Summer 2017

Grower Attitudes Towards Water Management Strategies While Mitigating Seawater Intrusion: A Case Study Of The Castroville Seawater Intrusion Project

Jason Ray Reed
San Jose State University

GROWER ATTITUDES TOWARDS WATER MANAGEMENT STRATEGIES WHILE MITIGATING SEAWATER INTRUSION: A CASE STUDY OF THE CASTROVILLE SEAWATER INTRUSION PROJECT

A Thesis

Presented to

The Faculty of the Department of Environmental Studies

San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Jason Reed

August 2017

The Designated Thesis Committee Approves the Thesis Titled

GROWER ATTITUDES TOWARDS WATER MANAGEMENT STRATEGIES WHILE MITIGATING SEAWATER INTRUSION: A CASE STUDY OF THE CASTROVILLE SEAWATER INTRUSION PROJECT

by

Jason Reed

APPROVED FOR THE DEPARTMENT OF ENVIRONMENTAL STUDIES

SAN JOSÉ STATE UNIVERSITY

August 2017

Dustin Mulvaney, Ph.D.	Department of Environmental Studies
Alex Gershenson, Ph.D.	Department of Environmental Studies
Patrick Ferraro, M.S.	Department of Environmental Studies

ABSTRACT

GROWER ATTITUDES TOWARDS WATER MANAGEMENT STRATEGIES WHILE MITIGATING SEAWATER INTRUSION: A CASE STUDY OF THE CASTROVILLE SEAWATER INTRUSION PROJECT

by Jason Reed

The Salinas River Valley Watershed has endured the effects of seawater intrusion for decades caused by overpumping groundwater from the Salinas River Groundwater Basin. The Castroville Seawater Intrusion Project began delivering recycled water in 1998 with other water sources due to wells becoming too saline. One-on-one, in-person interviews with eighteen growers, who own or lease farmland within the Project's service area, were conducted during a severe, statewide drought. Interview questions explored grower attitudes and concerns regarding their water supply, and the impact of management strategies on the mitigation of seawater intrusion. Two research questions were posed, exploring factors that influence grower acceptance of alternative water supplies, and whether environmental impacts affect their attitudes. Four prominent factors were found that influence grower acceptance of alternative water supplies: perceived need for water supply, changes to cost and/or water quality, information/education, and level of trust. The study also revealed three motivations of growers for choosing water supplies that do not increase seawater intrusion or contribute to adverse environmental impacts: protecting harvest/land, managing associated cost of operations, and avoiding increased regulations and/or oversight. Growers with fewer numbers of farms and smaller acreage of farmland tended to have a greater perceived need to acquire sustainable water supplies, while being more reluctant to implement water sources of lesser quality.

ACKNOWLEDGMENTS

The Environmental Studies graduate program at San José State University (SJSU) has proven to be the most challenging and rewarding experience of my life. The process and completion of the Master of Science degree at SJSU has empowered me with an enormous sense of accomplishment and achievement that far exceeded my expectations.

Along this enlightening path, I discovered two true passions in life: water resource management and photography. My academic background and profession led me to water resource management and the SJSU program. Working with my thesis committee, Dr. Dustin Mulvaney, Dr. Alex Gershenson, and Mr. Patrick Ferraro, helped me develop a professional and academic interest into a true passion. All were patient mentors as I made progress with my research and writing. They lent knowledge and insight to my investigations and helped guide me. Photography, my second passion, was discovered incidentally in Dr. Gary Klee's class at SJSU. I am forever grateful to Dr. Klee for his inspirational and life-changing mentorship of my photographic efforts. My experience would not have been nearly as rewarding without all of these professionals.

This study was possible because of the 18 growers who participated in my survey, and who took time out of their demanding schedules and lives to voluntarily contribute to my research. I am extremely thankful and appreciative to each and every participant.

My success could not have been possible without the support of friends, family, coworkers, students, SJSU faculty/staff, and enormous amounts of coffee. I am indebted to Tahiya Marome, Robin Burdick, and Curtis Satake for all their support. The fact that specific people are not listed is a constraint of space, not gratitude. Thank you all.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AFD - acre feet per day

AFY - acre feet per year

AWT - advanced water treatment

CSIP - Castroville Seawater Intrusion Project

DWR – Department of Water Resources

MCWRA - Monterey County Water Resources Agency

MGD - million gallons per day

MRWPCA - Monterey Regional Water Pollution Control Agency

MWRSA - Monterey Wastewater Reclamation Study for Agriculture

PRVW - Pajaro River Valley Watershed

PVWMA - Pajaro Valley Water Management Agency

PWM - Pure Water Monterey

SGMA - Sustainable Groundwater Management Act

SJSU - San José State University

SRDF - Salinas River Diversion Facility

SRGB - Salinas River Groundwater Basin

SRVW - Salinas River Valley Watershed

SWRCB - State Water Resources Control Board

SVWP - Salinas Valley Water Project

TDS - total dissolved solids

1. Introduction

1.1 Motivation and scope

Water is arguably the most precious resource on Earth and is crucial to the success and sustainability of urban developments, agricultural demands, and economic infrastructure. Unfortunately, the availability of usable water supplies is decreasing, while demand is increasing (Famiglietti, 2014; James, Effers, & Reilly, 2015; Levin et al., 2002). Causes run the gamut from land use choices and application of water use to growing populations and climate impacts. Numerous present and future impacts associated with global warming and climate change are predicted: rising sea levels, fluctuating temperatures, and periodic wet and dry years with potential droughts and floods (Gleick, 1998; Levin et al., 2002). All of these challenges will cumulatively affect the overall water cycle of the planet, directly impacting water management strategies (Jackson et al., 2001). Water management strategies become increasingly difficult when water sources are scarce, especially in drought conditions when additional water is unavailable or extremely limited (Famiglietti, 2016).

The growers and stakeholders of farmland in the Castroville Seawater Intrusion Project (CSIP) service area along the Central California Coast, near the city of Castroville, are facing myriad problems. Seawater intrusion into the local CSIP groundwater aquifers has become a catastrophic problem over recent decades, due to historic overpumping of groundwater at such proximity to the coast (Brown and Caldwell, 2016; Walton, 2015). Groundwater pumping is the extraction of water stored below ground from an aquifer or groundwater basin generally through a well with pumps to transport the water to the surface for use. CSIP began delivering recycled water in 1998 to mitigate seawater intrusion by augmenting the growers' water supply to reduce groundwater pumping, and solve problems caused by discharging wastewater into Monterey Bay (Monterey Regional Water Pollution Control Agency [MRWPCA], 2017a). Demand for water in the area has increased in recent years due to more crop rotations through the year, and due to an increase in strawberry production, a water-intensive crop (see Figure 1). Meanwhile, climate change impacts presently taking

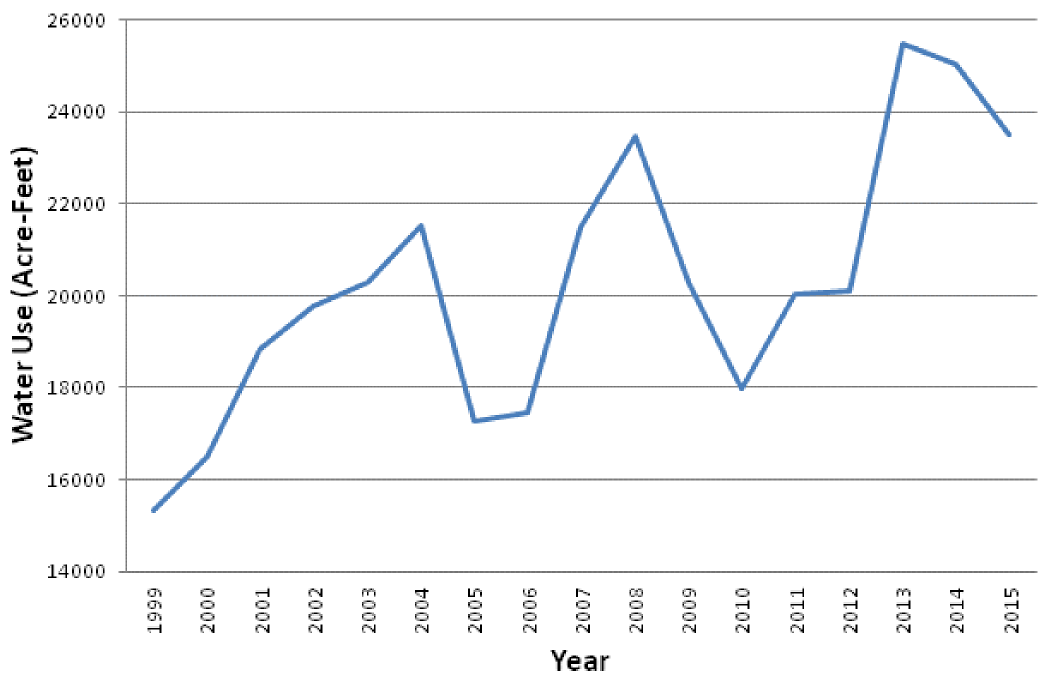


Figure 1. Water use for the Castroville Seawater Intrusion Project distribution system (1999-2015). Data obtained with permission from Monterey Regional Water Pollution Control Agency.

place are predicted to continue with fluctuating severity and durations of time. For example, CSIP and California as a whole have been dealing with a severe drought and extremely limited water sources for over five years (Dimick, 2014). Coupled with the current drought conditions, there are statewide problems in California due to overpumping groundwater, which prompted California's Governor Jerry Brown to sign the Sustainable Groundwater Management Act in September 2014 (Department of Water Resources [DWR], 2017a; Leahy, 2016; Monterey County Water Resources Agency [MCWRA], 2017i). Notably, the groundwater basin beneath the CSIP area has been officially listed by the California Department of Water Resources as one of the 21 "Critically Overdrafted Groundwater Basins" in California (DWR, 2017b).

1.2 Background

1.2.1 Climate change impacts. Weather conditions and patterns drastically affect many aspects of human life and interactions that include a wide variety of activities, economic ventures, and land use development. Weather is defined as short-term changes and fluctuations in temperature, precipitation, cloud cover, levels of humidity, and wind in a small region, or within a city or town (National Aeronautics and Space Administration [NASA], 2011). Additionally, climate is defined as the weather conditions of a particular area or region that have been averaged over a longer period of time, generally for several years (NASA, 2011). Hence, climate change is the alteration of climate conditions for Earth as a whole, or for a large region. Often, climate change and global warming are interchangeably used as descriptors of changes in weather; however, global warming specifically refers to the long-term increase in the average temperature of the Earth (NASA, 2011).

Climate change indicators include, but are not limited to, extreme temperature fluctuations, dramatic changes in rainfall quantity, and rising sea levels. Many related changes cascade from these larger patterns to affect every aspect of global weather (Gleick, 1998; Levin et al., 2002). The cascading effects of climate change can create increased stresses on a wide variety of resources including water availability and use (James et al., 2015). For example, increasing global temperatures cause thermal expansion of water and the melting of polar ice caps which lead to rising sea levels (Loáiciga, Pingel, & Garcia, 2012; Sherif & Singh, 1999). Furthermore, one of the major contributors to the increase in the Earth's overall temperature is an increase in the concentrations of carbon dioxide, nitrous oxide, and methane, collectively known as greenhouse gases (NASA, 2011; Sherif & Singh, 1999). Human activities are the primary cause of increased concentrations of greenhouse gases that have a direct impact on climate patterns. The increased concentration of greenhouse gases in the Earth's atmosphere, along with the rising overall temperatures, impact the entire hydrologic cycle by increasing evaporation rates and potentially reducing water availability (Loáiciga et al., 2012; Sherif & Singh, 1999). Increasing temperatures and accelerated evaporation rates generally cause an increase in water demand for human consumption and for agricultural purposes. The aforementioned problems exacerbate the increased demand for water when coupled with an extended period of drought and limited water availability (Famiglietti, 2016; Levin et al., 2002). Rising sea levels impact land management by way of increased erosion or loss of land that becomes submerged under water (Thead, 2016). Additionally, seawater has the potential to intrude into freshwater sources as a direct result of rising sea levels; however, that depends mostly on the location and composition of the aquifer (Loáiciga et al., 2012; Mazi, Koussis, & Destouni, 2013; Priyanka & Mahesha, 2015). Seawater intrusion is discussed in greater detail within Section 1.2.2.

One of the major impacts of climate change on water resource management is depletion of groundwater sources resulting from increased temperatures. Coupled with increased water demand and/or a period of drought, this leads to water scarcity and the addition of deeper wells (Famiglietti, 2014; James et al., 2015). Satellite imagery has revealed that 20 out of 37 of the world's major groundwater basins are being depleted at a rate much faster than they are being replenished naturally (Famiglietti, 2016). The effects of climate change are challenging the way water managers plan and secure resources and water supplies. Preparing for future demand is becoming increasingly complex since the past weather patterns are no longer reliable predictors of future trends (Famiglietti, 2014; Rasmussen et al., 2013; Walton, 2015).

Issues resulting from climate change play a critical role in water resource management and cannot be understated. Specific to this research, securing sustainable water supplies and reliable sources for irrigating food crops is a complicated problem that, by nature, is extremely political. Dramatic fluctuations in weather patterns and climate conditions require the need for long-term planning and a wide variety of coordinated efforts from a broad spectrum of water managers and stakeholders that should use fact-based and innovative strategies to best manage water resources within a specific region.

1.2.2 Seawater intrusion. Overpumping groundwater supplies from coastal aquifers creates seawater intrusion by extracting the groundwater faster than the water would naturally replace itself with rainfall and percolation through the soil (Asano & Cotruvo, 2004). In simple terms, groundwater pumping is the pumping of water stored below the surface from an aquifer or groundwater basin, generally through a well. If the aquifer or groundwater basin is hydraulically connected to seawater, and freshwater is overdrawn, seawater will most likely intrude inland (see Figure 2). Seawater intrusion is one of the most significant coastal water management problems. Once saltwater makes its way into

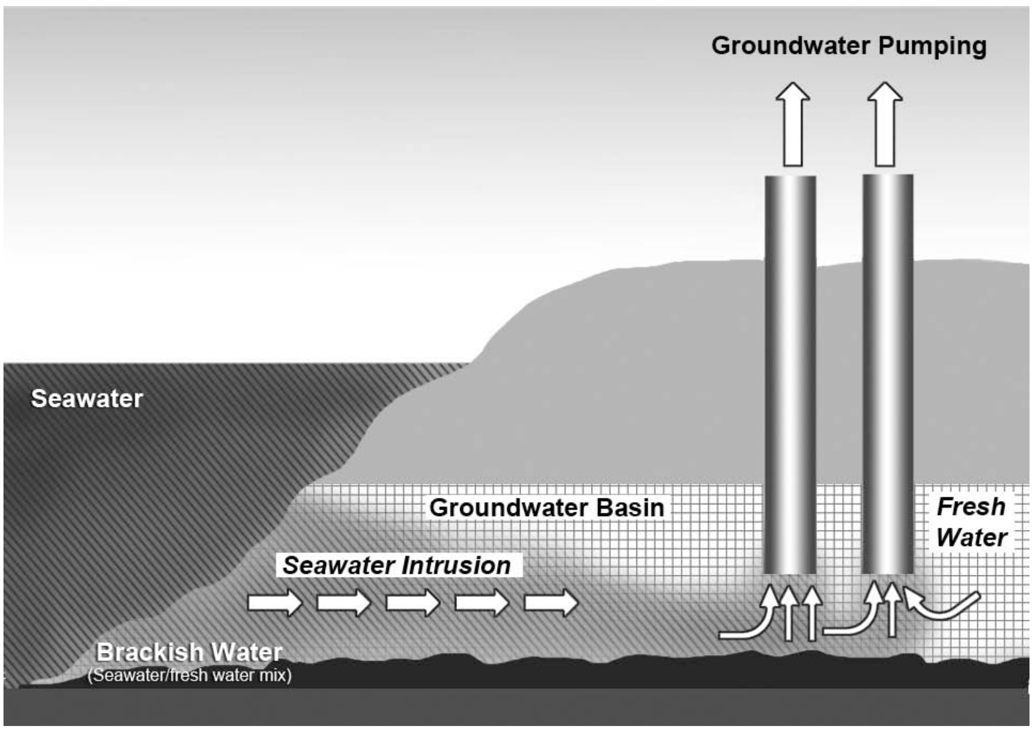


Figure 2. Seawater intrusion diagram.

the groundwater basin, the entire water supply becomes more saline, a substantive change in water quality that is very costly and difficult to remedy. Water with high salt content, and salt accumulation in soils, have severe, negative impacts on food crops. Crops do not grow in soils that are too saline, therefore the amount of salt in the water is crucial to water quality for growers in particular (Hamilton et al., 2005). The water gradient level of freshwater in relation to the seawater (also referred as brackish water, see Figure 2) must be maintained in order to mitigate seawater intrusion. The main driving factor for the advancement of seawater into freshwater supplies is overpumping groundwater near the coast (Brown and Caldwell, 2016; Lathashri & Mahesha, 2015). Rising sea levels may impact the mitigation of seawater intrusion by affecting the water gradient level (Lathashri & Mahesha, 2015; Mazi et al., 2013; Rasmussen et al., 2013). Potentially, the seawater intrusion could occur in the deeper portions of an aquifer; however, that is contingent upon the composition of the relative aquifer (Sherif & Singh, 1999).

The two means to reduce, or halt, seawater intrusion are reducing or stopping groundwater pumping, and performing groundwater recharge. Another water source is required to reduce or stop groundwater pumping, which is often difficult and impractical for meeting current and future water demands, especially in geographically isolated coastal regions. Groundwater recharge is the artificial reallocation and transferring of water into the groundwater basin in order to replenish groundwater supplies at an accelerated rate compared to that of natural percolation through the soil (Asano & Cotruvo, 2004; MacDonald & Dyack, 2004; Po et al., 2005). Groundwater recharge can be performed with any available water supply of acceptable quality and, obviously, must come from a water source other than the groundwater basin itself (see Figure 3). Two methods of performing groundwater recharge are direct injection and surface spreading. Direct injection pumps water into the groundwater basin through wells, while surface spreading is applied in an area where the new water source can penetrate and permeate through the soil to enter the groundwater basin (Asano & Cotruvo, 2004; Heir, 2016).

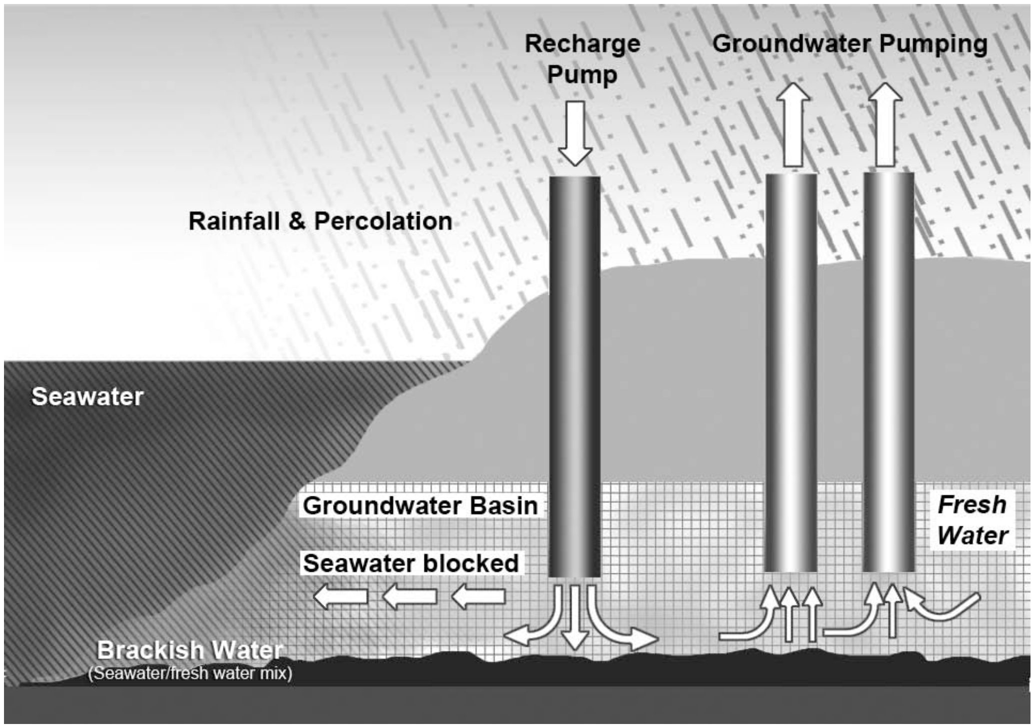


Figure 3. Groundwater recharge diagram.

In addition, groundwater recharge can be a means of storing water in the groundwater basin to be drawn up at a later date for distribution to water users (Asano & Cotruvo, 2004; MacDonald & Dyack, 2004; Po et al., 2005).

1.2.3 Water supply issues. Pressures on water supplies around the world have taxed natural water systems to the point of being dangerously depleted or destroyed (Adewumi, Bakopoulou, Polyzos, & Kungolos, 2007; Famiglietti, 2016; Ilemoblade, & Van Zyl, 2010). Coastal areas face unique issues that complicate the importation or transferring of water supplies from neighboring regions. Physical barriers, such as mountains or valleys, impede the transportation of water from outside sources. Geographic limitations, such as land availability, also reduce the potential number of surface water reservoirs. A dearth of surface water collection and storage causes a greater dependence on groundwater supplies.

California, on a statewide level, has endured a severe drought from 2010–2015. Groundwater levels have been dropping throughout the state due to the overpumping of groundwater. This prompted the signing of the Sustainable Groundwater Management Act (SGMA) in September 2014 by the Governor of California, Jerry Brown (DWR, 2017a; Leahy, 2016). The SGMA initiates the monitoring and management of previously unregulated groundwater basins in the State of California (Kiparsky et al., 2016). California voters recently passed Proposition 1, allocating $800 million for groundwater management and protection (State Water Resources Control Board, 2017a). Several bills going through the California state legislature now will help determine the implementation and execution of the groundwater basin management of the SGMA (DWR, 2017a). The Department of Water Resources (DWR) will oversee some of the SGMA decisions. DWR has also released a map showing the 21 critically overdrawn groundwater basins in California (DWR, 2017b).

Water conservation and water reuse are the two most frequently applied solutions to the problem of declining water supplies in the face of increased demand (Anderson, 2000). Water conservation seeks to improve efficiency of water use by reducing consumption for a particular function, business, or on a per-person basis. Managing current water resources and multiple strategies could potentially conserve present and future water supplies. Water reuse is the collection of a water source that is treated before being distributed to customers, and is often referred to as “alternative water sources.” The two most common alternative water sources are recycled water and desalination. Both water sources are being seriously considered, or are already in use, in many regions throughout the world (Chen, Ngo, & Guo, 2012; Levin et al., 2002; Po et al., 2005).

In the United States, recycled water is typically used for nonpotable purposes and conveyed through a separate distribution system to prevent its blending with drinking water. The nonpotable purposes include, but are not limited to: irrigation, agriculture, dual plumbing in buildings for toilet flushing, groundwater recharge, and industrial or commercial applications (Riper & Geselbracht, 1999; Smith, 1995). Recycled water consists of collecting wastewater, typically from residential and commercial use, treating and disinfecting the water in a treatment facility in order to achieve specific water quality standards, then distributing the treated water to customers for an approved use or application (Chartzoulakis, Paranychianakis, & Angelakis, 2001).

Desalination, a process similar to treating wastewater, is used mostly in coastal and arid regions, predominantly in the Middle East, North Africa, and Australia (Dolnicar, Hurlimann, & Grun, 2011). The desalination process removes excess salts and total dissolved solids (TDS) from seawater at a treatment facility, and produces water of quality comparable to potable water (Dolnicar, Hurlimann, & Grun, 2011; Hurlimann & Dolnicar, 2011).

Alternative water sources also bring controversy, and may not always be accepted or welcomed by the public or end user. Recycled water is often perceived as a "public health hazard" due to the presence of bacteria, viruses, and other organic compounds in wastewater which may not get disinfected properly and so may remain present in the final product (Dolnicar & Schafer, 2009). Also, there are more pharmaceutical medications and compounds used in recent years referred to as "constituents of emerging concern" that may get past the treatment process (State Water Resources Control Board, 2017b). Desalination is often perceived as "environmentally unfriendly" due to the high energy consumption, greenhouse gases emitted, and discharge and disposal of TDS and leftover concentrated salts referred to as "brine" (Dolnicar & Schafer, 2009). Nonetheless, the introduction of new, alternative water sources brings with it the opportunity to initiate steps to support and restore natural water systems to normal levels through practices not previously possible (Menegaki, Hanley, & Tsagarakis, 2007; Tsagarakis & Georgantzis, 2003). Recycled water creates positive applications for wastewater, preventing it from being discharged into bodies of water. It offsets groundwater pumping and conserves drinking water for current and future supplies (Anderson, 2000; Asano & Cotruvo, 2004; MacDonald & Dyack, 2004). Furthermore, desalination is especially useful when recycled water is not practical or is limited in supply, and new freshwater sources are not available or accessible (Hurlimann & Dolnicar, 2011).

1.3 Literature review

1.3.1 Managing water supplies. Water shortages are a reality across the globe, and effective strategies to manage water resources for current and future needs are in high demand. Obtaining a water source to offset a water shortage essentially comes down to seven major questions:

1) How much will it cost?
2) Who will pay for it?
3) How will one obtain the water source?
4) What are the environmental impacts of the water source?

5) What quality of water will result?
6) How much water will become available over what period of time?
7) Will the end users' attitudes affect the rate of adoption of the new source?

Alternative water supplies, water reuse, and storage are at the forefront of solutions to increase water supply and reliability. Generally speaking, an alternative water supply is one that is obtained from a source other than groundwater or surface water collection. Where water supplies are augmented with controversial alternative sources such as desalinated or recycled water, use and acceptance will hinge on the success of policymakers and water agencies at engaging stakeholders, the general public, and users, while earning their trust and subsequent cooperation (Adewumi et al., 2010; Chen et al., 2012; Menegaki et al., 2007).

A shortage of water generally drives implementation of recycled water as an alternative water supply for growers. Adewumi, Ilemoblade, and Van Zyl (2010) discuss water resources in South Africa, and the rationale to implement recycled water use brought on by drought conditions and increased water demand. It was important to give due consideration to attitudes of local stakeholders and determine levels of acceptance, so as to incorporate these variables into management of the program (Adewumi et al., 2010). Three of the recommendations by Adewumi et al. (2010) to South Africa's Department of Water Affairs and Forestry are to: create national guidelines for recycled water use, create a system of tariffs that provide incentives to use recycled water, and communicate general awareness to customers, the public, and decision makers.

Assessing and determining the sustainability of water management programs can be crucial for implementing successful, long-lasting water management schemes in the

United States and throughout the world (Chen et al., 2012). Chen, Ngo, and Guo (2012) evaluated a variety of recycled water programs and schemes using several environmental assessment tools, such as a Life Cycle Assessment, Material Flow Analysis, and Environmental Risk Assessment. Their study offers an invaluable tool and exercises for stakeholders to use when incorporating various strategies into their water use and management schemes to evaluate the impacts of their overall water use. Life Cycle Assessment is used to select the most efficient technologies for wastewater treatment. Material Flow Analysis assesses the entire environmental sanitation system and its impact. Environmental Risk Assessment identifies the potential hazards involved with the use of recycled water within the given environment (Chen et al., 2012). Environmental impacts and the associated cost to produce an alternative source of water motivate stakeholders and policymakers to pursue the most sustainable solutions and infrastructure projects. In addition to environmental considerations, public perception and end user attitudes regarding the implementation and use of the chosen water source become limiting factors when incorporating water management strategies (Dolnicar & Schafer, 2009). Dolnicar and Schafer (2009) compared the environmental impacts, cost, and public perception of the two most widely used alternative water sources in Australia: desalination and recycled water. The general population had previously perceived desalination as being “environmentally unfriendly” and recycled water as being a “public health hazard.” Opinions of both recycled water and desalination became more positive as water restrictions increased, and demand for an alternative water source in Australia increased (Dolnicar & Schafer, 2009). The major concerns for recycled water were the potential “public health hazards” associated with wastewater, meaning the potential for bacteria, viruses, or other organic compounds present in wastewater to possibly bypass the treatment process and affect the quality of recycled water. The concern for water quality is generally alleviated in the treatment process where reverse osmosis is implemented, which “usually achieves a water quality better than most tap or bottled waters” (Dolnicar & Schafer, 2009). The major concerns for desalinated water were about the energy consumption and costs associated with removing total dissolved solids (TDS). Seawater has much greater TDS concentrations ranging from 35 to 350 times greater than that of pretreated recycled water, making the environmental impacts and costs much greater for desalinated water than for recycled water (Dolnicar & Schafer, 2009). The cost to desalinate water is at least twice that of processing and treating recycled water of the same quantity (Dolnicar & Schafer, 2009). Other environmental impacts associated with desalinated water are an increase in greenhouse gas emissions from the additional energy consumption and the discharge of the concentrated salts and TDS, referred to as “brine” (Dolnicar & Schafer, 2009). Cost is difficult to project and must incorporate the scale and size of advanced treatment facilities as well as brine disposal and other costs of operation.

Groundwater recharge with recycled water is a logical part of sustainability efforts and is perceived as a positive water management strategy (Asano & Cotruvo, 2004). Asano and Cotruvo (2004) reviewed the management of groundwater recharge with recycled water in California with respect to health and regulatory concerns. Five advantages of recycled water being stored in an underground aquifer through means of groundwater recharge were listed in the review offered by Asano and Cotruvo (2004):

1) Cost may be less to recharge the groundwater basin rather than the cost to store the same amount of water on the surface
2) Storing water at the surface can lead to algae and odor problems
3) Lack of availability for surface storage
4) Water is transported through the aquifer similar to a distribution system
5) Transitioning from a groundwater supply to a blended water source that includes recycled water

An additional advantage of recycled water that was not listed, and is applicable to the CSIP, is the added benefit of halting or slowing seawater intrusion. Asano et al. (2004) described four health concerns regarding water quality that have inhibited the implementation of groundwater recharge projects using recycled water injected into the groundwater basin:

1) Poor microbiological quality and the possible presence of pathogenic microorganisms
2) Higher concentrations of total dissolved solids (TDS)
3) Chance of heavy metal toxicants
4) Concentrations of stable, potentially harmful, organic substances

Two examples of solutions offered in this review alleviated most of the risk from the list of concerns above. One was to perform advanced water treatment on the recycled water that includes processes such as reverse osmosis, microfiltration, and nanofiltration. The second was to have the water resonate longer in the underground aquifer before extracting it (Asano & Cotruvo, 2004). Asano and Cotruvo (2004) concluded:

> The lack of specific criteria and guidelines governing artificial recharge of groundwater is currently hampering the implementation of additional large-scale groundwater recharge operations. Thus, the establishment of policies and guidance for planning and implementing new groundwater recharge projects is encouraged. (p. 1947)

MacDonald and Dyack (2004) discuss several reasons why water reuse and conservation are not managed and utilized as well as they could be in Australia. They found that it is unclear who owns, and has rights to, groundwater. Moreover, if someone does inject recycled water into an underground aquifer, it is uncertain if they are entitled to extract that same volume (MacDonald & Dyack, 2004). The authors conclude that successful water reuse and conservation depends on complete information channels, between knowledge, available technology, policies, and codes and regulations (MacDonald & Dyack, 2004). With multiple agencies and stakeholders involved in water reuse projects, the two studies above reinforce the assertion that there needs to be a coordinated effort and clear communications among all of the policymakers to carry out any program successfully.

1.3.2 Water management program success. Agriculture and irrigation are important use sectors for recycled water, and numerous programs have been implemented around the world. Acceptance of water management programs and projects are more likely to be successful with increased trust and communication among all involved parties (Carr, Potter, & Nortcliff, 2011; Chang & Ma, 2012). Another action to support the acceptance of a water management program is that communication must begin during the planning stages, and should incorporate input and feedback about acceptance levels of the different options being considered (Khan & Gerrard, 2006).

Chartzoulakis, Paranychianakis, and Angelakis (2001) evaluated water management practices in Crete, Greece, an agriculturally intensive island that applies 84.5% of its water to agriculture. Chartzoulakis et al. (2001) made nine suggestions for potentially improving the sustainability of agriculture and water resources in Crete:

1) Water conservation and efficient use
2) Water sectorial use such as more planning and management of water resources
3) Water pricing and cost recovery
4) Wastewater reuse
5) Water quality management and use of saline water
6) Other cost-effective technologies such as artificial recharge of groundwater
7) Technology transfer such as using improved techniques or technologies in water use
8) Education and training
9) Development of an integrated water resources plan

As water issues become more common, planning for replenishing traditional sources such as groundwater, rather than allowing those sources to become depleted, must be part of any strategy to secure sustainability of water sources (Chartzoulakis et al., 2001).

Opinions regarding the success of recycled water programs and related distribution system infrastructure vary greatly (Arias, 2011; Hartley, 2006; Khan & Gerrard, 2006; Macgregor & Warren, 2006; Po, Kaercher, & Nancarrow, 2003). Arias (2011) surveyed a panel of 28 stakeholders as to how they would rate the success of recycled water programs in California, Arizona, and Florida. The panel was broken out into six subgroups as follows: Recycled Water Program, Water Supply Program, Regulatory Agency, Non-governmental Organization, Recycled Water Customer, and Academia. The research team found that evaluating recycled water programs with criteria that all stakeholders can agree upon is very challenging, and that new programs face very different impediments than existing programs (Arias, 2011).

Whenever multiple people or organizations must cooperate, information and communication play major roles in effectiveness. Khan and Gerrard (2006) performed a review of research that analyzed communication between stakeholders and the community regarding recycled water and the acceptance of its use. The main conclusions were that communication must start early in the planning process and must be maintained over the duration of a program or project (Khan & Gerrard, 2006).

Macgregor and Warren (2006) studied 30 Scottish growers to discover motivations and management practices. The growers were very skeptical and lacked trust in the enforcement of environmental regulations. Macgregor and Warren (2006) stated improvements were necessary to communicate with, and educate, stakeholders and growers regarding local environmental problems.

Po, Kaercher, and Nancarrow (2003) completed an analysis of studies and programs pertaining to public acceptance of recycled water programs in the United States and Australia that tend to be controversial. This work indicated that getting the public involved early to promote informed choice, and creating trust within the community regarding recycled water projects or programs, are crucial to success. Additionally, Po et al. (2003) opined that trust with authorities and water managers must be strong to achieve successful outcomes. Their study also discussed projects that had initially failed due to lack of public acceptance, such as the San Diego Water Purification Project. In more recent years (2009-2013) since the Po et al. (2003) study was completed, the city of San Diego increased its outreach and education programs, including additional research, to promote the San Diego Water Purification Project (City of San Diego, 2017). The project has been “granted conceptual approval” by the California Department of Public Health and the San Diego Regional Water Board (City of San Diego Public Utilities Department, 2017). The city of San Diego is currently working on moving forward to implement recycled water augmentation to their drinking water supply (City of San Diego, 2017).

1.3.3 Alternative water supplies - public acceptance. Identifying factors that affect acceptance of alternative water sources, such as recycled water or desalinated water, can be extremely useful for policymakers and stakeholders when considering policy and regulatory decisions. Po et al. (2005) was a case study performed in Australia that surveyed 161 public participants analyzing their perceptions and attitudes towards the use of recycled water for a wide variety of applications. One of the relevant findings in this study was that a majority of respondents who had a higher level of trust with the recycled water authorities also displayed a more positive attitude regarding recycled water and its use (Po et al., 2005). Moreover, participants with lower levels of education expressed lower levels of trust with authorities and water managers than those with more education. Conversely, if the respondent associated a higher level of risk with recycled water use then he/she would exhibit a more negative response to recycled water programs and applications. Furthermore, participants who expressed an obligation to protect the environment also had an increased positive attitude towards the use of recycled water on vegetables they purchased (Po et al., 2005). Their study concluded that people's emotions, and the opinions and influences of peers, play a large role in the acceptance of recycled water programs.

Hartley (2006) conducted workshops, case study reviews, and peer reviews with experts regarding public participation and perception in recycled water and its programs within the United States. One of the findings was that "information, knowledge, local context, and education all play an important role in shaping perception and the nature of public participation...the uncertainty or incompleteness of information in any of these information categories influences perception about water reuse" (Hartley, 2006, p. 120). Their study revealed that public acceptance of water reuse in the United States tends to be higher when:

1) Public health is protected and made clear
2) Community awareness of a water shortage is known
3) Perception of the quality of the recycled water is positive
4) Confidence and trust of the governing agencies overseeing water management is high

Hartley (2006) also concluded that more knowledge and awareness of water reuse made both proponents and opponents more entrenched in their respective sides of the argument.

Dolnicar, Hurlimann, and Grun (2011) conducted an online survey of 3,094 Australian residents, and asked several hypothetical questions as to whether respondents preferred to use recycled water or desalinated water. The independent variables in the survey by Dolnicar et al. (2011) included:

1) Environmental attitudes
2) Environmental concern
3) Pro-environmental behavior
4) Active involvement in searching for information about water issues
5) Previous use of recycled or desalinated water
6) Experience with water restrictions
7) Knowledge about recycled and desalinated water

The majority of respondents had experienced water restrictions, and also had a positive perception of recycled water. Dolnicar et al. (2011) proposed the following findings based on their research: acceptance decreased with more knowledge about desalinated water due to environmental concerns, while acceptance of recycled water increased with more awareness and information.

Hurlimann and Dolnicar (2011) conducted a study with Australian residents that asked them whether or not they would relocate if their water supply ran out, or if recycled or desalinated water augmented their supply. The results showed that respondents would relocate if water supplies ran out, and that they would accept the use of recycled or desalinated water to augment their supply, even though there is opposition to that practice (Hurlimann et al., 2011). The results of this study emphasize not only the importance and value of water as a resource, but the impact of perceived need on decision-making. The results of studies involving public acceptance and awareness of alternative water sources may not be extrapolated to include suppositions about growers, but survey designs used to understand public attitudes toward various water sources could be used in similar research with growers. Also, public acceptance of alternative water supplies can affect the public attitude toward crops in the marketplace, as well as water management decisions that require voting and/or public comment.

Maintaining a water distribution program without large increases in operational costs, or the cost per unit of water used, is perceived as crucial by the customer (Chang & Ma, 2012; Dutta & Tiwari, 2005; Garcia, Guérin-Schneider, & Fauquert, 2005). Chang and Ma (2012) analyzed and compared fresh water and recycled water use in Beijing, China, and looked at significant factors that influence policy in an effort to improve social acceptance and increase the use of recycled water. They found that the greater the difference between the price of freshwater and recycled water, the greater the impact on willingness to use recycled water. Predictably, the study also found that the price of recycled water directly affects the acceptance level by customers (Chang & Ma, 2012).

Dutta and Tiwari (2005) performed a study in Delhi, India that looked at the full cost of water delivered, and what the customer was willing to pay for it. The study surveying 1,100 households had two purposes: provide a framework to analyze the full environmental cost of providing water to urban areas, including the cost of environmental impact, and try to determine what residential customers are willing to pay for water of greater quality and reliability. They found that households were willing to pay more for improved quality and reliability; but unwilling to pay the true cost of water. They concluded it was “unworkable” to charge the true price (Dutta & Tiwari, 2005).

Garcia, Guérin-Schneider, and Fauquert (2005) was a study conducted in France, looking at the cost of water in an open market and willingness to pay. The paper discusses the competition and how private operators and firms can bid on providing water, as well as the technical factors involved. This would give customers a choice in water providers, and is largely based on cost (Garcia et al., 2005).

1.3.4 Alternative water supplies - grower acceptance. A review of several studies performed in Greece researched the willingness to use, and pay for, recycled water by both growers and consumers (Menegaki et al., 2007). The growers used the recycled water for irrigating their crops, and the consumers were the subjects who decided whether or not to purchase produce irrigated with recycled water. Menegaki, Hanley, and Tsagarakis (2007) found that the willingness to pay and the willingness to use, for both groups, was based heavily on both the available choices between water options and the choice of produce grown with other water sources. Income levels also played a major role in their decisions. The cost of the water itself was a huge factor in the willingness to pay for growers, who stated they would pay up to 55% of the cost of potable water for recycled water (Menegaki et al., 2007). Their study concluded that this supports the need to change policies in Crete and impose requirements to use recycled water. Additionally, recycled water should be priced according to water consumption and the produce grown with it (Menegaki et al., 2007). Since those growers clearly expressed a view that recycled water was less valuable than potable water, which prompts the question of whether there are other correlating factors impacting the perceived value of recycled water when compared to potable water.

A survey of 107 growers in Greece by Bakopoulou, Polyzos, and Kungolos (2007) was conducted in the Thessaly region, and concluded that the growers' willingness to use recycled water is positively correlated with higher education. Bakopoulou et al. (2007) found that most of the growers (57.9%) would pay half of the price for recycled water as compared to potable water, and that a third of the growers (33.6%) would not pay for recycled water at all if potable water is available. However, the willingness to use, and pay for, recycled water increases dramatically once there is a shortage of potable water, which occurs every summer (Bakopoulou et al., 2007). Their study recommended that a new nationwide environmental policy for Greece was necessary for water management in order to achieve sustainable practices, and should include alternative water resources and the creation of infrastructure to support the new policy. Furthermore, a new national policy will not be readily enforceable if it does not address the reasons the Greek growers were unwilling to use recycled water in the presence of potable water (Bakopoulou et al., 2007).

Tsagarakis and Georgantzis (2003) surveyed 247 growers from Crete, Greece. They found growers' willingness to use recycled water was positively correlated with a higher level of income and a higher level of education. In addition, growers with higher levels of education and income demonstrate a positive correlation with knowledge of environmental issues, and more readily express their concerns and take action on those issues (Tsagarakis & Georgantzis, 2003). Small-scale growers increase their willingness to use recycled water and display a more positive attitude towards its use with increased knowledge and availability of information regarding the positive effects on social and private well-being resulting from recycled water use (Tsagarakis & Georgantzis, 2003). Another finding is that short, informative and educational sessions had a strong positive impact on the growers' willingness to use recycled water, and "living standards and education level have a positive effect on both the willingness to use and the degree of acceptance of the informative session" (Tsagarakis & Georgantzis, 2003, p. 112). Their study concluded that there should be policies created that support and encourage recycled water use, with a focus on economic benefits, including indirect benefits, such as reduced fertilizer use due to increased nutrients in the water (Tsagarakis & Georgantzis, 2003).

One measure of success of a water program, from the grower perspective, is the reliability of the water supply and acceptable water quality level (Carr et al., 2011; Chang & Ma, 2012; Gunatilake, Yang, Pattanayak, & Choe, 2007; Mojid, Wyseure, Biswas, & Hossain, 2010). Chang and Ma (2012) researched ways to improve social acceptability and increase the use of recycled water in Beijing, China. They found that water quality was a primary factor affecting the promotion of recycled water use. Their study also showed that guaranteeing the delivery of higher quality recycled water will definitely improve acceptance levels of recycled water (Chang & Ma, 2012).

Carr, Potter, and Nortcliff (2011) explored the perceptions and attitudes of 50 growers from Jordan who used recycled water directly or indirectly. They found that the perceptions of growers varied regarding water quality among the direct and indirect users, surmising that they may have been influenced by factors beyond the interview. The recommendation by Carr et al. (2011) for future research included exploration of how growers are included in the water quality decision-making process, and how to increase their involvement in that process.

The study by Mojid, Wyseure, Biswas, and Hossain (2010) was conducted in Bangladesh, and included growers' perceptions and knowledge of using recycled water in 12 different locations. The wastewater was treated at varying levels or, at times, not treated at all. Subsequently, health problems such as skin infections and blistering were associated with the water. The growers' overall acceptance was low, due to poor water quality; however, some opinions varied because of reduced cost, since they did not have to add fertilizers or pay to pump groundwater (Mojid et al., 2010).

A study by Gunatilake, Yang, Pattanayak, and Choe (2007) looked at how to estimate the cost of water supply and sanitation projects in the Asia and Pacific regions, and what the agencies' willingness to pay would be. They used the contingent valuation method to determine willingness to pay with hypothetical scenarios that included water quality and water quantity. The contingent valuation method is a means to equate a monetary value for environmental impacts or services. Even though the Gunatilake et al. (2007) study had very different parameters than those faced by agencies and water distribution systems within the United States, the attempt to improve the method of determining willingness to pay for water projects is applicable to the United States, and other countries, based on environmental impacts and the scarcity and increased demand for water.

1.4 Problem statement

Growers in the CSIP service area have been struggling with water supply issues for over 20 years. Seawater intrusion led to the implementation of recycled water in 1998 to offset groundwater pumping, and became CSIP's main water source. Approximately 60% of the water used in CSIP is recycled water (MRWPCA, 2017c). It is also the largest distribution system of recycled water for food crop irrigation in the world (California Agricultural Water Stewardship Initiative [CAWSI], 2017; MRWPCA, 2017c). Demand for water in the CSIP area has increased in recent years due to harvesting more water-intensive crops, such as strawberries. Also, there has been an increase in crop rotations throughout the year in order to achieve higher yields. Meanwhile, CSIP, and California as a whole, have been experiencing a severe drought over the last five years, complicating the task of finding and securing another water source in the absence of any additional local sources. Simultaneously, the recycled water supply has diminished due to water conservation among residential and commercial customers, the source of wastewater that gets recycled. All of the issues are compounded with the lack of water storage throughout the CSIP distribution system that is limited to approximately 80 acre feet (or 26 million gallons) of water, which is approximately one day of water use (MRWPCA, 2017a). All of the aforementioned problems have left CSIP growers seeking more long-term, sustainable water supplies.

The highest priorities for water supplies are quantity, quality, and cost. The follow-up concerns are who pays for the processing and delivery of water, and who is responsible for implementing and executing the program. Alternative water supplies can be controversial and must be positively received by the public, growers, and other stakeholders. Recycled water has already proven acceptable for the CSIP service area (Engineering-Science, 1987); however, extensive research and outreach were conducted to gain support for recycled water prior to its implementation (Haddad, 2002; Sheikh, Cort, Kirkpatrick, Jaques, & Asano, 1990). In 1987, the research exploring the safety and water quality of using recycled water to irrigate food crops was released in a report titled "Monterey Wastewater Reclamation Study for Agriculture" (Engineering-Science, 1987). Desalination is a possibility as a water source due to the close proximity to the coast. Currently, there is not enough supply to meet the demand of the CSIP growers without increasing the groundwater pumping and exacerbating the seawater intrusion problem, meaning another water supply is needed. Groundwater recharge and water storage are two other strategies that may be incorporated. Beyond that, the neighboring growers to the CSIP distribution system have a high demand and desire to become annexed into the CSIP service area. The annexation will help the overall management of the Salinas River Groundwater Basin by further reducing groundwater pumping. The overall management will be eventually enforced and determined by the Sustainable Groundwater Management

Act. Furthermore, the current and future impacts of climate change, both locally and globally, must be mitigated by all water managers. Such mitigation will require increased planning and preparation for a variety of climate change impacts, such as increased temperatures, reduced rainfall, and rising sea levels.

1.4.1 Research questions.

1) What factors influence grower acceptance of alternative water supplies?

2) How does growers' level of concern regarding seawater intrusion and environmental impact affect their attitudes towards different water supply options?

1.4.2 Objectives. The objective of this research was to investigate the current attitudes and concerns of the growers within the CSIP area, and evaluate factors that may influence their respective points of view. The first intent of this study is to serve as a resource for policymakers, agencies, and other entities with a stake in the CSIP, including the management of the Salinas River Groundwater Basin (SRGB), when they consider decisions that affect growers' current, and future, water supply. The second intent is to discuss and document the successes of CSIP, and analyze its efforts to provide a reliable water supply to growers going forward while mitigating seawater intrusion and effects from climate change.

This is a unique case study that offers an inside look at CSIP growers' attitudes and perspectives with respect to their specific water management issues. This study was purposely narrow in scope and focused on a particular water distribution system with its specific and unique problems, and long track record of grower adoption. This study seeks to contribute information and insight to the search for sustainable water supply solutions along the California Central Coast, improve understanding of baseline attitudes and perceptions that influence acceptance levels of new solutions, and advance the body of knowledge available to other regions faced with similar dilemmas. The data and information recorded and discussed may be applied to many regions with water issues across the globe, especially in agriculturally intensive areas along coastlines that also mitigate seawater intrusion. In the race to address impending water shortages the world over, collecting and analyzing relevant data is going to be critical to identifying and evaluating solutions.

2. Methods

2.1 Study site

2.1.1 Location, climate, and history. The respondents for this study are exclusively growers who are owners and/or leasing managers of farmland that is served by the CSIP's distribution system. CSIP is located within the Salinas River Valley Watershed (SRVW) along the California Central Coast in Monterey County adjacent to Monterey Bay, and includes parts of the coastal cities of Castroville and Marina.

The CSIP area generally experiences a mild climate throughout the year, making it an ideal location for agricultural purposes. The average monthly temperature for Castroville is approximately 54°F with a low monthly average in December of 48°F, and a high monthly average in August through November of 58°F (Areavibes, 2017). The lowest recorded temperature of 12°F in Castroville was in December 1990, while the highest temperature was recorded at 106°F in October 1987 (Intellicast, 2017). Historically, the CSIP area does not receive a lot of precipitation throughout the year. It generally rains during the winter and early spring, while remaining mostly dry during the summer and fall. Castroville has an average annual rainfall of 23.25 inches with a low monthly average of 0.07 inches in August, and a high of 4.72 inches in January (Intellicast, 2017).

CSIP is a world renowned agricultural region that has been cultivating farmland for over 200 years (Division of Water Resources, 1946). The first recorded diversions of the Salinas River for irrigating crops began in 1797, and groundwater pumping started in 1890 (Brown and Caldwell, 2015). At the same time that demand for water increased for agricultural purposes, technology advanced for well production and water extraction.

Seawater intrusion was first detected in CSIP along the coast in the 1930s (Division of Water Resources, 1946). The inland extent of the seawater intrusion was first mapped in 1944 and continues to the present day (MCWRA, 2017h). Naciemento Dam and San Antonio Reservoir were constructed in 1957 and 1967, respectively, to assist with the mitigation of seawater intrusion, flood control in the area, and to have the ability to store water and redistribute it with water releases via the Salinas River (MCWRA, 2017b). The two reservoirs are located at the southern border of the Monterey County line, which is about 20 miles southeast from the CSIP area. There is a project known as the Interlake Tunnel that is currently underway, with the goal of transferring water between the two reservoirs (MCWRA, 2016; MCWRA, 2017d).

Seawater intrusion and the lack of other available water sources became the catalyst for designing and implementing a water distribution system for CSIP to deliver a blend of all water sources, including recycled water, to growers. The CSIP distribution system was constructed and began delivering recycled water blended with other available sources in 1998 (MCWRA, 2017e). Prior to that time, all of the CSIP growers were using individual, private wells. Active, functional wells that were once private were incorporated into the CSIP distribution system as "supplemental wells," which supply the system with additional water when needed for pressure and/or volume. Twenty-two supplemental wells were active at the time that CSIP went online in 1998 in order to supply additional water when needed for pressure or volume (MRWPCA, 2017c). Many of the wells have been removed or became too saline since that time, and there currently are 10 supplemental wells that are active and functional within the CSIP service area, although that number may fluctuate at a given time due to maintenance and repair (M. Foxworthy [with MCWRA], personal communication, January 26, 2017; MRWPCA, 2017b).

The implementation and application of recycled water used to irrigate crops in CSIP simultaneously provided the following benefits: reusing treated wastewater and becoming an additional water source, helping combat and mitigate seawater intrusion by reducing groundwater pumping, and averting discharging water into waterways and Monterey Bay (Haddad, 2002). Interestingly, the paradigm regarding recycled water has shifted from being a discharge and wastewater issue to becoming a viable water source. The CSIP distribution system currently serves over 12,000 acres of farmland with over 45 miles of pipeline, and is known as the largest distribution system of recycled water for food crop irrigation in the world (CAWSI, 2017; MRWPCA, 2017c). The CSIP service area and water distribution system is dedicated to serving agriculture on farmlands only, with the water intended strictly for irrigating food crops. The most common crops typically grown in CSIP are artichokes, broccoli, Brussels sprouts, cabbage, cauliflower, celery, lettuce, spinach, and strawberries.

Several events and water management strategies took place prior to the availability of recycled water and the completion of the CSIP distribution system in 1998. In the late 1960s, there were profound wastewater discharge issues and polluted waterways throughout the United States that led to the implementation of the Clean Water Act of 1972. In order to protect the Monterey Bay, one larger treatment facility, the Monterey Regional Water Pollution Control Agency (MRWPCA), was constructed in order to merge eight local treatment plants that were each reaching full capacity (Engineering-Science, 1987). The eight merged sewer systems served the following residential and commercial locations: Castroville, Moss Landing, Monterey, Salinas, Sand City, Pacific Grove, Del Rey Oaks, Seaside, Fort Ord, Marina, and unincorporated parts of Monterey County (MRWPCA, 2017a). A Board of Directors known as the Joint Powers Authority was formed to oversee the operations of the MRWPCA. It consists of eleven members representing multiple stakeholders (MRWPCA, 2017a). In May 1974, the Central Coast Regional Water Quality Control Board completed a regional water quality management plan that recommended the "reuse of reclaimed wastewater for crop irrigation and possible enhancement of the lower Salinas River" (Engineering-Science, 1987, p. 13). Reclaimed and treated wastewater (recycled water) had to be proven safe and acceptable for irrigating food crops (Haddad, 2002; Sheikh, Cooper, & Isreal, 1999). The planning process began in 1976 with a study titled "Monterey Wastewater Reclamation Study for Agriculture" (MWRSA), and consisted of several plots using a variety of water sources for five years (1980-1985). The final report and study results were released in 1987 which involved input from many stakeholders, policymakers, consumers in produce distribution, and the growers (Engineering-Science, 1987). The collaboration and communication among all of the aforementioned, along with the findings that recycled water did not have significant negative impacts, led to the success and acceptance of recycled water being distributed and used by growers (Haddad, 2002; Sheikh et al., 1990).

The five primary objectives of the MWRSA for evaluating the use of recycled water to irrigate food crops were to:

1) Evaluate the health and safety of consumers and farm workers with respect to viruses, bacteria, or trace elements being present in the water, soil, or crops produced
2) Assess the effects of soil degradation and yield, as well as quality of crops
3) Evaluate the acceptance by consumers
4) Provide design criteria for the implementation of the program
5) Provide field operational experience for using recycled water to irrigate food crops

The results of the MWRSA indicated there were no adverse effects on the soil, and the crops grown using recycled water were just as good as, or better than, those irrigated with groundwater. Also, interviews with 144 individuals involved with produce distribution in 1983 concluded that there should not be any negative impacts when using recycled water for irrigating food crops, so products did not need to be labeled differently (Engineering-Science, 1987).

MRWPCA has the capacity to treat up to 29.6 million gallons per day (MGD) of wastewater, which is equivalent to roughly 91 acre-feet per day (AFD). On average, the MRWPCA treats 16 to 18.5 MGD of sewage from approximately 250,000 local residents (MRWPCA, 2017a). The majority of the 16 to 18.5 MGD of wastewater originates from the Salinas River Groundwater Basin (SRGB); however, a small portion comes from the neighboring Seaside Groundwater Basin (B. Boatman [with MRWPCA], personal communication, July 25, 2016; MRWPCA, 2017a). The standard level of treatment for recycled water that is delivered to the growers by MRWPCA is tertiary, which includes a third level of treatment known as disinfection (MRWPCA, 2017c). A secondary level of treatment (without disinfection) is acceptable for wastewater that is discharged into bodies of water (Department of Toxic Substances Control, 2017; MRWPCA, 2017d). Therefore, excess wastewater (or wastewater that is not tertiary treated and distributed to growers) has historically been sent to an outflow pipe that discharges that wastewater into Monterey Bay approximately two miles off shore (MRWPCA, 2017a). Efforts are in progress to utilize the excess wastewater with a program called Pure Water Monterey that will treat the excess wastewater (Pure Water Monterey [PWM], 2017).

The MRWPCA has a Storage Pond located at the beginning of the distribution system, which acts as a buffer in between the treatment facility and the CSIP distribution system. In addition to the buffer between the facility and the system, the Storage Pond is where other water sources can be blended with the recycled water before being delivered to the CSIP system. The Storage Pond can hold up to about 80 acre feet (or 26 million gallons) of water, which is approximately one day of water use (MRWPCA, 2017c). Currently, the only storage of water within the entire CSIP distribution system is the water contained in the Storage Pond, with the exception of the water that is being delivered through the water mains. The active supplemental wells throughout the distribution system in CSIP provide a supplemental source of water that assists with offsetting peak demands for pressure and volume availability.

The MCWRA began implementing the Salinas Valley Water Project (SVWP) in 2002 in response to increased water demands by local growers in CSIP, and to offset groundwater pumping (MCWRA, 2017e). Collectively, CSIP and SVWP are known as the Monterey County Water Recycling Project. The SVWP consists of three main functions and actions: increasing water releases during peak summer months from

Nacimiento and San Antonio Reservoirs via Salinas River for groundwater replenishment, increasing winter storage of water by modifying the spillway of the Nacimiento Dam, and constructing the Salinas River Diversion Facility (SRDF). SRDF is a facility that is located near MRWPCA and uses an inflatable dam to divert water from the Salinas River (MCWRA, 2017g). The SRDF also consists of a fish ladder, fish screens, pump station, and a pipeline that connects the diverted water from the Salinas River to the CSIP distribution system (Feldsher & Wu, 2010). The SRDF is only allowed to operate from April to October, months with the highest water demand and is coordinated with the water releases into the Salinas River from Naciemento and San Antonio Reservoirs approximately 20 miles away. Water from SRDF is blended with the recycled water from MRWPCA at the Storage Pond before entering the CSIP system. The construction of the SRDF was completed, and began diverting water from the Salinas River in May 2010. In October 2013, SRDF was not allowed to operate and divert water from the Salinas River due to the lack of available water from the intensity of the drought. Also, water releases were halted from Naciemento and San Antonio Reservoirs as the water levels dropped. The intensity of the drought made it difficult to secure another local water source; however, CSIP was able to receive water from the Salinas Industrial Ponds. The Salinas Industrial Ponds are wastewater collection ponds from industrial and commercial use from the City of Salinas. Since February 2014, approximately 3 MGD of water is being treated by MRWPCA, blending with the CSIP water supply at the Storage Pond, and being delivered to the growers (MRWPCA, 2015; MRWPCA, 2017b).

2.1.2 Local water supply issues. The overall water use and demand has been rising for several years within the CSIP service area (see Figure 1). The CSIP water use dates back to a full calendar year in 1999 since the distribution system was first constructed, and began delivering water in 1998 (MRWPCA, 2015; MRWPCA, 2017c). Prior to 1998, the CSIP farmland was utilizing individual, private wells. Generally speaking, the years in which the water use dropped or rose considerably were years that received an increase or decrease in the amount of rainfall, respectively. Per Ordinance 3851, since 1991 growers in the Salinas Valley are required to annually submit Agricultural Water Conservation Plans that outline and report various best management practices concerning water use to the MCWRA (MCWRA, 2017f). Two reasons for the overall increase in water use and demand in CSIP are an increase in strawberry production and an increase in crop rotations throughout the year in order to create year-round harvesting. Strawberries are more water-intensive than other crops grown in the region, and are grown later in the year, previously a time in which no crops, or less water-intensive crops, were grown. In addition, there have also been a few farms in the CSIP area that have come online in the last number of years that were previously still using their private, individual wells. Currently, there are only a few farms within the CSIP service area that are not using the MRWPCA turn-outs that distribute the blended CSIP water supply. Meanwhile, there is a very high interest from the growers that are adjacent to CSIP to become annexed into the CSIP distribution system. The annexation process will require extensions and improvements to the existing distribution system to allow access for the adjacent growers including water mains, pumps, valves, and other necessary appurtenances. Figure 4 shows the overall water use broken down into the individual water sources dating back to 1999 (MRWPCA, 2015). Recycled water accounts for approximately 60% of the overall water used by the CSIP growers (MRWPCA, 2015; MRWPCA, 2017c). The amount of wastewater that is received by MRWPCA to treat and

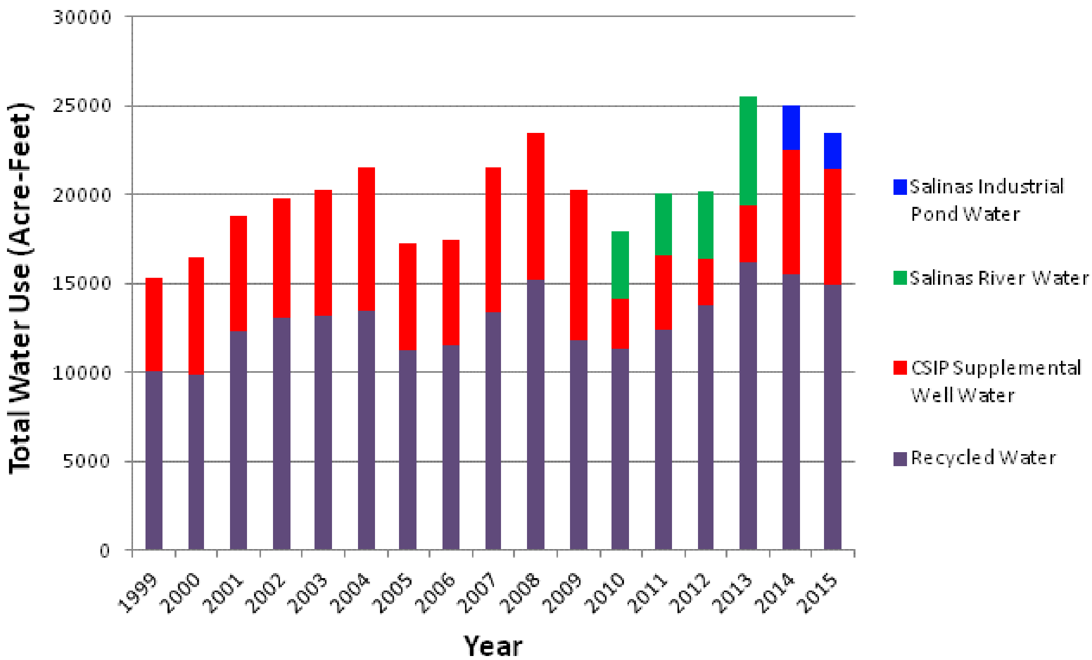


Figure 4. Total water use, per water source, for the Castroville Seawater Intrusion Project distribution system (1999-2015). Data obtained with permission from Monterey Regional Water Pollution Control Agency.

deliver as recycled water has been reduced in recent years due to conservation efforts and drought conditions. Currently, there are ten supplemental wells that are active and functional that supply the CSIP system with additional water when needed for pressure and/or volume (M. Foxworthy [with MCWRA], personal communication, January 26, 2017; MRWPCA, 2017b). SRDF diverted water from the Salinas River into the CSIP distribution system via a rubber dam from 2010 to 2013. Due to a lack of available water and severe drought conditions, the SRDF was taken offline until there is an ample amount of water available for diversion from the Salinas River. The blending and implementation of Salinas Industrial Pond water began in February 2014 to fill the void after SRDF went offline. The Salinas Industrial Pond water is wastewater collected from industrial uses in the City of Salinas, and has overall low water quality levels that require treatment by MRWPCA (MRWPCA, 2017e). The Salinas Industrial Pond water also has limited availability of approximately 3 MGD (MRWPCA, 2017b).

Historically, excess recycled water that was not utilized by the CSIP distribution system was discharged into Monterey Bay, a federally protected marine sanctuary. The discharging generally occurred in the winter months during low-demand times due to the fact that there is only 80 acre feet of water storage within the CSIP distribution system at the Storage Pond. The MRWPCA discharged the excess recycled water through an outfall pipe that extends approximately two miles off the coast so it will have less impact on the environment by reducing changes to salinity levels and temperature of the water off the coast of Monterey Bay (MRWPCA, 2017a). The excess recycled water is now being sent to a groundwater replenishment project known as Pure Water Monterey (PWM), which is currently in the planning and implementation process that had its Environmental Impact Report approved in January 2016 (PWM, 2017). The PWM is a partnership between MRWPCA and the Monterey Peninsula Water Management District (PWM, 2017). The state previously mandated restrictions for extracting water from Carmel River; therefore, another water source was needed to meet the demands of the residential and urban use for Seaside, and the surrounding area (Johnson, 2015). The PWM will treat various sources of water at an Advanced Water Treatment (AWT) facility located at MRWPCA, and convey that water south to groundwater recharging facilities in the adjacent groundwater basin, Seaside Groundwater Basin (PWM, 2017). AWT is the next step in water treatment after tertiary treatment which involves reverse osmosis, microfiltration, and an oxidation process that includes ultraviolet light and hydrogen peroxide, which is required by the state to meet water quality standards for treated water being conveyed into a groundwater supply (Department of Toxic Substances Control, 2017). The other alternative water sources that will be conveyed to AWT include capturing local stormwater and collecting agricultural tile drain water and surface water at four locations: Lake El Estero, the Reclamation Ditch, Tembladero Slough, and Blanco Drain (PWM, 2017). PWM has committed to reducing 3,500 acre feet per year (AFY) of water extracted from the Carmel River, and to inject that amount into the Seaside Groundwater Basin (PWM, 2017). PWM expects to provide CSIP with 4,500 to 5,900 AFY of treated water from the AWT, which represents approximately 20% of the overall water used (23,500 AFY) within CSIP in 2015 (MRWPCA, 2015).

There are many agencies and stakeholders involved in water management programs and decisions, which can become a complicating factor in many facets of policymaking. There are some areas of overlapping responsibilities and duties among the agencies, which are generally categorized in one of three political levels: local, state, or federal. Requirements and regulations can be stricter at the local level relative to state or federal levels, and the state level can be more stringent than federal rules. However, regulations cannot be less stringent than what is set at the federal level.

Due to the 2014 Sustainable Groundwater Management Act (SGMA), the management of the Salinas River Groundwater Basin (SRGB) will likely change some of the roles of agencies and stakeholders within CSIP and Monterey County (DWR, 2017a, MCWRA, 2017i). Currently, Monterey County Water Resource Agency (MCWRA) is the lead agency that is responsible for the management and protection of water resources within the Salinas River Valley Watershed (SRVW). The management of water resources also includes overseeing and implementing the mitigation of seawater intrusion in the SRVW (MCWRA, 2017h).

The MCWRA operates under the guidance and provisions of a Board of Directors that represents several local agencies and stakeholders (MCWRA, 2017a). The Monterey Regional Water Pollution Control Agency (MRWPCA) under the supervision of MCWRA is in charge of treating, blending, and distributing water to CSIP growers (MRWPCA, 2017g). The blended water that is distributed to CSIP growers must meet or exceed water quality standards that are set by the State Water Resources Control Board (Department of Toxic Substances Control, 2017; MRWPCA, 2017e). More stringent water quality standards have been set by the Monterey County Water Recycling Project's "Water Quality and Operations Committee," which is comprised of policymakers, stakeholders, and CSIP growers (MRWPCA, 2017b; MRWPCA, 2017e). MCWRA and MRWPCA coordinate and collaborate efforts with a variety of other agencies, such as Department of Water Resources, California Department of Public Health, Central Coast Regional Water Quality Control Board, California Department of Fish and Game, and the Environmental Protection Agency. In a nutshell, the aforementioned agencies either regulate, or are concerned with, the water quality for water entering or leaving the CSIP service area or any associated environmental impacts.

The Pajaro River Valley Watershed (PRVW) is enduring similar predicaments as CSIP in regards to seawater intrusion and water supply issues. The PRVW is about 50 miles north of CSIP, along the coast of Monterey Bay, and is an agriculturally intensive area located in, and around, the city of Watsonville. PRVW is located within the Santa Cruz, Santa Clara, and San Benito Counties. Similar to CSIP, overpumping groundwater is the main cause for seawater intrusion in the PRVW and the most affected areas are closest in proximity to Monterey Bay. The challenge of mitigating the seawater intrusion problem in the PRVW led to the creation of the Pajaro Valley Water Management Agency (PVWMA) in 1984. The PVWMA oversees water supplies in the PRVW and is charged with reducing and limiting the amount of seawater intrusion (Pajaro Valley Water Management Agency [PVWMA], 2017). The city of Watsonville partnered with the PVWMA to create the Watsonville Area Water Project, which began delivering recycled water with blended water sources in April 2009 to farmlands in Watsonville. It currently delivers approximately 4,000 AFY of recycled water to Watsonville farms, in a blend with 2,000 AFY of potable water (PVWMA, 2017). The PVWMA has not implemented the use of desalinated water due to high operation and energy costs, and the complexity of obtaining a permit for the brine discharge (Raines, Melton & Carella, Inc., 2002). The PVWMA recently began implementing a rigorous groundwater recharge program to help replenish water levels for the Pajaro Valley Groundwater Basin (PVWMA, 2017). The Pajaro Valley Groundwater Basin will be managed under SGMA of 2014, and has also been listed as one of the 21 "Critically Overdrafted Groundwater Basins" in California by the Department of Water Resources (DWR, 2017b).

2.1.3 Local seawater intrusion. The Salinas River Groundwater Basin (SRGB) lies underneath the Salinas River Valley Watershed (SRVW). The SRGB extends as far south as the city of Paso Robles located in San Luis Obispo County. In 2015, the Monterey County Water Resources Agency (MCWRA) released its groundwater monitoring plan to the Department of Water Resources to the California Statewide Groundwater Elevation Monitoring program for the SRGB (MCWRA, 2015a). Near the border between Monterey County and San Luis Obispo County and in the SRGB is an underground geologic formation known as the San Miguel Dome that is essentially an underground mountain or peak. The San Miguel Dome is a physical barrier between the two areas within SRGB when groundwater levels are low; however, the areas north and south are hydraulically connected when the water levels are elevated (H. Franklin [with MCWRA], personal communication, June 17, 2016). The border for the respective counties has historically acted as a political boundary for groundwater management purposes. This discussion regarding SRGB will focus on the portion that is within Monterey County and north of the San Miguel Dome which has been historically overseen and managed by MCWRA, and is currently being petitioned to the Department of Water Resources for the implementation of managing the SRGB via the Sustainable Groundwater Management Act (MCWRA, 2017c).

The Monterey County portion of the SRGB is further divided into four subareas (Pressure, East Side, Forebay, and Upper Valley) that are all connected hydraulically

(Brown and Caldwell, 2015; MCWRA, 2015b). The boundaries for the four subareas are distinguished by how each subarea receives groundwater recharge through the soil, and the geography and alluvial structures that comprise each respective subarea (Brown and Caldwell, 2016; MCWRA, 2017c).

CSIP is located within the Pressure subarea in the northern portion of the SRGB, near the coastline of Monterey Bay. Two layers of aquitards, physical barriers below ground composed of clay that separate aquifers from one another, create the unique formation of the Pressure subarea (Brown and Caldwell, 2016). Each aquifer is named in relation to the approximate depth from the surface: 180-foot Aquifer, 400-foot Aquifer, and Deep Aquifer (MCWRA, 2017e). The Pressure subarea receives natural groundwater recharge through percolation in the soil, and at various locations along the Salinas River, where the strata of the riverbed allow for percolation.

Currently, the only means of artificial groundwater recharge occurs when water supplies are available and released upstream into the Salinas River from Naciemento and San Antonio Reservoirs located near the Monterey County line (Brown and Caldwell, 2016). Another purpose and benefit for releasing water from the two reservoirs is to provide additional water for CSIP to blend with other sources via the rubber dam at the Salinas River Diversion Facility. This method of groundwater recharge is very inefficient due to the distance that water must travel along the Salinas River, and the large amounts of water lost through evapotranspiration, uptake from riparian vegetation, and any diversions along the way (Brown and Caldwell, 2016). Nonetheless, the geological composition of the groundwater basin in much of the Pressure 180-foot subarea makes it more difficult to have conventional groundwater recharge such as injection wells (H. Franklin [with MCWRA], personal communication, June 17, 2016). The release of water has immensely improved the mitigation of seawater intrusion, and the advancement of the seawater intrusion appeared to be halted entirely in 2013.

The seawater intrusion maps are in the process of being updated at this time, and it is expected that the seawater intrusion has advanced a considerable amount since 2013 due to the intensity of the drought, and the halting of releases from the reservoirs due to lack of available water (H. Franklin [with MCWRA], personal communication, June 17, 2016). Seawater intrusion was first recorded in the Pressure subarea in the 1930s with local groundwater pumping beginning 40 years prior to that, and the seawater intrusion has since advanced to approximately eight miles inland within the 180-foot Aquifer, and about four miles inland within the 400-foot Aquifer (Brown and Caldwell, 2016; MCWRA, 2017h). The advancement of the seawater intrusion is measured by groundwater reaching 500 parts per million of chloride (Brown and Caldwell, 2016).

The most significant method that advances seawater intrusion inland in the Pressure subarea is overpumping groundwater at a rate faster than SRGB can replenish that water supply (Brown and Caldwell, 2015). The critical mechanism that determines the extent of the seawater intrusion within the Pressure subarea is the gradient level of the freshwater in relation to the seawater (H. Franklin [with MCWRA], personal communication, June 17, 2016). Once the freshwater gradient is lowered, the void is filled with the advancing seawater replacing the freshwater. To simplify the seawater intrusion process, the groundwater pumping near the coast creates a gradient level within the Pressure subarea that is represented as a potentiometric surface (H. Franklin [with MCWRA], personal communication, June 17, 2016). The seawater intrusion maps that show the extent of the seawater intrusion within the SRVW are representing the hydraulic head of the gradient (MCWRA, 2017h). The maps do not accurately reflect the vertical components of the seawater intrusion; however, the maps incorporate many facets including water quality analysis, contours of the groundwater basin, and a greater understanding of the aquifers and the SRGB (H. Franklin [with MCWRA], personal communication, June 17, 2016).

Farther from the coast and more inland is the city of Paso Robles in San Luis Obispo County where land subsidence is occurring. Land subsidence is similar to seawater intrusion, except when the void is created in the groundwater basin then the surface collapses into the groundwater basin, rather than being filled with seawater. The amount of land subsidence within the Pressure subarea and Monterey County, as a whole, has historically been very minimal and insignificant (H. Franklin [with MCWRA], personal communication, June 17, 2016).

Another means for the advancement of seawater intrusion within the Pressure subarea is the transference of water through the aquitards between the three levels of aquifers (180-foot, 400-foot, and Deep Aquifers). The water can travel between the aquifers via porous sections within the clay and sediment that composes the aquitard, and also via poorly constructed wells and well casings that can allow water to be transferred (Brown and Caldwell, 2016).

In general, with regards to seawater intrusion, there are insignificant and minimal impacts associated with the amount of water conveyed between the four subareas (H.

Franklin [with MCWRA], personal communication, June 17, 2016). Even though the subareas are all connected hydraulically, the border of each subarea within SRGB represents one or more of the following: substantial change in elevation, various geological formations, and alluvial deposition of various sediments. Therefore, the Pressure subarea is somewhat isolated within the SRGB, and is not significantly impacted by the groundwater pumping in the other three subareas. Due to the complex and sensitive geologic formation of the Pressure subarea, the notion of transferring water between subareas, or constructing and operating injection wells, is not recommended and not a consideration at this time with MCWRA (H. Franklin [with MCWRA], personal communication, June 17, 2016).

The Pressure subarea of the SRGB is included in the January 2016 Department of Water Resources list of “21 Critically Overdrafted Groundwater Basins” (DWR, 2017b). While management of the SRGB is mandated by the newly instated Sustainable Groundwater Management Act, the agency (or agencies) that will implement and execute that management has not been determined (DWR, 2017a).

2.1.4 Local climate change impacts. Climate change is a global phenomenon and process impacting the planet with drastic changes in rainfall, temperatures, and sea levels. All of these measurable changes have potentially significant impacts on water supplies in both local and regional expanses and climate zones. Climate cycles and patterns are considered and described relative to spans of time in which they occur. This discussion of local climate change specifically addresses patterns, of longer or shorter duration, in the context of particular weather conditions with respect to shifts in intensity. While climate change is often framed in global (or far removed) terms, the discussion must be brought down to the local level to appreciate impact that appears more imminent and likely in the context of a given region or locale. This research discusses California on a smaller, local scale to put the potential climate changes in context for the CSIP, the Salinas River Valley Watershed (SRVW), and Monterey County. For example, the entire state of California endured an intense and extensive drought, which immensely impacted every region in the state. A severe shortage of water, compounded by the inability to obtain additional water, is a profoundly difficult water management issue.

Aside from the magnitude of scale, one of the largest discrepancies between global and local climate change is the fact that human activities and land use development are centered around weather conditions on a local scale, and so seemingly minor shifts in weather conditions can have profound effects. One of the major difficulties in preparing for climate change is the fact that historical patterns are not as reliable for predicting future trends, complicating the planning process for water managers. Some changes may be abrupt and need immediate attention, such as droughts or floods. Others are gradual and need attention and foresight over longer periods of time. Slight temperature changes, or sea levels rising over time, fall into this category. Situations that are not perceived to require immediate attention are not typically deemed high priorities. Most agencies are reactionary and do not have, or secure, the time, staff, or funding to be proactive. Or, if individuals do have foresight, they have difficulty gaining buy-in from other stakeholders to invest in solutions for problems not yet manifesting. The stakeholders within the CSIP area and the SRVW have been extremely successful managing water sources to the present day, and have many more challenges ahead to maintain sustainable water supplies to meet demand at a local level. Nonetheless, preparation and planning for the most relevant climate changes that CSIP will likely endure are critical for ongoing survival and success.

A wide variety of potential climate change conditions could affect water supplies, crops grown, and the environment in and around CSIP; however, the potential changes with the highest probability of occurrence, on a local level, are the focus of this discussion. First of all, the amount and intensity of rainfall may increase or decrease dramatically over shorter or longer periods of time, leading to a wide spectrum of challenges ranging from drought to flood to unseasonal temperatures affecting plant life cycles. In drought conditions, water becomes scarcer and well users tend to increase groundwater pumping out of necessity. They also drill deeper wells in order to access the limited water supply. Long periods of drought are one of the greatest concerns for managing water resources in the SRVW.

The Pressure subarea in CSIP can generally sustain droughts better than other subareas within the Salinas River Groundwater Basin due to a larger amount of storage. Although utilizing the stored water in the Pressure subarea will likely exacerbate and accelerate seawater intrusion (H. Franklin [with MCWRA], personal communication, June 17, 2016). In addition, an increase in groundwater pumping near the coast will lower the water gradient level of freshwater in relation to the seawater, which is the main driving factor for seawater intrusion (Brown and Caldwell, 2016).

Secondly, overall temperatures are predicted to become more extreme for the highs and lows, profoundly impacting the types of crops planted, and success or failure of harvests. Vegetation is extremely sensitive to temperature levels and temperature swings. The overall increase in temperatures is likely to be a long-term change, and successful strategies will be those that adapt to those changes continually as they take place.

Finally, sea levels are expected to rise several feet in the next few decades and beyond. If that prediction is realized, mitigating seawater intrusion may escalate dramatically in priority, unless the water gradient level can be maintained (Brown and Caldwell, 2016). There is potential for rising sea levels to result in the advancement of seawater intrusion (Loáiciga et al., 2012; Sherif & Singh, 1999). However, rising sea levels would have to adversely affect the water gradient level in order to be directly related to the advancement of seawater intrusion (Mazi et al., 2013; Rasmussen et al., 2013). Depending on the rate at which sea levels rise, land currently along the coast may become partially submerged, threatened with flooding, in a relatively short period of time. Such results would be irreversibly detrimental, even ruinous, to the growers in those areas and the land adjacent to those farms.

2.2 Study design

Identifying a subject for study within management of water resources that included the use, or planned use, of alternative water sources was driven both by the researcher's interest and the increased demand for water during the California drought. Among potential local research projects, the CSIP area was not only compelling, but also presented other real-world issues of interest, such as agricultural needs and the on-going mitigation of seawater intrusion. As the drought in California intensified, interest grew, and management of water resources became a priority topic of discussion at the local and state level. Focusing on the specific issues that the CSIP area is currently facing, and the history behind those issues, promised to reveal the most about the possible future outcomes.

Case study was the most appropriate research method once the complex issues and involvement of many stakeholders in the CSIP area became apparent. The case study research method is defined as a "...method that concentrates on one thing, looking at it in detail, not seeking to generalise from it" (Thomas, 2011, p. 3). Furthermore, a case study leverages several disciplines, along with the collection of data, to gain a better understanding of complex issues and interactions among a variety of social groups (Gerring, 2007; Yin, 2014). Numerous meetings and discussions with various stakeholders, policymakers, and professors were conducted to narrow the focus of this study and refine the questions to pose in the interview (Appendix: Interview Questionnaire). In addition, a wide variety of data and literature was reviewed and researched. Over one year prior to conducting the interviews for this study, the researcher regularly attended Monterey County Water Recycling Project's "Water Quality and Operations Committee" meetings, an advisory committee consisting of several policymakers, stakeholders, and growers within the CSIP service area. The meetings address current issues and provide updates on current water deliveries, as well as operations and maintenance of the CSIP distribution system. The researcher continually attended the advisory committee meetings after the interviews had concluded as well in order to keep current with CSIP issues.

To better understand and obtain the most relevant perspectives on the research questions, the study respondents consisted exclusively of growers who are either owners or leasing managers (or both) of farmland within the CSIP service area of water distribution. The intent of requiring that growers, at minimum, be owners or lessees of land in CSIP was to restrict the survey to those who are end-users, and who are most directly affected by decisions made regarding CSIP’s water supply and operations.

The survey consisted of a semi-structured interview with CSIP growers who were asked 62 total questions (Appendix: Interview Questionnaire). In the early stages of designing and creating the survey, the researcher decided that all interviews with respondents would be conducted in-person, and one-on-one. There was no prior discussion about specific questions on the survey with the respondents; however, the subject matter was discussed to explain the research. No handouts were given to the respondents before or after the interview, ensuring the questions were unknown prior to each session. The Interview Questionnaire was intended to be comprehensive and thorough in order to elicit answers sufficiently detailed to gain perspectives and knowledge regarding the two research questions (Section 1.4.1) and insights from the CSIP growers.

The structure of the questionnaire consisted of three sections: background and demographic, Likert scale statements, and open-ended questions (Appendix: Interview Questionnaire). First, the background and demographic section posed numerous questions about each respondent's experience and perspective. Several demographic groups were examined, including the growers' ages, income levels, highest levels of education, number of farms, size of farms, and the number of years in the farming industry. Second, the Likert scale statements section addressed growers' general opinions of the amount of communication and levels of trust with policymakers and stakeholders. The Likert scale statements section included five statements, each offering a choice of the following possible answers: strongly disagree, somewhat disagree, neutral, somewhat agree, and strongly agree. This gave the respondents a more accurate expression in assessing his or her response to each statement. It also allowed the interpretation of the results to be more direct, providing the researcher with higher fidelity between the expression and intention of responses. Third, the open-ended questions comprised the bulk of the questionnaire and explored the growers' preferences regarding water supply decisions, perspectives toward policy or operational changes, and attitudes about a variety of environmental concerns. The open-ended section also allowed the respondents to expand their answers, if they chose.

Content analysis was deemed as the best technique to analyze the data in this study. Content analysis applied to qualitative data is considered unobtrusive to the participants (Babbie, 2011). Reis and Judd (2000) define content analysis as "a technique used to extract desired information from a body of material (usually verbal) by systematically and objectively identifying specified characteristics of the material" (p. 314). Content analysis offers the ability to represent a large amount of qualitative data in a vastly reduced and manageable density (Reis & Judd, 2000). It facilitates finding patterns based on key words, allowing researchers to draw conclusions about perceptions and attitudes of human respondents.

2.3 Data collection

The data collection for this case study consists of two types of data: primary data and secondary data. To explain, primary data is information created by the researcher, whereas secondary data was created previously by others. The primary data within this study consists of the results from semi-structured, in-person, one-on-one interviews with growers working in the CSIP service area. Secondary data is the analysis and referencing of previous works regarding the CSIP area, and related information such as websites, written documents, maps, figures, data, and other information. All secondary data is cited throughout the document where applicable.

The sample population employed for this study was discovered entirely by two non-probability types: purposive and snowball sampling methods. In purposive sampling, the researcher selects different respondents to better serve the research (Babbie, 1998). The researcher employed a variety of networking methods to create interest and generate contacts for potential and actual respondents. Snowball sampling occurs when the initial respondents refer the subsequent potential participants for the study (Babbie, 1998; Rea & Parker, 2005). Snowball sampling method was initiated at the end of the interview by asking respondents to refer other eligible CSIP growers, who might have been willing to participate in the study. This tactic proved to be extremely effective for locating subsequent growers to survey. Respondents appeared to have a high level of trust with the researcher and willingness to participate in the interview. This can likely be attributed to the fact that a colleague or coworker referred them, and that the researcher was familiar, having attended their advisory committee meetings.

A total of 18 in-person, one-on-one, semi-structured interviews took place between December 2013 and November 2014. Finding the next respondent, and scheduling the time to conduct the interview, proved challenging on occasion. Such issues are to be expected for in-depth data collection from human subjects. The interviews were held at locations convenient for the respondents — most often their own offices, or farmlands in the CSIP area, although the locations varied. Interviews were conducted in a consistent manner to limit bias in data collection, and all interviews were in-person, conducted by the researcher. To establish a relaxed, yet professional atmosphere for both parties, the researcher wore semi-casual attire with a button-down shirt and blue jeans. The responses, along with any additional notes, were both written down and recorded. Each respondent was required to read and sign a consent form prior to the start of the interview, acknowledging that the interview was being recorded using a digital voice recorder. The consent form also stipulated that the respondent's participation was completely voluntary, and that he/she did not have to answer questions he/she did not choose to answer. Only four respondents declined to answer regarding their level of income; otherwise, all questions were answered in all of the interviews. All information collected during the interviews remains anonymous, such that neither the grower, nor his or her company, would be directly associated with any statements. Each question was read to all respondents by the researcher (Appendix: Interview Questionnaire). The duration of each interview varied with an average total time of 49 minutes, within a range of 30 to 90 minutes. The variation in total time per interview was due to the length of answers to open-ended questions and tangential conversation.

2.4 Data analysis

The first step in analyzing the interviews was to transcribe all of the recordings into documents for coding and analysis. The conversion into documents was performed by a professional transcriptionist hired by the researcher. Prior to the start of any work or transferring of any files, a confidentiality agreement was signed between the transcriptionist and the researcher. The agreement stated that all shared files and correspondence between the two parties are to remain confidential. The transcribed documents were reviewed for errors and/or discrepancies by the researcher.

All of the data from the 18 transcribed interviews were uploaded and analyzed in a web-based software application called Dedoose. The quantitative data within the demographics and background sections, and Likert scale statements were uploaded as spreadsheets into the Dedoose website. In addition, the transcripts of the qualitative data, as part of the open-ended questions portion of the interviews, were uploaded as documents. The qualitative data has a unique identifier associated with its information which, in this case, is a specific number associated with its respective interview. Transcriptions are coded by applying a code to a particular word, phrase, or statement by highlighting the text to tag it. Each respondent was assigned a random and unique reference number (i.e., 1313A) in order to refer to a particular interview while remaining anonymous. In order to report the results while keeping the respondents' identity and company information anonymous, the unique reference number was used to correlate information, such as cross-referencing responses with grower demographics and to record specific quotes. The Dedoose software performs the cross-referencing and displays the information in a variety of ways. It is the researcher's responsibility to meticulously review the outcome and ensure analysis results in accurate and correct outputs within the Dedoose software, demonstrating that the coding functioned as intended to ensure valid correlation and analytic results.

Open coding is the most appropriate method to code and categorize responses from the interviews. It allows categories and identifying features to be devised and revised during analysis. It can also use the data to "discover, name, and categorize phenomena according to their properties and dimensions" (Strauss & Corbin, 1998, p. 206). Open coding was used to encode the qualitative portion of the data: open-ended questions which allowed the respondents to articulate their own answers to questions and elaborate on a topic as they deemed necessary (Babbie, 1998). The Likert scale statements allowed for a five-scale gradient range of responses as follows: strongly disagree, somewhat disagree, neutral, somewhat agree, and strongly agree. The responses from the Likert scale statements were correlated to the respective demographic and background answers in order to draw conclusions and comparisons among various determining factors regarding the growers' attitudes and perspectives.

A variety of additional statistical analyses of the data from the interviews was also performed using Microsoft Excel. Data entered into spreadsheets were analyzed using pivot tables in order to get counts of responses from the respondents' respective demographic groups. Statistical analysis allowed mathematical comparisons, revealing average rates of response and other statistically indicative relationships among answers.

Percentages shown for responses shown in Table 1 were divided by the number of respondents, eighteen (unless noted), and were rounded up or down to whole numbers.

Table 1

Number of Respondents Represented by Percentage

Respondents	Percentage	Respondents	Percentage
1	6%	10	56%
2	11%	11	61%
3	17%	12	67%
4	22%	13	72%
5	28%	14	77%
6	33%	15	83%
7	39%	16	89%
8	44%	17	94%
9	50%	18	100%

Some questions received multiple responses per answer; therefore, the numbers are shown as a count of the total number of responses, rather than a percentage based on the total number of respondents.

3. Methods

3.1 Grower demographics

Approximately 20 questions in the background and demographics section were asked of each of the 18 respondents (Appendix: Interview Questionnaire). Respondents remain anonymous throughout this paper, and their answers are presented without identifying personal information or company affiliation to protect their interests and identities, and to preserve the integrity of this case study. For example, the vast majority of the participants were male; therefore, the gender demographic will not be analyzed. Such a small sample of female respondents would not comprise a statistically significant proportion from which to draw conclusions. In addition, names and locations of the growers' farms were recorded, but will not be published directly. The information was, however, used to calculate the approximate representation of respondents' land within CSIP, which was approximately 75% or more of the 12,000 acre total. The statistic regarding the respondents' main customers for their crops turned out to be large produce distributors and wholesalers, although that specific listing will not be published. This question was intended to reveal growers' target customers to gain insight into their business objectives, but since all respondents target similar markets, any discovery related to these data will be treated as generally applicable across the board. The results in Table 2 illustrate the diverse background of the sample by grouping the respondents into discrete categories and groups. Six of the most pertinent profile variables are discussed in detail and shown in Table 2: Age (M = 51 years, SD = 10.2 years), Income level (M = 150K, SD = 75.7K), Highest level of education (M = Bachelor's degree, SD = 0.8), Number of years in the

Table 2

Demographics of Respondents

Profile variable	Demographic group
Age	under 40 years = 6% 40-45 years = 39% 46-50 years = 11% 51-55 years = 6% 56-60 years = 17% 61 years or over = 22%
Income level (N = 14)	under 100K = 29% 100-149K = 21% 150-199K = 21% 200K or over = 29%
Highest level of education	High school = 6% Some college = 28% Bachelor's degree = 50% Master's degree = 17%
Number of years in farming industry	11-15 years = 11% 16-20 years = 33% 21-30 years = 22% 31 or more years = 33%
Number of farms	1-2 farms = 33% 3-5 farms = 22% 6-10 farms = 28% 11-15 farms = 6% 16 or more farms = 11%
Total size of farms	50-100 acres = 6% 101-200 acres = 22% 201-500 acres = 6% 501-999 acres = 28% 1,000-1,999 acres = 22% 2,000 or more acres = 17%

Note. N = 18, unless noted.

farming industry (*M* = 27 years, *SD* = 10.5 years), Number of farms (*M* = 6 farms, *SD* = 5.6 farms), and Total size of farms (*M* = 1,087 acres, *SD* = 1,192.2 acres). There are three highlights from the demographic groups in Table 2 that are worth pointing out: the most common Age is 40-45 years old, the Income level is evenly distributed among respondents, and two-thirds of the respondents have either a Bachelor's or Master's degree.

A wide variety of other background questions were asked of the growers in order to reveal the nature of the respondents' connection to their farmland, and the degree of interaction they have with farming processes on that land (Appendix: Interview Questionnaire). Forty-four percent of the respondents stated that they are "both" owners and leasing managers within CSIP. Meanwhile, 39% of the respondents are strictly "leasing managers," and the remaining respondents (17%) are specifically "owners" of CSIP farmland. Furthermore, none of the participants considered himself/herself as solely an "organic farmer." However, 39% were self-described as "both" organic and conventional farmers. Therefore, the remaining 61% responded as a "conventional farmer."

Table 3 shows a complete list of crops grown by respondents in the last 2 years within the CSIP service area. The four most common crops grown by the respondents are as follows (listed in order of most to least): lettuce, broccoli, cauliflower, and strawberries. The respondents stated they generally keep the same rotation of crops from year to year, and only three respondents have different crops they plan to grow in the coming year that were not planted in the previous two years.

Table 3

List of Crops Grown by Respondents

Type of crop	Respondents	Type of crop	Respondents
Artichokes	8	Fennel	4
Broccoli	15	Lettuce	17
Brussels sprouts	5	Pumpkins	1
Cabbage	2	Rapini	1
Cardoon	1	Spinach	3
Cauliflower	13	Squash	1
Celery	9	Strawberries	12

There were a few questions at the end of the background and demographics section that inquired about their water-use and experience with alternative water sources. Interestingly, 94% of respondents stated that they have functional wells on their farms; 11 of those 17 functional wells are active on their farms, and three of those active wells are being used as supplemental wells to supply and augment the CSIP distribution system. An overwhelming majority of the respondents work strictly within the CSIP area, and began doing so before recycled water was introduced. Fifty-six percent of the respondents have been irrigating with recycled water for “15 years or more.” Meanwhile, only 17% have used recycled water for “5 years or less.” Only one respondent had any prior experience using desalinated water.

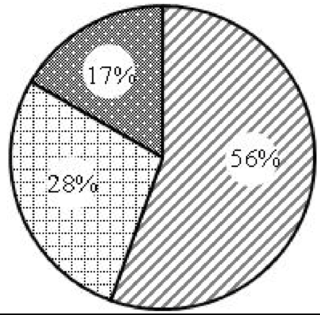
3.2 Grower self-assessed attitudes

The Likert scale statements offer direct insight into the growers’ self-assessed attitudes on specific topics they may not express directly in the open-ended questions. Additionally, the Likert scale statements provide a snapshot of the growers’ opinions and perceptions regarding their views and experience with CSIP stakeholders that would otherwise have to be inferred from their responses. Each of the 18 respondents heard five Likert scale statements that required 1 out of 5 possible responses: strongly agree, somewhat agree, neutral, somewhat disagree, or strongly disagree (Appendix: Interview Questionnaire). Each statement was discrete with a one-to-one response to statement ratio. There were no follow-up questions to the Likert scale statements.

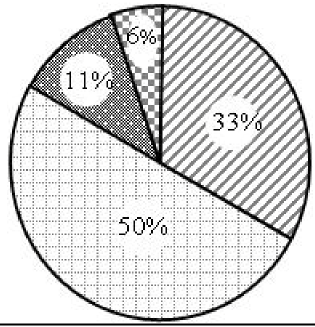
The Likert scale statements were put to the respondents immediately following the background and demographics section of the interview. Figure 5 displays the statements, in order, along with the tally of the growers' responses represented in pie charts. Answers scaled along a five-point continuum in which "5" represents "strongly agree" and "1" represents "strongly disagree." The representative numerical answer is then used to determine the mean (*M*) and standard deviation (*SD*) for each statement.

Over 70% of the respondents either strongly or somewhat agreed to each of the five Likert scale statements (see Figure 5). On a five-point scale, where five respresents "strongly agree," the mean (*M*) for all of the answers ranged from 3.89 to 4.61 with a standard deviation (*SD*) ranging 0.7 to 1.0. The first Likert scale statement read "Information regarding the CSIP is readily available and given in a timely manner," and 17% were neutral while the remaining respondents either chose strongly or somewhat agree. Eighty-three percent of the respondents agreed (strongly or somewhat agree) that "Communication is acceptable (and positive overall) between the growers and CSIP's policymakers and stakeholders." However, one respondent stated "strongly disagree." This statement resulted in the highest standard deviation (*SD* = 1.0), indicating the respondents' answers fluctuated the most out of the five statements. The third Likert scale

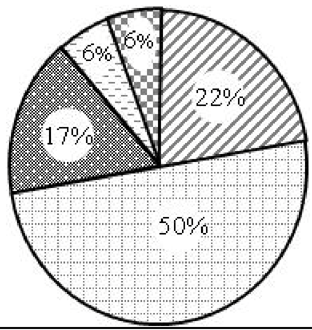
1. Information regarding the CSIP is readily available and given in a timely manner.



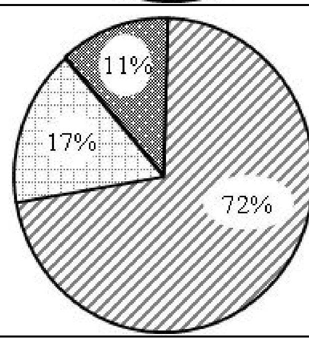
2. Communication is acceptable (and positive overall) between the growers and CSIP's policymakers and stakeholders.



3. Trust levels are acceptable (and positive overall) between the growers and CSIP's policymakers and stakeholders.



4. There needs to be more proactive work regarding the saltwater intrusion problem in the Salinas River Valley Watershed.



5. CSIP needs to be more proactive with policies and procedures to become more "grower friendly," and to have the growers in their best interest.

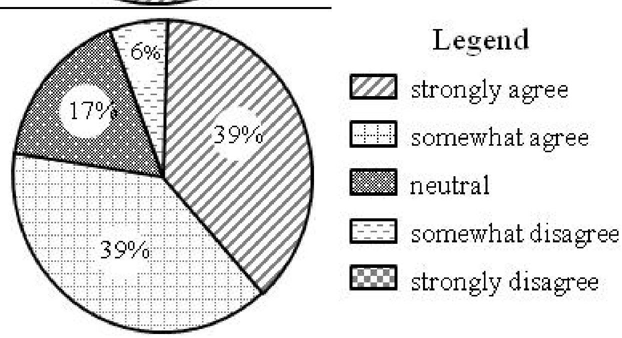


Figure 5: Results of the Likert scale statements

statement was similar to the second, but instead referred to trust levels being acceptable (and positive overall), with which 77% either “strongly” or “somewhat agree.” Meanwhile, one respondent stated “somewhat disagree,” and another with “strongly disagree” with the third Likert scale statement. This statement resulted in the lowest overall mean ($M = 3.89$), which ranks just below “somewhat agree.” The statement “There needs to be more proactive work regarding the saltwater intrusion problem in the Salinas River Valley Watershed,” found 89% either “strongly” or “somewhat agree” while the remaining 11% were “neutral.” This statement resulted in the highest mean ($M = 4.61$), which ranks closest to “strongly agree” and had the lowest standard deviation ($SD = 0.70$). The final Likert scale statement “CSIP needs to be more proactive with policies and procedures to become more ‘grower friendly,’ and to have growers in their best interest” found respondents either agreed (strongly or somewhat agree) or stated “neutral” with the exception of one that responded with “somewhat disagree.”

3.3 Alternative water supplies - acceptance and knowledge

CSIP started delivering recycled water in 1998, and blending the alternative water source with its other source, groundwater. Since 1998, two other major alternative water sources have also been blended and distributed to the CSIP growers: Salinas River Water and Salinas Industrial Pond Water (see Figure 4). The Salinas River Water was implemented in 2010, but was subsequently halted in 2013 due to continuing drought conditions. The Salinas Industrial Pond Water was first implemented and delivered to CSIP growers in February 2014, during the time the interviews for this study took place: December 2013 through November 2014. The respondents’ have 27 years in the farming industry, on average; therefore, a majority of the respondents were working in the CSIP area before recycled water was introduced and witnessed the implementation of its initial use. Consequently, most of the respondents have experienced the seawater intrusion problem personally in one way or another. The use of desalinated water as an alternative water source to blend with other CSIP water sources has been discussed for several years, but has never been implemented. Interestingly, only one of the respondents has previous experience using desalinated water to irrigate crops.

Most of the questions regarding alternative water supplies pertained to recycled water, the most familiar alternative water source to respondents, since they have used it continuously since 1998 (Appendix: Interview Questionnaire). When asked: [#2] “How do you feel about using recycled water to irrigate your crops?” 94% were positive about using recycled water to irrigate crops, while the remaining respondent, who expressed uncertainty about recycled water and its impact on the soil, was deemed slightly negative. Respondent 6714J stated that there were not enough data about the long term impacts of recycled water on the soil, and that more studies and data about those impacts are needed.

Excerpt from Interview 6714J:

> For us, the jury is out on that...I don’t think there is enough data and I think that somebody needs to sit down and study that properly,..., they might find something that doesn’t go well for the long term. Some kind of study on the quality of the soil — how the soil is being affected [regarding recycled water use]. That would probably be our main concern. Because quality of harvest grown on that is really secondary to quality of the soil.

The follow up question asked: [#2A] “Is there a better alternative source of water [rather than recycled water]?” Forty-four percent responded with “no, recycled water is the best,” and the second most common response was “not sure/don’t know” (39%). The remaining three answers were "storm water," "desalination," and "Salinas River Water" (17%).

The next question read: [#2B] "Do you think the use of recycled water negatively impacts your customers' attitudes about your crops?" An overwhelming majority of the growers (72%) felt the use of recycled water does not negatively impact their customers' attitudes about their crops. Conversely, 17% replied with their opinion that the use of recycled water does negatively impact their customers' attitudes, while the remaining 11% of respondents said they were not sure or didn't know.

The first question pertaining to desalinated water asked: [#4] "If given the choice between using recycled water or desalinated water which would you choose?" Sixty-seven percent chose "recycled water" (see Figure 6). The remaining participants evenly chose "desalinated water" (17%), or "neutral/don't know" (17%). When asked "Why?" they made their particular choice: four growers gave multiple answers, so the results are shown in total number of tallied responses, not percentages of the number of respondents. The four different responses are as follows: "cost" (7), "environmental concerns" (6), "water quality" (5), and "familiar with recycled water" (4). The following questions were the only portion of the interview that included a reference to cost, since it is difficult, as well as misleading, to discuss cost hypothetically. The intent of this question, and the follow up questions that included cost, was to have the growers consider the potential impact of a cost factor on their preference for a particular source of water. The follow up questions sought to compare their responses with, and without, cost considerations. Figure 6 displays the questions and responses on preference between

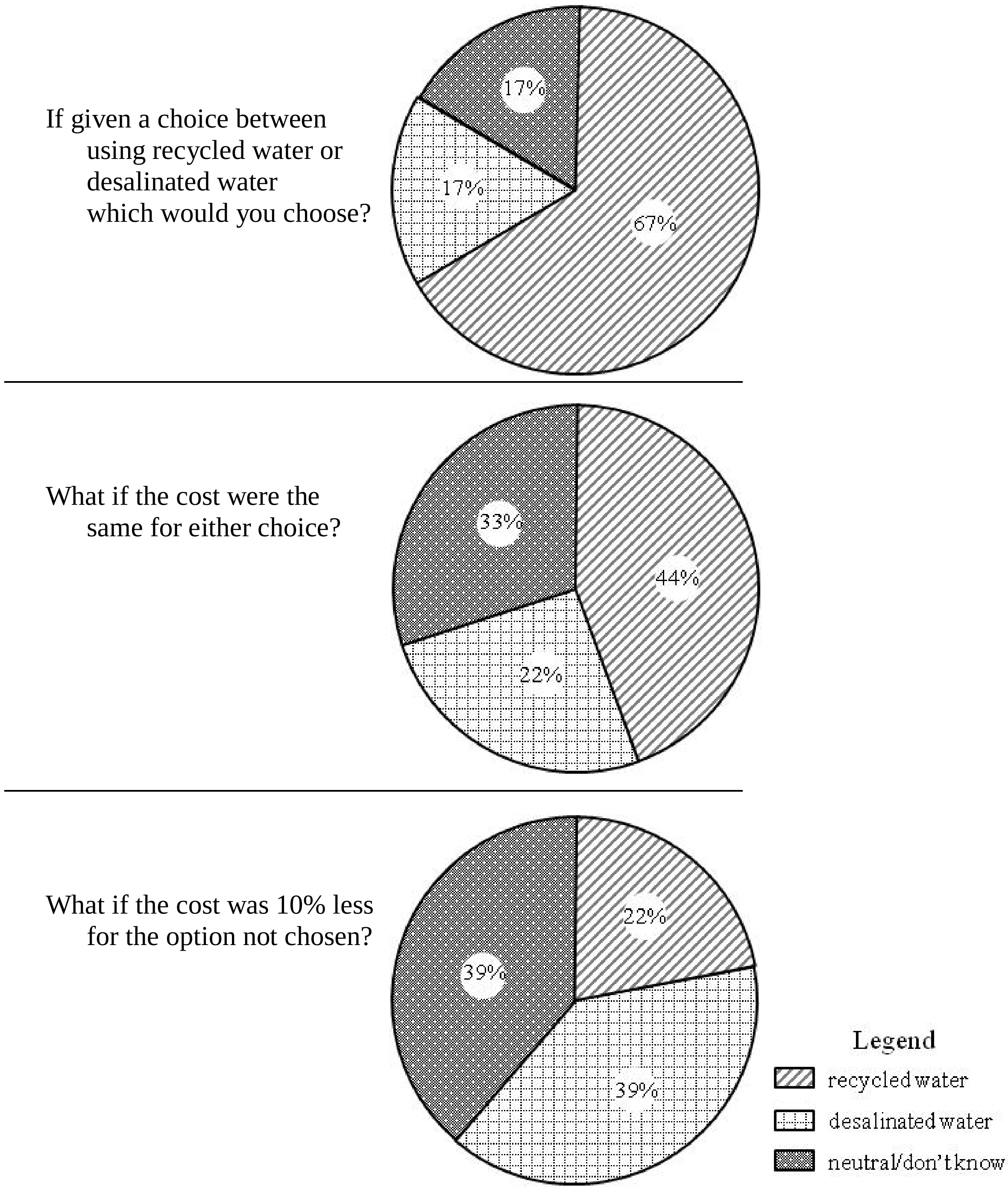


Figure 6: Choice between recycled water or desalinated water

recycled water and desalinated water along with cost considerations. Some of the respondents changed their answers when asked, [#4B] “What if the cost were the same for either choice [recycled water or desalinated water]?” The most frequent response was “recycled water” (45%), dropping from 67% in the previous question. “Desalinated water” increased to 22%, while “neutral/don’t know” went up to 33%. When elaborating on why they changed their answer, the most common response, excepting those who did not specify an answer, was “water quality” (4). The follow up question [#4C] asked growers to re-evaluate their choice if the cost was 10% less for the option they did not choose. The response for “recycled water” continued to drop to 22%, and “desalinated water” and “neutral/don’t know” both increased to 39%. The top two reasons respondents cited for changing their answer was “cost” (9) and “water quality” (8). Those who did not change their answer generally stated that the cost was not significant enough to affect their choice. Respondent 2745D elaborated on the answers provided from the previous questions regarding choices between recycled water and desalinated water and made the point that there would need to be more information, such as water quality (referred to as “agronomics”), in order to make an informed decision.

Excerpt from Interview 2745D:

> I don’t have any experience with desalinated water so I couldn’t really say. Recycled water has been real good to us at this point and I have no reservations continuing with that...I don’t know what the agronomics of it would be. I can’t really answer that question without that information. Well, I mean if the benefit is there and it’s 10% less, I mean by all means, just general business decision would be to go with less to get equal or better quality than what we have now. So again, without having all the specifics of it, I don’t really know.

The next series of questions pertained to the growers' acceptance of using desalinated water to irrigate crops. The first item was very broad: [#5] "What are your thoughts about implementing the use of desalinized water to augment the CSIP supply and blending that with existing sources?" Eighty-nine percent were positive. Meanwhile, the two remaining respondents were negative, and neutral or don't know. The follow up questions were designed to find out if the growers' acceptance of desalinated water was affected by the amount of energy used, or the environmental impacts caused by the water source. The first of two questions read: [#5A] "Does the amount of energy required to desalinate water make you more, or less, accepting of its use as your water source?" Seventy-seven percent of the respondents stated that they are "less accepting," and 17% stated that the amount of energy used to desalinate water was "no problem," while the remaining six percent were "neutral/don't know." A similar, yet slightly different, subsequent question [#5B] asked whether or not the environmental impacts required to desalinate water made the growers more or less accepting of its use. A majority of the respondents (61%) stated that they were "less accepting," while 22% stated that the environmental impacts were "no problem," and 17% were "neutral/don't know." There was some confusion with the second question among respondents regarding environmental impacts versus energy use in relation to processing desalinated water. The interviewer explained that the question assumes incorporating all of the environmental impacts associated with the desalination process, including the environmental impacts of generating additional energy, as well as leftover salts and total dissolved solids, known as brine. Five of the respondents changed their answer from the first question to the second question. Regardless, majority of the respondents (77% and 61%, respectively) are less accepting of desalinated water due to its high energy use and environmental impacts.

The first of the last two questions reveals grower knowledge of alternative water supplies: [#8] “What alternative water sources are you aware of that CSIP is debating to implement and use?” The question was open-ended, and multiple responses were given. No prompts for alternative water sources were offered. Sixty-one percent were aware of, and could name, “two or more sources” that CSIP had been debating, while 22% named “one source,” and 17% were not able to name any potential alternative water sources that CSIP was considering. The top two responses for potential CSIP alternative water sources were “Salinas Industrial Water” (8), and “desalination” (7). The follow up question asked [#8A] “Which source is your preference to implement and use?” The following were the responses given for their preferences: “Salinas Industrial Water” (5), “not sure/don’t know” (5), “adding supplemental wells” (4), “Blanco Drain” (2), “desalination” (1), “water storage” (1), and “storm water” (1). One respondent could not decide on a single source, resulting in nineteen total answers given for a preferred alternative water source. When asked to elaborate on this answer regarding their preference of alternative water sources, respondents stated “best choice” (7), “neutral/don’t know” (6), “best water quality” (3), “cost” (3), and “large available water supply” (1).

3.4 Seawater intrusion and environmental impacts - level of concern

Environmental impact is a broad and varied list of topics when discussing modern day agriculture, a business that is completely intertwined with the environment, both as a resource and a product. This section focuses on the level of concern growers' expressed about mitigating seawater intrusion and associated environmental impacts due to their farming practice. Associated environmental impacts include decisions made that have direct and indirect impacts on the environment, such as supporting the implementation of a water source that has adverse effects on the environment in order to process and deliver said source. As discussed in greater detail in Section 2.1.1, seawater intrusion was first detected along the coast in the 1930s of what is known today as the CSIP service area (Division of Water Resources, 1946). Growers in the CSIP service area have been aware of, and mitigating, seawater intrusion for over 70 years. Recycled water was introduced to CSIP in 1998 and has been blended with other water sources ever since. The majority of the study participants have been in the farming industry for over 27 years, so they have experienced the promotion and implementation of recycled water, and other alternative water sources, to both mitigate seawater intrusion and meet grower demand for water.

The first question asked growers: [#11] "How do you feel about the saltwater intrusion problem along the coast?" Ninety-four percent stated that they feel it is a major concern. The respondent (Interview 7915B) who did not consider seawater intrusion to be a major concern stated:

Excerpt from Interview 7915B:

Well, we've got a solution. It's called recycled water. And I'm glad we did it.

The follow up question asked: [#11A] "What do you think is the best way to address and manage the problem?" This open-ended question prompted 30 responses that focused on nine different possible solutions. Five out of the nine possible solutions had multiple responses which are as follows: "less groundwater pumping" (10), "already doing a good job" (7), "alternative water supplies" (4), "groundwater recharge" (3), and "best management practices for irrigation" (2).

One of the questions from the first portion of the interview (demographics and background) relating to the growers' levels of concern for seawater intrusion and environmental impacts was: [#13] "What are the two highest concerns for you regarding water quality?" Despite a wide variety of answers to this open-ended question, the most frequent answer was "salt" (77%), which was followed by "chloride" (56%). Furthermore, all of the answers were directly related to seawater intrusion and its impacts on water quality.

As stated previously in Section 3.2, one of the five Likert scale statements read: [#4] "There needs to be more proactive work regarding the saltwater intrusion problem in the Salinas River Valley Watershed." Seventy-two percent chose "strongly agree," while 17% "somewhat agree," and the remaining 11% were "neutral" (see Figure 5). A large majority of the respondents expressed an emphatic concern about mitigating seawater intrusion within CSIP: 89% agreed to some degree, and none of the respondents disagreed.

The growers were asked a question designed to explore their perception and approach to environmental issues related to their profession: [#10] "Do you believe that growers have a different relationship with the land and the environment than those who do not farm?" Ninety-four percent responded with a very affirmative and resounding "yes." However, one respondent (Interview 7746R) gave a qualified answer expressed in the quote below. The respondent points out that many farms are owned and run by corporations that may not be as “in tune” with their farmland and the environment as an independent grower may be.

Excerpt from Interview 7746R:

> A lot of the growers are corporations now because there is not many independent guys anymore...usually, where a grower owns some land, he has a little more understanding about that land and he is more particular in those cases.

Discussed at length in Section 3.3, the respondents were asked whether the amount of energy required to desalinate water made them more or less accepting of its use within CSIP, and 77% replied that they were “less accepting.” The following question asked essentially the same question, but in terms of the environmental impacts associated with desalinating water, and 61% were “less accepting” of using desalinated water. The “less accepting” response suggests that the level of concern is very high for respondents who regard environmental impacts as a significant consideration.

The respondents were asked back-to-back questions about their highest and lowest priorities regarding environmental impacts resulting from farming practices. The first question was: [#9] “Regarding environmental impacts of concern due to farming practices, which do you feel is the highest priority for a grower?” The three most common responses were “runoff” (39%), “water management” (17%), and “pesticide application” (17%). The second question was: [#9A] “Which impact of concern is the lowest priority for a grower?” The most common responses were “animal intrusion” (28%), “not sure/don’t know” (17%), “air quality” (11%), and “soil erosion” (11%).

3.5 Increasing water storage – attitudes

A Storage Pond located at the beginning of CSIP’s distribution system is where recycled water (treated wastewater from about 250,000 local residents) is blended with other water sources and delivered to growers. The Storage Pond also acts as a buffer between the distribution system and the Monterey Regional Water Pollution Control Agency (MRWPCA), the agency and facility that treats and delivers recycled water and other water sources to CSIP growers. Twenty-two supplemental wells were active and in use once CSIP went online in 1998 in order to supply additional water when needed for pressure or volume (MRWPCA, 2017c). Currently, there are ten supplemental wells that are active and functional within the CSIP service area, although that number may fluctuate at a given time due to maintenance and repair (M. Foxworthy [with MCWRA], personal communication, January 26, 2017; MRWPCA, 2017b). Currently, the Storage Pond is the only water storage in CSIP, with the exception of that which is delivered through the water mains. The Storage Pond can hold up to approximately 80 acre feet (or 26 million gallons) of water, which is approximately one-day of water use.

The first question pertaining to water storage, while incorporating the use of recycled water, asked: [#3] “How do you feel about using recycled water to recharge groundwater during winter months and redrawing it at a later date?” When this question was posed, excess recycled water was still being discharged into the Monterey Bay during the low-demand times of the winter months, due to lack of water storage. A groundwater replenishment project, known as Pure Water Monterey is currently underway, and will utilize the excess recycled water formerly discharged into the Monterey Bay.

Eighty-three percent were positive, while 11% were neutral or were not sure about the idea now being implemented. One respondent’s (Interview 3099E) answer was negative, he/she elaborated saying:

Excerpt from Interview 3099E:

> I think that's a very complicated question, that we don't know enough about recycled water....I don't think that's a good idea. We're using it [recycled water] because agronomically in this climate and in this growing area it's our solution to saltwater intrusion. It's the lesser of the evils. But, I don't think it's a good idea to think of it as recharging an aquifer. An aquifer should be higher quality than what we have here.

Interestingly, Interview 3099E was the only respondent to voice any apprehension about using recycled water to recharge groundwater, and questioning its water quality.

A series of three questions were asked later in the interview, specific to water storage, which did not distinguish the water source used, as in question #3 above (Appendix: Interview Questionnaire). The first asked: [#6] "How do you feel about increasing water storage to have a surplus during low demand and a reserve for high demand times?" All respondents stated that they were positive about increasing water storage. However, one of the respondents (Interview 3099E) also qualified his/her answer by stating that implementing water storage "depends" on the source of water, and the cost to treat and store it. The quote below stresses an underlying theme about the use and reuse of available water sources.

Excerpt from Interview 3099E

> We have some very low areas that have tile drain in them because they're basically swamps if they don't have tile drain and so we can't grow crops on them if they aren't drained. And that tile drain water is more and more scrutinized as to quality, as to nitrate level, as to other potential sources of contamination of the Monterey Bay and the wetlands, and everything else. We don't know those qualities are negative. We just know that people are questioning whether or not it should go directly into the streams and into the bay. One thought we had was if we could . . . we're pumping that out and rather than just dump it in the ditch that goes out to the Monterey Bay, we could pump that up to our reservoir and could be reused to irrigate, but that would be a large cost. If you didn't spend that much money to treat it or to filter it, you could at least use it perhaps to water up your cover crop or at the very least to water your roads and your surrounding buffer areas.

> Depends on what the source of water is, and what the cost would be to treat and store the water.

The follow-up question asked: [#6A] “Would you be willing to establish private water storage on your property if there was an incentive by CSIP?” Twelve of the respondents were “positive.” However, five of those twelve respondents also said their willingness to establish private water storage “depends.” Three other respondents also characterized their answer as depending on additional factors, for a total of eight. Three respondents were negative, and one respondent was neutral or unsure. This question was intended to discover the growers’ willingness to establish private water storage without specifying extensive hypothetical parameters necessary for a real-world implementation. Three examples of the “depends” qualifiers are:

Excerpt from Interview 1313A:

> How much land are you talking about? What’s the incentive?... How much land we got to take out of production?

Excerpt from Interview 2941T:

> We’d consider it, but we’d have to look at the costs because for this ranch, it’s pretty flat. There are no valleys to create a pond...you would have to take away farm ground if you wanted to do a pond. And then if you’re going to have tank storage, I don’t think it could hold enough to make it worthwhile. When you consider, Ag wells pump something like a 1,000 gallons a minute. And if you look at the tanks around here and they’re 10-20 thousand gallon tanks and they look huge, but in 10 or 20 minutes, they’re empty... I don’t think you could have enough storage to make it worthwhile—in individual farms. I see the concept of distributing all that and then having smaller quantities rather than having a big reservoir some place, but it seems to me that the reservoir—the big reservoir—solution is the more cost effective one if you can do it.

Excerpt from Interview 4949M:

> If the incentive covered the cost...I may be shortsighted and just thinking of the short term. You know, probably in 10 years, I’ll look back and say, ‘Yeah, I should have done it quicker or should have gone on board quick’,

> but right now, I would probably be like, 'Man! I don't need any other expense.'

The final water storage question was: [#6A] "Or should assessment fees be adjusted for the growers based on who participates or not?" Fourteen responded "yes," three said "no," and a total of four respondents said "depends" on how costs and fees would be set up and enforced. Three excerpts from respondents answering "depends" express some fundamental considerations:

Excerpt from Interview 2848C:

> It's all got to be based on the incentives and land use. I mean it just makes sense in some areas. In other areas, it probably wouldn't make sense.

Excerpt from Interview 2941T:

> Let's assume it is economically viable to put tanks on the ranches and then we certainly would consider it. And then if we found it economically viable given the incentive, we would do it, especially if there was a disincentive not to do it. I mean that would add to the costs. I mean that would be part of the equation.

Excerpt from Interview 3099E:

> No, I'm not in favor of a lot of different mechanisms regulatory-wise. Although it would, maybe in my case, be advantageous, I just don't like the approach of carrots and sticks all over the place. We should be doing what we can regardless of the carrots or the sticks. And I believe that water agencies are relying too heavily on regulations. I think you need more information. You need more education. You need more grower cooperation. But you have to move that away from the regulatory sphere and into something practical that people can do because they can see and understand that it's a useful and important thing to do.

3.6 Efficient water practices and incentives - perspectives

In order to explore the growers' perspective, a series of four questions were asked regarding the efficiency of their water practices and willingness to participate in a few water management strategies. The first asked: [#7] "Do you consider your watering practices to be efficient?" Ninety-four percent of the respondents considered their watering practices to be efficient. However, one respondent stated that they "could improve" their watering practices. The response was not weighed heavily, or analyzed, since it was not based on any other information, and the answer was self-assessed. The question and answers are useful to show how the growers perceive themselves. The second question asked: [#7A] "Would you participate in following Best Management Practices guidelines concerning water conservation?" The intention of this question was to find out the growers' willingness to participate in guidelines that concern water conservation, regardless of their current involvement with the self-reported information annually submitted to MCWRA for their "Groundwater Extraction Summary Report" (MCWRA, 2015b). Ninety-four percent said "yes," and two of those respondents elaborated their answer with "depends" by stating the following:

Excerpt from Interview 2941T:

> If the Water Board came to me and said 'Here is the Best Management Practices we think you should be following. Follow them.' Without any data to back it up, I would be skeptical, but given that the Best Management Practices do work, sure... assuming the Best Management Practices are proven and they work, then sure, why not do them?

Excerpt from Interview 6714J:

> If they made sense...we tend not to be interested when outside groups come in and say 'Hey! You need to be doing this' or the government says that because usually, they don't know what they're talking about. Because they're not farmers. It's not an arrogant thing to say. They just seriously don't know what they're talking about.

One respondent said "no," and strongly expressed apprehension and unwillingness to be regulated by any agency as shown in the following quote:

Excerpt from Interview 3099E:

> I don't want to participate in anything that's got to do with regulatory agencies unless I have to. I think if they can provide information, if they can provide some support... we've got a lower-volume drip tape and we've run into different issues

> regarding that lower-volume drip tape. Everyone has ideas on what we could do to use less water, but in the end, the person doing it is the person learning what the pitfalls are. So regulation to me doesn't fit very well in that scenario. You can't regulate common sense. You can't regulate experimentation. You can't regulate trying to pass on good ideas to other people or throw away the bad ideas. That's not regulation. And that's what we need to be doing.

The third question was: [#7B] "Would you participate in a water budget program?" When the respondents asked for clarification of the hypothetical water budget program, the explanation was that this is a "black and white" hypothetical question and that the budget would be structured so that the amount of water delivered would be allotted based on acreage and/or over a period of given time. The driving force behind asking this question was to explore the growers' perspective and willingness to participate in a general, hypothetical water budget program, since the logistics of a real-world program cannot be realistically discussed without extensive research and cost estimates. Fifty percent stated "yes." However, 28% said "no," that they would not be willing to participate in a water budget. The remaining 22% answered "depends." Two of those respondents explained:

Excerpt from Interview 2941T:

> Not if it's made public... one of the nice things about CSIP and the Monterey County Water Resources Agency in particular is that they're very protective of information, and although we have to report water usage to the county, they don't report that outside of the agency. I guess it's hard to say if we would or not depending on the conditions of what that means. If it means we have to report our water usage, then maybe not.

Excerpt from Interview 3099E:

> We went down to a lower-flow drip tape and then the manufacturer changed their style and so, we had plugging. We ended up having to use more water, and replace the tape at the same time. There are too many unknowns in any given situation. So if you're shooting for a certain amount, it's not that you don't have that goal, and you don't have the tools to get there. You may have the tools, but then all of a sudden, you may not have the tools to get there. So you shouldn't be penalized or you shouldn't be limited...I think the system that they have right now in which you pay

> for as many acre-feet as you use is fair. If there can be incentives on a certain level to use less, then that gives people a goal, but budgeting sounds a little bit scary to me.

The fourth and final question regarding water practices and efficient water use was: [#7C] "Would you be willing to plant different crops to be more efficient with water use?" This question was asked in order to discover how the growers would react to changing their crop rotation based on more efficient water use, which also impacts their market demand from customers. Thirty-nine percent answered "yes," while 28% said "no." A total of seven respondents stated "depends," with one of those respondents also answering "yes." Those that answered "depends" generally referred to one or more of the following reasons for being reluctant to plant different crops: they have a fixed crop rotation, they have a particular market demand from their customers, and all of the associated costs would be prohibitive.

Excerpt from Interview 1313A:

> The land value is so high. If we can't grow high valued crops, we are not going to be in business.

Excerpt from Interview 5762V:

> Only if they pay the bills. Some offset incentive or if it's actually a viable crop that we could sell. I mean our schedule is the schedule. Could be a little difficult to change our cropping pattern.

One of the questions asked during the interview was a broad, generalized inquiry as to how the growers would feel about an incentive, or disincentive, fee structure imposed on them. The question was: [#7D] "Do you prefer a rewards (incentive) or a consequence (disincentive) fee structure for growers?" Forty-four percent chose "rewards," while 22% answered "both," and 17% stated "consequences." One respondent said "none of the above," and did not approve of any incentives for a fee structure. Three respondents stated “depends,” and their responses below give interesting insight as to why they responded with “depends:”

> *Excerpt from Interview 1313A:*
> It would depend on what the strings that are attached to it are. If there were no strings attached, I would support the program.

> *Excerpt from Interview 2941T:*
> I’d prefer rewards, but, you know, depending on how they structure it. You know, a reward structure can be a disincentive as well.

> *Excerpt from Interview 7746R:*
> Actually, it could be either one. I mean it would be nice, but I think there’d be a lot of objection among the growers. They would say, ‘You gave him a bonus? And you aren’t giving me one? I’m just as efficient!’ Well, somebody would have to monitor it.

3.7 CSIP policy or operation - changes needed

Policies and operations regarding the CSIP distribution system have adapted and evolved since its inception in 1998. There are numerous stakeholders and policymakers that coordinate their efforts in order to distribute reliable water to CSIP growers. This can create a politically charged climate where some entities may benefit more than others, and some impactful decisions may affect many. CSIP has faced considerable diverse challenges for over 20 years, including the successful mitigation of seawater intrusion, implementing the use of recycled water, and meeting the water demand of growers.

The only open-ended question that directly asked about the growers’ opinion of changes needed for CSIP was: [#12] “What policy or operation of the CSIP distribution system has the highest priority and need for change?” Many of the respondents had multiple answers that totaled 30, across 14 different areas of policy or operation. Nine out of fourteen areas of policy or operation had multiple responses which are as follows:

“already doing a good job” (5), “increasing the water supply” (5), “communication from policymakers” (3), “expand the service area” (2), “flexible water availability” (2), “keeping costs down” (2), “future planning by policymakers” (2), “stop pumping groundwater” (2), and “water ordering issues” (2). Two of the more interesting comments expressed a perceived need for drastic changes to the current outlook and policies of CSIP. One respondent (Interview 2777L) addressed the relationship between proper implementation and procedural oversight, and enforcement. Another (Interview 2745D) brought up the possibility that isolation among stakeholder agencies impedes their ability to come together and plan for crises before they are at hand.

Excerpt from Interview 2777L:

> I think this landowner, grower and irrigator education on how to operate the system is going to be huge. And the consequences that are going to be implemented for people who don’t follow the rules has got to be pretty tough and it’s got to be enforced. You know, we’ve got this system, but we’re not 100% on our management and use of the system.

Excerpt from Interview 2745D:

> All levels of government tend to work in silos... a lot of times I think that they wake up and live for the day that they are in as opposed to tomorrow or the next week. This whole conversation: ‘What do we do in a drought situation?’ That shouldn’t be happening when we’re in a drought. It should be happening when we’re in a wet year and we have a sufficient supply of water as to what do we need to do to make sure that when we do get into a drought. ‘What crisis management plan should we have?’ And to me that doesn’t exist...., their ability to forecast and plan is hindered by their ability to not work together.

The subject of CSIP policy or operation change was also discussed at length in Section 3.2 “Grower self-assessed attitudes.” The responses to five Likert scale statements were presented, and are shown graphically in Figure 5. The statements touched on growers’ attitudes toward, and interactions with, CSIP stakeholders and policymakers. Information availability, communication, and perceived trust levels were key areas of inquiry. Two out of the five Likert scale statements are directly related to this section, as they address policy or operation changes the respondent sees as necessary. All respondents either agreed or were neutral with the statement “There needs to be more proactive work regarding the saltwater intrusion problem in the Salinas River Valley Watershed” (see Figure 5). The other related statement, “CSIP needs to be more proactive with policies and procedures to become more ‘grower friendly,’ and to have growers in their best interest,” found that one respondent stated “somewhat disagree,” and all of the other respondents were neutral or agreed to some extent (see Figure 5).

3.8 Water supply - greatest concern

This survey, conducted December 2013 to November 2014, was taken when the entire state of California was in the midst of an intensive drought. CSIP was strongly impacted by the drought and resultant lack of available water sources. The implementation of the Salinas River Diversion Facility, begun in April 2010, diverted water from the Salinas River to be blended and distributed to CSIP growers. Drought conditions reduced the amount of water in the Salinas River so that by October 2013, CSIP was not able to divert water to serve growers. As of two months prior to the start of this survey, water diverted from the Salinas River was no longer an option.

The above situation set the tone for the first open-ended survey question: [#1] “Which is a greater concern for you: CSIP’s current water quality, or CSIP’s water supply?” Sixty-one percent stated “water supply” was a greater concern while 17% answered “both” as their greatest concern. The remaining 22% ranked “water quality” as the greatest concern. Figure 7 is a pie chart depicting the results. Respondent 3099E’s

Which is a greater concern for you:
CSIP's current water quality
or CSIP's water supply?

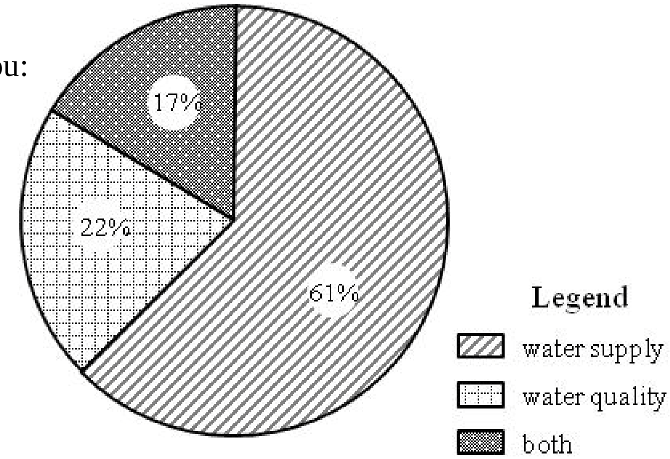


Figure 7: Greatest concern for CSIP

elaboration on an answer of "both" echoes the thoughts of other interviewees who saw supply and quality as equally important:

> *Excerpt from Interview 3099E:*
> Both! Water quality is over the long run impacting the salt levels in the soil. That is a very large concern. But of course, since we are in a drought, supply has to be a major concern at the same time. We're glad to have water of whatever quality right now. But I don't see that we have a good long-term solution to either the saltwater intrusion or enough water. Period.

When prompted to elaborate on why they answered as they did, most respondents gave multiple answers. The following are the responses that were repeated: "less available water" (13), "need to find another water source" (5), "cannot grow crops" (4), "sustainability" (4), "water conservation resulting in reducing recycled water" (4), "increased water demand" (3), and "stop pumping groundwater" (2).

The final question of the survey asked subjects to compare current concerns to their predictions of imminent needs or issues: [#13] "What is your greatest concern with the CSIP distribution system now, and in the near future?" Predictably, respondents gave multiple answers. Everyone who listed "water quality" as the greatest concern ranked "water supply" as equally concerning. Five out of the eight different responses that repeated are as follows: "water supply" (14), "water quality" (5), "protecting supplemental wells" (3), "keeping costs down" (2), and "proactive maintenance" (2). Two interesting quotes address very practical concerns about the CSIP distribution system. One respondent (Interview 2777L), projecting into the future, saw no resolution for the supply issues ahead. Another grower (Interview 2123X) questioned the capacity to maintain and secure infrastructure in the long term.

Excerpt from Interview 2777L:

> CSIP isn't able to maintain its water supply and also that CSIP isn't able to grow—to annex. Because I think if you don't do anything about the City of Salinas, saltwater intrusion is going keep on growing. I mean CSIP as it is now has slowed it to some degree, but the saltwater intrusion is still growing. I mean look at it. So if the saltwater intrusion is going to grow, that means CSIP's needs to grow, too. We're going to start losing more wells in that area. But right now the way things look, it doesn't look like we're going to be able to secure enough water supply there to grow CSIP.

Excerpt from Interview 2123X:

> Making sure the infrastructure is sound; CSIP continues to maintain it—not only the actual pipelines, but the actual wells—make sure those wells are constructed to the standards that they are making private landowners drill wells in 2013-2014 ... make sure the casings are still sound, their auxiliary wells are not exasperating the problem by having cross-contamination between aquifers.

3.9 Grower post-interview comments

Interviews lasted between 30 to 90 minutes, averaging just over 49 minutes per session. On concluding, respondents were asked if they had any additional comments. Surprisingly, almost all of the respondents added to their contributions, elaborating on earlier topics or initiating new discussions. This was surprising because the interview was voluntary, and respondents had already answered approximately 60 questions, talking for almost an hour, yet they continued to speak and extend discussion.

The six excerpts below are representative of the most insightful and noteworthy post-interview comments. The purpose of documenting these comments was to capture some of the ideas and perceptions expressed by the growers that were not prompted by the researcher or the questionnaire. Most of the excerpts have a common theme of one or more of the following: the importance of water, the use of recycled water, or planning for the future. The first quote (Respondent 4949M) appears to be an honest recollection of the transition to implementing the use of recycled water in CSIP. This expresses some of the opposition that the policymakers and stakeholders had to face years ago, upon deciding to implement recycled water.

Excerpt from Interview 4949M:

> In the very beginning, when the project started, we were against it. We made phone calls, tried to get out of it. They actually listened to our opposition to it and tried to think of a way maybe they could accommodate, but in the end, I'm really glad we just did it and went with it. It's been a savior.

The second quote (Respondent 1842N) highlights the success of CSIP as a world renowned program. The interviewee expresses gratitude for the program, which speaks to the value of foresight in water policy implementation despite initial resistance.

Excerpt from Interview 1842N:

> It's [CSIP's] a good project. Hopefully, it's used as a model for other projects. Not only in the area, but in the world. Bottom line is with more people on this planet, we have to find a way to use water twice. And using water twice, I mean, drink and once you flush it and then use it to grow crops. And maybe we can use it even three times. I mean, you know, it's

> just we have to be more efficient. And like I said, with the population, it's just common sense to use water twice.

The next statement (Respondent 1313A) conveys the significance of recycled water, and the inevitable increase of its use. The grower touches on the concept that water is already "recycled," in that it has been used before at some point. This is a reminder that water is, in fact, a global system, and issues of supply and demand are experienced by everyone.

Excerpt from Interview 1313A:

> I think that the use of recycled water is part of the future water supplies of the world... I think that someday you'll see more people drinking water that's been treated to high level that is reused. There is no way around it. And in a sense, we already do anyway.

The following post-interview comment (Respondent 2745D) stresses the importance of water as a resource to growers. The speaker mentions efforts being made by growers to conserve and increase their awareness of the use and application of water. Because agriculture is a business, growers focus on market impacts is bound to affect their attitudes and points of view. The respondent brings up points about the public response as increased costs for water supplies raise prices in the marketplace.

Excerpt from Interview 2745D:

> I'm glad you're working on this and going forward, water is a resource that is extremely important to us as farmers. We need to have the resource available to us. We've taken all the steps that we can for conservation and are open to listening to new ways or new methods of conservation. We hope that our local governments, whether it's the local government or the state government can work together to make sure that we can continue to farm. With the reduction in water on the ranch, it's going to impact everybody. When you grow 80% of the nation's vegetables and our costs go up to grow those, it affects everybody's pocket. And one of the things you look at what we've done in conservation methods such as drip irrigation, knowing our soil water holding capacity, being able to irrigate properly, using soil moisture monitor sensors that are monitoring all the root zones of the active crop so you can watch depletion rates on the daily basis, easing evapotranspiration.

Another post-interview comment (Respondent 2009P) communicates the importance of public education, in furthering acceptance of recycled water and other farming related practices. Additionally, the point made about media focus falling primarily on the negative side of recycled water, while outside the scope of this research, does speak to a factor that is bound to influence growers, as it does everyone.

Excerpt from Interview 2009P:

> I think, with regards to recycled water along with some of the other challenges that we face in terms of public perception—food safety, pesticide, fumigation usage, nitrate contamination of groundwater, recycled water along with these other hot topics in agriculture. I think public education is key. I don't think that quite enough is done in that area—just educating the public on the safety of it and the benefits of it, and in general enough of the positives of it. It's somewhat just focused on the negatives in the media,... the general population could be more educated on the pros of recycled water versus on the cons. And I think if the general population was better educated on recycled water—and not just this system, but the systems that are in place throughout the state, country and even the world—there would be greater acceptance or at least an increased comfort level.

The final commentary (Respondent 7746R) articulates concern for the near future, and stresses the value of being proactive. Their statement reinforces the point that the future must be planned. At the same time, those very plans must have enough inherent flexibility to position agencies to meet unforeseen challenges with innovative responses; lessons learned in the past may not hold all the answers going forward.

Excerpt from Interview 7746R:

> All these things are gonna have to be adjusted as we go down the road instead of someone thinking 'what happens this year' and 'what happens five years from now' may be totally different. So you gotta be adjustable whether you like it or not.

4. Discussion

The survey, conducted during a severe statewide drought from December 2013 through November 2014, was comprised of one-on-one interviews with growers who are either owners or leasing managers of farmland within the CSIP service area along the central coast of California. The 18 participants are responsible for approximately 75% of the 12,000 total acres of farmland within CSIP's service area; therefore, the sample size of 18 is representative of the CSIP service area.

While statistical analysis of the data yields important information, the discussion and conclusions take into account the fact that these findings cannot be assumed to represent and describe all cases or groups of growers. Some of the information and results are applicable to growers and farmland throughout the world, but must be considered on a case-by-case basis when attempting to apply strategies or principles from this case study to other regions. Rather, the insights gleaned from this study are offered as touch points for policymakers and stakeholders to refer to when facing water management challenges similar to those found within the CSIP service area.

While growers presented as comfortable and forthright with the interviewer and the questions, the self-assessment of general attitudes (prompted by the Likert scale statements) only covers general perceptions of trust and confidence over a broad scope. The open-ended questions centered on scenarios and programs, and consequently revealed more about growers' thought processes and underlying priorities. Additionally, the qualitative nature of the open-ended responses can be analyzed to infer drivers of acceptance that would not be revealed by the discrete answers to the Likert scale inquiries.

The first of two research questions asks “What factors influence grower acceptance of alternative water supplies?” For the purpose of this discussion, factors describing the background of a specific demographic of growers will be termed “profile variables.” Profile variables include age, highest level of education, total size of farms, and other demographic groups (see Table 2) that correspond to data considered when categorizing growers’ answers as more or less accepting of a given proposal. References to smaller/greater, younger/older, or less/more are in relation to the mean value of the respective demographic group. Analysis and discussion of the profile variables that are statistically significant offer insight into the voice(s) behind the respective answer(s). The features of the choices that growers must consider, including CSIP policies and practices, will be referred to as “situational factors.” Situational factors are parameters like cost levels, water quality comparisons, or CSIP policies or regulations presented to the growers in the context of hypothetical choices.

The most critical factor for influencing grower acceptance of an alternative water supply during this survey appears to be the perceived need for water supply. The perception of dire need for water was dominant at the time of the survey, due to the extensive and intense drought throughout the region and state. While there is no way to predict results if the questions were posed at a different time, the participants clearly perceived water supply as a pressing issue during their respective interviews. The drought created an increased concern about limited available water supplies and the resultant increase in reliance on groundwater pumping which, in turn, exacerbates the seawater intrusion dilemma. Additionally, the Salinas River, one of CSIP's water supplies, was no longer a viable option as a water source. Diverting the river was halted in October 2013, just prior to the start of the interviews. The Salinas Industrial Pond Water was essentially the only additional available water source once the drought became more intense at the end of 2013, and was not very desirable due to low water quality and limited supply.

The perceived need for water supply was expressed emphatically throughout the survey by a large majority of the respondents, and was expressed fairly consistently through all profile variables. The most common answer to the final question in the survey "What is your greatest concern with the CSIP distribution system now, and in the near future?" was "water supply" from 14 respondents (77%). Interestingly, the younger growers (under 51), appear to put a higher priority on water supply, while the older growers (over 51) tend to evaluate water supply and quality in tandem.

Prior to the implementation of recycled water delivery in 1998, a perceived need for water supply among CSIP growers was also a driving concern. At that time, the focus was reducing and offsetting groundwater pumping to mediate seawater intrusion, and to reduce discharge into the Monterey Bay. Respondents expressed a strong baseline of acceptance for the use of recycled water, after using it for almost 20 years. The general acceptance of recycled water locally is likely due to the success of CSIP itself, as it is currently the largest distribution system of recycled water for food crop irrigation in the world (CAWSI, 2017; MRWPCA, 2017c). In fact, all but one of the respondents (94%) were positive about using recycled water to irrigate their crops. Furthermore, a large majority of respondents (72%) stated that their customers' attitudes are not negatively impacted by their use of recycled water. Interestingly, the three respondents who felt their customers' attitudes are negatively impacted by the use of recycled water are younger (under 51). This was a surprising result since this was stated despite widespread information and education on alternative water supplies and improved general acceptance with the public, the marketplace, and growers throughout the world. The fact that younger growers have a slightly less accepting perception of recycled water may indicate a reduced level of outreach activity since CSIP has been in operation for 20 years.

When asked about implementing the use of desalinated water, most of the respondents were positive (89%). Interestingly, all ten of the younger respondents (under 51) only answered positively. Most CSIP growers are unfamiliar with using desalinated water (94%), but their perceived need for water during the drought contributed to a more receptive stance on any possible source, especially as options became more limited. In all cases, the perception of the need for a water supply appears to correlate with an increase in positive responses to the idea of desalinated water being delivered and blended with the CSIP water supply.

Heightened perception of diminishing or limited water supply leads to urgency. A water source that may have seemed less desirable at another time invites consideration. The profile variables that correlated with a more vocal expression of the need for water supply are as follows: younger (under 51 years of age), smaller total acreage (under 1,087 acres), and a higher level of education (Bachelor's degree or higher). Potential drivers within the three demographic groups are: younger growers may have not have dealt with an intense drought, those on smaller farms may feel that they could receive a smaller portion of the available water since they have less land and every unit of water is critical, and growers with a higher level of education may be more aware of the logistics for trying to obtain water rights during an intense drought and probable water rationing.

Changes in cost and/or water quality are extremely important to growers' acceptance of alternative water supplies. Cost and water quality have a mutually impacting relationship between them that becomes obscured if they are considered separate factors and discussed individually. Generally speaking, cost reflects water quality in that quality is a direct outcome of the level of treatment required to produce a desirable level of water quality. Agriculture is a business which inherently strives for larger profit margins. Therefore, costs of production are carefully examined and have a large sway in decision-making. The cost of water, from any source, figures large in growers' calculations. Meanwhile, water quality, the other end of the cost/quality see-saw, must be good enough to preclude any possibility of lower quality harvests or harmful impacts on the growers' soil.

During the survey, a series of three questions was asked about preferences of recycled water or desalinated water as alternative water supplies (see Figure 6). The first question asked whether respondents preferred recycled or desalinated water. The second question asked which supply they preferred, assuming cost was the same. The third question asked which supply they would choose if the supply not chosen were 10% less costly than the preferred supply (see Figure 6). The intention of discussing cost and/or water quality without using "real world" numbers was to discern attitudes towards costs, rather than learn the desirability of specific price points. When respondents did change their choice of water supply, the top two reasons stated were “cost” and “water quality.” A definite impact on the growers’ acceptance and responses to this series of questions is the fact that, at the time of the survey, only one respondent had prior experience with desalinated water, while all growers were familiar with using recycled water to irrigate their crops. Respondent 2745D elaborated on the choice between recycled and desalinated water, stating “...I don’t know what the agronomics of it would be. I can’t really answer that question without that information.” The quote illustrates the grower’s desire for concrete information when considering water supply solutions, so the intent of the question was fulfilled. Respondents’ answers revealed that growers are very concerned with cost, but have a full awareness that cost is not a singular concern and has to be weighed as one metric among several, rather than the sole determining factor. Some of the respondents clearly expressed that water quality is their greatest concern with additional water supplies, while cost is a lower priority, comparatively speaking. Respondent 3087H expresses that view stating “I’d pay whatever it took for the best quality of water. 10% savings is negligible..., it’s not going to drive decision-making in our industry.”

Cost and/or water quality weighs heavily on growers’ attitudes and decisions regarding their available (or potential) water supply. This situational factor is crucial for the success of an agricultural business which must produce harvests that remain in demand by the market and sustain acceptable profits. Specific price points were not part of the investigation, despite respondents’ frequent requests for hard numbers. Water pricing and assessment fees are affected by multiple variables, forces, and agencies.

Obtaining sustainable, adequate, and reliable water sources for CSIP will come at an as-yet-unknown cost. This case study reveals the complexity of forces affecting cost issues as the growers express perceiving them.

Information/education is a critical factor that can build or negate grower acceptance of alternative water supplies. Continuing education and accessible information, while consistently available, are vital for gaining growers' receptivity to, and eventual acceptance of, the potential options. Not only does it satisfy growers' desires to feel that their decisions are well-informed, this situational factor helps CSIP stakeholders and policymakers gather feedback throughout the process of their research and on-going planning process. Communication/outreach, a crucial subset within this situational factor, allows growers and stakeholders to become more engaged with one another and promotes continued interaction into the future. Information/education is not enough if growers and other stakeholders are not aware of it, or do not access or discuss it.

Part of CSIP's success, prior to implementing the use of recycled water in 1998, was the vast effort by stakeholders to conduct research and to inform and educate the CSIP growers, while providing communication and outreach. Promoting recycled water in 1998 was much more challenging than it is today. Production and use of recycled water was extremely limited in the United States at that time, and the idea of treated wastewater used to irrigate crops was cause for doubt in some quarters. In 1987, a decade prior to the use of recycled water by CSIP growers, extensive research was completed and released in a document titled "Monterey Wastewater Reclamation Study for Agriculture" (Engineering-Science, 1987). The MWRSA was a driving component that led to the success of implementing recycled water and laid the foundation for its continued acceptance among the CSIP growers. While some CSIP growers opposed the transition to recycled water, most eventually came on board. The shift toward acceptance was in part due to the availability of information and education delineating the authentic pros and cons of the water source. Furthermore, one interesting viewpoint regarding the initial implementation of recycled water was shared by Respondent 4949M when he/she stated "..., when the project started, we were against it..., but in the end, I'm really glad we just did it and went with it. It's been a savior." The quote shows that, despite initial opposition to decisions or policies proposed by CSIP stakeholders and policymakers, continued support and communication played a role in turning the tide. This supports the strategy to keep two-way communication open for both growers and policymakers, and to have research and information available to support a particular direction or option, such as the case with recycled water.

Information/education also figures large in the perceived need for a new water supply. If a grower is unaware of potential water sources, he/she may believe there are few, or no, options available. It appears that younger growers, and those on smaller or fewer farms, are either unable to recall potential water sources, or are not receiving the appropriate amount of information from CSIP stakeholders. It is possible that outreach efforts have diminished over the years so that growers late to the area may not encounter as much information as those who have been around longer. In fact, CSIP began blending Salinas Industrial Pond Water in February 2014, yet less than half of respondents (44%) offered that answer as a potential water source. Information regarding CSIP's policies and operations may not be reaching the growers as intended, or spreading to all who should have it. The question was open-ended, and the growers may not have offered that answer because the water source was already in use at the time of the survey, and so not perceived as additional.

Five Likert scale statements, on a five-point scale, were read to the respondents prompting growers to self-assess their outlook and perceptions on several topics (see Figure 5). Two out of the five statements checked the growers' perspectives regarding the availability of CSIP information, and whether communication is acceptable and positive between themselves and CSIP's policymakers and stakeholders. The statements did not allow growers to expand on their responses, nor were there any follow-up questions. While the results show that the responses are positive overall for both statements, the results also reveal that not all respondents are fully confident or satisfied with the communication and information currently provided by CSIP stakeholders and policymakers. Surprisingly, the same two profile variables (under 51 and smaller total farm size) that describe those who "strongly agree" that information is readily available, and communication is acceptable from CSIP, also apply to those who knew of "one source" or "no source" of water CSIP was potentially going to implement. Therefore, it is possible that the information is available, but inadequate communication/outreach is preventing the information from reaching some portion of the growers. Prior to giving their response throughout all of the interviews, the growers expressed interest in receiving more information about hypothetical questions. This characteristic can be anticipated in real-world scenarios and discussions as well.

One explanation is that while the information may be available, the outreach and education pushing that information may be weaker. Or it could be that the growers did not recall potential water sources at the time of that particular open-ended question. Otherwise, it appears that growers find the amount of information and communication is at an acceptable level with CSIP's policymakers and stakeholders. Information/education coupled with the underlying subset of communication/outreach are essential factors for making informed decisions, and having knowledge of the current status of CSIP and its policies and procedures

Level of trust is an underlying and essential situational factor that affects grower acceptance of alternative water supplies. It impacts growers' attitudes toward stakeholders' decision-making. When trust is low, decisions fall under greater scrutiny and proposals may be regarded with doubt or suspicion, potentially hampering acceptance of any number of policies or proposals. The level of trust between an end-user and various stakeholders may be difficult to gauge or evaluate since trust is earned and granted by individuals, may fluctuate over time, can be influenced by peers, and affected by other variables. In general, trust levels between the grower and overseeing agencies are based upon four short-term and long-term variables on a sliding scale: consistency, reliability, transparency, and representing the growers' interest. Trust level is greatly reduced when any, or all, of the aforementioned variables are perceived to be unpredictable or inauthentic. There is also potential to lose trust due to misinformation, omitted information, or a breakdown in communication on either side that is not addressed.

Two of the five Likert scale statements specifically addressed the growers' level of trust with stakeholders and policymakers (see Figure 5). The intention was to reveal whether or not respondents perceived all of the CSIP growers as having trust levels which are acceptable and positive, so the results do not necessarily reflect any individual grower's attitude. The overall results were positive; however, it must also must be noted that of the five Likert scale statements, this statement regarding trust levels had the lowest mean with a 3.89 average, which ranks between "somewhat agree" and "neutral" on a five-point scale.

The other Likert scale statement that relates to level of trust read "CSIP needs to be more proactive with policies and procedures to become more 'grower friendly,' and to have growers in their best interest." A large majority of the respondents (78%) were in agreement (strongly or somewhat) that CSIP needs to become more "grower friendly" (see Figure 5). This result is surprising since the remaining interview responses did not yield a comparably strong expression from the growers about CSIP policies and procedures needing to be more "grower friendly." However, the concept of "grower friendly" incorporates many things, including information/education about policies and procedures being available and known, and communication about the potential ramifications of decisions that could lead to regulatory oversight.

Level of trust is a situational factor that resonates throughout all of the other factors for growers' acceptance of alternative water supplies and decision-making processes. Respondents who work with a smaller total size of farms (under 1,087 acres) expressed that they felt CSIP growers have a higher level of trust with policymakers and stakeholders than other profile variables. Surprisingly, the same profile variable of smaller farms was also one of the larger demographic groups that stated CSIP needs to be more "grower friendly" with policies and procedures. The younger respondents (under 51) also responded with a higher perception of growers' level of trust with CSIP, yet stated CSIP should be more "grower friendly." While trust is difficult for anyone to gauge with certainty, all of the respondents appeared comfortable and forthcoming throughout the interviews, both in verbal answers and non-verbal communication, such as facial expressions, tones of voice, and posture. Their answers are all taken at face value.

The second research question asks "How does growers' level of concern regarding seawater intrusion and environmental impact affect their attitudes towards different water supply options?" Again, the four situational factors affecting grower acceptance of alternative water supplies (perceived need for water supply, changes in cost and/or water quality, information/education, and level of trust) play into an examination of growers' level of concern about seawater intrusion, as do the environmental impacts from those water supply options. The mitigation of seawater intrusion, and the environmental impacts related to different water supply options, typically falls under the situational factor of changes in cost and/or water quality. A grower's business is dependent on the environment. At the same time, the cost of operation includes the preservation of that environment in order to sustain the business. With that, there is regulatory oversight that may be costly or cumbersome. Environmental conditions directly impact the growers' harvests and land. Degradation of the environment eventually lowers productivity and reduces profits. Cost subsequently increases to remedy the situation or the land becomes less valuable. Arguably, only the intense and immediate need for a water supply would override considerations of a water source that could have negative impacts to the farmland or potentially exacerbate seawater intrusion.

The questions in the interview were intentionally general around specifics of cost scenarios. This was motivated by two factors. First, specifics of costs for hypothetical sources of water are too complex to calculate in the abstract. Second, the researcher wanted to determine how growers perceive the relationships between costs and other variables, not how they would react to specific dollar amounts. To that end, questions were posed comparing cost, and changes in cost, considered against other variables.

Throughout the interview, growers expressed a high regard for the environment, either in a straightforward or subtle way. A straightforward example is when the growers were asked “Do you believe that growers have a different relationship with the land and the environment than those who do not farm?” all but one respondent (94%) replied with a straightforward “yes.” One respondent (7746R) essentially answered “yes and no” by stating “A lot of the growers are corporations now because there is not many independent guys anymore.” This distinction identified a fundamental split between growers that are corporations and those who are individual owners, and the opinion that corporations are not as “in tune” with their farmland as individuals. Another example of a direct response was when growers expressed that they are less accepting of implementing desalinated water due to its energy use and environmental impacts. The initial question revealed that a large majority (89%) were positive about implementing desalinated water. The two follow-up questions revealed that a large majority were “less accepting” of desalinated water due to the amount of energy (77%), and environmental impacts (61%) required to process and produce desalinated water. Some of the respondents' answers changed between the increased energy use and environmental impacts. It is possible that the respondents inferred a direct correlation between cost increases and greater energy use, which does not automatically preclude concern for environmental impacts. Another possibility is that the growers who changed their answers lacked knowledge of the environmental impacts due to processing desalinated water, such as the disposal of brine and the inclusion of energy creation and consumption.

The reality of the drought, and the need for a water source, most likely overshadowed the amount of energy used to produce desalinated water in the hierarchy of their respective priorities. The overall results of the follow-up questions show how the growers view themselves and what they take into consideration when the local environment is impacted by their farming practices. Decisions that have environmental ramifications can have cascading effects, and could cost growers time, money, or energy that may be unnecessary or entirely avoidable.

Another strong response to levels of concern about the environment was expressed when answering the question "How do you feel about the saltwater intrusion problem along the coast?" All but one respondent (94%) emphatically stated that the problem is a major concern. The one respondent (7915B), who expressed a neutral response by stating "...we've got a solution. It's called recycled water. And I'm glad we did it." The respondent appears to be under the impression that most of the problem has been addressed and resolved due to implementing the use of recycled water. In fact, recycled water is only a partial solution, and offsets the amount of groundwater pumping only by the quantity of available recycled water. With increased efforts in water conservation and overall reductions in water use, less wastewater is created and delivered to the Monterey Regional Water Pollution Control Agency; therefore, less recycled water is produced. Furthermore, there has been an increase in water demand from the CSIP growers in recent years due to more water-intensive crops, such as strawberries, being planted in CSIP. Finally, an increase in crop rotations is proving to be an additional challenge to providing an adequate water supply.

An interesting profile variable is that almost all respondents have been farming in the CSIP service area before 1998, when recycled water was first implemented. The majority experienced the adverse effects of seawater intrusion directly and participated in the transition to a water distribution system. The growers also lived through a period of decline in their property values, especially near the coast, as a direct result of wells becoming saline due to seawater intrusion. This development drastically diminished land values, which were only restored after recycled water became a viable water supply option. Once the CSIP distribution system was built, and began delivering a more sustainable water supply, demand for the land skyrocketed. A post-interview conversation included a narrative of land near the coast that became essentially worthless without a reliable water source just prior to the creation of the CSIP distribution system. Once CSIP came online, the land regained value. Direct experience with seawater intrusion makes CSIP growers predisposed to continue mitigating the effects of this pervasive threat to their farms and businesses. Having personal knowledge of the potential damage seawater intrusion represents, they are unlikely to be receptive to any water management solutions that don’t at least maintain the mitigation currently being achieved.

One of the five Likert scale statements read “There needs to be more proactive work regarding the saltwater intrusion problem in the Salinas River Valley Watershed,” and 72% replied with “strongly agree.” A large majority of the respondents clearly stated that more proactive work is needed within the CSIP service area (see Figure 5). These results were not as clearly evident when analyzing the rest of the data. It is imperative to ask direct questions, as well as analyze more complex responses, to infer a connection to growers’ attitudes or perceptions. The results from the Likert statement above may not mean the growers perceive water resource managers within the Salinas River Valley Watershed as not doing a good job. Rather, the statement may express that growers support more proactive work regarding seawater intrusion and wish to be prepared by planning for the future. The results clearly indicate growers are supportive of the ongoing mitigation of seawater intrusion, and encourage more forward thinking about future work to continue the battle against it.

Growers revealed their levels of concern about seawater intrusion and environmental impacts throughout the interview. The top two answers respondents gave to the question “What are the two highest concerns for you regarding water quality?” were “salt” and “chloride,” the two main contaminants that result from seawater intrusion. In fact, the extent of the seawater intrusion that is mapped by Monterey County Water Resources Agency is determined by the chloride levels reaching 500 parts per million in the groundwater basin. Additionally, salt and chloride are generally known as the most detrimental elements potentially present in water for irrigating crops. The long-term effects of these two elements are especially harmful to the soil and land, as well as to the growers' harvest and crops. Respondents were extremely vocal about this topic, and did not hesitate to express the importance of these two problematic water quality issues as the highest of priorities.

At several points in the interviews, growers displayed a high regard for the environment in a subtle way. Numerous respondents asked for more information when given scenarios containing general information about environmental variables. For example, when open-ended questions touched on water efficiency/conservation efforts, water storage, and water quality, interviewees asked for more details and expressed hesitation on decisions when scenarios did not spell out environmental impacts. These expressions are deemed subtle by the researcher as growers did not directly describe environmental factors as defining conditions of acceptance or refusal of water supply options. At the same time, the open-ended questions revealed awareness of environmental health as being a condition of continued operation.

Respondents' interest in the environment demonstrates that concerns for ecology need not be motivated by altruism to motivate sustainable practices. Growers predictably prefer to avoid imposed regulations and/or oversight, which might increase costs and reduce autonomy. This perspective reinforces the significance of levels of trust with stakeholders and policymakers. High levels of trust may contribute to greater voluntary transparency, which supports cooperation across stakeholder groups. Arguably, well-informed growers with up-to-date information may be more inclined to self-regulate, as well as cooperate with more innovations and sustainable practices out of self-interest.

There were two series of questions that revealed more subtle responses which led to requests for more information. Growers wanted to determine whether or not local CSIP agencies would be managing them more closely or whether they would be subject to higher levels of regulations with local, state, or federal agencies. The first series of questions pertained to how the respondents felt about increasing water storage with a positive response from all growers, save one, who stated that it “depends.” The follow-up question asked “Would you be willing to establish private water storage on your property if there was an incentive by CSIP?” The positive response dropped to 67%, and the number of respondents answering “depends” rose to eight growers. The second series of questions addressed efficient water practices and incentives. The first question was well received, with 94% self-assessing their water practices as being efficient. One of the follow-up questions asked “Would you participate in a water budget program?” Half of the respondents (50%) stated “yes,” and the remainder stated “no” or “depends.” The intent of these questions were to ask a very general question about whether or not growers would be willing to participate in a program in theory, which was explained in that manner to the respondents during the interview. Again, a portion of the respondents requested more information about the details of what the actual program would be before responding.

The next question asked if the respondent would be willing to plant different crops to be more efficient with water use, and twelve of the responses included either "no" or "depends." Most of those responses either stated that they were on a particular schedule, planting particular crops to satisfy their market demand, and/or that the respective grower did not welcome that level of oversight. The intent of the questions was to explore growers' general willingness to collaborate or participate in group programs. The prompt did not include detailed hypothetical scenarios in order to keep answers focused on general attitudes toward options, rather than collect opinions on minute details or parameters. Nonetheless, it can be inferred that the increased oversight, and the potential for being regulated and closely managed by various agencies increases hesitation about participation. CSIP history demonstrates that robust research/outreach and information/education can help overcome hesitation, as was the case with recycled water.

Another question asked what farming practices that impact the environment are of greatest concern to growers. The answers revealed that avoidance of regulation and/or oversight does affect attitudes. The most common response was "runoff," and respondents repeatedly expressed that runoff is already being regulated to some extent and may see more strict regulation imposed going forward. Respondent 2941T elaborated by stating "Not just the amount of runoff, but constituents in the runoff because they think that's what we're going to get regulated on next." The aforementioned quote, and the responses around avoiding regulations and/or oversight, supports the assertion that while growers desire and welcome more information/education about programs and processes, they are interested in staying ahead of regulatory demands, likely in hopes of reducing those demands. Growers have shown in several straightforward and subtle ways that they prefer to protect their own business and resources, managing their respective farmlands themselves, rather than being closely managed or forced into regulation and compliance by other entities.

In summary, the three themes or motivations behind growers' interest in operating with minimal environmental impacts are protecting harvest and land, managing associated cost of operations, and avoiding increased regulations and/or oversight. Grower attitudes toward seawater intrusion or environmental impacts may not necessarily be driven by environmental concerns alone. Nonetheless, the motivation to cause minimal environmental impacts is functionally integral to the cost of operation. At the same time, growers are not free to assess and respond to environmental impacts independently or idiosyncratically. With implementation of alternative water supplies, it is likely that growers will have to accept some level of regulatory oversight to mitigate environmental impacts should self monitoring fail to achieve necessary outcomes. Or, they may come under particular rules, laws, or guidelines that initiate oversight from more distant authorities. The profile variables of those most cohesive on this research question are the same demographic groups discovered in the findings of the first research question (under 51 years of age, hold a Bachelor's degree or higher, and operate a smaller total acreage of farmland). It is the opinion of the researcher that growers are inherently pro-environment due to the nature of their profession, coupled with the protection and preservation of their businesses. Whether this environmental concern extends to the larger ecology beyond that affecting their specific interests was not an area of inquiry in this case study. In any case, it is in the growers' best interest to choose, or be accepting of, water supply solutions that do not accelerate seawater intrusion or other environmental degradation.

5. Conclusion

This case study has revealed numerous interpretations and discussions regarding information and policies within the CSIP service area, and agricultural business in general. The intent of this study is to provide an objective perspective of the entire experience, and to focus on continuing the discussion and improving the experience for all parties involved in the present and going forward. This study identified four prominent factors that influence growers' acceptance of alternative water supplies:

1) Perceived need for water supply
2) Changes in cost and/or water quality
3) Information/education
4) Level of trust

The perceived need for water supply is the most critical factor and is the impetus for seeking additional water sources. The perception of need intensifies with scarcity and drives greater acceptance of any available water source. Changes in cost and/or water quality are crucial and should be managed together. They impact the growers' businesses in the short-term and long-term with reduced profit margins and potential harm to their harvests and/or farmland. Information/education is necessary to promote informed decisions and includes a subset of communication/outreach underlying all the other factors. Making information available is not adequate if it never reaches the growers. Consistent communication and proactive outreach support an informed community of growers. Level of trust is also pervasive throughout all the other factors and can fluctuate with growers' perceptions of policymakers as levels of consistency, reliability, transparency, and the representation of growers' interest vary. Growers' level of trust is perceived on an individual basis and can be influenced by other growers' positive/negative experience with the aforementioned influences on level of trust.

Several interesting trends were uncovered throughout the respondents' profile variables, otherwise known as the growers' demographic backgrounds. There appeared to be a gap with information received about CSIP among younger growers (under 51), and growers with fewer years in the farming industry (less than 27 years). The income level was evenly distributed above and below 150K, as were their opinions that CSIP needs to become more "grower friendly." Growers with a higher level of education (Bachelor's degree or higher) appeared to have a greater understanding of the entire distribution system along with policies and the need for water supply. Overall, the more experienced growers (greater than 27 years in the farming industry), and older growers (over 51) appear to be less put off by the high energy used to process desalinated water. The perceived need for water supply during the intense drought is likely the dominant factor in their receptivity. Growers with a smaller number of farms (under 6 farms) and less total acreage (under 1,087 acres) seem to have a greater perceived need to acquire a sustainable water supply. Both groups are also simultaneously more mindful of, and reluctant to implement, a water source that has lower water quality or creates detrimental effects on the environment.

Additionally, this study revealed a productive overlap of motivating concerns regarding CSIP growers' attitudes towards water supply options that negatively impact the environment and/or the mitigation of seawater intrusion. Growers' motivations center on the following three themes:

1) Protecting harvest and land
2) Managing associated cost of operations
3) Avoiding increased regulations and/or oversight

Seawater intrusion remains an extremely high priority for CSIP growers who expressed that CSIP, as a whole, needs to be more proactive with the mitigation of seawater intrusion. The growers expressed determination to protect their harvests and farmland, so any water management decisions that may potentially affect seawater intrusion and/or bring adverse environmental impacts are viewed as a threat to their businesses. A preference for proactive self-regulation was shown regarding environmental impacts in order to avoid additional oversight, or costs, being imposed by various agencies and entities. Robust and detailed information, along with specific parameters (including cost, water quality, and policies), must be researched by overseeing CSIP agencies and conveyed to growers, in order to determine their precise level of concern regarding environmental impacts associated with water management strategies. Whether concern for environmental impact is driven by the desire to maintain profits or by pure environmentalism, the result can be a more environmentally sustainable practice.

This study revealed interesting tendencies and patterns among all of the respondents regarding their attitudes, perceptions, and insights toward two known alternative water supplies: recycled water and desalinated water. Both supplies were well received by majority of the respondents, which was likely due to water scarcity. Growers' familiarity with using recycled water, coupled with extensive education and communication, likely promoted their strongly positive responses, and preference for recycled water over using desalinated water. A lack of experience with desalinated water, along with the high energy consumption and associated costs, likely drive decreased acceptance of desalinated water, and reluctance to implement its use in CSIP.

In summary, while perceived need for more water is the initial driver of grower receptivity to supplies, during intense periods of drought, the other influencing factors identified in this case study cannot be underestimated. Education and communication in particular greatly impacts growers' acceptance and participation. Providing information and educating growers are in themselves ways to promote trust, a factor that affects growers' willingness to interact and communicate with policymakers and other stakeholders, even when water supplies are perceived as sufficient. The CSIP case study reveals more than growers' acceptance of water sources and management strategies. It provides a glimpse into a set of factors that should remain constant for all water management strategies, but the order of priority will shift depending on the heightened issue at that time. This case study is specific and unique to the policymakers, stakeholders, and growers within the CSIP service area; however, there are many facets that may resonate with water managers, water users, and growers throughout the world.

6. Applications and Recommendations

Management of water resources is a very complicated and arduous task, which relies on multiple coordinated efforts involving numerous agencies, entities, and people. The task is ongoing, and is most successful when efforts are proactive and preventive, rather than reactive. The task of managing water resources becomes more daunting when mitigating seawater intrusion. There is increased urgency to remain ahead of the consequences of seawater intrusion and proactively halt its progression, rather than respond to its effects. Water management also becomes a major challenge when water demand cannot be met. In the absence of additional water sources, such as during intense drought or in locations where demand has outpaced supply, the best solution is to proactively prepare a surplus water supply and/or water storage to allow for fluctuations of water availability on a small or large scale. Climate change conditions are changing historic rainfall patterns, indicating more uncertainty ahead.

The following recommendations given for potential water management strategies are intended to promote discussions among policymakers, stakeholders, and growers. They are meant to be flexible and will accommodate real-world implementation. Like all water management efforts, these will require coordinated efforts among numerous stakeholders and will demand varying amounts of time, money, and effort. Some strategies may not be currently actionable. Various legal issues and/or existing regulations, cost prohibitions, or other barriers may hamper or block implementation or pursuit of particular strategies. But, the role of research is to make information and insight available. Once options and parameters are clarified, change can be sought. Growers' level of concern regarding environmental impacts will likely be more accurately determined once cost and water quality options are determined and conveyed. It is important that cost and water quality data be accurate so as to preserve grower confidence in sources of information. How the information and educational context are communicated to growers is key to the success of water management strategies or the implementation of new water sources. The growers' levels of trust depend on their respective perceptions of policymakers' and stakeholders' presentation of the information. Information must be available and supported with ongoing outreach and two-way communication. Growers must see their needs reflected in the dialogue. Trust, once lost, is very difficult to restore, and mistrust spreads quickly. Conversely, if the level of trust is high, and ongoing interactions reinforce that confidence, it can become the baseline. The key for success between overseeing agencies and growers is to keep two-way communication accessible and available, and to remain transparent and open to all parties.

The applications and recommendations in the following section have been divided into two major categories:

1) Management of the entire Salinas River Groundwater Basin (SRGB)
2) Management of the Castroville Seawater Intrusion Project (CSIP)

The CSIP service area is close in proximity to the coast of central California, and located above a small portion of the SRGB that has been listed as one of 21 "Critically Overdrafted Groundwater Basins" by the California Department of Water Resources (DWR, 2017b). The State of California's Governor, Jerry Brown, signed the Sustainable Groundwater Management Act (SGMA) in September 2014 to mandate closer management of groundwater basins within the state of California, and to determine who will implement and execute that management (DWR, 2017a). The agencies and entities overseeing the entire SRGB have yet to be determined at the time of this writing.

The management of the entire SRGB is essential when looking at the "big picture," and planning how to protect the groundwater basin from further overdraft and additional seawater intrusion. The management of CSIP will be greatly affected by the efforts and strategies of the entities that will implement and execute the SGMA. The management of the entire SRGB will hopefully alleviate, or at least reduce, some obstacles for coordinating efforts with CSIP among multiple policymakers and stakeholders. In addition to critically stressed groundwater basins, the governing entities also face population growth, climate change, and fluctuations in availability of water during periods of drought. Five ideal recommendations, listed in order of importance, for the entire SRGB are as follows:

1) Secure additional water source(s)
2) Increase oversight of all water withdrawn
3) Establish a Water Trading and/or Water Credit Program
4) Develop and administer a Well User Program
5) Expand the CSIP service area

To begin with, securing an additional water source (or sources) is crucial for the successful management of the SRGB. While difficult and costly, this undertaking is preferable to the possibility of running out of water supplies, creating and regulating water budgets for all users, or increasing the intrusion of seawater within the groundwater basin. One option is to increase the production of recycled water, which would likely be located farther inland. That new source of recycled water can either be used to offset further groundwater pumping in the CSIP service area, recharge the groundwater along the Salinas River, or be delivered to the Naciemento Dam and San Antonio Reservoir for release into the Salinas River to replenish the river and increase recharge. Another option is to invest in an appropriately scaled treatment plant to produce desalinated seawater. The production of desalinated water is generally cost prohibitive when applied to groundwater recharge or for water storage. However, the desalinated water can be used to offset groundwater pumping and reduce the water demand on the SRGB.

Second, increasing oversight of all water withdrawn from the SRGB is an important data collection option. Tracking all of the water withdrawn from the SRGB through meters would capture important information for managing water use and application going forward. Once use patterns and quantities are measurable for all users, the data can become the basis of fee structures that can then fund infrastructure for additional water sources and strategies. The fees assessed should include a well permit-and-use fee, and fixed water rates for specific units of water extracted from the SRGB. Essentially, any person or entity that extracts water from the SRGB would be required to replace the water used or pay for its replacement. This would ensure the future of the groundwater basin. Additionally, all wells that are not being used, for which no use is planned, should be abandoned and sealed properly, thus reducing undocumented groundwater pumping, and lowering potential contamination of the groundwater supply, or undesirable expanses of seawater intrusion via wells or well casings.

Another recommendation is establishing a Water Trading and/or Water Credit Program among local agencies and water utilities. Such a program can help improve water resource management in the region by transferring large volumes of water from entities that have a surplus of water to those that are in need. Water trading might also forestall the need to devise storage while preventing excess water from going to waste. The challenge of this strategy lies in the logistics of physically transferring the water supply between the various entities. If multiple agencies are involved in such a program, then the water exchange does not have to be a one-to-one agency trade, opening up alternative methods to manage the water source, including Water Credits.

The fourth recommendation for SRGB is to develop and administer a Well User Program. There are countless ways to set up a Well User Program. This could establish a means of communication and outreach for overseeing agencies to connect with the appropriate person(s) operating groundwater wells within the SRGB. One suggestion is to require a “supervisor” or “contact” for each permitted well as a condition of the well permit itself. This proposed Well User Program can incorporate and expand on the existing Groundwater Reporting Program that collects various water use data for the “Groundwater Extraction Summary Report” (MCWRA, 2015b). Classes or other educational activities could be required of that supervisor periodically as a way to maintain communication and up-to-date information among well users. The program can also be a means of collecting periodic inspection reports for the permitted well(s). The inspections can be self-reported, conducted by trained/certified personnel and would check for efficient operation, water quality, and other metrics of interest to managers of the groundwater basin. Also, this program can be a way of gathering and/or verifying accurate meter reading.

Lastly, expanding the CSIP service area and distribution system, while highly desirable, cannot be developed or implemented until there is an adequate and sustainable water supply for the existing CSIP service area. Furthermore, the infrastructure of the CSIP system will need to be upgraded to address pressure issues, replace aging pipelines, and upsize the existing water mains to account for the increased water demand. Assessment fees will also need to be developed and administered for new and existing customers within CSIP. The fee structure will likely engender debate and become political, since it is plausible that existing CSIP customers may be assessed different fees than any new customers. To explain, the existing customers have been paying fees for about 20 years, and therefore have a large capital investment in the existing CSIP distribution system. The new customers may specifically be asked to pay most, or all, of the cost to expand the CSIP distribution system, and possibly pay higher fees to cover some of the infrastructure costs that have already been encumbered. One prominent benefit of expanding the CSIP service area is that it will further offset groundwater pumping. As a result, more wells closer to the coast can be abandoned and sealed to reduce the expansion of seawater intrusion.

The management of CSIP will have its challenges, as it has in the past, and should remain proactive using strategies similar to those previously implemented to continue the success of its mitigation of seawater intrusion. Successful past strategies of CSIP include: conducting research and securing new water sources, communicating with growers, remaining transparent, and providing enough water of reliable quality to meet demand while mitigating seawater intrusion. At this time, it is unclear how the SRGB will be overseen under the SGMA. In any case, CSIP will most likely drive that management; otherwise, the management of the SRGB will drive CSIP's efforts. There are some overlapping recommendations with CSIP and SRGB management, but for the sake of this discussion, the next strategies presented are for CSIP alone, regardless of SRGB management.

The overseeing agencies for CSIP must remain proactive and diligent in their management efforts to accommodate for future water demand (both short-term and long-term), extended periods of drought, and climate change issues. The lessons learned over the duration of the drought should be documented and used by stakeholders to plan ahead and secure enough sustainable water supplies to create a surplus. CSIP could potentially put itself in a position to provide water to others in future shortages, rather than scrambling to find it. Five beneficial recommendations, listed in order of importance, for managing CSIP are as follows:

1) Secure additional water source(s)
2) Adjust cost and fees to support water demand
3) Create water storage and increase reliability of its water distribution system
4) Develop and administer a Supervising Grower Program
5) Compare policies and procedures with other similar agencies

First, securing an additional water source (or sources) is crucial for the successful management of CSIP, similar to the SRGB. It would benefit all of those involved within CSIP to be proactive in securing a sustainable water supply with an eye toward maintaining a surplus of water, since future droughts and water shortages are inevitable. The expansion of the CSIP distribution system cannot be accommodated until there is an ample and reliable water supply that will not only serve the existing service area, but allow for the increased demand. One option for a new water source is to increase the amount of wastewater from other facilities and service areas that flow to the Monterey Regional Water Pollution Control Agency (MRWPCA) in order to process and produce more recycled water. Or, MRWPCA can partner with another treatment plant to purchase and/or trade recycled water, and install infrastructure to exchange large volumes of water. Otherwise, the methods can be used that were discussed under the SRGB recommendations, such as sending the water to the Naciemento Dam and San Antonio Reservoir to be released into the Salinas River, or send the water upstream in the Salinas River to recharge the groundwater. The two methods above are less desirable since there are large volumes of water that will be lost in the exchange due to environmental conditions along the Salinas River. Plus, these methods would continue the reliance on groundwater pumping, which should be reduced or discontinued for greater success with mitigating seawater intrusion. Building a desalination treatment plant is an option, albeit at an extremely high cost. Therefore, unless other entities collaborate with CSIP, building a desalination plant is unlikely. Another option is to partner with Pure Water Monterey to increase the scale of the existing Advanced Water Treatment facility, and increase the amount of water allotted to CSIP. CSIP could also initiate a Water Trading and/or Water Credit Program (or agreements) similar to the one discussed under the SRGB. The bottom line is that there is not enough water in the local region, and a new water source must be introduced for CSIP in order to reduce, or halt, groundwater pumping so the mitigation of seawater intrusion can continue, while still meeting the water demand from growers.

The second recommendation for CSIP is to adjust cost and fees to support its water demand. The cost to secure additional water sources and supply growers with reliable water quality will likely be extremely high for CSIP. Therefore, several decisions will have to be made by all parties as to the value and expense of acquiring and delivering water. One item to address is changing the expectations of the marketplace for certain harvests and crops provided by the CSIP growers. Historically, CSIP has accommodated the increasing water demand set by the growers, which were passed on to them by the market. In recent years, growers have felt higher demand from the market for increased turnaround on the number of harvests, and for crops that are more water intensive, such as strawberries. This notion is controversial and likely to be a sensitive topic for many, since the marketplace drives growers' business decisions. However, CSIP has reached a point where they may have to choose between drastically increasing costs for acquiring and delivering an adequate water supply, or turn to regulating a reduction in water use by creating water budgets and restricting quantities of water used in given periods of time. Alternatively, CSIP may find it necessary to require different crops that are less water-intensive, or rotation schedules that conserve water supplies. It is safe to assume that the latter options for regulating water use and crop types/frequency is not desired by any party. The increased oversight would be burdensome for CSIP policymakers, and likely not welcomed or encouraged by the market or the growers.

Third, it is highly recommended for CSIP to create water storage and increase reliability of its water distribution system. Water storage within CSIP would be an immense benefit to the operation of its distribution system, creating a buffer to accommodate water demand on a smaller scale. The storage could potentially alleviate water pressure fluctuations within the distribution system. Cost benefit analysis must be meticulous to find the most appropriate locations for water storage, along with the most efficient number, size, and mechanisms of water storage. Other options could include storing water below ground to retrieve at a later date, or the possibility of incentivizing private storage for individual growers within CSIP. Water quality must also be researched closely when determining the means to store water, since water cannot remain stagnant for extended periods without degrading in quality. Additionally, CSIP infrastructure should be proactively maintained and replaced in order to continue reliable water delivery. Aging or neglected infrastructure can lead to catastrophic problems. The distribution system is critical, now that so many CSIP growers rely on it. Due to the fact that many of the growers' wells are too saline and no longer in production, the CSIP distribution system has to be kept functional and efficient.

Another beneficial suggestion for the betterment of CSIP is to develop and administer a Supervising Grower Program. The intent of such a program is similar to the Well User Program for the SRGB. CSIP could require a "supervisor" or "contact" to be the liaison for a particular farm, or at a point of connection, to the water distribution system, also referred to as a turnout. This contact would become a means for CSIP to communicate directly with the appropriate growers in a timely manner regarding the distribution system or other related subject matter. The program could also require that the contact person participate in specific training and/or fill out annual reports or pertinent surveys regarding CSIP. Depending on the design of the program, it could allow for more open and transparent communication between the growers and CSIP agencies. Respondents were very vocal about their desire to obtain more information regarding specific details prior to answering questions. A consistent channel for disseminating this information could support water management strategies into the future. It would also behoove CSIP stakeholders and policymakers to stay apprised of the demographic make up of growers, and disseminate information that reflects their needs before initiating and administering a program.

The last recommendation is for CSIP to compare its policies and procedures with other similar agencies. This can prove to be very helpful, either to get assistance with making more effective choices, or to avoid the failure of an unsuccessful or inefficient decision. The Pajaro Valley Water Management Agency (PVWMA) is the ideal agency with which CSIP can compare and contrast water management strategies. PVWMA is located less than 50 miles north of CSIP along the coast, and manages many issues and scenarios similar to those dealt with by CSIP. The PVWMA is a distribution system that delivers water to growers, similar to CSIP, while blending recycled water with other water sources in order to mitigate seawater intrusion and offset groundwater pumping. While the physical distance between the two agencies is relatively small, sharing water supplies is currently impractical due to pumping costs to transport the water, as well as the dearth of adequate infrastructure for the task.

The cost associated with majority of the aforementioned recommendations will likely be enormous, and some may be determined to be ineffective or implausible. Water management decisions must also incorporate the associated impacts to the environment, including seawater intrusion, along with the potential for triggering increased oversight of growers. Complex water management strategies are much easier to discuss in hypothetical terms than to implement in the real world. Nonetheless, in light of the intense drought that growers just endured, the recommended investments can be viewed as offering a two-fold benefit. First, securing a more sustainable water supply and continuing to deliver water via a reliable distribution system proactively brings piece-of-mind in the present. Second, the future benefits of the investments include lowering the likelihood of water shortages, decreasing the potential for increased oversight like water rationing, avoiding preventable failures of the water distribution system, and forestalling advancement of seawater intrusion.

Literature Cited

Adewumi, J.R., Ilemoblade, A.A., and Van Zyl, J.E. (2010). Treated wastewater reuse in South Africa: Overview, potential and challenges. *Resources, Conservation, and Recycling*, 55, 221-231.

Anderson, J. (2000). The environmental benefits of water recycling and reuse. *Water Science and Technology*, 3(4), 1-10.

Areavibes (2017). Castroville, CA Weather. Retrieved June 4, 2017. http://www.areavibes.com/castroville-ca/weather/

Arias, M. (2011). *Developing Criteria and Metrics for Assessing Recycled Water Program Effectiveness* (Master's Thesis). San Jose State University Scholarworks. Paper 4118.

Asano, T., & Cotruvo, J.A. (2004). Groundwater recharge with reclaimed municipal wastewater: health and regulatory considerations. *Water Research*, 38, 1941-1951.

Babbie, E. (2001). *The Practice of Social Research*. Chapman University: Wadsworth Publishing Company.

Babbie, E. (1998). *The Basics of Social Research*. Chapman University: Wadsworth Publishing Company.

Bakopoulou, S., Polyzos, S., & Kungolos, A. (2007). Investigation of farmers' willingness to pay for using recycled water for irrigation in Thessaly region, Greece. *Desalination*, 250, 329-334.

Brown and Caldwell (2015, December 10). *Executive Summary: State of the Salinas River Groundwater Basin report*. Retrieved June 4, 2017. http://www.co.monterey.ca.us/home/showdocument?id=19588

Brown and Caldwell (2016, January 16). *State of the Salinas River Groundwater Basin report*. Retrieved June 4, 2017. http://www.co.monterey.ca.us/home/showdocument?id=19586

Carr, G., Potter, R.B., & Nortcliff, S. (2011). Water reuse for irrigation in Jordan: Perceptions of water quality among farmers. *Agricultural Water Management*, 98, 847-854.

CAWSI (2017). California Agricultural Water Stewardship Initiative. Use of Municipal Recycled Water. Retrieved June 4, 2017. http://agwaterstewards.org/practices/use_of_municipal_recycled_water/

Chang, D., & Ma, Z. (2012). Water reclamation and reuse in Beijing: Influence factors and policy implications. *Desalination*, 297, 72-78.

Chartzoulakis, K.S., Paranychianakis, N.V., & Angelakis, A.N. (2001). Water resources management in the Island of Crete, Greece, with emphasis on the agricultural use. *Water Policy*, 3, 193-205.

Chen, Z., Ngo, H.H., & Guo, W. (2012). A critical review on sustainability assessment of recycled water schemes. *Science of the Total Environment*, 426, 13-31.

City of San Diego (2017). Water Purification Demonstration Project. Retrieved June 4, 2017. https://www.sandiego.gov/water/purewater/demo

City of San Diego Public Utilities Department (2017). *Water Purification Demonstration Project*. Retrieved June 4, 2017. https://www.sandiego.gov/sites/default/files/legacy/water/pdf/purewater/prdemo.pdf

Department of Toxic Substances Control (2017). Laws, Regulations and Policies. Retrieved June 4, 2017. http://www.dtsc.ca.gov/LawsRegsPolicies/Title22/

Department of Water Resources (2017a). Sustainable Groundwater Management. Retrieved June 4, 2017. http://www.water.ca.gov/groundwater/sgm/

Department of Water Resources (2017b). Critically Overdrafted Groundwater Basins. Retrieved June 4, 2017. http://www.water.ca.gov/groundwater/sgm/cod.cfm

Dimick, D. (2014, August 21). If you think the water crisis can’t get worse wait until the aquifers are drained. *National Geographic*. Retrieved June 4, 2017. http://news.nationalgeographic.com/news/2014/08/140819-groundwater-california-drought-aquifers-hidden-crisis/

Division of Water Resources (1946). State Department of Public Works, California. *Bulletin 52-B: Salinas Basin Investigation Report*

Dolnicar, S., & Schafer, A. (2009). Desalinated versus recycled water: public perceptions and profiles of the acceptors. *Journal of Environmental Management*, 90, 888-900.

Dolnicar, S., Hurlimann, A. & Grun, B. (2011). What Affects Public Acceptance of Recycled and Desalinated Water. *Water Research*, 45, 933-943.

Dutta, V., & Tiwari, A.P. (2005). Cost of services and willingness to pay for a reliable urban water supply: a study from Delhi, India. *Water Science and Technology: Water Supply*, 5(6), 135-144.

Engineering-Science (1987, April). *Monterey Wastewater Reclamation Study for Agriculture – Final Report* (1987, April) Prepared for Monterey Regional Water Pollution Control Agency by Engineering-Science. Retrieved June 4, 2017. http://www.mrwpca.org/docs/about/mwrsa.pdf

Famiglietti, J.S. (2014, November). The global groundwater crisis. *Nature Climate Change*, 4, 945-948. Retrieved June 4, 2017. https://webfiles.uci.edu/jfamigli/Website/Famiglietti-NCC-291014.pdf

Famiglietti, J.S. (2016, April 16). Is the California drought America's water wake-up call? *Los Angeles Times*. Retrieved June 4, 2017. http://www.latimes.com/opinion/op-ed/la-oe-famiglietti-chronic-water-scarcity-20160417-story.html

Feldsher, T.B. & Wu, J. (2010). United States Society on Dams. *Geotechnical design and construction of the Salinas River Diversion Facility*.

Garcia, S., Guérin-Schneider, L., & Fauquert, G. (2005). Analysis of water price determinants in France: cost recovery, competition for the market and operator's strategy. *Water Science and Technology: Water Supply*, 5(6), 173-181.

Gerring, J. (2007). Case study research: principles and practices. Cambridge University Press.

Gleick, P. (1998). Water in crisis: paths to sustainable water use. *Ecological Applications*, 8(3), 571-579.

Gunatilake, H., Yang, J., Pattanayak, S., & Choe, K.A. (2007). Good practices for estimating reliable willingness-to-pay values in the water supply and sanitation sector. *Asian Development Bank*, 1-53.

Haddad, B. (2002). Monterey County Water Recycling Project: Institutional Study. *Journal of Water Resources Planning and Management*, 128(4), 280-287.

Hamilton, A.J., Boland, A., Stevens, D., Kelly, J., Radcliffe, J. Ziehrl, A., Dillon, P., & Paulin, B. (2005). Position of the Australian horticultural industry with respect to the use of reclaimed water. *Agricultural Water Management*, 71, 181-209.

Hartley, T.W. (2006). Public perception and participation in water reuse. *Desalination*, 187, 115-126.

Heir, O. (2016, May 20). Artificial recharge of groundwater with recycled municipal wastewater in the Pajaro Valley. University of San Francisco at Gleeson Library. Paper 344. Retrieved June 4, 2017. http://repository.usfca.edu/cgi/viewcontent.cgi?article=1362&context=capstone

Hurlimann, A., & Dolnicar, S. (2011). Voluntary relocation – An exploration of Australian attitudes in the context of drought, recycled and desalinated water. *Global Environmental Change*, 21, 1084-1094.

Intellicast (2017). Castroville, California. Retrieved June 4, 2017. http://www.intellicast.com/Local/History.aspx?location=USCA0196

Jackson, R.B., Carpenter, S.R., Dahm, C.N., McKnight, D.M., Naiman, R.J., Postel, S.L., & Running, S.W. (2001). Water in a changing world. *Ecological Applications*, 11(4), 1027-1045.

James, I., Effers, S., & Reilly S. (2015, December 10). Pumped dry: The global crisis of vanishing groundwater. *The Desert Sun*. Retrieved June 4, 2017. http://www.desertsun.com/pages/interactives/groundwater/

Johnson, J. (2015, March 11). Revised Carmel River cutback proposal would ease restrictions. *Monterey Herald*. Retrieved June 4, 2017. http://www.montereyherald.com/article/NF/20150311/NEWS/150319937

Khan, S.J., & Gerrard, L.E. (2006). Stakeholder communications for successful water reuse operations. *Desalination*, 187, 191-202.

Kiparsky, M., Owen, D., Nylen, N.G., Christian-Smith, J., Cosens, B., Doremus, H., Fisher, A., and Milman, A. (2016, March). Designing effective groundwater sustainability agencies: Criteria for evaluation of local governance options. *U.C. Berkeley School of Law, Center for Law, Energy & the Environment*. Retrieved June 4, 2017. https://www.law.berkeley.edu/wp-content/uploads/2016/02 /CLEE_GroundwaterGovernance_2016-03-08.pdf

Lathashri, U.A. & Mahesha, A. (2015). Simulation of saltwater intrusion in a coastal aquifer in Karnataka, India. *Aquatic Procedia*, 4, 700-705.

Leahy, T. C. (2016, January). Desperate times call for sensible measures: The making of the California Sustainable Groundwater Management Act. *Golden Gate University Environmental Law*, 9(1), 1-36. Retrieved June 4, 2017. http://www.ocwd.com/media/3986/desperate-times-call-for-sensible-measures.pdf

Levin, R.B., Epstein, P.R., Ford, T.E., Harrington, W., Olson, E., & Reichard, E.G. (2002). U.S. drinking water challenges in the twenty-first century. *Environmental Health Perspectives*, 110(1), 43-52.

Loáiciga, H.A., Pingel, T.J., & Garcia, E.S. (2012). Sea water intrusion by sea-level rise: scenarios for the 21st century. National GroundWater Association. *Ground Water*, 50(1), 37-47.

MacDonald, D.H., & Dyack, B. (2004). Exploring the institutional impediments to conservation and water reuse – National issues. Report for the Australian Water Conservation and Reuse Research Program. *CSIRO Land and Water*, 1-29.

Macgregor, C.J., & Warren, C.R. (2006). Adopting sustainable farm management practices within a Nitrate Vulnerable Zone in Scotland: The view from the farm. *Agriculture, Ecosystems and Environment*, 113, 108-119.

Mazi, K., Koussis, A.D., & Destouni, G. (2013). Tipping points for seawater intrusion in coastal aquifers under rising sea level. *IOP Publishing Ltd*. Environmental Research Letters, 8(1), 1-6.

Monterey County Water Resources Agency (2015, March 10)[a]. *CASGEM monitoring plan for high and medium priority basins in the Salinas Valley Groundwater Basin*. Salinas, CA.

Monterey County Water Resources Agency (2015, October)[b]. *Groundwater extraction summary report*. Salinas, CA.

Monterey County Water Resources Agency (2016, April). *Interlake Tunnel and Spillway Modification Project*. Salinas, CA. Retrieved June 4, 2017. http://www.co.monterey.ca.us/home/showdocument?id=18922

Monterey County Water Resources Agency (2017)[a]. Board of Directors. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/2016-board-of-directors/overview#wra

Monterey County Water Resources Agency (2017)[b]. Dams and Reservoirs. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/dams-and-reservoirs#wra

Monterey County Water Resources Agency (2017)[c]. Hydrogeologic Reports. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/documents/hydrogeologic-reports#wra

Monterey County Water Resources Agency (2017)[d]. Interlake Tunnel. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/interlake-tunnel#wra

Monterey County Water Resources Agency (2017)[e]. Monterey County Water Recycling Projects (CSIP/SVRP). Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/castroville-seawater-intrusion-project-salinas-valley-reclamation-project-csip-#wra

Monterey County Water Resources Agency (2017)[f]. Ordinances. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/ordinances#wra

Monterey County Water Resources Agency (2017)[g]. Salinas River Diversion Facility (SRDF). Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/salinas-river-diversion-facility-srdf#wra

Monterey County Water Resources Agency (2017)[h]. Seawater intrusion monitoring. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/programs/seawater-intrusion-monitoring#wra

Monterey County Water Resources Agency (2017)[i]. Sustainable Groundwater Management Act. Retrieved June 4, 2017. http://www.co.monterey.ca.us/government/government-links/water-resources-agency/programs/sustainable-groundwater-management-act#wra

Menegaki, A.N., Hanley, N., & Tsagarakis, K.P. (2007). The social acceptability and valuation of recycled water in Crete: A study of consumers' and farmers' attitudes. *Ecological Economics*, 62, 7-18.

Mojid, M.A., Wyseure, G.C.L., Biswas, S.K., & Hossain, A.B.M.Z. (2010). Farmers' perscptions and knowledge in using wastewater for irrigation at twelve peri-urban areas and two sugar mill areas in Bangladesh. *Agricultural Water Management*, 98, 79-86.

Monterey Regional Water Pollution Control Agency (2015). Castroville Seawater Intrusion Project water use data, 1999-2015. Used with permission.

Monterey Regional Water Pollution Control Agency (2017)[a]. MRWPCA History. Retrieved June 4, 2017. http://www.mrwpca.org/about_history.php

Monterey Regional Water Pollution Control Agency (2017)[b]. Public Meetings. Retrieved June 4, 2017. http://mrwpca.org/about_governance_public_meetings.php

Monterey Regional Water Pollution Control Agency (2017)[c]. Recycled Water. Retrieved June 4, 2017. http://www.mrwpca.org/about_facilities_water_recycling.php

Monterey Regional Water Pollution Control Agency (2017)[d]. Wastewater Treatment. Retrieved June 4, 2017. http://www.mrwpca.org/about_facilities_treatment.php

Monterey Regional Water Pollution Control Agency (2017)[e]. Water Quality Data and Studies. Retrieved June 4, 2017. http://www.mrwpca.org/about_facilities_water_quality.php

National Aeronautics and Space Administration (2011, October 26). *What are climate and climate change?* Retrieved June 4, 2017. https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-climate-change-58.html

Po, M., Kaercher, J.D., and Nancarrow, B.E. (2003). Literature Review of Factors Influencing Public Perceptions of Water Reuse. *CSIRO Technical Report 54/03*. Australia: Author.

Po, M., Nancarrow, B.E., Leviston, Z., Porter, N.B., Syme, G.J., & Kaercher, J.D. (2005). Predicting community behaviour in relation to wastewater reuse: What drives decisions to accept or reject? *Water for a Healthy Country National Research Flagship*. CSIRO Land and Water: Perth.

Priyanka, B.N., and Mahesha, A. (2015). Parametric studies on saltwater intrusion into coastal aquifers for anticipate sea level rise. *Aquatic Procedia*, 4, 103-108.

Pajaro Valley Water Management Agency (2017). Retrieved June 4, 2017. http://www.pvwma.dst.ca.us

Pure Water Monterey (2017). A groundwater replenishment project. Retrieved June 4, 2017. http://purewatermonterey.org/about-us/

Rea, L. M., & Parker, R. A. (2005). Designing & Conducting Survey Research A Comprehensive Guide. Jossey-Bass.

Reis, H.T. & Judd, C. M. (2000). Handbook of research methods in social and personality psychology. Cambridge University Press

Riper, C.V., & Geselbracht, J. (1999). Water reclamation and reuse. *Water Environment Research*, 71(5), 720-728.

Raines, Melton & Carella, Inc. (2002, February) *Revised Basin Management Plan*. Retrieved June 4, 2017. http://www.pvwma.dst.ca.us/about-pvwma/assets /bmp_2000/2002_BMP_Complete_Document.pdf

Sheikh, B., Cooper, R.C., & Isreal, K.E. (1999). Hygienic evaluation of reclaimed water used to irrigate food crops – A case study. *Water Science and Technology,* 40(4-5), 261-267.

Sheikh, B., Cort, R. P., Kirkpatrick, W.R., Jaques, R.S., & Asano, T. (1990). Monterey wastewater reclamation study for agriculture. Research Journal of the Water Pollution Control Federation, 62(3), 216-226.

Sherif, M.M., & Singh, V.P. (1999). Effect of climate change on sea water intrusion in coastal aquifers. *Hydrological Processes*, 13(8), 1277-1287.

Smith, R.G. (1995). Water reclamation and reuse. *Water Environment Research*, 67(4), 488-495.

Strauss, A., and Corbin, J. (1998). Basics of Qualitative Research. Sage Publications, Inc.

State Water Resources Control Board (2017)[a]. Financial Assistance Funding – Grants and Loans (Proposition 1). Retrieved June 4, 2017. http://www.waterboards.ca.gov/water_issues/programs/grants_loans/proposition1.shtml

State Water Resources Control Board (2017)[b]. Recycled Water – Constituents of Emerging Concern (CECs). Retrieved June 4, 2017. http://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/recycledwater_cec.shtml

Thead, E.A. (2016, October). Sea level rise: risk and resilience in coastal cities. *Climate Institute*. Retrieved June 4, 2017. http://climate.org/sea-level-rise-risk-and-resilience-in-coastal-cities/

Thomas, G. (2011). How to do your case study: a guide for students and teachers. Sage Publications, Inc.

Tsagarakis, K.P., & Georgantzis, N. (2003). The role of information on farmers' willingness to use recycled water for irrigation. *Water Science and Technology,* 3(4), 105-113.

Walton, B. (2015, September 23). Here comes the Sea: The struggle to keep the ocean out of California's coastal aquifers. *Circle of Blue*. Retrieved June 4, 2017. http://www.circleofblue.org/2015/world/here-comes-the-sea-the-struggle-to-keep-the-ocean-out-of-californias-coastal-aquifers/

Yin, R. (2014). Case study research: design and methods. Sage Publications, Inc.

Appendix: Interview Questionnaire

I. Background and demographics

A. Name

B. Gender

C. What is your age?

D. What is your income level?

E. What is your highest level of education?

____ did not graduate high school
____ high school diploma
____ GED
____ some college
____ Bachelor’s Degree
____ some graduate college
____ Master’s Degree
____ PhD or greater

F. Are you a Leasing Manager or Owner (or both) in the CSIP service area?

1. How many farms?
2. What are the names of the farm(s)?
3. Location of your farm(s) *(shade or circle farms on attached map)*
4. Approximate size of farm(s)
5. How many years total have you been at your current farm(s)?
6. How many years total have you been in the farming industry?
7. What crops have been grown on your farm(s) for the last 2 years?
8. What crops will be grown on your farm(s) in the next year?
9. Do you have any private wells that are still active and functional?

    9A. If so, are you using the well water?

    9B. If so, is CSIP using the well water?

10. Who are your main customers for your crops?
11. Do you consider yourself to be an organic farmer or a conventional farmer?
12. Are your farms certified as organic?

13. What are the two highest concerns for you regarding water quality?
14. How many years total have you had experience with using recycled water for crop irrigation?
15. What percentage of your water used to irrigate crops was recycled water?
16. Have you had experience with using desalinated water for crop irrigation?
    - 16a. If so, how many years?
    - 16b. If so, what percentage of the water used was desalinated?

II. Likert scale statements

1. Information regarding the CSIP is readily available and given in a timely manner.

    _____ strongly disagree
    _____ somewhat disagree
    _____ neutral
    _____ somewhat agree
    _____ strongly agree

2. Communication is acceptable (and positive overall) between the growers and CSIP's policymakers and stakeholders.

    _____ strongly disagree
    _____ somewhat disagree
    _____ neutral
    _____ somewhat agree
    _____ strongly agree

3. Trust levels are acceptable (and positive overall) between the growers and CSIP's policymakers and stakeholders.

    _____ strongly disagree
    _____ somewhat disagree
    _____ neutral
    _____ somewhat agree
    _____ strongly agree

4. There needs to be more proactive work regarding the saltwater intrusion problem in the Salinas River Valley Watershed.

    _____ strongly disagree
    _____ somewhat disagree
    _____ neutral
    _____ somewhat agree
    _____ strongly agree

5. CSIP needs to be more proactive with policies and procedures to become more "grower friendly," and have the growers in their best interest.

    _____ strongly disagree
    _____ somewhat disagree
    _____ neutral
    _____ somewhat agree
    _____ strongly agree

III. Open-ended questions

1. Which is a greater concern for you:

    CSIP's current water quality or CSIP's water supply?

    1A. Why?

2. How do you feel about using recycled water to irrigate your crops?

    2A. Is there a better alternative source of water?

    2B. Do you think the use of recycled water negatively impacts your customer's attitude about your crops?

3. How do you feel about using recycled water to recharge groundwater during winter months and redrawing it at a later date?

4. If given a choice between using recycled water or desalinated water which would you choose?

    4A. Why?

    4B. What if the cost were the same for either choice?

    4C. What if the cost was 10% less for the option not chosen?

5. What are your thoughts about implementing the use of desalinized water to augment the CSIP supply and blending that with existing sources?

    5A. Does the amount of energy required to desalinate water make you more or less accepting of its use as your water source?

    5B. Do the environmental impacts required to desalinate water make you more or less accepting of its use as your water source?

6. How do you feel about increasing water storage to have a surplus during low demand and a reserve for high demand times?

    6A. Would you be willing to establish private water storage on your property if there was an incentive by CSIP?

    6B. Or should the assessment fees be adjusted for the growers based on who participates or not?

7. Do you consider your watering practices to be efficient?
    - 7A. Would you participate in following Best Management Practices guidelines concerning water conservation?
    - 7B. Would you participate in a water budget program?
    - 7C. Would you be willing to plant different crops to be more efficient with water use?
    - 7D. Do you prefer a rewards (incentive) or a consequence (disincentive) fee structure for growers?
8. What alternative sources are you aware of that CSIP is debating to implement and use?
    - 8A. Which source is your preference to implement and use?
    - 8B. Why?
9. Regarding environmental impacts of concern due to farming practices, which do you feel is the highest priority for a grower?
    - 9A. Which impact of concern is the lowest priority for a grower?
10. Do you believe that growers have a different relationship with the land and the environment than those who do not farm?
11. How do you feel about the saltwater intrusion problem along the coast?
    - 11A. What do you think is the best way to address and manage the problem?
12. What policy or operation of the CSIP distribution system has the highest priority and need for change?
13. What is your greatest concern with the CSIP distribution system now, and in the near future?

Additional Comments and/or Concerns: