## A Research Report by



# Agriculture and Irrigation in Oregon's Deschutes and Jefferson Counties



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HEADWATERS ECONOMICS

### Agriculture and Irrigation in Oregon's Deschutes and Jefferson Counties

May 2017

#### **ABOUT HEADWATERS ECONOMICS**

Headwaters Economics is an independent, nonprofit research group whose mission is to improve community development and land management decisions in the West.

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#### **EXECUTIVE SUMMARY**

This report describes irrigation practices and farming productivity in irrigation districts withdrawing Deschutes River water for use in Deschutes and Jefferson counties located in Central Oregon in the Upper Deschutes River Basin. We compare socioeconomic data and agricultural trends between Deschutes County, situated along the Upper Deschutes River, and Jefferson County, located downstream. Findings from this report suggest the present system of water allocation encourages ineffective water use for upstream senior water rights holders while driving water conservation measures for downstream junior water rights holders. Important lessons therefore can be learned from downstream water conservation strategies that, if applied basin-wide, could improve how water is distributed and used within the region.

This report is also intended to inform understanding of water management of the Deschutes River within Deschutes and Jefferson counties. We demonstrate how minimal water flows necessitate conservation strategies and improved water efficiencies for junior water right holders. We similarly show how agricultural yield and economic value are highest on farms receiving the least amount of irrigated water. In doing so, we hope to inform dialogue around a more balanced approach of water appropriation and use of the Deschutes River.

Seven irrigation districts divert water from the Deschutes River and collectively serve 123,334 acres of cropland, pasture, and residential landscapes in the Upper Deschutes River Basin.<sup>1</sup> The two largest irrigation districts are the Central Oregon Irrigation District (COID), located primarily in Deschutes County, and the North Unit Irrigation District (NUID), located in Jefferson County. Together, the two irrigation districts account for nearly 84 percent of all water diverted from the Deschutes River. Yet how this water is used and applied reflects significant differences between the two districts. For instance, the COID diverts 304,195 acre-feet (AF) to irrigate approximately 45,000 acres, while the NUID diverts 188,046 AF to irrigate nearly 60,000 acres.<sup>2</sup> Other key findings from this report include:

- The irrigation districts in Deschutes County serve a more urban and developed area, with diverse needs and relatively less economic dependence on agricultural production. By contrast, the NUID in Jefferson County largely serves farmers who depend on irrigated water for crop production.<sup>3</sup>
- Between 2006 and 2013, farmers in Jefferson County harvested an average of nearly 13,000 acres of specialty crops, such as vegetable and grass seeds, per year and diverted 60 percent less water from the Deschutes River compared to farmers in Deschutes County who averaged 239 acres of specialty crops per year.<sup>4</sup>
- Gross income from agricultural commodity sales totaled \$74.4 million in Jefferson County and contributed more than \$260 million to the Central Oregon economy in 2012. At the same time, agricultural commodity sales in Deschutes County averaged \$26.1 million and contributed \$91.3 million in total economic impacts.<sup>5</sup>
- As junior water rights holders, farmers with NUID apply water conservation strategies such as canal lining, pressurized pumps, drip irrigation systems, and lateral piping to achieve an average 93.8 percent water efficiency. In contrast, senior water rights holders in Deschutes County irrigation districts have averaged as low as 42.9 percent water efficiency.<sup>6</sup>

Given the uncertainty of meeting annual irrigation needs, Jefferson County farmers with NUID have adopted water conservation measures to sustain agricultural productivity and economic livelihood. Implementing similar water use practices across all the irrigation districts could alleviate supply concerns of junior water rights holders and benefit the overall health of the Deschutes River.

#### I. INTRODUCTION

Water management of Oregon's Deschutes River is complicated by diverse economic conditions. Multiple demands on the river have altered historic flow regimes and impacted the quantity and quality of water. The legacy of water rights within the Deschutes River Basin dictates who benefits and who sacrifices when it comes to water shortages.

Running along the eastern slopes of Oregon's Cascade Mountains to its northern confluence with the Columbia River, the Deschutes River is one of the state's premier waterways. Segments of the river are renowned for world-class fly fishing and whitewater opportunities, among other recreational pursuits.

The Deschutes River has been used heavily by farmers for more than a century. Water rights for irrigation greatly exceed available water. Withdrawals from seven different irrigation districts primarily on the upper section of the river serve nearly 125,000 acres annually.<sup>7</sup> Diversion of the river for irrigation purposes generates both controversy and opportunities for collaboration.

#### II. BACKGROUND

#### The Deschutes River Basin

The Deschutes River begins its southern descent from the Little Lava Lake, within the Cascade Range, and runs approximately 8.5 miles to Crane Prairie Reservoir and then approximately 2 miles downstream to Wickiup Reservoir.<sup>8</sup> Upon leaving Wickiup Reservoir the river changes course and runs northward for 60 miles to the City of Bend. From Bend, the river continues to flow north into Lake Billy Chinook, then through the town of Maupin, and empties into the Columbia River more than 250 miles from its source (Figure 1).

Historically, the Deschutes River maintained one of the most consistent and stable water flows within the region. The unique underlying volcanic physiography and porous soil profile allow surface water to percolate into the subsurface and recharge the water table. Under natural conditions and prior to the construction of the Wickiup Dam in 1947, estimated historical flows for the Upper Deschutes River averaged 660 cubic feet per second (cfs) in the wintertime and 730 cfs in the summertime.<sup>9</sup> However, heavy irrigation and diversion of the river have altered annual water flows. In winter months the river below Wickiup Reservoir experiences water flows as low as 14 cfs with higher flows in the summer when the irrigation canals are opened. Median water flows in July and August are in the 1,400 cfs range, reaching a maximum flow of around 2,000 cfs.<sup>10</sup>

Exacerbating the need to rely on irrigation systems is central Oregon's arid climate. Often referenced as a high desert, annual precipitation in the Upper Deschutes River Basin ranges from around 60 inches at its highest elevations near the Three Sisters mountains to less than 15 inches in the Basin's lowlands.<sup>11</sup> The lack of rainfall is largely due to the rain shadow effect of its leeward location on the eastern slopes of the Cascade mountains. In addition, the relatively dry and warm climate of the Deschutes River Basin is combined with a high number of sunny days. On average, the region enjoys nearly 300 days of sunshine with temperatures usually averaging between 45 to 85 degrees Fahrenheit in the summer and 20 to 40 degrees Fahrenheit during the winter months.<sup>12</sup>



Figure 1: The Deschutes River in Deschutes and Jefferson Counties, Oregon.

#### Irrigation Districts in Deschutes and Jefferson Counties Diverting Deschutes River Water

Seven irrigation districts in Deschutes and Jefferson counties divert water from the Deschutes River (Figure 2). A majority are relatively small providers yet combined, these irrigation districts serve 123,334 acres within Deschutes, Jefferson, and Crook counties.<sup>13</sup> Two districts, the North Unit Irrigation District (NUID) and Central Oregon Irrigation District (COID), account for more than 84 percent of the total acreages irrigated by the seven districts. In general, the COID serves irrigators in Deschutes County, with the exception of delivering water to about 250 acres in southern Jefferson County and another portion located in Crook County.<sup>14</sup> The NUID is located north of the COID and exclusively serves irrigators in Jefferson County. Together, the NUID and COID provide water to almost all of the commercial farms located in the Upper Deschutes River Basin served by the Deschutes River. The NUID irrigates nearly 60,000 acres of agricultural lands and COID irrigates around 45,000 acres.

The other five irrigation districts include Arnold, Lone Pine, Swalley, Tumalo, and Walker Basin irrigation districts, which collectively irrigate less than 20,000 acres of farmland in Deschutes County. In addition, there is the Ochoco Irrigation District, which diverts water from the Crooked River and its tributaries, and the Three Sisters Irrigation District, which diverts water from Whychus Creek. Combined, there are nine irrigation districts that operate in the Upper Deschutes River Basin and serve nearly 150,000 acres.<sup>15</sup>

The quantity of water each irrigation district is allowed to divert from the Deschutes River is determined through a hierarchical system of water rights. Similar to many western states, water rights in Oregon are mandated through prior appropriation laws, decreeing the "first in time, first in right" prioritization of water. In the Upper Deschutes River Basin, the oldest water rights date back to the turn of the century while the youngest water rights were awarded as recently as the 1960s. A majority of water rights were granted between 1905 and 1915.<sup>16</sup>

Figure 2: Irrigation Districts Within the Upper Deschutes River Basin, Excluding the Walker Basin Cooperative, Including priority Water Rights Date.



For the irrigation districts, and in particular NUID and COID, the appropriation of water rights is significant to the management and economic sustainability of their farms. Irrigators within the COID are senior water right holders and retain some of the earliest water privileges from the early 1900s. In general, water deliveries to COID rights holders average four acre-feet (AF) per acre.<sup>17</sup> By contrast, irrigators with NUID hold junior water rights dating from 1913 and receive water deliveries that average around two AF per acre.<sup>18</sup> In addition, both irrigation districts hold storage water rights, meaning that when the natural flow of the river is unable to satisfy the water rights allocate up to 200,000 AF from the Wickiup Reservoir. Storage water rights for COID are up to 26,000 AF from Crane Prairie Reservoir.<sup>19</sup> Essentially, irrigation needs for COID and the other irrigation districts within Deschutes County are provided by diverting water from the Deschutes River, while irrigation needs for NUID irrigators are largely served from water stored in the Wickiup reservoir during the winter. Water is released from Wickiup for NUID in the summer, increasing river flow until it is diverted into the main irrigation canals in Bend.

As downstream users with junior water rights who depend on the reservoir for water, irrigators with NUID are unfavorably positioned to receive adequate water supply. The uncertainties of a reliable water supply make it challenging for NUID irrigators to plan cropping operations and other farming activities.

#### III. DATA AND METHODS

This report draws on published statistics from a variety of sources. The principal demographic and economic data sources include: U.S. Department of Commerce, U.S. Census Bureau, U.S. Department of Labor, and others.<sup>20</sup> Statistics related to agricultural use, crop yields, and irrigation patterns were acquired from U.S. Department of Agriculture, and Oregon State University Extension Service.

All data sources are documented in the References section at the end of this report. For more details on regional data, see the Economic Profile System developed by Headwaters Economics at: <u>https://headwaterseconomics.org/tools/economic-profile-system/about/</u>.

Although much of the following data describes overall socioeconomic and agricultural trends within Deschutes and Jefferson counties and is not specific to individual irrigation districts, it is helpful in understanding the different contexts in which the irrigation districts operate.

#### IV. FINDINGS

#### **Socioeconomic Characteristics**

A comparison of socioeconomic trends between Deschutes County and Jefferson County reveals significant differences in demographic and economic composition that reflect similar transitions taking place across the American West. Areas rich in recreational opportunities, scenic amenities, and other quality of life values, such as Deschutes County, often experience an increase in population, personal income, and employment. Areas with fewer recreational and scenic pursuits, and which tend to predominantly dependent on agriculture, timber, and other natural resource-related industries, such as Jefferson County, undergo only moderate growth in local demographics and economy.

According to the most recent U.S. Census Bureau reports, Deschutes County is one of the fastest growing areas in the country with a population increase of 452 percent since 1970 (Figure 3).<sup>21</sup> Much of this growth has been directed toward the City of Bend and surrounding metropolitan area. From 2000 to 2014 alone, the county gained 53,770 people, or a 46 percent increase. A majority of the growth during this time period, nearly 85 percent, is attributed to people migrating to Deschutes County from outside the county.<sup>22</sup>



Figure 3: Population Trends for Deschutes and Jefferson Counties, OR (1970-2014)

Since 1970, Jefferson County has grown at about a third the rate of Deschutes County. From 1970 to 2014, Jefferson County grew by 13,500 people or a 158 percent increase. In recent decades, population growth has slowed down, adding 3,000 people since 2000. Unlike Deschutes County, however, nearly all of the population growth in Jefferson County from 1970 to 2014 was attributed to net natural changes in births exceeding deaths rather than migration.<sup>23</sup> While people have not been moving to Jefferson County in large numbers, people are not moving out of the county either.

Trends in the local economy mirror changes in Deschutes and Jefferson counties' population base. In Deschutes County, employment grew 654 percent from 1970 to 2014. From 2001 to 2014, nearly 26,000 jobs were added to the employment base, a 34 percent increase. During this same time period, almost half of the employment (47 percent) was in services-related industries such as retail trade, medicine, finance, and insurance (Figure 4). Growth in other job sectors included government employment with a 22 percent increase and non-services-related industries, such as farming, mining, construction, manufacturing, and timber, with a 5 percent increase.



Figure 4: Employment Trends by Major Industry for Deschutes County, Oregon (2001-2014)

Source: U.S. Department of Commerce. 2015. Bureau of Economic Analysis.

Jefferson County employment trends were significantly more modest in comparison. From 2001 to 2014, overall employment grew by 246 jobs, from 8,325 to 8,571, or a 2.95 percent increase (Figure 5). While jobs in services-related industries grew by 13 percent, employment in government and in most non-services-related industries declined. During this time period, jobs in government decreased by 6.2 percent and employment in Jefferson County's construction and manufacturing sectors was reduced from 1,809 jobs in 2001 to 1,288 jobs in 2014, or a 28.8% decline. Employment decline was not consistent across all non-services-related industries, however. Farming, for example, slightly grew from 723 jobs in 2001 to 773 jobs in 2014, remaining one of Jefferson County's more stable employment sectors during this time period.<sup>24</sup>

The recent Great Recession impacted Deschutes and Jefferson counties in different ways. For much of the 1990s and 2000s, Deschutes County experienced an increasingly diversified economy with strong job growth in construction, real estate, health care, and other industries. Variation in the employment base was largely a reflection of the area's growing appeal as a recreational hub and tourist destination, as jobs in accommodation, food, and trade were growing. Yet, when the recession hit in late-2007 and 2008, Deschutes County was among the most impacted areas in the country. Unemployment in the county reached a historic high of 16.7 percent in 2009, well above the national average of around 9.5 percent.<sup>25</sup> Jobs in construction precipitously dropped, declining more than 42 percent from 2005 to 2010. The loss of job opportunities did not deter some people from moving to or staying in Deschutes County, however, and by 2011 most employment sectors were beginning to show signs of recovery. Data from 2014 indicates that while jobs in construction, manufacturing, and farming had yet to reach their pre-recession levels, employment in services-related industries such as retail and wholesale trade, transportation, finance, real estate, education, and health have surpassed where they were before the recession.<sup>26</sup>



Figure 5: Employment Trends by Major Industry for Jefferson County, Oregon (2001-2014)

Source: U.S. Department of Commerce. 2015. Bureau of Economic Analysis.

In Jefferson County, the economic impacts of the Great Recession were more nuanced. With the exception of manufacturing, most employment sectors in Jefferson County were not significantly impacted, although many did experience a slight downturn from 2008 to 2010. The highest decline was in manufacturing jobs, which dropped from 1,722 jobs in 2005 to 901 jobs in 2010, a decrease of nearly 48 percent. Employment in retail trade, accommodation, and construction similarly declined but not as significantly. Interestingly, jobs in government grew during the recession, from 2,534 jobs in 2005 to 2,617 jobs in 2010. By 2014, employment in non-services-related industries such as construction and manufacturing was still recovering, but employment in farming and most services-related industries such as tourism, accommodation and food, and public administration, had exceeded pre-recession levels.<sup>27</sup>

Deschutes County's growing professional and non-services-related workforce is associated with a robust local economy. From 1970 to 2014, labor earnings, or total net revenue from wage and salary employment, grew from \$542 million to \$3.77 billion, an increase of 596 percent. During the same time period, non-labor income, or investment, retirement, social security, medical payments, and other transfer payments substantially rose from \$220 million in 1970 to more than \$3.3 billion in 2014, a 1,416 percent increase (Figure 6).<sup>28</sup> The dramatic rise in non-labor income suggests Deschutes County's ongoing appeal as a recreation and retirement destination.

The average earnings per job in Deschutes County has seen little change from 1970 to 2014, only increasing from \$41,588 to \$41,721 (Figure 7). By contrast, per capita income, which includes labor earnings as well as non-labor income, has grown from \$24,659 in 1970 to \$41,675 in 2014, an increase of nearly 70 percent.<sup>29</sup>



Figure 6: Labor Earnings and Non-Labor Income for Deschutes County, Oregon (1970-2014)

Source: U.S. Department of Commerce. 2015. Bureau of Economic Analysis.

Figure 7: Average Earnings Per Job and Per Capita Income for Deschutes County, Oregon (1970-2014)



Source: U.S. Department of Commerce. 2015. Bureau of Economic Analysis.

During recent decades, Jefferson County has similarly demonstrated an increasing reliance on non-labor income rather than income generated from wages and salaries. For example, while labor earnings grew from \$133.4 million to \$332 million between 1970 and 2014, non-labor income increased from \$44.7 million to \$351 million, a 685 percent increase during the same time period (Figure 8).

Average earnings per job have fluctuated in recent decades, from \$38,480 in 1970 to a peak of just more than \$50,000 in 1974, and then returning to \$38,661 in 2014. However, per capita income in Jefferson County has experienced relative stagnation during the past thirty years, averaging around \$30,000 per year, from 1974 to 2014 (Figure 9).<sup>30</sup>



Figure 8: Labor Earnings and Non-Labor Income for Jefferson County, Oregon (1970-2014)

Source: U.S. Department of Commerce. 2015. Bureau of Economic Analysis.



Figure 9: Average Earnings per Job and per Capita Income for Jefferson County, Oregon (1970-2014)

Source: U.S. Department of Commerce. 2015. Bureau of Economic Analysis.

Since the 1970s, Deschutes and Jefferson counties have grown in population, employment base, and per capita income. In Deschutes County, this increase has been exponential and characterizes one of the fastest growing economies in the West. A large percentage of this growth is a result of non-labor income, or wealth from retirement income, investment savings, and other forms of payments not directly tied to a wage or salary. Alternatively, overall growth in Jefferson County has been more moderate. In Jefferson County, natural births account for nearly all of the population growth since 2000 and employment is largely driven by jobs in manufacturing, farming, government, and some services-related industries. While both Deschutes and Jefferson counties demonstrate an upward trend in socioeconomic performance, the pace and scale of growth between the two counties are different.

#### **Irrigation Patterns and Crop Yields**

As stated above, seven different irrigation districts in Deschutes and Jefferson counties, serving nearly 125,000 acres, draw water from the Upper Deschutes River. Demand is highest during the warm and dry months of June, July, and early August, and lowest in the spring and fall. The Central Oregon Irrigation District (COID) annually diverts an average of 304,195 AF of water from the Deschutes River to irrigate 44,784 acres. Alternatively, the North Unit Irrigation District (NUID) annually diverts an average of 188,046 AF to serve 58,868 acres.<sup>31</sup> Together, the two irrigation districts account for 84 percent of all irrigated water diverted from the Upper Deschutes River. Yet, how the irrigation districts use and distribute irrigation water varies significantly.

Since the 1950s, land irrigation patterns in Deschutes and Jefferson counties have paralleled broader socioeconomic changes taking place across the region. In Deschutes County, from the mid-1970s until the Great Recession, the number of irrigated farms increased sharply from 362 farms in 1974 to a historic high of 1,425 farms in 2002 (Figure 10). This upward trend reflected the county's booming population, which continued to climb from 1970 until late 2007,<sup>32</sup> and the ongoing fragmentation of farms under real estate development pressure and other impacts from urbanization.

Comparatively, in Jefferson County, the number of irrigated farms has remained relatively unchanged, going from 298 farms in 1974 to 311 farms in 2002. By 2012, Deschutes County reported 1,025 irrigated farms and Jefferson County reported 304 irrigated farms.<sup>33</sup> The trend in irrigated farming units in Jefferson County implies a pattern of land consolidation as individual farms acquire more acreage and add to the overall agricultural land base within the county.





The average size of individual irrigated farms is significantly smaller in Deschutes County relative to Jefferson County. For example, a report by Alyward (2006) indicated that one-third of total irrigated acreage in Deschutes County was on farms between 10 and 50 acres in size, in contrast to Jefferson County where irrigated acreage was on farms between 260 and 2,000 acres.<sup>34</sup>

In addition, much more of Deschutes County's irrigated land is distributed to both cropland and pasture. On average from 1978 to 2012, approximately 56 percent of irrigated land in Deschutes County is cropland and 44 percent is pastureland or grazing land for livestock (Figure 11). Jefferson County is almost exclusively cropland with 90 percent of irrigated land dedicated to crop production and only 10 percent reserved for pasture or grazing.<sup>35</sup>



Figure 11: Percent of Irrigated Land in Pasture vs. Cropland in Deschutes and Jefferson Counties, OR.

In Jefferson County, the large land allocation for cropland is demonstrated with the county's diverse annual yields. Among the myriad of crops grown in Jefferson County, vegetable seeds, grass seeds, garlic, wheat, alfalfa, potatoes, oil crops, and flower seeds are the most common. Cultivating a hybrid carrot seed is particularly popular and lucrative in Jefferson County. Approximately 85 percent of hybrid carrot seeds planted in the United States<sup>36</sup> and 40 percent of the global market<sup>37</sup> are grown within Jefferson County and nearby counties. More than 4,700 acres of hybrid carrot seeds were planted in Jefferson County in 2013, grossing nearly \$15 million.<sup>38</sup>

In Deschutes county, only 110 acres of carrot and vegetable seeds were grown in 2013. However, other specialty crops are grown in Deschutes County, defined as fruits, vegetables, tree nuts, dried fruits, and horticulture and nursery crops (including floriculture)<sup>39</sup>, as well as traditional crops like hay and other grains (Figure 12). In total, in Jefferson County, an average of 12,981 acres of select specialty crops were farmed per year between 2006 and 2013 including vegetable seeds, grass seeds, and other field crops. During the same time period, Deschutes County planted an average of 239 acres of specialty crops per year.<sup>40</sup>

Given the variation in the amount and type of irrigated cropland in Deschutes and Jefferson counties, it is unsurprising that the value of crop commodities sold in Jefferson County far exceeds that of Deschutes County. From 2000 to 2012, commodity sales of crops in Jefferson County averaged around \$43 million per year, in real dollars. During this same time period, crop commodity sales in Deschutes County averaged \$11.7 million.<sup>41</sup> When taking livestock sales into account, commodity sales averaged \$55 million for Jefferson County per year and \$20 million per year in Deschutes County from 2000 to 2012. At the same time, the highest crop and livestock sales for both counties was in 2012, when Jefferson County generated nearly \$75 million and Deschutes County grossed more than \$26 million (Figure 13). As a percentage of total gross sales, including both crops and livestock, 77 percent of Jefferson County's

agricultural revenue came from crops and 23 percent came from livestock. In Deschutes County, gross sales were shared evenly between crops and livestock, with 51 percent coming from crops and 49 percent from livestock sales.<sup>42</sup>



Figure 12: Total Acres of Specialty Crops Harvested in Deschutes and Jefferson Counties

Source: OSU Extension Service, Local Agricultural Statistics, 2006-2013.



Figure 13: Value of Crops and Livestock in Deschutes and Jefferson Counties, OR.

Source: OSU Extension Service, Local Agricultural Statistics, 2006-2013.

In estimating the larger economic impacts of agricultural products generated by Deschutes and Jefferson counties, Oregon State University Extension applies a multiplier to measure the total economic impact of agricultural products sold in each county. According to their calculations, between 2000 to 2012, an

average of \$274.5 million was contributed annually by Deschutes and Jefferson counties to the Central Oregon economy.<sup>43</sup> During this time period, agricultural values were at their highest in Deschutes and Jefferson counties in 2012, yielding more than \$351 million in that year alone; commodity sales were at their lowest in 2002 at \$215.2 million. When total economic impacts are disaggregated between the two counties, Jefferson County commodity sales resulted in an economic impact more than twice that of Deschutes County, averaging almost \$194 million in contrast to \$80.5 million (Figure 14). According to the most recent figures in 2012, gross income from agricultural commodity sales in Jefferson County contributed more than \$260 million to the Central Oregon economy, compared to \$90 million from agricultural commodity sales in Deschutes County.<sup>44</sup> As the larger and more diverse producer, Jefferson County consistently outperforms Deschutes County in terms of agricultural sales and economic revenue.





Source: OSU Extension Service, Local Agricultural Statistics, 2000-2012.

Despite volatility in the market, agriculture remains an important way of life for many residents of Deschutes and especially Jefferson counties. In Deschutes County, farming has become less of an economic mainstay as other forms of employment offer higher paying wages and greater long-term security. By contrast, agriculture is vital to the economy and sociocultural fabric of Jefferson County. Farms are often multi-generational family operations, and while the county may not be adding new farms each year, they are not losing farms either. The tradition of farming in Jefferson County cultivates a highly productive agricultural industry with at times high profit returns.

#### V. WATER USE PRACTICES

During recent decades, demographic and economic shifts have shaped land use patterns in Deschutes and Jefferson counties in distinctive ways. In comparison to Deschutes County, the vast majority of agricultural land in Jefferson County is dedicated to growing a wide assortment of crops and in particular hybrid carrot seed. While also irrigating a large land area, Jefferson County has fewer farms producing substantially higher yields and subsequent gross profit. Further, farmers in Deschutes County divert 60

percent more water from the Deschutes River compared to Jefferson County farmers, generating very different agricultural and economic outcomes.<sup>45</sup>

As senior water rights holders, farmers in Deschutes County are afforded priority access to irrigation water, which is increasingly used for farming activities centered around amenities.<sup>46</sup> In downstream Jefferson County, farmers with junior water rights depend on irrigation water from the Deschutes River for their livelihood yet the reliability and consistency of this water is uncertain. The disparate allocation of water rights in contrast to the value of water used on the ground makes it challenging for Jefferson County irrigators to plan for short- and long-term cropping needs.

#### Irrigation Efficiency and Water Conservation

Further exacerbating water security issues across the Upper Deschutes River Basin is water loss resulting from on-farm and canal evaporation, seepage, and other forms of leakage due to inefficient conveyance systems. Up to 95 percent of all the water diverted from the Deschutes River occurs at the Central Oregon canal and the North Canal Dam in Bend, including natural flows as well as stored releases.<sup>47</sup> This water is channeled to the various irrigation districts through a labyrinth of canals and pipelines. Unlined canals are exposed to high losses as water can easily seep into the ground. Lined canals are effective if the whole canal is covered and there is no deterioration in the lining, which is difficult to maintain. On average, seepage losses for the Upper Deschutes River range from 30 to 50 percent of total diversions. In other words, only half to two-thirds of every gallon of water diverted from the river will make it to the fields.<sup>48</sup>

Seepage, evaporation, and other forms of leakage in canals and on-farm losses are ubiquitous among the seven irrigation districts and totals around 336,000 acre-feet (AF) per year. In 2001, the United States Geological Survey (USGS) found that the North Unit Irrigation District (NUID) was among the lowest of the seven irrigation districts for water lost to canal seepage, averaging around 2.1 AF of water loss per acre annually.<sup>49</sup> Alternatively, Central Oregon Irrigation District (COID) averaged higher at 3.81 AF, and Arnold District and Swalley District reported much higher seepage loss at 7.00 AF and 11.22 AF respectively.<sup>50</sup>

In response, a number of water conservation projects have been implemented during the past decade across the Upper Deschutes River Basin. Most common among these has been lateral piping projects intended to improve water conveyance efficiency and augment instream flows.<sup>51</sup> As of 2006, more than 43 miles of piping and canal lining has replaced traditional canal systems to transport water from the river to each irrigation district. Based on estimates of the water conservation projects with reliable data, at least 45,360 AF or 126.53 cfs of irrigated water has been saved annually within the seven irrigation districts plus the Three Sisters Irrigation District. This figure is likely much higher but a lack of data makes it difficult to get a more accurate assessment of total water savings. The total costs to develop these conservation projects, distributed among all of the irrigation districts, totaled around \$15 million.<sup>52</sup>

Several large-scale water conservation projects have been proposed for future implementation in the Upper Deschutes River Basin. Involving nearly 125 miles of new piping and canal lining, these proposed water conservation projects could save up to 110,268 AF of water per year by preventing inadvertent water loss through seepage and evaporation. According to a 2006 report by Newton and Pearle, the costs to develop and maintain the projects were estimated to be around \$100 million.<sup>53</sup> More recently, the COID has proposed two new piping projects with the potential to conserve 82,752 AF of water per year, and cost an estimated \$400 million.<sup>54</sup>

Another cost-effective and immediate approach in mitigating water loss is on-farm conservation measures. These include switching from flood irrigation to pressurized sprinkler systems, upgrading

nozzles in sprinklers, utilizing micro irrigation techniques, like drip systems, and applying weathercontrol systems to better match water demand with crop need.<sup>55</sup> Of the total amount of 336,000 AF of irrigated water lost through seepage and other forms of leakage, 166,560 AF or roughly half is from inefficient on-farm irrigation methods.<sup>56</sup> On-farm losses are by far the lowest in the NUID (94 percent mean irrigation efficiency) and highest in the Central Oregon Irrigation District (43 percent mean irrigation efficiency) (Table 1).<sup>57</sup>

Irrigation District	North Unit (NUID)	Lone Pine	Ochoco	Tumalo	Arnold	Swalley	Central Unit (COID)
% Water Efficiency	93.8%	88.8%	66.1%	60.2%	51.6%	51.0%	42.9%
Potential Water Savings with 70% Efficiency	N/A	N/A	3,369 AF	3,706 AF	4,571 AF	4,979 AF	93,214 AF

Table 1: Percent Water Efficiency Use Per Year by Irrigation District, Upper Deschutes River Basin.

Source: Newton, et al. 2006; BOR, 1997.

Downstream irrigators in Jefferson County, who largely constitute the NUID, are especially efficient in water consumption because they have adapted to increasingly unpredictable irrigation flows. The two principal methods of irrigation used in the NUID include surface and sprinkler methods. During the past several decades, sprinkler irrigation systems which are around 20 percent more efficient have replaced traditional methods such as flood irrigation. By 2011, 65 percent of the district's irrigation involved sprinkler methods.<sup>58</sup>

Further, many sprinkler irrigation systems in the NUID have recently been converted from traditional gravity application methods to pressurized pumps. Nearly 95 percent of the sprinkler-irrigated cropland in the district is pressurized by pumping.<sup>59</sup> Low-pressure pumping and the use of center pivot systems are some of the most efficient irrigation methods available, at 85 to 90 percent efficiency or higher.<sup>60</sup> By contrast, in the COID where irrigation water is more plentiful, approximately 60 percent of the irrigation district users continue to apply the original method of flood irrigation.<sup>61</sup> Unlike sprinkler systems, flood irrigation is only 30 to 45 percent efficient because much of the diverted water is lost to evaporation and leakage.<sup>62</sup>

Drip irrigation systems are some of the most efficient watering methods available (Image 1). Due to its precision application on the ground, drip irrigation is also known as micro or trickle irrigation and uses 20 to 50 percent less water than conventional irrigation systems.<sup>63</sup> While installing the drip system can be time consuming and costly upfront, water efficiency can average around 90 to 95 percent.<sup>64</sup>

Image 1: Example of a Drip Irrigation System



In Jefferson County, drip irrigation is used alongside pressurized pumps to irrigate the most land with the least water loss. If similar or other on-farm conservation measures were applied across all the districts, it's estimated an additional 112,410 to 146,698 AF of water could be saved annually.<sup>65</sup> Opportunities for the greatest improvement in water efficiency on the farm include installing canal lining and lateral piping to

reduce seepage loss, converting surface systems to sprinkler irrigation systems, combining furrow irrigation with a pumpback system, repairing outdated flood irrigation systems and broken sprinkler gaskets, and conducting other operational and maintenance upgrades.

A number of district-wide water conservation measures have been proposed for future implementation on individual farms. These projects generally include improvements in the delivery and distribution of water such as canal lining, extended pipeline construction, and improved collaboration between multiple users. Other proposed on-farm water conservation projects address the need for improved support tools, such as online scheduling applications and digital monitoring of water usage and flow levels, energy audits, tiered rate structures, and other financial and administrative mechanisms.

#### VI. CONCLUSION

The differing development trajectories in Deschutes and Jefferson counties influence land and water use patterns across the region. Despite their adjacency to one another, Deschutes County outpaces Jefferson County with respect to population growth, employment trends, and most other socioeconomic indicators. Deschutes County's diverse workforce and growing appeal as a recreation and migration destination correlate with strong increases in economic performance, particularly in services-related industries such as real estate, trade, and finance. In Jefferson County, agriculture remains a vital component of the economy and local land use base. While population and employment trends remain relatively unchanged, agricultural production has increased in the county as farms are becoming larger and more efficient.

In Jefferson County, parcel sizes have increased as farms consolidate and new farmland is incorporated into existing agricultural operations. In contrast to Deschutes County, the 59,000 acres irrigated by the Deschutes River in Jefferson County is almost entirely cropland. Due to the diversity of crops and high returns on specialty crops like carrot seed, crop commodity sales yield more than \$40 million a year in the county.<sup>66</sup> The impact of Jefferson County's agricultural production is substantial to Oregon's economy and contributes an average of \$194 million per year, in contrast to \$80.5 million generated by Deschutes County's agricultural sales.<sup>67</sup>

The asymmetric relationship between water consumption and economic yield in Deschutes and Jefferson counties is reinforced with an existing system of water rights. As senior water rights holders, irrigators with Deschutes County's COID have priority access to water from the Deschutes River yet are the least efficient water users among the region's seven irrigation districts. Alternatively, farmers with Jefferson County's NUID are junior water rights holders and average nearly 94 percent water efficiency, the highest among the seven irrigation districts within the Upper Deschutes River Basin.<sup>68</sup>

The uncertainty of consistent water flow, especially during dry summer months, has compelled NUID irrigators to integrate water conservation efficiency measures such as drip irrigation, canal lining, and closed pressurized pipelines into their farming practices. In doing so, NUID irrigators are using less water to irrigate a greater amount of productive land. At the same time, there are no mechanisms in place to encourage improved water use by irrigators in Deschutes County who irrigate smaller, less productive land. Introducing incentives to support on-farm conservation measures and other water-saving activities in Deschutes County could help alleviate insecurities downstream for NUID irrigators.

The water conservation strategies employed by NUID farmers demonstrate practical on-the-ground solutions to reducing water loss from seepage, evaporation, and conveyance. Water use practices and conservation measures applied by NUID provide a useful example of potential water savings in the region. If adopted region-wide, these measures could maximize the benefits of irrigated water from the Deschutes River.

#### VII. REFERENCE

<sup>2</sup> Oregon Water Resources. Gage data for COID diversions for the years 1992-2011 was downloaded from gages accessible on the Oregon Water Resources Website. Gage #14069500 and Gage #4066500 were combined; Gage #14069700 and Gage #14069699 were subtracted as they are deliveries through the same system to other districts. Gage data for NUID diversions for the years 1992-2011 was downloaded from Gage #14069000 and Gage #14069699. Daily flows were converted from cfs to acre-feet (AF) (*cfs x 1.98*). This number represents the median rather than the mean to reduce the influence of outliers. Data available online: http://apps.wrd.state.or.us/apps/sw/hydro\_near\_real\_time/.

<sup>3</sup> U.S. Department of Agriculture. 2012. National Agricultural Statistics Service. Census of Agriculture. Washington D.C. County-Level Data. Water efficiencies have presumably increased since the originally cited 1997 study
<sup>4</sup> Oregon State University Central Oregon Agricultural Research Center. 2016. Local Ag Statistics 2006-2013. Available online: http://oregonstate.edu/dept/coarc/local-ag-statistics.

<sup>5</sup> Oregon State University. 2011. Oregon Agricultural Information Network (OAIN), Extension Economic Information Office. Also see Deschutes River Conservancy. 2012. Upper Deschutes River Background Paper. <sup>6</sup> Newton D., and Perle M. 2006. Irrigation District Water Efficiency Cost Analysis and Prioritization. DWA Final Report. Bend (OR): Deschutes Water Alliance. Available online: <u>http://www.deschutesriver.org/Irrigation-District-Water-Efficiency.pdf</u>.; U.S. Bureau of Reclamation.1997. Upper Deschutes River Basin Water Conservation Study, Special Report, Crook, Deschutes, and Jefferson Counties, Oregon. Water efficiencies have presumably increased since the originally cited 1997 study by the U.S. BoR. A new study by the Basin Study Working Group is currently underway and is expected to revise the efficiency estimates for individual irrigation districts.

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<sup>8</sup> Deschutes River Conservancy. 2012. Upper Deschutes River Background Paper. Available online: <u>http://www.deschutesriver.org/Upper%20Deschutes%20River%20Background%20Paper\_FINAL\_Sep12.pdf</u>.

<sup>9</sup> Hardin-Davis, Inc. 1991. Instreamflow Study for the Deschutes River above Bend. Bend, OR: USDA Forest Service, Deschutes National Forest, Bend Ranger District; Deschutes Water Planning Initiative. 2012. Deschutes River Conservancy. Available online: <u>http://www.usbr.gov/watersmart/cwmp/docs/2012-</u> examples/DeschutesRiverConservancy.pdf.

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<sup>13</sup> Aylward B. 2006. Growth, Urbanization and Land Use Change: Impacts on Agriculture and Irrigation Districts in Central Oregon. DWA Final Report. Bend (OR): Deschutes Water Alliance. Available online: <u>http://www.deschutesriver.org/Growth-Urbanization-and-Land-Use-Change.pdf</u>.

<sup>14</sup> Central Oregon Irrigation District. 2011. Water Management Conservation Plan. Available online: <u>http://filepickup.wrd.state.or.us/files/Publications/WMCP/Requested%20Files/Approved%20Agricultural%20WMCP</u> <u>Ps/COID\_Final%20%20WMCP\_2%2027%2012.pdf</u>.

<sup>15</sup> Technically, the Walker Basin is a cooperative water users' association (La Pine Cooperative Water Association) and not a formal irrigation district. However, it does divert water from the Little Deschutes River and was therefore included in this report. The Three Sisters Irrigation District is largely located in Deschutes County, although a small

<sup>&</sup>lt;sup>1</sup> Aylward B. 2006. Growth, Urbanization and Land Use Change: Impacts on Agriculture and Irrigation Districts in Central Oregon. DWA Final Report. Bend (OR): Deschutes Water Alliance. Available online: http://www.deschutesriver.org/Growth-Urbanization-and-Land-Use-Change.pdf.

portion extends north into Jefferson County. The Tumalo Irrigation District draws primarily from the Deschutes River but also is served by its tributary, the Tumalo Creek. Source: Deschutes River Conservancy. 2012. Deschutes Water Planning Initiative. Available online: <u>http://www.usbr.gov/watersmart/cwmp/docs/2012-examples/DeschutesRiverConservancy.pdf</u>.

<sup>16</sup> Deschutes River Conservancy. 2012. Upper Deschutes River Background Paper. Available online: <u>http://www.deschutesriver.org/Upper%20Deschutes%20River%20Background%20Paper\_FINAL\_Sep12.pdf</u>. See also Aylward B. 2006. Growth, Urbanization and Land Use Change: Impacts on Agriculture and Irrigation Districts in Central Oregon. DWA Final Report. Bend (OR): Deschutes Water Alliance. Available online:

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<sup>26</sup> U.S. Department of Commerce. 2015. Bureau of Economic Analysis, Regional Economic Accounts, Washington D.C. Table CA25.

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<sup>30</sup> Ibid.

<sup>31</sup> Oregon Water Resources. Gage #14069500, 4066500, 14069700, and 14069699 (NUID); Gage #14069000 and 14069699 (COID). (See reference #2 above for methodologies.) Available online:

http://apps.wrd.state.or.us/apps/sw/hydro\_near\_real\_time/. Of the 58,868 acres served by the North Unit Irrigation District, 50,050 acres are served by the Deschutes River and the remaining 8,818 acres are served by the Crooked River. Source: Deschutes River Conservancy. 2012. Deschutes Water Planning Initiative. Available online: http://www.usbr.gov/watersmart/cwmp/docs/2012-examples/DeschutesRiverConservancy.pdf.

<sup>32</sup> U.S. Department of Agriculture. 2012. National Agricultural Statistics Service. Census of Agriculture. Washington D.C. County-Level Data.

<sup>33</sup> Ibid.

<sup>34</sup> Aylward B. 2006. Growth, Urbanization and Land Use Change: Impacts on Agriculture and Irrigation Districts in Central Oregon. DWA Final Report. Bend (OR): Deschutes Water Alliance. Available online: http://www.deschutesriver.org/Growth-Urbanization-and-Land-Use-Change.pdf.

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