AN ABSTRACT OF THE THESIS OF

Cally A. Whitman for the degree of Master of Science in Water Resource Policy and Management presented on May 29, 2013.

Title: Identification of Economic, Social, and Policy Factors Influencing Irrigation District Participation in Water Transactions in the Deschutes Basin.

Abstract approved:

William T. Jarvis

Surface water in the Deschutes Basin of central Oregon has been largely over allocated since the early 1900s. Therefore, rapid population growth and urban demand for water in the upper Basin lead to an increased reliance on groundwater in the last three decades. The Oregon Department of Water Resources (OWRD) became concerned in the mid-1990s that groundwater pumping was negatively affecting senior water rights in the lower Deschutes Basin. A USGS study determined that there is a hydrologic connection between the upper and lower portions of the Deschutes Basin. As a result, OWRD banned further groundwater pumping without mitigation in the Basin. In an effort to allow further groundwater development and improve streamflows a coalition of local water users and State government personnel developed the Deschutes Groundwater Mitigation Program (DGMP). The DGMP is a voluntary market-based approach to water management that allows water rights holders to transfer excess water instream, which creates mitigation credits that other water users can purchase to offset new groundwater uses.

Senior water rights holders in the Basin are primarily irrigation districts. This research uses the Institutional Analysis and Development (IAD) framework to determine the physical, cultural and institutional factors that influence irrigation district participation in water transactions and the relationships between different levels of decision-making in the Deschutes Basin. Research participants were asked

to describe the relationships and interactions between operational decisions, policy formation decisions and constitutional decisions in the Deschutes Basin. Data was collected through open-ended interviews with Basin irrigation districts and a broad section of other water managers (State agencies, environmental advocacy groups, tribes, hydrogeological consultants, landowners and municipalities), and then qualitatively coded to identify important themes and relationships.

Results from the operational level of analysis indicate that irrigation districts are primarily motivated by a fiduciary responsibility to their patrons. Water transfers and leases are seen as tools that can mitigate the negative consequences of urbanization and avoid enforcement of environmental regulations related to the reintroduction of anadromous fish into the Deschutes River. Conservation projects help boost instream flows and allow irrigation districts to improve their water supplies and reduce costs. At the policy level of analysis, research participants recognized the value of collaboration in developing shared goals and mutually beneficial water management policies. However, they expressed concerns about the functionality of regional water management organizations. *Fort Vannoy v. OWRD*, was a 2008 Oregon Supreme Court case that decided who has access to participate in the Deschutes Groundwater Mitigation Bank (DGMB). This was as a constitutional level decision that determined irrigation districts are holders of water right certificates, not landowners, and irrigation districts have the right to determine if excess agricultural water can be transferred to another use in the Basin. These results suggest that there are issues of access and equity within the Deschutes Basin that need to be further examined.

Identification of Economic, Social, and Policy Factors Influencing Irrigation District Participation in Water Transactions in the Deschutes Basin.

by

Cally A. Whitman

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APPROVED:

Major Professor, representing Water Resource Policy and Management

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Director of the Water Resource Graduate Program

Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of the Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Cally A. Whitman, Author

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CHAPTER 1. INTRODUCTION

Water management in the western United States is going through a period of transition. Old water management paradigms were based on the belief that all water should be used for beneficial use, which resulted in patterns of over allocation in many western basins (Anisfeld, 2010). There is also an increased demand for water to meet growing western populations. Both of these trends are coming into conflict with the physical limitations of the arid western landscape to provide water for new uses, and increasingly stringent environmental management regulations (Figure 1). As a result, there is potential for conflict between water users. Despite the potential for conflict, many regions in the western United States have successfully developed coping strategies that simultaneously meet the water needs of the environment, the people, and agriculture, while still respecting the rights of senior water rights holders. These strategies can include conservation projects and water transactions between water rights holders and those that have unmet water demands. This study seeks to examine how senior water rights holders view these strategies and what factors encourage or discourage their voluntary participate in these strategies.

In this case study, water transactions are defined as any agreement between two or more parties that shifts water to another use. [1] Transactions can include permanent transfers of water rights to other uses, or temporary leases of water. Water transactions can occur in open markets under the assumption of supply and demand (Jaeger, 2005). Water transactions can also occur in closed markets with limited numbers of acceptable buyers and sellers. Two different types of intermediaries can facilitate water transactions. Water banks operate as trading platforms that enable buyers and sellers to find each other and help the buyers and sellers gain regulatory approval for the transaction. Water brokerages work on behalf of a client (either a seller or a buyer) to find trading partners and facilitate the

[1] Acronyms and key terms are located in Appendix 1.

water transaction (ACCC, 2010). These terms are not used precisely in western water management. An organization can call itself a bank but function as a brokerage, or the organization can operate with aspects of both banks and brokerages. As a result, this study will refer to water transactions unless discussing a specific water transfer mechanism or organization.

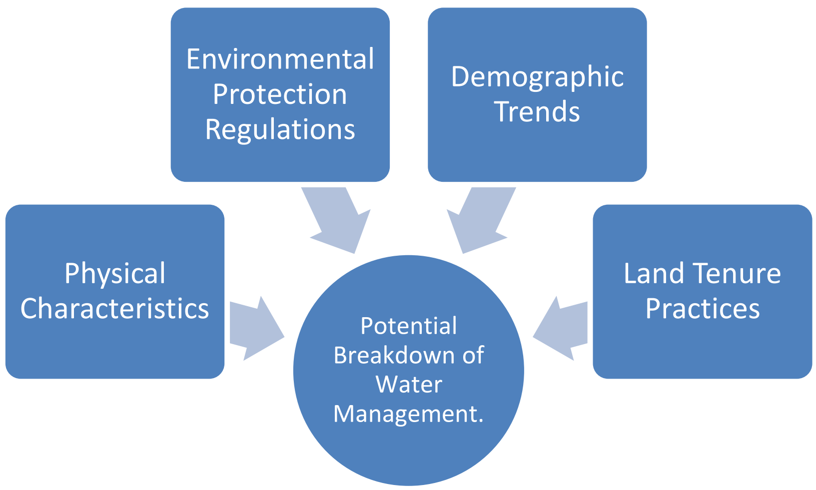

Figure 1. Intersecting trends in western water management

Research Goals

This study seeks to provide insight into the larger issue of managing water resources for multiple uses, while respecting senior water rights, by focusing on the Deschutes Basin, located in central Oregon. This Basin has experienced many of the same trends as the rest of the western United States. Surface water in the Deschutes Basin has been fully appropriated since the early 1900s, with the majority of the senior water rights belonging to irrigation districts (Bastasch, 2006). In the last thirty years, the upper Deschutes Basin has experienced rapid population growth resulting in increased urban population and a decrease in farm size (U.S. Census Bureau, 2012) (USDA, 2007).

Irrigation districts are the focus of this case study in the Deschutes Basin because they hold the majority of the senior water rights in the Basin.

Three central research topics are presented here:

1) Variables that encouraged or enabled irrigation districts' voluntary participation in water transactions.
2) Variables that discouraged or inhibited irrigation districts' voluntary participation in water transactions.
3) Identification of action arenas and the relationships between multiple action arenas and actors.

CHAPTER 2. CONCEPTUAL FRAMEWORK GUIDING RESEARCH

The Institutional Analysis and Development (IAD) framework is a public policy conceptual framework that provides insight into the relationships between institutions that govern the action and outcomes within collective action arrangements. In this case, institutions are defined as a set of prescriptions and constraints that humans use to organize all forms of repetitive and structured interactions. IAD is a particularly useful framework to apply to this study because it gives equal weight to formal and informal institutions in the decision making process. IAD also provides a framework for exploring the relationships between nested rules at different levels of organization. This level of conceptual flexibility and complexity allows for a more nuanced and systematic analysis of the variables that influence irrigation district participation in water transactions in the Deschutes Basin.

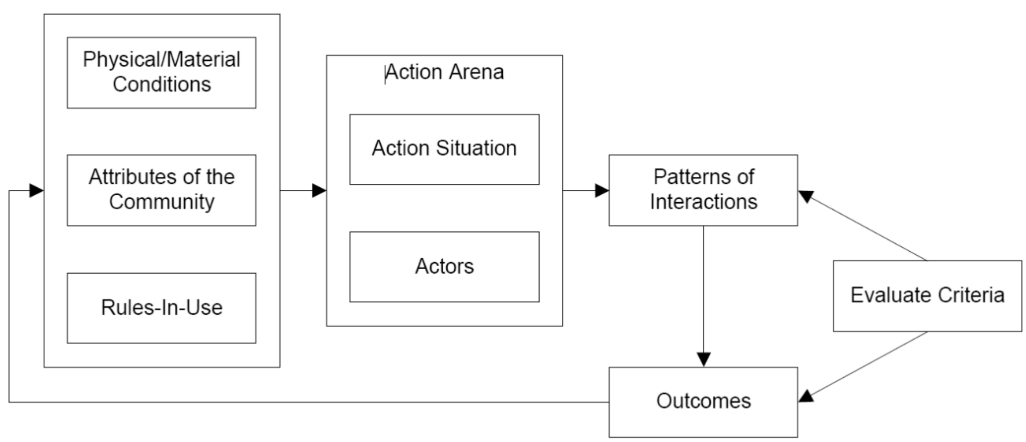

Figure 2. Conceptual Map of the IAD Framework (Sabatier, 2007)

At the center of the IAD framework is the action arena, which can be utilized to analyze, predict or explain behavior within institutional arrangements (Ostrom, 2005). Action arenas are social spaces where individuals interact, trade, cooperate, compete, etcetera. Action arenas are composed of actors and the action situation. Actors can be individuals or groups of individuals acting as one and they create the outcomes of the action arena. The variables used to evaluate actors are: 1) their resources, 2) their values or preferences for different actions, 3) their information processing capabilities, and 4) the processes they use for selecting a particular action. Due to the complex, uncertain nature of natural resource management, actors are assumed to make choices using bounded rationality. Bounded rationality contends that individuals cannot make optimal decisions because they lack complete information about all possible alternatives and outcomes, have imperfect information processing capabilities, and limited time to make decisions. Instead, decision makers seek satisfactory decisions that meet minimum requirements (Simon, 1991). Action situations are analytical concepts that isolate the immediate institutions affecting a decision, process or outcome. There are seven variables that characterize action situations: 1) participants in the situation, 2) participants' positions, 3) the outcomes of decisions, 4) the costs and benefits associated with outcomes, 5) the connection between actions and outcomes, 6) the participants' control in the situation, and 7) information (Ostrom, 2007).

The action arena is independently influenced by three categories of variables: the rules-in-use, the attributes of the community, and the physical and material conditions of the environment within which the community acts. Rules-in-use are the formal and informal institutions that organize relationships between actors and govern their behavior in the action arena. They can include both organizations and the rules, norms and strategies adopted by individuals operating within an organization (Ostrom, 2005). The attributes of the community consists of socially acceptable behavioral norms, access to resources, quantity of common understanding between actors and homogeneity of preferences for outcomes. The rules-in-use and the attributes of the community combine to give structure to the action arena, while the physical and material characteristics of the environment places limits on the possible outcomes.

Outputs of the action arena are outcomes and patterns of interactions. According to Ostrom, the IAD framework can be used for theoretical analysis to predict outcomes or empirical analysis to evaluate the effectiveness of outcomes. The predictive capacity of the IAD framework is dependent on the assumptions of complete information, limited choices, and clearly defined cost and benefits of outcomes. These assumptions cannot be applied to all action arenas, so a more universally effective use of the IDA framework is empirical analysis. There are multiple parameters that can be used to evaluate outcomes and patterns of behavior including economic efficiency, fiscal equity, redistributional equity, accountability, conformance to general morality, and adaptability (Sabatier, 2007).

In addition to identifying variables that explain collective choices, the IAD framework also identifies three levels of institutional analysis: the operational level, the collective-choice level, and the constitutional level. The operational level of analysis focuses on generating practical outcomes in the world. Operational rules direct how individuals make collective decisions about day-to-day activities by focusing on appropriation provision, monitoring and enforcement processes. At the policy level, decision-makers form policy bounded by collective-choice rules and focus on management and adjudication processes. Collective-choice rules focus on selecting mutually acceptable operational rules and dictating who is eligible. The constitutional level of analysis focuses on formulation, governance, adjudication and rule modification processes. Constitutional choice rules determine the authorized actors for collective-choice decisions and the rules governing those decisions. Action arenas and decision-making organizations frequently operate at more than one level of institutional analysis. Therefore, these three levels are linked together and interdependent.

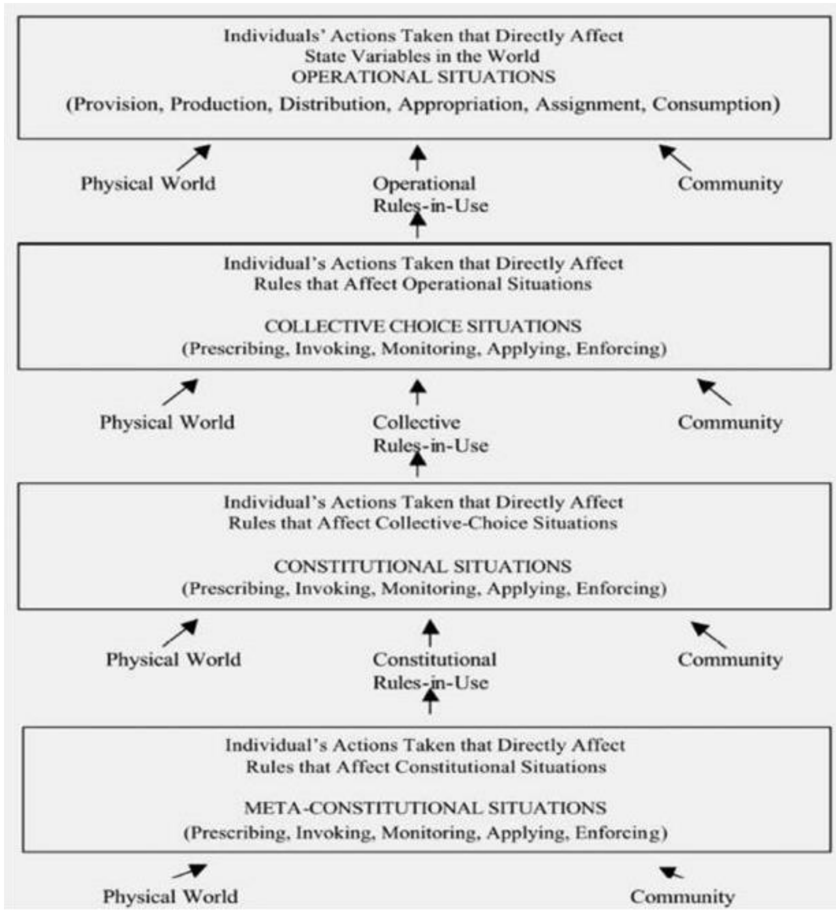

Figure 3. Levels of Analysis and Outcomes (Sabatier, 2007)

Applying the IAD Framework to this Case Study

The IAD framework shaped this study in multiple ways. First, the background information in the following chapters correlates to the three categories that influence the action arena. There are sections describing the physical characteristics and demographic trends of the Deschutes Basin that correspond to the physical and material conditions of the community. The section on land tenure practices in the Deschutes Basin explores both the attributes of the community and some of the rules-in-use that effect water in the Basin. The section on environmental protection concerns in the Deschutes Basin focuses on some of the more recent rules-in-form that affect water management. Second, the actors in the action arena are water managers in the Deschutes Basin. While the primary focus of the research is on irrigation districts, a cross section of other water mangers was included to provide multiple viewpoints. Third, the interview questions placed the research participants at the operational level action arena and asked them to describe all the variables that influenced their decisions to participate or not participate in water transactions; including any factors from the collective choice or constitutional levels of analysis. Interviews also examined the relationships between action arenas at different level of analysis. Finally, results are presented as narratives that explicate the important variables associated with specific outcomes.

CHAPTER 3. PHYSICAL CHARATERISTICS OF THE DESCHUTES BASIN

The physical characteristics of the Deschutes Basin not only determine the quantity of water available for use, but also the water's location, seasonality and quality. Climate information can identify productive agricultural land and help to explain land use patterns in the Deschutes Basin. All of this information provides the physical boundaries that shape water management decisions in the Deschutes Basin.

Figure 4. Map of the Deschutes Basin with sub-basins (Deschutes River Conservancy, 2013)

The Deschutes Basin is a 10,484 square mile river basin, the second largest in Oregon, and a major sub-basin of the Columbia River (Bastasch, 2006). The Deschutes Basin is divided into three large regions in this study. The upper Deschutes Basin contains about 4,500 square miles of land that drains into the Deschutes River above the confluence of the Deschutes, Metolius and Crooked Rivers (Lieberherr, 2008). The upper Deschutes contains the cities of La Pine, Bend, Redmond, and Sisters; as well as Swalley Irrigation District (ID), Arnold ID, Central Oregon ID, Three Sisters ID, and Tumalo ID. The Crooked River sub-basin lies to the southeast of the upper Basin and also drains approximately 4,500 square miles. The Crooked sub-basin contains the City of Prineville and Ochoco ID. The lower Deschutes Basin consists of all the land below the confluence of the Deschutes, Metolius and Crooked Rivers and contains the City of Madras, North Unit ID and the Confederated Tribes of Warm Springs Reservation.

The Deschutes Basin is semi arid, with precipitation ranging from 14 to less than 10 inches (NOAA, 2012). Along with the rest of Oregon, the Deschutes Basin experiences a seasonal weather pattern characterized by wet winters and dry summers due to an oscillating jetstream pattern in the Northern Hemisphere over the Pacific Ocean (NOAA, 2009). Nearly half of Oregon's annual precipitation occurs during the winter, with only ten percent falling on the State during the summer months. This seasonal precipitation accumulates in the Cascade Mountains as snow during winter and is stored until spring, delaying the release of water in the Basin.

Elevation in the Deschutes Basin increases from north to south. Warm Springs, in the northern, lower Basin is 1000 feet above sea level, while La Pine, a community in the southern, upper Basin is 4200 feet above sea level (OSU, 2011). According to the Oregon Climate Service, the Deschutes Basin is a cold region with a short growing season. Due to the area's generally high elevation and resulting thin atmosphere it can experience radiational cooling and frosts at any time of the year. Elevation changes within the Basin are also responsible for local variability in temperature, precipitation and growing season. Higher elevations tend to have longer and colder winters and lower night temperatures. In Bend, the growing season averages 82 days and precipitation averages 12.74 inches annually (Western Regional Climate Center, 2005). Redmond, a town ten miles to the north of Bend, has a growing season of 88 days with an average of 8.34 inches annual precipitation (Western Regional Climate Center, 1980). The most productive agricultural land in the Deschutes Basin can be found in the lower Basin (DRC, 2012).

Table 1. Summary of Oregon Climate Data for the Deschutes Basin (Oregon Climate Service)

Location	Annual Mean Precipitation (inches)	Elevation (feet)	Average Growing Season (# days)	Annual Max. and Min. Temp. (^{o}F) (from 1971-2000)
Bend	11.73	3650	80-90	59.2/32.9
La Pine	22.03	4200	70-80	57.6/31.9
Madras	10.26	2230	90-100	64.5/34.1
Prineville	10.49	2840	80-90	63.1/30.5
Redmond	8.00	3060	80-90	61.3/33.8
Sisters	14.19	3280	75-85	59.8/30.1
Sunriver	--	4156	70-80	--
Warm Springs	--	1000	100-110	--

The hydrogeology of the Deschutes Basin shapes the distribution of water across the landscape. This study will only describe the coarsest scale geological formations in the Basin to provide a basic framework for understanding management decisions. However, it is important to note that there is a great deal of finer scale geological variation that shapes water management decisions locally. Fine-scale geologic and topographical variations not captured by the following geologic description do influence water management decisions and could become important during the data analysis and discussion portion of this case study.

The John Day Formation is assumed to underlie all other geologic formations in the Deschutes Basin. This formation dates from the Eocene to early Miocene and consists of rhyolitic ash-flow tuffs, lava flows, tuffaceous sedimentary rocks and vent deposits. The John Day Formation is the least permeable layer of the local geology and acts as a barrier, preventing groundwater from seeping downward (Lite Jr. & Gannett, 2002).

The next oldest formation is the 15.7 million year old Prineville Basalt, that overlies the John Day Formation in the northeast corner of the Deschutes Basin. The Prineville Basalt consists of fractured basalt containing local, small-scale fractures and some inter flow zones. This Formation's groundwater productivity is highly variable on a smaller scale. Water users in this part of the Basin do not always have a reliable groundwater source (Lite Jr. & Gannett, 2002).

The Deschutes Formation overlies the Prineville Basalt and fills an alluvial basin to the southeast of the Prineville Basalt. The Deschutes Formation consists of a variety of deposits including lava flows, ignimbrites, fallout tephra, debris flows, hypeconcentrated flood deposits and alluvium. The Deschutes Formation has a limited geographical sequence and exhibits a heterogeneous sequence. Most importantly, the Deschutes Formation is highly permeable and porous, resulting in plentiful storage of groundwater. An important formation in the Deschutes Formations is a small alluvial deposit near La Pine and serves as a local aquifer under the La Pine community (Lite Jr. & Gannett, 2002).

The youngest formations of interest make up the Cascade Mountains. The Cascade Volcanic Deposits overlie parts of the southern portion of the Deschutes Formation, are less than 1.6 million years old, and consists of lava flows, domes, vent deposits, pyroclastic deposits and volcanic sediments. These formations are highly permeable at shallow depths (Lite Jr. & Gannett, 2002).

Due to the highly permeable, volcanic nature of the Deschutes Basin geology, the main stem of the Deschutes River system is primarily groundwater fed. The snow that accumulates on the slopes of the Cascade Range during the winter is a major source of groundwater recharge in the Deschutes Basin (Gannett, Lite, Morgan, & Collings, 2001). Half of the groundwater from that region daylights in springs at the foothills of the Cascade Range, becoming the headwaters of the Deschutes. Evidence for the groundwater reliant nature of the Deschutes Basin can be found by examining the Deschutes River itself. The Deschutes River is spring fed with few tributaries or ephemeral streams. The Deschutes River also exhibits a remarkably constant flow. Most of the seasonal and annual volumetric fluctuations naturally exhibited by other river systems are absent on the Deschutes because the Cascade Volcanic Deposits are a large groundwater recharge area, with a long retention time. Most of the spikes or dips in precipitation are mitigated by the time groundwater becomes streamflow. The other half of groundwater recharge from the Cascade Mountains becomes deep groundwater that moves through the Deschutes Formation until it comes into contact with the rising, impermeable John Day Formation and is forced to the surface at the confluence of the Crooked, Metolius and Deschutes Rivers, resulting in a rapid volumetric increase of the Deschutes River (Gannett, Lite, Morgan, & Collings, 2001; O'Connor, Grant, & Haluska, 2003).

The portion of the Deschutes Basin overlying the Prineville Basalt experiences a different distribution of water resources than the majority of the region. The Prineville Basalt is less permeable than the Deschutes formation, resulting in a lower proportion of precipitation becoming groundwater and more precipitation becoming surface flows. Productive aquifers are isolated and small. The Crooked River is fed via surface flows and includes an extensive network of perennial and ephemeral streams. The Crooked River hydrograph responds more rapidly to precipitation than the main stem of the Deschutes River with occasional flooding during the spring snowmelt and very low flows during the dry summer months (Gannett, Lite, Morgan, & Collings, 2001).

CHAPTER 4. CHANGING LAND TENURE PRACTICES INFLUENCE ON THE DISTRIBUTION OF WATER IN THE DESCHUTES BASIN

Land tenure defines the relationship people have with land; it includes how a group of people uses natural resources like water and what they value about the landscape. Land tenure is an important part of social, political and economic structures and encompasses both defined and unspoken social, technical, economic, institutional and legal factors. When new groups of people move into a landscape they bring their land tenure beliefs with them, which profoundly impacts how those people reshape the landscape and use its natural resources (Food and Agriculture Organization of the United Nations, 2002). This chapter will explore how the changing land tenure practices of Native Americans, the setters and farmers in the Deschutes Basin and State and Federal water agencies have altered the distribution of water across the landscape and the hydrology of the Basin.

Native American Land Tenure Practices (Pre-1850s)

Historical Native American land tenure practices are important to the current discussion about regional water management for two reasons. First, and most importantly, The Confederated Tribes of Warm Springs value their cultural history and seek to honor that heritage by managing their natural resources respectfully. As water managers with regulatory authority over portions of the lower Deschutes River, they have the authority and leverage to encourage other water users in the Basin to also mange for instream flows and water quality. Second, Native American land tenure practices offer useful tools for improving rangelands in the Basin that in turn improves water availability.

Native American Land Tenure Practices Influence on Surface Water

Prior to 1850, two Native Americans tribes lived in the northern part of the Deschutes Basin; the Warm Springs and Wasco tribes (both tribes are current members of The Confederated Tribes of Warm Springs). They lived along the lower reaches of the Deschutes River near the Cascade Mountains and along the Columbia.

Both tribes relied heavily on salmon fishing to supply their food. Water was at the center of their religion and the rivers and the salmon sustained by the rivers were considered sacred. Fish were highly prized, and were a significant part of the many special festivals and rituals as well as part of the regular Indian diet (Miller & Rose, 1999). Religious feasts like the First Catch (Nusux Sapálwit), or Salmon Feast, in the spring recognized the migration of salmon (Hunn, 1990).

During this period, the Deschutes River system experienced a natural flow regime as described in the previous chapter. While there is no documented record of the hydrology of the Basin for this time, oral histories suggest that the main stem of the Deschutes exhibited relatively constant streamflows consistent with the geology of the Basin. In the Crooked River sub-basin, there is evidence of a natural hydrograph that exhibited high seasonal and annual variation (Hunn, 1990).

Native American Land Tenure Practices Influence on Groundwater

The dry eastern portion of the Deschutes Basin marks the extreme western boundary of the migratory, hunter and gatherer tribes of the Great Plains. One of these tribes was the Paiutes, which would later join the Confederated Tribes of Warm Springs Reservation near Madras. The Great Plains tribes relied on the sagebrush-grasslands to provide grazing for game and edible plants. Paleogeographic and landscape ecologists have discovered that some of these tribes used fire as a management tool. There is debate about why Native American tribes used fire on the landscape. Perhaps it was used to renew the grasslands and improve the quality of forage for game. It is also possible that Native American tribes used fire as a weapon to starve out other bands, or as a tool to flush game (Whitlock & Knox, 2002). Despite the debate about the purpose of Native fire use, the fact remains that while Native Americans had control of the Basin there were more frequent, smaller and less intensive fires across the sagebrush-grasslands.

Fire has an important relationship to groundwater in the Deschutes Basin. Western juniper (*Juniperus Occidentalis*) is a species that is very well adapted to the semiarid and arid conditions found in the lower reaches of the Deschutes Basin. They have extensive and deep root systems that tap into soil moisture far from dry surface soils. Junipers can access water other plants cannot reach and they have higher rates of evapotranspiration compared to grasses or sagebrush. As a result, juniper forests can dry surface soils, drop water tables, increase surface erosion and ultimately reduce surface flows (Fisher, 2004). Native American tribe's use of fire in the Deschutes Basin prevented western juniper forests from expanding into the majority of the Basin because juniper saplings are very sensitive to fire and thrive in partially shaded conditions. Frequent, low intensity fires lit by Native Americans kept the western juniper out of Deschutes Basin by killing saplings before they could become hardier, more fire resistant juvenile trees (Miller & Rose, 1999).

Figure 5 is a block diagram that summarizes both the major hydrogeological features of the Deschutes Basin described in Chapter 3 and provides examples of how Native American land tenure practices influenced plant communities and the distribution of water across the landscape. While this diagram is not to scale and does not include all of the topographical features of the Basin it is a useful tool for examining the relationship between the geology, landscape, water distribution and land tenure practices in the Deschutes Basin.

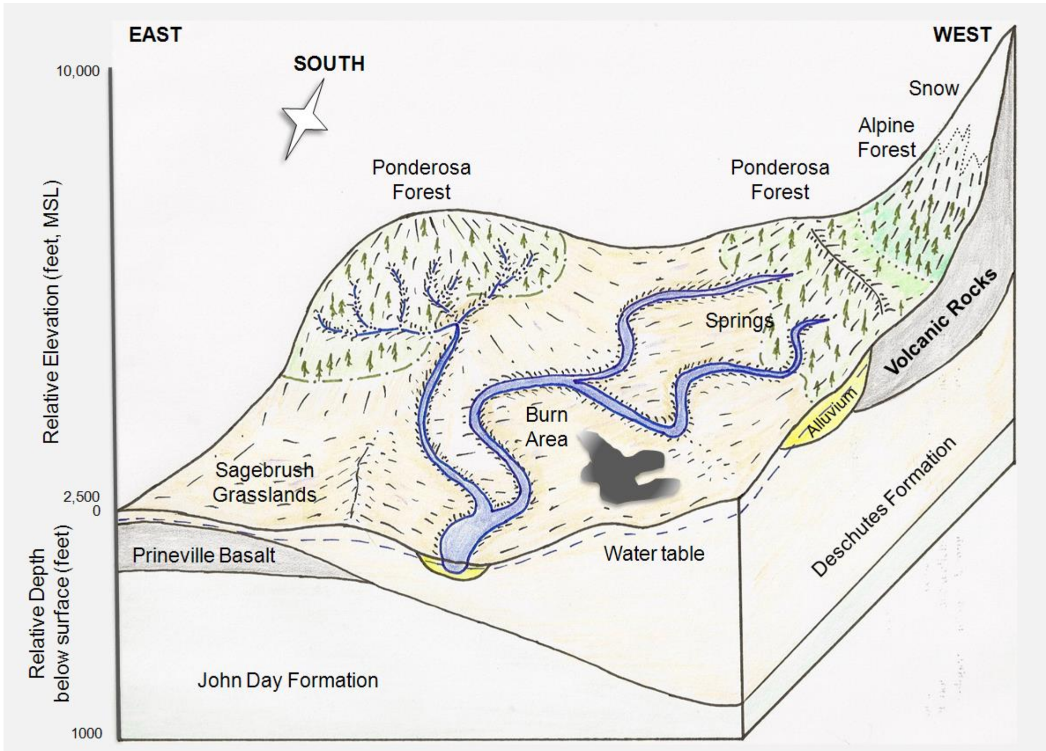

Figure 5. Block Diagram of Pre 1850s Land Tenure Practices influence on Water (Jarvis, 2012)

Oregon Land Tenure Practices (1850s-present)

To the new landowners moving into the Deschutes Basin in the 1850s, water was not sacred. Water was a tool that could be used to produce something of value, but had little inherent value of its own. Landowners felt that any surface water that made it to the sea had been wasted (Bastasch, 2006). To encourage agriculture and economic development, water was diverted from the Deschutes River system to irrigate agricultural land throughout the Deschutes Basin. Redistribution of water for agriculture motivated the creation of storage, changed the quantity and quality of water in the river and changed where groundwater recharge occurred.

Diverting water for beneficial uses was a conflict-filled endeavor for the first 50 years of statehood because Oregon did not have a clearly defined water law until 1909. During that period of time water users inconsistently applied both riparian and prior appropriation doctrines to the distribution of surface water in the Basin. The riparian doctrine was developed in wetter European countries and stated that water was a common property shared by those that have direct access to the stream and those water users were free to use the resource as they wished as long as they did not significantly alter the natural flow of the stream (Anisfeld, 2010). The riparian doctrine was not a successful mechanism for sharing water in the arid western United States because it limited the development of agricultural land that was not adjacent to a surface water source. The prior appropriation doctrine was better adapted to the western United States because it assigned water users a usafructuary right to use a portion of water for a specific purpose regardless of the uses location in relation to the surface water source (Anisfeld, 2010).

At the turn of the twentieth century, the U.S. Reclamation Service was ready to invest in extensive irrigation projects to further develop western agriculture. To qualify for the irrigation project funding, states had to have a functional system of water laws and rights (Autobee, 1996). In 1909, Oregon adopted a water law modeled after other western States that enshrined the prior appropriation doctrine and the concept that water's value was derived from its ability to provide an economic benefit for property owners (Bastasch, 2006).

Water Storage's Influences on Surface Water in the Deschutes Basin

The first example of a private landowner diverting water for agriculture in the Deschutes Basin occurred in 1871 when water was taken from Whychus Creek (previously named Squaw Creek) to irrigate lands west of what is now Redmond (Autobee, 1996). Due to the high cost of building and maintaining irrigation infrastructure there are relatively few examples of private landowners diverting water in the Basin. This is reflected in the very small number of private landowners with surface water rights in the Deschutes Basin (OWRD, 2013).

Instead, the majority of agricultural development in the Basin has been the result of irrigation districts. From 1893-1908, private and unregulated irrigation companies erected irrigation systems in the Deschutes Basin and sold water to farmers under the authority of the Federal Desert Land Act. The Federal Desert Land Act was enacted by Congress on August 18, 1894, with the goal of increasing the disposal of public desert lands by ensuring farmers would have access to irrigation water (Pisani, 2002). These initial diversions consisted of small local projects that allowed for a conversion from grazing to wheat cultivation in the Basin. In 1922, North Unit Irrigation District completed the first successful, medium scale, private irrigation infrastructure project in what is now Crane Prairie, southwest of Bend by building a primitive log-crib rockfill dam. That dam irrigated 40,000 acres but was plagued with leaks.

In 1910, Oregon and U.S. Reclamation Service conducted a feasibility study to identify opportunities to invest in new infrastructure in the Deschutes Basin. The first comprehensive study of all irrigation possibilities in the Basin was released in 1914, and it focused on potential opportunities for storage. However, the U.S. Reclamation Service was reluctant to invest in irrigation infrastructure in the Deschutes Basin because the region was geographically isolated and did not have reliable access to agricultural markets (Autobee, 1996). It was not until after World War I that the U.S. Reclamation Service really became interested in investing in water distribution infrastructure in the Deschutes Basin. This was due to the regions new rail system and increased agricultural output that resulted from a decade of unusually wet weather. The area grew rapidly in the 1920-1930, resulting in a 21 percent increase in the number of farms (USDA, 2012).

During the first half of the 1930s, however, the Deschutes Basin was dealt a number of blows that negatively influenced the region’s agricultural economy. Surface water was fully appropriated in the Basin and there was a severe drought in

1934 that resulted in a complete crop failure. This situation served to highlight the need for a reliable supply of irrigation water and forced local irrigation districts to petition the U.S. Reclamation Service to renovate Crane Prairie Dam. The Bureau of Reclamation (BOR) decided quickly that the desired Crane Prairie improvements were inadequate. The BOR wanted to build a new dam and large reservoir below Crane Prairie to serve almost all of North Unit irrigation district, and with the permission of the irrigation districts decommission Crane Prairie. Local farmers opposed this plan and demanded that Crane Prairie be repaired on the grounds that new construction would place too much of a financial burden on local farmers. Eventually a compromise was reached that resulted in both the repair and refurbishment of Crane Prairie dam and reservoir and building a new dam that would become Wickiup dam and reservoir.

The Civilian Conservation Corps (CCC) workers first refurbished the Crane Prairie dam and built all associated major canals. The new Crane Prairie Dam is 36 feet high with a 285 feet long crest, and when filled, its reservoir holds 55,300 acre-feet and covers 4,940 acres and went into service by the fall of 1940. CCC also began construction on the 65 mile long North Unit Canal in 1938 and Wickiup Reservoir in 1939. By 1946 the main portion of the project was compete. Wickiup Reservoir covers 11,170 acres and holds nearly 200,000 acre-feet of water. The project furnishes irrigation water for approximately 59,000 acres of land within North Unit Irrigation District (NUID, 2011). The remaining aspects of the 235-mile distribution system were completed between 1946 and 1949. Operation and maintenance of NUID, including Wickiup Reservoir, was transferred to NUID on January 1, 1955 from the U.S. Reclamation Service. It was determined by Reclamation that it took three to four days for water to travel from Wickiup to the northern most reaches of NUID, resulting in large water losses due to seepage. Additional storage would reduce the transportation time, reduce waste through seepage and meet unexpected demands.

Therefore, construction on Haystack Dam and Reservoir began in 1956 about 11 miles south of Madras, and was completed in 1957. The reservoir formed by Haystack Dam covers 233 acres and holds 5,635 acre-feet. The man-made lake is filled by water directed from the Main Canal through a feeder canal 2,500 feet long with a 600 foot outlet canal returning releases back to the Main Canal.

In 1954, Congress authorized emergency rehabilitation of the original Crescent Lake Dam for Tumalo Irrigation District. The original dam was built in the 1920s and was a timber and rock-fill structure thirty-feet high and 150-feet long. It formed a reservoir designed to store 86,000 acre-feet of water but was only able to store 36,000 acre-feet. The Crescent Lake Dam Project was completed in 1956, and consists of the Crescent Lake Dam and multiple canals and laterals, including the Bend Feed Canal and the Tumalo Feed Canal. Crescent Lake Reservoir now holds a maximum of 86,900 acre-feet of water. The reservoir stores water from the Deschutes River and provides supplemental irrigation for Tumalo Irrigation District when necessary (Linenberger T. R., 1999).

The Bureau of Reclamation is also responsible for two dams in the Crooked River sub-basin, the Ochoco Dam and the Arthur R. Bowman Dam (formerly Prineville Dam). Initial Ochoco Dam construction was complete in 1921 and Ochoco Irrigation District (OID) operated the Dam privately until it required U.S. Reclamation Service rehabilitation in 1948, which Congress authorized that same year. Ochoco Dam has formed the Ochoco Reservoir, which has an active capacity of 46,500 acre-feet and is used for irrigation. U.S. Reclamation Service also explored the possibility of expanding storage in the Crooked River sub-basin to bring additional acres under cultivation in the 1940s. Ultimately, Reclamation decided on a location for the new Arthur R. Bowman Dam that spans the Crooked River just south and west of Prineville. Construction on Bowman Dam, the Barnes Butte and Ochoco Relift Pumping Plants, and distribution system began in 1957 and was completed in 1962.

Arthur R. Bowman Dam forms the Prineville Reservoir, which has a total capacity of 154,700 acre-feet and an active capacity of 152,800 acre-feet. Water in the Prineville Reservoir is managed for multiple uses. Congress allocated 92,800 acre-feet for exclusive irrigation use; the additional 60,000 acre-feet was allocated to joint irrigation and flood control use. Irrigators had contracted for 70,282 acre-feet of storage, leaving 82,518 acre-feet available. Reclamation manages the un-contracted water for in-reservoir use, instream flows, and supplemental irrigation (Linenberger T. R., 2001).

Figure 6 is a teacup diagram from the Bureau of Reclamation showing the location and relative sizes of the 6 reservoirs in the Deschutes Basin used primarily for irrigation storage.

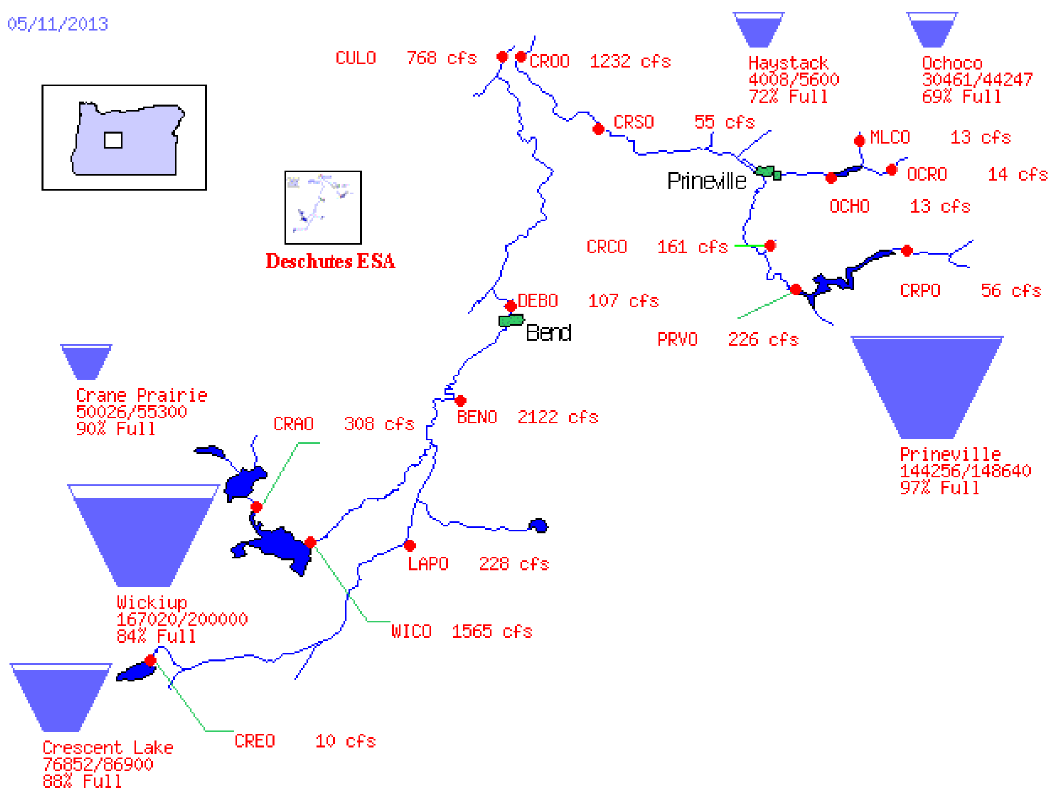

Figure 6. Bureau of Reclamation Hydromet - Reservoir Storage "Teacup" Diagram for the Deschutes Basin (Bureau of Reclamation, 2013)

Portland General Electric (PGE) and the Confederated Tribes of Warm Springs (CTWS) jointly own the Pelton Round Butte hydroelectric project located west of Madras. Figure 7 shows that the project consists of three dams built between 1957 and 1964 that are managed for irrigation and hydropower production. Round Butte is near the confluence of the Metolius, Crooked and Deschutes rivers and forms Lake Billy Chinook. The middle dam, Pelton, forms Lake Simtustus on the main stem of the Deschutes River and the last dam is a re-regulating dam used to balance river flows and meet peak power demands located below Pelton on the Deschutes. The dams included fish ladders during the initial construction to maintain populations of Chinook salmon, steelhead, redside trout (rainbow trout), Pacific lamprey, and bull trout above the Dams. Unfortunately, Round Butte Dam altered current patterns in the River enough that fish could no longer navigate downstream, which ultimately blocked all fish migration at Pelton. In 1968, a fish hatchery was established below the dams to maintain fish populations in the lower Deschutes Basin. PGE and The CTWS have been studying solutions to the fish passage problem since 1995 that ultimately lead to the construction of a fish tower that attracts fish moving downstream and transports them to the other side of the Round Butte (PGE, 2013).

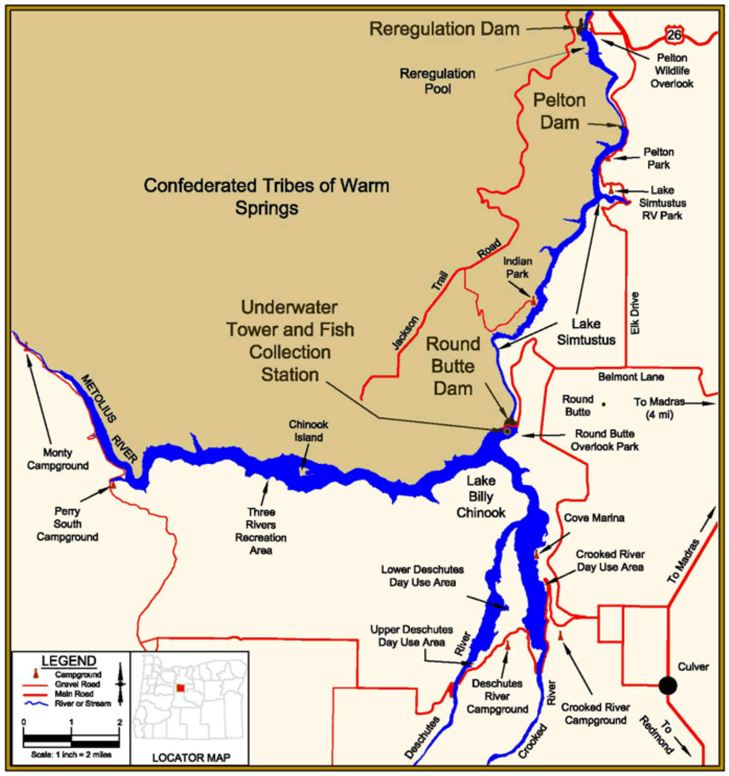

Figure 7. Map of PGE Hydropower projects in the lower Deschutes Basin (Portland General Electric, Deschutes Passage)

Table 2. Inventory of Large Storage Projects in the Deschutes Basin (U.S. Bureau of Reclamation, 1981; Portland General Electric, 2013)

Managing Entity	Project Name	Stream Location	Dam/Res. (height)	Volume (acre-feet)	Authorized Use	Additional Information
U.S. Bureau of Reclamation	Arnold (water rec'd from Crane Prairie Res.)	Deschutes River	---	---	Irrigation	Arnold ID, 4,292 acres served
U.S. Bureau of Reclamation	Crescent	Crescent Creek	Crescent Lake (40 ft)	86,900	Irrigation	Tumalo ID, 8,000 acres served
U.S. Bureau of Reclamation	Crooked River	Crooked River	Arthur C. Bowman (245 ft)	154,700	Irrigation, Flood Control	Ochoco ID, 19,070 acres served
U.S. Bureau of Reclamation	Ochoco	Ochoco Creek	Ochoco (125 ft)	48,000	Irrigation	Ochoco ID
U.S. Bureau of Reclamation	Wickiup	Deschutes River	Wickiup (100 ft)	200,000	Irrigation	North Unit ID, 50,000 acres served
U.S. Bureau of Reclamation	Crane Prairie	Deschutes River	Crane Prairie (36 ft)	---	Irrigation	COID
U.S. Bureau of Reclamation	Haystack	Haystack Creek	Haystack (105 ft)	---	Irrigation	North Unit ID
PGE, CTWS	Pelton	Deschutes River	Pelton (204 ft)	---	Hydropower	---
PGE, ODFW	Round Butte	Crooked, Deschutes and Metolius Rivers	Round Butte (404 ft)	---	Hydropower	---

Crane Prairie, Wickiup Dam and the associated irrigation diversions have altered the natural flows of the upper and middle Deschutes River. In the upper Deschutes, once stable annual natural flows have been replaced with low flows during the winter storage season and higher flows during the summer months to meet irrigation demand. The current average flows between November and March are 37 cfs and average flows between July and August are 1,150 cfs at the OWRDs WICO streamflow gage. This pattern becomes less significant as tributaries and springs augment streamflow north of Sunriver (DRC, 2012). In the middle Deschutes

River, 6 different irrigation diversion canals withdraw nearly 90% of the water near the City of Bend (DRC, 2012). This diversion pattern results in lower summer flows and continuing low winter flows due to storage in the middle Deschutes. Conversely, natural flows in Deschutes River tributaries were historically more variable than those in the main stem. For example, stream flows from the Crooked River sub-basin experienced annual and seasonal variation due to the geologic nature of the area. Storage has mitigated much of the natural variation of the Crooked River sub-basin hydrograph (NPCC, 2005). Current flows in the Crooked River are moderated for flood control and irrigation.

Oregon Land Tenure Practice's Influence on Groundwater

Groundwater and Domestic Wells in the upper Deschutes

Access to groundwater has not been as strictly regulated in Oregon as access to surface water, due to the difficulty in measuring and monitoring groundwater use. Until the 1990s, the Deschutes Basin's unhindered use of groundwater for development showed that groundwater was largely viewed as an unlimited resource. After a USGS study identified a hydrological connection between groundwater in the upper Basin and surface flows in the lower Basin, it became clear that unrestricted pumping in the upper Basin could negatively affect senior water rights holders in the lower Basin (Lite Jr. & Gannett, 2002). Groundwater was no longer considered an unlimited resource and local water managers became interested in surface water conservation as a new way to meet water demand. However, there is a complicated relationship between surface water and groundwater. As changes are made to the surface water system, they also influence groundwater.

The manipulation of surface water for storage and irrigation in the first half on the twentieth century affected groundwater through artificial recharge. The irrigation districts in the Basin divert approximately 3,250 cfs of surface water annually (Deschutes Basin Board of Control, 2008). According to irrigation district personnel, irrigation distribution system inefficiencies vary from 30 to 70 percent. So, while it is difficult to determine the exact amount of artificial recharge, the volume is clearly quite large.

It is possible that artificial recharge supplies water to exempt, domestic well users but there are not enough data available to conclusively determine a relationship. Evidence to support this assumption is provided anecdotally by several local hydrogeological consultants that have seen irrigation district conservation projects affect local domestic wells. It is also unclear exactly how many domestic wells there are in the Basin. According to the Oregon Water and Monitoring Well Standard database maintained by OWRD, there are approximately 980 domestic wells in the Basin, but that is a low estimate due to the lack of regulatory control over exempt wells (OWRD, Oregon Water & Monitoring Well Standard Repository - Deschutes Basin, 2013). Reduction of local groundwater tables and the potential impact that might have on domestic well users is not a primary management concern in the Basin. The upper Deschutes Basin is considered groundwater rich, so it is assumed that domestic well users in the Basin can access more water by deepening their wells. Irrigation districts are also legally protected from any accusation of injury that may result from conservation projects by Oregon water law. In addition, water management goals are set at a broad spatial extent within the Basin. These goals attempt to manage the relationship between surface water and groundwater at the basin, sub-basin and zone-of-impact scale and do not focus on small scale; local phenomena (see Chapter 5).

Juniper and Groundwater in the Crooked River sub-basin

Shifting land tenure practices have also affected water supplies in the Crooked River sub-basin. Between 1850 and 1900, Native American tribes lost control of the Deschutes Basin and were relocated onto the Warm Springs Reservation. The farmers and ranchers that took their place had land tenure practices that differed from those of the Tribes. They did not see fire as a valuable rangeland management tool. Instead, to farmer and ranchers, fire was destructive and had to be prevented to save valuable fences, cattle and crops. As a result of active fire suppression, fires became more infrequent in the Deschutes Basin, which caused accidental fires to become more intense and destructive due to fuel build-ups. Ranchers also used the rangeland to graze far more livestock than could be sustainably maintained on the sagebrush-grasslands. The shift in fire management patterns and overgrazing of the rangeland are important because they allowed the range of the western juniper to expand into the Deschutes Basin.

Juniper forests are not the most desirable vegetation community for the Deschutes Basin because they experience surface erosion during heavy precipitation. Juniper are so efficient at finding and exploiting deep subsurface water that they lower water tables and can make semi-arid regions even dryer (Fisher, 2004). Wetlands, riparian zones, grasslands and streams can disappear in mature juniper forests.

Managing the negative impacts of western juniper forests on groundwater supply and rangeland quality is especially important in the Crooked River subbasin. The subbasin is unique in the Deschutes Basin because groundwater is not as abundant there as in other parts of the Deschutes Basin. The reduced permeability of the geology of the subbasin means that a higher proportion of precipitation moves through the landscape as rapid surface flows. Reduced groundwater recharge and storage capabilities of the local aquifers means that groundwater is a valuable and limited resource. In addition, the Crooked River subbasin is an agriculturally productive area that includes both irrigated crops along the valley bottom and extensive rangelands at higher elevations. These rangelands are owned by private landowners and Federal agencies and are predominantly covered in mature western juniper forests (Nielsen-Pincus, n.d.). The Crooked River Watershed Council (CRWC) advocates the removal of western juniper from the Crooked River subbasin as a management tool to improve the rangeland quality and the long-term availability of groundwater and surface water in the subbasin. Rangeland management often involves reducing the number of junipers in a basin through thinning and fire to restore groundwater levels and allow more diverse and economically useful plant communities to develop (Fisher, 2004).

Figure 8 is a block diagram that summarizes how the land tenure practices in the Deschutes Basin over the past 160 years have altered the distribution of surface water and groundwater across the Deschutes Basin landscape. Surface water has been stored for future need and diverted across the Basin for municipal and agricultural uses. Figure 8 also highlights the affect people have had on the distribution of groundwater and plant communities.

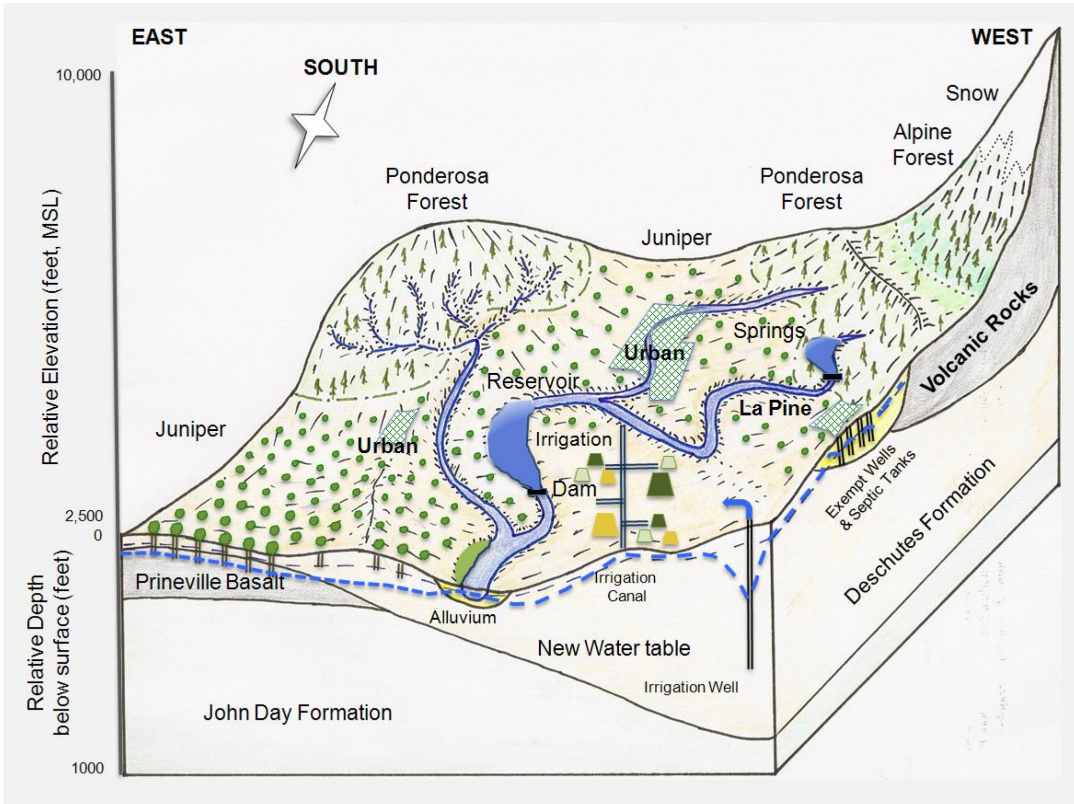

Figure 8. Block Diagram of Oregon Land Tenure Practices influence on Water (Jarvis, 2012)

CHAPTER 5. OREGON WATER LAW

The Oregon Water code was passed into law by the State legislature in February 24, 1909 and established four principles that form the foundation of current Oregon water law:

- Water belongs to the public.
- The right to use water is controlled by the state government through a permit system.
- The doctrine of prior appropriation applies to all water rights holders. Water users with the oldest, most senior water rights are entitled to water before newer, more junior water rights holders, and may have their water right fully met before the next junior water right may use water.
- Permits can only be granted for beneficial use without waste. If the condition of beneficial use without waste is not met then the water right may be forfeit.

Water rights are legal contracts allowing a private individual to use the state's water for a specific purpose. It is important to note that water rights do not meet the economic definition of property rights. Property rights are defined by three characteristics: 1) the exclusive right to select the use of a resource, 2) exclusive access to the services of a resource, and 3) the right to exchange all or part of the resource (Alchian & Demsetz, 1973). Water rights do not enable a water user to determine how he will use the water or exchange the water without the express permission of the OWRD. Water rights also do not confer exclusive access to the services that result from the use of water (i.e. recreation). Instead, a water right defines the beneficial use, sources, priority date, duty (volume of water used), rate (volume of water diverted over time), point of diversion, location of use, and any other requirements demanded by the OWRD that a water user must abide by to maintain access to water. The Oregon water code also ties water rights to land, meaning that a land purchase includes the water right for the land. Water transactions that result in changes to a water right must be approved by the OWRD and new uses are held to the same standards (beneficial use without waste) as the original water right. Water rights holders involved in water transactions are frequently monetarily compensated for any transfer of water rights by those that would gain new access to water, but this compensation does not constitute a sale because there is no transfer of ownership from one person (or organization) to another (Jaeger, 2005). The OWRD continues to manage the water on behalf of the public (the owner) regardless of the water's beneficial use. Many of these provisions are common in western water law, but Oregon water law is distinguished from other states by the unique innovation of a court-based process for settling water rights disputes (Oregon Revised Statutes, 2011).

The three concepts of beneficial use, waste, and forfeiture combined to produce a "use it or lose it" water use ethic in Oregon. For example, if a water right holder does not need the full amount of water on the water right to achieve the beneficial use and does not use a portion of his water allocation for a five year period the water may be forfeit, or returned to the State. The possibility of forfeiting part of a water right if the water is not used for a beneficial use without waste has disincentivized water conservation in the past (Bastasch, 2006).

The terms beneficial use and waste have not been clearly defined in the statues and their meanings have changed over time to reflect new land tenure values, and evolving legislative priorities and legal precedents. Oregon water management originally enshrined the economic value of water when developing criteria for beneficial use, with little regard for the environmental, aesthetic, or recreational uses of water. Agricultural water use was considered beneficial when water was applied to crop lands to produce an agricultural product that contributed to the State's economy. Over time that definition has expanded to include uses like wetland maintenance, aesthetic quality, or fish and aquatic life. Beneficial uses also once included activities like hydraulic mining that resulted in widespread pollution and environmental damage. Hydraulic mining is no longer considered a beneficial use of Oregon's water and is not practiced due to it negative environmental consequences.

In the last 60 years, the perception of the value of water for environmental uses has increased and has resulted in an expansion of the definition of beneficial use. We find evidence for the increased value of water for environmental, aesthetic, or recreational purposes reflected in legislation from 1955. At that time, the legislature created minimum perennial streamflows to support aquatic life, minimize pollution and maintain recreational value (ORS 536.310(7)). Minimum perennial streamflows are administrative rules that received a priority date that was junior to all existing water rights in the same system. Instead of maintaining a specific level of water in a stream, minimum perennial streamflows protected the remaining instream flows from additional appropriation (Bastasch, 2006). The legislature allowed other agencies to apply for minimum perennial flows as researchers developed a better understanding of flow requirements in the 1960s (ORS 536.325). The requested flows were higher than those previously considered and the OWRD Board was reluctant to approve them until 1983, when the legislature mandated that OWRD would prioritize minimum perennial streamflows. The OWRD Board no longer uses minimum perennial streamflows as a tool for instream flow protection because they protect a limited number of beneficial instream uses, cannot be requested by Oregon Parks and Recreation Department for recreational uses, and are rules, not rights, and therefore subject to change. In 1987, the Instream Water Right Act was adopted and converted all minimum perennial streamflows into instream water rights.

Waste has been defined by the judicial system in western water law. The courts have determined through multiple cases in several states that waste is defined as an atypical and overtly wasteful water use for a specific area. As an example, flood irrigators have been protected in some areas if their water use is typical for the region. Likewise, irrigation districts with dirt lined canals and high rates of distribution system inefficiency are not considered wasteful if that is the standard practice for the region. This means that Deschutes Basin irrigation districts have not been considered wasteful in the past and are not subject to forfeiture due to water loss from infiltration (Neuman, 1998). Interestingly, as some water users invest in new and more efficient water infrastructure they begin to alter the definition of typical water use in an area. As some farmers invest in sprinkler systems, or as some irrigation districts line their canals to prevent water loss, the definition of waste will change. It is theoretically possible that the OWRD could use a changing definition of waste, and the threat of forfeiture, to encourage other water rights holders to adopt new water management practices. However, given the OWRD conservative management style and Oregon's general focus on voluntary participation in water transactions and it seem unlikely that OWRD would utilize such strict regulatory tools.

The following sections describe the different mechanisms Deschutes Basin water managers can use to transfer water between uses within the Basin.

Water Transfers

Water transfers are mechanisms for transferring existing water right certificates or permits to another water use or location while retaining their original priority date. Transfers can introduce changes to types of use, points of diversion or places of use (ORS 540.520(1)). The application process is straightforward and involves a description of the current water use, the proposed water use and location, a justification for the change of water use and proof that the water right has not been forfeited (ORS 540.520(2)). Applicants must pay examination and filing fees plus an additional fee for every cfs of water beyond the first. The application goes through a proposed and final order process and includes a public comment period. This process provides the opportunity to determine if the transfer will result in an enlargement of the water right, or an injury to an existing water right. Once the application is approved, a new water certificate or permit is issued to confirm the new water right.

In 1995, the Oregon State Legislature made provisions for the creation of temporary transfers. At the same time, they allowed a surface water point of diversion to be transferred to a groundwater use (ORS 540.531). This permitted cities to switch from surface water to groundwater, which made compliance with the Federal Safe Drinking Water Act more feasible.

Instream water rights are transferred in much the same way as other water transfers, with a few important exceptions. Senior water rights cannot be impaired by instream water rights (OSR 537.334). Only three state departments (Fish and Wildlife, Environmental Quality, and Parks and Recreation) are authorized to apply for instream water rights transfers. Instream rights can be requested for "public" beneficial uses such as recreation, pollution abatement, navigation, and conservation, maintenance, and enhancement of aquatic life, fish, wildlife, and habitat (OSR 537.350). Water availability standards are based on natural flows rather than standards for other uses that measure the level of over-appropriation in a water source (OAR 690-77-0015). There are no fees charged for instream water rights. Instream water rights certificates are issued to the OWRD, and OWRD acts as a trustee for the public. Finally, senior instream rights may have water taken away by junior water rights for municipal water supplies or storage projects (ORS 537.352).

Temporary Instream Leases

The instream leasing program is addressed under OAR Chapter 690, Division 77. Instream leases enable a water rights holder to avoid forfeiture and retain a water right for water that does not currently have a use while simultaneously improving streamflows. Instream leases do not require a water transfer. However, instream leases must prove that the transaction will not cause injury to other water rights holders, and that it will provide a beneficial use. Instream leases cannot exceed 5 years, but they can be renewed. The leasing program can use surface water, storage water and conserved water.

Allocation of Conserved Water Program

The Allocation of Conserved Water Program is authorized under ORS 537.455 to 537.500 and implemented in Oregon Administrative Rules (OAR) Chapter 690, Division 18 and was passed into law in 1987 by the Legislative Assembly. This program is very important because it combats the “use it or lose it” concept in Oregon water law. The program has three goals: promote the conservation of water, maximize beneficial use and enhance streamflows. The statute defines conservation as "the reduction of the amount of water diverted to satisfy an existing beneficial use achieved either by improving the technology or method for diverting, transporting, applying or recovering the water or by implementing other approved conservation measures." This program enables water right holders to gain some benefit from water conservation projects by allowing them to use a portion of the conserved water on additional lands without a transfer, or sell or lease conserved water, or transfer the water to instream uses.

To determine how much water the applicant is eligible for the OWRD Commission first determines how much water was conserved, then how much water is needed to mitigate the effect of the conservation project on other water users. The remaining conserved water is split into two shares: the applicant’s share and the

State's share. The OWRD Commission typically allocates 25 percent of the remaining conserved water to the state, and 75 percent to the applicant; unless the applicant wants to transfer more water to state control or more than 25 percent of the funding for the project came from federal or state public sources. If public funding contributes more than 25 percent, then the Commission allocates to the state a percentage of conserved water equal to the percentage of public funds, although the water right holder is always guaranteed a minimum of 25 percent of the conserved water (OAR Chapter 690, Division 18).

The state's share of conserved water is usually transferred to instream uses. Conserved water retains its original priority date, so conservation is an especially attractive mechanism for increasing instream flows in the Deschutes Basin. Prior to 2000, the Department had received only 10 applications for the entire state. However, interest in the program has grown considerably. By 2005, 30 new applications had been submitted as water users have sought to expand supplies and support for streamflow restoration has increased (Bastasch, 2006).

Deschutes Groundwater Mitigation Bank

The Deschutes Groundwater Mitigation Program (DGMP) is authorized under ORS 537.746 and implemented in Oregon Administrative Rules (OAR) Chapter 690, Divisions 505 and 521 (OWRD, 2013). The Water Resources Commission approved rules for the DGMP in 2002 and the program is subject to renewal in 2014 (Lieberherr, 2008). The program's goals are to: 1) maintain flows for Scenic Waterways and senior water rights, 2) restore flows in the middle Deschutes River and tributaries and, 3) accommodate growth through new groundwater development while sustaining existing water rights. To achieve those goals, new groundwater permit applicants must acquire groundwater mitigation credits before a groundwater permit can be approved by OWRD. The strategy is to offset groundwater withdrawals on an annual, volumetric basis. An important caveat to this program is that new domestic wells are not required to mitigate withdrawals.

Mitigation program rules state that credits can be produced through a wide array of mitigation projects including instream transfers, aquifer recharge, storage release, and conserved water projects. However, OWRD has indicated that irrigation district conservation projects would not likely establish any mitigation credits. One mitigation credit equals one acre-foot of mitigation water that has been legally protected for instream use. Mitigation projects reduce consumptive use in one area and then transfer the excess water instream, which allows new groundwater withdrawals to occur and development in the Basin to continue without negatively influencing stream flows or downstream senior water rights holders.

Permanent credits may be purchased from water rights holders, or temporary credits may be leased. Temporary credits are supplied by instream leases and must be purchased annually from the DRC Deschutes Water Exchange, the only state-sanctioned temporary mitigation bank in the Basin. There is no guarantee that temporary credits will be available to meet mitigation demand. Permanent mitigation credits are supplied by the direct purchase of an existing surface water or groundwater right in the same zone of impact as the new groundwater application. Permanent mitigation credits can also be obtained from the Deschutes Water Alliance Water Bank (DWAWB), which is administered by the DRC. The DWAWB is a voluntary, market-based institution using existing Oregon water law statutes under a cooperative agreement between the Deschutes River Conservancy, Central Oregon Irrigation District, Swalley Irrigation District, City of Bend, City of Redmond, and Avion Water Company (OWRD, 2013).

OWRD has identified zones of impact in the Deschutes River Basin as areas that are hydrologically linked to specific sections of the river system. Groundwater pumping in a zone of impact will theoretically affect flows in the associated river reach. As a result, OWRD has required permanent mitigation to occur in the same zone of impact as the new groundwater withdrawal (Lieberherr, 2008). Zones of impact are determined by a combination of factors: 1) local and regional groundwater elevations, 2) shallow and regional head gradient, 3) surface water elevation of nearby streams, 4) surface water elevations of the closest gaining stream reaches, 5) distances to nearby streams and gaining reaches along the local and regional flow paths, and 6) local geological information (Cooper, 2008).

There is a 200 cfs cap on final orders for new groundwater permits, which was exceeded in 2009 (OWRD, 2009). There have been long delays for some new groundwater permits due to a lack of mitigation in associated zones of impact.

CHAPTER 6. DESCHUTES BASIN DEMOGRAPHIC TRENDS

The previous two chapters consist of a detailed examination of how water management and land tenure practices have altered the distribution of water across the Deschutes Basin to support agriculture; and described the laws and policies used to manage water for past needs. In this chapter, the focus shifts to examining new pressures that are being placed on water resources and management organizations in the Deschutes Basin. The purpose of this chapter is to identify new water demands and explore how the current distribution of water resources in the Basin may not meet the needs of Basin residents. This imbalance between historical water distribution and current water need could provide motivation for Deschutes Basin water rights holders to participate in some of the water transactions described in the previous chapter.

Rapid population growth in the upper Deschutes Basin (corresponding to Deschutes County) over the past thirty years has contributed to land use changes that in turn influence water use and management. Figure 9 shows that the central Oregon population has grown at an average rate of 44 percent every decade, nearly double the Oregon average (Aylward, 2006). Most of the growth has centered in the Cities of Bend and Redmond and affected Tumalo Irrigation District, Swalley Irrigation District, Arnold Irrigation District, and Central Oregon Irrigation District (COID).

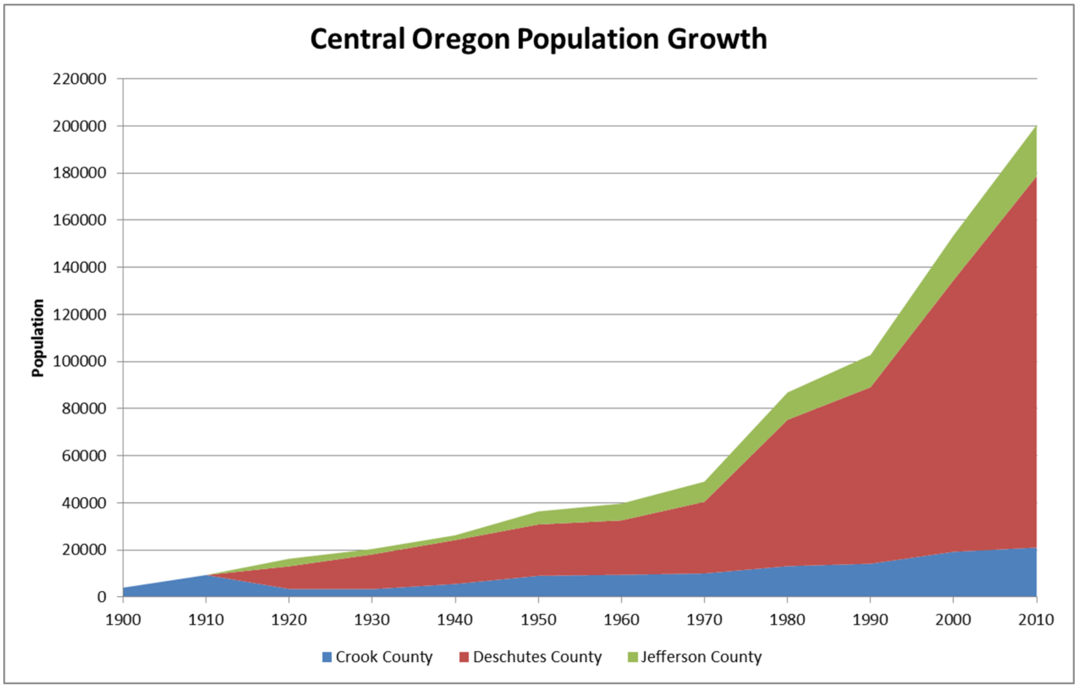

Figure 9. Population growth in Crook, Deschutes and Jefferson Counties (US Census Bureau)

Agriculture in Deschutes County is characterized by decreasing farm sizes, increased numbers of lifestyle farmers, and insignificant contributions to the local economy. US Department of Agriculture (USDA) census data shows that in 1969, the average farm size was 325 acres; in 2007, the average had dropped to 92 acres (figure 10). USDA data from 2002 show that 93 percent of farms in Deschutes County are family operated. At least 60 percent of these operators qualify as lifestyle farmers because they live on their farm, report gross farm sales of less than $250,000, and earn the majority of their income from occupations other than farming (Hoppe & Banker, 2010).

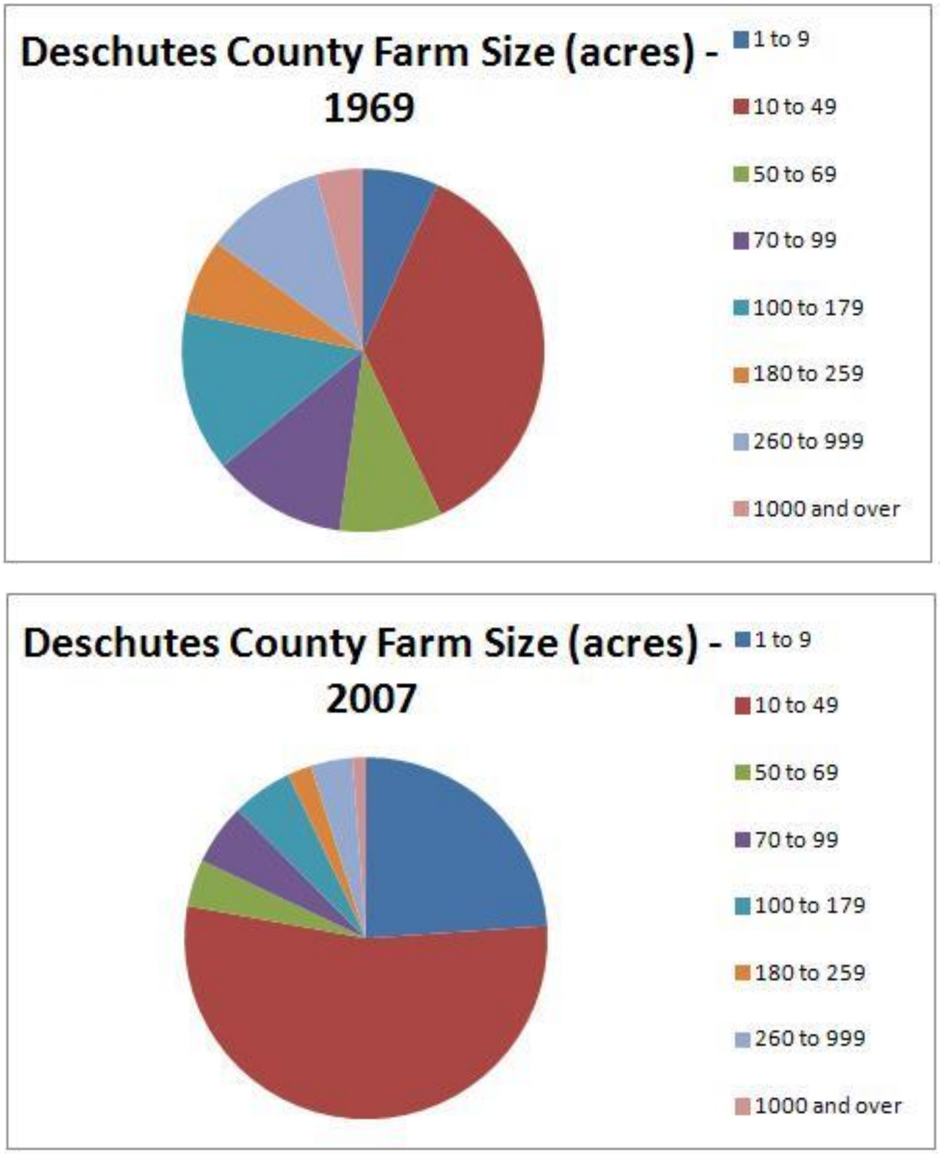

Figure 10. 1969 and 2007 Deschutes County farm size (USDA-NASS)

Agriculture in Deschutes County made up only 1 percent of County income in 2002, while agriculture made up about 10 percent of county income in Crook County and Jefferson County (Aylward, 2006). More recent information from the 2007 USDA Agricultural Census shows that the market value of products from Deschutes County have continued to drop and the value of agricultural products for Jefferson County has increased by 39 percent (Table 3). In both regions of the Basin, relatively low value forage crops are the primary agricultural products.

Table 3. 2007 Census Statistics for Central Oregon Agriculture (USDA-NASS; DBBC)

County	Average Farm Size (acres)	Market Value of Products Sold	Market value compared to 2002 data	Main Crops	Irrigation Districts
Deschutes	92	$20M	- 6%	Forage, Cattle	COID, AID, Swalley, Walker, TID
Jefferson	1,390	$57M	+ 39%	Hay, Cattle, Forage, Vegetable seed, grass seed	NUID
Crook	1,224	$31M	- 5%	Grazing, Cattle, Hay	OID

CHAPTER 7. METHODS

This research project employed a case study interview approach, which allowed for an in-depth, holistic and nuanced examination of the factors that encouraged or prevented senior water rights holders (irrigation districts) from participating in voluntary water transactions within the Deschutes Basin. This explanatory case study seeks to discover previously unknown relationships among variables.

Case studies are defined by the subject, or specific phenomena to be researched; and the object, which is the class of phenomena to be illuminated by the research (Yin, 2008). Thomas further proposed a typology of case studies that is particularly useful when defining the purpose and boundaries of this case study. The typology classifies a case study by its purpose, approach and process (Thomas, 2011). Case studies rely on empirical observations, multiple qualitative or quantitative methods and data sources to develop a deeper understanding of the contextual factors contributing to phenomena (Yin, 2008). Each data collection and data analysis method used in this study must also be identified. The following table summarizes these parameters for this research project.

Table 4. Case Study Typology (Thomas, 2011)

Classification Level	Purpose	Notes
Object	Senior water rights holders voluntary participation in water transfer mechanisms	Western water law includes the prior appropriation doctrine, which gives legal preference to water users with senior water rights regardless of regional water demand patterns.
Subject	Deschutes Basin Irrigation Districts	Irrigation districts hold the majority of the senior water rights in the Deschutes Basin.
Purpose	Exploratory	Study seeks to find underlining principals through the study of causation.
Approach	Theory Building	Study attempts to discover new relationships between variables,

		institutions (formal and informal) and actors.
Process	Single, retrospective	This study examines a single category of water users' response to shifting water demand over time.
Data Collection Method	Semi-structured interviews	A flexible interview format exploring themes that alters questions to explore interviewees' previous responses.
Data Analysis Method	Content analysis	A careful and detailed examination of data to identify patterns, themes, biases and meanings.

Applying the IAD framework to this study's methodology guided the development of interview themes and questions and helped bound the case study. One major line of interview questions focused on the identification of variables that significantly influenced the choices of senior water users within the Deschutes Basin. The second line of questions explored the relationships between different actors and the identification of action levels at different levels of analysis. This examination of multiple levels is required to understand how conditions in one action situation can influence the decisions made in other action situations. The third line of questions developed for this interview focused on identifying the connections between action situations at multiple levels. Specifically, these questions involved examining how and why the water transfer policies were negotiated at the Basin wide level, how those policies were implemented, and examining the institutions that carry out water transactions. Finally, this study examined the decisions of senior water rights holders in the Basin. This multi-level analysis enables us to examine how these nested set of rules ultimately influenced outcomes.

Case Study Site Selection

In case studies, the most useful information about causation is often found not in typical or average situations but in the examination of extreme or atypical situations (Flyvbjerg, 2006). The Deschutes Basin has had an active water transfer mechanism for over ten years. While the number of annual transactions is not high, transactions have been constant throughout the past decade. This pattern indicates that the system is resilient and could provide valuable insight into the factors that influence senior water rights holders to participate in voluntary water transactions. The researcher also have a unique level of access to and an in-depth knowledge of the Deschutes Basin that allowed her to identify key stakeholders and arrange for them to participate in the research. The researcher is from from the Deschutes Basin and has worked in the local water management sector for over five years as a water quality technician for the City of Bend. The combination of regional uniqueness and researcher access makes the Deschutes Basin a valuable research site for this case study.

Data Collection

This research study used two data collection methods: semi-structured interviews and document collection to triangulate the findings of the research projects and improve its validity through cross-verification. Eighteen interviews were conducted over a five-month period in the spring and summer of 2012. Research participants were identified by purpositive sampling, with the goal of obtaining a representative sample of Deschutes Basin irrigation districts. These key water users were identified through publically available information including lists of board members for the Deschutes River Conservancy, the Deschutes Basin Board of Control and Oregon Water Resource Department records of senior water rights holders for the three counties (Jefferson, Crook and Deschutes) that comprise the majority of the Deschutes Basin. Saturation was achieved with the irrigation districts, with 6 of a possible participant pool of 7 agreeing to participate in the case study. Further participant recruitment was carried out through a combination of snowball sampling and purpositive sampling. Initial participants recommend additional potential participants who were then contacted to request an interview. In addition, initial review of interviews provided new variables and insights that were explored through additional interviews. Purpositive sampling was used to identify potential research participants to represent other (non-irrigation district) institutions involved in a specific topic, or to identify individuals that could provide a unique personal perspective on a particular topic. Recruitment of non-irrigation district participants did not achieve saturation. Despite the lack of saturation achieved in most of the stakeholder categories, the research was deemed complete when interviews stopped offering unique insights. In effect, content became saturated before research participant categories became saturated.

Table 5. List of Research Participants Organized by Type of Water User

Stakeholder Group / Institution(s)	Population Pool	Individuals Contacted	Number of Interviews	Percentage of Population Interviewed
Irrigation Districts	7	7	6	86%
State and County Regulatory Agency Managers	4	3	1	25%
Municipal Water Managers	8	8	3	38%
Tribes	1	1	1	100%
Nongovernmental agencies (NGOs)	5	4	2	40%
Hydrogeologists/consultants	variable	5	2	NA
Farmers	variable	6	2	NA
Resource Economist/consultant	variable	1	1	NA
Total	NA	35	18	NA

Each research participant was provided with a letter of informed consent that outlined his or her rights as a research subject, described how the data were going to be used and what steps would be taken to protect the anonymity of the research participant. For example, each research participant was assigned an anonymous identification number to be used on all publically published materials. A record, in the form of a signed letter of informed consent, was obtained from each research participants indicating his or her preferred level of participation. The majority (14/18) of the participants agreed to have their interviews recorded and transcribed. A minority (4/18) requested that their interviews not be recorded and only allowed notes during the interview. Interviews were conducted between April and July 2012. Interview length varied from twenty minutes to two and a half hours, with an average length of around one hour. Interviews were audio recorded, then transcribed and supplemented with researcher field notes.

Data Analysis

Transcripts and field notes were examined in detail and segments of text containing single concepts (opinion, relationship, or fact) were summarized for brevity and then tagged with three codes. The first was the research participant's identification number. A time stamp was also included to indicate when an event occurred or to identify the period of time an opinion or perception was held by the research participant. Time stamping each segment of text enabled the study to track how perception of events changed over time. The third code was used to indicate the emphasis and importance of ideas that is typically lost during the transition from audio recordings to transcripts. Positive (+) or negative (-) signs were used to indicate the emotional connotation of the idea. The number of positive or negative signs used indicated the degree of importance of the statement to the research participant. All positive or negative codes were identified while the researcher was reviewing the audio tracks.

Next, the individual responses were organized in a dichotomous key (Figure 11). At the first level of specificity, responses were divided according to research participant. The first category contained all irrigation district manager transcripts and field notes. The second category consisted of non-irrigation district responses and field notes. The second level of specificity divided each response by its relevancy to the three central research topics:

4) Variables that encouraged or enabled irrigation districts’ voluntary participation in water transactions.
5) Variables that discouraged or inhibited irrigation districts’ voluntary participation in water transactions.
6) Identification of action arenas and the relationships between multiple action arenas and actors.

If responses were applicable to more than one research question they were applied to all relevant research topics. The third level of specificity separated responses into categories that correspond to the three broad categories of variable that shape the action arena of the IAD framework: 1) the physical and material conditions 2) attributed of the community and, 3) rules-in-use.

After the responses were organized into categories, they were inductively coded to reduce responses into codes identifying patterns of human activity, action and meaning and provide insight into the research topics (Berg & Lune, 2012).

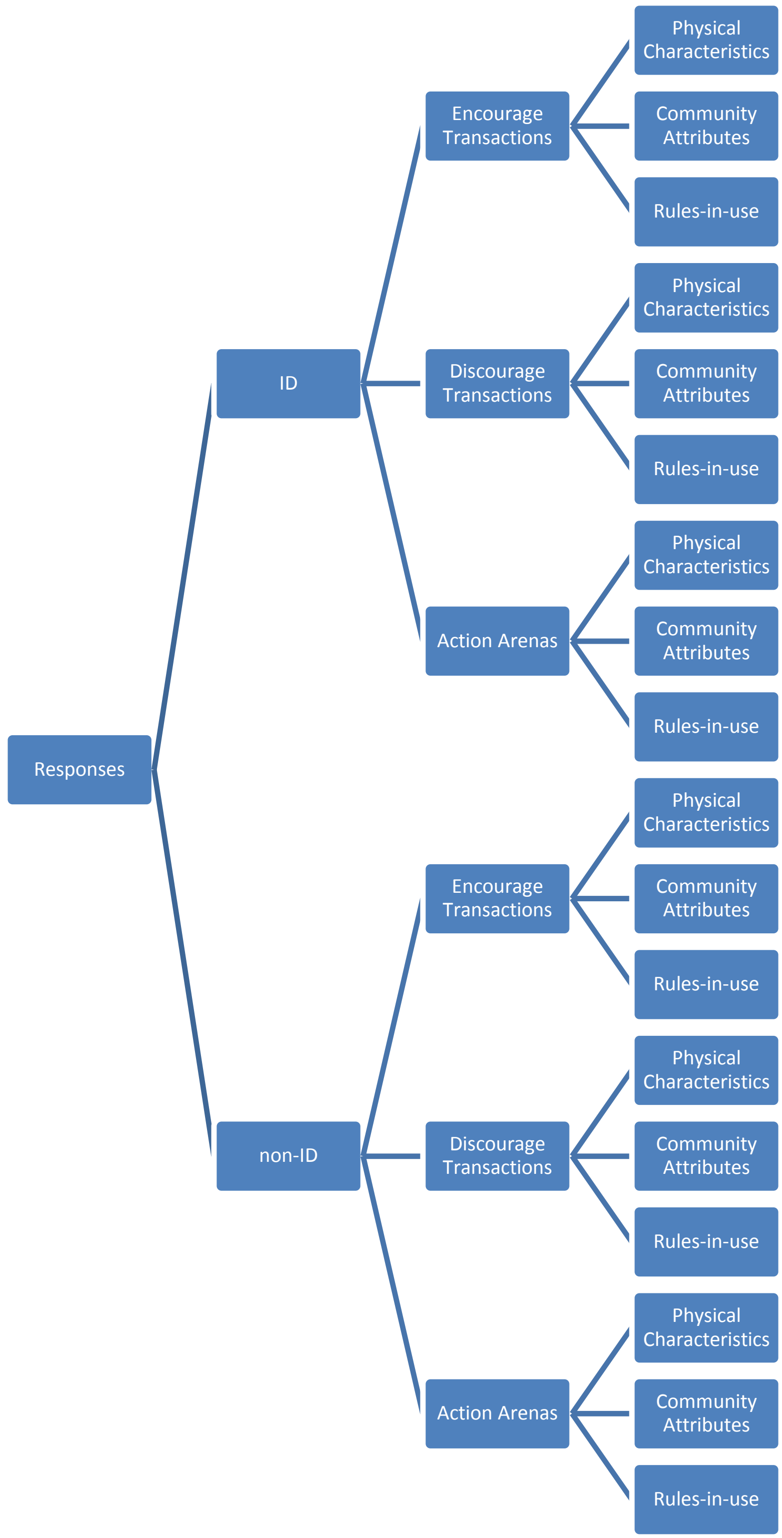

Figure 11. Data analysis dichotomous key.

Quality Control of Data

Determining the quality of content analysis relies on the reproducibility of results. Intercoder reliability refers to the extent in which two independent analysts derive similar codes from research participant responses and is a critical measure of the objectivity and validity of research results. Reliability is quantified by the intercoder agreement coefficient, which is a ratio of the number of agreed upon codes divided by the total number of responses coded by both analysts (Neuendorf, 2002). The majority of the sources available show that an intercoder reliability coefficient of 0.9 or above is excellent, 0.8 to 0.9 is considered good, and 0.7 to 0.8 is acceptable. Intercoder reliability coefficients below 0.7 are difficult to interpret and raise questions about the reproducibility of results (Miles & Huberman, 1994; Riffe, 1998; Berg & Lune, 2012). This research project seeks minimal acceptable intercoder agreement coefficient levels of at least 0.7.

To aid in the measurement of intercoder reliability, a coding guide (Appendix 3) was developed. The coding guide provides a systematic way for an analyst to identify and summarize the opinions of the research participants. It does this by first providing a dichotomous key (Figure 11) to organize concepts. A table is also included that defines variables in the dichotomous key and shows examples of text that would, or would not be acceptable in each conceptual slot. Once responses have been organized according to the dichotomous key they are placed in a table that allows each conceptual slot to be examined in isolation and summarized through the development of a code. A code is a central issue, theme or theory (Berg & Lune, 2012).

To measure intercoder reliability a 4-page segment of text from one transcript was provided to two different individuals with at least 6 months experience working with qualitative data and content analysis. They were also given the coding guide and asked to use it to develop codes from the text. After they coded the segments of text, the intercoder agreement coefficient was calculated.

Every effort was made to respect the anonymity of the research participants. Context clues were removed from the interview segment that could be used to identify the research participant. Personal names and organization names were replaced with fictitious names and the topic of the interview segment was water management at the basin level, a broad topic that could have been provided from many different research participants.

Table 6. Calculating intercoder reliability

Analyst	Number of codes that are the same as the primary analyst	Number of coded that are different than the primary analyst	Intercoder Agreement Coefficient	Percentage of Agreement
A	11	4	11/(11+4) = 0.73	73%
B	13	2	13/(13+2) = 0.87	87%

While the intercoder agreement coefficients correlate to different levels of reproducibility, they are both within acceptable parameters and indicate that the codes developed for this research project are reasonably accurate and reproducible. Closer examination of the codes that did not match those derived by the primary analyst showed a pattern indicating that different levels of knowledge about the Deschutes Basin affect code identification. The primary analyst has a more thorough understanding of the physical characteristics of the Basin and tended to identify codes that relate specific outcomes to tangible parameters. The secondary analysts were more likely to relate outcomes to social relationships and institutional goals that were in turn shaped by the physical characteristics of the Basin.

Methodological Limitations

This research project presents three main limitations. This section identifies and describes the limitation and the efforts taken to mitigate the negative consequences of those limitations. There are three issues that require examination: 1) low participation rates by some groups and a lack of saturation; 2) the inherent bias associated with snowball samples; and 3) the biases that are inherent to conducting research in one's own community.

The sample population consisted of individuals associated with irrigation district management and Basin water manager or advocates from a broad spectrum of other organizations and interests. A majority of irrigation districts were represented (6/7). As a result, conclusions about irrigation district motivations and priorities can be considered representative of the population. The same level of confidence cannot be assigned to non-irrigation district participants. The number of research participants for most water mangers and advocates groups was less than half of the potential sample pools and it is unlikely that saturation was achieved in these groups. Conclusions drawn from non-irrigation district research participants cannot be considered representative of the beliefs of other water mangers or advocates in the same sector. Instead, non-irrigation district participation provides context and alternate viewpoints to irrigation district responses that opened new avenues of inquiry.

Snowball sampling can introduce bias into the participant recruitment process (Gray, 2009). Irrigation district personnel and a handful of other Basin water managers formed the original group of purposively identified research participants. This initial group was asked to identify other water managers and water users to participate. It is possible that those recommendations referred to people who shared viewpoints with the original research participants. Alternatively, these people could have been exceptionally motivated individuals with an unusual interest in the topic. As a result, their views might not be representative of their respective sectors of water management.

The final caveat involves a discussion of bias reduction in the interview process. Bias consists of the preconceived notions and expectations that interviewers and interviewees have about each other (Berg & Lune, 2012). Bias consists of both true and untrue notions and can skew data.

Interviewer bias in this study could result from the interviewer's experience within the community. The interviewer is a member of the central Oregon community, was raised on a farm in a local irrigation district, has worked for a local municipality in a water management related field, and has been involved with two different environmental advocacy groups in the Basin focusing on water related issues. This life experience was both an asset and a limitation.

The interviewer had increased access to, and knowledge of, water managers that aided in research participant identification and recruitment. Conversely, the researchers had to be aware of her biases and develop strategies to minimize the impact of bias on the interviews. Interview questions were designed to be open-ended and neutral, so that responses were not preferentially presented to the interviewees. The interviewer also attempted to remain neutral in dress, tone and body language and not give opinions during the interview process.

To reduce the negative effect of interviewee bias the researcher employed the strategy of role-taking. Role-taking is a conscious selection, from among one's actual role repertory, of the role thought most appropriate to display to a particular respondent at the moment (Gorden, 1992). The researcher self-identified as having grown up on a farm, worked for the City of Bend, or participated in various environmental causes based on the perceived preferences of the interviewee. This strategy produced two positive outcomes. First, it built rapport, or positive feelings that develop between interviewer and interviewee. Secondly, it circumvented some of the avoidance tactics research participants might otherwise use, which resulted in frank, unguarded responses to the research questions (Berg & Lune, 2012).

CHAPTER 8. RESULTS AND DISCUSSION

The research results for this case study are presented and discussed in the following chapter. Results for each of the three major research questions are presented separately. However, the discussion of findings for each research question focuses on the connections between variables and an examination of how those variable interact to produce specific outcomes. As a result, the discussion portions of this chapter spans multiple research questions in an effort to provide a well-rounded and thorough understanding of the factors that influence irrigation district participation in water transactions in the Deschutes Basin.

Research Question 1. Identification of variables that encouraged or enabled irrigation districts' voluntary participation in water transactions.

Table 7 summarizes variables that were identified by all research participants (n=18) as encouraging irrigation district participation in water transactions. These responses focus on aspects of local institutions, community preferences, and events that created an environment where voluntary water transactions became a valid policy choice for Deschutes Basin water users. The major findings from this table are that: 1) a crisis event was needed to motivate innovation, 2) water users had to develop a shared goals and definitions of successful outcomes, and 3) transparent knowledge about resources aided in consensus building.

Table 7. Variables contributing to Deschutes Basin collaboration, all research participants (n=18)

	Code	Count	Percent (%)
Community attributes	Collaboration is the best way to find mutually beneficial solutions to regional water problems.	17	94
	Trust between water users.	16	89
	Shared goal…central Oregon should continue to grow.	13	72
	Preserve lifestyle (agriculture, and	2	11

	recreation).		
	Perception of water as a limited resource.	2	11
Rules-in-use	Development of mutually beneficial transaction mechanisms.	18	100
	Groundwater moratorium created urgency that motivated innovation.	14	78
	Transparency, equal access to information.	3	17
	Groundwater moratorium increased the number of people interested in water management.	3	17
	Basin residents wanted a local solution.	2	11
Physical characteristics	Easy to measure surface water supply.	3	17
	Constant surface water supply.	3	17
Future trends	Consolidation of IDs in the future, lower fixed costs, use assessment fees more effectively.	15	83

In the mid-1990s, the USGS carried out a large-scale groundwater study in the Deschutes Basin that determined there was a hydrologic connection between the mid-Basin and the lower Basin (Gannett, Lite, Morgan, & Collings, 2001). As a result, increased ground water pumping in the mid-Basin due to development and population growth negatively affected water users in the lower Basin with senior water rights. The Oregon Water Resource Department (OWRD) responded by instituting a moratorium on all new groundwater pumping from 1998 to 2002 in the Basin to prevent injury to senior water right holders (OWRD, 2013).

Due to the region's over-allocation of surface water decades earlier, and the region's subsequent reliance on groundwater, the moratorium had the potential to halt development in the Deschutes Basin. The initial response to the groundwater moratorium was confusion and uncertainty about the future; and resulted in a breakdown in communication between Deschutes Basin water managers and the OWRD. Locals were concerned that the moratorium would negatively affect the local economy. Municipalities were especially discontented with the groundwater moratorium because the ban directly interfered with their legal obligation to secure a twenty-year water supply to meet their communities' future needs. Local stakeholders were unwilling to let the OWRD develop a water management solution for the Basin because that was viewed as a loss of local control. Many Basin water managers felt that any solution from outside the region would be ineffective because that solution would not be tailored to local conditions or include local goals.

Every research participant involved in water management in the Deschutes Basin in the 1990s identified the OWRD's groundwater moratorium as the single most influential factor contributing to the creation of mutually beneficial water transfer mechanisms in the Basin. Table 7 shows that the groundwater moratorium was viewed as a crisis that provided the visibility, sense of urgency and political capital needed to encourage collaboration and innovation. It also highlighted the importance of water as a resource that affects every aspect of the Basin's environment and economy. Stakeholders that did not have a direct interest in groundwater management became interested in mitigating the secondary effects of the groundwater moratorium. All stakeholders were also forced to view water as a limited resource that had to be managed for multiple uses. Those three factors provided the impetus to form the Vision Group, a cross-section of Basin water users that sought a collaborative solution to mitigate the negative consequences of the groundwater moratorium. The Vision Group held informal conversations about the Basin's water supply, stakeholder water demands and potential tradeoffs between water users in the Deschutes Basin. These conversations resulted in the development of institutions like the DRC and DWA that strive to use the water transfer and conservation policies of the OWRD to create mutually beneficial solutions involving the conservation of agricultural water, which was used to increase stream flow that in turn mitigated the impact of new, municipal groundwater pumping.

Trust between water managers in the Basin was acknowledged as a key variable allowing collaboration to occur in 88 percent of responses. When the research participants were asked to describe what fostered trust in the Basin, most identified close, informal working relationships between organizations, the shared goal of maintaining growth in the Deschutes Basin, and the perception that water was a finite resource that all water users in the Basin were responsible for managing to protect the central Oregon way of life as contributing factors. Interestingly, only 17 percent of respondents recognized that physical and material characteristics of the Basin also contributed to trust. The hydrology of the Basin is well characterized and all water managers have equal access to information about available water supplies. Stream flow in the upper Basin is regular and predictable so collaborators can make agreements about the distribution of water and expect that those agreements will be carried out in the future.

Eighty-three percent of all research participants identified increased levels of consolidation within the irrigation districts as a likely strategy that would allow irrigation districts to reduce their fixed costs, operate more efficiently and maintain their financial stability. Two respondents theorized that an efficient use of assessment fees could allow irrigation districts to conduct more water transfers. Most research participants assumed that consolidation would first occur between irrigation districts bordering the City of Bend.

Table 8 summarizes the variables that directly influence irrigation district's decisions to participate in water transactions. Responses are divided by water transaction type to highlight the different factors that make specific types of water transactions attractive to irrigation districts. The most important findings on Table 8 include: 1) instream transfers relationship to urbanization, 2) the connection between the Conserved Water Program and water security, and 3) irrigation district preferences for leases.

Table 8. Variables encouraging irrigation district participation in water transactions, Irrigation District respondents (n=6)

Type of Transaction	Code	Count	Percent (%)
Instream Transfers	*Fort Vannoy v. OWRD* prevents water speculation.	6	100
	Urbanization of ID land, lose of assessment fees.	2	33
	Exit fees and remnant parcel policies.	2	33
	*Flow restoration and avoidance of future regulatory compliance issues (permanent or temporary transfers)	3	50
Allocation of Conserved Water Program	Porous, volcanic geology causes high inefficiency rates.	6	100
	High inefficiency rates lead to water scarcity.	5	83
	Conservation projects improve water supply for patrons.	5	83
	Conservation projects let us pressurize our distribution systems and reduce on farm energy bills.	3	50
	*Flow restoration and avoidance of future regulatory compliance issues (permanent or temporary transfers)	3	50
Instream Leasing	Leasing allows IDs to hold onto water right.	3	50
	Preference for leasing over permanent transfers.	3	50

*** Flow restoration was a goal for instream transfers and the conserved water program**

The pattern of water user collaboration to mitigate the negative effects of regulatory enforcement first identified in the formation of the Deschutes Groundwater Mitigation Program was reproduced in the irrigation district response to the reintroduction of hatchery steelhead above the Pelton Round Butte Dam Complex. Before 2007, the reintroduction efforts did not pose any significant barriers to irrigation management. However, on August 14, 2007, *Alsea Valley Alliance v. Lautenbacher* ruled that NOAA Fisheries could consider the extinction risk of both wild fish and hatchery fish when making an Evolutionary Significant Unit

(ESU) status determination (*Alsea Valley Alliance v. Lautenbacher*, 2007). NOAA Fisheries included hatchery steelhead in the Deschutes River ESU, which placed a protected fish population above the Pelton Round Butte Dam Complex. This drastically and abruptly changed the regulatory requirements irrigation districts would need to meet to measure and mitigate harm to the protected steelhead population. The Deschutes Basin Board of Control (DBBC) was formed to deal with the reintroduction issue and includes all seven irrigation districts in the Deschutes Basin and the City of Prineville. The primary goal of the DBBC is to share the costs associated with the study of the impact of water users on the protected steelhead population and to prepare a Habitat Conservation Plan (HCP). The HCP will describe the anticipated effects of the proposed taking; how those impacts will be minimized, or mitigated; and how the HCP is to be funded. HPCs provide protection from the liability of an illegal take, or the unintentional killing of a protected species.

In addition to the creation of the DBBC, the reintroduction process has influenced the priorities of irrigation districts when conducting water transactions. Half of the irrigation district participants identified flow restoration to avoid future Endangered Species Act (ESA) regulatory compliance issues as an important variable that motivated participation in permanent and temporary transfer of water to instream water rights.

In the early part of 2013, NOAA Fisheries issued its final 10(j) rule for the Deschutes River, changing the official designation of any reintroduced steelhead above Lake Billy Chinook to non-essential and experimental. The label, which exempts reintroduced steelhead from ESA protections, will extend until 2025. Irrigation districts consider this an excellent outcome because it will allow habitat restoration and water conservation efforts in the Basin to continue without risk of litigation.

Two distinct sets of variables were identified in the irrigation district interviews that influenced their preferences for specific water transaction mechanisms. Permanent instream transfers were most often connected to urbanization of agricultural land. Participation in the Conserved Water Program was tied to improving water security and service to patrons and instream flows for anadromous fish. Instream leasing was seen as a tool that allows irrigation districts to avoid forfeiture of a water right and maintain control of a valuable asset. All three of these transfer mechanisms can technically be used to create credits for the Deschutes Groundwater Mitigation Bank, although the Conserved Water Program has not, and most likely will not, be used to produce mitigation credits. Participation in the Bank was also most often mentioned by irrigation districts near the Cities of Bend and Redmond in the upper Basin.

Outcome 1: Participation in Instream Transfers

Only two of the irrigation districts that participated in this research identified urbanization as a significant variable contributing to their decisions to participate in water transactions. Swalley and Central Oregon Irrigation District (COID) are in the middle Basin near the fast growing communities of Bend and Redmond. The number of responses identifying urbanization as an important variable that directly influenced outcomes may be relatively low, but as urban centers in the Basin continue to grow these irrigation districts can serve as useful examples to other irrigation districts. Therefore, a detailed examination of the variables that influence these two irrigation districts decisions and shaped outcomes is well worth pursuing.

Urbanization results in a loss of irrigation district land and reduction of assessment fees collected by the irrigation district. Farmers pay assessment fees each year for their water deliveries and irrigation district use that money for their operation and maintenance budgets (a fixed cost). Any reduction in assessment fees could negatively influence an irrigation district’s fiduciary responsibility to its remaining patrons by forcing the irrigation district to increase the remaining patron's assessment fees. It is important to note that these financial considerations are a primary variable guiding irrigation district water management decisions and participation in water transactions.

Irrigation District Responses to Urbanization

Water rights are one of the most valuable assets irrigation districts possess. Therefore, the willingness to participate in the permanent transfer of a water right was linked to incentives that mitigated the negative financial consequences of a reduction in the irrigation district's assessment base. Both Swalley and COID have exit fee policies, in which the buyer of mitigation credits pays the irrigation district an exit fee to release mitigation credits. The exit fee is invested and the interest covers expected future operation and maintenance costs and long-term debt.

As an Urban Growth Boundary (UGB) expands into an irrigation district, landowners will usually sell their irrigation water back to the district and acquire city water. However, if patrons refuse to sell water back to the district, then agricultural land can become surrounded by developments and isolated from the rest of the irrigation district. The district is still responsible for providing water to the isolated patron at the same assessment rate as the rest of the district, but the cost of delivering water to isolated patrons is much higher than for the rest of the district. Both Swalley and COID have developed Remnant Parcel Policies that state if continuing to provide this service is an undue burden for the remaining patrons; then the district can charge the patron for the overages. This way other patrons are not subsidizing their deliveries. Remnant Parcel Policies provide a disincentive to encourage patrons to sell their water back to the district. Patrons can have an emotional attachment to water and a belief that irrigation water is cheaper than city water, so this process can be challenging (COID, 2013).

Water Speculation

In the mid 2000s, central Oregon was experiencing a real estate and economic boom (Office of Economic Analysis, 2013). Bend and Redmond's urban growth boundaries (UGBs) were expanding, development of agricultural land was common and municipal demand for water was increasing. Water speculators were presented with an opportunity to buy agricultural land and sell the water rights to the cities for profit. Water speculation was viewed negatively by all irrigation districts because it further eroded irrigation district assessment bases and placed irrigation districts in a more unstable financial position. Thirty three percent of irrigation districts felt that water speculation could drive the price of water too high.

There were some conflicts between irrigation districts and water speculators in 2006-2007 as irrigation districts attempted to use the Anti-Speculation Doctrine of Colorado to argue that water rights had to be used for their stated beneficial use and could not be held, unused, in anticipation of a future water rights transfer (Clark & Joseph, 2005-2006). Landowners contested this statement and it appeared that there would be a protracted period of lawsuits in the region to clarify ownership of agricultural water. However, the problem was removed in 2008, when the Oregon Supreme Court ruled on *Fort Vannoy v. OWRD,* and irrigation districts gained the legal tools to stop water speculation in the Basin.

In *Fort Vannoy v. OWRD,* a landowner in the Fort Vannoy Irrigation District outside of Grants Pass, Oregon petitioned the OWRD to modify five water rights certificates by consolidating seven points of water diversion within the Fort Vannoy Irrigation District into two points of diversion outside of the district's control. The petition was originally approved by OWRD, but Fort Vannoy Irrigation District contested the OWRD decision on the grounds that they are owners of the water rights certificates, and are a necessary party to any application regarding a change in diversion points under those certificates. The Oregon Supreme Court decision affirmed the irrigation district position and determined that ownership of a portion of the appurtenant land within an irrigation district does not equate with ownership of the certificate water right. Irrigation district patrons are not the "holders" of water rights and are not authorized to petition the OWRD to change any aspect of the water right without the consent of the irrigation district (*Fort Vannoy Irrigation District and Herman Baertschiger, Jr. v. Water Resource Commission and Ken-Wal Farms, Inc.*, 2008).

Fort Vannoy v. OWRD was a constitutional level change to the rules-in-use of the Deschutes Basin because it determined who would have access to water management decisions in the Basin. Not surprisingly, the irrigation districts that participated in this study were uniformly in favor of *Fort Vannoy v. OWRD* and its outcome, but other research participants were more measured in their response. Four non-irrigation district research participants discussed *Fort Vannoy v. OWRD* in their interviews. They identified controlling the price of water in the Basin and simplifying the water transaction process as positive outcomes of *Fort Vannoy v. OWRD.* Eleven percent of all the research participants expressed some type of reservation, ranging from concern about the equity of excluding water users from the water management decision-making process, to the long-term viability of the court decision in the face of potential future legal challenges, and the prevention of the development of an open water market. An open water market (with higher water prices due to increased demand) could incentivize on-farm water conservation (Jaeger, 2005). When asked why *Fort Vannoy v. OWRD* had been accepted uncontested in the Basin the interview participants mentioned that the implementation of *Fort Vannoy v. OWRD* coincided with the Great Recession (2007-2009) and a reduced demand for municipal water (Office of Economic Analysis, 2013).

Outcome 2: Participation in Oregon's Allocation of Conserved Water Program

Deschutes Basin irrigation districts hold the majority of the senior water rights in the Basin. Irrigation district water rights range from 1895 to 1966, with the majority (9/11) on or before 1914 (OWRD, 2013). In accordance with the prior appropriation doctrine in the Oregon water code, irrigation districts have primary access to surface water in the Basin, and their water rights are fully satisfied before junior water rights holders may divert surface water. As a result, at the onset of this project we did not expect Basin irrigation districts to face issues of water scarcity. This assumption proved to be wrong. During the interview process, multiple irrigation district research participants identified a pervasive and persistent pattern of agricultural water scarcity throughout the Basin.

Nearly all (83 percent) of the irrigation district participants identified water distribution system inefficiency from the use of dirt lined canals and high rates of groundwater infiltration due to porous volcanic geology (100 percent) as the cause of agricultural water scarcity within his or her district. Irrigation district inefficiency rates vary from a maximum of 70 percent water loss to a minimum of 30 percent water loss between the point of diversion and the outer edges of the district's water distribution system. Even in wet years, some irrigation districts in the Basin have been forced to rotate water delivery between patrons and activate drought management agreements between patrons simply to assure that all farms get a portion of their water rights.

A solution to this problem was found in a new Oregon water management regulation. Oregon's Allocation of Conserved Water Program (ORS 537.455 – ORS 537.500) encourages water conservation by enabling water rights holders to keep a portion of their conserved water for another use (Bastash, 2006). Deschutes Basin irrigation districts can obtain grants from agencies that include the Oregon Watershed Enhancement Board (OWEB) and the Oregon Bureau of Reclamation.

These funds are used for piping projects that reduce the districts inefficiency rates and allow the districts to improve the security of their water supplies, despite having a portion of the conserved water transferred to instream uses. There are also secondary benefits identified by 50 percent of irrigation district research participants that motivated irrigation districts to seek piping projects. Piping a distribution system allows the system to be pressurized, which reduces the need for on-farm pumps to move water within the system and creates significant energy savings for farmers.

While piping projects are largely viewed positively by the irrigation district research participants, there are negative aspects of the process that can slow or prevent Oregon Conserved Water Program transactions from occurring in the Deschutes Basin. Sixty-six percent of irrigation district participants identified regulatory hurdles as a barrier that slowed the rate of transactions; specifically the long period required to gain approval from the OWRD for any changes to an irrigation district water right and the OWRDs resistance to novel or unusual transactions. For example, North Unit Irrigation District obtained a grant for a conservation project that they wanted to carry out in Central Oregon Irrigation District (COID), which experiences a much higher rate of distribution system inefficiency due to regional variations in geologic formations. A portion of the conserved water from this project would then be transferred to North Unit. By funding a conservation project in another District, North Unit was able to maximize it money spent to water conserved ratio. However, this transaction was very difficult for the OWRD to process and required a significant amount of time and resources before it gained approval.

The high level of competition for conservation grants from state agencies between irrigation districts was identified as inhibiting participation in transactions by 66 percent of irrigation district research participants. Irrigation districts are never certain if their projects will be funded on any specific year. To reduce this uncertainty some irrigation districts divide their conservation projects into smaller segments and seek smaller grants. While this strategy allows more projects to be funded on any particular year from the limited state budget, it is also an inefficient way to fund large infrastructure projects. There are unavoidable costs associated with starting up and shutting down any construction project. Larger conservation projects would minimize these costs.

Finally, the number of conservation projects an irrigation district can carry out is finite, once all the cost effective projects have been completed irrigation districts will not be able to participate in this program. For example, Ochoco Irrigation District (OID) has always had to focus on water conservation due to the variable summer water supply of the Crooked River sub-basin. The OID does not participate in conservation projects because they do not have any cost-effective projects left to carry out.

Outcome 3. Instream Leases

Half of the irrigation district participants expressed a preference for instream leases over permanent transfers and indicated that they would seek leases in the future. Instream leases are seen as valuable tools that allow irrigation districts to deal with the loss of agricultural land from urbanization while retaining water rights. Leases also preserve any water surpluses that result from conservation projects or patron forfeiture. To 83 percent of irrigation districts, the recent central Oregon recession, slowing urban growth, and inactivity of the Deschutes Water Alliance Bank has provided a welcome break from urban demand for permanent water right transfers. Underlying this preference are the beliefs that preserving agriculture in the Basin is an important goal (33 percent), and that it is not the job of the irrigation districts to supply cities with water (67 Percent).

In the Deschutes Basin, instream leases provide temporary credits for groundwater mitigation. Temporary credit must be purchased annually and there is no guarantee that credits will be available to meet demand. Municipalities can purchase these credits to offset the impact of additional groundwater pumping, but would prefer to purchase permanent credits to increase the security of their water supplies. Municipal demand for mitigation credits maybe relatively low right now, but as the local economy recovers there may be some conflict between municipal and irrigation water users due to their differing mitigation credit preferences.

Research Question 2. Identification of variables that discouraged or inhibited irrigation districts' voluntary participation in water transactions

Table 9 introduces variable that were identified by all research participants as inhibiting water transactions in the Deschutes Basin. The focus of these responses is primarily on the institutional roadblocks that prevent or slow water transactions and problems related to the voluntary, collaborative management scheme used in the Deschutes Basin to develop water management strategies.

Table 9. Variables inhibiting Deschutes Basin collaboration, all research participants (n=18)

	Code	Count	Percent (%)
Community attributes	Collaboration fatigue (questions the efficiency, effectiveness and long-term viability of collaboration)	9	50
	Distrust between water users.	3	17
	Questioned the effectiveness of collaboration as a resource management strategy (day-to-day operation)	3	17
Rules-in-use	DWA financial stability concerns.	9	50
	Unsure about division of shared responsibilities between DRC and DWA.	9	50
	Lack of information about DWA purpose.	7	39
	Regional water planning will be shared between DWA and DRC.	6	33
	Fort Vannoy v. OWRD gives too much power to IDs.	2	11
	Informal working relationships are not always	1	5

	well defined and people cannot be easily replaced if they leave.		
Physical characteristics	Time sink.	4	22
Future trends	There should be a cap on growth.	1	5
	Future conflict over water.	1	5

The Deschutes Water Alliance (DWA) was formed in 2004 to plan for future water needs in the Basin and act as an advocate for Deschutes water issues at the State level. DWA members include the eight cities and seven irrigation districts of the Deschutes River Basin, as well as the Confederated Tribes of Warm Springs and the Deschutes River Conservancy (DRC). Since its inception, it has struggled to maintain momentum. DWA members are currently working on revitalizing the organization, but they must combat some of the negative perceptions of the Basin's water managers. Fifteen of the 18 research participants mentioned at least one concern about the DWA or DRC. Half of the participants questioned the financial stability of the DWA. They cited the DWAs past challenges with acquiring adequate funding from its participating members, and inability to find matching funds from State agencies. An additional 39 percent of respondents questioned the legitimacy of the DWA and were unsure about what products or services the DWA had to offer. Fifty percent of respondents were unsure about the working relationship between the DWA and the DRC. Some respondents thought that DWA would become the regional water policy advocacy group while the DRC would focus on increasing instream flows through transfers and the Deschutes Groundwater Mitigation Bank. Thirty-three percent of respondents thought the DWA and the DRC were going to share regional water management planning and expressed uncertainty about how those two organizations actions and authority would overlap. Concerns about the coordination between the DWA and the DRC include identifying the different functions of the two organizations, clarifying how the two organizations will coordinate activity between them, and the perceived redundancy of the DWA.

Ninety-four percent of the research participates held positive opinions about collaboration and felt that collaboration was the best way to develop mutually beneficial solutions to regional water management problems. However, a closer reading of the interviews identified aspects of the collaboration process that were viewed negatively and could best be describes as collaboration fatigue. Collaboration fatigue was identified in 50 percent of research participants. Collaboration fatigue is defined in this study as opinions that question the efficiency, effectiveness and long-term viability of collaboration as a regional water management strategy. Sixteen percent of respondent identified a lack of trust between water users as inhibiting collaboration.

The act of collaboration is a time-intensive activity often assigned to an individual in addition to other management duties. Twenty-two percent of research participants felt that maintaining the long-term and intensive involvement needed to cultivate collaborative institutions negatively affected their other duties. In addition, the Deschutes Basin has relied on personal and informal working relationships between individuals to develop the collaborative approach. While this has many advantages, namely that it fosters trust between individuals that enabled people to be flexible and respond to water management issues creatively; it also had weaknesses that 5 percent of the research participants identified. Informal, personal institutions are not transferable. When a collaborator leaves, he takes his institutional capitol with him, resulting in a loss of function in the institution. Some level of formality and organization is needed to define individual duties in an institution and working relationships so that institutions can continue to function effectively as individuals move in and out of different roles.

Seventeen percent of research participants questioned the effectiveness of collaboration as a resource management strategy. An important distinction needs to be made here. The respondents uniformly agreed that consensus building and collaboration was the only real way to develop management goals for a shared resource like water. Their concerns had more to do with ability of voluntary and collaborative organizations to quickly and effectively manage a shared resource. During the process of collaboration it can take a long time to establish commonalities between collaborators from different backgrounds and create shared management goals. That is an expected occurrence, although it can be frustrating for those participating in the process. Thirty three percent of water mangers expressed concern that collaborative management can easily stall, and fail to deliver concrete outcomes.

When asked to speculate about the future of water management in the Basin, 5 percent of the respondents thought there would be conflict over water, and that a cap on growth would be the ultimate solution to managing a finite resource like water.

Table 10 presents the variables that discourage irrigation districts from participating in water transactions in the Deschutes Basin. Major findings include: 1) the connection between the loss of assessment fees and permanent transfers, and 2) difficulty in obtaining funding for conservation projects.

Table 10. Variables discouraging irrigation district participation in water transactions, Irrigation District respondents (n=6)

	Code	Count	Percent (%)
Physical Attributes	Water speculation, lose of assessment fees.	6	100
	Central Oregon recession slowed urbanization.	5	83
	Water speculation raises the price of water.	2	33
	ID is already efficient, no reason to participate in the Conserved Water Program.	1	17
Community	IDs are not responsible for supplying the cities	4	67

Attributes	with water.		
	Agriculture needs to be preserved in the Basin.	2	33
Rules-in-use	DWA needs funding, clear goals.	5	83
	Bureaucratic roadblocks (too slow or not flexible).	4	67
	Competition for limited funding (conservation program)	4	67
	DRC and DWA seem repetitive.	2	33
	DWA is only focusing on the main stem of the Deschutes in the upper Basin (exclusion).	2	33

Research Question 3. Identification of action arenas and the relationships between multiple action arenas and actors.

Action situations involving more than one institution in the Deschutes Basin fall into four categories: geographical proximity, functional similarity, regional collaboration, and regulator-to-regulated relationships (Table 11). Relationships between institutions that are in geographical proximity to one another were defined by shared access to, and co-management of the same surface or groundwater sources for different uses. These relationships focus on organizations (cities, irrigation districts) rather than individuals (rate payers, patrons) and can be somewhat contentious. Organizations that serve the same function in different areas of the Basin have close working relationships with one another to advocate for mutually beneficial policies within the larger management community. Most organizations are involved in regional collaboration, but the level of commitment varies over time and location. If the regional organization is not engaging an organization or addressing an issue important to the organization then the relationship is not as valuable to the organization. The relationship between regulators and the regulated can be close when regulators work with the regulated to find solutions to problems, but when regulators rely on enforcement the regulated organizations work with each other to avoid regulatory consequences.

Table 11. Frequency of actor identification in datasets as indicator of relationships between actors

Count of actor appearance in ID and non-ID datasets.			
	Agency	Irrigation District Responses	Non Irrigation District Responses
Federal Agencies	NOAA	5	1
	DEQ	2	4
	USFS	3	15
	BLM	7	3
	Bureau of Reclamation	22	26
State Agencies	OWEB	38	18
	ODFW	3	6
	OWRD	40	67
Companies	PGE	14	34
	Avion	3	11
NGOs	WaterWatch	9	5
	FreshWater Trust	4	1
	Trout Unlimited	4	0
	American Rivers	4	0
Tribes	Confederated Tribes of Warm Springs	19	25
Individual Stakeholders	Farmers/patrons	93	21
	City Dwellers/customers	0	19
	Farmers/non-patrons	6	12
Municipalities	City of Bend	45	65
	City of La Pine	0	5
	City of Redmond	13	22
	City of Sisters	7	2
	City of Prineville	16	29
	City of Madras	6	0
Irrigation Districts	Swalley	49	20
	Tumalo	35	11

	Arnold	12	6
	COID	52	33
	Ochoco	46	41
	Three Sisters	29	14
	North Unit	30	18
Regional Organizations	DRC	104	88
	DSWCD	10	4
	COCO	0	6
	DWA	74	89
	DBBC	90	20
	Watershed Councils	18	28

CHAPTER 9. CONCLUSION

The Deschutes Basin has developed a market-based approach for meeting the water demands of different water users in the Basin while still respecting existing water rights. This market relies on voluntary participation from irrigation districts. This study sought to identify the variables that encourage or discourage irrigation district participation in water transactions with the IAD framework. The IAD Framework provided the conceptual structure to identify the formal institutions, informal institutions, physical characteristics, rules-in-use and community attributes that result in water transactions and the relationships between different levels of decision-making in the Deschutes Basin. Research participants were also asked to describe the relationships and interactions between operational decisions, policy formation decisions and constitutional decisions in the Deschutes Basin. Data were collected through open-ended interviews with Basin irrigation districts and a broad section of other water managers and then qualitatively coded to identify important themes and relationships.

Results from the operational level of analysis indicate that irrigation districts are primarily motivated by a fiduciary responsibility to their patrons. Water transfers and leases are seen as tools that can mitigate the negative consequences of urbanization and avoid enforcement of environmental regulations related to the reintroduction of anadromous fish into the Deschutes River. Conservation projects help boost instream flows and allow irrigation districts to improve their water supplies and reduce costs.

At the policy level of analysis, research participants recognized the value of collaboration in developing shared goals and mutually beneficial water management policies. However, they expressed concerns about the functionality of regional water management organizations in the Deschutes Basin. Future research into this issue could develop recommendations for improving regional water management in the Basin.

Fort Vannoy v. OWRD, was an important constitutional level decision that determined who has access to the collective-choice action arena and who may participate in the Deschutes Groundwater Mitigation Bank (DGMB). According to the Oregon Supreme Court, irrigation districts hold the agricultural water rights certificates and have the right to approve any changes to the certificates. By changing who has access to the collective-choice action arena in the Deschutes Basin the criteria used to define successful outcomes have also changed to reflect the priorities of the remaining participants. Further research into the access and equity within the Deschutes Basin could investigate how excluding landowners from the water management decision-making arena has changed the definition of successful outcomes in the Basin.

Findings that can inform future research:

- Understanding the physical characteristics of a region allows for the development of novel, region appropriate solutions to local water use problems.
- Open access to all information for all water users prevents conflict.
- Individuals within organizations prioritize decisions that are for the good of the organization as a whole.

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APPENDIX 1 – GLOSSARY OF ACRONYMS AND KEY TERMS

Acronyms

COCO - Central Oregon Cities' Organization

COID – Central Oregon Irrigation District

CRWC – Crooked River Watershed Council

DBBC – Deschutes Basin Board of Control

DEQ-Department of Environmental Quality

DGWMB- Deschutes Groundwater Mitigation Bank

DRC – Deschutes River Conservancy

DWA – Deschutes Water Alliance

ESA – Endangered Species Act

HPC – Habitat and Conservation Plan

ID – Irrigation District

NGO – Nongovernmental Organization

NIMBY- Not in My Back Yard

OWEB – Oregon Watershed Enhancement Board

PGE – Portland General Electric

TMDL- Total Maximum Daily Load

UGB - Urban Growth Boundary

Key Terms

Water Banks operate as trading platforms that enable buyers and sellers to find each other and help the buyers and sellers gain regulatory approval for the transaction (ACCC, 2010).

Water Brokerages work on behalf of a client (either a seller or a buyer) to find trading partners and facilitate the water transaction (ACCC, 2010).

Water Transactions encompass a wide array of agreements that result in the movement of water from one use to another. They are characterized by open or closed water markets, transaction intermediaries can be water banks or water brokerages, and the transaction mechanism can include permanent and temporary transfers of water.

Rules are the shared understandings that actions in particular situations must, must not, or may be undertaken and that sanctions will be taken against those who do not conform (Buck & Ostrom, 1998)

Norms are internal valuations that an individual associates with an action or choice, often learned through interactions with others (Buck & Ostrom, 1998).

Strategies are regularized plans that individuals make within the structure of incentives produced by rules, norms, and expectations of the likely behavior of others in a situation affected by relevant physical and material conditions (Sabatier, 2007).

APPENDIX 2 – INTERVIEW QUESTIONS

Identification of economic, social, and political factors that influence irrigation district participation in water transactions with other stakeholder groups in the Deschutes Basin.

Semi-Structured Questions for:
Irrigation district managers and other water managers in the Deschutes Basin.

1) I would like to start out by learning more about you and your background.
   a) What lead you to become involved in managing an irrigation district?
   b) What is rewarding about this type of work?
   c) What is your educational background?
   d) What other types of agricultural work are you involved in?
      -farming as a primary source of income
      -farming as a supplementary source of income
      -farming for personal enjoyment
      -any other profession associated with agriculture

2) Tell me about your irrigation district or organization.
   a) What are the irrigation district demographics?
      -total size of irrigation district, typical size of farms and crops grown, acre-feet of water diverted annually, priority dates of water rights.
   b) How is the irrigation district organized and funded?
   c) Irrigation district history?
   d) How has land use patterns changed within the irrigation district in the last twenty years?

3) Next, I would like to learn more about the irrigation district's relationship to other water users in the Basin.
   a) What stakeholder groups are interested in water management in your basin?
   b) What are the organizations and formal agreements that outline cooperation between irrigations districts and other water users in the basin?
   c) What types of water transactions has your irrigation district been involved in the last ten years?
      -Agriculture to agriculture (as either a water seller or water buyer).
      -Agriculture to non-agriculture water use in a private agreement.
      -Agriculture to non-agriculture water use mediated by a third party water market.
      -Any other type of water transaction?

d) For any type of water transaction what is/was your irrigation districts level of participation?

-Is your irrigation district still participating?

-How long did your irrigation district participate in the water market?

-Did your irrigation district lease water or permanently sell water rights?

4) If appropriate, I would like to learn more about your experiences with water transactions with non-agricultural water users in a private agreement.

a) Could you describe the water transaction in more detail?

b) What was your rational for your decision to participate (or not participate) in the water transaction?

-What factors ultimately made you decide on a particular course of action?

-Did you have any concerns about the water transaction?

-Anything you were enthusiastic about.

c) What did you think about the experience you had with the water transaction?

-What where your expectations for the water transaction?

-Where your expectations met?

5) If appropriate, I would like to learn more about your experiences with water transactions with non-agricultural water users mediated by a third party water market.

a) What was your rational for your decision to participate (or not participate) in the water transaction?

-What factors ultimately made you decide on a particular course of action?

-Did you have any concerns about the water transaction?

-Anything you were enthusiastic about.

b) What did you think about the experience you had with the water market?

-What where your expectations for the water market?

-Where your expectations met?

c) How would you change the water market to increase participation of irrigation districts?

6) What is the purpose of the water market?

-Deal with drought

-over-allocation

-environmental or recreational flows

-get water to cities

-aid in agricultural water transfers
-other purposes, if so, what?

7) Does the water market offer a fair price for water?
a) What should be included in a fair price for water?
- Market value vs. non-market value of water.
b) How should the value of leased water and permanently sold water rights be calculated?

8) Tell me about the affects of irrigation efficiency projects (piping canals or installing new irrigation technology) on the local community?
a) How do efficiency projects affect property values?
b) In your experience what has been the public opinion of irrigation efficiency projects?
c) Injury to a third party due to reduced groundwater recharge and increased consumptive use.

9) What is the most valuable aspect of restoring river flows?
-Preserving recreation opportunities.
-The economic well being of the community.
-Restoring the river for its own sake.
-Other.

10) That is all the questions I have for you. Do you have any questions for me?

APPENDIX 3 – CODING GUIDE

Purpose

This coding guide provides a systematic way to identify and summarize the opinions of the research participants. It does this by first providing a dichotomous key to organize concepts. A table is also included that defines variables in the dichotomous key and shows examples of text that would, or would not be acceptable in each conceptual slot. Once responses have been organized according to the dichotomous key they are placed in a table that allows each conceptual slot to be examined in isolation and summarized through the development of a code. A code is a central issue, theme or theory.

Coding directions

1) Examine transcripts, audio recordings and field notes in detail.
2) Identify segments of text containing single concepts (opinions, relationships, or facts).
3) Summarized concepts for brevity and then tag each segment with three codes.
    a. The research participant's identification number.
    b. A time stamp (when an event occurred, or the period of time an opinion or perception was held by the research participant).
    c. Add positive (+) or negative (-) signs to indicate the emotional context of the concept. The number of positive or negative signs used (up to three) indicates the degree of importance of the concept to the research participant.
        i. Identify positive or negative codes while reviewing the audio tracks and reading field notes.
4) Organize concepts in a dichotomous key (Figure 1 of this guide). Table 1 provides definitions of variables and examples of acceptable and

unacceptable text for each level of the dichotomous key to aid in intercoder reliability.

a. Concepts were first divided according to research participant (irrigation distract v. non-irrigation district).
b. Separate each concept by its relevancy to the three central research topics (concepts can be applied to more than one research question):
    i. Variables that encouraged or enabled irrigation districts' voluntary participation in water transactions.
    ii. Variables that discouraged or inhibited irrigation districts' voluntary participation in water transactions.
    iii. Identification of action arenas and the relationships between multiple action arenas and actors.
c. Separate concepts into categories that correspond to the three broad categories of variables from the IAD framework:
    i. the physical and material conditions of the environment,
    ii. attributed of the community (culture) and,
    iii. rules-in-use.

5) Place concepts into the appropriate sections of Table 2 and analyze.
    a. Group similar concepts together within each response section of Table 2.
    b. Develop a code that summarizes the groups of similar concepts (add to codes column).
    c. Count the number of times a concept is mentioned (add to count column).

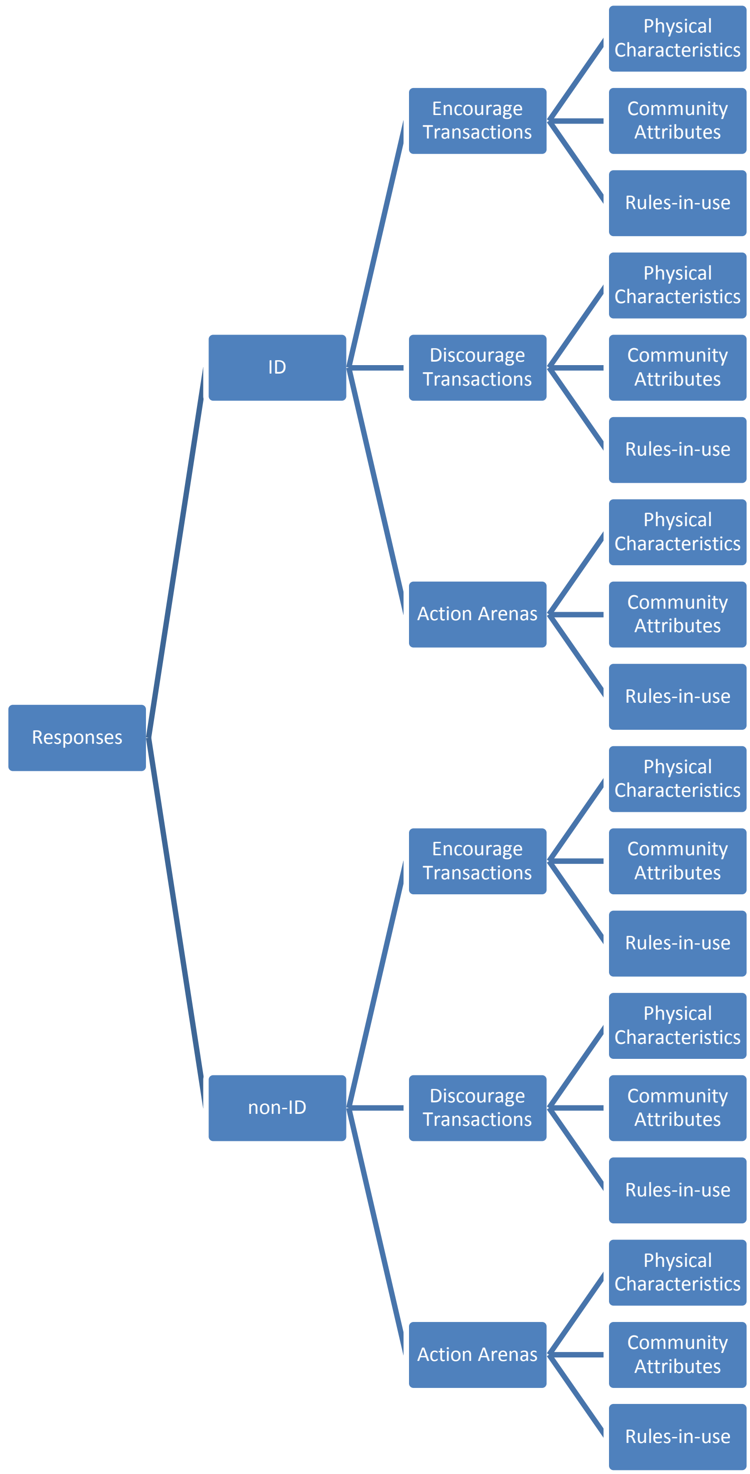

Figure 1. Data analysis dichotomous key.

Table 1. Variable definitions

Variable	Level of specificity	Definition	Examples of acceptable text	Examples of unacceptable texts
Response	1	-The separation of interviews into discrete concepts (opinion, relationship, or fact). -tag response with time code, and respondent identification number.	-DBBC is made up of all 7 IDs and the City of Prineville. -DBBC is working on the HPC. -it is not our responsibility to supply water to the cities.	-DBBC is made up of all 7 IDs and the City of Prineville and the DBBC is working on the HPC.
Irrigation District	2	-Irrigation district personnel.	------	-------
Non-Irrigation District	2	-All other interview participants (NGOs, municipalities, state or federal agency, consultants, landowners)	------	-------
Variables that encouraged or enabled ID participation in water transactions.	3	-All formal or informal institutions, physical characteristics and attributes of community. -These variables can influence the outcome by their presence or absence.	-Over allocation of surface water. -Urbanization. -Water supply improvement. -Lack of efficiency. -Water for fish. -Protect assessment base.	-Bureaucratic roadblocks. -Preserve water right, valuable asset. -Distribution system is already as efficient as possible.
Variables that discouraged or inhibited ID participation in water transactions.	3	-All formal or informal institutions, physical characteristics and attributes of community. -These variables can influence the outcome by their presence or absence.	--Bureaucratic roadblocks. -Preserve water right, valuable asset. -Distribution system is already as efficient as possible.	-Over allocation of surface water. -Urbanization. -Water supply improvement. -Lack of efficiency. -Water for fish. -Protect assessment base.
Action	3	-Action arenas are	-The Conserved	-Protect

arenas, relationships between action arenas and actors.		social spaces where individuals interact, trade, cooperate, and compete.	Water Program helps us pipe irrigation ditches. -OWEB funds our efficiency projects.	assessment base. -Preserve water right, valuable asset.
physical and material conditions	4	Hydrogeological information, demographic trends, climate data, economic considerations.	-The subbasin is flashy and experiences seasonal floods. -UGB is expanding into our ID. -Assessment base is damaged by urbanization.	We manage the dam for flood control and irrigation.
community attributes	4	Behavior accepted in the community, common understanding, homogeneity of preferences, distribution of resources, and culture of the community.	-We try to be good neighbors. -We all want win-win solutions. -We are not responsible for the city's water supply.	-The DGWMB is a tool that lets us deal with urbanization. - We manage the dam for flood control and irrigation.
rules-in-use	4	formal and informal institutions that organize relationships between actors and govern their behavior in the action arena (organizations, rules, norms and strategies)	-We work with the DRC. -Our organization strives for transparency. - We manage the dam for flood control and irrigation. -The DBBC meets so often we have a close, comfortable working relationship.	-We try to be good neighbors. -We all want win-win solutions. -We are not responsible for the city's water supply.

Table 2. Example of table used to code either irrigation district or non-irrigation district responses

	Responses	Codes	Count
Variables that encouraged or enabled ID participation in water transactions.			
physical and material conditions			
community attributes			
rules-in-use			
Variables that discouraged or inhibited ID participation in water transactions.			
physical and material conditions			
community attributes			
rules-in-use			
Action arenas, relationships between action arenas and actors.			
physical and material conditions			
community attributes			
rules-in-use			