Long-Range Water Resources Management in Central Oregon: Balancing Supply and Demand in the Deschutes Basin

DWA Final Report

August 2006

Bruce Aylward, Ph.D.[*]

David Newton, P.E.[†]

[*] Water Bank Director, Deschutes River Conservancy, 700 NW Hill Street, Bend, Oregon 97701, (541) 382-4077, bruce@deschutesrc.org

[†] President, Newton Consultants, Inc. 521 SW 6th Street, Suite 100, Redmond, OR, 97756; (541) 504-9960 dnewton@newtonconsultants.com

The authors wish to thank the Bureau of Reclamation for sponsoring this report as part of the Deschutes Water Alliance Water 2025 Grant (see www.deschutesriver.org/Water_summit for more information. The authors also wish to thank Mathias Perle, Brett Golden and Kate Fitzpatrick for their assistance and comments on this paper.

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1 Water Resource Issues

Clean, reliable water supply for agriculture, ecosystems and cities has long been a key issue in Central Oregon (Deschutes, Jefferson and Crook Counties). Beginning in the 1960s, the Bureau of Reclamation has studied the potential of conservation and water-use efficiency to improve the availability of water in the upper Deschutes Basin for multiple uses, including instream flows, reservoir recreation development, fishery resources, water quality, and water supply for municipal, industrial and domestic uses (BOR 1972; 1991; 1997; 1999).

Water resources issues in the Basin have become more critical in recent years as additional demands are placed on the resource base. Water storage and diversion by federal and private irrigation districts result in the dewatering of several reaches of the Deschutes and its tributaries and the listing of impaired waters on the State's 303(d) list. EPA requirements drive the development of this list and of basin-wide water quality targets (TMDLs). Federal Energy Regulatory Commission (FERC) relicensing of the Pelton-Round Butte Hydropower Complex will result in the reintroduction of anadromous fish above the Complex, likely resulting in an Endangered Species Act listing in Whychus Creek and the Lower Crooked River. At the same time, rapid growth and development in Central Oregon has led to the need for a safe and reliable water supply to meet the future needs of the basin's growing communities and the need to find a way to address the impacts of land use change on irrigation districts and the agricultural community.

With surface water rights fully allocated and Safe Drinking Water Act provisions in place new needs will often be met through groundwater development. In 2002, the State of Oregon began implementing an innovative groundwater mitigation program in the upper Deschutes basin that effectively ties land development into the agriculture-ecosystem nexus – growing demand for groundwater from municipalities, resorts and irrigators will be met by converting existing water rights to instream flow as 'groundwater mitigation.'

Conflicts occurring in the Klamath Basin underscore the need for proactive and collaborative measures for responding to these needs. The rapid growth and subsequent water needs that the Deschutes Basin is experiencing has made water usage and availability a major topic in discussions among basin water suppliers, planners, business and the general public. Due to increased dialogue and awareness relative to water issues, regional urban water suppliers, irrigation districts and other private, government and individual water users now recognize their interdependency in the use, management and protection of Deschutes Basin water resources. This recognition and related dialogue has led major actors in water supply and demand to call for a common vision that commits energy and resources in a collaborative effort to respond to basin water issues.

1.2 Organization

In 2004 a diverse coalition of partners from the Deschutes applied for and received a grant from Reclamation's Water 2025 Program for a 'Deschutes Water Alliance: Formation and Pilot Water Bank Project.' The grant was received by Central Oregon Irrigation District on behalf of

- Deschutes Basin Board of Control (DBBC): Seven basin irrigation districts including Reclamation's Deschutes (North Unit Irrigation District) and Ochoco Projects.

- Central Oregon Cities' Organization (COCO): basin cities (e.g. Bend, Redmond, Madras, Prineville) and affiliated regional drinking water suppliers.

- Deschutes River Conservancy (DRC): a 501(c)(3) non-profit corporation carrying out ecosystem restoration projects in the basin (with federal authorization and representation Under PL106-270, Deschutes Resources Conservancy Reauthorization Act of 2000)

- Confederated Tribes of the Warm Springs Reservation (CTWS): a tribal entity representing Warm Springs, Paiute and Wasco Tribes

The Water 2025 grant consisted of three components: the formation of an alliance, the development of a series of planning studies and the initiation of a pilot water bank.

1.3 Vision and Objectives

At an early meeting of Alliance group, districts, cities, CTWS and the DRC agreed on a vision for the future in which the uses of water resources in the Deschutes are 'balanced to serve and sustain agriculture, urban and ecosystem needs.' It was felt that it is possible to simultaneously meet new and existing demands for water in the Deschutes Basin whether they are for agriculture, cities, or rivers – thereby raising the productivity of water in the Basin. Ongoing efforts gave the participants the expectation that this could happen through cooperation and voluntary participation of the key water suppliers and users in Central Oregon. The desired to balance uses and needs was further defined in terms of sectoral objectives:

- Move stream flows toward a more natural hydrograph while securing and maintaining improved instream flows and water quality to support fish and wildlife

- Secure and maintain a reliable and affordable supply of water to sustain agriculture

- Secure a safe, affordable, and high quality water supply for urban communities

These objectives form the basis for further development of measurable outcomes and subsequent efforts to evaluate the feasibility of realizing the vision.

1.4 Studies

As part of the Water 2025 grant a number of Issues Papers identifying the long-range trends in demand and supply for water resources in Central Oregon were developed. These include studies of:

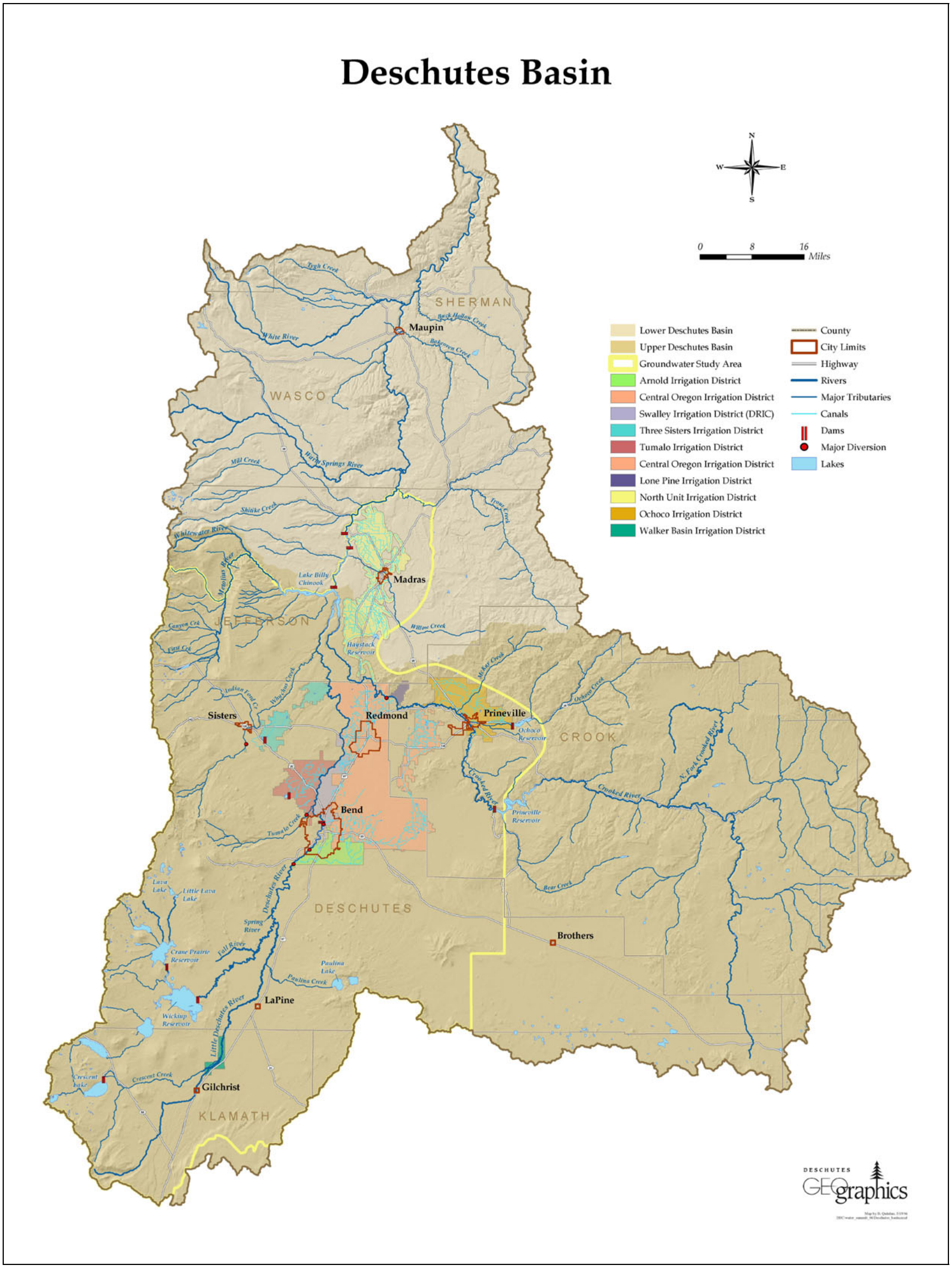
- Groundwater Demand – assessment of the groundwater pumping and groundwater mitigation needs for resorts, municipal water suppliers, agriculture and other uses (Newton et al. 2006)
- Instream Demand – analysis of water needed to meet instream flow targets for fish and wildlife (Golden and Aylward 2006)
- Agricultural Surface Water Demand – inventory of amounts, patterns and rates of district water rights becoming surplus due to trends in growth, development and land use change (Aylward 2006)
- Supply from Water Efficiency – an evaluation and prioritization of opportunities to save water through piping and lining of canals, laterals and ditches, as well as through on-farm conservation technologies (Newton and Perle 2006)
- Supply from Reservoir Management – identifying and briefly assessing ways in which the use of storage can contribute to instream flows and improve reliability of agricultural water rights (Fitzpatrick et al. 2006)

The papers provide the measurable outcomes in terms of water demand, as well as identification and quantification of supply opportunities. This paper uses the data and findings of these studies to examine the question of whether a long-term balance between demand and supply is possible and, if so, under what circumstances. Following a grounding in the context of the basin, the paper presents the data, methods and results from the analysis. Discussion of these results and emerging conclusions on water resource management in the Deschutes are then provided.

2. Background

The Deschutes Basin is the second largest river basin in Oregon covering 10,700 square miles (see Figure 1). The counties of Crook, Deschutes, Jefferson, Sherman and Wasco make up a majority of the basin. Central Oregon, which is comprised of Crook, Deschutes and Jefferson counties, constitutes 73% of the basin (see Table 1). Central Oregon is roughly congruent with the upper Deschutes Basin defined as the area above the confluence of the Metolius, Deschutes and Crooked Rivers and above the bulk of the immense groundwater recharge that happens above, in and just below the Pelton-Round Butte complex. Total area for the upper basin is just over 5,000 square miles. Another important hydrologic unit is the regional aquifer (demarcated as the Groundwater Study Area in Figure 1) through which a large amount of the precipitation input passes on its way to discharge in the confluence area of the Deschutes, Crooked and Metolius rivers.

Figure 1. Deschutes Basin



Land and Agriculture

For the Basin as a whole just 40% of the land area is in private hands, with the remainder under public or tribal control. The Confederated Tribes of the Warm Springs Reservation hold 641,000 acres or 7% of the Basin. Of land available for private uses in Central Oregon, 1.77 million acres is dedicated to farming and livestock according to the 2002 National Agricultural Census. The proportion of farm area that is irrigated is roughly one-tenth, or 180,000 acres reflecting the predominance of dryland ranching as a land use in Crook and Jefferson counties. Central Oregon is the home of the family farm with over 92% of owners living on the farm. However, 60% of farm operators also work part-time of the farm and 40% effectively work full-time off the farm. Agriculture makes up around 10% of county income in Crook and Jefferson County and only 1% in Deschutes County. Jefferson County is home to large farms, with irrigation largely for the purposes of growing crops. Crook County is home to both smaller irrigated parcels growing crops and very large ranches with irrigated areas in the valley bottoms. Deschutes County is largely home to lifestyle or hobby farming, with just a few areas remaining of large commercial farms.

Table 1. Deschutes Basin: Land Area and Population

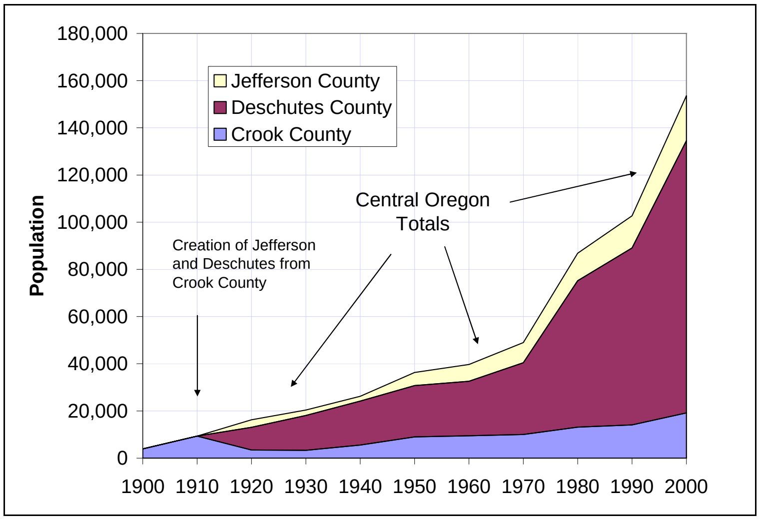
	Population					Land
	Total	Urban		Rural		Total
	(#)	(#)	(%)	(#)	%	(acres)
Administrative Units - Counties						
Crook	20,650	8,640	42%	12,010	58%	1,914,231
Deschutes	135,450	84,800	63%	50,650	37%	1,955,191
Jefferson	20,250	7,070	35%	13,180	65%	1,146,235
Subtotal - Central Oregon (3 counties)	176,350	100,510	57%	75,840	43%	5,015,656
Wasco	23,900	13,970	58%	9,930	42%	1,533,433
Sherman	1,900	1,140	60%	760	40%	531,838
Subtotal - Five counties	202,150	115,620	57%	86,530	43%	7,080,927
Drainage Unit - Watershed						
Deschutes Basin						6,847,968
Upper Deschutes Basin						5,004,800
Groundwater Unit - Aquifer						
Groundwater Study Area						2,879,987
Oregon	3,582,600	2,434,922	68%	1,147,678	32%	61,437,792

Source: Aylward (2006)

Growth and Development

As of 2004, the population of Central Oregon totaled 176,000, 57% of which live in incorporated areas. Central Oregon has gone through periods of explosive growth, notably in the 1970s and from 1990 onwards. Averaged over the last century Central Oregon's population has grown at a rate of 44% every decade (see Figure 2). In comparison Oregon's rate was 24% and for US as a whole it was 14%. The figure below shows that the bulk of the population gain in Central Oregon has been in Deschutes County. During the 1990s the population of Deschutes County increased by 50% from 75,000 to 115,000. Since 2000, Central Oregon continues to grow rapidly, recording a 20% increase in population in the last five years. Of this increase 27,000 comes in incorporated areas and 5,000 in unincorporated areas. For Bend and Redmond, the two largest population centers, growth rates have oscillated between 4 and 11%. While official population forecasts suggests a slowdown in these rates, there is little in the last 15 years experience or current trends to suggest that given the opportunity rates of growth in both urban and rural areas will not continue. In fact, future population forecasts simply suggested a continuation of the 44% per decade increase in population over the next 20 years.

Figure 2. Central Oregon Counties Population, 1910 to 2000



Source: Aylward (2006)

Water Resources, Groundwater and Instream Flows

In Central Oregon, water that moves through the aquifer discharges into streams throughout the upper Deschutes Basin (Gannett et al. 2001). These discharges occur most noticeably at the headwater of the Metolius River and near the confluence area of the Deschutes, Crooked and Metolius Rivers at Lake Billy Chinook. This upwelling of groundwater is largely due to the intersection between the younger Deschutes Formation and the older John Day Formation. The groundwater flows through the permeable Deschutes Formation until it runs into the impermeable John Day Formation. Groundwater flows upwards and emerges as springs at the surface. In hydrologic units that drain to the Crooked River, soils and geology are largely of the impermeable John Day Formation. Little groundwater recharge occurs in these hydrologic units, and runoff patterns vary rapidly with precipitation.

Assessment of water resources for the Groundwater Study area, which forms a significant portion of the upper Deschutes Basin confirms that human activities in the upper Deschutes Basin have significantly altered the flow regime in the basin, but on balance have led to the consumption of only a relatively small amount of available water resources and an even smaller portion of the annual turnover in groundwater in the Basin (Golden and Aylward 2006). These impacts do appear to have had a seasonal impact in the lower Deschutes River (in the early months of the calendar year) the reach where all the changes in storage, diversion and surface-groundwater interactions come together in one place. Yet the most dramatic modifications to the water resources regime are clearly seen in terms of low flows below irrigation district diversions in the upper Deschutes Basin.

Reservoir storage and releases for irrigation have highly altered flows in five of the seven water quality impaired reaches in the basin. The upper Deschutes River reach does not often meet target flows in the winter due to upstream reservoir storage. Irrigation diversions have reduced summer flows in six of the seven water quality impaired reaches. Most reaches experience low summer flows due to irrigation diversions. Prior to current restoration efforts, sections of Whychus Creek and Tumalo Creek typically went dry during the irrigation season due to extensive diversion. The daily probability of reaching flow targets during each month is summarized in the table below.

Table 2. Probability of Meeting Instream Flow Targets

Historic Probability of Meeting Instream Flow Target*								
Month	Little Deschutes River	Upper Deschutes River	Middle Deschutes River	Tumalo Creek	Whychus Creek	Metolius River	Lower Crooked River	Lower Deschutes River
Jan	Very High	Low	Very High	Very High	Very High	Very High	Very High	High
Feb	Very High	Low	Very High	Very High	Very High	Very High	Very High	High
Mar	Medium	Low	Very High	Low	Very High	Very High	High	Very High
Apr	High	High	Medium	Low	Low	Very High	High	High
May	Low	Very High	Very Low	Low	Medium	Very High	Low	High
Jun	Low	Very High	Very Low	High	Medium	Very High	Low	High
Jul	Medium	Very High	Very Low	Low	Very Low	Very High	Medium	High
Aug	High	Very High	Very Low	Very Low	Very Low	Very High	High	Very High
Sep	Very High	Very High	Very Low	Very Low	Very Low	Very High	Very High	Very High
Oct	Very High	High	Medium	Medium	Very Low	Very High	Very High	Very High
Nov	Very High	Very Low	Very High	Very High	Very High	Very High	Very High	Very High
Dec	Very High	Low	Very High	Very High	Very High	Very High	Very High	Very High

*period of record varies for each reach

Key to Table

Percent of Days Meeting Target	Historic Probability
80-100%	Very High
60-79%	High
40-59%	Medium
20-39%	Low
0-19%	Very Low

Source: Golden and Aylward (2006)

Federal and state regulatory approaches all have the potential to affect instream flow allocation in the Deschutes Basin. Federal approaches include the Wild and Scenic Rivers Act, the Clean Water Act, and the Endangered Species Act. State approaches include the State Scenic Waterways Act and instream flow rights to support aquatic life. Voluntary, market-based approaches, enabled by the state and federal legal framework, however, provide the greatest opportunity for restoring instream flows in the Deschutes Basin. Tools available include instream transfers, leases, storage leases, allocation of conserved water. The Deschutes River Conservancy, local irrigation districts and state and federal partners are working together to restore water to reaches by using these tools.

Irrigation Districts

Historically in Central Oregon, the bulk of water rights and water use has been by irrigated agriculture, particularly a number of large irrigation districts (see Table 3). These districts include Reclamation's Deschutes (North Unit ID) and Ochoco projects (Ochoco ID). The potential for conflict over water arises due to increasing demand for groundwater for municipalities and rural destination resorts and increasing recognition of the importance of restoring instream flow. In addition, as urban areas expand they move into irrigation district areas, threatening the continued delivery of water to patrons and the financial solvency of the district (through a decline in the assessment base). The Central Oregon Water Bank builds on early efforts by local irrigation districts to work with the DRC on instream leasing and represents an effort to make long-term and permanent reallocations in water rights in order to avoid future conflict over water in the basin.

Table 3. District Water Right Acreages, Customers and Farm Size

District	Point of Diversion	Irrigation Rights (acres)	Total Rights (acres)	Customers[1]	Average Farm Size (acres)[1]
Swalley	Deschutes River at Bend	4,351	4,561	755	6
COID	Deschutes River at Bend	43,747	44,784	4,497	10
Lone Pine	Deschutes River at Bend	2,369	2,369	20	120
Arnold	Deschutes River above Bend	3,976	4,384	792	6
North Unit	Deschutes River at Bend and Crooked River above Smith Rock	58,868	58,868	850	69
Walker Basin	Little Deschutes above LaPine	1,534	1,534	10	153
Tumalo	Tumalo Creek and Middle Deschutes at Bend	7,367	7,381	632	12
Three Sisters	Whychus Creek above Sisters	7,568	7,651	129	59
Ochoco	Ochoco Creek and Crooked River above Prineville, McKay Creek below Prineville	20,150	20,332	745	27
Totals		149,924	151,878	8,897	17

Source: Aylward (2006)

Notes: [1]Estimates only for some districts

Assessment of water delivery by irrigation districts in Central Oregon indicates that seepage loss potential is very high in some and very low in others with an average transmission loss of 37% (see Table 4). Further evaluation indicates seepage potential is correlated with geologic conditions in the district areas. Districts in Deschutes and Jefferson County that convey water across terrain underlain by the Deschutes Formation record very high seepage losses – in some cases approaching 60%. On-farm losses in these areas are also considerable. Seepage losses overall are significant, totaling almost 600,000 acre-feet, thereby revealing significant opportunity to engage in water efficiency projects.

Table 4. District Delivery Systems

District	Canals (miles)	Laterals (miles)	Irrigation System Diversions (AF)	On-Farm Losses (AF)	Transmission Loss (AF)	Delivery Efficiency
Swalley	11.60	16.80	42,410	8,990	23,140	45%
COID	76.50	129.70	351,510	137,550	91,250	74%
Lone Pine	40.10	5.40	14,560	580	9,080	38%
Arnold	15.50	24.50	38,400	8,420	20,520	47%
North Unit	65.00	83.90	221,770	7,890	87,530	61%
Tumalo	35.70	26.30	67,000	10,550	38,980	42%
Three Sisters	20.90	39.50	26,420	12,120		63%
Ochoco	33.90	37.50	20,490	20,490	7,580	63%
Totals	299.20	363.60	782,560	203,170	290,920	63%

Source: BOR (1997)

Water Rights: A Closed Basin

Carey Act irrigation districts formed in Central Oregon at the turn of the last century. In 1913 the federal government reserved remaining waters in the main stem of the Deschutes for a future federal reclamation project. For all intents and purposes, creeks and rivers in the upper basin are closed to further appropriation of surface waters by the Oregon Water Resources Department. Water trading within irrigation districts and between districts and cities have a long history as a means of reallocation of surface water rights. In the 1930s and the 1950s the City of Bend secured surface water rights to meet its future needs through transactions with Tumalo Irrigation District.

In the 1990s, growth and development in Central Oregon led municipalities, developers and small irrigators to turn to groundwater to supply new water needs. Growing demand for groundwater led to concern that the groundwater permitting process ignored the potential for impact of groundwater withdrawal on surface waters. A USGS and OWRD study released in 2001 confirmed that aquifer discharge provide much of the surface water to streams in the Deschutes Basin (Gannett et al. 2001). The results suggested the potential for groundwater withdrawals to impact surface water flows and cause injury to surface water rights holders, including junior instream rights.

In 2002, following, a multi-year collaborative process, the Water Resources Department put forward a market-based program intended to offset withdrawals on a long-term volumetric basis. The Water Resources Commission approved rules for the implementation of the Deschutes Groundwater Mitigation Program in September 2002 (OAR 690-505). The Program allows for water development while mitigating for the effects of groundwater withdrawals on surface water flows in the Basin through instream transfers, aquifer recharge, storage release and conserved water projects. Concerns regarding timing of mitigation (and other issues) led to a prima facie lawsuit by a number of protestants, including WaterWatch of Oregon against the Program rules. The suit was decided in favor of the protestants in early 2005. Subsequently HB 3494 was passed by the legislature confirming that the existing rules provide ‘mitigation’ and will govern the allocation of new groundwater permits in the Deschutes through 2014.

Four years into the program only leases and transfers have been used to create mitigation credits. State-chartered groundwater mitigation banks may use temporary transfers to establish credits subject to holding an equal amount of credits in reserve (OAR 690-521). The groundwater mitigation bank operated by the Deschutes River Conservancy uses demand from the mitigation credit to fund a portion of its instream leasing efforts. In 2006, the mitigation bank has 35 active accounts with groundwater applicants and new permitholders, providing funding for just less than 15% of the DRC’s 2006 total lease of 6,200 acres (at the 2 acres leased to 1 acre of credit extended ratio).

Closed to further appropriation of surface water rights and with new groundwater rights effectively provided only upon mitigation for consumptive use, the upper Deschutes basin is effectively closed to further appropriation of consumptive use. With the appropriation of consumptive use capped, new needs for surface can only be met by trading surface water, while new needs for groundwater may be met by trading existing surface water or groundwater rights. As the basin balances future demand and supply it should therefore yield important insight into voluntary, market-based approaches to conjunctive use management.

3. Data

This analysis of long-range water management in Central Oregon builds a number of potential scenarios based on detailed data with respect to future trends in demand and supply identified in the DWA Issues Papers. On the demand side, measurable outcomes include:

- future groundwater demand based on data on population growth rates and resulting increases in municipal water demand from work undertaken by the Central Oregon Cities Organization, as well as data on pending and prospective groundwater permits from the Oregon Water Resources Department (see Table 5)
- instream flow needs in five dewatered reaches in the upper basin based on an assessment of current flows, natural flow levels, and fish and wildlife targets (see Table 6)

Table 5. Future Groundwater Demand and Mitigation Obligations

Water Use	Estimate Annual Volume (acre-feet)	Volume of Consumptive Use (acre-feet)	Percent of Total Consumptive Use (%)	Volume of Consumptive Use Subject to Mitigation (acre-feet)	Mitigation Obligation (acres)
Water Suppliers Inside UGBs	17,600	8,800	33.9	2,768	1,538
Pending Groundwater Permits – Other Uses Outside UGBs	18,066	7,623	29.4	7,623	4,235
Prospective Uses for Resorts, etc – Outside UGBs	7,890	4,125	15.9	4,125	2,292
Exempt Wells	13,444	5,378	20.7	NA	NA
Grand Total	57,000	25,926	100.0	14,516	8,065

Source: Newton et al. (2006)

Table 6. Instream Flow Demand

	Flow Targets	Needs to 2025	
Reach	Rate (cfs)	Rate (cfs)	Volume (acre-feet)
Upper Deschutes*	300	146	62,000
Middle Deschutes	250	224	94,913
Lower Crooked	75	22	16,079
Tumalo	20	14	5,932
Whychus	20	14	5,932
Totals	665	421	184,856

Source: Golden and Aylward (2006)

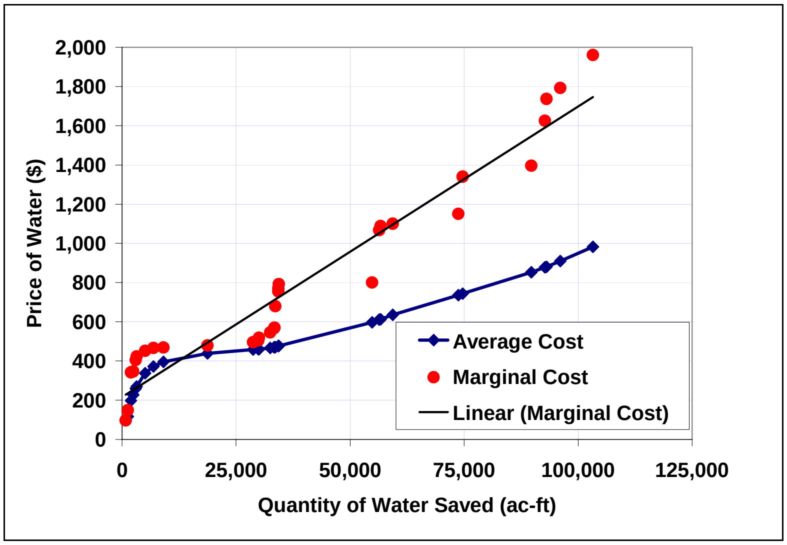
With respect to demand for water from irrigated agriculture the current trend is toward a lessening of demand due to continued growth, urbanization and land use change. This lessening in demand also presents the opportunity for reallocation of these water rights to other uses. The analysis of irrigation water use is therefore both an analysis of demand and of supply. Information employed comes from Aylward (2006) and includes:

- detailed information on eight irrigation districts in Central Oregon, including rate and duty calculations on 151,000 acres of appurtenant water rights, water available for conservation and transfer, district assessments, and exit policies.
- GIS analysis of current location of irrigation district water rights relative to urban and county boundaries to evaluate water rights at risk in urban areas and estimate resulting decrease in agricultural surface water demand from urban areas
- GIS analysis of water rights currently leased instream to identify decrease in agricultural surface water demand from rural areas.

On the supply side the following information is employed:

- cost and water savings information on over thirty water efficiency and conservation projects across the irrigation districts (see Figure 3)
- pricing data on leasing, purchase and exit fees for the districts (Aylward 2006)
- different methods for making water available from reservoir management and storage reallocation including a total of 21,000 acre-feet from reservoir optimization, trading of water allocations and district water management projects made available for agricultural and instream use (Fitzpatrick et al. 2006)

Figure 3. Price and Quantity for Water Efficiency Projects



Source: based on data from Newton and Perle (2006)

4. Scenarios

Three scenarios were used in this analysis: a base case scenario and low and high growth scenarios. Water management tools employed in 'moving' water and water rights from one use to another include:

- Instream Leasing (restoration only)
- Transfers for groundwater mitigation and for instream restoration
- Main canals and lateral water efficiency projects
- On-Farm water efficiency projects
- Reservoir Management

The Base Case Scenario is defined by the following assumptions and forecast trends for the twenty year period from 2006 to 2025:

- All irrigation district water rights currently found within urban growth boundaries (UGBs) and urban reserve areas (URAs) – a total of 9,773 acres – are transferred permanently instream

- Instream leasing of district and individual water rights on rural lands outside urban areas continues in line with current levels, i.e. just under 4,000 acres per year
- A few select high priority non-district rural water rights are included in the analysis to the extent that information on existing or proposed transactions is available – 800 acres of which are transferred instream.
- Total groundwater demands by 2025 of 57,000 acre-feet, with a consumptive use of 25,926 and a total groundwater mitigation obligation of 14,516 acre-feet of credits, or 8,065 acres (see Table 5)

For the Low Growth Scenario the following changes were made to reflect future conditions if lower than expected population growth and development pressure in Central Oregon occurs:

- acres within URAs were not included in the acres transferred permanently instream, so that a total of only 5,256 acres was transferred from urban lands
- the prospective destination resorts included in the original groundwater demands were deleted leaving a total demand for groundwater mitigation of 6,123 acres

For the High Growth Scenario the following change was made to approximate an assumption of a higher than projected growth rate in Central Oregon

- the only change from the Base Case Scenario was to make the assumption that higher development pressure would further reduce the comparative financial benefits of keeping land in agriculture – leading to an across the board transfer of 5% of rural irrigation district properties to instream use.

While these scenarios are simplistic they serve to highlight the major issues driving water resource management in Central Oregon. A further necessary assumption was that public funding existed to provide the necessary supply from conservation projects to meet instream flow targets. In a sense then the scenarios respond to the question of what level of investment in conservation is required to meet instream needs at different levels of growth and development pressure.

All calculations in the scenarios are carried out on an irrigation district and stream reach basis. Driving the scenarios is the rate of land use change and resulting availability of surface water rights to meet demand for groundwater mitigation and instream flow. Demands for groundwater are classified according to municipal water needs, destination resort needs, new agricultural needs and other needs (homeowner's associations, industrial, etc). Satisfaction of groundwater demand results in augmentation of instream flow through the State's Groundwater Mitigation Program that requires water rights to be transferred instream to mitigate for new groundwater pumping. Water rights transferred and leased that are not required for groundwater mitigation go to instream flow restoration.

Remaining demand for instream flow restoration must be met through improved reservoir management and water efficiency projects. A portion of reservoir management gains by 2025 are predetermined and another portion come from reductions in demand due to leases, transfers and conservation. Conservation projects are ranked in order of reach priority and costeffectiveness and then called on to meet the remaining demand for instream flow and provide flexibility in reservoir management.

Instream flow demands are then met on a reach-by-reach basis according to the following protocol based on physical connectivity and legal fungibility of water and water rights between the reaches and districts:

- Whychus Creek – flows met from transfers, leases and conservation projects in the reach
- Tumalo Creek – flows met from transfers, leases and conservation projects in the reach; water surplus to targets is 'assigned' to the middle Deschutes as Tumalo Irrigation District has ability to source switch due to natural flow and storage rights held on the Deschutes by the district subject to the capacity of the Bend Feed Canal (which is now fully piped to the district's diversion from Tumalo Creek)
- middle Deschutes – flows met from transfers, leases and conservation projects in the reach plus additional surplus water from Tumalo Creek; water surplus to targets is 'assigned' to the Upper Deschutes as many of the districts diverting at Bend from the middle Deschutes also have storage rights in Wickiup and Crane Prairie reservoir
- Upper Deschutes – instream flows and reliability of junior agricultural rights are met from optimization of reservoir allocations, conservation projects in districts holding storage and surplus water from the middle Deschutes reach, water surplus to flow targets is 'assigned' to the Crooked River as North Unit Irrigation district has some ability to source switch between Deschutes storage and Crooked River rights (on the further assumption that pending North Unit Irrigation District legislation to expand its district and use Deschutes water on its Crooked River lands is approved)
- Crooked River – instream flows and agricultural needs in North Unit are met from transfers, leases and surplus water from the Upper Deschutes (once agricultural needs are met in North Unit, Crooked River rights may be dedicated to instream use).

In the scenarios no binding constraint was placed on funding for groundwater mitigation needs, restoration transfers and leasing, reservoir management and conservation projects. In other words one output of the scenarios is the calculation of the costs and funding needs over the 20-year period. All funding needs are expressed as simple totals of costs over the 20-year period (i.e. costs and funds are not discounted).

Proactive Solutions: Deschutes/Crooked River Lining and Water Rights Exchange Project

The North Unit Irrigation District (NUID) is part of Reclamation's Deschutes Project and supplies water to the basin's most productive cropland. By lining additional portions of the NUID main canal up to 60 cfs of saved water may be acquired a portion of which can be used to restore Deschutes river flows and the remainder used to replace unreliable junior rights on 9,000 acres of lands served by pumping from the Crooked River. The project benefits farmers by avoiding $400,000 in annual power costs and making deliveries more reliable. At the same time the project benefits Crooked River flows, improving water quality and habitat conditions, responding to upcoming TMDL provisions and reintroduction of anadromous fish species in the lower Crooked River

5. Results

Key results from the scenario are summarized in Table 7 and in Figure A-1, A-2 and A-3. Findings consistent across the scenarios include:

- Municipal water suppliers easily meet their groundwater mitigation water needs at a total cost of around $4 million over twenty years.
- Rural needs on county lands – for resort and agricultural uses – form the bulk of groundwater mitigation demand
- Instream flow targets in the upper Basin are met in Tumalo Creek, Whychus Creek, the middle Deschutes River, Upper Deschutes River and lower Crooked River
- Reliability, delivery and cost of agricultural water is ensured as additional reservoir storage is made available to junior users,
- North Unit Irrigation District switches supply to 10,000 acres from costly pumps on the Crooked River to gravity flow from the Deschutes, and districts affected by growth and land use change buffer their landowners from increases in assessment fees through receipt of millions of dollars for their O&M Endowment Funds.
- Water efficiency projects reduce district maintenance costs and liability issues by piping and lining canals and laterals, and provide large amounts of natural flow and stored water for redistribution to instream and agricultural uses.

Table 7. Key Indicators for 2025 Scenarios

		2025 Scenarios		
Key Indicators	Units	Base Case	Slow Growth	Fast Growth
Instream Flow Restored	acre-feet	196,171	196,171	200,657
Municipal Demand Met	%	100%	99%	100%
Groundwater Demand Met	%	100%	99%	100%
Irrigated Land Change	%	-4%	-2%	-9%
District Revenues	$million	10	6	16
Landowner Revenue	$million	22	16	35
Saved Transmission Loss	%	31%	41%	21%
Total Expenditure	$million	135	170	115

In terms of outcomes that vary between the scenarios the largest differences are observed in terms of the net loss of irrigated land, the water efficiencies realized and the distribution of financial costs and benefits. In the Base Case Scenario the net loss of irrigated acres is 4% (balancing a decrease in acres irrigated with surface water and an increase in acres irrigated with groundwater). Total transmission loss saved through water efficiency projects is 31% and teh total cost of carrying out all the projects, transfers and leases is $135 million – of which $32 million goes to agriculture split between districts ($10 million) and landowners ($22 million).

With the Base Case Scenario as an intermediate growth scenario in terms of these outcomes it is possible to characterize the trade-offs between the three scenarios in terms of the level of growth. Generalizing, lower growth rates:

- reduce the amount of instream transfer water that is for restoration; in the Low Growth Scenario all transfer water is for mitigation and only the leased water is for restoration
- reduce the pressure on irrigation district lands
- increase the proportion of instream flow coming from water efficiency projects
- raise the cost of meeting instream and groundwater needs.

Conversely, higher growth rates:

- increase the amount of instream transfer water that is for river restoration (rather than groundwater mitigation)
- increase the pressure on irrigation district lands
- increase financial flows to irrigation districts and their landowners
- decrease the need for the more costly water efficiency projects
- lower the cost of meeting instream and groundwater needs.

6. Discussion

6.1 Limitations

Three limitations to the analysis are discussed below – one related to an important outcome that the scenarios do not assess and two inherent limitations with the methods employed.

First, the water management scenarios do not attempt to evaluate the impact of significant changes in current water management on groundwater recharge in the upper basin and resulting aquifer discharge at the confluence areas and how these will combine with altered surface water flows to affect flows in the lower Deschutes River. Whether or not, and to what degree, Increased flows in the Upper Deschutes in the winter and middle Deschutes in the summer will affect the lower Deschutes once the long-term effects on groundwater recharge of increased groundwater pumping and decreased recharge from transmission loss and on-farm use in irrigation are included in the analysis is an open question. This highlights the importance of continued investment in developing a suite of models that can answer the question. At present USGS, Reclamation, OWRD and CTWS consultants are engaged in a cooperative modeling effort that seeks to deploy the already existing USGS Modflow groundwater model and re-develop prior MODSIMs surface water distribution models to this end (Gannett and Lite 2004; LaMarche 2001).

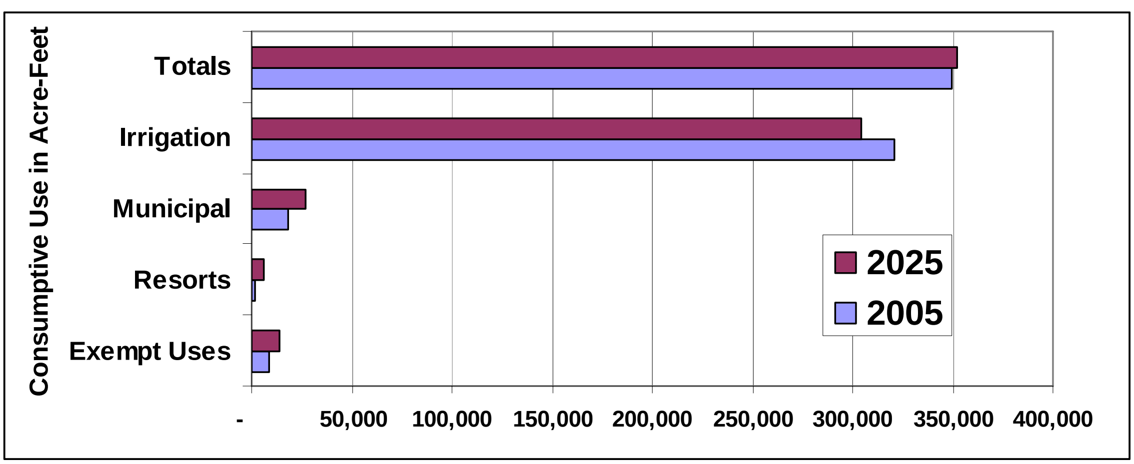
Two factors influencing the costing of the scenarios are not well developed and their potential impacts on the large disparity between the costs of the three scenarios needs to be noted. Most importantly, the water efficiency projects identified and costed by the study team are insufficient to meet the need for saved water in a low growth scenario (where more water is needed from water efficiency projects to compensate for lower amounts of water from transfers). In the absence of information on what additional projects would cost it was assumed that large amounts of additional saved water could be generated at the cost of the last (i.e. marginal) project in the project rankings. It may well be that less expensive efficiency projects do exist but have simply not been uncovered by the study team to this point in time. The average cost of the projects that were costed is just under $1,000/acre-foot whereas the marginal project is $1,700/acre-foot. This factor probably tends to overstate the difference in costs between the scenarios.

The second factor that the model does not adequately treat is the price response in the market for water. In the low growth scenario, the availability of water rights to meet mitigation needs is reduced and thus there might be upward pressure on price. In the high growth scenario, water rights are made surplus at a rapid rate. In the Base Case Scenario mitigation demand is already satisfied and river restoration is the marginal source of demand to acquire these rights. With an even larger amount of acres as surplus and for sale, market conditions can be expected to worsen for sellers with downward pressure on purchase price and district exit fees. This factor would tend to exacerbate the difference in costs between the scenarios, making restoration less expensive in the high growth setting and more expensive in the low growth setting.

6.2 Mitigation Program Leakage

With respect to the State's Groundwater Mitigation Program a cursory examination of projections for 2025 suggests that there is some 'leakage' from the Program. In other words, due to the variance between actual projected pumping volumes and legal requirements for mitigation for new permits it is clear from Table 5 that municipalities will be required to mitigate for only a portion of their incremental pumping. Meanwhile exempt uses (in Oregon) are completely unregulated. Thus, there are sources of leakage from the implicit cap placed on conjunctive use. With scenarios projecting water demand and supply out twenty years it is possible to calculate current and future consumptive use based on direct human uses, i.e. for domestic, industrial, commercial and irrigation. The results (shown in Figure 4) are necessarily imprecise, but they suggest that when the before and after uses are totalled there is a fairly imperceptible increase in net consumptive use in the upper basin. This can be explained in terms of the decrease in consumptive use associated with the portion of retired irrigation rights which are placed instream for restoration rather than explicitly for groundwater mitigation.

Figure 4. Comparison of Total Direct Human Consumption of Water (including irrigation), 2005 to 2026



6.3 Transactional Feasibility

An important question is the degree to which water can 'move' in the manner envisioned by the scenarios. In this regard, existing collaborative efforts in the basin and the legal framework provided by Oregon Law as administered by OWRD provide for cautious optimism. The Deschutes River Conservancy (DRC) received congressional authorization and federal funding beginning in 1996 to implement stream flow restoration projects in the Deschutes Basin. Partnerships between the DRC, landowners and irrigation districts on water efficiency projects and instream leasing have already resulted in over 20 cfs of conserved water and 80 cfs of leased water protected instream by OWRD. Initial transfers of district and non-district water rights for groundwater mitigation and flow restoration have also been completed successfully. The DRC groundwater mitigation bank is also providing crucial temporary liquidity to the nascent groundwater mitigation market. Pilot efforts to develop a Central Oregon Water Bank to integrate both temporary and permanent reallocation to ensure an orderly transition are also underway between irrigation districts, the DRC and municipalities.

Still, some actions contemplated over the long run in the scenarios are not yet feasible legally. Already mentioned is the issue of the mobility of federal project water. Arriving at agreements and procedures for improving reservoir management is still a discussion at the early stages, although a pilot project is underway for 2006/7.

Perhaps the most critical need is to resolve the issue of limited capacity at OWRD to support these voluntary, transactional approaches. The number of water rights transactions is increasing at a rapid pace. For example, the DRC and its partners in the upper basin have submitted 12 conserved water applications since the DRC was created, but fully half of these were submitted in the last year alone. These transactions require time from Salem and Bend office staff not only for processing, but monitoring and enforcement. At the same time as the transactional volume is increasing, OWRD's budget (derived wholly from general funds) is flat or declining. Action needs to be taken to either reverse this funding trend or devolve more administrative authority to the basin; else collaborative efforts may come for naught in the face of an administrative logjam.

7. Conclusions

Results from a number of preliminary scenarios for managing water resources in the upper Deschutes Basin reveal the potential to meet future needs on the part of growing communities, agriculture, and upper basin rivers and creeks. Specifically, analysis conducted thus far shows:

- Municipal water needs are easily provided for as the urbanization process releases irrigation water at a rate that exceeds new supply needs.
- Reliability and delivery of agricultural water is ensured through an aggressive program of major canals/laterals piping and lining.
- Cost of agricultural water and irrigation district finances are secured through a collaborative, non-profit Central Oregon Water Bank that acquires surplus water rights generated by land use change and growth and reallocates such rights to new groundwater and surface water users, as well as to ecosystem needs.

- Instream flow targets are met through conservation, leasing, transfers and improved reservoir management.

A remaining consideration is to assess the impacts of these water management scenarios on groundwater and downstream reaches of the Crooked and Deschutes River, so as to ensure that the ecosystem and human values of these rivers are protected, or even improved.

In sum, new and non-traditional needs for water resources in Central Oregon can be met from existing sources and rights under a number of scenarios considered here. This can largely be accomplished using currently available administrative regulations for the management of water rights in the Deschutes and Oregon. In order to close the loop and realize the instream flow targets – as well as meet community and irrigation needs – a key ingredient will be obtaining the financing for the necessary water efficiency projects. A further conclusion is that water availability is unlikely to constrain continued growth in Central Oregon. Growing subdivisions appear to require less water than growing alfalfa and significant amounts of rural lands are leased instream from year to year as lifestyle farming reduces the productive, commercial use of water for irrigation. As a result, legal requirements for providing groundwater mitigation can be met through permanent transfers and 'renting' water from the groundwater mitigation bank.

However, this is not to say that land use and economic planning cannot be improved if planners and decision-makers take better account of the mechanics of water resources in the basin – whether in terms of the legal, socio-economic, hydrologic or environmental aspects of these resources. Further development of water management scenarios and the application of existing surface water distribution and groundwater flow models to the Deschutes Basin should greatly assist ongoing efforts at integrated water resources management and attempts to better coordinate regional planning more generally.

References

Aylward, B. 2006. 'Growth, Urbanization and Land Use Change: Impacts on Agriculture and Irrigation Districts in Central Oregon.' Water Summit Draft. Bend: Deschutes Water Alliance. (available at www.swalley.com)

Bureau of Reclamation, 1972. 'Special Report on Potentials for Expansion and Improvement of Water Supplies, Deschutes Project, Central Division, Oregon.' Boise: Bureau of Reclamation

Bureau of Reclamation. 1991., 'Geology Report, Central Oregon Canal System, Upper Deschutes River Basin Water Conservation Project, Oregon.' Boise: Bureau of Reclamation

Bureaus of Reclamation. 1997. 'Upper Deschutes River Basin Water Conservation Study: Special Report.' Boise: Bureau of Reclamation.

Bureau of Reclamation.1999. 'Canal-Lining Demonstration Project Year 7 Durability Report', R-99-06. Boise: Bureau of Reclamation

Fitzpatrick, K., Gorman, K and B. Aylward. 2006. 'Reservoir Management.' Water Summit Draft. Bend: Deschutes Water Alliance. (available at www.swalley.com)

Gannett, M.W. and K.E. Lite. 2004. Simulation of Regional Ground-Water Flow in the Upper Deschutes Basin, Oregon. Water Resources Investigations Report 03-4195. Portland, OR: United States Geological Survey. 84 pp.

Gannett, M.W., Lite, K.E., Morgan, D.S. and C.A. Collins. 2001. *Ground-Water Hydrology of the Upper Deschutes Basin, Oregon.* Water-Resources Investigations Report 00–4162. Portland, OR: USGS. 72 pp.

Golden, B. and B. Aylward. 2006. 'Instream Flow in the Deschutes Basin: Monitoring, Status and Restoration Needs.' Water Summit Draft. Bend: Deschutes Water Alliance. (available at www.swalley.com)

Newton, D. and M. Perle. 2006. 'Irrigation District Water Efficiency Cost Analysis & Prioritization.' Water Summit Draft. Bend: Deschutes Water Alliance. (available at www.swalley.com)

LaMarche, J. 2001. 'Upper and Middle Deschutes Basin Surface Water Distribution Model.' Surface Water Open File Report #SW02-001. Bend: Oregon Water Resources Department.

Newton, D., Perle, M. and J. Polvi. 2006. Future Groundwater Demand in the Upper Deschutes Basin.' Water Summit Draft. Bend: Deschutes Water Alliance. (available at www.swalley.com)

Population Research Center. Various Years. Annual Oregon Population Report. Portland: Portland State University. http://www.pdx.edu/prc/annualorpopulation.html.

Figure A-1. Base Case Water Management Scenario, 2006 to 2025

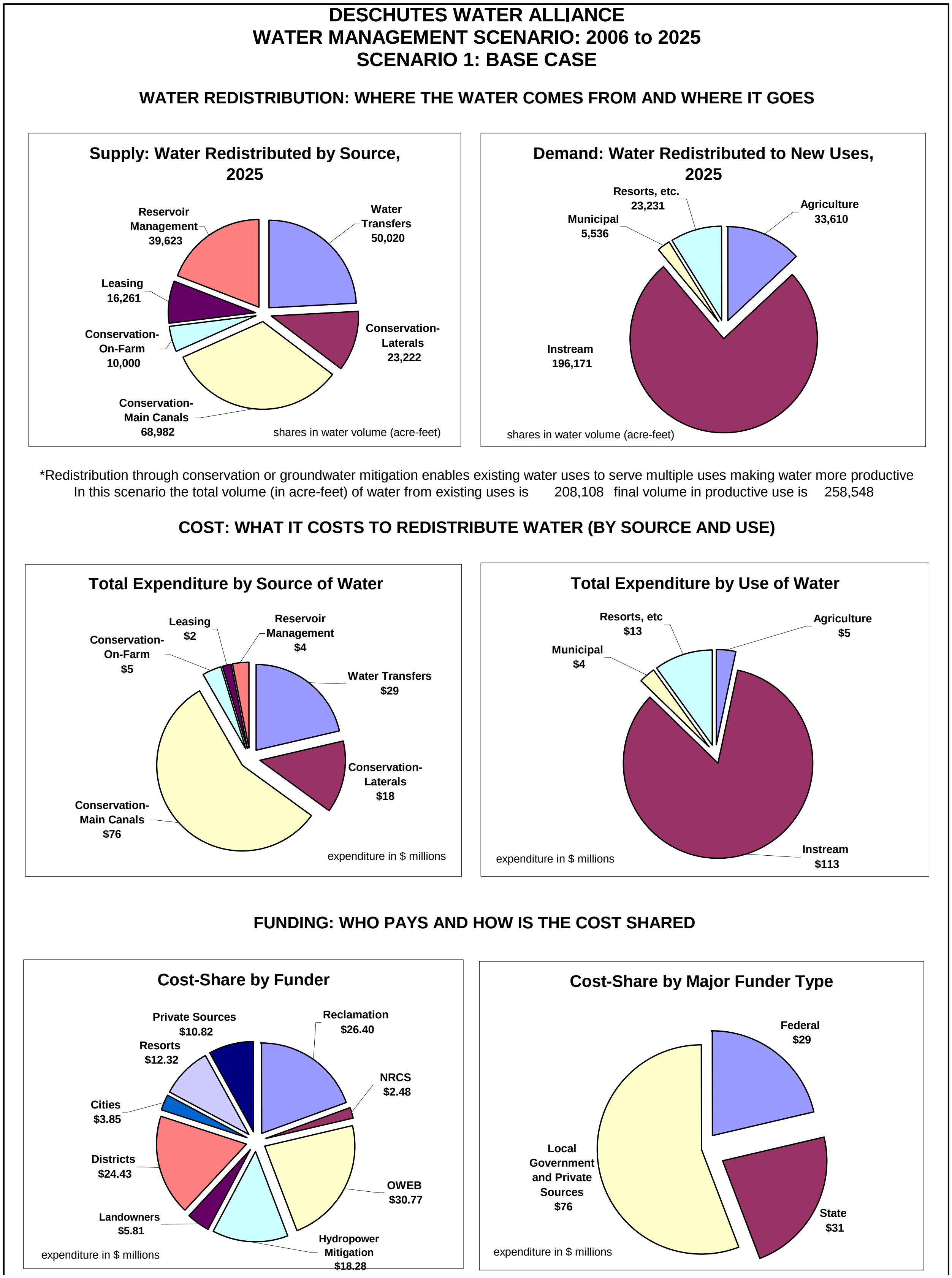
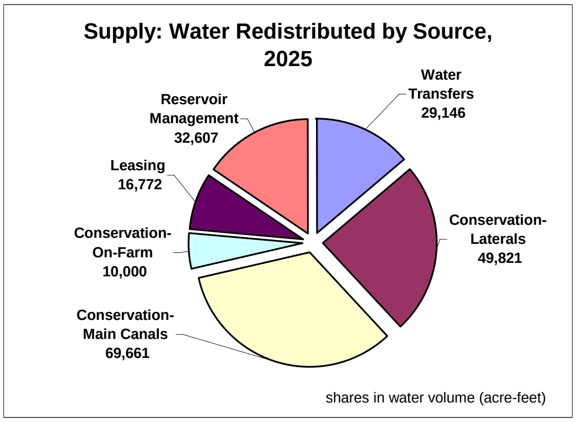
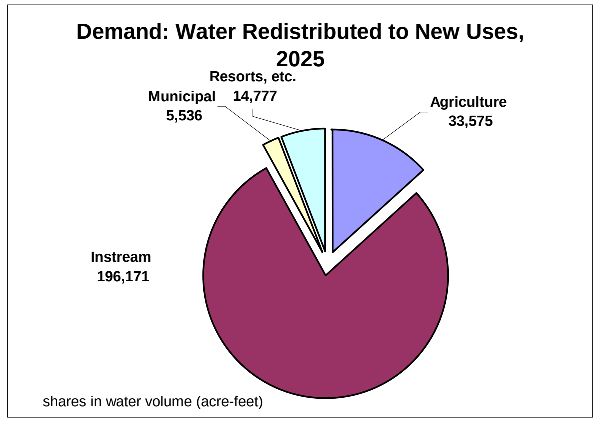


Figure A-2. Low Growth Case Water Management Scenario, 2006 to 2025

DESCHUTES WATER ALLIANCE
WATER MANAGEMENT SCENARIO: 2006 to 2025
SCENARIO 2: LOW GROWTH CASE

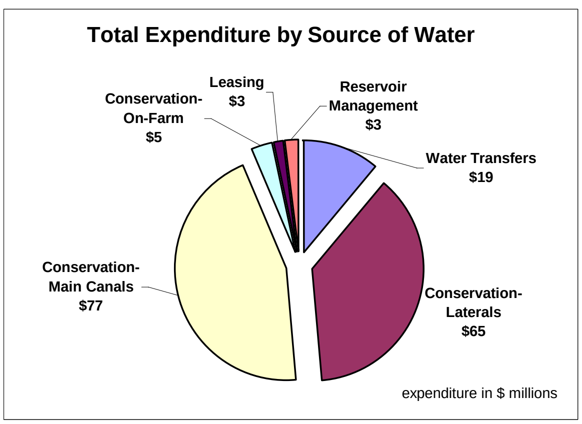
WATER REDISTRIBUTION: WHERE THE WATER COMES FROM AND WHERE IT GOES

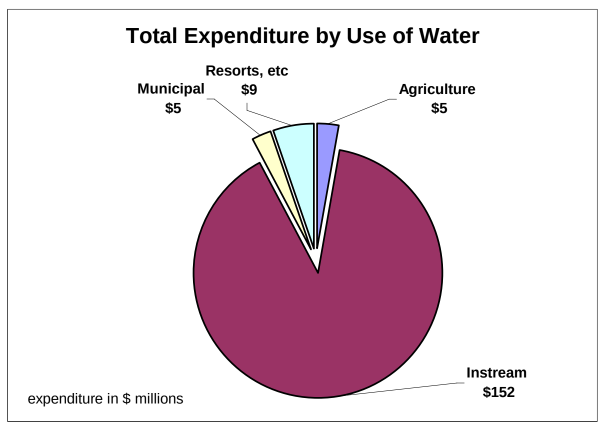




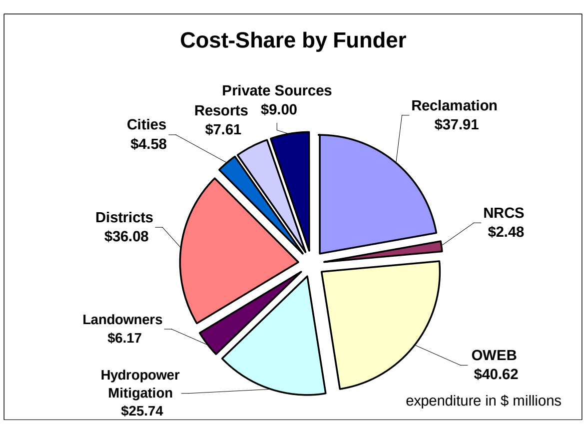
*Redistribution through conservation or groundwater mitigation enables existing water uses to serve multiple uses making water more productive
In this scenario the total volume (in acre-feet) of water from existing uses is 208,007 final volume in productive use is 250,059

COST: WHAT IT COSTS TO REDISTRIBUTE WATER (BY SOURCE AND USE)





FUNDING: WHO PAYS AND HOW IS THE COST SHARED



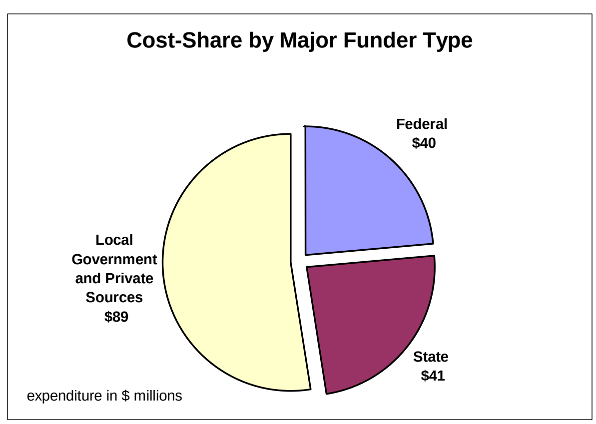


Figure A-3. High Growth Water Management Scenario, 2006 to 2025