were allowed to be excused at anytime if they felt uncomfortable with the interview. This research project was approved for exemption by the Texas State Institutional Review Board under category 2 on August 27, 2015 (EXP2015F343178V).

Chapter Summary

This chapter discussed the research methodology used in this study. This research is a case study, supported by document analysis and interviews while the conceptual framework is operationalized. The next chapter presents the results of the San Marcos, TX water reuse program case study.

Chapter V – Results

Chapter Purpose

Chapter five provides the results from the document analysis and interviews used to assess water reuse programs. This chapter is organized by the working hypotheses that incorporate the three criteria developed by the exploratory model: communication, public health, and policies & practices. The results indicate all three criteria are incorporated into the water reuse program in considerable amounts. However, some specific facets of the three criteria are only included in limited amounts (i.e. coordination between/within agencies, public perception, reuse inventory). The water reuse program operating in San Marcos could be improved if these practices were included in operations.

WH1: Water reuse programs adequately address public acceptance regarding the practice of water reuse through *communication*.

This study utilizes three criteria developed by the exploratory model to assess the existence of communication in a water reuse program. Identifying the leadership of a water reuse program is the first. The second involves the water reuse program engaging in education and public outreach. The third regards coordination between/within agencies associated with the water reuse program.

Identify the Leadership (WH1a)

Document Analysis

The document analysis specifies the leadership of the water reuse program. The document analysis includes examination of the City of San Marcos and Guadalupe-Blanco River Authority (GBRA) websites. The City of San Marcos website provides information on the leadership of the water reuse program by identifying the director and

the organization in charge of maintenance and daily operations (Figure 5.1). The GBRA website also recognizes the director of the program as well as the organizations tasked with maintenance and daily operations. Recognizing the leadership enables the public to make judgments regarding their confidence in the leadership of the water reuse programs. The documents evaluated in this study provide a considerable amount of evidence that the water reuse program identifies the leadership.

Figure 5.1 Identifying the Leadership – City of San Marcos

Figure 5.2 Identifying the Leadership – GBRA

Don Meador, Director
Hays County
Appointed: 2013

Meador of San Marcos is a retired rancher and engineer and will represent Hays County. He is a past member of the Texas and Southwestern Cattle Raisers Association and American Angus Association, and a past board member of the Texas Angus Association. He is past president of the Hays County Farm Bureau, past board vice chair of the Hays County Water Conservation District, and a former commissioner of the City of Coppell Planning and Zoning Commission. He served in the U.S. Army. Meador received a bachelor's degree from Texas Tech University and a master's degree in industrial engineering from Oklahoma State University.

Interviews

Structured interviews were also used to verify that the water reuse program identifies the leadership. Interview responses indicated the leadership was identified to, "give the program a face." The results of the interviews suggest that the leaders of water reuse programs are selected based on merit. One respondent suggested, "The water reuse leader is not chosen out of thin air. There is a pool of qualified individuals and, the best candidate gets the job." These findings strongly demonstrate that the water reuse program identifies the leadership.

Engage in Education & Public Outreach (WH1b)

Document Analysis

This document analysis also involved the websites of the City of San Marcos and the GBRA. Analysis of both documents reveals that the water reuse program engages in education and public outreach. The display of education and public outreach is stronger by the GBRA than the City of San Marcos. The City of San Marcos provides a list of programs that involves public outreach. The programs listed on the City of San Marcos'

website are more geared toward programmatic goals (public outreach) than formal learning (education). The GBRA website clearly depicts efforts of education and public outreach on their website with links labeled “Education” and “Public Outreach”. The GBRA “Education” link includes: elementary classroom materials, secondary classroom material, classroom presentations, and field trips. The GBRA “Public Outreach” link includes: water quality publications, water quality interactive modules, water conservation education water-related interactive activities, speaking engagements, and displays. Education and public outreach informs the public and stakeholders and promotes a water reuse community in order to strengthen communal confidence. These findings greatly demonstrate the water reuse programs’ efforts to engage in education and public outreach.

Figure 5.3 Education and Public Outreach – City of San Marcos

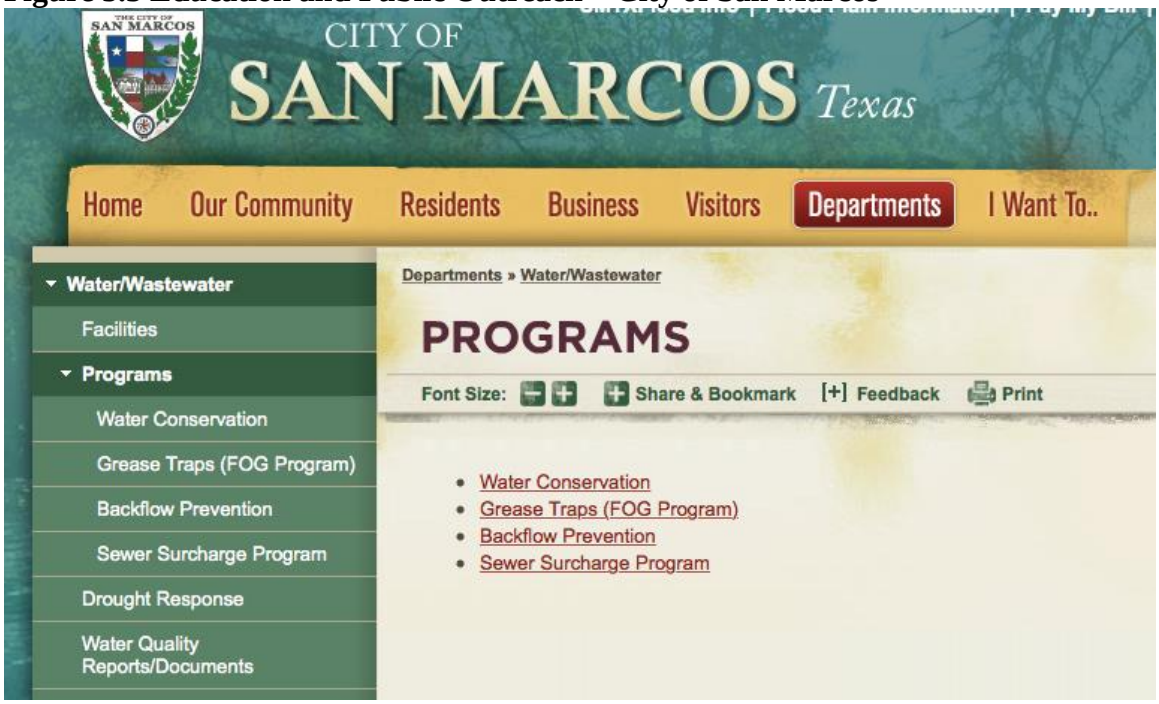
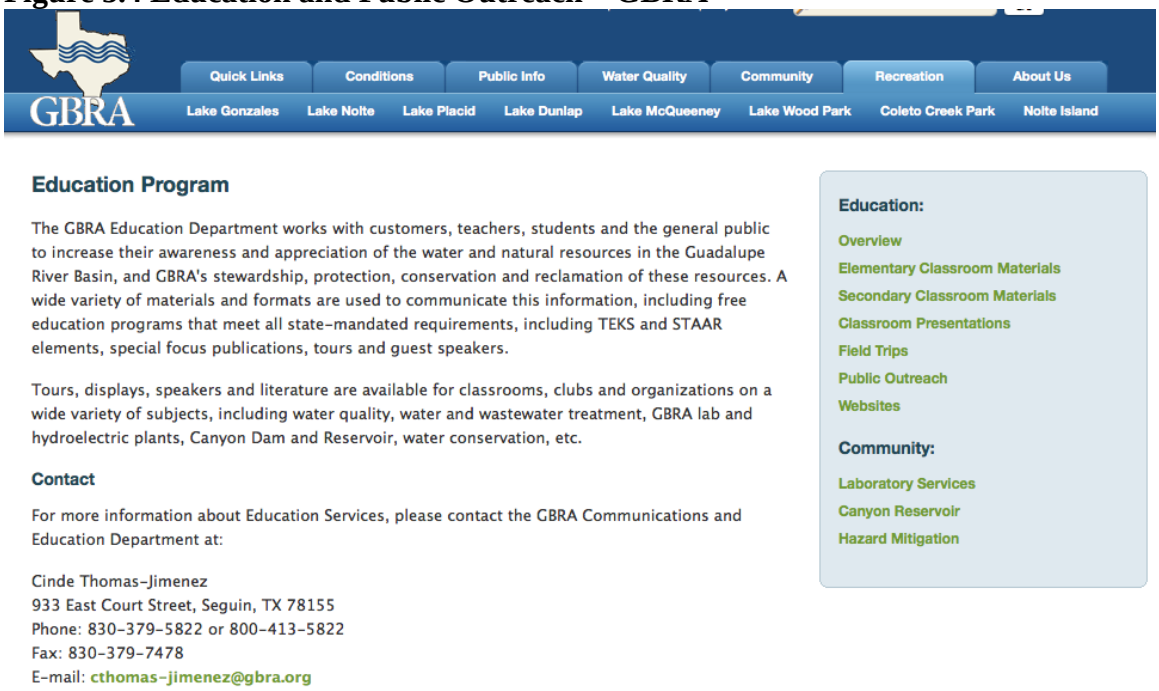


Figure 5.4 Education and Public Outreach – GBRA



Interviews

Structured interviews were also used to verify that the water reuse program engages in education and public outreach. Interview responses specified efforts geared to educating the public and provided publications that enhance the understanding of water reuse activities. One respondent offered, “We can’t operate without the approval of the citizens. We can’t expect them to approve if they don’t understand.” These findings provide substantial evidence of the water reuse program engaging in education and public outreach.

Coordinate Between/Within Agencies (WH1c)

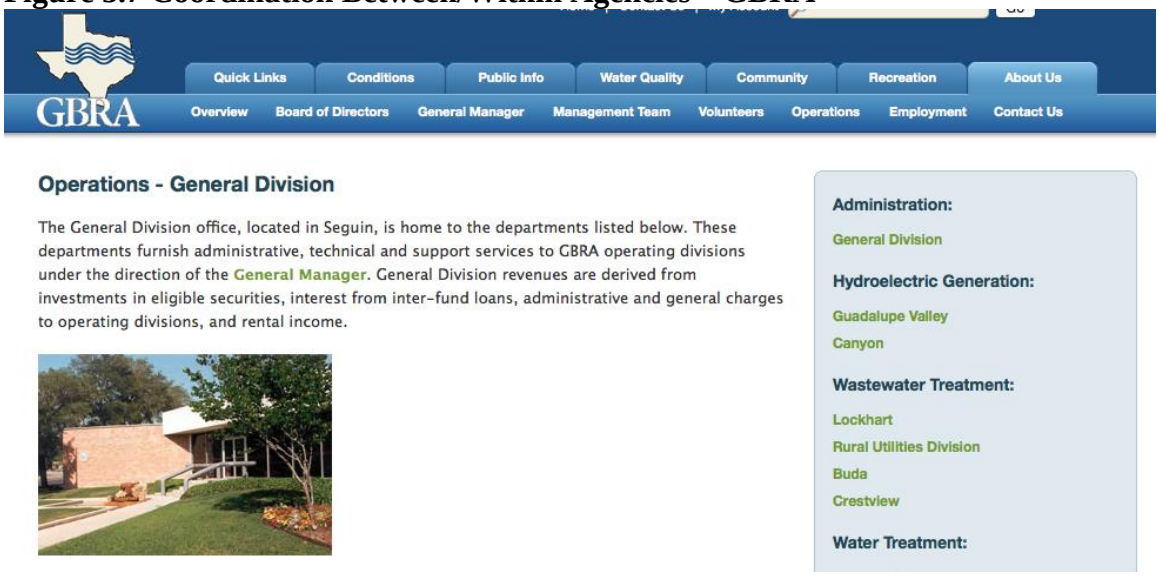
Document Analysis

Document analysis was also used to confirm coordination between/within agencies associated with the water reuse program. Combining the evidence from both websites, City of San Marcos and GBRA, provide the agencies affiliated with the water

reuse program and the nature of the relationship. The City of San Marcos website lists "Regional Partners" that cooperate with San Marcos and the water reuse program. The "Regional Partners" associated with the water reuse program in San Marcos are: Hays Caldwell Public Utility Agency, Edward Aquifer Authority, and Guadalupe-Blanco River Authority. The GBRA website describes the nature of these relationships. The relationships are categorized by the GBRA website: Accounting and Finance, Human Resources, Engineering, Project Development, Public Communications and Education, and Business Development and Resource Management. Communications between/within agencies build public confidence and encourages public acceptance of water reuse programs. This evidence demonstrates coordination between/within agencies associated with the water reuse program in San Marcos. This evidence was rated as weak because the analysis of the individual documents yielded limited support.

Figure 5.6 Coordination Between/Within Agencies – City of San Marcos

Figure 5.7 Coordination Between/Within Agencies – GBRA



Interviews

Interviews were also used to verify coordination between/within agencies associated with the water reuse program. One respondent stated, "Coordination within our own organization and with other agencies is crucial. These relationships allow us to operate safely and efficiently." These findings provide evidence of the water reuse program coordinating between/within agencies.

Summary of Findings (WH1)

Document analysis and structured interviews demonstrate that the water reuse program operating in San Marcos, addresses acceptance of water reuse through communication. Each source of evidence demonstrates that the program encourages public acceptance of water reuse practices through communication. The evidence was limited regarding the individual document analysis of coordination between/within agencies. However, combining the document analysis provides stronger support. Table 5.1 summarizes the findings for working hypothesis 1.

Table 5.1 Results for WH1

WH1: Water reuse programs adequately address public acceptance regarding the practice of water reuse through *communication*.		
WH1a: Water reuse programs should identify the leadership.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program identifies the leadership	Sufficient
GBRA (website)	Water reuse program identifies the leadership	Sufficient
Interviews	Water reuse program identifies the leadership	Sufficient
WH1b: Water reuse programs should engage in education and public outreach.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program engages in education and public outreach	Sufficient
GBRA (website)	Water reuse program engages in education and public outreach	Sufficient
Interviews	Water reuse program engages in education and public outreach	Sufficient

WH1c: Water reuse programs should coordinate between/within agencies.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program coordinates between/within agencies	Weak
GBRA (website)	Water reuse program coordinates between/within agencies	Weak
Interviews	Water reuse program coordinates between/within agencies	Sufficient

WH2: Water reuse programs adequately address *public health* concerns regarding public acceptance.

This study utilizes three criteria develop by the exploratory model to evaluate the water reuse programs' approach to public health concerns. To appease public perception of a water reuse program is the first. The second involves the water reuse program adopting and implementing health and safety rules. The third regards the water reuse program maintaining a water reuse inventory.

Appease Public Perception of Water Reuse (WH2a)

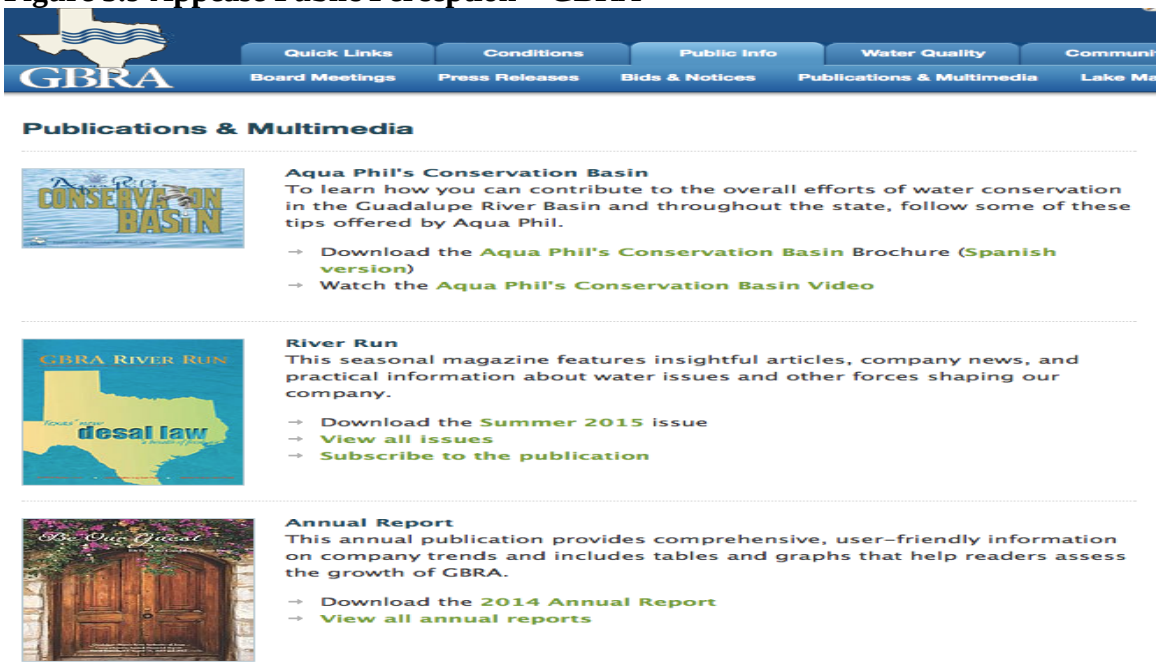
Document Analysis

This document analysis partially revealed evidence of the water reuse program adequately addressing public health concerns through appeasing public perception. The analysis consisted of the City of San Marcos website and the GBRA website. Both documents included evidence regarding the water reuse programs' efforts to conduct research and produce literature. However, neither explicitly discussed aesthetic

wastewater treatment. Water reuse programs can appease the public perception through aesthetic wastewater treatment, conducting research, and producing literature that enhances the technical knowledge of the general public. Program documents analyzed include: Lead Reports, Water Quality Reports/Consumer Confidence Reports, Advantages of 'Smart Meters', Oldest Electric Meter Gives Way to High Tech, Drought Responses. These findings result in a weak level of support due to the lack of evidence regarding aesthetic wastewater treatments.

Figure 5. 8 Appease Public Perception – City of San Marcos

Figure 5.9 Appease Public Perception – GBRA



Interviews

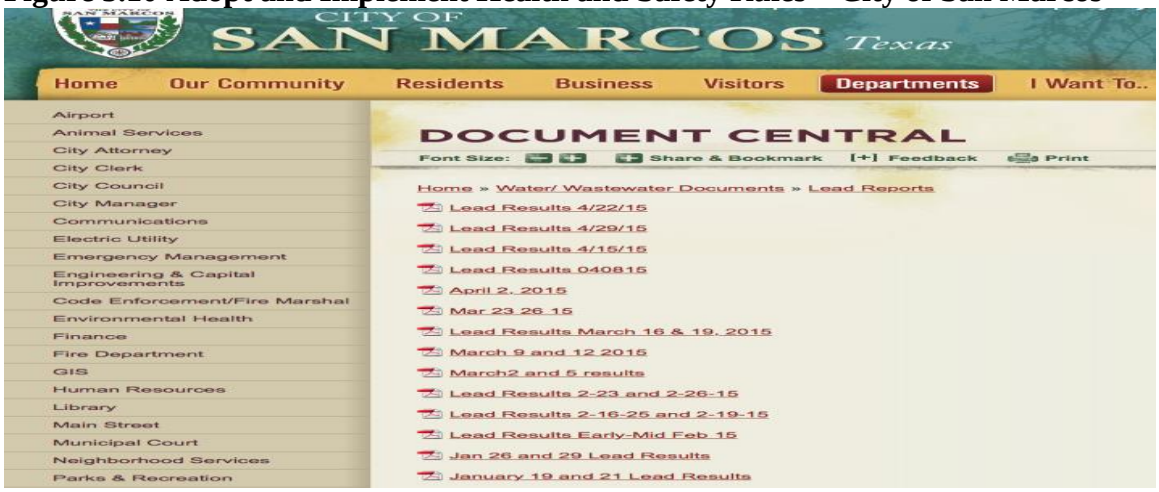
Structured interviews were also used to verify the water reuse programs' approach to appease public perception regarding water reuse. One respondent replied, "Perception is reality. What the public perceives is their reality. We have to ensure that the reality and perception of our program is interpreted as safe and efficient." The interviews provided concrete examples of appeasing public perception such as water quality reports and drought responses. These finding indicate that the water reuse program appeases the public perception of water reuse.

Adopt and Implement Health and Safety Rules (WH2b)

Document Analysis

Document analysis provided limited evidence of the water reuse program's ability to address public health concern through adopting and implementing health and safety rules. Adopting and implementing health and safety rules governing water reuse confirms that the environment, and the public residing in the environment, is protected. The City of San Marcos website provides documentation revealing compliance with local, state, and environmental regulations. For example, the City of San Marcos website includes a detailed report of lead in drinking water, complete with samples dating to 2014 and the Texas Commission on Environmental Quality (TCEQ) regulations. The GBRA website generated limited information regarding health and safety rules involving public health concerns. These findings indicated a sufficient level of support for the City of San Marcos and a weak level of support for the GRBA.

Figure 5.10 Adopt and Implement Health and Safety Rules – City of San Marcos



Interviews

The use of interviews demonstrated that the water reuse program adopts and implements health and safety rules to encourage public acceptance of water reuse. One

respondent replied that compliance with the regulatory agencies was how they adopted and implemented rules. “Without compliance, we can’t operate.” The interviews provided concrete examples of health and safety rule implementation such as compliance to The Clean Water Act and National Environmental Policy Act. This evidence suggests that the water reuse program demonstrates that they adopt and implement health and safety rules.

Maintain a Water Reuse Inventory (WH2c)

Document Analysis

Document analysis was also used to confirm the practice of maintaining a water reuse inventory by the water reuse program. A reuse inventory builds communal trust and promotes transparency in water reuse practices. Community trust is essential to the public acceptance of a water reuse programs. Both documents analyzed, the City of San Marcos and GBRA websites, failed to demonstrate the water reuse program maintaining a water reuse inventory. The City of San Marcos website mentions the “permitted average daily flow of 9 million gallons per day (MGD) and a two-hour peak we weather flow of 31 MGD.” The City of San Marcos fails to provide any kind of monthly/annual report that reveal the water reuse program is operating according to this permit. The GBRA website also fails to provide any evidence suggesting the water reuse program maintains an inventory. Records provided by the GBRA involve streamflow data and rainfall data. The evidence from this document analysis suggests that the water reuse program does not maintain a water reuse inventory.

Interviews

Interviews were also used to examine the demonstration of the water reuse program maintain a water reuse inventory. The results of the interviews indicated that inventories were in place to, "record daily activities and operations of the water reuse program." This evidence demonstrates the water reuse programs' efforts to maintain a water reuse inventory.

Summary of Findings (WH2)

Document analysis and structured interviews demonstrate that the water reuse program operating in San Marcos, addresses public health concerns regarding public acceptance of water reuse. Each source reveals limited evidence that the program encourages public acceptance of water reuse practices through addressing concerns regarding public health. Document analysis failed to demonstrate the application of a water reuse inventory (WH2c). The document analysis yielded limited evidence regarding public perception (WH2a) and health and safety rules (WH2b). However, the structured interviews did demonstrate the presence of all three criteria (WH2a, WH2b, WH2c). Table 5.2 summarizes the findings for working hypothesis 2.

Table 5.2 Results for WH2

WH2: Water reuse programs adequately address *public health* concerns regarding public acceptance.		
WH2a: Water reuse programs should appease public perception of water reuse.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program appeases public perception	Weak
GBRA (website)	Water reuse program appeases public perception	Weak
Interviews	Water reuse program appeases public perception	Sufficient
WH2b: Water reuse programs should adopt and implement health and safety rules.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program adopts and implements health and safety rules	Sufficient
GBRA (website)	Water reuse program adopts and implements health and safety rules	Weak
Interviews	Water reuse program adopts and implements health and safety rules	Sufficient

WH2c: Water reuse programs should maintain a reuse inventory.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program maintains a reuse inventory.	None
GBRA (website)	Water reuse program maintains a reuse inventory.	None
Interviews	Water reuse program maintains a reuse inventory.	Sufficient

WH3: Water reuse programs adequately address the issues of public acceptance through *policies and practices* consistent with community, state and environmental norms.

This study utilizes three criteria develop by the exploratory model to assess the existence of local, state, and federal policies and practices in a water reuse program. The water reuse program establishing reclaimed water standards is the first. The second involves the water reuse program clarifying the intended use for the recycled water. The third regards mitigating the effects on the community.

Establish Reclaimed Water Standards (WH3a)

Document Analysis

This document analysis was used to confirm the presence of reclaimed water quality standards. Standards regarding water reuse programs revolve around communicating risks associated with reclaimed water to the public and employing a regional approach to water planning. Both document analyzed provided evidence to risk

communication. The City of San Marcos and GBRA website contained both emergency (flood) and pre-emergency (drought) communications. Likewise, both documents describe regional water planning efforts to manage water/wastewater activities. This documents analysis demonstrated the water reuse programs compliance with water quality standards.

Figure 5.11 Reclaimed Water Quality Standards – City of San Marcos

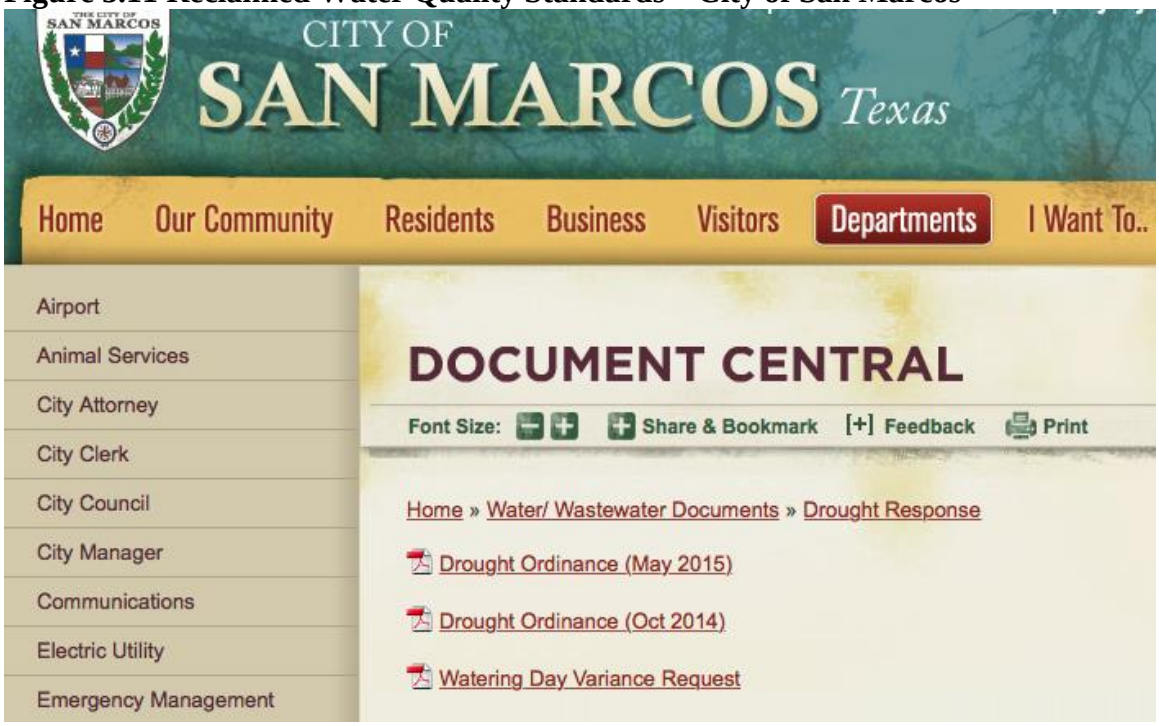
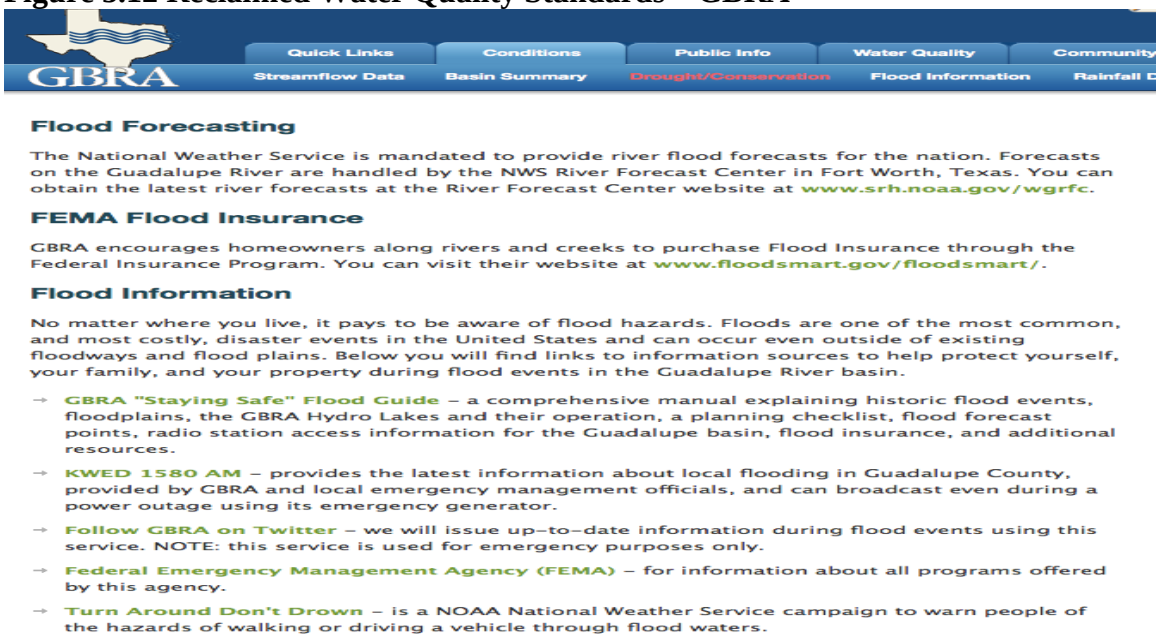


Figure 5.12 Reclaimed Water Quality Standards – GBRA



Interviews

Structured interviews were also used to confirm the presence of reclaimed water quality standards. Respondents stated that risk communication was done through the website and other form of social media (i.e. Facebook, Twitter). Respondents also discussed the importance of regional planning. One respondent replied, "The hydrologic cycle doesn't just affect San Marcos. We have to take into consider users downstream, all the way to The Gulf (Gulf of Mexico)." These findings provide evidence suggesting the water reuse program meet reclaimed water quality standards.

Clarify the Intended Use for the Recycled Water (WH3b)

Document Analysis

This document analysis was also used to examine the demonstration of the water reuse program clarifying the intended use for the recycled water. Two significant factors influencing public acceptance include the intended purpose of the reclaimed water and

the likelihood of public contact with the recycled water. The City of San Marcos website fails to mention the intended purpose of the reclaimed water and the likelihood of public contact with the recycled water. However, the GBRA website includes descriptions of both the likelihood of public contact and the intended purpose of the reclaimed water. This evidence proves a "weak demonstration" of the water reuse program clarifying the intended use for the recycled water.

Figure 5.13 Clarifying the Intended Use – GBRA

Interviews

The use of interviews demonstrated that the water reuse program clarifies the intended use of the recycled water. Respondents stated that uses for reclaimed water were

declared by ordinance in compliance with state and federal regulations. This evidence suggests that the water reuse program clarifies the intended use of the reclaimed water.

Mitigate the Effects on the Community (WH3c)

Document Analysis

This document analysis was used to confirm the water reuse programs efforts to mitigate the effects on the community. Buffer zones and odor abatement tactics are the most common approaches to mitigate the effects on a community. Both documents analyzed, the City of San Marcos and GBRA websites, provided evidence suggesting the water reuse program mitigates the effects on the community. The documents provide a description of "odor control modifications" that were completed in August of 2006 and the area considered the buffer zone. This analysis demonstrates that the water reuse program mitigates the effects on the community.

Figure 5.14 Mitigate the Effects on the Community – City of San Marcos

Interviews

Interviews were also used to demonstrate the water reuse programs approach to mitigate the effects on the community. One respondent mentioned the odor abatement measures that were completed in 2006. Another respondent suggested, "We built the treatment plant away from everybody." This reveals the application of a buffer zone. These finding demonstrate that the water reuse program mitigates the effects on the community.

Summary of Findings (WH3)

Document analysis and structured interviews demonstrate that the water reuse program operating in San Marcos, addresses public acceptance of water reuse through policies and practices. Each source of evidence demonstrates that the program encourages public acceptance of water reuse practices through policies and practices. The only source that failed to yield evidence was the document analysis of the City of San Marcos website regarding the clarity of the intended use of reclaimed water (WH3b). Table 5.3 summarizes the findings for working hypothesis 3.

Table 5.3 Results for WH3

WH3: Water reuse programs adequately address the issues of public acceptance through *policies and practices* consistent with community, state and environmental norms.		
WH3a: Water reuse programs should establish reclaimed water standards.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program establishes reclaimed water standards.	Sufficient
GBRA (website)	Water reuse program establishes reclaimed water standards.	Sufficient
Interviews	Water reuse program establishes reclaimed water standards.	Sufficient
WH3b: Water reuse programs should clarify the intended use for the recycled water.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program clarifies the intended use for the recycled water	None
GBRA (website)	Water reuse program clarifies the intended use for the recycled water	Sufficient
Interviews	Water reuse program clarifies the intended use for the recycled water	Sufficient

WH3c: Water reuse programs should mitigate the effects on the community.		
Source	Finding	Level of Support
City of San Marcos (website)	Water reuse program mitigates the effects on the community	Sufficient
GBRA (website)	Water reuse program mitigates the effects on the community	Sufficient
Interviews	Water reuse program mitigates the effects on the community	Sufficient

Chapter Summary

This chapter provides the results from the document analysis and interviews used to assess water reuse programs. The results indicate all three criteria are incorporated into the water reuse program in considerable amounts. However, some specific facets of the three criteria are only included in limited amounts (i.e. coordination between/within agencies, public perception, reuse inventory).

Chapter VI: Recommendations and Conclusion

Chapter Purpose

The purpose of this research was three-fold. First this applied research project develops an exploratory model to assess a water reuse program. Second, this applied research project uses the exploratory model to evaluate a water reuse program in San Marcos, TX. Third, based on the evaluation of the water-reclaiming program, recommendations for improvement are developed. The following provides recommendations and conclusions based on the case study.

Recommendations

A case study was used to assess the levels of communication, public health concerns, and policies and practices present in the water reuse program operating in San Marcos.

Communication

The water reuse program operating in San Marcos demonstrates two out of the three criteria developed by the exploratory model for communication. Coordination between/within agencies was only "somewhat demonstrated" as the document analysis failed to recognize all the criteria developed by the exploratory model. The principal recommendation here is for the water reuse program to improve the data presented on the websites for public evaluation. Specifically the information regarding coordination between/within agencies regarding the GBRA website.

Public Health

Public health concerns regarding the water reuse program yielded limited evidence regarding the criteria developed by the exploratory model. Interviews revealed that public health concern regarding the public acceptance of water reuse were crucial to the operations of the program operating in San Marcos. The lack of evidence regarding document analysis suggests that the evidence is not presented in a public forum (i.e. City of San Marcos or GBRA websites). The primary recommendation to improve the approach to public health concerns regarding water reuse would be to increase the volume of data presented to the public on the organizational websites.

Policies & Practices

The water reuse program demonstrated policies and practices in all three categories developed by the exploratory model. The only instance in which support was limited was in the case of document analysis of the City of San Marcos website regarding the intended use of the reclaimed water (WH3b). The principal recommendation here is for the water reuse program to include the intended use for the reclaimed water in a public application. Specifically, including the intended use for the reclaimed water on the City of San Marcos website.

Table 6.1 Findings and Recommendations

Table 6.1 Water Reuse Case Study Summary		
Working Hypothesis	Evidence	Findings/ Recommendations
WH1: Water reuse programs adequately address public acceptance regarding the practice of water reuse through **communication.**		
WH1a: Water reuse programs should **identify the leadership.**	Exceptional	**Finding:** The water reuse program evaluated in this study publicly identifies the leadership via website. Brief biographies are included describing the leadership.
		Recommendation: Continue presenting the leadership in the manner discussed above.
WH1b: Water reuse programs should **engage in education & public outreach.**	Exceptional	**Finding:** The water reuse program evaluated in this study engages in various educational programs aimed to enlighten the public on the intricacies of water reuse.
		Recommendation: Continue participating in education & public outreach in the manner discussed above.
WH1c: Water reuse programs should **coordinate between/within agencies.**	Sufficient	**Finding:** The water reuse program evaluated in this study demonstrates an adequate amount of coordination between/within agencies. Examples of coordination include: regional partnerships, project development, and resource management.
		Recommendation: Increase the volume of information regarding coordination that is presented on the websites. Provide greater detail describing the nature of the relationships.
WH2: Water reuse programs adequately address **public health** concerns regarding public acceptance.		
WH2a: Water reuse programs should **appease public perception of water reuse.**	Sufficient	**Finding:** The water reuse program evaluated in this study provides an adequate amount of evidence that public perception is satisfied. The evidence lacked discussion of aesthetic wastewater treatments.
		Recommendation: Increase the volume of information regarding the use and purpose of aesthetic water treatments that is presented on the websites.

WH2b: Water reuse programs should **adopt and implement health and safety rules governing water reuse.**	Sufficient	**Finding:** The water reuse program evaluated in this study provides an adequate amount of evidence that health and safety rules are implemented to govern water reuse. The GBRA document analysis had no discussion of health and safety rules involving public health concerns.
		Recommendation: Increase the volume of information regarding health and safety rules concerning public health presented on the GBRA website.
WH2c: Water reuse programs should **maintain a reuse inventory.**	Weak	**Finding:** The water reuse program evaluated in this study provides a limited amount of evidence that a reuse inventory is maintained. Document analysis yielded no evidence.
		Recommendation: Increase the volume of information regarding water reuse inventories that is presented on the websites.
WH3: Water reuse programs adequately address the issues of public acceptance through **policies and practices** consistent with community, state, and environmental norms.		
WH3a: Water reuse programs should **establish reclaimed water standards.**	Exceptional	**Finding:** The water reuse program evaluated in this study provides a substantial amount of evidence that reclaimed water standards are established that includes risk communication and regional planning.
		Recommendation: Continue establishing reclaimed water standards in the manner discussed above.
WH3b: Water reuse programs should **clarify the intended use for the recycled water.**	Sufficient	**Finding:** The water reuse program evaluated in this study provides an adequate amount of evidence that the purpose of the reclaimed water is clarified. The city of San Marcos website failed to discuss the intended purposes of recycled water.
		Recommendation: Increase the volume of information regarding the intended uses of recycled water that is presented on the City of San Marcos website.

WH3c: Water reuse programs should **mitigate the effects on the community.**	Exceptional	**Finding:** The water reuse program evaluated in this study provides considerable evidence that the effects on the community are mitigated through odor abatement tactics and buffer zones.
		Recommendation: Continue mitigating communal effects in the manner discussed above.

Future Research

Suggestions for further research include applying the criteria of the exploratory model to water reuse programs operating outside of San Marcos, TX. The exploratory model is developed from universal criteria that can be applied to all water reuse programs across the globe.

Conclusion

The results demonstrate the application of communication and policies and practices to encourage public acceptance of water reuse. The criteria regarding public health concerns were not demonstrated by document analysis but did appear during the structured interviews. Specifically, document analysis regarding the maintenance of a water reuse inventory failed to yield evidence. The presence of support in the interviews suggests that the inventory is in place but not presented to the public via the Internet. As interviews demonstrated support for all of the criteria, increasing the volume of published information for the public would improve the water reuse program. Not increasing the available information for the public will limit the understanding of the intricacies of the water reuse program and may result in a decline of public support.

Chapter Summary

This chapter provided recommendations and conclusions based on the water reuse program case study. The results indicate that communication, public health, and policies and practices are applied in various degrees by the water reuse program operating in San Marcos. This chapter also provided information on suggestions for future research.

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