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# Spring Database for the Basin and Range Carbonate-Rock Aquifer System, White Pine County, Nevada, and Adjacent Areas in Nevada and Utah

Data Series 272

**U.S. Department of the Interior**
**U.S. Geological Survey**

**Cover:**
**Top:** Photograph of unnamed spring looking west, White River Valley, Nevada. (Photograph taken by Michael T. Pavelko, U.S. Geological Survey, July 8, 2005.)
**Bottom:** Photograph of Indian Springs looking west, White River Valley, Nevada. (Photograph taken by Michael T. Pavelko, U.S. Geological Survey, July 8, 2005.)

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DIRK KEMPTHORNE, Secretary

**U.S. Geological Survey**
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# Foreword

Water demands from the lower Colorado River system are increasing with the rapidly growing population of the southwestern United States. To decrease dependence on this over-allocated surface-water resource and to help provide for the projected increase in population and associated water supply in the Las Vegas area, water purveyors in southern Nevada have proposed to utilize the ground-water resources of rural basins in eastern and central Nevada. Municipal, land management, and regulatory agencies have expressed concerns about potential impacts from increased ground-water pumping on local and regional water quantity and quality, with particular concern on water-rights issues and on the future availability of water to support natural spring flow and native vegetation. Before concerns on potential impacts of pumping can be addressed, municipal and regulatory agencies have recognized the need for additional information and improved understanding of geologic features and hydrologic processes that control the rate and direction of ground-water flow in eastern and central Nevada.

In response to concerns about water availability and limited geohydrologic information, Federal legislation (Section 131 of the Lincoln County Conservation, Recreation, and Development Act of 2004; PL 108-424) was enacted in December 2004 that directs the Secretary of the Interior, through the U.S. Geological Survey (USGS), the Desert Research Institute (DRI), and a designee from the State of Utah, to complete a water-resources study of the basin-fill and carbonate-rock aquifers in White Pine County, Nevada, and smaller areas of adjacent counties in Nevada and Utah. The primary objectives of the Basin and Range carbonate-rock aquifer system (BARCAS) study are to evaluate: (1) the extent, thickness, and hydrologic properties of aquifers, (2) the volume and quality of water stored in aquifers, (3) subsurface geologic structures controlling ground-water flow, (4) ground-water flow direction and gradients, and (5) the distribution and rates of recharge and ground-water discharge. Geologic, hydrologic, and supplemental geochemical information will be integrated to determine basin and regional ground-water budgets.

Results of the study will be summarized in a USGS Scientific Investigations Report (SIR), to be prepared in cooperation with DRI and the State of Utah, and submitted to Congress by December 2007. The BARCAS study SIR is supported by USGS and DRI reports that document, in greater detail than the summary SIR, important components of this study. These reports are varied in scope and include documentation of basic data, such as spring location and irrigated acreage, and interpretive studies of ground-water flow, geochemistry, recharge, evapotranspiration, and geology.

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# Conversion Factors and Datums

## Conversion Factors

| Multiply | By | To obtain |
|---|---|---|
| foot (ft) | 0.3048 | meter (m) |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second ($m^3/s$) |
| gallon per minute (gal/min) | 0.06309 | liter per second (L/s) |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C=(°F-32)/1.8.$$

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8×°C)+32.$$

## Datums

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD83).

Altitude, as used in this report, refers to distance above the vertical datum.

# Spring Database for the Basin and Range Carbonate-Rock Aquifer System, White Pine County, Nevada, and Adjacent Areas in Nevada and Utah

By Michael T. Pavelko


## Abstract

A database containing nearly 3,400 springs was developed for the Basin and Range carbonate-rock aquifer system study area in White Pine County, Nevada, and adjacent areas in Nevada and Utah. The spring database provides a foundation for field verification of springs in the study area. Attributes in the database include location, geographic and general geologic settings, and available discharge and temperature data for each spring.


## Introduction

The Basin and Range carbonate-rock aquifer system (BARCAS) study area encompasses about 13,500 $mi^2$ and covers about 80 percent of White Pine County, and parts of Elko, Eureka, Nye, and Lincoln Counties in Nevada, as well as parts of Tooele, Millard, Beaver, Juab, and Iron Counties in Utah (fig. 1). White Pine County is within the carbonate-rock province, a relatively large area extending from western Utah to eastern California where ground-water flow is predominantly or strongly influenced by carbonate-rock aquifers. Much of the carbonate-rock aquifer is fractured and, where continuous, forms a regional ground-water flow system that receives recharge from high-altitude areas where fractured carbonate rocks are exposed. Most areas in White Pine County, Nevada, are within four regional ground-water flow systems (fig. 2)—the larger Colorado and Great Salt Lake Desert flow systems, and the smaller Goshute Valley and Newark Valley flow systems (Harrill and others, 1988). Water moving through the carbonate-rock aquifer provides some recharge to overlying basin-fill aquifers, sustains many of the large, perennial low-altitude springs, and hydraulically connects similar carbonate-rock aquifers in adjacent basins.

The regional carbonate-rock aquifer typically is overlain by a basin-fill aquifer in the intermountain basins. The basin-fill aquifer is composed of gravel, sand, silt, and clay and often reaches thicknesses of several thousand feet (Harrill and Prudic, 1998). The gravel and sand deposits typically yield water readily to wells and this aquifer is the primary water supply in the area for agricultural, domestic, or municipal use.

The carbonate-rock aquifer extends beneath numerous surface-water drainage basins, or hydrographic areas[1]. Past studies have combined hydrographic areas to delineate basin-fill or regional ground-water flow systems, based primarily on the direction of interconnected ground-water flow in the underlying carbonate-rock aquifer and the location of terminal discharge areas (Harrill and Prudic, 1998). Although the boundary lines between hydrographic areas generally coincide with actual topographic basin divides, some boundaries are arbitrary or represent hydrologic divisions that have no topographic basis. Hydrographic areas were further divided into sub-basins that are separated by areas where pre-Cenozoic rocks are at or near the land surface (Welch and Bright, 2007). Hydrographic area names in this report generally refer to formal hydrographic areas of Harrill and others (1988) with two exceptions: (1) ‘Little Smoky Valley’ refers to hydrographic areas 155A and 155B, which are the northern and central parts of Harrill and others (1988) description of Little Smoky Valley, respectively, and (2) ‘Butte Valley’ refers only to hydrographic area 178B, which is the southern part of Harrill and others (1988) description of Butte Valley. For most figures and tables in this report, water-budget components were estimated for the northern and central parts of Little Smoky Valley, but were combined and reported as one value.

[1] Formal hydrographic areas in Nevada were delineated systematically by the U.S. Geological Survey and Nevada Division of Water Resources in the late 1960s (Cardinalli and others, 1968; Rush, 1968) for scientific and administrative purposes. The official hydrographic-area names, numbers, and geographic boundaries continue to be used in U.S. Geological Survey scientific reports and Division of Water Resources administrative activities.

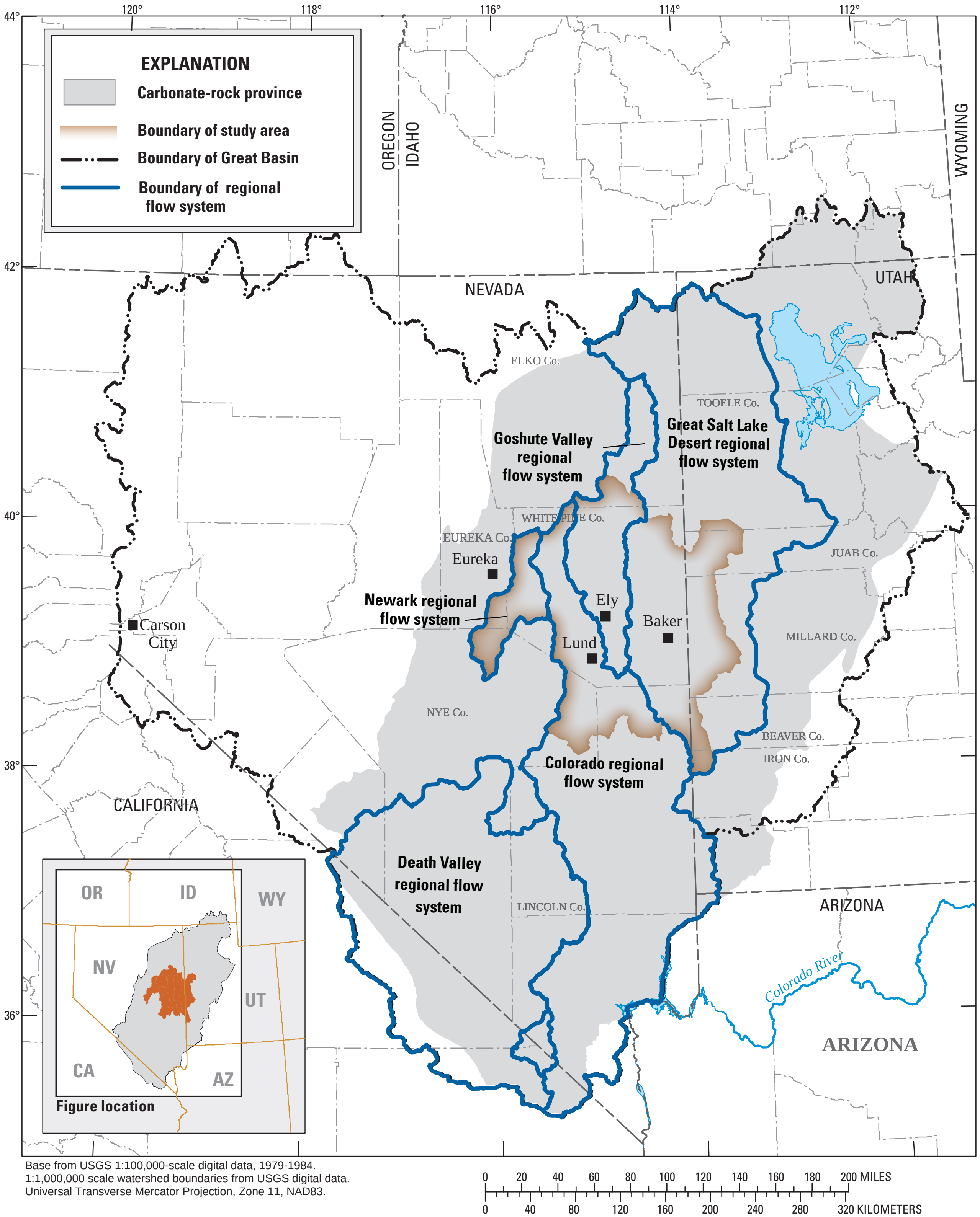
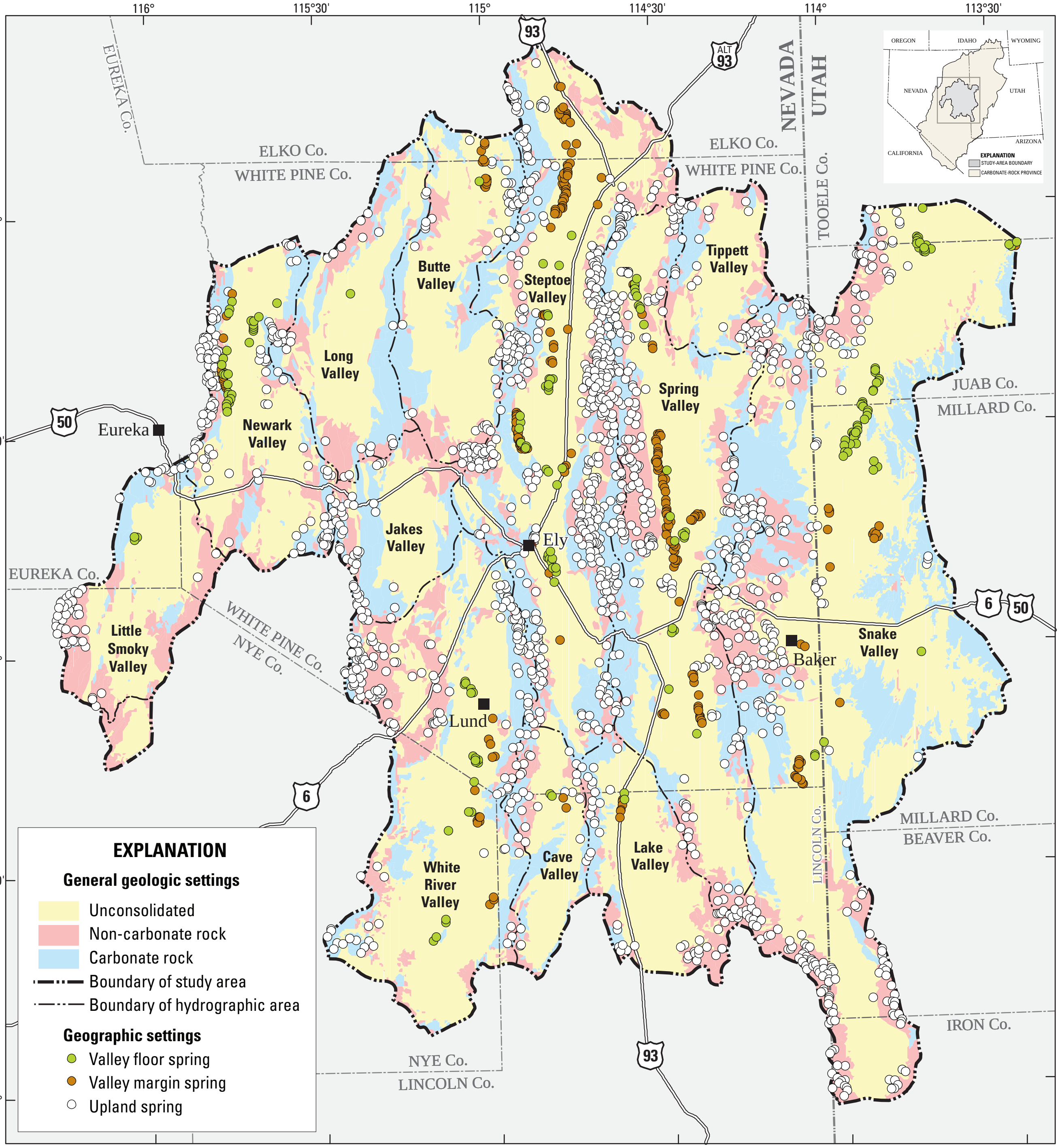



**Figure 1.** Carbonate-rock province, Basin and Range carbonate-rock aquifer system study area, and associated regional ground-water flow systems, Nevada and Utah.




Base from U.S. Geological Survey 1:100,000-scale digital data, 1979–84.
1:1,000,000-scale hydrographic area boundaries from U.S. Geological Survey digital data.
Universal Transverse Mercator Projection, Zone 11, NAD 1983.

Geology modified from Stewart and Carlson, 1978;
Hintze and others, 2000; and Raines and others, 2003

**Figure 2.** Hydrographic areas, springs by geographic setting, and simplified geology in the Basin and Range carbonate-rock aquifer system study area, Nevada and Utah.

A spring is where ground water flows to, or discharges from, the land surface. Spring discharge can form pools or creeks and can provide water to plants and animals. In the BARCAS study area, springs are an important water resource. Historically, Native Americans, early pioneers and settlers, and modern residents, including farmers and ranchers, have used spring water for drinking, bathing, agriculture, mining, and recreational purposes. Many of the settlements and towns in the BARCAS study area are located near larger springs that have been a source of water since Native Americans began utilizing them. Springs help sustain unique aquatic, riparian, and phreatophytic ecosystems that support threatened or endangered species endemic to the region, such as the Relict dace (*Relictus solitarius*) and the White River spinedace *(Lepidomeda albivallis)*, as well as provide water for widely ranging wildlife, such as elk and migratory birds.

Springs also are an important and complex component of the BARCAS ground-water budget. Spring discharge can originate from a local or regional source, or a mixture of more than one source. Geography, geology, and precipitation control spring discharge. Discharge from springs can flow along the land surface, infiltrate back into the ground-water system, evaporate, be transpired, or undergo a combination of these processes. Measurable properties of spring discharge reflect these sources, controls, and processes, and therefore can be used to estimate local or regional components of the BARCAS study area ground-water budget.

The BARCAS spring database is a compilation of reported springs, their locations, geographic and geologic settings, and available discharge and temperature data. The database is a compilation of existing data sources. Spring locations were not field verified independently for the database development. The database provides information necessary to assess aquifer permeability, reveal geologic and geographic controls on ground-water flow, recognize springs that discharge regionally derived water, and improve the current conceptualization of ground-water flow in the BARCAS study area. This report documents the development and limitations of the BARCAS spring database.

# Spring Database

The BARCAS spring database consists of 3,392 reported springs, their locations, and selected attributes (table 1). Each of the springs in the database has an identification number and is characterized by geographic and general geologic setting. The hydrographic area, location, and a location source code, are given for each spring. The number of discharge and temperature measurements, and average measured discharge and temperature are reported in appendix A. Individual discharge and temperature measurements are reported in appendixes B and C, respectively. The BARCAS spring database was developed primarily using digital cartographic methods and is distributed with this report in a Microsoft® Excel workbook.

## Database Development

Most spring locations in the database are from the National Hydrography Dataset (NHD; http://nhd.usgs.gov/data.html) or digitized from USGS topographic maps published in Digital Raster Graphic (DRG) format (http://topomaps.usgs.gov/drg/). Additional spring locations are from Desert Research Institute (DRI), Southern Nevada Water Authority (SNWA), and USGS National Water Inventory System (NWIS) databases. The NHD is a comprehensive set of digital spatial data that contains information about water features such as lakes, ponds, streams, rivers, springs, and wells. NHD spring locations are based on high (1:24,000 scale) and medium (1:100,000 scale) resolution USGS Digital Line Graph (DLG) hydrography data. Spring locations in the NHD generally correspond to the locations of spring symbols shown on USGS topographic DRG maps. For high resolution NHD, 90 percent of features are within 40 ft of their actual geographic position; for medium resolution NHD, 90 percent of features are within 167 ft of their actual geographic position (http://nhd.usgs.gov/nhd_faq.html#q108). Spring locations digitized from topographic maps are as accurate as corresponding NHD data because the maps were created from the same DLG data. The accuracy of all other spring locations is unknown.

Of the 3,392 springs in the database, 2,993 spring locations are from the high-resolution NHD, 201 are from 1:24,000-scale DRG maps, 188 are from the medium-resolution NHD, 7 are from NWIS, 2 are from DRI databases, and 1 is from an SNWA database. The locations of all medium-resolution NHD springs and springs in DRI, SNWA, and NWIS databases were compared to 1:24,000-scale spring locations. Medium-resolution NHD springs were added to the database only if there were no corresponding 1:24,000-scale springs, and springs in the DRI, SNWA, and NWIS databases were added only if there were no corresponding 1:24,000- or 1:100,000-scale springs. Springs were considered duplicates at the 1:24,000- and 1:100,000-scale if they had the same name or if the 1:24,000-scale spring was within about 300 ft of the 1:100,000-scale spring. Spring locations documented in published reports did not yield additional or more accurate spring location information.

**Table 1.** Description of spring attributes in the spring database for the Basin and Range carbonate-rock aquifer system study area, Nevada and Utah.

[**Abbreviations:** NA, not applicable; NHD, National Hydrography Dataset; NAD83, North American Datum of 1983; NWIS, USGS National Water Information System; DRI, Desert Research Institute; SNWA, Southern Nevada Water Authority; NGVD29, National Geodetic Vertical Datum of 1929]

| Attribute name | Attribute value | Description |
|---|---|---|
| Identification number | NA | Unique number to identify springs. Identification numbers that begin with "188888" denote springs that are not documented in the NHD. All other identification numbers are the common identifiers (ComID) used in the NHD. |
| Spring name | NA | The majority of spring names are from the NHD; some names are from NWIS, DRI, or SNWA databases when there was no NHD name. All unnamed springs are unnamed springs from the NHD. |
| Hydrographic area | NA | Hydrographic area that the spring is in. |
| Geographic setting | Valley floor | Broad, flat valley bottoms. |
| | Valley margin | Along valley-floor margins, typically where alluvial fans intersect valley floors. |
| | Upland | Above valley margins, including alluvial fans, unconsolidated deposits above valley margins, and mountain-block bedrock. |
| General geologic setting | Unconsolidated sediments | Unconsolidated deposits, including basin fill on valley floors and valley margins, alluvial fans, and high-altitude deposits. |
| | Carbonate bedrock | Primarily limestone and dolomite, including relatively thin sediments or soils that may overlie carbonate bedrock. |
| | Non-carbonate bedrock | Primarily igneous, silici-clastic, and metamorphic rock, including relatively thin sediments or soils that may overlie non-carbonate bedrock. |
| Number of discharge measurements | NA | Total number of reported discharge measurements. See appendix B for discharge data. |
| Average discharge (gallons per minute) | NA | Arithmetic mean of reported discharge measurements. |
| Number of temperature measurements | NA | Total number of reported temperature measurements. See appendix C for temperature data. |
| Average temperature (°Fahrenheit) | NA | Arithmetic mean of reported temperature measurements. |
| Spring location coordinates | UTM Easting (NAD83; zone 11) | Universal Transverse Mercator, zone 11, easting coordinates, in meters; referenced to NAD83. |
| | UTM Northing (NAD83; zone 11) | Universal Transverse Mercator, zone 11, northing coordinates, in meters; referenced to NAD83. |
| | Latitude (NAD83) | Latitude, in decimal degrees; referenced to NAD83. |
| | Longitude (NAD83) | Longitude, in decimal degrees; referenced to NAD83. |
| Altitude (feet) | NA | Altitude of spring, in feet above NGVD29. |
| Location source code | 0 | Location is from high-resolution NHD. |
| | 10 | Location was digitized from 1:24,000-scale USGS topographic map. |
| | 15 | Location was digitized from 1:24,000-scale USGS topographic map; corresponds to a named spring without a spring symbol and not documented in the NHD. |
| | 20 | Location is from NWIS; plots at or is near a wetland, reservoir, or flowing well symbol on 1:24,000-scale USGS topographic map. |
| | 25 | Location is from NWIS or near an NWIS location that does not correspond to a 1:24,000- or 1:100,000-scale spring symbol. |
| | 30 | Location is from DRI or SNWA database or near a DRI or SNWA location that does not correspond to a 1:24,000- or 1:100,000-scale spring symbol. |
| | 100 | Location is from medium-resolution NHD; corresponds to a 1:100,000-scale spring symbol. |
| | 105 | Location is from medium-resolution NHD; does not correspond to a 1:100,000-scale spring symbol. |

Each spring was assigned a unique identifier after reconciling the location with digital cartographic methods. The original database sources were tracked with a location source code. Geographic settings (fig. 2; table 2) were determined by examining 1:24,000-scale topographic maps, modified 1:500,000-scale hydrogeology maps (Stewart and Carlson, 1978; Hintze and others, 2000; Raines and others, 2003), and aerial and satellite imagery. General geologic settings (fig. 2; table 2) were extracted from modified 1:500,000-scale hydrogeology maps (Stewart and Carlson, 1978; Hintze and others, 2000; Raines and others, 2003). Summaries of spring discharge and temperature data were compiled where available. Spring names in this database are from the database denoted on the location source code.

Most of the 3,392 springs in the database (fig. 2; table 2; appendix A) are in Snake Valley, Spring Valley, and Steptoe Valley hydrographic areas. Cave Valley, Jakes Valley, Lake Valley, Little Smoky Valley, Long Valley, and Tippet Valley hydrographic areas each have less than 100 springs. Geographically, upland springs (2,455) account for more than 70 percent of the springs in the BARCAS study area. Geologically, unconsolidated (1,484) and non-carbonate-bedrock (1,474) springs together account for nearly 90 percent of the springs. Discharge (appendix B) and temperature (appendix C) measurements are sparse for the BARCAS study area. Discharge has been measured at 185 springs and temperature at 441 springs. Most of these measurements were made at springs in the larger hydrographic areas: Snake Valley, Spring Valley, Steptoe Valley, and White River Valley.

## Limitations

The BARCAS study spring database is a compilation of existing data sources and, as such, any errors and omissions in the source databases are present in this database. Spring locations were not field verified for the development of this database. Location errors other than those attributed to the source database could result from the shifting or loss of a spring due to changing hydrologic conditions or from manmade diversions or other alterations. Anecdotal evidence indicates that mapped springs can be little more than wet ground, and in some cases non-existant.

The BARCAS spring database may not include all springs in the BARCAS study area. Some wetland areas in the study area have been identified as springs by the USGS, even though the springs are not in the NHD and they do not have spring symbols on 1:24,000- or 1:100,000-scale topographic maps. It is possible, therefore, that other springs, including other wetland areas and ephemeral and low-discharge seeps and springs, have not been identified and are not included in this database.

The geographic settings of the springs are qualitative. The accuracy of the geographic settings is controlled partly by the accuracy of the hydrogeology and topographic maps used in their determination. The general geologic settings of the springs are only as accurate as the modified 1:500,000-scale hydrogeology maps (Stewart and Carlson, 1978; Hintze and others, 2000; Raines and others, 2003). The geographic and general geologic settings identified by cartographic methods were not field verified.

**Table 2.** Spring density, geographic setting, general geologic setting, and discharge and temperature data for the Basin and Range carbonate-rock aquifer system study area, Nevada and Utah.

| Hydrographic area | Area (square miles) | Number of springs / springs per square mile | Valley floor / valley margin / upland | Unconsolidated / carbonate bedrock / non-carbonate bedrock | Springs with measured discharge/ total number of measurements | Springs with measured temperatures/ total number of measurements |
|---|---|---|---|---|---|---|
| Butte Valley | 747 | 118 / 0.158 | 1 / 21 / 96 | 37 / 9 / 72 | 8 / 10 | 12 / 16 |
| Cave Valley | 353 | 34 / 0.096 | 3 / 2 / 29 | 12 / 3 / 19 | 1 / 2 | 12 / 23 |
| Jakes Valley | 421 | 57 / 0.135 | 0 / 0 / 57 | 18 / 16 / 23 | 3 / 3 | 13 / 19 |
| Lake Valley | 550 | 69 / 0.125 | 2 / 8 / 59 | 16 / 12 / 41 | 11 / 37 | 23 / 31 |
| Little Smoky Valley | 590 | 85 / 0.144 | 4 / 0 / 81 | 12 / 7 / 66 | 4 / 19 | 5 / 11 |
| Long Valley | 665 | 29 / 0.044 | 1 / 0 / 28 | 3 / 5 / 21 | 2 / 2 | 8 / 12 |
| Newark Valley | 792 | 290 / 0.366 | 38 / 22 / 230 | 154 / 27 / 109 | 9 / 14 | 29 / 40 |
| Snake Valley | 3,688 | 686 / 0.186 | 151 / 55 / 480 | 301 / 64 / 321 | 37 / 96 | 66 / 102 |
| Spring Valley | 1,700 | 626 / 0.368 | 34 / 181 / 411 | 306 / 80 / 240 | 20 / 42 | 90 / 117 |
| Steptoe Valley | 1,958 | 1,069 / 0.546 | 48 / 316 / 705 | 520 / 166 / 383 | 65 / 183 | 117 / 169 |
| Tippett Valley | 348 | 33 / 0.095 | 0 / 0 / 33 | 4 / 4 / 25 | 3 / 5 | 10 / 16 |
| White River Valley | 1,595 | 296 / 0.186 | 26 / 24 / 246 | 101 / 41 / 154 | 22 / 690 | 56 / 121 |
| BARCAS study area | 13,407 | 3,392 / 0.253 | 308 / 629 / 2,455 | 1,484 / 434 / 1,474 | 185 / 1,103 | 441 / 677 |

## Summary

The spring database distributed with this report includes location, general geographic and geologic setting, and available discharge and temperature data for 3,392 springs in the Basin and Range carbonate-rock aquifer system study area, White Pine County, Nevada, and adjacent areas of Nevada and Utah. The database was developed primarily using digital cartographic methods and is distributed with this report in a Microsoft® Excel workbook. Spring locations were derived from 1:24,000- and 1:100,000-scale hydrography data, and USGS, DRI, and SNWA databases. Spring attributes in the database are identification number, name, geographic setting, general geologic setting, hydrographic area, discharge measurements, average discharge, temperature measurements, average temperature, UTM coordinates, latitude and longitude, and location source code.

About 70 percent of the springs are in an upland geographic setting and nearly 90 percent are in either an unconsolidated (44 percent) or non-carbonate bedrock (43 percent) geologic setting. Steptoe Valley has 1,069 springs, the most of any hydrographic area. The database includes 1,103 discharge measurements from 185 springs and 677 temperature measurements from 441 springs.

There are limitations to the spring database. All data, including spring locations and discharge and temperature data, come from existing databases and were not field verified. Springs that contribute water to wetland areas and ephemeral and low-discharge seeps and springs may be missing from the database. In other cases mapped spring locations may represent only wet ground or be non-existant. Scale differences for the spring-location map and maps used to determine geographic settings and general geologic settings may have resulted in incorrect attributes. The assigned geographic settings are qualitative and subject to changing environmental conditions.

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# Appendixes

The spring database distributed with this report is in Microsoft® Excel 2003 format. Spring attributes (column headers) for appendix A are described in detail in table 1 and on a spreadsheet of the database. Discharge (appendix B) and temperature (appendix C) data also are in the workbook. To obtain a copy of the database, proceed to http://pubs.water.usgs.gov/ds272/. The database can be accessed and downloaded by clicking on the above link.

**Appendix A.** Spring database for the Basin and Range carbonate-rock aquifer system study area, Nevada and Utah.

**Appendix B.** Discharge data for springs in the Basin and Range carbonate-rock aquifer system study area, Nevada and Utah.

**Appendix C.** Temperature data for springs in the Basin and Range carbonate-rock aquifer system study area, Nevada and Utah.

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