NEVADA STATE WATER PLAN

PART 2 – WATER USE AND FORECASTS

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Nevada Division of Water Planning
Department of Conservation and Natural Resources

Nevada State Water Plan
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Section 1
Historic and Current Water Use

Introduction

Comprehensive water use information is critical to the success of all water planning and management functions. This section of the *State Water Plan* provides an overview of historic and current water use estimates and discusses observed trends in Nevada's water use.

Estimating Water Use

Approximately 65 to 75 percent of the total water withdrawn annually from groundwater and surface water sources in Nevada is either measured with detailed diversion records maintained by various entities or estimated by the State annually in detailed pumpage and crop inventories. According to the State Engineer's Office, water use data submitted to the Office and calculated by staff in the pumpage and crop inventories accounts for about 90 percent of the total groundwater usage. The balance of the groundwater and surface water usage must be estimated. The most significant water use estimation program in Nevada is implemented by the U.S. Geological Survey (USGS) as part of the USGS National Water Use Information Program.

USGS National Water Use Information Program

The USGS has the only program in Nevada responsible for estimating statewide water use on a routine and comprehensive basis. Staff in the USGS's National Water Use Information Program compile and disseminate water use information on local, state and national levels. In developing their estimates, the USGS staff work in cooperation with local, state, and federal agencies.

Since 1950, the USGS has estimated statewide water use at 5-year intervals and published these estimates in a national summary report. USGS water use estimates for Nevada and other states are included in the national summary report, but a separate detailed Nevada water use report with individual county breakdowns is not published. The national summary report includes water use information for each of the 50 states, plus the District of Columbia, Puerto Rico and the Virgin Islands, and for each of the 21 major water resources regions in the United States. The USGS water use estimates for Nevada have been maintained in an electronic database since 1985.

It is important to note that the Nevada water use figures developed by USGS staff are estimates and that the water use values developed are based upon a mixture of *measured* and *estimated* water use. To the extent possible, the USGS compiles water use data collected by other agencies. Much of the information is obtained from the State Engineer's Office (Nevada Division of Water Resources). As discussed in Part 1, Section 4 of the *State Water Plan,* the State Engineer's Office develops crop and pumpage inventories for about 40% of the basins. Pumpage data from about 30% of the 256 hydrographic areas are submitted by water right holders to the State Engineer's Office as a requirement of permit conditions. However, the pumpage data that are submitted may not represent all water usage within a particular basin. The USGS obtains additional information through personal communcations with various irrigation districts, federal water masters, water purveyors and from any recent USGS studies for a particular region. Federal law does not allow the USGS to mail out surveys to collect additional data.

Much of the water use data presented in this section has been developed by the USGS as part of the National Water Use Information Program. Upon review of the USGS estimates, the Division of Water Planning identified some inconsistencies in the data. However, it is difficult to make adjustments to these data because the USGS does not produce a separate Nevada water use report documenting data sources and assumptions. Nevertheless, as feasible, modifications were made to the USGS estimates by the Nevada Division of Water Planning (NDWP) to address a portion of these inconsistencies. Clearly, a more comprehensive water measurement and/or estimation program is needed to improve water use quantification. Both the original source data obtained from the USGS and the NDWP modifications are presented in the appendix. The "Water Use Measurement and Estimation" issue discussion in Part 3 of the *State Water Plan* provides additional information on available data and needs.

Current Water Use and Past Trends

This section presents statewide water use estimates for the period 1970-1995 at 5-year intervals. These estimates are divided into 8 categories of water use:

- public supply
- domestic
- commercial
- industrial
- thermoelectric
- mining
- irrigation
- livestock

For the public supply category (municipal water systems), this section provides estimated withdrawals by source and deliveries to domestic, commercial, industrial, and thermoelectric power users. The other categories represent both public supplied and self-supplied uses. Self-supplied withdrawals by source, deliveries from public suppliers (where applicable), and consumptive use estimates are given for these categories. Detailed county estimates are presented in the appendices.

Public Supply Water Use

Public supply refers to water withdrawn by public and private water suppliers and delivered for a variety of uses such as domestic, commercial, industrial, thermoelectric, and public uses such as park landscape irrigation. Public supply use is also referred to as Municipal and Industrial (M&I) water use. "Public supply systems" are defined as those which provide water to at least 25 people or 15 connections.

Background on Data Sources. Water use information submitted to the State Engineer for water right permit compliance was the primary source of data utilized by the USGS in their public supply water use estimations. Currently, about 20% of the approximately 300 public supply systems in Nevada are required to submit water withdrawal information to the State Engineer's Office for permit compliance. These systems include over 95% of the total population served by public supply systems. However, the data submitted to the State Engineer do not include details needed to develop a comprehensive picture of public supply water use. Such details include:

- number of persons served by the system;
- deliveries by categories, i.e. domestic, commercial, industrial, thermoelectric;
- consumptive use amounts; and
- estimation of public uses and losses.

In developing their water use figures, the USGS relied on other data sources or estimations for these types of information. Upon review of the USGS estimates, the Division of Water Planning identified some inconsistencies in the data and modified the estimates as appropriate. Both the original USGS estimates and the Division of Water Planning modifications are presented in the appendix.

1995 Public Supply Water Use. More than 90 percent of Nevada's population is currently served by about 300 public supply systems. The percentage of the population that is served by public supply systems varies from county to county (Table 1-1). According to the U.S. Census Bureau, about 92.5% of Nevada's population were served by public supply systems in 1990 with the remaining 7.5% served by domestic wells or other individual water systems. For 1995, the USGS estimated that about 94.2% of the population was supplied by public supply systems.

Table 1-1. Percentage of Population on Public Supply Systems

County	1970	1980	1990
Carson City	86.1	92.2	92.9
Churchill	42.0	48.4	49.1
Clark	94.8	97.1	97.5
Douglas	78.5	81.6	77.1
Elko	80.0	85.2	84.8
Esmeralda	54.2	65.8	68.1
Eureka	60.4	67.3	58.1
Humboldt	71.6	72.0	63.9
Lander	81.5	82.4	77.6
Lincoln	83.7	85.2	77.1
Lyon	58.0	61.4	64.4
Mineral	87.5	90.6	92.5
Nye	72.4	59.0	51.3
Pershing	89.8	72.2	76.7
Storey	99.4	70.9	57.7
Washoe	91.9	93.1	92.5
White Pine	89.8	84.8	75.8
Average	90.7	92.4	92.5

Table 1-2 provides a summary of public supply water use estimates for 1995 (see appendix for more detailed water information). Public supply systems withdrew approximately 525,000 acre-feet (af) in 1995, which is about 13% of the total statewide water withdrawals. Approximately 37% (196,000 af) of the withdrawals were consumptively used by the various users.

While only about 10% of the public supply systems utilize surface water, over 70% of the people on public supply systems receive surface water as some portion of their drinking water supply. As of 1995, about 75% of public supply system withdrawals were surface water. Most of the surface water use is in the Las Vegas area (Colorado River) and the Reno-Sparks and Lake Tahoe areas (Lake Tahoe/Truckee River system).

Table 1-2. Estimated Public Supply Water Use for 1995

Category	Value
Population	
Population served	1,487,640
Percentage of total population	94.2%
Withdrawals (acre-feet)	
Groundwater	131,958
Surface Water	392,903
Total	524,861
Deliveries & public uses/losses (acre-feet)	
Domestic	342,605
Commercial	129,707
Industrial	2,454
Thermoelectric	1,624
Total deliveries	476,388
Public uses and losses	48,473
Total deliveries and public uses and losses	524,861
Consumptive use (acre-feet)	196,444
Water use per person (gallons per person per day)	
Withdrawals per person	315
Domestic deliveries per person	206

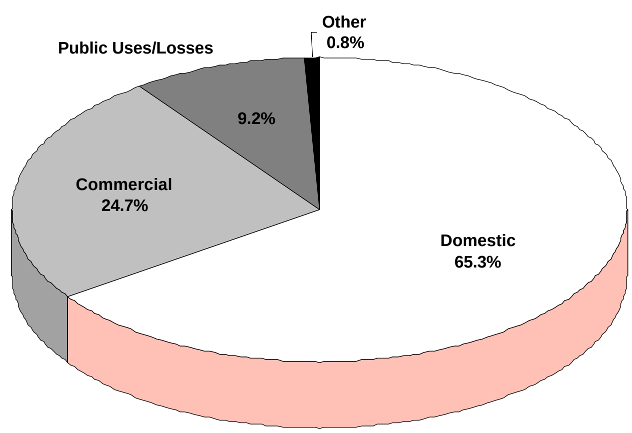
Note: Data are estimates only and subject to revision.

Source: U.S. Geological Survey with modifications by Nevada Division of Water Planning

In 1995, public supply systems delivered approximately 65% (343,000 af) to domestic users, 25% (130,000 af) to commercial users, and 1% (4,000 af) to industrial and thermoelectric users. The remaining 9% (48,000 af) was estimated for public uses (firefighting, street washing, etc.) and losses from the distribution system (Figure 1-1).

Often public supply water use is presented in terms of gallons per person (capita) per day (gpcd). In 1995, Nevada's public supply systems withdrew an average of about 315 gallons each day for each person on these systems. This factor includes all water used for all purposes such as domestic, commercial, industrial, and thermoelectric, and also includes public uses and system losses. Domestic deliveries accounted for about 65% of all water used within the public supply systems, resulting in a residential use factor of 206 gpcd (Table 1-2). Per capita water use tends to vary from county to county and region to region. Nevada's average per capita water use is greatly impacted by Clark County usage rates. Public supply water use in Clark County accounts for over 70% of all public supply usage in Nevada.

Fig. 1-1. 1995 Public Supply Water Uses by Category



Data Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning

Per capita public supply water use varies from state to state with higher per person water use in the western United States compared to the eastern states. According to USGS estimates for the period 1970-90, Nevada has typically had one of the highest per capita water use rates in the country. Figure 1-2 presents 1995 per capita water use for each of the western states and the remaining states as a whole. In 1995, Nevada had the highest per capita water use (315 gpcd) for all public supply uses and the highest per capita use (206 gpcd) for domestic public supply uses.

There are a few possible explanations for Nevada's high per capita water use. For instance, about 1/3 of the water withdrawn by Nevada public supply systems is used for landscape watering. As Nevada is the driest state in the U.S., more landscape watering is generally required than in other states thereby increasing our increasing our per capita water usage. Another possible explanation is that the public withdrawal amounts estimated by USGS include water used by hotels and casinos, and other tourism-dependent operations. However only the resident population is included in the per capita estimates. The large number of visitors to Nevada result in higher public supply water use and per capita rates.

<u>Public Supply Water Use Trends.</u> As expected, public supply water use has increased as Nevada's population has grown. Public supply withdrawals have increased from approximately

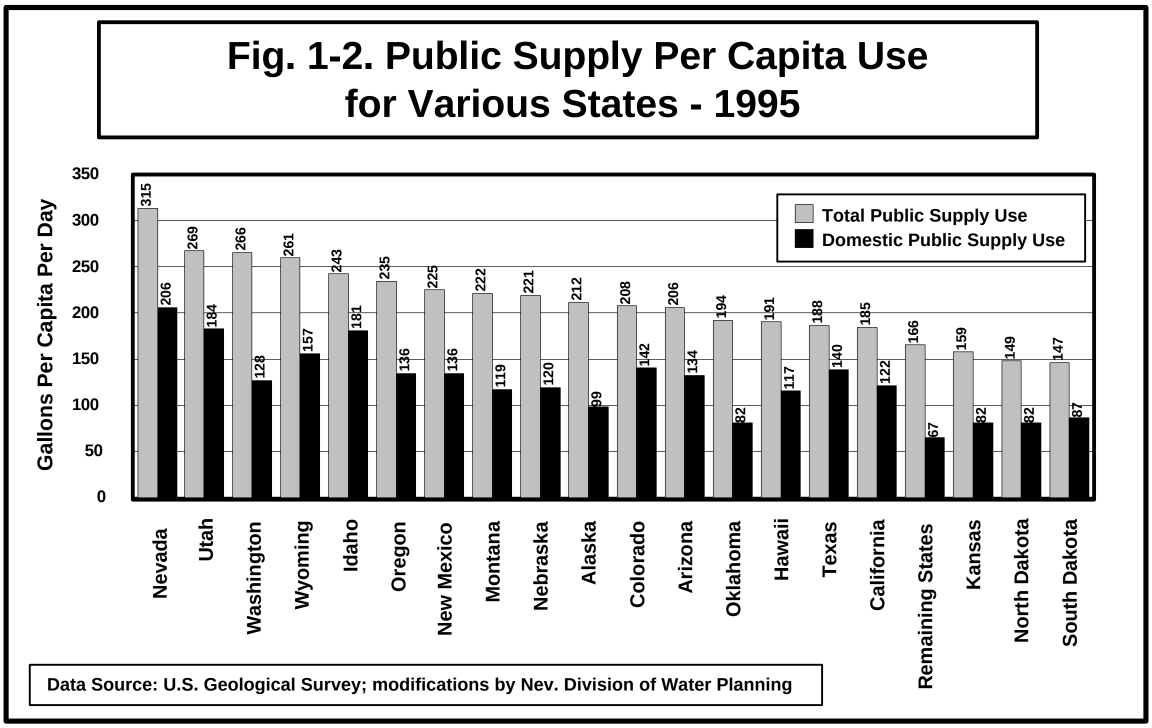


Fig. 1-2. Public Supply Per Capita Use for Various States - 1995

151,000 acre-feet to 525,000 acre-feet from 1970 to 1995 (Table 1-3, Figure 1-3). For the same period, the population served by public supply systems increased from about 441,000 to about 1,488,000. From 1970 to 1990, public supply water use rates in Nevada increased from 306 to 334 gallons per capita per day (gpcd). Successful conservation programs during the 1990s have lowered statewide M&I water use down to 315 gpcd by 1995. A majority of this decrease was due to aggressive conservation in the Las Vegas area. For example, M&I use within the Las Vegas Valley Water District decreased from 358 gpcd in 1989 to 320 gpcd in 1997. Detailed county water use data for 1985-95 are included in the appendices.

Table 1-3. Estimated Public Supply Withdrawals and Consumptive Use, 1970-95

Category	1970	1975	1980	1985	1990	1995
Withdrawals (acre-feet)	151,219	192,664	260,993	322,143	431,322	524,861
Consumptive Use (acre-feet)	51,526	58,247	77,290	123,358	153,321	196,444

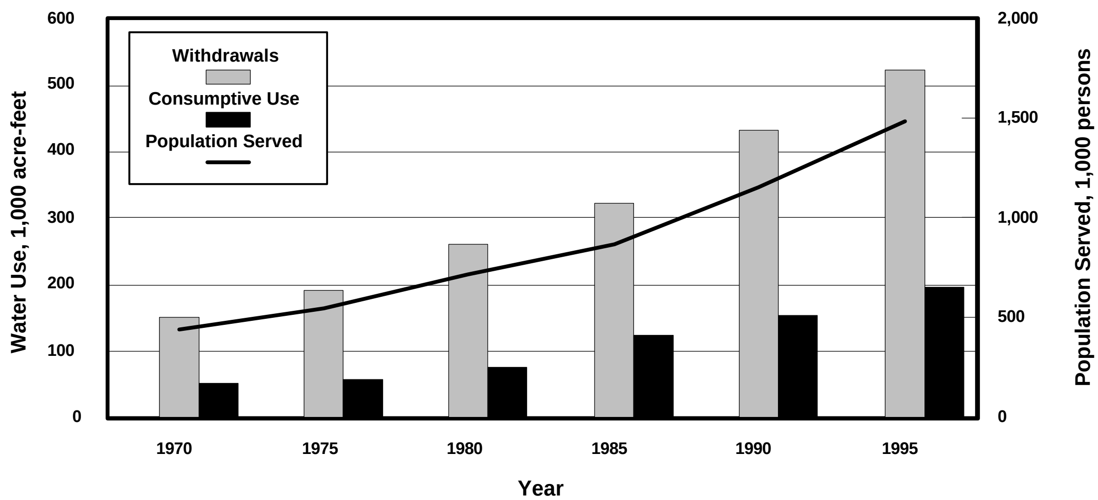
Population Served	441,000	545,000	721,000	871,140	1,152,770	1,487,640
% of State Population	90.2%	90.1%	90.1%	91.1%	93.3%	94.2%
Withdrawals Per Person (gpcd)	306	316	323	330	334	315

gpcd = gallons per capita (person) per day
Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning
Note: Data are estimates only and subject to revision

Domestic Water Use

Domestic use refers to water used for household purposes and includes both indoor and outdoor uses, such as drinking, food preparation, bathing, clothes and dish washing, and lawn and garden watering. Domestic water needs are met by either public supply systems or self-supplied systems

Fig. 1-3. Public Supply Water Use and Population Served, 1970-95



Data Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning

(domestic wells, individual pumps, cisterns, etc.).

<u>Background on Data Sources.</u> As described earlier, the major public supply systems submit water withdrawal information to the State Engineer's Office. However, these data are not divided into categories such as domestic, commercial, industrial, and thermoelectric, nor do they include information on the number of persons served. Fortunately, the larger water systems produce planning documents that provide these types of details. The USGS relies primarily on these planning documents and other available reports to analyze the domestic use portion of the total public supply use. For those smaller public supply systems lacking detailed water use reports, the USGS estimates the domestic use portion based upon factors developed for larger systems in the same region. Populations served by public supply systems are estimated based upon the available water planning documents.

Measurements of self-supplied domestic use are limited and, thus estimation is required for most values. As part of the National Water Use Information Program, the USGS estimates self-supplied domestic use by assuming a water use rate of approximately 120 gallons per person per day. A higher value is deemed to be more appropriate. For the *State Water Plan*, self-supplied domestic use for each county is assumed at 90 percent of county public-supplied domestic use. By multiplying these per person water use rates and the number of persons on private domestic systems, total self-supplied domestic water usages are estimated. The number of person on private domestic systems are estimated by subtracting the population served by public systems from total county populations.

1995 Domestic Water Use. Table 1-4 presents a summary of domestic water use estimates for 1995 as developed by the USGS and modified by the Division of Water Planning (see the appendices for more detailed estimates). In 1995, domestic use withdrawals were approximately 361,000 acre-feet with 50% (180,000 acre-feet) of this amount consumed. Domestic water withdrawals accounts for about 9% of the 1995 state total water withdrawals.

In 1995, the domestic water needs of 94.2% of Nevada's population (1,488,000) were met with public supply systems. Self-supplied systems provided domestic water for the other 5.8% (92,000). Over 96% (343,000 acre-feet) of the water needed for domestic purposes was delivered by public supply systems. Domestic self-supplied systems withdrew about 18,000 acre-feet in 1995, with groundwater being the primary source.

Table 1-4. Estimated Domestic Water Use for 1995

	Self-Supplied Domestic	Public-Supplied Domestic	All Domestic Combined
Population served	91,510	1,487,640	1,579,150
% of total population	5.8%	94.2%	100.0%
Withdrawals or deliveries, acre-feet			
Groundwater	17,783	86,303 *	104,086*
Surface water	321	256,302 *	256,623*
Total	18,105	342,605	360,710
Consumptive Use, acre-feet	9,022	171,015	180,037
Water use per person (gallons per person per day)	177	206	204

* Estimated by Nevada Division of Water Planning
Source: U.S. Geological Survey with modifications by Nevada Division of Water Planning
Note: Data are estimates only and subject to revision.

Domestic Water Use Trends. Domestic water use has increased over the years in response to the growing population. From 1970 to 1995, domestic water use increased from about 117,000 acre-feet to about 361,000 acre-feet (Table 1-5, Figure 1-4). Nevada's population increased from about 489,000 to about 1,579,000 during the same period, with the percentage of people served by public supply systems increasing from about 90% to 94% of the total population. Refer to the appendices for detailed county water use data for 1985-95.

Table 1-5. Estimated Domestic Withdrawals and Consumptive Use, 1970-95

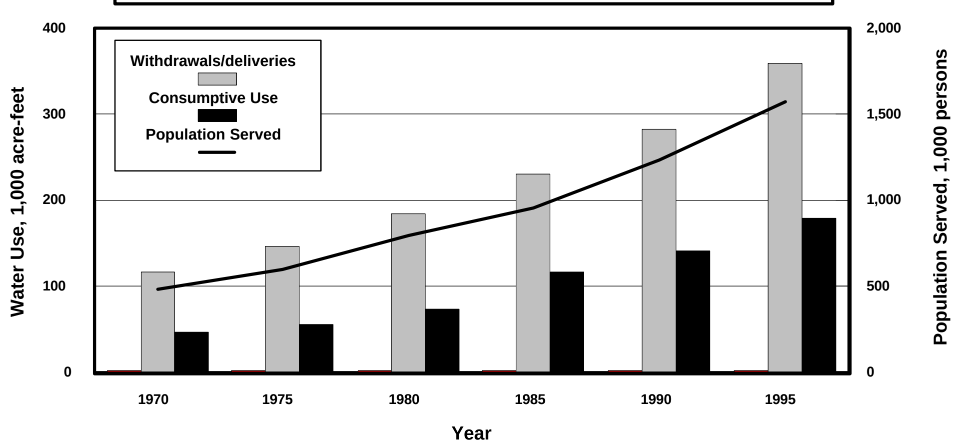
Category	1970	1975	1980	1985	1990	1995
Self-Supplied Domestic						
Withdrawals, acre-feet	10,200	13,400	16,500	19,673	16,668	18,105
Consumptive Use, acre-feet	5,100	6,700	8,250	10,092	8,385	9,022
Population Served	47,700 *	60,000 *	79,500 *	84,670	83,360	91,510
% of Total Population	9.8%	9.9%	9.9%	8.9%	6.7%	5.8%
Withdrawals Per Person, gpcd	190 *	200 *	185 *	207	179	177
Public-Supplied Domestic						
Deliveries, acre-feet	106,400 **	134,400 **	168,000 **	211,896	266,906	342,605
Consumptive Use, acre-feet	43,000 *	49,000 *	65,000 *	107,129	133,442	171,015
Population Served	441,000	545,000	721,000	871,140	1,152,770	1,487,640
% of Total Population	90.2%	90.1%	90.1%	91.1%	93.3%	94.2%
Withdrawals Per Person, gpcd	215	220	208	217	207	206
All Domestic Combined						
Withdrawals/deliveries, acre-feet	116,600 **	147,800 **	184,500 **	231,569	283,574	360,710
Consumptive Use, acre-feet	48,100 *	55,700 *	73,250 *	117,221	141,827	180,037
Population Served	488,700 *	605,000 *	800,500 *	955,810	1,236,130	1,579,150
Withdrawals Per Person, gpcd	213 *	218 *	206 *	216	205	204

* Data not available from USGS. Estimated by NDWP.
** Includes public uses & losses.
gpcd = gallons per capita (person) per day
Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning
Note: Data are estimates only and subject to revision.

Commercial Water Use

Commercial use includes water for casinos, motels, restaurants, office buildings, campgrounds, other commercial facilities, and civilian and military institutions. Commercial water needs are met by

Fig. 1-4. Domestic Water Use and Population Served, 1970-95



Data Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning either public supply systems (community water systems) or self-supplied systems (non-community systems).

Background on Data Sources. In quantifying a portion of the public-supplied commercial water use, the USGS has relied upon reports produced by the larger public supply systems. For those smaller systems lacking detailed water use reports, the USGS estimated public-supplied commercial water use with factors developed for the larger public supply systems and other factors (such as water use per employee estimates).

There are about 400 self-supplied water systems in Nevada which provide water for casinos, motels, campgrounds and other commercial facilities. In general, the USGS applies various use factors to estimate water use by these systems thereby quantifying self-supplied commercial usage. The USGS also uses available water use information collected by the State Enginer's Office. None of the USGS estimates were modified by the Nevada Division of Water Planning.

1995 Commercial Water Use. Table 1-6 provides a summary of 1995 commercial water use estimates as developed by the USGS (see appendix for more detailed estimates). In 1995, about 153,000 acre-feet was used for commercial purposes, with about 17% (26,000 acre-feet) of these withdrawals being consumed. Commercial water use accounts for 4% of the state total. About 85% (130,000 acre-feet) of the water needed for commercial operations in 1995 was delivered by public supply systems. The remaining 15% (23,000 acre-feet) was provided by self-supplied systems. Surface water was the principal source for self-supplied water furnishing about 66% (16,000 acre-feet) of the self-supplied withdrawals.

Table 1-6. Estimated Commercial Water Use for 1995

	Self-Supplied Commercial	Public-Supplied Commercial	All Commercial Combined
Withdrawals or deliveries, acre-feet			
Groundwater	7,919	32,674 *	40,593 *
Surface water	15,559	97,033 *	112,592 *
Total	23,477	129,707	153,184
Consumptive Use, acre-feet	3,193	23,268	26,461

* Estimated by the Nevada Division of Water Planning

Source: U.S. Geological Survey

Note: Data are estimates only and subject to revision.

Commercial Water Use Trends. Commercial water use has increased from about 69,000 acre-feet to about 153,000 acre-feet during the period 1985 to 1995 (Table 1-7). Commercial water use trends cannot be established for previous years. Prior to 1985, the USGS had not provided water use estimates for commercial purposes as a separate category but rather commercial usage was aggregated under other uses. Refer to the appendices for detailed county water use data for 1985-95.

Table 1-7. Estimated Commercial Withdrawals and Consumptive Use, 1985-95

Category	1985	1990	1995
Self-Supplied Commercial			
Withdrawals (acre-feet)	8,287	25,426	23,477
Consumptive Use (acre-feet)	1,669	3,583	3,193
Public-Supplied Commercial			
Deliveries (acre-feet)	60,340	100,218	129,707
Consumptive Use (acre-feet)	12,096	18,401	23,268
All Commercial Combined			
Withdrawals/deliveries (acre-feet)	68,627	125,644	153,184
Consumptive Use (acre-feet)	13,765	21,984	26,461

Source: U.S. Geological Survey
Note: Data are estimates only and subject to revision.

Industrial Water Use

Industrial use includes water for manufacturing and construction. Industrial water needs are met by either public supply systems or self-supplied systems.

Background on Data Sources. To estimate industrial water usage, the USGS utilizes data obtained from water-supply companies, and Nevada Division of Water Resources pumpage records. However, these data generally cover only a portion of the industrial water use. Also, few public supply systems record industrial and commercial use as two separate categories. Due to the lack of data, the USGS estimates much of the industrial usage in Nevada. None of the USGS estimates were modified by the Nevada Division of Water Planning.

1995 Industrial Water Use. Industrial water use estimates for 1995 are shown in Table 1-8 (see the appendices for more detailed estimates). In 1995, approximately 19,000 acre-feet were used for industrial purposes with about 29% (5,000 acre-feet) being consumed. Industrial water withdrawals account for 0.5% of the state total. About 87% (17,000 acre-feet) of the water used for industrial purposes was furnished by self-supplied systems, with the other 13% provided by public supply systems. The self-supplied systems withdrew almost equal amounts of surface water and groundwater during 1995.

Table 1-8. Estimated Industrial Water Use for 1995

	Self-Supplied Industrial	Public-Supplied Industrial	All Industrial Combined
Withdrawals or deliveries, acre-feet			
Groundwater	8,322	618 *	8,940 *
Surface water	8,446	1,836 *	10,282 *
Total	16,768	2,454	19,222
Consumptive Use, acre-feet	4,952	537	5,489

* Estimated by the Nevada Division of Water Planning

Source: U.S. Geological Survey

Note: Data are estimates only and subject to revision.

Industrial Water Use Trends. Total industrial water use changed little during the period 1985 to 1995 (Table 1-9). Industrial water use trends cannot be established for previous years. Prior to 1985, the USGS did not separate out water use estimates for industrial purposes, rather industrial usage was aggregated with other uses. Refer to the appendices for detailed county water use data for 1985-95.

Table 1-9. Estimated Industrial Withdrawals and Consumptive Use, 1985-95

Category	1985	1990	1995
Self-Supplied Industrial			
Withdrawals (acre-feet)	11,369	11,437	16,768
Consumptive Use (acre-feet)	2,139	2,228	4,952
Public-Supplied Industrial			
Deliveries (acre-feet)	7,057	2,946	2,454
Consumptive Use (acre-feet)	1,411	582	537
All Industrial Combined			
Withdrawals/deliveries (acre-feet)	18,426	14,383	19,222
Consumptive Use (acre-feet)	3,550	2,810	5,489

Source: U.S. Geological Survey
Note: Data are estimates only and subject to revision.

Thermoelectric Water Use

Thermoelectric use includes water used in the production of electric power generation from fossil fuel and geothermal sources. Nevada has 22 thermoelectric powerplants, seven of which are fossil fueled and 15 are geothermal.

Background on Data Sources. Thermoelectric water use data, as compiled by the USGS, were obtained directly from the power plants, State Engineer’s records and/or estimated. No modifications were performed by the Nevada Division of Water Planning.

1995 Thermoelectric Water Use. Thermoelectric water use estimates for 1995 are shown in

Table 1-10 (see the appendices for detailed county estimates). In 1995 approximately 65,000 acre-feet were used for thermoelectric power generation with about 63% (41,000 acre-feet) being consumed. Thermoelectric water withdrawals accounts for 2% of the state total. The USGS estimated that Nevada's thermoelectric plants generated about 19 billion kilowatt-hours in 1995.

Table 1-10. Estimated Thermoelectric Water Use for 1995

	Self-Supplied Thermoelectric	Public-Supplied Thermoelectric	All Thermoelectric Combined
Withdrawals or deliveries, acre-feet			
Groundwater	40,650	409 *	41,059 *
Surface water	23,176	1,215 *	24,391 *
Total	63,825	1,624	65,449
Consumptive Use, acre-feet	39,429	1,624	41,053

* Estimated by the Nevada Division of Water Planning
Source: U.S. Geological Survey
Note: Data are estimates only and subject to revision.

Over 97% (about 64,000 acre-feet) of the water needed for thermoelectric operations in 1995 was furnished by self-supplied systems. The remaining 2,000 acre-feet was provided by public supply water systems. Groundwater was the primary source for self-supplied water furnishing about 64% (41,000 acre-feet) of the self-supplied withdrawals.

Thermoelectric Water Use Trends. Total thermoelectric water withdrawals have more than doubled from 1985 to 1995 increasing from about 29,000 acre-feet to 65,000 acre-feet (Table 1-11). Over the 10 year period, public supply systems provided a minor portion of the total thermoelectric water used. Usage trends cannot be presented for previous years. Prior to 1985, the USGS did not compile water use estimates for all thermoelectric purposes as a separate category.

Table 1-11. Estimated Thermoelectric Withdrawals and Consumptive Use, 1985-95

Category	1985	1990	1995
Self-Supplied Thermoelectric			
Withdrawals (acre-feet)	26,278	74,019	63,825
Consumptive Use (acre-feet)	23,668	49,298	39,429
Public-Supplied Thermoelectric			
Deliveries (acre-feet)	2,722	896	1,624
Consumptive Use (acre-feet)	2,744	896	1,624
All Thermoelectric Combined			
Withdrawals/deliveries (acre-feet)	29,022	74,915	65,449
Consumptive Use (acre-feet)	26,390	50,194	41,053

Source: U.S. Geological Survey
Note: Data are estimates only and subject to revision.

Mining Water Use

Mining use refers to water used in the extraction, milling, and processing of naturally occurring minerals (including petroleum), and other activities that are part of mining, such as dust control. Minerals mined in Nevada can be divided into two categories: metals and industrial minerals. Metals mined in Nevada include gold, silver, lead, zinc, molybdenum and copper. Mined industrial minerals include aggregate, barite, clay, gypsum, lime, diatomite, lithium carbonate, magnesite and silica. Water use varies widely from operation to operation and is dependent upon the mineral being recovered and the recovery process employed.

Background on Data Sources. In developing mining water use estimates for Nevada, the USGS relies upon pumpage data available from the Nevada Division of Water Resources and prepares estimates where data gaps exist. Prior to 1985, the USGS did not have a separate estimate for mining water use.

Many mines operate dewatering systems to maintain dry conditions as ore and other materials are removed. Under the USGS National Water Use Information Program, any water removed for mine dewatering that is not consumptively used in the mine operations is not included in the withdrawal figures. However in Nevada, mine dewatering represents a significant share of total water withdrawals and may impact the amount of water available for other uses. Therefore, mine dewatering needs to be considered in any planning effort. For this reason, the Division of Water Planning modified the USGS water use estimates to include all dewatering withdrawals. Utilizing the State Engineer's pumpage records for 1990 and 1995, the Division calculated the nonconsumptive use portion of the withdrawals. The mine dewatering figures include water that is reinjected into the groundwater, utilized for another use such as irrigation, or discharged. The nonconsumptive use dewatering values were added to the USGS consumptive use figures to arrive at total mining water withdrawals. Adjustments were not made to the USGS estimates for 1985 as no pumpage data are available from the State Engineer's Office for that year.

1995 Mining Water Use. Mining water use estimates for 1995 are shown on Table 1-12 (see the appendices for more detailed estimates). Of the estimated 274,000 acre-feet per year withdrawn in 1995, approximately 89,000 acre-feet per year (about 32%) was consumptively used by mining operations. The remaining 68% (185,000) was reinjected, infiltrated, evaporated, discharged to surface water bodies, or used for irrigation purposes. In some areas, mine dewatering discharges are being used for irrigation as a substitute for pumped water from irrigation wells. In these instances, the irrigation operation is temporarily using the mine dewatering discharge rather than pumping its own permitted groundwater wells.

Mine water withdrawals accounted for about 7% of the total state water withdrawals. A majority of statewide mine water withdrawals occur in the Humboldt River basin. In 1995, mine water withdrawals in the Humboldt River basin accounted for about 70% of the state total mine water withdrawals.

Table 1-12. Estimated Mining Water Use for 1995

Use Category	Use, acre-feet
Withdrawals	
Groundwater	270,524
Surface water	3,909
Total	274,433
Consumptive Use	89,163
Nonconsumptive Use	185,270

Source: U.S. Geological Survey with modifications by Nev. Division of Water Planning

Note: Data are estimates only and subject to revision.

Mining Water Use Trends. Mining water use has changed significantly since 1985. According to Table 1-13, total mining withdrawals have increased by a factor of 10 from 1985 to 1995 with consumptive uses increasing by a factor of 4. A majority of this increase is attributable to an increase in mining activities within the Humboldt River basin. Mining water use trends cannot be established for previous years. Prior to 1985, the USGS did not compile water use estimates for mining as a separate category. Refer to the appendix for detailed county water use data for 1985-95.

Table 1-13. Estimated Mining Withdrawals and Consumptive Use, 1985-95

Category	1985	1990	1995
Withdrawals (acre-feet)	27,309	120,124	274,433
Consumptive Use (acre-feet)	22,469	67,858	89,163
Nonconsumptive Use (acre-feet)	4,840	52,266	185,270

Source: U.S. Geological Survey: modifications by Nevada Division of Water Planning
Note: Data are estimates only and subject to revision.

Irrigation Water Use

Irrigation use, as classified by the USGS for the National Water Use Information Program, refers to water withdrawn and applied to lands to grow crops and pasture as well as self-supplied water used to irrigate golf courses and parks. Under this category, water for irrigation is self-supplied or supplied by irrigation companies or districts. The amount of self-supplied water used for golf course and park irrigation is minor compared to the agricultural irrigation use and could not be presented as a separate category due to data limitations. Landscape watering from a public supply water system is not included in the *irrigation use* category, but rather in the public supply category. The main field crops grown in Nevada include alfalfa and other hay, alfalfa seed, winter and spring wheat, potatoes, garlic and onions. These crops account for about 70% of the total irrigated acreage. In addition to harvested field crops, about 30% of the irrigated acreage in Nevada is pasture.

Background on Data Sources. Although irrigation is the largest use of water in Nevada, only limited irrigation measurements are available. The measured data that do exist must be obtained from a variety of sources which sometimes contain conflicting information.

For those areas of Nevada lacking measured water use data, the USGS typically estimates irrigation water use as follows:

- compile estimates of irrigated land by crop type and irrigation method (flood, sprinkler);

- develop consumptive use factors (acre-feet used per acre) and irrigation efficiency coefficients (ranging from 0.0 [least efficient] to 1.0 [most efficient]); and

- develop consumptive use and withdrawal estimates by applying the above factors to the irrigated acreage values.

The USGS staff has used a variety of data sources to develop irrigation water use estimates. Irrigated acreage estimates were generally derived from Nevada Division of Water Resources crop and pumpage inventories, data obtained from irrigation districts, other USGS project reports, some satellite imagery, the *Census of Agriculture* developed by the U.S. Census Bureau every 4 to 5 years, (however periods do not necessarily coincide with the USGS estimates), and the *Nevada Agricultural Statistics* published annually by the Nevada Agricultural Statistics Service (reports harvested crops only which accounts for about 70% of irrigated land). Consumptive use rates for different areas of the State and various crops were obtained from the U.S. Natural Resources Conservation Service; and irrigation efficiency factors were developed from available information and literature. The following general equations were utilized by the USGS to estimate consumptive use and withdrawals:

consumptive use (acre-feet) = irrigated acreage (acres) x consumptive use factor (acre-feet/acre)

withdrawals (acre-feet) = consumptive use (acre-feet) / irrigation efficiency coefficient

With the exception of the 1995 data, the USGS irrigation water use estimates for the previous years were utilized for the *State Water Plan*. The original 1995 data showed a significant drop in irrigated acreage and water use from 1985/90 to 1995 which was not consistent with data presented in the *Nevada Agricultural Statistics* reports. Therefore, the Division of Water Planning modified the 1995 estimates for inclusion in the *Plan*.

According to the USGS, the 1995 acreage estimates were based upon the 1992 U.S. Agriculture Census which indicated a sharp decline in irrigated land as a result of the drought. Also, the consumptive use factors utilized for the 1995 estimates were generally lower than those used for the previous 1985/90 estimates. For the *State Water Plan*, the Division of Water Planning developed new 1995 irrigated acreage estimates based upon *Nevada Agricultural Statistics* data. As the *Nevada Agricultural Statistics* reports only harvested hay acreages by county (which accounts for only about 70% of the total irrigated acreage), these data were adjusted as needed to include all irrigated lands. Consumptive use and withdrawal amounts were then developed by utilizing use consumptive use factors and efficiency coefficients more consistent with the 1985 and 1990 estimates. A detailed explanation of this methodology is presented in the appendix.

Irrigation water use in Nevada can be extremely variable from year to year in response to water availability. During periods of drought, irrigated acreage and water use typically decline or groundwater use may increase to augment reduced surface supplies. It must be emphasized that the USGS water use estimates are developed only every 5 years and as such these estimates do not accurately reflect the annual variations in irrigation water use.

<u>1995 Irrigation Water Use.</u> Table 1-14 provides a summary of 1995 irrigation water use estimates (see appendix for more detailed estimates). In 1995 about 3.1 million acre-feet were withdrawn for irrigation purposes, of which about 1.6 million acre-feet were consumed. Irrigation water withdrawals accounted for 77% of the 1995 total state withdrawals.

Table 1-14. Estimated Irrigation Water Use for 1995

Category	Value
Withdrawals, acre-feet	
Groundwater	1,138,184
Surface water	1,975,401
Total	3,113,585
Consumptive use, acre-feet	1,612,079
Irrigated Land, acres	
Sprinkler	175,284
Flood	540,156
Total	715,440

Source: U.S. Geological Survey with modifications by Nevada Division of Water Planning
Note: Data are estimates only and subject to revision.

It is estimated that about 63% of the total water withdrawn in 1995 was diverted from surface water sources with the remaining 37% produced from groundwater sources. Flood irrigation was used for about 75% of the approximate 715,000 acres irrigated, with sprinklers used for the other 25%. The average amount of water withdrawn for irrigation was about 4.4 acre-feet per irrigated acre (which includes conveyance losses). Consumptive use averages about 1/2 that amount, or 2.3 acre-feet per irrigated acre.

<u>Irrigation Water Use Trends.</u> USGS estimates (with 1995 Division of Water Planning modifications) show that irrigated acreage and water use decreased during the period 1970 to 1995 (Table 1-15, Figure 1-5). Due to the uncertainty with the data, it is unknown if this decrease is indicative of any statewide trend or is merely an artifact of the estimation process.

Table 1-15. Estimated Irrigation Withdrawals and Consumptive Use, 1970-95

Category	1970	1975	1980	1985	1990	1995
Withdrawals (acre-feet)	3,400,000	3,500,000	3,500,000	3,750,000	3,161,000	3,114,000
Consumptive Use (acre-feet)	1,600,000	1,700,000	1,700,000	1,934,000	1,634,000	1,613,000
Irrigated Land (acres)	830,000	860,000	850,000	844,000	729,000	715,000

Source: U.S. Geological Survey; 1995 USGS estimates modified by Nevada Division of Water Planning
Note: Data are estimates only and subject to revision.

Other data sources for the amount of historically irrigated lands include the U.S. Census and the *Nevada Agricultural Statistics*. U.S. Census data show that irrigated acreage fluctuated during the period 1959 to 1992 (Figure 1-6) varying from lows of about 550,000 acres in 1959 and 1992 (both dry years) to a high of 881,000 acres in 1978. Data published in *Nevada Agricultural Statistics* reports indicates that the amount of harvested cropland has fluctuated widely during the 1960 to 1995 period (Figure 1-7). The amount of harvested cropland peaked at just over 600,000 acres during the early 1980s. According to the U.S. Census data, harvested cropland accounts for about 70% of the total irrigated land in Nevada.

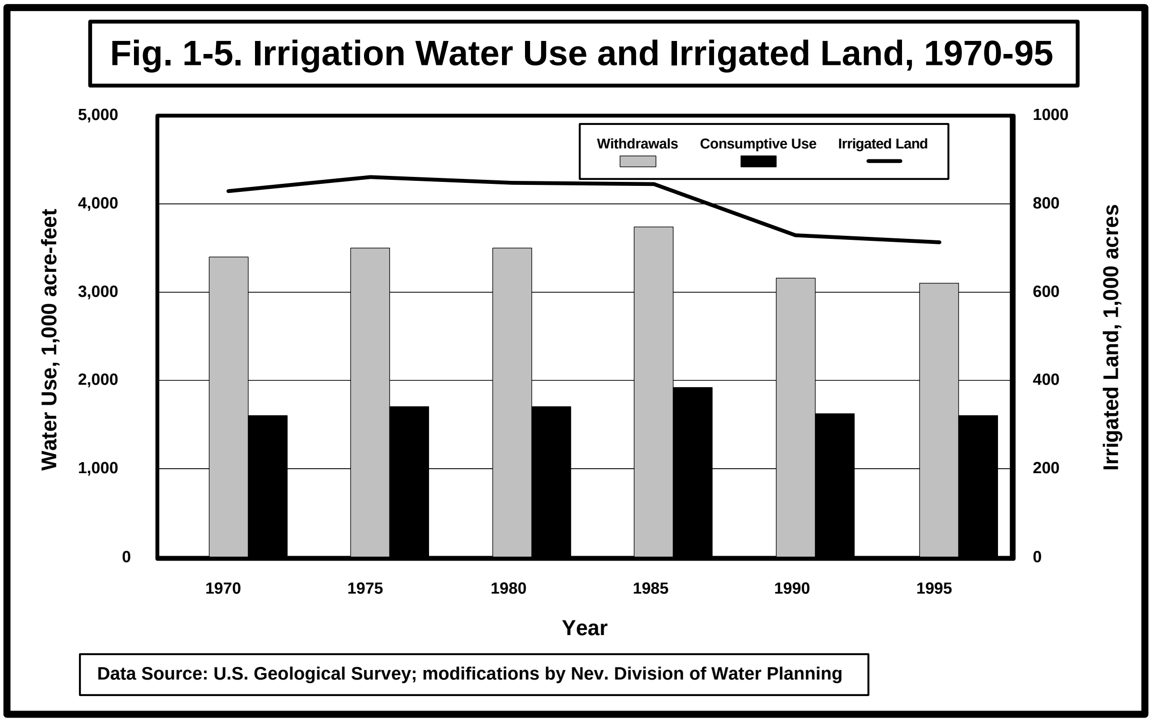


Fig. 1-5. Irrigation Water Use and Irrigated Land, 1970-95
Withdrawals
Consumptive Use
Irrigated Land
Water Use, 1,000 acre-feet
5,000
4,000
3,000
2,000
1,000
0
Irrigated Land, 1,000 acres
1000
800
600
400
200
0
1970
1975
1980
1985
1990
1995
Year
Data Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning

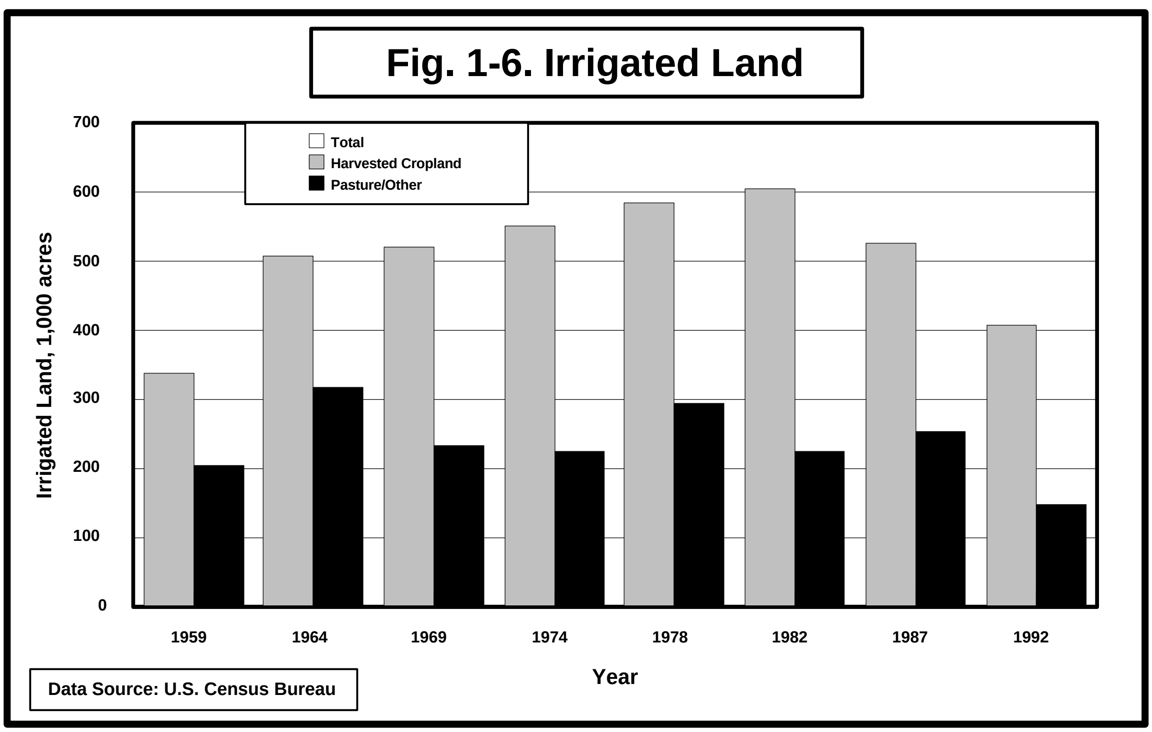
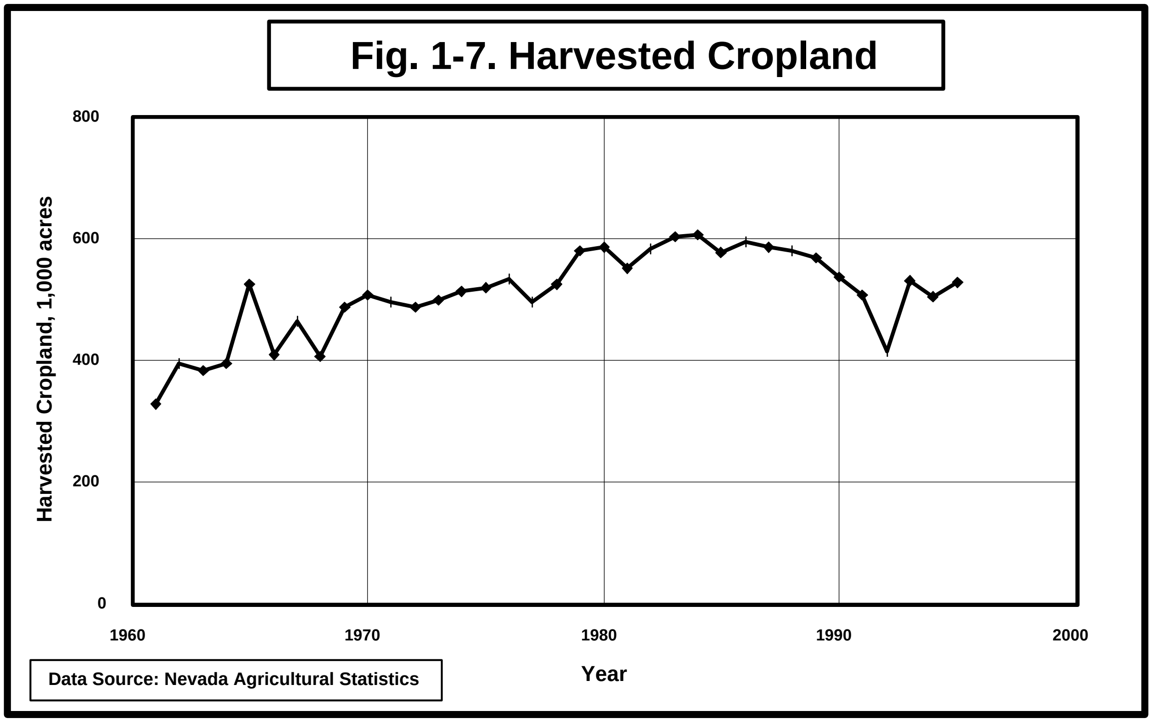


Fig. 1-6. Irrigated Land
Total
Harvested Cropland
Pasture/Other
Irrigated Land, 1,000 acres
700
600
500
400
300
200
100
0
1959
1964
1969
1974
1978
1982
1987
1992
Year
Data Source: U.S. Census Bureau



Livestock Water Use

Livestock use refers to water used for stock watering, feed lots, dairy operations, and other on-farm needs. Cattle are the major livestock raised in Nevada with most grazed on open range. Other livestock include sheep, horses and hogs.

<u>Background on Data Sources.</u> Several sources are used by the USGS in deriving livestock water use estimates. Livestock population estimates are compiled from a number of agencies such as the Nevada Department of Agriculture, U.S. Bureau of Census, and U.S. Bureau of Land Management. Assumed water use rates per animal are applied to the population counts to estimate water use. None of the USGS estimates were modified by the Division of Water Planning.

Table 1-16. Estimated Livestock Water Use for 1995

Category	Value
Withdrawals, acre-feet	
Groundwater	1,119
Surface water	5,210
Total	6,329
Consumptive Use, acre-feet	2,319

Source: U.S. Geological Survey
Note: Data are estimates only and subject to revision

<u>1995 Livestock Water Use.</u> Table 1-16 provides a summary of 1995 livestock water use estimates (see appendix for more detailed estimates). In 1995 about 6,000 acre-feet was withdrawn for livestock purposes, of which about 2,000 acre-feet was consumed. About 80% of the total water withdrawn in 1995 was diverted from surface water sources. Livestock water withdrawals accounted for about 0.2% of the 1995 total state use.

<u>Livestock Water Use Trends.</u> USGS estimates for 1970-95 shows wide fluctuations in statewide livestock water use (Table 1-17). The variations in the data may be the result of inconsistent estimation techniques from year to year. As a result, these data may not be suitable as a basis for evaluating past water use trends. The *Nevada Agricultural Statistics* reports are an alternative data source for examining livestock trends. According to the *Nevada Agricultural Statistics*, during the 1970 to 1995 period there was a general decline in the number of head of cattle, sheep and hogs from about 850,000 to about 600,000 (Figure 1-8).

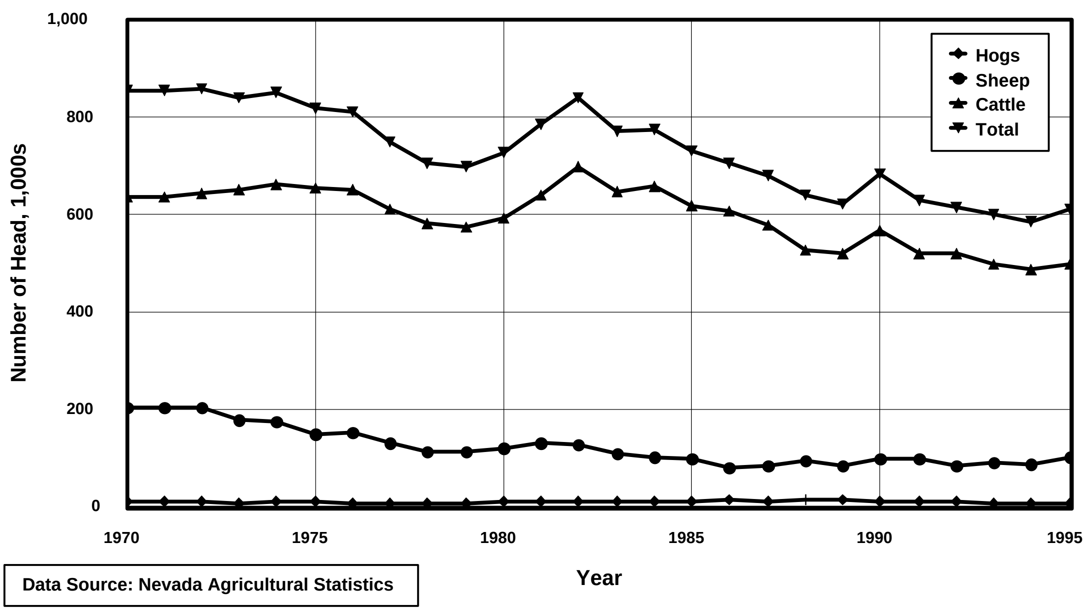
Table 1-17. Estimated Livestock Withdrawals and Consumptive Use, 1970-95

Category	1970	1975	1980	1985	1990	1995
Withdrawals (acre-feet)	4,900	13,400	13,400	29,100	6,300	6,300
Consumptive Use (acre-feet)	2,400	9,900	10,000	7,400	2,300	2,300

Source: U.S. Geological Survey

Note: Data are estimates only and subject to revision

Fig. 1-8. Livestock Inventory, 1970-95



Data Source: Nevada Agricultural Statistics

Water Use Summary

Statewide water use for the period 1970 to 1995 is summarized in two different forms in the following tables and figures. Tables 1-18 and 1-19, and Figure 1-9 presents water use divided into two major categories - public supply uses and self-supplied uses. Table 1-20 and 1-21, and Figure 1-10 provides a water use breakdown by type of use regardless of water supplier.

Over the last 20 years, statewide water withdrawals in Nevada have been about 4 million acre-feet per year, with a little under 2 million acre-feet consumptively used. In 1995, about 60 percent of the withdrawals were from surface water sources. Irrigation has historically been the largest water use in Nevada varying from about 80 percent to 90 percent of the total statewide water withdrawals and consumptive use. In 1995, irrigation use accounted for about 77 percent of the total state withdrawals. Variations in irrigation water use are primarily the result of Nevada's variable weather and streamflow conditions.

Fig. 1-9. 1995 Statewide Water Withdrawals by Public Supply and Self-Supplied Uses

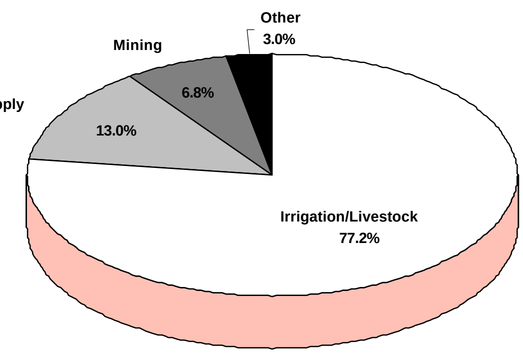
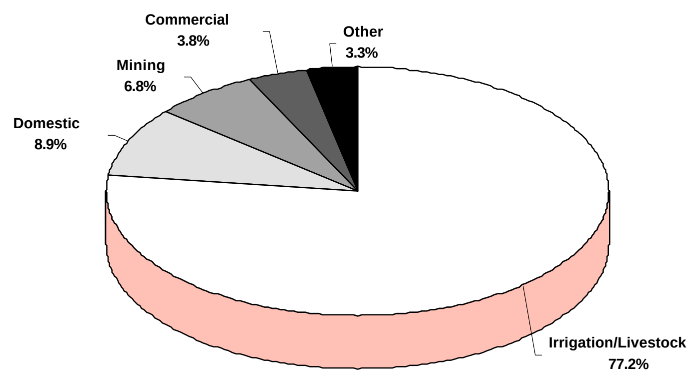


Fig. 1-10. 1995 Statewide Water Withdrawals by Type of Use



Overall, the total statewide water use has changed little since 1970, however, there have been some significant changes within certain use sectors. The most significant changes have occurred with "Public Supply" and "Mining" water uses. Public supply water use has more than tripled since 1970 in response to Nevada's ever increasing population. Mining water use has experienced a significant increase since 1985 mostly as a result of increased mining activity in the Humboldt River basin.

Table 1-18. Summary of Estimated Statewide Water Use (1970-95) Grouped by Public Supply and Self-Supplied Uses (in acre-feet)

Water Use Category		1970	1975	1980	1985	1990	1995
Public Supply							
Domestic	Withdrawals	106,400	134,400	168,000	211,900	266,900	342,600
	Consumptive Use	43,000	49,000	65,000	107,100	133,400	171,000
Commercial [1]	Withdrawals				60,300	100,200	129,700
	Consumptive Use				12,100	18,400	23,300
Industrial [1]	Withdrawals	44,800	58,300	93,000	7,100	2,900	2,500
	Consumptive Use	8,500	9,200	12,300	1,400	600	500
Thermoelectric [1]	Withdrawals				2,700	900	1,600
	Consumptive Use				2,700	900	1,600
Public Uses and Losses [1]	Withdrawals	Included in "Public Supply - Domestic" Category			40,100	60,400	48,500
	Consumptive Use				0	0	0
Total Public Supply	Withdrawals	151,200	192,700	261,000	322,100	431,300	524,900
	Consumptive Use	51,500	58,200	77,300	123,400	153,300	196,400
Self-Supplied							
Domestic	Withdrawals	10,200	13,400	16,500	19,700	16,700	18,100
	Consumptive Use	5,100	6,700	8,300	10,100	8,400	9,000
Commercial [1]	Withdrawals				8,300	25,400	23,500
	Consumptive Use				1,700	3,600	3,200
Industrial [1]	Withdrawals				11,400	11,400	16,800
	Consumptive Use	150,000	260,000	270,000	2,100	2,200	5,000
Thermoelectric [1]	Withdrawals	55,000	80,000	95,000	26,300	74,000	63,800
	Consumptive Use				23,700	49,300	39,400
Mining [1]	Withdrawals				27,300	120,100	274,400
	Consumptive Use				22,500	67,900	89,200
Irrigation	Withdrawals	3,400,000	3,500,000	3,500,000	3,750,000	3,160,700	3,113,600
	Consumptive Use	1,600,000	1,700,000	1,700,000	1,934,000	1,633,800	1,612,100
Livestock	Withdrawals	4,900	13,400	13,400	29,100	6,300	6,300
	Consumptive Use	2,400	9,900	10,000	7,400	2,300	2,300
Total							
	Withdrawals	3,716,300	3,979,500	4,060,900	4,194,100	3,846,000	4,041,400
	Consumptive Use	1,714,000	1,854,800	1,890,600	2,124,800	1,920,800	1,956,600

Source: U.S. Geological Survey; modifications by Nevada Division of Water Planning

Note: Figures may not add to totals because of independent rounding. Data are estimates only and subject to revision.

[1] Individual estimates were not available for 1970-80

Table 1-19. Estimated 1995 Statewide Groundwater and Surface Water Withdrawals for Public Supply and Self-Supplied Uses (in acre-feet)

Category	Source	Amount
Public Supply		
Total Public Supply	Groundwater	132,000
	Surface water	392,900
	Total	524,900
Self-Supplied		
Domestic	Groundwater	17,800
	Surface water	300
	Total	18,100
Commercial	Groundwater	7,900
	Surface water	15,600
	Total	23,500
Industrial	Groundwater	8,300
	Surface water	8,400
	Total	16,700
Thermoelectric	Groundwater	40,700
	Surface water	23,200
	Total	63,900
Mining	Groundwater	270,500
	Surface water	3,900
	Total	274,400
Irrigation	Groundwater	1,138,200
	Surface water	1,975,400
	Total	3,113,600
Livestock	Groundwater	1,100
	Surface water	5,200
	Total	6,300
Total		
Statewide Total	Groundwater	1,616,500
	Surface water	2,424,900
	Total	4,041,400

Source: U.S. Geological Survey; modifications by Nevada Division of Water Planning

Note: Figures may not add to totals because of independent rounding. Data are estimates only and subject to revision.

Table 1-20. Summary of Estimated Statewide Water Use (1970-95) Grouped by Type of Use (in acre-feet)

<table>
<tr><th colspan="2">Water Use Category</th><th>1970</th><th>1975</th><th>1980</th><th>1985</th><th>1990</th><th>1995</th></tr>
<tr><td rowspan="2">Domestic (self-supplied & public supplied)</td><td>Withdrawals</td><td>116,600</td><td>147,800</td><td>184,500</td><td>231,600</td><td>283,600</td><td>360,700</td></tr>
<tr><td>Consumptive Use</td><td>48,100</td><td>55,700</td><td>73,300</td><td>117,200</td><td>141,800</td><td>180,000</td></tr>
<tr><td rowspan="2">Commercial [1] (self-supplied & public supplied)</td><td>Withdrawals</td><td rowspan="8">194,800
63,500</td><td rowspan="8">318,300
89,200</td><td rowspan="8">363,000
107,300</td><td>68,600</td><td>125,600</td><td>153,200</td></tr>
<tr><td>Consumptive Use</td><td>13,800</td><td>22,000</td><td>26,500</td></tr>
<tr><td rowspan="2">Industrial [1] (self-supplied & public supplied)</td><td>Withdrawals</td><td>18,400</td><td>14,400</td><td>19,200</td></tr>
<tr><td>Consumptive Use</td><td>3,600</td><td>2,800</td><td>5,500</td></tr>
<tr><td rowspan="2">Thermoelectric [1] (self-supplied & public supplied)</td><td>Withdrawals</td><td>29,000</td><td>74,900</td><td>65,400</td></tr>
<tr><td>Consumptive Use</td><td>26,400</td><td>50,200</td><td>41,100</td></tr>
<tr><td rowspan="2">Mining [1]</td><td>Withdrawals</td><td>27,300</td><td>120,100</td><td>274,400</td></tr>
<tr><td>Consumptive Use</td><td>22,500</td><td>67,900</td><td>89,200</td></tr>
<tr><td rowspan="2">Irrigation</td><td>Withdrawals</td><td>3,400,000</td><td>3,500,000</td><td>3,500,000</td><td>3,750,000</td><td>3,160,700</td><td>3,113,600</td></tr>
<tr><td>Consumptive Use</td><td>1,600,000</td><td>1,700,000</td><td>1,700,000</td><td>1,934,000</td><td>1,633,800</td><td>1,612,100</td></tr>
<tr><td rowspan="2">Livestock</td><td>Withdrawals</td><td>4,900</td><td>13,400</td><td>13,400</td><td>29,100</td><td>6,300</td><td>6,300</td></tr>
<tr><td>Consumptive Use</td><td>2,400</td><td>9,900</td><td>10,000</td><td>7,400</td><td>2,300</td><td>2,300</td></tr>
<tr><td rowspan="2">Public Supply - Public Uses and Losses</td><td>Withdrawals</td><td colspan="3" rowspan="2">Included in "Domestic" Category</td><td>40,100</td><td>60,400</td><td>48,500</td></tr>
<tr><td>Consumptive Use</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">Total</td><td>Withdrawals</td><td>3,716,300</td><td>3,979,500</td><td>4,060,900</td><td>4,194,100</td><td>3,846,000</td><td>4,041,400</td></tr>
<tr><td>Consumptive Use</td><td>1,714,000</td><td>1,854,800</td><td>1,890,600</td><td>2,124,800</td><td>1,920,800</td><td>1,956,600</td></tr>
</table>

Source: U.S. Geological Survey; modifications by Nevada Division of Water Planning

Note: Figures may not add to totals because of independent rounding. Data are estimates only and subject to revision.

[1] Individual estimates were not available for 1970-80.

Table 1-21. Estimated 1995 Statewide Groundwater and Surface Water Withdrawals for Use Types

Category	Source	Amount
Domestic (self-supplied & public supplied)	Groundwater	104,100
	Surface water	256,700
	Total	360,800
Commercial (self-supplied & public supplied)	Groundwater	40,600
	Surface water	112,600
	Total	153,200
Industrial (self-supplied & public supplied)	Groundwater	8,900
	Surface water	10,300
	Total	19,200
Thermoelectric (self-supplied & public supplied)	Groundwater	41,100
	Surface water	24,400
	Total	65,500
Mining	Groundwater	270,500
	Surface water	3,900
	Total	274,400
Irrigation	Groundwater	1,138,200
	Surface water	1,975,400
	Total	3,113,600
Livestock	Groundwater	1,100
	Surface water	5,200
	Total	6,300
Public Supply - Public Uses and Losses	Groundwater	12,200
	Surface water	36,300
	Total	48,500
Total	Groundwater	1,616,700
	Surface water	2,424,800
	Total	4,041,500

Source: U.S. Geological Survey; modifications by Nevada Division of Water Planning
Note: Figures may not add to totals because of independent rounding. Data are estimates only and subject to revision.

Index - Part 2, Section 1 - Water Use

Nevada State Water Plan
PART 2 — WATER USE AND FORECASTS

Section 2
Socioeconomic Assessment and Forecasts

Introduction

This section of the *Nevada State Water Plan* presents population, demographic and economic conditions and trends for the Nevada economy and provides individual county and statewide population and socioeconomic forecasts. In Part 2, Section 3 of the water plan, these demographic forecasts, particularly as they related to population and employment, are used to predict future water needs over a planning horizon extending through the year 2020. More specifically, population forecasts and their relationship to total employment comprise the foundation of the forecasts for municipal and industrial (M&I), domestic (residential), and commercial and industrial water withdrawals as well as M&I public use and losses.

Population forecasts for each Nevada county and the total state are contained in Appendix 2 of the Appendices of the water plan. Appendix 3 of the Appendices presents the employment forecasts, which are derived from population forecasts, and also contains specific water use coefficients in either gallons per person or per worker per day to forecast each county's M&I, domestic (residential) and commercial and industrial water use. County forecasts for these measures are aggregated for the statewide total. Tables showing individual county population, employment and water withdrawal estimates and projects are contained in this appendix. Other categories of water withdrawals, namely thermoelectric (including geothermal), mining (including both consumptive and non-consumptive uses, such as mine dewatering), irrigation and livestock (total agriculture), are forecast using methods unique to each of these sectors as explained in Part 2, Section 3, Water Use Assessment and Forecasts.

Population and Demographic Trends

Nevada's population is expected to continue to become increasingly concentrated in its primary urban areas of Las Vegas (Clark County), Reno-Sparks (Washoe County) and Carson City. This increasing level of urbanization will have varied spillover effects on neighboring counties, e.g., Nye County for Clark County, and Churchill, Douglas, Lyon, and Storey counties for Washoe County and Carson City. Population forecasts incorporated into this plan for Clark and Washoe counties were provided by the Clark County Department of Comprehensive Planning and the Washoe County Department of Community Development, respectively. The population forecasts for Washoe County were slightly modified by the Nevada Division of Water Planning (NDWP) to smooth the intervening period forecasts, matching Washoe County's population forecast for the year 2020. Other county population forecasts were developed by the NDWP in conjunction with county inputs and were based on an extension and moderation of recent historical growth trends and the incorporation of estimated industrial development and employment forecasts based on inputs provided by the Nevada Department of Employment, Training and Rehabilitation (DETR).

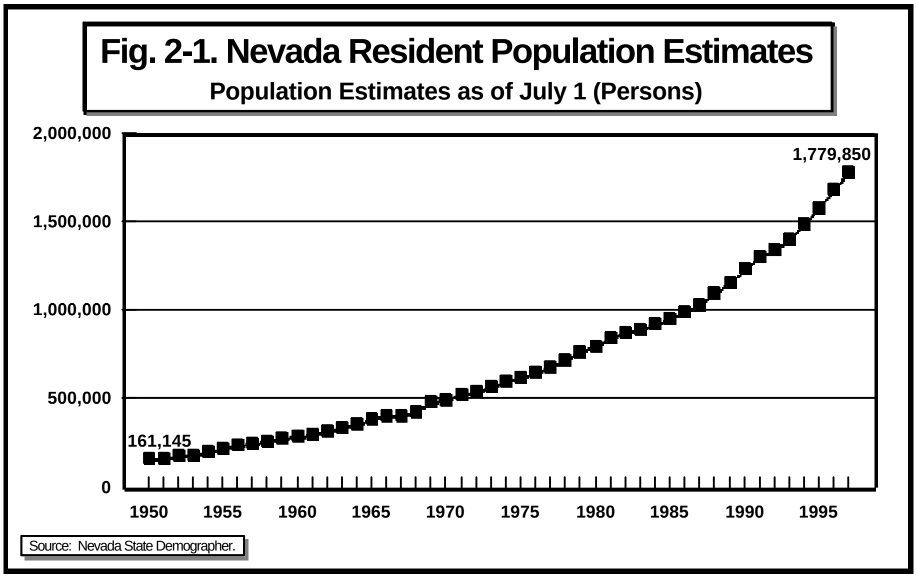


Fig. 2–1. Nevada Population Estimates, and Fig. 2–2. Nevada Population Growth Rates show annual population trends from 1950 through 1997. From Fig. 2–1, one can see the more recent acceleration of growth occurring since 1990 with the arrival of the first mega-resort casino in the Las Vegas gaming market. Table 2–1. Nevada Population Share Analysis — 1950–1997, presents historical and forecasted populations and population shares (in terms of county shares of the state's total population) for Nevada and its seventeen counties at ten-year intervals from 1950 to 1997. This table shows that in 1997, Clark County's total resident population was estimated at 1,192,200 persons and accounted for nearly 67.0 percent of the state's total population. This represented an increase of 36.7 percentage points in Clark County's share of the state's total population since 1950.

Also from Table 2–1, Washoe County's population was estimated at 308,700 persons in 1997, accounting for 17.3 percent of Nevada's total population, a decline of 14.0 percentage points in its share of statewide population since 1950. Carson City's population of 50,410 persons in 1997 comprised 2.8 percent of the state's total population, an increase of just over 0.2 percentage point in its population share since 1950. Together, these three Nevada urban areas accounted for 87.2 percent of the state's total population in 1997. Elko County, representing the other principal population center in Nevada, had an estimated population of 47,710 persons in 1997, accounting for 2.7 percent of the state's population and representing a decline of 4.6 percent points in state population share since 1950.

Table 2–1 also shows that the combined population share of the state's principal urban areas of Clark County, Washoe County and Carson City increased from 64.2 percent in 1950 to 87.2 percent of the state's total population in 1997. This represents an increase of 23.0 percentage points in these area's share of statewide total population from 1950 to 1997. The gain in population share from 1950 to 1997 was due entirely to the rapid growth in Clark County as Carson City showed virtually no change in its population share over the 1950-1997 time period and Washoe County actually lost 14.0 percentage points in its share of the state's total population from 1950 to 1997.

Table 2–1. Nevada Population Share Analysis — 1950–1997

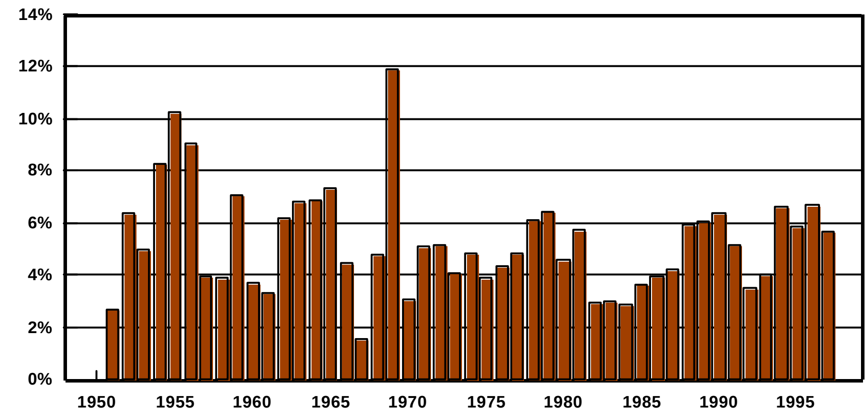
Shares Based on Percent of Total State Population (Persons/Percent of Total State)

State/County	1950	1960	1970	1980	1990	1997
NEVADA	**161,145**	**287,660**	**494,990**	**800,508**	**1,236,130**	**1,779,850**
Carson City	4,198	8,020	16,054	32,022	40,950	50,410
Statewide Share	2.61%	2.79%	3.24%	4.00%	3.31%	2.83%
Churchill County	6,188	8,505	10,650	13,917	18,100	23,860
Statewide Share	3.84%	2.96%	2.15%	1.74%	1.46%	1.34%
Clark County	48,811	128,734	277,230	463,087	770,280	1,192,200
Statewide Share	30.29%	44.75%	56.01%	57.85%	62.31%	66.98%
Douglas County	2,023	3,575	7,067	19,421	28,070	39,590
Statewide Share	1.26%	1.24%	1.43%	2.43%	2.27%	2.22%
Elko County	11,703	12,051	13,946	17,269	33,770	47,710
Statewide Share	7.26%	4.19%	2.82%	2.16%	2.73%	2.68%
Esmeralda County	611	634	623	777	1,350	1,460
Statewide Share	0.38%	0.22%	0.13%	0.10%	0.11%	0.08%
Eureka County	897	775	938	1,198	1,550	1,660
Statewide Share	0.56%	0.27%	0.19%	0.15%	0.13%	0.09%
Humboldt County	4,870	5,723	6,380	9,449	13,020	17,520
Statewide Share	3.02%	1.99%	1.29%	1.18%	1.05%	0.98%
Lander County	1,860	1,580	2,653	4,076	6,340	7,030
Statewide Share	1.15%	0.55%	0.54%	0.51%	0.51%	0.39%
Lincoln County	3,850	2,378	2,526	3,732	3,810	4,110
Statewide Share	2.39%	0.83%	0.51%	0.47%	0.31%	0.23%
Lyon County	3,703	6,245	8,437	13,594	20,590	30,370
Statewide Share	2.30%	2.17%	1.70%	1.70%	1.67%	1.71%
Mineral County	5,588	6,329	6,961	6,217	6,470	6,860
Statewide Share	3.47%	2.20%	1.41%	0.78%	0.52%	0.39%
Nye County	3,101	4,642	5,459	9,048	18,190	27,610
Statewide Share	1.92%	1.61%	1.10%	1.13%	1.47%	1.55%
Pershing County	3,122	3,178	2,656	3,408	4,550	6,600
Statewide Share	1.94%	1.10%	0.54%	0.43%	0.37%	0.37%
Storey County	657	571	696	1,503	2,560	3,520
Statewide Share	0.41%	0.20%	0.14%	0.19%	0.21%	0.20%
Washoe County	50,484	84,988	122,574	193,623	257,120	308,700
Statewide Share	31.33%	29.54%	24.76%	24.19%	20.80%	17.34%
White Pine County	9,479	9,732	10,140	8,167	9,410	10,640
Statewide Share	5.88%	3.38%	2.05%	1.02%	0.76%	0.60%

Note: County population shares are based on a percentage of the statewide total population.
Source Data: Nevada State Demographer.

The population share trends presented in Table 2–1 indicate that while virtually every rural county in Nevada (i.e., all counties excluding Clark, Washoe and Carson City), has grown in its total resident population, they have declined in terms of their shares of statewide population between 1950 and 1997. The only exception to this has been Douglas County, where population trends have been strongly influenced by the county's increasing status as a "bedroom" community for neighboring Carson City. Unique population trends exist for other Nevada counties as well. For example, rapid population growth in Elko County has been due in large part to trends in the mining industry, especially since the late 1980's. Between 1950 and 1970, Elko County's population grew by only 2,243 persons. However, over the next 27 years its population grew by nearly 30,000 persons. Much of this growth was due to mining, both in Elko County and neighboring Eureka County. Lyon County represents another county where growth in neighboring Carson City, primarily, has affected its population growth. Similarly, recent rapid growth in Nye County has been primarily centered in the southern part of the county at Pahrump, which has been influenced by rapid growth in nearby Las Vegas.

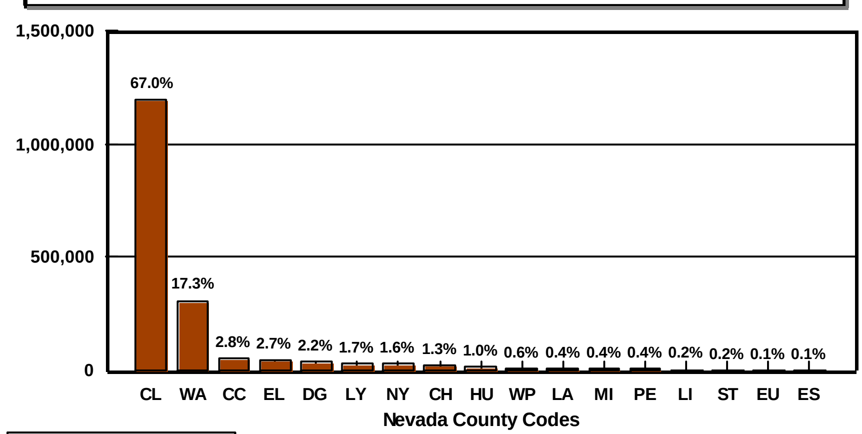
Figure 2-2. Nevada Population Growth Rates
Year-Over-Year Annual Population Rates of Growth (Percent)



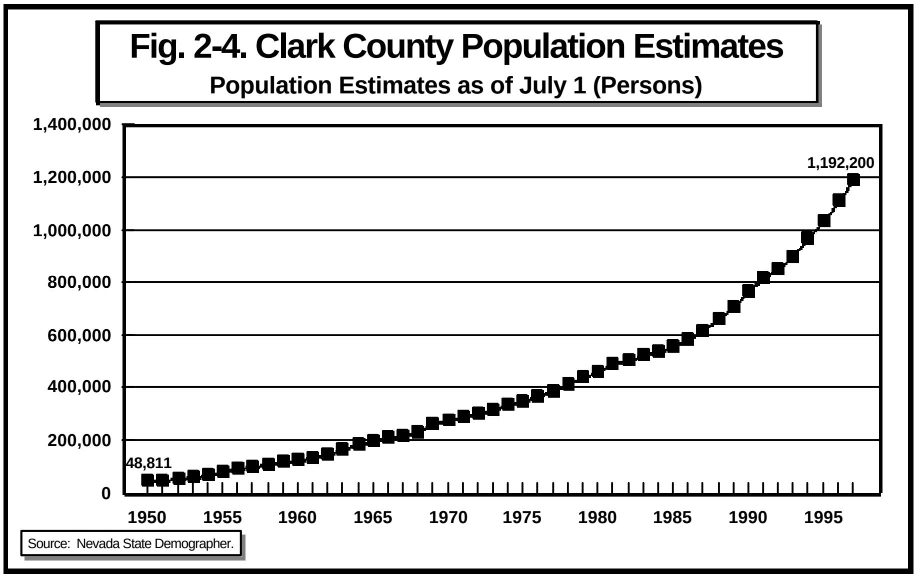
Source: Nevada State Demographer.

<u>Gaming and Tourism.</u> Casino gaming and tourism in Nevada represent the primary "driving" economic force most affecting the state's overall population trends. While growth in tourism and gaming win (revenues) has more recently slowed in the state's principal northern Nevada casino gaming markets of Reno-Sparks (Washoe County) and South Lake Tahoe (Douglas County), this trend has been more than off-set by high rates of growth in the southern Nevada gaming market of Las Vegas (Clark County), and specifically by trends within the Las Vegas Strip gaming sub-market, which alone accounts for nearly 50 percent of the state's total gaming win. The introduction of the mega-resort complex to the Las Vegas Strip gaming market beginning in late 1989 established a trend of rapid employment growth, population expansion,

Fig. 2-3. Nevada Population Shares by County
Population Estimates and Shares as of July 1, 1997 (Persons/Percent)



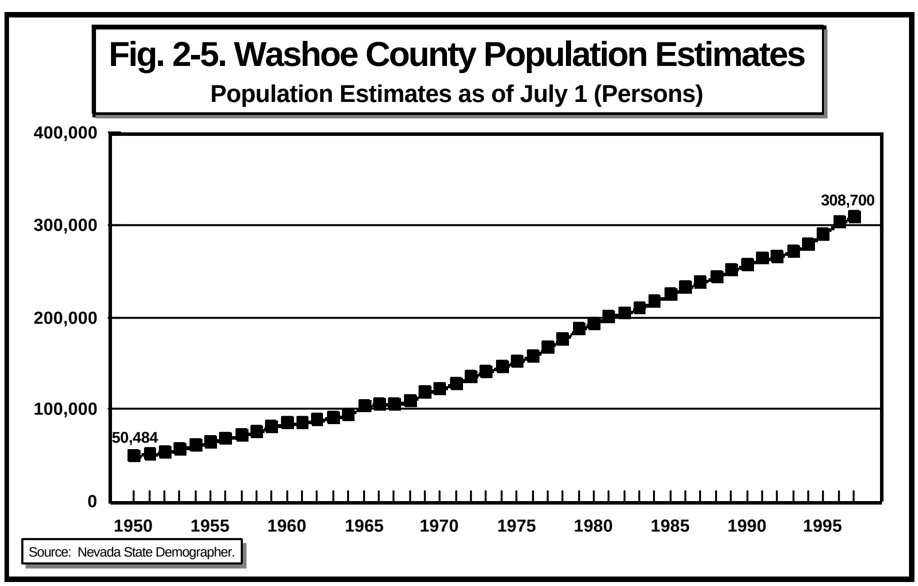
Source: Nevada State Demographer.



and gaming win growth that has characterized this market throughout the 1990's. The mega-resort casino complex, with employment requirements for each new facility frequently exceeding 5,000-6,000 workers (the Bellagio, which opened in late 1998, employs over 9,000 workers), has produced significant impacts on population growth, the expansion of support service businesses, infrastructure requirements, and water demands. Furthermore, new resort complexes opening in this gaming market through 1999 and into 2000 will extend these growth trends into the next century.

Mining. While gaming and tourism have had significant impacts on growth in Clark and Washoe counties, mining has had major influences on many of the rural counties' population and employment growth, demographic trends, and economic development. Since 1989, gold mining in Nevada has made a major contribution to a number of rural counties' economic growth, most especially Elko, Eureka, Humboldt, Lander, Nye, and Pershing counties.

More recently, however, this industry has come under growing economic stress. Beginning in late 1997 and extending into 1999, due primarily to European monetary reform(the creation of the European Monetary Union, or EMU) and Asian economic and financial problems, gold prices realized by Nevada mines have slipped dramatically. The average price of gold fell from $387.87 per (troy) ounce in 1996 to $331.29 per ounce in 1997, and by mid-1998 the price received by Nevada's mining interests was well below $300 per ounce. By late 1998, gold's price had rebounded somewhat to "around" $300 an ounce. Some of this price decline has, for the time



being, been mitigated through the mining industry's use of "forward" contracts wherein the mining companies have locked in to committed prices for future gold sales.

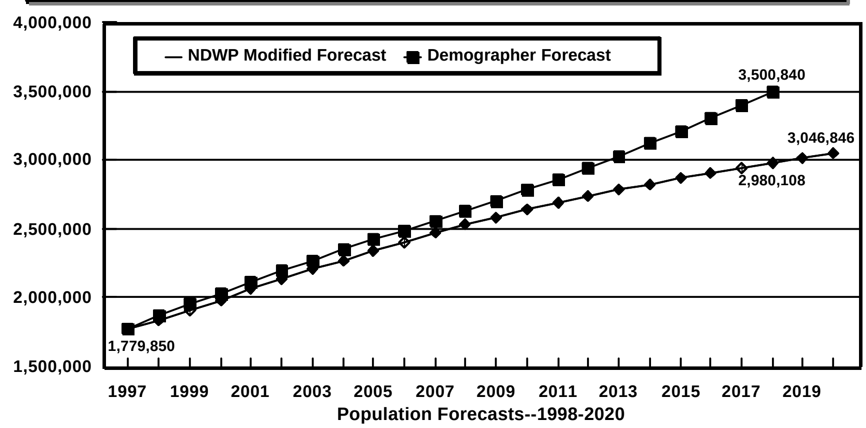
Over the plan's forecast period, international economic and financial conditions are expected to continue to affect the nature and structure of mining operations in Nevada, and, in the process, the demographic and economic growth prospects of the rural, mining-dependent Nevada counties. Long-term conditions within the mining industry are expected to stabilize gold's price at approximately $280–$350 per ounce, which has become incorporated into the levels of forecast production for the industry and particularly the amount of economically recoverable reserves.

Nevada Population Analysis and Forecasts

Two separate population forecasts are presented in the water plan. Every year the Nevada State Demographer estimates the current population and, following this, produces a twenty-year population forecast for all counties and the total state. All state agencies are required by the Governor's Executive Order to utilize the population forecasts of the State Demographer in their budgeting and planning activities. Per agreement with the state's population contracting agency, the Nevada Department of Taxation, the NDWP has developed an alternate set of county and state population forecasts based on inputs received from the individual counties, inputs from the Nevada Department of Employment, Training and Rehabilitation (DETR), and from the NDWP's own best estimates.

Overall, the NDWP's statewide population forecast predicts a more moderate population growth than that of the State Demographer. The reason for this is that Nevada's total population is largely influenced by the trends in Clark County's population, which in 1997 accounted for nearly 67 percent of the state's resident population. Based on infrastructure requirements and current resource limitations, local planners in Clark County expect slower growth over the plan's forecast horizon than does the Nevada State Demographer. The water plan incorporates both sets of population forecasts, as shown in Table 2–2. Nevada Population Forecast Comparisons, to present an anticipated "range of expected growth." However, only the NDWP's forecasts are incorporated into the water plan's future water withdrawal projections. The complete set of population forecasts and related graphical analysis for each county is presented in Appendix 2 of the Appendices. This

Fig. 2-6. Nevada Population Forecast Comparisons
State Demographer and NDWP Modified--July 1 (Persons)



Sources: Nevada State Demographer; Nevada Division of Water Planning modified forecast.

appendix also contains the comparative analysis of the two sets of forecasts for all individual counties.

The Nevada State Demographer has forecast a population for Nevada for the year 2018 of 3,500,840 persons, primarily based on the continued virtual exponential growth in Clark County. This forecast represents an overall increase in statewide population of 1,720,990 persons between 1997 and 2018, a near doubling of Nevada's population over the next 20 years. The State Demographer's forecast scenario results in an average annual rate of growth of statewide population of 3.3 percent per year for the overall forecast period of 1998 to 2018, with a sub-period average annual rate of growth of 3.6 percent between 1998 and 2008 slowing to 2.9 percent between 2008 and 2018. The State Demographer's forecasted population for 2018 is approximately 15 percent higher than that of the NDWP.

Table 2–2. Nevada Population Forecast Comparisons

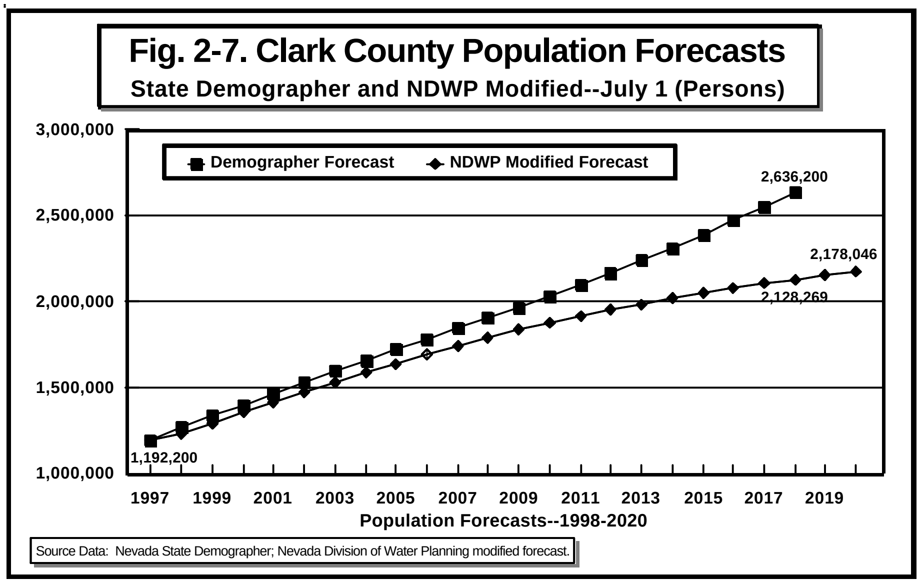
Nevada State Demographer and Nevada Division of Water Planning (NDWP)

Nevada Forecasts by Source	**2000**	**2005**	**2010**	**2015**	**2018**	**2020**
State Demographer						
Resident Population (persons)	2,034,020	2,421,020	2,783,700	3,313,260	3,500,840	n.a.
Nevada Division of Water Planning						
Resident Population (persons)	1,986,257	2,341,374	2,640,306	2,868,979	2,980,108	3,046,846
Difference (persons)	47,763	79,646	143,394	343,281	520,732	–
Percent Difference	2.4%	3.3%	5.2%	10.7%	14.9%	–

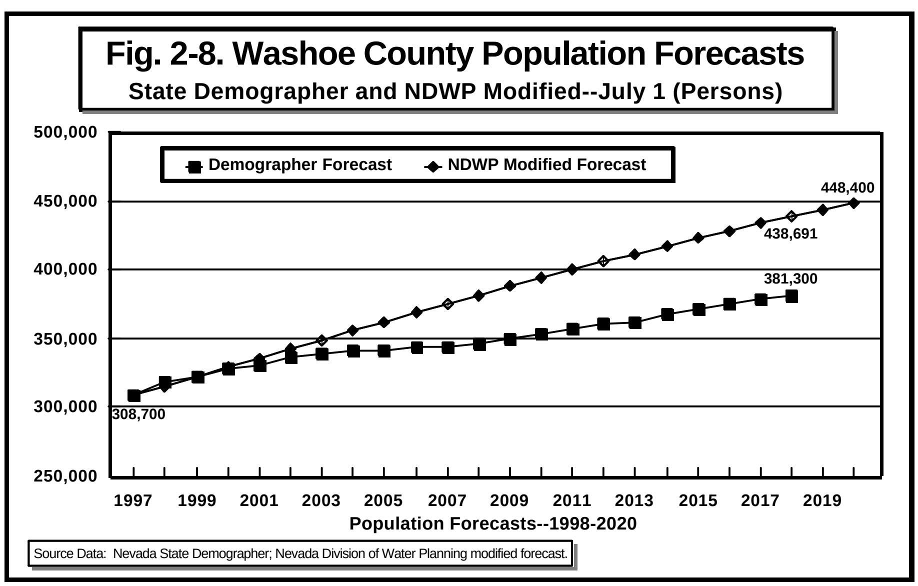
Note: The population forecasts of the State Demographer currently extend only through the year 2018. The difference amount represents the difference between the forecasts of the State Demographer and NDWP. NDWP population forecasts for Clark and Washoe counties are based on population forecast inputs from those counties.
Source Data: Nevada State Demographer; Nevada Division of Water Planning (NDWP).

The NDWP forecast scenario, based primarily on slower population growth in Clark County, assumes a more modest 2.5 percent overall annual rate of population growth for Nevada between the years 1998 and 2018, with sub-period average annual rates of 3.2 percent per year for 1998 to 2008 falling to an average annual rate of growth of 1.6 percent for the years 2008 through 2018.

Based on the "range" of population forecasts developed independently by the State Demographer and the NDWP, Nevada is projected to grow at a rate of between 2.5–3.3 percent per year through 2018. Growth rates are expected to average between 3.2–3.6 percent per year between 1998 and 2008 and then moderate to between 1.6–2.9 percent per year between 2008 and 2018. This overall rate of growth represents an increase in Nevada's total population of between 1,200,258 persons (NDWP) and 1,720,990 persons (State Demographer) between 1997 and 2018, resulting in a total forecasted population range of 2,980,108–3,500,840 persons by July 1, 2018. In the near term, the increase in the state's population will continue to be fueled in large part by strong growth in the Las Vegas economy, particularly from its casino gaming and tourism industry. The gaming sector, at least for the next several years, will continue to see new major resort-casino construction, continuing to make southern Nevada the premier destination resort location in the world.



By contrast, the Washoe County and Carson City areas, and in fact much of northern Nevada, are beginning to see slower growth due to more intense competition in the gaming and tourism industry. Based on the growth in legalized gaming in other jurisdictions, and particularly the rise of Indian gambling on reservation lands, especially in California and the Pacific Northwest, it is reasonable to expect a continued slowdown in the growth of gaming and tourism throughout Nevada from approximately the year 2005 onward. The November 1998 passage of "Proposition 5", which legalized slot devices in Indian reservation casinos in California, is destined to have profound impacts on gaming in that state. While at least two constitutional challenges to Proposition 5 have been filed, California voters appear to have changed their attitude towards legalized casino gaming within their state and further moves in this direction may be reasonably expected. Also, in early January 1999, California's Governor and Attorney General withdrew their support for any



challenge to Proposition 5.

While many of Nevada's tourism and gaming attractions, both man-made and natural, continue to be unrivaled with respect to featured offerings in competitive markets, studies have shown that proximity has an important influence over player patronage. As a result, Nevada's casino gaming industry will have to work hard to compete with developing gaming markets located closer to population centers throughout the U.S. The anticipated slowing in the growth in Nevada's gaming industry, however, is not expected to be uniform and will be stronger in those markets which do not offer features of a distinctive nature to lure consumers from more proximate gaming opportunities.

Table 2–3. Nevada Population Forecast Summary, 1995–2020, presents a summary of the population forecasts for those larger Nevada counties expected to equal or exceed a total resident population of 50,000 persons by the year 2020. Complete population forecasts and analysis for all Nevada's counties may be found in Appendix 2 of the Appendices. These population forecasts and county shares of total state population are based on the modified forecasts made by the NDWP and specifically incorporate the population forecasts provided by the Clark County Department of Comprehensive Planning and the Washoe County Department of Community Development.

Table 2–3. NDWP Nevada Population Forecast Summary

Population Forecasts and Shares for Larger Nevada Counties — 1997–2020

(For counties expected to exceed 50,000 persons by the year 2020)

State/County	1997	2000	2005	2010	2015	2020
Nevada						
Resident Population (persons)	**1,779,850**	**1,986,257**	**2,341,374**	**2,640,306**	**2,868,979**	**3,046,846**
Carson City						
Resident Population (persons)	50,410	54,445	60,703	66,041	70,099	72,587
Percent of Total State	2.83%	2.74%	2.59%	2.50%	2.44%	2.38%
Clark County (Las Vegas)						
Resident Population (persons)	1,192,200	1,355,368	1,640,444	1,874,431	2,046,229	2,178,046
Percent of Total State	66.98%	68.24%	70.06%	70.99%	71.32%	71.49%
Douglas County						
Resident Population (persons)	39,590	42,834	48,180	53,272	57,900	61,854
Percent of Total State	2.22%	2.16%	2.06%	2.02%	2.02%	2.03%
Elko County						
Resident Population (persons)	47,710	51,665	57,857	63,224	67,408	70,113
Percent of Total State	2.68%	2.60%	2.47%	2.39%	2.35%	2.30%
Lyon County						
Resident Population (persons)	30,370	33,721	39,377	44,878	49,914	54,170
Percent of Total State	1.71%	1.70%	1.68%	1.70%	1.74%	1.78%
Washoe County (Reno)						
Resident Population (persons)	308,700	329,021	362,260	393,884	422,917	448,400
Percent of Total State	17.34%	16.56%	15.47%	14.92%	14.74%	14.72%

Note: Counties included are only those that are forecast to equal or exceed a resident population of 50,000 persons by the end of

the forecast horizon (2020).
Source Data: Nevada State Demographer (1997 estimate); Nevada Division of Water Planning (2000–2020 forecasts).

Nevada's Employment Composition and Industry Trends

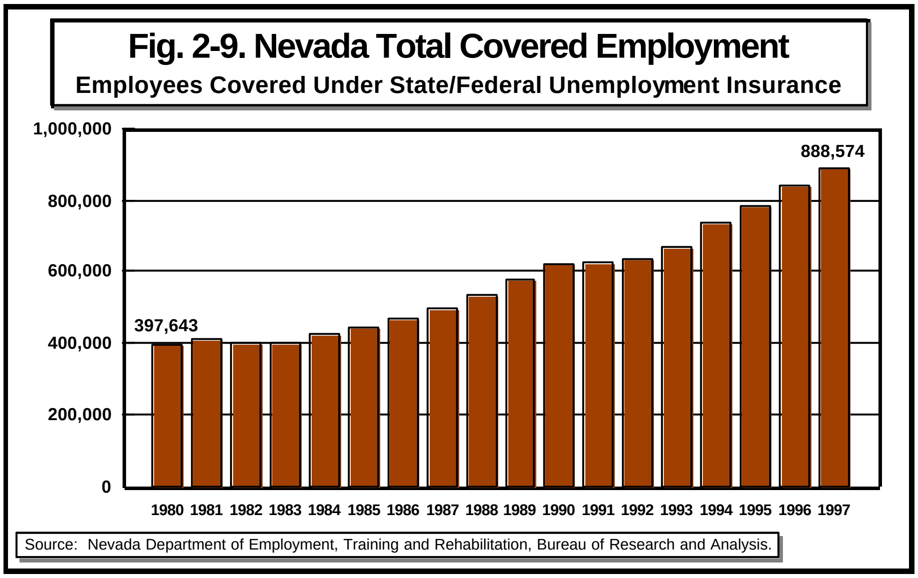


Table 2–4. Nevada Covered Employment — 1980–1997, shows trends in Nevada's total "covered employment" (a definition of employment which includes those employees covered under state and federal unemployment insurance programs) as well as trends in the shares of total employment by principal industry sector. Employment trends and industry composition are important considerations in forecasting commercial and industrial water withdrawals as each industry sector tends to use water at different rates in terms of gallons per employee per day. To forecast commercial and industrial water withdrawals for the water plan, an average commercial and industrial "water use coefficient" for all industry sectors is used in conjunction with forecasted total employment. It is therefore important to assess anticipated changes in future employment composition by specific industry sectors to insure that no dramatic changes are expected which might significantly alter the average usage factor and thereby jeopardize the reasonableness and usefulness of this forecast methodology.

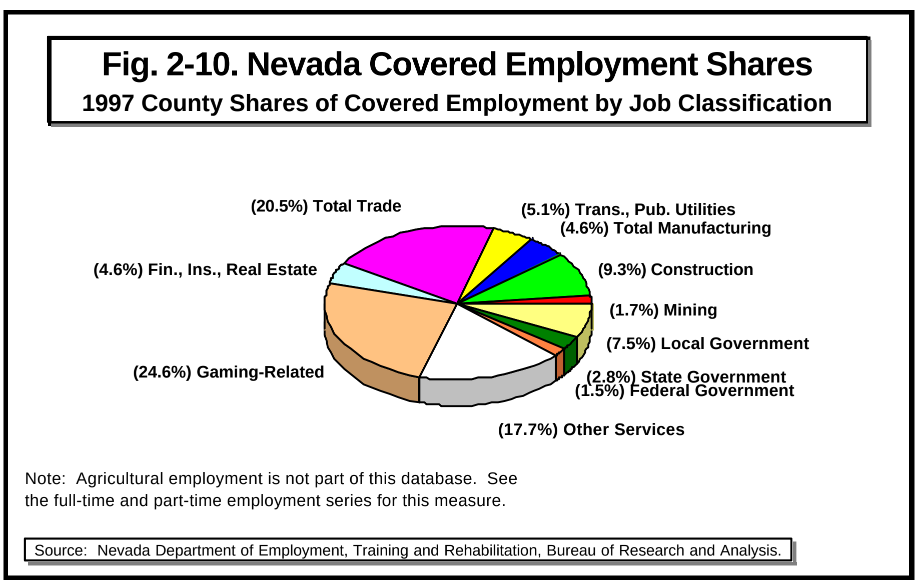


Fig. 2–9. Nevada Total Covered Employment shows the trend in statewide total employment from 1980 to 1997. This graph shows the slowdown in employment growth in Nevada during the national recessionary periods of 1980-82 and 1990-91, clearly indicating Nevada's linkages to national business cycles. The state's covered employment data,

compiled by the Nevada Department of Employment, Training and Rehabilitation (DETR), represents the most accurate and detailed measure of commercial and industrial employment in the State of Nevada.

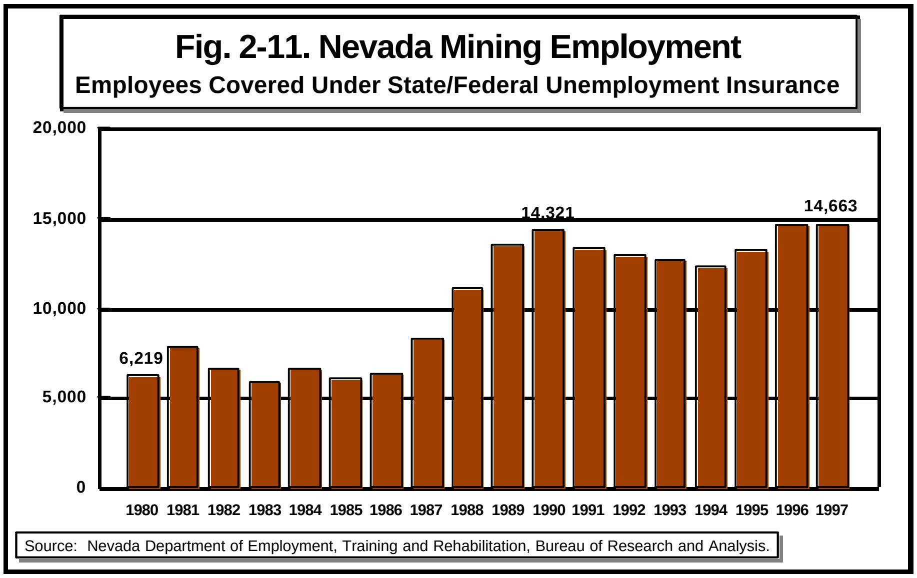
Table 2–4. Nevada Covered Employment Trends — 1980–1997

Trends in Covered Employment and Shares by Principal Industry Sector (Workers)

Industry Category	1980	1985	1990	1997	1980-97 Change in Workers	1980-97 Percent Change
Total State	**397,643**	**443,527**	**619,638**	**888,574**	**490,931**	**123.5%**
Mining Percent of Total	6,219 1.56%	6,081 1.37%	14,321 2.31%	14,663 1.65%	8,444	135.8%
Construction Percent of Total	26,434 6.65%	24,121 5.44%	46,903 7.57%	81,953 9.22%	55,519	210.0%
Total Manufacturing Percent of Total	19,200 4.83%	21,958 4.95%	26,245 4.24%	40,604 4.57%	21,404	111.5%
Trans., Public Utilities Percent of Total	22,403 5.63%	23,908 5.39%	31,445 5.07%	44,877 5.05%	22,474	100.3%
Total Trade Percent of Total	80,330 20.20%	90,874 20.49%	124,260 20.05%	180,425 20.31%	100,095	124.6%
Fin., Ins., Real Estate Percent of Total	17,777 4.47%	21,287 4.80%	28,245 4.56%	40,338 4.54%	22,561	126.9%
Service Industries Percent of Total	165,516 41.62%	192,289 43.35%	267,067 43.10%	371,753 41.84%	206,237	124.6%
Gaming-Related Percent of Total	114,950 28.91%	125,483 28.29%	165,384 26.69%	216,491 24.36%	101,541	88.3%
Total Government Percent of Total	56,830 14.29%	59,788 13.48%	75,962 12.26%	104,254 11.73%	47,424	83.4%
Federal Government Percent of Total	10,369 2.61%	10,462 2.36%	12,341 1.99%	13,519 1.52%	3,150	30.4%
State & Local Gov't Percent of Total	46,462 11.68%	49,325 11.12%	63,621 10.27%	90,736 10.21%	44,274	95.3%
State Government Percent of Total†	15,300 32.93%	15,621 31.67%	19,354 30.42%	24,974 27.52%	9,674	63.2%
Local Government Percent of Total†	31,162 67.07%	33,704 68.33%	44,267 69.58%	65,762 72.48%	34,600	111.0%

Notes: Includes employment covered under state and federal unemployment insurance programs. State and local government employment shares for the years 1980, 1985, and 1990 are estimated based on trends of 1993 through 1997. Agriculture and related employment categories (i.e., agricultural services, forestry and fisheries) are not part of this database).
† Percent of total for state government and local government are based on a percent of total state and local government only.
Source Data: Nevada Department of Employment, Training and Rehabilitation (DETR), Research and Analysis Bureau.

Fig. 2–10. Nevada Covered Employment Shares, shows the distribution of total covered employment across Nevada's principal industry sectors for 1997. However, this database does not include workers in the sectors of farming, agricultural services, forestry or fisheries. Therefore, employment



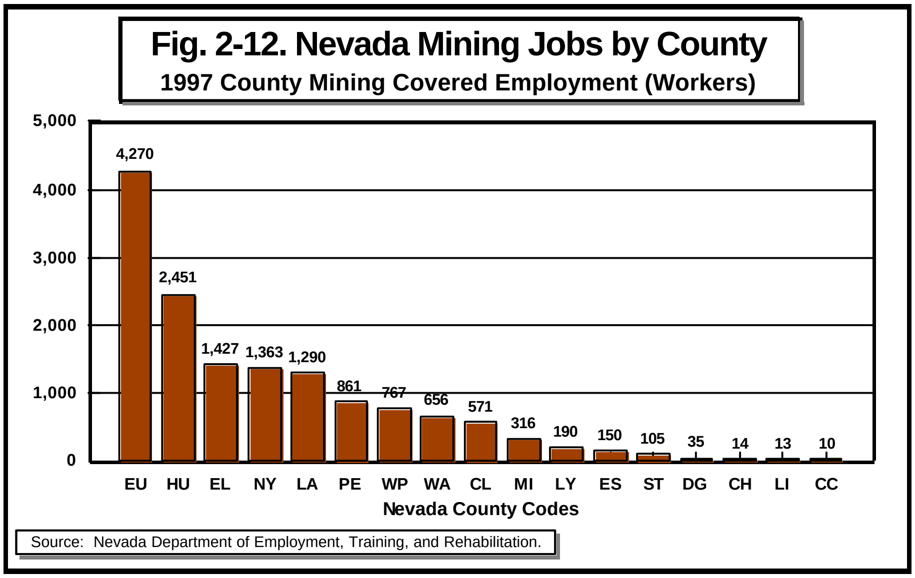
in these sectors was analyzed using another employment measure, termed "full and part-time employment," which is compiled by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). Fig. 2–15. Nevada Full/Part-Time Employment Shares, presents this alternative employment measure and, while not as recent as the covered employment data, it does incorporate agricultural and related employment for the State of Nevada. Fig 2–15 shows a wide range in employment shares for 1996 in various sectors from a high of 42.7 percent in total services to 1.5 percent in farming and related agricultural service industry jobs.

Table 2–4 shows that since 1980, covered employment in Nevada's construction industry has shown the most rapid growth, which is not surprising in a rapidly growing state like Nevada. This construction industry growth has been driven by construction needed for commercial development (primarily major casino complexes in the Las Vegas economy) as well as growth in associated retail trade businesses, residential housing units and various infrastructure requirements such as airport facilities, roads and highways, public utilities, schools, etc. Since 1989, statewide construction jobs in support of Nevada's mining industry also contributed to these totals. In the following section each principal industry sector is analyzed in terms of its historical trends and future prospects for growth.

Employment Analysis by Industry Sector

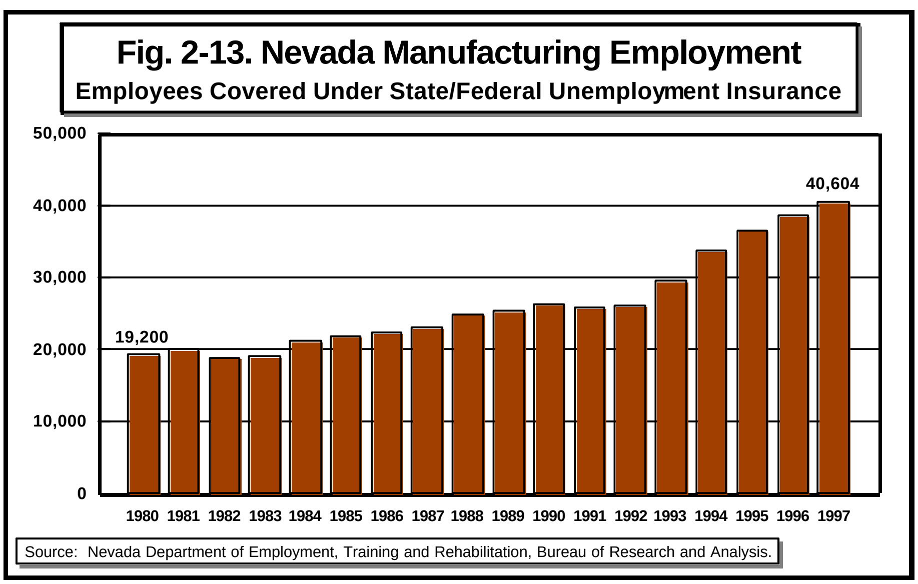
Construction. In addition to its rapid growth, construction employment has proven to be the most volatile employment sector in the state. Nevada's construction employment declined by 25.0 percent, or 6,594 workers from 1980 to 1983, reflecting the 1980-82 national recessionary period. Then, reflecting the 1990-91 national recession, Nevada's construction employment declined again by 16.4 percent or 7,690 workers between 1990 and 1993. The construction industry increased its share of statewide total covered employment from 6.6 percent in 1980 to 9.2 percent by 1997. Continued strong, albeit more moderate, growth trends in this sector are expected into the next century, with some slowdown occurring in the later part of the plan's forecasting horizon (1998-2020).

Mining. Mining jobs in Nevada rose by 8,444 workers, an increase of nearly 136 percent between 1980 and 1997 (see Fig. 2–11). More recent trends have indicated a marked slowdown in this industry sector due to price pressures on Nevada's primary mineral, gold, and resultant cost restraints on mining operators. Due to the take-off of Nevada's gold mining industry in the late 1980's, this



industry's share of statewide total covered employment rose from 1.6 percent in 1980 to 2.3 percent by 1990. By 1997, due to significant declines in the price of gold, Nevada's mining industry's share of total covered employment slipped back to 1.6 percent, the same share of statewide total employment it held in 1980. Over the near term, mining employment in Nevada is expected to decline, eventually falling and then remaining at about 12,000-13,000 workers over most of the water plan's forecast period. Impacts on the mining industry due to price swings and continued uncertainty in world gold markets will affect both employment and population growth in Nevada's rural and mining-dependent counties. Fig. 2–12 shows the number of 1997 mining jobs ranked by county.

Manufacturing. Manufacturing has shown relatively good growth in terms of employment. Between 1980 and 1997, employment in this industry sector has risen by 21,404 workers, or 111.5 percent (see Fig. 2–13). As a primary industry targeted for the state's economic diversification efforts, continued growth in the state's manufacturing sector is expected. Although manufacturing's share of statewide total covered employment has actually declined slightly from 1980 (4.8 percent to 4.6 percent), its relative stability in terms of employment share is counter to national trends in which manufacturing employment slid significantly from over 20 percent of total employment in the early 1960's to only 14 percent in the 1990's.



Transportation and Public Utilities. Nevada's transportation and public utility jobs, as well as jobs in finance, insurance and real estate, represent two industry sectors in which only modest gains to employment are anticipated over the forecast horizon. These industries are being particularly impacted by mergers (finance and especially banking) and deregulation (public utilities, particularly electrical power, gas and water), with the net effect of only modest increases expected to employment over the forecast horizon. Since 1980, transportation and public utility jobs have grown by 100.3 percent, or 22,474 workers. This industry's share of statewide total covered employment has fallen, however, from 5.6 percent in 1980 to 5.0 percent by 1997.

Recent trends in the mandated deregulation of the electrical power industry are destined to result in mergers and, initially, reduced levels of employment. However, there also has been a tendency for these newly deregulated businesses to expand into new businesses more or less related to their primary business of power generation or distribution. Consequently, later in the forecast horizon, more rapid employment growth in the public utility sector may be expected.

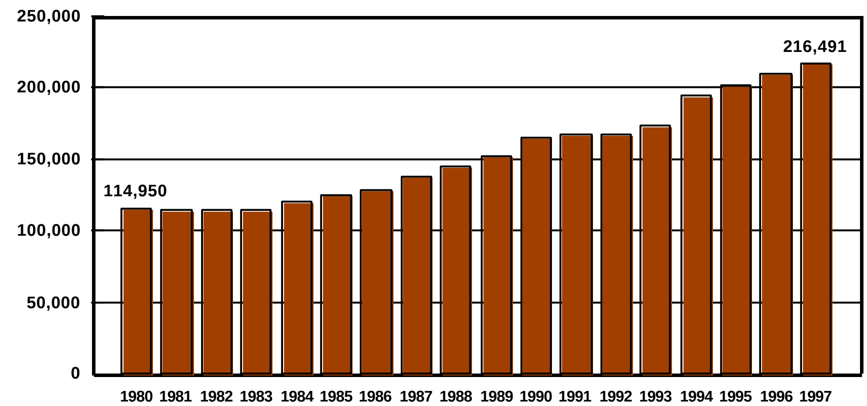
Finance, Insurance and Real Estate (F.I.R.E.). Finance-related jobs in Nevada have shown an increase of 126.9 percent since 1980, representing an addition of 22,561 workers to total state employment. Much of this increased employment has come in the real estate area, whereas employment trends in the state's financial institutions, and banking in particular, have been and will continue to be adversely impacted by out-of-state ownership and continued mergers and acquisitions. Financial-related employment in the state showed virtually the same share of total jobs in 1997 as it did in 1980, 4.5 percent.

Wholesale and Retail Trade. Total wholesale and retail trade employment growth from 1980 to 1997 has shown gains slightly above those of the state average (124.6 percent versus 133.5 percent). From 1980 to 1997, employment in this industry sector has grown by 124.6 percent, representing an addition of 100,095 workers since 1980. The majority of this growth has occurred in the state's retail trade businesses and has been closely linked to growth in Nevada's tourism and gaming industries, as well as the rapid growth in resident population. This industry's share of statewide total employment has changed only slightly since 1980, rising from 20.2 percent to 20.3 percent of statewide employment by 1997. More modest increases in the state's gaming and tourism industry sectors are destined to also moderate future growth rates in total trade employment.

Total Services. Employment in all of Nevada's service industries (i.e., gaming-related, medical and health care services, personal services, business services, etc.), which represents the dominant industry sector in the state, has advanced by 124.6 percent since 1980, resulting in an addition of 206,237 new workers. Particularly strong employment growth has been shown in business services and medical and health care services industry sectors. Due primarily to more modest gains in gaming-related employment, which accounted for over 58 percent of total service industry employment in 1997, jobs in total services have only increased slightly since 1980, rising from a 41.6 percent share of statewide total employment to 41.8 percent by 1997.

Services – Gaming and Tourism. Relative to other principal industry sectors, gaming-related employment in Nevada has shown more modest employment growth since 1980 (see Fig. 2–14). This trend primarily reflects the effects of a more competitive gaming industry, both interstate and intra-state, and a maturing Nevada economy in which gaming continues to represent the dominant basic industry, but one of diminishing importance as support industries expand their employment levels. Gaming's share of statewide total employment has fallen from 28.9 percent in 1980 to 24.4 percent by 1997 as Nevada's support industries have, in effect, played "catch-up" to the lead that the gaming and tourism industry showed beginning in the early 1980's. Gaming, however, will continue as the primary industry sector, although its dominance is destined to slowly decline as the market for tourists becomes increasingly saturated and Nevada finds itself competing with the growing number of legalized gaming locations throughout the U.S. and the world.

Fig. 2-14. Nevada Gaming Industry Employment
Employees Covered Under State/Federal Unemployment Insurance



Source: Nevada Department of Employment, Training and Rehabilitation, Bureau of Research and Analysis.

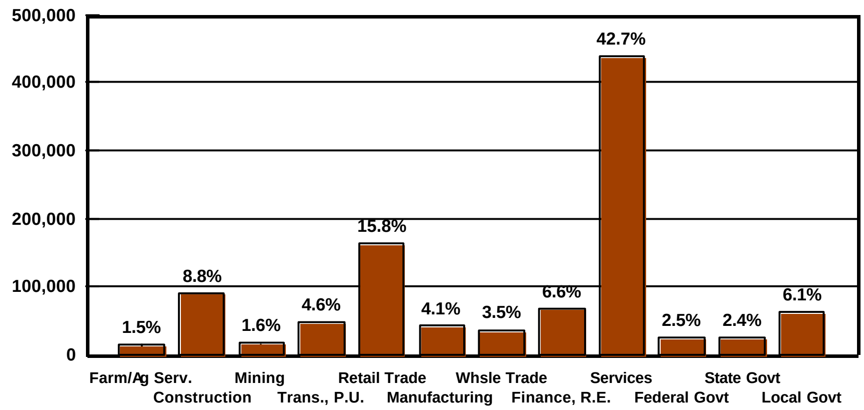
<u>Government.</u> Statewide total government employment (federal, state, and local governments) has reflected the effects of rapid population growth and the need to provide public services by local (county and city) governments. As a result, the greatest growth in the overall government sector has occurred at the local government level, where employment has risen 111.0 percent since 1980, reflecting a statewide increase of 34,600 jobs. Local government's share of total government employment has risen from approximately 67 percent in 1980 to over 72 percent by 1997. State government has also been influenced by population demands, but not to the extent shown by Nevada's local governmental entities. Total state government employment rose from 15,300 workers in 1980 to nearly 25,000 workers by 1997, an increase of 63.2 percent or 9,674 workers. By comparison, total employment in Nevada has risen by nearly twice this amount, or nearly 124 percent since 1980.

Characteristically, federal government employment has risen more in response to program requirements and federal budgetary restrictions than local population effects. On this basis, Nevada's federal government employment rose by only 30.4 percent since 1980, representing an increase of 3,150 workers over 17 years. Over the planning horizon covered by the State Water Plan, federal government employment growth is expected to remain relatively stable and state government employment to slow from prior periods. Local government employment will also moderate somewhat as statewide overall economic activity begins to slow and state and local government budgets become more strained.

<u>Agriculture and Related Industries.</u> Using BEA's full time and part-time employment data, Nevada's agriculture (farming) industry accounted for only 1.5 percent of Nevada's total employment in 1996 and has shown virtually no growth since 1970. On the other hand, employment in agricultural services, forestry and fisheries has expanded more dramatically. While it appears that total agricultural-related employment has increased since 1970 (see Fig. 2-16. Nevada Agricultural/Related Employment), on-farm jobs have actually declined slightly from 1970 to 1996. Fig. 2-17. Nevada Agricultural Employment Composition shows that agricultural service and related jobs have grown from 820 workers in 1970 to 10,963 workers in 1996. The majority of these jobs are in lawn services and landscaping and are primarily located in the more urban areas of the state. For example, of this total amount, 9,432 agricultural and related service jobs, or 86.0 percent, were located in either Carson City, Clark or Washoe counties. Employment growth in the farm sector is expected to continue to decline moderately while the agricultural and related employment sectors are expected to continue to show strong growth along with population and commercial and industrial expansion.

Fig. 2-15. Nevada Full/Part-Time Employment Shares

1996 Full and Part-Time Employment Shares--Percent of Total

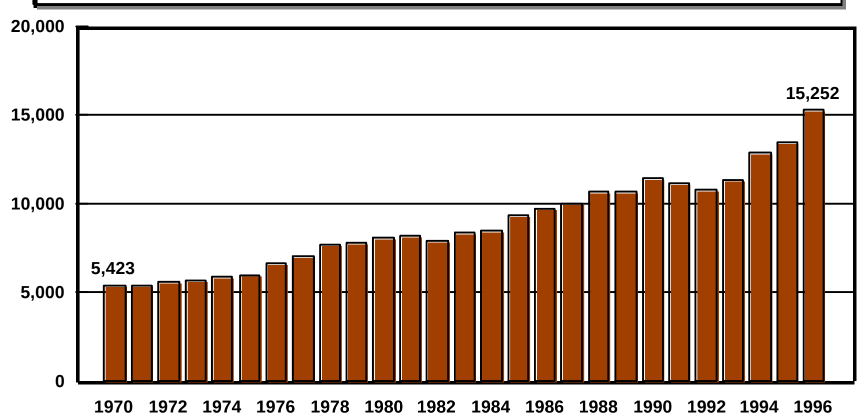


Source: U.S. Department of Commerce, Bureau of Economic Analysis (BEA).

While some changes are expected in the overall composition and share of industry sectors within individual counties and for the total state, it is not expected that these changes in job mix will be significant enough to preclude the use of an average commercial and industry water use factor (i.e., gallons per worker per day) to estimate future commercial and industrial water use patterns based on total employment trends. Both state and county economic and employment data sets and the related water use coefficients will be updated as new

Fig. 2-16. Nevada Agricultural/Related Employment

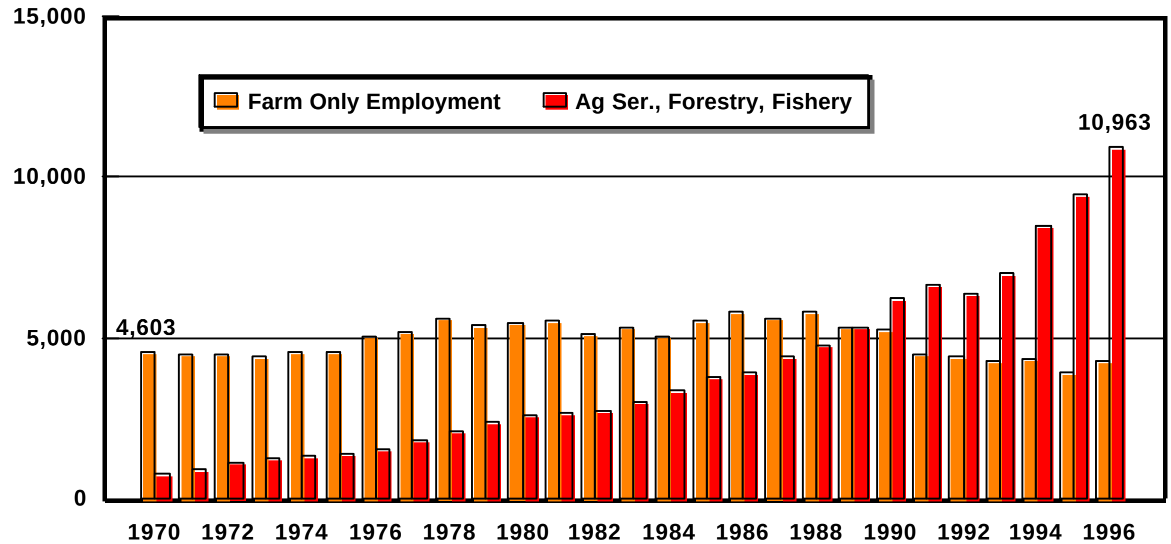
Full and Part-Time Employment (Number of Jobs)



Note: Includes farming, agricultural services, forestry and fishery employment.

information becomes available.

Fig. 2-17. Nevada Agricultural Employment Composition
Full and Part-Time Employment (Number of Jobs)



Note: Includes farming, agricultural services, forestry and fishery employment.

Nevada's Casino Gaming Industry

Casino gaming represents Nevada's primary industry sector in terms of persons employed, payrolls, "exports" (of gaming-related products and services) and impacts on other industry sectors both in terms of employment and productive output. Table 2–5. Nevada Casino Gaming Win — 1970–1997 presents basic revenue trends in Nevada's gaming industry for its principal gaming markets (Clark, Washoe and Elko counties, South Lake Tahoe, and Carson Valley in Table 2–5) and the various gaming sub-markets within these principal gaming markets. The gaming win measures the dollar volume of casino patrons' wagered amounts that are retained by the casino after all payouts as winnings. This amount is also referred to as the "house hold". As a primary revenue source, the gaming win represents the most fundamental measure of the economic and financial health of this industry and the effects of tourists' patronage of Nevada casinos.

Table 2–5 shows the effects that increasing intra-state competition has had on Nevada's various casino gaming markets. Rapid casino expansion, primarily in the Las Vegas (Clark County) gaming sub-markets of the Las Vegas Strip and the Boulder Strip, has adversely affected gaming revenue trends of other sub-markets within Clark County, i.e., the Las Vegas Downtown and Laughlin casinos. Laughlin's revenue growth has also been adversely affected by Indian casinos around Phoenix, Arizona, a principal "feeder" market for this gaming location. Even so, the Clark County gaming market has shown impressive gaming win growth and now accounts for nearly 80 percent of the state's total gaming win (see Fig. 2–18).

Table 2–5. Nevada Casino Gaming Win — 1970–1997

Total Casino Gaming Win† by Principal Gaming Market (Millions of Dollars)

Principal Gaming Market or Sub-Market	1970	1980	1990	1997	1990-97 Change in Gaming Win and Share	1990-97 Percent Change in Gaming Win
TOTAL STATE	**$604.35**	**$2,478.45**	**$5,480.25**	**$7,802.70**	**$2,322.45**	**42.38%**
Clark County[1]	$394.24	$1,697.41	$4,103.39	$6,152.42	$2,049.03	49.94%
Percent of Total	65.23%	68.49%	74.88%	78.85%	3.97%	
Las Vegas Strip	$290.90	$1,231.98	$2,604.98	$3,809.40	$1,204.41	46.23%
Percent of Total	48.13%	49.71%	47.53%	48.82%	1.29%	
Las Vegas Downtown	$91.50	$348.63	$676.91	$679.05	$2.15	0.32%
Percent of Total	15.14%	14.07%	12.35%	8.70%	-3.65%	
Laughlin	n.a.	n.a.	$398.64	$482.26	$83.62	20.98%
Percent of Total			7.27%	6.18%	-1.09%	
Boulder Strip	n.a.	n.a.	$142.14	$411.79	$269.64	189.70%
Percent of Total			2.59%	5.28%	2.68%	
Rest of Clark County[2]	$11.84	$116.80	$280.72	$769.93	$489.21	174.27%
Percent of Total	1.96%	4.71%	5.12%	9.87%	4.75%	
Washoe County[3]	$119.52	$462.28	$814.14	$995.23	$181.09	22.24%
Percent of Total	19.78%	18.65%	14.86%	12.75%	-2.10%	
City of Reno	$91.72	$362.12	$628.02	$751.21	$123.19	19.62%
Percent of Total	15.18%	14.61%	11.46%	9.63%	-1.83%	
City of Sparks	n.a.	n.a.	$104.04	$150.64	$46.61	44.80%
Percent of Total			1.90%	1.93%	0.03%	
South Lake Tahoe[4]	$72.21	$221.09	$339.16	$294.97	($44.19)	-13.03%
Percent of Total	11.95%	8.92%	6.19%	3.78%	-2.41%	
Carson Valley[5]	$3.88	$34.63	$57.26	$73.75	$16.49	28.80%
Percent of Total	0.64%	1.40%	1.04%	0.95%	-0.10%	
Elko County	$7.48	$37.87	$111.67	$198.31	$86.64	77.58%
Percent of Total	1.24%	1.53%	2.04%	2.54%	0.50%	
City of Wendover	n.a.	n.a.	$53.39	$99.83	$46.44	86.99%
Percent of Total			0.97%	1.28%	0.31%	

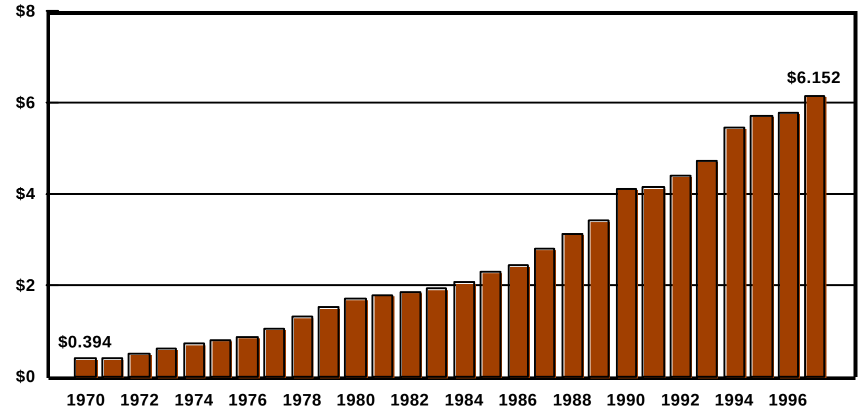
Notes: "Percent of Total" measures each gaming market's share of Nevada's total gaming win. Average annual growth rates (Ave. Ann.) are the average annual rate of growth between 1990 and 1997. Principal gaming markets are presented in bold face type; gaming "sub-markets" appear in regular type. Carson Valley casinos include those in Carson City and Douglas County, excluding the South Lake Tahoe properties.

† Casino gaming win is equal to the "house hold," or the amount retained by the casino after all payouts as winnings to customers. n.a. = Gaming win data not available for these time periods.

Source Data: Nevada Gaming Commission, State Gaming Control Board.

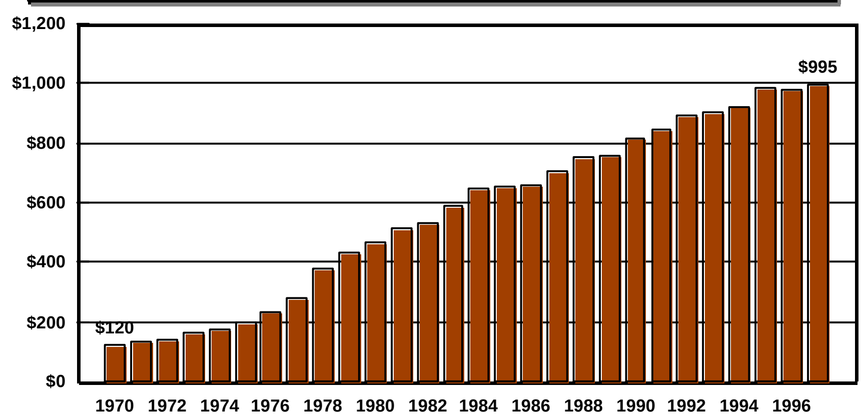
The expansion of mega-resort casino complexes along and just off the Las Vegas Strip has also had an adverse impact on the northern Nevada gaming markets of Washoe County (Reno-Sparks) and South Lake Tahoe (Douglas County) as can be seen by a marked slowing of growth in these markets in the 1990's (see Fig. 2–19). These trends, combined with near-term openings of major casino resort complexes along the Las Vegas Strip (Bellagio, Mandalay Bay, Venetian, Paris, etc.) in late 1998 and into 1999 portend a continuation of intensifying competition for a limited supply of tourists and casino patrons. Consequently, based on both interstate and intra-state competition, the forecast for this industry is for more modest overall growth over the entire forecast horizon and even slower growth in those gaming markets which do not make sufficient investments to maintain a competitive advantage in this industry. Due to the relatively greater importance of gaming to the Las Vegas economy, this assessment constitutes the primary reason for lower rates of growth in forecasts for both employment and population in southern Nevada.

Fig. 2-18. Clark County (Las Vegas) Total Gaming Win
For Years Ended December 31, (Billions)



Source: Nevada Gaming Commission, State Gaming Control Board.

Fig. 2-19. Washoe County (Reno) Total Gaming Win
For Years Ended December 31, (Millions)



Source: Nevada Gaming Commission, State Gaming Control Board.

Nevada's Mining Industry

Table 2–6. Nevada Mineral, Petroleum, Geothermal Production, shows the relative concentration of Nevada's mineral industry in gold and silver production, especially gold. This is particularly true with respect to mining's effects on employment in a number of rural counties. Also shown in this table are the relatively wide price fluctuations which have typified the market behavior of these precious metals. In 1997, gold prices had averaged $331 for Nevada's mining operations and by early 1998 they had moved below $300 per ounce, creating severe pressures on the state's gold producers. Based on both economic fundamentals and financial market conditions, it is expected that some recovery to the price of gold will be experienced over the forecast horizon, but it is doubtful that prices will recover to levels shown in the early 1990's. Consequently, mining employment in Nevada is expected to decline slightly over the next 20 years as producers attempt to cut costs, especially salaries, and improve operating efficiencies. (See Fig. 2–20 for trends in the gross proceeds of Nevada's mines from 1977 through 1997, and Fig. 2–21 for county shares of 1997's gross proceeds of mines.)

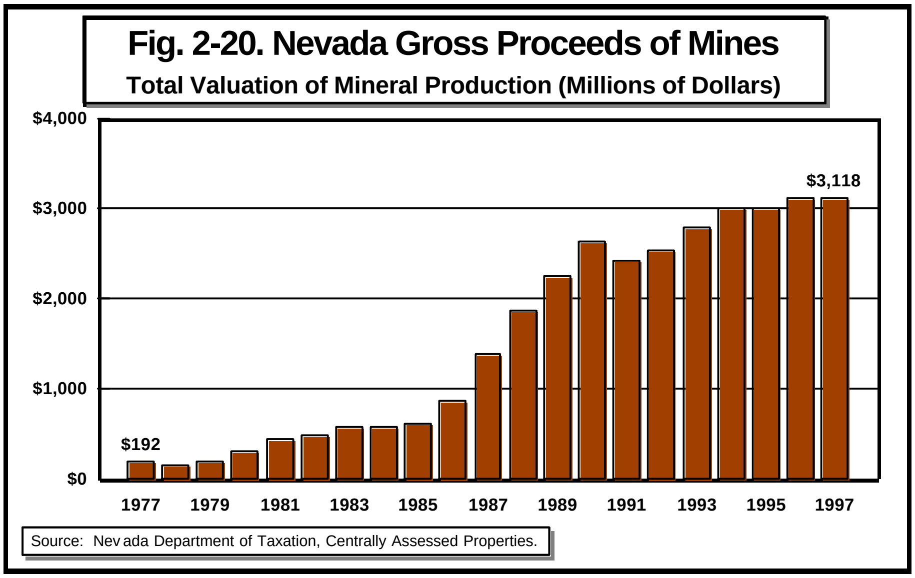
Table 2–6. Nevada Mineral, Petroleum, Geothermal Production

Statewide Production of Principal Minerals for Years 1978–1997 (Units of Production)

Mineral	1978	1980	1985	1990	1995	1997
Barite (thousands of short tons)	1,788	2,268	590	405	514	586
Copper (thousand lbs)	20,543	—	—	11,067	13,000	148,600
Geothermal Power (thousands of mega-water hours)	—	—	—	884	1,360	1,348
Gold (troy ounces)	**260,895**	**250,618**	**1,276,114**	**5,813,000**	**6,764,000**	**7,828,000**
Mercury (76-pound flasks)	24,163	3,300	16,530	—	—	—
Petroleum (thousands of 42-gallon barrels)	1,269	893	3,060	4,012	1,342	1,000
Sand and Gravel (thousands of short tons)	10,040	7,000	9,979	26,000	28,000	28,000
Silver (troy ounces)	**804,000**	**167,000**	**4,947,000**	**21,529,000**	**24,602,000**	**24,645,000**
Gold–Average Price per Ounce (dollars)	$193.55	$613.28	$317.66	$380.02	$384.09	$324.99
Silver–Average Price per Ounce (dollars)	$5.40	$21.54	$6.14	$5.00	$5.19	$4.62

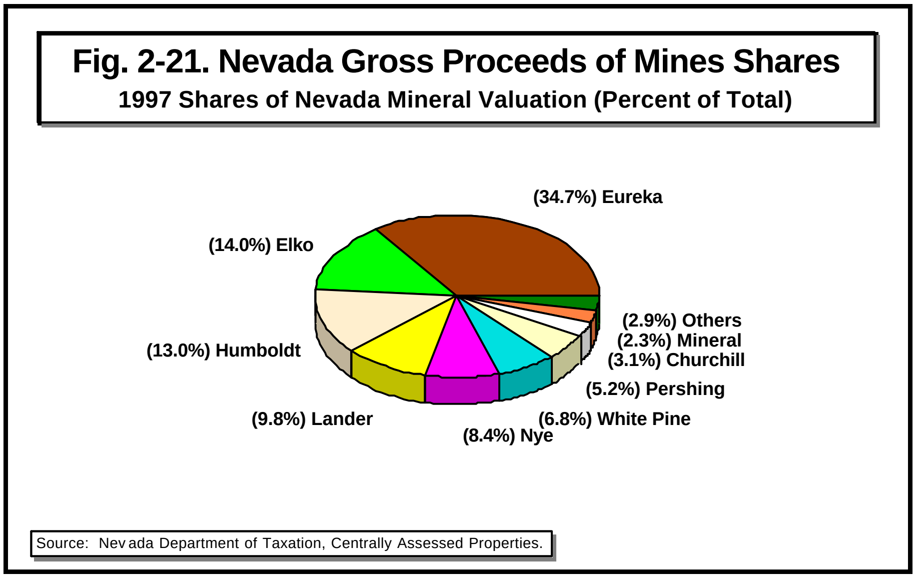
Note: In 1997, gold and silver comprised nearly 86 percent of total mineral valuation in Nevada.
Source Data: Nevada Bureau of Mines and Geology, *The Nevada Mineral Industry*, various issues.

Table 2–6 shows the historical relative market prices received for Nevada's precious metals. This information shows that market prices for both gold and silver have varied greatly over the entire period of presentation, and most especially during times of economic uncertainty and inflation, i.e., the 1980-82 recessionary period. This high price variability reflects the more historic use of these precious metals, and particularly gold, as a "store of value" and inflation hedge. From these trends, which show the price of gold varying from a low of $194 per ounce in 1978 to a high of $613 per ounce in 1980 (an inflationary and recessionary year), and the price of silver ranging between $5.00 and $21.54 per ounce, it becomes more obvious why Nevada's production of these minerals has shown such extreme variation over recent years. In fact, gold production in Nevada has been relatively stable during the more recent period of economic stability during the 1990's when gold's price has remained within a relatively narrow range well above $300 per ounce.



The declining price of gold has resulted in significant declines in mining-dependent taxable sales (a major source of county tax revenues) as mining companies have curtailed major investment projects and reduced local spending. To offset declining market prices and revenues, Nevada's gold mines have been able to reduce their weighted average cash production costs from an average of $229 per ounce in 1996 to $214 per ounce in 1997. Much of this cost constraint has come from the unique relationship between the market price of gold and production costs. As market prices decline, gold producers quickly switch to higher grade deposits (higher concentrations of gold per ton of earth removed), thereby automatically lowering production costs. More recently, mines have been able to effect this change very rapidly, thereby virtually "locking in" production costs to market prices.

Based on continuing international financial changes (European monetary reform and the backing levels in gold of the European Monetary Union) and economic turmoil (Asia), some further moderation to the price of gold is expected in 1998 and into 1999. Mining and construction-related employment have begun to reflect the impacts of these gold price declines and production cost restraints. Even though Nevada currently remains one of the most efficient (i.e., least-cost) gold producers in the world (e.g., in 1997 South Africa showed an average production cost of $301 per ounce and Australia showed $261 per ounce), the extent of the worldwide decline in the price of gold has nonetheless forced severe cost-cutting measures and altered the



Nevada gold industry's development and production efforts, shifting emphasis to higher grade ore bodies and more productive underground gold mining versus surface (open pit) mining. Uncertainty about the price of gold is destined to affect future employment and population growth in the rural Nevada counties

So long as gold has been priced at a "premium" based on its extensive use as an effective hedge against inflation and economic uncertainty, and not priced solely on its intrinsic (i.e., industrial or commercial usage) value, such price fluctuations will likely continue. More recent trends, however, show gold's diminished role as an inflation hedge as well as a less important role as a monetary reserve held by central banks in support of national currencies. In particular, the formation of the European Monetary Union, with its requirement for significantly lower holdings of gold reserves, has resulted in large bullion sales, consequently depressing gold prices below $300 per ounce in early 1998. Once these transitory effects have settled down, however, some recovery to gold's longer-term price is expected, although it is uncertain as to the extent of that recovery. Forecasts for Nevada's mining industry will depend primarily on the market price of gold, as this price "drives" economically-recoverable reserves upon which industry production and exploration depend. Forecast assumptions incorporated into this plan for mineral production and mining water withdrawals are based on an industry-accepted long-term price of gold at $280–$350 per ounce.

The resurgence of copper mining in Nevada, principally in White Pine County, is also a recent trend as reflected in Table 2–6. As with precious metals, falling copper prices have affected this industry and it is not certain if recent cost-cutting efforts will insure the long-term survivability of copper mining in Nevada. The fluctuating world-wide prices of both industrial and precious minerals has characterized Nevada's mining industry since the late 1800's and makes forecasting this industry (e.g., production, employment, water withdrawals, etc.) especially difficult in the face of numerous economic, financial, political and environmental related influences and uncertainties.

Nevada's Agricultural Industry

Agriculture represents one of Nevada's oldest and most lasting economic activities. Since the first settlements were established in the 1850's, agriculture in Nevada has continued to survive and even prosper. Today, agriculture remains a fundamental socioeconomic underpinning for a number of rural Nevada counties and, no doubt, will remain an integral part of these counties' economies irrespective of current or future mining trends. While on the whole agriculture may appear to have relatively little impact on Nevada's overall economic trends, the importance of agriculture for a number of rural counties cannot be overstated. See Fig. 2–22 for trends in Nevada's total farm marketings since 1970 and Fig. 2–23 for 1996 shares of total farm marketings by county.

Table 2–7. Nevada Agricultural Statistics — 1974–1995, summarizes key agriculture statistics for Nevada in terms of irrigated acreage, total farm marketings (monies received from farm marketing sales), farm worker employment and employment in agricultural services, forestry and fisheries. From the information in this table, it appears that agriculture, in terms of total irrigated acreage, peaked in the state during the late 1970's or early 1980's. (Precise determination is difficult and some important agricultural data, for example irrigated acreage, is only obtained by the Census Bureau every four or five years.) Based on rising agricultural prices, farm marketings, however, continued to increase through at least 1990 despite fewer acres being irrigated. Livestock and related sales constituted over 70 percent of total farm marketings from 1974 through at least 1987, falling to 60 percent by 1995.

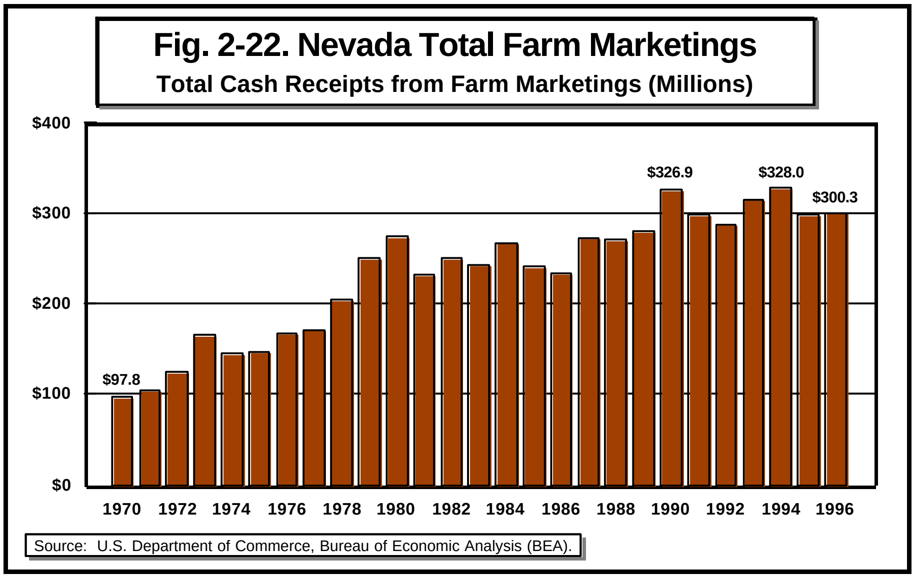
Table 2–7. Nevada Agricultural Statistics — 1974–1995

Irrigated Acreage, Farm Marketings and Farm-Related Employment

NEVADA	1974	1978	1982	1987	1990	1995
Irrigated Acres	777,510	881,151	829,761	773,588	728,350	715,439
Farm Marketings ($000s)	$145,458	$204,047	$250,610	$271,904	$326,889	$298,085
Livestock and Products	$115,979	$154,820	$181,373	$203,774	$211,486	$179,589
Percent of Marketings	79.7%	75.9%	72.4%	74.9%	64.7%	60.2%
Total Crops	$29,479	$49,227	$69,237	$68,130	$115,403	$118,496
Percent of Marketings	20.3%	24.1%	27.6%	25.1%	35.3%	39.8%
Total Agric. Employment	5,895	7,728	7,863	10,033	11,487	13,142
Farm Workers	4,570	5,639	5,140	5,628	5,260	3,962
Percent Total Employment	77.5%	73.0%	65.4%	56.1%	45.8%	30.2%
Agric. Services Workers	1,325	2,089	2,723	4,405	6,227	9,180
Percent Total Employment	22.5%	27.0%	34.6%	43.9%	54.2%	69.8%

Source Data: Irrigated acreage figures for 1974, 1978, 1982 and 1987 are from the U.S. Bureau of the Census, Agriculture Division; irrigated acreage figures for 1990 are estimates from the USGS data; irrigated acreage for 1995 are derived from estimates made by the NDWP. Farm marketings, number of farm and agricultural service workers are from U.S. Department of Commerce, Bureau of Economic Analysis (BEA). Agricultural Services Workers include workers in agricultural services, which is primarily landscaping and lawn care occupations, as well as jobs in the forestry and fisheries employment areas.

There has also been a more recent trend towards a strong statewide decline in on-farm workers and a growing importance of employment in related agricultural-related fields, primarily consisting of agricultural service workers, most typically representing the landscaping and lawn care service industries. From Table 2–7, workers involved in on-farm activities declined from 4,570 workers in 1974, comprising 77.5 percent of total agriculture and related employment, to 3,962 workers, or 30.2 percent of employment, by 1995. Meanwhile, workers in agricultural-related activities increased from 1,325 workers in 1974 (22.5 percent of employment in these fields) to 9,180 workers by 1995 (nearly 70 percent of total agricultural-related employment). In viewing the individual county agricultural-related figures (which are presented in Appendix 4 of the Appendices), particularly with respect to the amount of irrigated acreage, there appears wide fluctuations in estimated levels of irrigated acreage. Such fluctuations tend to indicate either highly volatile irrigation and crop production cycles or, more than likely, fundamental problems in reporting and gathering accurate data on this industry sector.

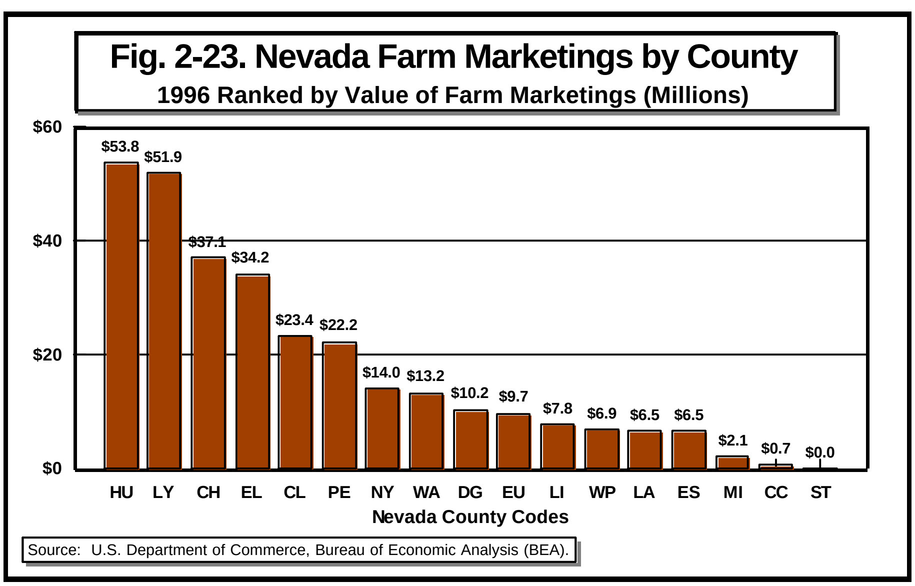


The volatility in historical measures of this industry, particularly with respect to irrigated acreage, related water usage rates and livestock figures, makes forecasting irrigation and livestock water use especially difficult. However, there does appear to be a trend towards no increase in agricultural lands being brought under cultivation and in some counties, e.g., Carson City, Churchill, Douglas, and Washoe in particular, it appears that encroaching urbanization and the transfer of water rights to other uses, i.e., municipal and industrial, is causing the level of irrigated lands to actually decline. Given new and growing demands for limited water resources in the state, particularly for municipal use, wildlife protection and fishery restoration, instream flows and recreation, the future of agriculture in Nevada is somewhat uncertain.

Table 2–8. Nevada Forecasted Irrigated Acreage presents the Nevada Division of Water Planning's forecasts for total irrigated acreage Nevada and the state's principal agricultural counties. Nevada's total irrigated acreage figures are based on individual county forecasts which were then aggregated to produce the statewide total. Forecasts of irrigated acreage are expected to show declines in all counties, with accelerated declines in the more urbanized counties, i.e., Washoe County in Table 2–8.

Table 2–8. Nevada Forecasted Irrigated Acreage

Selected Counties – Estimated (1995) and Forecasted (2000–2020) Irrigated Acreage (Acres)



Nevada/Selected Counties	1995	2000	2005	2010	2015	2020
Nevada Total Irrigated Acreage	**715,440**	**727,500**	**715,563**	**700,742**	**683,247**	**665,753**
Churchill County Irrigated Acreage	56,094	54,523	54,130	53,685	53,191	52,696
Douglas County Irrigated Acreage	38,640	37,877	37,266	36,554	35,746	34,937
Elko County Irrigated Acreage	213,903	214,007	211,077	207,396	203,001	198,606
Humboldt County Irrigated Acreage	142,558	144,936	141,487	136,988	131,536	126,084
Lyon County Irrigated Acreage	60,975	61,317	60,643	59,884	59,045	58,207
Pershing County Irrigated Acreage	27,368	29,079	28,441	27,688	26,831	25,974
Washoe County Irrigated Acreage	27,048	25,716	24,671	23,483	22,176	20,869

Notes: The selected counties presented above accounted for nearly 80 percent of Nevada's total estimated irrigated acreage in 1995. Nevada totals are based on an aggregation of individual county estimates and forecasts of total irrigated acreage. Estimates of irrigated acreage for 1995 are based on U.S. Geological Survey (USGS) estimates, modified by the Nevada Division of Water Planning (NDWP) with modifications based on other source information (U.S. Department of Agriculture, Nevada Agricultural Statistics Service, and U.S. Department of Commerce, Bureau of Economic Analysis). County forecasts of irrigated acreage for 2000–2020 were based on NDWP forecasts derived from a non-linear "best fit" line for each county's 1945–1995 data and then extrapolated out to the year 2000.
Source Data: 1995 irrigated acreage – USGS and NDWP; irrigated acreage forecasts – NDWP.

Fig. 2-24. Nevada Irrigated Acreage, shows both estimates of historical irrigated acreage since 1945 and the Division of Water Planning's forecasts for Nevada's total irrigated acreage through the year 20202 based on individual county forecasts which are aggregated to the statewide total. Detailed forecasts for all counties and the total state appear in Appendix 4 of the Appendices. Forecasts were based on the approximation of a non-linear "best fit" line which tracked historical trends and then was extrapolated (extended) out to the year 2020 based upon estimates of agricultural trends and other factors, for example urban encroachment.

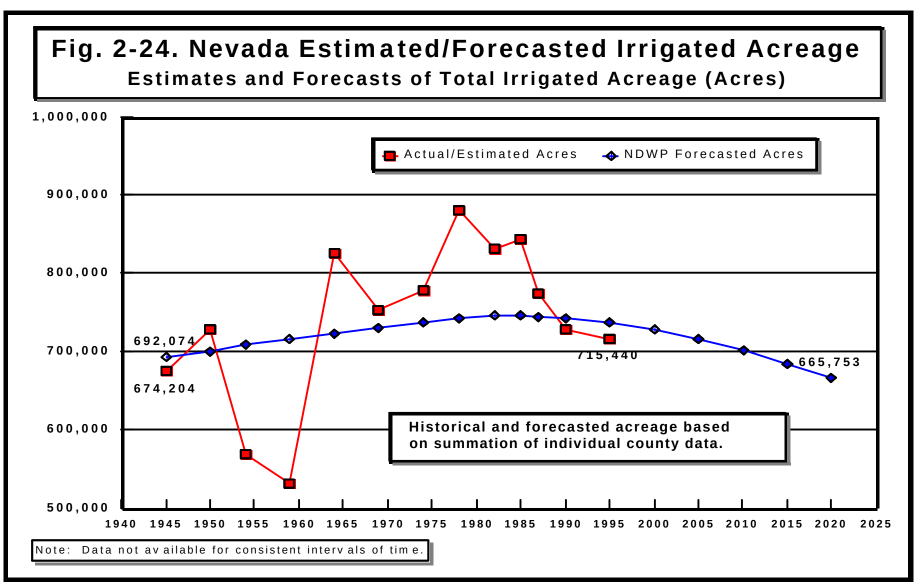


Fig. 2-24. Nevada Estimated/Forecasted Irrigated Acreage

Nevada's Population and Employment Forecasts

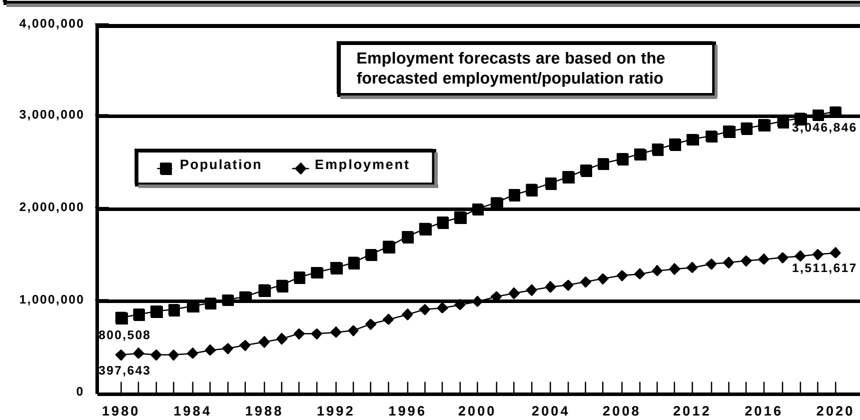
Forecasted employment-to-population ratios for each county are crucial in forecasting employment levels from the respective county's population forecasts. This analysis and related statistical tests are presented in Appendix 3 of the Appendices for each county and aggregated for the total state. The resultant forecasts of county total employment, combined with estimated historical and commercial and industrial water use factors (gallons per worker per day), are then used to forecast each county's commercial and industrial water withdrawals and, through aggregation, commercial and industrial water withdrawals for the total state.

Omitting the effects of national economic recessions, Nevada's ratio of its total covered employment to its resident population have tended to be relatively stable over time. For the period of 1980-1997, Nevada's ratio of its employment to population has averaged 48.2 percent. The average employment-to-population ratio, omitting recessionary periods, has tended to be closer to 50 percent. Nevada's relatively high employment-to-population ratio is typical of an economy that is being driven primarily by commercial expansion and related strong employment growth. Also evident from an analysis of these trends is that Nevada's employment-to-population ratio has shown marked sensitivity to national business cycle fluctuations, notably the U.S. recessionary periods of 1980-82 and 1990-91. While this point needs to be recognized, future recessions do not constitute any part of the forecasts for water withdrawals.

Another factor which would tend to affect the employment-to-population ratio is that as an economy "matures" and employment growth moderates relative to population growth, the trend towards household formation and a larger retired population component begins to affect this relationship, typically lowering the employment-to-population ratio over time. Changes in this relationship may also be influenced by changes in certain demographic factors, for example, changing birth rates (fertility rates) which would tend to alter the relationship between population growth and employment growth. Also, a change in the status of an area, for example, its appeal as a major retirement community, would tend to change the ratio of an area's employment to population over time.

Fig. 2-25. Nevada Population and Employment Forecasts

Total Population (Persons) and Total Covered Employment (Workers)



Source Data: Nevada State Demographer; DETR; Forecasts-NDWP.

Table 2–9. Nevada Population and Employment Forecasts shows historical and forecasted population, employment and employment-to-population ratios for Nevada for selected years from 1997 through 2020. Unlike the forecast output tables which begin with the last estimated year of water withdrawal measures, i.e., 1995, this table uses 1997 to show the last year of population and employment estimates and hence the last actual measure of the employment-to-population ratio. A more extensive presentation of this information for the total state and all counties for all years from 1980 through 2020 can be found in Appendix 3 of the Appendices. The information and forecasts in this appendix were based on historical levels and omit possible effects of future national and local recessions. Inputs on demographic trends and industrial development were also provided by the Nevada Department of Employment, Training and Rehabilitation (DETR).

Table 2–9. Nevada Population and Employment Forecasts

Population/Employment Estimates — 1997, NDWP Forecasts — 2000–2020
(Annual Averages — Persons and Workers)

NEVADA	1997	2000	2005	2010	2015	2020	1997-2020 Change	1997-2020 Percent Change*
Population	1,779,850	1,986,257	2,341,374	2,640,306	2,868,979	3,046,846	1,266,996	71.2%
Employment	888,574	987,950	1,162,764	1,310,176	1,423,256	1,511,617	623,043	70.1%
Employment-to-Population Ratio	49.9%	49.9%	49.8%	49.7%	49.7%	49.7%	–	-0.20%

Note: Changes in the employment-to-population ratios are measured in percentage points. The Nevada employment-to-population figure is based on the aggregation of individual county estimates (1997) and forecasts (2000–2020).
Source Data: Population estimates (1997) – Nevada State Demographer; employment estimates (1997) – Nevada Department of Employment, Training and Rehabilitation (DETR); population and employment forecasts (2000–2020) – Nevada Division of Water Planning (NDWP). Population forecasts for Clark County were provided by the Clark County Department of Comprehensive Planning; population forecasts for Washoe County were derived from forecasts adopted by the Washoe County Department of Community Development.

Fig. 2-25. Nevada Population and Employment Forecasts presents forecasts of Nevada's population and employment through the planning horizon. Population forecasts are more fully presented in the Appendix 2 of the Appendices while the employment forecasts are presented in Appendix 3 of the Appendices and are derived from the forecasts of employment-to-population ratios developed for each county. The total state figures are obtained from an aggregation of the individual county estimates and forecasts.

Index to Part 2, Section 2:

Nevada State Water Plan
PART 2 — WATER USE AND FORECASTS

Section 3
Water Withdrawal Forecasts

Introduction

This section of the *Nevada State Water Plan* presents the water withdrawal forecasts for the state. In addition, this section also presents the methodology used in forecasting water withdrawals by various source and use categories. Fourteen separate categories of water withdrawals were forecast for the water plan as shown below. For definitions of these source and use categories, see Section 5, Technical Supplement – Water Use Coefficient and Related Factor Development and Application.

Forecasted Categories of Water Use

The water plan includes forecasts for fourteen categories of water withdrawals which comprise either unique forecasted water use categories, i.e., irrigation water withdrawals, or an aggregation of forecasted categories, i.e., total mining water withdrawals derived from forecasts of mining processing water withdrawals and mine dewatering. Forecasts were made by the source of water, i.e., municipal and industrial (M&I) water withdrawals, or by the use of water, e.g., domestic (residential) withdrawals. The following represents a listing of the public supply and water use categories presented in this plan:

By Public Supply:
- Total Municipal and Industrial (M&I) Water Withdrawals

By Water Use Type:
- Total Water Withdrawals
  - Total Domestic (Residential) Water Withdrawals
    - Domestic Public Supply Withdrawals
    - Domestic Self-Supplied Withdrawals
  - Commercial and Industrial Water Withdrawals
  - Thermoelectric Water Withdrawals
  - M&I Public Use and Losses
  - Total Mining Water Withdrawals
    - Mine Processing (Consumptive) Withdrawals
    - Mine Dewatering (Non-Consumptive) Withdrawals
  - Total Agricultural Water Withdrawals
    - Irrigation Withdrawals
    - Livestock (including Fisheries and Hatcheries) Withdrawals

In addition to forecasts of water withdrawals for these categories, estimates are also presented of consumptive water use by specific use category. The material in this section is supported by Section 5, which, in addition to providing a more detailed explanation of the methodology of the forecasts, also presents graphs of the county-specific water use coefficients and other factors used in the development of the water withdrawal. In addition, a number of appendices to the water plan lend themselves to providing greater detail for the water use forecasts and underlying socioeconomic forecasts. Specifically, Appendix 1 of the Appendices provides historical water use data for the years 1985, 1990, and 1995; Appendix 2 of the Appendices develops the population forecasts; Appendix 3 develops the employment forecasts from the population forecasts and provides detailed county forecasts for all source and use categories forecasted using these socioeconomic variables. Appendix 4 of the Appendices develops the county and state forecasts of irrigated acreage; and Appendix 5 of the Appendices presents a summary of all forecasts for the state and all counties.

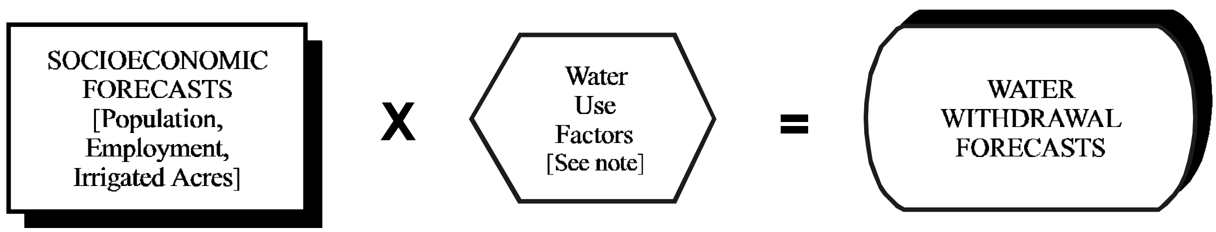
The Nevada Division of Water Planning's (NDWP's) water use forecast methodology is intended to link the socioeconomic growth rate assumptions and forecasts developed in Part 2, Section 2, Nevada Socioeconomic Forecasts, for population, employment and agricultural irrigated acreage, with individual county and statewide forecasts for water withdrawals through the use of estimated "water use" factors. The water use factors were calculated from historical water withdrawal amounts divided by populations, employment, or irrigated acreage. This process of linking the socioeconomic forecasts with water withdrawal forecasts is more extensively explained in the following section, "The Forecast Methodology." [Note: For a detailed explanation of the development of the water use factors, or coefficients, and their application to specific water withdrawal forecasts, see Part 2, Section 5.] The forecast methodology represents an integrated forecasting technique which only requires forecasts of population and agricultural irrigated acreage in order to produce most of the state's water withdrawal forecasts by water use category. It should be noted that all water withdrawal forecasts presented in this section are made at the county level and then aggregated to produce the forecasts for the State of Nevada.

The Forecast Methodology

The forecast methodology developed for the water plan uses a forecast of key socioeconomic variables multiplied by a water use factor or coefficient to produce a water withdrawal forecast. This process is depicted in its simplest form in Flow Chart 1. Basic Forecasting Methodology. Specifically, forecasts of population, employment (which itself is derived from the population forecast), and irrigated acreage provide the means to develop a number of water withdrawal forecasts by water use category, including withdrawals for domestic (both public and self-supplied), municipal and industrial (M&I), public use and losses, commercial and industrial, irrigation and livestock water withdrawals. The only forecasted categories which use a different methodology are thermoelectric and mining water uses.

Flow Chart 2. Forecast Methodology by Use Category, expands the basic concept of Flow Chart 1 to show how the various water withdrawal forecasts by source or use category are determined. Flow Chart 2 introduces a "Units Conversion Factor" factor which merely converts the water use coefficients, measured in either gallons per capita or per employee per day, to a total water withdrawal figure in acre-feet per year. Flow Chart 2 depicts how the fundamental socioeconomic forecasts (population, employment and irrigated acreage) are used to develop specific forecasts of water withdrawal by category. This chart also shows how mining water uses (both consumptive and

Flow Chart 1. Basic Forecast Methodology
Socioeconomic Forecasts to Water Withdrawal Forecasts



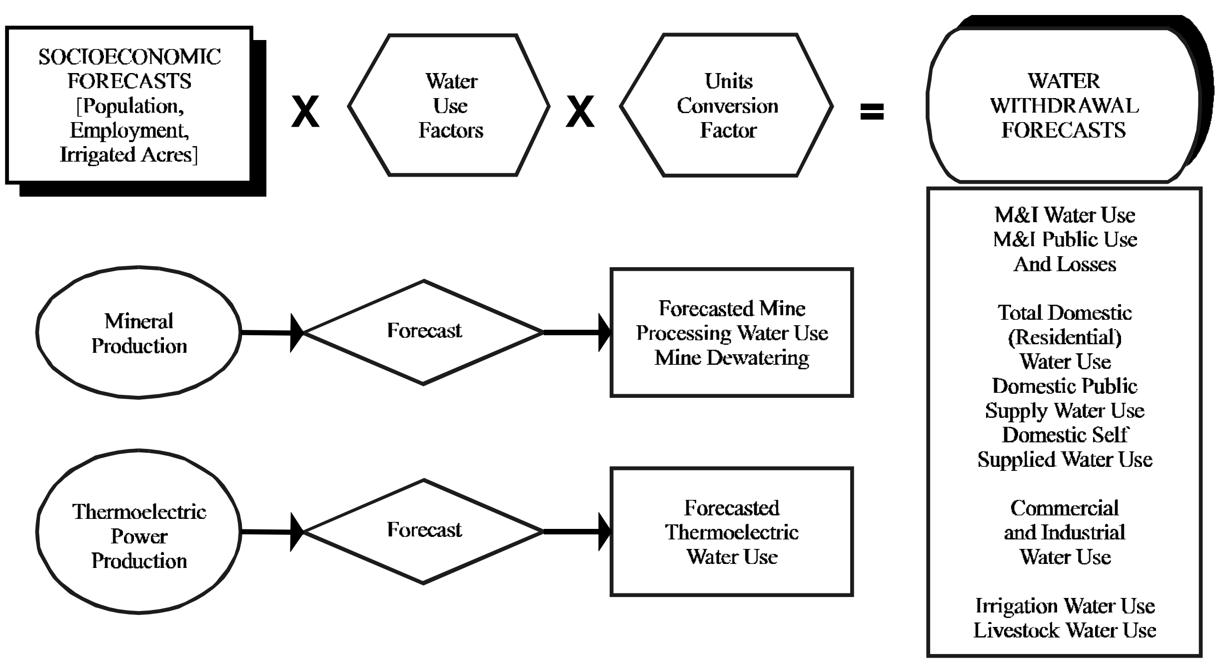
Note: Water Use Factors Measured in Gallons per Capita per Day, Gallons per Employee per Day, or Acre-Feet per Acre per Year

Nevada Division of Water Planning/Socioeconomic Analysis and Planning

Flow Chart 2. Forecast Methodology by Use Category
Socioeconomic Forecasts to Water Withdrawal Forecasts

Note: Water Use Factors Measured in Gallons per Capita per Day, Gallons per Employee per Day, or Acre-Feet per Acre per Year

Note: Units Conversion Factor from Use per Day to Water Withdrawals per Year



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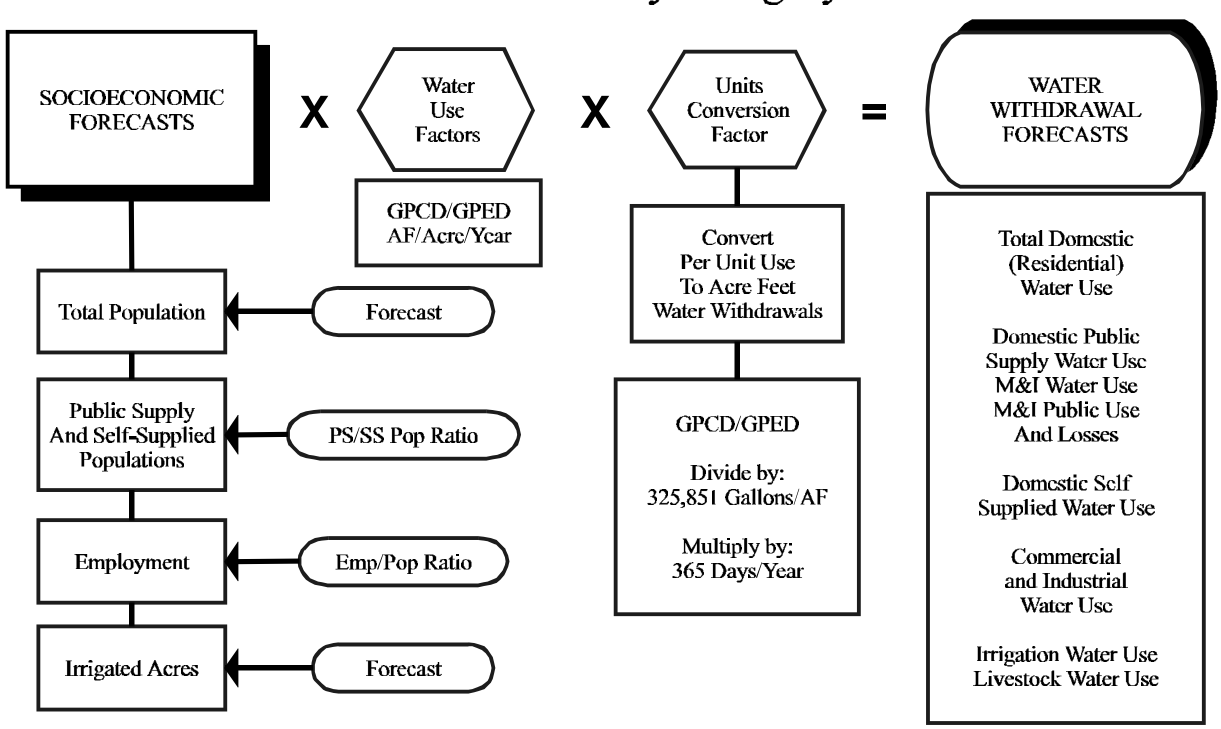
non-consumptive) are forecast from estimates of mining activity and production levels. Also shown is the methodology for thermoelectric water withdrawal forecasts, which are estimated from general forecasts of future production levels based on such factors as population growth and regional mining activity.

Flow Chart 3. Socioeconomic and Water Withdrawal Forecasts, shows in greater detail the interaction of the socioeconomic forecasts (population, employment and irrigated acreage), the water use factors, other forecasts assumptions (factors) and the units conversion factors, to produce the water withdrawal forecasts for the M&I, domestic, commercial and industrial and agriculture use categories. Of special note is that forecasts for all water withdrawal categories are made at the county level and then aggregated county-by-county to produce the statewide totals for all categories of water use. By this aggregation process, however, the water use coefficients reflected for the total state vary over time depending on individual county trends. This is based on the fact that the statewide water use coefficients represent, in effect, weighted averages of individual county use coefficients and therefore will vary depending on individual county trends.

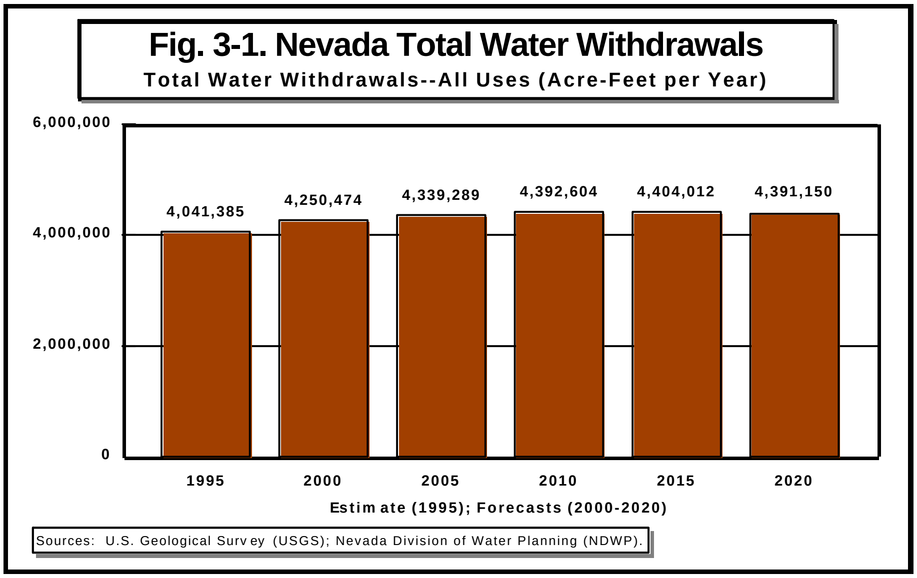
Flow Chart 3 shows that the forecast of total population, multiplied by a total domestic water use factor in gallons per capita (per persons) per day (GPCD) and then multiplied by a units conversion factor, provides a forecast of total domestic (residential) water withdrawals. Similarly, the forecast of total population, multiplied by a public supply/self-supplied population factor (“PS/SS Pop Ratio”

Flow Chart 3. Socioeconomic and Water Withdrawal Forecasts
Socioeconomic Forecasts, Forecast Factors, Conversion Factors
and Forecasted Water Withdrawals by Category



Nevada Division of Water Planning/Socioeconomic Analysis and Planning

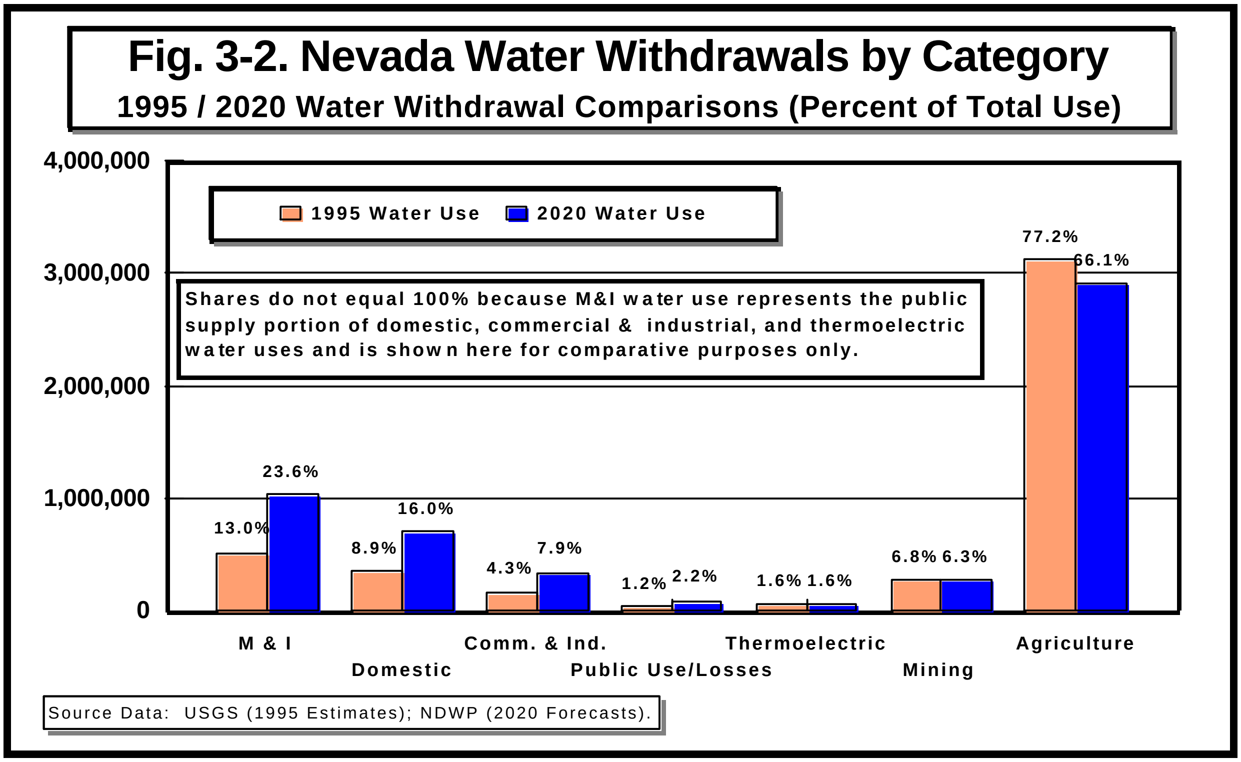
in Flow Chart 3) provides both a public supply population and a self-supplied population from which (using appropriate water use factors) domestic public supply and domestic self-supplied water withdrawal forecasts are made. The total municipal and industrial water withdrawals are projected using the estimates of the population on public supply water systems multiplied by a M&I water use factor. The M&I public use and losses are estimated (at approximately 10 percent of total M&I water withdrawals for the total state) based on historical public use and losses.



Commercial and industrial water withdrawals are based on the forecasted level of employment, which is estimated from the population forecast. Water withdrawals are then estimated using an employment-to-population ratio multiplied by a commercial water use factor. This water use factor is calculated from historical use patterns in gallons per employee per day (GPED) to yield total commercial and industrial water withdrawals. Since mining water use is forecasted using a different methodology, mining workers are subtracted from the forecasts of total employment.

Irrigation water withdrawal forecasts are made using forecasts of county irrigated acreage multiplied by an irrigated acreage water requirement factor in acre-feet per acre per year. Livestock water withdrawal forecasts are made based upon a factor (ratio) of livestock water withdrawals to irrigation water withdrawals. Total agricultural water withdrawal forecasts represent the sum of irrigation water withdrawals and livestock water withdrawals. [*Note:* The terms "water withdrawal" and "water use" are used interchangeably in this forecast analysis. While assumed to have the same meaning in this presentation, the term water withdrawal represents the total amount of water withdrawn for a specific use category without reference to the amount of return flow. Thus, it does not measure consumptive use, which represents water which is not returned to a source or able to be used again. Table 3–8 presents estimates and forecasts of both total water withdrawals and the estimated consumptive use.]

Thermoelectric (including geothermal) water withdrawal forecasts did not lend themselves to the use of the water use factor method described above. In addition, power production across the state is generally not dependent upon the socioeconomic conditions in any one county. Consequently, these forecasts were based primarily on general population trends and increasing demands for electrical power, particularly from mining operations in some of the rural counties. Mining water withdrawal



forecasts (including both consumptive and non-consumptive withdrawals, such as mine dewatering), also presented a unique forecasting environment where employment is not directly related to water used in mineral production. These forecasts were therefore based principally on the projected state of Nevada's gold industry, and specifically on the market price of gold, the grade of available ore bodies which influences the type of processing required and the amount of water used in processing, the level of economically-recoverable reserves, the nature of production (underground mining versus open-pit mining), and the continued need for mining dewatering in relation to future mining operations. As with all of the forecasts, the forecasted future mining water withdrawals are estimates only and actual future water use will be highly dependent on the price of gold.

Summary of Water Withdrawals by Use Category

Table 3–1. Nevada Water Withdrawal Forecast Summary, presents historical estimates (1995) and forecasts (2000–2020) of water withdrawals by major use category along with each categories' percentage share of total statewide water withdrawals. This table represents a condensed version of Table 3–7. Nevada Estimated and Forecasted Water Withdrawals, which appears later in this section with the addition of the forecasted percentage share changes by water use category. See Fig. 3–1 for estimated and forecast water withdrawals for 1995 through 2020 and Fig. 3–2 for changes in the shares of water withdrawals between the years 1995 and 2020. In Table 3–1, the water withdrawals for domestic, commercial and industrial and thermoelectric use categories include water from both public and self-supplied sources. Public use and losses are assumed to be from public supply water sources only. It should be noted that these water withdrawal forecasts are based on the most current available level of water use and the state of water conservation. Therefore, these forecasts do not explicitly incorporate the introduction of new technology and changes in policy and pricing actions which may tend to change the water use rates used to develop these forecasts.

Table 3–1. Nevada Water Withdrawal Forecast Summary

Estimated (1995) and Forecasted (2000–2020) Water Use by Use Type

Acre Feet per Year and Percent of Statewide Total Water Withdrawals

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Domestic (Residential) Withdrawals[1]	360,710	455,464	538,090	607,467	660,315	701,338
Percent of Total Withdrawals	8.9%	10.7%	12.4%	13.8%	15.0%	16.0%
Commercial & Industrial Withdrawals[2]	172,407	220,355	261,880	296,905	323,811	344,919
Percent of Total Withdrawals	4.3%	5.2%	6.0%	6.8%	7.4%	7.%
Public Use and Losses[3]	48,472	61,195	72,313	81,707	88,930	94,582
Percent of Total Withdrawals	1.2%	1.4%	1.7%	1.9%	2.0%	2.2%
Thermoelectric Withdrawals[4]	65,449	67,085	68,427	69,522	70,412	71,223
Percent of Total Withdrawals	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Total Mining Use[5]	274,434	278,996	282,708	284,965	283,764	277,566
Percent of Total Withdrawals	6.8%	6.6%	6.5%	6.5%	6.4%	6.3%
Total Agriculture Withdrawals[6]	3,119,914	3,167,378	3,115,872	3,052,038	2,976,780	2,901,522
Percent of Total Withdrawals	77.2%	74.5%	71.8%	69.5%	67.6%	66.1%
Total Water Withdrawals (Use)	**4,041,385**	**4,250,474**	**4,339,289**	**4,392,604**	**4,404,012**	**4,391,150**

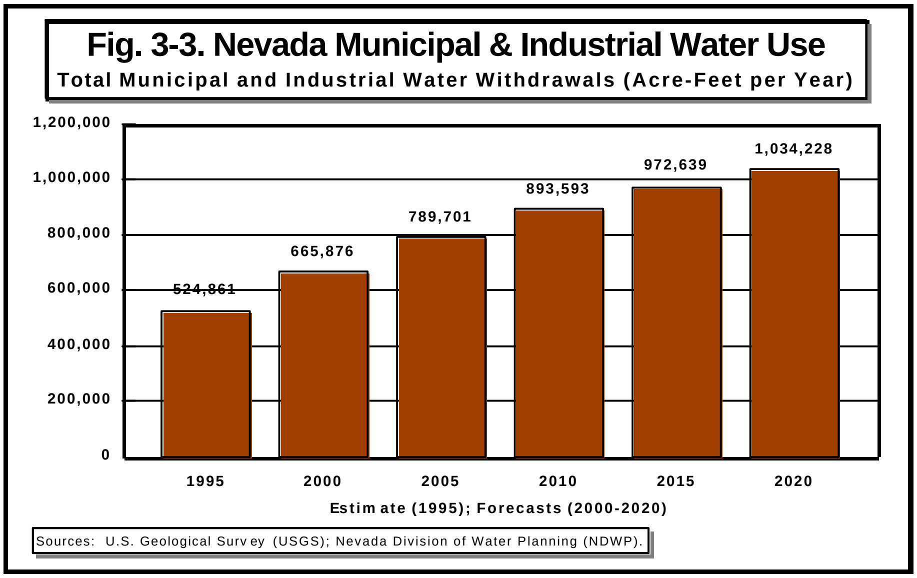
Notes: "Water Withdrawal" and "Water Use" are equivalent terms, but are not the same as consumptive use; they do not account for return flows. Figures for total State of Nevada are based on an aggregation of individual county water withdrawal estimates and forecasts. Water withdrawal forecasts are based on the existing levels of conservation.

[1] Total Domestic Withdrawals includes the total residential use, both indoors and outdoors (i.e., residential landscaping).
[2] Includes both public and self-supplied withdrawals.
[3] Public Use and Losses is forecasted as a percent of total M&I water use based on historical trends.
[4] Thermoelectric Withdrawals includes water used for geothermal power plants and cooling water for conventional plants.
[5] Total Mining Withdrawals includes both consumptive and non-consumptive uses (i.e., mining dewatering).
[6] Total Agriculture Withdrawals include both irrigation and livestock water use.

Source Data: Nevada State Demographer; Nevada Department of Employment, Training and Rehabilitation (DETR); U.S. Geological Survey (USGS); and Nevada Division of Water Planning (NDWP); Irrigated acreage and 1995 irrigation water withdrawals based on USGS estimates modified by NDWP; Forecasts through 2020 based on 1995 water usage rates and NDWP forecasts of population, employment, general business conditions and estimated irrigated acreage.

Table 3–1 shows that domestic water withdrawals are expected to increase their share of statewide total water withdrawals from 8.9 percent to 16.0 percent, rising from an estimated 360,710 acre-feet in 1995 to a forecasted 701,338 acre-feet by 2020. Commercial and industrial water withdrawals are expected to rise from 4.3 percent of statewide total withdrawals in 1995 to 7.9 percent from an estimated 172,407 acre-feet in 1995 to 344,919 acre-feet by the year 2020. Public use and losses, which are forecasted by this methodology as a constant percent of total municipal and industrial withdrawals, increases from 1.2 percent of total water withdrawals in 1995 to 2.2 percent by 2020.

Thermoelectric water withdrawals, which are based primarily on continued growth in population and industry in the state, are expected to remain essentially constant at 1.6 percent of statewide total



water withdrawals. Mining water withdrawals are projected to show a slight decline in both the amount of water withdrawn between 1995 and 2020 and the share of statewide water withdrawals from 6.8 percent in 1995 to 6.4 percent by 2020. The most dramatic declines in shares of water withdrawals are expected in agriculture and specifically, irrigation water withdrawals. Agriculture's share of statewide total water withdrawals is expected to decline from an estimated 77.2 percent in 1995 to 66.4 percent in 2020. This decline is based on an assumption of relatively stable to modest declines in the levels of irrigated acreage in Nevada's rural counties and the continued conversion of irrigated farmlands into urban lands and residential tracts in more urbanized counties. Fig 3-2 shows the various changes in water withdrawal shares by specific water use over the forecast horizon of 1995 to 2020.

Municipal & Industrial Water Withdrawal Forecasts

Table 3–2. Municipal & Industrial (M&I) Water Withdrawal Estimates and Forecasts, presents the statewide 1995 estimated and 2000 to 2020 forecasted municipal and industrial (M&I) water withdrawals for Nevada. M&I water use consists of withdrawals from public supply water systems for domestic, commercial and industrial and thermoelectric uses. In effect, it represents total withdrawals from public supply water systems, excluding public use and losses, which are presented separately. Table 3–2 presents the population growth assumptions and water use factors used in developing the statewide forecasts for M&I water use. The table also presents an estimate of consumptive use. These figures were developed by aggregating the individual county forecasts as presented in Appendix 3 of the Appendices. The key components to this forecast methodology are: (1) estimates and forecasts of the resident population (see Appendix 2 of the Appendices); (2) estimates and forecasts of the resident population on public supply water systems (see Appendix 3 of the Appendices); and (3) estimates of the municipal and industrial water use factor (in gallons per person per day). All water withdrawal factors used in these forecasts for each individual county are presented in Appendix 3 of the Appendices. See Fig. 3–3 for estimates and forecasts of M&I water withdrawals for the years 1995 through 2020.

Municipal and industrial water withdrawal forecasts are based on the resident population utilizing a public supply water system multiplied by a water use factor which is determined from historical conditions and trends. The water use factor for M&I water use for 1995 was based on the trends for that year and therefore represents the level of M&I water use conservation at that time. Further, throughout the forecast, the M&I water use factor is not fixed, but rather varies over time as the proportion of the resident population on public supply water systems changes (see Table 3–2, line "Percent Population on Public Supply"). Table 3–2 shows the variation in the M&I water use factor over time ("Municipal & Industrial Use Factor"), that is, from 315.0 gallons per person per day in 1995 to 317.6 gallons per person per day by 2020, reflecting the assumption that an increasing proportion of Nevada's total population will be provided water by a public supply water system.

Table 3–2. Municipal & Industrial (M&I) Water Withdrawals

Estimates and Forecasts of Total Public Supply Water Withdrawals

(Water withdrawals in acre-feet per year; Use factors in gallons per person per day)

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Resident Population (persons)[1]	1,579,150	1,986,257	2,341,374	2,640,306	2,868,979	3,046,846
Percent Population on Public Supply[2]	94.2%	94.6%	94.8%	95.0%	95.2%	95.4%
Population on Public Supply[3]	1,487,636	1,878,477	2,221,592	2,510,991	2,733,001	2,906,882
Population Self Supplied	91,514	107,780	119,783	129,315	135,978	139,964
Municipal & Industrial (M&I) Factor[4]	315.0	316.5	317.3	317.7	317.7	317.6
Municipal & Industrial Withdrawals[4]	**524,861**	**665,876**	**789,701**	**893,593**	**972,639**	**1,034,228**
Percent of Total Water Withdrawals	13.0%	15.7%	18.2%	20.3%	22.1%	23.6%
M&I Consumptive Use[5]	196,444	249,223	295,568	334,452	364,037	387,089
Public Use and Losses[6]	**48,472**	**61,195**	**72,313**	**81,707**	**88,930**	**94,582**
As a Percent of Total M&I Use[6]	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%
Percent of Total Water Withdrawals	1.2%	1.4%	1.7%	1.9%	2.0%	2.2%

Notes: One acre-foot equals approximately 325,851 gallons. Water withdrawals and water use are equivalent terms, but are not the same as consumptive use as they do not account for return flows. Nevada figures represent an aggregation of individual county estimates and forecasts. As aggregated into the total Nevada figures, population forecasts for Clark County are based on population forecasts adopted by the Clark County Department of Comprehensive Planning; Population forecasts for Washoe County are based on population forecasts adopted by the Washoe County Department of Community Development. Water withdrawal forecasts are based on the existing levels of conservation.

[1] 1995 population estimate developed by the Nevada State Demographer; population forecasts for 2000–2020 were developed by the Nevada Division of Water Planning (NDWP).

[2] Percent of population on public supply water systems for 1995 is based on USGS estimates; changes to this percent over the forecast horizon are estimated by NDWP.

[3] Total Nevada figure based on aggregation of individual county totals.

[4] Total M&I water use includes all public supplied water for domestic, commercial, industrial and thermoelectric uses; includes effects of a variable population on public supply water systems.

[5] M&I consumptive water use estimated from a fixed 37.4 percent of total M&I estimated and forecasted water withdrawals. The consumptive use factors are presented for all water use categories in Table 3.8.

[6] Public Use and Losses based on a fixed percent of total M&I water withdrawals for each county. The Nevada figure is based on the aggregation of the county totals and while shown here as a fixed 9.2 percent of M&I withdrawals, this figure actually varies slightly over the forecast horizon based on individual county growth patterns.

Source Data: Nevada State Demographer; U.S. Geological Survey (USGS); Nevada Division of Water Planning (NDWP).

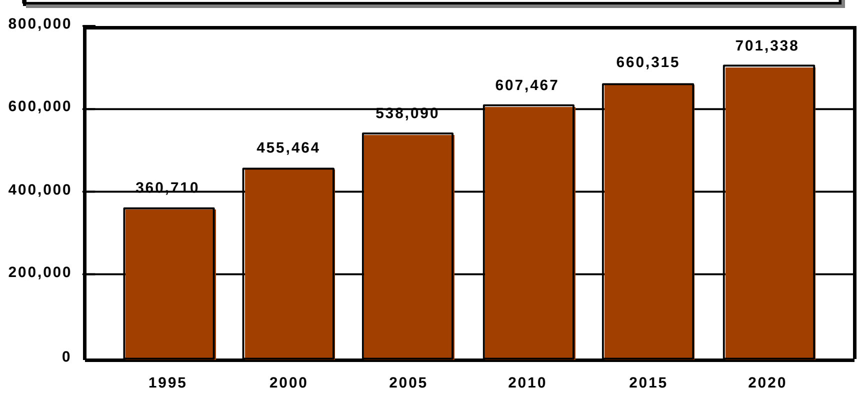
The public supply domestic water use factor was assumed to be higher than the usage rate for self supplied domestic water users. As a result, as the proportion of the population receiving its waters from public supply water systems increases the water usage rate will tend to raise as well. This approach also assumes that other principal M&I uses, i.e., commercial and industrial, have constant usage rates in gallons per worker per day. Based on both increasing population and commercial development, water use forecasts call for total M&I water withdrawals to increase from an estimated 524,861 acre-feet in 1995 to 1,034,228 acre-feet by the year 2020, a total increase of over 97 percent. This corresponds to an average annual increase of 2.8 percent per year over the state water plan's forecast horizon.

Domestic (Residential) Water Withdrawal Forecasts

Domestic water withdrawal forecasts were based on both population and usage rates as determined from historical trends. Table 3–3. Domestic Water Withdrawal Forecasts, presents domestic (residential) water withdrawal forecasts for both domestic public supply and self-supplied water withdrawals. The key components to the domestic water forecast methodology are: (1) estimates and forecasts of the total resident populations (see Appendix 2 of the Appendices); (2) estimates and forecasts of the resident population on public supply water systems (see Appendix 3 of the Appendices); (3) estimates and forecasts of the population on self-supplied water systems; and (4) estimates of specific water use factors for total domestic water use (using the entire population), public supplied domestic water use (using public supply population only), and self-supplied domestic water use (using only the self-supplied population).

The forecasts for domestic water withdrawals presented in Table 3–3 and in Fig. 3–4 assume that a varying proportion of the total population is on public supply water systems. Varying the percent of the population on public water systems over time is believed to represent a more realistic estimate of future water use conditions. This assumption is also supported by historic trends, which have more typically shown such variations. These changes to the proportion of the population on public supply systems were estimated individually for each county based on NDWP estimates of future growth characteristics. All forecast changes are presented in Appendix 3 of the Appendices.

Fig. 3-4. Nevada Domestic (Residential) Water Use
Total Domestic (Residential) Water Withdrawals (Acre-Feet per Year)



Sources: U.S. Geological Surv ey (USGS); Nevada Division of Water Planning (NDWP).

Based on the forecasts presented in Table 3–3, total domestic water withdrawals are forecasted to rise from an estimated 360,710 acre-feet in 1995 to an estimated 701,338 acre-feet by the year 2020. This represents a total increase of 94 percent and an average annual increase of 2.7 percent per year. It is also estimated that the percent of the population on public supply water systems would increase over this forecast period. This results in the total domestic water use factor rising slightly over time (from 203.9 gallons per person per day in 1995 to 205.5 gallons per person per day by 2020).

Table 3–3. Domestic (Residential) Water Withdrawal Forecasts

Based on Variable Percent of Population on Public Supply Water Systems
(Water withdrawals in acre-feet per year; Use factors in gallons per person per day)

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Resident Population (persons)[1]	1,579,150	1,986,257	2,341,374	2,640,306	2,868,979	3,046,846
Percent Population on Public Supply[2]	94.2%	94.6%	94.8%	95.0%	95.2%	95.4%
Population on Public Supply[3]	1,487,636	1,878,477	2,221,592	2,510,991	2,733,001	2,906,882
Population being Self Supplied	91,514	107,780	119,783	129,315	135,978	139,964
Variable Domestic Use Factor[4]	203.9	204.7	205.2	205.4	205.5	205.5
Public Supply Use Factor	205.6	206.3	206.7	206.8	206.9	206.9
Self-Supplied Use Factor	176.6	177.3	177.5	177.5	177.4	177.2
Total Domestic Water Withdrawals[4]	**360,710**	**455,464**	**538,090**	**607,467**	**660,315**	**701,338**
Percent of Total Water Withdrawals	8.9%	10.7%	12.4%	13.8%	15.0%	16.0%
Public Supply Domestic Water Use	**342,605**	**434,063**	**514,277**	**581,756**	**633,300**	**673,563**
Self-Supplied Domestic Water Use	**18,105**	**21,401**	**23,813**	**25,711**	**27,016**	**27,775**
Total Domestic Consumptive Use[5]	180,037	227,331	268,571	303,198	329,575	350,051

Notes: One acre-foot equals approximately 325,851 gallons. Water withdrawals and water use are equivalent terms, but are not the same as consumptive use as they do not account for return flows. Nevada figures represent an aggregation of individual county estimates and forecasts. As aggregated into the total Nevada figures, population forecasts for Clark County are based on population forecasts adopted by the Clark County Department of Comprehensive Planning; Population forecasts for Washoe County are based on population forecasts adopted by the Washoe County Department of Community Development. Water withdrawal forecasts are based on the existing levels of conservation.

[1] 1995 population estimate developed by the Nevada State Demographer; population forecasts for 2000–2020 were developed by the NDWP in conjunction with Clark and Washoe counties.

[2] Percent of population on public supply water systems for 1995 is based on USGS estimates; changes to this percent over the forecast horizon are estimated by NDWP.

[3] Total Nevada figure based on aggregation of individual county totals.

[4] Variable Total Domestic Use Factor represents change in population on public supply water systems for each county and was developed from the aggregation of individual county forecasts.

[5] Domestic consumptive water use based on a fixed 49.9 percent of total domestic estimated and forecasted water withdrawals. The consumptive use factors are presented for all water use categories in Table 3–8.

Source Data: Nevada State Demographer; Department of Employment, Training and Rehabilitation (DETR); U.S. Geological Survey (USGS); and Nevada Division of Water Planning (NDWP).

Domestic water withdrawals for public supply water users are expected to increase from 342,605 acre-feet per year in 1995 to 673,563 acre-feet by 2020, an overall increase of 97 percent or 2.7 percent per year. Water withdrawals made by self-supplied domestic water users are expected to increase from 18,105 acre-feet in 1995 to 27,775 acre-feet by 2020, an overall increase of 53 percent or 1.7 percent per year.

Commercial and Industrial Water Withdrawal Forecasts

Commercial and industrial water use forecasts are presented in Table 3–4. Commercial and Industrial Water Withdrawal Forecasts. These forecasts are based on the forecasted number of employees multiplied by a water use factor measured in gallons per worker per day for each county and then aggregated to a statewide total. However, the employment figures used for each county were adjusted to remove mining workers, as water use by these workers (and the mining industry) are presented separately.

Table 3–4. Commercial and Industrial Water Withdrawal Forecasts

Based on Total Employment less the Estimated and Forecasted Number of Mining Workers (Water withdrawal in acre-feet per year; Use factor in gallons per employee per day)

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Resident Population (persons)[1]	1,579,150	1,986,257	2,341,374	2,640,306	2,868,979	3,046,846
Employment-Population Ratio	49.7%	49.7%	49.7%	49.6%	49.6%	49.6%
Total Employment (workers)	784,486	987,950	1,162,764	1,310,176	1,423,256	1,511,617
Employment less Mining Workers	771,299	973,251	1,148,331	1,295,999	1,409,685	1,499,030
Commercial/Industrial Use Factor[2]	199.6	202.1	203.6	204.5	205.1	205.4
Commercial/Industrial Withdrawals[2]	**172,407**	**220,355**	**261,880**	**296,905**	**323,811**	**344,919**
Percent of Total Water Withdrawals	4.3%	5.2%	6.0%	6.8%	7.4%	7.9%
Comm./Industrial Consumptive Use[3]	31,950	40,836	48,531	55,022	60,008	63,920

Notes: One acre-foot equals approximately 325,851 gallons. Water use and water withdrawals are equivalent terms, but are not the same as consumptive use as they do not account for return flows. As aggregated into the total Nevada figures, population forecasts for Clark County are based on population forecasts adopted by the Clark County Department of Comprehensive Planning; Population forecasts for Washoe County are based on population forecasts adopted by the Department of Community Development. Water withdrawal forecasts are based on the existing levels of conservation.

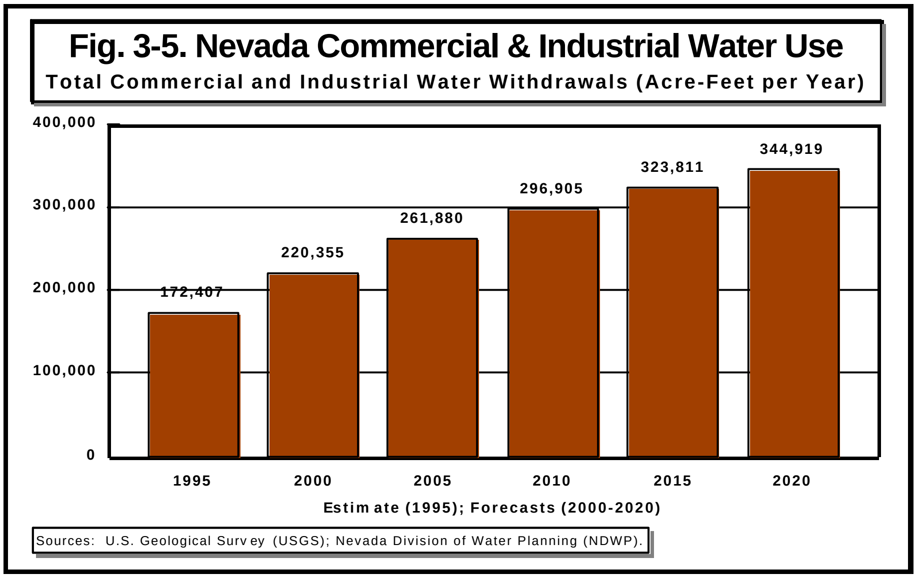
[1] 1995 population estimate developed by the Nevada State Demographer; population forecasts for 2000–2020 developed by the Nevada Division of Water Planning (NDWP) in conjunction with Clark and Washoe counties.

[2] Excludes water used in mining operations and by mining workers; mining water use is calculated separately.

[3] Commercial and Industrial consumptive water use is based on fixed 18.5 percent of commercial and industrial estimated and forecasted water withdrawals. The consumptive use factors are presented for all water use categories in Table 3.8.

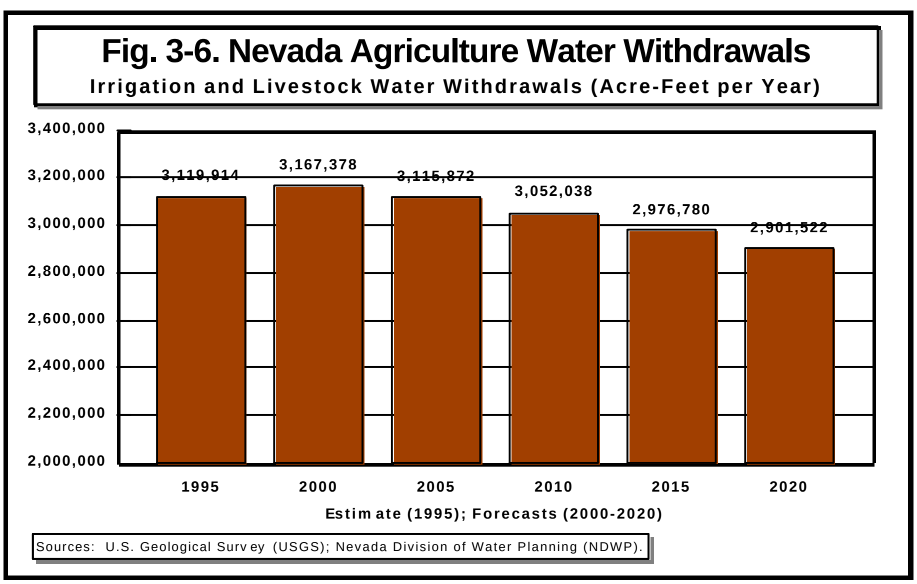
Source Data: Nevada State Demographer; Department of Employment, Training and Rehabilitation (DETR); U.S. Geological Survey (USGS); and Nevada Division of Water Planning (NDWP).

The employment forecasts for each county were determined from historical trends in that county's employment-to-population ratio. Individual county information showing population forecasts, forecasts of each county's employment-to-population ratio, total employment and mining employment forecasts are presented in Appendix 3 of the Appendices. Based on these individual county forecasts, statewide total commercial and industrial water use is expected to increase from an estimated 172,407 acre-feet in 1995 to 338,881 acre-feet by 2020 (see Fig. 3–5), corresponding to an overall increase of 96.6 percent and an average annual increase of 2.7 percent per year.



Agricultural Water Withdrawal Forecasts

Agricultural water withdrawal forecasts for Nevada were developed using forecasts of county irrigated acreage multiplied by a county-unique irrigated acreage water use factor, measured in acre-feet per acre per year. The forecasts for irrigated acreage were presented in Part 2, Section 2, Socioeconomic Assessment and Forecasts and are also presented for each county in Appendix 4 of the Appendices. The forecasts of irrigated acreage were made for each county using a non-linear "curve-fitting" estimation process and extrapolation out to the year 2020. The water use factor represents an average water requirement derived from 1995 data which is unique to each county and which is assumed to be applicable to all irrigated lands in that county. The individual irrigation water use factors were not varied over the forecast period. Using a constant irrigation factor is reasonable given that each irrigator's water use permit or certificate specifies a fixed application quantity or rate. It also implies that there will be no significant changes in the nature of the crops being grown or the number of croppings per year. Forecasted figures of



irrigated acreage were multiplied by the county-unique irrigated acreage water use factor.

Livestock water withdrawals were estimated from forecasted irrigation water withdrawals based on the historical trends of the ratio of livestock water use to total irrigation water use. Table 3–5. Nevada Agricultural Water Withdrawal Forecasts, presents forecasts of Nevada's irrigated acreage, irrigation water withdrawals, the irrigated acreage water use factor, livestock water withdrawals, livestock/irrigation water use factor, and total agricultural water withdrawals (irrigation and livestock combined) for 5-year intervals between 1995 through 2020. These figures represent an aggregation of individual county forecasts which are presented in Appendix 4 of the Appendices along with a statewide average irrigation water requirement.

Table 3–5. Nevada Agricultural Water Withdrawal Forecasts

Irrigated Acreage (Acres), Water Requirement (Acre-Feet per Acre per Year), and Irrigation and Livestock Water Use (Acre-Feet) — 1995–2020 (Acres and Acre-Feet per Year)

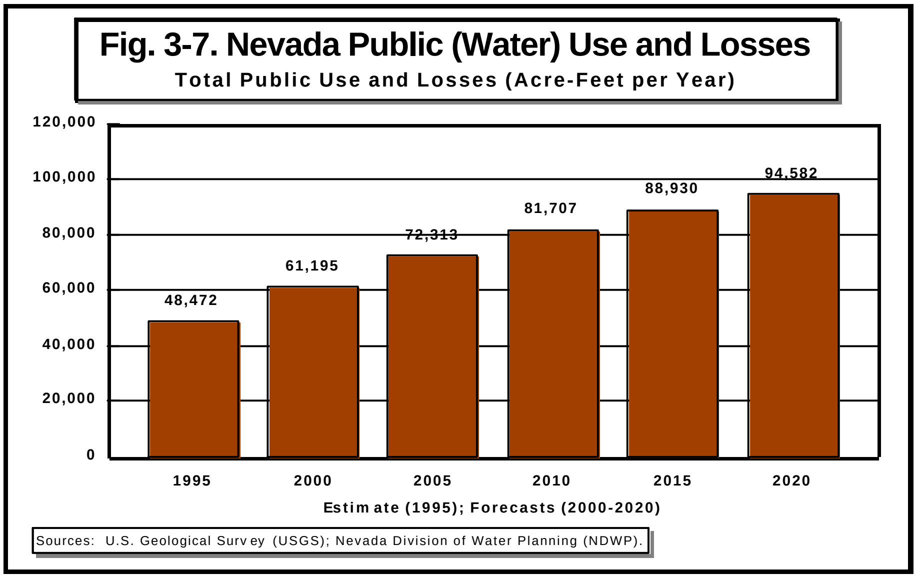
Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Total Irrigated Acreage	715,439	727,500	715,563	700,742	683,247	665,753
Irrigation Water Withdrawals	**3,113,585**	**3,160,754**	**3,109,348**	**3,045,636**	**2,970,521**	**2,895,406**
Percent of Agricultural Withdrawals	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%
Irrigation Water Requirement	4.4	4.3	4.3	4.3	4.3	4.3
Irrigation Consumptive Use†	1,612,079	1,636,501	1,609,885	1,576,898	1,538,007	1,499,115
Livestock Water Withdrawals	**6,329**	**6,624**	**6,524**	**6,402**	**6,259**	**6,116**
Percent of Agricultural Withdrawals	0.20%	0.21%	0.21%	0.21%	0.21%	0.21%
As a Percent of Irrigation Use	0.203%	0.210%	0.210%	0.210%	0.211%	0.211%
Livestock Consumptive Use†	2,319	2,427	2,390	2,346	2,293	2,241
Total Agricultural Water Use	**3,119,914**	**3,167,378**	**3,115,872**	**3,052,038**	**2,976,780**	**2,901,522**
Percent of Total Water Withdrawals	77.2%	74.5%	72.0%	70.0%	67.9%	66.4%
Agricultural Consumptive Use	1,614,398	1,638,928	1,612,275	1,579,244	1,540,300	1,501,356

Notes: One acre-foot equals approximately 325,851 gallons. Water use and water withdrawals are equivalent terms, but are not the same as consumptive use as they do not account for return flows. 1995 irrigation figures based on U.S. Geological Survey (USGS) estimates, modified by the Nevada Division of Water Planning (NDWP). Forecasts through 2020 are based on 1995 usage rates and relationships and NDWP forecasted irrigated acreage amounts. Livestock water use as a percent of irrigation water use based on 1990 USGS studies. Nevada totals based on aggregation of individual county estimates and forecasts. Water withdrawal forecasts are based on the existing levels of conservation.

† Consumptive uses for both irrigation and livestock are estimated from a fixed percent of respective water withdrawals.

Source Data: 1995 irrigated acreage – USGS and NDWP; Irrigated acreage forecasts – NDWP; Irrigation water use factor (water duty) – USGS and NDWP; Livestock water use rates – USGS and NDWP.

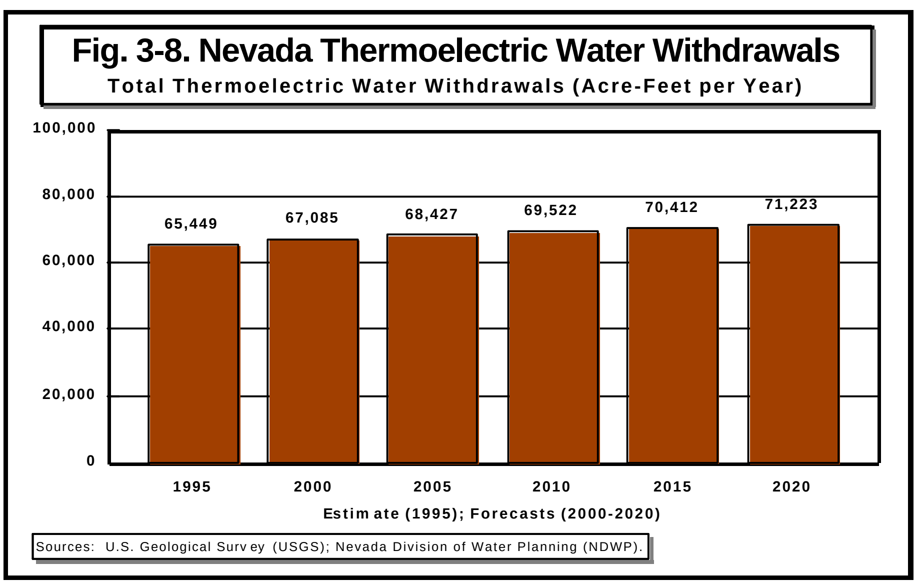
Table 3–5 shows that Nevada's total irrigated acreage is forecast to increase slightly from an estimated 715,440 acres in 1995 to 727,500 acres by the year 2000. Subsequently, irrigated acreage is forecast to decline through the year 2020 to 665,753 acres, representing a total period decline of 6.9 percent, or an average annual decline of 0.3 percent per year.



Based on an average water use coefficient of 4.3–4.4 acre-feet per acre per year (based on an aggregation of the individual county irrigation water use requirements), statewide total irrigation water withdrawals are expected to go from an estimated 3,113,585 acre-feet in 1995 to 2,895,406 acre-feet by the year 2020, representing a total decline of 7.0 percent and an average annual decline of 0.3 percent per year. Livestock water withdrawals are expected to decline from 6,313 acre-feet in 1995 to 6,116 acre-feet in the year 2020. Thus, total agricultural water withdrawals are expected to decline from 3,119,914 acre-feet in 1995 to 2,901,522 acre-feet by the year 2020, representing a total decline in this sector's water use of 218,392 acre-feet or 7.0 percent over the next 20 years.

Public Use and Losses

Forecasts of public use and losses (see Fig. 3–7) were developed using the assumption that this water use category constituted essentially a fixed percent of total municipal and industrial (M&I) forecasted water withdrawals and are presented in Table 3–2 along with the M&I water withdrawal forecasts. The statewide total for this water use category was based on an aggregation of individual county estimates and forecasts. The percentage figures for each individual county's public use and loss water use ratio to total M&I water withdrawals were based on 1995 relationships.



Thermoelectric Water Withdrawals

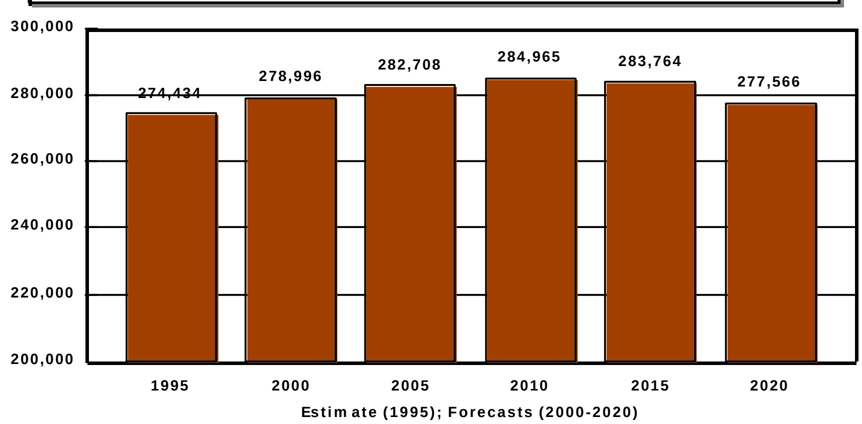
Forecasts for the statewide total thermoelectric water withdrawals (see Fig. 3–8) were based on an aggregation of individual county estimates and forecasts. County forecasts were made based on historical trends in this water withdrawal category and general forecasts of populations and commercial and industrial activities, particularly including anticipated future mining production served by these electrical power systems.

Mining Water Withdrawal Assumptions and Forecasts

Water withdrawal forecasts for Nevada's mining industry are based on the expected trends in the state's gold mining industry, which constitutes the majority of this economic sector's production, employment and water withdrawals. Water withdrawal estimates for the mining industry for 1995 showed a total of 274,434 acre-feet of water withdrawals, of which mine dewatering activities, mostly in support of open-pit gold mining, accounted for over two-thirds. In addition, gold mining processing operations, consisting primarily of washing, scrubbing and leaching, accounted for a significant portion of the mines' processing (consumptive) water withdrawals. Based on conditions and assumptions presented below, the forecasts for mining water withdrawals are presented in Table 3–6. Nevada Forecasted Mining Water Withdrawals. Fig. 3–9 shows total forecasted mining withdrawals, to include both consumptive (processing) use and non-consumptive (mining dewatering) withdrawals.

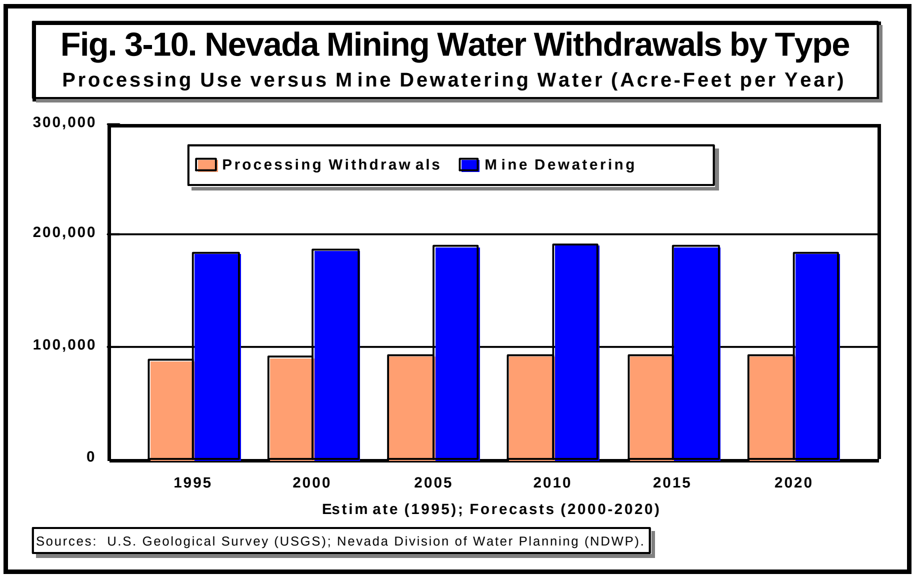
Fig. 3-9. Nevada Mining Water Withdrawals

Total Processing & Mine Dewatering Water Use (Acre-Feet per Year)



Sources: U.S. Geological Survey (USGS); Nevada Division of Water Planning (NDWP).

With respect to the state of the gold mining industry, several key factors and critical assumptions come into play. First, future gold mining activity in Nevada, and thus future water use, are critically dependent on the price of gold which determines the level of economically-recoverable gold reserves. As gold's market price declines, irrespective of the use of futures contracts to "lock in" on an economically viable price, available reserves which are economically feasible for recovery also decline. Conversely, as the price of gold increases, more marginal ore bodies now become economically attractive based on production costs of recovery. Also, the gold industry has become far more resilient in its ability to adjust its cost structure to current gold prices. Therefore, falling prices do not necessarily spell an end to gold mining, as the industry rapidly adjusts to the mining of available higher grade ore, thereby lowering the mines' overall cost structure. Consequently, while exploration and future investment may wane with falling gold prices, reasonable production levels are likely to be maintained.



In 1997, Nevada's gold mining industry produced over 7 million ounces of gold at an average market price of around $330 per ounce. At an estimated "recovery" price of between $280 and $350 per (troy) ounce, which is the long-term market price anticipated by the industry for gold once the economic and financial fundamentals become better stabilized, there currently exists estimated recoverable reserves in Nevada of just over 95 million ounces. This indicates an estimated economic life of this industry of 12–15 years at current production levels. However, historically, estimated recoverable reserves have been periodically bolstered by new discoveries as existing ore bodies and proven reserves near depletion. Therefore, as an over-riding assumption in mining water use forecasts, it is assumed that with continued exploration some level of economically profitable gold mining in Nevada will continue throughout the forecast horizon.

Table 3–6. Nevada Forecasted Mining Water Withdrawals

Estimated (1995) and Forecasted (2000–2020) Water Use (Acre-Feet/Year)

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Total Mining Water Withdrawals[1]	**274,434**	**278,996**	**282,708**	**284,965**	**283,764**	**277,566**
Percent of Total Water Withdrawals	6.8%	6.6%	6.5%	6.5%	6.4%	6.3%
Mine Processing (consumptive use)	**89,164**	**90,947**	**92,402**	**93,289**	**93,469**	**92,751**
Percent of Total Mining Water Use	32.5%	32.6%	32.7%	32.7%	32.9%	33.4%
Mine Dewatering (non-consumptive)	**185,270**	**188,049**	**190,306**	**191,676**	**190,296**	**184,815**
Percent of Total Mining Water Use	67.5%	67.4%	67.3%	67.3%	67.1%	66.6%

Notes: "Water Use" and "Water Withdrawals" are equivalent terms, but are not the same as consumptive use; do not account for return flows. Water withdrawal forecasts are based on the existing levels of conservation.
[1] Total Mining Use includes both consumptive (processing) and non-consumptive uses (i.e., mining dewatering).
Source Data: U.S. Geological Survey (USGS); and Nevada Division of Water Planning (NDWP); Forecasts through 2020 based on 1995 mining processing and dewatering usage rates and NDWP assumptions of mineral (gold) prices, economically-recoverable

reserves, type of production activities and general market conditions.

Other important mining issues are the nature of production and how changes in production techniques will modify both consumptive water use and mining dewatering. Whether the industry follows current production trends towards more underground mining of higher-grade ore, or continues its present emphasis on open-pit mining of lower-grade ore is, to a degree, dependent on gold's market price and will affect the amount of water use. Currently, the industry does not expect a significant alteration in dewatering levels even if more mining operations move below ground; dewatering of adjacent or nearby open pits is usually sufficient to also dewater mine shafts in the near vicinity of the pit. In addition, there is a general belief within the industry that underground mining may not necessitate the same level of either processing water use (due to higher grade ores and difference processing needs), or require mining dewatering as in the past. However, some degree of mine dewatering is expected to continue irrespective of the type of production activity. Based on these assumptions, in general agreement with mining association production estimates, forecasts for both mine productive water use and mining dewatering are anticipated to grow only slightly over the near-term and then begin to decline moderately after the year 2010 (see Fig. 3–10).

Total Water Use Forecasts

Table 3–7. Nevada Estimated and Forecasted Water Use by Sector, presents the entire set of water withdrawal forecasts by category for Nevada. The table shows water withdrawal estimates for 1995 and forecasts at five-year intervals out to 2020. These forecasts for the total state are based on the aggregation of county figures as presented in Appendix 5 of the Appendices. All forecasts are based on existing conservation measures and do not account for significant changes in water use patterns. From these projections, statewide total water withdrawals are expected to begin to level off between 2010 and 2015 and then begin to decline. While M&I, domestic and commercial and industrial water withdrawals are expected to continue to grow based on increasing population, employment, commercial and industrial expansion, the sectors of irrigation and mine dewatering are expected to show a decline in water withdrawals.

Based on these projections, Nevada's total water withdrawals for all sectors and categories is expected to increase from 1995's estimated 4,041,385 acre-feet of total water withdrawals to approximately 4,391,000 acre-feet of annual water withdrawals by the year 2020, an increase of nearly 350,000 acre-feet, or 8.6 percent. The state's total municipal and industrial water withdrawals are expected to grow by 509,000 acre-feet from 524,861 acre-feet in 1995 to approximately 1,034,000 acre-feet by 2020, an increase of 97 percent. However, it is expected that much of this increase will be offset by decreased agricultural water withdrawals, especially irrigation water withdrawals. Annual water use for irrigation is expected to decline by 218,179 acre-feet, or 7.0 percent, from an estimated 3,113,585 acre-feet in 1995 to a forecasted 2,895,000 acre-feet by 2020.

Total domestic (residential) water withdrawals are expected to increase by over 340,000 acre-feet, or 94 percent by 2020, from an estimated 360,710 acre-feet of water withdrawals in 1995 to a forecasted 701,000 acre-feet by the year 2020. Domestic public supply water withdrawals are expected to increase by 331,000 acre-feet, or nearly 97 percent, from an estimated 342,605 acre-feet in 1995 to a forecasted 674,000 acre-feet by 2020. Self-supplied domestic water withdrawals are forecasted to increase by 9,700 acre-feet, or 53 percent from an estimated 18,105 acre-feet in 1995 to nearly 28,000 acre-feet by 2020. Commercial and industrial water withdrawals are expected to increase by 172,500 acre-feet, or 100 percent by 2020, from an estimated 172,407 acre-feet in 1995 to a forecasted 345,000 acre-feet of water withdrawals by the year 2020.

Table 3–7. Nevada Estimated and Forecasted Water Withdrawals

Estimated (1995) and Forecasted (2000–2020) Water Use by Use Type (Acre-Feet/Year)

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Total Domestic (Residential) Use[1]	360,710	455,464	538,090	607,467	660,315	701,338
Domestic–Public Supplied[2]	342,605	434,063	514,277	581,756	633,300	673,563
Domestic–Self Supplied	18,105	21,401	23,813	25,711	27,016	27,775
Commercial and Industrial Use	172,407	220,355	261,880	296,905	323,811	344,919
Public Use and Losses[3]	48,472	61,195	72,313	81,707	88,930	94,582
Thermoelectric Use[4]	65,449	67,085	68,427	69,522	70,412	71,223
Total Mining Use[5]	274,434	278,996	282,708	284,965	283,764	277,566
Mine Processing (consumptive)	89,164	90,947	92,402	93,289	93,469	92,751
Mine Dewatering (non-consumptive)	185,270	188,049	190,306	191,676	190,296	184,815
Total Agriculture Withdrawals[6]	3,119,914	3,167,378	3,115,872	3,052,038	2,976,780	2,901,522
Irrigation Water Withdrawals	3,113,585	3,160,754	3,109,348	3,045,636	2,970,521	2,895,406
Livestock Water Use	6,329	6,624	6,524	6,402	6,259	6,116
Total Water Withdrawals (Use)	**4,041,385**	**4,250,474**	**4,339,289**	**4,392,604**	**4,404,012**	**4,391,150**

Notes: One acre-foot equals approximately 325,851 gallons. Water withdrawals and water use are equivalent terms, but are not the same as consumptive use as they do not account for return flows. Water withdrawal forecasts are based on the existing levels of conservation.

[1] Total Domestic Withdrawals equals the total residential use, both indoors and outdoors (i.e., residential landscaping).
[2] Domestic Public Supplied Water Withdrawals is residential use of water supplied by public supply water systems.
[3] Public Use and Losses are estimated at a fixed percent of total M&I based on historical trends.
[4] Thermoelectric Withdrawals includes water used for geothermal power plants and cooling water for conventional plants.
[5] Total Mining Withdrawals includes both consumptive and non-consumptive uses (i.e., mining dewatering).
[6] Total Agriculture Withdrawals includes both irrigation and livestock water withdrawals.

Source Data: Nevada State Demographer; Nevada Department of Employment, Training and Rehabilitation (DETR); U.S. Geological Survey (USGS); and Nevada Division of Water Planning (NDWP).

Based on patterns in forecasted total irrigated acreage determined from individual county forecasts, total agricultural water withdrawals, including both irrigation and livestock water withdrawals, are forecasted to peak around the year 2000 at approximately at 3.167 million acre-feet and then decline by some 266,000 acre-feet, or 8.4 percent, to 2.902 million acre-feet by the year 2020. This decline is based solely on forecasted trends in irrigated acreage. Total mining water withdrawals are expected to peak around the year 2010 at nearly 285,000 acre-feet, an increase of 10,500 acre-feet, or 3.8 percent from 1995's estimated mining water withdrawals.

As more of Nevada gold mining goes underground, total mining water withdrawals are expected to decline to approximately 277,600 acre-feet by 2020, a decline of 7,400 acre-feet, or 2.6 percent from water withdrawals forecasted for 2010. Most of this decline occurs in mine dewatering as mining operations and mine processing water withdrawals are expected to decline only modestly after the year 2010. Thermoelectric water withdrawals continue to increase throughout the forecast period based on rising population, continued mining activity, and other electrical energy demands. Total thermoelectric water withdrawals are expected to increase by 5,800 acre-feet, or 8.8 percent between

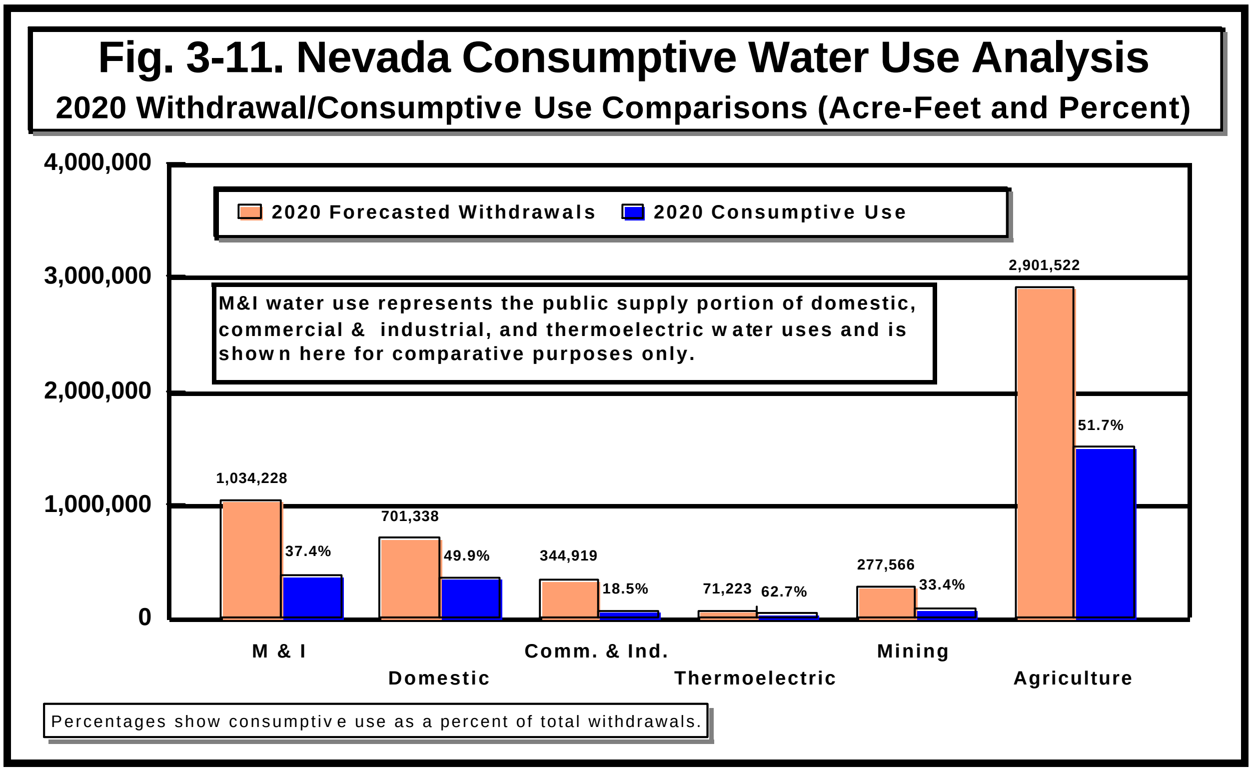


Fig. 3-11. Nevada Consumptive Water Use Analysis
2020 Withdrawal/Consumptive Use Comparisons (Acre-Feet and Percent)

1995 and 2020.

Consumptive Use Forecasts

Table 3–8. Nevada Consumptive Use Forecast Summary presents estimates of consumptive water use by principal use category based on total water withdrawals for these same categories. The forecasts in this table were based on historical relationships between water withdrawals and respective consumptive use patterns. The total consumptive use figure, representing the summation of all categories, is expected to decrease from 48.4 percent of total water withdrawals to 46.8 percent as water use patterns change across the various water use categories primarily from agriculture (with a consumptive use estimated at 51.7 percent including both irrigation and livestock consumptive uses) to municipal and industrial which has an average consumptive use estimated at 37.4 percent, i.e., a 63 percent return flow. Fig. 3–11 shows the statewide total forecasted water withdrawals by use category for the year 2020 and that portion of each water withdrawal which is expected to be consumptively used.

Table 3–8. Nevada Consumptive Use Forecast Summary

Estimated (1995) and Forecasted (2000–2020) Consumptive Use by Use Type (Acre-Feet/Year)

Total Nevada	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Domestic (Residential) Withdrawals[1]	360,710	455,464	538,090	607,467	660,315	701,338
Total Consumptive Use	180,037	227,331	268,571	303,198	329,575	350,051
Percent Consumptive Use	49.9%	49.9%	49.9%	49.9%	49.9%	49.9%
Commercial & Industrial Withdrawals	172,407	220,355	261,880	296,905	323,811	344,919
Total Consumptive Use	31,950	40,836	48,531	55,022	60,008	63,920
Percent Consumptive Use	18.5%	18.5%	18.5%	18.5%	18.5%	18.5%
Thermoelectric Withdrawals[2]	65,449	67,085	68,427	69,522	70,412	71,223
Total Consumptive Use	41,053	42,079	42,921	43,608	44,166	44,675
Percent Consumptive Use	62.7%	62.7%	62.7%	62.7%	62.7%	62.7%
Total Mining Use[3]	274,434	278,996	282,708	284,965	283,764	277,566
Total Consumptive Use	89,164	90,947	92,402	93,289	93,469	92,751
Percent Consumptive Use	32.5%	32.6%	32.7%	32.7%	32.9%	33.4%
Total Agriculture Withdrawals[4]	3,119,914	3,167,378	3,115,872	3,052,038	2,976,780	2,901,522
Total Consumptive Use	1,614,398	1,638,928	1,612,275	1,579,244	1,540,300	1,501,356
Percent Consumptive Use	51.7%	51.7%	51.7%	51.7%	51.7%	51.7%
Irrigation Water Withdrawals	3,113,585	3,160,754	3,109,348	3,045,636	2,970,521	2,895,406
Irrigation Consumptive Use	1,612,079	1,636,501	1,609,885	1,576,898	1,538,007	1,499,115
Percent Consumptive Use	51.8%	51.8%	51.8%	51.8%	51.8%	51.8%
Livestock Water Withdrawals	6,329	6,624	6,524	6,402	6,259	6,116
Livestock Consumptive Use	2,319	2,427	2,390	2,346	2,293	2,241
Percent Consumptive Use	36.6%	36.6%	36.6%	36.6%	36.6%	36.6%
Total Water Withdrawals (Use)	**4,041,385**	**4,250,474**	**4,339,289**	**4,392,604**	**4,404,012**	**4,391,150**
Total Consumptive Use	1,956,602	2,040,121	2,064,701	2,074,361	2,067,518	2,052,752
Percent Consumptive Use	48.4%	48.0%	47.6%	47.2%	46.9%	46.7%

Notes: "Water Withdrawal" and "Water Use" are equivalent terms, but are not the same as consumptive use; do not account for return flows. Estimates of consumptive use are based on estimates provided by the U.S. Geological Survey (USGS). Figures for the total State of Nevada are based on an aggregation of individual county estimates and forecasts of water withdrawals and consumptive use. Water withdrawal forecasts are based on the existing levels of conservation.

[1] Total Domestic Use equals the total residential use, both indoors and outdoors (i.e., residential landscaping).
[2] Thermoelectric Use includes water used for geothermal power plants and cooling water for conventional plants.
[3] Total Mining Use includes both consumptive and non consumptive uses (i.e., mining dewatering).
[4] Total Agriculture Withdrawals includes both irrigation and livestock water use.

Source Data: Nevada State Demographer; Nevada Department of Employment, Training and Rehabilitation (DETR); U.S. Geological Survey (USGS); and Nevada Division of Water Planning (NDWP).

Index to Part 2 Section 3:

Nevada State Water Plan
PART 2 — WATER USE AND FORECASTS

Section 4
Meeting Our Future Water Supply Needs

Introduction

The future presents Nevada with many water resource challenges as a result of an ever increasing population, and competition over our limited water resources. Every effort should be made to ensure that all Nevadans have adequate and safe water supplies while protecting the quantity and quality of our water resources for current and future uses. This section of the *State Water Plan* is intended as an overview of future water demands, alternatives for meeting those needs, and water supply options identified in regional water plans.

Future Demands

As presented in Part 2, Section 3 of the *State Water Plan*, total statewide annual water withdrawals during the period 1995 to 2020 are forecasted to increase about 350,000 acre-feet (af) from 4,041,000 to 4,391,000 acre-feet per year (afy), assuming current levels of conservation. Correspondingly, annual consumptive use will increase about 96,000 af from 1,957,000 to 2,053,000 afy. This projected increase in water use is directly attributable to increasing population and related increases in economic endeavors, resulting in rising public supply (M&I), domestic, commercial, industrial and thermoelectric water usage.

The anticipated increase in total statewide water withdrawals is primarily the result of increasing public supply (M&I) water usage. Annual M&I water use is projected to increase by 509,000 af from 525,000 to 1,034,000 afy, almost doubling from 1995 to 2020. A majority of this increase in demand will be met with surface water supplies. Approximately 91 percent of this increase can be attributed to anticipated growth in Clark and Washoe counties. It is expected that M&I usage will account for almost one-quarter of the total statewide usage by 2020. One of Nevada's water resource challenges will be meeting the water needs of the nearly 3 million people expected to reside in the state by 2020.

The M&I water use projections presented in Part 2 of the *State Water Plan* are based upon existing water use patterns and conservation measures and do not include the effects of future conservation efforts. The implementation of additional M&I conservation measures will result in lower M&I water withdrawals (in 2020) than the 1,034,000 afy predicted in the water plan. Planning groups for Southern Nevada and Washoe County have estimated that their proposed additional conservation measures will result in annual M&I withdrawals about 150,000 af less than would occur without these additional measures. The achievement of additional conservation is an integral part of Southern Nevada's water supply plan for the future.

Based upon the economic forecasts in Part 2 of the *State Water Plan*, agricultural water use could experience a 7 percent decline through 2020. Nonetheless, agriculture will continue to account for a majority of the statewide use during the next 20 years. It must be noted that statewide agricultural water use is highly variable depending upon weather conditions and water supplies, and can vary more than 25 percent from a wet year to a dry year as a result of changing water availability. While the projections in the *State Water Plan* suggest that agricultural water use will decrease in the future, planning and management efforts need to consider providing more reliable water supplies for irrigation during drought periods.

Almost 6 to 7 percent of statewide water withdrawals occur in the mining industry. It is anticipated that mining water withdrawals will remain relatively constant at around 275,000 afy with a slight increase over the next 10 years followed by a slight decline after 2010. A majority of the withdrawals are associated with mine dewatering, and about 185,000 acre-feet per year of these withdrawals are either discharged to surface water systems, reinjected into aquifers or used by other sectors such as irrigation. The impacts of these future mine dewatering activities will continue to be monitored and evaluated.

Water Availability

Approximately 60 percent of the water withdrawn in Nevada comes from surface water sources. Most of Nevada's surface water is the result of runoff from melting snow, with peak flows generally occurring in May and June. Available surface water supplies are highly dependent upon weather conditions with variable monthly and annual flows. For example, the Humboldt River at Palisade (midway down the river) has experienced flows of 1,336,000 acre-feet during one year and only 25,000 acre-feet during another year. With such wide fluctuations, it is difficult to provide adequate and consistent water supplies to users on the system. Utilization of above ground and below ground storage capabilities are one strategy for smoothing out some of the flow fluctuations, thereby guaranteeing more reliable supplies.

Generally, Nevada's surface water sources have been fully appropriated and utilized for many years. Expanded usage of our surface water resources can only occur to a restricted extent. With limited "excess" surface water available, those looking to surface supplies to meet future demands will need to examine a variety of options such as water right acquisitions and transfers, storage and improved management.

Groundwater supplies provide about 40 percent of our water needs. In some areas, groundwater is used as a sole source. In other areas, groundwater is used as a supplemental source during times of limited surface water flows. Currently, about 60 percent of Nevada's groundwater basins have varying amounts of water available for additional appropriations for agriculture, urban and other uses. However, most of these groundwater resources exist in areas distant from the anticipated water demand growth areas. Development of these sources can become an expensive endeavor if interbasin transfers are involved.

Options for Meeting Future Water Needs

Meeting our future water needs will require implementation of a combination of strategies. Possible strategies have been divided into two categories: demand management and supply development. Through demand management, water purveyors make wiser use of the available water thereby lessening the need for new source development. Supply development strategies include a variety of methods for increasing supplies and improving supply reliability.

Increasing demands and competition for our limited resources oblige water managers and suppliers to implement both demand management and supply development strategies. However, each option needs to be evaluated on a case-by-case basis for suitability, cost effectiveness and public acceptance.

Demand Management Strategies

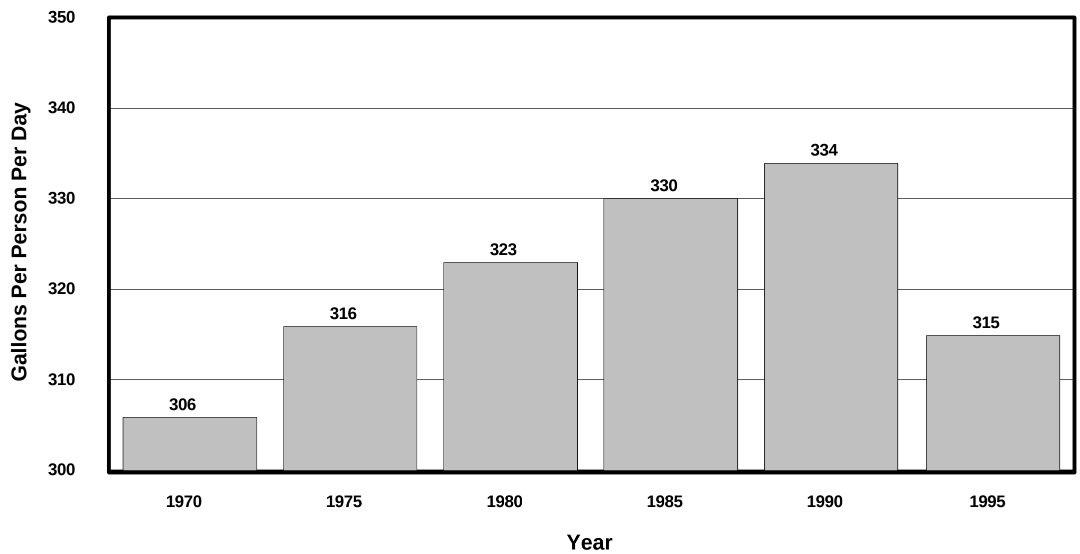
The time is past when water supply needs can be met simply by developing more water withdrawal, storage and delivery systems. Demand management must also be part of any long-range water supply plan. By reducing demands, new supply developments can be delayed with potential savings to the users. Demands can be managed through conservation measures and alternate strategies such as effluent reuse, greywater use and dual water systems.

Conservation. Conservation is recognized by most water suppliers and users as a cost-effective approach for extending water supplies, improving supply reliability during times of shortages, and deferring the need for new supply development. Numerous case studies have shown that a good conservation program can reduce demands significantly.

A comprehensive municipal water conservation program typically includes features such as: water system audits and leak detection, a public information and awareness program, utilization of increasing block billing, new ordinances, installation of low flow fixtures, landscape demonstration projects, use of drought tolerant plants and implementation of a xeriscape program, and installation of meters.

From 1970 to 1990, Municipal & Industrial (M&I) water use rates in Nevada were on the rise (Figure 4-1). Successful conservation programs during the 1990s have lowered statewide M&I water use from 334 gallons per person per day (gpcd) in 1990 to 315 gpcd in 1995. In the Las Vegas area, the critical impact of conservation to the region's water planning efforts has been recognized by the Southern Nevada Water Authority and participating water purveyors. The local governments and water suppliers have implemented a variety of conservation measures, such as: banning the creation of artificial lakes, adopting water waste ordinances, restricting lawn watering, establishing increasing block rates for billing purposes, establishing an active public education and outreach

Fig. 4-1. M&I Per Capita Water Use in Nevada



Data Source: U.S. Geological Survey; modifications by Nev. Division of Water Planning

program, and pursuing the use of lower quality water in lieu of potable supplies where feasible. As a result of these conservation efforts, Municipal & Industrial (M&I) water use in the Las Vegas Valley Water District has decreased from 358 gpcd (gallons per capita per day) in 1989 to 320 gpcd in 1997. Residential use has decreased from 213 gpcd to 197 gpcd during the same period.

Agricultural conservation programs typically include: laser leveling of fields, lining of ditches, use of soil and plant moisture monitoring devices, conversion to overhead or drip irrigation methods, and selection of low water use crops. Nevada's agricultural community has been implementing many of these conservation measures throughout the State, particularly in the Walker River and Carson River basins and the Lovelock area (Humboldt River basin).

For additional information on conservation, refer to Part 3 of the *State Water Plan.*

Alternate Strategies for Reducing Potable Water Demands. Conservation reduces potable water demands by decreasing the overall water needs of the users. Other options to achieve potable water demand reductions involve the utilization of lower quality water in lieu of treated potable water. The main options in this category include: effluent reuse, greywater reuse and dual distribution systems. These alternate strategies may not reduce overall water usage, but rather shift some of the demand from one water source (potable) to another (nonpotable). These approaches may not be appropriate in all situations and must be examined on a case-by-case basis.

- **Effluent reuse.** One way to reduce demands for potable water and thus extend the higher quality supplies is through the use of treated wastewater effluent as a replacement source in Nevada.

Current uses for reclaimed water include: urban landscaping such as golf courses, parks, road medians, cemeteries, etc.; agricultural irrigation; industrial uses such as cooling water and process water; wetlands applications; and construction water.

Effluent reuse is not only a tool for managing and reducing potable water demands, but also a tool for managing treated wastewater. Increasingly stringent wastewater discharge requirements have induced some municipalities and industries to seek alternative methods to dispose of treated wastewater effluent. Effluent reuse decreases potable water demands only if it is used as a replacement source.

Effluent reuse is increasing in Nevada. In Clark County, approximately 11,000 acre-feet of treated wastewater was reused for landscape and golf course irrigation, and power plant purposes during 1997. The Southern Nevada Water Authority has projected wastewater reuse to reach approximately 25,000 acre-feet per year by the year 2000. Approximately 4,000 acre-feet of the wastewater generated in Washoe County (about 2,000 acre-feet from Lake Tahoe basin for reuse in Douglas County, about 2,000 acre-feet from Truckee Meadows area) was reused during 1997 for landscape, golf course and agricultural irrigation, and environmental uses, such as wetlands. According to the "1995-2015 Washoe County Comprehensive Regional Water Management Plan," effluent reuse is expected to increase as treated wastewater is substituted for fresh water used for irrigation. The City of Carson City reuses all of its treated wastewater (approximately 6,000 acre-feet in 1997) for landscape and agricultural irrigation, and will continue to do so as the community population and the associated wastewater volumes increase. Also, all wastewater generated (about 4,000 acre-feet in 1997) in Nevada's portion of the Lake Tahoe basin is exported for reuse in Douglas County.

Treated wastewater is also used in other counties, primarily Elko, and Lyon. Generally, effluent reuse has served both as a replacement for potable water and as an alternative disposal method.

- **Greywater Use.** Another potential method for reducing potable water demands is to irrigate trees and shrubs with greywater - water that has already been used for bathing or clothes washing. Greywater can account for more than one-half of all residential indoor water use. However, some household water, such as wastewater from toilets, kitchen sinks, dishwashers, or laundry water from soiled diapers, is not suitable for reuse because it may contain bacterial contaminants, grease or residues of detergents that are harmful to plants. Because greywater systems require dual piping, surge tanks and distribution piping, they can be expensive to install and may be more suitable for new construction rather than retrofit situations.

In the early 1990s, California developed standards for household use of greywater for irrigation. The standards set specifications for plumbing design and equipment to ensure that greywater is safe for intended uses. The California Urban Water Conservation Council considers greywater use to be a potential Best Management Practice (BMP), but has taken no action to elevate it to a mandatory BMP. At this time, greywater is reused to a limited extent in Nevada.

- **Dual Water Systems.** The use of dual water systems is another method for reducing potable water demands. With this strategy, lower quality water (nonpotable) is used for outdoor landscape irrigation and is delivered to users via a second pipeline system separate from the potable water distribution network.

  Approximately one-third of our treated drinking water is used for landscape irrigation. Utilizing untreated water for landscape purposes has the potential to significantly decrease potable water needs. Dual water systems allow public water systems to extend their high quality water sources and reduce water treatment costs. However the requirement for an additional distribution system can cause dual water systems to be cost prohibitive. As with some of the other demand management strategies, the use of dual water systems may be more cost effective for new construction and limited retrofit situations.

  Dual water systems are common along the Wasatch Front in Utah. Most communities in that area utilize dual systems to pipe untreated water for landscape water purposes.

Supply Development Strategies

Supply development strategies include alternative methods for increasing supplies and improving supply reliability, such as use of uncommitted supplies, acquisition and transfer of existing water rights, improved management of both groundwater and surface water supplies, utilization of lower quality (saline) water, and increasing natural supplies. The strategies presented in the following discussion may not be appropriate in all situations and must be examined on a case-by-case basis.

Use of Existing Committed and Uncommitted Supplies. With this strategy, water suppliers further utilize supplies under their existing water rights and/or obtain new appropriations for previously unallocated water. In general, future new allocations will be limited to groundwater as most of the surface water resources have been fully appropriated. For some areas of Nevada, this strategy may be an expensive proposition as most of the unappropriated groundwater resources exist in areas distant from the growing metropolitan areas.

Water Transfers. One tool for increasing available supplies to meet future demands is water transfers. Under this option, water rights are purchased or leased from one user for use by another. As most groundwater and surface water sources are fully appropriated, opportunities for new appropriations are typically limited to basins distant from the growing metropolitan areas. In some cases, water transfers from existing uses may be more cost effective than developing distant sources.

Additional information on transfers is provided in the "Interbasin Transfer" discussion in Part 3 of the *State Water Plan*.

Groundwater Recharge and Recovery. Artificially recharging aquifers is a water resource management option available to some areas as a means of securing more reliable water supplies during periods of low surface water flows. This strategy involves recharging groundwater aquifers with available surface water for later use. In effect, it makes use of an underground reservoir to store water in much the same way that surface water reservoirs are used. The stored water is then removed when needed to augment other supplies. It must be noted that groundwater recharge/recovery is only feasible in certain areas as dictated in part by aquifer conditions.

Underground water storage has a number of advantages over surface reservoirs. In general, surface reservoirs may have higher construction costs and more difficult environmental permitting requirements, and higher water losses (due to evaporation). Nevada state water law provides criteria for the establishment of groundwater recharge/recovery programs.

Additional information on groundwater recharge and recovery is provided in the "Integrated Groundwater and Surface Water Management" discussion in Part 3 of the *State Water Plan*.

Conjunctive use. Conjunctive use is the coordinated management of both surface water and ground water supplies. Under an active form of conjunctive use, surface water is used when available, excess surface water (if available) is stored in groundwater aquifers, and groundwater and stored surface water is then pumped to meet demands over and above those met with the surface water supplies. (Note: With the groundwater recharge/recovery strategy, only the stored surface water is removed to augment existing surface water supplies.) A passive form of conjunctive use is to simply rely on surface water in wet years and use groundwater in dry years with no institutional groundwater recharge program. Benefits of conjunctive use include improved management of resources, more reliable supplies, emergency and drought relief capacity, and summer peaking options.

Additional information on conjunctive use is provided in the "Integrated Groundwater and Surface Water Management" discussion in Part 3 of the *State Water Plan*.

Desalination. Desalination is a process that removes dissolved minerals (including but not limited to salt) from seawater, saline water, or treated wastewater. A number of technologies have been developed for desalination, examples being reverse osmosis (RO) and distillation. Of the more than 7,500 desalination plants in operation worldwide, 60 percent are located in the Middle East. In contrast, 12 percent of the world's desalination capacity is in the Americas, with most of the plants located in the Caribbean and Florida. According to the California Water Plan, California has more than 150 desalting plants (combined capacity of 66,000 acre-feet per year) providing freshwater for municipal, industrial, power, and other uses. In California, the main applications, in order of treatment capacities, are groundwater recovery, wastewater desalination and seawater desalting.

The desalination of saline waters is proven technology but has little application in Nevada. While Nevada does have areas of high salinity groundwater, the cost of developing other freshwater supply options has been more cost effective. Desalination may become more cost effective in the future as available freshwater sources become fully utilized and/or more expensive to develop. As long as cheaper freshwater sources are available, future use of desalination plants in Nevada will be limited.

Desalination for Southern Nevada has been suggested in the form of an exchange with California, i.e. Las Vegas would pay for desalination facilities in California in exchange for the use by Southern Nevada of a portion of California's Colorado River apportionment. However, high desalting costs continue to keep this option as a lower priority.

Cloud Seeding. Cloud seeding is a weather modification technique involving the injection of a substance into a cloud for the purpose of increasing precipitation amounts, thereby increasing snowpack amounts and associated streamflows. In northern Nevada where the primary water source is snowmelt from the Sierra Nevada and other mountain ranges, the appropriate cloud seeding option is one which augments the winter snowpack over these mountain ranges.

Operational cloud seeding over mountain ranges in the western United States has been conducted for over 40 years. Currently, most of the watersheds on the western slopes of the Sierra Nevada have wintertime cloud seeding projects associated with them, with sponsorship primarily by farming organizations and power companies. The value of water to these groups has made cloud seeding a viable alternative for additional water for many years. Cloud seeding first began in Nevada in the Lake Tahoe basin in the 1960s. Currently, cloud seeding activities exist in the drainage basins of Lake Tahoe, Truckee River, Carson River, Walker River, upper Humboldt River, South Fork of the Owyhee River, and Reese River. The Desert Research Institute has designed and operated the Nevada state cloud seeding program since its inception. Estimates of augmented water from seeding have varied from 35,000 to 60,000 acre-feet over each of the last ten years.

Meeting Future Municipal and Industrial (M&I) Water Needs

As already discussed, statewide M&I water use could increase from 525,000 to 1,034,000 acre-feet per year by the year 2020 if current water use patterns continue. Approximately 91 percent of this increase can be attributable to anticipated growth in Clark and Washoe counties. According to planning documents for Clark and Washoe counties, the increase in their M&I demands will be met primarily with expanded utilization of surface water supplies. Projections show that a number of other counties are also expected to experience significant M&I water use growth from 1995 to 2020: Nye (113 percent), Lyon (105 percent), Churchill (89 percent), Pershing (76 percent), Douglas (74 percent), Elko (64 percent), Storey (57 percent), Carson City (56 percent), and Humboldt (55 percent).

Many of these counties have developed or are actively developing plans to deal with these increasing water needs. The most common solutions being considered in these plans are: conservation; expanded use of current supplies; acquisition and transfer of existing rights; reclaimed water use; groundwater recharge/recovery; and conjunctive use. Following is a discussion of some regional water planning efforts that have been undertaken around the State. This is not intended to be an exhaustive presentation of all water supply planning activities in Nevada, but rather an overview of some of the major M&I supply challenges facing different regions and associated potential solutions. Each region has its own unique set of challenges and solutions must be evaluated on a case-by-case basis.

Southern Nevada Water Authority

The Southern Nevada Water Authority (SNWA) was created in 1991 through a cooperative agreement among the seven regional water and wastewater agencies in Clark County. SNWA membership includes:

- Big Bend Water District (Laughlin)
- City of Boulder City
- Clark County Sanitation District
- City of Henderson
- City of Las Vegas
- Las Vegas Valley Water District
- City of North Las Vegas

It should be noted that water use by entities within the Authority accounts for a majority of the Municipal & Industrial (M&I) use in Clark County. The purposes of SNWA are to seek new water resources for Southern Nevada, to manage existing and future water resources, to construct and manage regional water facilities, and to promote responsible conservation. In 1994, the Authority began an integrated resource planning process to aid in the selection of appropriate combinations of resources, facilities and conservation programs to meet future water demands in Southern Nevada. The SNWA Water Resource Plan was completed January 1996 and amended February 1997.

Water Use Forecasts. M&I water withdrawals in Clark County have been forecasted by the Division of Water Planning to increase from about 380,000 acre-feet in 1995 to 784,000 acre-feet in 2020 (Table 4-1). This value corresponds favorably with SNWA's Year 2020 forecasts ("With Existing Conservation" Scenario) for Authority water purveyors. Conservation measures are being successfully implemented by SNWA purveyors. For example, Las Vegas Valley Water District has reduced their total M&I usage from 358 gallons per capita per day (gpcd) in 1989 to 320 gpcd in 1997, a decline of about 11 percent. Domestic usage decreased from 213 gpcd to 197 gpcd during that same period.

The achievement of additional conservation is an integral part of SNWA's Water Resource Plan and needed to meet demands to the Year 2025. Based upon planned additional conservation in the future, SNWA estimated M&I water withdrawals to be approximately 642,000 acre-feet in the Year 2020 and 714,700 acre-feet in 2030 (Table 4-1). The SNWA Water Resource Plan presents options for meeting these demands.

Table 4-1. Comparison of M&I Water Withdrawal Projections for Southern Nevada

Agency	Scenario	Applicable Region	1995 (acre-feet)	2020 (acre-feet)	2030 (acre-feet)
USGS	Estimated historic use	Clark County	380,000	not applicable	not applicable
NDWP	Based upon 1995 water use and conservation patterns	Clark County	See USGS data	784,000	not applicable
SNWA (per SNWA Water Resource Plan)	Based upon existing conservation measures	SNWA water purveyors (Note: Includes about 96% of Clark County's M&I usage; includes both potable and nonpotable water usage)	364,400	777,500	865,400
	With planned additional conservation greater than 1995 patterns			642,000	714,700

Data Sources: U.S. Geological Survey, SNWA Water Resource Plan (1997), Nev. Division of Water Planning

Supply Options. According to the SNWA Water Resource Plan, water demands can be met from now until approximately 2007 by fully utilizing the Authority's existing long-term water supplies, unused Nevada (non-SNWA) Colorado River water, the Las Vegas Valley aquifer, and continuing conservation efforts. The existing long-term water supplies include:

- reclaimed water;
- current groundwater rights;
- pre-1992 Colorado River water rights;
- Colorado River water acquired from Southern California Edison and Basic Management Inc.; and
- SNWA's 1992 contract with the Secretary of the Interior for additional Colorado River water.

To meet increased water demands from 2007 until 2025, the Authority intends to utilize Colorado River surpluses (if available), the Southern Nevada Groundwater Bank, the Arizona Banking Demonstration Project, and the future Arizona groundwater bank (if necessary). The Authority also intends to exercise the 1992 contractual rights it has with the Secretary of the Interior (right similar to those relied upon by California). These rights provide for an annual distribution by the Secretary of the Interior of unused apportionments and surplus flows within the lower Colorado River. Banked water, unused apportionments and surplus flows are all critical resources for the Authority. Since unused apportionments and surplus flows are uncertain, however, the Authority will continue to aggressively pursue other future resources.

Under the Southern Nevada Groundwater Bank, the Las Vegas Valley Water District is recharging available Colorado River water into the regional groundwater system for later use. Under the Arizona Banking Demonstration Project, the Authority paid the Central Arizona Water Conservation District to store a portion of Arizona's Colorado River apportionment in Arizona aquifers for use by Nevada. Under certain conditions, Nevada will be able to divert additional Colorado River water in exchange for the water stored in the Arizona aquifers.

To meet water demands beyond 2025, future resource possibilities for SNWA include: utilization of surface water from the Virgin and/or Muddy rivers, Colorado River water banked in the Southern Nevada Groundwater Bank or the Arizona Groundwater Bank, managed surpluses of Colorado River water, Colorado River transfers and marketing, or construction of the Cooperative Water Project to import groundwater from sixteen hydrologic basins in southern and eastern Nevada via a pipeline network.

Washoe County

In 1995, the Nevada State Legislature approved legislation which created the Washoe County Regional Water Planning Commission and provided the basis and direction for the Commission and the 1995-2015 Washoe County Comprehensive Regional Water Management Plan. This legislation required that the Commission develop "...a comprehensive plan for the region covering the supply of municipal and industrial [public supply] water, quality of water, sanitary sewerage, treatment of sewerage, drainage of storm waters and control of floods." The plan was completed and approved by the 1997 State Legislature. All areas of Washoe County are included in the plan except for the Tahoe Basin, the Pyramid Lake Paiute Reservation, and generally the area north of Pyramid Lake. Water use by the public water systems within the Washoe County Plan area accounts for a majority of the potable water use in Washoe County.

Water Use Forecasts. The Washoe County Plan includes potable water withdrawal projections up to the year 2015 and discusses options for meeting these future needs. Because of uncertainty in future water use patterns, the Washoe County Plan provides a range of potential water use figures.

The Division of Water Planning projected Washoe County public supply withdrawals at 115,800 acre-feet per year for the year 2015 and 123,000 acre-feet for 2020 (Table 4-2). These forecasts were developed using factors representative of 1995 water use patterns and conservation efforts. NDWP's 2015 forecast of 115,800 acre-feet per year is just slightly higher than Washoe County's forecast of 111,500 (with 1996 typical conservation). One reason for the difference is that the NDWP projections include Lake Tahoe, Pyramid Lake Paiute Reservation, and northern Washoe County public supply water usage.

At the direction of the Washoe County Regional Water Planning Commission, the Washoe County Plan identifies the scenario "with Negotiated Settlement" (94,000 acre-feet in the year 2015) as the most probable potable water demand projection. The Washoe County Plan also provides non-potable water demand forecasts. According to the Plan, "[T]he outlook [for non-potable water usage] is for a broad decline in freshwater use to irrigate large public areas (e.g. parks, golf courses) and remaining agricultural lands."

Table 4-2. Comparison of M&I Water Withdrawal Projections for Washoe County

Agency	Scenario	Applicable Region	1995 (acre-feet)	2015 (acre-feet)	2020 (acre-feet)
USGS	Estimated historic use	Washoe County	79,400	not applicable	not applicable
NDWP	Based upon 1995 water use and conservation patterns	Washoe County	See USGS data	115,800	123,000
Washoe County (per Washoe County Water Plan)	With 1996 typical conservation	Washoe County excluding Lake Tahoe basin, Pyramid Lake Paiute Reservation, and northern regions (Note: includes about 95% of Washoe County's M&I usage)	83,300[1]	111,500[1]	not available
	With Negotiated Settlement conservation and metering			94,000[1]	
	With aggressive conservation			86,600[1]	

[1]Values include water withdrawals for domestic wells, however the Washoe County Plan does not provide a detailed breakdown to represent estimated domestic well usage. According to NDWP estimates, 1995 domestic water use was approximately 5,000 acre-feet.

Data Sources: U.S. Geological Survey, 1995-2015 Washoe County Comprehensive Regional Water Management Plan (1997), Nev. Division of Water Planning

Supply Options. Current primary water sources for public supply systems within the Washoe County Plan study area include Truckee River water (about 75 percent) and/or groundwater (about 25 percent). Both of these sources are utilized to meet potable water needs in the Central Truckee Meadows and some outlying areas. For most of the basins outside the Central Truckee Meadows, groundwater is the primary water resource. Conjunctive use of Truckee River water and groundwater is implemented to optimize the yield of the region's water resources, thus reducing the risk that some outlying basins in Washoe County will experience groundwater overdrafts in the near future. Of the current potable water withdrawal of approximately 83,000 acre-feet/year, about 60,000 to 70,000 acre-feet is diverted from the Truckee River with the remainder withdrawn from groundwater sources. The primary water purveyor in Washoe County is Sierra Pacific Power Company (SPPCo) which has produced it own plan entitled "1995-2015 Water Resource Plan." Since issuance of its plan, SPPCo has entered into a service territory agreement with Washoe County making its Truckee River water supplies available regionwide through wholesale agreements. The Washoe County Regional Water Plan recommends that the SPPCo plan serve as the basis for water resource planning in the Central Truckee Meadows and adjoining systems which are interconnected to SPPCo.

The Washoe County Water Plan is based upon the assumption that the Negotiated Settlement (Public Law 101-618) will be fully implemented. The Negotiated Settlement not only provides sufficient water resources for the next 50 years or more, it also secures the community's existing Truckee River supply. The Settlement quiets bi-state claims to Truckee River water, resolves many years of litigation, provides environmental and Tribal benefits, and more than triples available drought storage. Upon full implementation, the Negotiated Settlement will provide a water supply from the Truckee River of 119,000 acre-feet/year (current usage is 60,000 to 70,000 acre-feet/year), sufficient to meet regional water needs well past the Year 2020. Incremental yield of the Negotiated Settlement has been estimated at 39,000 acre-feet per year which reflects the conversion of 42,900 acre-feet of

Truckee River irrigation rights to municipal uses.

Since the Negotiated Settlement is not yet in effect, SPPCo has studied and evaluated alternate resource options. In the event the Settlement is not completed, subsequent Washoe County Plan revisions will need to include alternate water supplies, including regional conjunctive use of resources, artificial recharge and contract(s) for storage in Federal reservoirs.

The Washoe County Water Plan also identifies water supply alternatives for meeting future M&I needs in the valleys north of the Central Truckee Meadows area. These options include: delivery of Truckee River water, and importation of surface water and groundwater from neighboring hydrographic basins.

Douglas County

In 1994, the "Carson Valley Comprehensive Water Plan" was prepared to provide a comprehensive review of municipal water resource supply and provisions of water service to the various communities within the Carson Valley. The plan elements and recommendations were updated and included in the Douglas County Master Plan adopted in 1996. This element of the Water Plan addresses the water needs of those public supply systems in the Carson Valley and Topaz Lake regions of the county. There are a number of public supply systems in the Lake Tahoe basin portion of Douglas County which are not included in the master plan element. Subsequent to the adoption of the 1996 Master Plan, Douglas County has developed updated water use projections for Carson Valley (Douglas County only).

Water Use Forecasts. NDWP has forecasted Douglas County M&I water withdrawals at approximately 18,000 acre-feet for the year 2015 and 19,200 acre-feet for 2020 (Table 4-3). Utilizing higher population estimates, the County has projected annual M&I use (excluding Lake Tahoe basin and the Topaz Lake area) at about 19,500 acre-feet by 2017.

Supply Options. The water element of the Douglas County Master Plan recommends that the future M&I demands (Year 2015) be met by consolidating some of the water systems and further utilizing existing M&I water rights. There are approximately 14 public water supply systems in the Carson Valley and Topaz Lake regions of Douglas County. When considered as a whole, these public supply systems possess sufficient cumulative M&I groundwater rights to meet future M&I water system demands beyond the year 2015. However some of the public supply systems have excess rights, while others have insufficient rights to meet these future demands. The Douglas Master Plan water and wastewater element recommends the physical interconnection of a number of these systems to benefit the systems with inadequate water rights and to improve overall water supply reliability.

Table 4-3. Comparison of M&I Water Withdrawal Projections for Douglas County

Agency	Scenario	Applicable Region	1995 (acre-feet)	2015 (acre-feet)	2020 (acre-feet)
USGS	Estimated historic use	Douglas County	11,100	not applicable	not applicable
NDWP	Based upon 1995 water use and conservation patterns	Douglas County	See USGS data	18,000	19,200
Douglas County Master Plan	With 1996 typical conservation	Douglas County - excluding Lake Tahoe basin and Topaz Lake area (Note: includes about 75% of Douglas County's M&I usage)	9,531 (1996)	19,500 (2017)	not applicable
	With 10% conservation			17,531 (2017)	

Data Sources: U.S. Geological Survey, Douglas County Master Plan (1996), correspondence from Douglas County, Nev. Division of Water Planning

Summary

The previous discussion presented a brief summary of current M&I water supply planning efforts undertaken by SNWA, Washoe County, and Douglas County. Each planning effort has identified strategies that may be useful for other planning efforts.

Upon reviewing these regional plans, a number of observations can be made and some lessons can be learned:

- Water purveyors are utilizing demand management as a means for delaying or reducing the need for additional supplies. Conservation has become commonplace and additional conservation measures are planned for the future. For example, the achievement of additional conservation is an integral part of Southern Nevada Water Authority's water supply plan for the future.

- Effluent reuse has increased in recent years and these plans indicate that this trend will continue during the planning horizon.

- In general, these plans call for a variety of strategies and sources for meeting future demands. By not putting all their eggs in one basket, water purveyors will be able to provide reliable and safe drinking water supplies.

- Conjunctive use and recharge/recovery program are recognized as useful tools for managing both groundwater and surface water sources. The implementation of conjunctive use and recharge/recovery programs will expand in the future.

- Municipal and Industrial water supply planning is being done on a regional basis. All persons within a region can benefit when planning includes all users and interest groups, and considers both water quantity and quality within a region.

- Creative water supply solutions are being developed. With our limited water resources and growing demands, it has become necessary to look for creative solutions, such as SNWA's Arizona Banking Demonstration Project.

- The positive value of regional, consolidated M&I water systems is being acknowledged. Improved water management and "economies of scale" can be realized through water system consolidation.

- Currently, there is little reliance upon greywater and dual water systems, and desalination treatment due to the higher costs of these options. These plans suggest that this trend will probably continue.

One or all of the options presented in the SNWA, Washoe County and Douglas County plans may have possible application for M&I water systems throughout Nevada. Other water purveyors and planners stand to gain valuable insight into their own water supply problems and solutions by studying other water plans.

Meeting Future Agricultural Water Needs

According to U.S. Geological Survey estimates, annual irrigation withdrawals have varied from 3.1 to 3.4 million acre-feet over the last 25 years. Irrigation withdrawals in 1995 were estimated at about 3.1 million acre-feet, with about 63 percent diverted from surface water sources. Historically, irrigated acreage and associated water usage has varied greatly from year to year in response to our fluctuating precipitation and surface water supplies. With highly variable streamflows in Nevada, those agricultural operations utilizing surface water are faced with unreliable supplies during low flow periods. As a result, many of these irrigators have developed groundwater supplies to supplement surface water sources. However, pumping groundwater is generally expensive and may not be cost effective in some cases.

Based upon past use trends, NDWP projects that statewide agricultural water withdrawals could experience a 7 percent decline through 2020. In part, encroaching urbanization and the transfer of agricultural water rights to other uses such as municipal and natural resource needs will drive future agricultural water use reductions.

While the projections in the water plan suggest that the agricultural water supply will be generally adequate to meet future usage, that should not preclude water managers, planners and users from evaluating other water supply and management issues and options such as:

- methods to improve water supply reliability for agricultural users dependent upon fluctuating surface water sources, including storage:
- implementation of water conservation methods;
- increased utilization of treated wastewater effluent; and
- development of available groundwater resources.

Meeting Future Mining Water Needs

Mining water withdrawals are anticipated to remain relatively constant at about 275,000 afy with a slight increase up to the year 2010 followed by a slight decline. Beginning in the early 1990s, a majority of the mining withdrawals have been associated with mine dewatering. These withdrawals have been significantly higher than the mines' consumptive use needs, thereby requiring the mining operations to develop alternative disposal methods for the excess water. A majority of this "excess" water has been either discharged to surface water systems, reinjected into aquifers or used by other sectors such as irrigation. It is anticipated that this trend will continue with pit dewatering activities generating water volumes in excess of mine processing and consumptive needs.

The forecasted future mining withdrawals are estimates only and are highly dependent upon the price of gold. Actual water use may also be affected by shifts from open pit mining to underground mining. However, some degree of mine dewatering is expected to continue regardless of the type of production activity.

Meeting Future Domestic Water Needs

Statewide domestic water withdrawals are forecasted to increase from about 361,000 afy to about 701,000 afy by 2020 in response to a growing population. Public supply systems are the primary providers of water for domestic uses. As of 1995, the domestic water needs for about 94.2 percent of Nevada's population were met by public water systems. This percentage is projected to increase to 95.4 percent by 2020. Nevertheless, the number of persons on domestic wells is still expected to increase from 92,000 to 140,000 over the next 20 years.

Meeting Future Commercial, Industrial and Thermoelectric Water Needs

In 1995, commercial, industrial and thermoelectric sectors withdrew about 238,000 af of water accounting for about 6 percent of total statewide withdrawals. Public supply systems met a majority (about 85 percent) of the total commercial needs in Nevada. In the industrial and thermoelectric sectors, self-supplied systems provided most (95 percent) of the water needs (Table 4-3).

Table 4-3. 1995 Commercial, Industrial and Thermoelectric Water Use

Sector	Self-Supplied Withdrawals (acre-feet per year)	Public Supplied Deliveries (acre-feet per year)	Total Water Use (acre-feet per year)
Commercial	23,500 [15% of total commercial]	129,700 [85% of total commercial]	153,200
Industrial	16,800 [87% of total industrial]	2,500 [13% of total industrial]	19,300
Thermoelectric	63,800 [98% of total thermoelectric]	1,600 [2% of total thermoelectric]	65,400
Total	104,100 [44% ot total commercial, industrial, thermoelectric]	133,800 [56% of total commercial, industrial, thermoelectric]	237,900

Source: U.S. Geological Survey

By the year 2020, commercial, industrial and thermoelectric withdrawals are projected to increase to about 416,000 afy. It is anticipated that public supply systems will continue to satisfy a majority of future commercial water needs, while self-supplied systems will be utilized to meet most future industrial and thermoelectric demands.

Meeting Future Wildlife and Environmental Water Needs

Interest in obtaining the necessary water supplies to meet wildlife and environmental water needs is increasing. However, quantifying these water needs is a challenge. In the broadest sense, all water (with the possible exception of deep groundwater) may provide benefits to wildlife and the environment. For example, all surface water whether in rivers, ponds, lakes or reservoirs supports a variety of flora and fauna, while also supporting other needs such as public system and irrigation uses. Additionally, shallow groundwater supports riparian vegetation and phreatophytes which provide habitat. Also, habitat may be created as a result of other activities such as irrigation. Wildlife and environmental water needs become difficult to quantify when examined in this broad manner.

The securing of water supplies for wildlife and environmental purposes is still a relatively new resource management concept. In recent years, governmental agencies and conservation organizations in Nevada have used a variety of mechanisms to obtain water for fishes, wildlife, special status species, wetlands and water quality improvement. Water has been obtained by purchasing and transferring water rights to a designated water body or portion thereof, filing for new appropriative water rights and entering into formal and informal agreements for reuse of water from agricultural irrigation systems, wastewater treatment plants, mine dewatering operations and an electric generating station. The water obtained for wildlife and environmental needs is generally used to augment stream flow, reservoir and lake levels, spring pools, wetlands and riparian areas.

Water rights have been acquired for the Lower Truckee River, Meadow Valley Wash (Condor Canyon), Upper Blue Lake (Humboldt County), Bruneau River, Carson Lake and Pasture and for a number of other aquatic and wetland resources on various federal wildlife refuges and state wildlife management areas. Many water acquisition projects have been cooperative interagency actions to meet requirements of state and federal legislation, such as the Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Public Law 101-618) Endangered Species Act, Section 404 of the Clean Water Act (wetland protections), the Migratory Bird Treaty Act and the National Environmental Policy Act.

Currently, efforts to assess and provide water supply needs are commonly retrospective, having been concentrated where ecosystem components already are deteriorating. Providing for future wildlife and environmental water supplies requires implementation of an ongoing, structured assessment process to determine where additional water supplies for wildlife and environmental needs are not being met as evidenced by deterioration in essential resource conditions. Laws and regulations have been instituted which require assessment and management actions to minimize the risk that municipal and industrial water supplies will not meet demand. A similar policy approach is needed for wildlife and environmental resources.

Meeting Future Recreation Water Needs

The popularity of water based outdoor recreation continues to grow. The number of people fishing, wildlife watching, boating, and swimming in Nevada's waters has never be higher, significantly adding to the state and local economies. In fact, tourism officials now commonly advertise the other side of Nevada, its expansive landscape and comparatively unique and rare water resources in the desert. Government agencies responsible for maintaining recreation resource values have acquired water for recreation purposes, primarily at reservoirs in the state. However, as recent experience has shown parks managers and visitors, droughts can dramatically impact water supplies at reservoirs, resulting in significant loss of available recreation resource area. Sometimes the seniority of acquired water rights does not ensure water availability during drier seasons.

As with wildlife and environmental water needs, quantification of recreational water needs may be difficult. In some instances, water for recreation is provided as the result of other water use activities. For example, reservoirs created for irrigation or municipal water supplies also provide recreation opportunities as a secondary or additional benefit. Anticipating future water needs for recreation will require implementation of a comprehensive and integrated assessment process. In fact, recreation resource needs are often intertwined with those of wildlife and the environment. Therefore, it would be practical to combine recreation and natural resource water needs assessments.

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Nevada State Water Plan
PART 2 —WATER USE AND FORECASTS

Section 5
Technical Supplement
Water Use Coefficient and Related Forecast Factor Development and Application

Introduction

This technical supplement to the water withdrawal (use) forecasts presented in Section 3, Part 2 of the *Nevada State Water Plan* provides more detailed information as to the methodology behind the forecasts. Specifically, this section provides (1) a description of the water withdrawal categories analyzed and forecasted in this water plan and (2) the process by which specific water use coefficients and related forecast factors were estimated and the methodology used in the forecast development process. Graphs are also provided which present county-specific water use coefficients and other, related forecasts factors. The water use coefficients or factors, presented in gallons per person per day for municipal and industrial (M&I) water use and domestic water use, gallons per worker per day for commercial and industrial water use, or acre-feet per acre per year for irrigation water use, allow for the direct incorporation of socioeconomic forecasts (population, employment, irrigated acreage) into the water planning and forecasting process. This methodology provides the means by which forecasts of water withdrawals for certain economic sectors can be determined directly from changes in related socioeconomic factors.

Water Withdrawal (Use) Forecast Categories (Sectors)

The following water withdrawal categories were analyzed and forecast in this plan.

Total Water Withdrawals — Includes water withdrawals from both public and self-supplied sources for the categories of domestic, commercial and industrial, thermoelectric, public use and losses, mining and agricultural water uses.

Domestic (Residential) Water Withdrawals — Water withdrawn normally for residential purposes, including household use, personal hygiene, drinking, washing clothes and dishes, flushing toilets, watering of domestic animals, and outside uses such as car washing, swimming pools, and for lawns, gardens, trees and shrubs. The water may be obtained from a public supply water system or may be may be self supplied. The State Water Plan presents forecasts for total domestic, public supply domestic and self-supplied domestic water withdrawals.

Commercial and Industrial Water Withdrawals — Water withdrawals for motels, hotels, restaurants, office buildings, and other commercial facilities and institutions, both civilian and military. The water may be obtained from a public supply or may be self supplied. As used in this plan, commercial and industrial water withdrawal forecasts include all water withdrawals by businesses and industry, excluding thermoelectric and mining.

Public Use and Losses **—** Water supplied from a public water supply system (PWSS) and used for such purposes as fire fighting, street washing, and municipal parks, golf courses, and swimming pools. Also includes system water losses (water lost to leakage). Also referred to as public water use or utility water use.

Thermoelectric Water Withdrawals **—** Water withdrawals used for thermoelectric power generation and for cooling purposes in electric power plants. The water may be obtained from a public water supply system or may be self supplied. Only total thermoelectric water withdrawals are forecast within this water plan.

Mining Water Withdrawals **—** Consists of water withdrawals for mining processing functions (presumed to be consumptive uses) and for mine dewatering purposes (assumed to be a non-consumptive use). In actuality, all processing uses are not necessarily consumptive in nature and, similarly, all mine dewatering is not necessarily non-consumptive. For purposes of this water plan, forecasts are presented for total mining water withdrawals as well as those withdrawals for mine processing use and mine dewatering.

Total Agricultural Water Withdrawals **—** All water withdrawals for agricultural purposes consisting of water withdrawals for both irrigation applications (crops and irrigated pasture lands) and livestock watering purposes. Forecasts are presented for total agricultural water withdrawals and its component parts of irrigation water withdrawals and livestock (to include fishery, i.e., hatchery) water withdrawals.

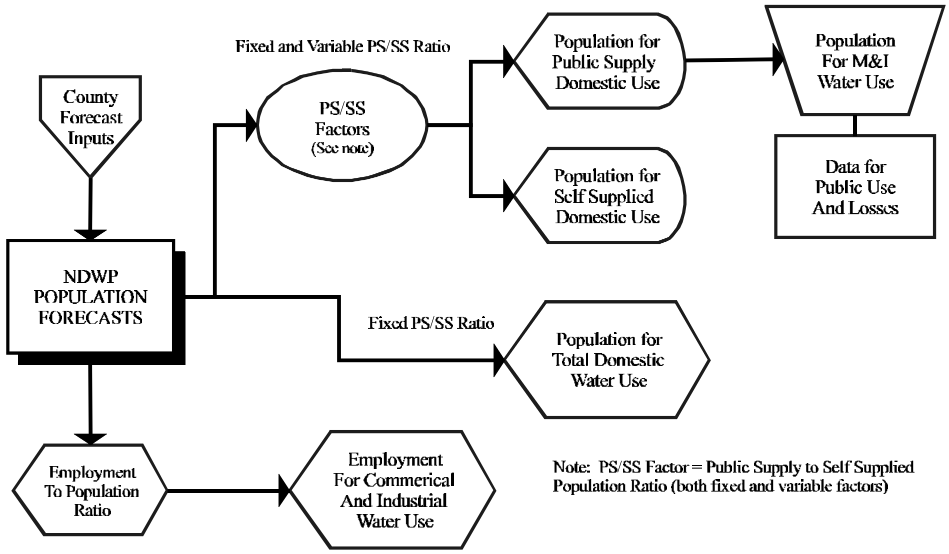
Municipal and Industrial (M&I) Water Withdrawals **—** All water withdrawals supplied by public supply water systems. For the purposes of this planning and forecasting effort, these withdrawals are assumed to consist of water withdrawals for domestic (residential), commercial, industrial and thermoelectric purposes. Unlike the water "use" categories listed above which comprise total water withdrawals, M&I water withdrawals are not so much a water use as it is a measure of the withdrawals from a water "source".

Water Use Coefficient Development and Application in the Water Withdrawal Forecasts

The presentation on water use coefficients (or water use factors) and related factor terms and their application to forecasting water withdrawals for the State of Nevada and its counties is presented in the following sections. These sections pertain specifically to the development of specific and county-unique water use coefficients and their use in forecasting municipal and industrial (M&I) water withdrawals, domestic (residential) water withdrawals (both public supply and self supplied withdrawals), commercial and industrial water withdrawals and total agricultural water withdrawals (consisting of both irrigation and livestock water withdrawals). [*Note:* The terms "water withdrawal" and "water use" are used interchangeably in this presentation. While assumed to have the same in meaning, the term water withdrawal is a more descriptive term as it is intended to represent the total water withdrawn for a specific use category and makes no inference as to degree of consumptive use and return flows from that particular use.]

Flow Chart 1. Population Forecasts and Water Withdrawals shows the basic relationship between the county population forecasts and various water withdrawals by sector. Water withdrawals may be considered as by the source of water, i.e., M&I water from public supply water systems, or by use, i.e., domestic, commercial, industrial, thermoelectric, etc. Population forecasts constitute a crucial part of the forecasts for municipal and industrial (M&I) water withdrawals, public use and losses (from M&I water withdrawals), domestic water withdrawals (both public supply and self supplied), and commercial and industrial water withdrawals (from employment which was based on employment-to-population ratios). The remaining flow charts in this technical supplement reflect the method by which water withdrawal forecasts were determined and are described in greater detail by the equations which follow.

Flow Chart 1. Population and Water Withdrawal Forecasts



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Municipal and Industrial (M&I) Water Withdrawals

The technique to develop M&I water withdrawals is presented in Flow Chart 2. Municipal & Industrial (M&I) Water Withdrawals and the equations which follow. The forecasts for (M&I) Public Use and Losses were based on a county-specific fixed relationship (factor) between the M&I water withdrawal forecast and historical use patterns and then aggregated for the total state. These factors averaged between 9 and 10 percent on a statewide based and are presented for each county in Appendix 3 of the Appendices.

This section on M&I water withdrawals is presented in two parts. Part (A) describes the development of M&I water withdrawals forecasts based on a fixed proportion of the total resident population remaining on public supply water systems whereas Part (B) incorporates a specific variation in this proportion which is unique to each county and uses, as a starting value, the proportion figures for each county for the year 1995. The basic assumption under Part (B) was that there will exist a change in the proportion of the population on public supply water systems, which tends to agree with historical experience. The specific M&I water withdrawal forecasts incorporated in the water plan use the assumption of a variable proportion of the population on public supply water systems.

M&I Fixed Water Withdrawals. (Assumption: A fixed proportion of the population remains on public supply water systems resulting in the use of a fixed total M&I water use coefficient). This population assumption is shown in Equation [1]:

$$[\text{Population on Public Supply Water Systems}]_{\text{Fixed Proportion}} = [\text{Total Resident Population Forecast}] \times [\text{Constant PS/SS Percentage Factor}] \quad [1]$$

The term [Total Resident Population Forecast] in Equation [1] represent the county population forecasts based on NDWP's population growth assumptions (see Appendix 2 of the Appendices for each county's forecasts and aggregated forecasts for the total state). Also in Equation [1], the term

[Constant PS/SS Percentage Factor] [2]

represents a constant proportion (PS/SS = public supply population to self supplied population) of the resident population for 1995 assumed to remain on public supply water systems (and therefore a constant proportion continues to be self supplied). These county-unique fixed proportions are presented in the summary table of water use coefficients and related forecasting factors in Appendix 3 of the Appendices. From this information, total M&I water withdrawals, measured in acre-feet per year and based on a fixed proportion of the population on public supply water systems was determined from

$$[\text{Total M\&I Water Withdrawals}]_{\text{Fixed}} = [\text{Population on Public Supply}]_{\text{Fixed Proportion}} \times [\text{M\&I Water Use Factor}]_{\text{Fixed}} \quad [3]$$

where the M&I water use coefficient (factor) was determined from 1995 historical data by

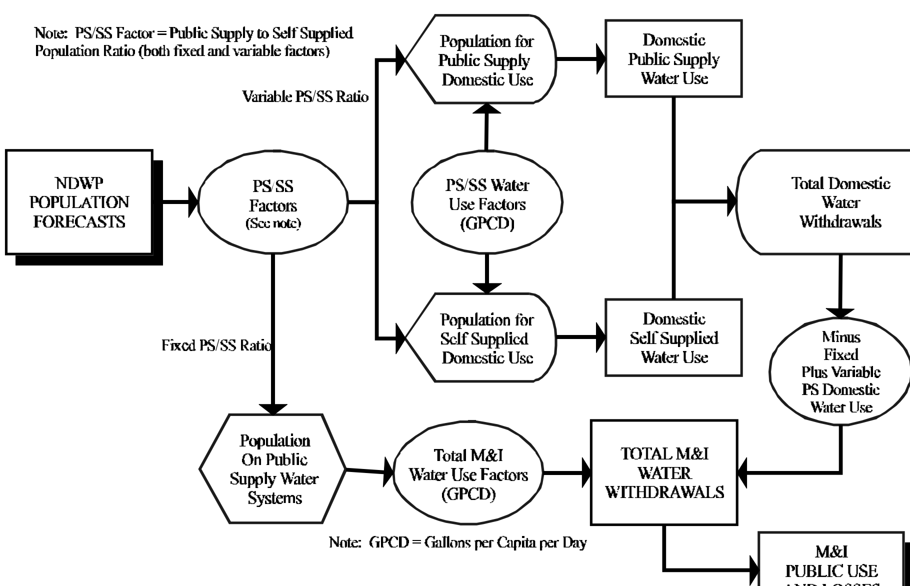
$$[\text{M\&I Water Use Factor}]_{\text{Fixed}} = [\text{M\&I Water Use}]_{1995} / [\text{Population on Public Supply}]_{1995} \quad [4]$$

and is measured in gallons per capita (per person) per day (GPCD).

M&I Variable Water Withdrawals. (Assumption: A variable proportion of the population was on public supply water systems resulting in a variable total M&I water use coefficient; variation in total M&I water use coefficient was based on the difference in total domestic water use based on a varying percent of the population on public supply water systems and the differences in the water use coefficients for domestic public supply usage and domestic self supplied usage). Conceptually, total M&I water withdrawals based on the assumption of a varying proportion of the population on public supply water systems could be calculated using a relationship similar to that presented in Equation [3] above, or,

$$[\text{Total M\&I Water Withdrawals}]_{\text{Variable}} = [\text{Population on Public Supply}]_{\text{Variable Proportion}} \times [\text{M\&I Water Use Factor}]_{\text{Variable}} \quad [5]$$

Flow Chart 2. Municipal & Industrial (M&I) Water Withdrawals



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where the population on public supply water systems in Equation [5] was determined from Equation [6] presented below:

$$[\text{Population on Public Supply}]_{\text{Variable Proportion}} = [\text{Total Resident Population Forecast}] \times [\text{Variable PS/SS Percentage Factor}] \quad [6]$$

In Equation [6], the term [Variable PS/SS Percentage Factor] represents a variable proportional term unique for each county based on the historical (1995) proportion of the population on public supply water systems and forecasts of changes in this proportion through the year 2020. This information for each county is presented in Appendix 3 of the Appendices. However, the water use coefficient term, $[\text{M\&I Water Use Factor}]_{\text{Variable}}$, presented in Equation [5] is unknown in this situation as it will vary by population proportions (public and self supplied) and specific water use coefficients for these types of uses. Furthermore, it cannot be readily calculated and will therefore have to be calculated indirectly.

The change in total M&I water withdrawals based on the forecast assumption of a varying proportion of the population on public supply water systems, however, can be determined from the change in total domestic water withdrawals based on changes in the proportion of the population on public supply water systems. Therefore, the following equation will be used in lieu of Equation [5] to calculate the total M&I water withdrawals based on variations in the population on public supply water systems:

$$[\text{Total M\&I Water Withdrawals}]_{\text{Variable}} = [\text{Total M\&I Water Withdrawals}]_{\text{Fixed}} - [\text{Public Supply Domestic Water Withdrawals}]_{\text{Fixed}} + [\text{Public Supply Domestic Water Withdrawals}]_{\text{Variable}} \quad [7]$$

In Equation [7] the term $[\text{Total M\&I Water Withdrawals}]_{\text{Fixed}}$ was calcuated in Equation [3], above, and both the terms $[\text{Public Supply Domestic Water Withdrawals}]_{\text{Fixed}}$ and $[\text{Public Supply Domestic Water Withdrawals}]_{\text{Variable}}$ can be determined directly from population forecasts, estimated proportions of the population on public supply water systems, and appropriate domestic public and self supplied water use coefficients. These calculations and equations are presented in the next section on forecasting domestic water withdrawals.

The term $[\text{Public Supply Domestic Water Withdrawals}]_{\text{Variable}}$ in Equation [7], unlike the term $[\text{Public Supply Domestic Water Withdrawals}]_{\text{Fixed}}$, will therefore incorporate the effects of a varying proportion of the population on public supply water systems. Inherent in this methodology is that the water use factors for other components of M&I water use, i.e., commercial and industrial, will not change over time. From Equation [7], the variable M&I water use coefficient term, $[\text{M\&I Water Use Factor}]_{\text{Variable}}$, measured in gallons per capita (person) per day (GPCD), can then be determined from Equation [8]:

$$[\text{M\&I Water Use Factor}]_{\text{Variable}} = [\text{Total M\&I Water Withdrawals}]_{\text{Variable}} / [\text{Population on Public Supply}]_{\text{Variable Proportion}} \quad [8]$$

As the calculation of this M&I water use coefficient (factor) in Equation [8] is made “after the fact,” that is, after the (variable population) total M&I water withdrawals have already been calculated, the coefficient itself serves no useful function in the forecast development and only shows the resultant variation in the M&I water use coefficient based on the assumption of a varying proportion of the population being served by public supply water systems. Also, since the coefficient incorporates specific assumptions about population forecasts and forecasts of the proportion of that population on public supply water systems, its usefulness in future forecasts and planning is restricted to retaining these exact assumptions.

The final water use forecast described in this section deals with public use and losses. As shown in Flow Chart 2, forecasts of this type of water withdrawal are based directly on the level of M&I water withdrawals. The relationship between each county's historical public use and losses and its total M&I water withdrawals resulted in a county-specific public use and loss factor as presented in Appendix 3 of the Appendices. These factors were then used to forecast public use and losses as follows:

$$\text{[Public Use and Losses]} = \text{[Total M\&I Water Withdrawals]}_{\text{Variable}} \times \text{[Public Use and Losses Factor]}_{\text{Fixed}} \qquad [9]$$

from which the fixed term [Public Use and Losses Factor]$_{\text{Fixed}}$ in Equation [9] is based on historical 1995 data as calculated from

$$\text{Public Use and Losses Factor]}_{\text{Fixed}} = \text{[Public Use and Losses]}_{1995} \, / \, \text{[Total M\&I Water Withdrawals]}_{1995} \qquad [10]$$

No changes in these factor terms for all counties were made over the forecast horizon.

Total Domestic (Residential), Public Supply Domestic, and Self-Supplied Domestic Water Withdrawals

The technique to develop the domestic water withdrawal forecasts are presented in Flow Chart 3. Total Domestic (Residential) Water Withdrawals. This flow chart, and the equations below, describe the method used to develop water use forecasts on both a fixed and variable basis, that is, (1) the assumption that a fixed proportion of the population remains on public supply systems (Part A) and (2) that this proportion varies over the forecast horizon (Part B). This distinction becomes important as it is the variable Total Domestic Water Withdrawal forecasts that are incorporated in this plan and are also used for the development of the Total M&I Water Withdrawal forecasts presented in the previous section.

Total Domestic, Public Supply and Self-Supplied Fixed Water Withdrawals. (Assumption: A fixed proportion of the resident population remains on public supply water systems resulting in a fixed total domestic water use coefficient). Total domestic water withdrawals, in acre-feet per year, can be calculated from the relationship in Equation [11]:

$$\text{[Total Domestic Water Withdrawals]}_{\text{Fixed}} = \text{[Total Resident Population Forecast]} \times \text{[Total Domestic Water Use Factor]}_{\text{Fixed}} \qquad [11]$$

where the water use factor, in gallons per capita (person) per day (GPCD), was determined from historical information on water withdrawals and populations such that

$$\text{[Total Domestic Water Use Factor]}_{\text{Fixed}}$$

$$= [\text{Total Domestic Water Use}]_{1995} \,/\, [\text{Total Resident Population}]_{1995} \qquad [12]$$

Similarly, for the domestic public supply water withdrawals, in acre-feet per year, we can use

$$[\text{Domestic Public Supply Water Withdrawals}]_{\text{Fixed}}$$
$$= [\text{Resident Population}]_{\text{Public Supply–Fixed}} \text{ x } [\text{Domestic Public Supply Use Factor}]_{\text{Fixed}} \qquad [13]$$

where the domestic public supply water use factor, measured in gallons per capita (person) per day (GPCD), was calculated using historical relationships such that

$$[\text{Domestic Public Supply Water Use Factor}]_{\text{Fixed}}$$
$$= [\text{Domestic Public Supply Water Use}]_{1995} \,/\, [\text{Population on Public Supply}]_{1995} \qquad [14]$$

Likewise, for the domestic self-supplied water withdrawals, also measured in acre-feet per year, we can use

$$[\text{Domestic Self-Supplied Water Withdrawals}]_{\text{Fixed}}$$
$$= [\text{Resident Population}]_{\text{Self Supplied–Fixed}} \text{ x } [\text{Domestic Self-Supplied Use Factor}]_{\text{Fixed}} \qquad [15]$$

where the domestic self-supplied water use factor, measured in gallons per capita (person) per day (GPCD), was calculated using historical data such that

$$[\text{Domestic Self-Supplied Water Use Factor}]_{\text{Fixed}}$$
$$= [\text{Domestic Self-Supplied Water Use}]_{1995} \,/\, [\text{Population being Self Supplied}]_{1995} \qquad [16]$$

Total Domestic, Public Supply and Self-Supplied Variable Water Withdrawals. (Assumption: A variable proportion of the population is on public supply water systems resulting in a variable total domestic water use coefficient; variation in the total domestic water use coefficient is based on the differences in the domestic public supply usage rate and the domestic self supplied usage rate). Here, the total domestic water withdrawals cannot be calculated directly due to the variations that will occur in the total domestic water use factor from the changing proportion of the population on public supply water systems. Therefore, total domestic water withdrawals are calculated from its separate components, as shown in Equation [17] below:

$$[\text{Total Domestic Water Withdrawals}]_{\text{Variable}} = [\text{Domestic Public Supply Water Withdrawals}]_{\text{Variable}}$$
$$+ [\text{Domestic Self-Supplied Water Withdrawals}]_{\text{Variable}} \qquad [17]$$

where domestic public supply water withdrawals, measured in acre-feet per year and assuming a variable proportion of population on public supply water systems, can be calculated from Equation [18] below:

$$[\text{Domestic Public Supply Water Withdrawals}]_{\text{Variable}}$$
$$= [\text{Population on Public Supply}]_{\text{Variable Proportion}} \text{ x } [\text{Domestic Public Supply Use Factor}]_{\text{Fixed}} \qquad [18]$$

Similarly, the domestic self supplied water withdrawals in acre-feet per year can be calculated from

$$[\text{Domestic Self-Supplied Water Withdrawals}]_{\text{Variable}}$$

$$= [\text{Population being Self Supplied}]_{\text{Variable Proportion}} \times [\text{Domestic Self-Supplied Use Factor}]_{\text{Fixed}} \quad [19]$$

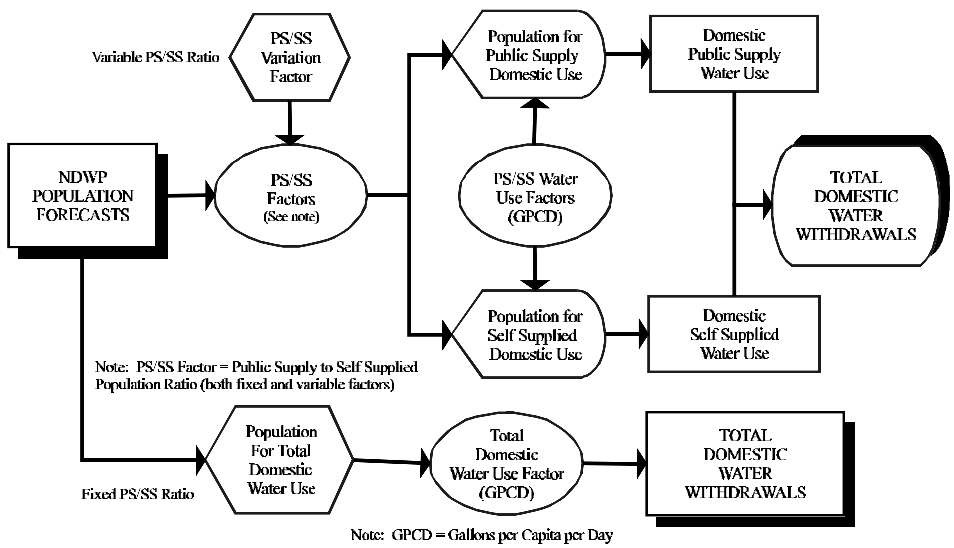
In order to determine the proportion of the resident population being self supplied, we can use the relationship shown in Equation [6] for the determination of the variations in the population on public supply water systems (and therefore the population being self supplied). Based on this relationship, we have the relationship shown in Equation [20]:

$$[\text{Population on Public Supply}]_{\text{Variable Proportion}} = [\text{Total Resident Population Forecast}] \times [\text{Variable PS/SS Percentage Factor}] \quad [20]$$

with the requirement that

$$[\text{Total Resident Population Forecast}] = [\text{Population on Public Supply}]_{\text{Variable Proportion}} + [\text{Population being Self Supplied}]_{\text{Variable Proportion}} \quad [21]$$

Flow Chart 3. Domestic (Residential) Water Withdrawals



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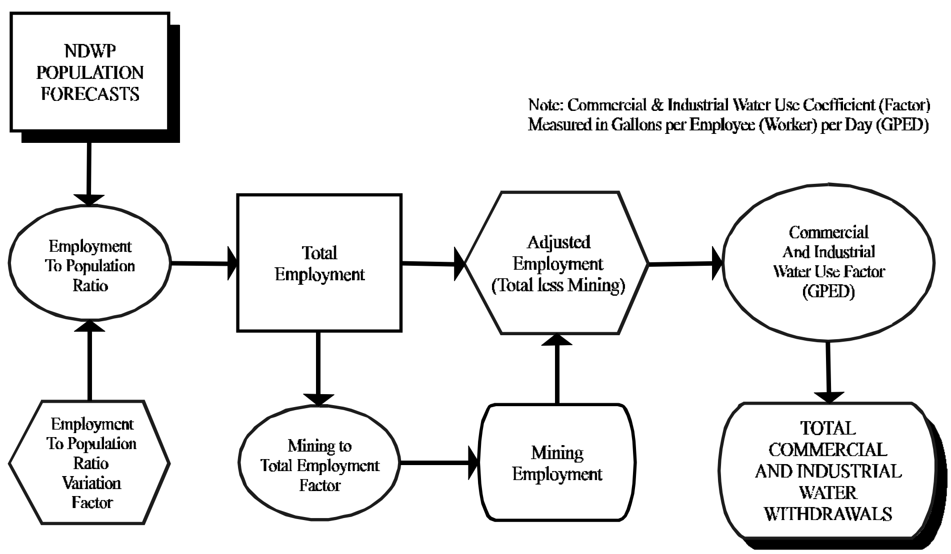
Calculations of total domestic, public supply domestic and self supplied domestic water withdrawal forecasts, along with all assumptions, water use factors and population proportions on public supply water systems, are presented in Appendix 3 of the Appendices for all counties and aggregated for the total state.

Commercial and Industrial Water Withdrawals

The water withdrawal forecasts for commercial and industrial water use are presented in Flow Chart 4. Commercial and Industrial Water Withdrawals and presented in more detail in the equations below. Flow Chart 4 shows that this forecast methodology incorporates three forecast factors. First, total employment was estimated for each county based on a unique forecast of that county's employment-to-population ratio. This ratio was based on the county's 1997 figure and assumed to vary over the forecast horizon. The ratio variation rate constituted the second forecast factor. The third forecast factor was the county-specific commercial and industrial water use coefficient, in gallons per employee (per worker) per day (GPED), and was based on each individual county's commercial structure and historical water use patterns. This coefficient was kept constant over the forecast horizon as its value was based more on the nature of production and the state of technology.

Total commercial and industrial water withdrawals were therefore forecast using forecasts of a socioeconomic measure (i.e., employment) and a water use factor. The water use factor, in gallons per employee per day, represented an average water usage rate for all employment classifications. While it is known that various industry sectors use water at different rates (i.e., at varying gallons per employee per day, or GPED's) based on unique processing and business conditions, so long as the overall composition of employment and production does not show significant changes over the forecast horizon, this fixed commercial water use coefficient represents a reasonable assumption of average water use rate for all industry sectors.

Flow Chart 4. Commercial & Industrial Water Withdrawals



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One important alteration in this methodology was the exclusion of mining employment from the total employment figures and from the determination of the commercial and industrial water use coefficient calculation. This was necessary as mining water withdrawals were determined from direct forecasts of mining output. Using this methodology, total commercial and industrial water withdrawals, measured in acre-feet per year, were calculated from Equation [22]:

$$[\text{Commercial \& Industrial Water Withdrawals}] = [\text{Total Employment}]_{\text{Adjusted}} \text{ x } [\text{Commercial \& Industrial Use Factor}]_{\text{Fixed}} \quad [22]$$

where the adjusted total employment term in Equation [22] was derived from

$$[\text{Total Employment}]_{\text{Adjusted}} = [\text{Total Employment}] - [\text{Mining Employment}] \quad [23]$$

Equation [23] reflects the removal of the forecasted mining employment from the forecasts of each county's total employment. These forecasts of total employment and mining employment are presented In Appendix 3 of the Appendices for each county and the total state, with the statewide total being an aggregation of the individual counties. The commercial and industrial water use coefficient, measured in gallons per worker per day, was calculated from historical data on water use and employment using the following equation:

$$[\text{Commercial \& Industrial Use Factor}]_{\text{Fixed}}$$

$$= [\text{Commercial \& Industrial Water Use}]_{1995} \,/\, [\text{Total Employment} - \text{Mining Employment}]_{1995} \quad [24]$$

As can be seen from Equation [24], above, the development of the commercial and industrial water use factor also incorporated the removal of mining employment. Total employment for each county was determined uniquely from historical relationships between the total employment and the total resident population and presented in the form of a county-unique employment-to-population ratio.

Historical employment-to-population ratios for 1997 for Nevada and all counties are presented in Fig. 5–9. Employment to Population Ratios. These ratio, which varied uniquely for each county over the forecast horizon, were then used to forecast each county's total employment (and the total state from an aggregation of the county forecasts) as shown in the following equation:

$$[\text{Total Employment}] = [\text{Total Resident Population Forecast}] \times [\text{Employment-to-Population Ratio}]_{\text{Variable}} \quad [25]$$

where forecasts of the term [Employment-to-Population Ratio]$_{\text{Variable}}$ in Equation [25] were estimated uniquely for each county based on forecasts of future industrial development and related employment trends versus population forecasts. Each county's mining employment (aggregated to a statewide total) was also determined uniquely based on current mining conditions and trends and forecasts of future mining activity. These forecasts of mining employment are presented in detail for each county in Appendix 3 of the Appendices and were based on the following calculation:

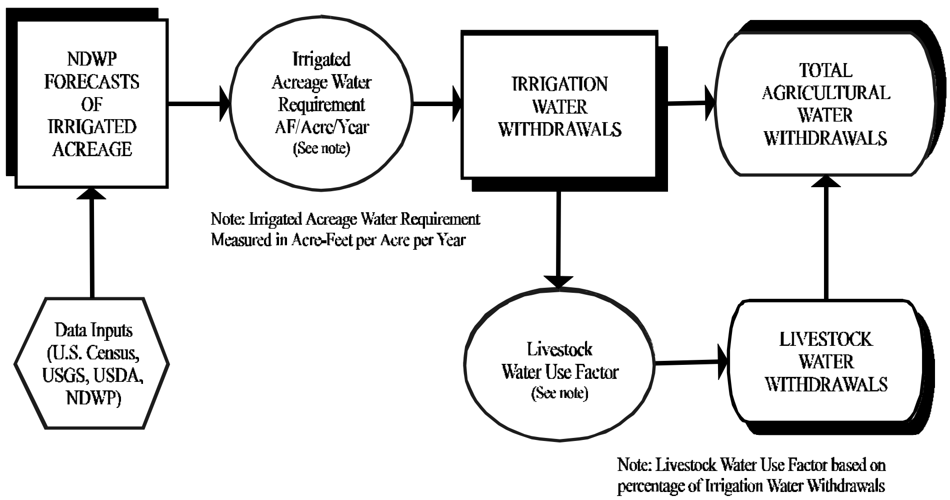
$$[\text{Mining Employment}] = [\text{Total Employment}] \times [\text{Mining Employment Factor}]_{\text{Variable}} \quad [26]$$

where [Mining Employment Factor]$_{\text{Variable}}$ represented the assumption of a variable percent of mining employment to total county employment.

Agricultural Water Withdrawals

The methodology for total agricultural, irrigation and livestock water withdrawals is presented in Flow Chart 5. Total Agricultural, Irrigation and Livestock Water Withdrawals and is presented greater detail in the equations below. Agricultural water withdrawals were driven from forecasts of (1) irrigated acreage, (2) county-unique irrigated acreage water use requirements, and (3) county-specific relationships of irrigation water withdrawals and livestock water withdrawals. This assumption of a consistent link (i.e., fixed factor) between livestock water needs and irrigation water withdrawals represented a simplifying assumption and precluded the need to make county-specific livestock forecasts independently of forecasts of irrigated acreage and pasture lands, which itself may be subject to errors and inconsistencies. All historical trends, irrigation and livestock forecast assumptions, and forecasts for both irrigation and livestock water withdrawals are presented in Appendix 4 of the Appendices for each county and aggregated for the statewide total.

Flow Chart 5. Total Agriculture, Irrigation and Livestock Water Withdrawals



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The basic calculation for forecasting each county's total agricultural water withdrawals, measured in acre-feet per year, was based on the relationship shown in Equation [27]:

[Total Agricultural Water Withdrawals]
= [Irrigation Water Withdrawals] + [Livestock Water Withdrawals] [27]

where forecasted irrigation water withdrawals in Equation [27] are based on forecasts of total irrigated acreage (including irrigated pasture lands) times a fixed irrigated acreage water use requirement, measured in acre-feet per acre per year, such that

[Irrigation Water Withdrawals]
= [Irrigated Acreage] x $[\text{Irrigated Acreage Water Use Requirement}]_{\text{Fixed}}$ [28]

Livestock water withdrawals in Equation [27] are based on the level of irrigation water withdrawals times a "livestock water use factor" which is based on historical conditions, or

$$[\text{Livestock Water Withdrawals}] = [\text{Irrigation Water Use}] \times [\text{Livestock Water Use Factor}]_{\text{Fixed}} \qquad [29]$$

Forecasts of each county's irrigated acreage were based on historical trends and a "best fit" non-linear line (curve fit) of these trends extrapolated out to the year 2020. Graphs and tables of historical data and forecasts for each county's irrigated acreage are presented in detail in Appendix 4 of the Appendices. The irrigated acreage water use requirement coefficient term was determined from historical water use patterns by the equation

$$[\text{Irrigated Acreage Water Use Requirement}]_{\text{Fixed}} = [\text{Irrigation Water Withdrawals}]_{1995} / [\text{Total Irrigated Acreage}]_{1995} \qquad [30]$$

The livestock water withdrawals were assumed to be based on the level of irrigation water withdrawals and a fixed factor term, $[\text{Livestock Water Use Factor}]_{\text{Fixed}}$, in Equation [29] representing the historical relationships between livestock water withdrawals and irrigation water withdrawals, such that

$$[\text{Livestock Water Use Factor}]_{\text{Fixed}} = [\text{Livestock Water Withdrawals}]_{1995} / [\text{Irrigation Water Withdrawals}]_{1995} \qquad [31]$$

Both the irrigated acreage water use requirement (as shown in Fig. 5-11. Irrigated Acreage Water Requirement) and the livestock use coefficient (as shown in Fig. 5-12. Livestock to Irrigation Water Withdrawals), while unique to each county, are assumed to be fixed over the forecast horizon. State of Nevada totals for both irrigation water withdrawals and livestock water withdrawals were based on the aggregation of individual county forecasts of these measures.

Graphs: Water Use Coefficients and Related Forecast Factors

The graphs on the following pages present the county-specific water use coefficients and related forecasts factors used in the forecast model equations just described.

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Nevada State Water Plan
PART 2 — WATER USE AND FORECASTS

Section 6
Glossary of Terminology

[Source: Nevada Division of Water Planning's *Water Words Dictionary*. Words presented in italics and the referenced appendices may be found in the Dictionary. Words and definitions included in this glossary which explain or summarize elements of existing water law are not intended to change that law in any way.]

Acre-Feet (AF) — A unit commonly used for measuring the volume of water. See *Acre-Foot*.

Acre-Foot (AF) — A unit commonly used for measuring the volume of water; equal to the quantity of water required to cover one acre (43,560 square feet or 4,047 square meters) to a depth of 1 foot (0.30 meter) and equal to 43,560 cubic feet (1,234 cubic meters), or 325,851 gallons.

Agricultural Use — The use of any tract of land for the production of animal or vegetable life; uses include, but are not limited to, the pasturing, grazing, and watering of livestock and the cropping, cultivation, and harvesting of plants.

Agricultural Water Use (Withdrawals) — Includes water used for irrigation and non-irrigation purposes. Irrigation water use includes the artificial application of water on lands to promote the growth of crops and pasture, or to maintain vegetative growth in recreational lands, parks, and golf courses. Non-irrigation water use includes water used for livestock, which includes water for stock watering, feedlots, and dairy operations, and fish farming and other farm needs.

Average Water Year — A term denoting the average annual hydrologic conditions based upon an extended or existing period of record. Because precipitation, runoff, and other hydrologic variables vary from year to year, planners typically project future scenarios based on hydrologic conditions that generally include average, wet (high-water), and drought (low-water) years.

Basin — (1) (Hydrology) A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often natural or man-made lakes. Also referred to as *Drainage Basin*, *Watershed*, or *Hydrographic Region*. (2) (Irrigation) A level plot or field, surrounded by dikes, which may be flood irrigated. (3) (Erosion Control) A catchment constructed to contain and slow runoff to permit the settling and collection of soil materials transported by overland and rill runoff flows. (4) A naturally or artificially enclosed harbor for small craft, such as a yacht basin.

Blackwater — Water that contains animal, human, or food wastes; wastewater from toilet, latrine, and agua privy flushing and sinks used for food preparation or disposal of chemical or chemical-biological ingredients. Compare to *Greywater*.

CFS (Cubic Foot per Second) — A unit of discharge for measurement of flowing liquid equal to a flow of one cubic foot per second past a given section. A rate of flow equivalent to 448.83 gallons per minute. Also called *Second-Foot*.

CFS-Day — The volume of water represented by a flow of 1 cubic foot per second for 24 hours. It equals 86,400 cubic feet, 1.983471 acre-feet, or 646,317 gallons.

Cloud Seeding — A *Weather Modification* technique involving the injection of a substance into a cloud for the purpose of influencing the cloud's subsequent development. Ordinarily, this refers to the injection of a nucleating agent, which creates a nucleus around which precipitation will form. In common practice, cloud seeding involves the aerial release of silver iodide particles into convective clouds to create thunderstorms.

Commercial Water Use (Withdrawals) — Water for motels, hotels, restaurants, office buildings, and other commercial facilities and institutions, both civilian and military. The water may be obtained from a public supply or may be self supplied. The terms "water use" and "water withdrawals" are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also see *Industrial Water Use (Withdrawals)*, *Public Water Supply System* and *Self-Supplied Water*.

Community Water System — A public water system with 15 or more connections and serving 25 or more year-round residents and thus is subject to the *U.S. Environmental Protection Agency (EPA)* regulations enforcing the *Safe Drinking Water Act (SDWA)*.

Conjunctive Management — The integrated management and use of two or more water resources, such as a (groundwater) aquifer and a surface water body.

Conjunctive (Water) Use — (1) The combined use of surface and groundwater systems and sources to optimize resource use and prevent or minimize adverse effects of using a single source; the joining together of two sources of water, such as groundwater and surface water, to serve a particular use. (2) The integrated use and management of hydrologically connected groundwater and surface water.

Conservation — (1) Increasing the efficiency of energy use, water use, production, or distribution. (2) The careful and organized management and use of natural resource, for example, the controlled use and systematic protection of natural resources, such as forests, soil, and water systems in accordance with principles that assure their optimum long-term economic and social benefits. Also, preservation of such resources from loss, damage, or neglect.

Consumption, Domestic — The quantity or quantity per capita (person) of water consumed in a municipality or district for domestic uses during a given period, usually one day. Domestic consumption is generally considered to include all uses included in "municipal use of water," in addition to the quantity of water wasted, lost, or otherwise unaccounted for. Also see *Consumption, Municipal*; *Municipal Use of Water*.

Consumption, Industrial — The quantity of water consumed in a municipality or district for mechanical, trade, and manufacturing uses during a given period, usually one day.

Consumption, Municipal — The quantity of water consumed through use in developed urban areas. Also see *Consumption, Domestic*; *Consumptive Use*.

Consumptive (Water) Use — (1) A use which lessens the amount of water available for another use (e.g., water that is used for development and growth of plant tissue or consumed by humans or animals). (2) A use of water that renders it no longer available because it has been evaporated, transpired by plants, incorporated into products or corps, consumed by people or livestock, or otherwise removed from water supplies. (3) The portion of water withdrawn from a surface or groundwater source that is consumed for a particular use (e.g., irrigation, domestic needs, and industry), and does not return to its original source or another body of water. No typical use is 100 percent efficient; there is always some return flow associated with a use either in the form of a return to surface flows or as a ground water recharge. Nor are typically nonconsumptive uses of water entirely nonconsumptive. There are evaporation losses, for instance, associated with maintaining a reservoir at a specified elevation to support fish, recreation, or hydropower, and there are conveyance losses associated with maintaining a minimum streamflow in a river, diversion canal, or irrigation ditch.

Consumptive Water Use, Irrigation — The quantity of water that is absorbed by the crop and transpired or used directly in the building of plant tissue, together with that evaporated from the cropped area. Does not include runoff or deep percolation in support of the *Crop Leaching Requirement*.

Crop Irrigation Requirement — The amount of irrigation water in acre-feet per acre required by the crop; it is the difference between *Crop Consumptive Use*, or *Crop Requirement*, and the effective precipitation for plant growth. To this amount the following items, as applicable, are added: (1) irrigation applied prior to crop growth; (2) water required for leaching; (3) miscellaneous requirements of germination, frost protection, plant cooling, etc.; and (4) the decrease in soil moisture should be subtracted.

Cropland — Land currently tilled, including cropland harvested, land on which crops have failed, summer fallowed land, idle cropland, cropland planted in cover crops or soil improvement crops not harvested or pastured, rotation pasture, and cropland being prepared for crops, or newly seeded cropland. Cropland also includes land planted in vegetables and fruits, including those grown on farms for home use. All cultivated (tame) hay is included as cropland. Wild hay is excluded from cropland and included in pasture and range.

Cross-Sectional Analysis — (Statistics) Observations or characteristics of a variable analyzed without respect to variations due to time. Cross-sectional econometric models provide information on the behavior of a variable due to external factors. Contrast with *Time-Series Analysis*.

Cubic Feet Per Second (CFS) — A unit expressing rate of discharge, typically used in measuring streamflow. One cubic foot per second is equal to the discharge of a stream having a cross section of 1 square foot and flowing at an average velocity of 1 foot per second. It also equals a rate of approximately 7.48 gallons per second, 448.83 gallons per minute. 1.9835 acre-feet per day, or 723.97 acre-feet per year.

Cubic Feet Per Second Day (CFS-Day) — The volume of water represented by a flow of one cubic foot per second for 24 hours. It equals 86,400 cubic feet, 1.983471 acre-feet, or 646,317 gallons.

Demand Management Alternatives — Water management programs that reduce the demand for water, such as water conservation, drought rationing, rate incentive programs, public awareness and education, drought landscaping, etc.

Dependable Supply — That water which can be expected to be available at a time and place with the quality demanded; sometimes the amount of water available is at a stated percentage of time.

Dependable Yield — The maximum annual supply of a given water development that is expected to be available on demand, with the understanding that lower yields will occur in accordance with a predetermined schedule or probability. More frequently referred to as *Firm Yield*.

Desalination, or Desalinization — (1) To remove salts and other chemicals, as from sea water or soil, for example. Usually used with respect to the salt contained in water. (2) Specific treatment processes to demineralize sea water or brackish (saline) water for reuse. Also referred to as *Desalting*.

Designated Groundwater Basin — A basin where permitted ground water rights approach or exceed the estimated average annual recharge and the water resources are being depleted or require additional administration. Under such conditions, a state's water officials will so designate a groundwater basin and, in the interest of public welfare, declare *Preferred Uses* (e.g., municipal and industrial, domestic, agriculture, etc.). Also referred to as *Administered Groundwater Basin*.

Designated Groundwater Basin [Nevada] — In the interest of public welfare, the Nevada State Engineer, *Division of Water Resources*, *Department of Conservation and Natural Resources*, is authorized by statute (Nevada Revised Statute 534.120) and directed to designate a ground water basin and declare *Preferred Uses* within such designated basin. The State Engineer has additional authority in the administration of the water resources within a designated ground water basin.

Dewater, and Dewatering — (1) To remove water from a waste produce or streambed, for example. (2) The extraction of a portion of the water present in sludge or slurry, producing a dewatered product which is easier to handle. (3) (Mining) The removal of ground water in conjunction with mining operations, particularly open-pit mining when the excavation has penetrated below the ground-water table. Such operations may include extensive ground-water removal and, if extensive enough and if not re-injected into the groundwater, these discharges may alter surface water (stream) flows and lead to the creation of lakes and wetland areas. As such water removals only last so long as the mine is in operation, eventually surface water impacts, if present, will be eliminated, consequently jeopardizing surface water uses, such as irrigation, livestock, wildlife, or riparian habitat that may have become dependent upon the continuation of these temporary flows. Also, when the mine dewatering operations cease, the remaining open pit will eventually begin to fill up with ground water, resulting in significantly increased evaporation from ground water reservoirs.

Domestic Water — Water supplied to individual dwellings and other land uses which is suitable for drinking.

Domestic Water Use (Withdrawals) — Water used normally for residential purposes, including household use, personal hygiene, drinking, washing clothes and dishes, flushing toilets, watering of domestic animals, and outside uses such as car washing, swimming pools, and for lawns, gardens, trees and shrubs. The water may be obtained from a public supply or may be self supplied. The terms "water use" and "water withdrawals" are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also referred to as *Residential Water Use*. Also see *Public Water Supply System* and *Self-Supplied Water*.

Evapotranspiration (ET) — (1) The quantity of water transpired (given off), retained in plant tissues, and evaporated from plant tissues and surrounding soil surfaces. (2) The sum of *Evaporation* and *Transpiration* from a unit land area. (3) The combined processes by which water is transferred from the earth surface to the atmosphere; evaporation of liquid or solid water plus transpiration from plants. Evapotranspiration occurs through evaporation of water from the surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants (*Phreatophytes*) whose roots tap the capillary fringe of the groundwater table. The sum of evaporation plus transpiration.

Forecast (Forecasting) — (Statistics) A forecast is a quantitative estimate (or set of estimates) about the likelihood of future events based on past and current information. This "past and current information" is specifically embodied in the structure of the econometric model used to generate the forecasts. By extrapolating the model out beyond the period over which it was estimated, we can use the information contained in it to make forecasts about future events. It is useful to distinguish between two types of forecasting, *ex post* and *ex ante*. In an *ex post* forecasts all values of dependent and independent variables are known with certainty and therefore provides a means of evaluating a forecasting model. Specifically, in an *ex post* forecast, a model will be estimated using observations excluding those in the *ex post* period, and then comparisons of the forecasts will be made to these actual values. An *ex ante* forecast predicts values of the dependent variable beyond the estimation period using values for the explanatory variables which may or may not be known with certainty.

Forecast Horizon — (Statistics) The number of time periods to be forecasted; also, the time period in the future to which forecasts are to be made.

Gallon [U.S.] — A unit of capacity, containing four quarts, used in the United States primarily for liquid measure. One U.S. gallon contains 231 cubic inches, 0.133 cubic feet, or 3.7853 liters. It takes approximately 325,851 gallons to make up 1 acre-foot (AF). [*Historical Note:* The U.S. gallon is the same as the old English *wine gallon* which was originally intended in England to be equivalent to a cylinder of seven inches in diameter and six inches in height.]

Gallons per Capita (GPC) — A term used relative to water use per person per specified time, usually a day.

Gallons per Capita (Person) per Day (GPCD) — An expression of the average rate of domestic and commercial water demand, usually computed for public water supply systems. Depending on the size of the system, the climate, whether the system is metered, the cost of water, and other factors, *Public Water Supply Systems (PWSS)* in the United States experience a demand rate of approximately 60 to 150 gallons per capita per day. Also see *Gallons per Employee per Day (GED)* for information on the application of this concept to commercial water use by *Standard Industrial Classification (SIC) Code*. [See Appendix C–4, Gallons Per Capita Per Day (GPCD), Water Used for Public Water Supplies by State.]

Gallons per Employee (Worker) per Day (GED, or GPED) — A measure or coefficient expressing an area's commercial water use per worker (employee), typically for distinct industry sectors. It is based on an analytical technique for measuring and forecasting commercial water use in a service area based upon the unique, seasonal, business-related water use by specific industrial sectors. GED commercial water-use coefficients are typically developed based upon Standard Industrial Classifications (SIC) codes for which comparable commercial water use and employment data are available. For forecasting more frequently than annually, GED coefficients will incorporate seasonal patterns (monthly or quarterly) as well. By deriving forecasts of trends in industry sector employment and combining them with appropriate, industry-specific GED coefficients, relatively accurate forecasts of the corresponding commercial water use may be obtained.

Gallons per Minute — A unit expressing rate of discharge, used in measuring well capacity. Typically used for rates of flow less than a few cubic feet per second (cfs).

GPCD — Gallons per capita (per person) per day — a measure of water use in municipalities. [See Appendix C–4, Gallons Per Capita Per Day (GPCD), Water Used for Public Water Supplies by State.]

GPD — Gallons per day, a measure of the rate of flow or the rate of water withdrawal from a well. Typically used when the rate of flow in cubic feet per second (cfs) is too low to be useful.

Greywater (Graywater) — Wastewater from clothes washing machines, showers, bathtubs, hand washing, lavatories and sinks that are not used for disposal of chemicals or chemical-biological ingredients.

Hydrographic Area [Nevada] — The 232 subdivisions (256 *Hydrographic Areas* and *Hydrographic Sub-Areas*) of the 14 Nevada *Hydrographic Regions* as defined by the State Engineer's Office, Department of Conservation and Natural Resources, Division of Water Resources. Primarily these are sub-drainage systems within the 14 major drainage basins. Hydrographic Areas (valleys) may be further subdivided into Hydrographic Sub-Areas based on unique hydrologic characteristics (e.g., differences in surface flows) within a given valley or area. [A listing of Nevada's Hydrographic Regions, Areas and Sub-Areas is presented in Appendix A–1 (hydrographic regions, areas and sub-areas), Appendix A–2 (listed sequentially by area number) Appendix A–3 (listed alphabetically by area name), and Appendix A–4 (listed alphabetically by principal Nevada county(ies) in which located).]

Hydrographic Region [Nevada] — Nevada has been divided into 14 hydrographic regions or basins, which are now used by the Nevada Division of Water Resources, Department of Conservation and Natural Resources, and the U.S. Geological Survey (USGS) to compile information pertaining to water resources and water use. These regions are also further subdivided into 232 *Hydrographic Areas* (256 Hydrographic Areas and Sub-Areas, combined) for more detailed study. See *Basins [Nevada]*, for a complete listing and description of Nevada's 14 Hydrographic Regions.

Impound — To accumulate and store water as in a reservoir.

Indirect Water Uses — Uses of water that are not immediately apparent to the consumer. For example, a person indirectly uses water when driving a car because water was used in the production process of steel and other automotive components.

Industrial, Self-supplied Water — Water withdrawn from privately developed sources and delivered through water systems established entirely or primarily for commercial and industrial use. Includes water used by mining, manufacturing, military establishments, educational and penal institutions, golf courses, hotels, motels, restaurants, casinos and other small businesses.

Industrial Water Use (Withdrawals) — Industrial water use includes water used for processing activities, washing, and cooling. Major water-using manufacturing industries include food processing, textile and apparel products, lumber, furniture and wood products, paper production, printing and publishing, chemicals, petroleum, rubber products, stone, clay, glass and concrete products, primary and fabricated metal industries, industrial and commercial equipment and electrical, electronic and measuring equipment and transportation equipment. The terms "water use" and "water withdrawals" are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also see *Commercial Water Use (Withdrawals)*.

Injection Well — Refers to a well constructed for the purpose of injection treated wastewater directly into the ground. Wastewater is generally forced (pumped) into the well for dispersal or storage into a designated aquifer. Injection wells are generally drilled into nonpotable aquifers, unused aquifers, or below freshwater levels.

Irrigate — (1) To supply (dry land) with water by means of ditches, pipes, or streams; to water artificially. (2) To wash out (a body cavity or wound) with water or a medicated fluid. (3) To make fertile or vital as if by watering.

Irrigation — (1) The controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall. (2) The application of water to soil for crop production or for turf, shrubbery, or wildlife food and habitat.

Irrigation Water Use (Withdrawals) — Artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth on recreational lands, such as parks and golf courses. The terms "water use" and "water withdrawals" are equivalent, but not the same as *Consumptive Use* as they do not account for return flows. Also see *Irrigation Return Flow*.

Livestock Water Use — Water use for stock watering, feed lots, dairy operations, fish farming, and other on-farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry. Also included are such animal specialties as horses, rabbits, bees, pets, fur-bearing animals in captivity, and fish in captivity. Also see *Rural Water Use*.

M&I (Municipal and Industrial) Water Withdrawals (Use) — Water supplied for municipal and industrial uses provided through a municipal distribution system.

Mining Water Use — Water use for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, well operations (*Dewatering*), milling (crushing, screening, washing, flotation, and so forth), and other preparations customarily done at the mine site or as part of a mining activity, such as dust control, maintenance, and wetland restoration. Generally, most of the water used at a mining operation is self-supplied. Also see *Self-Supplied Water*.

Model — (Statistics) A simulation, by descriptive, conceptual, statistical, or other means, of a process or thing that is difficult or impossible to observe directly, as in an *Economic Consumption Model* or a *River Flow Model*.

Modeling (Forecasting and Simulation Analysis) — The application of a mathematical process or simulation framework, for example a mathematical or *Econometric Model*, to describe various phenomenon and analyze the effects of changes in independent (i.e., explanatory) variables on dependent variables.

Municipal and Industrial (M & I) Water Withdrawals (Use) — Water supplied for municipal and industrial uses provided through a municipal distribution system for rural domestic use, stock water, steam electric powerplants, and water used in industry and commerce.

Municipal Water System — A water system which has at least five service connections or which regularly serves 25 individuals for 60 days. See *Public Water System (PWS).*

Non-Community Water System (NCWS) — A public water system that is not a community water system, e.g., the water supply at a camp site or national park.

Non-Consumptive Water Use — Non-consumptive water use includes a water use that is not consumed, for example, water withdrawn for purposes such as hydropower generation. This also includes uses such as boating or fishing where the water is still available for other uses at the same site. No typical consumptive use is 100 percent efficient; there is always some return flow associated with such use either in the form of a return to surface flows or as a ground water recharge. Nor are typically non-consumptive uses of water entirely non-consumptive. There are evaporation losses, for instance, associated with maintaining a reservoir at a specified elevation to support fish, recreation, or hydro-power, and there are conveyance losses associated with maintaining a minimum streamflow in a river, canal, or ditch.

Non-Transient Non-Community Water System — (1) A public water system that regularly serves at least 25 of the same non-resident persons per day for more than six months per year. (2) A public water system that is not a community water system and that regularly serves at least 25 of the same people over six months per year. Common types of such water systems are those serving schools, daycare centers, factories, restaurants, nursing homes, and hospitals.

Open-Pit Mining — The process of removing mineral deposits that are found close enough to the surface so that the construction of tunnels (underground mining) is not necessary. The soil and strata that cover the deposit are removed to gain access to the mineral deposit.

Population — (Statistics) The total number of potential observations in a specific category, for example, the human population of a particular city, or the number of animals of a particular species within a defined area. Typically, measurements of the behavior and characteristics of the population are not possible and therefore a *Sample* is selected which, if an *Unbiased Sample*, will, even in its limited numbers, be representative of the characteristics of the total population.

Population Density — (1) The number per unit area of individuals of any given species at a given time. (2) (Water Planning) The number of people in a given area. The number may be obtained by multiplying the number of dwelling units per unit area (e.g., square mile, square kilometer, acre, etc.) by the number of residents per dwelling unit.

Potable Water — Water that is drinkable. Specifically, freshwater that generally meets the standards in quality as established in the U.S. Environmental Protection Agency (EPA) *Drinking Water Standards* for drinking water throughout the United States. Potable water is considered safe for human consumption and is often referred to as *Drinking Water*. Freshwater that exceeds established chloride and dissolved solids limits is often referred to as slightly saline, brackish, or nonpotable water and is either diluted with fresher water or treated through a desalination process to meet potable-water standards for public supply.

Price Elasticity (of Water) — Defined as the ratio of the percent change in the quantity demanded of water (or any other economic good) and the percent change in price, or

$$n_{water} = \text{Percent Change in } Q_{water} / \text{Percent Change in } P_{water}$$

An elastic demand results when the ratio of n_{water} is greater than unity (>1), implying that a given change in price will result in a greater (percentage) change in the quantity demanded. Under such conditions of "elastic demand" for water, consumers tend to be responsive to changes in the price for water. Conversely, an inelastic demand results when the ratio of n_{water} is less than unity (<1), implying that a given change in price will result in a smaller (percentage) change in the quantity demanded. Under such conditions of "inelastic demand," consumers are relatively unresponsive to changes in the price for water. Along any given (downward sloping) demand curve, the elasticity will vary from inelastic, to unity, to elastic as the price rises further.

Public Supply Water — (1) Water withdrawn for all users by public and private water suppliers and delivered to users that do not supply their own water. (2) Water withdrawn by and delivered to a public water system regardless of the use made of the water. Includes water supplied both by large municipal systems and by smaller quasi-municipal or privately-owned water companies. Water suppliers provide water for a variety of uses, such as *Domestic Water Use* (also referred to as *Residential Water Use*), *Commercial Water Use*, *Industrial Water Use*, *Thermoelectric Power Water Use* (domestic and cooling purposes), and *Public Water Use*.

Public Utility — A private business organization, subject to government regulation, that provides an essential commodity or service, such as water, electricity, transportation, or communications, to the public.

Public Water Use — Water supplied from a *Public Water Supply System (PWSS)* and used for such purposes as fire fighting, street washing, and municipal parks, golf courses, and swimming pools. Public water use also includes system water losses (water lost to leakage) and brine water discharged from desalination facilities. Also referred to as *Utility Water Use*.

Reclaimed Water — Waste water that becomes suitable for a specific beneficial use as a result of treatment or brackish water demineralized for use. General types of reclaimed waste water include:

[1] ***Primary Effluent*** — reclaimed water that only has had sewage solids removed and is typically used only for surface irrigation of tree, fodder, and fiber crops;

[2] ***Secondary Effluent*** — reclaimed water that has had sewage solids removed and has been oxidized and disinfected and is used to irrigate golf courses and cemeteries and provide water for pasture and food crops; and

[3] ***Tertiary Recycled Water*** — water produced by conventional sewage treatment followed by more advanced procedures including filtration and disinfection, providing it with the broadest range of uses.

Residential Water Use — Water used normally for residential purposes, including household use, personal hygiene, and drinking, watering of domestic animals, and outside uses such as car washing, swimming pools, and for lawns, gardens, trees and shrubs. The water may be obtained from a public supply or may be self supplied. Also referred to as *Domestic Water Use*. Also see *Public Water Supply System* and *Self-Supplied Water*.

Resident Population — The number of persons who live within a state or other political subdivision (county, city, etc.) who consider it their permanent place of residence. College students, military personnel, and inmates of penal institutions are counted as permanent residents. According to this definition, tourist and seasonal or part-time residents are considered nonresident population.

Return Flow — (1) The amount of water that reaches a ground or surface water source after release from the point of use and thus becomes available for further use. (2) That part of a diverted flow which is not consumptively used and returns to its original source or another body of water. (3) (Irrigation) Drainage water from irrigated farmlands that re-enters the water system to be used further downstream. Such waters may contain dissolved salts or other materials that have been leached out of the upper layers of the soil.

Reuse (of Water) — (1) Water that is discharged by one user and is used by other users. (2) Repeated use of the same water by subsequent users in sequential systems. Sometimes, it also means water discharged by one unit and used by other units in the same plant. Also referred to as *Recycled Water*.

Reuse Systems — Refers to the deliberate application of reclaimed water for a beneficial purpose. Reuse may encompass landscape irrigation (such as golf courses, cemeteries, highway medians, parks, playgrounds, school yards, nurseries, and residential properties), agricultural irrigation (such as food and fruit crops, wholesale nurseries, sod farms and pasture grass), aesthetic uses, ground-water recharge, environmental enhancement of surface water and wetland restoration, fire protection, and other useful purposes.

Reverse Osmosis — (1) (Desalination) Refers to the process of removing salts from water using a membrane. With reverse osmosis, the product water passes through a fine membrane that the salts are unable to pass through, while the salt waste (brine) is removed and disposed. This process differs from electrodialysis, where the salts are extracted from the feedwater by using a membrane with an electrical current to separate the ions. The positive ions go through one membrane, while the negative ions flow through a different membrane, leaving the end product of freshwater. (2) (Water Quality) An advanced method of water or wastewater treatment that relies on a *Semi-permeable Membrane* to separate waters from pollutants. An external force is used to reverse the normal osmotic process resulting in the solvent moving from a solution of higher concentration to one of lower concentration.

Self-Supplied Water — Water withdrawn from a surface or ground-water source directly by a user rather than being obtained from a *Public Water Supply System (PWSS)*.

Self-Supplied Water (Industrial) — Water for industrial use, supplied from sources other than municipal distribution systems.

Sigmoid Growth — (Data Analysis) A growth rate trend characterized by an elongated S–shaped, or sigmoid curve. Typical of population growth rate trends which begin rapidly at an exponential rate but slow as limiting factors are encountered until a limit is approached asymptotically.

Significant (Statistical) — A term applied to differences, correlations, cause-and-effect relationships, etc., to indicate that they are probably not due to chance alone. Significant ordinarily indicates a probability of not less than 95 percent, while highly significant indicates a probability of not less than 99 percent.

Thermoelectric Power — Electrical power generated using fossil-fuel (coal, oil, or natural gas), geothermal, or nuclear energy.

Thermoelectric (Power) Water Use — Water used in the process of the generation of *Thermoelectric Power*. The water may be obtained from a *Public Water Supply System* or may be self supplied. Also see *Self-Supplied Water*.

Time-Series Analysis — (Statistics) Techniques that attempt to predict the future by using historical data rather than by building cause-and-effect models. Typically, such techniques are most appropriate when the historical data is relatively well behaved and when forecasts, primarily, are sought and not precise cause-and-effect relationships. Contrast with *Cross-Sectional Analysis*.

Variable — (Statistics) A series of comparable observations or characteristics of a phenomenon taken as a single set of data; a listing of specific characteristics of a population or a number of observations taken over a specific period of time which may reasonably be expected to vary from observation to observation.

Water Conservation — The physical control, protection, management, and use of water resources in such a way as to obtain maximum sustained benefits while reducing water use. Water conservation results in a reduction in applied water due to more efficient water use such as through the implementation of *Best Management Practices (BMP) — Urban Water Use*, or *Efficient Water Management Practices (EWMP) — Agricultural Water Use*.

Water Demand — The water requirements for a particular purpose, such as irrigation, power production, municipal supply, plant transpiration, or storage.

Water Supply System — Includes the works and auxiliaries for collection, treatment, storage, and distribution of the water from the sources of supply to the free-flowing outlet of the ultimate consumer. Also see *Public Water System (PWS).*

Water Use — The amount of water used for a variety of purposes including drinking, irrigation, processing of goods, power generation, and other uses. The amount of water used is typically less than the amount of water withdrawn for a particular use due to water transfers, the recirculation or recycling of the same water, return flows, etc. For example, a power plant may use the same water multiple times, but withdraw a significantly different amount. Also see *Water Use, Types*, below.

Water Use, Types — The use of water may be classified by specific types according to distinctive uses, such as the following:

- [1] Commercial Water Use
- [2] Domestic Water Use
- [3] Hydroelectric Power Water Use
- [4] Irrigation Water Use
- [5] Livestock Water Use
- [6] Mining Water Use
- [7] Navigational Water Use
- [8] Other Water Use
- [9] Public Water Use (same as *Utility Water Use*)
- [10] Residential Water Use (same as *Domestic Water Use*)
- [11] Rural Water Use
- [12] Thermoelectric Power Water Use

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Section 7
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These will be combined into one master index in the final printing.]

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