Utah FOUNDATION Research Report

Report Number 667, August 2004

UTAH'S WATER SITUATION

HIGHLIGHTS

- At an aggregate state level, drought conditions in 1990 were worse than conditions in 2002.
- However, for the Lake Powell and Cache County areas, this drought cycle has been the worst in 100 years.
- In 2000, Utahns used a total of 4.76 billion gallons of water a day, with irrigation comprising the largest percentage.
- Lot size of residential property seems to have a large influence on the amount of water used for outdoor purposes, when comparing Salt Lake City to other areas within Salt Lake County and Utah County.
- 57.1% of the water in Utah's municipal systems comes from groundwater sources, ranking Utah 10th in the nation for the percentage of drinking water that comes from ground sources.

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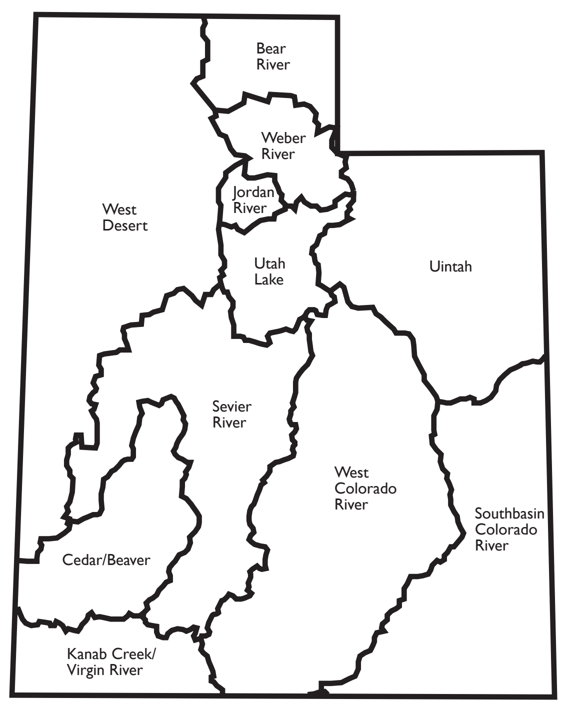
DROUGHT CYCLES & WATER LOCALITY

A Deseret Morning News article from August 8, 2004 stated that, based on flow data of the Colorado River, the current drought is considered the worst in 500 years. This statistic is alarming, but while the Colorado River is an important part of Utah's overall landscape, residents in the most populous parts of the state utilize very little of the river's water. The flow rates of the Colorado have a greater impact downstream in Nevada and California.

Figure 1: Water Basins in Utah



Source: Utah Division of Water Resources

Still, the ongoing drought has impacted, to a greater or lesser extent, all of the river basins in Utah. The map in Figure 1 charts the basins as labeled by the Utah Division of Natural Resources. Each basin can be considered a discrete river system unto itself, since each has unique features, both geologically and climatologically. One unique feature of each basin is the amount of annual precipitation the area receives and when the basin receives an above average or below average amount of precipitation.

Figure 2 shows a summary of Palmer Index data for each of the Division of Natural Resources' seven divisions, which roughly correspond to the eleven basins shown in Figure 1. The Palmer Index has been used since 1895 to determine monthly precipitation relative to the area's "normal" or "average" amount. The Palmer Index ranges from +4 to -4, with a +4 being extremely moist and a -4 extremely dry. For each of the seven divisions, Utah

Figure 2: Palmer Indices and Utah Foundation Statewide Drought Rating for Selected Years

Division 1-West Desert*

	Moderate	Severe	Extreme
1985	1	0	0
1990	0	5	7
1995	2	0	0
2000	5	3	4
2002	0	4	3
Extreme	1954		

Division 2-Southwest Corner

	Moderate	Severe	Extreme
1985	0	0	0
1990	4	6	2
1995	0	0	0
2000	5	5	0
2002	0	3	9
Extreme	1900		

Division 3-Wasatch Front

	Moderate	Severe	Extreme
1985	0	0	0
1990	0	0	12
1995	0	0	0
2000	4	3	0
2002	10	2	0
Extreme	1934		

Division 4-South Central

	Moderate	Severe	Extreme
1985	0	0	0
1990	0	2	10
1995	0	0	0
2000	1	0	0
2002	5	2	3
Extreme	1902		

Division 5-Northeast Mtn.

	Moderate	Severe	Extreme
1985	0	0	0
1990	6	6	0
1995	0	0	0
2000	5	0	0
2002	10	2	0
Extreme	1931-35		

Division 6-Central Highlands

	Moderate	Severe	Extreme
1985	0	0	0
1990	2	10	2
1995	0	0	0
2000	4	3	0
2002	0	6	6
Extreme	1900-02		

Division 7-Southeastern

	Moderate	Severe	Extreme
1985	0	0	0
1990	1	4	7
1995	0	0	0
2000	5	4	0
2002	5	3	4
Extreme	1900-04		

Statewide Total

	Moderate	Severe	Extreme	Drought Rating
1985	1	0	0	0.6
1990	13	33	40	85.6
1995	2	0	0	1.2
2000	29	18	4	38.4
2002	30	22	25	67.9

*2002 data for Division 1 is incomplete
Source: Utah Division of Water Resources

Foundation examined the Palmer Index for five-year intervals from 1985-2000 as well as the last complete year of data, 2002. The years examined correspond with the US Geological Service water use data by state, which is discussed later in this report.

The Palmer Index ranges monthly data on a continuum from extremely moist to extremely dry. This data, however, is not arranged in chronological order. This puts researchers at a slight disadvantage when using this data. When examining the data, a reader cannot tell, for example, if January 1990 was moderately dry while July 1990 was extremely dry, just that there were four months of moderately dry conditions and eight months of extremely dry conditions within a given region during 1990. Since Utah is dependent on winter snow being captured by reservoirs and released during the summer months, a moderately dry February has a greater impact on water supply than an extremely dry June. Despite this limitation, the data are very important in quantifying Utah's drought cycles.

The Palmer Index data in Figure 2 tallies the number of moderately dry, severely dry, and extremely dry months for each division and each year noted. For each division, the year that had the largest number of extremely dry months is highlighted. As the data show, with the exception of Divisions 2 and 6, 1990 had more extremely dry months than 2002. Utah Foundation then tallied the division totals into one "grand total" in the last column. This grand total shows there were more moderately dry months in 2002 on an aggregate state basis than in 1990, but fewer severely and extremely dry months.

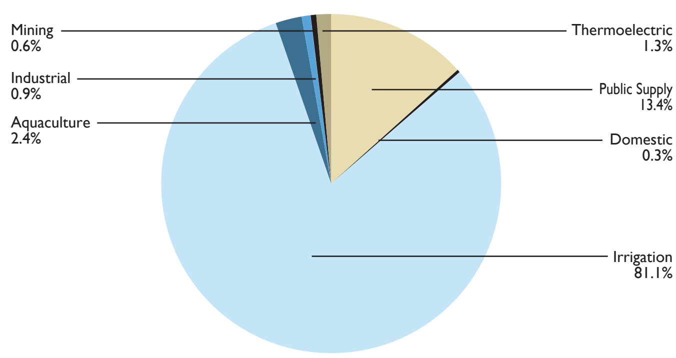
From this grand total, Utah Foundation created a weighted drought index for the entire state. This index weights extremely dry months more heavily than those of less severity. By dividing this weighted figure against the "worst case scenario," twelve months of extremely dry conditions in all seven districts, a drought severity index can be calculated. An index reading of 100 would reflect the worst case scenario, while an index reading of 0 would mean no drought conditions exist. For the years 1985, 1990, 1995, 2000, and 2002, the index rating for each year is shown in the very last column in the statewide total section. The index shows that at the aggregate state level, the drought during 1990 was more severe than during 2002. However, the rapid increase in the ratings between 2000 and 2002 is cause for concern. The current drought began in 1999, but vigorous population growth during 1990-2000 raises concerns about demand outstripping supply even when drought conditions don't exist.

The final piece of information gleaned from the Palmer Index is the last historical point during which conditions were at least as severe in each region as the highlighted time period in Figure 2. For Divisions 2 and 6, the division that have experienced the greatest impact from the current drought cycle, one has to go back to the turn of the last century to find years in which they had more extremely dry months than they had in 2002. For Division 2, the year was 1900 and for Division 6, it was 1902.

STATEWIDE WATER USAGE

Every five years, the U.S. Geological Survey releases data on water usage by state. The data detail the amount of water used for agriculture, municipal and industrial uses (M&I- public or private water utility providers), mining, private industrial wells, and thermoelectric generation. The data also provide a look at the sources of water within the state, either surface sources, such as lakes, reservoirs, and rivers, or ground sources –such as wells and springs. The release of these data is slow, and data from 2000 have just recently been published. Along with previous reports from 1985, 1990, and 1995, these data provide a time series of water usage in Utah and other states. This is the longest state by state data series that can be generated from USGS data. Prior to 1985, state comparisons are not possible because data were released by basin. According to the 2000 data, Utahns used 4.76 billion gallons of water per day. Figure 3 shows the breakout of water

Figure 3: Utah Fresh Water Use by Category, 2000



Source: United States Geological Survey (USGS)

Figure 4: M&I Water Use by State 1985-2000

State	1985	1990	1995	2000
	Per Capita Water Use in gallon/day			
Alabama	175	193	237	233
Arkansas	218	245	213	190
Arizona	200	209	206	222
Arkansas	153	174	191	181
California	219	229	184	203
Colorado	245	213	208	240
Connecticut	135	140	155	159
Delaware	150	161	158	154
Florida	172	172	170	174
Georgia	179	187	195	186
Hawaii	181	225	191	219
Idaho	301	262	242	263
Illinois	181	184	175	161
Indiana	157	151	156	150
Iowa	164	154	173	159
Kansas	158	167	159	166
Kentucky	146	166	148	150
Louisiana	161	171	166	191
Maine	130	154	141	140
Maryland	217	203	200	189
Massachusetts	144	130	130	126
Michigan	170	184	188	159
Minnesota	175	176	145	133
Mississippi	138	167	152	164
Missouri	156	166	161	183
Montana	257	227	222	224
Nebraska	188	251	222	237
Nevada	327	344	325	336
New Hampshire	140	137	141	128
New Jersey	156	152	150	141
New Mexico	226	226	225	203
New York	180	183	185	150
North Carolina	172	169	162	177
North Dakota	135	157	149	129
Ohio	160	143	153	154
Oklahoma	184	193	194	214
Oregon	214	212	234	207
Pennsylvania	196	189	171	145
Rhode Island	131	109	130	129
South Carolina	142	166	200	179
South Dakota	146	137	146	149
Tennessee	171	175	176	170
Texas	194	192	187	215
Utah	**285**	**308**	**269**	**293**
Vermont	155	117	149	166
Virginia	138	151	158	136
Washington	271	221	266	208
West Virginia	115	136	133	146
Wisconsin	184	174	169	172
Wyoming	298	259	262	264
U.S. Average	184	186	184	183
Intermountain Region Average	267	256	245	256

Source: USGS

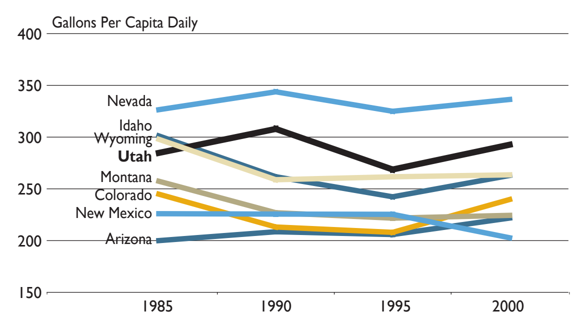
use by category in percentage terms. Irrigation remains Utah's largest use category, and the percentage of water used for this purpose is up slightly from 79.2% in 1995.

In addition to the increase in the percentage of water used for irrigation purposes, the consumption of municipal water per capita in Utah also increased from 1995 to 2000. In 1995, 269 gallons were used per person per day in the state. In 2000, that climbed to 293 gallons. This was one of the largest increases in the country. Only four states, Colorado, Hawaii, Texas, and Louisiana had larger increases in the amount of municipal water used per person. All four states were experiencing drought conditions in 2000 and increased demand by residents for outdoor water may explain the increase in overall M&I water consumption. The table in Figure 4 shows the per capita use of M&I water for all states since 1985 and the percent change and ranking over the time period. Utah ranks 20th in the nation in terms of growth, while Alabama saw the greatest growth in per capita water consumption, and Pennsylvania saw the greatest decline.

Utah's per capita usage fluctuates greatly between drought and non-drought years. In 1990, the rate was 308 gallons per day. In 2000, when the current drought started to become of greater concern statewide, the rate was 293 gallons per capita daily. When comparing the gallons per capita daily from 1985 through 2000 to the drought index for each of those years, there is a correlation between the two sets of data. Since there are only five data points to each set, the correlation should be used with caution, but the Pearson's R squared that is returned when the calculations are performed. This means that approximately 83% of the variance in the amount of gallons per capita daily for 1985-2000 can be explained by the point at which the state finds itself in the drought cycle. To test the true validity of this correlation, further research into other states' water usage and Palmer Indices is necessary.

Figure 5 shows that the intermountain states mostly followed a trend similar to Utah in which water usage increased during the drought years of 1990 and 2000 and was lower in the normal-to-wet years of 1985 and 1995. In fact, Utah appears to have reduced water consumption over time from wet year to wet year (1985 to 1995) and from dry year to dry year (1990 to 2000).

Figure 5: Intermountain States Water Usage, Gallons Per Capita Daily



Source: USGS

WATER USAGE BY BASIN

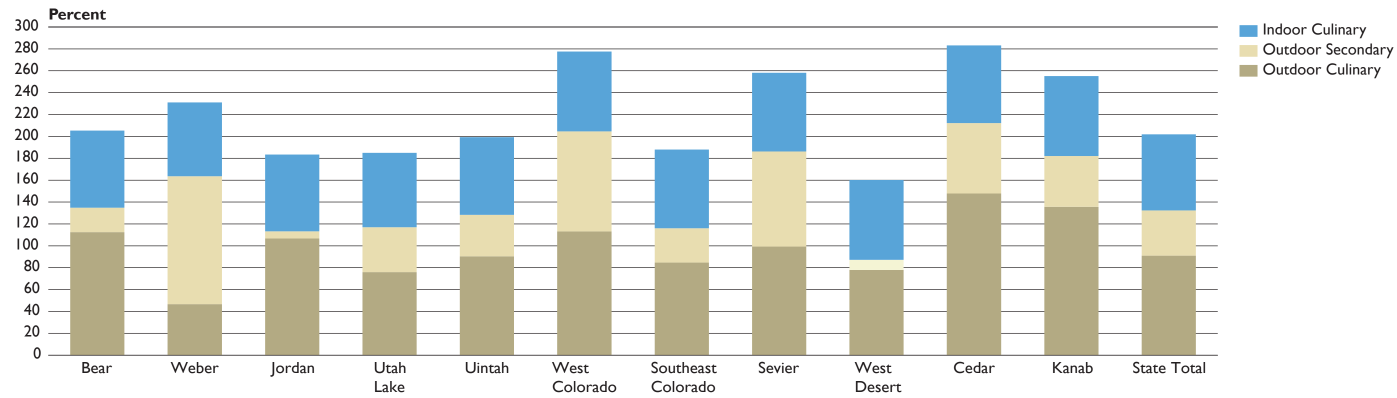
While statewide data are important, they are totals and aggregates of the water usage that occurs in each of the state's eleven basins. As was mentioned before, each of these eleven basins can be viewed as discrete water use areas. There is a surprising amount of variation in usage around the state, as shown in Figure 6 (next page). There are two important notes to these data provided by the Division of Water Resources. First, the volume of water for each basin only includes water utilized in public M&I systems. It does not include privately supplied industrial or residential entities that have their own well system, nor does it include agricultural water. However, the volume does count secondary water systems that municipalities employ for outside watering by residents and businesses. Second, some of these data are old, collected at the time each basin's latest water plan was authored. For example, the Cedar/Beaver River Basin Plan was released in 1995, and population information contained in that report is from 1992. Population growth in Cedar City since that time has been more robust than the figures in the report account for. This may be a

Figure 6: 2000 Public Community System Water Use

HYDROLOGIC RIVER BASIN		BEAR		WEBER		JORDAN		UTAH LAKE		UINTAH		WEST COLORADO		SOUTHEAST COLORADO		SEVIER		WEST DESERT		CEDAR/BEAVER		KANAB/VIRGIN		STATEWIDE TOTAL	
WATER USE CATAGORY		Pop. (1999) 126,418		Pop. (1992) 387,112		Pop. (1999) 879,850		Pop. (1993, 1998) 354,000		Pop. (1995) 35,778		Pop. (1996) 36,523		Pop. (1996) 16,466		Pop. (1996) 47,815		Pop. (1996) 29,438		Pop. (1992) 26,541		Pop. (1997) 85,535		Pop. (2000) 2,025,476	
		Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	Ac-Ft/Yr	GPCD	AC-Ft/Yr	GPCD
POTABLE																									
Residential:	Indoor	9,974	70	29,271	68	69,162	70	26,964	68	2,845	71	2,987	73	1,328	72	3,856	72	2,406	73	2,111	71	6,994	73	157,898	70
	Outdoor	15,930	112	20,235	47	105,125	107	30,116	76	3,622	90	4,630	113	1,562	85	5,318	99	2,569	78	4,395	148	12,998	136	206,500	91
	Total	25,904	183	49,506	114	174,287	177	57,080	144	6,467	161	7,617	186	2,890	157	9,174	171	4,975	151	6,506	219	19,992	209	364,398	161
Commercial:	Indoor	3,138	22	9,414	22	28,267	29	7,697	19	706	18	812	20	515	28	1,302	24	414	13	517	17	7,101	74	59,882	26
	Outdoor	785	6	2,353	5	7,067	7	1,924	5	176	4	203	5	129	7	325	6	103	3	129	4	1,775	19	14,970	7
	Total	3,923	28	11,767	27	35,334	36	9,621	24	882	22	1,015	25	644	35	1,627	30	517	16	646	22	8,876	93	74,852	33
Institutional:	Indoor	505	4	4,219	10	5,187	5	2,855	7	243	6	240	6	67	4	469	9	383	12	121	4	416	4	14,705	6
	Outdoor	2,020	14	16,878	39	20,748	21	11,418	29	972	24	959	23	267	14	1,877	35	1,534	47	485	16	1,662	17	58,820	26
	Total	2,525	18	21,097	49	25,935	26	14,273	36	1,215	30	1,199	29	334	18	2,346	44	1,917	58	606	20	2,078	22	73,525	32
Industrial:	Total	3,713	26	2,682	6	10,744	11	5,185	13	1,026	26	360	9	79	4	1,169	22	517	16	290	10	527	6	26,292	11
	Subtotal	**36,065**	**255**	**85,052**	**196**	**246,300**	**250**	**86,159**	**217**	**9,590**	**239**	**10,191**	**249**	**3,947**	**214**	**14,316**	**267**	**7,926**	**240**	**8,048**	**271**	**31,473**	**328**	**539,067**	**237**
NON-POTABLE																									
Residential:	Outdoor	3,167	22	50,689	117	6,512	7	16,258	41	1,520	38	3,740	91	578	31	4,654	87	308	9	1,912	64	4,450	46	93,788	41
Commercial:	Outdoor	496	4	2,815	6	2,487	3	3,232	8	10	0	0	0	0	0	2	0	0	0	160	5	1,586	17	10,788	5
Institutional:	Outdoor	1,528	11	4,399	10	3,759	4	1,925	5	1,099	27	1,073	26	750	41	1,112	21	1,111	34	1,255	42	4,584	48	22,595	10
Industrial:	In/Out	0	0	0	0	0	0	566	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	567	0
	Subtotal	**5,191**	**37**	**57,903**	**134**	**12,758**	**13**	**21,981**	**55**	**2,629**	**66**	**4,813**	**118**	**1,328**	**72**	**5,769**	**108**	**1,419**	**43**	**3,327**	**112**	**10,620**	**111**	**127,738**	**56**
STATEWIDE TOTALS		**41,256**	**291**	**142,955**	**330**	**259,058**	**263**	**108,140**	**273**	**12,219**	**305**	**15,004**	**367**	**5,275**	**286**	**20,085**	**375**	**9,345**	**283**	**11,375**	**383**	**42,093**	**439**	**666,805**	**293**
Total Culinary (Potable) Water																									
Residential Only		**25,904**	**183**	**49,506**	**114**	**174,287**	**177**	**57,080**	**144**	**6,467**	**161**	**7,617**	**186**	**2,890**	**157**	**9,174**	**171**	**4,975**	**151**	**6,506**	**219**	**19,992**	**209**	**364,398**	**161**
Total Potable & Non-Potable																									
Residential		**29,071**	**205**	**100,195**	**231**	**180,799**	**183**	**73,338**	**185**	**7,987**	**199**	**11,357**	**278**	**3,468**	**188**	**13,828**	**258**	**5,283**	**160**	**8,418**	**283**	**24,442**	**255**	**458,186**	**202**
Commercial		**4,419**	**31**	**14,582**	**34**	**37,821**	**38**	**12,853**	**32**	**892**	**22**	**1,015**	**25**	**644**	**35**	**1,629**	**30**	**517**	**16**	**806**	**27**	**10,462**	**109**	**85,640**	**38**
Institutional		**4,053**	**29**	**25,496**	**59**	**29,694**	**30**	**16,198**	**41**	**2,314**	**58**	**2,272**	**56**	**1,084**	**59**	**3,458**	**65**	**3,028**	**92**	**1,861**	**63**	**6,662**	**70**	**96,120**	**42**
Industrial		**3,713**	**26**	**2,682**	**6**	**10,744**	**11**	**5,751**	**15**	**1,026**	**26**	**360**	**9**	**79**	**4**	**1,169**	**22**	**517**	**16**	**290**	**10**	**527**	**6**	**26,858**	**11**
TOTALS		**41,256**	**291**	**142,955**	**330**	**259,058**	**263**	**108,140**	**273**	**12,219**	**305**	**15,004**	**367**	**5,275**	**286**	**20,084**	**375**	**9,345**	**283**	**11,375**	**383**	**42,093**	**439**	**666,804**	**293**

Source: Utah Division of Drinking Water

Figure 7: Indoor & Outdoor Residential Water Use by Basin, Gallons Per Capita Daily, 2000



Source: Utah Division of Water

reoccurring imprecision throughout the state, since the most recent population figures used are from 1999 and 2000.

Despite these limitations, the data can be used to compare one basin against another. Figure 6 also shows water use by type of customer and if that water is potable or not. The categories of customers include residential, commercial, institutional (including schools and churches) and industrial. Non-potable water is used outdoors, although some is utilized by industrial customers indoors. Some of the information provided by these data includes water use and utilization by customer type as well as the reliance customers in each basin have on culinary water for outdoor purposes. Overall water use, potable and non-potable, ranges from a low of 263 gallons per capita daily (GPCD) in the Jordan River basin, to 439 GPCD in the Kanab/Virgin River basin. Additionally, these data show that the residential users in the southern part of the state have the highest GPCD rate when potable and non-potable residential use are added together, while the Sevier basin has the lowest GPCD. When one examines the percentage each customer class makes up of a basin's total public system, residential customers range from a low of 56.5% in the Sevier basin to a high of 75.7% in the Uintah basin. Residential customers are both the largest customer type and the largest water consumers for community water systems. Commercial and institutional each account for 20% or less of consumption within public systems, with two exceptions. In the Cedar/Beaver basin, commercial customers account for approximately 25% of all water consumed. In the Sevier basin, institutional customers make up 32.4% of consumption. Finally, industrial users range from a high of 9.0% of water consumed in the Bear River basin to a low of 1.3% in the Cedar/Beaver basin. For the purpose of conservation efforts, these percentages are important to know. In most basins' efforts to reduce demand on the system, targeting residential customers will have the largest impact. However, in the few basins highlighted above, efforts to conserve water may also need to include institutional or business entities.

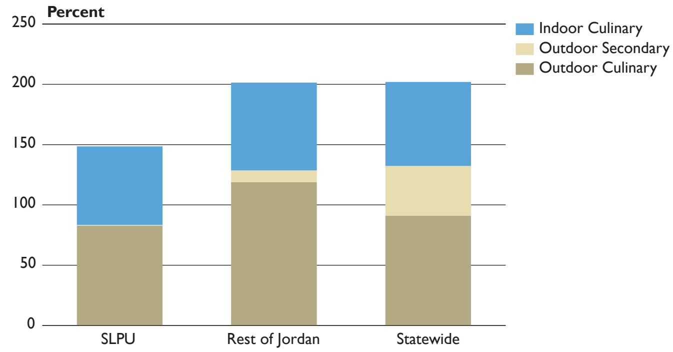
Another factor that needs to be considered when examining water usage in each basin is the availability of a secondary water system. This system contains water that is not potable but can be used outdoors for lawns and gardens. Secondary supply systems get a mixed review among water policymakers in Utah. The benefits provided by secondary systems are that they lessen the demand on culinary systems, thus extending the life of those systems. Additionally, since the water does not need to be treated to drinking standards, costs for water treatment may be lessened. On the downside, secondary systems may cause customers to consume more water, since secondary system water usually costs the homeowner less than culinary water, and the pricing structure is often flat. This means that if a homeowner uses 100,000 gallons of secondary water in a month, they pay the same amount as a homeowner that uses 10,000 gallons of secondary water in the same month. Finally, it is challenging and costly to retrofit existing developments with secondary systems. Older neighborhoods are less likely to have access to secondary systems.

Figure 7 highlights the amount and proportion of residential water used inside and outside the home by basin, including culinary and secondary water. Using Weber Basin as an example, residents in that area use 164 GPCD outside the home. This accounts for 70.8% of their total water consumption. Of that 164 gallons used for outdoor purposes, only 47 GPCD come from the culinary system; the rest is provided via a secondary system. Weber Basin has the highest secondary water utilization rate, followed by Sevier and the West Colorado Basin. On the opposite end of the spectrum, the Jordan Valley Basin has the lowest rate of secondary system utilization. 94% of outdoor water comes from the culinary system. However, Jordan Valley residents are fairly thrifty with outdoor water use, ranking only behind the West Desert Basin for the second lowest amount (113 GPCD) and proportion (62%) of residential water that is used outside.

WATER USE WITHIN A BASIN

There can also be differences in water usage patterns within a basin. Figure 8 illustrates the amount and proportion of water used outdoors for residential customers that are part of the Salt Lake City Public Utility system relative to their counterparts in the rest of the Jordan Valley Basin and statewide figures. As the data show, homeowners that are part of SLPU have a lower level of outdoor water use, and secondary water use is negligible. Residential customers in the rest of the Jordan Valley Basin are more reliant on secondary water than SLPU customers and they also use a larger percentage of their water outside.

Figure 8: Indoor & Outdoor Residential Water Use, Gallons Per Capita Daily, 2000



Source: Ibid

These differences between utilization of water resources within the Jordan Valley Basin may have several root causes. First, residents of the SLPU service area don't have much access to secondary systems; therefore all water comes from the culinary system. As was stated above, culinary water is more expensive. Additionally, SLPU has recently restructured the water rate system into an increasing block rate model that couples high water usage with increasingly high rates. This type of pricing structure is meant to discourage overuse of water for outdoor purposes. Beyond these measures, SLPU residential customers seem to be more receptive to ideas such as voluntary drought restriction measures and investment in xeric landscaping. Lot sizes may be another factor that should be considered.

A cursory examination of residential property for sale on a large statewide real estate website that accessed Utah's multiple listing service revealed an interesting trend in lot sizes that is highlighted in Figure 9. Properties listed for sale were grouped by two variables- location and lot size. Location was defined as Salt Lake City, other cities within Salt Lake County, and Utah County. Lot sizes were placed into categories by 1/10 of an acre increments. In order to understand more fully the limitations of these data, a couple of caveats are necessary. First, the data do not include homes that are for sale by owner. Homes for sale by owner are especially prevalent in Utah County; therefore the data on houses in Utah County may not be representative of all homes for sale within the county. Second, condominiums, townhouses and other multi-family units for sale are included in the category 0.0 to 0.9. The decision to include these dwellings was made because most multi-family homes do have common landscaped areas and lawns that draw on municipal water. However, there were also some single-family detached dwellings in all three areas that were situated on lots less than 1/10 of an acre. Within Salt Lake City, there were 17 homes (3.9% of total homes for sale) that had lot sizes smaller than 0.10 of an acre. For the rest of the county, there were 11 homes (2.3% of the total homes for sale) that had lot sizes smaller than 0.10 of an acre. In Utah County, the figures were three homes or 1.3% of the total.

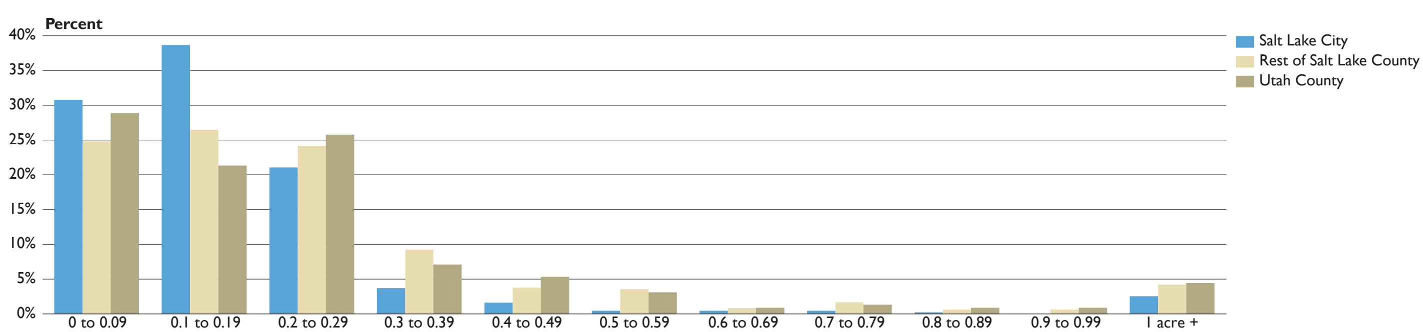
Even with these limitations on the data, the story shown by Figure 9 is compelling. The percent of Salt Lake City lots that are between 0.10 of an acre to 0.19 of an acre are significantly higher than other cities in the county or in Utah County. Additionally, Salt Lake City has a smaller percentage of lots that are above 0.20 of an acre than the other two areas. Additionally, while a tally was not kept by price, it appeared that houses of higher price ranges ($350,000 and up) were just as likely in Salt Lake City to be on small lots as lower priced houses. This was not true in the rest of Salt Lake County or in Utah County. Both factors, lot size and price, are important. Smaller lots require less water, and wealthier homeowners are more likely to have the monetary ability to install xeric landscaping.

Combining this information with the data in Figure 8 infers that smaller lot sizes lead to a lower proportion of outside water use. However, smaller lots also usually mean more households (water users) per acre, and it is not clear whether this increased density would lead to aggregate reductions in water use.

PRICING

Salt Lake Public Utility has, in recent years, changed its summer pricing structure to increasing block rate pricing. The impact of the new pricing scheme is not reflected in the data in Figure 8, since the data were gathered prior to the change. However, research in other arid western states suggests that block rate pricing is an important tool in encouraging conservation. Block rate pricing has the greatest impact when the marginal cost of an additional block is high enough to discourage consumption. The standard approach to creating this type of pricing scheme is to price incrementally smaller blocks of water at higher rates. A less effective, but more popular approach is to increase

Figure 9: Residential Property for Sale by Lot Size



Source: Wasatch Front Regional Multiple Listing Service (MLS), calculations by Utah Foundation

Figure 10: Examples of Municipal Water Pricing Structures

	Base or Lifeline		Block 1			Block 2			Block 3			Block 4			Overage				
	Rate	Gallons	Rate	Per Gallons	Max. Gallons	Rate	Per Gallons	Max. Gallons	Rate	Per Gallons	Max. Gallons	Rate	Per Gallons	Max. Gallons	Rate	Per Gallons	Max. Gallons	Cost for 100,000 Gallons	Cost per 1,000 Gallons
City A	$25.00	100,000																$25.00	$0.25
City B	25.00	25,000	$1.25	1,000	20,000	$1.50	1,000	15,000	$1.75	1,000	10,000	$2.00	1,000	5,000	$2.25	1,000	75,000+	156.25	1.56
City C	25.00	25,000	1.25	1,000	25,000	1.50	1,000	25,000	1.75	1,000	25,000							137.50	1.38
City D	25.00	10,000	1.00	1,000	50,000	0.50	1,000	100,000	0.25	1,000	200,000	0.13	1,000	400,000				95.00	0.95
City E	25.00	10,000	2.75	1,000	20,000	3.50	1,000	15,000	4.25	1,000	10,000	5.00	1,000	5,000	5.75	1,000	75,000+	430.00	4.30

Source: Hypothetical rates created by Utah Foundation, based on observations from the 2002 Utah Community Drinking Water Survey, Utah Division of Drinking Water

the price on uniformly sized blocks of water. Figure 10 utilizes data from the 2002 Utah Community Drinking Water Survey to illustrate this point. Five representative cities were created from the Drinking Water Survey data, and their pricing schemes were analyzed using 100,000 gallons of residential consumption during one month. The 100,000 gallons might be an exaggeration of typical household use; however there were eight municipalities that indicated on the survey forms they charge a flat rate for usage up to 100,000 gallons, with rates ranging between $4.30 and $150.00 a month. This is illustrated by City A. For a consumer in City A, using 25,000 gallons would cost the same as using all 100,000. Additionally, the unit cost per 1,000 gallons would be higher for using 25,000 gallons ($1.00 per 1,000) versus the unit cost of all 100,000 ($0.25 per 1,000). Therefore, a consumer in City A actually has a strong incentive for using the maximum amount of water allowable.

This contrasts with City B, which has a traditional block rate pricing structure; prices increase with each block, and the amount of water within each block decreases. There are only four blocks in this example. No Utah municipality that responded to the survey had more than four blocks. Therefore, to reach the 100,000 gallons, the example has an "overage rate," which is essentially a flat block on the upper end. Theoretically, it is possible to extend blocks indefinitely. Most municipalities, however, prefer simplicity in their billing systems and four or five blocks seems to be the limit of feasibility. In the City B example, the first 25,000 gallons is extended to a residential household at a flat rate-often called a "lifeline" rate. This is the minimum amount of water that is calculated by the municipality to meet basic needs. The rate on this "lifeline" is purposely kept low, to ensure affordability. The unit cost per 1,000 gallons in City B is $1.00 for the first 25,000 gallons. However, if a resident uses more than 25,000 gallons, the price is increased. For the next 20,000 gallons, the cost per 1,000 gallons increases to $1.25, and so on. For the total 100,000 gallons, a resident in City B would spend $156.25. Overall, the unit cost per 1,000 gallons is $1.56. This is slightly above the statewide average of $1.39 given in the Drinking Water Survey.

City C represents a compromise approach to block rate pricing. The price of water increases with use, but the amount of water within each block does not decrease. While this approach costs the consumer almost as much as the City B model, $137.50 versus $156.25, it ignores the marginal cost of the water. By having such large uniform blocks, a municipality may be encouraging people to use up to the maximum allowed by a block, since the difference in the monthly bill between a consumer that uses 55,000 gallons and a consumer that uses 74,000 gallons is relatively small.

City D represents a pricing structure utilized by two of the municipalities that responded to the Drinking Water Survey, that of decreasing block rate pricing. The premise is the more a customer uses, the less that customer pays per unit. Decreasing block rates are generally employed by municipalities that have a few large industrial, commercial, or institutional customers that make up the bulk of the customer base. Under decreasing block rates, the baseline rate is set high and the gallons covered by that rate are low. In this example, the cost per 1,000 gallons is $2.50 at the base. The rate per 1,000 gallons in the next block is $1.00, and the next is $0.50 per 1,000 gallons. If a customer uses 100,000 gallons, the charges would be $95. However, to double the amount of water used to 200,000 gallons would only cost the customer $40 more for a bill of $135.

City E, representing a block rate structure similar to City B, illustrates a municipality that is aggressively encouraging conservation. There wasn't a Utah municipality in the survey that had block rate pricing this steep. However, the cost per 1,000 gallons is close to that of Reno, Nevada. Reno has one of the highest costs per 1,000 gallons of cities within the intermountain region. The block rate pricing structure represented by City E brings the price per 1,000 gallons close to that of Reno. However, it assumes that the majority of customers would be using 100,000 gallons per month. Since this is not feasible, rates in Reno might actually be higher, or the blocks smaller, in order to have an overall rate of $3.39 per 1,000 gallons. City E, unlike City B, has a smaller amount of water included in the base, but is paying the same amount, $25.00. Thus, residents in City E are paying $2.50 per 1,000 compared to $1.00 per 1,000 gallons in City B. For simplicity, City E has the same size blocks as City B, but the cost per 1,000 is higher and increases more rapidly. The end result is that a consumer in City E who uses 100,000 gallons would have a monthly bill of $430.00, compared to $156.25 in City B, and the per 1,000 gallon cost would be $4.30.

These scenarios only include costs collected through billing for actual water used. They do not include revenue that is generated from taxes, impact fees, or connection fees. According to the Drinking Water Survey, 27 of the 229 systems (11.8%) that responded with usable data collected tax revenue in addition to billing. When the data were examined at a county level, Weber County had the largest number

Figure 11: Utah Municipal Pricing Structure Comparisons by County

County	Avg. No. of Connections	Median No. of Connections	No. of Systems that Collect tax revenue	Percent of Systems that Collect tax revenue	Avg. Monthly Cost	Avg. Monthly Cost w/o Tax Revenue	Difference in Cost	Taxes as a Percent of Avg. Monthly Cost
Beaver	NA	NA	NA	NA	NA	NA	NA	NA
Box Elder	657	240	1	5.6%	$40.82	$24.73	$16.09	39.4%
Cache	1,507	563	0	0.0%	26.56	26.56	0.00	0.0%
Carbon	1,550	1,113	2	40.0%	30.76	29.24	1.52	4.9%
Daggett	NA	NA	NA	NA	NA	NA	NA	NA
Davis	4,364	2,971	1	8.3%	20.48	20.15	0.33	1.6%
Duchesne	378	349	2	40.0%	45.01	39.67	5.34	11.9%
Emery	989	428	1	25.0%	29.14	25.38	3.76	12.9%
Garfield	335	109	1	20.0%	21.73	21.41	0.33	1.5%
Grand	996	1,168	1	33.3%	41.92	41.68	0.25	0.6%
Iron	861	132	0	0.0%	28.11	28.11	0.00	0.0%
Juab	611	285	0	0.0%	38.54	38.54	0.00	0.0%
Kane*	363	64	3	50.0%	471.22	49.71	421.50	89.5%
Millard	373	246	0	0.0%	23.38	23.38	0.00	0.0%
Morgan	248	141	0	0.0%	39.19	39.19	0.00	0.0%
Piute	NA	NA	NA	NA	NA	NA	NA	NA
Rich	NA	NA	NA	NA	NA	NA	NA	NA
Salt Lake	13,459	3,940	2	14.3%	37.16	36.48	0.68	1.8%
San Juan	527	444	0	0.0%	46.47	46.47	0.00	0.0%
Sanpete	640	517	2	20.0%	26.87	25.14	1.74	6.5%
Sevier	463	220	0	0.0%	21.35	21.35	0.00	0.0%
Summit	860	335	1	14.3%	27.37	25.95	1.42	5.2%
Tooele	1,678	252	1	14.3%	21.36	21.25	0.11	0.5%
Uintah	1,067	630	4	66.7%	38.70	33.39	5.30	13.7%
Utah	4,138	1,532	0	0.0%	29.94	29.94	0.00	0.0%
Wasatch	839	127	0	0.0%	28.44	28.44	0.00	0.0%
Washington	1,180	268	0	0.0%	36.48	36.48	0.00	0.0%
Wayne	171	144	0	0.0%	19.46	19.46	0.00	0.0%
Weber	4,288	2,045	5	38.5%	25.22	23.97	1.25	5.0%
Statewide	2,442	389	27	11.8%	32.96	27.20	5.76	17.5%

* Kane County has one small (15 connections) water system that uses tax revenue as its major funding source. This system skews the figures for Kane County.
Source: Utah Division of Drinking Water

of systems that collect tax revenue, 5 of 13 systems. Uintah County had the largest percentage, with 4 of 6 systems collecting tax revenue. These data can be found in Figure 11.

Figure 11 also shows that in most counties, there is one large system with the majority of connections and several smaller ones. This is highlighted by the difference in the average number of connections and the median number of connections. The average is skewed upwards due to the presence of one large system. In Salt Lake County, Salt Lake Public Utilities has 89,126 connections. The next largest system, the Sandy Water System, has 26, 411 connections. Additionally, while tax revenue accounts for 11.8% of overall statewide revenue, it varies from county to county. Tax revenue as a percentage of total revenue is the highest in Box Elder County at 39.4%. Kane County, because it has one small water system using tax revenue as its major funding source, is excluded from this ranking, because that water system skews the figures.

One of the concerns around water systems that collect tax revenue in addition to billing for water use is that the system can charge customers less than the full cost of the water and use tax revenue to make up the difference. In this broad analysis, that does not seem to be the case, at least when the county averages are compared against each other. Customers in thirteen counties have average monthly costs higher than the statewide average. Of these thirteen, five are counties in which water systems collect tax revenue and seven have water systems that do not collect taxes. Only one county, Box Elder, has an average total cost above the state average, while the average minus tax revenue is below the state average. This may mean that the system in Box Elder that is collecting tax revenue may be using taxes to supplement billing revenue. However, the problem with making this assumption is that there is no data on the amount of money these systems spend to procure their water. A system that has low rates and does not collect tax revenue may also have extremely low costs, and the margin between revenue and expenditures is wider than a system that has high revenues, including tax revenue, and high costs. Without a detailed examination of individual systems, including the costs incurred by the system, there is no reliable way to assess whether or not municipalities are using tax revenue to supplement billing charges. However, the data presented above begin to give policymakers an idea of similarities and differences in water systems throughout the state.

WATER SOURCES IN UTAH AND THE WEST

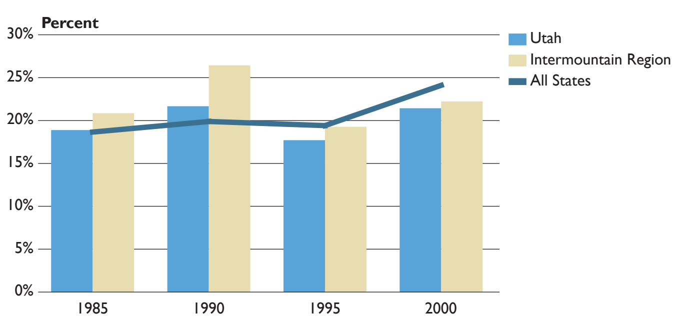
Water is classified as having two sources of origin. Water comes from either surface sources (lakes, rivers, and streams) or from ground sources (springs and wells). In Utah, 78.6% of total water withdrawals are from surface sources. However, for public drinking water supplies, 57.1% comes from ground water sources. Ground water tends to be of a higher quality and requires less treatment to reach drinking water quality. Utah's 57.1% ranks the state 10th in the nation for the percentage of public drinking water that originates from ground sources. Figure 12 details ground water withdrawals for M&I use by state. Perhaps the most interesting comparisons are with Utah's neighboring states. For example, Colorado is one of the lowest ground water users in the nation; only 6% of Colorado's publicly supplied drinking water originates from ground sources. Conversely, both Idaho and New Mexico receive over 88% of their drinking water from ground sources. In the case of New Mexico, there is little potable surface water to utilize in public systems. In Idaho, it appears to be a case of water rights. Most of the surface water in the state goes for irrigation. Municipalities in that state need to search elsewhere for water resources.

Figure 12: Public Supply by State and Source, 2000

State	M&I (Withdrawals MGPD*) Surface	Ground	Total	M&I Sources Surface	Ground	Rank Ground Withdrawals as a Percent
Alabama	553.0	281.0	834.0	66.3%	33.7%	27
Alaska	50.7	29.3	80.0	63.4%	36.6%	23
Arizona	613.0	469.0	1,082.0	56.7%	43.3%	19
Arkansas	289.0	132.0	421.0	68.6%	31.4%	30
California	3,320.0	2,800.0	6,120.0	54.2%	45.8%	17
Colorado	846.0	53.7	899.7	94.0%	6.0%	50
Connecticut	358.0	66.0	424.0	84.4%	15.6%	44
Delaware	49.8	45.0	94.8	52.5%	47.5%	15
Florida	237.0	2,200.0	2,437.0	9.7%	90.3%	02
Georgia	968.0	278.0	1,246.0	77.7%	22.3%	36
Hawaii	017.6	243.0	250.6	3.0%	97.0%	01
Idaho	25.3	219.0	244.3	10.4%	89.6%	03
Illinois	1,410.0	353.0	1,763.0	80.0%	20.0%	40
Indiana	326.0	345.0	671.0	48.6%	51.4%	13
Iowa	79.8	303.0	382.8	20.8%	79.2%	07
Kansas	244.0	172.0	416.0	58.7%	41.3%	20
Kentucky	455.0	71.0	526.0	86.5%	13.5%	47
Louisiana	404.0	349.0	753.0	53.7%	46.3%	16
Maine	72.5	29.6	102.1	71.0%	29.0%	32
Maryland	740.0	84.6	824.6	89.7%	10.3%	48
Massachusetts	542.0	197.0	739.0	73.3%	26.7%	33
Michigan	896.0	247.0	1,143.0	78.4%	21.6%	38
Minnesota	171.0	329.0	500.0	34.2%	65.8%	08
Mississippi	40.4	319.0	359.4	11.2%	88.8%	04
Missouri	594.0	278.0	872.0	68.1%	31.9%	29
Montana	92.4	56.1	148.5	62.2%	37.8%	22
Nebraska	63.8	266.0	329.8	19.3%	80.7%	06
Nevada	478.0	151.0	629.0	76.0%	24.0%	34
New Hampshire	64.1	33.0	97.1	66.0%	34.0%	26
New Jersey	650.0	400.0	1,050.0	61.9%	38.1%	21
New Mexico	33.8	262.0	295.8	11.4%	88.6%	05
New York	1,980.0	583.0	2,563.0	77.3%	22.7%	35
North Carolina	779.0	166.0	945.0	82.4%	17.6%	42
North Dakota	31.2	32.4	63.6	49.1%	50.9%	14
Ohio	966.0	500.0	1,466.0	65.9%	34.1%	25
Oklahoma	562.0	113.0	675.0	83.3%	16.7%	43
Oregon	447.0	118.0	565.0	79.1%	20.9%	39
Pennsylvania	1,250.0	212.0	1,462.0	85.5%	14.5%	45
Rhode Island	102.0	16.9	118.9	85.8%	14.2%	46
South Carolina	462.0	105.0	567.0	81.5%	18.5%	41
South Dakota	39.1	54.2	93.3	41.9%	58.1%	09
Tennessee	569.0	321.0	890.0	63.9%	36.1%	24
Texas	2,970.0	1,260.0	4,230.0	70.2%	29.8%	31
Utah	274.0	364.0	638.0	42.9%	57.1%	10
Vermont	40.6	19.5	60.1	67.6%	32.4%	28
Virginia	650.0	70.7	720.7	90.2%	9.8%	49
Washington	552.0	464.0	1,016.0	54.3%	45.7%	18
West Virginia	149.0	41.6	190.6	78.2%	21.8%	37
Wisconsin	293.0	330.0	623.0	47.0%	53.0%	12
Wyoming	49.4	57.2	106.6	46.3%	53.7%	11
TOTAL	27,300.0	16,000.0	43,300.0	63.0%	37.0%	NA

* Millions of Gallons Per Day (MGPD)
Source: USGS

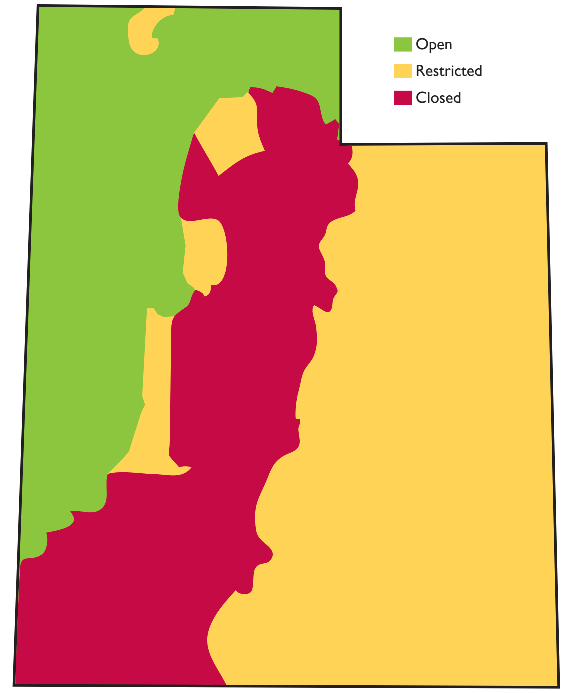
Figure 13: Utah, Intermountain States and US Groundwater Usage as a Percent of Total Water Withdrawals, 1985-2000



Source: USGS

An ongoing concern about ground water usage is that the water is not as readily replenished as surface water, and that over-usage of this resource will dry up deep aquifers, some of which are the source of surface waters. Nationally, there seems to be an increase in the proportion of ground water used. In the Intermountain West as well

Figure 14: Groundwater Permitting Availability in Utah



Source: Utah Division of Water Rights

as in Utah, ground water usage has fluctuated over the time series with a peak in 1990, as shown in Figure 13. Both indicators suggest there is reason to be concerned about overuse of groundwater sources, and that perhaps groundwater is being used to cushion residents in western states from the full impact of drought conditions.

Currently, the best way to gauge groundwater usage conditions in the state is to examine the parts of the state that are open or closed to new groundwater claims through the Division of Water Rights. Figure 14 details the portions of the state in which new water rights claims for groundwater can be filed, which areas have restrictions on those filings and which are closed to new claims. The areas closed to new claims create a swathe through the middle of the state, including the Wasatch Front and areas in the southwest, both of which are experiencing population growth. Restricted areas include most of eastern Utah. Contained in the restricted area are the source springs for many of the rivers and streams that feed into the surface water supply. The areas of the state that are still open to groundwater claims are in the western portion of the state, when water is scarce and may not be potable. The Division of Water Rights has expressed concern that groundwater rights are over-allocated along the Wasatch Front. Additionally, in the southwestern corner of the state, groundwater mining is dropping water levels faster than they can be replenished.

CONCLUSION

Utah's water use has been largely dependent on the drought cycle. A comparative analysis of drought conditions versus statewide water usage confirms that in times of scarce precipitation, residents rely more heavily on water stored in reservoirs and from deep wells. Much of Utah's M&I water is still used outdoors; however more of it is coming from secondary systems. This approach has mixed results, and may encourage residents to use more water outdoors than necessary, since most secondary systems charge less for water than culinary systems, and rate structures for secondary water are flat.

Water usage overall, and outdoor use specifically, varies from basin to basin in Utah. Even within basins, there can be significantly different patterns of water usage. Policymakers need to be aware that efforts towards conservation in one area may not be successful in another; depending on the mix of customers, some basins may need to focus on customers other than residential homes in order to reduce water use. While pricing has been shown to be an effective tool in conservation efforts, local officials may want to consider land use regulations as well.

Finally, Utah's reliance on groundwater in the municipal system may be cause for concern as the population grows and continues to move into urban and suburban areas. Continued monitoring of groundwater levels, and an assessment of availability and use, would be helpful in determining an acceptable level of groundwater use.

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