Case No. 84739

IN THE SUPREME COURT OF THE STATE OF NEVADA

Electronically Filed
Nov 08 2022 04:38 p.m.
Elizabeth A. Brown
Clerk of Supreme Court

ADAM SULLIVAN, P.E., NEVADA STATE ENGINEER, et al.

Appellants,

vs.

LINCOLN COUNTY WATER DISTRICT, et al.

JOINT APPENDIX

VOLUME 30 OF 49

Volume 3

Physical Settings of Selected Springs in Clark, Lincoln, and White Pine Counties Groundwater Development Project

January 2008

PREPARED IN COOPERATION WITH
THE BUREAU OF LAND MANAGEMENT

SE ROA 43514

JA_13243

PREFACE

This report was prepared by the Southern Nevada Water Authority in cooperation with the U.S. Department of Interior's Bureau of Land Management. The U.S. Geological Survey served as technical advisor to the Bureau of Land Management in the preparation of this report.

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TABLES

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ACRONYMS

BLM	U.S. Bureau of Land Management
DRI	Desert Research Institute
GPS	Global Positioning System
HA	hydrographic area
MAT	mean annual air temperature
MVWD	Moapa Valley Water District
NDOW	Nevada Division of Wildlife
NDWR	Nevada Division of Water Resources
SNWA	Southern Nevada Water Authority
SR	State Route
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WY	water year

ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
af	acre-foot
afy	acre-feet per year
amsl	above mean sea level
cfs	cubic feet per second
ft	foot
gpm	gallons per minute
in.	inch
m	meter
Ma	million years
mi	mile
mm	millimeter
pmc	percent modern carbon

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1.0 INTRODUCTION

This report describes the springs in an area of east-central and southeastern Nevada and adjacent western Utah. The report includes a description of the springs' general setting, geologic setting, discharge, and diversions and water use.

1.1 Project Background

The Clark, Lincoln and White Pine Counties Groundwater Development Project (hereafter referred to as the Project) proposes to develop unused groundwater resources within selected basins of eastern Nevada where Southern Nevada Water Authority (SNWA) holds groundwater rights and applications. These basins include Coyote Spring, Delamar, Dry Lake, Cave, Spring, and Snake valleys (hereafter referred to as the Project Basins) and are depicted in Figure 1-1.

In 2004, SNWA applied to the Bureau of Land Management (BLM) for issuance of rights of way to construct Project facilities, most of which will be located on public lands administered by the BLM. These facilities include groundwater production wells, water conveyance facilities, water storage and regulating reservoirs, and power facilities. BLM issuance of these rights of way to construct, maintain, and operate these facilities requires a federal action for which the National Environmental Policy Act and Endangered Species Act must be considered. BLM has determined that preparation of an Environmental Impact Statement is required to assess the potential environmental effects that may result from permitting the rights of way, including the potential indirect effects of the proposed groundwater development. This report was prepared in support of that assessment.

1.2 Regional Groundwater Flow Systems

A set of hydraulically connected valleys forms a flow system. A single valley that is not hydraulically connected to another valley can form its own flow system. Several flow systems, as defined by Harrill et al. (1988) and Nichols (2000), occur within the study area and vicinity. The primary flow systems of interest to this project are: the White River, Goshute Valley, Great Salt Lake Desert, and Meadow Valley Wash Flow systems. The regional groundwater flow system prevailing within the study area and vicinity is composed of multiple hydrographic basins, also called valleys. In many of the northern valleys, evapotranspiration is the principal source of groundwater discharge. However, the valleys that are in the central-southern part of the system, have a significant amount of groundwater discharge as subsurface outflow through the carbonate aquifer. Although numerous structural features (Dettinger et al., 1995; SNWA, 2003) compartmentalize different parts of the carbonate aquifer system, the hydraulic connectivity of the valleys is believed to be expansive.

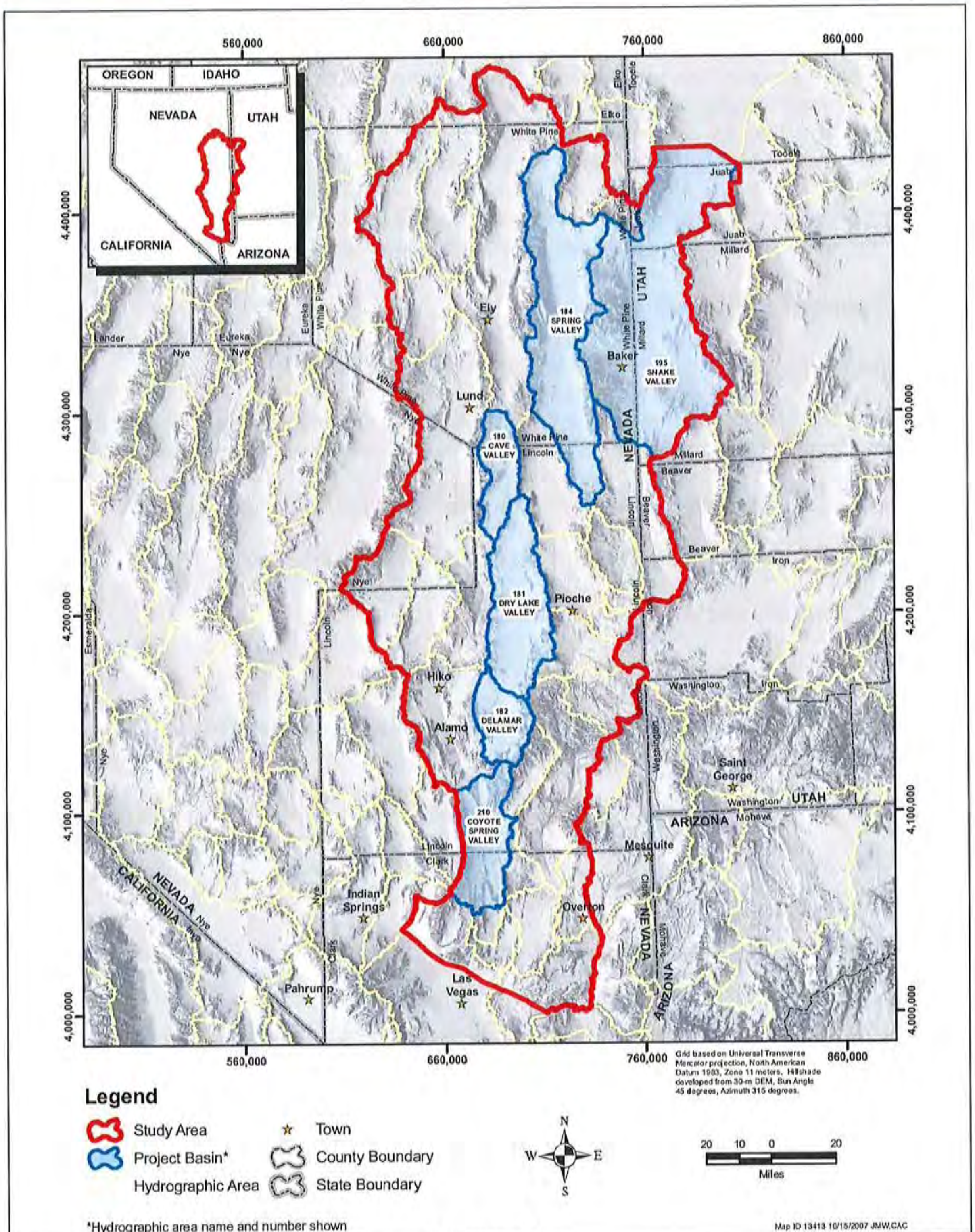

Figure 1-1
Location of Project Basins

1.3 Purpose and Scope

The purpose of this report is to provide data and documentation of the baseline hydrologic conditions of springs that were compiled during inventories conducted in the area surrounding the project basins. Springs located within 13 basins were inventoried. The scope of work consisted of compiling background data and information on each spring and determining the current physical characteristics of the springs. The scope included compilation of historical data, photographic documentation, conducting miscellaneous discharge measurements, acquiring historical and current diversion data, documenting anthropogenic influences, and detailed geologic mapping of selected springs.

1.4 Document Organization

This document consists of five sections and five appendices, as follows:

- Section 1.0 provides a description of the project background, description of regional flow systems, the purpose and scope of this report, and an overview of the structure of this report.
- Section 2.0 documents the methods and procedures used to collect the data for this report.
- Section 3.0 documents the current physical characteristics of the springs.
- Section 4.0 provides a summary of the findings of this report.
- Section 5.0 provides a list of references cited in this report.
- Appendix A tabulates the location, elevation, geologic setting, and the magnitude of discharge of the springs described in this report.
- Appendix B tabulates the discharge measurements of the springs described in this report.
- Appendix C shows examples of the site inventory form and the Discharge Measurement forms.
- Appendix D is a copy of the U.S. Forest Service Springs Survey Report with attached database.
- Appendix E tabulates additional spring locations that were not physically visited by SNWA. These locations were found in data sets maintained by the U.S. Geological Survey (USGS), Desert Research Institute (DRI) or found on 1/24,000 topographic maps.

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2.0 Methods and Procedures

2.1 Data Collection

Data in this report came from published reports, published and preliminary data from USGS, and from field investigations conducted by SNWA during the summer and fall of 2004 and 2005.

Investigations conducted by SNWA of the springs included compilation of existing information and data from available data sources, including published and unpublished reports and databases, photographic documentation, discharge measurements, water-chemistry sampling, a written description of the physical setting of the spring, and in some cases detailed geologic mapping at the spring site.

Data collection procedures were established to ensure consistent and accurate compilation and collection of data during the spring inventory. Key points of the data collection program are as follows:

- Photographic documentation
- Discharge measurement
- Water-chemistry sampling
- Written description of each spring
- Detailed geologic mapping for a subset of the springs.

2.1.1 Selection of Springs

The selection of springs was made through a collaborative effort by a team of professional hydrologists and geologists who have numerous years of experience in the project area. A list of criteria were developed by the team and are given below:

- Aerial distribution
- Discharge
- Lithologic setting

Springs were chosen to represent each hydrographic basin as possible in both aerial extent and elevation. This was difficult to achieve because spring locations are generally not equally spaced in each valley. Springs of different magnitudes of discharge were considered for inclusion in the data set. The lithologic setting was also considered. Springs in alluvial materials, and different types of consolidated rocks were observed.

Locations of springs that were not visited but are in each of the valleys are listed in Appendix E.

2.1.2 Photographic Documentation

Photographs at spring sites include pictures of the spring pool, orifice, surrounding vegetation, diversion facilities including any impoundments, head gates, flumes, weirs, and irrigation canals. Once all photographs were reviewed, they were archived in the SNWA photo repository.

2.1.3 Discharge Measurements

Discharge measurements were performed at each spring when conditions allowed. For example, if the spring was inaccessible or other conditions existed that prevented a physical measurement from being made, the discharge was estimated. Measurements were made upstream of any diversions when possible. If this was not possible, the diversions were accounted for by either measurement or estimate of their respective discharges and summed together with the discharge measurement of the undiverted flow. A detailed description of where and how the discharge was measured is recorded in field notes, which accompanied the discharge measurement form documenting the measurement.

Discharge measurements were made and computed using the standard methods outlined in Rantz et al. (1982a and b) and Malone (1931).

The discharge measurements were recorded using USGS *Standard Discharge Measurement Notes,* form number 9-275. All discharge measurements were recorded on these forms, regardless of the method used to measure the discharge from the spring. An example of these forms can be found in Appendix C.

2.1.4 Field Notes

Summary information and data related to the spring and the surrounding area were recorded on the SNWA Site Inventory Sheet, an example of this form can be found in Appendix C. In addition, a written description describing the physical setting and hydrologic observations was completed for each spring visited. The description included the size and shape of the spring pool(s), the geometry of the discharge channel, and bathymetry of the spring pool. The bed and bank material of the stream channel was described using a modified version of the Wentworth Scale (Buffington and Montgomery, 1999). Table 2-1 describes the grain size division and names. Discharge measurement points were described, and a thorough description of all diversion facilities including any impoundments, diversions, and measuring devices was logged in the field notes. When describing the measurement and diversion devices, the general state of repair and dimensions of each were noted. The general location of the spring was observed, and a road log was also recorded.

Locations of all diversions, measurement devices, spring orifices, and wells were collected using the Global Positioning System (GPS).

2.1.5 Geology

A generalized geologic description was produced for each spring. This description included any obvious geomorphic features and the geologic unit from which the spring emanates. Detailed

Table 2-1
Bed Material Grain Size Division

Aggregate Name	Aggregate Detail	Size Range (mm)	Size Range (approximate in.)
Boulder	Coarse	>1,024	>40
	Medium	512 to 1,024	20 to 40
	Fine	256 to 512	10 to 20
Cobble	Coarse	128 to 256	5 to 10
	Fine	64 to 128	2.5 to 5
Gravel	Coarse	16 to 64	0.63 to 2.5
	Medium	8 to 16	0.32 to 0.63
	Fine	2 to 8	0.08 to 0.32
Sand	Coarse	0.5 to 2	0.02 to 0.08
	Fine	0.125 to 0.5	--
Fine Material (silts/clays)	--	< 0.125	--

Source: Modified from Buffington and Montgomery, 1999

geologic mapping was conducted at selected springs, and a summary description of the geologic setting, including geologic features likely influencing local groundwater flow, was prepared. A geologic map and generalized geologic cross section were constructed for each spring location where detailed mapping was conducted. A detailed description of geologic units is available in Volume 1.

2.2 *Classification of Springs*

Springs have been classified in many different ways, including discharge, temperature, and the geologic unit from which discharge occurs. In this report they are classified by discharge rates, as proposed by Oscar Meinzer in 1923 (Meinzer, 1942), and by temperature.

2.2.1 *Discharge*

Table 2-2 is taken after the system proposed by Oscar Meinzer in 1923 and is used in this report.

2.2.2 *Temperature*

Defining what constitutes a "thermal spring" versus warm and cold springs is arbitrary at best. It is a general practice to use the mean annual air temperature (MAT) at the location of the spring as a baseline from which to compare the temperature of spring discharge. If the temperature of the spring discharge is warmer than the MAT, a spring is said to be a warm spring. If it is cooler than the MAT, a spring is considered a cold spring. A more accurate temperature classification depends on several variables, including the initial temperature of the recharge water, heating or cooling during near surface movement, heating while moving to greater depths, cooling while returning to shallower depths, and the cooling or heating while mixing with other groundwater (Garside and Schilling, 1979).

Table 2-2
Classification of Spring Size Based on Volume of Discharge

Order of Magnitude	Discharge	
	cfs	gpm
First	>100	> 44,883
Second	10 to 100	4,448 to 44,883
Third	1 to 10	449 to 4,488
Fourth	0.223 to 1	100 to 449
Fifth	0.022 to 0.223	10 to 100
Sixth	0.002 to 0.022	1 to 10
Seventh	0.0003 to 0.002	0.125 to 1
Eighth	< 0.0003	<0.125

After Meinzer, 1942

Table 2-3 lists the temperature classifications used in this report and their stereotypical occurrences.

Table 2-3
Classification of Springs Based on Physical Temperature

Description	Temperature (°C)	Stereotypical Occurrences
Hot	>32.2	Thermal springs associated with deep circulation
Warm	21.1 to 32.2	Springs in the central part of valleys
Cold	<21.1	Springs near recharge areas in mountain blocks

2.3 *Location Description*

2.3.1 *Geographical Coordinates*

All coordinates of springs given in this report are reported in Universal Transverse Mercator (UTM) Zone 11 using the North American Datum of 1983. All coordinates were determined using GPS.

2.3.2 *Altitude*

Altitudes were compiled from published topographic maps, published reports, or were determined using GPS equipment. All altitudes are reported in feet above mean sea level using the North American Vertical Datum of 1988.

2.3.3 Local Number

Local numbers are used to describe the spring's location using Township, Range, Section, and subdivisions of a section. This report addresses spring locations in Nevada and Utah. An explanation of both methods follows.

Nevada Local Number

Example: 209 N05 E64 26AACC

The first part of the Nevada Local Number is based on hydrographic area (HA) number as defined by Rush (1968). This is followed by the Township, Range, and Section numbers followed by a sequence of up to four letters, each being A, B, C, or D. In Nevada all references of Township and Range are related to the Mount Diablo Base Line and Meridian. Townships are described as either north or south of the Mount Diablo Base Line, and Ranges are described as east or west of the Mount Diablo Meridian. (Every Range in Nevada is east of the Mount Diablo Meridian). The section number is next and may be subdivided into quadrants labeled A, B, C, or D, in a counterclockwise direction starting with the northeast corner. When additional subdivisions are necessary, the divisions (A, B, C, or D) may be repeated up to three more times (Stockton et al., 2003).

Utah Local Number

Example: (C-28-10)29ADD

The first part of the Utah Local Number is based on the four quadrants that Utah is divided into by the intersection of the Salt Lake Base Line and the Salt Lake Meridian. These are labeled by capital letters A to D, in a counterclockwise direction starting in the northeast corner of the state. This is followed by the Township, Range, and Section numbers, followed by a sequence of up to four letters. The section number is next and may be subdivided into quadrants labeled A, B, C, or D in a counterclockwise direction, starting with the northeast corner. When additional subdivisions are necessary, the divisions (A, B, C, or D) may be repeated up to three more times (Tibbetts et al., 2003).

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3.0 PHYSICAL DESCRIPTION OF SPRINGS

This section describes the springs inventoried as part of this study in 13 hydrographic areas. The general setting, geologic setting, discharge, and diversions and water use are described for many of the springs in this report.

3.1 Steptoe Valley (HA 179)

Steptoe Valley is located in the northern part of the study area and comprises the southern portion of the Goshute Valley Flow System. The valley is approximately 95 mi long and averages 9 mi in width. The valley is bounded by the Schell Creek Range to the east and the Egan Range to the west. U.S. Highway 93 runs north from Ely, Nevada, almost the entire length of the valley until it exits at the northern portion of the valley.

This study inventoried 6 springs in Steptoe Valley. Figure 3-1 shows the springs' locations and their magnitudes of flow and temperature. Two of the springs are discussed in detail in the following section.

3.1.1 Cherry Creek Hot Springs

General Setting

Cherry Creek Hot Springs, also known as John Salvi Hot Springs, are located approximately 1.25 mi southwest of Cherry Creek, Nevada, at the base of Cocomongo Mountain along the eastern slope of the Egan and Cherry Creek ranges. This group of three small springs is located on the John Salvi Ranch. The ruins of a small bathhouse can be seen near the southern two springs (Figure 3-2).

Geologic Setting

Cherry Creek Hot Springs discharge from Quaternary alluvium near the base of a small Tertiary intrusive outcrop. The outcrop consists of a biotite-quartz monzonite dated at approximately 40.3 Ma (Hose et al., 1976). The high temperature of the spring water (47.8°C to 57.2°C) may either be the result of the deep circulation of groundwater along structures associated with the intrusive rocks or with a higher than average geothermal gradient associated with the intrusive body.

The two northernmost springs form small mounds approximately 2 to 3 ft high covering an area of about 100 ft^2, each. The southernmost spring appears to a form small pool and does not appear to have formed any mounds.

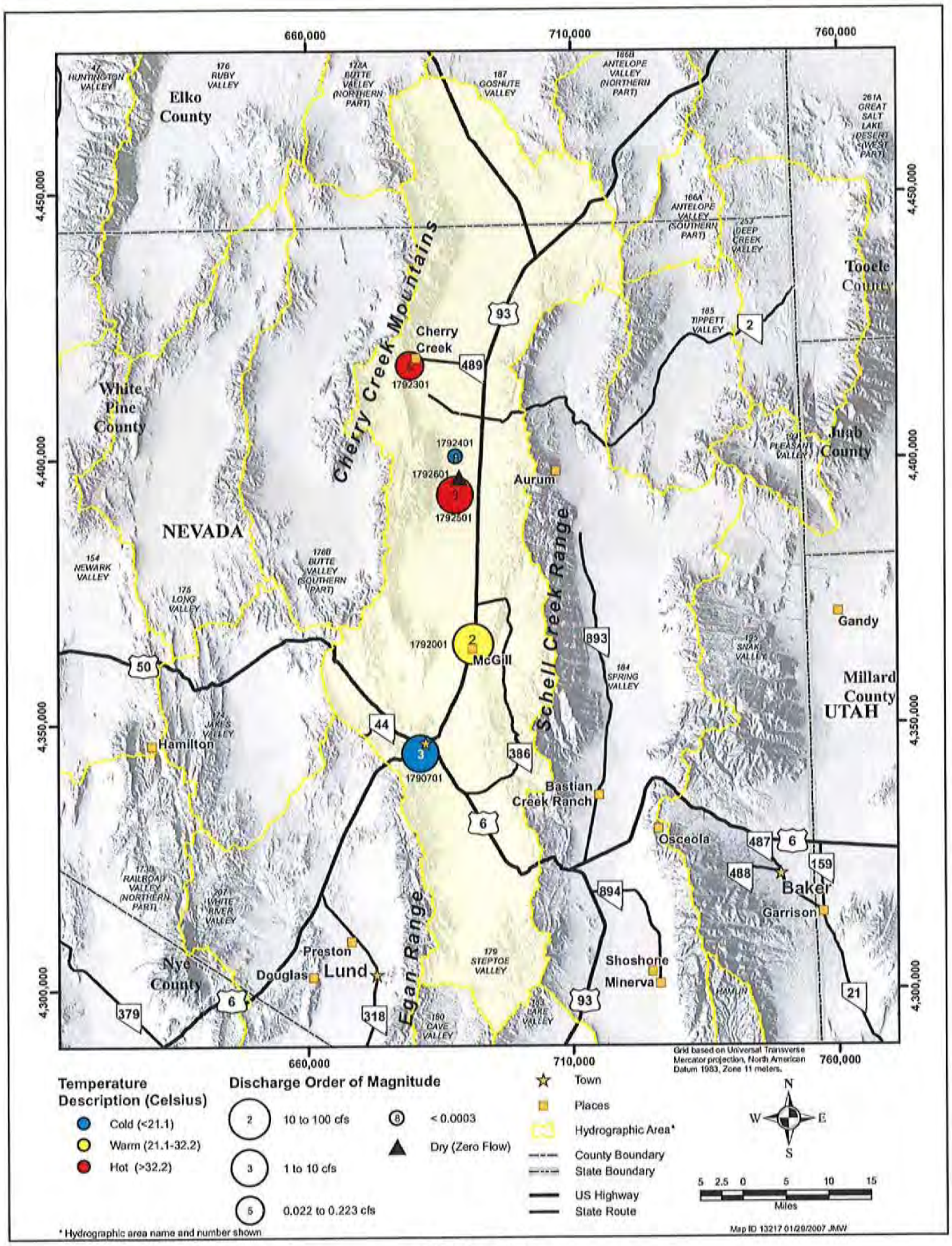

Figure 3-1
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Steptoe Valley, Nevada

Figure 3-2
Ruins of the Cherry Creek Hot Springs Bath House

Discharge

Discharge in July 2004 was estimated at 0.10 cfs (approximately 45 gpm). As a comparison, the combined flow during 1917 (Clark and Riddell, 1920) of the three springs was measured at 0.08 cfs (approximately 36 gpm), and water temperatures at the three springs, from north to south, were 47.8°C, 51.1°C, and 57.2°C.

Diversions and Water Use

Water use at the springs has changed over time. In the early part of the 20th century, the springs were used for bathing and irrigation (Clark and Riddell, 1920). Currently these three springs discharge eastward and fill a small reservoir on the ranch (Figures 3-3 and 3-4).

3.1.2 Monte Neva Hot Springs

General Setting

Monte Neva Hot Springs are located on the west side of Steptoe Valley on the east flank of the Egan Range, 11 mi north of McGill, Nevada, and 4 mi west of U.S. Highway 93 as shown on Figure 3-1. Figure 3-5 is looking east at Monte Neva Hot Springs.

Figure 3-3
Looking North (top) and West (bottom) at the Two Larger Orifices of Cherry Creek Hot Springs

Figure 3-4
Looking Northeast at Cherry Creek Hot Springs Reservoir

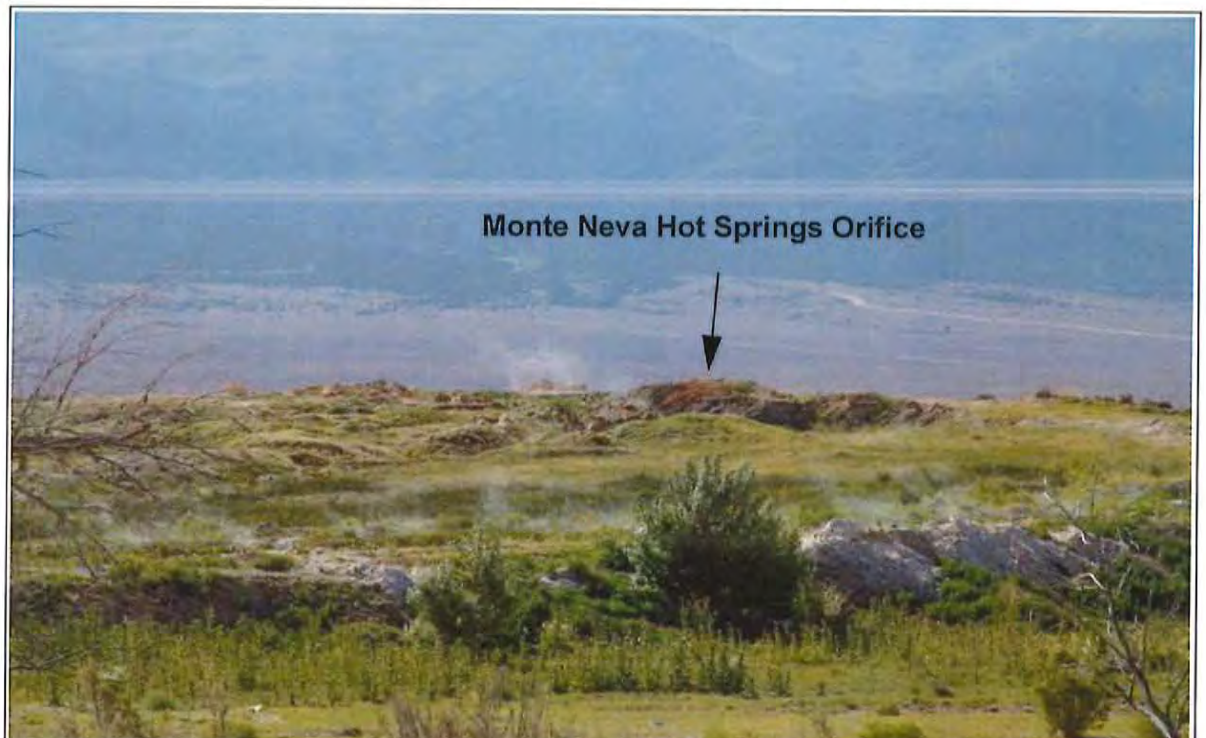

Figure 3-5
Looking Eastward toward Monte Neva Hot Springs Site

Geologic Setting

Monte Neva Hot Springs are located on easterly dipping alluvial fans. Isolated outcrops of Devonian Guilmette Formation (Hose et al., 1976) are approximately 1 mi east of the springs' location. One and a half miles to the northwest of the springs, the Mississippian Chainman Shale, Devonian Sevy Formation, and the Devonian Guilmette Formation are exposed and truncated by a large range-front fault along the eastern flank of the Egan Range. Altogether, six separate and distinct north-trending basin-range faults were mapped. Monte Neva Hot Springs are located on the easternmost of these faults (Figure 3-6). Several thousand feet of displacement occur along these faults. Historically, the range-front fault west of the springs was active, evidenced by the large amount of tufa/travertine deposits along the trace of this fault. No other mounds or orifices were found in this area.

Monte Neva Hot Springs form a large mound approximately 15 ft high and cover an area of more than 10 acres. The core of the spring mound is formed by sinter, with the balance of the material appearing to be windblown, fine-grained sediments held in place by vegetation and light to moderate carbonate cementation. The extent of the spring mound can be observed in the field where the light grass ends and the sagebrush begins abruptly (Figure 3-7).

Discharge

The springs currently discharge from one orifice, but evidence from the spring mound suggests that the orifice migrated over time (Figure 3-8). The discharge channel is artificial in nature and receives regular maintenance to keep it free of the mineral deposits. The stream varies between 2 to 3 ft wide and 0.5 to 1 ft deep. The flow in the channel is controlled by the steep banks lined with travertine (Figure 3-7).

The discharge and temperature measured in 1917 were 1.39 cfs (approximately 624 gpm) and 79°C, respectively (Clark and Riddell, 1920). In 2004, the discharge was estimated at 1.5 cfs (approximately 673 gpm) and the temperature was 76°C, measured 25 ft below the orifice. At the orifice, the water appears boiling, but this is believed to be the degassing of the water (Figure 3-9). There are no discharge-measuring devices installed at Monte Neva Hot Springs.

Diversions and Water Use

Documented spring diversion began in early 1917. However, the spring may have been diverted as early as 1907 when John Melvin started a ranch and platted a town site at the spring (Clark and Riddell, 1920).

Diversions at Monte Neva Hot Springs consist of a trench excavated into the west side of the spring (approximately 10 ft deep and 5 ft wide) and two aqueducts. The trench excavated into the side of the spring mound was completed before 1917 (Clark and Riddell, 1920). The first aqueduct, no longer in use, drained in a northwesterly direction. The currently used aqueduct drains directly west from the spring mound, continues north, and discharges into the first of three ponds. The aqueduct has been modified from its original route that supplied water to the swimming pool and bathhouse. The aqueduct is approximately 800 ft long. The color of the aqueduct's bed transitions from a dark red/brown near the orifice to white and then to orange. This color difference may be explained by

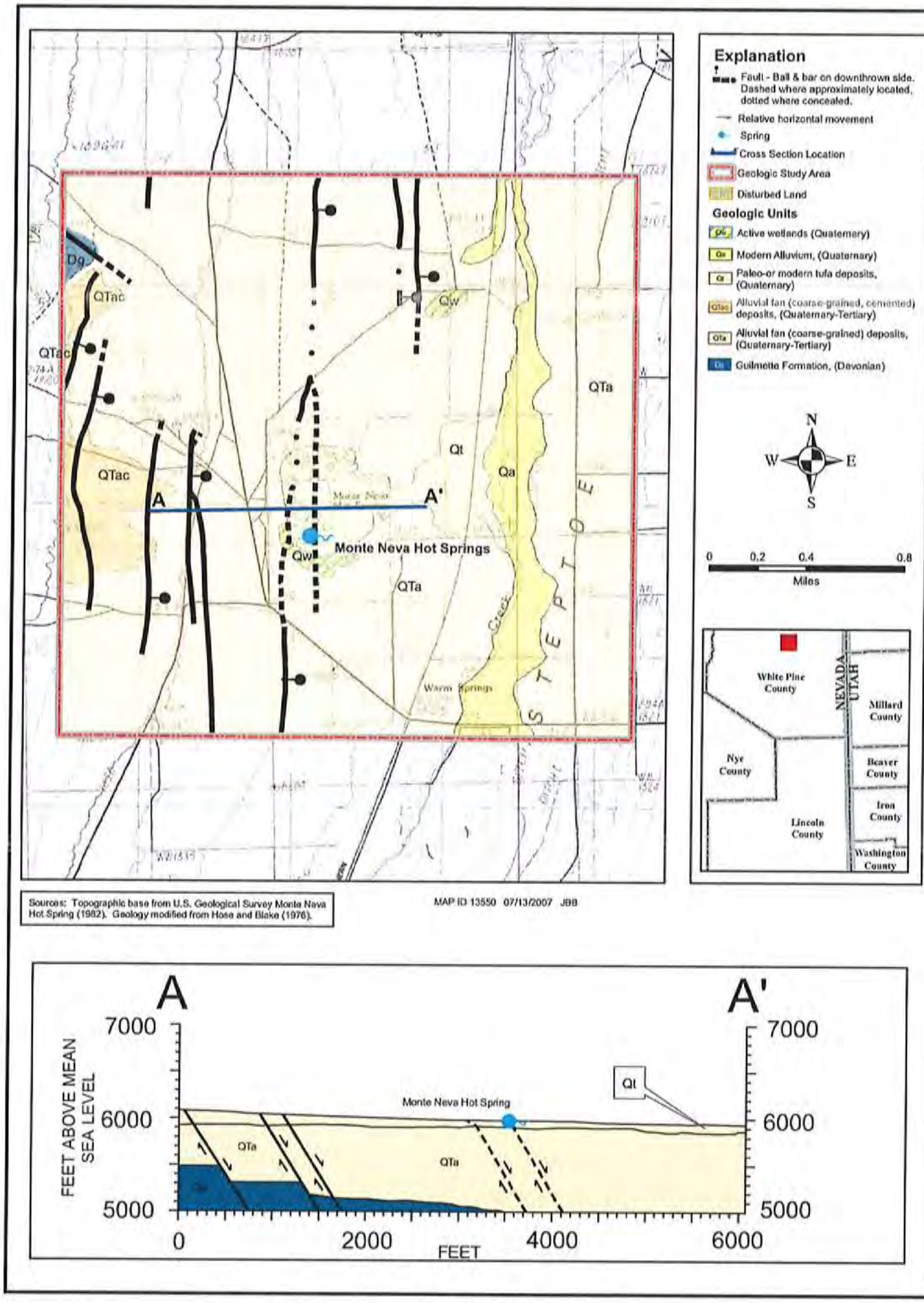

Figure 3-6
Geologic Map and Cross Section of Monte Neva Hot Springs, White Pine County, Nevada

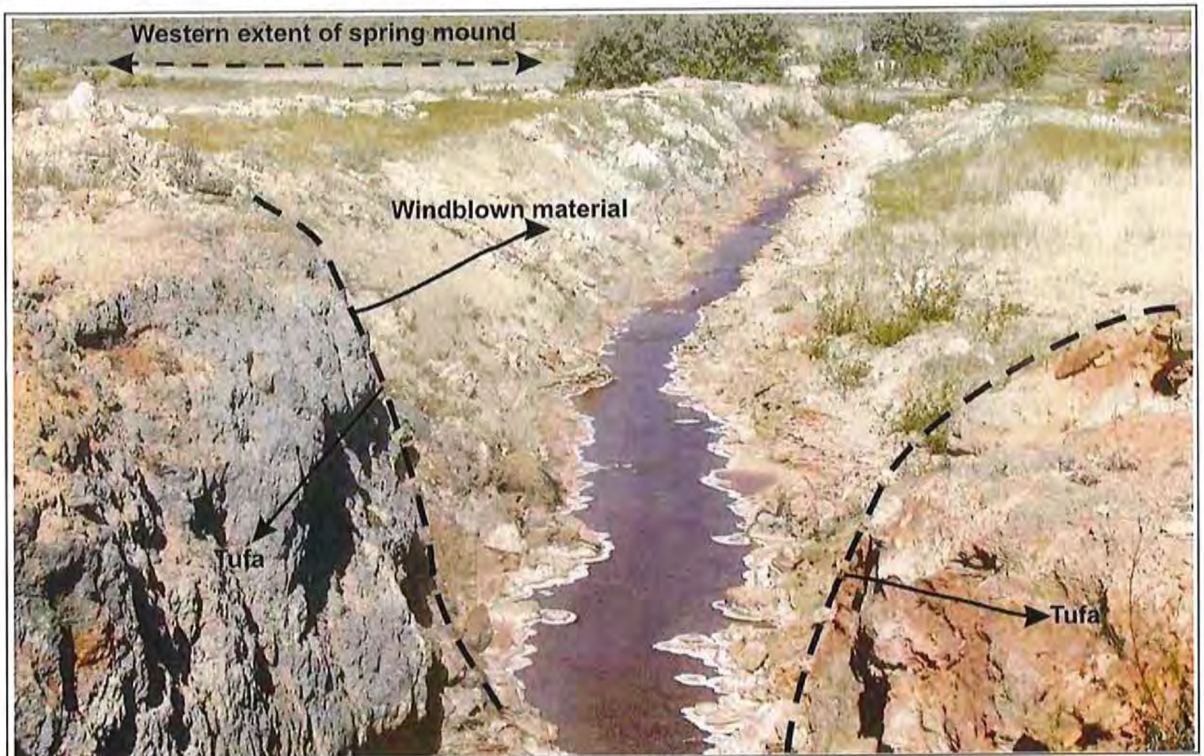

Figure 3-7
Internal Lithology of Monte Neva Hot Springs, View Looking Downstream from Orifice

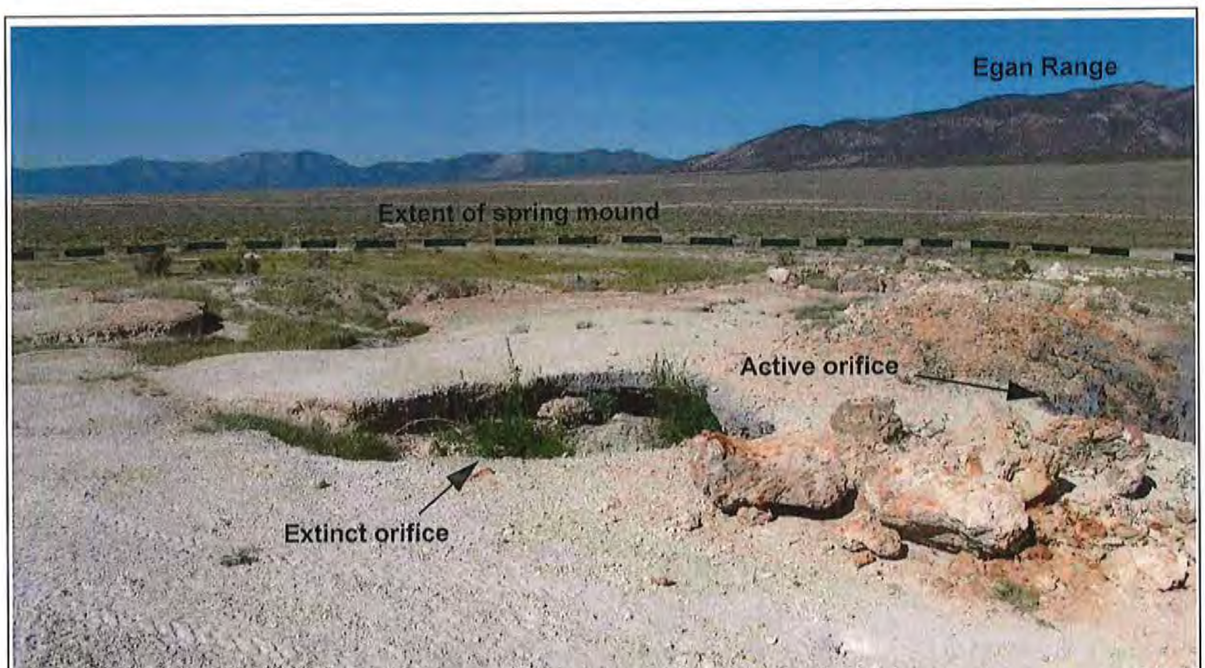

Figure 3-8
View Looking Southwest from the Top of Monte Neva Hot Springs Site

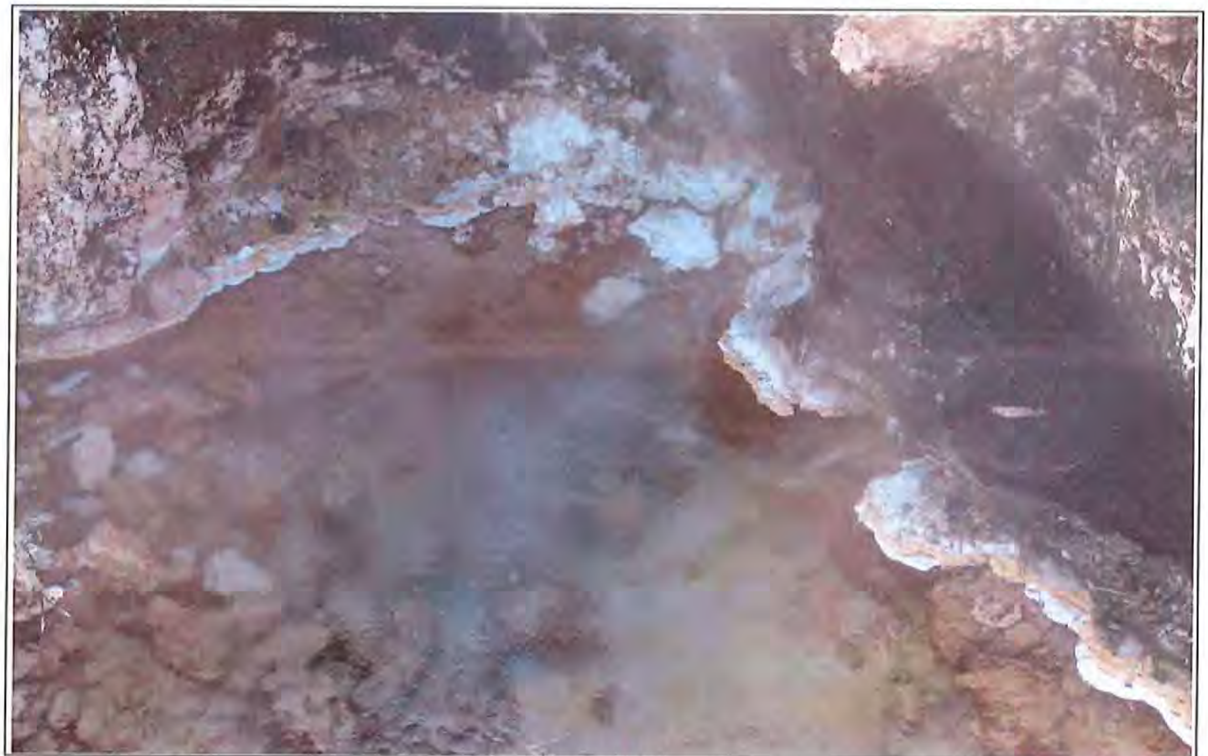

Figure 3-9
"Boiling" Water in the Orifice of Monte Neva Hot Springs

mineral deposition, bacteria colonies, algal communities, or a combination of the three (Figure 3-10). The different reaches are briefly described in Table 3-1.

From 1907 until the early 1920s, the water was used for irrigation and domestic purposes. In the 1920s a resort was built on the property, and the spring water was used for recreational and agricultural purposes. By the 1930s the resort was gone. Currently, the water is used for irrigation and livestock watering (Shaputis, 2005).

3.2 Spring Valley (HA 184)

Spring Valley comprises the southwestern portion of the Great Salt Lake Desert Flow System. The valley is approximately 120 mi long and averages 16 mi wide. Spring Valley is bounded by the Schell Creek Range to the west, the Antelope Range to the north, the Snake Range and the Limestone Hills to the east, the Wilson Creek Range to the south, and the Fortification Range to the southwest. Most of Spring Valley is in White Pine County except for the very southern portion located in Lincoln County. U.S. 50 Highway bisects the valley and U.S. Highway 93 runs along the valley's western flank.

This study inventoried 23 springs in Spring Valley and 8 are described in this section. Figure 3-11 depicts the springs' locations and their magnitudes of flow and temperature.

(From top left in a clockwise direction) Reach 1: 50 ft below the orifice, Reach 3: a weed that has been replaced by mineral deposits, Reach 4: Transition Zone, and Reach 5.

Figure 3-10
Selected Reaches in Monte Neva Hot Springs Aqueduct

Table 3-1
Description of the Reaches of Monte Neva Hot Springs

Reach Number	Color of Reach	Reach Length (ft)
1	Red/Brown	160
2	Transition Zone 1	35
3	White	140
4	Transition Zone 2	30
5	Orange	450

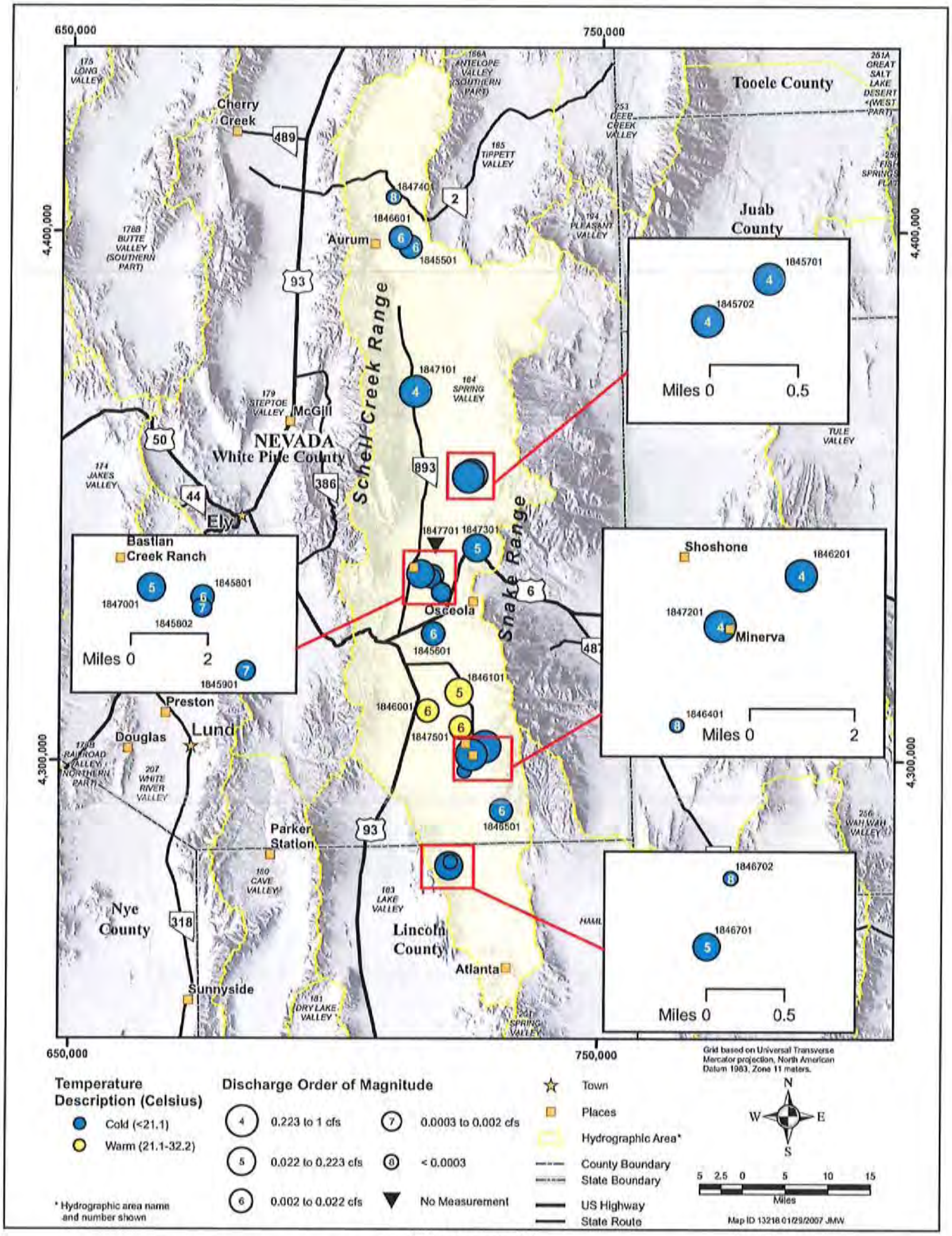

Figure 3-11
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Spring Valley, Nevada

3.2.1 *Willow Spring*

General Setting

Willow Spring is located in northern Spring Valley, approximately 5 mi east of Aurum, Nevada. The spring is small and has two distinct orifices that discharge to the south and join to form a single channel. From this channel, a small man-made impoundment catches the water to form a small pond. High-water marks indicate the pond could be as deep as 3 ft, when water is available. The spring area is approximately 100 ft wide and 125 ft long. This area is covered with a Bermuda-like grass, Rabbit Brush and is surrounded by sagebrush. A similar spring is located approximately 1 mi to the southwest. The water use appears to be for livestock and wildlife (Figure 3-12).

Parshall flume is in the center of the photograph.

Figure 3-12
Looking North toward the Orifice of Willow Spring

Geologic Setting

The spring discharges from Quaternary alluvium, primarily composed of fine sands and silts. Willow Spring is one of several springs that surface along a northeast trending lineation, suggesting the presence of a concealed fault.

Discharge

Discharge was measured using a 3-in. modified Parshall flume. The flume was placed 5 ft below the confluence of the two channels discharging spring flow from two orifices which are located approximately 75 ft above the measurement section. The discharge on October 9, 2007, was 0.009 cfs (approximately 4.0 gpm) and the temperature was 22.9°C. The flow was steady, and the measurement was rated excellent (Figure 3-13).

Figure 3-13
Three-Inch Modified Parshall Flume, 75 ft Downstream of the Willow Springs Orifice

Diversions and Water Use

The discharge of the spring is collected in a small reservoir 100 ft downstream of the measurement site. The reservoir is approximately 25 to 30 ft in diameter. The water use appears to be for livestock and wildlife (Figure 3-14).

3.2.2 North and South Millick Springs

General Setting

North and South Millick springs are approximately 3.5 mi southeast of the center of Yelland Dry Lake and approximately 6 mi east of the West Spring Valley Highway (SR 893). They are in north-central Spring Valley on the west flank of the Snake Range, about 6 mi north of U.S. Highway 50. South Millick Spring is approximately 0.5 mi to the southwest of North Millick Spring.

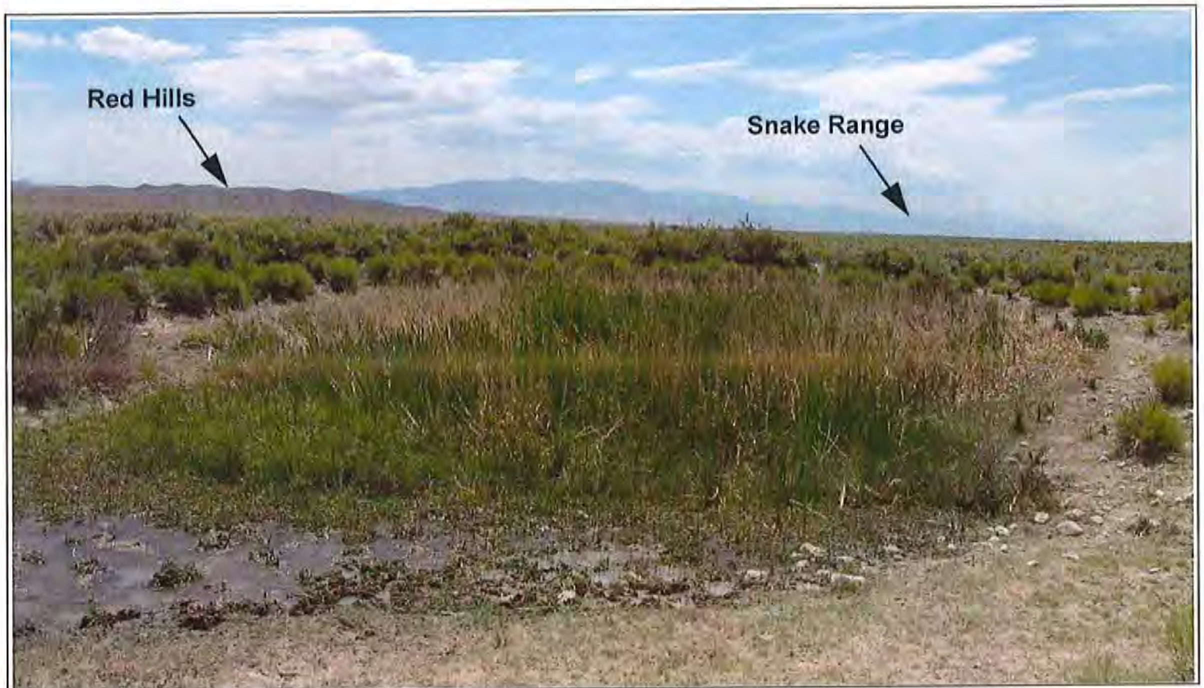

Figure 3-14
View Looking Southeast toward Willow Springs Reservoir

Several small orifices contribute flow to form large spring pools at each spring. Both springs flow westward towards the center of the valley. The spring pools are incised nearly 10 ft below the surrounding land surface, and their downstream channels are incised 4 to 5 ft below land surface (Figures 3-15 and 3-16).

Geologic Setting

Both North and South Millick springs are located on a northeast/southwest-trending normal fault that appears to straighten to the north past North Millick Spring. Both springs are located in alluvium separated by a high terrace. The most notable features in the area are the Pleistocene gravel bars, consisting of lenticular and subrounded pebbles, subparallel to the fault described previously. A barrow pit is located just south of which Millick Spring along one of the beach strands (Figure 3-17).

Discharge

The discharge of South Millick Spring was measured on October 8, 2007, at 1.25 cfs (approximately 561 gpm) using a pygmy current meter. A fair rating was assigned to the measurement, based on moderate aquatic plant growth in the channel and nonlaminar flow (Figure 3-18). The measurement cross section was a silt-lined channel with a low gravel percentage. Water-chemistry samples were collected at each spring and are listed in Appendix C.

The discharge of North Millick Spring was measured on October 8, 2007, at 0.647 cfs (approximately 290 gpm) using a pygmy current meter. A good rating was assigned to the measurement, based on

Figure 3-15
View Looking Northwest toward the North Millick Spring Orifice Pool

The Snake Range is in the background.

Figure 3-16
View Looking East toward the South Millick Orifice Pool

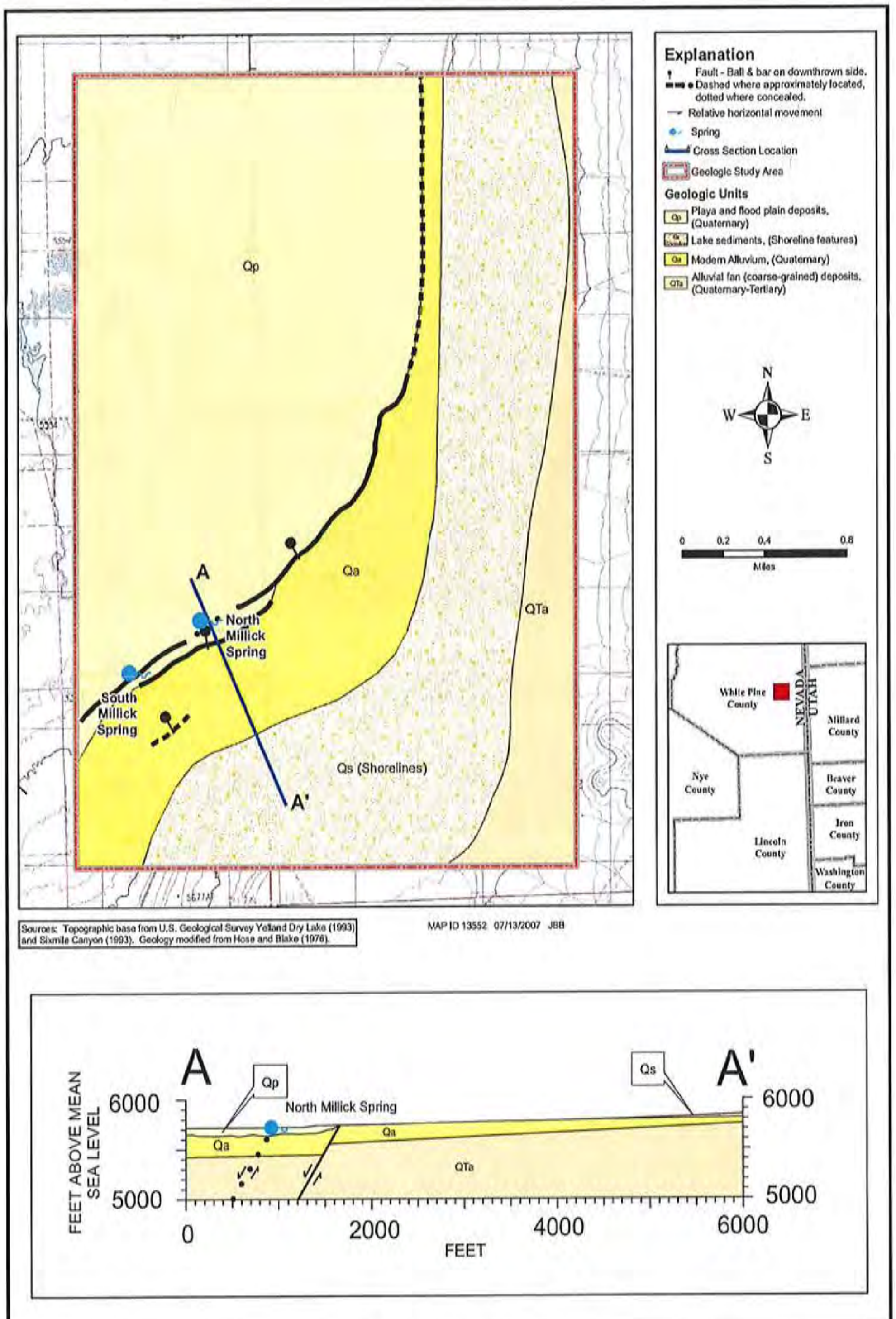

Figure 3-17
Geologic Map and Cross Section of North and South Millick Springs, White Pine County, Nevada

Flow is from left to right.

Figure 3-18
View Looking South at South Millick Spring Discharge Measurement Section

low aquatic plant growth in the immediate channel and smooth steady flow. The temperature of the water was 14.3°C. The measurement cross section was an incised channel with grass and sagebrush-lined banks (Figure 3-19). The left bank is nearly vertical and the right bank has a gentle slope.

Diversions and Water Use

Water from North and South Millick springs is used to water livestock by George Eldridge and Son, Inc. (Eldridge, 2004).

3.2.3 Layton Spring

General Setting

Layton Spring is located approximately 2.5 mi north of U.S. Highway 50 along the eastern flank of Spring Valley. The area is surrounded by sagebrush, and some shrubs are over 5 ft tall (Figure 3-20).

Geologic Setting

Layton Spring discharges from the base of a small scarp, in the alluvial deposits, approximately 6 to 8 ft high.

Orifice is approximately 300 to 400 yards to the east.

Figure 3-19
Looking West at the North Millick Spring Discharge Measurement Section

The Snake Range is in the background.

Figure 3-20
Layton Spring Discharge Pipe and Watering Trough, at the Base of a Small Scarp

Discharge

SNWA measured a maximum discharge of 0.002 cfs (1 gpm) measured on March 26, 2007. The spring has been observed dry during several years.

Diversions and Water Use

When flowing, the spring discharges from a 2-in. diameter pipe into a watering trough, then overflows into a shallow reservoir.

3.2.4 South Bastian Spring

South Bastian Spring is located approximately 2.8 mi southeast of Bastian Creek Ranch, and approximately 2.3 mi northwest of Layton Spring. The spring discharges along the western edge of an extensive marshy area with large cedar trees (*Juniperus scopulorum)* (Figure 3-21). Two other springs with similar conditions and diversion structures were observed located in the area.

Orifice is in the center of the photograph.

Figure 3-21
View Looking Northeast at South Bastian Spring Discharge Area

Geologic Setting

South Bastian Spring and the other nearby springs discharge several hundred yards to the east of a small terrace (scarp?) in the Quaternary alluvium.

Discharge

Discharge at South Bastian Spring is variable. The minimum discharge measured was 0.001 cfs (0.45 gpm) in August 2006, and the maximum discharge of 0.011cfs (4.76 gpm) was measured August 2005. The volume of the discharge was measured from the outfall of a 2-in. pipe protruding from a 20-in. pipe. The flow was clear and the temperature varies between 12.0 to 12.9°C (Figure 3-22).

Figure 3-22
South Bastian Spring Area, Showing Grasses, Cedar Trees, and Discharge Pipe

Diversions and Water Use

Water is diverted at the source of the spring. The spring flow is captured by a 20-in. diameter galvanized casing that routes the flow to a 2-in. pipe that discharges to a water trough. The trough then overflows onto the ground where it forms a marshy area approximately 25 ft in diameter. The water is used by livestock and wildlife. Two other springs in the vicinity had a similar completion (Figure 3-23).

3.2.5 North Spring

General Setting

North Spring is located 10 mi north of Lake Valley Summit and 2 mi east of U.S. Highway 93. (Figure 3-24). Water-chemistry samples were collected from the spring, and these results are listed in Appendix C.

Figure 3-23
South Bastian Spring Diversion Appliances

Figure 3-24
View Looking East from North Spring toward the Snake Range

Geologic Setting

North Spring discharges along a north-south-trending fault and is flanked on the east and west by additional north-south-trending faults (Figure 3-25). There is another small spring approximately 900 to 1,200 ft north of North Spring that appears to discharge from the same fault.

Discharge

Discharge was estimated to be 0.022 cfs (10 gpm) during the June 22, 2004, field visit. No other discharge measurements have because the conditions are not conducive to making a discharge measurement. The spring discharges to the east, and the flow travels only 150 yards before it is lost to infiltration and evapotranspiration. The spring pool appears to have been excavated. There was no distinct orifice that could be observed.

Diversions and Water Use

The water is used for livestock watering and supports a small grassy area downstream of the spring.

3.2.6 The Cedars

General Setting

The Cedars are two wells located approximately 8 mi. north of Minerva, Nevada, and 17 mi south of the Osceola, Nevada, turnoff from U.S. Highway 50. The area is at the toe of an alluvial fan originating on the Snake Range's western flank. The Cedars have multiple wells flowing under artesian pressure (Figure 3-26). Cedar #1 is a 2-in. diameter well with a 1-in. diameter discharge pipe. Cedar #2 is a 4-in. diameter well with a 2-in. diameter discharge pipe (Figure 3-27).

Geologic Setting

The wells at The Cedars are drilled near the toe of an alluvial slope consisting mainly of carbonate clasts.

Discharge

Discharge volume for both wells was measured on July 28, 2004. Cedar #1 was discharging 0.018 cfs (approximately 8 gpm), and Cedar #2 was discharging 0.074 cfs (approximately 33 gpm). The discharge measurements are rated as good and fair, respectively. The flow of Cedar #2 is estimated at least twice what was measured because of the piping arrangement at the wellhead (described below). that half of the discharge is that half is diverted to Shoshone Pond, which serves as a refugia for Pahrump poolfish (*Empetrichthys latos*) and relict dace (*Relictus solitarius*). Total discharge from the two wells is estimated at 0.166 cfs (0.018 cfs + (0.074 cfs × 2)).

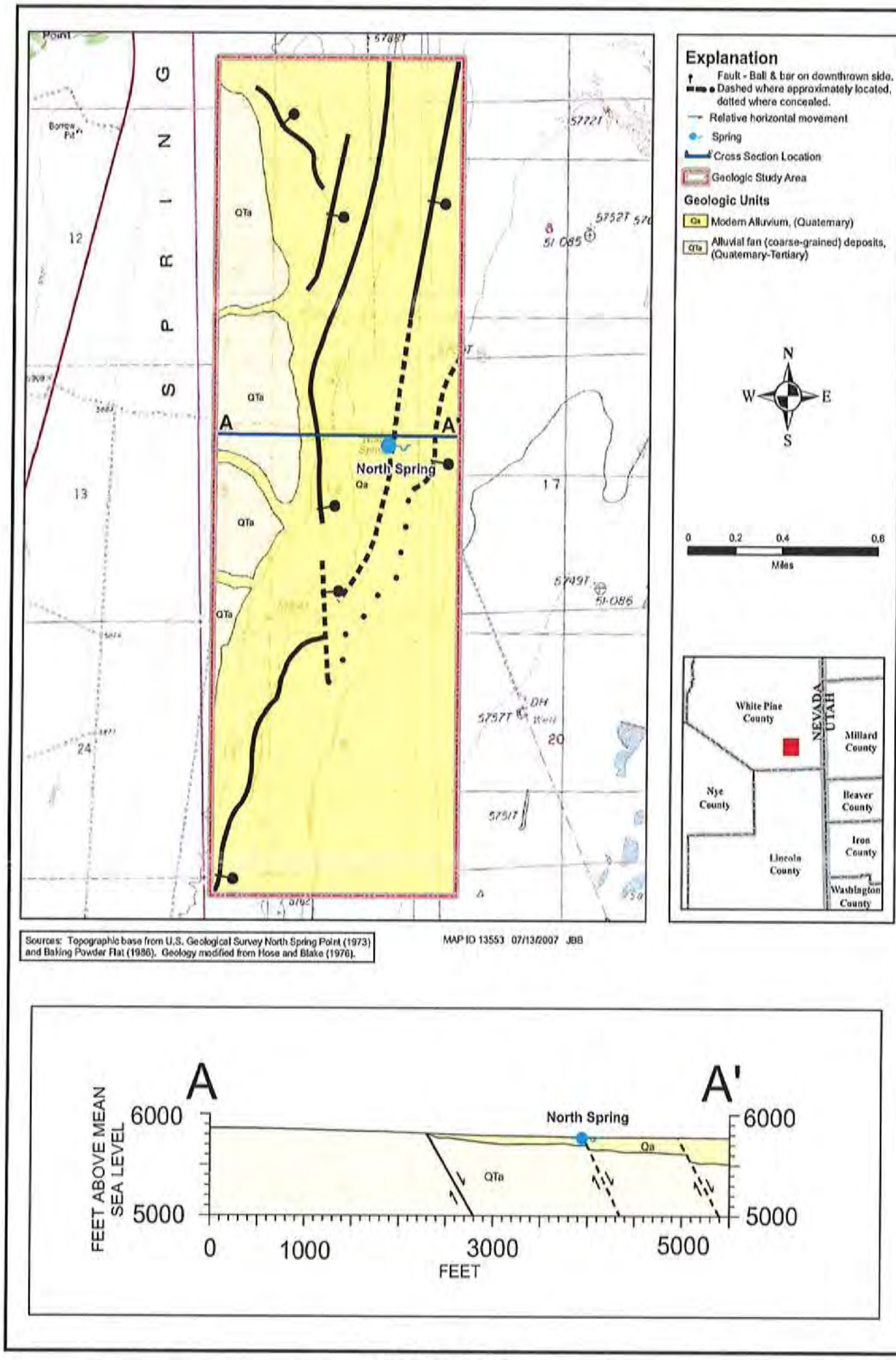

Figure 3-25
Geologic Map and Cross Section of North Spring, White Pine County, Nevada

Figure 3-26
View Looking Southwest from The Cedars #1 toward Mt. Grafton

Diversions and Water Use

Historically, water has been diverted from Cedar #1; however, water is currently diverted from Cedar #2. The water from Cedar #2 is diverted by 2-in. diameter pipe from the 4-in. diameter casing. A "T" fitting in the discharge line splits the 2-in. diameter pipe, routing flow to either Shoshone Pond or the ground surface that forms a small creek supporting a large meadow for cattle. Water routed to Shoshone Pond keeps the pond full and overflows into the meadow.

3.2.7 Swallow Springs

General Setting

Swallow Springs are located in a grove of large cottonwood trees, 1.5 mi north of Shoshone, Nevada, and east of SR 894 1.5 mi. (Figure 3-28). The springs are located approximately a quarter mile from the head of the Swallow Canyon alluvial fan on the Snake Range's western flank. The spring orifices (referred to as the northern and southern) discharge into separate channels, which join to form a single channel. At one time, the southern orifice was diverted towards Minerva, Nevada, while the northern orifice flows into an aqueduct and is delivered to Shoshone, Nevada.

Figure 3-27
(Top) The Cedars #1 is a One-Inch Well, (Bottom) The Cedars #2 is a Four-Inch Well

Figure 3-28
Grove of Cottonwood Trees at Swallow Springs

Geologic Setting

Swallow Springs is located in the middle of a large alluvial fan approximately a quarter mile from an outcrop of middle Cambrian limestone (Hose et al., 1976).

Discharge

Discharge was measured downstream of the north and the south orifices during a field investigation on November 29, 2007. Discharges of 0.664 cfs (298 gpm) in the southern channel, and 0.087 cfs (39 gpm) below the northern orifice were measured. The combined discharge of these orifices was 0.751 cfs (approximately 337 gpm). The measurements were made using a 3-in. modified Parshall flume in the northern channel and a pygmy meter in the southern channel (Figure 3-29). Both flows were clear and steady. The northern channel is incised nearly 2 ft in places.

Diversions and Water Use

Swallow Springs were likely diverted sometime before 1920, based on the observation that parts of the aqueduct for the southern channel are constructed from redwood pipe (Figure 3-30). Redwood pipe was typically not available after 1920 (Seymour, 2004). The intake of the southern channel diversion was located approximately 15 ft below the spring orifice. It appears the aqueduct fell into disrepair, and the southern channel was then diverted by a small dam with a head gate routing water to the natural channel then to a channel that sent the water towards Minerva, Nevada. Currently, the head gate for the diversion is submerged, and the flows traverse through a portion of the diversion channel and into the natural channel through a breach in the ditch (Figure 3-31).

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Figure 3-29
Discharge Measurement of Swallow Spring, North Channel, Using a Modified Parshall Flume

Figure 3-30
Gate Valve and an Exposed Section of Redwood Pipe along Southern Channel Diversion of Swallow Springs

Figure 3-31
Submerged Head Gate, Formerly Used to Transfer Swallow Springs Water to Either Shoshone, Nevada to the North or Minerva, Nevada, to the South

The northern channel flows freely into the natural channel where there is an 8 × 8 ft concrete building. From this point on, the spring appears to have been diverted into an aqueduct towards Shoshone, Nevada. Currently, the discharge continues in the natural channel toward Shoshone, Nevada.

3.2.8 Blind Spring

General Setting

Blind Spring is located in southern Spring Valley approximately 7 mi east of U.S. Highway 93 and 2 mi southwest of Minerva, Nevada.

Blind Spring is an oblong pool approximately 75 × 50 ft, roughly centered in an area of grasses and greasewood that encompass an area of about 7,500 ft^2 (Figure 3-32). The pool has heavy aquatic plant growth, and the water appears to be stagnant. Blind Spring has a raised rim surrounding it, and the pool's water elevation is about 4 ft below land surface. It appears that the raised rim is anthropogenic in origin and not a natural feature.

Geologic Setting

Blind Spring appears to be a water-table spring, as the pool represents the potentiometric surface of the aquifer. Approximately 0.75 to 1.0 mi to the southwest are sand dunes 8 to 10 ft high and

Large number of greasewood surrounding the spring area.

Figure 3-32
View Looking Northeast from Blind Spring

containing pieces of tufa with a fine sandy texture, suggesting that this was a paleo-discharge area as well.

Discharge

Blind Spring discharges directly into a stagnant pool. No discharge measurements were made.

Diversions and Water Use

Water from Blind Spring is used for wildlife and livestock.

3.3 Snake Valley (HA 195)

Snake Valley comprises the central portion of the Great Salt Lake Desert Flow System. The valley is approximately 95 mi long and 40 mi wide near Garrison, Utah. Snake Valley is bounded by the Snake Range to the west, the Confusion Range, Conger Range, and Burbank Hills to the east, and a low-alluvial divide to the south. To the north, Snake Valley opens to the Great Salt Lake Desert. U.S. Highway 50 traverses the southern one-third of the valley and runs east-west through the Snake Range, then exits the valley in the east. This study inventoried 17 springs in Snake Valley. Figure 3-33 provides the locations of these springs and their magnitudes of flow and temperature. A description of three of these springs is given in the following sections. The Wilson Hot Springs Group and Cold Springs Group are discussed in the Fish Springs Flat Section.

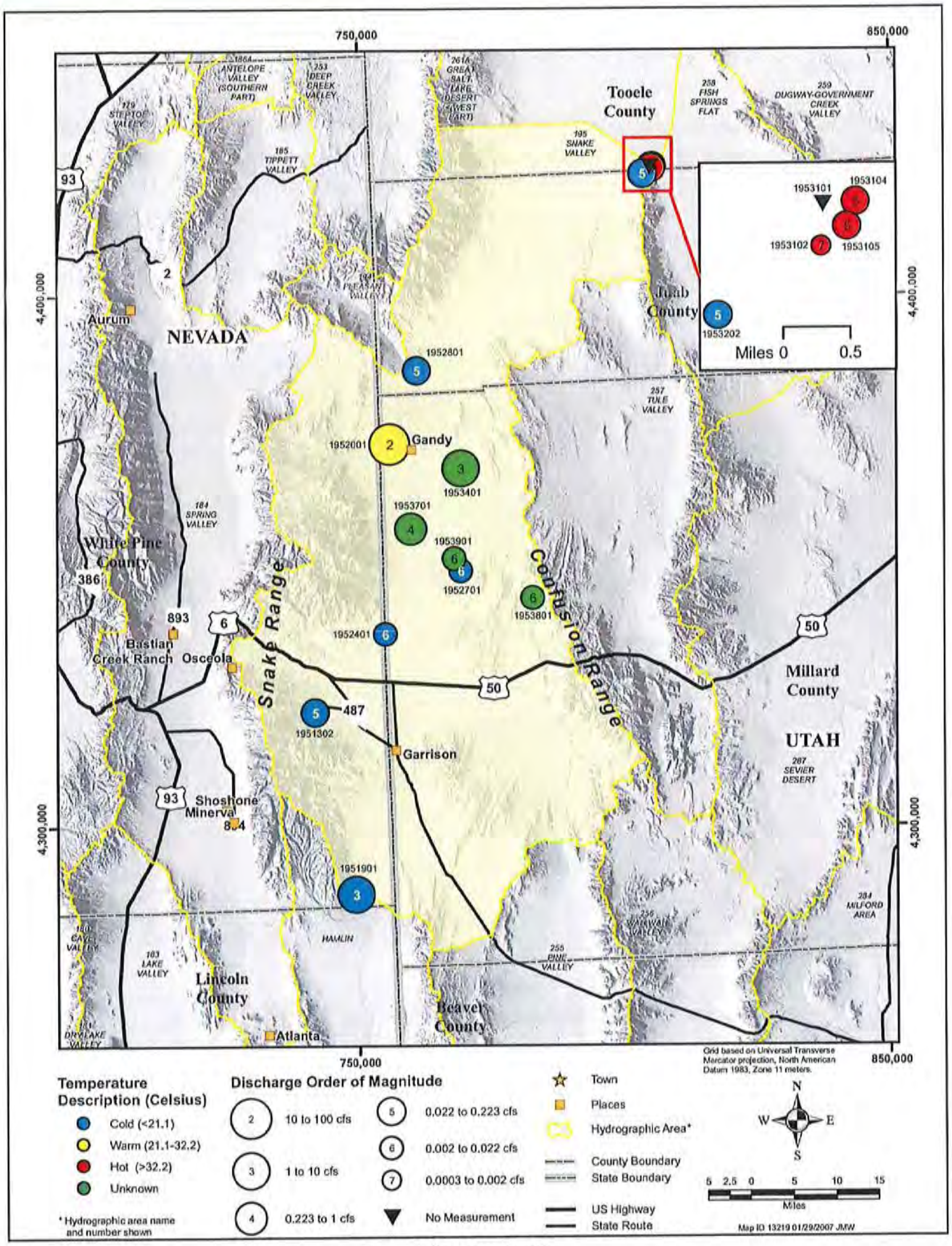


Figure 3-33
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Snake Valley, Nevada and Utah

3.3.1 Warm Springs

General Setting

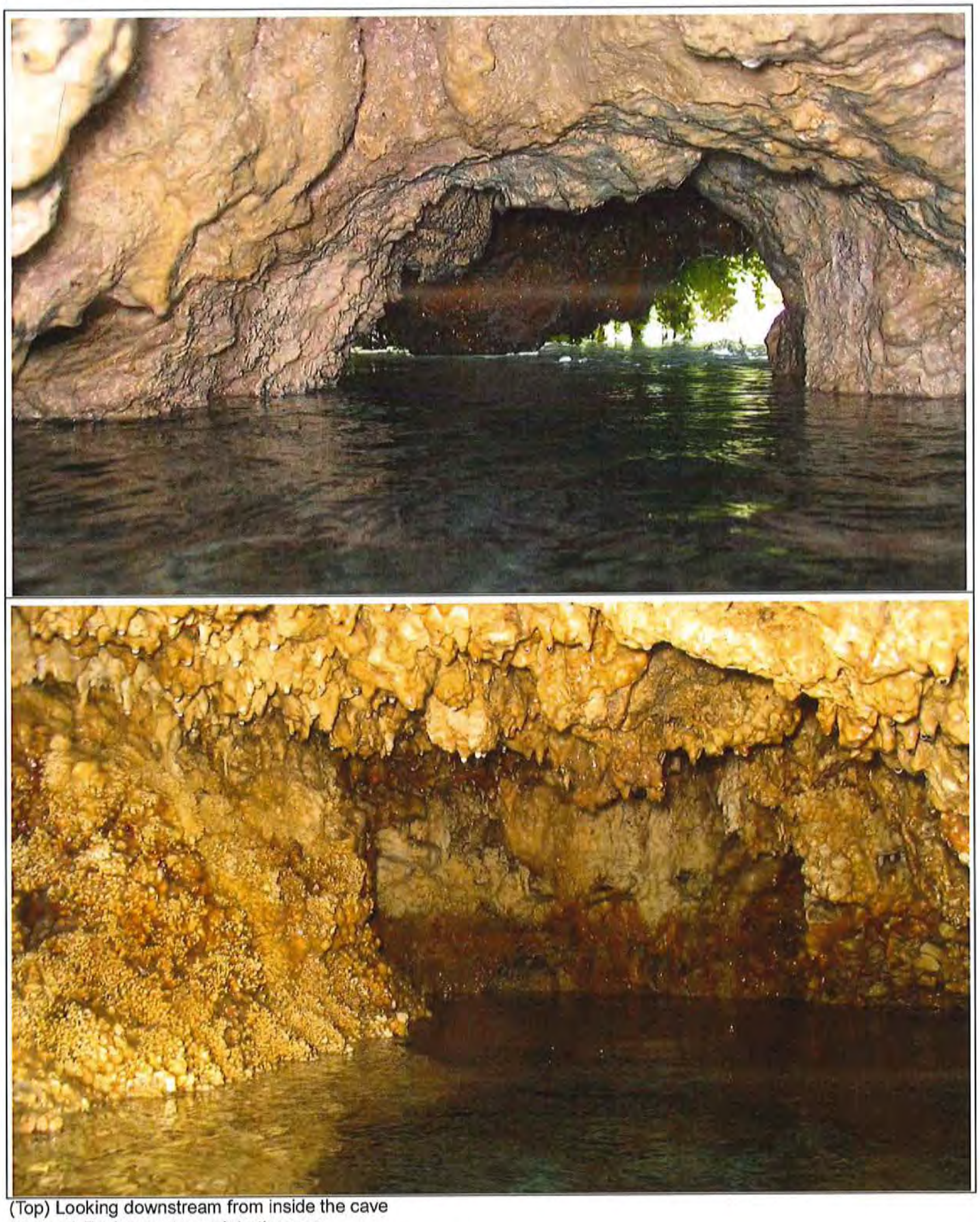
Warm Springs is approximately 0.5 mi east of the Nevada state line and 3 mi west of Gandy, Utah. U.S. Highway 50 is approximately 35 mi south of the spring. A large ranch is 0.5 mi to the east of the spring. This spring discharges from a multiple-orifice system emanating from Paleozoic carbonate rocks and flows in an easterly direction toward Gandy, Utah. The spring area is a popular recreation area with local residents. Swimmers are able to swim approximately 30 ft upstream to the main orifice in a solution cavern. The cavern is approximately 7 ft high and 10 ft in diameter (Figures 3-34 and 3-35).

Entrance to the cave is in the shaded area at the left of the photograph.

Figure 3-34
Confluence of the Three Main Orifices of Warm Springs

Geologic Setting

There are several orifices in the spring complex. The largest is at the northeast reach of the stream channel where a large pool has formed. To the southwest of the main orifice, two and possibly three other source areas were noticed along the trace of a northeast-southwest-trending normal fault. These sources appear to coincide with fault and fracture zones perpendicular to the northeast-southwest-trending fault (Figure 3-36).



(Top) Looking downstream from inside the cave
(Bottom) Facing upstream into the cave

Figure 3-35
Cave at Warm Springs

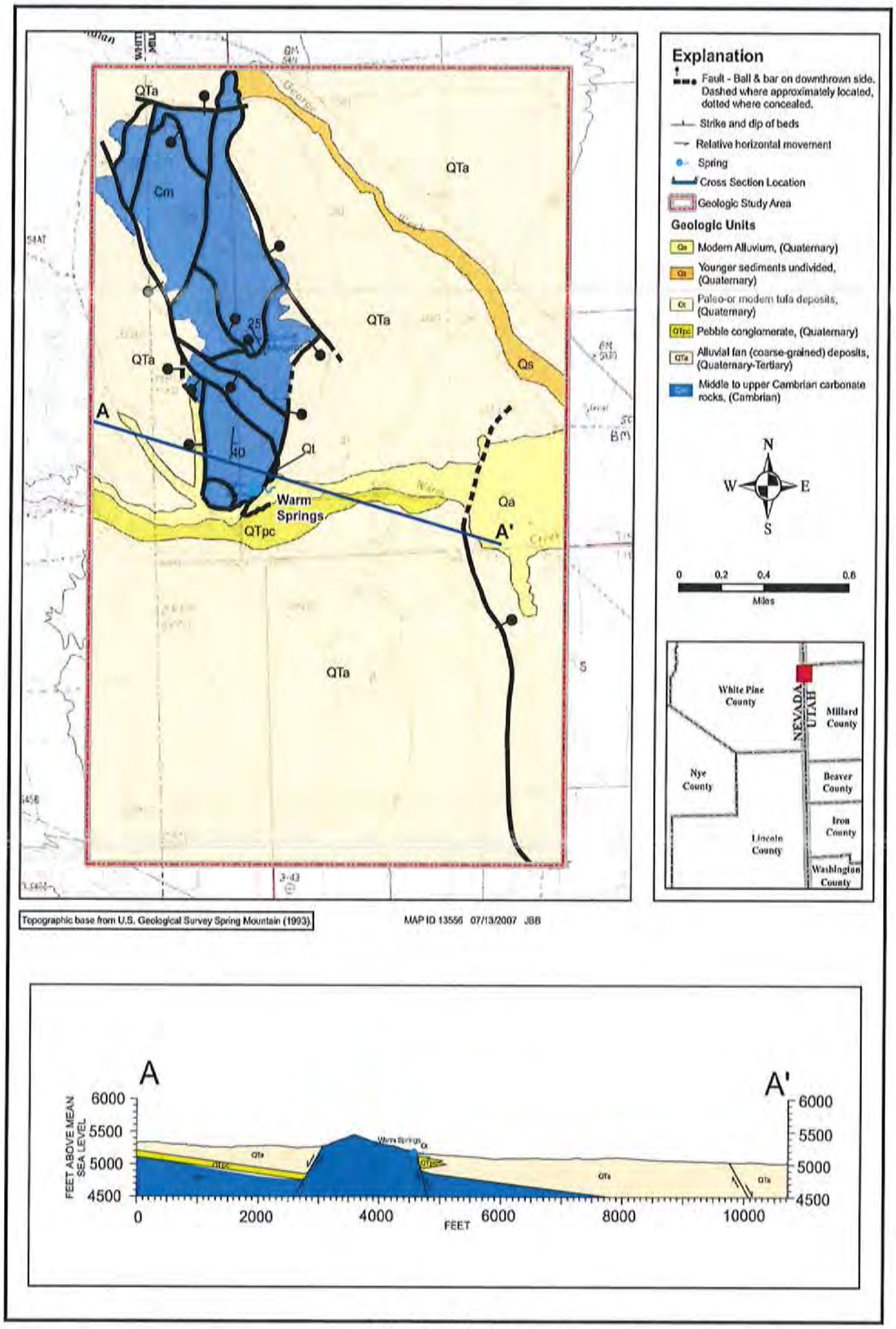
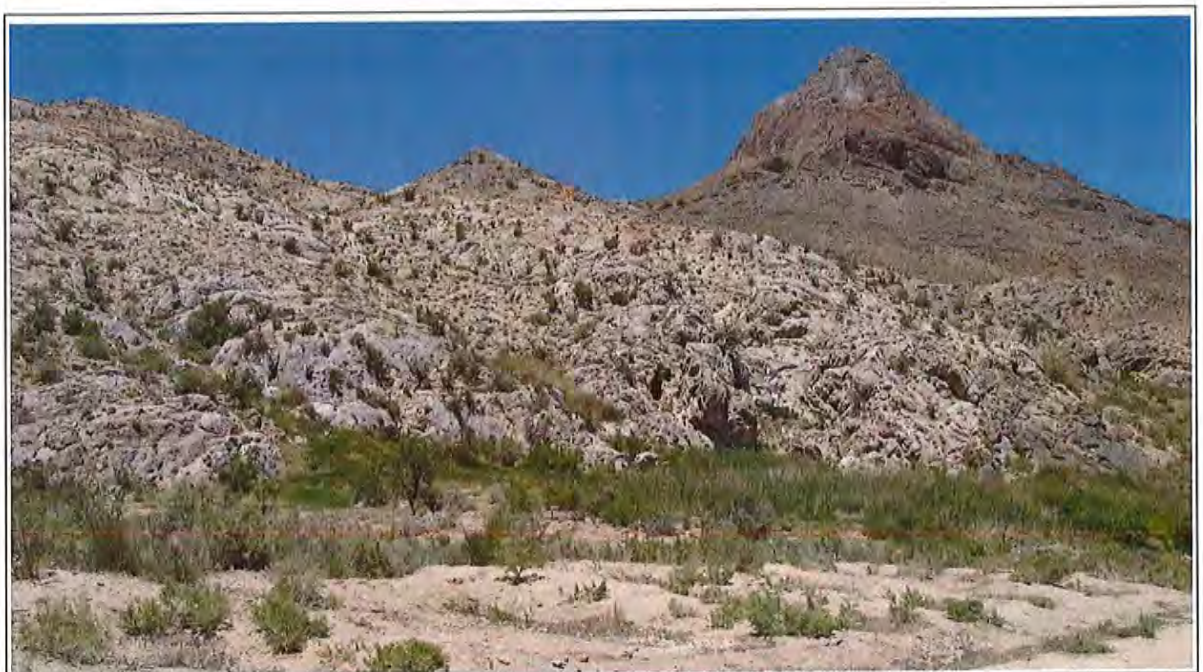


Figure 3-36
Geologic Map and Cross Section of Warm Springs, Millard County, Utah

At the intersection of these faults, thick (greater than 6.5 ft) tufa deposits were formed and are forming, similar to the main spring to the northeast. Bedrock in the area is highly complex. Hintze and Davis (2002) mapped these rocks as part of the Cambrian sequence, i.e., limestone and dolomite of the Orr Formation (middle Cambrian) (Figure 3-37). The ridge to the north of the spring is the Notch Creek Formation of upper Cambrian and consists of dolomite and limestone (Hintze and Davis, 2002).



Spring Mountain is in the background.

Figure 3-37
Source Rock at Warm Springs

There are numerous faults in the area. The northeast-southwest-trending fault more than likely controls the Warm Springs complex. Two large displacement faults north of the springs form the horst (ridge). This ridge is truncated to the south by two northeast-southwest-trending faults (these faults control the discharge at the springs). A very young Quaternary fault with several feet of displacement is exposed in the alluvium east of the site and the ranch.

Discharge

The discharge on November 3, 1964, was reported to be 8.0 cfs (Hood and Rush, 1965). The discharge was measured on June 22, 2004, at 8.42 cfs (3,780 gpm) while wading using a standard Price AA current meter. The water temperature was 27°C at the time of the measurement. The measurement was taken after extensive work was done to clear the brush along the right bank to make a measurement section. While collecting measurements, care was taken to make sure the swimmers dam was kept clear of debris so as not to affect the quality of the discharge measurement.

The channel is incised approximately 5 ft. and the bed material of the square-bottomed channel is mostly coarse sand, gravel, and limestone cobbles. Both channel banks are steep and lined with dense brush. The main discharge comes from a large orifice approximately 25 ft upstream of the measurement cross section (Figure 3-38).

Figure 3-38
Discharge Measurement Section on Warm Springs Creek, below the Orifice

Additional data were collected downstream of the main orifice. Approximately 0.5 mi downstream, the discharge was measured at the approach to a concrete diversion. During the October 30, 2004 measurement the discharge was recorded as 15.0 cfs (6,730 gpm), and the measurement was rated fair (Squires, 2004).

On August 4, 2005, discharge measurements were made 75 ft below the orifice and at the diversion structure. A discharge of 15.5 cfs (6,960 gpm) was measured below the orifice, and 17.8 cfs (7,990 gpm) was measured at the diversion. Both measurements were made using a Price AA meter and were rated fair. After the October 2004 and August 2005 measurements were made, it was apparent that the November 1964 and the June 2004 measurements missed significant incoming flow to the creek.

During September 2005, the USGS Utah District installed a gaging station (10172860) on Warm Springs Creek at the diversion structure. During the 2006 water year, the mean daily average was 16.8 cfs (7,540 gpm) or approximately 12,160 afy. The minimum daily flow was 14 cfs (6,284 gpm) and the maximum daily flow was 19 cfs (8,528 gpm) (USGS, 2006b).

Diversions and Water Use

Diversions are all approximately 0.5 mi downstream of the orifice. Here the flow is diverted to the south and the east towards Gandy, Utah, to support agriculture on the valley floor. The water enters the diversion structure through a 4-ft flume, then it is split into two streams. The east stream enters into a drop pipe, the west stream is split again, and both of these streams enter into drop pipes (Figures 3-39 and 3-40).

Figure 3-39
Warm Springs Creek Passing through Flume and Entering the Splitter Box

3.3.2 Caine Spring

General Setting

Caine Spring is located approximately 10 mi north of Baker, Nevada, and 24 mi south of Gandy, Utah, along Millard County Route 159 (Gandy Road). The spring emanates from two small seeps. One seep has been improved with a flowing 3-in. diameter well. The main spring (3-in. diameter well) is near a large Russian olive tree and flows northward into a small reservoir (Figure 3-41).

Geologic Setting

The spring discharges from alluvial deposits at the base of a scarp 2 to 3 ft in height. Two additional unnamed springs discharge along this same structure that strikes approximately north 20 degrees east.

Figure 3-40
Second Splitter Box on Warm Springs Creek

Figure 3-41
Caine Spring Discharge Area, Snake Valley, Utah

Discharge

Discharge from Caine Spring was difficult to estimate because of the poor condition of the 3-in.-diameter well and the heavy vegetation surrounding it (Figure 3-42). Discharge was estimated at 0.011 cfs (5 gpm); however, this value is considered poor because of adverse measurement conditions.

Figure 3-42
Discharge Pipe at Caine Spring

Diversions and Water Use

The entire discharge of Caine Spring is collected in a small reservoir, and the water is used for livestock and wildlife.

3.3.3 Big Springs

General Setting

Big Springs is located approximately 19 mi southwest of Garrison, Utah, and approximately 19 mi northeast of Atlanta, Nevada, at the southeast terminus of the Snake Range. The water supplies irrigation needs at the Big Springs Ranch, and the remainder flows northeast into Big Springs Creek, which becomes Lake Creek east of the Utah-Nevada border, and finally into Pruess Lake 3 mi southeast of Garrison, Utah (Figure 3-43). Big Springs begins as a few seeps then rapidly increases in discharge within 25 ft. The left bank of the creek is heavily overgrown with Willow and other woody plants, and the right bank is a steep slope that is covered in light grass.

A large pool is formed by a diversion structure consisting of two Cippoletti weirs with crest lengths of 15 and 4 ft.

Figure 3-43
Big Springs at Big Springs Ranch, Snake Valley, White Pine County, Nevada

Geologic Setting

Big Springs is the largest spring in a complex of springs emanating from the alluvium in the central to lower part of Snake Valley. Big Springs is located on a prominent Quaternary fault escarpment with several meters of displacement and a north-northeast strike. Local field mapping suggests that both Big Springs and an unnamed spring complex, located approximately 1.5 mi northeast, are on the same large fault. A northernmost spring complex, also unnamed, is about 2.5 mi northeast of Big Springs and is located on a normal fault that is subparallel to the main fault. This fault separates from the main fault just north of Big Springs. Both of these faults appear to be subparallel to a range-bounding fault that has minimal expression and appears to be oriented nearly north to south. South of Big Springs the main fault bends and becomes north-northwest and is less distinct about a mile south of Big Springs (Figure 3-44).

North Little Springs and South Little Springs are minor spring complexes approximately 1 to 2 mi southeast of Big Springs (Figure 3-44). Each of these complexes is located on separate but subparallel north-northeast to northeast striking faults. North-northeast faults, most commonly oriented approximately 20 degrees east, appear to be very common throughout this part of Snake Valley and control the locations of washes, terminations of alluvial fans, and bedrock outcrops. In general, most of the structures appear to be down to the west. However, the faults at and near Big Springs are down to the east, due to the proximity of a large range-bounding fault on the east side of the Snake Range.

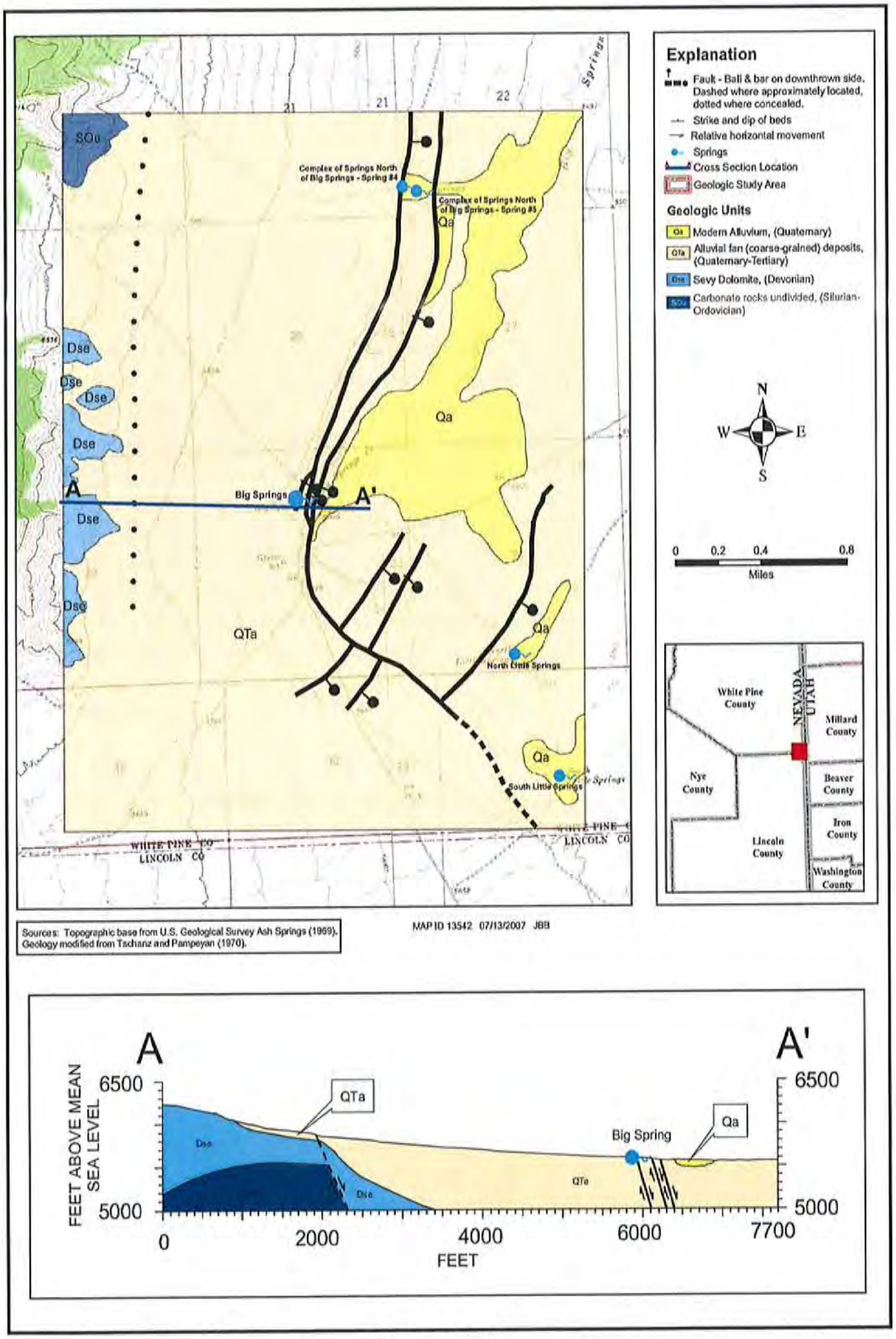


Figure 3-44
Geologic Map and Cross Section of Big Springs, White Pine County, Nevada

Discharge

The discharge of Big Springs is measured below each of the two Cippoletti weirs diverting its flow. This report considers this combined amount as "Big Springs" total flow. It is necessary to define this as the measurement point for this spring because the Big Spring Creek gains significantly in discharge below this point. In 1908, Meinzer (1911) reported that several additional springs below Big Spring contribute to the 18 cfs (8,080 gpm) discharge of Lake Creek. In 1964, Hood and Rush (1965) estimated the discharge to be 8 cfs (3,590 gpm) near the orifice of Big Springs. Walker (1972) clarified the large discrepancy in discharge values by taking measurements below the diversion structure and in three irrigation ditches. On November 18, 1972, Walker measured the discharge below the Cippoletti weirs as 8.92 cfs (4,000 gpm). He then measured the total flow downstream in the diversion ditches at 19.1 cfs (8,570 gpm), demonstrating a 10.18 cfs (4,570 gpm) gain below the diversion structure. Walker installed graphic recorders on the three diversion ditches and obtained daily discharges between 15 and 19 cfs (6,730 gpm and 8,530 gpm) from June through November, 1972. Squires (2004) measured 10.4 cfs (4,670 gpm) in November 2004, below the weirs. In early 2005, USGS in cooperation with SNWA and the Nevada Division of Water Resources (NDWR) installed a gaging station at Big Springs. The gaging station data is published under two separate gaging station numbers. 10243224 is Big Springs Creek South Channel near Baker, NV (Big Springs South) and 102432241 is Big Springs Creek North Channel near Baker, NV (Big Springs North). The 2006 mean annual discharge at Big Springs South is 6.27 cfs or 2,290 afy. The minimum and maximum daily discharges are 5.3 cfs (2,648 gpm) and 7.9 cfs (3,546 gpm) respectively. In 2006 Big Springs North had minimum and maximum discharges of 2.8 cfs (1,257 gpm) and 5.6 cfs (2,513 gpm) respectively.

Diversions and Water Use

There are numerous diversions at Big Springs. There are several portable pumps installed to divert water. In addition, there is a splitter box consisting of two Cippoletti weirs. The first weir has a crest length of 15 ft and diverts approximately 40 percent of the discharge in a northerly direction. The second weir has a crest length of 4 ft and diverts approximately 60 percent of the discharge in an easterly direction. Both weirs were clear of debris and unobstructed. The water from this spring is used for agricultural purposes; unused water flows northeasterly emptying into Pruess Lake.

3.4 White River Valley (HA 207)

White River Valley comprises most of the northern third of the White River Flow System and is the largest valley in the flow system. The valley is approximately 80 mi long and approximately 22 mi wide at Lund, Nevada. White River Valley is bounded by the White Pine Range in the northwest, the Horse and Grant Ranges to the west and the Egan Range to the east, and a low alluvial divide separates the valley from Garden and Coal valleys. The surface water drainage of White River Valley is contiguous with Pahroc Valley to the southeast. SR 318 travels north-south along the eastern side of the valley and intersects U.S. Highway 6 north of Lund, Nevada. As part of this study, 18 springs were inventoried in White River Valley and 11 are described in detail in the following sections. Figure 3-45 provides the locations of these springs and their magnitudes of flow and temperature. A description of each of these springs is listed in the following sections of this report.

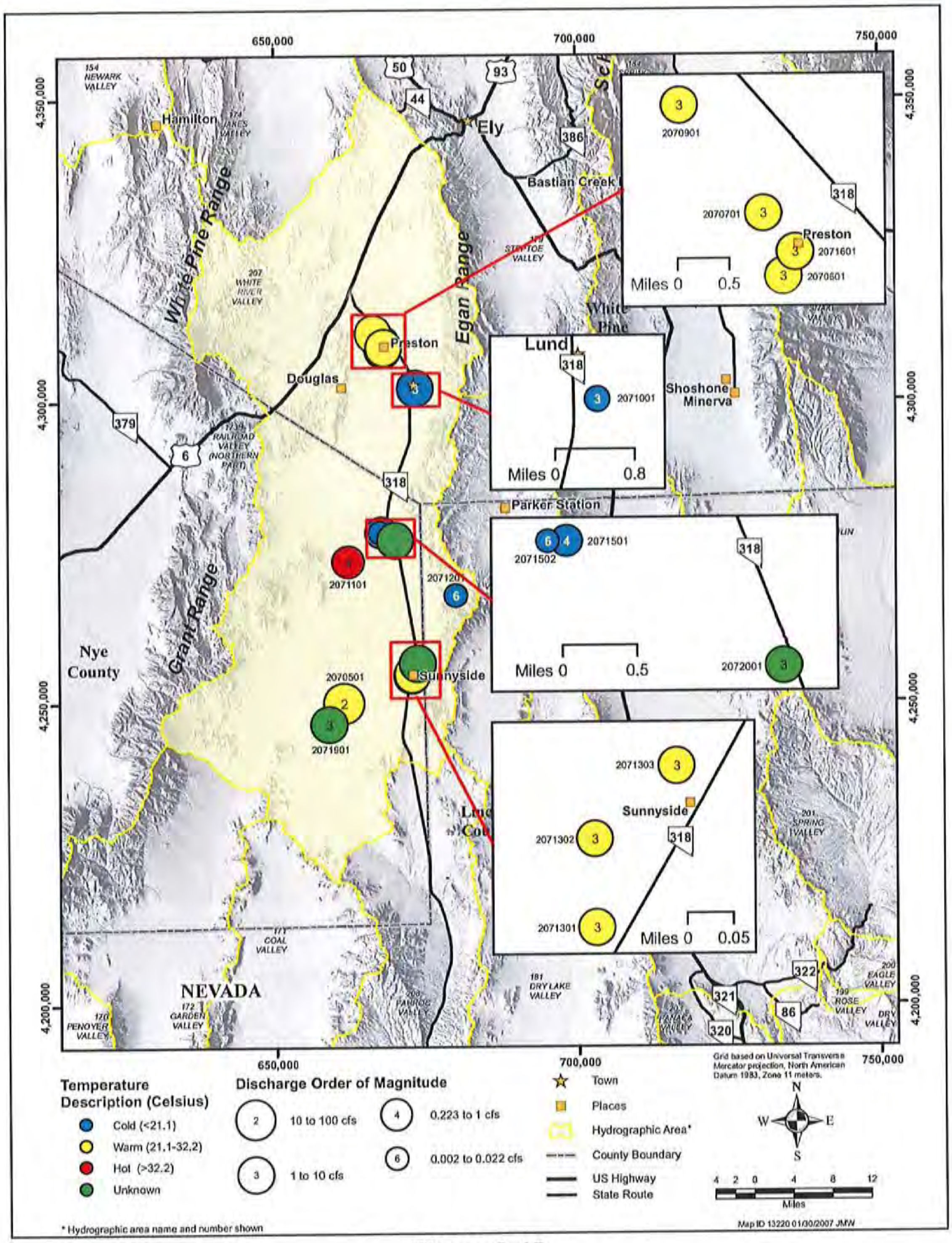


Figure 3-45
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in White River Valley, Nevada

3.4.1 Williams Hot Spring

General Setting

Williams Hot Spring is located 4.5 mi northeast of U.S. Highway 6 and approximately 12 mi northwest of Preston, Nevada. The spring is on private property and appears to have three separate orifices (Figure 3-46). The spring is labeled on USGS 1:100,000 topographic map as "Warm Spring." It is published in Garside and Schilling (1979) as Williams Hot Springs; Maxey and Eakin (1949) refer to it as Williams Hot Spring.

Spring orifice is in the concrete box in the foreground.

Figure 3-46
4-H Camp at Williams Hot Spring

Geologic Setting

Williams Hot Spring discharges from near the center of a Tertiary caldera on the western flank of the White Pine Range. The spring discharges from a small hill of younger Tertiary sediments (Hose et al., 1976).

Discharge

Garside and Schilling (1979) reported the discharge of the spring to be 0.111 (50 gpm) to 0.412 cfs (185 gpm) at temperatures ranging from 51.1°C to 53.3°C. A volumetric discharge measurement of

0.067 cfs (30 gpm) was made during the July 26, 2006 field visit, at an overflow pipe to the reservoir downstream of the spring.

Diversions and Water Use

The three orifices have been improved with concrete boxes. It appears that they discharge into a small creek that is colored white and orange with either mineral deposits or thermal bacteria. The creek then empties into a small reservoir used recreationally by the 4-H Camp. The water then flows into a narrow, well-incised ditch and is eventually used for agricultural purposes.

3.4.2 Douglas Spring

General Setting

Douglas Spring is located in a small alluvial valley approximately 6 mi southwest of Preston, Nevada, at the site of Douglas, Nevada (Figure 3-47). The spring is unnamed on USGS topographic maps but is referred to as "Douglas Spring" by the local population.

Douglas Creek is shown in the lower right of the photograph.

Figure 3-47
Douglas Spring Discharge Area

Geologic Setting

Douglas Spring surfaces along a small fault scarp near Douglas, Nevada. The spring is located in Tertiary volcanic rocks. Approximately 1 mi to the east, the volcanic rocks are in contact with the

Devonian Guilmette Formation. Beyond this point, the creek, formed by Douglas Spring, infiltrates into the stream bed.

Discharge

Using a 3-in. modified Parshall flume on July 26, 2005, the discharge was measured at 0.271 cfs (120 gpm) and the temperature was 18.1°C. The flow was steady, clear, and even. The banks of the channel were steep and lined with grass and aquatic plants (Figure 3-48).

Figure 3-48
Three-Inch Modified Parshall Flume Installed 75 ft Downstream of Douglas Spring Orifice

Diversions and Water Use

Water appears to have once been diverted into a small reservoir from the channel approximately 50 ft below the orifice. Evidence of pipes possibly used to transfer water were found in the area. It is assumed that the water was used for livestock and possibly a minor amount of agriculture. However, the diversion works are currently in disrepair, and the water is possibly used for livestock and wildlife.

3.4.3 Preston Big Spring

General Setting

Preston Big Spring is a large spring located approximately 1 mi northwest of Preston, Nevada, west of SR 318 (Figure 3-49). The spring orifice is located in an incised area approximately 15 ft below the land surface in the alluvial deposits on the valley floor. The orifice area and channel are overgrown

Figure 3-49
USGS Gaging Station No. 09415510-Preston Big Spring near Preston, Nevada

with aquatic plants and a healthy grove of wild roses, and a large Russian olive tree. The orifice banks consist of fine-grained material with little to no cementation. This area is heavily overgrown and cannot be clearly observed. There does not appear to have been any anthropogenic disturbances to the orifice area. The channel near the gaging station is incised 3 ft below land surface.

Geologic Setting

Preston Big Spring is located in highly dissected alluvial terraces. Numerous faults cut these alluvial fan sequences, suggesting recent uplift. The faults at Preston Big Spring strike to the northwest; this differs from the faults in the more southerly Mormon Spring area, which strike to the northeast. This difference suggests that between the two springs a major east-west structure has changed the alignment in the White River Valley from a prominent north-northeast pattern in the central and southern parts of the valley to a northwest trend in the north (Figure 3-50).

Discharge

USGS maintains and operates a gaging station approximately 1,200 ft downstream of the orifice and 10 ft upstream of the diversion splitter box. The data are reported as USGS Gaging Station No. 09415510-Preston Big Spring near Preston, Nevada. Average daily discharge records have been computed by USGS from December, 1982 to September, 1985 and from March, 2000 to the present. The gaging station was located at the diversion structure until December 1982 when it was moved

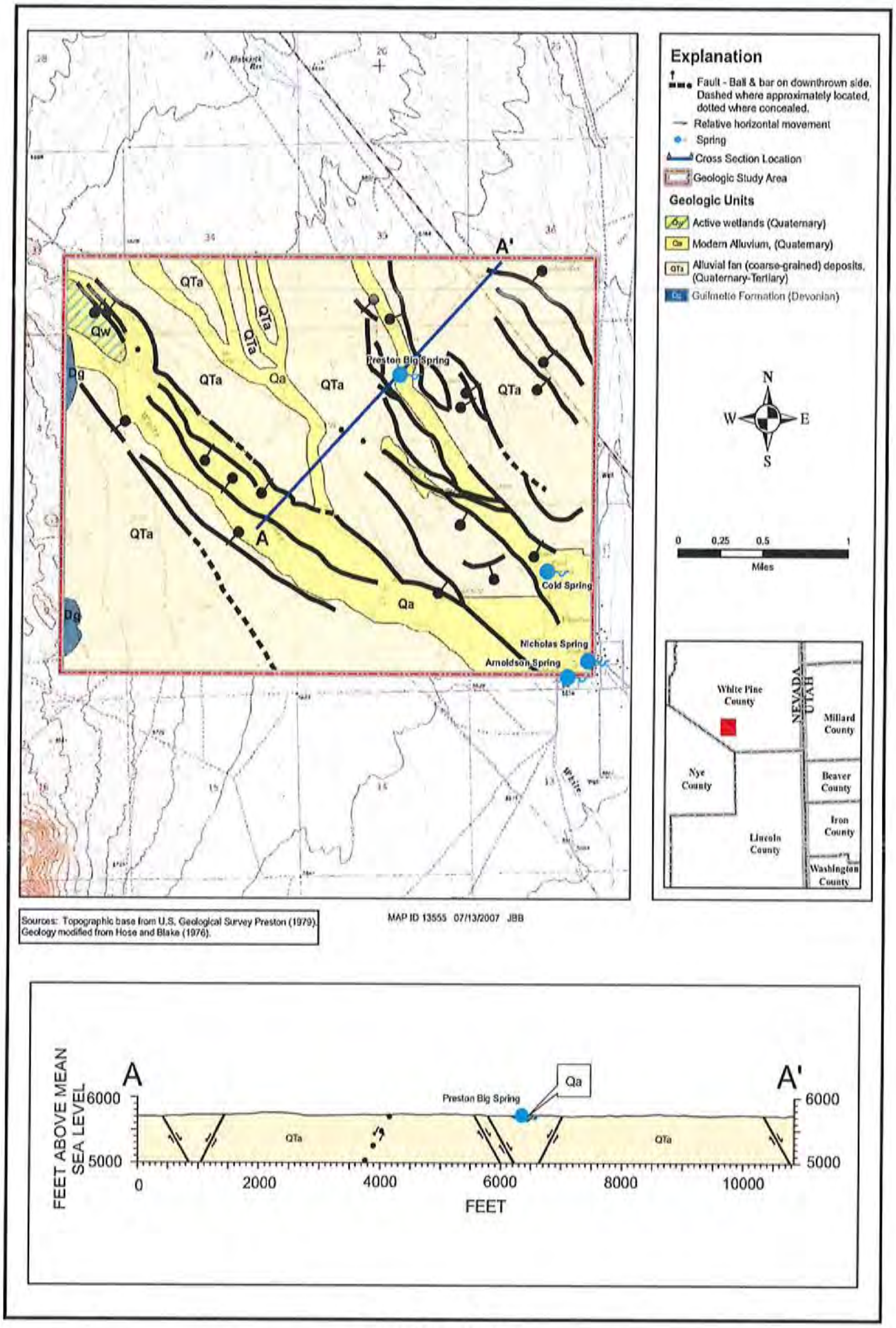


Figure 3-50
Geologic Map and Cross Section of Preston Big Spring, White Pine County, Nevada

upstream 0.2 miles. When the gaging station was reactivated in March of 2000 the station was again installed on the irrigation diversion structure. On July 29, 2005 the gage was moved again upstream 0.2 miles to eliminate the backwater problem caused by the debris catching on the structure. The average annual discharge is 7.86 cfs (3,528 gpm) and the minimum and maximum average annual discharges are 7.24 cfs (3,250 gpm) in 1984 and 9.38 cfs (4,210 gpm) in 2006. Average annual discharge for water years (WY) 1983 to 2006 is 5,700 afy (USGS, 2006). Discharge measurements are available in Appendix B. Discharge records for this spring are regularly affected by heavy aquatic plant growth. Both USGS and Preston Irrigation Company frequently remove the debris that accumulates on the structure (Figure 3-51).

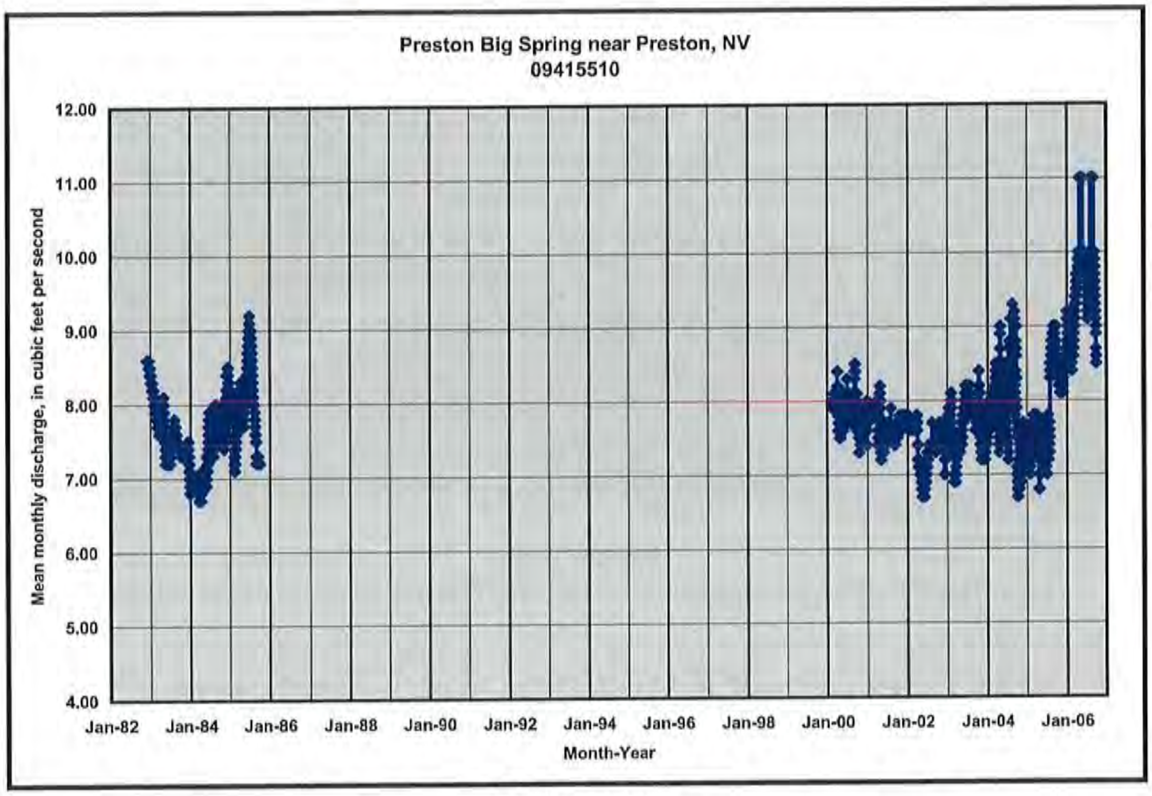
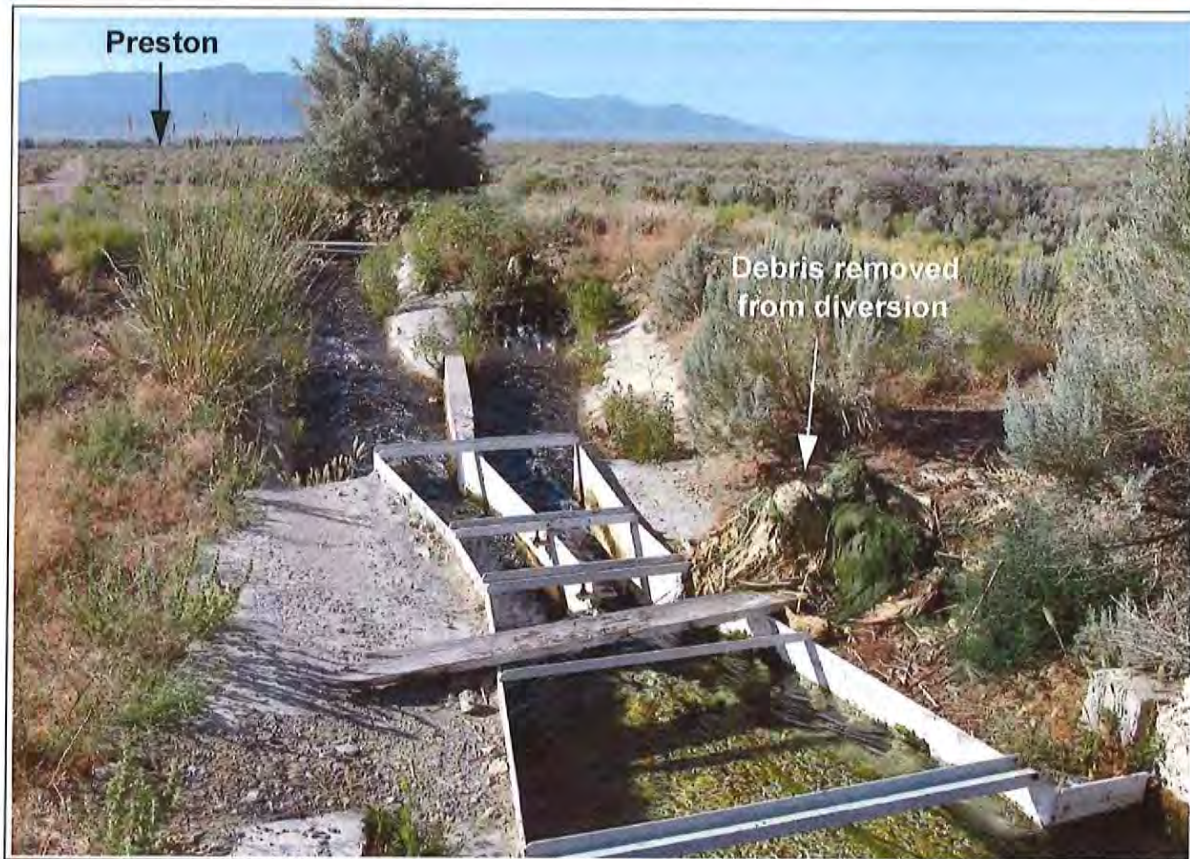


Figure 3-51
Hydrograph of Mean Monthly Discharge at Preston Big Spring, near Preston, Nevada

Diversions and Water Use

Approximately 1,200 ft downstream from the orifice, the entire flow passes through a large flume and is then split into two channels. These channels are then piped to various agricultural users near Preston, Nevada. When the flow of the main diversion becomes restricted and the water backs up, a culvert on the right bank 5 to 10 ft above the gage, diverts water into an overflow ditch (Figure 3-52).

Water from Preston Big Spring was used for agriculture before 1890 at the Maddox Ranch, which later became Preston, Nevada (Shaputis, 2005). Preston, Nevada was formally founded in 1898, and



Debris pile shown on the right bank.

Figure 3-52
Looking Downstream at the Preston Big Spring Diversion Structure

it can be assumed that water resource development was an early priority for settlers. In 1911, the Preston Irrigation Company was formed and reportedly irrigated 400 acres of land. The principal crops were alfalfa, grains, and potatoes (Malone, 1931). By 1938, the irrigated acreage was 1,100 acres, with the water sources originating from Preston Big Spring and Arnoldson Spring (Smith, 1938). In 1958, irrigated land totaled 900 acres, and the principal crops were alfalfa and small grains (Muth, 1958).

3.4.4 Preston Springs Group

The Preston Springs Group consists of three different springs: Arnoldson, Nicholas, and Cold springs.

General Setting

For the purpose of this report, Arnoldson, Nicholas, and Cold springs are considered a spring group. These three springs are located on private land in Preston, Nevada. The temperatures of these three springs are similar, ranging from 21°C to 22°C (Garside and Schilling, 1979). All of the springs discharge from alluvial sediments, and their waters are used for irrigation in or around Preston and Lund, Nevada.

Geologic Setting

The Preston Springs Group is located south of Preston Big Spring and discharges from alluvium that has been dissected by the same complex of northwest-striking faults (Figure 3-50).

Discharge

Discharge is measured semiannually by USGS. Available data for these three springs are listed in Appendix B. On September 13, 2006 the following discharge measurements were made by the USGS: Arnoldson Spring, 3.45 cfs (1,548 gpm); Nicholas Spring, 2.89 cfs (1,297 gpm); and Cold Spring, 0.79 cfs (355 gpm).

Diversions and Water Use

The discharge from the Preston Springs Group is divided between the Preston and Lund Irrigation Companies by many aqueducts, pipes, and other water conveyance accoutrements. The Lund Irrigation Company was formed in 1907 and the Preston Irrigation Company was formed in 1911. The formation of these companies was a formality because the Preston and Lund area had been using the water for agriculture before 1890 (Jones, 1994). In 1938, the irrigation companies completely or partially used the following springs: Preston Big, Lund, Nicholas, Cold, Horsley, and Arnoldson. The combined irrigated acreage for the two companies during this year was 2,600 acres, with crops consisting mainly of alfalfa, other grains, and potatoes (Smith, 1938; Malone, 1931).

3.4.5 Lund Spring

General Setting

Lund Spring is located at the extreme southeast corner of Lund, Nevada, just east of a large set of corrals. The entire flow of the spring is diverted by a series of Cippoletti weirs. The spring pool is nearly 50 ft in diameter. Discharge from the pool forms a channel on the northwest end of the pool. Along the right bank of the channel is dense vegetation, including willows and other plants. The bed of the channel is heavily overgrown with moss and other aquatic plants (Figure 3-53).

Geologic Setting

Lund Spring discharges from the fault contact between the alluvium and Permian-Pennsylvanian Ely Limestone. The spring discharge is coincident with a range-front fault forming the western side of a horst block. The beds of the Ely Limestone dip in an eastward direction (Figure 3-54).

Flow is towards the top of the photograph.

Figure 3-53
Lund Spring Orifice Pool

Discharge

During 2006 the USGS conducted semiannual discharge measurements at Lund Spring. The discharges were measured April 27, 2006 (9.47 cfs or 4,250 gpm) and September 13, 2006 (12.1 cfs or 5,431 gpm) (USGS, 2006).

During the site visit when these discharge measurements were taken, the Cippoletti weirs had slight algal growth. Therefore, the measurement was rated as good rather than excellent.

Diversion and Water Use

The entire flow of Lund Spring is diverted approximately 150 ft downstream of the orifice pool by the three Cippoletti weirs (Figure 3-55). This spring is used in conjunction with other local springs to irrigate 2,000 acres (Muth, 1958).

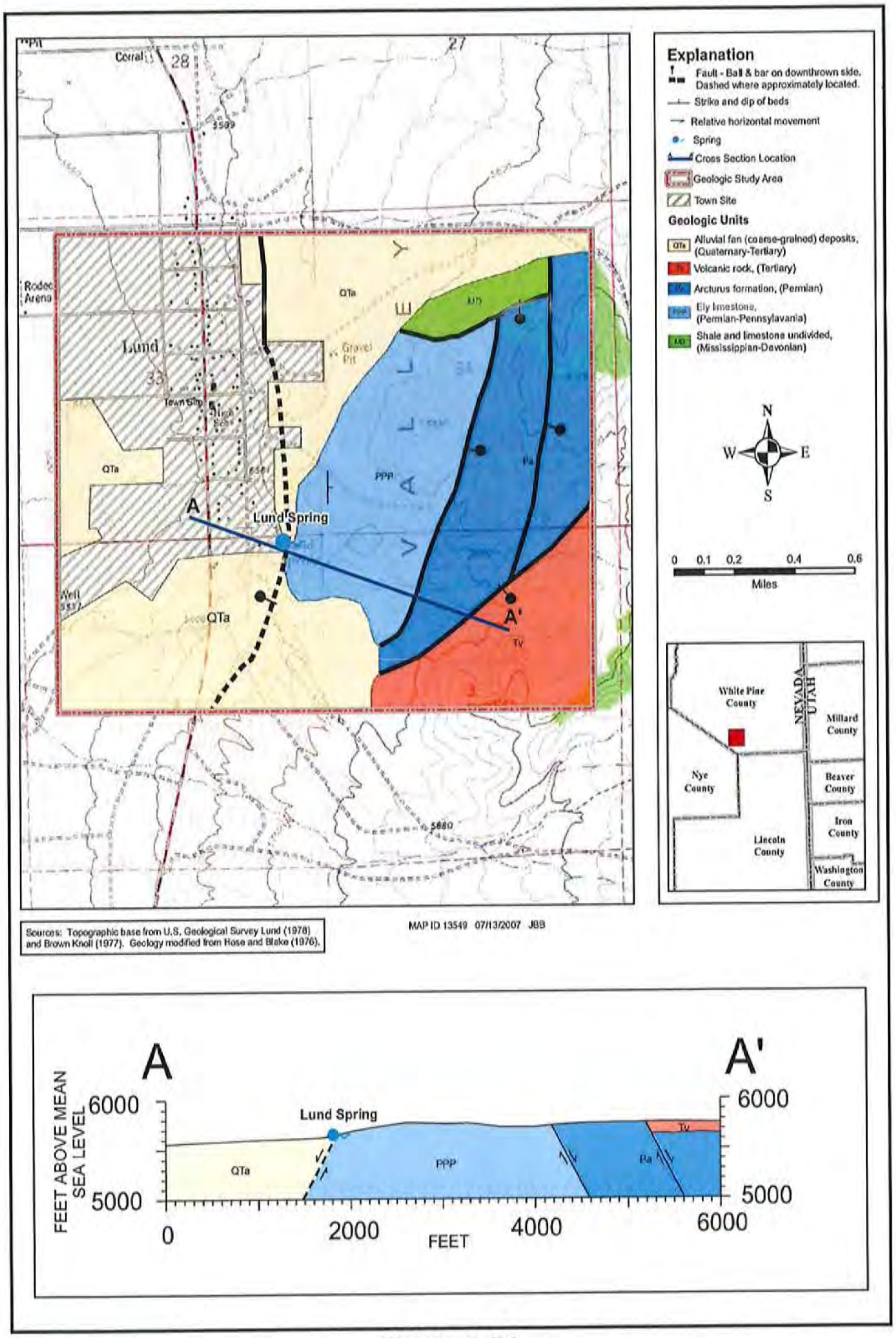


Figure 3-54
Geologic Map and Cross Section of Lund Spring, White Pine County, Nevada

Figure 3-55
View Looking Downstream at the Lund Irrigation Company's Diversion Structure on Lund Spring

3.4.6 Shingle Spring

General Location

Shingle Spring is 50 ft south of Shingle Pass Road and approximately 4 mi east of SR 318 in a densely forested area. The spring is located in the mountain block approximately 6,600 ft-amsl. Its discharge area has been modified to capture water for livestock watering (Figure 3-56).

Geologic Setting

The spring discharge area is in alluvium below a low hill of undifferentiated volcanic rocks (Tshantz and Pampeyan, 1970).

Discharge

Bunch and Harrill (1984) estimated that Shingle Spring discharge was 0.004 cfs (2 gpm) in August, 1979. A volumetric discharge measurement of approximately 0.001 cfs (0.35 gpm) was taken on September 14, 2004, where the spring discharges into a watering trough. The water temperature during this measurement was 17°C. September 7, 2007 the spring was observed to be dry.

Figure 3-56
Discharge Area of Shingle Spring at Shingle Pass, Egan Range

Diversions and Water Use

Shingle Spring is diverted by piping to a large stock tank. No open water was observed at the spring orifice; it is assumed that some kind of collection gallery at the source has been installed to transfer water to the stock tank nearly 50 ft to the east.

3.4.7 Butterfield Spring

General Location

Butterfield Spring is located on private land controlled by the Rocking 13 Ranch located approximately 1 mi west of SR 318 near Sunnyside, Nevada.

Geologic Setting

Butterfield Spring discharges from Quaternary alluvial deposits. Along the eastern side of White River Valley.

Discharge

Discharge from Butterfield Spring is measured biannually by USGS. USGS records indicate that the discharge from the spring ranges from 2.0 to 4.2 cfs (900 to 1,890 gpm). In 2006 the measured discharge at Butterfield Springs was 2.84 cfs (1,275 gpm) in April and 2.62 cfs (1,176 gpm) in September. Discharge measurements are listed in Appendix B.

Diversions and Water Use

The spring appears to be captured by a small reservoir near the ranch. From the ranch, the spring discharges down the alluvial fan and is used by livestock and wildlife.

3.4.8 Flag Springs Group

The Flag Springs Group consists of three different springs: Flag Springs Nos. 1, 2, and 3.

General Setting

The Flag Springs Group is located at the Nevada Division of Wildlife (NDOW) Headquarters for the Wayne Kirsch Wildlife Management Area. The three springs discharge from coarse alluvial gravels in an area 900 ft wide to 1,200 ft long.

Geologic Setting

The Flag Springs Group discharges from Quaternary alluvial deposits.

Discharge

The discharge of Flag Spring No. 1 and Flag Spring No. 3 is measured biannually by USGS. In 2006, the following discharge measurements were made by the USGS at the Flag Springs Group: Flag Spring 1, April 28th 2.4 cfs (1,077 gpm); Flag Spring 2, April 28th 2.65 cfs (1,189 gpm); Flag Spring 3, April 28th 2.19 cfs (983 gpm). Discharge measurements are listed in Appendix B.

Diversions and Water Use

From the ranch, the spring discharges into Sunnyside Creek. It then flows into the Adams-McGill Reservoir, where it is used by livestock and wildlife.

3.4.9 Hardy Springs Group

The Hardy Springs Group consists of the Upper Hardy Springs Group and Hardy Spring Northwest as shown in Figure 3-45.

General Setting

The Hardy Springs Group is approximately 16 mi south of Lund, Nevada and 1.5 mi west of SR 318 (Figure 3-57). The springs discharge from alluvial sediments consisting mainly of fine-grained material. The Upper Hardy Springs Group is comprised of five individual spring orifices that discharge into a main channel that joins the White River.

Figure 3-57
Hardy Spring Northwest, Looking Northeast toward the Egan Range

Geologic Setting

The Hardy Springs Group discharge from Quaternary alluvial deposits. Paleozoic carbonate rocks are present 2 mi to the east in the Egan Range.

Discharge

Discharge was measured at the confluence of the upper group of springs and also at one individual spring located northwest of the upper group. In several of these spring pools, there is a thick layer of fine silt that has settled 0.2 to 0.4 ft below the water's surface. Several of the spring pools appear to boil as water discharges from the orifice. During the September 14, 2005 field investigation, the water regularly discharged through the silt layer through small underwater mud fountains. Large, intermittent eruptions occur for 20 to 30 seconds, after which the "boiling" effect ceases temporarily for a few seconds and then resumes. While this intermittent discharge was observed at the spring, it was not observed in the flume discharge measurements located approximately 20 ft downstream. The pulsating effect was probably dampened by the aquatic vegetation in the channel between the orifice and the flume.

Discharge was measured at the Hardy Spring Northwest and below the confluence of the upper spring group. Total discharge at the Hardy Spring Northwest was measured using a modified Parshall 3-in. flume; the upper spring group was measured using a pygmy current meter. The measured discharges were 0.011 cfs and 0.455 cfs (5 and 204 gpm), respectively. With additional springs contributing to the flow, it is estimated that the total flow into the White River channel is approximately 0.75 to 1.0 cfs (336 to 449 gpm).

Diversions and Water Use

A small diversion was observed 100 to 150 ft downstream of the confluence of the upper group. Currently, the diversion is in disrepair but could be used again if needed. The entire flow of the upper group can be either diverted into an aqueduct that flows directly west or allowed to flow along its current course.

3.4.10 Moorman Spring

General Setting

Moorman Spring is located approximately 20 mi southwest of Lund, Nevada, in White River Valley (Figure 3-58). The spring is located on the Rocking 13 Ranch. The spring pool has been enhanced through anthropogenic activities.

Moorman Spring forms a small pool, approximately 30 ft long and 15 to 20 ft wide, behind an old irrigation diversion structure. The spring discharges from the alluvium along a fault scarp. The pool is partially encircled by a man-made berm that appears to have been used to contain the spring in a reservoir. There are dense grasses in and around the spring area, and the spring pool has moderate algal growth along the edges and bottom. The main orifice of the spring is in the southwestern corner of the spring pool. The area around the spring is fine-grained material that has little to no cementation. A head gate and two aqueducts artificially control Moorman Spring's pool elevation, and all diversion works are in poor condition. The aqueducts discharge northward then turn west and discharge to a large shallow reservoir. From the reservoir, the water discharges into an approximately 2 ft wide channel that continues south for a several miles. Vegetation around the spring consists of grasses and sage brush.

Geologic Setting

Moorman Spring sets in a highly dissected alluvial fan. The Guilmette limestone formation of Devonian age is exposed approximately 2 to 3 mi west of the spring (Kleinhampl and Ziony, 1985). Because of its close proximity to outcrops, a shallow depth to bedrock is possible, especially with the highly dissected alluvium around the site. The site itself is a tufa mound cut by several northeast-trending faults (Figure 3-59). The mound is approximately 10 ft high and forms a subcircular shape around the spring complex. The fault that cuts the mound projects to the southwest along the spring channel for approximately 3 mi.

Figure 3-58
Orifice Pool of Moorman Spring, White River Valley, Nevada

Discharge

The discharge at Moorman Spring is measured semiannually by USGS; the discharge measurements are listed in Appendix B. Since 1985, the average discharge at Moorman Spring has been approximately 0.500 cfs, and the discharge measurements appear relatively constant.

There are two channels joining to form a larger channel that is heavily overgrown with rushes and other aquatic plants. During the 2006 water year the USGS made the following discharge measurements at Moorman Spring: April 27th, 0.53 cfs (238 gpm); September 13th, 0.46 cfs (206 gpm).

Diversions and Water Use

Moorman Spring is diverted approximately 25 ft downstream of the orifice. The pool is controlled by a 1 ft wide head gate that regulates and directs the two aqueducts' discharge. The system appears to have been designed to allow flow to the western aqueduct to be completely shut off, diverting the entire flow to the eastern aqueduct. Raising the head gate would allow the entire flow to be diverted to a large reservoir located several hundred yards to the west. From this reservoir, the discharge could be regulated from the earthen dam at the south end of the reservoir. The diversion structures in both

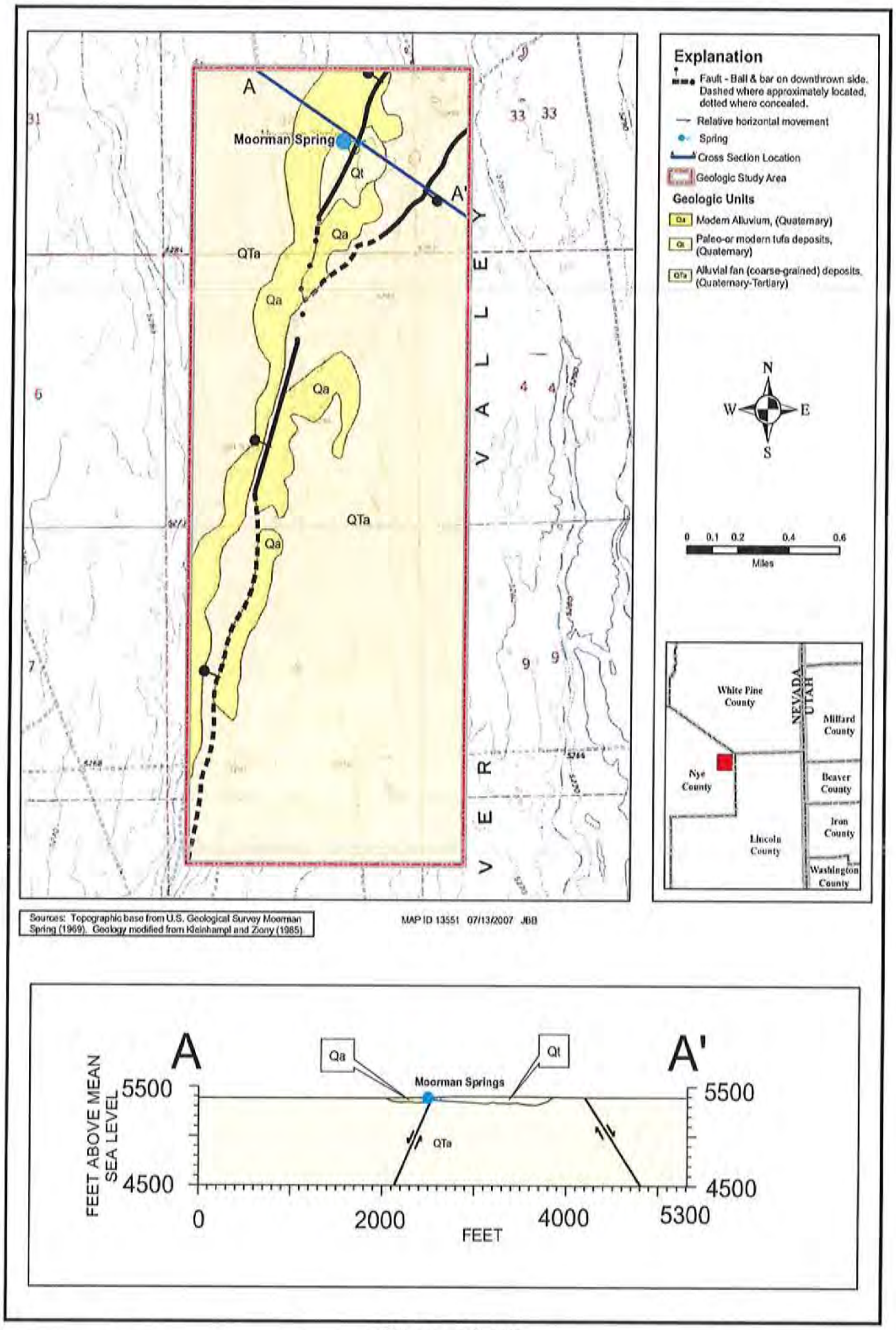


Figure 3-59
Geologic Map and Cross Section of Moorman Spring, Nye County, Nevada

the reservoir and at the spring pool appeared in poor and possibly inoperable condition during the 2004 field investigation. Currently, the water appears to be used for livestock and wildlife.

3.4.11 Hot Creek Spring

General Setting

Hot Creek Spring is in southern White River Valley, approximately 0.75 mi northeast of Hot Creek Butte and 2 mi west of Adams-McGill Reservoir. The Adams-McGill Reservoir is on the Wayne Kirch Wildlife Management Area, administered by NDOW.

Hot Creek Spring forms a large, irregularly shaped pool approximately 65 ft wide by 75 ft long. At the orifice, the pool was measured to be 22 ft deep (Figure 3-60). Hot Creek Spring is the only major spring visited during the field investigations that is undisturbed at the orifice. The spring discharge area is approximately 5 acres in size and is covered by dense grasses. The channel has moderate growth of rushes. The spring discharge forms Hot Creek, which flows southeast to the Adams-McGill Reservoir. At one point in time, it was possible to divert the flow of Hot Creek to Dacey Reservoir in the northeast. The vegetation in and around the spring consists mainly of grasses and reeds.

Figure 3-60
Underwater View (Field of View is 20 ft Wide) of the Hot Creek Spring Main Orifice

Geologic Setting

The Hot Creek Spring tufa mound is exposed to the northwest of the spring complex, which has been cut by northeast-trending faults. The area's most common feature is the large amount of tufa/travertine deposits. When isolated from a spring complex, these deposits are not easily identified as being related either to the spring or to the Pleistocene lake deposits. A prominent northeast-trending ridge of Paleozoic rocks is exposed to the southwest of the Hot Creek Spring complex. The oldest rock on the ridge is the Pogonip Limestone of Ordovician age, followed by the Eureka Quartzite and Ely Springs Dolomite of Ordovician age, and the Sevy Dolomite of Devonian age. These are the most recognizable Paleozoic units in the study area. The rocks dip approximately 25 degrees to the east, striking north 10 degrees east. The ridge forms a prominent northeast-striking horst with distinctive faults flanking the horst. The fault with the greatest influence on Hot Creek Spring is located on the east side of the horst and projects through the principal discharge area in the spring. This west-northwest fault of the horst influences springs approximately 1 mi southwest of the ridge (Figure 3-61). The presence of these Paleozoic rocks in the center of the White River Valley strongly suggest that this is one of the shallowest basins in all of central Nevada.

Discharge

Past discharge measurements had been made semiannually by the USGS. During the 2006 water year, the USGS installed a gaging station on Hot Creek Spring. The measurements are listed in Appendix B. Discharge is measured 50 to 60 ft below the earthen dam and swimming area (Figure 3-62). The channel bottom is soft and is made of fine material to fine sand, with steep grass-lined banks. April 28, 2006 the USGS measured the discharge as 14.0 cfs (6,284 gpm).

Diversions and Water Use

Currently, there are no active diversions on Hot Creek Spring. However, at one time, the total flow of the spring could be diverted northeast to the Dacey Reservoir. The diversion works consist of an earthen dam, a 24-in. diameter galvanized pipe, and a head gate. These works are located approximately 1,200 ft downstream of the spring pool. The dam was constructed across Hot Creek Spring, and the head gate was used to direct and regulate the amount of discharge to each reservoir. The water from Hot Creek Spring discharges to Hot Creek, which flows eastward to Adams-McGill Reservoir and supplies water for livestock and wildlife (Figure 3-62).

3.5 Pahranagat Valley (HA 209)

Pahranagat Valley is located in southern Lincoln County, Nevada, and comprises part of the White River Flow System. The valley is approximately 42 mi long and about 11 mi wide. The valley is bounded by the South Pahroc Range to the east, the Pahranagat Range to the west, and the Hiko Range in the north. In the south, the valley is truncated by the east-northeast-trending Pahranagat Shear Zone.

U.S. Highway 93 travels one-third of the way up the center of the valley and intersects SR 318 and SR 375. SR 318 traverses north to Pahroc and White River valleys, while U.S. Highway 93 continues to Dry Lake Valley to the east. SR 375 traverses west to Tikaboo Valley North. Pahranagat Valley

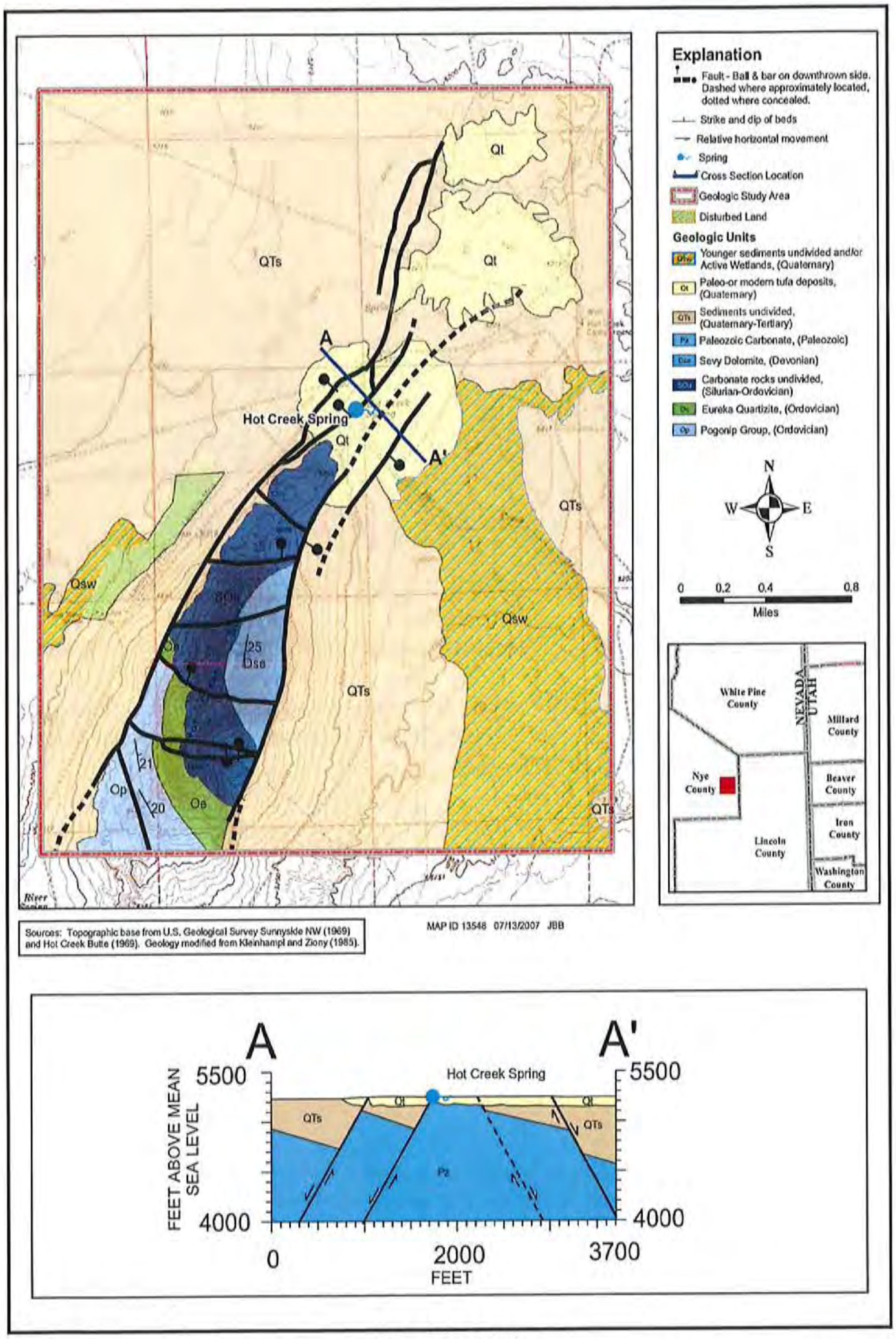


Figure 3-61
Geologic Map and Cross Section of Hot Creek Spring, Nye County, Nevada

Figure 3-62
Looking East and Downstream of the Old Diversion Structure on Hot Creek Spring

has three population centers: the towns of Alamo, Ash Springs, and Hiko. The economy of the area is primarily based on agriculture and ranching. In the Paiute Indian language "Pahranagat" translates to "valley of many waters" (Hardman and Miller, 1934).

Although there are many springs and seeps found throughout the valley, this study inventoried 6 springs in Pahranagat Valley, 5 are discussed in detail in the following sections. Figure 3-63 provides the locations of these springs and their magnitudes of flow and temperature. Two springs of third-order magnitude (Hiko and Crystal Springs) and one spring of second magnitude (Ash Springs) discharge approximately 25,400 afy (35 cfs) into the valley; this is consistent with the estimate made by Eakin (1963).

3.5.1 Hiko Spring

General Setting

Hiko Spring is on the Cannon Ranch approximately one-half mile northeast of Hiko, Nevada, in the north end of Pahranagat Valley (Figure 3-64). The water at Hiko Spring has been in constant use since approximately 1865 when a camp was established. In 1866, a five-stamp mill was established at Hiko, and the population grew. Hiko was Lincoln County's seat from 1867 to 1871, when it was moved to Pioche, Nevada. Only one of the original buildings is still intact at the original Hiko town site. The spring discharges from the base of the Hiko Range and is used for domestic, agricultural, and wildlife purposes (State of Nevada, 2004b).

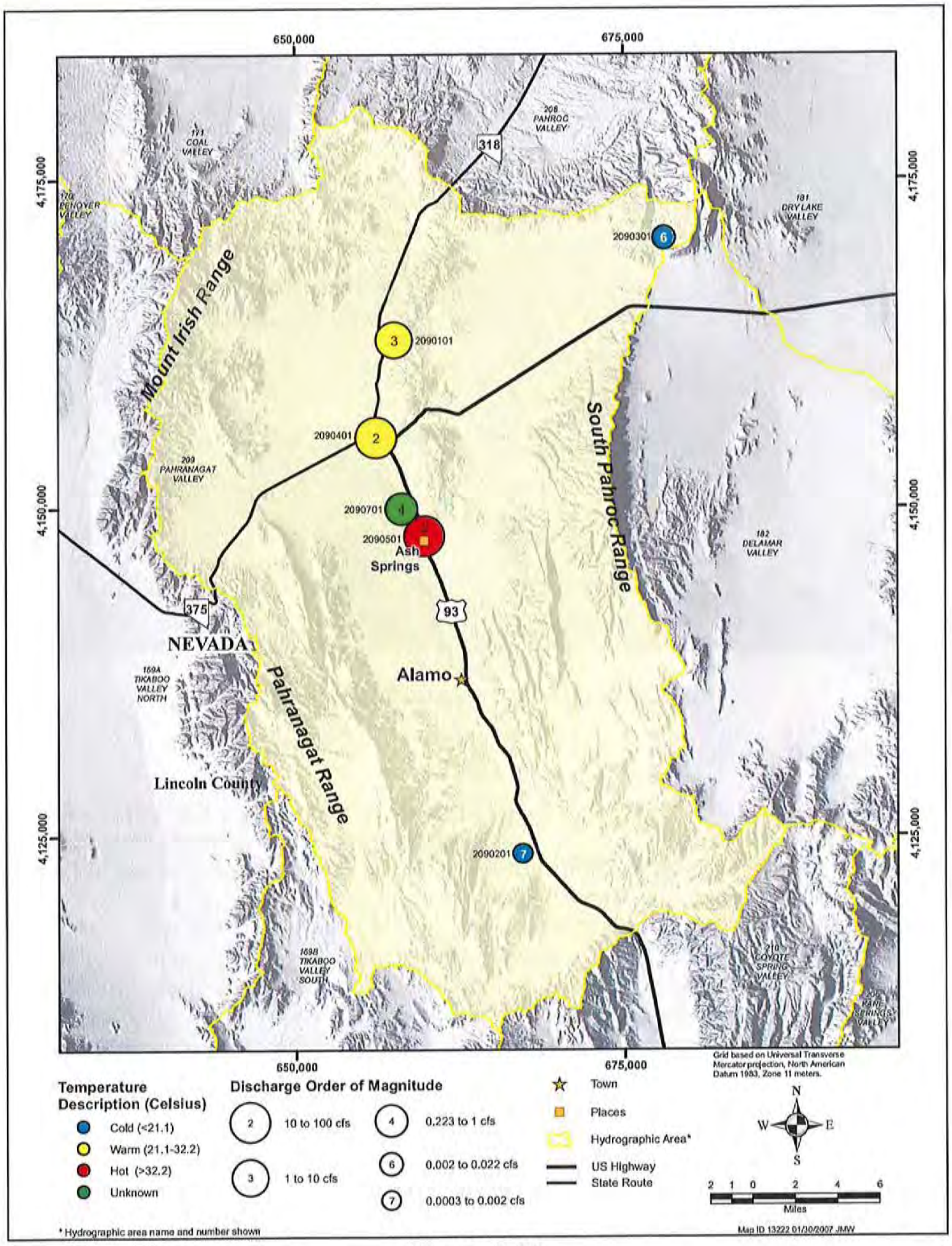


Figure 3-63
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Pahranagat Valley, Nevada

Figure 3-64
Hiko Spring Reservoir and Springhouse

Geologic Setting

The rock immediately east of the orifice is a 20-ft-thick, heavily faulted and brecciated, brown, fine-grained limestone and limy-dolomite, with an attitude of north 32 degrees east. The brown limestone contains many white high-angle calcite veins, perhaps the locations of former orifices. The brown limestone is faulted against (on the north), and apparently overlain by, a yellow-weathering thin- to medium-bedded limestone that dips northeast and is at least 50 ft thick. This yellow limestone is rich in fossils, dominated by spiriferoid brachiopods; some corals were also found. The fault strikes about north 40 degrees east and controls the spring, although at the orifice the rock appears to be a faulted, eastward-plunging anticline. The yellow rock was mapped by Tschanz and Pampeyan (1970) as a down-faulted block of Devonian Guilmette Formation (Dg), and their descriptions of this unit and its fossils are the same as the descriptions listed previously. The brown limestone may have been mapped as Devonian Simonson Dolomite by Tschanz and Pampeyan (1970), but it is not clear on their map. The map also shows it as Guilmette Formation, faulted down against a high hill of Simonson Dolomite farther to the east. A spring mound (Qs) forms a hill about 100 yards southwest of the spring pool. North and south of the spring, a possible north-striking fault appears to cut off the western edge of older fan deposits (Qfo) and may pass through the spring mound and continue southward as the same fault one-half mile east of Crystal Springs. In addition, a major north-striking range-front fault, downthrown on the west side, is present about one-half mile to the east of Hiko Spring (Figure 3-65).

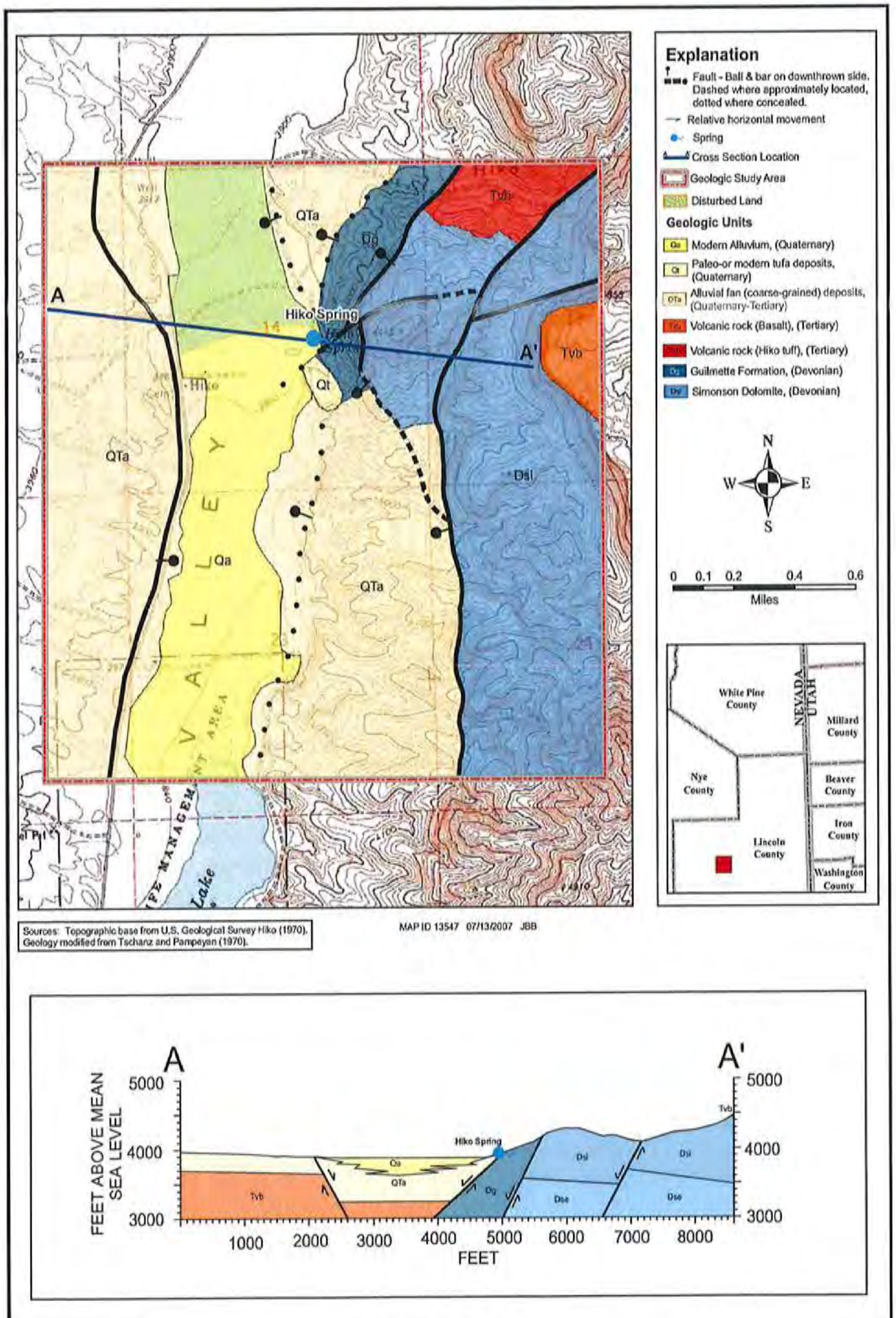


Figure 3-65
Geologic Map and Cross Section of Hiko Spring, Lincoln County, Nevada

Discharge

An average discharge of approximately 6.5 cfs (2,917 gpm) was reported at Hiko Spring from 1934 to 1943 (Smith, 1938, 1942, and 1944). During 1963 a discharge of 5.36 cfs (2,406 gpm) was reported by Eakin (1963). This lower value may have been caused by the poor condition of the diversion structure. During the field investigation on July 19, 2004, it was determined that a measurement could not be made because of the diversion works configuration. However, by correlating past discharge rates of Hiko Spring and the past and current discharge rates of Crystal and Ash springs, the discharge rate of Hiko is estimated to be 6 cfs (2,693 gpm).

Spring discharge measurements are listed in Appendix B. However, there is a possible error in the measurements reported by Carpenter (1915) and Hardman and Miller (1934) for Hiko Spring and Crystal Springs. Carpenter (1915) reported discharges to be 9 cfs and 7 cfs (4,040 and 3,140 gpm), respectively. While Carpenter's (1915) descriptions of the springs are correct, it is possible that he assigned the wrong discharge value to each spring (i.e., since 1938, Crystal Springs flow has been greater than Hiko Spring). This apparent reversal happens again with the 1931 measurements of Hardman and Miller (1934), who reported Hiko Spring's discharge is 11.96 cfs (5,370 gpm) and Crystal Springs' discharge is 5.96 cfs (2,680 gpm).

Diversions and Water Use

In 1939, a dam was constructed in front of the spring orifice to form a reservoir. The dam had three equally-sized flumes installed at the same elevation to automatically divide the water equally among the water-right holders. Only two of the wooden flumes were operated simultaneously so that the water-right holders could each receive half of the total spring flow. In 1939, small springs at the base of the dam were reported (Smith, 1940).

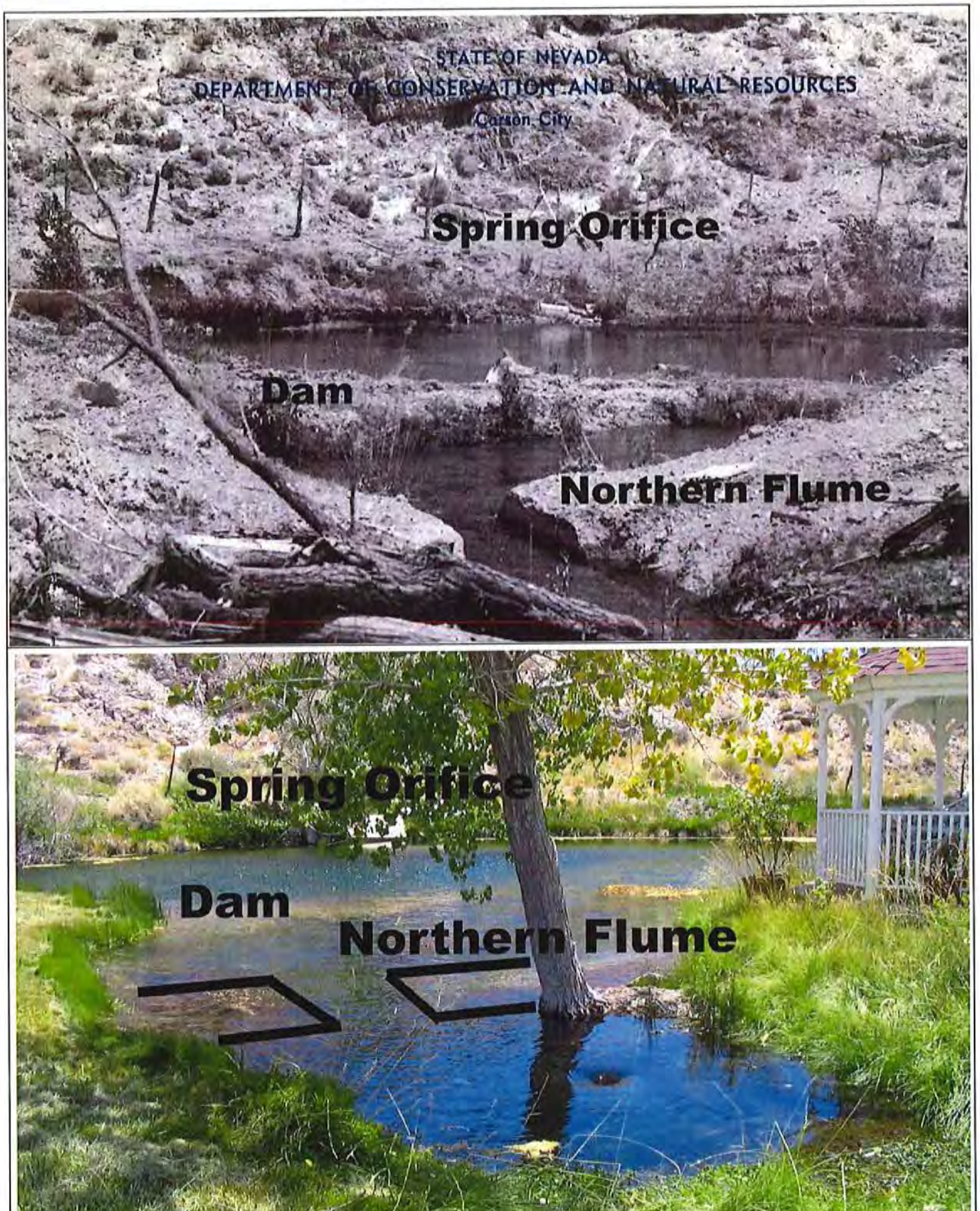
The water was diverted using this diversion system until approximately 1980, when a new dam was constructed and the old diversion ditches were converted to pipelines (Figure 3-66). Currently, several pipes enter a submerged springhouse/box located at the orifice. Occasionally, a pump can be heard pumping water from the spring for domestic uses.

3.5.2 Crystal Springs

General Setting

Crystal Springs is located approximately a quarter mile west of the SR 318/SR 375 Junction and one-half mile west of the U.S. Highway 93/SR 318 Junction in Lincoln County. Crystal Springs is located approximately 4 mi south of Hiko, Nevada, and 5 mi north of Ash Springs, Nevada (Figure 3-67).

With the discovery of silver in Pahranagat Valley in 1865, Lincoln County was created. Crystal Springs was designated as the provisional county seat in 1866. This locale, used as a watering place and campsite, was the principal stopover on the Mormon Trail alternate route (State of Nevada 2004a).



(Top) From the cover of Eakin, 1963 (Bottom) Hiko Spring in 2004.

Figure 3-66
Hiko Spring Diversion Structure

Diversion ditch is shown at the top right of the photograph.

Figure 3-67
Crystal Springs Reservoir and Orifice

Geologic Setting

The Crystal Springs are approximately 2 mi west of the Hiko Range. The main orifice discharges from bedrock on the east side of a small hill of limestone and sandstone. On the east side of the hill, the rock is largely a fault breccia in which blocks of westward-dipping rock protrude from a mass of breccia. The rocks on the east side of the hill (the lowest part of the sequence) consist of 50 ft of dirty medium-grayish-brown, resistant, finely crystalline, well-bedded limestone and interbedded thin-bedded limestone and dark-brown sandstone in which ripple marks, cross-beds, and soft-sediment deformation structures are present. Mottled, apparent burrows are common in the limestone. The top of the hill includes a 10-ft-thick, light tan, resistant sandstone/quartzite that resembles the Ordovician Eureka Quartzite. It is overlain by 20 ft of interbedded limestone and sandstone and, in turn, by 30 ft of limestone that makes up the western side of the hill. South of the top of the hill, a north 45 degrees east steeply dipping fault places the sandstone sequence against limestone south of the fault. The unit underlying the hill is correlated with the upper part of the Ordovician Pogonip Group (Op), which underlies the Eureka Quartzite in the area. This upper part of the Pogonip Group has been mapped as the Antelope Valley Limestone in areas to the south (Tschanz and Pampeyan, 1970). The main fault that places the hill against alluvium to the east is assumed to strike north and underlie the spring complex east of the hill. It is shown as such on Figure 3-68. The age of the fault cannot be determined and is assumed to be Pliocene or late Miocene. About one-half

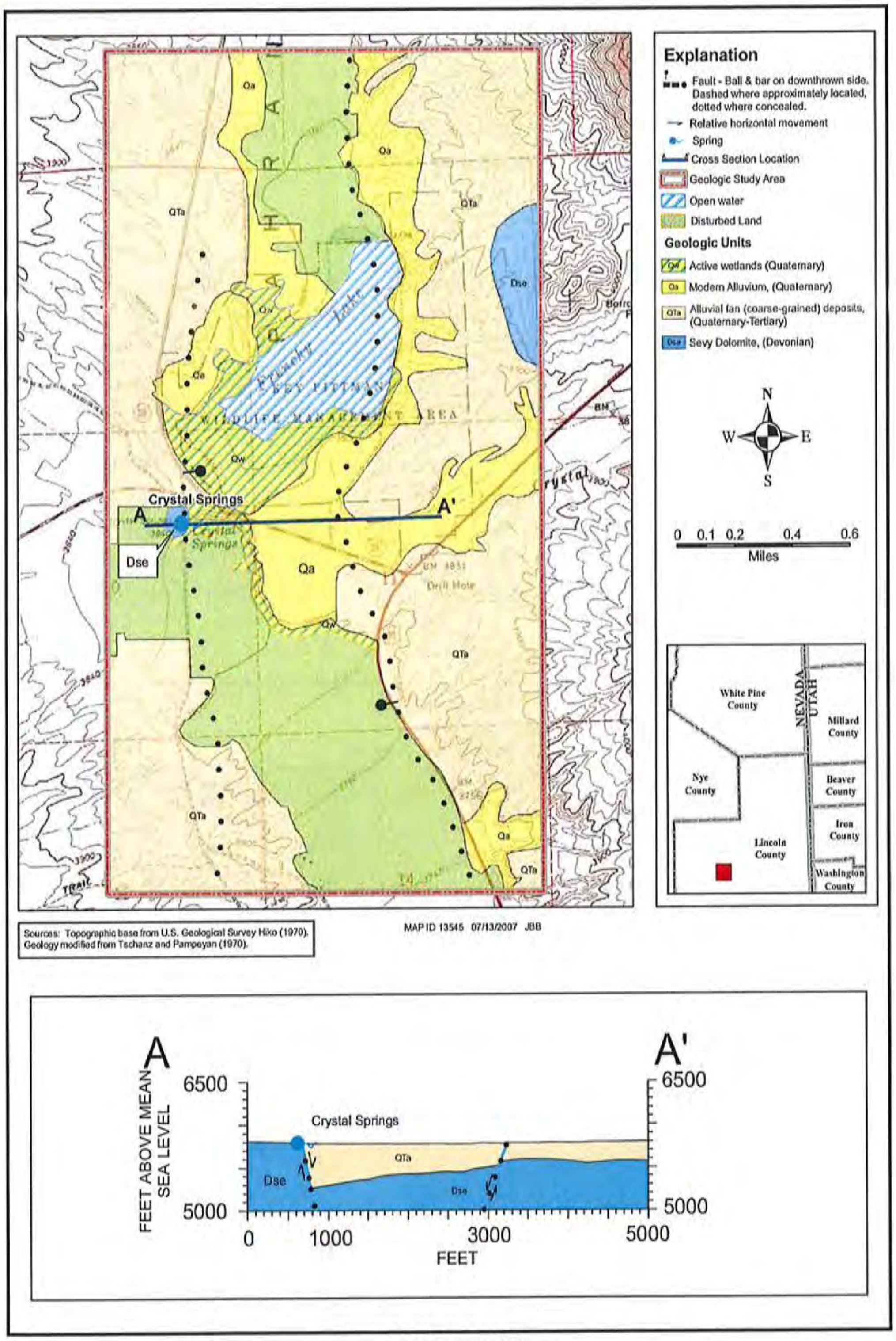


Figure 3-68
Geologic Map and Cross Section of Crystal Spring, Lincoln County, Nevada

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mile to the east of Crystal Springs (just east of U.S. Highway 93), middle to early Pleistocene older fan deposits (Qfo) are cut by a fault that is downthrown on the west side and are overlain by young fan deposits (Qfy); the fault thus is early to middle Pleistocene. Two miles to the east, the west side of the Hiko Range is bounded by a north-striking normal fault with down throw to the west side; the range here contains west-dipping Sevy Dolomite (Tschanz and Pampeyan, 1970). This fault is overlain by older fan deposits, so is likely pre-Quaternary.

Discharge

Discharge at Crystal Springs is currently measured with a permanently installed 4-ft Parshall flume and a continuous stage recorder operated by USGS. The discharge at Crystal Springs has been documented with miscellaneous measurements since 1912 and with a continuous recording gage since late 1985. The periods of record for the gage are from 1985 to 1988, 1990 to 1994, and 1998 to present (Figure 3-69). In 2004 the USGS installed a gaging station on the irrigation diversion.

The Crystal Springs discharge measurements range from 1 to 14 cfs (450 to 6,280 gpm). The reason for this large difference is that the combined discharge from the main orifices is intermittently diverted to an irrigation ditch supplying agricultural uses to the south. The diversion structure and its operation are discussed in detail in the subsequent section. Except for leakage from the dam or flow seeping through the banks containing the secondary spring orifice, the entire flow may be diverted for irrigation.

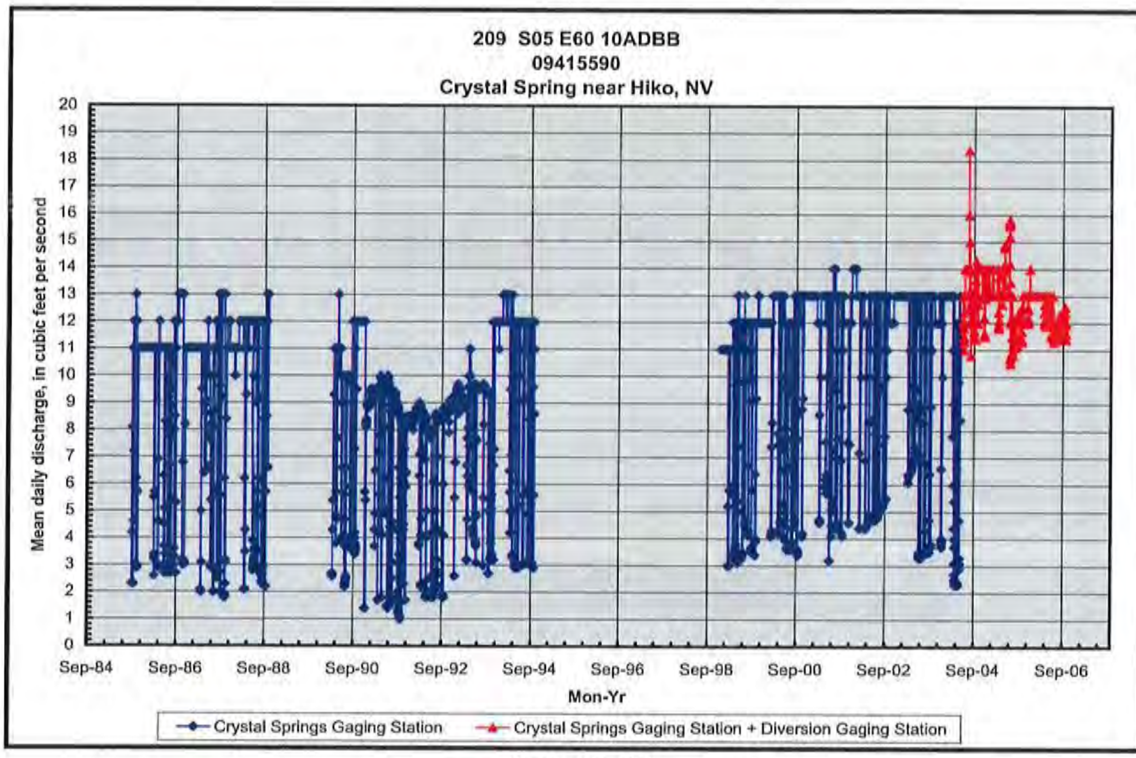

Figure 3-69
Published Mean Daily Values for Crystal Springs near Hiko, Nevada

The continuous record at Crystal Springs is heavily biased due to the irrigation diversion located approximately a quarter of a mile upstream of the gaging station. While the gage was accurately recording data, it was not recording the entire flow. At times the recording of partial discharge of a spring may be useful, it is misleading when trying to determine the spring's historical discharge. In 2004, a supplemental gage on the diversion channel was installed to correct this problem and in 2005 the first data from this gage was published by the USGS. Water years 1990 through 1993 and 1999 were not used in the analysis of this spring. The water years 1990 and 1999 were incomplete years and 1991 to 1993 appear to have been diverted every day. When examining the mean daily values previous to October 6, 1991 the undiverted mean daily discharge is 12 cfs (5,386 gpm) the mean daily value does not reach this value again until October 19, 1993. During this time period the maximum daily discharge is 11 cfs for 7 days in April 1993. The most probable cause for this decline in discharge was a problem with the diversion. Data from 2005, 2006, and the period of record are summarized below (Table 3-2).

Table 3-2
Annual Discharges at Crystal Spring

Water Year	Crystal Springs (09415590)		Crystal Springs Diversion (09415589)		Total Combined Discharge	Days Diverted	Percentage of Year Diverted (%)	Percent of Annual Discharge Diverted (%)
	Annual Discharge (afy)	Average Annual Discharge (cfs)	Annual Discharge (afy)	Average Annual Discharge (cfs)				
2005[a]	8,110	11.2	1,230	1.70	9,340	78	21	13
2006[b]	8,190	11.3	923	1.28	9,113	67	18	10
2005-2006 Average	8,150	11.2	1,080	1.49	9,226	72	20	12
Average for the period of record[c]	7,855	10.8	1,090	1.51	8,945	75	21	12

[a]Water Years 1990, 1991, 1992, 1993 and 1999 are excluded as explained in the text.
[b]Data from USGS Water Resources Data - Nevada Water years 2005 and 2006.
[c]These values are extrapolated from the Crystal Springs gaging station record published by the USGS.

Diversions and Water Use

The water users of Crystal Springs organized into the Alamo Irrigation Company in 1922. The irrigation ditches were lined with concrete to minimize losses and allowed easier cleaning (Smith, 1948).

The diversion system consists of a small earthen dam and a single head gate to control the spring's discharge. When the head gate is closed, the entire spring flow is diverted into an irrigation canal and is used for irrigation along Pahranagat Valley's western side. When the head gate is open, the entire discharge continues down the main channel and is used for irrigation.

3.5.3 Ash Springs

General Setting

Ash Springs is located in Ash Springs, Nevada, and is approximately 600 ft east of U.S. Highway 95. The spring is used for irrigation, domestic supply, and recreation and consists of many orifices that extend more than a quarter mile along the north-south-trending Hiko Fault. The spring area was developed in the 1970s and through the 1980s as a privately owned resort. The main orifice is on public land administered by the BLM and has a large picnic area and swimming pool (Figure 3-70).

Figure 3-70
Main Pool and Orifice of Ash Springs

Geologic Setting

The bedrock about 20 ft east of the main pool was mapped as the Devonian Sevy Dolomite (Tschanz and Pampeyan, 1970). It is a light gray, resistant, fine-grained, well-bedded dolomite with an attitude of north 30 degrees east 26 degrees west. The bedrock forms a low, northeast-north-trending fault scarp along the springs. The trace of the fault and the local geology are shown on Figure 3-71. The faulting brecciated the bedrock along most of this scarp. Sitting on the dolomite just east of the main pool is a small (about 6 × 10 ft in plan view) eroded mass of light gray and tan, resistant, porous, spring carbonate (limestone that fizzes violently in acid). It also is likely early Pleistocene. Bedrock pieces and dikes of carbonate are scattered along most of the range front east of the springs. A hill of tufa deposits, presumably early Quaternary and about 30 ft high and at least 300 × 100 ft in plan, lies just south of the spring complex, south of the burned-out lunchroom of the old resort and just east of

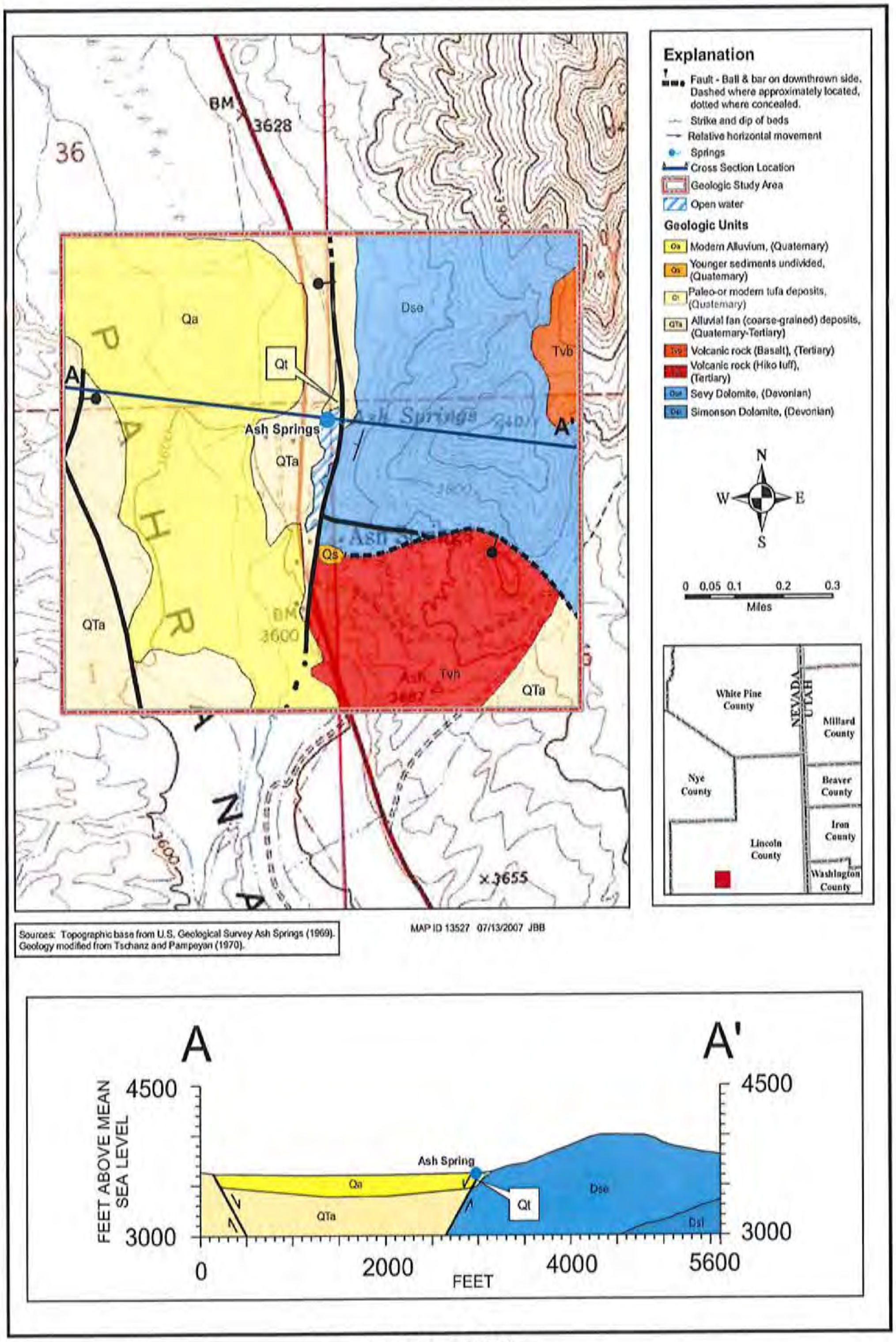

Figure 3-71
Geologic Map and Cross Section of Ash Springs, Lincoln County, Nevada

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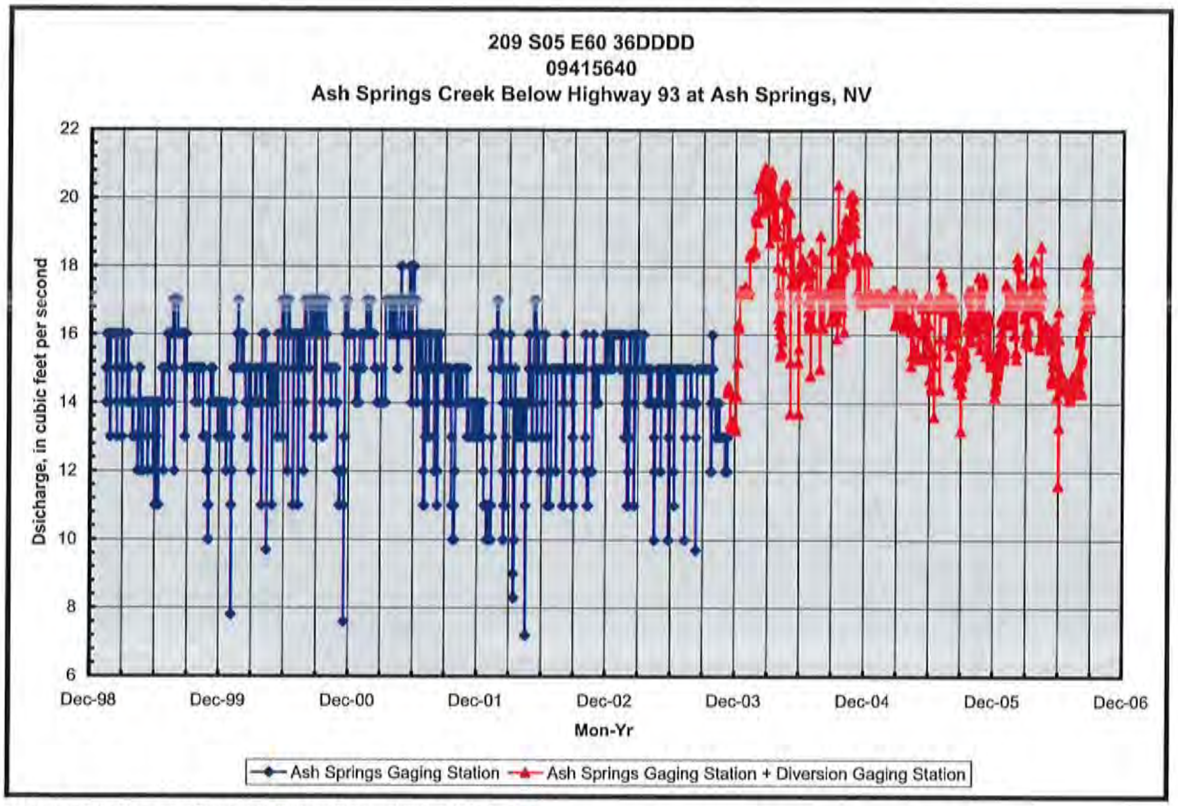
U.S. Highway 93. Low hills east and southeast of this spring mound consist of Hiko Tuff, an 18-Ma ash-flow tuff derived from the Caliente caldera complex to the east (Rowley et al., 1995). These volcanic rocks are faulted down against the Sevy Dolomite to the north along generally east-striking faults. The main fault passes through a small canyon to the east and through the large spring mound. A parallel fault to the north, with brecciated Sevy Dolomite and spring limestone north and south of it, has an attitude of north 80 degrees east. This was mapped in a small canyon just east of the bathhouse.

Discharge

Discharge at Ash Springs has been measured intermittently since 1912, similar to Hiko Spring and Crystal Springs. Prior to the 2004 water year, only the discharge in the main channel was measured by the USGS. Like the discharge record for Crystal Springs, the discharge record for Ash Springs consists only of a partial record because a portion of the flow was intermittently diverted for agricultural purposes above the gage. Currently, the USGS operates gaging stations on both the main channel and on the diversion channel. Figure 3-72 shows a hydrograph of the spring discharge at Ash Springs. However, there may be some natural variations in the spring's discharge. A notable example of this was reported by Smith (1944).



Large variations in flow are diversions above the gage.

Figure 3-72
Hydrograph of Published Ash Springs Mean Daily Discharge Values

Donald K. Perry, Water Commissioner for the Pahranagat Lake and Tributaries, reported that on July 4, 1943, the spring increased in discharge from 17.36 to 18.56 cfs (7,790 to 8,330 gpm) and remained at this discharge until he left the valley on September 3, 1943. He described this event as "very unusual" and that the spring had been known to decrease in discharge, but this was the first time it had shown any increase in discharge.

Discharge data are summarized below in Table 3-3.

Table 3-3
Annual Discharges at Ash Springs

Water Year	Ash Springs (09415640)		Ash Springs Diversion (09415639)		Total Combined Discharge (afy)	Days Diverted	Percentage of Year Diverted (%)	Percentage of Annual Discharge Diverted (%)
	Annual Discharge (afy)	Average Annual Discharge (cfs)	Annual Discharge (afy)	Average Annual Discharge (cfs)				
2005[a]	10,080	13.9	2,190	3.03	12,270	365	100	18
2006[a]	8,780	12.1	2,810	3.88	11,590	365	100	24
2005-2006 average	9,430	13.0	2,500	3.46	11,930	365	100	21
Average for the period of record	10,360	14.3	2,221[b]	3.07[b]	12,581[b]	--	--	18[b]

[a] Data from USGS Water Resources Data-Nevada Water Years 2005 and 2006.
[b]Period of record for Ash Springs Diversion gage is December 12, 2003 to present. The missing days for the 2004 water year were estimated.

The spring currently discharges into a channel that is incised 4 to 6 ft in the alluvial sediments. The spring's main pool is fed by a series of pipes and originates from the buried orifice. The spring area is approximately a quarter mile long and is controlled by a head gate near U.S. Highway 93. From this head gate, the flow can be diverted into another channel that transfers water to different parts of the valley for irrigation.

Diversions and Water Use

Ash Springs has been diverted to supply agricultural uses since the early 20th century, much like Crystal Springs and Hiko Spring. Currently, the springs are used to supply domestic needs to the gas station east of U.S. Highway 93 and for recreation, wildlife, and agricultural uses. The discharge record reflects these diversions, so all the data reported reflects only the water that passed the gaging station, not what was actually discharged from the springs. Since late 2003, this problem has been corrected by the installation of a supplemental gage at the irrigation diversion. The domestic diversion for the gas station is still reflected in the discharge record.

3.5.4 Solar Panel Spring

General Setting

Solar Panel Spring also known as Cottonwood Spring is approximately 9.5 mi south of Alamo, Nevada and 1 mi west of U.S. Highway 93 on the U.S. Fish and Wildlife Service (USFWS) Pahranagat Wildlife Refuge (Figure 3-63), and 1.5 mi south of the Refuge Headquarters along the Corn Creek/Alamo Road.

The spring pool is approximately 20 ft in diameter and 3 to 5 ft below the surrounding land surface. The pool is about 1 to 2 ft deep. The pool is heavily overgrown with cattails and other types of aquatic vegetation. A metal catwalk extends from the western edge of the spring to the 12-in. stilling well, which is accessed via a trap door. A ring of vegetation consisting primarily of broad leafy plants and grasses surrounds the pool. A small grove of six to ten Cottonwood trees is located along the northern edge of the spring area (Figure 3-73).

Figure 3-73
Solar Panel Spring Discharge Area

Geologic Setting

The spring discharges from alluvium just east of a small terrace that is most likely a fault scarp.

Discharge

Measurements of discharge and water temperature were conducted at Solar Panel Spring during the May 24, 2004 field investigation. The discharge was estimated at 0.25 to 1.0 gpm, and the water temperature was 20.3°C. The discharge was measured approximately 15 yards downstream of the spring's orifice near a permanently installed 3-in. flume. The channel reach from the orifice to the flume is heavily overgrown with cattails and other aquatic plants and is incised approximately 1 to 1.5 ft below land surface. The width of the channel is about the same as the flume. The heavily overgrown channel controls the flow from the spring pool.

Other devices at the spring include an unknown type of probe installed in a stilling well and a 30-degree V-notch weir plate. All of these devices, including the 3-in. Parshall flume, were in poor condition. The probe in the stilling well was disconnected from the power source, and the stilling well was overgrown with cattails. Water no longer passes over the 30-degree V-notch weir plate, and it is also overgrown. The Parshall flume was no longer level and also overgrown. It is estimated that 50 percent of the flow was by passing the flume at the time of the field investigation.

During the Spring of 2007 the USFWS reinstalled the 3-in. Parshall Flume and have recorded variable flow rates of .027 cfs (12 gpm) in April 2007 and less than 0.002 cfs (< 1 gpm) in June of 2007. They measured a temperature of 16°C, and anticipate the release of this data in mid 2008 (USFWS, written communication).

Diversions and Water Use

No diversions were observed during the field investigation. The spring's water is used for wildlife.

3.5.5 Pahroc Spring

General Setting

Pahroc Spring is located in the southern Pahroc Mountains, 30 mi west of Caliente, Nevada, and 15 mi east of Hiko, Nevada. In 1915, Pahroc Spring was listed as an important source of water while crossing Delamar and Dry Lake valleys (Carpenter, 1915). However, one of the earliest descriptions (1898) of Pahroc Spring is found in the journal of Carl A. Purpus, who while he was collecting plants for the University of California herbarium, described the spring as "a meager spring that trickled from under a rock" (Purpus, 1898). A complete listing of the reported discharge from Pahroc Spring is listed in Appendix B.

Geologic Setting

Pahroc Spring discharges from Tertiary volcanic rocks.

Discharge

Carpenter (1915) reported the spring's discharge as 0.004 cfs (2 gpm) in 1912. Bunch and Harrill (1984) reported discharge of 0.009 cfs (4 gpm). On July 19, 2004, the spring's discharge was estimated at 0.022 cfs (10 gpm). The discharge area is 200 ft wide and has dense vegetation, making it hard to obtain an accurate discharge estimate.

Diversions and Water Use

Water from Pahroc Spring is currently used for livestock and wildlife. Ruins of an old stone cabin and stone corrals are located at the spring. The water was used by travelers between the mines near Pioche, Nevada, and Pahranagat Valley (Carpenter, 1915).

3.6 Cave Valley (HA 180)

Cave Valley is a narrow valley located between White River and Lake valleys, with portions of the basin residing in both White Pine and Lincoln counties. Cave Valley comprises a portion of the White River Flow System. The valley trends in a north-south direction, typical of the Basin and Range Province. Cave Valley is approximately 40 mi long and averages approximately 12 mi in width. The valley is bounded in the east by the southern portion of the Schell Creek Range and the smaller Fairview Range, and in the west by the Egan Range. The southern portion of the valley is truncated where the Egan and Schell Creek ranges merge. Ranching is the principal economic activity in the valley. Historically, there was limited mining activity from 1870 to 1940s associated with the Cave Mining District, which was formed on March 17, 1869, and produced a small amount of ore from the area. Cave Valley is accessible using improved gravel roads that enter the valley through Shingle Pass (west side from SR 318), Sidehill Pass (east side from U.S. Highway 93), and other smaller and less maintained dirt roads. This study inventoried 2 springs in Cave Valley. Figure 3-74 shows the locations of these springs and their magnitudes of flow and temperature. A description of each of these springs is provided in the following sections.

3.6.1 Cave Spring

General Setting

Cave Spring is located at the far southwest corner of a low northeast-southwest-trending hill approximately 3 mi southeast of Parker Station, Nevada, and 65 mi northwest of Bristol Wells, Nevada (Figure 3-74). The area was listed by Hose et al. (1976) as having abundant water (Cave Spring).

Geologic Setting

Tschanz and Pampeyan (1970) mapped the ridge north of the spring as Cambrian Pole Canyon limestone flanked by and faulted down against Cambrian Pioche shale. In addition to these two faults, there is a northeast-striking fault that is intersected by an east-west fault that dips 72 degrees to the north. This fault has been trenched where a dipping angle of 72 degrees was obtained. The limestone and possibly shale dip 30 to 32 degrees to the southeast and strike north 45 degrees east. The limestones are thin- to medium-bedded oolitic limestone with corals. This unit could correlate with the lower part of the Highland Peak Formation. Between the spring orifice and ridge of

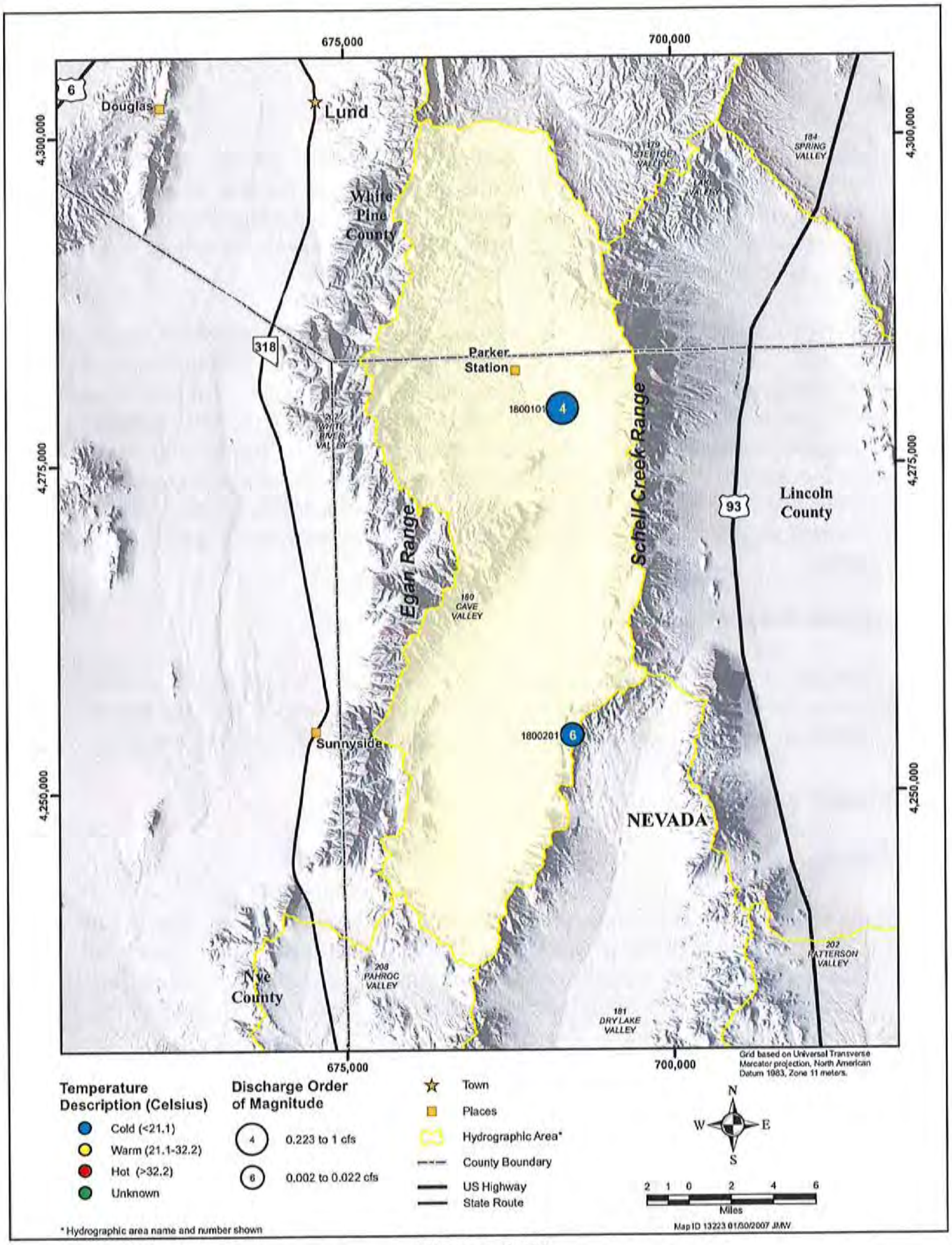


Figure 3-74
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Cave Valley, Nevada

Cambrian rocks, there is a large basin-range fault that drops this section into the valley floor (Figure 3-75).

Discharge

The spring discharges from Pole Canyon Limestone into a small creek incised 3 to 4 ft into the alluvium. In 1968, Mifflin (1968) described the spring discharge as variable, although it is not clear whether the reported discharge was measured, estimated, or based on another investigator's data. Bed material during periods of high flow is coarse angular limestone gravels; in periods of low flow the coarse material is covered with fine material and moss (Figure 3-76).

Discharge was measured at Cave Spring three times during separate field sessions in June, July, and September of 2004. All measurements were taken within 50 ft of the orifice. The measurements decreased in discharge during each visit. The measured discharges on June 23, July 16, and July 29, 2004, were 0.233, 0.081, and 0.022 cfs (105, 36 and 10 gpm), respectively. On September 14, 2004, the spring was again visited and was observed to be dry. During the 2006 water year the discharge of Cave Spring was measured 3 times. In October 2006 it was 0.033 cfs or approximately 15 gpm. In July and September of 2007 the spring was observed to be dry. The decrease in discharge rates during the summer months and the cold temperature of the water indicate that this spring is fed solely by local precipitation.

Diversions and Water Use

Currently, there are no active diversions at the spring. Historically, it appears that a small, hand-dug well was placed in the stream channel and used to divert water by pump. The water now flows freely down the channel into a small reservoir in the center of the valley and is used for livestock.

3.6.2 Sidehill Spring

General Setting

Sidehill Spring is located on the western flank of the Egan Range approximately 3.5 mi north of Sidehill Pass on the east side of Cave Valley (Figure 3-77). The spring area appears to have been modified by heavy equipment to increase the spring discharge yield. An area approximately 200 ft long has been disturbed. A fence was built to isolate the spring from livestock and wildlife, but much of the fence has been knocked down.

Geologic Setting

The spring discharges from volcanic tuffs.

Discharge

On June 21, 2004, a spring discharge of 0.006 cfs (3 gpm) was measured from a discharge pipe inside a buried 500-gallon propane tank used as a collection box. Based on field observations, this measurement likely represented only about three quarters of the total discharge.

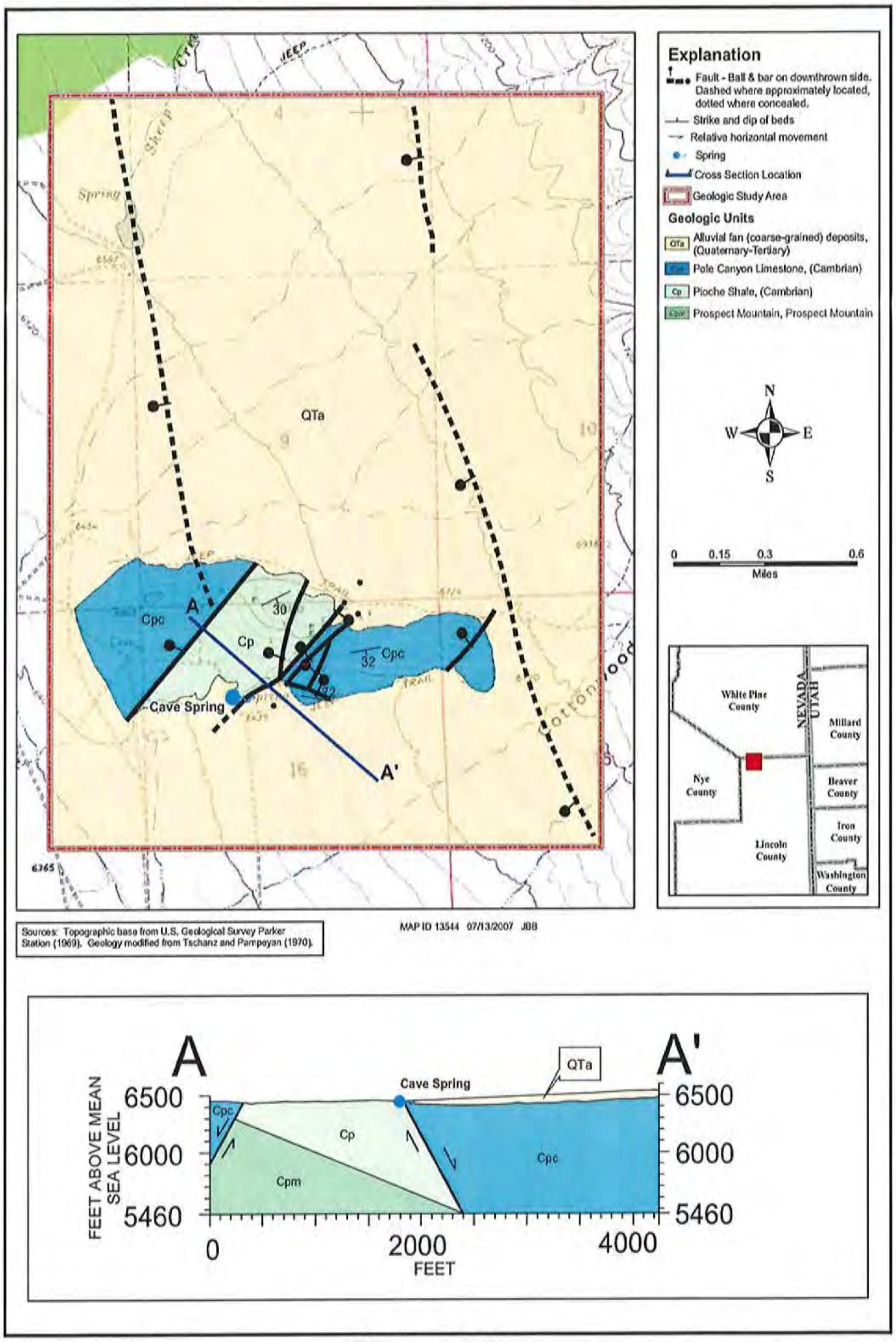
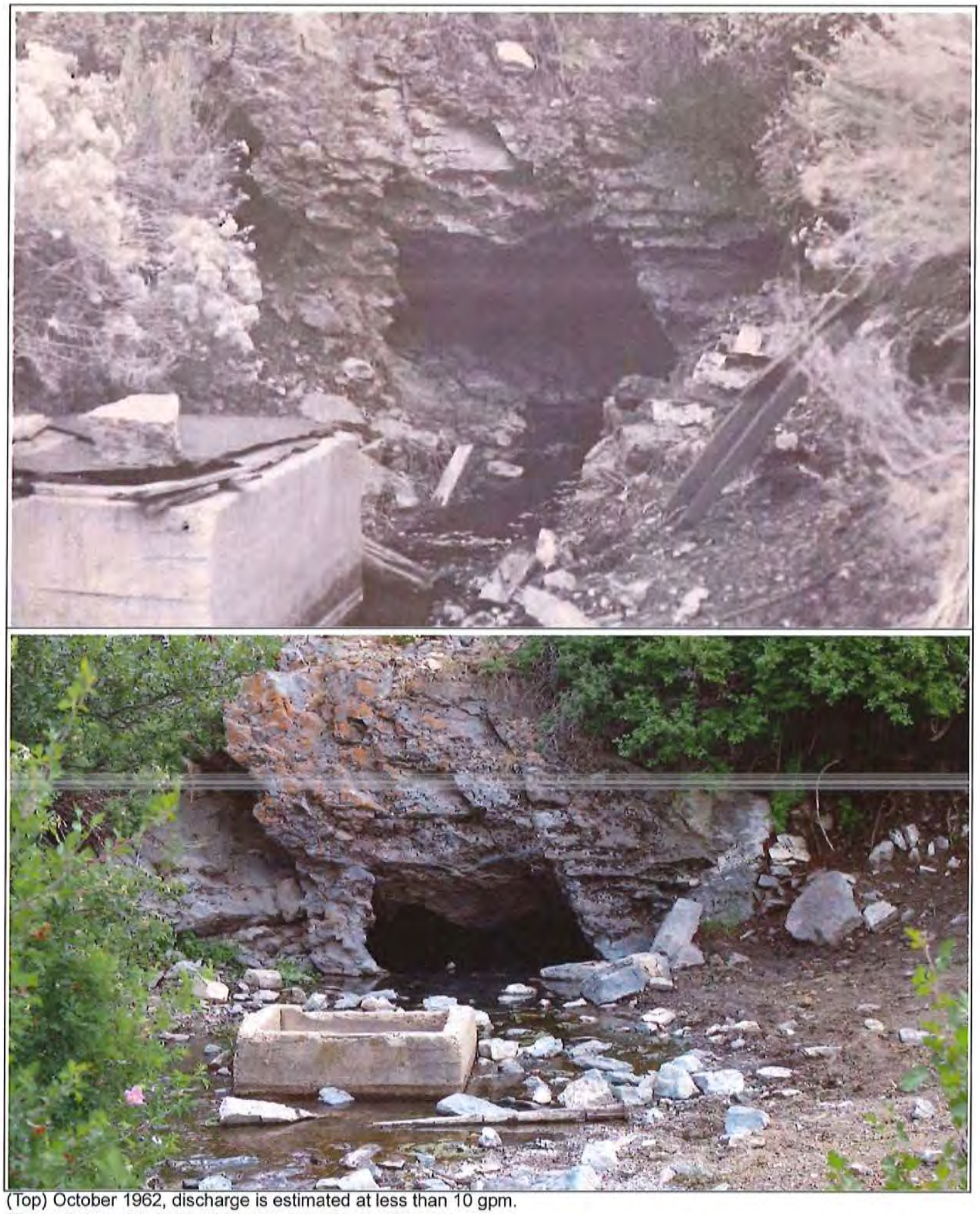


Figure 3-75
Geologic Map and Cross Section of Cave Spring, Lincoln County, Nevada



(Top) October 1962, discharge is estimated at less than 10 gpm.
(Bottom) June 29, 2004, discharge is 0.022 cfs (10 gpm).

Figure 3-76
Cave Spring

Figure 3-77
View Looking Northwest at Sidehill Spring Discharge Area

Diversions and Water Use

The water is piped from the disturbed area into the tank described previously. The discharge is then routed through another pipe to a large livestock tank on the valley floor, suggesting that the water is used for livestock watering.

3.7 Delamar Valley (HA 182)

Delamar Valley is located in central Lincoln County, with Pahranagat Valley to the west, Dry Lake Valley to the north, and Kane Springs and Coyote Spring valleys to the south. It comprises a portion of the southern third of the White River Flow System. The valley is bounded in the east by the Delamar Mountains and on the west by the Pahroc Range. The valley is approximately 25 mi long and averages 17 mi wide.

Gold was discovered in Delamar Valley in 1891 at a location later known as Helene, Nevada. In 1893, gold was discovered about two miles to the south at a location later known as Delamar. Production of gold stopped around 1909, and both towns were deserted over the next few years (Tschanz and Pampeyan, 1970).

Water had been developed from several of the small mountain block springs which include Squaw, Baker, Nesbit and Horn springs, (Carpenter, 1915) to support mining activities in Delamar Valley. Because the volume of water developed from these springs proved to be too small, an attempt was made to drill a well in Delamar Valley to augment the spring supply. The well was drilled to a total depth of 900 ft without encountering any water. Unsuccessful in acquiring groundwater, the mines installed a pumping plant in Stine, Nevada, and pumped the water from Meadow Valley Wash to Delamar Valley via a 3.5-in. pipe. A second pipeline was installed within a year. The pipelines required three pump stations to lift the water over the 2,100 ft of elevation change from Meadow Valley Wash to Delamar Valley.

Delamar Valley is accessible using improved gravel roads that intersect U.S. Highway 93 and enter the valley from the north, south, and west (Alamo). This study inventoried one spring in Delamar Valley. Figure 3-78 provides the location of this spring and its magnitude of flow and temperature. A description of this spring is provided in the following sections.

3.7.1 Grassy Spring

General Setting

Grassy Spring is located approximately 4.5 mi north of Helene, Nevada, and 40 mi south of Bristol Wells, Nevada, along the western flank of the Delamar Mountains (Figure 3-79).

Geologic Setting

The spring discharges from alluvial sediments near where they are in contact with volcanic rocks.

Discharge

During a field investigation on June 2, 2004, the discharge of the spring was measured at less than 0.001 cfs (0.5 gpm). The discharge was measured volumetrically at the livestock tank, approximately 300 ft west of the spring.

Diversions and Water Use

The spring is currently used for livestock. The discharge is captured at the source and is transferred to a livestock tank through a 1-in. diameter black polyvinyl tubing.

3.8 Dry Lake Valley (HA 181)

Dry Lake Valley has sometimes been known as Bristol Valley and Desert Valley in the past (Carpenter, 1915). The valley is in Lincoln County and is part of the White River Flow System. Carpenter (1915) reported that the only permanent water sources in Dry Lake Valley consisted of the Bristol Well and Bailey, Maloy, and Coyote springs. The valley is approximately 60 mi long and averages approximately 20 mi wide. The valley is bounded in the west by the southern extension of the Schell Creek Range. The Pahroc, Fairview, Bristol and Highland Peak ranges bound the valley to the east.

Dry Lake Valley is accessible using improved gravel roads that enter the valley from the south from U.S. Highway 93, and from the east from U.S. Highway 93 in Lake Valley through Bristol Pass. This

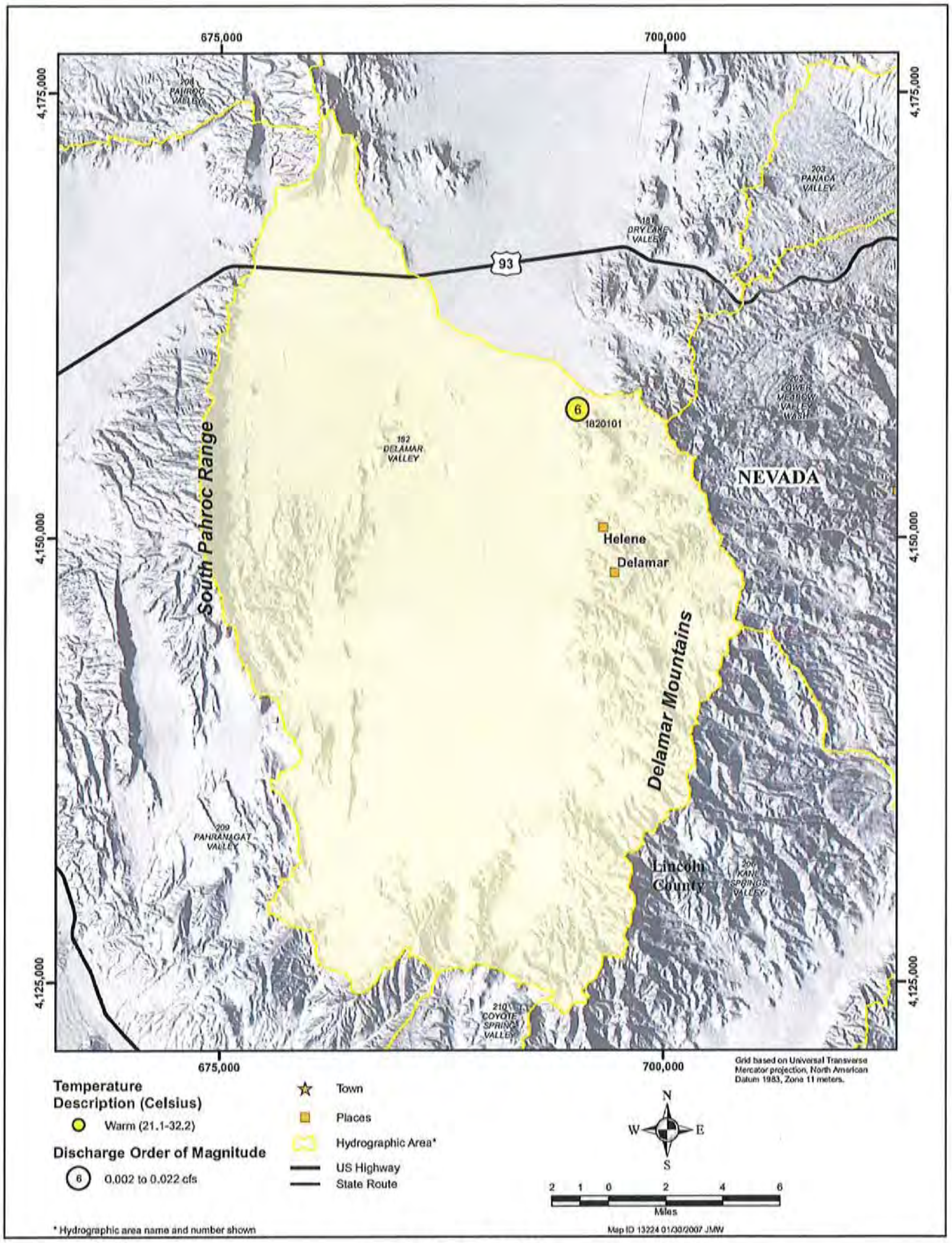


Figure 3-78
Map Showing the Location, Magnitude of Discharge, and Temperature of Grassy Spring in Delamar Valley, Nevada

Figure 3-79
Discharge Area of Grassy Spring, Delamar Valley, Lincoln County

study inventoried four springs in Dry Lake Valley. Figure 3-80 shows the locations of these springs and their flow and temperature. A description of each of these springs is provided in the following sections of this report.

3.8.1 Bailey Spring

General Setting

Bailey Spring is approximately 5.5 mi northwest of Bristol Wells. There are two spring orifices and an old homestead located at the spring site (Figure 3-81). Both orifices have been excavated.

Geologic Setting

Bailey Spring emanates from Tertiary volcanic rocks along a small fault.

Discharge

In 1912, a discharge of about 0.007 cfs (3 gpm) was reported (Carpenter, 1915). In May 1980, the discharge was reported to be 0.004 cfs (2 gpm) (Bunch and Harrill, 1984). During a field investigation conducted on June 3, 2004, the discharge was measured with a 3-in. Parshall flume. A discharge of less than 0.001 cfs (0.03 gpm) was recorded at this time. The water temperature in 2004 was measured at 13°C.

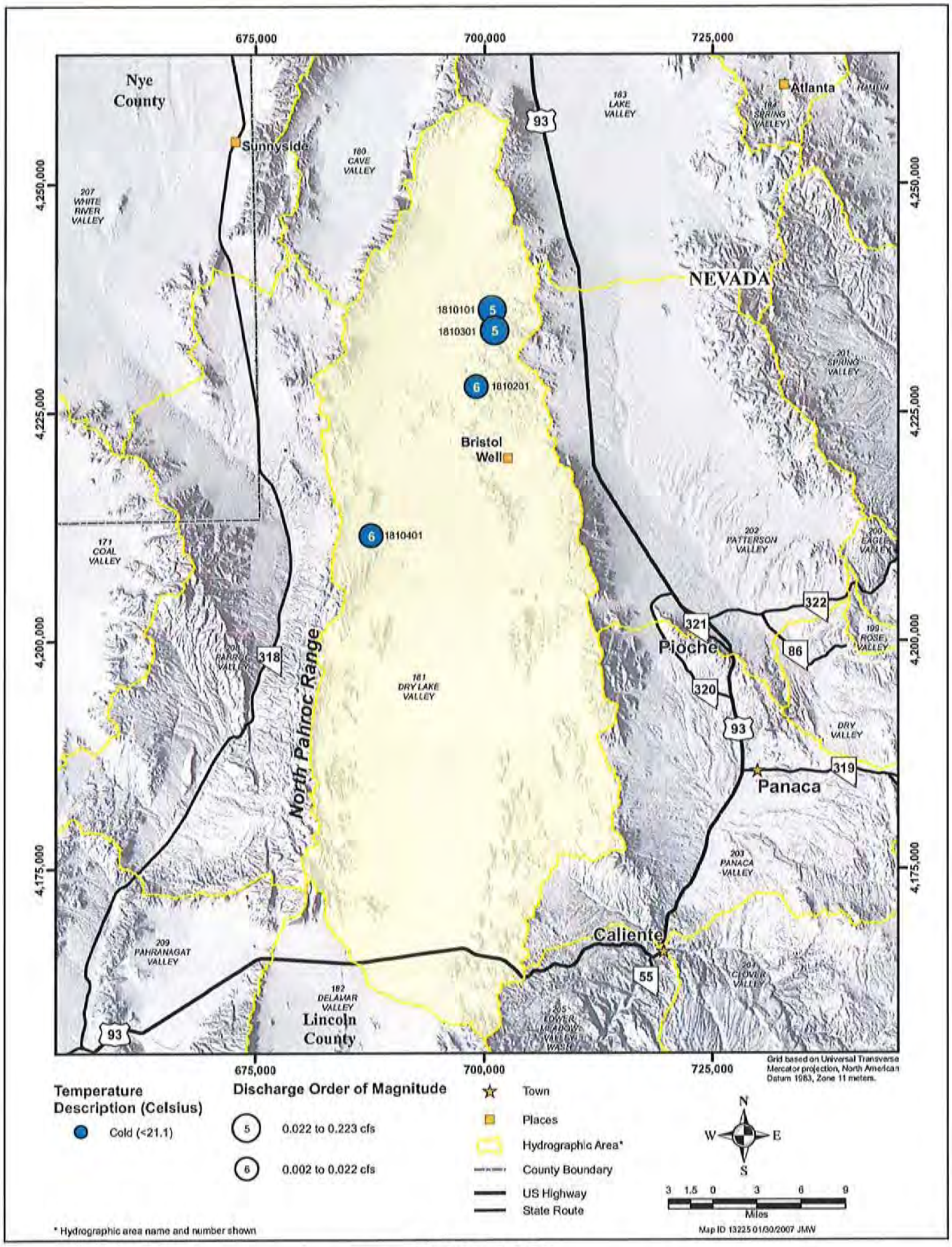


Figure 3-80
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Dry Lake Valley, Nevada

Figure 3-81
Discharge Area at Bailey Spring, Dry Lake Valley, Nevada

Diversions and Water Use

During the 2004 field investigation, the spring's only observable discharge use was for wildlife. There is a small abandoned homestead at Bailey Spring.

3.8.2 Meloy Spring

General Setting

Meloy Spring is approximately 6 mi north of Bailey Spring. An old homestead is located at the spring. The spring discharges below an outcrop of volcanic rock and has been modified to increase its yield. The orifice area is overgrown with wild rose bushes, making it inaccessible to measure discharge or collect water-chemistry samples.

Geologic Setting

Meloy Spring discharges from the base of small scarp in Tertiary volcanic rocks.

Discharge

In May 1980, the spring's discharge was measured at 0.183 (82 gpm) cfs. In 1997, SNWA estimated the discharge as 0.1 cfs (45 gpm). The site was not accessible in 2004.

Diversions and Water Use

According to Carpenter (1915), Meloy Spring was used as a watering place for travelers. The water is currently used for livestock and wildlife.

3.8.3 Coyote Spring

General Setting

Coyote Spring (Figure 3-82) is located approximately 8 mi west-southwest of Bristol Wells and lies at the center of a large homestead/compound. In 1912, the spring area was described by Carpenter (1915) as "a house and corral have been built near the spring, but neither appears to have been used for some time." Currently, a similar description can be applied; the ranch/homestead appears abandoned and/or only used intermittently.

Geologic Setting

The spring discharges from the base of a scarp approximately 15 ft high, in volcanic rocks.

Discharge

Discharge was measured at 0.011 cfs (5 gpm) in 1912 and at 0.002 cfs (0.9 gpm) in August 1979. On June 3, 2004, discharge was measured at 0.11 gpm (less than 0.001 cfs). By June 21, 2004, the discharge rate had declined to 0.02 gpm (less than 0.001 cfs).

Diversions and Water Use

There are two distinct orifices at Coyote Spring, and each has tubing that routes the discharge to a large concrete livestock tank (Figure 3-83). In the past, water was used for livestock; however, currently the spring area looks unused by livestock.

3.8.4 Littlefield Spring

General Setting

Littlefield Spring is located approximately 3 mi northwest of Bailey Spring. Recent development in the spring area includes a new fence around the spring area and surface grading near the spring (Figure 3-84). This spring is the only inventoried spring in Dry Lake Valley that did not have a homestead associated with it.

Geologic Setting

The spring discharges from the alluvium near an outcrop of volcanic rock.

Figure 3-82
Coyote Spring in Dry Lake Valley, Nevada

Figure 3-83
Stock Tank and Diversion Pipe at Coyote Spring, Dry Lake Valley, Nevada

Figure 3-84
Discharge Area at Littlefield Spring, Dry Lake Valley, Nevada

Discharge

This spring had a reported discharge of 0.022 cfs (10 gpm) in May 1980 (Bunch and Harrill, 1984). During a June 3, 2004 field investigation, the discharge was measured at 0.026 cfs (12 gpm) and the temperature was 15°C.

Diversions and Water Use

There were neither diversions near the orifice of the spring nor along the road. The spring had recently been fenced with barbed wire, and it appeared that the area was freshly graded.

3.9 Black Mountain Area (HA 215)

The Black Mountains Area is bounded by the Colorado River (Lake Mead) in the east, the Black Mountains in the southwest, and the Muddy Mountains in the northwest. The most dominant features are the Muddy Mountains, Bitter Spring Valley, and the large washes of Gypsum, Callville, Echo, and Valley of Fire. This study inventoried two springs in the Black Mountain Area. Figure 3-85 shows the locations of these springs and their magnitudes of flow and temperature. A description of each of these springs is provided in the following sections.

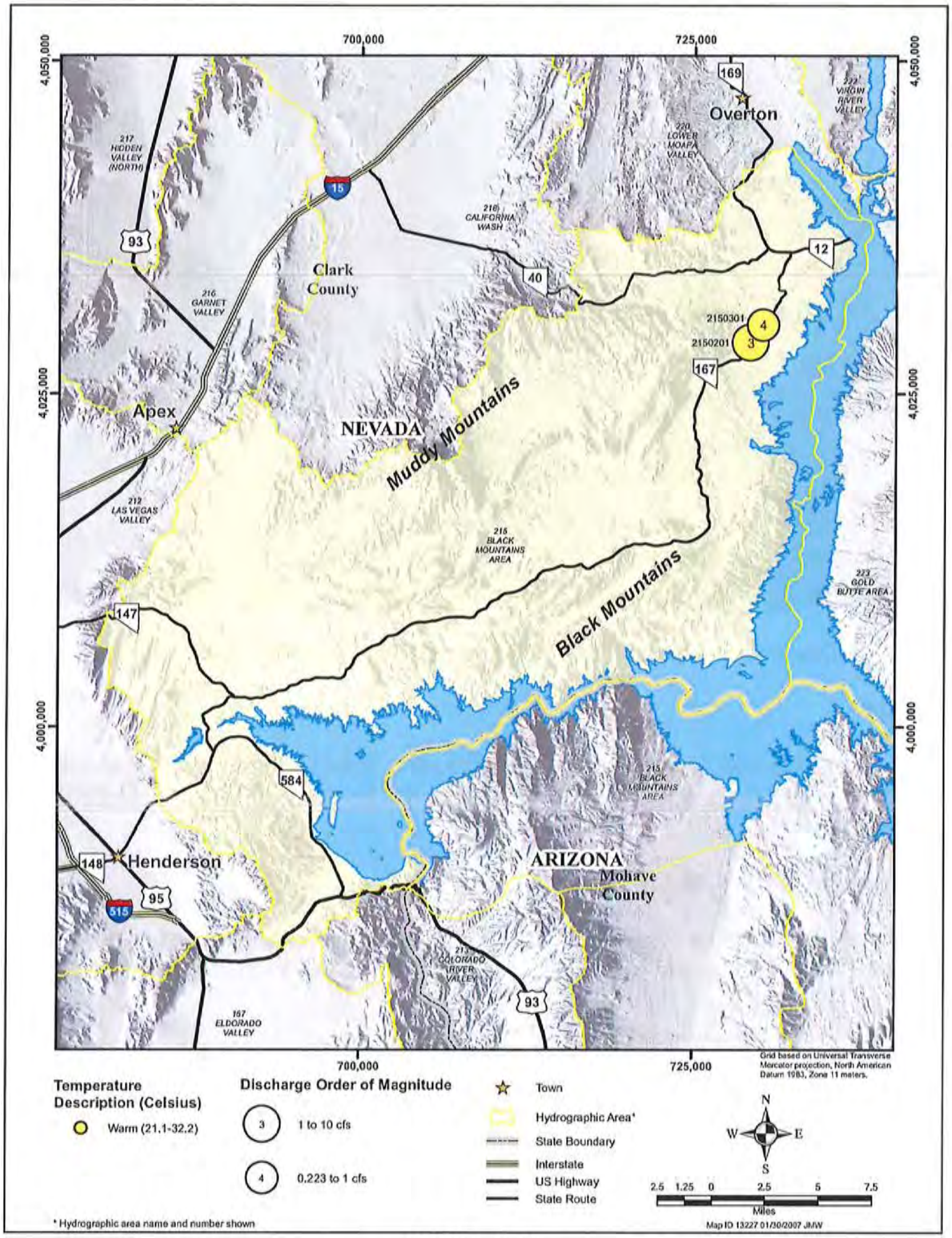


Figure 3-85
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in the Black Mountains Area, Nevada

3.9.1 Rogers Spring

General Setting

Rogers Spring is located approximately 14 mi south of Overton, Nevada, at mile marker 40 along North Shore Road in the Lake Mead National Recreation Area (Figure 3-86). The spring is open to the public for recreational purposes.

Orifice is at the base of the fault in the center of the photograph.

Figure 3-86
Orifice at Rogers Spring, in Black Mountains Area, Nevada

Geologic Setting

Rogers Spring discharges along a major Basin and Range fault separating the Tertiary Muddy Creek Formation from Paleozoic carbonate rocks. Paleo-orifices can be observed 50 ft above the current orifice.

Discharge

Discharge at Rogers Spring is measured by the USGS Gaging Station No. 09419550-Rogers Spring near Overton Beach, Nevada, which is a 1-ft fiberglass flume equipped with a continuous data logger. The current gage replaced the old gaging station located 10 ft upstream, which was a stilling well with the natural channel being the control. From 1985 to 2006, the average annual discharge of Rogers Spring was 1.66 cfs (745 gpm). The minimum and maximum average annual discharges are 1.47 and 1.88 cfs (660 and 844 gpm), recorded in 1992 and 1993, respectively (Figure 3-87). The 2006 annual discharge was 1,210 afy and the average daily discharge was 1.68 cfs (754 gpm).

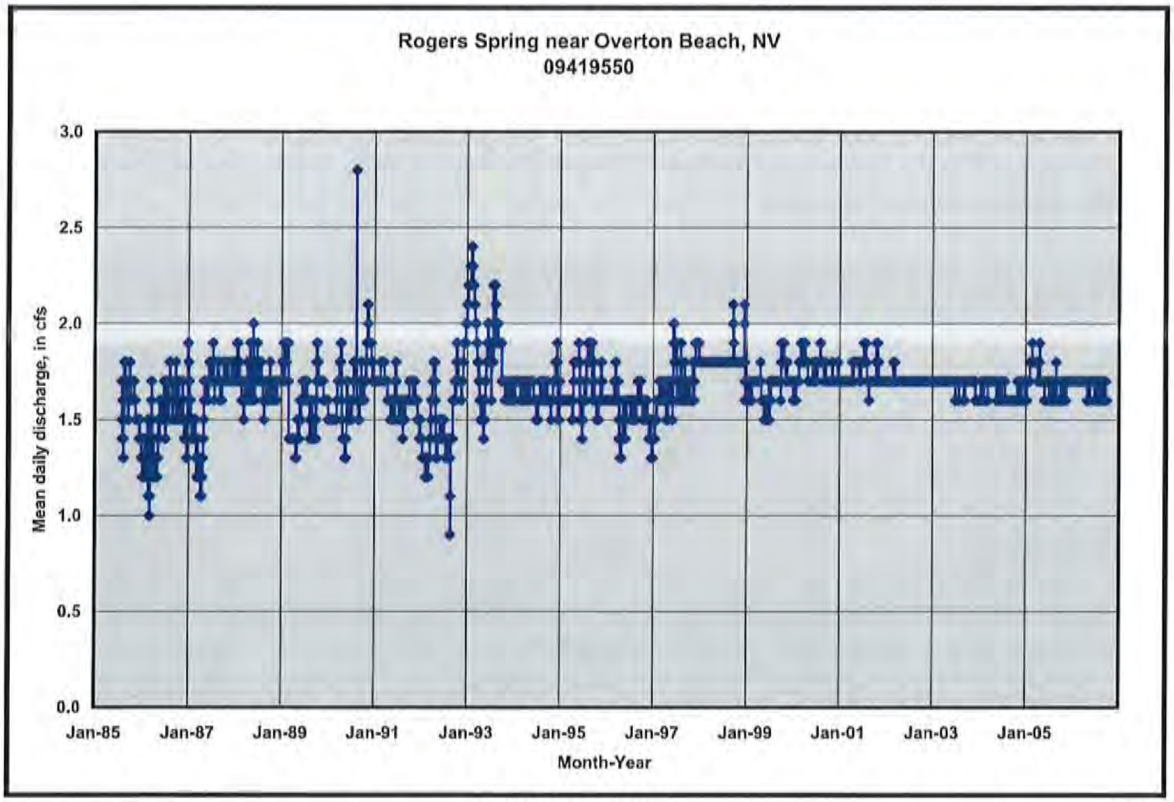


Figure 3-87
Hydrograph of Rogers Spring near Overton Beach, Nevada

Diversions and Water Use

Rogers Spring discharges directly from a fault in the carbonate rocks into a small reservoir used for recreational bathing. The pool's dimensions are approximately 100 ft wide, 150 ft long, and averages about 2 ft deep. The pool's elevation is controlled artificially by a rock and concrete spillway, and the reservoir's water elevation frequently changes when swimmers construct dams across the control.

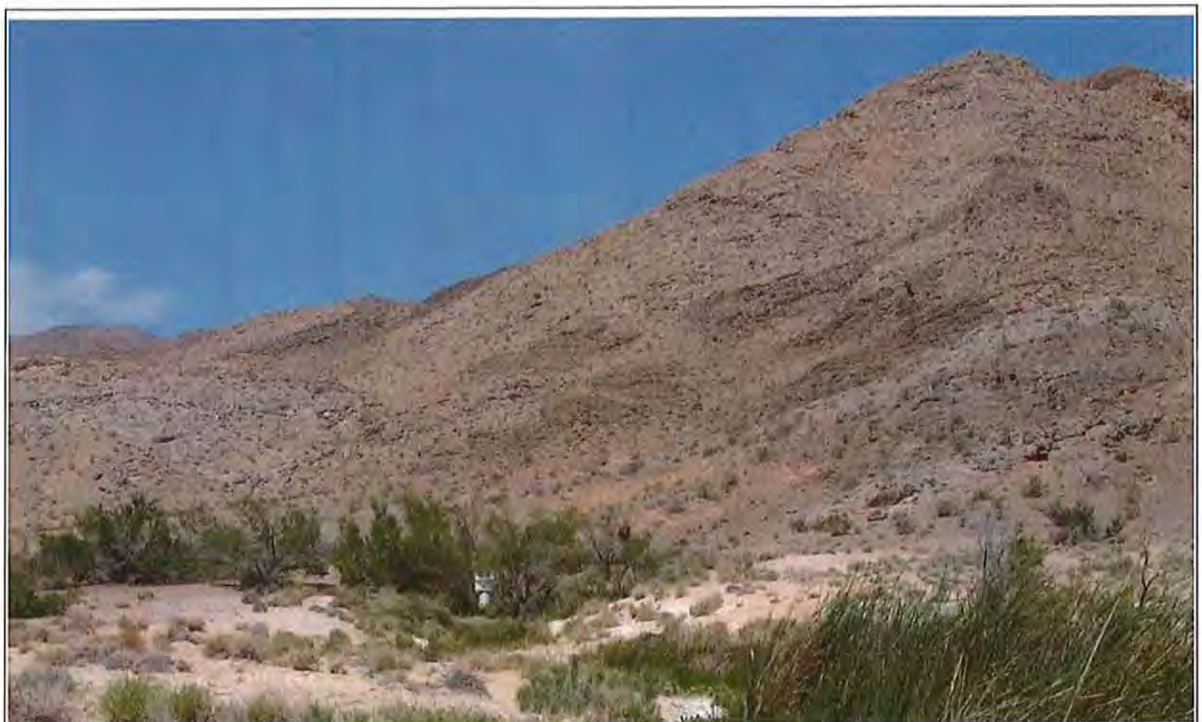
3.9.2 Blue Point Spring

General Setting

Blue Point Spring is located approximately 13 mi south of Overton, Nevada, at mile marker 41 along North Shore Road in the Lake Mead National Recreation Area. The spring is open to the public for limited recreational opportunities.

Geologic Setting

Blue Point Spring discharges from the same fault that affects Rogers Spring to the southwest (Figure 3-88).



Gage house is in the center of the photograph.

Figure 3-88
Discharge Area of Blue Point Spring, in Black Mountains Area, Nevada

Discharge

The spring discharges from below a large mesquite tree and bubbles up from the bed of the channel. The pool is heavily overgrown with bullrushes (Figure 3-89). The orifice is incised in the channel approximately 4 ft and the active portion of the channel is approximately 2 ft wide. USGS, in cooperation with the National Park Service, operates USGS Gaging Station No. 09419547-Blue Point Spring near Valley of Fire State Park, Nevada. The station is a stilling well equipped with a continuous stage recorder and is approximately 30 ft downstream of the orifice. The channel has a 90-degree V-notch weir plate as a control, which is in fair to poor condition. The weir plate is made of mild steel and is heavily corroded. The approach to the weir is a concrete channel that has heavy algal growth along its sides and bottom.

The average annual discharge reported by USGS is 0.55 cfs (398 gpm) for water year 2006. The minimum and maximum average annual discharge during the period of record were 0.50 and 0.57 cfs, respectively (224 and 256 gpm), recorded in 2002 and 2001 (Figure 3-90). The mean annual discharge for the period of record is 0.55 cfs or 397 afy.

Diversions and Water Use

Both above and below the weir is a natural channel, and there are no diversions above the gage.

Figure 3-89
Blue Point Spring Weir Plate and Concrete Channel, Showing Heavy Algae Growth

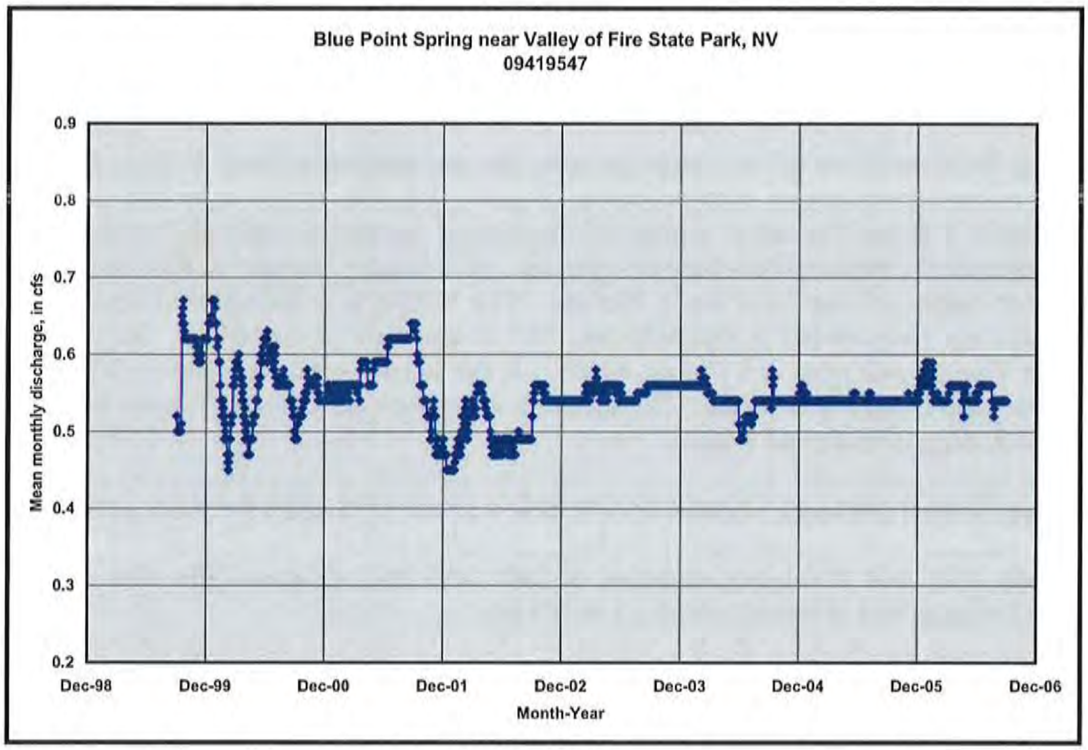


Figure 3-90
Hydrograph of Blue Point Spring near Valley of Fire State Park, Nevada

3.10 Muddy River Springs Area (Upper Moapa Valley HA 219)

The Muddy River Springs Area contains the largest thermal springs in Nevada (Garside and Schilling, 1979). There are six major spring groups within the area: Cardy Lamb, Baldwin, Pipeline Jones/Apcar, Big Muddy, Pederson, and Plummer (Beck et al., 2006). The Muddy Springs Area is one of the lowest discharge points and potential terminus of the White River Flow System. However, there has been speculation that a portion of the regional flow reaches the Colorado River (USFWS, 2006). The Muddy Springs form the headwaters of the Muddy River. From 1913 to 1918, the average daily discharge of the Muddy River near Moapa, Nevada, was 46.9 cfs and the average annual discharge was approximately 34,000 afy (Wells, 1960). The average annual discharge from 1914 to 1962 was reported as 33,700 afy (46.5 cfs) (Eakin, 1964). An estimated 2,000 to 3,000 afy was being consumed by irrigation and phreatophytes between the spring area and the gaging station (Eakin, 1964). Figure 3-91 provides a hydrograph of mean monthly discharge at the Muddy River near Moapa, Nevada. The decline in the hydrograph in the late 1950s to early 1960s is the result of surface water diversions and alluvial groundwater pumping.

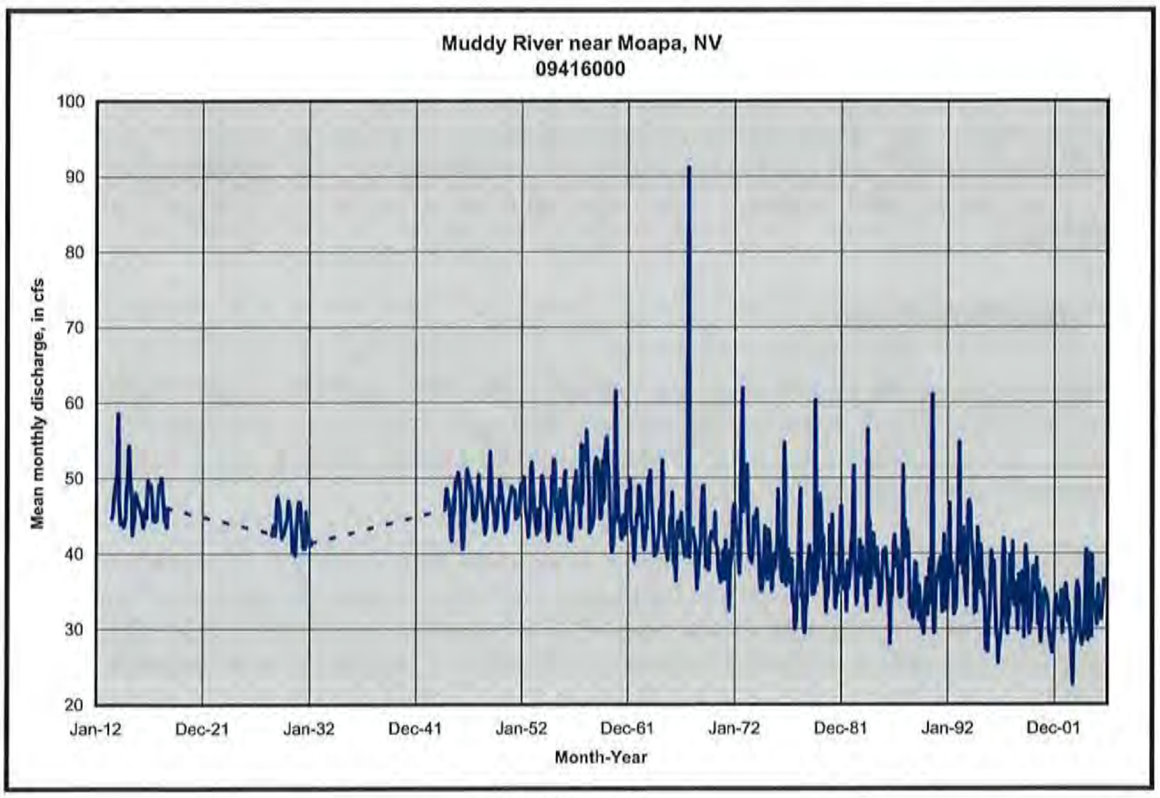


Figure 3-91
Hydrograph of Mean Monthly Discharge at Muddy River near Moapa, Nevada

3.10.1 Cardy Lamb Group

This group of springs is the farthest north and west group of springs of the Muddy River Springs Area. Several springs discharge into a man-made pool that was once used for recreational purposes. The pool is no longer used for recreation but is occasionally used as storage for irrigation downstream.

3.10.2 Baldwin Spring

The Moapa Valley Water District (MVWD) has developed Baldwin Spring into a public water supply. When the spring is used by the MVWD, it is piped into MVWD's distribution system and passes through a flow meter, and the water diversion is reported to NDWR. Water not placed into MVWD's distribution system is allowed to flow into the natural channel and can be measured several hundred feet downstream by a 3-ft Parshall flume.

3.10.3 Pipeline Jones/Apcar Spring

Pipeline Jones/Apcar Spring was developed in 1954 when the Moapa Valley Water Company and Overton Water District (now MVWD) used a dragline to improve the discharge of the spring (Beck et al., 2006). The spring currently discharges about 1.5 to 1.6 cfs (673 to 718 gpm) with MVWD diverting 1.0 cfs (449 gpm) of the total flow for municipal use. The undiverted portion flows east into Apcar stream which continues to gain water from subsurface seepage along the entire stream (USFWS, 2006).

3.10.4 Big Muddy Spring

Big Muddy Spring is the largest of all the springs. The USGS operates a gage (USGS Station Number 09415900) at the LDS farm. Mean annual discharges range from 7.18 cfs in 1991 to 8.44 cfs cfs in 1999 and the mean annual discharge over the period of record is 7.74 cfs or 5,610 afy. In 2006 the mean annual discharge was 7.24 cfs or 5,240 af.

The data for this gage is problematic due to the unmeasured church diversion upstream of the gage (Figure 3-92). The water is diverted from the spring to fill a swimming pool (Figure 3-93) and is then discharged back into the channel below the gage. The spring pool has been modified with a diversion gate and is drained weekly to clean it for recreational swimming. These diversions are reflected in the gage record.

3.10.5 Pederson Group

The Pederson Group of springs is made up of two main springs, Pederson Spring (Figure 3-94, top) and Pederson East Spring, and several smaller springs below the two main springs. Discharges are measured continuously at Pederson and Pederson East springs and semi-annually at springs M-11, M-12, and M-13. Both Pederson and Pederson East springs were formerly used for recreational purposes. The Pederson Spring record has been the subject of much discussion. The aluminum weir was found to be severely warped and it is speculated this happened when a fire burned through the

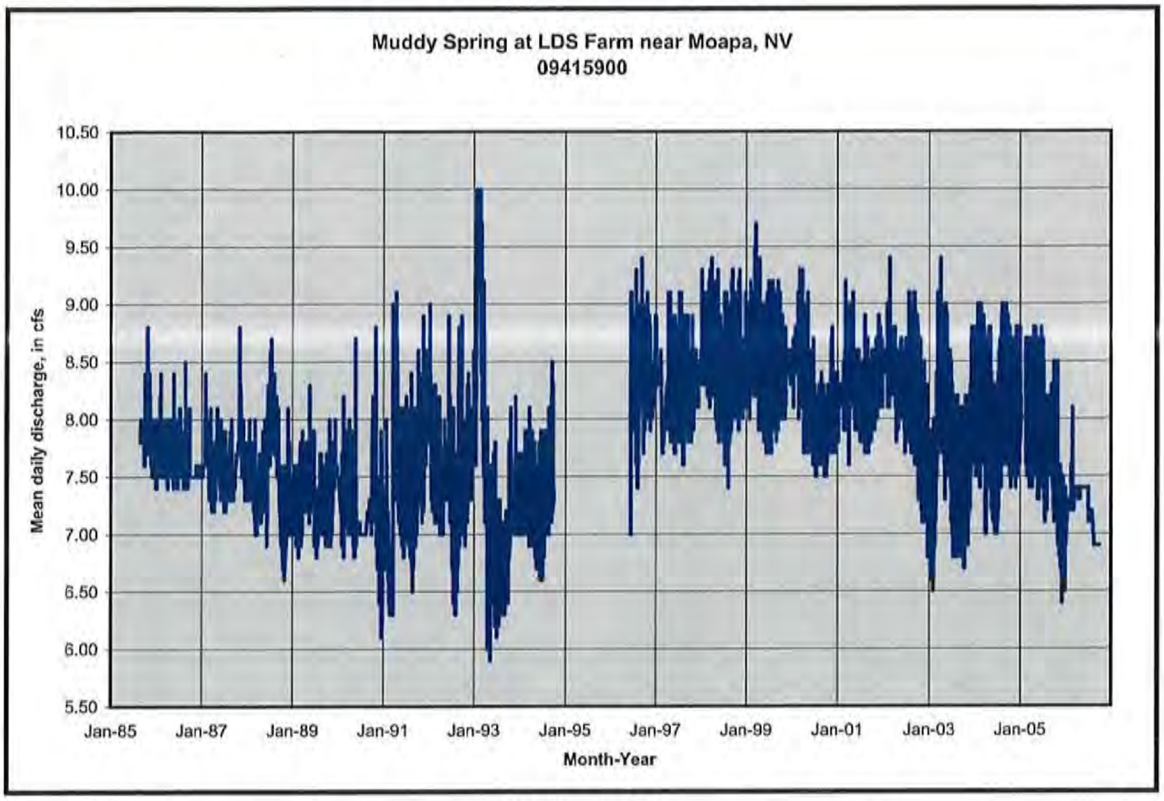
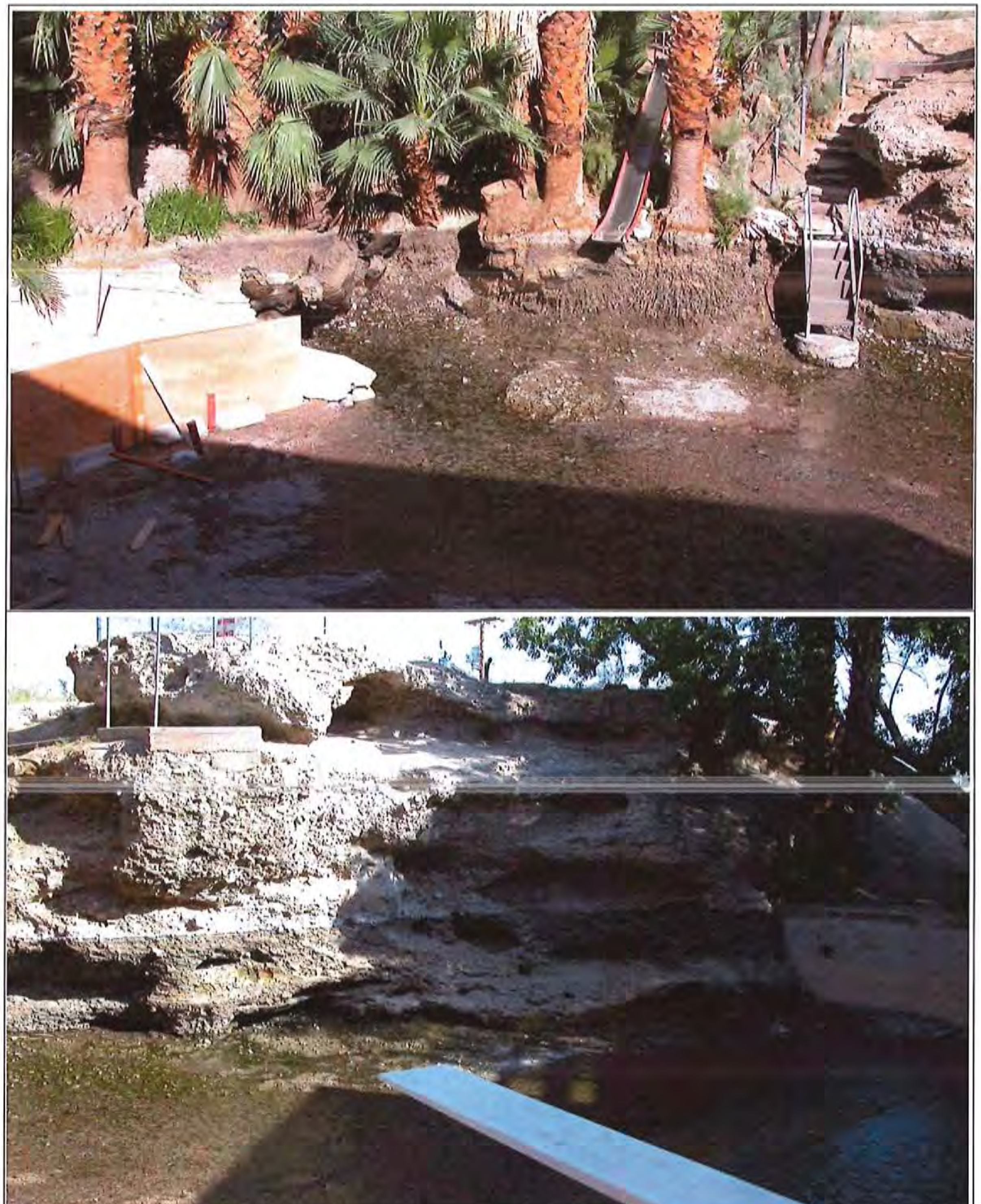


Figure 3-92
Hydrograph of Muddy Spring at LDS Farm near Moapa, Nevada

area in 1994 (Figure 3-94, bottom). Regardless of the cause of the warping of the weir its accuracy was altered. Then in 2002/2003 the weir began to leak and as a result, the gage was not recording the entire flow. USFWS began restoring the springs in 2002, and through a cooperative effort between USGS, USFWS, NDWR, and SNWA the Pederson gage was rehabilitated in early 2004, with a new control structure and since then correctly reports the discharge. The annual mean discharge for Pederson Spring is 0.22 cfs or 161 afy. The minimum and maximum discharges for the period of record are 0.19 cfs in (85 gpm) 1989 and 0.27 cfs (121 gpm) in 2006. The annual discharge for 2006 was 197 af. The annual mean discharge for Pederson East Spring is 0.22 cfs or 156 afy. The minimum and maximum discharges for the period of record are 0.19 cfs in (85 gpm) 2004 and 0.24 cfs (108 gpm) in 2006. The annual discharge for 2006 was 175 af. Except for an unmeasured diversion, the total discharge of the Pederson Group is measured at USGS Gaging Station No. 09415920-Warm Springs west near Moapa, Nevada (Figures 3-95, 3-96, and 3-97). The mean annual discharge, for the period of record, at the gage is 3.68 cfs (2,670 afy); the minimum discharge was 3.38 cfs (1,517 gpm) measured in 1992; the maximum discharge was 3.96 cfs (1,777 gpm) measured in 1998. In the 2006 water year the mean annual discharge was reported to be 3.90 cfs or 2,830 af.

M-11, M-12, and M-13 are three springs located over a linear distance of 150 ft. M-19 is located near these springs. The magnitude of the discharge from these four springs changes from year to year.



The main orifice can be seen in the top photograph.

Figure 3-93
Muddy Spring Pool Fed by Big Muddy Spring at the LDS Recreation Area

(Top) Looking north at the Pederson Spring Group. (Bottom) The warped weir plate at Pederson Spring. Photos taken before replacement of the weir.

Figure 3-94
View of Pederson Spring Group and Flow at Pederson Spring

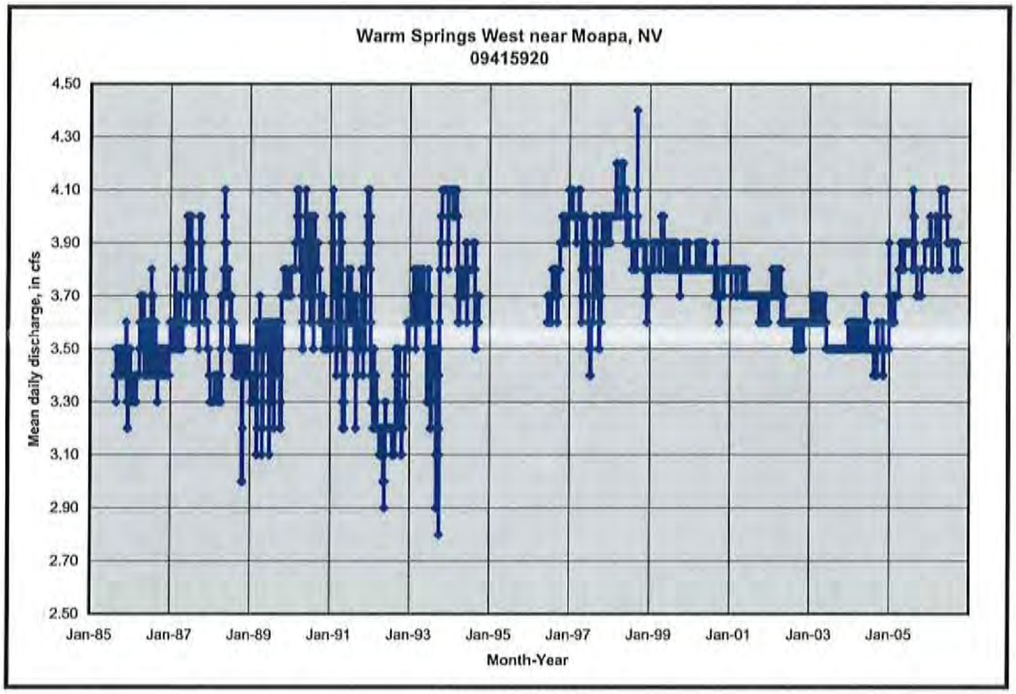


Figure 3-95
Hydrograph of Warm Springs West near Moapa, Nevada

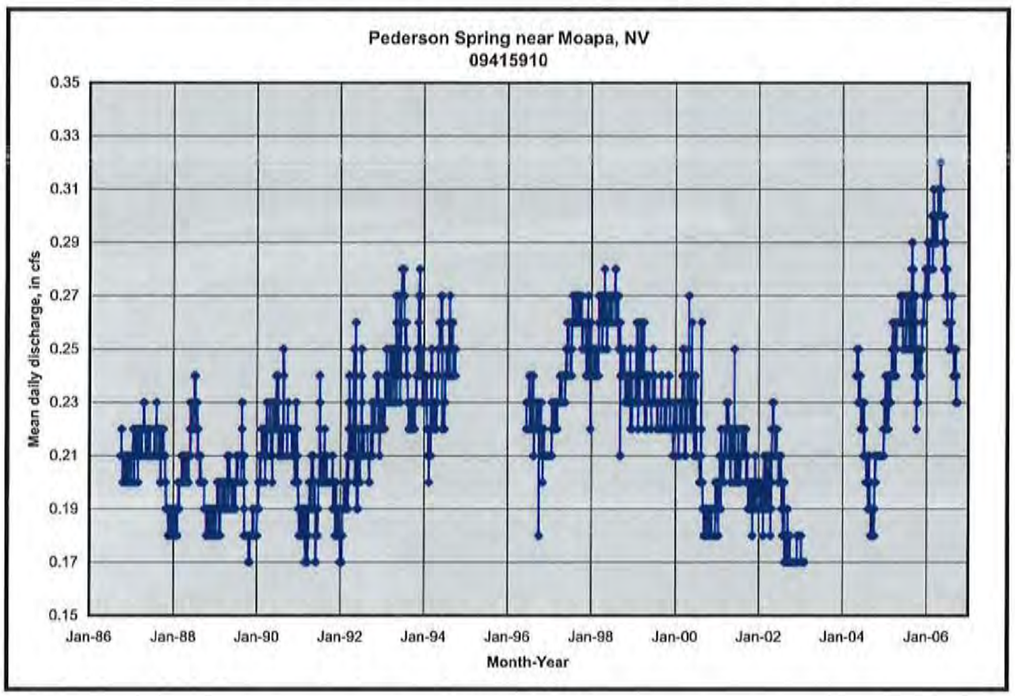


Figure 3-96
Hydrograph of Pederson Spring near Moapa, Nevada

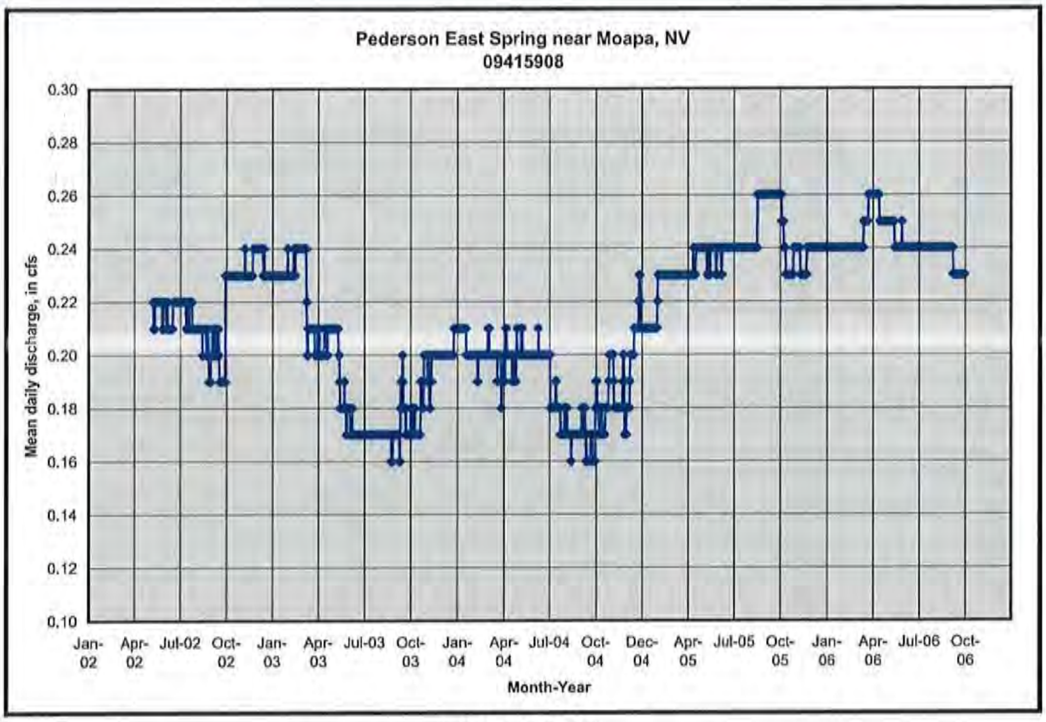


Figure 3-97
Hydrograph of Pederson East Spring near Moapa, Nevada

The data does not indicate any pattern to the discharge as might be expected. These data are presented in Table 3-4 and on Figure 3-95.

Based on the quality of available data, determining historical discharge trends are problematic. While there are periods of good measurements, there have been unmeasured diversions above some of the gaging stations or other problems with there controls. The semiannual data should be used with caution when performing any analysis.

3.10.6 Plummer Group

The Plummer Group of springs that were used primarily for recreation and are now being restored by USFWS. Discharge is measured semiannually by USGS at several sites. The total discharge from the Plummer Group and Pederson Group of springs is gaged at USGS Gaging Station No. 09415927-Warm Springs Confluence at Iverson flume near Moapa, Nevada. The mean daily discharge at the gage is 8.72 cfs (3,910 gpm).

Geologic Setting

Muddy River Springs Area is composed of several spring complexes in and near the community of Moapa, Nevada. Field mapping of the main areas of springs indicates that there are several north-south, high-angle normal subparallel faults west of and within the area of the springs. The

Table 3-4
Comparison of Discharges of Four Springs in the Pederson Spring Group near Moapa, Nevada

Spring	April Discharge (gpm)	September Discharge (gpm)	Net Change, April to September (gpm)	Percent Difference, April to September
Water Year 2001[a]				
M-11	427	669	242	44%
M-12	158	149	-9	-6%
M-13	417	330	-87	-23%
M-19	414	370	-44	-11%
Water Year 2003				
M-11	471	458	-13	-3%
M-12	114	130	16	13%
M-13	303	350	47	14%
M-19	473	435	-38	-8
Water Year 2004				
M-11	350	370	20	6
M-12	140	140	0	0
M-13	260	480	220	59
M-19	330	430	100	26
Water Year 2007[b]				
M-11	391	446	55	13
M-12	141	254	113	57
M-13	489	203	-286	-83
M-19	458	320	-138	-35

[a]In Water Year 2002, the springs were measured only in April. In Water Year 2005, the springs were not measured. In Water Year 2006, the springs were measured in January and September.
[b]Water Year 2007 data is provisional.

position of the faults explain the locations of the various spring complexes and the distribution of the modern and paleo-spring deposits. All of the springs in this area emerge from alluvium; however, this alluvium appears to have minimal thickness, and Permian and Pennsylvanian carbonate rocks are exposed within a mile. The faults serve as conduits from the carbonate rocks to the spring orifices, which are in the hanging wall of the structures (Donovan et al., 2004).

Diversions and Water Use

Diversions from Baldwin and Apcar springs have averaged a combined total of approximately 1,400 afy. The MVWD diverts the two springs for municipal supply. Nevada Power Company can divert up to about 3,500 afy from the Muddy River just above the Moapa gaging station. There are other small agricultural diversions from the other springs, but these amounts have not been quantified.

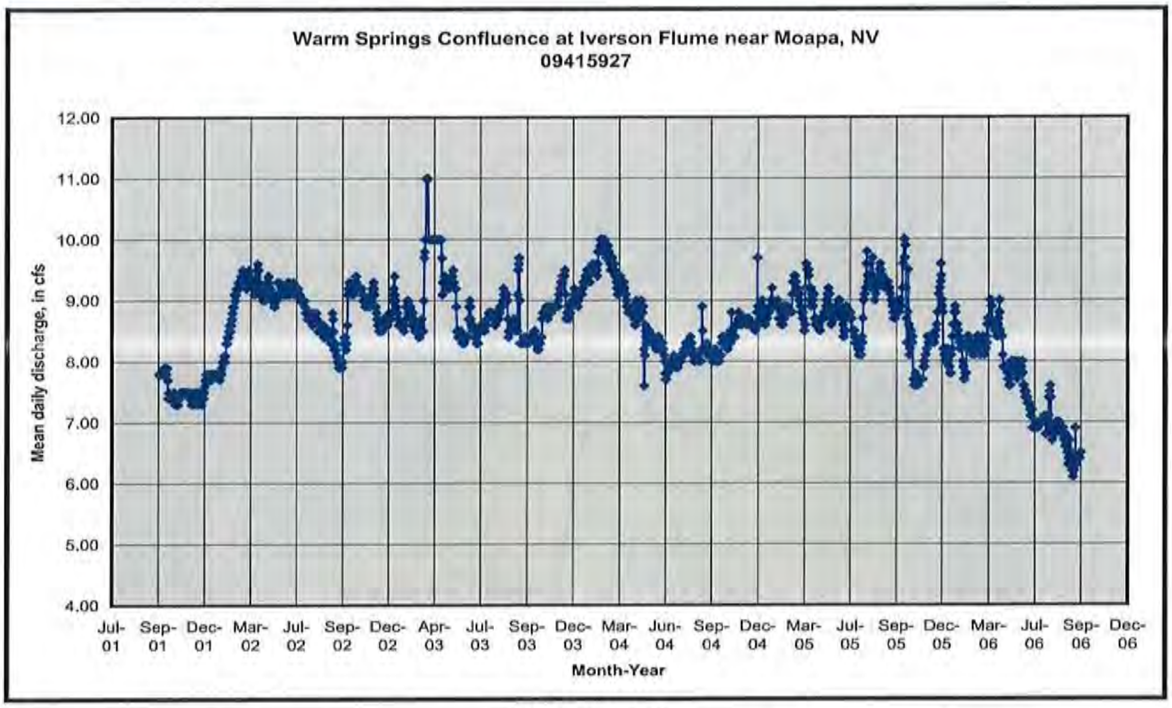


Figure 3-98
Hydrograph of Warm Spring Confluence at Iverson Flume near Moapa, Nevada

3.11 Panaca Valley (HA 203)

Panaca Valley is approximately 25 mi long and 20 mi wide near Panaca, in Lincoln County, Nevada. The valley is bounded on the west by the Highland and Chief ranges, on the north by the Pioche Hills, on the east by the Dew Mountain, on the south by the Cedar Range, and drains to the south into Lower Meadow Valley Wash via Meadow Valley Wash. U.S. Highway 93 traverses the Panaca Valley in a north-south direction. This study inventoried two springs in Panaca Valley. Figure 3-99 shows the location of these springs and their magnitudes of flow and temperature. A description of each of these springs is listed in the following sections of this report.

3.11.1 Panaca Spring

General Description

Panaca Spring is a warm spring a little more than a mile north of Main Street (SR 319), Panaca, Nevada. The spring discharges to a small reservoir to the west of the spring that is dammed on its west end.

Geologic Setting

The spring discharges from bedrock at the southwest end of the Pioche Hills. The main orifice is submerged beneath a heavily vegetated marsh that makes up the northeastern end of the spring pool.

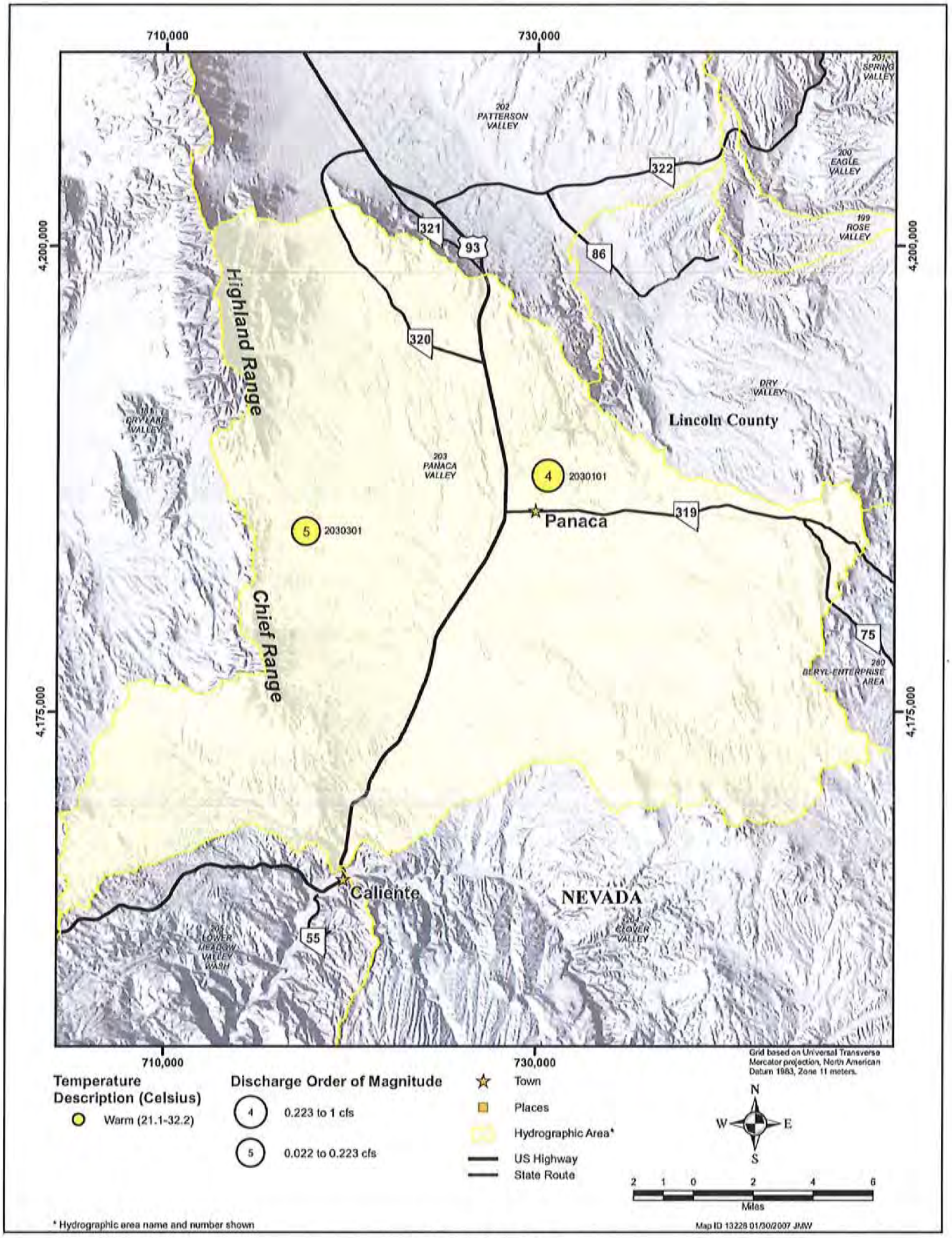


Figure 3-99
Map Showing the Location, Magnitude of Discharge, and Temperature of Selected Springs in Panaca Valley, Nevada

The bedrock at the east end of the spring is gray to black, resistant, well-bedded, thin- to medium-bedded limestone of the Cambrian Highland Peak Formation (Tschanz and Pampeyan, 1970). The rock underlies a bedrock prong that extends west from the main part of this small range. The west end of the prong is faulted along a north 80 degrees west high-angle fault against the main part of the prong. The trace of the fault is easily visible, about 30 ft east of the spring pool. This fault passes through the southern edge of the prong and then through the middle of the marshy southeast part of the spring pool area and on into the range.

The rock along the trace of the fault is brecciated and poorly exposed, but a northern splay of this fault is exposed. Several parallel faults can be seen in the range. These are shown on Figure 3-100. The trace of the Pioche Hills is northwesterly. Several miles to the north, the range-front fault on its west side is clearly visible. It is likely that faults of the same strike occur near the warm springs, and a fault of the same northwesterly strike is interpreted just west of the prong.

Discharge

Hardman and Miller (1934) reported the discharge on October 5, 1912, as 4.0 cfs. Phoenix (1948) reported a discharge, measured in 1948, of approximately 8.02 cfs (3,600 gpm) and a temperature of approximately 30.5°C. Rush (1964) reported a discharge of 10.88 cfs (4,880 gpm) on October 28, 1963. From 1987 to the present, no discharge greater than 2 cfs (898 gpm) has been reported. During a field investigation of Panaca Spring on July 19, 2004, a discharge of 0.5 cfs (224 gpm) was estimated. During 2006 the USGS measured a discharge of 10.2 and 10.6 cfs (4578-4758 gpm). The large variability in the discharge measurements suggests that additional measurements are needed to reduce the uncertainty of the discharge (Figure 3-101).

Diversions and Water Use

Water is stored in a small reservoir created by a concrete dam approximately 150 ft below the spring orifice. The dam has three outlets that divert water to different users in the valley. One outlet is left partially open and acts as a spillway for the dam. Water from the spring is used for agriculture and livestock watering, and the reservoir is used for recreational purposes.

3.11.2 Bennett Spring

General Setting

Bennett Springs is approximately 13 mi south of Pioche, Nevada, and 8 mi west of Panaca, Nevada. The springs emanate from the western flank of the Chief Range along a concealed fault (Garside and Schilling, 1979). A small concrete dam forms the eastern edge of the spring pool. The entire 100 × 150 ft pool is surrounded by cottonwood trees and mostly filled with aquatic plants (Figure 3-102). A nonfunctioning head gage is located on the northeastern edge of the pool. Approximately 200 ft northeast of the spring pool is a small orchard (Figure 3-103) associated with the old homestead located near the spring. While early reports list Bennett Springs as being an important watering place, no discharge measurements were made (Carpenter, 1915).

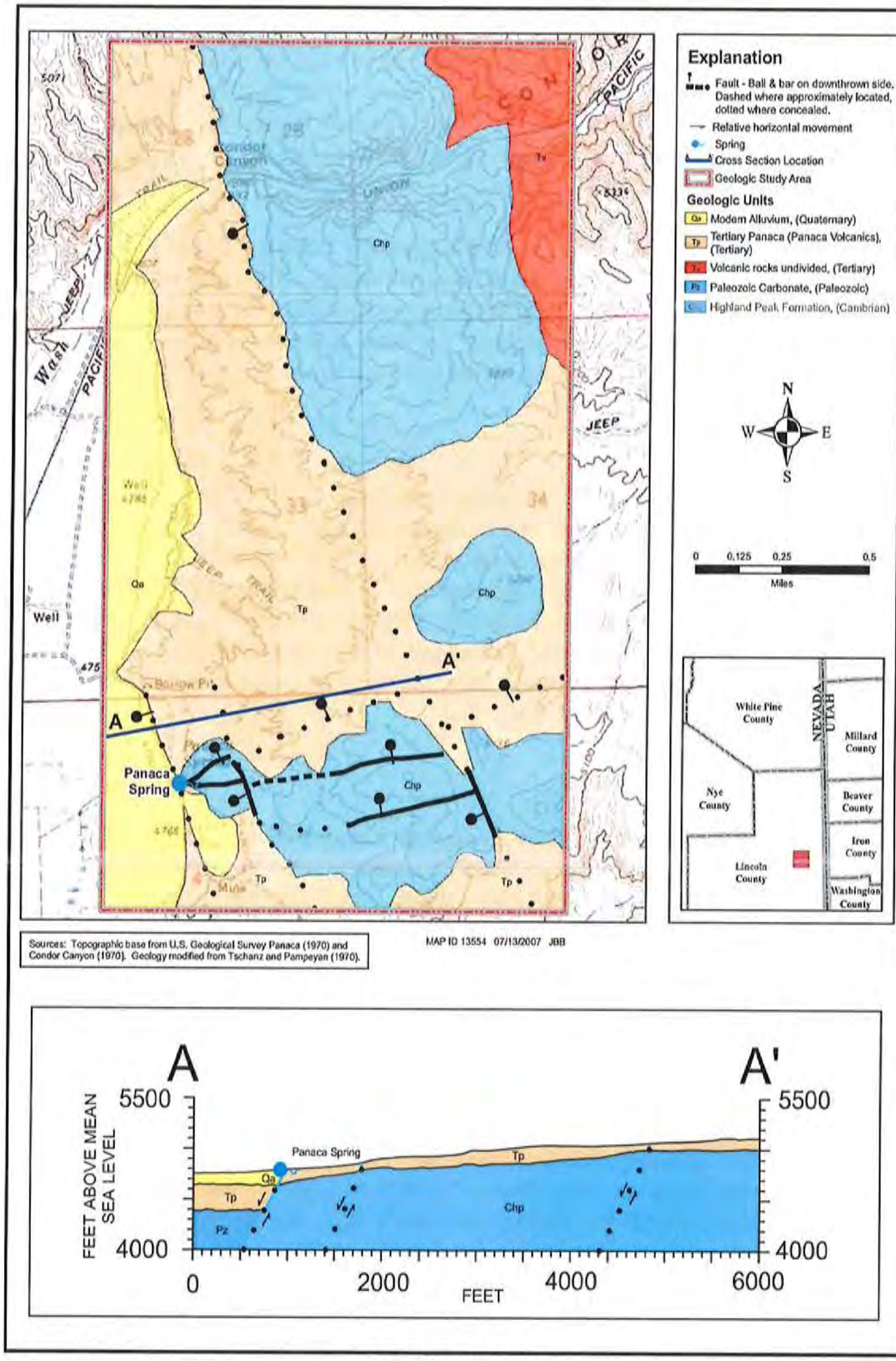


Figure 3-100
Geologic Map and Cross Section of Panaca Spring, Lincoln County, Nevada

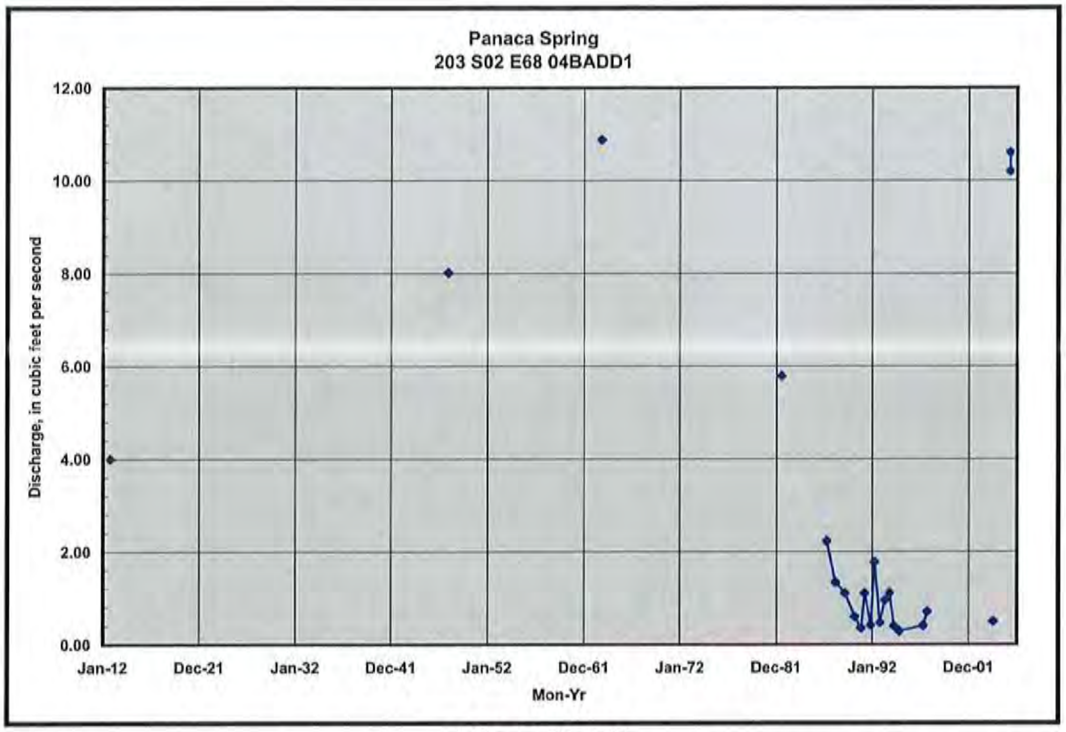


Figure 3-101
Hydrograph of Panaca Spring Discharge Measurements, 1912 to 2006

Figure 3-102
Pool of Bennett Spring, Panaca Valley, Nevada

Figure 3-103
Bennett Spring Orchard, Panaca Valley, Nevada

Geologic Setting

According to Phoenix (1948), the spring's discharge is from Quaternary gravels near Tertiary volcanic rocks along a buried fault.

Discharge

The first published record about Bennett Spring reported a discharge measurement of 0.022 cfs or about 10 gpm (Phoenix, 1948). Garside and Schilling (1979) reported a discharge of 0.022 cfs and a temperature of 29.4°C. Because of channel conditions observed during the May 17, 2005 field investigation, the discharge was estimated at 0.05 cfs (22 gpm) and the temperature was 21°C.

Diversions and Water Use

The diversions at Bennett Springs consist of a small concrete dam along the eastern side of the spring pool and a head gate on the northeastern end of the dam. Water is no longer regulated by the head gate and flows freely over portions of the dam into Bennett Wash. The small orchard at the site was probably irrigated by the waters from the spring. Phoenix (1948) reported that the water from the spring was used for agriculture and livestock watering. Observations made during the 2005 field investigation suggest that the water from the spring is currently being used for livestock watering and wildlife.

3.12 Lake Valley (HA 183)

Lake Valley is approximately 40 mi long and 20 mi wide and located in eastern Nevada. The northern quarter of the valley is located in White Pine County and the southern three quarters are in Lincoln County. The valley is bounded by the Fortification Range on the northeast and east, by the Wilson Creek Range on the southeast, by the Ely Range on the southwest, and by the Schell Creek Range on the west and northwest. U.S. Highway 93 is located along the western side of Lake Valley and runs the length of the valley in a north-south direction. This study inventoried 4 springs in Lake Valley 1 is discussed below. Figure 3-104 shows the location of these springs and their magnitude of flow and temperature.

3.12.1 Geyser Spring

General Setting

Geyser Spring is located on the eastern flank of the Schell Creek Range in Lincoln County, Nevada. The spring discharges from the alluvial slope that contains primarily quartzite boulders and cobbles. The area is forested with juniper trees. Discharge from the spring is periodic and because its discharge increases and decreases, it resembles a geyser. One theory explaining this phenomenon is that the spring is plumbed by fractures that act as a siphon in the rock (Meinzer, 1942). According to Meinzer (1942), there is only one spring of this type in Nevada (Figure 3-105).

Geologic Setting

Geyser Spring has a single orifice along a north-south-trending basin-range frontal fault. The sediments are all terrace gravels, predominately of Ordovician Eureka Quartzite and Cambrian Prospector Mountain Quartzite, with some shales of indeterminate age. There are no outcrops in the vicinity of the spring (Figure 3-106).

Discharge

There have been many discharge measurements taken of Geyser Spring. On October 24, 1912, Geyser Spring was reported at 1.0 cfs and the temperature was 12.2°C (Hardman and Miller, 1934). In 1950, USGS made a series of discharge measurements approximately 75 ft west of U.S. Highway 93 near the headquarters of the Geyser Ranch. These are depicted in Figure 3-107. On August 4, 1963, a series of measurements were taken approximately 150 ft downstream of the orifice. These are depicted in Figure 3-107. From 1985 to 1994, miscellaneous discharge measurements were taken at Geyser Spring by USGS and are provided in Appendix B.

On June 23, 2004, a discharge of 0.922 cfs (414 gpm) was measured 50 ft downstream of the orifice. During this investigation, no additional measurements were made to observe the cyclical action of the spring. During the 2004 site visit, a partially buried 6-in. flume was found in the channel (Figure 3-108). It has not been determined when the flume was installed or by whom. Because of its cyclical nature, the miscellaneous measurements do not help to determine the spring's average discharge.

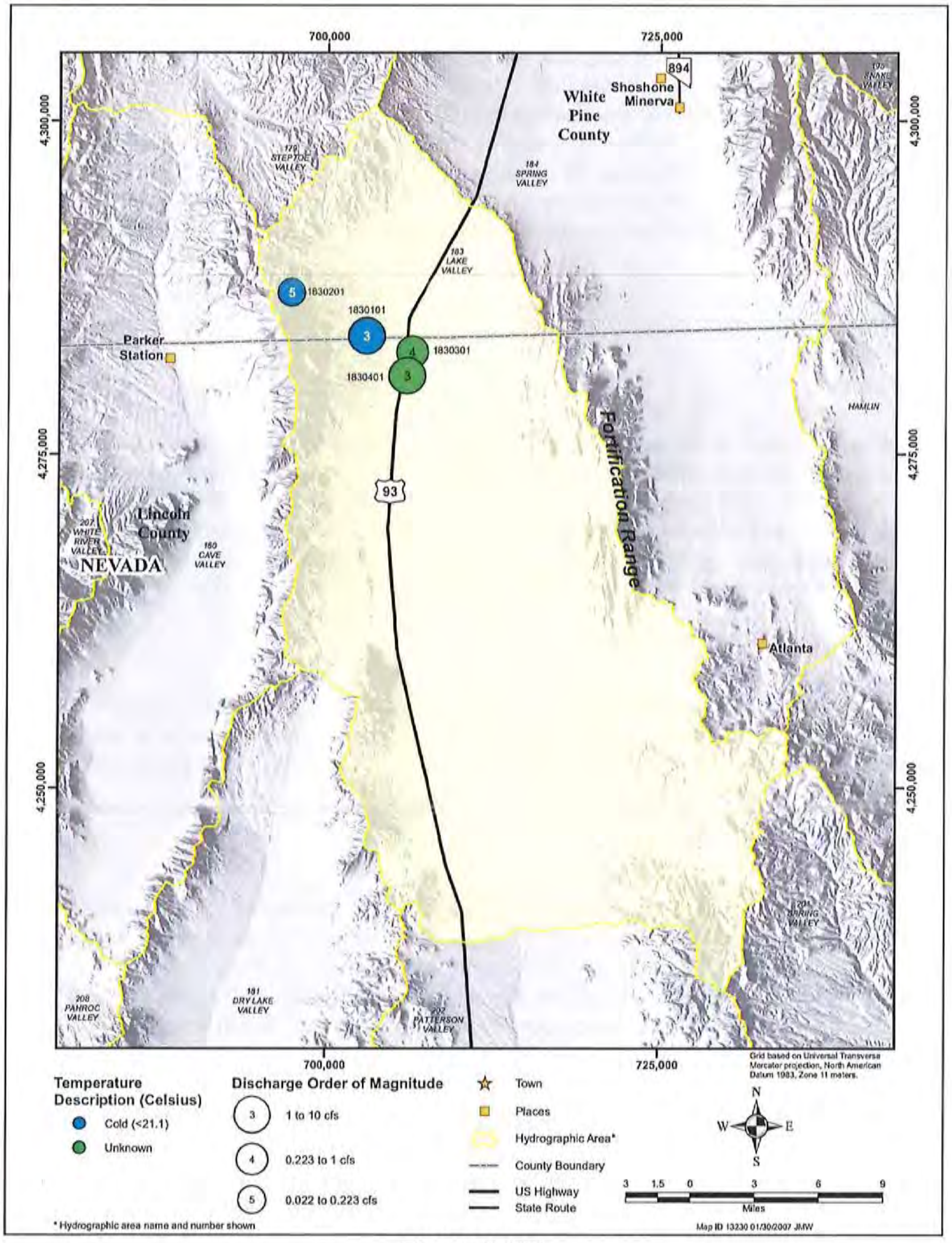


Figure 3-104
Map Showing the Location, Magnitude of Discharge, and Temperature of Geyser Spring in Lake Valley, Nevada

Figure 3-105
Orifice Pool of Geyser Spring, Lake Valley, Nevada

During December 2005 the USGS installed the Geyser Creek at Spring Orifice near Minerva, Nevada gaging (10245100) station (USGS, 2006).

Diversions and Water Use

Geyser Spring forms Geyser Creek, which flows eastward in an unlined channel and into two small reservoirs at the Geyser Ranch at U.S. Highway 93. From these reservoirs, water is released for irrigation and livestock watering on the valley floor.

3.13 Fish Springs Flat (HA 258)

Fish Springs Flat encompasses about 590 mi^2 in Tooele, Juab, and Millard Counties in Utah. The valley is bounded by the Fish Springs Range on the west, the Dugway and Thomas Ranges and Drum Mountains on the east, the Little Drum Mountains on the southeast and a low divide between Swasey Mountain and the Little Drum Mountains form the southern boundary. Fish Springs Flat opens to the Great Salt Lake Desert to the north (Bolke and Sumsion, 1978). Callao, Utah is located approximately 25 miles to the west of Fish Springs and Delta, Utah is approximately 78 mi to the southeast. The Fish Springs National Wildlife Refuge (NWR) was founded in 1959 and is located in the northwest corner of Fish Springs Flat (USFWS, 2004). Located in Fish Springs Flat, are several springs. The largest group in located on and near the NWR, and are described by Mundorff (1970) as the Fish Springs Group which consists of Wilson Hot Springs (a.k.a. Wilson Health Springs), Cold Spring, (C-11-14) 4bbb-S1, Big Spring (a.ka. North Spring), Deadman Spring, Walter Spring and

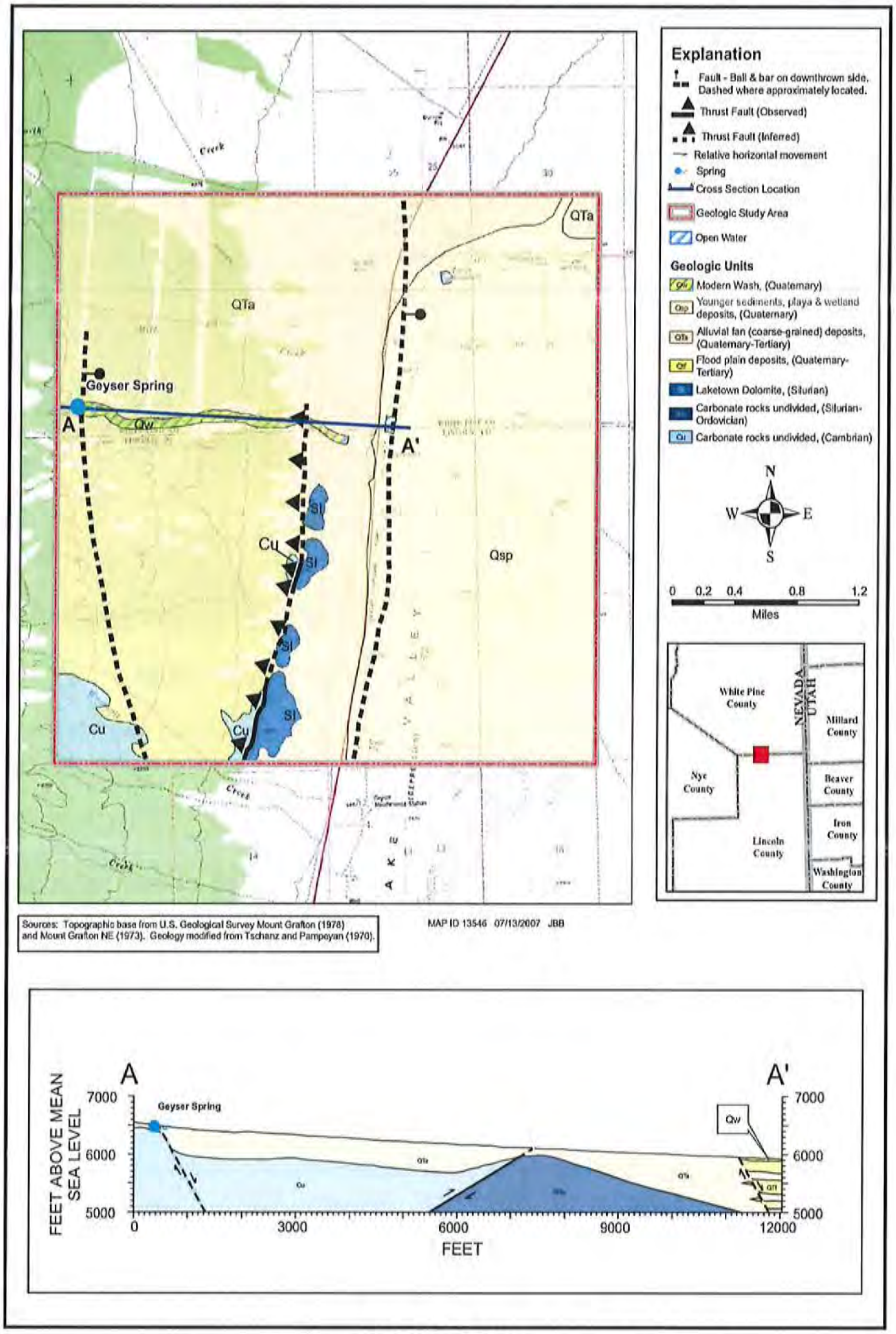
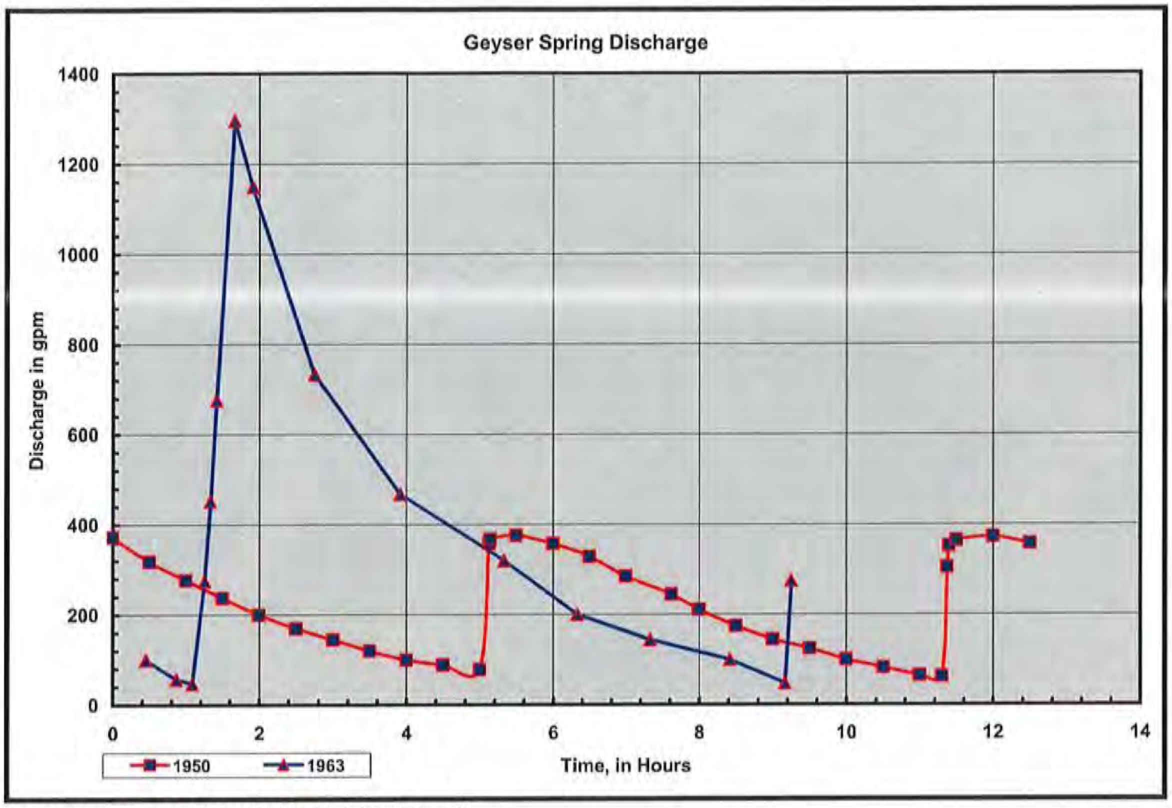


Figure 3-106
Geologic Map and Cross Section of Geyser Spring, Lincoln County, Nevada



Note: Extrapolated from Eakin (1963, Figure 3)

Figure 3-107
Hydrograph of Geyser Spring Discharge, March 30, 1950 and August 5, 1963

Fish Springs (House, Mirror, Thomas, Middle, Lost, Crater, South, and Percy Springs). The total discharge from the Fish Springs Group of Springs is about 21,000 afy or 28.69 cfs (USFWS, 2004). Bolke and Sumsion (1978) estimate the remaining springs in Fish Springs Flat account for 600 afy or 1.3 cfs. In this report the Fish Springs Group will be further subdivided into the Wilson Hot Springs Group, Cold Springs Group and North Springs Group and the Fish Springs Group. The Wilson Hot Springs Group and Cold Springs Group are actually in the Snake Valley hydrographic area, but due to their close proximity to Fish Springs Flat, and the fact that other authors have treated them as part of the same spring system as Fish Springs, they will be discussed in this section (Figure 3-109).

3.13.1 Wilson Hot Springs Group

General Location

The Wilson Hot Springs Group also known as Wilson Health Springs is located approximately 4.5 mi northwest of the NWR and approximately 15 mi east of Callao, Utah at the north end of the Fish Springs Range.

Figure 3-108
Partially Buried 6-in. Parshall Flume Found in Channel below Geyser Spring Lake Valley, Nevada

Geologic Setting

Wilson Hot Springs consists of several springs that discharge along a northeast-trending line from the north end of the Fish Springs Range. Several of the mounds discharge from mounds of various heights (Mundorff, 1970) and (Meinzer, 1911). Meinzer (1911) observed that the larger mounds had smaller discharges than springs that had a smaller or no mound at all, thus the springs must be at hydrostatic equilibrium. Mundorff, 1970 speculates that the high water temperature could be due to a localized, elevated geothermal gradient in the area.

Discharge

Published discharge data at Wilson Hot Springs is sparse. The range in discharge of the 5 springs listed in Bolke and Sumsion (1978) is <1 gpm to 60 gpm (<0.001 cfs to 0.134 cfs). The temperature of the springs range from 55.6 to 60.6°C.

Diversions and Water Use

The hot waters of at least one of the springs supplied a bath house in the early 1900s, but today the springs are used by wildlife (Meinzer, 1911).

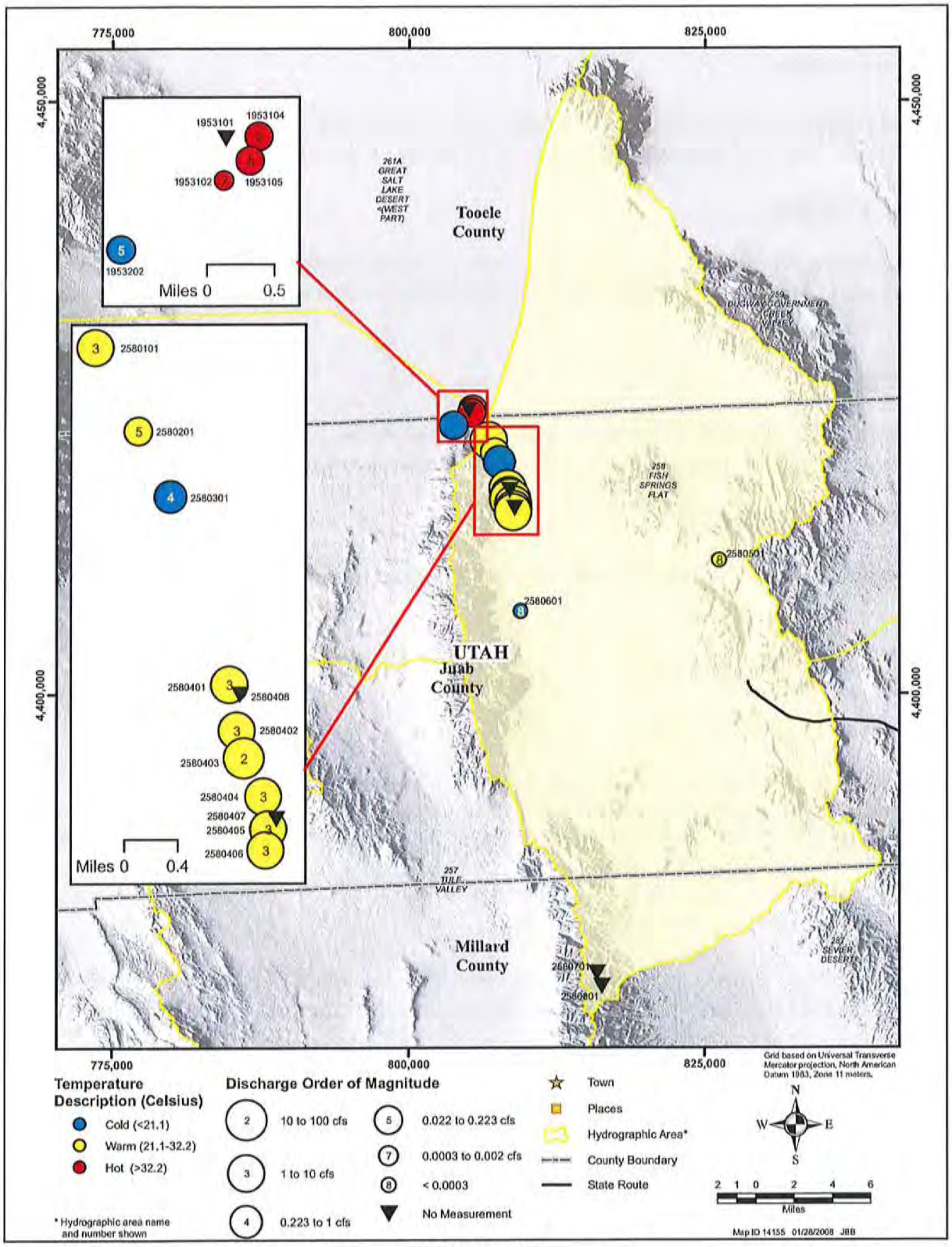


Figure 3-109
Map Showing the Location, Magnitude of Discharge, and Temperature of Fish Springs Group, UT

3.13.2 Cold Springs Group

General Location

The cold springs group is located approximately 0.50 mi south of the Wilson Springs Group, 14.5 mi east of Callao, Utah and 4 mi northwest of the NWR at the north end of the Fish Springs Range.

Geologic Setting

The Cold Springs Group discharge from a thin layer of alluvium with the ultimate source likely being the Paleozoic Carbonate rocks immediately to the south, which make up the northern Fish Spring Range.

Discharge

The western spring of the Cold Springs Group was measured on August 24, 1976 and had a reported discharge of 20 gpm or 0.045 cfs. No published discharge record of Cold Spring could be located.

Diversions and Water Use

From published literature it appears that these springs are unused and only wildlife currently uses them.

3.13.3 North Springs Group

General Location

The North Springs Group consists of 3 springs, North (Big Spring), Deadman and Walter Springs. These springs are locate on the northeast flank of the Fish Springs Range and North Spring is approximately 1 mi southeast of Wilson Hot Springs. North Spring is also reported as Big Springs in Meinzer (1911) and Mundorff (1970).

Geologic Setting

The North Springs Group discharge from alluvium with the source water likely coming from the Paleozoic Carbonate rocks in the Fish Springs Range, directly to the west.

Discharge

Bolke and Sumison (1978) report discharges of 3,140 gpm (7 cfs), 100 gpm (0.22 cfs), and 150 gpm (0.33 cfs) at North Spring, Deadman Spring and Walter Spring respectively. They report that the variability of North Springs discharge is about 15 percent based on a gage height record from 1965 to 1968.

Diversions and Water Use

The North Spring Group is used for wildlife purposes on the NWR.

3.13.4 Fish Springs Group

General Location

The Fish Springs Group is located entirely on the NWR, about 24 mi east of Callao, Utah and 78 mi northwest of Delta, Utah. The springs discharge along a fault scarp in the quaternary alluvial deposits. The source of the water is likely the Paleozoic Carbonate rocks of the Fish Springs Range to the west.

Geologic Setting

Springs that belong to the Fish Springs Group discharge along a north-northwest line along a inferred or concealed fault (Bolke and Sumison, 1978).

Discharge

A combined discharge of 33.5 cfs (15,050 gpm) in July and August 1976 was reported by Bolke and Sumison (1978). Discharges ranged from 1.90 cfs (850 gpm) at House Spring to 12 cfs (5,400 gpm) at Middle Spring.

Diversions and Water Use

Water use at the Fish Springs group helps irrigate land and support wildlife at the NWR.

4.0 SUMMARY

Using standardized data collection techniques, a large variety of springs were inventoried in eastern Nevada and western Utah. To supplement the field observations, an extensive literature search was conducted. From the field observations, it has been determined that the vast majority of springs have been modified to some extent since settlers first arrived in the area.

Springs were selected for inventory based on their topographic location, spatial distribution, discharge, geologic conditions, and data availability. Data regarding discharge, geologic setting, and diversions and water use were collected in the field when possible. Detailed geologic maps were prepared at selected springs based on topographic and geologic setting.

The amount of available data varies from spring to spring and appears to be independent of spring size, temperature, or any other physical characteristic. For example, for Hot Creek Spring in White River Valley there is very little early discharge data available, yet it has a large average discharge of 11.0 cfs. Conversely, Cold, Arnoldson, and Nicholas springs, also located in White River Valley, have discharges of 1.32, 3.60, and 2.64 cfs, respectively, and have a relatively complete record from the early 1900s to the present.

Spring development began in the 1860s when the population of eastern Nevada increased after discoveries of gold and silver deposits. Since then, springs have been modified to facilitate the beneficial use of their waters, including their channels and discharge areas. Some modifications range from an extensive diversion network, such as at Lund, Preston Big, Hiko, Crystal, and Ash springs, to the construction of a simple, small impoundment several yards downstream of the orifice, such as at Willow Spring in northern Spring Valley. The condition of these diversion works varies from new and improved facilities, such as at Panaca and Lund springs, to diversion works that appear to be unused and long since abandoned, such as at Moorman and Hardy springs in White River Valley.

Most of the inventoried springs are currently used for agricultural purposes, such as livestock water supply and irrigation for crops. In the past, uses for spring waters have included watering places for travelers, municipal and domestic, mining and milling, agricultural, wildlife and recreation. The Pederson and Plumber Groups of springs have undergone several iterations of development. Originally used for agricultural purposes, they later were turned into a recreational destination. Currently they have undergone extensive restoration to eliminate any trace of their previous uses. Other springs, like Hot Creek in White River Valley, support populations of endangered species, while Shoshone Pond supports an expatriated population of endangered species. Spring Creek Spring in Snake Valley supplies water for the NDOW fish-rearing station.

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Appendix A

Spring Locations

Table A.1-1
Spring Locations
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Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
179	1790701	179 N16 E63 29AAAA	Murry Springs	681,314	4,344,366	6,562	Spring discharges from Pennsylvanian Ely Limestone formation	—	3	Cold
179	1792001	179 N16 E64 21	McGill Spring	691,240	4,364,955	6,562	Spring discharges from valley alluvium between two parallel faults.	—	2	Warm
179	1792301	179 N23 E63 6C	Cherry Creek Hot Springs	679,565	4,417,460	6,797	Springs discharge from alluvium, east of Tertiary Intrusive rocks.	Young's Hot Spring, John Salvi Hot Spring, 179 N23 E63 06CCC 1 Spring	5	Hot
179	1792401	179 N22 E63 35AD	Cow Trim Spring	688,200	4,400,350	5,971	Spring discharges from alluvium in center of valley.	—	8	Cold
179	1792501	179 N21 E63 25BA	Monte Neva Hot Springs	688,116	4,393,119	6,011	Spring discharges from fault in alluvium, 2 miles east of Devonian Carbonate Rocks.	Melvin, Goodrich	3	Hot
179	1792601	179 N21 E63 12DC	Cold Spring	688,748	4,396,434	5,458	Spring discharges from alluvial fan 1.5 miles east of normal fault.	—	Dry	Cold
180	1800101	180 N09 E64 16AC	Cave Spring	691,760	4,279,249	6,488	Spring discharges from Pole Canyon limestone.	Cave Valley Spring	4	Cold
180	1800201	180 S07 E64 33CD	Sidehill Spring	692,407	4,254,280	6,527	Spring discharges from tuffs and tuffaceous sediments.	—	6	Cold
181	1810101	181 N05 E65 32AD	Meloy Spring	700,888	4,236,201	6,174	Spring discharges at the base of a hill from Tertiary ashflow tuff and interbedded airflow tuff.	Maloy Spring	5	Cold
181	1810201	181 N04 E65 30DB	Bailey Spring	699,080	4,227,795	6,086	Spring discharges from Lower Pennsylvanian Limestone	—	6	Cold
181	1810301	181 N04 E65 04DBD	Littlefield Spring	701,112	4,233,949	6,146	Spring discharges near the base of a small hill from a thin veneer of alluvium overlying Tertiary ashflow tuff and interbedded airflow tuff	Little Field	5	Cold
181	1810401	181 N02 E63 13CAC	Coyote Spring	687,693	4,211,513	5,220	Spring discharges from a thin veneer of alluvium 300 yds. east of outcrop of Tertiary ashflow tuff w/ interbedded airflow tuff	—	6	Cold
182	1820101	182 S05 E64 02CB	Grassy Spring	695,124	4,157,193	5,783	Spring discharges from hillslope comprised of Tertiary andesitic/dacitic lava flows/flow breccias	DR-20	6	Warm
183	1830101	183 N09 E65 04DB	Geyser Springs	702,990	4,283,851	6,494	Spring discharges from alluvium, mid-alluvial fan, 0.4 miles east of a normal fault	—	3	Cold

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Table A.1-1
Spring Locations
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Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
183	1830201	183 N10 E65 19C	North Creek Springs	697,324	4,287,127	8,202	Spring discharges from Middle Cambrian/Late Proterozic sedimentary rocks	—	5	Cold
183	1830301	183 N09 E65 04DC	Unnamed spring flowing north	706,418	4,282,630	5,978	Spring discharges from valley alluvium 0.3 miles east of normal fault; Silurian and Upper Ordovician dolomite outcrop 0.6 mi. to the west	Unnamed spring flowing N	4	—
183	1830401	183 N09 E65 04DC	Unnamed spring flowing south	706,019	4,280,858	5,978	Spring discharges from valley alluvium 0.2 miles east of normal fault; Silurian and Upper Ordovician dolomite outcrop 0.6 mi. to the west	Unnamed spring flowing S	3	—
184	1840705	184 N20 E66 30CC	Kalamazoo Spring	706,665	4,382,371	6,956	Spring discharges from fault zone in Paleozoic Carbonate rocks near their contact with preCambrian Clastic rocks.	Dos Tetones Spring Creek above Kalamazoo Creek	3	Cold
184	1845501	184 N21 E66 15BC	Willow Spring	713,830	4,397,068	5,982	Spring discharges from scarp in valley alluvium 0.7 miles west of normal fault	—	6	Cold
184	1845601	184 N14 E67 32AC	Willard Springs	718,891	4,323,976	5,755	Spring discharges from scarp, 3.0 miles west of Cambrian sedimentary units with Jurassic-age intrusions; normal faults lie 2.5 miles east and 2.5 miles west	—	6	Cold
184	1845701	184 N17 E67 25DB	North Millick Spring	725,523	4,354,156	5,590	Spring discharges from alluvium 1.9 miles west of normal fault	—	4	Cold
184	1845702	184 N17 E67 25CD	South Millick Spring	725,031	4,353,754	5,592	Spring discharges from alluvium 2.1 miles west of normal fault	So. Mulick Spr., S. Mulick	4	Cold
184	1845801	184 N15 E67 29DB	South Bastian Spring	718,388	4,334,865	5,660	Spring discharges from alluvium in center of valley	—	6	Cold
184	1845802	184 N15 E67 29DC	South Bastian Spring 2	718,361	4,334,397	5,669	Spring discharges from alluvium in center of valley (Middle spring)	—	7	Cold
184	1845901	184 N14 E67 04DB	Layton Spring	720,204	4,331,794	5,698	Spring discharges from alluvial scarp, 1.9 miles west of normal fault; Middle Cambrian/late Proterozoic sedimentary rocks are 2.2 miles to the east	—	7	Cold

Table A.1-1
Spring Locations
(Page 3 of 10)

Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
184	1846001	184 N12 E67 18AD	North Spring	717,768	4,309,388	5,763	Spring discharges from alluvium 0.6 miles east of normal fault	—	6	Warm
184	1846101	184 N12 E67 02AB	The Cedars	723,712	4,312,911	5,783	Spring discharges from mid-valley scarp, in alluvium	Cedar #1, Cedar #2	5	Warm
184	1846201	184 N11 E68 05CA	Swallow Springs	728,597	4,302,920	6,080	Spring discharges from alluvium, 0.5 miles east are Upper/Middle Cambrian limestones	184 N11 E68 05CA 1 Spring	4	Cold
184	1846401	184 N11 E67 23DA	Blind Spring	724,717	4,298,025	5,773	Spring discharges north of old spring mounds, in alluvium 1.1 miles west of normal fault	—	8	Cold
184	1846501	184 N10 E68 15AB	Lower Murphy Wash Spring	731,810	4,290,564	6,560	Spring discharges at the base of Riepe Spring Limestone and Ely Limestone	—	6	Cold
184	1846601	184 N21 E66 09BB	Osborne Springs	711,959	4,398,798	6,127	Spring discharges from scarp in valley alluvium 1.1 miles west of normal fault	—	6	Cold
184	1846701	184 N09 E67 15BD	Indian Springs East	721,971	4,280,083	6,380	Spring discharges from Tertiary ash-flow tuff w/ interbedded airfall tuff	Indian Springs East	5	Cold
184	1846702	184 N09 E67 15BA	Indian Springs West	722,213	4,280,791	6,209	Spring discharges from alluvium overlying Tertiary ash-flow tuff w/ interbedded airfall tuff	—	8	Cold
184	1847001	184 N15 E67 30BD	Four Wheel Drive Spring	716,255	4,335,256	5,754	Spring discharges from alluvium in valley basin	—	5	Cold
184	1847101	184 N18 E66 01DC	Keegan Spring	714,906	4,369,756	5,617	Spring discharges from valley alluvium 1.5 miles east of normal fault/exposed metamorphosed Precambrian basement rock	—	4	Cold
184	1847201	184 N11 E67 12DB	Minerva Spring	726,101	4,301,025	5,825	Spring discharges from valley alluvium 1.9 miles west of normal fault and 1.5 miles north of parallel normal fault; to the east are Precambrian limestones	—	4	Cold
184	1847301	184 N15 E68 08AC	Rock Spring	726,798	4,340,204	6,364	Spring discharges from alluvium overlying Middle/Lower Ordovician quartzite and metamorphosed Precambrian basement rock	—	5	Cold

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Table A.1-1
Spring Locations
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Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
184	1847401	184 N22 E66 17CA	Stonehouse Spring	710,511	4,406,507	6,256	Spring discharges from valley alluvium 0.3 miles east of normal fault	—	8	Cold
184	1847501	184 N12 E67 26AC	The Seep	724,060	4,306,263	5,764	Spring discharges from alluvium in valley basin	—	6	Warm
184	1847701	184 N15 E67 09BBB	Unnamed 5 Spring	718,911	4,340,641	5,645	Spring discharges from alluvium in center of valley	—	—	Cold
195	1951302	195 N13 E69 10DD	Rowland Spring at Great Basin Nation Park near Baker, NV	741,778	4,321,448	6,580	Spring discharges from alluvium overlying Upper/Middle Cambrian limestone	Rowland Spring	5	Cold
195	1951901	195 N10 E70 33B	Big Springs	749,422	4,287,293	5,568	Spring discharges from scarp, in alluvium, 0.6 miles east of normal fault; one mile to the west is outcrop of Sevy Dolomite	—	3	Cold
195	1952001	195 (C-15-19) 31CB	Warm Creek near Gandy, UT	756,007	4,371,984	5,156	Spring discharges from valley alluvium 1.6 miles west of normal fault	Warm Spring Creek	2	Warm
195	1952401	195 (C-19-20) 24 CB	Caine Spring	755,138	4,336,186	5,028	Spring dischargers from alluvium, two miles to the west Lower Cambrian rocks outcrop	—	6	Cold
195	1952701	195 (C-18-18) 16AB	Knoll Spring	769,378	4,348,105	4,869	Spring discharges from valley alluvium 0.7 miles northwest of normal fault	—	6	Cold
195	1952801	195 (C-14-19) 23BD	Coyote Spring	761,146	4,385,850	5,092	Spring discharges from valley alluvium 0.2 miles from normal fault	—	5	Cold
195	1953101	195 (C-10-14) 33C	Wilson Hot Spring 1	805,047	4,423,960	4,293	Spring discharges from alluvium 0.8 miles east and 1.2 miles west of two normal faults	Wilson Health Spring, (C-10-14) 33c-S1	—	Hot
195	1953102	195 (C-10-14) 33CDC	Wilson Hot Spring 2	805,030	4,423,459	4,293	Spring discharges from alluvium 0.8 miles east and 1.2 miles west of two normal faults	Wilson Health Spring, (C-10-14) 33cdc-S1	7	Hot
195	1953103	195 (C-10-14) 33CDD	Wilson Hot Spring 3	805,163	4,423,580	4,293	Spring discharges from alluvium 1.1 miles east and 1.2 miles west of two normal faults	Wilson Health Spring, (C-10-14) 33cdd-S1	6	Hot
195	1953104	195 (C-10-14) 33DBA	Wilson Hot Spring 4	805,477	4,423,985	4,298	Spring discharges from alluvium 1.2 miles east and 0.9 miles west of two normal faults	Wilson Health Spring, (C-10-14) 33dba-S1	5	Hot
195	1953105	195 (C-10-14) 33DCB	Wilson Hot Spring 5	805,343	4,423,694	4,298	Spring discharges from alluvium 1.1 miles east and 1.2 miles west of two normal faults	Wilson Health Spring, (C-10-14) 33dcb-S1	5	Hot

Table A.1-1
Spring Locations
(Page 5 of 10)

Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
195	1953201	195 (C-11-14) 4AB	Cold Spring	805,007	4,422,425	4,303	Spring discharges from contact between alluvium and Devonian carbonate sedimentary rocks; lies between two parallel normal faults	(C-11-14) 4AB-S1	—	Cold
195	1953202	195 (C-11-14) 04BBB	(C-11-14)4bbb-S1	803,797	4,422,636	4,298	Spring discharges from alluvium 164 yds. from contact with Devonian carbonate sedimentary rocks; lies 0.5 miles southeast of normal fault	Unnamed Spring USGS Tech Report 64, (C-11-14) 4bbb-S1	5	Cold
195	1953401	195 (C-16-18) 16DAD	Foote Res. Spring	769,356	4,367,388	4,825	Spring discharges from valley alluvium 2.0 miles west of Permian Arcturus formation outcrop and 0.5 miles east of normal fault	—	3	—
195	1953701	195 (C-17-19) 21	Kell Spring	759,929	4,356,001	4,910	Spring discharges from valley alluvium 1.6 miles east of normal fault	—	4	—
195	1953801	195 (C-19-17) 02AB	Conger Spring	782,909	4,342,951	6,760	Spring discharges from outcrop at contact between Permian/Pennsylvanian limestone and Missippian Chainman Shale formation	195 (C-18-16) 31	6	—
195	1953901	195 (C-18-18) 08A	Unnamed Spring	768,130	4,350,397	4,853	Spring discharges from valley alluvium 2.2 miles northwest of normal fault	195 (C-18-18) 8a	6	—
203	2030101	203 S02 E68 04BADD	Panaca Spring	730,624	4,187,657	4,799	Spring discharges at fault contact with Middle Cambrian limestone	—	4	Warm
203	2030301	203 S02 E67 07CD	Bennett Springs	717,613	4,184,673	5,216	Spring discharges from alluvium 0.8 miles east of normal fault	—	5	Warm
207	2070501	207 N06 E61 18AADA	Hot Creek Spring	661,573	4,249,541	5,225	Spring discharges from alluvium 300 yds. E of normal fault and 200 yds. NE of Sevy Dolomite	NDW-Hot Creek Spring	2	Warm
207	2070601	207 N12 E61 12DCCD	Arnoldson Spring	667,919	4,308,473	5,625	Spring discharges from alluvium in the center of the valley	Preston Irrigation	3	Warm
207	2070701	207 N12 E61 12BDAD	Cold Spring	667,609	4,309,454	5,653	Spring discharges from alluvium in the center of the valley	—	3	Warm

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Table A.1-1
Spring Locations
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Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
207	2070901	207 N12 E61 02ACAB	Preston Big Spring	666,296	4,311,153	5,732	Springs discharge from alluvium 0.8 miles east of normal fault	Preston Big Spring near Preston, Nevada	3	Warm
207	2071001	207 N11 E62 04AABA	Lund Spring	673,266	4,302,019	5,608	Spring discharges from contact between alluvium and Pennsylvanian Ely Limestone	—	3	Cold
207	2071101	207 N09 E61 32DABC	Moorman Spring	662,053	4,273,440	5,299	Springs discharge from valley alluvium	Morman Spring	4	Hot
207	2071201	207 N08 E63 19AA	Shingle Spring	679,925	4,267,716	6,434	Spring discharges from alluvium 100 yds downslope of ashflow tuff w/ interbedded airflow tuff outcrop	—	6	Cold
207	2071301	207 N07 E62 33BCCC	Flag Springs 3	672,579	4,254,416	5,294	Spring discharges near the toe of a alluvial fan 0.5 miles west of normal fault	—	3	Warm
207	2071302	207 N07 E62 33BCCB	Flag Springs 2	672,576	4,254,570	5,285	Spring discharges near the toe of a alluvial fan 0.5 miles west of normal fault	—	3	Warm
207	2071303	207 N07 E62 33BCAB	Flag Springs 1	672,719	4,254,696	5,294	Spring discharges near the toe of a alluvial fan 0.5 miles west of normal fault	—	3	Warm
207	2071401	207 N07 E62 28ABDC	Butterfield Spring	673,530	4,256,472	5,324	Spring discharges from valley alluvium 0.4 miles west of normal fault	—	3	—
207	2071501	207 N09 E61 13CB	Hardy Springs	667,553	4,278,196	5,354	Springs discharge from valley alluvium	West Immigrant Spring	4	Cold
207	2071502	207 N09 E61 13CB	Hardy Spring NW	667,352	4,278,196	5,349	Springs discharge from valley alluvium	—	6	Cold
207	2071601	207 N12 E61 12DBDD	Nicholas Spring	668,104	4,308,847	5,635	Spring discharges from alluvium in the center of the valley	—	3	Warm
207	2071701	207 N12 E61 32CC	Douglas Spring	660,653	4,301,764	5,900	Spring discharges from Tertiary low-silicate rhyolite lava flows/volcanic domes	Springs at Douglas	4	Cold
207	2071801	207 N13 E60 33AB	Williams Hot Spring	653,089	4,312,874	6,300	Spring discharges from alluvium overlying Tertiary rhyolite lava flows/volcanic domes	Warm Spring	5	Warm

Table A.1-1
Spring Locations
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Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
207	2071901	207 N06 E60 25BDAD	Moon River Spring	658,908	4,246,394	5,223	Spring discharges from alluvium overlying the Pogonip Group formation and Middle/Lower Ordovician quartzite 0.6 miles northwest of normal fault	—	3	—
207	2072001	207 N09 E62 19DB	Emigrant Springs	669,895	4,276,841	5,480	Spring discharges from valley alluvium 0.5 miles southwest of normal fault	—	3	—
209	2090101	209 S04 E60 14DBAB	Hiko Springs	657,549	4,162,744	3,875	Spring discharges from Simonson Dolomite	—	3	Warm
209	2090201	209 S08 E61 23BABD	Solar Panel Spring	667,262	4,123,643	3,238	Spring discharges from fine-grained alluvial sediments at the toe of a small hill	—	7	Cold
209	2090301	209 S03 E62 25AB	Pahroc Spring	678,091	4,170,481	5,400	Spring discharges from Tertiary ashflow tuff w/ interbedded airfall tuff	—	6	Cold
209	2090401	209 S05 E60 10AD	Crystal Springs	656,165	4,155,348	3,803	Spring discharges from a small hill of Sevy Dolomite in the center of the valley	09415590 Crystal Spring near Hiko, Nevada	2	Warm
209	2090501	209 S06 E61 01AD	Ash Springs	659,684	4,147,460	3,622	Springs discharge from Sevy Dolomite	09415640 Ash Springs Creek below Highway 93 at Ash Springs, Nevada	2	Hot
209	2090701	209 S05 E60 26DAD 1	Brownie Spring	658,088	4,149,897	3,695	Spring discharges from alluvium in moderately-faulted valley (4 parallel faults within 3 mile radius)	209 S05 E60 26DAD 1 Brownie Spring	4	—
215	2150201	215 S18 E67 12DD	Rogers Spring	729,274	4,028,821	1,594	Spring discharges from the contact between the Muddy Creek formation and Paleozoic carbonate rocks.	—	3	Warm
215	2150301	215 S19 68E 07AB	Blue Point Spring	730,235	4,030,173	1,550	Spring discharges from the Muddy Creek formation near contacts with Jurassic sedimentary rocks, Middle/Lower Ordovician dolomites, and Tertiary alluvial, fluvial and lacustrine sediments; in association w/ inferred shear fault.	—	4	Warm
219	2190101	219 S14 E65 21BA	Pederson East Spring	703,965	4,065,062	1,800	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	09415908 Pederson East Spring near Moapa, Nevada	5	Warm

Table A.1-1
Spring Locations
(Page 8 of 10)

Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
219	2190201	219 S14 E65 21BA	Pederson Spring	704,008	4,065,088	1,811	Spring discharges from a thin veneer of alluvium near out crops Pennsylvanian, Mississippian, Permian carbonate rocks.	09415910 Pederson Spring near Moapa, Nevada	5	Warm
219	2190301	219 S14 E65 16DD	Jones Spring	703,714	4,065,661	1,784	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	3	Warm
219	2190401	219 S14 E65 16DB	Baldwin Spring	703,257	4,066,270	1,798	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	09415875 Baldwin Springs near Moapa, Nevada	3	Warm
219	2190501	219 S14 E65 16DA	Muddy Spring	704,018	4,066,348	1,747	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	09415900 Muddy Spring at L.D.S. Farm near Moapa, Nevada	2	Warm
219	2190601	219 S14 E65 15CC	Iverson Flume	704,571	4,065,302	1,757	Gaging station	—	3	—
219	2190701	219 S14 E65 21AABB1	M-11	704,070	4,065,194	1,800	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	4	Warm
219	2190801	219 S14 E65 21AABB4	M-12	704,021	4,065,162	1,800	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	5	Warm
219	2190901	219 S14 E65 21AABB3	M-13	704,022	4,065,131	1,800	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	5	Warm
219	2191001	219 S14 E65 21AAAA1	M-15	704,318	4,065,200	1,780	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	3	Warm

Table A.1-1
Spring Locations
(Page 9 of 10)

Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
219	2191101	219 S14 E65 21AAAB2	M-16	704,268	4,065,198	1,780	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks	—	4	Warm
219	2191201	219 S14 E65 21AABB5	M-19	704,047	4,065,101	1,800	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	4	Warm
219	2191301	219 S14 E65 21 1	M-20	704,368	4,065,170	1,778	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks.	—	4	Warm
219	2191401	219 S14 E65 21AAAA2	Warm Springs East	704,294	4,065,137	1,790	Confluence of Plummer Group of springs, which discharge from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks	—	4	Warm
219	2191501	219 S14 E65 21	Warm Springs West	704,211	4,065,272	1,772	Gaging Station, Confluence of Pederson Group of springs, which discharge from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks	09415920 Warm Springs West near Moapa, Nevada	3	Warm
219	2191701	219 S14 E65 16ABB 1	M-10	703,637	4,066,695	1,722	Spring discharges from a thin veneer of alluvium near outcrops of Pennsylvanian, Mississippian, Permian carbonate rocks	—	4	Warm
258	2580101	258 (C-11-14) 03DBD	North Springs	806,770	4,421,366	4,303	Spring discharges from alluvium 0.6 miles west of normal fault	(C-11-14) 3dbd-S1, Big Spring	3	Warm
258	2580201	258 (C-11-14) 03DBD	Deadman Spring	807,286	4,420,367	4,310	Spring discharges from alluvium 0.3 miles east of preCambrian outcrop and 0.3 miles west of normal fault	(C-11-14) 3dbd-S1	5	Warm
258	2580301	258 (C-11-14) 11CDB	Walter Spring	807,675	4,419,580	4,308	Spring discharges from alluvium 252 yds. west of normal fault	(C-11-14) 11cdb-S1	4	Cold
258	2580401	258 (C-11-14) 23ACA	House Spring	808,385	4,417,323	4,315	Spring discharges from alluvium 0.4 miles east of normal fault	(C-11-14) 23aca-S1	3	Warm

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Table A.1-1
Spring Locations
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Hydrographic Area	Report Spring ID	Local Number	Site Name	UTM Easting[a] (m)	UTM Northing[b] (m)	Elevation[b] (ft-amsl)	Geologic Summary	Alias	Discharge Magnitude	Temperature Classification
258	2580402	258 (C-11-14) 23DBD	Thomas Spring	808,479	4,416,770	4,315	Spring discharges from alluvium 0.5 miles east of normal fault	(C-11-14) 23dbd-S1	3	Warm
258	2580403	258 (C-11-14) 23DDC	Middle Spring	808,564	4,416,434	4,315	Spring discharges from alluvium 0.6 miles east of normal fault	(C-11-14) 23ddc-S1	2	Warm
258	2580404	258 (C-11-14) 26AAA	Lost Spring	808,796	4,415,980	4,310	Spring discharges from alluvium 0.8 miles east of normal fault	(C-11-14) 26aaa-S1	3	Warm
258	2580405	258 (C-11-14) 26ADD	South Spring	808,860	4,415,581	4,310	Spring discharges from alluvium 0.9 miles east of normal fault	(C-11-14) 26add-S1	3	Warm
258	2580406	258 (C-11-14) 26DAA	Percy spring	808,823	4,415,332	4,315	Spring discharges from alluvium 0.9 miles east of normal fault	(C-11-14) 26daa-S1	3	Warm
258	2580407	258 (C-11-14) 26AD	Crater Spring	808,950	4,415,708	4,305	Spring discharges from alluvium 0.9 miles east of normal fault	—	—	—
258	2580408	258 (C-11-14) 23AD	Mirror Spring	808,509	4,417,204	4,315	Spring discharges from alluvium 0.5 miles east of normal fault	—	—	—
258	2580501	258 (C-12-12) 10CBC	Wildhorse Spring	826,240	4,411,270	5,300	Spring discharges from Tertiary high-silica rhyolite lava flows/volcanic domes	(C-12-12) 10cbc-S1	7	Warm
258	2580601	258 (C-12-14) 23DCC	Cane Spring	809,493	4,406,988	4,333	Spring discharges from valley alluvium 1.7 miles east of normal fault	(C-12-14) 23dcc-S1	8	Cold
258	2580701	258 (C-15-13) 29DDC	Lost Spring	815,918	4,376,475	6,800	Spring discharges from Upper/Middle Cambrian limestone	(C-15-13) 29ddc-S1	—	—
258	2580801	258 (C-15-13) 33CBC	North Spring Canyon Spring	816,354	4,375,386	6,700	Spring discharges from Upper/Middle Cambrian limestone	(C-15-13) 33cbc-S1, North Spring	—	—

Note: See Section 2.2.1 for discharge magnitude description. See Section 2.2.2 for temperature classification description.
[a]Coordinates are in UTM Zone 11 and North American Datum of 1983
[b]Elevations are in North American Vertical Datum of 1988

Appendix B

Discharge Measurement for Selected Springs

B.1.0 DISCHARGE MEASUREMENT OF SELECTED SPRINGS

Table B.1-1 shows the discharge measurements of selected springs for this study.

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
179	1790701	03/01/1918	3,828	8.53	–	R	–	Clark and Riddell, 1920	
179	1790701	06/18/1918	5,413	12.1	–	R	–	Clark and Riddell, 1920	
179	1790701	01/11/1982	4,000	8.91	–	R	–	USGS-NWIS, 2006	
179	1790701	01/15/1985	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1790701	01/31/1986	4,000	8.91	–	R	–	USGS-NWIS, 2006	
179	1790701	02/12/1987	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1790701	02/23/1988	4,200	9.36	–	R	–	USGS-NWIS, 2006	
179	1790701	03/14/1989	3,300	7.35	–	R	–	USGS-NWIS, 2006	
179	1790701	10/26/1991	1,600	3.56	–	R	–	USGS-NWIS, 2006	
179	1790701	12/03/1991	1,600	3.56	–	R	–	USGS-NWIS, 2006	
179	1790701	03/19/1992	1,600	3.56	–	R	–	USGS-NWIS, 2006	
179	1790701	10/15/1992	1,100	2.45	–	R	–	USGS-NWIS, 2006	
179	1790701	04/05/1993	2,600	5.79	–	R	–	USGS-NWIS, 2006	
179	1790701	09/20/1993	2,900	6.46	–	R	–	USGS-NWIS, 2006	
179	1790701	03/23/1994	1,781	3.97	–	R	–	USGS-NWIS, 2006	
179	1790701	09/08/1994	2,937	6.54	–	R	–	USGS-NWIS, 2006	
179	1792001	10/01/1965	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	10/07/1965	4,758	10.6	–	R	–	USGS, 1966	Spring flow.
179	1792001	01/12/1982	4,400	9.80	–	R	–	USGS-NWIS, 2006	
179	1792001	07/06/1983	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	10/27/1983	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	06/13/1984	2,700	6.02	–	R	–	USGS-NWIS, 2006	
179	1792001	01/15/1985	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	05/26/1985	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	11/02/1985	6,000	13.4	–	R	–	USGS-NWIS, 2006	
179	1792001	02/04/1986	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	02/12/1987	6,000	13.4	–	R	–	USGS-NWIS, 2006	
179	1792001	08/11/1987	4,000	8.91	–	R	–	USGS-NWIS, 2006	
179	1792001	02/22/1988	6,000	13.4	–	R	–	USGS-NWIS, 2006	
179	1792001	03/13/1989	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	03/20/1990	5,000	11.1	–	R	–	USGS-NWIS, 2006	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
179	1792001	11/05/1990	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	03/01/1991	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	11/06/1991	4,400	9.80	–	R	–	USGS-NWIS, 2006	
179	1792001	03/19/1992	4,400	9.80	–	R	–	USGS-NWIS, 2006	
179	1792001	10/15/1992	5,000	11.1	–	R	–	USGS-NWIS, 2006	
179	1792001	04/05/1993	4,100	9.13	–	R	–	USGS-NWIS, 2006	
179	1792001	09/20/1993	4,400	9.80	–	R	–	USGS-NWIS, 2006	
179	1792001	03/23/1994	4,277	9.53	–	R	–	USGS-NWIS, 2006	
179	1792001	09/08/1994	4,345	9.68	–	R	–	USGS-NWIS, 2006	
179	1792301	08/29/1917	35.9	0.080	–	R	47-57	Clark and Riddell, 1920	Discharge is combined flow of 3 springs
179	1792301	06/07/1983	43.1	0.100	–	R	–	USGS-NWIS, 2006	
179	1792301	06/20/1983	35.0	0.080	–	R	–	USGS-NWIS, 2006	
179	1792301	07/05/1983	26.0	0.060	–	R	–	USGS-NWIS, 2006	
179	1792301	07/18/1983	26.0	0.060	–	R	–	USGS-NWIS, 2006	
179	1792301	08/02/1983	29.2	0.070	–	R	–	USGS-NWIS, 2006	
179	1792301	08/13/1983	29.2	0.070	–	R	–	USGS-NWIS, 2006	
179	1792301	07/14/2004	44.9	0.100	P	E	–	SNWA	Two pools to the north and one pool to the south discharge to a common pond.
179	1792401	06/22/2004	Dry	Dry	E	–	–	SNWA	
179	1792501	08/21/1917	624	1.39	–	R	78.8	Clark and Riddell, 1920	
179	1792501	06/22/2004	673	1.50	P	E	76	SNWA	
179	1792601	06/22/2004	Dry	Dry	E	–	–	SNWA	
180	1800101	05/24/1966	400	0.890	–	R	–	Hess and Mifflin, 1978	
180	1800101	06/15/1968	400	0.890	–	R	–	USGS-NWIS, 2006	
180	1800101	03/01/1980	1,000	2.23	–	R	12	Bunch and Harrill, 1984	
180	1800101	06/23/2004	105	0.233	G	C	12.3	SNWA	
180	1800101	07/16/2004	36.4	0.081	E	F	13	SNWA	
180	1800101	07/29/2004	9.90	0.022	F	C	–	SNWA	
180	1800101	09/14/2004	Dry	Dry	E	–	–	SNWA	
180	1800101	07/26/2005	359	0.799	F	C	12	SNWA	
180	1800101	10/12/2006	14.8	0.033	P	E	–	SNWA	
180	1800101	07/09/2007	Dry	Dry	E	–	–	SNWA	

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Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
180	1800101	09/07/2007	Dry	Dry	E	--	11.6	SNWA	
180	1800201	08/01/1979	--	--	--	R	17	Bunch and Harrill, 1984	
180	1800201	03/01/1980	1.00	0.00	--	R	--	Bunch and Harrill, 1984	Discharge is < 1 gpm
180	1800201	06/21/2004	2.70	0.006	P	V	15	SNWA	
181	1810101	03/01/1963	20.0	0.040	--	R	--	USGS-NWIS, 2006	
181	1810101	05/01/1980	82.0	0.180	--	R	--	USGS-NWIS, 2004	
181	1810101	07/13/1997	44.9	0.100	P	E	19.3	SNWA	
181	1810201	10/18/1912	3.00	0.010	--	R	--	Carpenter, 1915	
181	1810201	05/01/1980	2.00	0.00	--	R	--	Bunch and Harrill, 1984	Reported as 2-3 gpm
181	1810201	06/03/2004	0.400	0.001	E	F	13	SNWA	
181	1810301	05/01/1980	10.0	0.020	--	R	--	Bunch and Harrill, 1984	
181	1810301	06/03/2004	11.7	0.026	E	F	15	SNWA	
181	1810301	07/25/2005	59.7	0.130	E	F	17.9	SNWA	
181	1810401	10/18/1912	5.00	0.010	--	R	--	Carpenter, 1915	
181	1810401	08/01/1979	1.00	0.002	--	R	--	Bunch and Harrill, 1984	
181	1810401	06/03/2004	0.100	0.00	G	V	18	SNWA	
181	1810401	06/21/2004	Dry	Dry	E	V	--	SNWA	
181	1810401	07/14/2005	0.520	0.001	G	V	18	SNWA	
182	1820101	05/01/1980	7.00	0.020	--	R	11	Bunch and Harrill, 1984	
182	1820101	06/02/2004	0.100	0.00	F	V	20.5	SNWA	
182	1820101	07/14/2005	6.00	0.013	G	V	21.2	SNWA	
182	1820101	07/25/2005	5.40	0.012	F	V	--	SNWA	
183	1830101	10/24/1912	449	1.00	--	R	12.2	Hardman and Miller, 1934	
183	1830101	08/04/1963	1,153	2.57	--	R	--	USGS, 1963	Discharge measured at 18:26
183	1830101	08/04/1963	736	1.64	--	R	--	USGS, 1963	Discharge measured at 14:52
183	1830101	08/04/1963	673	1.50	--	R	--	USGS, 1963	Discharge measured at 18:12 (discharge was a field estimate)
183	1830101	08/04/1963	471	1.05	--	R	--	USGS, 1963	Discharge measured at 15:28
183	1830101	08/04/1963	449	1.00	--	R	--	USGS, 1963	Discharge measured at 18:08 (discharge was a field estimate)
183	1830101	08/04/1963	323	0.720	--	R	--	USGS, 1963	Discharge measured at 16:08

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
183	1830101	08/04/1963	197	0.440	–	R	–	USGS, 1963	Discharge measured at 16:39
183	1830101	08/04/1963	144	0.320	–	R	–	USGS, 1963	Discharge measured at 17:09
183	1830101	08/04/1963	94.3	0.210	–	R	–	USGS, 1963	Discharge measured at 17:35
183	1830101	08/04/1963	67.3	0.150	–	R	–	USGS, 1963	Discharge measured at 17:58
183	1830101	07/27/1982	633	1.41	–	R	–	USGS, 1982	
183	1830101	03/23/1985	633	1.41	–	R	–	USGS, 1985	
183	1830101	01/31/1986	426	0.950	–	R	–	USGS, 1986	
183	1830101	02/12/1987	323	0.720	–	R	–	USGS, 1987	
183	1830101	08/11/1987	444	0.990	–	R	–	USGS, 1987	
183	1830101	02/25/1988	301	0.670	–	R	–	USGS, 1988	
183	1830101	03/16/1989	579	1.29	–	R	–	USGS, 1989	
183	1830101	03/21/1990	310	0.690	–	R	–	USGS, 1990	
183	1830101	11/07/1990	229	0.510	–	R	–	USGS, 1991	
183	1830101	03/02/1991	180	0.400	–	R	–	USGS, 1991	
183	1830101	10/21/1991	171	0.380	–	R	–	USGS, 1992	
183	1830101	10/16/1992	197	0.440	–	R	–	USGS, 1993	
183	1830101	04/07/1993	2,424	5.40	–	R	–	USGS, 1993	
183	1830101	09/21/1993	283	0.630	–	R	–	USGS, 1993	
183	1830101	03/25/1994	435	0.970	–	R	–	USGS, 1994	
183	1830101	09/09/1994	449	1.00	–	R	–	USGS, 1994	
183	1830101	06/23/2004	414	0.922	G	C	10.8	SNWA	
183	1830201	08/04/1963	40.4	0.090	–	R	–	USGS, 1963	
183	1830201	07/27/1982	700	1.56	–	R	–	USGS-NWIS, 2006	
183	1830201	03/23/1985	440	0.980	–	R	–	USGS-NWIS, 2006	
183	1830201	01/31/1986	390	0.870	–	R	–	USGS-NWIS, 2006	
183	1830201	02/12/1987	310	0.690	–	R	–	USGS-NWIS, 2006	
183	1830201	08/11/1987	500	1.11	–	R	–	USGS-NWIS, 2006	
183	1830301	08/06/1963	431	0.960	–	R	–	USGS, 1963	
183	1830401	08/06/1963	974	2.17	–	R	–	USGS, 1963	
184	1840705	08/09/2001	1,176	2.62	F	C	–	SNWA	
184	1840705	08/07/2003	1,113	2.48	F	C	12	SNWA	
184	1840705	07/28/2005	403	0.897	F	C	–	SNWA	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
184	1840705	07/17/2007	947	2.11	E	F	–	SNWA	
184	1840705	08/28/2007	839	1.87	E	F	–	SNWA	
184	1840705	10/09/2007	821	1.83	E	F	11.9	SNWA	
184	1840705	11/27/2007	781	1.74	E	F	–	SNWA	
184	1845501	07/14/2004	1.80	0.004	E	F	–	SNWA	
184	1845501	08/17/2006	35.9	0.080	F	F	14.9	SNWA	
184	1845501	08/28/2007	4.00	0.009	G	F	16.6	SNWA	
184	1845501	10/09/2007	4.00	0.009	E	F	10.4	SNWA	
184	1845501	11/27/2007	6.70	0.015	E	F	10.6	SNWA	
184	1845601	07/15/2004	0.00	0.00	E	–	–	SNWA	Spring is stagnant water.
184	1845601	03/27/2007	3.00	0.001	P	E	7.9	SNWA	
184	1845701	06/24/2004	196	0.436	G	C	15.5	SNWA	
184	1845701	07/28/2005	328	0.730	G	C	–	SNWA	
184	1845701	08/16/2006	321	0.715	F	C	–	SNWA	
184	1845701	03/27/2007	325	0.724	F	C	–	SNWA	
184	1845701	05/08/2007	293	0.652	F	C	14.0	SNWA	
184	1845701	06/12/2007	266	0.592	P	C	16.4	SNWA	
184	1845701	07/23/2007	264	0.588	P	C	18.4	SNWA	
184	1845701	08/27/2007	287	0.639	P	C	16.4	SNWA	
184	1845701	10/08/2007	290	0.647	F	C	14.3	SNWA	
184	1845701	11/29/2007	270	0.602	F	C	10.9	SNWA	
184	1845702	07/12/1966	200	0.450	–	R	12.7	Hess and Mifflin, 1978	Reported by Mifflin as So. Mulick Spr. Data more closely matches the discharge for N. Millick Spring
184	1845702	07/15/2004	458	1.02	F	C	13.4	SNWA	
184	1845702	07/28/2005	624	1.39	G	C	–	SNWA	
184	1845702	08/16/2006	557	1.24	P	C	–	SNWA	
184	1845702	02/14/2007	469	1.04	P	C	10.2	SNWA	
184	1845702	03/27/2007	610	1.36	F	C	11.3	SNWA	
184	1845702	05/08/2007	727	1.62	G	C	15.7	SNWA	
184	1845702	06/12/2007	489	1.09	P	C	15.5	SNWA	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
184	1845702	07/23/2007	448	0.998	P	C	15.8	SNWA	
184	1845702	08/27/2007	471	1.05	P	C	15.1	SNWA	
184	1845702	09/25/2007	512	1.14	F	C	–	SNWA	
184	1845702	10/08/2007	561	1.25	F	C	13.0	SNWA	
184	1845702	11/29/2007	453	1.01	F	C	10.6	SNWA	
184	1845801	07/15/2004	3.91	0.009	G	V	12.9	SNWA	
184	1845801	08/03/2005	4.76	0.011	G	V	12	SNWA	
184	1845801	08/16/2006	0.500	0.001	F	V	–	SNWA	
184	1845802	08/16/2006	0.575	0.001	G	V	14.5	SNWA	
184	1845901	07/14/2004	Dry	Dry	E	–	–	SNWA	
184	1845901	08/03/2005	Dry	Dry	E	–	–	SNWA	
184	1845901	08/16/2006	0.300	0.001	E	V	21.9	SNWA	
184	1845901	03/27/2007	1.00	0.002	E	V	8.6	SNWA	
184	1845901	08/27/2007	0.300	0.001	E	V	22.0	SNWA	
184	1845901	10/08/2007	0.500	0.001	E	V	15.3	SNWA	
184	1845901	11/26/2007	0.557	0.001	E	V	9.0	SNWA	
184	1846001	06/22/2004	10.0	0.020	P	E	22.7	SNWA	
184	1846001	02/12/2007	0.00	0.00	E	–	–	SNWA	Spring was frozen.
184	1846101	07/28/2004	74.5	0.170	P	E	23.8	SNWA	"Discharge is estimated. Only half the flow from Cedar #2 could be measured, (.018 cfs +(2 x .074 cfs))=.166 cfs"
184	1846101	05/07/2007	33.7	0.075	G	F	23.9	SNWA	
184	1846101	06/11/2007	28.3	0.063	E	F	23.9	SNWA	
184	1846101	07/16/2007	36.7	0.082	F	V	23.8	SNWA	
184	1846101	08/27/2007	28.9	0.064	E	V	24.5	SNWA	
184	1846101	10/08/2007	20.6	0.046	P	F	23.7	SNWA	
184	1846201	07/12/1966	275	0.610	–	R	9.4	Hess and Mifflin, 1978	
184	1846201	06/15/1980	360	0.800	–	R	–	USGS-NWIS, 2004	
184	1846201	07/28/2004	340	0.760	G	C	10	SNWA	
184	1846201	07/27/2005	511	1.14	G	C	–	SNWA	
184	1846201	08/16/2006	435	0.970	F	C	12.6	SNWA	
184	1846201	02/16/2007	416	0.927	F	C	10.7	SNWA	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
184	1846201	03/27/2007	453	1.01	G	C	–	SNWA	
184	1846201	05/07/2007	467	1.04	G	C	11.0	SNWA	
184	1846201	06/11/2007	371	1.01	F	C	10.2	SNWA	
184	1846201	07/16/2007	402	0.896	F	C	10.3	SNWA	
184	1846201	08/27/2007	411	0.915	P	C	13.8	SNWA	
184	1846201	10/08/2007	300	0.668	F	C	12.2	SNWA	
184	1846201	11/29/2007	337	0.751	F	C	10.7	SNWA	
184	1846401	07/28/2004	0.00	0.00	E	–	–	SNWA	
184	1846401	06/11/2007	0.00	0.00	E	–	25.3	SNWA	
184	1846401	08/27/2007	0.00	0.00	E	–	–	SNWA	
184	1846401	10/08/2007	0.00	0.00	E	–	13.0	SNWA	
184	1846401	11/26/2007	0.00	0.00	E	–	2.2	SNWA	
184	1846501	08/16/2006	1.00	0.002	G	V	13.6	SNWA	
184	1846601	08/17/2006	2.70	0.006	G	F	13.2	SNWA	
184	1846701	08/14/2006	12.1	0.027	G	V	–	SNWA	
184	1846701	03/26/2007	12.8	0.028	E	V	–	SNWA	
184	1846701	05/07/2007	8.90	0.020	P	V	–	SNWA	
184	1846701	06/11/2007	11.0	0.024	G	V	14.4	SNWA	
184	1846701	07/23/2007	12.2	0.027	P	V	15.1	SNWA	
184	1846701	08/27/2007	10.4	0.023	P	V	15.6	SNWA	
184	1846701	10/08/2007	8.10	0.018	G	F	14.7	SNWA	
184	1846701	11/26/2007	13.9	0.031	E	F	14.1	SNWA	
184	1846702	08/14/2006	4.90	0.011	G	F	14.3	SNWA	
184	1846702	03/26/2007	Dry	Dry	E	–	–	SNWA	
184	1846702	05/07/2007	Dry	Dry	E	–	–	SNWA	
184	1846702	06/11/2007	Dry	Dry	E	–	–	SNWA	
184	1846702	07/23/2007	Dry	Dry	E	–	–	SNWA	
184	1846702	08/27/2007	Dry	Dry	E	–	–	SNWA	
184	1846702	10/08/2007	Dry	Dry	E	–	–	SNWA	
184	1846702	11/26/2007	Dry	Dry	E	–	–	SNWA	
184	1847001	08/28/2007	16.2	0.036	G	F	15.1	SNWA	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
184	1847001	10/09/2007	15.7	0.035	G	F	14.3	SNWA	
184	1847101	08/29/2007	260	0.580	P	C	14.4	SNWA	
184	1847101	10/10/2007	237	0.529	P	C	11.8	SNWA	
184	1847101	11/28/2007	203	0.453	F	C	8.1	SNWA	
184	1847201	06/15/1968	300	0.670	–	R	–	USGS-NWIS, 2006	
184	1847201	08/27/2007	380	0.846	P	E	–	SNWA	
184	1847201	10/08/2007	40.8	0.091	P	F	–	SNWA	
184	1847201	11/29/2007	310	0.691	F	C	–	SNWA	
184	1847301	08/27/2007	11.7	0.026	E	F	20.7	SNWA	
184	1847301	08/27/2007	8.10	0.018	E	F	–	SNWA	
184	1847301	10/08/2007	13.9	0.031	E	F	15.8	SNWA	
184	1847301	11/30/2007	15.7	0.035	E	F	9.0	SNWA	
184	1847401	08/28/2007	0.00	0.00	E	–	–	SNWA	
184	1847401	10/09/2007	0.00	0.00	E	–	3.6	SNWA	
184	1847401	11/27/2007	–	–	–	–	–	SNWA	Frozen
184	1847501	10/08/2007	4.50	0.010	P	F	23.6	SNWA	
184	1847501	11/29/2007	–	–	–	–	–	SNWA	Frozen
184	1847701	08/28/2007	–	–	E	–	15.9	SNWA	
184	1847701	10/09/2007	–	–	E	–	15	SNWA	
184	1847701	11/27/2007	–	–	E	–	11.8	SNWA	
195	1951302	07/22/2003	1,566	3.49	G	R	10	Elliott et al., 2006	
195	1951302	10/07/2003	1,198	2.67	G	R	9	Elliott et al., 2006	
195	1951302	08/04/2005	1,562	3.48	F	C	9.8	SNWA	
195	1951302	10/11/2006	26.5	0.059	F	A	–	SNWA	
195	1951901	11/03/1964	3,600	8.00	–	R	17.7	Hood and Rush, 1965	
195	1951901	09/30/1965	4,000	8.91	–	R	16	Hess and Mifflin, 1978	"Reported flows up to 25 cfs (Mifflin, 1968)"
195	1951901	11/18/1972	4,003	8.92	–	R	–	Walker, 1972	
195	1951901	07/17/1991	3,447	7.68	–	R	–	USGS, 1991	
195	1951901	10/28/2004	4,802	10.7	G	C	–	SNWA	
195	1951901	10/28/2004	4,802	10.7	G	R	–	Squires, 2004	
195	1951901	04/06/2005	3,838	8.55	–	R	–	USGS-NWIS, 2006	
195	1951901	05/10/2005	3,995	8.90	–	R	–	USGS-NWIS, 2006	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
195	1951901	05/26/2005	4,161	9.27	--	R	--	USGS-NWIS, 2006	
195	1951901	08/03/2005	4,129	9.20	F	C	--	SNWA	
195	1951901	08/04/2005	3,986	8.88	--	R	--	USGS-NWIS, 2006	
195	1951901	09/14/2005	4,143	9.23	--	R	--	USGS-NWIS, 2006	
195	1951901	11/29/2005	4,578	10.2	--	R	--	USGS-NWIS, 2006	
195	1951901	01/05/2006	4,623	10.3	--	R	--	USGS-NWIS, 2006	
195	1951901	03/09/2006	3,941	8.78	--	R	--	USGS-NWIS, 2006	
195	1951901	10/09/2006	4,668	10.4	G	A	--	SNWA	
195	1951901	03/29/2007	5,072	11.3	F	C	--	SNWA	
195	1951901	05/15/2007	4,663	10.4	F	C	--	SNWA	
195	1951901	06/18/2007	4,802	10.7	P	C	--	SNWA	
195	1951901	07/24/2007	4,623	10.3	F	C	--	SNWA	
195	1951901	08/30/2007	4,668	10.4	P	C	--	SNWA	
195	1951901	10/10/2007	4,466	9.95	P	C	--	SNWA	
195	1951901	12/06/2007	3,837	8.55	F	C	--	SNWA	
195	1951901	01/07/2008	4,093	9.12	F	C	--	SNWA	
195	1951903	08/03/2005	2,469	5.50	F	C	--	SNWA	
195	1951903	10/09/2006	3,142	7.00	G	A	16.9	SNWA	
195	1951903	02/21/2007	3,824	8.52	F	C	17.3	SNWA	
195	1951903	03/29/2007	2,922	6.51	F	C	17.4	SNWA	
195	1951903	05/15/2007	2,868	6.39	F	C	17.7	SNWA	
195	1951903	06/18/2007	2,904	6.47	P	C	17.8	SNWA	
195	1951903	07/24/2007	2,724	6.07	F	C	17.8	SNWA	
195	1951903	08/30/2007	3,039	6.77	P	C	19.4	SNWA	
195	1951903	10/10/2007	2,738	6.10	F	C	17.5	SNWA	
195	1951903	12/06/2007	2,145	4.78	F	C	16.9	SNWA	
195	1951903	01/07/2008	2,356	5.25	F	C	17.1	SNWA	
195	1951904	08/03/2005	1,661	3.70	F	C	--	SNWA	
195	1951904	10/09/2006	1,535	3.42	G	A	16.9	SNWA	
195	1951904	03/29/2007	2,132	4.75	F	C	17.4	SNWA	
195	1951904	05/15/2007	1,795	4.00	F	C	17.7	SNWA	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
195	1951904	06/18/2007	1,899	4.23	P	C	17.7	SNWA	
195	1951904	07/24/2007	1,890	4.21	F	C	--	SNWA	
195	1951904	08/30/2007	1,638	3.65	F	C	18.2	SNWA	
195	1951904	10/10/2007	1,728	3.85	P	C	17.5	SNWA	
195	1951904	12/06/2007	1,692	3.77	F	C	17.3	SNWA	
195	1951904	01/07/2008	1,737	3.87	F	C	17.1	SNWA	
195	1952001	08/14/1964	6,284	14.0	--	R	--	USGS, 1964	Spring flow.
195	1952001	11/03/1964	3,600	8.00	--	R	27.2	Hood and Rush, 1965	"May have been measured near the main orifice, suspected partial discharge"
195	1952001	08/01/1979	6,194	13.8	--	R	--	ERTEC, 1981	Reported as 6200 gpm
195	1952001	06/22/2004	3,780	8.42	F	C	27	SNWA	25' DS of orifice this is ~10 ft above swimmers dam
195	1952001	10/30/2004	6,714	15.0	F	R	--	Squires, 2004	
195	1952001	08/04/2005	7,990	17.8	G	C	--	SNWA	At diversion
195	1952001	08/04/2005	6,960	15.5	F	C	--	SNWA	75' DS of orifice this is below swimmers dam
195	1952001	08/23/2005	8,708	19.4	--	R	--	USGS-NWIS, 2006	
195	1952001	08/23/2005	8,707	19.4	G	R	--	USGS-NWIS, 2006	
195	1952001	08/31/2005	8,079	18.0	--	R	--	USGS-NWIS, 2006	
195	1952001	08/31/2005	8,079	18.0	G	R	--	USGS-NWIS, 2006	
195	1952001	08/31/2005	7,675	17.1	--	R	--	USGS-NWIS, 2006	
195	1952001	08/31/2005	7,675	17.1	G	R	--	USGS-NWIS, 2006	
195	1952001	10/04/2005	8,259	18.4	--	R	--	USGS-NWIS, 2006	
195	1952001	10/04/2005	8,258	18.4	G	R	--	USGS-NWIS, 2006	
195	1952001	10/14/2005	7,630	17.0	--	R	--	USGS-NWIS, 2006	
195	1952001	10/14/2005	7,630	17.0	G	R	--	USGS-NWIS, 2006	
195	1952001	11/17/2005	8,034	17.9	--	R	--	USGS-NWIS, 2006	
195	1952001	11/17/2005	8,034	17.9	G	R	--	USGS-NWIS, 2006	
195	1952001	12/01/2005	7,540	16.8	--	R	--	USGS-NWIS, 2006	
195	1952001	12/01/2005	7,540	16.8	G	R	--	USGS-NWIS, 2006	
195	1952001	12/01/2005	7,316	16.3	--	R	--	USGS-NWIS, 2006	
195	1952001	12/01/2005	7,316	16.3	G	R	--	USGS-NWIS, 2006	
195	1952001	12/29/2005	7,810	17.4	--	R	--	USGS-NWIS, 2006	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
195	1952001	12/29/2005	7,810	17.4	G	R	--	USGS-NWIS, 2006	
195	1952001	01/31/2006	7,765	17.3	--	R	--	USGS-NWIS, 2006	
195	1952001	01/31/2006	7,765	17.3	G	R	--	USGS-NWIS, 2006	
195	1952001	04/13/2006	7,451	16.6	--	R	--	USGS-NWIS, 2006	
195	1952001	04/13/2006	7,451	16.6	F	R	--	USGS-NWIS, 2006	
195	1952001	05/16/2006	7,899	17.6	G	R	--	USGS-NWIS, 2006	
195	1952001	07/11/2006	7,675	17.1	G	R	--	USGS-NWIS, 2006	
195	1952001	07/11/2006	7,675	17.1	G	R	--	USGS-NWIS, 2006	
195	1952001	08/15/2006	7,810	17.4	G	R	--	USGS-NWIS, 2006	
195	1952001	10/03/2006	7,316	16.3	G	R	--	USGS-NWIS, 2006	
195	1952001	04/02/2007	8,214	18.3	G	C	25.6	SNWA	
195	1952001	05/10/2007	8,124	18.1	G	C	26.1	SNWA	
195	1952001	06/20/2007	7,630	17.0	G	C	27.7	SNWA	
195	1952001	07/25/2007	7,496	16.7	G	C	27.3	SNWA	
195	1952001	08/30/2007	6,643	14.8	F	C	27.9	SNWA	
195	1952001	10/11/2007	7,540	16.8	G	C	26.0	SNWA	
195	1952001	12/05/2007	7,001	15.6	G	C	25.0	SNWA	
195	1952001	01/09/2008	6,822	15.2	G	C	24.5	SNWA	
195	1952401	07/14/2004	5.00	0.010	P	E	14.4	SNWA	
195	1952701	10/12/2006	3.30	0.007	E	V	19.7	SNWA	
195	1952701	07/25/2007	3.50	0.008	G	V	--	SNWA	
195	1952801	10/11/2006	59.7	0.133	E	F	15.2	SNWA	
195	1952801	02/22/2007	52.5	0.117	G	F	--	SNWA	
195	1952801	03/30/2007	45.8	0.102	G	F	--	SNWA	
195	1952801	05/09/2007	33.7	0.075	E	F	--	SNWA	
195	1952801	06/20/2007	25.6	0.057	E	F	21.9	SNWA	
195	1952801	07/25/2007	22.9	0.051	E	F	21.2	SNWA	
195	1952801	08/30/2007	13.9	0.031	G	F	25.7	SNWA	
195	1952801	10/11/2007	18.0	0.040	E	F	18.1	SNWA	
195	1952801	12/05/2007	24.7	0.055	E	F	12.4	SNWA	
195	1952801	01/09/2008	22.9	0.051	E	F	8.5	SNWA	

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Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
195	1953101	07/12/1967	--	--	--	R	60.5	Bolke and Sumsion, 1978	Water is unused
195	1953102	08/24/1976	1.00	0.002	--	R	55.6	Bolke and Sumsion, 1978	Discharge reported as <1 gpm; value is an estimate. Water is unused
195	1953103	08/24/1976	10.0	0.022	--	R	58.9	Bolke and Sumsion, 1978	Water is unused
195	1953104	08/24/1976	60.0	0.134	--	R	60.6	Bolke and Sumsion, 1978	Water is unused
195	1953105	08/24/1976	30.0	0.067	--	R	60.0	Bolke and Sumsion, 1978	Water is unused
195	1953201	06/07/1974	--	--	--	R	--	Bolke and Sumsion, 1978	Water is unused
195	1953202	08/24/1976	20.0	0.045	--	R	18.0	Bolke and Sumsion, 1978	Water is unused
195	1953401	10/15/1964	1,300	2.90	--	R	--	Hood and Rush, 1965	
195	1953701	01/01/1964	120	0.267	--	R	--	Hood and Rush, 1965	
195	1953801	01/01/1965	1.00	0.002	--	R	--	Hood and Rush, 1965	Reported date refers to the publication; no other date or source was listed
195	1953901	10/15/1964	2.00	0.004	--	R	--	Hood and Rush, 1965	
203	2030101	10/05/1912	1,795	4.00	--	R	--	Hardman and Miller, 1934	
203	2030101	01/01/1948	3,600	8.02	--	R	--	Phoenix, 1948	No date given for measurement.
203	2030101	10/28/1963	4,900	10.9	--	R	--	Rush, 1964	
203	2030101	07/28/1982	2,600	5.79	--	R	--	USGS-NWIS, 2004	
203	2030101	04/15/1987	1,000	2.23	--	R	--	USGS-NWIS, 2004	
203	2030101	03/09/1988	601	1.34	--	R	--	USGS, 1988	
203	2030101	02/28/1989	498	1.11	--	R	--	USGS, 1989	
203	2030101	03/13/1990	269	0.600	--	R	--	USGS, 1990	
203	2030101	11/06/1990	162	0.360	--	R	--	USGS, 1991	
203	2030101	03/21/1991	498	1.11	--	R	--	USGS, 1991	
203	2030101	11/07/1991	188	0.420	--	R	--	USGS, 1992	
203	2030101	03/24/1992	781	1.74	--	R	--	USGS, 1992	
203	2030101	10/16/1992	210	0.470	--	R	--	USGS-NWIS, 2004	
203	2030101	05/05/1993	430	0.960	--	R	--	USGS-NWIS, 2004	
203	2030101	10/20/1993	500	1.11	--	R	--	USGS-NWIS, 2004	
203	2030101	10/28/1993	494	1.10	--	R	--	USGS, 1994	
203	2030101	03/30/1994	184	0.410	--	R	--	USGS, 1994	
203	2030101	10/18/1994	126	0.280	--	R	--	USGS, 1995	
203	2030101	04/17/1997	183	0.410	--	R	--	USGS-NWIS, 2004	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
203	2030101	09/23/1997	318	0.710	–	R	–	USGS-NWIS, 2004	
203	2030101	07/19/2004	224	0.500	P	E	–	SNWA	
203	2030101	04/20/2006	4,758	10.6	–	R	–	USGS, 2006	
203	2030101	04/20/2006	4,578	10.2	–	R	–	USGS, 2006	
203	2030301	01/01/1948	10.0	0.022	–	R	21.1	Phoenix, 1948	
203	2030301	05/17/2005	22.4	0.050	P	E	21	SNWA	
207	2070501	04/06/1935	6,885	15.3	–	R	–	Maxey and Eakin, 1949	
207	2070501	12/07/1961	6,000	13.4	–	R	–	USGS-NWIS, 2004	
207	2070501	07/23/1982	6,000	13.4	–	R	–	USGS-NWIS, 2004	
207	2070501	07/26/1982	4,847	10.8	–	R	–	USGS, 1982	
207	2070501	01/16/1985	4,143	9.23	–	R	–	USGS, 1985	
207	2070501	02/01/1985	11,000	24.5	–	R	–	USGS-NWIS, 2004	Discharge appears high cfs may have been entered as gpm.
207	2070501	02/03/1986	4,143	9.23	–	R	–	USGS, 1986	
207	2070501	02/11/1987	6,328	14.1	–	R	–	USGS, 1987	
207	2070501	08/12/1987	3,519	7.84	–	R	–	USGS, 1987	
207	2070501	02/23/1988	7,002	15.6	–	R	–	USGS, 1988	
207	2070501	03/14/1989	3,999	8.91	–	R	–	USGS, 1989	
207	2070501	03/23/1990	6,400	14.3	–	R	–	USGS, 1990	
207	2070501	11/08/1990	5,000	11.1	–	R	–	USGS, 1991	
207	2070501	03/04/1991	6,001	13.4	–	R	–	USGS, 1991	
207	2070501	10/23/1991	2,783	6.20	–	R	–	USGS, 1992	
207	2070501	03/18/1992	4,197	9.35	–	R	–	USGS, 1992	
207	2070501	10/14/1992	4,084	9.10	–	R	–	USGS, 1993	
207	2070501	05/03/1993	3,950	8.80	–	R	–	USGS, 1993	
207	2070501	10/19/1993	494	1.10	–	R	–	USGS-NWIS, 2004	Discharge appears low.
207	2070501	03/29/1994	1,257	2.80	–	R	–	USGS, 1994	
207	2070501	10/19/1994	5,386	12.0	–	R	–	USGS, 1995	
207	2070501	04/17/1997	6,330	14.1	–	R	–	USGS-NWIS, 2004	
207	2070501	09/25/1997	5,430	12.1	–	R	–	USGS-NWIS, 2004	
207	2070501	04/29/1998	4,578	10.3	–	R	–	USGS-NWIS, 2004	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070501	09/22/1998	4,670	10.4	–	R	–	USGS-NWIS, 2004	
207	2070501	04/07/1999	4,760	10.6	–	R	–	USGS-NWIS, 2004	
207	2070501	09/13/1999	6,910	15.4	–	R	–	USGS-NWIS, 2004	
207	2070501	04/20/2000	3,480	7.75	–	R	–	USGS-NWIS, 2004	
207	2070501	09/14/2000	3,520	7.84	–	R	–	USGS-NWIS, 2004	
207	2070501	04/17/2001	4,850	10.8	–	R	–	USGS-NWIS, 2004	
207	2070501	09/13/2001	4,800	10.7	–	R	–	USGS-NWIS, 2004	
207	2070501	04/16/2002	4,940	11.0	–	R	–	USGS-NWIS, 2004	
207	2070501	09/17/2002	4,940	11.0	–	R	–	USGS-NWIS, 2004	
207	2070501	04/24/2003	4,420	9.85	–	R	–	USGS-NWIS, 2004	
207	2070501	08/05/2003	6,150	13.7	P	C	32	SNWA	
207	2070501	09/11/2003	4,760	10.6	–	R	–	USGS-NWIS, 2004	
207	2070501	04/23/2004	4,670	10.4	–	R	–	USGS-NWIS, 2004	
207	2070501	09/24/2004	4,580	10.2	–	R	–	USGS, 2004	
207	2070501	06/30/2005	4,246	9.46	–	R	–	USGS-NWIS, 2007	
207	2070501	09/22/2005	4,847	10.8	–	R	–	USGS-NWIS, 2007	
207	2070501	04/28/2006	6,283	14.0	–	R	–	USGS, 2006	
207	2070501	08/02/2006	6,418	14.3	–	R	–	USGS, 2006	
207	2070501	08/15/2006	6,104	13.6	–	R	–	USGS, 2006	
207	2070501	09/14/2006	6,283	14.0	–	R	–	USGS, 2006	
207	2070601	10/27/1910	1,409	3.14	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/15/1913	1,643	3.66	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/15/1922	1,580	3.52	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/07/1935	1,459	3.25	–	R	–	Maxey and Eakin, 1949	
207	2070601	03/06/1936	1,732	3.86	–	R	–	Maxey and Eakin, 1949	
207	2070601	03/29/1936	1,728	3.85	–	R	–	Maxey and Eakin, 1949	
207	2070601	03/30/1936	1,728	3.85	–	R	–	Maxey and Eakin, 1949	
207	2070601	04/07/1936	1,719	3.83	–	R	–	Maxey and Eakin, 1949	
207	2070601	04/29/1936	1,706	3.80	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/05/1936	1,706	3.80	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/07/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/12/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070601	05/16/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/19/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/23/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/26/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/30/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/02/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/05/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/09/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/16/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/19/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/23/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	06/27/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	07/07/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	07/12/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	07/19/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	07/26/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	08/04/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	08/15/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	08/25/1936	1,714	3.82	–	R	–	Maxey and Eakin, 1949	
207	2070601	05/09/1947	1,400	3.12	–	R	22	USGS-NWIS, 2004	
207	2070601	11/13/1966	1,380	3.07	–	R	22.2	Hess and Mifflin, 1978	
207	2070601	01/19/1982	1,804	4.02	–	R	–	USGS, 1982	
207	2070601	07/30/1984	1,499	3.34	–	R	–	USGS-NWIS, 2004	
207	2070601	01/21/1985	1,822	4.06	–	R	–	USGS, 1985	
207	2070601	02/01/1986	1,580	3.52	–	R	–	USGS, 1986	
207	2070601	02/23/1988	1,800	4.01	–	R	–	USGS, 1988	
207	2070601	03/14/1989	1,499	3.34	–	R	–	USGS, 1989	
207	2070601	04/04/1990	1,499	3.34	–	R	–	USGS, 1990	
207	2070601	11/06/1990	498	1.11	–	R	–	USGS, 1991	
207	2070601	03/03/1991	399	0.890	–	R	–	USGS, 1991	
207	2070601	10/24/1991	1,786	3.98	–	R	–	USGS, 1992	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070601	03/19/1992	1,854	4.13	–	R	–	USGS, 1992	
207	2070601	10/15/1992	1,885	4.20	–	R	–	USGS, 1993	
207	2070601	05/04/1993	1,571	3.50	–	R	–	USGS, 1993	
207	2070601	10/19/1993	1,436	3.20	–	R	–	USGS, 1994	
207	2070601	03/30/1994	1,571	3.50	–	R	–	USGS, 1994	
207	2070601	10/20/1994	1,706	3.80	–	R	–	USGS, 1995	
207	2070601	05/20/1997	1,490	3.32	–	R	–	USGS-NWIS, 2004	
207	2070601	09/24/1997	1,630	3.63	–	R	–	USGS-NWIS, 2004	
207	2070601	04/30/1998	2,410	5.37	–	R	–	USGS-NWIS, 2004	
207	2070601	09/23/1998	1,800	4.01	–	R	–	USGS-NWIS, 2004	
207	2070601	04/08/1999	1,830	4.08	–	R	–	USGS-NWIS, 2004	
207	2070601	09/14/1999	1,540	3.43	–	R	–	USGS-NWIS, 2004	
207	2070601	04/19/2000	1,600	3.56	–	R	–	USGS-NWIS, 2004	
207	2070601	09/13/2000	1,360	3.03	–	R	–	USGS-NWIS, 2004	
207	2070601	04/18/2001	1,450	3.23	–	R	–	USGS-NWIS, 2004	
207	2070601	09/12/2001	1,580	3.52	–	R	–	USGS-NWIS, 2004	
207	2070601	04/17/2002	1,480	3.30	–	R	–	USGS-NWIS, 2004	
207	2070601	09/18/2002	1,320	2.94	–	R	–	USGS-NWIS, 2004	
207	2070601	04/23/2003	1,130	2.52	–	R	–	USGS-NWIS, 2004	
207	2070601	09/10/2003	1,850	4.12	–	R	–	USGS-NWIS, 2004	
207	2070601	04/22/2004	1,250	2.79	–	R	–	USGS-NWIS, 2004	
207	2070601	04/27/2006	1,481	3.30	–	R	–	USGS, 2006	
207	2070601	09/13/2006	1,548	3.45	–	R	–	USGS, 2006	
207	2070701	10/27/1910	462	1.03	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/07/1935	588	1.31	–	R	–	Maxey and Eakin, 1949	
207	2070701	03/06/1936	601	1.34	–	R	–	Maxey and Eakin, 1949	
207	2070701	03/29/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	03/30/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	04/07/1936	633	1.41	–	R	–	Maxey and Eakin, 1949	
207	2070701	04/29/1936	633	1.41	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/05/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/07/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070701	05/12/1936	624	1.39	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/16/1936	646	1.44	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/19/1936	624	1.39	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/23/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/26/1936	583	1.30	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/30/1936	601	1.34	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/02/1936	669	1.49	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/05/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/09/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/16/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/19/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/23/1936	633	1.41	–	R	–	Maxey and Eakin, 1949	
207	2070701	06/27/1936	615	1.37	–	R	–	Maxey and Eakin, 1949	
207	2070701	07/07/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	07/12/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	07/18/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	07/19/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	07/26/1936	619	1.38	–	R	–	Maxey and Eakin, 1949	
207	2070701	08/04/1936	624	1.39	–	R	–	Maxey and Eakin, 1949	
207	2070701	08/15/1936	624	1.39	–	R	–	Maxey and Eakin, 1949	
207	2070701	08/25/1936	628	1.40	–	R	–	Maxey and Eakin, 1949	
207	2070701	05/09/1947	781	1.74	–	R	–	Maxey and Eakin, 1949	
207	2070701	11/13/1966	780	1.74	–	R	21.7	Hess and Mifflin, 1978	
207	2070701	01/19/1982	768	1.71	–	R	–	USGS, 1982	
207	2070701	07/30/1984	440	0.980	–	R	–	USGS-NWIS, 2004	
207	2070701	01/17/1985	404	0.900	–	R	–	USGS, 1985	
207	2070701	01/21/1985	440	0.980	–	R	–	USGS-NWIS, 2004	
207	2070701	02/01/1986	498	1.11	–	R	–	USGS, 1986	
207	2070701	02/23/1988	1,000	2.23	–	R	–	USGS-NWIS, 2004	
207	2070701	03/14/1989	1,499	3.34	–	R	–	USGS, 1989	
207	2070701	04/04/1990	911	2.03	–	R	–	USGS, 1990	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070701	11/09/1990	382	0.850	–	R	–	USGS, 1991	
207	2070701	03/05/1991	601	1.34	–	R	–	USGS, 1991	
207	2070701	10/24/1991	1,005	2.24	–	R	–	USGS, 1992	
207	2070701	03/19/1992	799	1.78	–	R	–	USGS, 1992	
207	2070701	10/15/1992	148	0.330	–	R	–	USGS, 1993	
207	2070701	05/04/1993	18.0	0.040	–	R	–	USGS, 1993	
207	2070701	10/19/1993	103	0.230	–	R	–	USGS, 1994	
207	2070701	03/30/1994	135	0.300	–	R	–	USGS, 1994	
207	2070701	10/20/1994	108	0.240	–	R	–	USGS, 1995	
207	2070701	04/23/2003	380	0.850	–	R	–	USGS-NWIS, 2004	
207	2070701	04/23/2003	350	0.780	–	R	–	USGS-NWIS, 2004	
207	2070701	09/10/2003	680	1.52	–	R	–	USGS-NWIS, 2004	
207	2070701	04/22/2004	260	0.580	–	R	–	USGS-NWIS, 2004	
207	2070701	07/01/2005	633	1.41	–	R	–	USGS, 2005	
207	2070701	09/21/2005	660	1.47	–	R	–	USGS, 2005	
207	2070701	04/27/2006	503	1.12	–	R	–	USGS, 2006	
207	2070701	09/13/2006	355	0.790	–	R	–	USGS, 2006	
207	2070901	03/27/1905	3,573	7.96	–	R	–	Maxey and Eakin, 1949	
207	2070901	10/27/1910	2,787	6.21	–	R	–	Maxey and Eakin, 1949	
207	2070901	08/16/1913	3,411	7.60	–	R	–	Maxey and Eakin, 1949	
207	2070901	10/16/1914	3,142	7.00	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/24/1916	3,591	8.00	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/07/1935	3,187	7.10	–	R	–	Maxey and Eakin, 1949	
207	2070901	08/13/1935	3,236	7.21	–	R	–	Maxey and Eakin, 1949	
207	2070901	03/06/1936	3,806	8.48	–	R	–	Maxey and Eakin, 1949	
207	2070901	03/30/1936	3,636	8.10	–	R	–	Maxey and Eakin, 1949	
207	2070901	04/07/1936	3,730	8.31	–	R	–	Maxey and Eakin, 1949	
207	2070901	04/29/1936	3,766	8.39	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/02/1936	3,721	8.29	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/05/1936	3,671	8.18	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/07/1936	3,680	8.20	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/12/1936	3,604	8.03	–	R	–	Maxey and Eakin, 1949	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070901	05/16/1936	3,716	8.28	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/19/1936	3,743	8.34	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/23/1936	3,703	8.25	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/26/1936	3,846	8.57	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/30/1936	3,815	8.50	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/02/1936	3,824	8.52	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/05/1936	3,779	8.42	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/09/1936	3,730	8.31	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/16/1936	3,833	8.54	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/19/1936	3,770	8.40	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/23/1936	3,815	8.50	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/27/1936	3,784	8.43	–	R	–	Maxey and Eakin, 1949	
207	2070901	07/07/1936	3,918	8.73	–	R	–	Maxey and Eakin, 1949	
207	2070901	07/12/1936	3,770	8.40	–	R	–	Maxey and Eakin, 1949	
207	2070901	07/18/1936	3,891	8.67	–	R	–	Maxey and Eakin, 1949	
207	2070901	07/19/1936	3,824	8.52	–	R	–	Maxey and Eakin, 1949	
207	2070901	07/26/1936	3,815	8.50	–	R	–	Maxey and Eakin, 1949	
207	2070901	08/04/1936	3,828	8.53	–	R	–	Maxey and Eakin, 1949	
207	2070901	08/15/1936	3,815	8.50	–	R	–	Maxey and Eakin, 1949	
207	2070901	08/25/1936	3,784	8.43	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/14/1937	3,815	8.50	–	R	–	Maxey and Eakin, 1949	
207	2070901	08/16/1939	3,743	8.34	–	R	–	Maxey and Eakin, 1949	
207	2070901	09/05/1939	3,909	8.71	–	R	–	Maxey and Eakin, 1949	
207	2070901	12/01/1939	3,694	8.23	–	R	–	Maxey and Eakin, 1949	
207	2070901	03/24/1941	3,743	8.34	–	R	–	Maxey and Eakin, 1949	
207	2070901	06/16/1941	3,766	8.39	–	R	–	Maxey and Eakin, 1949	
207	2070901	04/16/1943	4,057	9.04	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/17/1944	4,026	8.97	–	R	–	Maxey and Eakin, 1949	
207	2070901	07/27/1945	3,851	8.58	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/08/1947	3,878	8.64	–	R	–	Maxey and Eakin, 1949	
207	2070901	05/09/1947	3,878	8.64	–	R	–	Maxey and Eakin, 1949	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070901	11/13/1966	3,900	8.69	–	R	21.1	Hess and Mifflin, 1978	
207	2070901	01/19/1982	3,236	7.21	–	R	–	USGS, 1982	
207	2070901	07/22/1982	3,400	7.57	–	R	–	USGS-NWIS, 2004	
207	2070901	08/25/1982	3,630	8.09	–	R	–	USGS-NWIS, 2004	
207	2070901	12/09/1982	3,900	8.69	–	R	–	USGS-NWIS, 2004	
207	2070901	01/19/1983	3,703	8.25	–	R	–	USGS-NWIS, 2004	
207	2070901	03/23/1983	3,429	7.64	–	R	–	USGS-NWIS, 2004	
207	2070901	04/27/1983	3,631	8.09	–	R	–	USGS-NWIS, 2004	
207	2070901	05/19/1983	3,254	7.25	–	R	–	USGS-NWIS, 2004	
207	2070901	06/28/1983	3,246	7.22	–	R	–	USGS-NWIS, 2004	
207	2070901	08/02/1983	3,505	7.81	–	R	–	USGS-NWIS, 2004	
207	2070901	09/14/1983	3,312	7.38	–	R	–	USGS-NWIS, 2004	
207	2070901	10/27/1983	3,263	7.27	–	R	–	USGS-NWIS, 2004	
207	2070901	12/08/1983	3,330	7.42	–	R	–	USGS-NWIS, 2004	
207	2070901	01/19/1984	3,137	6.99	–	R	–	USGS-NWIS, 2004	
207	2070901	03/07/1984	3,110	6.93	–	R	–	USGS-NWIS, 2004	
207	2070901	04/12/1984	3,128	6.97	–	R	–	USGS-NWIS, 2004	
207	2070901	05/17/1984	3,137	6.99	–	R	–	USGS-NWIS, 2004	
207	2070901	06/27/1984	3,402	7.58	–	R	–	USGS-NWIS, 2004	
207	2070901	08/02/1984	3,348	7.46	–	R	–	USGS-NWIS, 2004	
207	2070901	09/19/1984	3,407	7.59	–	R	–	USGS-NWIS, 2004	
207	2070901	11/08/1984	3,362	7.49	–	R	–	USGS-NWIS, 2004	
207	2070901	12/12/1984	3,856	8.59	–	R	–	USGS-NWIS, 2004	
207	2070901	01/17/1985	3,800	8.47	–	R	–	USGS-NWIS, 2004	
207	2070901	03/22/1985	3,582	7.98	–	R	–	USGS-NWIS, 2004	
207	2070901	03/22/1985	3,299	7.35	–	R	–	USGS-NWIS, 2004	
207	2070901	04/19/1985	3,591	8.00	–	R	–	USGS-NWIS, 2004	
207	2070901	05/25/1985	3,649	8.13	–	R	–	USGS-NWIS, 2004	
207	2070901	07/29/1985	3,645	8.12	–	R	–	USGS-NWIS, 2004	
207	2070901	08/29/1985	3,218	7.17	–	R	–	USGS-NWIS, 2004	
207	2070901	10/24/1985	3,223	7.18	–	R	–	USGS-NWIS, 2004	
207	2070901	10/24/1985	3,205	7.14	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070901	11/02/1985	3,609	8.04	–	R	–	USGS-NWIS, 2004	
207	2070901	11/02/1985	3,505	7.81	–	R	–	USGS-NWIS, 2004	
207	2070901	02/11/1987	3,627	8.08	–	R	–	USGS, 1987	
207	2070901	08/11/1987	3,460	7.71	–	R	–	USGS, 1987	
207	2070901	02/23/1988	4,040	9.00	–	R	–	USGS-NWIS, 2004	
207	2070901	03/14/1989	4,201	9.36	–	R	–	USGS, 1989	
207	2070901	03/22/1990	3,800	8.46	–	R	–	USGS-NWIS, 2004	
207	2070901	11/06/1990	3,999	8.91	–	R	–	USGS, 1991	
207	2070901	03/03/1991	3,501	7.80	–	R	–	USGS, 1991	
207	2070901	10/24/1991	3,541	7.89	–	R	–	USGS, 1992	
207	2070901	03/19/1992	3,802	8.47	–	R	–	USGS, 1992	
207	2070901	10/15/1992	4,084	9.10	–	R	–	USGS, 1993	
207	2070901	05/04/1993	3,770	8.40	–	R	–	USGS, 1993	
207	2070901	10/20/1993	4,084	9.10	–	R	–	USGS, 1994	
207	2070901	03/30/1994	3,770	8.40	–	R	–	USGS, 1994	
207	2070901	10/20/1994	4,040	9.00	–	R	–	USGS, 1995	
207	2070901	05/20/1997	4,330	9.64	–	R	–	USGS-NWIS, 2004	
207	2070901	09/24/1997	3,430	7.64	–	R	–	USGS-NWIS, 2004	
207	2070901	04/30/1998	3,890	8.66	–	R	–	USGS-NWIS, 2004	
207	2070901	09/23/1998	3,830	8.53	–	R	–	USGS-NWIS, 2004	
207	2070901	04/08/1999	4,710	10.5	–	R	–	USGS, 1999	
207	2070901	09/14/1999	3,380	7.53	–	R	–	USGS-NWIS, 2004	
207	2070901	02/18/2000	3,280	7.31	–	R	–	USGS-NWIS, 2004	
207	2070901	04/04/2000	3,650	8.12	–	R	–	USGS-NWIS, 2004	
207	2070901	06/20/2000	3,510	7.82	–	R	–	USGS-NWIS, 2004	
207	2070901	07/20/2000	3,480	7.76	–	R	–	USGS-NWIS, 2004	
207	2070901	08/02/2000	3,600	8.03	–	R	–	USGS-NWIS, 2004	
207	2070901	08/07/2000	3,480	7.76	–	R	–	USGS-NWIS, 2004	
207	2070901	09/13/2000	3,520	7.85	–	R	–	USGS-NWIS, 2004	
207	2070901	10/18/2000	3,500	7.80	–	R	–	USGS-NWIS, 2004	
207	2070901	12/20/2000	3,640	8.10	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070901	03/16/2001	3,540	7.94	–	R	–	USGS-NWIS, 2004	
207	2070901	04/18/2001	3,590	8.03	–	R	–	USGS-NWIS, 2004	
207	2070901	04/18/2001	3,600	8.00	–	R	–	USGS-NWIS, 2004	
207	2070901	05/02/2001	3,300	7.36	–	R	–	USGS-NWIS, 2004	
207	2070901	06/20/2001	3,400	7.60	–	R	–	USGS-NWIS, 2004	
207	2070901	06/20/2001	3,393	7.56	–	R	–	USGS-NWIS, 2004	
207	2070901	08/01/2001	3,420	7.62	–	R	–	USGS-NWIS, 2004	
207	2070901	08/01/2001	3,420	7.34	–	R	–	USGS-NWIS, 2004	
207	2070901	09/12/2001	3,360	7.49	–	R	–	USGS-NWIS, 2004	
207	2070901	10/02/2001	3,490	7.81	–	R	–	USGS-NWIS, 2004	
207	2070901	10/02/2001	3,500	7.78	–	R	–	USGS-NWIS, 2004	
207	2070901	12/19/2001	3,460	7.80	–	R	–	USGS-NWIS, 2004	
207	2070901	12/19/2001	3,500	7.70	–	R	–	USGS-NWIS, 2004	
207	2070901	01/22/2002	3,410	7.94	–	R	–	USGS-NWIS, 2004	
207	2070901	01/22/2002	3,420	7.62	–	R	–	USGS-NWIS, 2004	
207	2070901	04/17/2002	3,190	7.20	–	R	–	USGS-NWIS, 2004	
207	2070901	04/17/2002	3,230	7.10	–	R	–	USGS-NWIS, 2004	
207	2070901	05/30/2002	2,960	7.00	–	R	–	USGS-NWIS, 2004	
207	2070901	05/30/2002	3,140	6.60	–	R	–	USGS-NWIS, 2004	
207	2070901	07/18/2002	3,280	7.69	–	R	–	USGS-NWIS, 2004	
207	2070901	07/18/2002	3,370	7.43	–	R	–	USGS-NWIS, 2004	
207	2070901	09/18/2002	3,280	7.34	–	R	–	USGS-NWIS, 2004	
207	2070901	10/16/2002	3,320	7.55	–	R	–	USGS-NWIS, 2004	
207	2070901	10/16/2002	3,410	7.39	–	R	–	USGS-NWIS, 2004	
207	2070901	12/05/2002	3,140	6.95	–	R	–	USGS-NWIS, 2004	
207	2070901	02/05/2003	3,230	7.24	–	R	–	USGS-NWIS, 2004	
207	2070901	03/19/2003	3,100	7.08	–	R	–	USGS-NWIS, 2004	
207	2070901	03/19/2003	3,190	6.91	–	R	–	USGS-NWIS, 2004	
207	2070901	04/23/2003	3,220	7.65	–	R	–	USGS-NWIS, 2004	
207	2070901	04/23/2003	3,430	7.18	–	R	–	USGS-NWIS, 2004	
207	2070901	06/25/2003	3,460	8.00	–	R	–	USGS-NWIS, 2004	
207	2070901	06/25/2003	3,590	7.70	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2070901	08/06/2003	4,223	9.41	F	C	21	SNWA	
207	2070901	09/10/2003	3,410	8.17	--	R	--	USGS-NWIS, 2004	
207	2070901	09/10/2003	3,680	7.60	--	R	--	USGS-NWIS, 2004	
207	2070901	10/28/2003	3,510	7.82	--	R	--	USGS-NWIS, 2004	
207	2070901	10/28/2003	3,330	7.42	--	R	--	USGS-NWIS, 2004	
207	2070901	12/10/2003	3,390	7.58	--	R	--	USGS-NWIS, 2004	
207	2070901	12/10/2003	3,400	7.56	--	R	--	USGS-NWIS, 2004	
207	2070901	02/11/2004	3,430	7.64	--	R	--	USGS-NWIS, 2004	
207	2070901	04/21/2004	3,285	7.32	--	R	--	USGS-NWIS, 2004	
207	2071001	10/27/1910	2,406	5.36	--	R	19	Maxey and Eakin, 1949	
207	2071001	10/26/1912	2,406	5.36	--	R	--	Carpenter, 1915	
207	2071001	03/16/1935	4,574	10.2	--	R	--	Maxey and Eakin, 1949	
207	2071001	03/16/1935	4,192	9.34	--	R	--	Maxey and Eakin, 1949	Spring orifice lowered
207	2071001	03/06/1936	2,868	6.39	--	R	--	Maxey and Eakin, 1949	
207	2071001	01/23/1937	3,240	7.22	--	R	--	Maxey and Eakin, 1949	
207	2071001	05/17/1944	3,654	8.14	--	R	--	Maxey and Eakin, 1949	
207	2071001	05/09/1947	4,300	9.58	--	R	--	USGS-NWIS, 2004	
207	2071001	05/09/1947	4,259	9.49	--	R	--	Maxey and Eakin, 1949	
207	2071001	06/15/1966	2,800	6.24	--	R	19	Hess and Mifflin, 1978	
207	2071001	01/18/1982	3,137	6.99	--	R	--	USGS, 1982	
207	2071001	01/17/1985	5,296	11.8	--	R	--	USGS, 1985	
207	2071001	02/01/1986	2,473	5.51	--	R	--	USGS, 1986	
207	2071001	02/11/1987	4,937	11.0	--	R	--	USGS, 1987	
207	2071001	02/23/1988	2,500	5.57	--	R	--	USGS, 1988	
207	2071001	03/14/1989	2,002	4.46	--	R	--	USGS, 1989	
207	2071001	03/22/1990	2,100	4.68	--	R	--	USGS, 1990	
207	2071001	11/09/1990	3,200	7.13	--	R	--	USGS, 1991	
207	2071001	03/03/1991	4,398	9.80	--	R	--	USGS, 1991	
207	2071001	10/24/1991	3,294	7.34	--	R	--	USGS, 1992	
207	2071001	03/19/1992	2,837	6.32	--	R	--	USGS, 1992	
207	2071001	10/14/1992	4,533	10.1	--	R	--	USGS, 1993	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071001	05/04/1993	3,501	7.80	–	R	–	USGS, 1993	
207	2071001	10/19/1993	3,860	8.60	–	R	–	USGS, 1994	
207	2071001	03/30/1994	3,860	8.60	–	R	–	USGS, 1994	
207	2071001	10/19/1994	2,872	6.40	–	R	–	USGS, 1995	
207	2071001	05/20/1997	2,990	6.66	–	R	–	USGS-NWIS, 2004	
207	2071001	09/24/1997	2,580	5.75	–	R	–	USGS-NWIS, 2004	
207	2071001	04/29/1998	3,240	7.22	–	R	–	USGS-NWIS, 2004	
207	2071001	09/23/1998	4,340	9.67	–	R	–	USGS-NWIS, 2004	
207	2071001	04/08/1999	3,830	8.53	–	R	–	USGS-NWIS, 2004	
207	2071001	09/14/1999	4,310	9.60	–	R	–	USGS-NWIS, 2004	
207	2071001	04/19/2000	4,010	8.93	–	R	–	USGS-NWIS, 2004	
207	2071001	09/13/2000	4,890	10.9	–	R	–	USGS-NWIS, 2004	
207	2071001	04/18/2001	3,280	7.31	–	R	–	USGS-NWIS, 2004	
207	2071001	09/13/2001	4,120	9.18	–	R	–	USGS-NWIS, 2004	
207	2071001	04/17/2002	3,670	8.18	–	R	–	USGS-NWIS, 2004	
207	2071001	09/18/2002	3,830	8.53	–	R	–	USGS-NWIS, 2004	
207	2071001	04/23/2003	3,070	6.84	–	R	–	USGS-NWIS, 2004	
207	2071001	08/06/2003	2,805	6.25	G	W	19.0	SNWA	
207	2071001	08/08/2003	2,805	6.25	G	W	–	SNWA	
207	2071001	09/10/2003	3,160	7.04	–	R	–	USGS-NWIS, 2004	
207	2071001	04/22/2004	3,190	7.11	–	R	–	USGS-NWIS, 2004	
207	2071001	06/24/2004	2,805	6.25	G	W	–	SNWA	
207	2071001	06/30/2005	4,412	9.83	–	R	–	USGS-NWIS, 2007	
207	2071001	09/21/2005	5,206	11.6	–	R	–	USGS-NWIS, 2007	
207	2071001	04/27/2006	4,252	9.47	–	R	–	USGS, 2006	
207	2071001	09/13/2006	5,433	12.1	–	R	–	USGS, 2006	
207	2071101	03/16/1935	4,574	10.2	–	R	–	Maxey and Eakin, 1949	Spring orifice lowered
207	2071101	09/15/1945	100	0.220	–	R	–	Miller and others, 1953	Possibly only half the flow
207	2071101	06/15/1949	1,900	4.23	–	R	–	Stearns et al., 1937	Measurement is likely 0.423 cfs
207	2071101	11/15/1966	1,900	4.23	–	R	37.8	Hess and Mifflin, 1978	"This is likely the wrong discharge, and is the same measurement as in 1949."
207	2071101	01/01/1968	225	0.500	–	R	37.0	Mifflin, 1968	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071101	07/23/1982	265	0.590	–	R	–	USGS, 1982	
207	2071101	01/17/1985	256	0.570	–	R	–	USGS, 1985	
207	2071101	02/01/1986	240	0.530	–	R	–	USGS-NWIS, 2004	
207	2071101	02/11/1987	274	0.610	–	R	–	USGS, 1987	
207	2071101	02/23/1988	251	0.560	–	R	–	USGS, 1988	
207	2071101	03/14/1989	301	0.670	–	R	–	USGS, 1989	
207	2071101	03/22/1990	229	0.510	–	R	–	USGS, 1990	
207	2071101	11/08/1990	301	0.670	–	R	–	USGS, 1991	
207	2071101	03/05/1991	310	0.690	–	R	–	USGS, 1991	
207	2071101	10/24/1991	202	0.450	–	R	–	USGS, 1992	
207	2071101	03/19/1992	260	0.580	–	R	–	USGS, 1992	
207	2071101	10/15/1992	193	0.430	–	R	–	USGS, 1993	
207	2071101	05/04/1993	171	0.380	–	R	–	USGS, 1993	
207	2071101	10/19/1993	193	0.430	–	R	–	USGS, 1994	
207	2071101	03/29/1994	206	0.460	–	R	–	USGS, 1994	
207	2071101	10/19/1994	211	0.470	–	R	–	USGS, 1995	
207	2071101	04/17/1997	170	0.380	–	R	–	USGS-NWIS, 2004	
207	2071101	09/24/1997	234	0.520	–	R	–	USGS-NWIS, 2004	
207	2071101	04/29/1998	255	0.570	–	R	–	USGS-NWIS, 2004	
207	2071101	04/08/1999	248	0.550	–	R	–	USGS-NWIS, 2004	
207	2071101	09/15/1999	175	0.390	–	R	–	USGS-NWIS, 2004	
207	2071101	04/20/2000	230	0.510	–	R	–	USGS-NWIS, 2004	
207	2071101	09/13/2000	222	0.490	–	R	–	USGS-NWIS, 2004	
207	2071101	04/17/2001	207	0.460	–	R	–	USGS-NWIS, 2004	
207	2071101	09/13/2001	156	0.350	–	R	–	USGS-NWIS, 2004	
207	2071101	04/18/2002	221	0.490	–	R	–	USGS-NWIS, 2004	
207	2071101	04/24/2003	211	0.470	–	R	–	USGS-NWIS, 2004	
207	2071101	09/10/2003	220	0.490	–	R	–	USGS-NWIS, 2004	
207	2071101	04/22/2004	260	0.580	–	R	–	USGS-NWIS, 2004	
207	2071101	06/23/2004	231	0.513	P	C	–	SNWA	
207	2071101	09/22/2004	211	–	–	R	–	USGS, 2004	

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Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071101	06/30/2005	192	0.427	–	R	–	USGS, 2005	
207	2071101	09/21/2005	188	0.420	–	R	–	USGS, 2005	
207	2071101	04/27/2006	238	0.530	–	R	–	USGS, 2006	
207	2071101	09/13/2006	206	0.460	–	R	–	USGS, 2006	
207	2071201	08/01/1979	2.00	0.004	–	R	–	Bunch and Harrill, 1984	
207	2071201	09/14/2004	0.350	0.001	E	V	17.0	SNWA	
207	2071201	09/07/2007	Dry	Dry	E	–	–	SNWA	
207	2071301	01/01/1949	1,122	2.50	–	R	–	Maxey and Eakin, 1949	Reported as 7/62-32D1
207	2071301	07/24/1982	1,046	2.33	–	R	–	USGS, 1982	
207	2071301	01/16/1985	983	2.19	–	R	–	USGS, 1985	
207	2071301	02/04/1986	758	1.69	–	R	–	USGS, 1986	
207	2071301	02/11/1987	907	2.02	–	R	–	USGS, 1987	
207	2071301	02/23/1988	902	2.01	–	R	–	USGS, 1988	
207	2071301	03/14/1989	902	2.01	–	R	–	USGS, 1989	
207	2071301	03/22/1990	938	2.09	–	R	–	USGS, 1990	
207	2071301	11/08/1990	799	1.78	–	R	–	USGS, 1991	
207	2071301	03/04/1991	902	2.01	–	R	–	USGS, 1991	
207	2071301	10/23/1991	853	1.90	–	R	–	USGS, 1992	
207	2071301	03/18/1992	754	1.68	–	R	–	USGS, 1992	
207	2071301	10/14/1992	718	1.60	–	R	–	USGS, 1993	
207	2071301	05/03/1993	808	1.80	–	R	–	USGS, 1993	
207	2071301	10/19/1993	539	1.20	–	R	–	USGS, 1994	
207	2071301	03/29/1994	673	1.50	–	R	–	USGS, 1994	
207	2071301	10/19/1994	763	1.70	–	R	–	USGS, 1995	
207	2071301	04/17/1997	1,460	3.25	–	R	–	USGS-NWIS, 2004	
207	2071301	05/21/1997	978	2.18	–	R	–	USGS-NWIS, 2004	
207	2071301	09/29/1997	1,020	2.27	–	R	–	USGS-NWIS, 2004	
207	2071301	04/29/1998	1,140	2.54	–	R	–	USGS-NWIS, 2004	
207	2071301	09/23/1998	1,260	2.81	–	R	–	USGS-NWIS, 2004	
207	2071301	04/08/1999	754	1.68	–	R	–	USGS-NWIS, 2004	
207	2071301	09/13/1999	1,180	2.63	–	R	–	USGS-NWIS, 2004	
207	2071301	04/04/2000	1,180	2.63	–	R	–	USGS-NWIS, 2004	

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Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071301	09/14/2000	1,640	3.65	–	R	–	USGS-NWIS, 2004	
207	2071301	04/17/2001	1,000	2.23	–	R	–	USGS-NWIS, 2004	
207	2071301	09/13/2001	1,320	2.94	–	R	–	USGS-NWIS, 2004	
207	2071301	04/16/2002	1,000	2.23	–	R	–	USGS-NWIS, 2004	
207	2071301	05/30/2002	890	1.98	–	R	–	USGS-NWIS, 2004	
207	2071301	09/19/2002	1,300	2.90	–	R	–	USGS-NWIS, 2004	
207	2071301	04/24/2003	930	2.07	–	R	–	USGS-NWIS, 2004	
207	2071301	09/11/2003	800	1.78	–	R	–	USGS-NWIS, 2004	
207	2071301	04/23/2004	825	1.84	–	R	–	USGS-NWIS, 2004	
207	2071301	09/11/2004	810	1.80	–	R	–	USGS, 2004	
207	2071301	09/24/2004	785	1.75	–	R	–	USGS, 2004	
207	2071301	06/30/2005	1,109	2.47	–	R	–	USGS-NWIS, 2007	
207	2071301	09/22/2005	1,073	2.39	–	R	–	USGS-NWIS, 2007	
207	2071301	04/28/2006	983	2.19	–	R	–	USGS, 2006	
207	2071302	07/24/1982	1,154	2.57	–	R	–	USGS, 1982	
207	2071302	01/16/1985	1,284	2.86	–	R	–	USGS, 1985	
207	2071302	02/04/1986	1,203	2.68	–	R	–	USGS, 1986	
207	2071302	02/11/1987	1,584	3.53	–	R	–	USGS, 1987	
207	2071302	02/23/1988	1,598	3.56	–	R	–	USGS, 1988	
207	2071302	03/14/1989	1,302	2.90	–	R	–	USGS, 1989	
207	2071302	03/22/1990	220	0.490	–	R	–	USGS, 1990	
207	2071302	11/08/1990	1,001	2.23	–	R	–	USGS, 1991	
207	2071302	03/04/1991	1,001	2.23	–	R	–	USGS, 1991	
207	2071302	10/23/1991	1,257	2.80	–	R	–	USGS, 1992	
207	2071302	03/18/1992	1,333	2.97	–	R	–	USGS, 1992	
207	2071302	10/14/1992	1,302	2.90	–	R	–	USGS, 1993	
207	2071302	05/03/1993	1,436	3.20	–	R	–	USGS, 1993	
207	2071302	10/19/1993	1,302	2.90	–	R	–	USGS, 1994	
207	2071302	03/29/1994	1,391	3.10	–	R	–	USGS, 1994	
207	2071302	10/19/1994	1,302	2.90	–	R	–	USGS, 1995	
207	2071302	04/17/1997	1,460	3.25	–	R	–	USGS-NWIS, 2004	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071302	09/29/1997	1,440	3.21	–	R	–	USGS-NWIS, 2004	
207	2071302	04/29/1998	1,570	3.50	–	R	–	USGS-NWIS, 2004	
207	2071302	09/23/1998	1,020	2.27	–	R	–	USGS-NWIS, 2004	
207	2071302	04/08/1999	1,280	2.85	–	R	–	USGS-NWIS, 2004	
207	2071302	09/13/1999	1,430	3.19	–	R	–	USGS-NWIS, 2004	
207	2071302	04/04/2000	1,400	3.12	–	R	–	USGS-NWIS, 2004	
207	2071302	09/14/2000	1,520	3.39	–	R	–	USGS-NWIS, 2004	
207	2071302	04/17/2001	1,440	3.21	–	R	–	USGS-NWIS, 2004	
207	2071302	09/13/2001	1,380	3.07	–	R	–	USGS-NWIS, 2004	
207	2071302	04/16/2002	1,390	3.10	–	R	–	USGS-NWIS, 2004	
207	2071302	09/16/2002	1,250	2.79	–	R	–	USGS-NWIS, 2004	
207	2071302	04/24/2003	1,380	3.07	–	R	–	USGS-NWIS, 2004	
207	2071302	09/11/2003	1,320	2.94	–	R	–	USGS-NWIS, 2004	
207	2071302	04/23/2004	1,095	2.44	–	R	–	USGS-NWIS, 2004	
207	2071302	09/24/2004	1,400	3.12	–	R	–	USGS, 2004	
207	2071302	06/30/2005	1,212	2.70	–	R	–	USGS-NWIS, 2007	
207	2071302	09/22/2005	1,203	2.68	–	R	–	USGS-NWIS, 2007	
207	2071302	04/28/2006	1,189	2.65	–	R	–	USGS, 2006	
207	2071303	07/25/1982	1,005	2.24	–	R	–	USGS, 1982	
207	2071303	01/16/1985	1,059	2.36	–	R	–	USGS, 1985	
207	2071303	02/04/1986	857	1.91	–	R	–	USGS, 1986	
207	2071303	02/11/1987	1,041	2.32	–	R	–	USGS, 1987	
207	2071303	02/23/1988	902	2.01	–	R	–	USGS, 1988	
207	2071303	03/14/1989	1,400	3.12	–	R	–	USGS, 1989	
207	2071303	03/22/1990	691	1.54	–	R	–	USGS, 1990	
207	2071303	11/09/1990	1,001	2.23	–	R	–	USGS, 1991	
207	2071303	03/04/1991	1,302	2.90	–	R	–	USGS, 1991	
207	2071303	10/23/1991	907	2.02	–	R	–	USGS, 1992	
207	2071303	03/18/1992	996	2.22	–	R	–	USGS, 1992	
207	2071303	10/14/1992	898	2.00	–	R	–	USGS, 1993	
207	2071303	05/03/1993	898	2.00	–	R	–	USGS, 1993	
207	2071303	10/19/1993	1,077	2.40	–	R	–	USGS, 1994	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071303	03/29/1994	942	2.10	--	R	--	USGS, 1994	
207	2071303	10/19/1994	853	1.90	--	R	--	USGS, 1995	
207	2071303	04/17/1997	1,070	2.38	--	R	--	USGS-NWIS, 2004	
207	2071303	09/25/1997	1,090	2.43	--	R	--	USGS-NWIS, 2004	
207	2071303	04/29/1998	952	2.12	--	R	--	USGS-NWIS, 2004	
207	2071303	09/23/1998	1,570	3.50	--	R	--	USGS-NWIS, 2004	
207	2071303	04/08/1999	956	2.13	--	R	--	USGS-NWIS, 2004	
207	2071303	09/15/1999	1,010	2.25	--	R	--	USGS-NWIS, 2004	
207	2071303	04/04/2000	1,160	2.58	--	R	--	USGS-NWIS, 2004	
207	2071303	09/14/2000	1,180	2.63	--	R	--	USGS-NWIS, 2004	
207	2071303	04/17/2001	826	1.84	--	R	--	USGS-NWIS, 2004	
207	2071303	09/13/2001	1,080	2.41	--	R	--	USGS-NWIS, 2004	
207	2071303	04/16/2002	970	2.16	--	R	--	USGS-NWIS, 2004	
207	2071303	04/16/2002	960	2.14	--	R	--	USGS-NWIS, 2004	
207	2071303	09/19/2002	1,390	3.10	--	R	--	USGS-NWIS, 2004	
207	2071303	04/24/2003	871	1.94	--	R	--	USGS-NWIS, 2004	
207	2071303	09/11/2003	915	2.04	--	R	--	USGS-NWIS, 2004	
207	2071303	04/23/2004	950	2.12	--	R	--	USGS-NWIS, 2004	
207	2071303	09/24/2004	950	2.12	--	R	--	USGS, 2004	
207	2071303	06/30/2005	965	2.15	--	R	--	USGS-NWIS, 2007	
207	2071303	09/22/2005	907	2.02	--	R	--	USGS-NWIS, 2007	
207	2071303	04/28/2006	1,077	2.40	--	R	--	USGS, 2006	
207	2071401	01/01/1949	1,122	2.50	--	R	--	USGS-NWIS, 2004	Reported as 7/62-28B1
207	2071401	03/09/1966	900	2.01	--	R	--	USGS-NWIS, 2004	
207	2071401	07/25/1982	1,127	2.51	--	R	--	USGS, 1982	
207	2071401	01/16/1985	1,423	3.17	--	R	--	USGS, 1985	
207	2071401	02/04/1986	1,477	3.29	--	R	--	USGS, 1986	
207	2071401	02/11/1987	1,028	2.29	--	R	--	USGS, 1987	
207	2071401	08/12/1987	1,872	4.17	--	R	--	USGS, 1987	
207	2071401	02/23/1988	1,001	2.23	--	R	--	USGS, 1988	
207	2071401	03/14/1989	1,400	3.12	--	R	--	USGS, 1989	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071401	03/22/1990	902	2.01	–	R	–	USGS, 1990	
207	2071401	11/08/1990	1,100	2.45	–	R	–	USGS, 1991	
207	2071401	03/04/1991	1,100	2.45	–	R	–	USGS, 1991	
207	2071401	10/23/1991	1,517	3.38	–	R	–	USGS, 1992	
207	2071401	03/18/1992	1,369	3.05	–	R	–	USGS, 1992	
207	2071401	10/14/1992	1,257	2.80	–	R	–	USGS, 1993	
207	2071401	05/03/1993	1,257	2.80	–	R	–	USGS, 1993	
207	2071401	10/19/1993	1,481	3.30	–	R	–	USGS, 1994	
207	2071401	03/29/1994	1,481	3.30	–	R	–	USGS, 1994	
207	2071401	10/19/1994	1,167	2.60	–	R	–	USGS, 1995	
207	2071401	04/17/1997	1,001	2.23	–	R	–	USGS-NWIS, 2004	
207	2071401	09/25/1997	1,300	2.90	–	R	–	USGS-NWIS, 2004	
207	2071401	04/29/1998	1,530	3.41	–	R	–	USGS-NWIS, 2004	
207	2071401	09/23/1998	1,500	3.34	–	R	–	USGS-NWIS, 2004	
207	2071401	04/08/1999	1,240	2.76	–	R	–	USGS-NWIS, 2004	
207	2071401	09/15/1999	1,210	2.70	–	R	–	USGS-NWIS, 2004	
207	2071401	04/20/2000	1,450	3.23	–	R	–	USGS-NWIS, 2004	
207	2071401	09/13/2000	1,490	3.32	–	R	–	USGS-NWIS, 2004	
207	2071401	04/17/2001	1,180	2.63	–	R	–	USGS-NWIS, 2004	
207	2071401	10/02/2001	1,330	2.96	–	R	–	USGS-NWIS, 2004	
207	2071401	04/16/2002	1,090	2.43	–	R	–	USGS-NWIS, 2004	
207	2071401	09/19/2002	1,250	2.79	–	R	–	USGS-NWIS, 2004	
207	2071401	04/24/2003	978	2.18	–	R	–	USGS-NWIS, 2004	
207	2071401	09/11/2003	978	2.18	–	R	–	USGS, 2003	
207	2071401	04/23/2004	1,020	2.27	–	R	–	USGS-NWIS, 2004	
207	2071401	09/24/2004	942	2.10	–	R	–	USGS, 2004	
207	2071401	06/30/2005	853	1.90	–	R	–	USGS-NWIS, 2007	
207	2071401	09/22/2005	1,001	2.23	–	R	–	USGS-NWIS, 2007	
207	2071401	04/27/2006	1,274	2.84	–	R	–	USGS, 2006	
207	2071401	09/14/2006	1,180	2.62	–	R	–	USGS, 2006	
207	2071501	11/14/1966	200	0.450	–	R	19.0	Hess and Mifflin, 1978	Reported as West Immigrant Spring
207	2071501	09/14/2004	200	0.445	F	C	15.0	SNWA	Discharge is confluence of five springs

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071502	09/14/2004	4.90	0.011	E	F	17.0	SNWA	200 yds. West of Hardy Springs
207	2071601	10/27/1910	1,023	2.28	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/07/1935	1,180	2.63	–	R	–	Maxey and Eakin, 1949	
207	2071601	03/06/1936	1,203	2.68	–	R	–	Maxey and Eakin, 1949	
207	2071601	03/29/1936	1,189	2.65	–	R	–	Maxey and Eakin, 1949	
207	2071601	03/30/1936	1,189	2.65	–	R	–	Maxey and Eakin, 1949	
207	2071601	04/07/1936	1,234	2.75	–	R	–	Maxey and Eakin, 1949	
207	2071601	04/29/1936	1,230	2.74	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/05/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/07/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/12/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/16/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/19/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/23/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/26/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	05/30/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/02/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/05/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/09/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/16/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/19/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/23/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	06/27/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	07/07/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	07/12/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	07/18/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	07/19/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	07/26/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	08/04/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	08/15/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	
207	2071601	08/25/1936	1,212	2.70	–	R	–	Maxey and Eakin, 1949	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071601	05/09/1947	1,122	2.50	–	R	71	USGS-NWIS, 2004	
207	2071601	11/13/1966	1,125	2.51	–	R	70	Hess and Mifflin, 1978	
207	2071601	01/19/1982	1,068	2.38	–	R	–	USGS, 1982	
207	2071601	07/30/1984	1,200	2.67	–	R	–	USGS-NWIS, 2004	
207	2071601	01/21/1985	965	2.15	–	R	–	USGS, 1985	
207	2071601	02/01/1986	1,086	2.42	–	R	–	USGS, 1986	
207	2071601	02/23/1988	1,598	3.56	–	R	–	USGS, 1988	
207	2071601	03/14/1989	301	0.670	–	R	–	USGS, 1989	Discharge appears low.
207	2071601	04/04/1990	1,100	2.45	–	R	–	USGS, 1990	
207	2071601	11/06/1990	1,302	2.90	–	R	–	USGS, 1991	
207	2071601	03/03/1991	1,499	3.34	–	R	–	USGS, 1991	
207	2071601	10/24/1991	1,167	2.60	–	R	–	USGS, 1992	
207	2071601	03/19/1992	108	0.240	–	R	–	USGS, 1992	
207	2071601	10/15/1992	1,346	3.00	–	R	–	USGS, 1993	
207	2071601	05/04/1993	1,346	3.00	–	R	–	USGS, 1993	
207	2071601	10/19/1993	1,257	2.80	–	R	–	USGS, 1994	
207	2071601	03/30/1994	898	2.00	–	R	–	USGS, 1994	
207	2071601	10/20/1994	1,302	2.90	–	R	–	USGS, 1995	
207	2071601	05/20/1997	1,190	2.65	–	R	–	USGS-NWIS, 2004	
207	2071601	09/24/1997	1,320	2.94	–	R	–	USGS-NWIS, 2004	
207	2071601	04/30/1998	1,360	3.03	–	R	–	USGS-NWIS, 2004	
207	2071601	09/23/1998	1,230	2.74	–	R	–	USGS-NWIS, 2004	
207	2071601	04/08/1999	1,310	2.92	–	R	–	USGS-NWIS, 2004	
207	2071601	09/14/1999	1,130	2.52	–	R	–	USGS-NWIS, 2004	
207	2071601	04/19/2000	1,260	2.81	–	R	–	USGS-NWIS, 2004	
207	2071601	09/13/2000	1,550	3.45	–	R	–	USGS-NWIS, 2004	
207	2071601	04/18/2001	952	2.12	–	R	–	USGS-NWIS, 2004	
207	2071601	09/12/2001	1,240	2.76	–	R	–	USGS-NWIS, 2004	
207	2071601	04/17/2002	1,270	2.83	–	R	–	USGS-NWIS, 2004	
207	2071601	09/18/2002	1,220	2.72	–	R	–	USGS-NWIS, 2004	
207	2071601	04/23/2003	1,260	2.81	–	R	–	USGS-NWIS, 2004	
207	2071601	09/10/2003	1,120	2.50	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2071601	04/22/2004	1,200	2.67	–	R	–	USGS-NWIS, 2004	
207	2071601	09/23/2004	1,185	2.64	–	R	–	USGS, 2004	
207	2071601	07/01/2005	1,207	2.69	–	R	–	USGS, 2005	
207	2071601	07/01/2005	1,207	2.69	–	R	–	USGS-NWIS, 2007	
207	2071601	09/21/2005	1,207	2.69	–	R	–	USGS, 2005	
207	2071601	09/21/2005	1,207	2.69	–	R	–	USGS-NWIS, 2007	
207	2071601	04/27/2006	1,145	2.55	–	R	–	USGS, 2006	
207	2071601	09/13/2006	1,297	2.89	–	R	–	USGS, 2006	
207	2071701	07/26/2005	122	0.271	E	F	18.1	SNWA	
207	2071801	01/01/1935	50.0	0.110	–	R	51	Stearns et. Al., 1935	
207	2071801	12/16/1947	134	0.300	–	R	53	Maxey and Eakin, 1949	
207	2071801	07/26/2005	30.0	0.070	F	V	27.3	SNWA	
207	2071901	01/01/1949	900	2.01	–	R	–	USGS-NWIS, 2006	
207	2071901	08/01/1979	700	1.60	–	R	–	Ertec, 1981	
207	2071901	01/16/1985	1,800	4.01	–	R	–	USGS, 1985	
207	2071901	02/03/1986	1,854	4.13	–	R	–	USGS, 1986	
207	2071901	02/11/1987	1,777	3.96	–	R	–	USGS, 1987	
207	2071901	08/11/1987	1,840	4.10	–	R	–	USGS, 1987	
207	2071901	02/23/1988	2,199	4.90	–	R	–	USGS, 1988	
207	2071901	03/14/1989	2,298	5.12	–	R	–	USGS, 1989	
207	2071901	03/22/1990	1,899	4.23	–	R	–	USGS, 1990	
207	2071901	11/08/1990	1,800	4.01	–	R	–	USGS-NWIS, 2006	
207	2072001	01/01/1949	1,300	2.90	–	R	–	USGS-NWIS, 2006	
207	2072001	07/24/1982	1,000	2.23	–	R	–	USGS-NWIS, 2006	
207	2072001	01/17/1985	1,000	2.23	–	R	–	USGS-NWIS, 2006	
207	2072001	02/01/1986	1,400	3.12	–	R	–	USGS-NWIS, 2006	
207	2072001	03/26/1987	800	1.78	–	R	–	USGS-NWIS, 2006	
207	2072001	08/12/1987	800	1.78	–	R	–	USGS-NWIS, 2006	
207	2072001	02/23/1988	800	1.78	–	R	–	USGS-NWIS, 2006	
207	2072001	03/14/1989	600	1.34	–	R	–	USGS-NWIS, 2006	
207	2072001	03/22/1990	800	1.78	–	R	–	USGS-NWIS, 2006	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
207	2072001	11/08/1990	500	1.11	–	R	–	USGS-NWIS, 2006	
207	2072001	03/05/1991	900	2.01	–	R	–	USGS-NWIS, 2006	
207	2072001	10/24/1991	800	1.78	–	R	–	USGS-NWIS, 2006	
207	2072001	03/18/1992	800	1.78	–	R	–	USGS-NWIS, 2006	
207	2072001	10/14/1992	340	0.760	–	R	–	USGS-NWIS, 2006	
207	2072001	05/04/1993	900	2.01	–	R	–	USGS-NWIS, 2006	
207	2072001	10/19/1993	600	1.34	–	R	–	USGS-NWIS, 2006	
207	2072001	03/29/1994	500	1.11	–	R	–	USGS-NWIS, 2006	
207	2072001	10/20/1994	500	1.11	–	R	–	USGS-NWIS, 2006	
209	2090101	11/15/1912	4,039	9.00	–	R	–	Carpenter, 1915	Discharge likely confused with Crystal Springs
209	2090101	01/01/1931	5,368	12.0	–	R	–	Hardman and Miller, 1934	Discharge likely confused with Crystal Springs
209	2090101	01/01/1934	2,949	6.57	–	R	–	Smith, 1938	
209	2090101	01/01/1941	2,926	6.52	–	R	–	Smith, 1942	
209	2090101	01/01/1943	2,872	6.40	–	R	–	Smith, 1944	
209	2090101	03/10/1962	–	–	–	R	26.7	Eakin, 1963	
209	2090101	06/15/1963	2,406	5.36	–	R	–	USGS, 1963	Drainage area not determined
209	2090101	02/07/1965	2,877	6.41	–	R	–	USGS, 1965	
209	2090101	05/19/1965	2,886	6.43	–	R	–	USGS, 1965	
209	2090101	07/13/1965	2,953	6.58	–	R	–	USGS, 1965	
209	2090101	10/12/1965	2,832	6.31	–	R	–	USGS, 1966	
209	2090101	07/29/1982	2,935	6.54	–	R	–	USGS, 1982	
209	2090101	01/21/1985	3,034	6.76	–	R	–	USGS, 1985	
209	2090101	01/28/1986	2,729	6.08	–	R	–	USGS, 1986	
209	2090101	03/25/1987	2,590	5.77	–	R	–	USGS, 1987	
209	2090101	02/12/1988	2,801	6.24	–	R	–	USGS, 1988	
209	2090101	03/14/1990	1,930	4.30	–	R	–	USGS, 1990	
209	2090101	11/05/1990	2,998	6.68	–	R	–	USGS, 1991	
209	2090101	04/03/1991	2,199	4.90	–	R	–	USGS, 1991	
209	2090101	11/04/1991	1,903	4.24	–	R	–	USGS, 1992	
209	2090101	03/25/1992	2,370	5.28	–	R	–	USGS, 1992	
209	2090101	10/14/1992	2,872	6.40	–	R	–	USGS, 1993	
209	2090101	04/20/1993	1,975	4.40	–	R	–	USGS, 1993	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090101	10/19/1993	1,795	4.00	–	R	–	USGS, 1994	
209	2090101	03/29/1994	2,065	4.60	–	R	–	USGS, 1994	
209	2090101	10/18/1994	2,693	6.00	–	R	–	USGS, 1995	
209	2090101	04/16/1997	2,150	4.79	–	R	–	USGS, 1997	
209	2090101	09/23/1997	2,730	6.08	–	R	–	USGS, 1997	
209	2090101	07/19/2004	2,693	6.00	P	E	27	SNWA	
209	2090201	05/24/2004	0.300	0.00	P	E	20.3	SNWA	
209	2090301	11/15/1912	2.00	0.004	–	R	–	Carpenter, 1915	
209	2090301	05/01/1980	4.00	0.010	–	R	15	Bunch and Harrill, 1984	Reported in Delamar Valley
209	2090301	07/19/2004	10.0	0.020	P	E	–	SNWA	
209	2090401	11/16/1912	3,142	7.00	–	R	–	Carpenter, 1915	Discharge is likely confused with Hiko Spring
209	2090401	01/01/1931	2,675	5.96	–	R	–	Hardman and Miller, 1934	Discharge is likely confused with Hiko Spring
209	2090401	01/01/1934	4,470	9.96	–	R	–	Smith, 1938	
209	2090401	01/01/1941	4,345	9.68	–	R	–	Smith, 1942	
209	2090401	01/01/1943	4,264	9.50	–	R	–	Smith, 1944	
209	2090401	03/10/1962	–	–	–	R	27.8	Eakin, 1963	
209	2090401	04/15/1963	–	–	–	R	27.2	Eakin, 1963	
209	2090401	06/17/1963	7,630	17	–	R	–	Eakin, 1963	
209	2090401	06/17/1963	2,078	4.63	–	R	–	USGS, 1963	
209	2090401	07/29/1982	5,431	12.1	–	R	–	USGS, 1982	
209	2090401	01/21/1985	4,937	11.0	–	R	–	USGS, 1985	
209	2090401	06/11/1985	1,445	3.22	–	R	–	USGS-NWIS, 2004	
209	2090401	06/11/1985	1,001	2.23	–	R	–	USGS-NWIS, 2004	
209	2090401	07/26/1985	3,788	8.44	–	R	–	USGS-NWIS, 2004	
209	2090401	08/23/1985	4,892	10.9	–	R	–	USGS-NWIS, 2004	
209	2090401	08/23/1985	3,510	7.82	–	R	–	USGS-NWIS, 2004	
209	2090401	10/14/1985	1,162	2.59	–	R	–	USGS-NWIS, 2004	
209	2090401	12/11/1985	4,937	11.0	–	R	–	USGS-NWIS, 2004	
209	2090401	01/27/1986	4,937	11.0	–	R	–	USGS, 1986	
209	2090401	03/26/1986	4,713	10.5	–	R	–	USGS-NWIS, 2004	
209	2090401	07/17/1986	4,488	10.0	–	R	–	USGS-NWIS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090401	03/26/1987	960	2.14	–	R	–	USGS-NWIS, 2004	
209	2090401	09/11/1987	4,713	10.5	–	R	–	USGS-NWIS, 2004	
209	2090401	11/19/1987	5,161	11.5	–	R	–	USGS-NWIS, 2004	
209	2090401	05/26/1988	1,284	2.86	–	R	–	USGS-NWIS, 2004	
209	2090401	02/28/1989	1,898	4.23	–	R	–	USGS, 1989	
209	2090401	03/14/1990	1,239	2.76	–	R	–	USGS, 1990	
209	2090401	04/19/1990	2,091	4.66	–	R	–	USGS-NWIS, 2004	
209	2090401	05/31/1990	1,378	3.07	–	R	–	USGS-NWIS, 2004	
209	2090401	07/10/1990	4,847	10.8	–	R	–	USGS-NWIS, 2004	
209	2090401	08/16/1990	1,768	3.94	–	R	–	USGS-NWIS, 2004	
209	2090401	10/04/1990	5,386	12.0	–	R	–	USGS-NWIS, 2004	
209	2090401	11/05/1990	5,431	12.1	–	R	–	USGS-NWIS, 2004	
209	2090401	11/15/1990	5,000	11.1	–	R	–	USGS, 1991	
209	2090401	12/18/1990	3,676	8.19	–	R	–	USGS-NWIS, 2004	
209	2090401	01/29/1991	3,425	7.63	–	R	–	USGS-NWIS, 2004	
209	2090401	03/20/1991	4,143	9.23	–	R	–	USGS-NWIS, 2004	
209	2090401	04/29/1991	893	1.99	–	R	–	USGS-NWIS, 2004	
209	2090401	06/14/1991	736	1.64	–	R	–	USGS-NWIS, 2004	
209	2090401	08/01/1991	4,147	9.24	–	R	–	USGS-NWIS, 2004	
209	2090401	09/19/1991	3,784	8.43	–	R	–	USGS-NWIS, 2004	
209	2090401	10/09/1991	3,591	8.00	–	R	–	USGS-NWIS, 2004	
209	2090401	11/04/1991	3,766	8.39	–	R	–	USGS, 1992	
209	2090401	12/08/1991	3,793	8.45	–	R	–	USGS-NWIS, 2004	
209	2090401	01/13/1992	3,820	8.51	–	R	–	USGS-NWIS, 2004	
209	2090401	02/24/1992	3,986	8.88	–	R	–	USGS-NWIS, 2004	
209	2090401	03/25/1992	3,842	8.56	–	R	–	USGS, 1992	
209	2090401	05/18/1992	3,519	7.84	–	R	–	USGS-NWIS, 2004	
209	2090401	06/30/1992	3,734	8.32	–	R	–	USGS-NWIS, 2004	
209	2090401	08/13/1992	3,739	8.33	–	R	–	USGS-NWIS, 2004	
209	2090401	10/05/1992	3,941	8.78	–	R	–	USGS-NWIS, 2004	
209	2090401	10/14/1992	4,354	9.70	–	R	–	USGS, 1993	
209	2090401	11/16/1992	4,048	9.02	–	R	–	USGS-NWIS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090401	01/07/1993	4,358	9.71	–	R	–	USGS-NWIS, 2004	
209	2090401	03/01/1993	3,981	8.87	–	R	–	USGS-NWIS, 2004	
209	2090401	04/20/1993	4,129	9.20	–	R	–	USGS, 1993	
209	2090401	05/25/1993	4,062	9.05	–	R	–	USGS-NWIS, 2004	
209	2090401	06/15/1993	4,268	9.51	–	R	–	USGS-NWIS, 2004	
209	2090401	07/28/1993	4,075	9.08	–	R	–	USGS-NWIS, 2004	
209	2090401	08/31/1993	4,120	9.18	–	R	–	USGS-NWIS, 2004	
209	2090401	10/13/1993	2,558	5.70	–	R	–	USGS-NWIS, 2004	
209	2090401	10/19/1993	4,937	11.0	–	R	–	USGS, 1994	
209	2090401	11/22/1993	5,341	11.9	–	R	–	USGS-NWIS, 2004	
209	2090401	11/23/1993	3,968	8.84	–	R	–	USGS-NWIS, 2004	
209	2090401	01/05/1994	4,488	10.0	–	R	–	USGS-NWIS, 2004	
209	2090401	02/15/1994	5,431	12.1	–	R	–	USGS-NWIS, 2004	
209	2090401	02/15/1994	5,251	11.7	–	R	–	USGS-NWIS, 2004	
209	2090401	03/29/1994	1,840	4.10	–	R	–	USGS, 1994	
209	2090401	05/05/1994	5,790	12.9	–	R	–	USGS-NWIS, 2004	
209	2090401	06/21/1994	5,206	11.6	–	R	–	USGS-NWIS, 2004	
209	2090401	08/02/1994	5,341	11.9	–	R	–	USGS-NWIS, 2004	
209	2090401	10/04/1994	5,431	12.1	–	R	–	USGS-NWIS, 2004	
209	2090401	10/18/1994	4,488	10.0	–	R	–	USGS, 1995	
209	2090401	12/13/1994	5,386	12.0	–	R	–	USGS-NWIS, 2004	
209	2090401	04/16/1997	4,980	11.1	–	R	–	USGS, 1997	
209	2090401	09/23/1997	5,430	12.1	–	R	–	USGS, 1997	
209	2090401	04/29/1998	5,790	12.9	–	R	–	USGS, 1998	
209	2090401	09/22/1998	5,835	13.0	–	R	–	USGS-NWIS, 2004	
209	2090401	09/22/1998	5,830	13.0	–	R	–	USGS, 1998	
209	2090401	01/14/1999	4,937	11.0	–	R	–	USGS-NWIS, 2004	
209	2090401	01/14/1999	4,668	10.4	–	R	–	USGS-NWIS, 2004	
209	2090401	02/22/1999	1,387	3.09	–	R	–	USGS-NWIS, 2004	
209	2090401	04/14/1999	5,072	11.3	–	R	–	USGS-NWIS, 2004	
209	2090401	05/18/1999	5,386	12.0	–	R	–	USGS-NWIS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090401	06/29/1999	5,251	11.7	–	R	–	USGS-NWIS, 2004	
209	2090401	07/12/1999	5,386	12.0	–	R	–	USGS-NWIS, 2004	
209	2090401	08/26/1999	5,521	12.3	–	R	–	USGS-NWIS, 2004	
209	2090401	10/14/1999	5,700	12.7	–	R	–	USGS-NWIS, 2004	
209	2090401	11/17/1999	5,341	11.9	–	R	–	USGS-NWIS, 2004	
209	2090401	01/18/2000	5,251	11.7	–	R	–	USGS-NWIS, 2004	
209	2090401	02/18/2000	5,700	12.7	–	R	–	USGS-NWIS, 2004	
209	2090401	03/30/2000	4,578	10.2	–	R	–	USGS-NWIS, 2004	
209	2090401	04/03/2000	2,015	4.49	–	R	–	USGS-NWIS, 2004	
209	2090401	05/17/2000	5,790	12.9	–	R	–	USGS-NWIS, 2004	
209	2090401	06/20/2000	1,638	3.65	–	R	–	USGS-NWIS, 2004	
209	2090401	08/08/2000	5,655	12.6	–	R	–	USGS-NWIS, 2004	
209	2090401	09/14/2000	1,580	3.52	–	R	–	USGS-NWIS, 2004	
209	2090401	10/05/2000	5,835	13.0	–	R	–	USGS-NWIS, 2004	
209	2090401	01/02/2001	5,790	12.9	–	R	–	USGS-NWIS, 2004	
209	2090401	02/16/2001	5,655	12.6	–	R	–	USGS-NWIS, 2004	
209	2090401	04/19/2001	5,925	13.2	–	R	–	USGS-NWIS, 2004	
209	2090401	06/20/2001	1,943	4.33	–	R	–	USGS-NWIS, 2004	
209	2090401	08/02/2001	5,835	13.0	–	R	–	USGS-NWIS, 2004	
209	2090401	09/11/2001	5,431	12.1	–	R	–	USGS-NWIS, 2004	
209	2090401	10/02/2001	5,431	12.1	–	R	–	USGS-NWIS, 2004	
209	2090401	12/04/2001	6,284	14.0	–	R	–	USGS-NWIS, 2004	
209	2090401	01/23/2002	5,925	13.2	–	R	–	USGS-NWIS, 2004	
209	2090401	04/18/2002	5,790	12.9	–	R	–	USGS-NWIS, 2004	
209	2090401	06/04/2002	2,101	4.68	–	R	–	USGS-NWIS, 2004	
209	2090401	07/16/2002	5,655	12.6	–	R	–	USGS-NWIS, 2004	
209	2090401	09/17/2002	5,835	13.0	–	R	–	USGS-NWIS, 2004	
209	2090401	10/17/2002	5,521	12.3	–	R	–	USGS-NWIS, 2004	
209	2090401	12/03/2002	5,655	12.6	–	R	–	USGS-NWIS, 2004	
209	2090401	02/04/2003	5,700	12.7	–	R	–	USGS-NWIS, 2004	
209	2090401	03/17/2003	2,769	6.17	–	R	–	USGS-NWIS, 2004	
209	2090401	04/22/2003	5,790	12.9	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090401	04/22/2003	5,700	12.7	–	R	–	USGS-NWIS, 2004	
209	2090401	06/26/2003	1,499	3.34	–	R	–	USGS-NWIS, 2004	
209	2090401	09/09/2003	5,655	12.6	–	R	–	USGS-NWIS, 2004	
209	2090401	10/22/2003	5,655	12.6	–	R	–	USGS-NWIS, 2004	
209	2090401	12/03/2003	5,610	12.5	–	R	–	USGS-NWIS, 2004	
209	2090401	02/10/2004	5,835	13.0	–	R	–	USGS-NWIS, 2004	
209	2090401	08/05/2005	3,824	8.52	G	R	–	USGS, 2007	
209	2090401	08/05/2005	3,725	8.30	G	R	–	USGS, 2007	
209	2090401	03/22/2006	3,986	8.88	G	R	–	USGS, 2007	
209	2090401	04/25/2006	3,667	8.17	P	R	–	USGS, 2007	
209	2090401	05/06/2006	3,344	7.45	G	R	–	USGS, 2007	
209	2090401	06/26/2006	3,492	7.78	P	R	–	USGS, 2007	
209	2090501	11/16/1912	8,977	20.0	–	R	–	Carpenter, 1915	
209	2090501	01/01/1931	10,274	22.9	–	R	–	Hardman and Miller, 1934	
209	2090501	01/01/1934	8,662	19.3	–	R	–	Smith, 1938	
209	2090501	01/01/1941	7,002	15.6	–	R	–	Smith, 1942	Summation of 4 irrigation ditches
209	2090501	01/01/1942	7,002	15.6	–	R	–	Smith, 1942	Summation of 5 irrigation ditches
209	2090501	07/04/1943	7,810	17.4	–	R	–	Smith, 1944	
209	2090501	09/03/1943	8,348	18.6	–	R	–	Smith, 1944	
209	2090501	06/17/1963	7,630	17.0	–	R	–	USGS, 1963	
209	2090501	02/07/1965	7,810	17.4	–	R	–	USGS, 1965	
209	2090501	10/12/1965	7,720	17.2	–	R	–	USGS, 1966	
209	2090501	07/30/1982	7,361	16.4	–	R	–	USGS, 1982	
209	2090501	01/21/1985	7,271	16.2	–	R	–	USGS, 1985	
209	2090501	01/27/1986	8,887	19.8	–	R	–	USGS, 1986	
209	2090501	04/16/1987	7,944	17.7	–	R	–	USGS, 1987	
209	2090501	02/12/1988	7,002	15.6	–	R	–	USGS, 1988	
209	2090501	02/27/1989	7,989	17.8	–	R	–	USGS, 1989	
209	2090501	03/14/1990	6,961	15.5	–	R	–	USGS, 1990	
209	2090501	11/05/1990	7,998	17.8	–	R	–	USGS, 1991	
209	2090501	03/19/1991	10,000	22.3	–	R	–	USGS, 1991	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090501	11/04/1991	7,495	16.7	–	R	–	USGS, 1992	
209	2090501	03/25/1992	7,630	17.0	–	R	–	USGS, 1992	
209	2090501	10/14/1992	7,899	17.6	–	R	–	USGS, 1993	
209	2090501	04/20/1993	7,944	17.7	–	R	–	USGS, 1993	
209	2090501	10/19/1993	7,406	16.5	–	R	–	USGS, 1994	
209	2090501	03/29/1994	8,303	18.5	–	R	–	USGS, 1994	
209	2090501	10/18/1994	7,181	16.0	–	R	–	USGS, 1995	
209	2090501	04/16/1997	7,270	16.2	–	R	–	USGS, 1997	
209	2090501	09/23/1997	7,990	17.8	–	R	–	USGS, 1997	
209	2090501	04/28/1998	9,201	20.5	–	R	–	USGS, 1998	
209	2090501	09/22/1998	9,960	22.2	–	R	–	USGS, 1998	
209	2090501	02/22/1999	7,181	16.0	–	R	–	USGS-NWIS, 2004	
209	2090501	04/14/1999	6,149	13.7	–	R	–	USGS-NWIS, 2004	
209	2090501	05/18/1999	6,643	14.8	–	R	–	USGS-NWIS, 2004	
209	2090501	06/29/1999	4,982	11.1	–	R	–	USGS-NWIS, 2004	
209	2090501	07/12/1999	5,117	11.4	–	R	–	USGS-NWIS, 2004	
209	2090501	08/26/1999	7,585	16.9	–	R	–	USGS-NWIS, 2004	
209	2090501	10/14/1999	6,688	14.9	–	R	–	USGS-NWIS, 2004	
209	2090501	11/16/1999	5,386	12.0	–	R	–	USGS-NWIS, 2004	
209	2090501	01/20/2000	4,937	11.0	–	R	–	USGS-NWIS, 2004	
209	2090501	02/18/2000	6,777	15.1	–	R	–	USGS-NWIS, 2004	
209	2090501	03/30/2000	4,475	9.97	–	R	–	USGS-NWIS, 2004	
209	2090501	05/17/2000	6,328	14.1	–	R	–	USGS-NWIS, 2004	
209	2090501	07/11/2000	7,496	16.7	–	R	–	USGS-NWIS, 2004	
209	2090501	08/08/2000	6,777	15.1	–	R	–	USGS-NWIS, 2004	
209	2090501	09/14/2000	7,585	16.9	–	R	–	USGS-NWIS, 2004	
209	2090501	10/05/2000	7,720	17.2	–	R	–	USGS-NWIS, 2004	
209	2090501	01/02/2001	7,720	17.2	–	R	–	USGS-NWIS, 2004	
209	2090501	02/16/2001	7,496	16.7	–	R	–	USGS-NWIS, 2004	
209	2090501	04/19/2001	7,989	17.8	–	R	–	USGS-NWIS, 2004	
209	2090501	06/20/2001	7,092	15.8	–	R	–	USGS-NWIS, 2004	
209	2090501	08/02/2001	5,162	11.5	–	R	–	USGS-NWIS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090501	09/11/2001	7,271	16.2	–	R	–	USGS-NWIS, 2004	
209	2090501	10/02/2001	6,912	15.4	–	R	–	USGS-NWIS, 2004	
209	2090501	12/04/2001	5,925	13.2	–	R	–	USGS-NWIS, 2004	
209	2090501	01/24/2002	4,758	10.6	–	R	–	USGS-NWIS, 2004	
209	2090501	04/18/2002	6,463	14.4	–	R	–	USGS-NWIS, 2004	
209	2090501	06/04/2002	5,880	13.1	–	R	–	USGS-NWIS, 2004	
209	2090501	07/16/2002	6,643	14.8	–	R	–	USGS-NWIS, 2004	
209	2090501	09/17/2002	6,553	14.6	–	R	–	USGS-NWIS, 2004	
209	2090501	10/17/2002	6,777	15.1	–	R	–	USGS-NWIS, 2004	
209	2090501	12/03/2002	6,688	14.9	–	R	–	USGS-NWIS, 2004	
209	2090501	02/04/2003	7,092	15.8	–	R	–	USGS-NWIS, 2004	
209	2090501	03/17/2003	7,271	16.2	–	R	–	USGS-NWIS, 2004	
209	2090501	04/22/2003	7,181	16.0	–	R	–	USGS-NWIS, 2004	
209	2090501	06/26/2003	6,912	15.4	–	R	–	USGS-NWIS, 2004	
209	2090501	09/09/2003	6,553	14.6	–	R	–	USGS-NWIS, 2004	
209	2090501	10/22/2003	6,777	15.1	–	R	–	USGS-NWIS, 2004	
209	2090501	12/03/2003	6,553	14.6	–	R	–	USGS-NWIS, 2004	
209	2090501	02/10/2004	7,047	15.7	–	R	–	USGS-NWIS, 2004	
209	2090501	05/06/2004	6,553	14.6	F	R	–	USGS-NWIS, 2007	
209	2090501	07/29/2004	6,373	14.2	F	R	–	USGS-NWIS, 2007	
209	2090501	09/21/2004	6,957	15.5	–	R	–	USGS-NWIS, 2007	
209	2090501	10/07/2004	6,867	15.3	F	R	–	USGS-NWIS, 2007	
209	2090501	03/17/2005	6,194	13.8	G	R	–	USGS-NWIS, 2007	
209	2090501	04/13/2005	5,655	12.6	G	R	–	USGS-NWIS, 2007	
209	2090501	06/23/2005	5,162	11.5	G	R	–	USGS-NWIS, 2007	
209	2090501	07/18/2005	3,923	8.74	G	R	–	USGS-NWIS, 2007	
209	2090501	09/20/2005	6,104	13.6	G	R	–	USGS-NWIS, 2007	
209	2090501	10/13/2005	6,418	14.3	G	R	–	USGS-NWIS, 2007	
209	2090501	10/24/2005	6,732	15.0	G	R	–	USGS-NWIS, 2007	
209	2090501	11/01/2005	4,802	10.7	G	R	–	USGS-NWIS, 2007	
209	2090501	12/06/2005	5,835	13.0	G	R	–	USGS-NWIS, 2007	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
209	2090501	01/04/2006	5,700	12.7	G	R	–	USGS-NWIS, 2007	
209	2090501	02/22/2006	4,892	10.9	G	R	–	USGS-NWIS, 2007	
209	2090501	03/28/2006	4,892	10.9	F	R	–	USGS-NWIS, 2007	
209	2090501	06/06/2006	5,431	12.1	G	R	–	USGS-NWIS, 2007	
209	2090501	06/26/2006	5,565	12.4	P	R	–	USGS-NWIS, 2007	
209	2090501	08/30/2006	6,598	14.7	G	R	–	USGS-NWIS, 2007	
209	2090501	10/10/2006	6,418	14.3	G	R	–	USGS-NWIS, 2007	
209	2090501	11/09/2006	4,439	9.89	G	R	–	USGS-NWIS, 2007	
209	2090501	01/17/2007	9,740	21.7	F	R	–	USGS-NWIS, 2007	
209	2090701	06/01/1963	224	0.500	–	R	–	Eakin, 1963	Reported as 0.5-1.0 cfs estimate
215	2150201	09/28/1912	898	2.00	–	R	26.7	Hardman and Miller, 1934	
215	2150201	01/31/1966	880	1.96	–	R	26.7	Hess and Mifflin, 1978	
215	2150201	02/05/1968	800	1.78	–	R	–	USGS-NWIS, 2004	
215	2150201	05/18/1977	417	0.930	–	R	–	USGS, 1977	
215	2150201	08/03/1982	696	1.55	–	R	–	USGS, 1982	
215	2150201	01/23/1985	700	1.56	–	R	–	USGS, 1985	
215	2150201	07/24/1985	705	1.57	–	R	–	USGS-NWIS, 2004	
215	2150201	08/21/1985	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	10/15/1985	750	1.67	–	R	–	USGS-NWIS, 2004	
215	2150201	12/12/1985	642	1.43	–	R	–	USGS-NWIS, 2004	
215	2150201	01/28/1986	570	1.27	–	R	–	USGS-NWIS, 2004	
215	2150201	03/18/1986	346	0.770	–	R	–	USGS-NWIS, 2004	Measurement is likely Blue Point Spring.
215	2150201	04/22/1986	839	1.87	–	R	–	USGS-NWIS, 2004	
215	2150201	05/15/1986	624	1.39	–	R	–	USGS-NWIS, 2004	
215	2150201	06/12/1986	696	1.55	–	R	–	USGS-NWIS, 2004	
215	2150201	07/18/1986	732	1.63	–	R	–	USGS-NWIS, 2004	
215	2150201	08/25/1986	696	1.55	–	R	–	USGS-NWIS, 2004	
215	2150201	11/29/1986	646	1.44	–	R	–	USGS-NWIS, 2004	
215	2150201	12/22/1986	579	1.29	–	R	–	USGS-NWIS, 2004	
215	2150201	02/23/1987	718	1.60	–	R	–	USGS-NWIS, 2004	
215	2150201	03/25/1987	606	1.35	–	R	–	USGS-NWIS, 2004	
215	2150201	05/04/1987	714	1.59	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150201	05/29/1987	705	1.57	–	R	–	USGS-NWIS, 2004	
215	2150201	07/23/1987	983	2.19	–	R	–	USGS-NWIS, 2004	
215	2150201	08/28/1987	736	1.64	–	R	–	USGS-NWIS, 2004	
215	2150201	09/30/1987	871	1.94	–	R	–	USGS-NWIS, 2004	
215	2150201	10/28/1987	750	1.67	–	R	–	USGS-NWIS, 2004	
215	2150201	11/20/1987	772	1.72	–	R	–	USGS-NWIS, 2004	
215	2150201	12/22/1987	844	1.88	–	R	–	USGS-NWIS, 2004	
215	2150201	01/29/1988	853	1.90	–	R	–	USGS-NWIS, 2004	
215	2150201	04/18/1988	727	1.62	–	R	–	USGS-NWIS, 2004	
215	2150201	06/02/1988	673	1.50	–	R	–	USGS-NWIS, 2004	
215	2150201	06/28/1988	835	1.86	–	R	–	USGS-NWIS, 2004	
215	2150201	08/09/1988	776	1.73	–	R	–	USGS-NWIS, 2004	
215	2150201	09/20/1988	808	1.80	–	R	–	USGS-NWIS, 2004	
215	2150201	11/04/1988	754	1.68	–	R	–	USGS-NWIS, 2004	
215	2150201	01/25/1989	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	03/16/1989	651	1.45	–	R	–	USGS-NWIS, 2004	
215	2150201	05/09/1989	700	1.56	–	R	–	USGS-NWIS, 2004	
215	2150201	07/05/1989	750	1.67	–	R	–	USGS-NWIS, 2004	
215	2150201	08/07/1989	646	1.44	–	R	–	USGS-NWIS, 2004	
215	2150201	09/18/1989	637	1.42	–	R	–	USGS-NWIS, 2004	
215	2150201	10/04/1989	790	1.76	–	R	–	USGS-NWIS, 2004	
215	2150201	02/28/1990	736	1.64	–	R	–	USGS-NWIS, 2004	
215	2150201	04/23/1990	700	1.56	–	R	–	USGS-NWIS, 2004	
215	2150201	06/07/1990	785	1.75	–	R	–	USGS-NWIS, 2004	
215	2150201	08/16/1990	7,181	16.0	–	R	–	USGS-NWIS, 2004	
215	2150201	08/28/1990	673	1.50	–	R	–	USGS-NWIS, 2004	
215	2150201	10/02/1990	732	1.63	–	R	–	USGS-NWIS, 2004	
215	2150201	11/15/1990	902	2.01	–	R	–	USGS, 1991	
215	2150201	12/20/1990	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	01/30/1991	763	1.70	–	R	–	USGS-NWIS, 2004	
215	2150201	03/14/1991	790	1.76	–	R	–	USGS-NWIS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150201	04/23/1991	714	1.59	–	R	–	USGS-NWIS, 2004	
215	2150201	06/12/1991	646	1.44	–	R	–	USGS-NWIS, 2004	
215	2150201	06/25/1991	687	1.53	–	R	–	USGS-NWIS, 2004	
215	2150201	08/14/1991	592	1.32	–	R	–	USGS-NWIS, 2004	
215	2150201	09/03/1991	642	1.43	–	R	–	USGS-NWIS, 2004	
215	2150201	10/09/1991	763	1.70	–	R	–	USGS-NWIS, 2004	
215	2150201	11/20/1991	727	1.62	–	R	–	USGS-NWIS, 2004	
215	2150201	01/09/1992	619	1.38	–	R	–	USGS-NWIS, 2004	
215	2150201	02/24/1992	521	1.16	–	R	–	USGS-NWIS, 2004	
215	2150201	03/23/1992	512	1.14	–	R	–	USGS, 1992	
215	2150201	04/23/1992	839	1.87	–	R	–	USGS-NWIS, 2004	
215	2150201	05/04/1992	597	1.33	–	R	–	USGS-NWIS, 2004	
215	2150201	06/08/1992	718	1.60	–	R	–	USGS-NWIS, 2004	
215	2150201	07/20/1992	583	1.30	–	R	–	USGS-NWIS, 2004	
215	2150201	08/19/1992	624	1.39	–	R	–	USGS-NWIS, 2004	
215	2150201	10/05/1992	745	1.66	–	R	–	USGS-NWIS, 2004	
215	2150201	10/15/1992	839	1.87	–	R	–	USGS-NWIS, 2004	
215	2150201	11/19/1992	736	1.64	–	R	–	USGS-NWIS, 2004	
215	2150201	01/07/1993	956	2.13	–	R	–	USGS-NWIS, 2004	
215	2150201	02/09/1993	1,073	2.39	–	R	–	USGS-NWIS, 2004	
215	2150201	03/24/1993	803	1.79	–	R	–	USGS-NWIS, 2004	
215	2150201	04/14/1993	700	1.56	–	R	–	USGS-NWIS, 2004	
215	2150201	05/10/1993	615	1.37	–	R	–	USGS-NWIS, 2004	
215	2150201	06/14/1993	790	1.76	–	R	–	USGS-NWIS, 2004	
215	2150201	07/26/1993	781	1.74	–	R	–	USGS-NWIS, 2004	
215	2150201	09/03/1993	745	1.66	–	R	–	USGS-NWIS, 2004	
215	2150201	10/27/1993	835	1.86	–	R	–	USGS-NWIS, 2004	
215	2150201	10/27/1993	364	0.810	–	R	–	USGS-NWIS, 2004	
215	2150201	11/19/1993	714	1.59	–	R	–	USGS-NWIS, 2004	
215	2150201	01/06/1994	745	1.66	–	R	–	USGS-NWIS, 2004	
215	2150201	02/15/1994	776	1.73	–	R	–	USGS-NWIS, 2004	
215	2150201	04/06/1994	754	1.68	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150201	05/16/1994	673	1.50	–	R	–	USGS-NWIS, 2004	
215	2150201	06/20/1994	646	1.44	–	R	–	USGS-NWIS, 2004	
215	2150201	07/29/1994	772	1.72	–	R	–	USGS-NWIS, 2004	
215	2150201	09/12/1994	794	1.77	–	R	–	USGS-NWIS, 2004	
215	2150201	10/18/1994	741	1.65	–	R	–	USGS-NWIS, 2004	
215	2150201	01/03/1995	687	1.53	–	R	–	USGS-NWIS, 2004	
215	2150201	04/03/1995	637	1.42	–	R	–	USGS-NWIS, 2004	
215	2150201	05/25/1995	844	1.88	–	R	–	USGS-NWIS, 2004	
215	2150201	06/21/1995	615	1.37	–	R	–	USGS-NWIS, 2004	
215	2150201	07/27/1995	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	08/02/1995	790	1.76	–	R	–	USGS-NWIS, 2004	
215	2150201	10/02/1995	700	1.56	–	R	–	USGS-NWIS, 2004	
215	2150201	11/20/1995	794	1.77	–	R	–	USGS-NWIS, 2004	
215	2150201	12/12/1995	700	1.56	–	R	–	USGS-NWIS, 2004	
215	2150201	01/17/1996	727	1.62	–	R	–	USGS-NWIS, 2004	
215	2150201	03/05/1996	512	1.14	–	R	–	USGS-NWIS, 2004	
215	2150201	04/15/1996	682	1.52	–	R	–	USGS-NWIS, 2004	
215	2150201	05/28/1996	678	1.51	–	R	–	USGS-NWIS, 2004	
215	2150201	07/08/1996	718	1.60	–	R	–	USGS-NWIS, 2004	
215	2150201	08/14/1996	660	1.47	–	R	–	USGS-NWIS, 2004	
215	2150201	10/03/1996	718	1.60	–	R	–	USGS-NWIS, 2004	
215	2150201	12/02/1996	642	1.43	–	R	–	USGS-NWIS, 2004	
215	2150201	12/26/1996	583	1.30	–	R	–	USGS-NWIS, 2004	
215	2150201	02/14/1997	763	1.70	–	R	–	USGS-NWIS, 2004	
215	2150201	04/04/1997	880	1.96	–	R	–	USGS-NWIS, 2004	
215	2150201	05/30/1997	691	1.54	–	R	–	USGS-NWIS, 2004	
215	2150201	07/08/1997	750	1.67	–	R	–	USGS-NWIS, 2004	
215	2150201	08/28/1997	776	1.73	–	R	–	USGS-NWIS, 2004	
215	2150201	10/02/1997	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	11/20/1997	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	12/30/1997	848	1.89	–	R	–	USGS-NWIS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150201	03/02/1998	956	2.13	–	R	–	USGS-NWIS, 2004	
215	2150201	03/02/1998	871	1.94	–	R	–	USGS-NWIS, 2004	
215	2150201	03/31/1998	736	1.64	–	R	–	USGS-NWIS, 2004	
215	2150201	05/12/1998	750	1.67	–	R	–	USGS-NWIS, 2004	
215	2150201	05/15/1998	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	06/25/1998	808	1.80	–	R	–	USGS-NWIS, 2004	
215	2150201	07/28/1998	799	1.78	–	R	–	USGS-NWIS, 2004	
215	2150201	10/07/1998	821	1.83	–	R	–	USGS-NWIS, 2004	
215	2150201	11/19/1998	741	1.65	–	R	–	USGS-NWIS, 2004	
215	2150201	02/18/1999	651	1.45	–	R	–	USGS-NWIS, 2004	
215	2150201	04/28/1999	781	1.74	–	R	–	USGS-NWIS, 2004	
215	2150201	06/01/1999	839	1.87	–	R	–	USGS-NWIS, 2004	
215	2150201	07/21/1999	745	1.66	–	R	–	USGS-NWIS, 2004	
215	2150201	09/17/1999	803	1.79	–	R	–	USGS-NWIS, 2004	
215	2150201	10/06/1999	857	1.91	–	R	–	USGS-NWIS, 2004	
215	2150201	10/28/1999	821	1.83	–	R	–	USGS-NWIS, 2004	
215	2150201	10/28/1999	790	1.76	–	R	–	USGS-NWIS, 2004	
215	2150201	12/03/1999	741	1.65	–	R	–	USGS-NWIS, 2004	
215	2150201	12/03/1999	723	1.61	–	R	–	USGS-NWIS, 2004	
215	2150201	01/24/2000	745	1.66	–	R	–	USGS-NWIS, 2004	
215	2150201	03/07/2000	763	1.70	–	R	–	USGS-NWIS, 2004	
215	2150201	04/05/2000	794	1.77	–	R	–	USGS-NWIS, 2004	
215	2150201	05/11/2000	741	1.65	–	R	–	USGS-NWIS, 2004	
215	2150201	06/24/2000	759	1.69	–	R	–	USGS-NWIS, 2004	
215	2150201	08/01/2000	808	1.80	–	R	–	USGS-NWIS, 2004	
215	2150201	09/07/2000	776	1.73	–	R	–	USGS-NWIS, 2004	
215	2150201	10/02/2000	754	1.68	–	R	–	USGS-NWIS, 2004	
215	2150201	11/13/2000	781	1.74	–	R	–	USGS-NWIS, 2004	
215	2150201	01/04/2001	768	1.71	–	R	–	USGS-NWIS, 2004	
215	2150201	02/14/2001	808	1.80	–	R	–	USGS-NWIS, 2004	
215	2150201	03/30/2001	871	1.94	–	R	–	USGS-NWIS, 2004	
215	2150201	06/18/2001	844	1.88	–	R	–	USGS-NWIS, 2004	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150201	08/03/2001	763	1.70	--	R	--	USGS-NWIS, 2004	
215	2150201	09/07/2001	759	1.69	--	R	--	USGS-NWIS, 2004	
215	2150201	10/02/2001	916	2.04	--	R	--	USGS-NWIS, 2004	
215	2150201	11/15/2001	521	1.16	--	R	--	USGS-NWIS, 2004	
215	2150201	12/07/2001	664	1.48	--	R	--	USGS-NWIS, 2004	
215	2150201	01/25/2002	664	1.48	--	R	--	USGS-NWIS, 2004	
215	2150201	03/06/2002	705	1.57	--	R	--	USGS-NWIS, 2004	
215	2150201	04/11/2002	570	1.27	--	R	--	USGS-NWIS, 2004	
215	2150201	05/31/2002	687	1.53	--	R	--	USGS-NWIS, 2004	
215	2150201	07/16/2002	772	1.72	--	R	--	USGS-NWIS, 2004	
215	2150201	09/05/2002	907	2.02	--	R	--	USGS-NWIS, 2004	
215	2150201	10/18/2002	925	2.06	--	R	--	USGS-NWIS, 2004	
215	2150201	11/20/2002	624	1.39	--	R	--	USGS-NWIS, 2004	
215	2150201	12/19/2002	934	2.08	--	R	--	USGS-NWIS, 2004	
215	2150201	01/29/2003	763	1.70	--	R	--	USGS-NWIS, 2004	
215	2150201	03/13/2003	606	1.35	--	R	--	USGS-NWIS, 2004	
215	2150201	04/23/2003	969	2.16	--	R	--	USGS-NWIS, 2004	
215	2150201	06/04/2003	624	1.39	--	R	--	USGS-NWIS, 2004	
215	2150201	07/09/2003	588	1.31	--	R	--	USGS-NWIS, 2004	
215	2150201	08/07/2003	754	1.68	--	R	--	USGS-NWIS, 2004	
215	2150201	10/15/2003	696	1.55	--	R	--	USGS-NWIS, 2004	
215	2150201	12/03/2003	561	1.25	--	R	--	USGS-NWIS, 2004	
215	2150201	02/08/2004	727	1.62	--	R	--	USGS-NWIS, 2004	
215	2150201	03/03/2004	727	1.62	--	R	--	USGS-NWIS, 2004	
215	2150201	05/07/2004	754	1.68	--	R	--	USGS-NWIS, 2004	
215	2150201	05/19/2004	776	1.73	--	R	--	USGS-NWIS, 2004	
215	2150201	06/29/2004	727	1.62	--	R	--	USGS-NWIS, 2004	
215	2150201	08/11/2004	754	1.68	--	R	--	USGS-NWIS, 2004	
215	2150201	10/06/2004	664	1.48	--	R	--	USGS-NWIS, 2004	
215	2150301	11/27/1945	400	0.890	--	R	26.7	Hess and Mifflin, 1978	
215	2150301	06/15/1967	150	0.330	--	R	--	USGS-NWIS, 2004	

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Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150301	05/18/1977	247	0.550	–	R	–	USGS, 1977	
215	2150301	12/15/1998	98.7	0.220	–	R	–	USGS-NWIS, 2004	
215	2150301	02/18/1999	162	0.360	–	R	–	USGS-NWIS, 2004	
215	2150301	04/28/1999	206	0.460	–	R	–	USGS-NWIS, 2004	
215	2150301	06/01/1999	215	0.480	–	R	–	USGS-NWIS, 2004	
215	2150301	07/22/1999	215	0.480	–	R	–	USGS-NWIS, 2004	
215	2150301	09/17/1999	184	0.410	–	R	–	USGS-NWIS, 2004	
215	2150301	09/29/1999	292	0.650	–	R	–	USGS-NWIS, 2004	
215	2150301	09/30/1999	256	0.570	–	R	–	USGS-NWIS, 2004	
215	2150301	10/13/1999	224	0.500	–	R	–	USGS-NWIS, 2004	
215	2150301	10/28/1999	283	0.630	–	R	–	USGS-NWIS, 2004	
215	2150301	10/28/1999	260	0.580	–	R	–	USGS-NWIS, 2004	
215	2150301	12/03/1999	265	0.590	–	R	–	USGS-NWIS, 2004	
215	2150301	01/24/2000	301	0.670	–	R	–	USGS-NWIS, 2004	
215	2150301	03/07/2000	202	0.450	–	R	–	USGS-NWIS, 2004	
215	2150301	04/05/2000	283	0.630	–	R	–	USGS-NWIS, 2004	
215	2150301	05/11/2000	215	0.480	–	R	–	USGS-NWIS, 2004	
215	2150301	06/27/2000	283	0.630	–	R	–	USGS-NWIS, 2004	
215	2150301	08/01/2000	269	0.600	–	R	–	USGS-NWIS, 2004	
215	2150301	09/07/2000	233	0.520	–	R	–	USGS-NWIS, 2004	
215	2150301	10/02/2000	220	0.490	–	R	–	USGS-NWIS, 2004	
215	2150301	11/13/2000	256	0.570	–	R	–	USGS-NWIS, 2004	
215	2150301	01/04/2001	242	0.540	–	R	–	USGS-NWIS, 2004	
215	2150301	02/14/2001	242	0.540	–	R	–	USGS-NWIS, 2004	
215	2150301	03/30/2001	251	0.560	–	R	–	USGS-NWIS, 2004	
215	2150301	06/18/2001	269	0.600	–	R	–	USGS-NWIS, 2004	
215	2150301	08/03/2001	283	0.630	–	R	–	USGS-NWIS, 2004	
215	2150301	09/07/2001	269	0.600	–	R	–	USGS-NWIS, 2004	
215	2150301	10/02/2001	292	0.650	–	R	–	USGS-NWIS, 2004	
215	2150301	11/15/2001	229	0.510	–	R	–	USGS-NWIS, 2004	
215	2150301	12/07/2001	224	0.500	–	R	–	USGS-NWIS, 2004	
215	2150301	01/25/2002	211	0.470	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
215	2150301	03/06/2002	224	0.500	–	R	–	USGS-NWIS, 2004	
215	2150301	04/24/2002	269	0.600	–	R	–	USGS-NWIS, 2004	
215	2150301	05/31/2002	211	0.470	–	R	–	USGS-NWIS, 2004	
215	2150301	07/16/2002	220	0.490	–	R	–	USGS-NWIS, 2004	
215	2150301	09/05/2002	220	0.490	–	R	–	USGS-NWIS, 2004	
215	2150301	10/18/2002	224	0.500	–	R	–	USGS-NWIS, 2004	
215	2150301	11/20/2002	139	0.310	–	R	–	USGS-NWIS, 2004	
215	2150301	12/19/2002	224	0.500	–	R	–	USGS-NWIS, 2004	
215	2150301	01/29/2003	126	0.280	–	R	–	USGS-NWIS, 2004	
215	2150301	03/13/2003	184	0.410	–	R	–	USGS-NWIS, 2004	
215	2150301	04/23/2003	175	0.390	–	R	–	USGS-NWIS, 2004	
215	2150301	06/04/2003	211	0.470	–	R	–	USGS-NWIS, 2004	
215	2150301	07/09/2003	233	0.520	–	R	–	USGS-NWIS, 2004	
215	2150301	08/07/2003	175	0.390	–	R	–	USGS-NWIS, 2004	
215	2150301	10/15/2003	175	0.390	–	R	–	USGS-NWIS, 2004	
215	2150301	12/03/2003	283	0.630	–	R	–	USGS-NWIS, 2004	
215	2150301	03/03/2004	206	0.460	–	R	–	USGS-NWIS, 2004	
215	2150301	05/07/2004	224	0.500	–	R	–	USGS-NWIS, 2004	
215	2150301	06/29/2004	126	0.280	–	R	–	USGS-NWIS, 2004	
215	2150301	06/29/2004	121	0.270	–	R	–	USGS-NWIS, 2004	
215	2150301	06/29/2004	98.7	0.220	–	R	–	USGS-NWIS, 2004	
215	2150301	08/11/2004	193	0.430	–	R	–	USGS-NWIS, 2004	
215	2150301	10/13/2004	233	0.520	–	R	–	USGS-NWIS, 2004	
219	2190101	07/11/2002	126	0.280	–	R	–	USGS-NWIS, 2004	
219	2190101	09/13/2002	98.7	0.220	–	R	–	USGS-NWIS, 2004	
219	2190101	10/10/2002	58.4	0.130	–	R	–	USGS-NWIS, 2004	
219	2190101	12/09/2002	44.9	0.100	–	R	–	USGS-NWIS, 2004	
219	2190101	02/06/2003	40.4	0.090	–	R	–	USGS-NWIS, 2004	
219	2190101	03/11/2003	103	0.230	–	R	–	USGS-NWIS, 2004	
219	2190101	04/23/2003	98.7	0.220	–	R	–	USGS-NWIS, 2004	
219	2190101	06/18/2003	44.9	0.100	–	R	–	USGS-NWIS, 2004	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190101	07/16/2003	89.8	0.200	–	R	–	USGS-NWIS, 2004	
219	2190101	08/25/2003	89.8	0.200	–	R	–	USGS-NWIS, 2004	
219	2190101	08/25/2003	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190101	10/07/2003	89.8	0.200	–	R	–	USGS-NWIS, 2004	
219	2190101	12/15/2003	85.3	0.190	–	R	–	USGS-NWIS, 2004	
219	2190101	03/01/2004	89.8	0.200	–	R	–	USGS-NWIS, 2004	
219	2190101	04/06/2004	94.3	0.210	–	R	–	USGS-NWIS, 2004	
219	2190101	05/18/2004	94.3	0.210	–	R	–	USGS-NWIS, 2004	
219	2190101	06/28/2004	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190101	08/12/2004	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190101	10/13/2004	71.8	0.160	–	R	–	USGS-NWIS, 2004	
219	2190101	12/08/2004	80.8	0.180	–	R	–	USGS-NWIS, 2004	
219	2190101	02/19/2005	80.3	0.179	G	R	–	USGS-NWIS, 2006	
219	2190101	04/12/2005	93.4	0.208	G	R	–	USGS-NWIS, 2006	
219	2190101	06/08/2005	108	0.241	G	R	–	USGS-NWIS, 2006	
219	2190101	07/28/2005	113	0.252	G	R	–	USGS-NWIS, 2006	
219	2190101	09/07/2005	97.8	0.218	G	R	–	USGS-NWIS, 2006	
219	2190101	10/14/2005	96.1	0.214	G	R	–	USGS-NWIS, 2006	
219	2190101	12/09/2005	99.6	0.222	G	R	–	USGS-NWIS, 2006	
219	2190101	01/13/2006	101	0.225	G	R	–	USGS-NWIS, 2006	
219	2190101	03/30/2006	113	0.252	F	R	–	USGS-NWIS, 2006	
219	2190101	05/17/2006	119	0.265	G	R	–	USGS-NWIS, 2006	
219	2190101	07/12/2006	110	0.244	G	R	–	USGS-NWIS, 2006	
219	2190101	08/25/2006	107	0.239	F	R	–	USGS-NWIS, 2006	
219	2190101	10/02/2006	93.4	0.208	F	R	–	USGS-NWIS, 2006	
219	2190101	12/12/2006	79.0	0.176	P	R	–	USGS, 2007	
219	2190101	01/30/2007	95.2	0.212	F	R	–	USGS, 2007	
219	2190101	03/12/2007	107	0.239	F	R	–	USGS, 2007	
219	2190101	05/16/2007	107	0.238	F	R	–	USGS, 2007	
219	2190201	10/25/1994	103	0.230	–	R	–	USGS, 1995	
219	2190201	07/11/2002	89.8	0.200	–	R	–	USGS-NWIS, 2004	
219	2190201	09/11/2002	80.8	0.180	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190201	10/10/2002	80.8	0.180	–	R	–	USGS-NWIS, 2004	
219	2190201	11/06/2002	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190201	12/10/2002	80.8	0.180	–	R	–	USGS-NWIS, 2004	
219	2190201	02/06/2003	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190201	03/11/2003	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190201	04/03/2003	76.3	0.170	–	R	–	USGS-NWIS, 2004	
219	2190201	04/03/2003	71.8	0.160	–	R	–	USGS-NWIS, 2004	
219	2190201	04/03/2003	62.8	0.140	–	R	–	USGS-NWIS, 2004	
219	2190201	04/03/2003	62.8	0.140	–	R	–	USGS-NWIS, 2004	
219	2190201	04/03/2003	62.8	0.140	–	R	–	USGS-NWIS, 2004	
219	2190201	04/03/2003	58.4	0.130	–	R	–	USGS-NWIS, 2004	
219	2190201	05/28/2003	71.8	0.160	–	R	–	USGS-NWIS, 2004	
219	2190201	07/16/2003	67.3	0.150	–	R	–	USGS-NWIS, 2004	
219	2190201	08/28/2003	53.9	0.120	–	R	–	USGS-NWIS, 2004	
219	2190201	10/07/2003	44.9	0.100	–	R	–	USGS-NWIS, 2004	
219	2190201	12/15/2003	44.9	0.100	–	R	–	USGS-NWIS, 2004	
219	2190201	03/01/2004	49.4	0.110	–	R	–	USGS-NWIS, 2004	
219	2190201	04/06/2004	53.9	0.120	–	R	–	USGS-NWIS, 2004	
219	2190201	08/12/2004	89.8	0.200	–	R	–	USGS-NWIS, 2004	
219	2190201	10/13/2004	85.3	0.190	–	R	–	USGS-NWIS, 2004	
219	2190201	12/08/2004	94.3	0.210	–	R	–	USGS-NWIS, 2004	
219	2190201	02/19/2005	112	0.250	F	R	–	USGS-NWIS, 2006	
219	2190201	04/12/2005	108	0.240	G	R	–	USGS-NWIS, 2006	
219	2190201	06/08/2005	112	0.250	G	R	–	USGS-NWIS, 2006	
219	2190201	07/28/2005	121	0.270	G	R	–	USGS-NWIS, 2006	
219	2190201	09/07/2005	130	0.290	F	R	–	USGS-NWIS, 2006	
219	2190201	10/14/2005	112	0.250	G	R	–	USGS-NWIS, 2006	
219	2190201	12/06/2005	126	0.280	G	R	–	USGS-NWIS, 2006	
219	2190201	01/13/2006	121	0.270	G	R	–	USGS-NWIS, 2006	
219	2190201	03/30/2006	128	0.286	F	R	–	USGS-NWIS, 2006	
219	2190201	07/12/2006	121	0.270	G	R	–	USGS-NWIS, 2006	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190201	08/25/2006	112	0.250	F	R	–	USGS-NWIS, 2006	
219	2190201	10/20/2006	113	0.252	F	R	–	USGS-NWIS, 2006	
219	2190201	12/12/2006	98.3	0.219	F	R	–	USGS-NWIS, 2007	
219	2190201	01/30/2007	111	0.248	F	R	–	USGS-NWIS, 2007	
219	2190201	03/12/2007	134	0.299	F	R	–	USGS-NWIS, 2007	
219	2190201	05/16/2007	115	0.257	F	R	–	USGS-NWIS, 2007	
219	2190301	07/15/1992	512	1.14	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1992	390	0.870	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1992	467	1.04	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1992	592	1.32	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/1992	471	1.05	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/1993	471	1.05	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/1993	480	1.07	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/1993	453	1.01	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1993	561	1.25	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1993	516	1.15	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/1993	682	1.52	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/1993	359	0.800	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1993	426	0.950	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1993	453	1.01	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190301	10/15/1993	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1993	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1994	781	1.74	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1994	548	1.22	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/1994	530	1.18	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/1994	646	1.44	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1994	646	1.44	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1994	664	1.48	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/1994	310	0.690	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1994	426	0.950	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/1994	503	1.12	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/1995	673	1.50	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/1995	435	0.970	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/1995	422	0.940	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1995	449	1.00	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1995	718	1.60	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/1995	462	1.03	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190301	07/15/1995	449	1.00	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1995	413	0.920	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1995	467	1.04	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/1995	422	0.940	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1995	426	0.950	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/1995	422	0.940	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/1996	395	0.880	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/1996	390	0.870	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/1996	417	0.930	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1996	422	0.940	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1996	413	0.920	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/1996	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/1996	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1996	408	0.910	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1996	462	1.03	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/1996	435	0.970	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1996	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/1996	404	0.900	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190301	01/15/1997	417	0.930	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/1997	408	0.910	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/1997	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1997	417	0.930	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1997	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/1997	399	0.890	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/1997	413	0.920	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1997	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1997	453	1.01	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/1997	449	1.00	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1997	390	0.870	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/1997	408	0.910	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/1998	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/1998	413	0.920	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/1998	408	0.910	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1998	422	0.940	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1998	539	1.20	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190301	06/15/1998	462	1.03	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/1998	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1998	462	1.03	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1998	435	0.970	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/1998	458	1.02	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1998	480	1.07	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/1998	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/1999	476	1.06	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/1999	453	1.01	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/1999	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/1999	413	0.920	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/1999	449	1.00	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/1999	435	0.970	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/1999	426	0.950	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/1999	399	0.890	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/1999	413	0.920	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/1999	301	0.670	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/1999	453	1.01	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190301	12/15/1999	390	0.870	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/2000	435	0.970	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/2000	404	0.900	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/2000	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/2000	390	0.870	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/2000	382	0.850	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/2000	386	0.860	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/2000	404	0.900	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/2000	408	0.910	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/2000	382	0.850	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/2000	382	0.850	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/2000	489	1.09	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/2000	377	0.840	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/2001	480	1.07	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/2001	422	0.940	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/2001	453	1.01	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/2001	417	0.930	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190301	05/15/2001	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/2001	462	1.03	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/2001	404	0.900	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/2001	462	1.03	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/2001	395	0.880	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/15/2001	408	0.910	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	11/15/2001	440	0.980	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	12/15/2001	525	1.17	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	01/15/2002	390	0.870	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	02/15/2002	417	0.930	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	03/15/2002	431	0.960	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	04/15/2002	404	0.900	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	05/15/2002	404	0.900	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	06/15/2002	444	0.990	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	07/15/2002	399	0.890	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	08/15/2002	449	1.00	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	09/15/2002	364	0.810	–	R	–	Moapa Valley Water District	Average monthly discharge based on totalizing meter readings
219	2190301	10/01/2004	1,225	2.73	G	F	–	SNWA	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190401	01/13/2006	443	0.987	–	R	–	USGS, 2006	
219	2190401	09/11/2006	1,688	3.76	–	R	–	USGS, 2006	
219	2190501	08/01/1982	3,582	7.98	–	R	–	USGS, 1982	
219	2190501	01/22/1985	3,133	6.98	–	R	–	USGS, 1985	
219	2190501	01/28/1986	3,384	7.54	–	R	–	USGS, 1986	
219	2190501	07/16/2002	3,591	8.00	–	R	–	USGS-NWIS, 2004	
219	2190501	09/13/2002	3,636	8.10	–	R	–	USGS-NWIS, 2004	
219	2190501	10/01/2002	3,568	7.95	–	R	–	USGS-NWIS, 2004	
219	2190501	12/16/2002	3,272	7.29	–	R	–	USGS-NWIS, 2004	
219	2190501	02/06/2003	2,967	6.61	–	R	–	USGS-NWIS, 2004	
219	2190501	03/24/2003	2,962	6.60	–	R	–	USGS-NWIS, 2004	
219	2190501	06/11/2003	3,757	8.37	–	R	–	USGS-NWIS, 2004	
219	2190501	07/22/2003	3,142	7.00	–	R	–	USGS-NWIS, 2004	
219	2190501	09/09/2003	3,218	7.17	–	R	–	USGS-NWIS, 2004	
219	2190501	10/07/2003	3,218	7.17	–	R	–	USGS-NWIS, 2004	
219	2190501	12/15/2003	1,432	3.19	–	R	–	USGS-NWIS, 2004	
219	2190501	03/01/2004	2,554	5.69	–	R	–	USGS-NWIS, 2004	
219	2190501	05/03/2004	2,518	5.61	–	R	–	USGS-NWIS, 2004	
219	2190501	05/18/2004	3,420	7.62	–	R	–	USGS-NWIS, 2004	
219	2190501	06/30/2004	3,312	7.38	–	R	–	USGS-NWIS, 2004	
219	2190501	08/12/2004	3,514	7.83	–	R	–	USGS-NWIS, 2004	
219	2190501	10/13/2004	3,371	7.51	–	R	–	USGS-NWIS, 2004	
219	2190501	12/09/2004	3,420	7.62	–	R	–	USGS-NWIS, 2004	
219	2190501	02/18/2005	2,859	6.37	P	R	–	USGS-NWIS, 2006	
219	2190501	04/12/2005	3,528	7.86	F	R	–	USGS-NWIS, 2006	
219	2190501	06/08/2005	3,101	6.91	P	R	–	USGS-NWIS, 2006	
219	2190501	07/26/2005	2,886	6.43	P	R	–	USGS-NWIS, 2006	
219	2190501	09/07/2005	3,088	6.88	P	R	–	USGS-NWIS, 2006	
219	2190501	10/14/2005	1,876	4.18	G	R	–	USGS-NWIS, 2006	
219	2190501	12/06/2005	3,348	7.46	F	R	–	USGS-NWIS, 2006	
219	2190501	03/10/2006	3,299	7.35	P	R	–	USGS-NWIS, 2006	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190501	05/17/2006	3,353	7.47	P	–	–	USGS-NWIS, 2006	
219	2190501	07/12/2006	3,187	7.10	P	R	–	USGS-NWIS, 2006	
219	2190501	08/25/2006	3,101	6.91	F	R	–	USGS-NWIS, 2006	
219	2190501	10/18/2006	2,733	6.09	F	R	–	USGS-NWIS, 2006	
219	2190501	01/10/2007	3,097	6.90	F	R	–	USGS, 2007	
219	2190501	03/12/2007	3,766	8.39	P	R	–	USGS-NWIS, 2007	
219	2190601	07/11/2002	4,004	8.92	–	R	–	USGS-NWIS, 2004	
219	2190601	09/13/2002	3,869	8.62	–	R	–	USGS-NWIS, 2004	
219	2190601	10/01/2002	3,577	7.97	–	R	–	USGS-NWIS, 2004	
219	2190601	12/09/2002	3,941	8.78	–	R	–	USGS-NWIS, 2004	
219	2190601	01/27/2003	3,941	8.78	–	R	–	USGS-NWIS, 2004	
219	2190601	03/11/2003	4,044	9.01	–	R	–	USGS-NWIS, 2004	
219	2190601	04/21/2003	4,183	9.32	–	R	–	USGS-NWIS, 2004	
219	2190601	06/11/2003	3,972	8.85	–	R	–	USGS-NWIS, 2004	
219	2190601	07/14/2003	3,905	8.70	–	R	–	USGS-NWIS, 2004	
219	2190601	08/27/2003	3,802	8.47	–	R	–	USGS-NWIS, 2004	
219	2190601	10/07/2003	3,770	8.40	–	R	–	USGS-NWIS, 2004	
219	2190601	12/15/2003	4,138	9.22	–	R	–	USGS-NWIS, 2004	
219	2190601	03/01/2004	4,363	9.72	–	R	–	USGS-NWIS, 2004	
219	2190601	04/06/2004	4,197	9.35	–	R	–	USGS-NWIS, 2004	
219	2190601	05/18/2004	3,833	8.54	–	R	–	USGS-NWIS, 2004	
219	2190601	06/30/2004	3,532	7.87	–	R	–	USGS-NWIS, 2004	
219	2190601	08/12/2004	3,653	8.14	–	R	–	USGS-NWIS, 2004	
219	2190601	10/13/2004	3,555	7.92	–	R	–	USGS-NWIS, 2004	
219	2190601	12/09/2004	4,048	9.02	–	R	–	USGS-NWIS, 2004	
219	2190701	09/01/1963	1,700	3.79	–	R	–	USGS-NWIS, 2004	
219	2190701	03/12/1987	600	1.34	–	R	–	USGS-NWIS, 2004	
219	2190701	02/03/1988	500	1.11	–	R	–	USGS-NWIS, 2004	
219	2190701	02/08/1989	310	0.690	–	R	–	USGS, 1989	
219	2190701	03/28/1990	512	1.14	–	R	–	USGS, 1990	
219	2190701	11/07/1990	498	1.11	–	R	–	USGS, 1991	
219	2190701	03/13/1991	700	1.56	–	R	–	USGS, 1991	

Table B.1-1
Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190701	11/13/1991	489	1.09	–	R	–	USGS, 1992	
219	2190701	04/01/1992	444	0.990	–	R	–	USGS, 1992	
219	2190701	10/13/1992	539	1.20	–	R	–	USGS, 1993	
219	2190701	04/15/1993	539	1.20	–	R	–	USGS, 1993	
219	2190701	10/22/1993	435	0.970	–	R	–	USGS, 1994	
219	2190701	04/06/1994	269	0.600	–	R	–	USGS, 1994	
219	2190701	10/25/1994	494	1.10	–	R	–	USGS, 1995	
219	2190701	04/14/1997	803	1.79	–	R	–	USGS-NWIS, 2004	
219	2190701	10/02/1997	287	0.640	–	R	–	USGS-NWIS, 2004	
219	2190701	04/13/1999	485	1.08	–	R	–	USGS-NWIS, 2004	
219	2190701	04/13/1999	445	0.990	–	R	–	USGS-NWIS, 2004	
219	2190701	09/07/1999	503	1.12	–	R	–	USGS, 1999	
219	2190701	04/14/2000	530	1.18	–	R	–	USGS-NWIS, 2004	
219	2190701	09/12/2000	530	1.18	–	R	–	USGS-NWIS, 2004	
219	2190701	04/26/2001	427	0.950	–	R	–	USGS-NWIS, 2004	
219	2190701	09/17/2001	669	1.49	–	R	–	USGS-NWIS, 2004	
219	2190701	04/22/2002	527	1.17	–	R	–	USGS, 2002	
219	2190701	04/21/2003	471	1.05	–	R	–	USGS-NWIS, 2004	
219	2190701	09/16/2003	458	1.02	–	R	–	USGS-NWIS, 2004	
219	2190701	04/20/2004	350	0.780	–	R	–	USGS, 2004	
219	2190701	09/21/2004	370	0.824	–	R	–	USGS, 2004	
219	2190701	01/13/2006	184	0.411	–	R	–	USGS, 2006	
219	2190701	09/11/2006	380	0.847	–	R	–	USGS, 2006	
219	2190801	03/12/1987	440	0.980	–	R	–	USGS-NWIS, 2004	
219	2190801	02/03/1988	50.0	0.110	–	R	–	USGS-NWIS, 2004	
219	2190801	02/08/1989	71.8	0.160	–	R	–	USGS, 1989	
219	2190801	03/28/1990	31.4	0.070	–	R	–	USGS, 1990	
219	2190801	11/07/1990	89.8	0.200	–	R	–	USGS, 1991	
219	2190801	03/13/1991	35.9	0.080	–	R	–	USGS, 1991	
219	2190801	11/13/1991	44.9	0.100	–	R	–	USGS, 1992	
219	2190801	04/01/1992	35.9	0.080	–	R	–	USGS, 1992	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190801	10/13/1992	22.4	0.050	–	R	–	USGS, 1993	
219	2190801	04/15/1993	121	0.270	–	R	–	USGS, 1993	
219	2190801	10/22/1993	18.0	0.040	–	R	–	USGS, 1994	
219	2190801	04/06/1994	26.9	0.060	–	R	–	USGS, 1994	
219	2190801	10/25/1994	40.4	0.090	–	R	–	USGS, 1995	
219	2190801	04/28/1998	96.0	0.210	–	R	–	USGS-NWIS, 2004	
219	2190801	09/22/1998	152	0.340	–	R	–	USGS-NWIS, 2004	
219	2190801	04/13/1999	127	0.280	–	R	–	USGS-NWIS, 2004	
219	2190801	04/13/1999	125	0.280	–	R	–	USGS-NWIS, 2004	
219	2190801	09/07/1999	153	0.340	–	R	–	USGS-NWIS, 2004	
219	2190801	04/14/2000	167	0.370	–	R	–	USGS-NWIS, 2004	
219	2190801	09/12/2000	146	0.330	–	R	–	USGS-NWIS, 2004	
219	2190801	04/26/2001	158	0.350	–	R	–	USGS-NWIS, 2004	
219	2190801	09/17/2001	149	0.330	–	R	–	USGS-NWIS, 2004	
219	2190801	04/22/2002	173	0.380	–	R	–	USGS, 2002	
219	2190801	04/21/2003	114	0.250	–	R	–	USGS-NWIS, 2004	
219	2190801	09/16/2003	130	0.290	–	R	–	USGS-NWIS, 2004	
219	2190801	04/20/2004	140	0.312	–	R	–	USGS, 2004	
219	2190801	09/21/2004	140	0.312	–	R	–	USGS, 2004	
219	2190801	01/13/2006	49.0	0.109	–	R	–	USGS, 2006	
219	2190801	09/11/2006	146	0.326	–	R	–	USGS, 2006	
219	2190901	01/28/1986	350	0.780	–	R	–	USGS-NWIS, 2004	
219	2190901	03/12/1987	270	0.600	–	R	–	USGS-NWIS, 2004	
219	2190901	02/02/1988	250	0.560	–	R	–	USGS-NWIS, 2004	
219	2190901	02/08/1989	130	0.290	–	R	–	USGS, 1989	
219	2190901	03/28/1990	148	0.330	–	R	–	USGS, 1990	
219	2190901	11/07/1990	238	0.530	–	R	–	USGS, 1991	
219	2190901	03/13/1991	130	0.290	–	R	–	USGS, 1991	
219	2190901	11/13/1991	184	0.410	–	R	–	USGS, 1992	
219	2190901	04/01/1992	247	0.550	–	R	–	USGS, 1992	
219	2190901	10/13/1992	121	0.270	–	R	–	USGS, 1993	
219	2190901	04/15/1993	171	0.380	–	R	–	USGS, 1993	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2190901	10/22/1993	148	0.330	–	R	–	USGS, 1994	
219	2190901	04/06/1994	256	0.570	–	R	–	USGS, 1994	
219	2190901	10/25/1994	274	0.610	–	R	–	USGS, 1995	
219	2190901	04/14/1997	327	0.730	–	R	–	USGS-NWIS, 2004	
219	2190901	10/02/1997	462	1.03	–	R	–	USGS-NWIS, 2004	
219	2190901	04/28/1998	274	0.610	–	R	–	USGS-NWIS, 2004	
219	2190901	09/22/1998	342	0.760	–	R	–	USGS-NWIS, 2004	
219	2190901	04/13/1999	243	0.540	–	R	–	USGS-NWIS, 2004	
219	2190901	04/13/1999	237	0.530	–	R	–	USGS-NWIS, 2004	
219	2190901	09/07/1999	328	0.730	–	R	–	USGS-NWIS, 2004	
219	2190901	04/14/2000	363	0.810	–	R	–	USGS-NWIS, 2004	
219	2190901	09/12/2000	361	0.800	–	R	–	USGS-NWIS, 2004	
219	2190901	04/26/2001	417	0.930	–	R	–	USGS-NWIS, 2004	
219	2190901	09/17/2001	330	0.740	–	R	–	USGS-NWIS, 2004	
219	2190901	04/22/2002	436	0.970	–	R	–	USGS, 2002	
219	2190901	04/21/2003	303	0.670	–	R	–	USGS-NWIS, 2004	
219	2190901	09/16/2003	350	0.780	–	R	–	USGS-NWIS, 2004	
219	2190901	04/20/2004	260	0.579	–	R	–	USGS, 2004	
219	2190901	09/21/2004	480	1.07	–	R	–	USGS, 2004	
219	2190901	01/13/2006	245	0.545	–	R	–	USGS, 2006	
219	2190901	09/11/2006	521	1.16	–	R	–	USGS, 2006	
219	2191001	02/09/1988	1,198	2.67	–	R	–	USGS, 1988	
219	2191001	03/28/1990	830	1.85	–	R	–	USGS, 1990	
219	2191001	11/07/1990	902	2.01	–	R	–	USGS, 1991	
219	2191001	11/13/1990	902	2.01	–	R	–	USGS, 1991	
219	2191001	03/13/1991	1,198	2.67	–	R	–	USGS, 1991	
219	2191001	11/13/1991	426	0.950	–	R	–	USGS, 1992	
219	2191001	04/01/1992	543	1.21	–	R	–	USGS, 1992	
219	2191001	10/13/1992	583	1.30	–	R	–	USGS, 1993	
219	2191001	04/15/1993	763	1.70	–	R	–	USGS, 1993	
219	2191001	10/22/1993	718	1.60	–	R	–	USGS, 1994	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2191001	04/06/1994	763	1.70	–	R	–	USGS, 1994	
219	2191001	10/25/1994	853	1.90	–	R	–	USGS, 1995	
219	2191001	04/14/1997	660	1.47	–	R	–	USGS, 1997	
219	2191001	10/25/1997	696	1.55	–	R	–	USGS, 1998	
219	2191001	04/28/1998	880	1.96	–	R	–	USGS, 1998	
219	2191001	09/22/1998	768	1.71	–	R	–	USGS, 1998	
219	2191001	04/14/2000	579	1.29	–	R	–	USGS, 2000	
219	2191001	09/11/2000	615	1.37	–	R	–	USGS, 2000	
219	2191001	04/26/2001	660	1.47	–	R	–	USGS, 2001	
219	2191001	09/17/2001	642	1.43	–	R	–	USGS, 2001	
219	2191001	04/22/2002	722	1.61	–	R	–	USGS, 2002	
219	2191001	04/21/2003	607	1.35	–	R	–	USGS, 2003	
219	2191001	09/16/2003	623	1.39	–	R	–	USGS, 2003	
219	2191001	04/20/2004	870	1.94	–	R	–	USGS, 2004	
219	2191001	09/21/2004	920	2.05	–	R	–	USGS, 2004	
219	2191001	01/13/2006	28.0	0.062	–	R	–	USGS, 2006	
219	2191001	09/11/2006	10.8	0.024	–	R	–	USGS, 2006	
219	2191101	02/14/1989	162	0.360	–	R	–	USGS, 1989	
219	2191101	03/28/1990	80.8	0.180	–	R	–	USGS, 1990	
219	2191101	11/07/1990	98.7	0.220	–	R	–	USGS, 1991	
219	2191101	03/13/1991	89.8	0.200	–	R	–	USGS, 1991	
219	2191101	11/13/1991	80.8	0.180	–	R	–	USGS, 1992	
219	2191101	04/01/1992	112	0.250	–	R	–	USGS, 1992	
219	2191101	10/13/1992	89.8	0.200	–	R	–	USGS, 1993	
219	2191101	04/15/1993	31.4	0.070	–	R	–	USGS, 1993	
219	2191101	10/22/1993	62.8	0.140	–	R	–	USGS, 1994	
219	2191101	04/06/1994	89.8	0.200	–	R	–	USGS, 1994	
219	2191101	10/25/1994	94.3	0.210	–	R	–	USGS, 1995	
219	2191101	04/28/1998	118	0.260	–	R	–	USGS, 1998	
219	2191101	09/22/1998	140	0.310	–	R	–	USGS, 1998	
219	2191101	01/14/2000	128	0.290	–	R	–	USGS, 2000	
219	2191101	09/11/2000	114	0.250	–	R	–	USGS, 2000	

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219	2191101	04/26/2001	107	0.240	–	R	–	USGS, 2001	
219	2191101	09/17/2001	143	0.320	–	R	–	USGS, 2001	
219	2191101	04/22/2002	161	0.360	–	R	–	USGS, 2002	
219	2191101	04/21/2003	116	0.260	–	R	–	USGS, 2003	
219	2191101	09/16/2003	114	0.250	–	R	–	USGS, 2003	
219	2191101	04/20/2004	90.0	0.200	–	R	–	USGS, 2004	
219	2191101	09/21/2004	120	0.270	–	R	–	USGS, 2004	
219	2191101	01/13/2006	660	1.47	–	R	–	USGS, 2006	
219	2191101	09/11/2006	188	0.418	–	R	–	USGS, 2006	
219	2191201	04/28/1998	440	0.980	–	R	–	USGS-NWIS, 2004	
219	2191201	09/22/1998	369	0.820	–	R	–	USGS-NWIS, 2004	
219	2191201	04/13/1999	436	0.970	–	R	–	USGS-NWIS, 2004	
219	2191201	04/13/1999	433	0.960	–	R	–	USGS-NWIS, 2004	
219	2191201	09/07/1999	392	0.870	–	R	–	USGS-NWIS, 2004	
219	2191201	04/14/2000	443	0.990	–	R	–	USGS-NWIS, 2004	
219	2191201	09/12/2000	360	0.800	–	R	–	USGS-NWIS, 2004	
219	2191201	04/26/2001	414	0.920	–	R	–	USGS-NWIS, 2004	
219	2191201	09/17/2001	370	0.820	–	R	–	USGS-NWIS, 2004	
219	2191201	04/22/2002	427	0.950	–	R	–	USGS, 2002	
219	2191201	04/21/2003	473	1.05	–	R	–	USGS-NWIS, 2004	
219	2191201	09/16/2003	435	0.970	–	R	–	USGS-NWIS, 2004	
219	2191201	04/20/2004	330	0.735	–	R	–	USGS, 2004	
219	2191201	09/21/2004	430	0.958	–	R	–	USGS, 2004	
219	2191201	01/13/2006	316	0.703	–	R	–	USGS, 2006	
219	2191201	09/11/2006	552	1.23	–	R	–	USGS, 2006	
219	2191301	04/19/1999	343	0.760	–	R	–	USGS, 1999	
219	2191301	04/19/1999	336	0.750	–	R	–	USGS, 1999	
219	2191301	09/07/1999	295	0.660	–	R	–	USGS, 1999	
219	2191301	04/14/2000	326	0.730	–	R	–	USGS, 2000	
219	2191301	09/11/2000	309	0.690	–	R	–	USGS, 2000	
219	2191301	04/26/2001	254	0.570	–	R	–	USGS, 2001	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2191301	09/17/2001	284	0.630	–	R	–	USGS, 2001	
219	2191301	04/22/2002	245	0.550	–	R	–	USGS, 2002	
219	2191301	04/21/2003	323	0.720	–	R	–	USGS, 2003	
219	2191301	09/16/2003	354	0.790	–	R	–	USGS, 2003	
219	2191301	04/20/2004	380	0.850	–	R	–	USGS, 2004	
219	2191301	09/21/2004	320	0.710	–	R	–	USGS, 2004	
219	2191301	01/13/2006	351	0.781	–	R	–	USGS, 2006	
219	2191301	09/11/2006	956	2.13	–	R	–	USGS, 2006	
219	2191401	08/02/1982	1,225	2.73	–	R	–	USGS, 1982	
219	2191401	01/22/1985	1,059	2.36	–	R	–	USGS, 1985	
219	2191401	01/28/1986	983	2.19	–	R	–	USGS, 1986	
219	2191401	03/12/1987	1,059	2.36	–	R	–	USGS, 1987	
219	2191401	11/13/1991	893	1.99	–	R	–	USGS, 1992	
219	2191401	04/01/1992	794	1.77	–	R	–	USGS, 1992	
219	2191401	10/13/1992	1,122	2.50	–	R	–	USGS, 1993	
219	2191401	04/15/1993	1,077	2.40	–	R	–	USGS, 1993	
219	2191401	10/22/1993	1,167	2.60	–	R	–	USGS, 1994	
219	2191401	04/06/1994	1,122	2.50	–	R	–	USGS, 1994	
219	2191401	10/25/1995	274	0.610	–	R	–	USGS, 1995	
219	2191401	04/14/1997	318	0.710	–	R	–	USGS, 1997	
219	2191401	10/02/1997	462	1.03	–	R	–	USGS, 1998	
219	2191401	04/28/1998	274	0.610	–	R	–	USGS, 1998	
219	2191401	09/22/1998	342	0.760	–	R	–	USGS, 1998	
219	2191401	09/07/1999	951	2.12	–	R	–	USGS, 1999	
219	2191401	04/14/2000	1,140	2.54	–	R	–	USGS, 2000	
219	2191401	09/11/2000	1,110	2.47	–	R	–	USGS, 2000	
219	2191401	04/26/2001	1,080	2.41	–	R	–	USGS, 2001	
219	2191401	09/17/2001	1,240	2.76	–	R	–	USGS, 2001	
219	2191401	04/22/2002	1,293	2.88	–	R	–	USGS, 2002	
219	2191401	04/21/2003	948	2.11	–	R	–	USGS, 2003	
219	2191401	09/16/2003	1,021	2.27	–	R	–	USGS, 2003	
219	2191401	04/20/2004	1,475	3.29	–	R	–	USGS, 2004	

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Disch arge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2191401	09/21/2004	1,780	3.97	–	R	–	USGS, 2004	
219	2191401	01/13/2006	1,311	2.92	–	R	–	USGS, 2006	
219	2191401	09/11/2006	1,486	3.31	–	R	–	USGS, 2006	
219	2191501	07/31/1982	1,638	3.65	–	R	–	USGS, 1982	
219	2191501	07/31/1982	1,600	3.56	–	R	–	USGS-NWIS, 2004	
219	2191501	07/31/1982	1,500	3.34	–	R	–	USGS-NWIS, 2004	
219	2191501	01/22/1985	1,364	3.04	–	R	–	USGS, 1985	
219	2191501	08/22/1985	1,600	3.56	–	R	–	USGS-NWIS, 2004	
219	2191501	10/15/1985	1,454	3.24	–	R	–	USGS, 1986	
219	2191501	12/11/1985	1,535	3.42	–	R	–	USGS, 1986	
219	2191501	01/28/1986	1,620	3.61	–	R	–	USGS, 1986	
219	2191501	04/01/1992	1,400	3.12	–	R	–	USGS, 1992	
219	2191501	07/11/2002	1,086	2.42	–	R	–	USGS-NWIS, 2004	
219	2191501	09/13/2002	1,203	2.68	–	R	–	USGS-NWIS, 2004	
219	2191501	10/10/2002	1,346	3.00	–	R	–	USGS-NWIS, 2004	
219	2191501	12/09/2002	1,526	3.40	–	R	–	USGS-NWIS, 2004	
219	2191501	02/06/2003	1,373	3.06	–	R	–	USGS-NWIS, 2004	
219	2191501	03/11/2003	1,643	3.66	–	R	–	USGS-NWIS, 2004	
219	2191501	04/23/2003	1,683	3.75	–	R	–	USGS-NWIS, 2004	
219	2191501	06/11/2003	1,625	3.62	–	R	–	USGS-NWIS, 2004	
219	2191501	07/17/2003	1,607	3.58	–	R	–	USGS-NWIS, 2004	
219	2191501	08/27/2003	1,719	3.83	–	R	–	USGS-NWIS, 2004	
219	2191501	10/07/2003	1,553	3.46	–	R	–	USGS-NWIS, 2004	
219	2191501	12/15/2003	1,522	3.39	–	R	–	USGS-NWIS, 2004	
219	2191501	03/01/2004	1,988	4.43	–	R	–	USGS-NWIS, 2004	
219	2191501	04/06/2004	1,679	3.74	–	R	–	USGS-NWIS, 2004	
219	2191501	05/18/2004	1,499	3.34	–	R	–	USGS-NWIS, 2004	
219	2191501	06/30/2004	1,382	3.08	–	R	–	USGS-NWIS, 2004	
219	2191501	08/12/2004	1,293	2.88	–	R	–	USGS-NWIS, 2004	
219	2191501	10/13/2004	1,333	2.97	–	R	–	USGS-NWIS, 2004	
219	2191501	12/09/2004	1,418	3.16	–	R	–	USGS-NWIS, 2004	

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Discharge Measurement of Selected Springs
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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
219	2191501	02/18/2005	1,436	3.20	P	R	--	USGS-NWIS, 2006	
219	2191501	04/12/2005	1,539	3.43	P	R	--	USGS-NWIS, 2006	
219	2191501	06/08/2005	1,593	3.55	G	R	--	USGS-NWIS, 2006	
219	2191501	07/28/2005	1,248	2.78	F	R	--	USGS-NWIS, 2006	
219	2191501	08/08/2005	16,696	37.2	--	R	--	USGS-NWIS, 2006	
219	2191501	09/07/2005	1,508	3.36	F	R	--	USGS-NWIS, 2006	
219	2191501	10/14/2005	1,522	3.39	G	R	--	USGS-NWIS, 2006	
219	2191501	12/06/2005	1,266	2.82	G	R	--	USGS-NWIS, 2006	
219	2191501	01/30/2006	1,382	3.08	F	R	--	USGS-NWIS, 2006	
219	2191501	03/29/2006	1,369	3.05	F	R	--	USGS-NWIS, 2006	
219	2191501	05/17/2006	1,441	3.21	F	R	--	USGS-NWIS, 2006	
219	2191501	07/12/2006	1,513	3.37	F	R	--	USGS-NWIS, 2006	
219	2191501	08/25/2006	1,382	3.08	F	R	--	USGS-NWIS, 2006	
219	2191501	10/04/2006	16,203	36.1	--	R	--	USGS-NWIS, 2006	
219	2191501	10/25/2006	1,266	2.82	F	R	--	USGS-NWIS, 2006	
219	2191501	12/07/2006	16,293	36.3	--	R	--	USGS, 2007	
219	2191501	12/12/2006	1,297	2.89	P	R	--	USGS, 2007	
219	2191501	02/02/2007	1,791	3.99	F	R	--	USGS, 2007	
219	2191501	03/12/2007	1,315	2.93	P	R	--	USGS, 2007	
219	2191701	04/20/2004	280	0.624	--	R	--	USGS, 2004	
219	2191701	09/21/2004	300	0.668	--	R	--	USGS, 2004	
219	2191701	01/13/2006	248	0.553	--	R	--	USGS, 2006	
219	2191701	09/18/2006	283	0.630	--	R	--	USGS, 2006	
258	2580101	08/24/1976	3,140	7.00	--	R	23.5	Bolke and Sumison, 1978	Water is used for wildlife
258	2580201	08/24/1976	100	0.223	--	R	23.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580201	11/15/1979	5.00	0.011	--	R	--	Ertec, 1981	Discharge was estimated
258	2580301	07/22/1976	150	0.334	--	R	--	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580301	08/23/1976	--	--	--	R	20.5	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580401	03/26/1956	--	--	--	R	24.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580401	07/22/1976	850	1.89	--	R	--	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580401	08/24/1976	--	--	--	R	20.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580402	03/26/1956	--	--	--	R	25.0	Bolke and Sumsion, 1978	Water is used for wildlife

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Hydrographic Area	Report Spring ID	Date	Discharge (gpm)	Discharge (cfs)	Measurement Rated as: (E,G,F,P)	Method	Water Temp. (°C)	Data Source	Remarks
258	2580402	07/22/1976	2,400	5.35	–	R	–	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580402	08/24/1976	–	–	–	R	27.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580403	03/26/1956	–	–	–	R	22.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580403	08/24/1976	5,400	12.0	–	R	27.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580404	03/26/1956	–	–	–	R	25.5	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580404	07/22/1976	1,100	2.45	–	R	–	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580404	08/24/1976	–	–	–	R	26.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580405	03/26/1956	–	–	–	R	21.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580405	07/22/1976	3,600	8.02	–	R	–	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580405	08/24/1976	–	–	–	R	27.5	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580406	07/22/1976	1,700	3.79	–	R	–	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580406	08/24/1976	–	–	–	R	26.0	Bolke and Sumsion, 1978	Water is used for wildlife
258	2580501	08/23/1976	1.00	0.002	–	R	22.0	Bolke and Sumsion, 1978	Discharge reported as less than 1 gpm; value is an estimate. Water is used for livestock
258	2580601	08/24/1976	–	–	–	R	20.0	Bolke and Sumsion, 1978	Water is unused. Discharge diffuses over a large area

Discharge Method Codes: C = current meter; E = estimated; F = flume; R = reported; V = volumetric; W = Weir

SE ROA 43750

JA_13479

B.2.0 REFERENCES

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Appendix C

Example Forms

Form: SNWA_SIS 06/04

SOUTHERN NEVADA WATER AUTHORITY

SNWA Site Inventory Sheet

Party ______ USGS Site ID ______
Date/Time ______ Basin Name ______
Site ID ______ 100K Map Name ______
Local Number ______ Photots yes / no GPS yes / no

Contact Information

Name ______
Affiliation ______
Phone # ______
Address ______

Road Log

______

Well Information

MP Desc. ______
Casing Size ______
Well Type ______
Well Use ______
Pump yes / no
Pump Type ______

Surface Water Information

Spring or Stream
X-section Desc. ______
Q Measured yes / no
Diversion Desc. ______

General Site Location

Detailed Site Schematic

Completed by: ______ Date: ______.
Checked by: ______ Date: ______.

Page ___ of ___.

Figure C.1-1
Site Inventory Form

G-174
9-275-F
(Apr. 93)

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

WATER RESOURCES DIVISION

Meas. No ....
Comp. by ....

Sta. No. .... **DISCHARGE MEASUREMENT NOTES** Checked by ....

Date .... , 20 .... Party ....
Width .... Area .... Vel. .... G.H. .... Disch. ....
Method .... No. secs. .... G.H. change .... in .... hrs. Susp. ....
Method coef. .... Hor. angle coef. .... Susp. coef. .... Meter No. ....
Type of meter .... Date rated .... Tag checked ....
Meter .... ft. above bottom of wt. Spin before meas. .... after ....
Meas. Plots .... % diff. from .... rating. Levels obtained ....

GAGE READINGS						WATER QUALITY MEASUREMENTS
Time	Inside				Outside	No .... Yes .... Time ....
						Samples Collected
						No .... Yes .... Time ....
						Method Used
						EDI .... EWI .... Other ....
						SEDIMENT SAMPLES
						No .... Yes .... Time ....
						Method Used
						EDI .... EWI .... Other ....
Weighted M.G.H.						BIOLOGICAL SAMPLES
G.H. correction						Yes .... Time ....
Correct M.G.H.						No .... Type ....

Check bar, chain found .... changed to .... at ....
Wading, cable, ice, boat, upstr., downstr., side bridge .... feet, mile, above, below gage.
Measurement rated excellent (2%), good (5%), fair (8%), poor (over 8%): based on the following cond:
Flow ....
Cross section ....
Control ....
Gage operating .... Weather ....
Intake/Orifice cleaned .... Air .... °C@.............. Water .... °C@ ....
Record removed .... Extreme Indicator: Max .... Min. ....
Manometer N_2 Pressure Tank .... Feed .... Bbl rate .... per min. ....
CSG checked .... Stick reading ....
Observer ....
HWM .... outside, in well
Remarks ....

G. H. of zero flow .... ft.   Sheet No. .... of .... sheets

RICKLY HYDROLOGICAL CO. COLUMBUS, OH (614) 297-9877 • FAX (614) 297-9878

.0 .10 .20 .30 .40 River at .50 .60 .70 .75

Angle coef-ficient	Dist. from initial point	Width	Depth	Observation depth	Revolu-tions	Time in seconds	VELOCITY At Point	VELOCITY Mean in vertical	Adjusted for hor. angle or	Area	Discharge

.80 .85 .90 .92 .94 .96 .97 .98 .99 .100 .99 .98 .97 .96 .94 .92 .90 .85 .80

.0 .10 .20 .30 .40 .50 .60 .70 .75

Figure C.1-2
Discharge Measurement Form (Pages 1 and 2)

Appendix D

U.S. Forest Service Springs Survey Report

(as provided by the USFS)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Nevada State Office
P.O. Box 12000 (1340 Financial Blvd)
Reno, Nevada 89520-0006
http://www.nv.blm.gov

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In Reply Refer To:

January 10, 2007

To: Paul Podborny, BLM-Ely Field Office
Lisa Luptowitz, Southern Nevada Water Authority
Scott Ellis, ENSR
Penny Woods, BLM-Nevada State Office

From: Robert Boyd, BLM-Nevada State Office Robert A. Boyd 1/10/07

Subject: Distribution of spring inventory information for Forest Service lands in the Ely District

The Forest Service and Eastern Nevada Landscape Coalition recently completed an inventory of springs and seeps on lands managed by the Forest Service-Ely District. Hydrologic, chemical, biologic, and physical data were also collected during this inventory. The data and summary reports are being provided on the enclosed CD. This information should be included with datasets being compiled and analyzed for the Clark, Linclon, and White Pine County Groundwater Development Project. Please forward this information to appropriate members of your technical staff.

U. S. D. A. Forest Service
Level 1 Survey of Springs on the Ely Ranger District
2006 Final Survey Report

Prepared by
Eastern Nevada Landscape Coalition
1500 Avenue F
P. O. Box 150226
Ely, NV 89315

November 6, 2006

ABSTRACT

As part of a collaborative working agreement, the U. S. D. A. Forest Service (USFS) and the Eastern Nevada Landscape Coalition (ENLC) began a Level 1 survey of springs within the Humboldt-Toiyabe National Forest, primarily on Forest lands within the vicinity of proposed groundwater withdrawal wells for the Southern Nevada Water Authority. The areas within the Forest that ENLC focused on for the spring surveys were divided into three separate units: South Snake Management Unit, Eastside Schell Management Unit, and Mount Moriah Management Unit. The ENLC survey crews surveyed for and monitored known and unknown springs in the South Snake Range and Eastside Schell Management Units. A USFS backcountry ranger monitored springs within the Mount Moriah Management Unit that occurred along recreational trails. By the end of the 2006 field season, the ENLC spring survey crews monitored 53 known and 148 unknown springs within the South Snake Range and Eastside Schell Management Units. Of the areas covered in the surveys, ENLC recommends future surveys be conducted within the following drainages which the survey crews were unable to survey in 2006: North Fork Cleve Creek, northwesternmost reaches of Cleve Creek, drainages north of Cleve Creek along the east slope of Black Mountain, and Taft Creek.

INTRODUCTION

In 2006, the U. S. D. A. Forest Service (USFS) and the Eastern Nevada Landscape Coalition (ENLC) collaborated together to initiate a Level 1 survey of springs within the Humboldt-Toiyabe National Forest. The purpose of the Level 1 survey of springs was to locate known and unknown springs within the Forest and collect baseline data characterizing the attributes of these springs. For the 2006 field season, ENLC focused surveying efforts primarily in the Forest lands that may be affected by proposed groundwater withdrawal activities of the Southern Nevada Water Authority in Spring Valley.

METHODOLOGY

Spring Survey Methods

In order to maximize the spring survey crews' efforts, three primary project areas were delineated: South Snake Management Unit (South Snake MU), Eastside Schell Management Unit (Eastside Schell MU), and the Mount Moriah Management Unit (Mount Moriah MU) (Figure 1). For the South Snake MU, ENLC focused primarily on areas deemed by a U. S. Geological Survey report to be susceptible to groundwater withdrawal activities (Figure 2). For the Eastside Schell MU, ENLC surveyed areas east of the ridgeline from Connors Pass northward towards Taft Creek. Once hunting season made surveying the more southern drainages hazardous, the survey crews moved northward to Kalamazoo Creek and began surveying its drainage for the last week of the field season.

Within the delineated areas of both the South Snake MU and Eastside Schell MU, ENLC crews surveyed for known and unknown springs by focusing on drainages within which the presence of water was likely. Crews typically began surveying a drainage at the Forest boundary and followed any flowing water to its source. The crews thoroughly searched the landscape for plant assemblages normally associated with the presence of water, using binoculars in areas not easily navigated. When water-associated plant assemblages were spotted, the crew would hike to the location and search the vegetation for surface water and then determine whether the presence of the surface water was an actual spring. The crews also located and collected data on known springs as they encountered them during their surveys for unknown springs.

Spring monitoring in the Mount Moriah MU was performed by April Johnson, a USFS backcountry ranger, as part of the USFS Ely Ranger District's wilderness monitoring protocol. For the wilderness monitoring protocol, the primary focus was to collect baseline data on springs that occur near established recreational trails within the wilderness (Figure 3). Areas located away from trails that would not be accessed by recreationalists were not surveyed for known and unknown springs. Due to time constraints and equipment availability, April Johnson performed only portions of the monitoring protocol. A total of 34 springs, two (2) known and 32 previously unknown, were inventoried along the recreational trails (Table 1). The data site number for springs collected as part of the wilderness monitoring protocol are preceded by "MM" in the Spring Inventory database in order to highlight entries that are incomplete.

In addition to performing surveys on USFS lands surrounding Spring Valley, the ENLC crews monitored seven known springs in the White Pine Range to collect baseline data for a juniper removal project and provide several reference points for spring monitoring outside the areas deemed susceptible to groundwater withdrawal in Spring Valley. As the area surrounding the White Pine Range is not believed to be highly susceptible to groundwater withdrawal activities in Spring Valley, the crews monitored a select few known springs and did not perform surveys for unknown springs. The monitoring data for the springs is included in the Spring Inventory database.

Spring Monitoring Protocol

Once a spring was located, the ENLC crews basically followed the protocol outlined by the USFS in its Spring Ecosystem Inventory Protocol (Appendix A). Due to unforeseen circumstances, the crews were unable to follow portions of the protocol but were able to learn or develop alternative methods in order to obtain information regarding the attributes of interest. The following is a description of alterations to the protocol originally provided.

Site ID Number: The UTM Zone was not included in the site ID number in the database.

GPS Datum: For the 2006 field season, the Forest Service provided ENLC with two Trimble Geo XM GPS units and ArcPad 7.0 for navigation and the collection of UTM coordinates. From 6/13/206 through 6/26/2006, the crews were still learning how to use the GPS software and did not collect the UTM coordinates on the GPS. For the ArcGIS layer which contains points for all of the monitored springs, the coordinates for springs monitored during this period were entered into an Excel file to create a layer within ArcGIS. The shapefile was then merged with all field-collected coordinates. The crews were able to collect the UTM coordinates in NAD 83 but were unable to determine how to differentially correct the coordinates with the software they chose to use. The crews were also unable to determine where the GPS unit displayed information regarding DGPS and WAAS but were able to obtain PDOP values (see Appendix C for definitions of acronyms).

Elevation: The elevation recorded was obtained from the GPS unit used in the field.

Orifice Geomorphic Type: Using both field observations and digitized geology maps in ArcGIS, the crews were able to differentiate between Tubular, Contact, Fault, and Sinkhole types. When none of these types were correct, the crews frequently experienced difficulty in differentiating between Seepage and Fracture/Joint orifice. In instances where the crews were uncertain, they listed both in the database entry with a question mark following each type name.

Primary Lithology of Source: In the field, the crews tested rocks within or immediately adjacent to the spring for limestone by physically splitting the rock and placing a drop of 10% hydrochloric acid on the newly exposed surface. The presence or absence of limestone was recorded on the datasheet. The geological unit for the spring location was later referenced in ArcGIS and recorded in the database.

Discharge: Initially the crews attempted several methods for measuring the discharge rate of the springs before selecting two that were relatively easy to implement in the backcountry given the nature and size of most springs encountered. The two methods most frequently used were the volumetric measurements ("calibrated bucket-and-pipe") procedure and the dye tracer procedure. The volumetric measurements procedure is described in the USFS Spring Ecosystem Inventory Protocol and was frequently used for springs with very small discharges that could easily be measured with containers as small as 130 mL. If a crew was unable to direct all of the water into the pipe, they visually estimated the percentage of the discharge that was not included in the measurement.

The dye tracer procedure was frequently used for springs with larger discharges or with substrate compositions that thwarted any efforts to channel and direct the water flow. The dye tracer procedure is similar to the float velocity procedure described in the USFS Spring Ecosystem Inventory Protocol in that beginning and ending points for measurement within the stream are first designated and the length, average width, and average depth of the area are then measured to obtain an estimated water volume. The dye tracer is dropped into the water flow at the beginning point and the time required for the dye tracer to reach the ending point is recorded.

In some instances, the discharge rate was either so small the crew was unable to detect any measurable flow or so dispersed or diffuse that they were unable to find any method available to them to effectively measure the discharge. In these instances, the crew noted they were unable to measure the discharge and described the reasons why in the "Notes" section.

Water Chemistry: For the 2006 field season, the ENLC crews were provided with two Horiba U-10 Water Quality meters and one Horiba U-22XD Water Quality meter to obtain the pH, dissolved oxygen, temperature, and electrical conductivity of the water. In the beginning of the field season, the crews experienced difficulties with the Horiba U-10 meters provided and the measurements recorded, particularly for pH and dissolved oxygen, may not have been correct. When the crews were aware of these problems, they recorded in the "Notes" section the difficulties experienced. For several weeks, one crew did not have a water quality meter as both Horiba U-10 meters were sent to the company for repairs. During this time period, the crew used a HACH Dissolved Oxygen test kit Model OX-2P, pH test strips, and a thermometer to obtain water chemistry values. Throughout the season, the crews recorded the make and model of water quality meter or test kits used in the database.

In addition to experiencing problems with the meters, the crews frequently found that they were unable to submerge the meters' probes fully into the water in the springs or spring brooks. This was generally due to insufficient water present or difficult substrates. Throughout the field season, the crews filled a 750 mL container with water collected as close to the spring orifice as possible and submerged the meters' probes in the container. After 8/03/2006, they also submerged the probe directly into any springs with sufficient water in order to compare whether there was a difference between measurements in the container and in the flowing water. Both sets of measurements were recorded in the database with the columns with the phrase "in flow" added to the heading titles for measurements obtained from submergence in the spring.

Some information requested in the protocol was not available to the ENLC crews. The crews were unable to find sources for the INFRA Reference Number and Water Rights Number and Status for developed and/or known springs. In instances where water is diverted, the crews frequently could not locate either the Point of Diversion or the Point of Use, especially when the water was being channeled into underground pipes and diverted to unknown, distant locations.

ACCOMPLISHMENTS

By the end of the 2006 field season, ENLC field crews monitored 53 known and 148 unknown springs in the South Snake and Eastside Schell MU's (Table 1). In the South Snake MU, the crews monitored twelve (12) known and 90 unknown springs in the areas demarcated by the U. S. Geological Survey as susceptible to groundwater withdrawal (Figure 4). The crews completed spring surveys in the South Snake MU for the following drainages: Baker Creek, western half of Board Creek, Dry Canyon, Hub Mine Basin, Mill Creek, Pine Creek, Ridge Creek, Shingle Creek, Snake Creek, Spring Creek, Weaver Creek, and Williams Canyon. The crews were unable to identify any springs in either Dry Canyon or the western half of Board Creek. Big Wash, located south of Snake Creek, was the only drainage deemed susceptible to groundwater withdrawal activities in the South Snake MU for which ENLC crews were unable to perform spring surveys. This was due to the crew's inability to access the drainage.

In the Eastside Schell MU, the crews monitored 41 known and 58 unknown springs (Figure 5). Crews completed surveys for springs throughout the Bastian Springs, Cooper Canyon, Ranger Creek and South Taft Creek drainages. Most of the Cleve Creek drainage was completed by the ENLC crew but they were unable to finish the westernmost sections of the drainage due to the onset of hunting season. In the crew's surveys, they encountered two (2) known spring locations, one in Ranger Creek and one in Cleve Creek, for which they were unable to locate any spring within the vicinity. The crew could not locate the known spring in Ranger Creek as heavy bank trampling of nearby streams by cattle created a very large, muddy track of land where the spring was to occur. The known spring in Cleve Creek that the crew could not locate was depicted to have been either within or adjacent to an active stream channel and may no longer exist due to channel movement. Even though neither spring was present to monitor, the crew still collected general information with regards to the known springs' supposed locations along with a note that the known spring no longer existed and included both of these springs in the Spring Inventory database. Neither spring was included in the ArcGIS shapefiles for monitored springs.

As part of ENLC's final report, ENLC is providing the following data in electronic form:

- Spring Inventory Access database
- ArcGIS shape files containing spring location data and delineated areas surveyed
- Spring monitoring photos
- Spring monitoring photos master list in Excel

All of the data files include data collected in the Mount Moriah MU by April Johnson and the seven known springs monitored in the White Pine Range.

FUTURE AREAS FOR SURVEYS

The ENLC field crews recommend the following areas for future surveys given observations made in the field. The northwestern fork of Cleve Creek and Kraft Canyon need to be completed as the crews were unable to continue working in the area due to hunting season. Crews were unable to perform surveys in the North Fork Cleve Creek drainage due to its inaccessibility and hazardous terrain. This area would still be worth surveying given the presence of several known springs in the drainage and the fact that the majority of the water in Cleve Creek originates from the North Fork. The crews were also unable to access the drainages north of Cleve Creek along the east slope of Black Mountain due to daily time constraints. These drainages, including Freehill, Vipoint, and Stephens, contain water-associated plant assemblages and known springs and are worth investigating. Future spring survey crews would likely need to camp overnight within the vicinity of the drainages in order to access them in a safe and timely manner. The ENLC also recommends a complete survey of Taft Creek as the drainage contains water-associated plant assemblages and the crews observed an aqueduct originating from the drainage.

TABLES AND FIGURES

Table 1. Total number of known and unknown springs monitored in 2006 per drainage in the South Snake Range and Eastside Schell Management Units

Management Unit Drainage	# of Known Springs Monitored	# of Unknown Springs Monitored	Total Springs Monitored
South Snake			
Baker Creek	0	14	14
Hub Mine Basin	1	5	6
Mill Creek	0	2	2
Pine Creek	0	5	5
Raised Spring area	1	1	2
Ridge Creek	0	3	3
Shingle Creek	0	12	12
Snake Creek	0	6	6
Spring Creek	0	7	7
Weaver Creek	10	25	35
Williams Canyon	0	10	10
South Snake Total	**12**	**90**	**102**
Eastside Schell			
Bastian Springs	3	0	3
Cleve Creek	17	29	46
Cooper Canyon	10	8	18
Kalamazoo Creek	3	3	6
Taft Creek	8	18	26
Eastside Schell Total	**41**	**58**	**99**
Mount Moriah*	2	32	**34**
White Pine Range*	7	NA	**7**
	Total springs surveyed		**242**

*Data from the Mount Moriah and White Pine Management Units were collected for separate projects but still included in the Level 1 Survey of Springs database.

Figure 1. 2006 Level 1 U. S. D. A. Forest Service Level 1 Survey of Springs Project Management Units within the Humboldt-Toiyabe National Forest, NV.

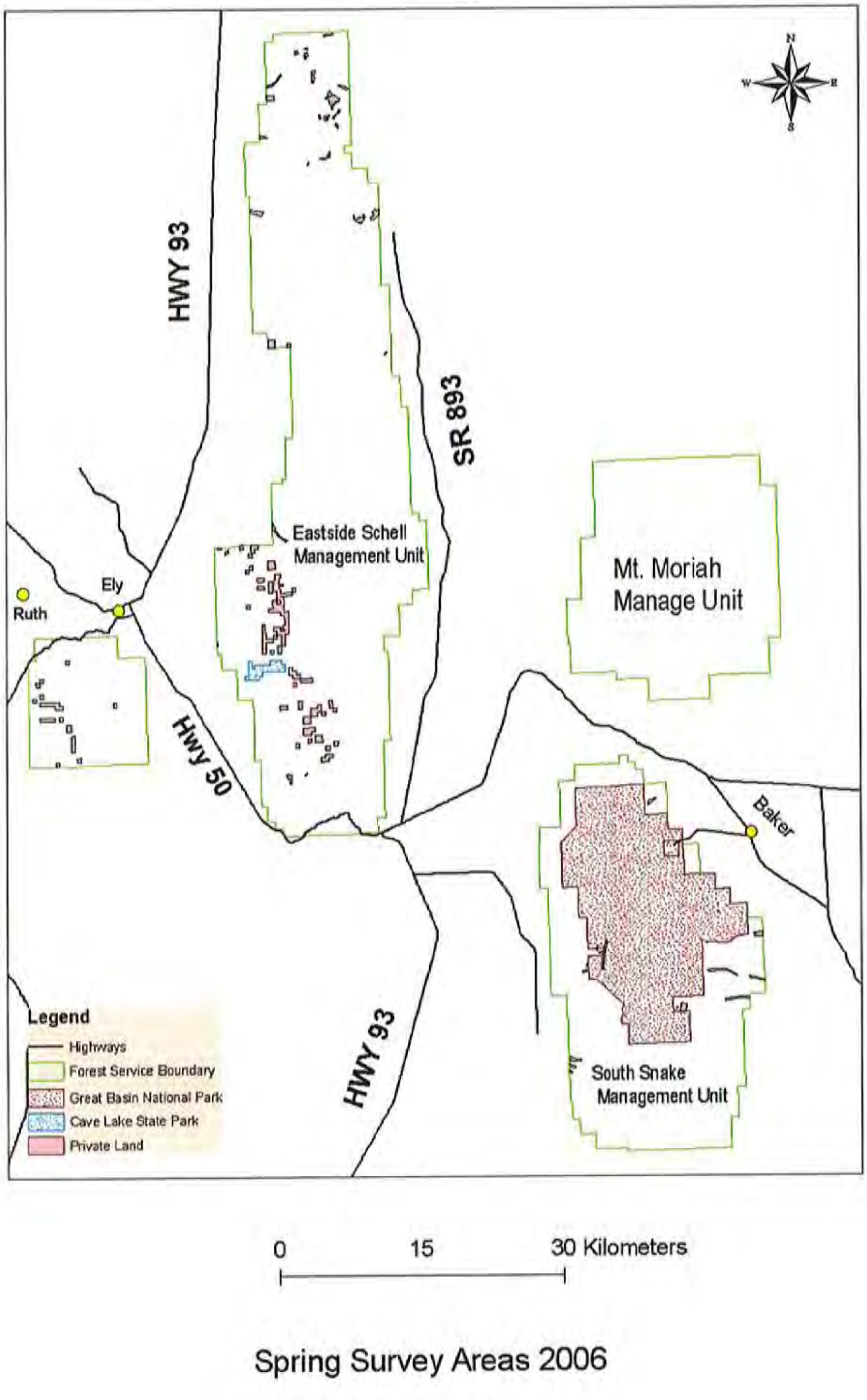
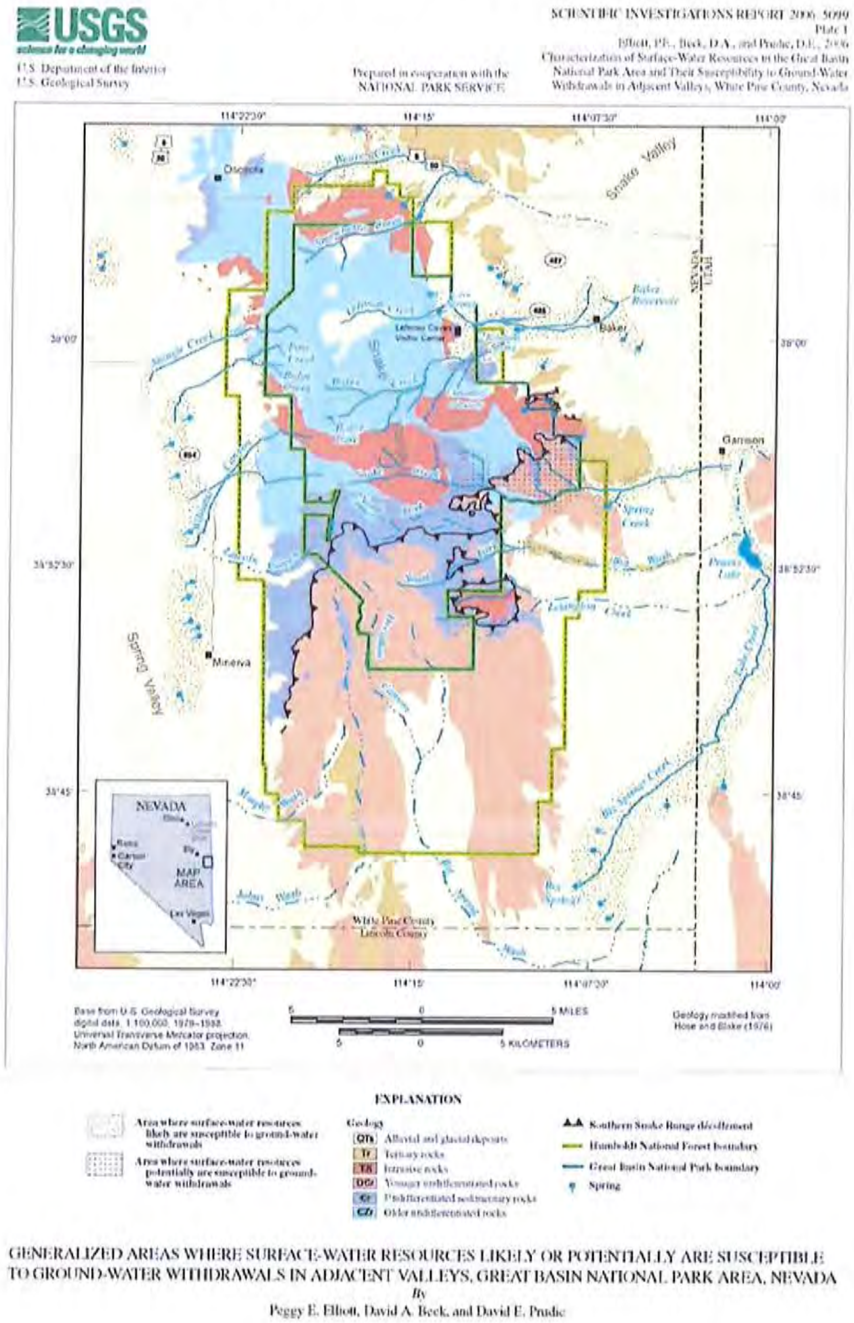
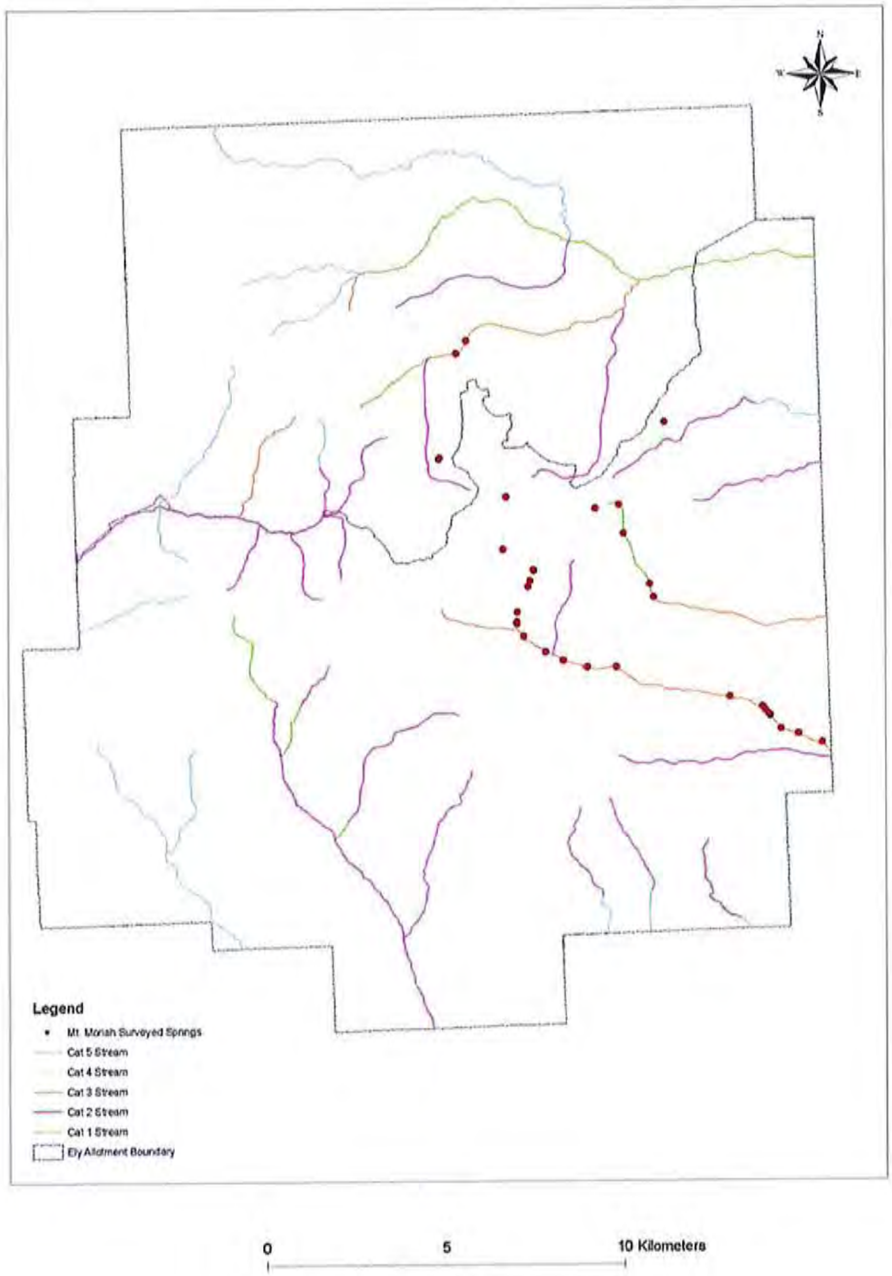


Figure 2. (PDF file from USGS report): Generalized areas where surface-water resources likely or potentially are susceptible to ground-water withdrawals in adjacent valleys, Great Basin National Park area, Nevada.



SE ROA 43767

Figure 3. Springs inventoried in 2006 by the U. S. D. A. Forest Service backcountry ranger in the Humboldt-Toiyabe National Forest Mount Moriah Management Unit, NV, for the wilderness monitoring program.



Mt. Moriah Surveyed Springs 2006

SE ROA 43768

Figure 4. Springs monitored in 2006 by the Eastern Nevada Landscape Coalition spring survey crews in the Humboldt-Toiyabe National Forest South Snake Management Unit, NV.

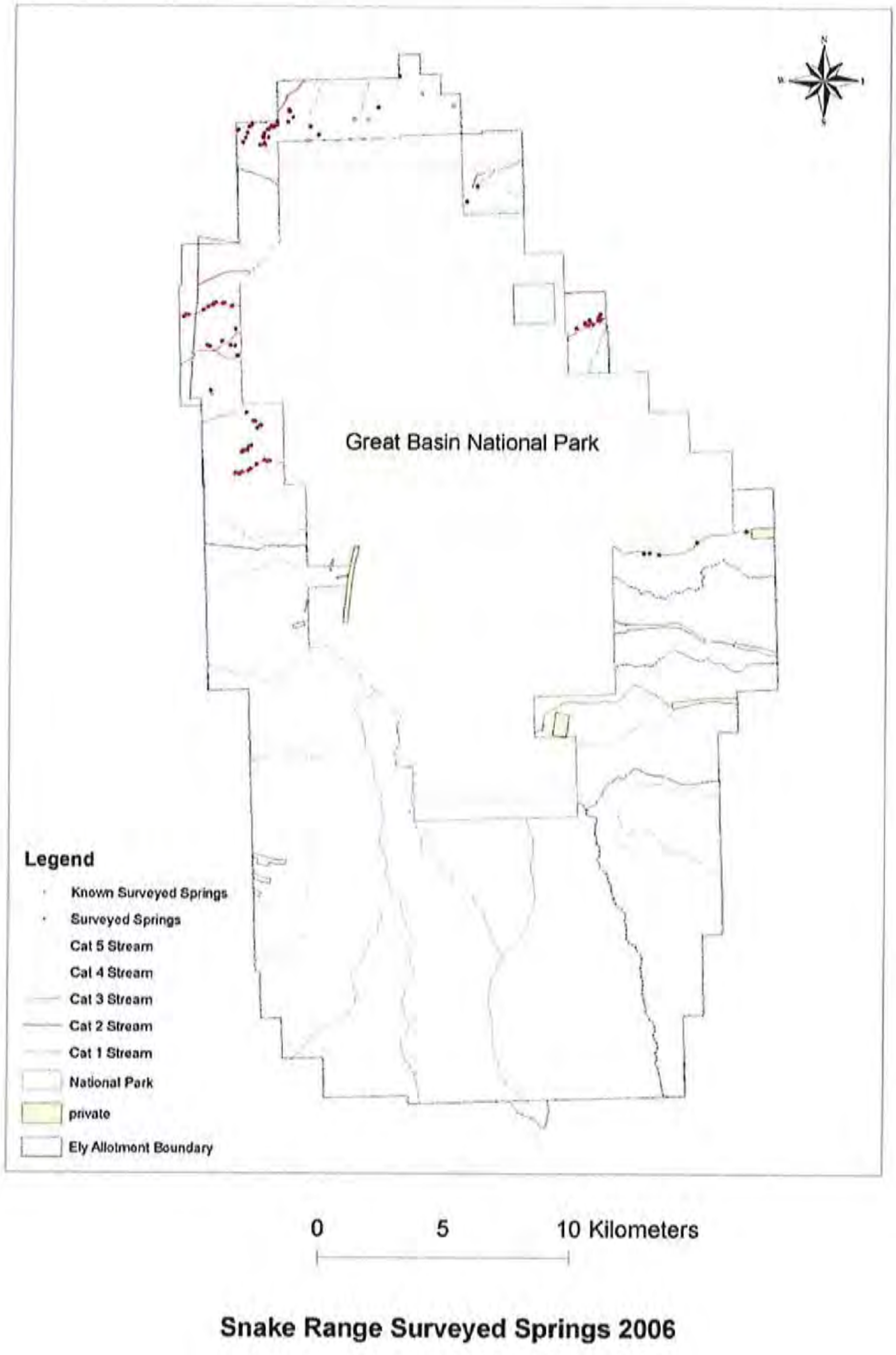
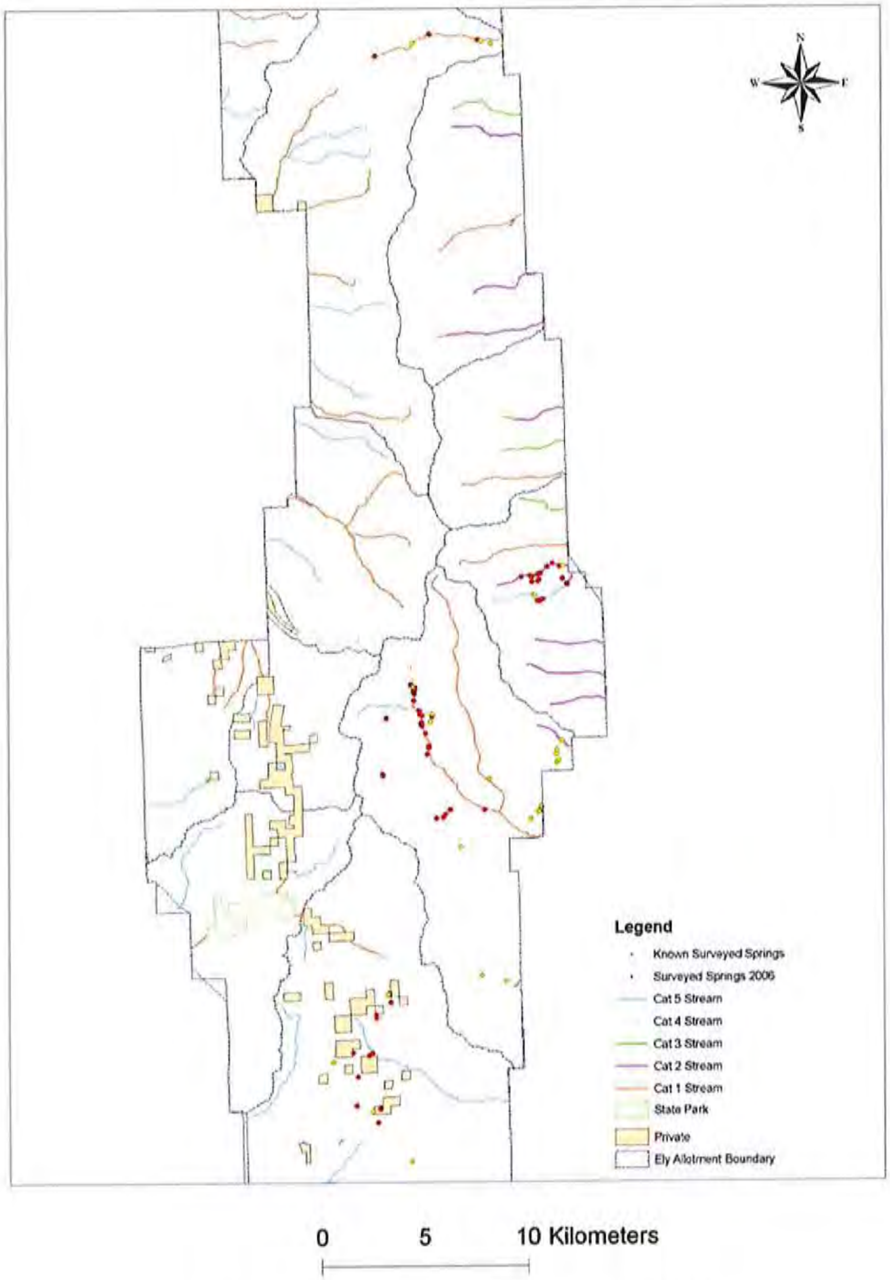


Figure 5. Springs monitored in 2006 by the Eastern Nevada Landscape Coalition spring survey crews in the Humboldt-Toiyabe National Forest Eastside Schell Management Unit, NV.



Schell Creek Range Surveyed Springs 2006

APPENDIX A. USDA FOREST SERVICE SPRING ECOSYSTEM INVENTORY PROTOCOL

DRAFT INTERIM PROTOCOL

USDA Forest Service
Ground-Water Resource Inventory and Monitoring Protocol

Level I Spring Ecosystem Inventory

Introduction

The Spring Ecosystem Inventory Protocol is a component of the *Draft Ground-Water Resource Inventory and Monitoring Plan* intended for use with the Aquatic Ecological Unit Inventory (AEUI) (Hixson et al. 2004) and Terrestrial Ecological Unit Inventory (TEUI) (Winthers et al. 2005) Technical Guide protocols. All data collection will comply with method validation, quality assurance, responsibilities, interagency coordination, and data management and storage requirements as specified in FSM 1940 and FSH 1909. All data will be stored in the Natural Resource Information System (NRIS) with springs organized within the Hydrologic Unit hierarchy.

The hierarchical structure defined by Maxwell et al. (1995) forms the framework for TEUI, AEUI, as well as the Ground-Water Resource Inventory and Monitoring Plan. This structure provides the basic sample unit for data collection and statistical analysis using common terminology. This basic unit is called an Aquatic Ecological Unit (AEU), or Aquatic Unit (AU). Aquifer sites, including springs, sinks, gaining stream reaches, and fens, are the smallest aquatic ecological unit for ground water systems.

Aquifer sites are potential sites of ground-water development and ecological damage and function as major linkages between surface and ground water and their biota. Mapping these features permits these major linkages to be evaluated and enhances protection of water quality and aquatic biota in both systems. Aquifer sites are commonly mapped at the 1:12,000 to 1:24,000 scale.

This protocol is based on protocols described by Sada et al. (2001), Sada and Pohlmann (2005), and Springer et al. (2005). These Level I data elements will, in many cases, require modification due to varying ecological, climatic, and geomorphic conditions in different regions of the country.

The Forest Service has developed goals for maintaining values such as biodiversity and watershed health, and information compiled during Level I inventories provides insight into the condition and biotic potential of individual springs.

In Appendix III is an example of how to use descriptions of biological and physical characteristics to prioritize the management and restoration of individual springs in Clark County, Nevada (Sada et al. 2003). This effort prioritized springs using matrix analyses by ranking biotic and abiotic elements of each spring (compiled during Level I and Level II inventories), and considering factors important to management.

Purpose of spring inventory and database

The purpose of this inventory and database is to provide fundamental water use and ground-water dependent ecosystem inventory information vital for making Forest Service spring ecosystem and water resource decisions at the Forest or District level. The electronic spring database will provide managers with information about the WHAT, WHERE, CONDITION, and RESOURCE IMPACTS of springs. To acquire the necessary information, a simple form-based, GIS-linked, field inventory must be completed. The inventory is designed to obtain only the minimum essential reconnaissance information required to identify the location, the type and condition of the springs, the location and type of use, aquatic resource concerns, and maintenance needs. Inventory information will be entered into an electronic database to facilitate information display, storage, and analysis. The survey information acquired through this inventory system provides information needed to make water and ecosystem management decisions and has direct application in administering spring water-related special-use permits.

A corporate spring inventory and database has multiple benefits:

1. It provides an electronic depository of spring and other ground-water dependent ecosystem information in a format compatible and accessible by all National Forests.
2. It gives managers the ability to generate GIS-based maps that display the spatial distribution of springs and other ground-water dependent ecosystems at watershed, Forest, and Regional scales.
3. It provides managers with the ability to query individual sites for pertinent resource information useful for making management decisions by directly linking to existing databases, such as State water rights systems, the Forest Service's INFRA, WUTS (water uses and water rights tracking system), and NRIS databases.
4. It provides managers with a database that facilitates the management of easements and special use permits related to springs by identifying facilities that need immediate maintenance to stop ongoing resource damage.
5. It improves the ability to make decisions about future water uses and allocations because it provides for a comprehensive picture of water movement, linkages, and resource impacts and conditions at multiple scales.

Levels of Inventory

Three hierarchical elements comprise the spring inventory and monitoring program described (Level I, Level II, and Level III). Following an office assessment to review previous work on springs within the management unit to be inventoried, the Level I inventory (Appendix I) is conducted to qualitatively locate and characterize springs and other ground-water dependent ecosystem resources within the management unit. These inventories provide qualitative information describing spring characteristics, spring condition attributed to natural factors and current management practices, and guidance for future management. Level I inventories may be conducted periodically to qualitatively determine temporal changes in biotic and abiotic characteristics a spring, but Level II inventories should be conducted when quantitative monitoring and assessment information is needed. Level II inventories quantitatively describe aquatic habitat, aquatic and riparian communities, and water chemistry. These inventories are limited to priority springs in a management unit that have been identified during Level I inventories. Level II inventories are the core of spring monitoring programs, and they are conducted on a regular basis to determine temporal variation in biotic communities, physiochemical aspects of the environment, and the response of springs to changes in management. When threats to springs with high resource values are identified, Level III inventories may be conducted. These inventories compile highly quantitative information that describes spatial and temporal variation in physiochemical characteristics of springs and the structure of their aquatic macroinvertebrate, vertebrate, and riparian communities. Level III studies also quantitatively describe the abundance, distribution, and habitat preferences for important organisms, and they should be implemented when there are requirements for long term monitoring to address legal challenges, public involvement in controversial management, and to quantitatively assess trends in the status of rare species.

Each of these inventories may be incorporated into monitoring programs to address management issues, and to evaluate management priorities. Level I inventories may be conducted periodically (every 5 to 10 years) to qualitatively assess the condition or extent of change in spring environments and important biota over comparatively long periods of time. Level II inventories quantify water chemistry, the physical environment, and the structure and functional characteristics of aquatic and riparian communities, and they constitute a rigorous monitoring program. These inventories require highly trained personnel to identify plants and animals, and to analyze water chemistry. Selection of sites and the frequency of Level II inventories may differ as a function of management questions and funding. They may be conducted annually for several years to quantify temporal variation in their biota and environments then reduced to once every five years if variability is low and the status of conditions is relatively secure. Level II inventories may also assess long-term changes in spring conditions over a large management area by including springs that are important for management and a number that are randomly selected. The number of springs used during this type of monitoring program should be determined with input from a statistician. Level III inventories are highly quantitative monitoring programs that are conducted at a limited number of sites where detailed information is needed. These inventories should be conducted at site determined by a team of hydrologists and aquatic and riparian ecologists.

Level I Inventory Protocol

Level I inventories survey isolated water features, that include 1) natural springs and seeps (groundwater that flows onto the land surface through natural processes), 2) hand and mechanically dug wells (groundwater that flows onto the land surface because of vertically oriented human excavation), 3) artificial surface water expressions or qanats, (groundwater that flows onto the land surface because of horizontally oriented human excavation), and flowing adits, 4) ground water emerging in stream channels that supports perennial reaches of streams, and 5) fens which are peat forming ground-water fed wetlands (see Appendix II for more information on fens). Level I inventories are designed to inventory springs by accurately locating them, characterizing salient aspects of their aquatic and riparian environments, and recording the presence of important species. These inventories are reconnaissance level observations that focus on assessing biotic potential to facilitate management and prioritize the relative importance of individual springs within a management area. This information is not highly detailed or is it accumulated in a rigorous manner that allows statistical analysis. Accumulation of highly quantified data requires much more detail, time, and substantially greater funding than is necessary for Level I inventories.

Level I inventories are designed to accumulate basic information describing the biological and physiochemical characteristics of each spring, identify the influence of current management on spring condition, and to guide the management prioritization of individual springs. Basic elements of these inventories recognize that:

- Springs are often difficult to locate, and existing map coordinates may be inaccurate.

- General biotic and abiotic characteristics of a spring can often be determined with relative ease, and without accumulating highly detailed information.

- Biotic and abiotic characteristics of springs are influenced by elevation, spring size, aquifer type, disturbance stressors (natural and anthropogenic), and physiochemical characteristics of aquatic and riparian environments. It is not necessary to quantify these features with detailed accuracy to determine the ecological characteristics of a spring.

- Generally, the taxonomic richness of aquatic and riparian communities is correlated with spring size (larger springs have greater discharge, deeper and wider aquatic habitat, and longer spring brooks) support more aquatic and riparian species than small springs. Ephemeral springs support a distinct, fishless and depauperate aquatic macroinvertebrate community, and riparian communities with low diversity. Persistent springs support aquatic and riparian communities that are more diverse.

- Taxonomic richness and functional characteristics of riparian and aquatic communities are correlated with the amount of environmental stress. Springs highly stressed by anthropogenic disturbances (including excessive livestock grazing, diversion, impoundment, etc.) or natural factors (e.g., affected by scouring floods, periodically dry, naturally high water temperatures or elevated solute concentrations) have fewer species, and more species that are tolerant of harsh conditions (often non-native riparian species and pollution tolerant aquatic macroinvertebrates) than minimally disturbed springs.

Although there are a number of individual elements recorded in Level I inventories, they fall into five categories, which are: 1) Recording inventory date and spring location, 2) Recording several water chemistry parameters, 3) Estimating physical characteristics of the aquatic and riparian environment (e.g., spring brook length, discharge, water depth, vegetative cover, and substrate composition, etc.), 4) Qualitatively assessing the amount a spring has been altered from natural condition, and 5) Identifying the presence or absence of important animals and plants.

Background Assessment

Springs are valuable resources to the public and the agency. As a result, they have been the subject of a wide variety of resource management programs. Many have been developed for recreational use, (e.g., picnic and camping, roadside facilities, etc.) and to support municipalities and livestock management. Water chemistry data have been collected at some springs during ground water studies, and some have been modified for conservation of rare crenobiontic species. As a result, records are often maintained at State and Federal agencies that shows location, development features, water chemistry, etc. This information should be compiled and organized into a database before field studies are initiated. One of the most valuable data sources for springs are water rights inventories that have identified springs for stockwater, wildlife use, and at recreational sites.

Field Inventory Preparation

Field personnel must be trained by qualified personnel to accurately conduct Level I inventories. This can be accomplished by a classroom and field season that expose field personnel to a wide diversity of spring sizes, types, and disturbances. Field personnel must be supervised to insure data are being properly collected, recorded, and filed. Training must also include safety instruction to prepare field personnel for working in remote regions where water is scarce. A Job Hazard Analysis should be developed for the field work.

Planning and preparation are necessary to conduct Level I inventories. Before going to the field, all equipment must be organized and tested, spare equipment purchased (e.g., batteries), and field forms printed and placed in a protective binder. Additional planning and preparation are necessary if many springs are to be inventoried over several days before returning to the office. Preliminary work should include studying maps and filling in the field form with information that can be compiled before the beginning of a field trip (e.g., spring name, map location, county, state, etc.).

Field Equipment

Limited equipment is needed for Level I inventories. All equipment should be sturdy and able to tolerate rugged conditions of being carried in a backpack or exposed to dust. All equipment should be checked prior to beginning a field trip, extra batteries should be carried, and directions and tools to calibrate instruments should be carried into the field. Calibration frequency and methods should follow manufacturer recommendations. Records must be kept and recorded in a metadata file to describe the manufacturer and model of all equipment used during field inventories. Key equipment necessary for Level I inventories includes:

Inventory form. Copies of the Level I inventory form or, more preferably, a field data recorder should be carried into the field. If forms are used, they should be printed onto 'write in the rain' paper.

Maps. Locating springs requires using maps of different scales. Road maps are needed to direct travel on paved roads that lead to remote areas. Greater detail that is provided by USGS topographic maps is necessary to locate dirt roads and geographic features that may be important for navigation to a specific site. While it is often convenient to use 7.5 minute topographic maps, the number required for broad inventories often make using these burdensome. The 100,000:1 scale maps are often sufficient. Maps should be reviewed prior to field work to maximize inventory efficiency.

GPS unit, included with a hand-held data logging system is preferred to minimize recording error.

Dissolved oxygen, pH, conductivity, and temperature meters. Preferred meters are those that are rugged, easy to calibrate, and a single instrument can measure multiple parameters.

Stop watch and several different size containers of known volume (no larger than 2 liters).

Current meter and wading rod.

Portable weir or flume.

100 meter measuring tape and metric ruler.

Geologic map, 10X hand lens, and acid bottle for determining geologic setting.

Camera

Kick-net, dipnet, aquarium net, or kitchen strainer

Forceps

Whirlpak bags, kill jar, and 15 mL glass vials filled with 70% ethyl alcohol for collections of plants, aquatic macroinvertebrates, and insects.

Water sampling equipment (if required).

Preventing Inter-Wetland Translocation of Foreign Material

Isolated springs and wetlands, especially in arid regions, can be occupied by distinctive aquatic communities. While inter-wetland translocation of vertebrates and invertebrates may occur via natural factors, such as transport via waterfowl and mammals, it is also caused by human activities such as recreational bathing, wildlife management, release of aquarium life, and scientific investigation. When caused by humans, translocation frequently results in establishment of non-native species, which has typically been detrimental to native fauna and ecosystem health. Translocation of macroinvertebrates and disease occur readily because many forms are able to live outside of water for extended periods of time. Translocation of vertebrates is less likely because they require a conscious effort to provide suitable habitat during transport, i.e. sufficient amounts of water to permit respiration and prevent over heating.

This Standard Operating Procedure describes mechanical and chemical methods to prevent accidental translocations that may occur during spring inventories. These methods must be employed upon completion of inventories at each isolated site and before additional inventories are conducted. There are two types of isolated sites: 1) individual, isolated springs, and 2) spring provinces where there is either continuous or periodic (e.g., seasonal) connectivity between springs that naturally permits inter-spring movement of life.

Equipment

- 10 % Clorox solution contained within a leak-proof, plastic bottle (approximately 250 ml that can be carried to remote sites, or 1 L that can be carried in a vehicle).

- Toothbrush and scrub brush (size is unimportant, but the bristles should be stiff and durable. A small brush may be carried to remote sites, and larger brushes may be used when there is vehicle support.

Methods

Every precaution should be taken to avoid wadding and getting shoes wet, which can be accomplished easily during Level I inventories because most springs are small and extensive biological sampling is not an element of the protocol. When wading is necessary, rubber boots must be worn (either hip boots or 'irrigator boots'). Upon completing the inventory, they should be rinsed in water from the spring to remove mud, vegetation, and all other material. Dry the boots, then wash boots in the Clorox solution, and dry again before entering another spring. Precautions should also be taken when shoes are kept dry and wading does not occur. This can be accomplished by using a small scrub brush to buff the soles and sides of shoes and remove all material that may have been gathered from the spring.

Equipment used to collect biological samples is the most likely translocation vector. After completing inventories at each isolated site, all equipment must be: 1) vigorously shaken to remove as much material as possible, 2) treated with Clorox by either dipping into a container and/or using a toothbrush to scrub surfaces and clean crevices where macroinvertebrates may be hidden, and 3) dried in the sun before initiating subsequent spring inventories.

APPENDIX 1

Spring Inventory Form and Instructions

Instructions for Spring Inventory Form

The following elements comprise a Level I spring inventory and are recorded on the data sheet or preferably on an electronic data recorder. All Level I information should be compiled at the spring source, and include the upper 50 m of aquatic habitat (at larger springs). All of the aquatic habitat should be included at springs with spring brooks less than 50 m long.

Site ID Number: The combined UTM zone, easting, and northing readings are the site identifier that is unique for the spring (e.g. 12 4508428N 597017E) in the North American Datum of 1983 (NAD83).

Site Name: This is best determined from a topographic map. Use an official or locally acknowledge spring name, if there is one. If the site is unnamed, record it as 'unnamed' with a brief geographical description that indicates its approximate location, e.g., 'unnamed spring in Willow Canyon'.

Date: Record the month, day, and year in the format MM-DD-YYYY the inventory is conducted.

State: Record the standardized two-letter abbreviation (e.g., CA = California) where the spring is located.

County: Record the county where the spring is located.

Forest: Record the Forest on which the spring is located.

District: Record the District on which the spring is located.

Field Inspection Crew: First initial and last name of individuals conducting inventory. Record the name of the crew leader first.

Start Time: Record the time the inventory is begun using military time.

Drainage Basin and HUC: Record the 6th level (12 digit) Hydrologic Unit Code (HUC) where the spring is located. If the spring is located within a river drainage, list the river drainage basin. If it occurs in an endorheic basin, identify the valley. This information must be compiled from maps, and it may be done while in the field or in the office.

INFRA reference number: If there is a development it should be in the INFRA database.

USGS Quad(s): Name of 1:24000 USGS quad(s) where spring is located.

GPS Make and Model: Record make and model of the Global Position System unit used. Take a picture of the GPS unit and record the photo number.

Global Position System location, and datum: Record the UTM zone in the North American Datum of 1983 (NAD83) of the spring/seep source. Document GPS files in a GPS log. All GIS data layers created from GPS files must include Geospatial metadata. Record PDOP or 'plus or minus' the number of feet/meters as metrics indicating accuracy of the GPS reading. Record if DGPS or WAAS was being received.

Access: The ease at which the public could visit a spring. Categories 1 through 5. Category 1 = inaccessible sites, access only by cross country hiking, Category 2 = sites that can be accessed only by arduous trail hike (e.g., greater than 5 miles), Category 3 = sites accessed by easy trail hike (e.g., 1-5 miles), Category 4 = sites easily accessed by walking less than 1 mile, and Category 5 = sites immediately adjacent to paved road.

Elevation: Use a hand-held meter, GPS system, or interpolate spring elevation from a USGS topographic map. There may be substantial error in all of these measurements, but these data are adequate to 'characterize' site elevation. For more accurate elevations, estimate them from 10-m Digital Elevation Model. Record methods used for elevation in notes section.

Source Location and Photos: Record the location of the spring in both Township and Range and UTM coordinates. Take at least two photos, one looking upstream viewing the spring source, and one looking downstream along the spring brook. At larger springs, take a photo of the source and a second from a distant area that encompasses as much of the riparian area as possible. At developed springs take photos of structures. Photos should be labeled by Site ID number, photo number, date, time, site name, and UTM coordinates for each photo. Photos should be taken using a digital camera. Maintain a photo log with digital photograph number and description. Take a photo of the GPS unit displaying location and time.

PHYSICAL CHARACTERISTICS

Geomorphic Setting: Choose the best descriptor of the geomorphic setting of the subaerial emergence environment. **Channel** - in active channel and may support a perennial or gaining reach of stream; **Floodplain** - on floodplain above banks of active channel; **Stream Terrace** - one of a series of level surfaces in a stream valley, flanking and more or less parallel to the stream channel, originally occurring at or below, but now above, the level of the stream, and representing the dissected remnants of an abandoned flood plain, stream bed, or valley floor; **Cliff** - Any high, very steep to perpendicular or overhanging face of rock; a precipice; **Flat** - in flat area with no discernable channel; **Hill Slope** - on side of long slope; **Saddle** - a low point in the crest line of a ridge, commonly on a divide between the heads of streams flowing in opposite directions; **Draw** - a sag or troughlike depression leading up from a valley to a gap between two hills; **Bench** - a long, narrow, relatively level or gently inclined strip or platform of land, earth, or rock, bounded by steeper slopes above and below; a (non-stream) terrace or step-like ledge breaking the continuity of a slope; **Ravine** - a small, narrow, deep depression, usually carved by running water; esp. the narrow excavated channel of a mountain stream

Slope Position: Choose the best descriptor of the slope position of the subaerial emergence environment. **Shoulder** - the convex part of a mountain or hill immediately below the summit; **Backslope** - the part of the mountain or hill slope between shoulder and foot;

Footslope - the base of the mountain or hill slope; the first obvious slope break above the drainage channel, this is a very common location for springs to emerge; **Toeslope** - the lowest nearly level part of a slope immediately adjacent to the drainage channel.

Orifice Geomorphic Type: Identify the geomorphic type for the spring orifice(s) from the following choices (Fetter, 2000). **Seepage** - groundwater exposed or discharged from numerous small openings in poorly consolidated and permeable material; **Fracture/Joint** - groundwater exposed or discharged from bedrock fractures or joints; **Tubular** - groundwater discharged from solution passages or tunnels; **Contact** - flow discharged along a stratigraphic contact (e.g., a hanging garden); **Fault** – groundwater exposed or discharged from a fault; **Sinkhole** - formed where water dissolves the limestone beneath the surface and creates a sinkhole. If the sinkhole is deep enough for the water table to reach the surface, then a sinkhole spring is formed.

Spring Type: Choose the best descriptor for the spring type. **Rheocrene** - a spring that discharges into a defined channel; **Limnocrene** - a spring that discharges into a ponded or pooled habitat before flowing into a defined channel; **Helocrene** - similar to a Limnocrene, but marshy and comparatively shallow, not an open pond or pool; **Mound** - emerges from a carbonate precipitate mound; **Fen** - peat forming wetland fed by ground water. Indicate if the fen is patterned (contains a series of pools) (see Appendix II); **Stream Baseflow** - emerges in the bottom of a stream channel and maintains a perennial reach of stream; **Hillslope** - emerges from a non-vertical hillslope at 30-60 degree slope and usually has indistinct or multiple sources; **Hanging Garden** - complex, multi-habitat springs emerging along geologic contacts and seep, drip, or pour onto underlying walls; **Gushette** - pour from cliff faces; **Geyser** - periodic thermal spring resulting from expansive force of super-heated steam within constricted subsurface channels; **Cave** - emerges entirely within a cave environment and not directly connected to surface flow; or unknown. In some areas, springs have been altered by native peoples or settlers by excavating the source to create a **Qanat**, which is a type of hand-dug well. Where these occur, water is regionally scarce. **Sinking Stream** - ground water recharge locations formed by solution of bedrock or semi-consolidated sediments. Also record if a site is a mechanically dug **Well** (usually with rock, metal, or plastic casing), a flowing mine **Adit,** or a **Hot Spring.** Record **Other** when the source is something else, such as a cliff face, boil, etc. Examples of disturbances that prevent identifying spring type include impoundment by dikes, sources in a spring box, or dredging and filling to capture water in a pipe leading to a trough. Spring alterations and spring condition are assessed, and recorded, in the "Site Condition" section below. If further description is necessary, it can be summarized in the Notes Section.

Primary Lithology of Source: Describe the primary lithology of the aquifer from which the spring water is emanating. Springs frequently emerge from talus or other unconsolidated material at the base of a slope. If this is the case try to determine the upgradient geologic unit that the spring water is origination from.

Discharge: Record discharge rate and units, and the method and instrument used to determine discharge.

It is difficult to estimate the discharge of most springs because they are small, water is usually shallow and broadly and unevenly spread over a wide area, and areas with moving water are often very limited. Because discharge often changes throughout the day, seasonally, or annually, this minimizes the effectiveness of single measurements to precisely quantify long-term discharge characteristics. These estimates combined with water width, depth, and spring brook lengths provide information to characterize spring discharge rates.

Measurement of spring discharge will vary from site to site. Therefore a variety of methods for measuring discharge are presented and discussed. The field investigator will first need to evaluate and determine the appropriate methods on a case-by-case basis. The following table lists the various instruments recommended for a range of discharge conditions. Three additional methods (with lower accuracy) are listed (float velocity and visual estimation) but are not recommended to be used - unless as last resort.

Recommended Approaches to Discharge Measurement

Discharge (gpm)	Discharge (metric)	Instrument(s)
No discernable	No discernable	Depression
< 0.12	< 10 mL/s	Depression, volumetric
0.12 to 1.0	10 to 100 mL/s	Weir, Volumetric
1.0 to 10.	0.10 to 1.0 L/s	Weir, Flume
10 to 100	1.0 to 10. L/s	Weir, Flume
100 to 448.8	10. to 100. L/s	Flume
448.8 to 4,488	0.10 to 1.0 m^3/s	Current meter
4,488 to 44, 880	1.0 to 10. m^3/s	Current meter
> 44,880	> 10. m^3/s	Current meter

Note: of all of the instruments listed, the flume is the largest and most difficult to pack into backcountry. It should only be used in the back country if it is essential to obtain an accurate measurement or if the spring has a discharge magnitude making a flume the optimal instrument.

Measure the quantity of water discharging from the spring with one of the methods listed above and described below. The name, serial number (if available), and accuracy of the instrument used to measure discharge should be recorded as well as any other important observations. Important observations may include the markers of any recent high discharges, such as high water marks, oriented vegetation or debris on or above the channel or floodplain. If there is a single channel, measure discharge in this single channel as close as possible to the spring orifice. If there are multiple channels, and if they all converge to a single channel, measure discharge in the single channel as close as possible to the confluence of all of the multiple channels.

- *Portable weir plate procedure (Buchanan and Somers, 1969):* The weir has a "v" notch, or other regular geometric shape through which all discharge in the channel must be focused. The weir should have a scale on the weir which directly reads discharge and have a solid plate below the notch which is driven into the loose material of the stream bed material.

Weirs do not work in bedrock channels or channels with bed material coarser than fine gravel without a significant amount of channel modification. To use a weir in a bedrock channel or channel material coarser than gravel, the channel must be significantly modified for weir emplacement. Once placed in the channel, the weir is leveled using a bubble level. The top of the weir plate is made horizontal and the plate must be plumb. Flow through the weir is allowed to stabilize prior to measurement. Gage height is recorded 3 to 5 times over a 3 to 5 minute interval, as appropriate. The mean is calculated from the three replicated and recorded. The volumetric discharge (L/s) is calculated using a standard equation specific to the weir plate being used. The accuracy of the weir is dependent on the size of the notch in the weir and the resolution of the scale on the weir.

- *Current meter procedure (Buchanan and Somers, 1969):* Typically, current meters are necessary in springs or in wide channels or high discharge channels where flow can not be routed into a weir or a flume. Measurement locations are selected in a straight reach where the streambed is free of large rocks, weeds, and protruding obstructions that create turbulence; and with a flat streambed profile to eliminate vertical components of velocity.

In the making of a discharge measurement, the cross section of the channel is divided into 20 to 30 partial sections, and the area and mean velocity of each section is measured separately. A partial section is a rectangle whose depth is equal to the measured depth at the location and whose width is equal to the sum of half the distances of the adjacent verticals. At each vertical, the following observations are recorded on the data sheet, (1) the distance to a reference point on the bank along the tag line, (2) the depth of flow, (3) the velocity as indicated by the current meter. The velocity should be measured at a depth which is 0.6 of the depth from the surface of water in the channel. The discharge of each partial section is calculated as the product of mean velocity times depth at the vertical times the sum of half the distances to adjacent verticals. The sum of the discharges of each partial section is the total discharge.

Measurements are made by wading the stream with the current meter along the tag line. The person wading the channel should stand downstream of the velocity meter. Because of the safety involved in wading a channel, the person wading should not wade in too deep of water or should not use hip waders in swift water without the use of a safety rope or other appropriate safety gear.

- *Portable Parshall Cutthroat Flume procedure (Buchanan and Somers, 1969):* Flumes work best in low gradient channels with fine-grained bed material. Flumes may be heavy and difficult to pack into back country. The wing walls of the flume are pointed upstream in the channel in such a fashion as to focus as much flow as possible through the regular profile of the opening of the flume. The flume requires free fall of water out the downstream end of the flume. The flume is set in a channel of loose material. A bubble level is used to make sure the flume is level. The floor of the upstream section is leveled both longitudinally and transversely. Flow is allowed to stabilize prior to measurement. Gage height is recorded 3 - 5 times over a 3-minute interval. A standard rating curve for the flume is used to translate gage height to discharge. The mean value for discharge (L/s) is calculated and recorded. Accuracy of the instrument is dependent on the scale on the flume. On some occasions, it may not be possible to capture 100 % of the discharge in the flume. If less than 100 % of the discharge is captured by the flume, the percent of flow captured by the flume should be estimated by for each of the 3 to 5 measurements and recorded. A correction to the discharge measurement should be made to account for the percent of discharge not captured by the flume.

- *Volumetric measurements procedure (Buchanan and Somers, 1969):* Volumetric measurements are typically used where there is a pour off, or other features that allow flow to be easily captured in a volumetric container. A temporary earthen dam is constructed using earth and nonpermeable materials. Water is diverted through the temporary earthen dam with a temporary pipe or constructed channel. Flow is allowed to stabilize prior to measurement. A volumetric container is used to catch discharge from pipe. The time to fill the container is recorded. Flow is recorded 3 to 5 times over a 3 to 5-minute interval, as appropriate. The mean value is calculated (ml/s) and recorded on the datasheet. Accuracy of the instrument is dependent on the accuracy of the volumetric container. A suite of varying size of containers appropriate for first to second magnitude discharge springs should be taken to the field site. When not used for volumetric measurements, the containers can be used to help pack various other field gear used for the rapid assessment.

- *Depression/sump procedure:* This method is typically used for unmeasurable springs with little to no surface expression of flow. A depression is constructed in the seep area. The volume of depression is calculated using volumetric calibration or calculation. The volumetric containers used for the volumetric measurement may be used to estimate the volume of the depression. The depression is evacuated, and the time required to fill depression is recorded. This procedure is repeated 3 to 5 times and the mean value is recorded as the measurement.

- *Float velocity procedure (Buchanan and Somers, 1969) (only recommended as last resort):* Two cross sections are selected and marked with flagging along a reach of straight channel. The distance between the two sections is measured with the measuring tape. The width and depth of each channel cross section is measured with the tape measure and recorded. Cross section locations are separated to allow for a travel time of >20 sec float time (if possible). A float (i.e., an object with the density of an orange is ideal) is placed in the stream channel and allowed to reach stream velocity before the upstream cross section is crossed. The position of the float relative to the channel sides is noted. The float is timed between the two cross sections. The position of the float is noted as it crossed the downstream cross section. This procedure is repeated 3 to 5 times, as the float is placed at different locations across the channel at the upstream cross-section. The velocity of the float is equal to the distance between the cross sections divided by the travel time. The mean value of surface horizontal velocity (m/s) is calculated. To convert mean surface velocity to mean vertical velocity a coefficient of 0.85 is multiplied by the mean surface velocity. Discharge (m^3/s) is calculated by multiplying the value of mean velocity by the average area of the section of the stream channel measured.

Float Method	

Reach length:		
Trial	Time elapsed	Velocity (reach length/time)
#1		
#2		
#3		
Average velocity x 0.85:		

- *The visual estimate procedure (only recommended as last resort):* Site conditions, such as dense vegetation cover, steep or flat slope, diffuse discharge into a marshy area, and dangerous access sometimes do not allow for a direct measurement of discharge by the techniques listed above. Although visual estimation is imprecise, it may be the only method possible for some springs. Photographs should be taken to record the surface area wetted or covered by water and observations recorded on the datasheet. Also, it should be noted if another method could be recommended for future site visits to measure discharge.

Habitat Size: The habitat is the area dominated by obligate and facultative vegetation types. In order to measure the area of spring habitat either use a 100 meter tape to measure the length and width of a site or pace the length and width with a known gate. Measuring habitat size should be conducted with as little disturbance to the site as possible. If a habitat type is inaccessible estimate the area.

Spring Brook Length: Use a tape to measure distance from the spring source (upstream limit of surface water) to the downstream limit of surface water or where it enters a larger channel. In some case this nay be a considerable distance and can be best measured from maps.

Average Water Depth: A qualitative estimate of the vertical distance from substrate to water surface that is found throughout the aquatic habitat.

Average Water Width: A qualitative estimate of the distance covered by water (and perpendicular to its flow) that lies between banks of the spring brook, less islands, emergent rocks, etc. (This is formally described as the length of wetted contact between flowing or standing water and the spring brook bank in a vertical plane at right angles to the direction of flow).

Percent of Emergent Cover: Estimate to the nearest 10 percent the vegetative, debris, or other material that arises within the water width and covers the water surface. Conduct ocular estimate calibration at the beginning of inventory projects and periodically throughout the life of the project.

Percent of Vegetative Bank Cover: Estimate to the nearest 10 percent the proportion of spring brook banks that is covered by live vegetation. Conduct ocular estimate calibration at the beginning of inventory projects and periodically throughout the life of the project.

Spring Brook Incision. Rate banks as being incised (positive) when bank angle >60 degrees from vertical, and not incised (negative) when bank angles are <60 degrees from vertical. For spring brooks, bank incision is generally an indicator of stability and the absence of trampling activities.

Substrate Method: Rocord the method used to determine substrate composition. The Wolman Pebble Count procedure as described in Bunte and Abt (2001) can be used to obtain a representative sample of the particle size distribution and the median diameter. Alternatively, visually describe the substrate by the proportional composition of materials.

Substrate Composition: Substrate size distributions can provide an indication of relative suitability of the spring brook habitat for various aquatic organisms. Changes in particle size distribution can be correlated with impact of land management activities and natural disturbance. Describe the substrate by the proportional composition of materials, where materials are classified as: Fines (<0.05 mm), Sand (0.05 mm - 2 mm), Gravel (2 mm - 64 mm), Cobble (64 mm - 256 mm), Boulder (>256 mm), bedrock, or peat. Size is defined as the intermediate dimension (b-axis), as would pass through a sieve. Record the presence of peat (peat is present in fens).

WATER CHEMISTRY

Field water-quality measurements from spring sites should be taken as close to the orifice as possible. Basic sampling strategy should be guided by the USGS National field manual for the collection of water-quality data (U.S. Geological Survey, variously dated). Laboratory analysis must be done by certified labs using Standard Methods for the Examination of Water and Wastewater (WEF, AWWA, APHA 1998). Note any red/orange staining or discoloration that could indicate acid rock drainage. Also note the presence of light-colored travertine precipitates that could indicate deep circulation of water.

Dissolved Oxygen Concentration: Measure D.O. in mg/liter using a field meter. The meter should be kept clean, with fresh batteries, and calibrated daily following the manufacture's recommendation. All water chemistry parameters should be measured as close to the spring source as possible and in flowing water if available. Note the location of the measurement if not taken at the source.

Water Temperature. Water temperature is an important factor structuring aquatic communities, and may give insight into source waters. This measurement (record in degrees Centigrade) is easily taken with a meter used to measure dissolved oxygen or conductivity, and it is necessary to calibrate some analytical meters (e.g., conductivity). Calibration is not necessary for temperature measurements using a high quality meter.

pH: pH is the measure of hydrogen ion activity, which indicates the acid/basic qualities of water. Low (<6.5) and high (>8.0) ph environments are stressful to aquatic life. pH can be measured using a hand-held field meter that can be calibrated (such as Oakton, pHtestr2). The meter should be kept clean, with fresh batteries, and calibrated daily following the manufacture's recommendation. These meters generally have a limited life, and a backup meter should always be carried.

Conductivity: (also called electrical conductance) Conductivity is measurement of the ability of an aqueous solution to carry an electrical current. This ability is dependent on the amount of dissolved ions, and is therefore an indicator of total dissolved solids in the solution. Conductivity provides insight into water sources and it is important to aquatic life because of requirements to maintain osmoregulatory balance. Conductivity is measured using a filed meter and recorded in microsiemens/centimeter (uS/cm). The meter should be kept clean, with fresh batteries, and calibrated daily following the manufacture's recommendation. Most high quality meters do not require frequent calibration.

BIOLOGY

Important Animals: Note the presence of important animals and identify the species, if possible (most field personnel will be unable to identify species, but the presence of animals within any of the groups on the form should be recorded). Important species occupy a wide variety of habitats, and they may be very scarce or abundant. Most species can be easily captured using a kitchen sieve to sample aquatic vegetation, debris, or the substrate. Each species prefers a distinct microhabitat, and sampling must collect from all types of habitat that occur in a spring. Note presence of other important species, such as bats. List species only when identification is certain. Circle species on the list provided. Modify the list to include appropriate species if necessary. Macroinvertebrates can be collected or photographed for later identification.

Important Native Vegetation: The Regional vegetation steward should develop a list to include appropriate taxa for the ecoregion to be inventoried. The Natural Resources Conservation Service (NRCS) PLANTS database symbols are the standard national coding system for plants and can be accessed at http://plants.usda.gov/. NRCS PLANTS has symbols for the Genus level when species cannot be determined. All plant symbols in the NRCS PLANTS database are valid choices. Some typical spring habitat species include rushes [Family Juncaceae], cattails (*Typha* sp.), reeds (*Scirpus* sp.), watercress (*Rorippa* sp.), spikerush (*Eleocharis* sp.), sedges (*Carex* sp.), yerba mansa (*Anemopsis californica*), mesquite (*Prosopis* sp.), wild rose (*Rosa* sp.), cottonwood (*Populus freemontii*), willow (*Salix* sp.), or other wetland obligate or facultative vegetation in the spring brook or riparian zone. Important moss species may also be identified, particularly for fens, such as sphagnum moss (*Spagnum spp.),* mosses belonging to the genus *Meesia*, sundew (*Drosera spp.*), as well as brown mosses (see Appendix II).

Important Vegetation: The Regional vegetation steward should develop a list to include appropriate taxa for the ecoregion to be inventoried. The Natural Resources Conservation Service (NRCS) PLANTS database symbols are the standard national coding system for plants and can be accessed at http://plants.usda.gov/. All plant symbols in the NRCS PLANTS database are valid choices. Some typical spring habitat species include rushes [Family Juncaceae], cattails (*Typha* sp.), reeds (*Scirpus* sp.), watercress (*Rorippa* sp.), spikerush (*Eleocharis* sp.), sedges (*Carex* sp.), yerba mansa (*Anemopsis californica*), mesquite (*Prosopis* sp.), wild rose (*Rosa* sp.), cottonwood (*Populus freemontii*), willow (*Salix* sp.), or other wetland obligate or facultative vegetation in the spring brook or riparian zone.

Non-Native Species: Note the presence of non-native species of plants and animals. Non-native plants that most likely occur at arid land springs include salt cedar (*Tamarisk* sp.), palm trees (Family Arecaceae), arundo (*Arundo donax*), and white top (*Cardaria pubescens*). The most likely non-native animals include mosquito fish (*Gambusia affinins*), bass (*Micropterus* sp.), trout, crayfish, red-rimmed melania (*Melanoides tuberculata*).

Collections Made: Record any plants or animals collected for further identification. Record collection number, examiner, and date on the collection. Assigning collection numbers allow samples to be easily related back to field forms or database entries later.

SITE CONDITION

Site Condition: Categorize each spring as undisturbed, slightly, moderately, or highly disturbed, and circle the appropriate category on the inventory form. Springs with these levels of disturbance appear as follows:

- *Undisturbed* springs have been unaffected by recent or historical factors or activities. All evidence of trampling by domestic livestock, diversion, fire, or drying is absent. Since most springs have been altered by humans, drought, fire, or flood, these types of springs are rare and most undisturbed springs are naturalizing from past disturbances.

- *Slightly Disturbed* springs exhibit little evidence that vegetation or soil have been disturbed. Vegetation shows slight signs of browsing and foraging, and animal footprints and scat are present by not prominent. Recreation may be evident, but its impact on riparian or aquatic environments is minimal. Evidence of fire or flooding in the distant past may be visible but these events occur infrequently; riparian vegetation is vigorous.

- *Moderately Disturbed* springs exhibit evidence of recent, comparatively high disturbance. Use by native and non-native ungulates, and recreation has reduced vegetation height and coverage from natural conditions. Vegetation covers, hoof prints, footprints, and scat are common. Where there has been diversion, spring box may be present but at least 50% of natural discharge remains within the natural spring brook. Neither the spring nor spring brook has been impounded. Where flooding or fire is apparent, >50% of the spring brook banks are covered by vegetation; flood and fire are infrequent and the spring in naturalizing.

- *Highly Disturbed* springs have little similarity to undisturbed springs. <50% of their banks are covered by vegetation, their spring brooks contain <50% of natural discharge, they are impounded or dredged, or spring boxes collect water. All impounded springs are highly disturbed because flow has been interrupted and functional characteristics of the aquatic system highly altered. Hoof prints and scat are abundant where ungulate use is heavy, and campsites are large, trashy, and vehicle use evident. These activities have decreased vegetative cover of spring brook banks to <50%. Riparian vegetation is sparse at springs recently affected by fire or flooding, there is recent evidence of elevated discharge, and spring brooks are usually incised.

Disturbance Type: This evaluation qualitatively identifies 1) disturbance factors stressing a spring. Harsh chemical conditions are not noted in this section, but can be easily determined from water quality and conductance measurements. Determine factors causing stress by looking for evidence of natural and human caused disturbances. Influences of flooding are indicated by location of a spring in the bottom of a gully, presence of a naturally incised channel, and usually a paucity of vegetation. The presence of pipes, dikes, or spring box indicates modifications for diversion. Abundance of hoof prints and droppings, and evidence of grazing indicates ungulate use of a spring. The presence of campsites and trash indicates recreation. The most common stressing factors are shown on the field form, and the appropriate factor(s) should be circled. Disturbance may be influenced by multiple factors such as, intensive livestock grazing around a trough, heavy recreation use along a spring brook (that tramples vegetation) where water is channelized away from areas used for picnicking. Circle each appropriate factor. If other factors are evident, circle "Other" and briefly describe in the Notes Section.

WATER USES

Water Right No. and Status: Record as none, applied, permit number, or water right number.

Tributary To: If the spring brook enters another stream, record the name of the stream.

Volume and Percent Diverted: Record the volume and percent of water being diverted to troughs, tanks etc. at time of inspection. Circle whether you estimate (visual) or measure (e.g. flow meter). Inspect flow upstream and downstream of diversion as well as water in the conveyance to determine percentage being diverted. Estimate to the nearest 10%.

Point of Diversion (POD): GPS the location of the point of diversion.

Point of Use (POU): GPS the location of the point of use.

Development Type: Record the type and size and condition of troughs, spring boxes, ponds, and piping, etc.

Uses: Circle the type of use.

Condition and Maintenance Needs of Developments: Record the condition and maintenance needs of troughs, spring boxes, ponds, and piping, etc. An evaluation of the type, condition and maintenance needs of fencing and gates is important in maintaining desired spring conditions. Fencing specifications vary for different types of animals to be excluded. For instance, wild horses and burro exclusion require higher fencing standards than cattle. Fencing requirements also vary for bighorn sheep verses antelope.

Record Notes to include additional pertinent information. This may include observations further describing site condition, use of the spring by other animals (e.g., bats, deer, etc.), clarification of difficulties in accessing the spring, etc.

Directions to Site. Give precise access directions to the site beginning with a landmark (e.g., a named point on the topographic map, a major highway, marked trailhead) readily locatable on a 7.5 minute topographic map as the starting point. Use clear sentences that will be understandable to someone who is unfamiliar with the area and has only your directions to follow. Give distances and use compass directions. Be aware of the ambiguity of words like "above", "near", beyond", "on the back side of", "past". If site locations lack major landmark features as guides, use township, range and sections from the topographic maps. Although the sample spring sites will not be permanently marked, others may want to be able to relocate them for long-term monitoring purposes. Careful documentation of the access route, obvious landmarks and vegetation is therefore extremely important.

Draw a Sketch of the Spring. This is very important in spring provinces where sample sites may be close to one another and map/GPS coordinates weakly describe the relative location of sample sites. The following items will be captured and documented on the sketch map for each site:

- Approximate locations/dimensions of each geomorphic/habitat surface
- Spring orifice and paleo-spring orifice
- Channel location
- Channel structural controls
- Pool locations
- GPS Reading Location
- Photo Points
- Location of Water Quality Measurements
- Indication of north (true or magnetic)

1.

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APPENDIX II

Identifying Fens

Identifying Fens

Nationwide classification of wetlands in the USA is presently defined by the National Wetland Inventory system (Cowardin et al. 1979), where fens and bogs are included in the palustrine system, but little is said to distinguish fens as a unique entity. Peatlands are generally divided into two main categories, bogs and fens, although the use of these terms varies (Bedford and Goodwin 2003). For the purposes of this protocol fens are separate from bogs based upon their hydrologic characteristics. Bogs are fed almost entirely by atmospheric precipitation, while fens are fed primarily by ground water, although they receive precipitation as well. Fens are wetlands distinguished by their strong connection to ground water. A wetland whose vegetation, water chemistry, and soil development are not determined, in large part, by the flows of ground water to is not a fen.

Many different definitions for fens exist. Some emphasize water source; others emphasize water chemistry, vegetation, or type of substrate. For the purposes of this protocol, we define fens as **wetlands that develop where a relatively constant supply of ground water to the plant rooting zone maintains saturated conditions most of the time and the water chemistry reflects the mineralogy of the surrounding and underlying soils and geological materials** (Bedford and Godwin 2003). Like many factors structuring ecosystems, the degree to which ground water dominates fen water budgets is a continuum. In all cases however, the influence of ground water exceeds that of precipitation and surface water, either in quantity or in terms of effects on water chemistry in the plant rooting zone. Fens do not experience prolonged inundation and generally have carbon accumulating substrates (Amon et al. 2002).

Distribution

Most basically, fens are ground-water-driven systems. Their hydrology, water and soil chemistry, and vegetation, as well as their function in the landscape, are determined in large part by the fact that they occur where ground water discharges to the plant rooting zone (Bedford and Godwin 2003). Fens tend to occur where climate and hydrogeologic setting sustain flows to the plant-rooting zone of mineral-rich ground water. They may occur on slopes, in depressions, or on flats (Brinson 1993). Frequently, fens occur at stratigraphic and/or topographic breaks that create hydrologic gradients causing ground water to reach the land surface.

In the United States, fens occur in almost every state but are more common in the glaciated Midwest (Amon et al. 2002) and Northeast, as well as portions of the Appalachian Mountains and mountainous West (Cooper and Andrus 1994; Chadde et al. 1998). Fens were found only at higher elevations in the southern, drier part of the U.S. The average elevation of the fens on the Inyo and Sequoia National Forests is 3,000 to 3,200 m, on the Lassen and Plumas National Forests fens occur at an average elevation of 1,700 m, (Cooper and Wolf 2005) and above 2700 m on the Ashley and Wasatch-Cache National Forests.

Water Chemistry

Fens may be acidic to alkaline, have pH ranging from 3.5 to 8.4, and may support calcicole or calcifuge plant species (Bedford and Godwin 2003). Depending on the flow rates and chemistry of ground water reaching the plant rooting zone, fens may be slightly acidic (poor fens), circumneutral (rich fens), or strongly alkaline (extreme rich fens, marl fens). Poor fens may arise either because ground water accounts for only a small fraction of their annual water budget or because ground water inputs move through non-calcareous materials with low solubility (e.g., gneiss, granite) or low buffering capacity (e.g., sand, quartz). In areas where ground water is supersaturated with respect to iron, iron hydroxides or iron sulfides may precipitate in the plant rooting zone and have a low pH typical of poor fens. Some fens, have so much iron in discharging ground water that ''bog iron'' (i.e., goethite, an iron oxyhydroxide) is precipitated.

At the other end of the continuum, extreme rich fens and marl fens arise where carbonates precipitate at the fen surface. Fens receiving high flows of calcium-rich water are called calcareous fens and support a distinct flora of plant species called calcicoles because of their affinity for calcium-rich sites (Almendinger and Leete 1998a and b, Olivero 2001). As ground water rich in calcium bicarbonate discharges to the surface at high rates, decreases in the partial pressure of CO_2 cause carbonates, such as calcite and calcium or magnesium carbonate (marl), to form in the plant rooting zone (Boyer and Wheeler 1989). Calcareous fens are confined to areas where the bedrock consists of limestone, dolomite, or sandstone containing dolomite and limestone. Rich fens lie in the middle of this continuum.

Vegetation

Fens are among the most floristically diverse of all wetland types, supporting a large number of rare and uncommon bryophytes and vascular plant species, as well as uncommon animals including mammals, reptiles, land snails, butterflies, skippers, and dragonflies (Bedford and Godwin 2003). In general, the vegetation of fens is dominated by bryophytes, sedges (Carex and several other genera of the Cyperaceae), dicotyledonous herbs, and grasses. The vegetation of poor fens associated with peatlands more closely resembles that of bogs, with Sphagnum mosses and ericaceous shrubs dominant. Rich fens, however, are dominated by sedges and brown mosses (mostly Amblestegiaceae), with many distinctive species of dicotyledonous herbs.

Fen Landforms

In general, fens occur at stratigraphic and/or topographic breaks that create hydrologic gradients causing ground water to reach the land surface. Fens form in several geomorphic settings, (1) basins/lake edge, (2) slopes, (3) spring mounds, (4) geologic contacts and (5) valley floors (Amon et al 2002; Cooper and Wolf 2005). Basin or lake edge fens originated as lakes or ponds, and formed as the pond was filled with partially decomposed plant remains (Fig. 3). They are typically flat, and open water may occur. Basin fens are widespread, may be quite large, and typically have floating mats that quake. *Sphagnum spp. is* common, as well as vascular plants.

Sloping fens are a very common type, and form at the base of hills where ground water discharges to the surface, as illustrated in Figure 1. Sloping fens can also occur on hillslopes where ground water discharges from alluvial fans, glacial moraines, permeable fault or fracture systems and other aquifers. Slopes can be steep or gentle, and although small pools may occur, large areas of open water are never present. This type of fen is common in the mountains of the western U.S.

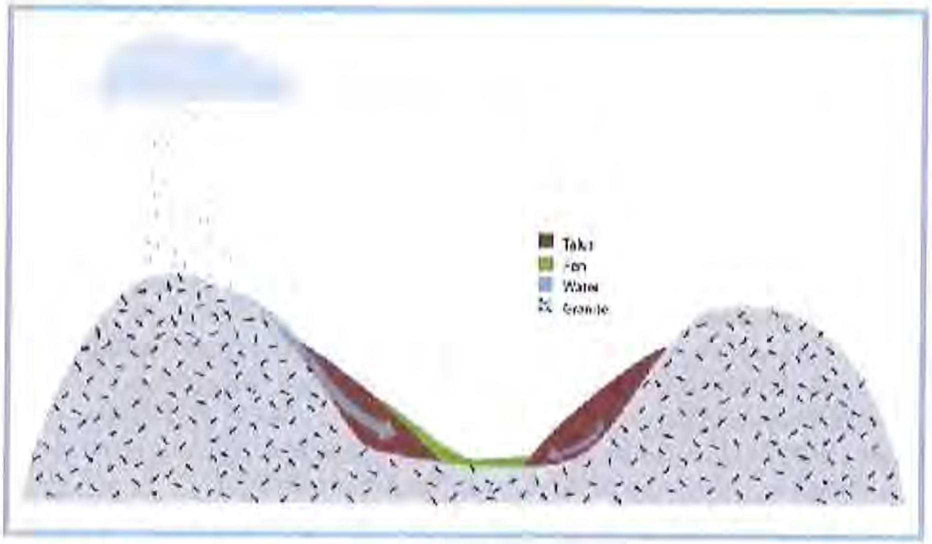

Figure 1. Sloping fen complex, green areas, at toe of slopes. (from Cooper and Wolk 2005)

Spring mounds, which are localized points of groundwater discharge, often support small fens (Fig. 2). Many spring mound fens are only tens of m in diameter, but they are morphologically and ecologically distinct. Spring mound fens may form within a sloping fen complex, and indicate a location of strong upward groundwater discharge and may also form over aquifer windows where a breach in a less permeable unit exposes a confined aquifer below (Fig. 3).

Fens may form at a contact between two rock types particularly where a highly permeable rock unit overlies an impermeable unit. Infiltrating ground water can be prevented from downward movement by the presence of a less permeable unit, forcing the water to move laterally where it can be discharged at the sloped surface. Fens of this type are common in the southern Cascade Range where ground water discharges from the bottom of lava beds.

Patterned fens are a unique type of fen characterized by a series of raised, linear hummocks oriented perpendicularly to the slope of the fen. These ridges, or strings, are separated from one another by linear pools of water known as flarks.

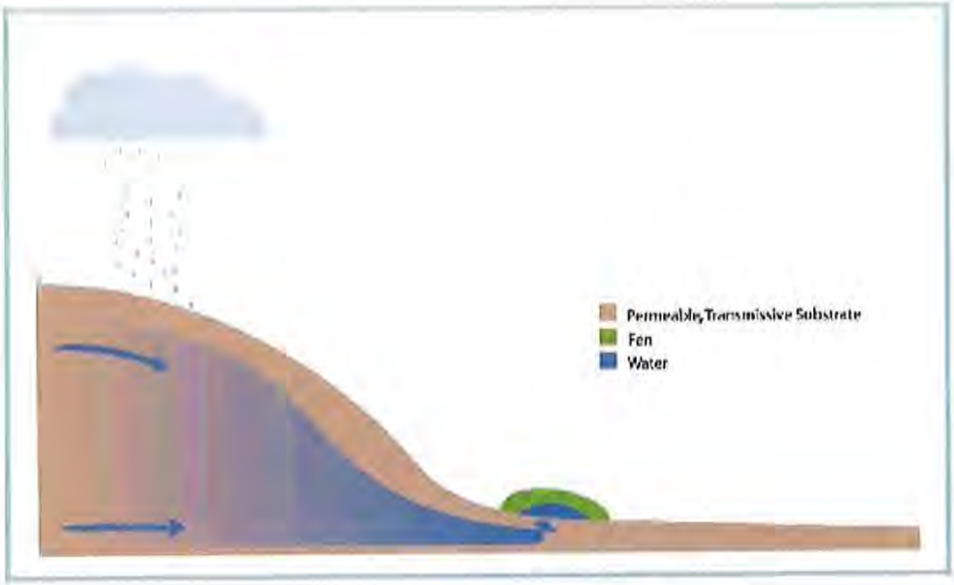

Figure 2. Diagram of spring mound fen. (from Cooper and Wolk 2005)

Disturbances and Condition of Fens

Few estimates of loss and current extent exist, but where estimates are available, they indicate extensive loss, fragmentation, and degradation. Two main types of disturbances to fens are hydrologic disturbances, and vegetation changes (Cooper and Wolk 2005). The development of channels that act as ditches can lead to drying of fens resulting in the oxidation of peat, and tree invasion. This is the most serious type of impact to fens, as sites are no longer saturated for long duration to the soil surface, and function more as wet meadows then fens. The peat body is then susceptible to burning during local forest fires. Floristic changes due to hoof punching and invasive species result from high livestock use. An additional concern is that logging should not occur within a distance that is one tree height of fens, because the additional of wood is a key component of fen organic matter, creates diverse habitat, and influences the hydrologic regime of fens by blocking drainages. Application of impermeable surfaces in the recharge area, and water withdrawal from the aquifer may alter the depth to water table and thus influence moisture in the root zone. Road building and pipelines alter the natural hydrologic
regime. With ground water no longer controlling the surface hydrology, rainfall can flush away mineral richness, and oxygen can penetrate into surface layers, eventually producing a non-fen successional environment (Siegel 1992).

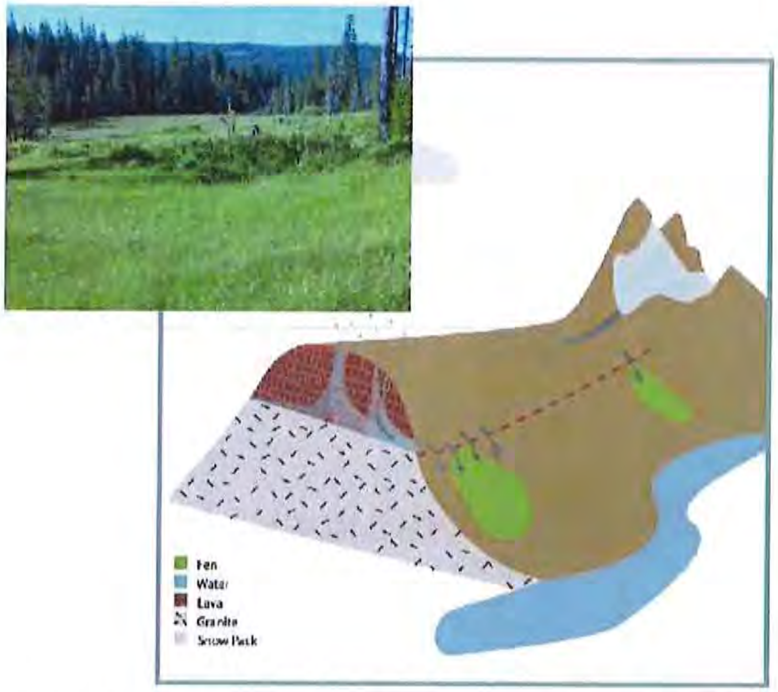

Figure 2. Diagram of fen formed where ground water discharges at the contact between two rock units. Inset photograph shows a fen, where large volumes of ground water flow from lava beds to the right of the photo. (from Cooper and Wolk 2005)

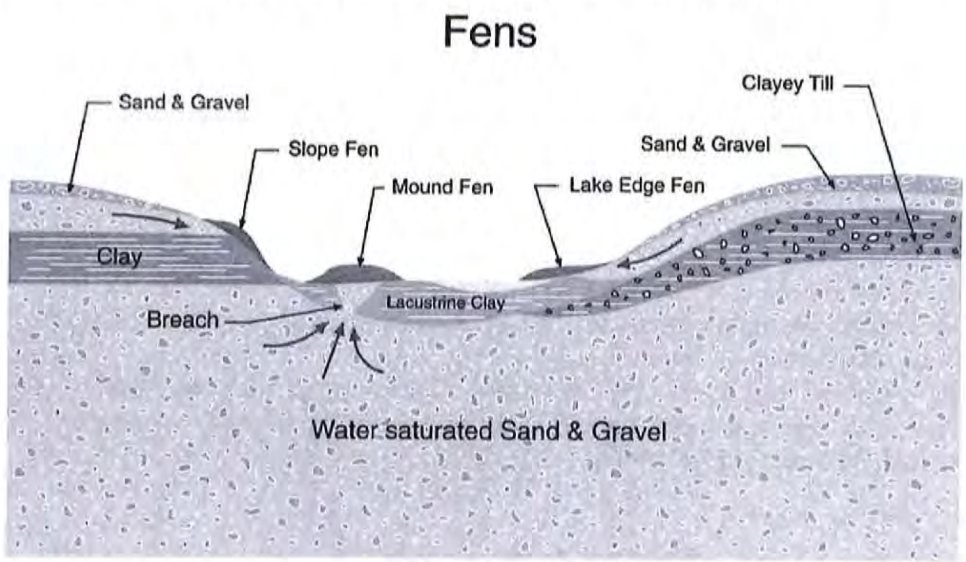

Figure 3. Geologic settings for Midwestern USA fens. Permeable deposits transmit ground water to the surface on hillsides to form slope fens, upward through openings in confining strata to form mound fens, and to the perimeter of lakes to form lake edge fens. (from Amon et al. 2002)

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APPENDIX III

Using Inventory Data to Set Management and Restoration Priorities

Management goals can be integrated with descriptions of biological and physical characteristics to prioritize spring management and restoration programs. The Forest Service has developed goals for maintaining values such as biodiversity and watershed health, and information compiled during Level I inventories provides insight into the condition and biotic potential of individual springs.

An example of this integration comes from recent work to prioritize the management and restoration of individual springs in Clark County, Nevada (Sada et al. 2003). This effort prioritized springs using matrix analyses by ranking biotic and abiotic elements of each spring (compiled during Level I and Level II inventories), and considering factors important to management. Matrix elements used to evaluate the management priority of individual springs are shown in Table 1 and elements to prioritize restoration are shown in Table 2. These examples are provided as one means to prioritize management and restoration. This method could be easily modified to evaluate priorities where other goals are guiding resource management. The matrix analyses is used as a process to reveal the relative importance of springs along a gradient of resource values and needs. In context of this gradient, additional planning is usually necessary to prioritize specific implementation programs within constraints such as funding and public involvement.

Matrix Analysis

Matrix I (Table 1) ranked the relative importance of each spring's resources to values at other springs in the Clark County. Elements in this matrix included rare species, factors indicating taxonomic richness (e.g., spring size, amount of disturbance [cultural and natural], the rarity of spring habitats across the landscape, land ownership, and the potential of conflicting uses that may affect biotic integrity. In this analysis, higher priority springs had higher matrix and resource values, and included larger springs (that generally do not dry during droughts), springs supporting critical crenobiontic species and high species richness. Higher priority springs were also in public ownership where management activities can be conducted, and springs where uses did not affect biotic integrity. Lower priority springs had lower matrix values and did not support critical species, had lower taxonomic richness (because they were small, subjected to scouring floods, etc.), periodically dried, occurred on private lands, and were affected by overwhelming uses that degraded their biotic integrity and minimized chances of restoring to natural character.

Matrix II (Table 2) ranks restoration priorities by considering habitat condition in addition to the elements used in Matrix I. Higher restoration priority is indicated by higher matrix values, which are given to springs with higher resource values and where restoration programs can achieve more rapid and effective success. Therefore, moderately disturbed springs with high resource values are given higher restoration priority than minimally disturbed springs with high resource values, and highly degraded springs with low resource value. Lower priority is assigned to the springs with lower resource values and higher disturbance where restoration may have minimal influence on riparian and aquatic communities.

Management priority rankings ranged from a maximum of 65 down to 20 in Clark County. Highest management priority springs were occupied by covered species, and they were relatively large, persistent, and in relatively good condition. Lower priority springs were small (many were ephemeral), not occupied by covered species, and they were highly disturbed by natural and anthropogenic factors. Clark County spring restoration priority values ranged from 100 down to 32. Highest rankings were generally assigned to springs that were also ranked highly in the management priority ranking. However, there was weak correlation between management priority and restoration priority rankings, which indicated that Matrix I and Matrix II analyses are necessary to rank management and restoration priorities.

Table 1. Elements and ranking values for Matrix I to rank the relative value of resources at springs. Each spring is ranked by evaluating each matrix element and summing the ranking values for all elements. Elements are described below.

Matrix I Criteria	**Ranking Value**
Presence of Rare Aquatic Species [1]	Present = 10, Absent = 0
Rarity Across Landscape [2]	Rare = 10, Sparse = 5, Common = 2
Spring Brook Length [3]	> 500 m = 10, < 500 > 200 = 7, < 200 > 50 = 5, < 50 = 2
Scouring [4]	None = 10, Occasional = 5, Frequent = 2
Aquatic Habitat Persistence [5]	Persistent = 10, Ephemeral = 2
Resource Threats [6]	High = 2, Medium = 10, Low = 7
Land Ownership [7]	Public = 10, Private = 3
Conflicting Uses [8]	< 1 = 10, 2-3 = 5, >3 = 2

2. Springs with rare plants or crenobiontic species are ranked 10, springs without rare species are ranked 0.

3. Spring rarity is a subjective scale of density across the landscape. In southern Nevada, density is comparatively high in spring provinces, moderate along the much of the east side of the Spring Mountains, and scarce in areas such as the west side of the Spring Mountain, in the McCullogh Range and Muddy Mountains.

4. Length is the distance of the spring brook from the source to the end of contiguous flowing surface water.

5. Scouring is based on the potential of scouring due to flooding. Frequent scouring may have a lower resource value and recovery potential.

6. Persistence is the long-term presence of surface water. It is indicated by riparian systems with obligate wetland species and macroinvertebrate communities that include large numbers of Ephemeropterans, Plectopterans, or Trichopterans. Riparian vegetation associated with non-persistent waters include more facultative wetland and upland species and macroinvertebrate communities are dominated by water boatman (corixids), diving beetles, and other highly vagile, invasive species. If spring snails are present, the spring has long-term persistence. Springs that dry have low recovery potential as aquatic habitats, but they may be important to amphibians.

7. Threats is a subjective evaluation of the likelihood that current activities will further degrade spring resource quality or keep it in a degraded condition. High threats usually mean a spring will be more difficult to restore. Low threats means land managers will likely want to keep the spring in its existing condition.

8. Ownership is either private, State, or Federal (public land).

9. Conflicting Uses is a subjective ranking of how current uses conflict with management objectives. In the Spring Mountains there are three primary types of conflicting uses: (1) introduced grazing, (2) diversions, (3) recreation. If none of these are present the ranking is 0. If one of these conflicting uses is present the ranking is 7. If two conflicting uses are present the ranking is 5, and if three are present the ranking is 2.

Table 2. Elements and ranking values for Matrix II to rank the restoration priority of springs. Each spring is ranked by evaluating each matrix element and summing the ranking values for all elements. Elements are as described for Matrix I, and below for elements used in only Matrix II.

Matrix II Criteria	**Analysis Scale**
Presence of Rare Aquatic Species [1]	Present = 10, Absent = 0
Rarity Across Landscape [2]	Rare = 10, Sparse = 5, Common = 2
Spring Brook Length [3]	> 500 m = 10, < 500 > 200 = 7, < 200 > 50 = 5, < 50 = 2
Scouring [4]	None = 10, Occasional = 5, Frequent = 2
Aquatic Habitat Persistence [5]	Persistent = 10, Ephemeral = 2
Resource Threats [6]	High = 2, Medium = 10, Low = 7
Land Ownership [7]	Public = 10, Private = 3
Conflicting Uses [8]	< 1 = 10, 2-3 = 5, >3 = 2
Habitat Condition [9]	Slight/Unmodified = 5, Moderate = 10, High = 2
Recoverability [10]	High = 10, Medium = 5, Low = 2

10. Habitat condition ratings are described in Level I protocol guidelines. Moderately disturbed springs receive higher ranking because restoration activities are more necessary than at slightly an undisturbed springs. Highly disturbed springs receive lower ranking because many of them are so badly disturbed that restoration is a very long-term process that requires substantial resources.

Recoverability includes the physical and biological aspects necessary to recover a spring. It does not include cost, feasibility, staffing needs, or political considerations.

References

Sada et al. 2003. Conservation management plan for springs in Clark County, Nevada. Unpublished report to Clark County, Nevada.

APPENDIX B. USDA FOREST SERVICE LEVEL 1 SPRING SURVEY DATASHEET

USDA Forest Service
Level I Spring Inventory Field Form

SITE ID#__________________________ **SITE NAME** ____________________________________ **DATE**__________

STATE _______ COUNTY _____________FOREST__________________DISTRICT__________________________

FIELD CREW ____

START TIME___________DRAINAGE & HUC CODE (6^{th}) ____

INFRA NO.______________ USGS QUAD(s)____

GPS Make and Model____________________________________ GPS Photo Number__________DGPS ___________

WAAS_________________ UTM ZONE ______________ PDOP ________+ - ________ DATUM: NAD____________

ACCESS______________________ ELEVATION (m)______________

SOURCE LOCATION: T_____ R_____SEC_____QQ_____ UTM______________N________________E

PHYSICAL CHARACTERISTICS

GEOMORPHIC SETTING (Circle): Channel, Floodplain, Stream Terrace, Cliff, Flat, Hill Slope, Saddle, Draw, Bench, Ravine

Other____

SLOPE POSITION (circle): Shoulder, Backslope, Footslope, Toeslope

ORIFICE GEOMORPHIC TYPE (circle): Seepage, Fracture/Joint, Tubular, Contact, Fault, Sinkhole

SPRING TYPE (circle): Rheocrene, Limnocrene, Helocrene, Mound, Fen, Stream Baseflow, Hillslope, Hanging Garden, Gushette, Geyser, Cave, Dry, Qanat, Well, Adit, Hot Spring, Sinking Stream, Other________________________

PRIMARY LITHOLOGY OF SOURCE____

DISCHARGE_______ (units) ________ METHOD & INSTRUMENT USED____________________________________

HABITAT SIZE (circle) <10 m^2 10 -100 m^2 100 -1000 m^2 0.1 -1 ha 1 -10 ha 10 -100 ha >100 ha

SPRING BROOK LENGTH (m) _______AVERAGE WATER DEPTH (cm) _______ AVERAGE WATER WIDTH (m) ________

EMERGENT COVER (%) ____________ VEGETATIVE BANK COVER (%)____________

SPRING BROOK INCISION (circle) >60 degrees from vertical, <60 degrees from vertical

SUBSTRATE METHOD (circle): Wolman Pebble Count, Visual Estimate, Other______________________________

SUBSTRATE COMPOSITION (%): fines (<0.05 mm)__________ sand (0.05 mm - 2 mm)__________ gravel (2 mm – 64 mm)________ cobble (64 mm - 256 mm)_________ boulder (>256 mm)_________ bedrock________peat__________

WATER CHEMISTRY

DO (mg/L) ____________TEMPERATURE (°C) ___________ pH ___________ CONDUCTIVITY (µS) _____________

BIOLOGY

IMPORTANT ANIMALS (circle): None, Springsnails (Scarce; Common; Abundant), Fish, Clams, Amphipods, Amphibians, Riffle Beetles, Crayfish, Red-Rimmed Melania, Ostracodes, incidental sitings of mammals, birds, and reptiles, Other _____________

____

____

SITE ID#____________________ SITE NAME ______________________________ DATE_________

IMPORTANT VEGETATION (Use NRCS PLANTS database symbols) ____________________________________

____

____

OTHER NON-NATIVE SPECIES____

COLLECTIONS MADE____

SITE CONDITION

SITE CONDITION (circle): undisturbed, slight, moderate, high

DISTURBANCE TYPE (circle): livestock, recreation, diversion, residence, drying, fire, flooding, dredging

Other____

____

WATER USES

WATER RIGHTS NO. /STATUS_________________________________TRIBUTARY TO_______________

VOLUME DIVERTED__________(units)__________ % DIVERTED__________ (Circle) estimated measured

POD: T______ R_______SEC_______QQ_______ UTM _________________N__________________E

POU: T______ R_______SEC_______QQ_______ UTM _________________N__________________E

DEVELOPMENT TYPE (circle): tank, trough, pond, guzzler, spring box, fencing, piping,

Other____

____

USES (circle): Livestock, Wildlife, Domestic, Recreation, Irrigation, In stream, Municipal, Mining, Other ______________

____

CONDITION AND MAINTENANCE NEEDS OF DEVELOPMENTS______________________________________

____

____

NOTES____

____

____

____

DIRECTIONS TO SITE____

____

____

SITE ID#____________________ SITE NAME ______________________________ DATE_________

Sketch – Provide general sketch of spring, developments, and setting (provide scale and north arrow)

SITE ID#____________________ SITE NAME ______________________________ DATE_________

PHOTO LOG

Project:		
Photographers Name:	Date:	☐ Digital ☐Film

No.	Digital #	Time	Northing	Easting	Description
					Looking upstream including the spring source
					Looking downstream

Digital Picture number is the number assigned by the computer when pictures are downloaded

APPENDIX C. DEFINITION OF GPS DATUM ACRONYMS

DGPS (Differential Global Positioning System) is a technique to increase the accuracy of the location data reported by the GPS. This technique requires that the receiving or roving GPS unit be able to receive signals from a second GPS receiver located at a known location or base station. The base station signal provides corrected information with regards to the satellites' data and allows the receiving GPS to more accurately report location data. Differential GPS can give location data within several centimeters of accuracy and is typically used in survey work.

PDOP (Position Dilution of Precision) is a ranking system of the position of the satellites relative to each other. Satellites positioned evenly spaced throughout the sky receive good rankings, the best with at least one satellite located directly above the receiving GPS and three other satellites located along the horizon equidistant from each other. PDOP values start at 1 as the best and can go on indefinitely, although a value greater than 8 is generally considered very poor.

WAAS (Wide Area Augmentation System) is a technique to increase the accuracy of location data by providing GPS signal corrections. It utilizes a network of satellites and ground stations in the United States to monitor satellite data. Two master stations, one on each coast, sends a signal with corrected information regarding the GPS satellite positions. WAAS is currently being developed for the Federal Aviation Administration to increase precision in airplane takeoffs and landings and can give location data within a few meters of accuracy.

Appendix E

Springs Inventory

E.1.0 PROJECT BASINS SPRINGS INVENTORY

Table E.1-1 contains a listing of springs inventoried by either USGS or DRI that were not part of the selected springs chosen for further study by SNWA. Table E.1-2 contains a listing of springs that were included in the National Hydrography Dataset, Geographic Names Information System, or contained on USGS 1:24,000 topographic maps. The springs within both of these tables are located within the Project Basins of Spring, Snake, Cave, Dry Lake, Delamar, and Coyote Springs valleys.

Table E.1-1
Additional USGS and DRI Inventoried Springs within the Project Basins
(Page 1 of 2)

Site Number	Site Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 180 Cave Valley					
180 N08 E64 25CA 1	Spring Schell Creek 1, SC-1	696,793	4,265,779	7,048	DRI
381658114523300	Lackawanna Springs	685,714	4,239,318	--	USGS
383556114545901	Big Spring-Egan Range, ER-4 (DRI)	681,373	4,274,318	--	USGS
384034114463601	Sheep Spring	693,335	4,283,174	--	USGS
385007114530301	Chimney Rock Spring	683,574	4,300,617	--	USGS
Hydrographic Area 181 Dry Lake Valley					
181 N01 E63 21CA 1	Deadman Spring, PR-5	683,347	4,200,439	5,400	DRI
181 N01 E63 22AD 1	Hamilton Spring, PR-2	685,632	4,200,787	5,300	DRI
181 N01 E63 28CB 1	Unnamed Spring, PR-4	682,958	4,198,637	5,400	DRI
181 S01 E64 06DB 1	Rattlesnake Spring, PR-8	689,192	4,195,827	5,500	DRI
181 S03 E63 06DA 1	Little Boulder Spring, PR-6	680,501	4,175,979	6,000	DRI
181 S04 E64 25DD 1	Red Rock Spring, DR-1	698,430	4,160,145	6,100	DRI
181 S04 E65 16BA 1	Oak Spring, DR-9	702,129	4,164,508	4,729	DRI
375443114550501	Black Rock Spring, PR-3	682,943	4,198,083	5,523	USGS
381443114421201	Unknown (NDWR Reconnaissance Report 16)	700,939	4,236,197	6,154	USGS
381706114413201	Unknown	701,770	4,239,950	6,244	USGS
381758114401601	North Mud Spring	703,576	4,241,599	6,404	USGS
381824114404201	Horse Corral Spring	702,925	4,242,385	6,364	USGS
382555114442201	Unknown	697,240	4,256,155	6,324	USGS
Hydrographic Area 182 Delamar Valley					
182 S05 E65 06DC 1	Cottonwood Spring, DR-18	699,122	4,156,520	6,750	DRI
182 S05 E65 20AC 1	Abandoned Spring, DR-19	700,760	4,152,669	6,600	DRI
Hydrographic Area 184 Spring Valley					
383645114265401	Cottonwood Spring	722,098	4,276,858	6,624	USGS
391516114292001	Unknown	716,602	4,348,010	5,704	USGS
384944114235101	Minerva Spring	725,842	4,300,999	5,804	USGS
385052114234501	Shoshone Spring	725,927	4,303,100	5,784	USGS
385403114202501	Mount Wheeler Mine Spring	730,577	4,309,127	7,965	USGS
390907114340001	Bastian Spring	710,196	4,336,450	6,697	USGS
392438114190801	Sp NE Face Mount Wheeler	730,759	4,365,760	--	USGS
393347114361801	Kalamazoo Creek Spring	706,815	4,382,117	7,204	USGS
394059114363301	North Creek Spring	704,918	4,395,982	8,004	USGS
395204114354101	Egan Creek Springs	705,647	4,415,842	6,654	USGS
393603114335801	Muncy Creek Spring	708,900	4,386,277	7,004	USGS

Table E.1-1
Additional USGS and DRI Inventoried Springs within the Project Basins
(Page 2 of 2)

Site Number	Site Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 Snake Valley					
391457113524101	(C-18-18)16abb-S1	769,340	4,349,065	4,874	USGS
385434114063901	Spring Creek Spring	750,448	4,310,689	6,124	USGS
390025114112001	Rowland Spring	743,344	4,321,299	6,304	USGS
390403113580301	254 1 Spring	762,294	4,328,637	5,009	USGS
391557113515601	(C-18-18) 3cca-S1	770,355	4,350,953	4,875	USGS
391859113595201	Kell Spring	758,759	4,356,178	4,944	USGS
392411113514301	(C-16-18)22cab-S1	770,137	4,366,197	4,807	USGS
393949113562301	(C-13-19)25bab-S1	762,454	4,394,891	5,584	USGS
392455113522601	Foote Reservoir Spring	769,061	4,367,518	4,829	USGS
392737114021201	(C-15-19)31cbd-S1	754,869	4,372,030	5,241	USGS
392815113593001	(C-15-19)31bc -S1	758,714	4,373,340	5,304	USGS
392952113544801	(C-15-18)19aba-S1	765,351	4,376,559	4,799	USGS
393501113572701	(C-14-19)23bdb-S1	761,230	4,385,958	5,089	USGS
393949113550001	(C-13-18)30abb-S1	764,432	4,394,959	5,284	USGS
394101114033701	Pleasant Valley Spring	752,038	4,396,765	6,004	USGS
394117113582601	(C-13-19)15acc-S1	759,431	4,397,505	6,564	USGS
394131113533301	(C-13-18)17aad-S1	766,397	4,398,176	5,284	USGS
394134113544201	(C-13-18)18aad-S1	764,750	4,398,211	5,784	USGS
394212114025701	Indian Spring	752,919	4,398,986	7,004	USGS
394235113585801	(C-13-19) 3ccc-S1	758,588	4,399,885	8,464	USGS
394428113543801	(C-12-18)30ddd-S1	764,660	4,403,580	7,454	USGS
394428113582101	(C-12-19)27dcd-S1	759,351	4,403,399	8,915	USGS
395055113484301	(C-11-17)19ccb-S1	772,686	4,415,811	5,599	USGS
395119113513901	(C-11-18)22bdc-S1	768,477	4,416,403	8,084	USGS
395138113450301	(C-11-17)22bab-S1	777,868	4,417,325	4,643	USGS
395141113511401	(C-11-18)22aba-S1	769,047	4,417,102	7,754	USGS
395247113490901	(C-11-18)12dcb-S1	771,945	4,419,243	6,264	USGS
395457113473000	(C-10-17)32bca-S1	774,153	4,423,336	5,260	USGS
363854114072701	Dud Spring	752,867	4,341,137	4,394	USGS
390010114184001	Theresa Lake Feeder Spring	732,773	4,320,517	--	USGS
395914113464201	(C-10-17) 5add-S1	775,007	4,431,302	4,889	USGS
394152113562101	(C-13-19)12cad-S1	762,372	4,398,685	6,644	USGS
Hydrographic Area 210 Coyote Springs Valley					
363830115041201	Wamp Spring	672,461	4,056,852	5,483	USGS
364050115103401	Sawmill Spring	662,891	4,060,981	8,124	USGS
365642115062101	Lamp Spring	668,590	4,090,442	5,683	USGS

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 1 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 180 - Cave Valley				
Lewis Well (Spring)	680,098	4,244,303	6,259	National Hydrography Dataset
Wolf Hole Spring (Dry)	678,115	4,246,267	7,069	Geographic Names Information System/National Hydrography Dataset
Horse Spring	680,402	4,248,398	6,490	
Rosebud Spring	697,429	4,266,810	7,481	
Unnamed Spring	686,803	4,269,631	7,210	24K Topographic Map
Quartzite Spring	695,170	4,271,188	6,601	Geographic Names Information System/National Hydrography Dataset
Big Travis Spring	680,543	4,278,447	7,206	
Little Travis Spring	683,834	4,278,596	6,882	Geographic Names Information System
Canyon Spring	696,280	4,278,989	8,062	
Cottonwood Spring	677,457	4,279,255	8,237	Geographic Names Information System/National Hydrography Dataset
Lewis Spring	684,709	4,279,680	6,772	
Cabin Spring	695,211	4,279,954	7,587	Geographic Names Information System
Unnamed Spring	677,969	4,280,271	8,091	National Hydrography Dataset
Mahogany Spring	696,432	4,280,616	8,997	Geographic Names Information System
Wall Spring	695,195	4,281,558	7,945	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	679,355	4,281,658	7,893	National Hydrography Dataset
Unnamed Spring	690,800	4,281,694	6,645	
Unnamed Spring	679,029	4,281,726	7,769	
Unnamed Spring	688,155	4,282,043	6,541	
Haggerty Spring	682,274	4,282,162	7,082	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	687,780	4,282,759	6,520	24K Topographic Map
Unnamed Spring	687,706	4,282,801	6,523	National Hydrography Dataset
Unnamed Spring	680,853	4,283,095	7,367	
Unnamed Spring	691,607	4,283,234	6,961	
Unnamed Spring	679,352	4,284,109	7,642	24K Topographic Map
Brush Spring	694,284	4,285,811	8,357	Geographic Names Information System/National Hydrography Dataset
Quartzite Spring	693,832	4,286,460	8,188	Geographic Names Information System
Sagahen Spring	694,271	4,287,645	8,085	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	680,099	4,287,657	7,786	National Hydrography Dataset
Unnamed Spring	680,703	4,288,215	7,447	
Willow Spring	681,042	4,290,397	7,551	Geographic Names Information System/National Hydrography Dataset
Wildcat Spring	694,376	4,290,517	8,327	
Unnamed Spring	682,747	4,292,351	7,270	National Hydrography Dataset
Unnamed Spring	682,289	4,292,516	7,311	
Robbers Roost Spring	692,697	4,293,649	7,535	Geographic Names Information System/National Hydrography Dataset
Carter Spring	679,993	4,294,650	8,210	
Currant Spring	681,314	4,296,717	7,902	Geographic Names Information System
Sagahen Spring	681,998	4,297,864	8,036	Geographic Names Information System/National Hydrography Dataset
Silver Spring	683,900	4,297,889	7,560	
Blind Spring	683,881	4,299,272	7,465	Geographic Names Information System

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 2 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 181 - Dry Lake Valley				
Pine Spring	699,705	4,158,329	6,520	Geographic Names Information System/National Hydrography Dataset
Canyon Number Two Spring	701,332	4,158,329	6,658	
Canyon Spring	700,131	4,158,551	6,467	
Moon Spring	699,177	4,159,318	6,291	Geographic Names Information System
Cyclone Spring	700,466	4,160,628	6,278	Geographic Names Information System/National Hydrography Dataset
Tyler Spring	700,585	4,162,631	6,095	
Seven Oaks Spring	697,857	4,162,923	5,739	
West Oak Spring	701,570	4,164,393	5,880	
Nelson Spring	703,686	4,165,657	6,016	
Long Point Spring	695,455	4,167,874	4,863	Geographic Names Information System
Dana Spring	702,394	4,171,166	5,500	Geographic Names Information System/National Hydrography Dataset
Cliff Springs	702,404	4,171,838	5,458	
Cliff Springs	702,418	4,171,898	5,444	
Rabbit Spring	702,478	4,172,387	5,385	
Brinkerhoff Spring	680,944	4,176,862	5,846	Geographic Names Information System
Porphory Spring	704,031	4,177,134	5,546	Geographic Names Information System/National Hydrography Dataset
Pine Spring	682,515	4,177,786	5,952	Geographic Names Information System
Klondike Spring	711,330	4,178,007	5,783	Geographic Names Information System/National Hydrography Dataset
Rye Grass Spring	685,592	4,178,064	5,192	Geographic Names Information System
George Roger Spring	711,513	4,178,528	5,798	
Mustang Spring	683,121	4,178,529	5,521	Geographic Names Information System/National Hydrography Dataset
West Side Spring	684,078	4,178,930	5,396	Geographic Names Information System
Mustang Spring	683,423	4,180,785	5,508	
Wheatgrass Spring	683,997	4,181,440	5,393	Geographic Names Information System/National Hydrography Dataset
Pace Spring	683,578	4,181,690	5,447	
Rattlesnake Spring	682,109	4,188,524	5,484	
Sand Spring	689,089	4,191,186	4,774	Geographic Names Information System
Two and One Half Spring	688,739	4,194,758	4,806	
Ely Springs	704,838	4,198,323	5,466	
Ely Springs	704,943	4,198,339	5,515	National Hydrography Dataset
Ely Springs	705,321	4,198,589	5,630	
Ely Springs	705,193	4,198,596	5,575	
Delmues Spring	706,663	4,199,574	5,948	Geographic Names Information System
Tex Spring	704,120	4,200,403	5,649	Geographic Names Information System/National Hydrography Dataset
Coal Spring	685,084	4,200,858	5,410	
Iron Tank Spring	706,440	4,201,442	6,098	Geographic Names Information System
Smith Spring	706,754	4,202,878	5,811	
Reindeer Spring	706,751	4,203,118	5,763	
Bullfrog Spring	706,123	4,203,657	5,620	

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Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 3 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 181 - Dry Lake Valley (Continued)				
Unnamed Spring	684,940	4,206,182	6,013	National Hydrography Dataset
Unnamed Spring	709,664	4,206,794	6,503	
Cabin Spring	685,814	4,207,521	5,741	Geographic Names Information System/National Hydrography Dataset
Simpson Spring	708,461	4,207,674	6,230	
Blind Mountain Spring	708,155	4,210,125	6,455	Geographic Names Information System/National Hydrography Dataset
Stonewall Spring	687,214	4,211,562	5,230	Geographic Names Information System
Coyote Spring	690,622	4,220,065	5,073	
Unnamed Spring	700,279	4,225,481	6,023	24K Topographic Map
Peers Spring	704,241	4,225,485	6,065	National Hydrography Dataset
Hornsilver Spring	701,784	4,226,107	6,087	Geographic Names Information System
Fox Cabin Spring	705,876	4,226,467	6,080	Geographic Names Information System/National Hydrography Dataset
Scotty Spring	702,943	4,226,637	6,278	
Lower Fairview Spring	705,382	4,227,849	6,215	
Upper Fairview Spring	704,510	4,229,028	6,376	
Indian Spring	703,023	4,231,335	6,555	
Robinson Spring	700,789	4,231,911	6,199	
ChokeCherry Spring	703,908	4,234,145	6,606	
Unnamed Spring	704,940	4,238,185	6,621	National Hydrography Dataset
Lone Cedar Spring	703,921	4,238,859	6,455	Geographic Names Information System
Rye Grass Seep	702,414	4,239,199	6,348	
Unnamed Spring	704,989	4,239,407	6,667	National Hydrography Dataset
By Pass Seep	701,710	4,239,457	6,275	Geographic Names Information System
One Trough Spring	704,217	4,240,522	6,709	
Unnamed Spring	702,189	4,240,557	6,380	24K Topographic Map
South Mud Spring	702,256	4,241,026	6,318	Geographic Names Information System/National Hydrography Dataset
Big Mud Springs	689,576	4,241,368	6,397	
Tribolata Spring	703,848	4,241,484	6,695	Geographic Names Information System
Hidden Seep Spring	702,187	4,241,503	6,285	
North Mud Spring	702,779	4,241,683	6,395	Geographic Names Information System/National Hydrography Dataset
Grass Patch Spring	704,088	4,242,107	6,677	Geographic Names Information System
Steward Spring	702,116	4,248,254	7,120	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	692,261	4,250,174	6,404	National Hydrography Dataset
Mule Shoe Spring	693,840	4,253,787	6,396	Geographic Names Information System
Jasper Spring	693,747	4,254,310	6,457	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	694,619	4,254,685	6,444	National Hydrography Dataset
Unnamed Spring	694,741	4,254,766	6,452	
Unnamed Spring	694,024	4,254,779	6,533	
Unnamed Spring	694,105	4,254,795	6,570	
Unnamed Spring	694,160	4,254,934	6,573	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 4 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 181 - Dry Lake Valley (Continued)				
Unnamed Spring	695,253	4,255,579	6,531	National Hydrography Dataset
Chris Spring	697,423	4,255,696	6,303	Geographic Names Information System/National Hydrography Dataset
Cris Spring	695,951	4,256,401	6,771	
Hydrographic Area 182 - Delamar Valley				
Stewart Spring	696,087	4,129,340	5,526	Geographic Names Information System
Holly Spring	693,976	4,132,681	5,324	
Jumbo Spring	697,317	4,132,856	6,214	National Hydrography Dataset/Geographic Names Information System
Ben Hur Spring	693,936	4,134,401	5,577	Geographic Names Information System
Jumbo Spring	697,856	4,136,467	5,732	
Bruno Spring	693,378	4,139,619	5,026	
Horn Spring	701,031	4,141,537	6,336	
Mona Spring	701,260	4,142,453	6,183	
Unnamed Spring	701,589	4,142,763	6,177	National Hydrography Dataset
Tunnel Spring	701,445	4,142,965	6,155	National Hydrography Dataset/Geographic Names Information System
Tunnel Number Three Spring	700,441	4,143,804	5,858	Geographic Names Information System
Tunnel Number Two Spring	701,410	4,144,204	5,926	
Tunnel Number One Spring	701,405	4,144,543	5,956	
Joshua Spring	701,559	4,145,351	6,091	
Blyth Spring	703,026	4,147,489	6,227	National Hydrography Dataset/Geographic Names Information System
Old Indian Spring	691,927	4,148,324	5,027	Geographic Names Information System
New Indian Spring	692,004	4,148,826	5,055	
Twin Spring	674,934	4,148,884	6,298	National Hydrography Dataset/Geographic Names Information System
Rye Patch Spring	674,914	4,149,403	6,393	Geographic Names Information System
Blythe Spring	696,236	4,149,754	5,681	
Boulder Spring	674,598	4,151,800	6,459	
East Boulder Spring	678,111	4,152,799	5,296	
Coyote Spring	700,472	4,152,822	6,603	National Hydrography Dataset/Geographic Names Information System
Robinson Seep	699,466	4,154,783	6,730	
Cottonwood Springs	689,005	4,156,114	4,921	Geographic Names Information System
Sawyer Spring	691,202	4,157,009	5,163	
Hughie Spring	688,342	4,158,267	4,927	
Six Mile Spring	676,944	4,161,453	4,994	
Hydrographic Area 184 - Spring Valley				
White Rock-Bailey Springs	730,005	4,255,343	7,297	Geographic Names Information System/National Hydrography Dataset
Brown Water Spring	731,247	4,255,752	7,068	
Unnamed Spring	735,264	4,258,044	6,948	National Hydrography Dataset
Bradshaw Spring	735,373	4,258,398	6,921	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	732,688	4,258,544	6,805	24K Topographic Map

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 5 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Silver Park Springs	729,881	4,258,828	7,079	Geographic Names Information System/National Hydrography Dataset
Silver Park Springs	730,129	4,258,933	7,052	National Hydrography Dataset
Silver Park Springs	730,159	4,259,003	7,048	
Cow Heaven Spring (dry)	724,149	4,267,275	6,691	Geographic Names Information System/National Hydrography Dataset
Basin Spring	723,388	4,269,189	6,688	
Pipe Spring	722,685	4,272,884	6,860	National Hydrography Dataset
Wild Horse Spring	721,185	4,275,755	7,709	Geographic Names Information System
Deer Spring	723,717	4,276,768	6,315	Geographic Names Information System/National Hydrography Dataset
Indian Springs	722,006	4,279,581	6,526	National Hydrography Dataset
Indian Springs	721,961	4,280,067	6,358	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	721,692	4,280,150	6,327	National Hydrography Dataset
Unnamed Spring	731,678	4,290,591	6,543	
Unnamed Spring	733,511	4,294,046	7,325	
South Fox Spring	714,767	4,294,390	5,791	Geographic Names Information System
Unnamed Spring	735,611	4,295,016	7,629	National Hydrography Dataset
Unnamed Spring	734,311	4,295,131	7,597	
Unnamed Spring	734,733	4,296,657	7,940	
Unnamed Spring	735,207	4,297,264	7,889	
Black Spring	705,025	4,301,298	7,304	Geographic Names Information System
Unnamed Spring	725,822	4,301,583	5,831	24K Topographic Map
Unnamed Spring	725,637	4,301,939	5,822	
Unnamed Spring	725,848	4,302,043	5,838	
Unnamed Spring	725,459	4,302,109	5,813	
Unnamed Spring	725,455	4,302,420	5,822	National Hydrography Dataset
Unnamed Springs	725,407	4,302,498	5,818	24K Topographic Map
Unnamed Spring	728,679	4,302,864	6,136	
Unnamed Spring	728,640	4,302,929	6,124	
South Spring	716,341	4,303,423	5,780	Geographic Names Information System
Willow Spring	705,390	4,303,465	7,681	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	705,220	4,303,621	7,788	National Hydrography Dataset
Unnamed Spring	725,163	4,303,877	5,798	24K Topographic Map
Unnamed Spring	725,152	4,303,955	5,800	
Unnamed Spring	725,141	4,304,048	5,803	
Unnamed Spring	725,220	4,304,573	5,807	National Hydrography Dataset
Unnamed Spring	725,227	4,304,768	5,805	
Unnamed Spring	725,205	4,304,917	5,810	
Basin Spring	706,723	4,306,330	7,542	Geographic Names Information System/National Hydrography Dataset
The Seep	723,833	4,306,337	5,761	24K Topographic Map
Unnamed Spring	731,004	4,309,431	7,962	National Hydrography Dataset
Bennett Spring	704,272	4,311,098	8,447	Geographic Names Information System/National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
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Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	724,009	4,311,265	5,769	24K Topographic Map
Unnamed Spring	723,988	4,311,293	5,768	
Unnamed Spring	723,804	4,313,255	5,812	
Worthington Spring	726,492	4,314,844	6,487	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	724,321	4,314,862	5,941	24K Topographic Map
Unnamed Spring	724,683	4,315,277	6,023	
Unnamed Spring	726,993	4,315,280	6,635	National Hydrography Dataset
Unnamed Spring	729,859	4,315,830	7,920	24K Topographic Map
Unnamed Spring	729,515	4,316,217	7,941	National Hydrography Dataset
Raised Spring	727,819	4,317,082	7,086	Geographic Names Information System/National Hydrography Dataset
Stevens Springs	703,665	4,318,075	8,105	
Limerock Spring	705,184	4,318,299	7,458	
Unnamed Spring	729,281	4,322,988	8,559	24K Topographic Map
Unnamed Spring	718,834	4,324,432	5,747	National Hydrography Dataset
Unnamed Spring	718,486	4,324,971	5,741	
Ohio Spring	727,669	4,325,303	8,119	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	728,137	4,325,556	8,780	National Hydrography Dataset
Unnamed Spring	727,327	4,325,746	8,611	
Unnamed Spring	727,553	4,325,751	8,596	
Unnamed Spring	726,995	4,325,816	8,399	
Allen Spring	705,658	4,327,959	7,314	Geographic Names Information System/National Hydrography Dataset
Jacks Spring	727,031	4,328,502	8,065	
Unnamed Spring	703,893	4,329,764	8,184	National Hydrography Dataset
Unnamed Spring	726,279	4,330,020	7,258	
Unnamed Spring	726,020	4,330,126	7,131	
Crethers Springs	703,700	4,330,197	7,933	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	726,158	4,330,584	7,193	National Hydrography Dataset
Unnamed Spring	726,169	4,330,736	7,174	
Unnamed Springs	703,060	4,332,320	7,346	
Unnamed Spring	702,117	4,332,386	7,746	
Unnamed Springs	703,045	4,332,394	7,341	
Unnamed Spring	718,375	4,334,128	5,674	24K Topographic Map
Unnamed Spring	718,332	4,334,386	5,671	
Aspen Spring	702,126	4,334,539	7,847	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	703,809	4,334,967	7,758	24K Topographic Map
Unnamed Spring	716,257	4,335,258	5,754	
Unnamed Spring	718,242	4,335,328	5,657	
Unnamed Spring	704,392	4,335,968	8,287	
Unnamed Spring	704,428	4,335,990	8,264	

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Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
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Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	704,477	4,336,033	8,245	24K Topographic Map
Unnamed Spring	701,394	4,336,034	8,649	
Unnamed Spring	703,408	4,336,069	8,135	National Hydrography Dataset
Unnamed Spring	715,616	4,336,213	5,762	24K Topographic Map
East Canyon Spring	704,707	4,336,293	8,283	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	702,439	4,336,432	8,149	National Hydrography Dataset
Unnamed Spring	718,340	4,336,449	5,644	24K Topographic Map
Unnamed Spring	717,417	4,336,584	5,676	
Bastian Spring	710,123	4,336,590	6,704	Geographic Names Information System/National Hydrography Dataset
Upper Bastian Spring	708,962	4,336,823	7,507	
Unnamed Spring	729,604	4,337,169	7,024	National Hydrography Dataset
Unnamed Spring	728,802	4,337,447	6,839	
Unnamed Stream	717,151	4,337,950	5,660	
Turnley Spring	728,697	4,338,048	6,775	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	727,556	4,339,380	6,445	National Hydrography Dataset
Unnamed Spring	727,875	4,339,689	6,519	
Unnamed Spring	727,179	4,339,692	6,380	
Rock Spring	726,805	4,340,219	6,367	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	728,193	4,340,332	6,652	National Hydrography Dataset
Unnamed Spring	728,104	4,340,528	6,641	
Unnamed Spring	718,917	4,340,645	5,645	24K Topographic Map
Unnamed Spring	719,735	4,342,149	5,617	
Unnamed Spring	719,585	4,342,321	5,621	
Unnamed Spring	719,098	4,342,428	5,641	
Unnamed Spring	719,033	4,342,581	5,643	
Cottonwood Spring	707,980	4,343,083	7,769	Geographic Names Information System/National Hydrography Dataset
Granite Spring	728,251	4,343,711	6,790	
Unnamed Spring	712,012	4,344,293	6,422	National Hydrography Dataset
Unnamed Spring	711,412	4,344,447	6,773	
Unnamed Spring	719,128	4,344,545	5,622	24K Topographic Map
Kolcheck Springs	711,801	4,344,805	6,740	Geographic Names Information System/National Hydrography Dataset
Kolcheck Springs	711,859	4,344,848	6,735	
Unnamed Spring	719,084	4,345,016	5,613	24K Topographic Map
Unnamed Spring	718,904	4,345,089	5,620	
Unnamed Spring	711,928	4,345,093	6,745	
Reservoir Basin Spring	732,436	4,345,225	7,800	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	718,594	4,345,253	5,638	24K Topographic Map
Unnamed Spring	718,475	4,345,371	5,640	National Hydrography Dataset
Unnamed Spring	718,537	4,345,461	5,634	
Unnamed Spring	718,835	4,345,473	5,614	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 8 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	718,455	4,345,571	5,636	National Hydrography Dataset
Unnamed Spring	732,758	4,345,635	7,515	24K Topographic Map
Unnamed Spring	719,211	4,345,735	5,601	
Unnamed Spring	718,124	4,345,812	5,654	National Hydrography Dataset
Unnamed Spring	710,151	4,345,825	7,014	24K Topographic Map
Unnamed Spring	718,096	4,345,906	5,657	National Hydrography Dataset
Unnamed Spring	713,255	4,346,254	6,462	24K Topographic Map
Unnamed Spring	718,729	4,346,262	5,601	National Hydrography Dataset
Unnamed Spring	713,419	4,346,278	6,422	24K Topographic Map
Unnamed Spring	713,517	4,346,319	6,354	National Hydrography Dataset
Unnamed Spring	709,412	4,346,413	7,222	24K Topographic Map
Smudge Spring	730,466	4,346,732	6,765	Geographic Names Information System/National Hydrography Dataset
Indian Springs	713,615	4,346,948	6,456	National Hydrography Dataset
Indian Springs	713,745	4,347,050	6,396	Geographic Names Information System/National Hydrography Dataset
Indian Springs	713,766	4,347,107	6,402	
Unnamed Spring	719,100	4,347,177	5,593	24K Topographic Map
Unnamed Spring	717,932	4,347,189	5,598	
Unnamed Spring	712,696	4,347,303	7,190	National Hydrography Dataset
Chokecherry Spring	731,996	4,347,479	6,919	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	706,440	4,347,755	7,302	24K Topographic Map
Unnamed Spring	712,651	4,347,777	7,622	National Hydrography Dataset
Unnamed Spring	721,580	4,348,226	5,587	24K Topographic Map
Unnamed Spring	721,547	4,348,623	5,586	National Hydrography Dataset
Unnamed Spring	716,984	4,348,823	5,594	24K Topographic Map
Fera Ninetysix Spring	707,610	4,348,884	8,654	Geographic Names Information System
Unnamed Spring	738,566	4,348,920	9,300	National Hydrography Dataset
Unnamed Spring	720,873	4,349,031	5,581	24K Topographic Map
Pete Spring	706,552	4,349,178	8,076	National Hydrography Dataset/Geographic Names Information System
Kraft Spring	702,872	4,349,399	9,643	
Unnamed Spring	706,091	4,349,476	7,764	24K Topographic Map
Unnamed Spring	716,940	4,349,599	5,593	
North Cleve Spring	709,395	4,349,640	9,285	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	717,025	4,349,934	5,594	24K Topographic Map
Unnamed Spring	717,091	4,350,085	5,593	
Unnamed Spring	717,201	4,350,232	5,593	
Unnamed Spring	717,287	4,350,318	5,592	
Unnamed Spring	707,210	4,350,326	9,038	
Unnamed Spring	717,193	4,350,346	5,594	National Hydrography Dataset
Unnamed Spring	717,274	4,350,363	5,593	24K Topographic Map
Unnamed Spring	717,291	4,350,465	5,593	

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Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
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Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	717,221	4,350,538	5,595	National Hydrography Dataset
Unnamed Spring	739,553	4,350,571	9,157	24K Topographic Map
Unnamed Spring	717,324	4,350,628	5,594	
Unnamed Spring	717,152	4,350,657	5,605	National Hydrography Dataset
Unnamed Spring	717,336	4,350,685	5,594	24K Topographic Map
Unnamed Spring	717,393	4,350,738	5,594	
Unnamed Spring	705,776	4,350,783	8,421	
Unnamed Spring	717,373	4,350,800	5,593	
Unnamed Spring	717,360	4,350,832	5,594	
Unnamed Spring	717,168	4,350,845	5,609	
Unnamed Spring	705,744	4,350,873	8,436	
Unnamed Spring	739,701	4,351,238	9,113	
Unnamed Spring	705,695	4,351,298	8,769	National Hydrography Dataset
Unnamed Spring	708,088	4,351,400	8,673	24K Topographic Map
Unnamed Spring	717,716	4,351,559	5,589	
Unnamed Spring	711,928	4,351,580	8,322	
Unnamed Spring	705,637	4,351,805	9,030	National Hydrography Dataset
Unnamed Spring	705,682	4,351,886	9,190	
Unnamed Spring	705,339	4,352,005	9,061	
Unnamed Spring	705,437	4,352,005	9,157	
Unnamed Spring	717,936	4,352,046	5,587	24K Topographic Map
Unnamed Spring	717,540	4,352,495	5,592	National Hydrography Dataset
Unnamed Spring	723,152	4,352,540	5,577	24K Topographic Map
Unnamed Spring	717,511	4,352,544	5,593	
Unnamed Spring	717,507	4,352,605	5,591	
Unnamed Spring	723,275	4,352,687	5,575	
Unnamed Spring	723,291	4,352,691	5,576	
Unnamed Spring	723,389	4,352,736	5,577	
Unnamed Spring	717,479	4,352,752	5,585	National Hydrography Dataset
Unnamed Spring	723,332	4,352,752	5,575	24K Topographic Map
Unnamed Spring	723,491	4,352,830	5,577	
Unnamed Spring	723,630	4,353,063	5,576	
Unnamed Spring	717,530	4,353,079	5,585	
Unnamed Spring	723,672	4,353,145	5,575	
Unnamed Spring	736,573	4,353,168	9,027	
Unnamed Spring	717,553	4,353,177	5,587	
Unnamed Spring	711,554	4,353,187	8,508	
Unnamed Spring	723,996	4,353,194	5,583	
Unnamed Spring	724,362	4,353,400	5,583	
Unnamed Spring	718,151	4,353,465	5,567	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
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Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	724,561	4,353,481	5,584	24K Topographic Map
Unnamed Spring	724,568	4,353,527	5,584	
Unnamed Spring	717,321	4,353,563	5,602	
Unnamed Spring	717,364	4,353,602	5,597	
Unnamed Spring	724,548	4,353,612	5,583	
Unnamed Spring	724,610	4,353,668	5,584	
Unnamed Spring	717,373	4,353,782	5,588	
Unnamed Spring	724,672	4,353,805	5,582	
Unnamed Spring	717,315	4,353,811	5,595	
Unnamed Spring	717,351	4,353,821	5,588	
Unnamed Spring	724,741	4,353,854	5,582	
Unnamed Spring	724,764	4,353,900	5,582	
Unnamed Spring	717,328	4,354,034	5,586	National Hydrography Dataset
Unnamed Spring	735,635	4,354,125	8,527	24K Topographic Map
Unnamed Spring	712,975	4,354,158	7,269	
Unnamed Spring	733,335	4,354,301	7,384	
Unnamed Spring	735,492	4,354,301	8,475	
Unnamed Spring	733,292	4,354,354	7,351	
Unnamed Spring	732,949	4,354,360	7,168	
Unnamed Spring	717,001	4,354,488	5,611	
Unnamed Spring	717,351	4,354,494	5,576	
Unnamed Spring	717,213	4,354,615	5,582	
Unnamed Spring	735,367	4,354,628	8,591	
Unnamed Spring	735,387	4,354,645	8,605	
Unnamed Spring	717,200	4,354,667	5,582	
Unnamed Spring	735,452	4,354,667	8,692	
Fourmile Spring	732,106	4,354,681	6,836	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	717,122	4,354,707	5,583	24K Topographic Map
Unnamed Spring	716,939	4,354,710	5,597	
Unnamed Spring	731,842	4,354,713	6,736	National Hydrography Dataset
Unnamed Spring	731,789	4,354,726	6,724	
Unnamed Spring	716,922	4,354,736	5,596	24K Topographic Map
Unnamed Spring	731,407	4,354,743	6,579	National Hydrography Dataset
Unnamed Spring	717,151	4,354,765	5,582	24K Topographic Map
Unnamed Spring	717,076	4,354,775	5,584	
Unnamed Spring	716,887	4,354,779	5,596	National Hydrography Dataset
Unnamed Spring	717,056	4,354,788	5,584	24K Topographic Map
Unnamed Spring	716,851	4,354,801	5,596	
Unnamed Springs	731,763	4,354,841	6,720	National Hydrography Dataset
Unnamed Spring	731,786	4,354,870	6,731	

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Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
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Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	716,893	4,354,873	5,592	24K Topographic Map
Unnamed Spring	716,916	4,354,883	5,591	
Unnamed Spring	716,909	4,354,935	5,590	
Unnamed Spring	716,932	4,355,020	5,587	
Unnamed Spring	716,896	4,355,033	5,588	
Unnamed Spring	717,158	4,355,033	5,576	
Unnamed Spring	717,105	4,355,037	5,578	
Unnamed Spring	711,482	4,355,324	8,288	
Unnamed Spring	717,220	4,355,360	5,571	
Unnamed Spring	713,138	4,355,831	6,961	National Hydrography Dataset
Unnamed Spring	716,951	4,356,651	5,593	24K Topographic Map
Unnamed Spring	716,954	4,356,772	5,592	
Unnamed Spring	711,075	4,357,545	7,927	
Unnamed Spring	732,467	4,357,572	7,143	National Hydrography Dataset
Unnamed Spring	716,951	4,357,710	5,600	24K Topographic Map
Unnamed Spring	733,061	4,358,055	7,618	National Hydrography Dataset
Sixmile Spring	733,222	4,358,060	7,715	Geographic Names Information System
Unnamed Spring	733,692	4,358,236	8,166	National Hydrography Dataset
Fera One Hundred Two Spring	712,683	4,358,365	6,920	Geographic Names Information System
Fera One Hundred Six Spring	712,241	4,359,440	7,054	
Unnamed Spring	716,944	4,359,742	5,582	24K Topographic Map
Unnamed Spring	732,493	4,360,675	7,708	National Hydrography Dataset
Unnamed Spring	707,922	4,360,678	9,127	24K Topographic Map
Unnamed Spring	707,977	4,360,767	9,181	
Unnamed Spring	710,343	4,360,989	7,679	
Unnamed Spring	716,479	4,361,405	5,608	
Unnamed Spring	716,402	4,361,559	5,612	
Unnamed Spring	708,401	4,361,575	9,326	
Unnamed Spring	709,941	4,362,249	8,435	
Unnamed Spring	716,363	4,362,512	5,612	National Hydrography Dataset
Unnamed Spring	716,475	4,363,315	5,578	24K Topographic Map
Eightmile Spring	733,828	4,363,395	8,072	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	716,411	4,363,655	5,582	24K Topographic Map
Unnamed Spring	716,405	4,363,700	5,583	
Unnamed Spring	716,379	4,363,770	5,584	
Unnamed Spring	708,834	4,364,332	8,893	
Unnamed Spring	716,286	4,364,634	5,579	
Unnamed Spring	716,116	4,364,804	5,587	
Unnamed Spring	716,058	4,364,887	5,589	
Unnamed Spring	716,976	4,365,258	5,564	National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 12 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	708,943	4,365,789	8,809	24K Topographic Map
Unnamed Spring	714,938	4,365,821	5,649	
Unnamed Spring	714,919	4,365,924	5,647	
Unnamed Spring	715,050	4,366,049	5,613	
Unnamed Spring	714,980	4,366,062	5,624	
Unnamed Spring	714,758	4,366,065	5,654	
Unnamed Spring	715,057	4,366,087	5,609	
Unnamed Spring	714,823	4,366,094	5,644	
Unnamed Spring	714,813	4,366,126	5,641	
Cottonwood Springs	732,326	4,366,129	7,534	Geographic Names Information System
Unnamed Spring	714,829	4,366,222	5,633	24K Topographic Map
Unnamed Spring	714,739	4,366,283	5,642	
Unnamed Spring	714,871	4,366,338	5,619	
Unnamed Spring	714,752	4,366,511	5,628	
Unnamed Spring	714,685	4,367,329	5,638	National Hydrography Dataset
Unnamed Spring	714,630	4,367,355	5,644	
Unnamed Spring	714,630	4,367,455	5,642	
Unnamed Springs	714,576	4,367,609	5,650	
Unnamed Springs	714,637	4,367,666	5,639	
Unnamed Spring	706,845	4,367,788	9,132	24K Topographic Map
Unnamed Spring	707,997	4,367,859	8,551	
Unnamed Springs	714,592	4,367,869	5,646	
Unnamed Spring	707,872	4,367,965	8,576	
Unnamed Spring	714,939	4,369,091	5,617	
Unnamed Spring	714,949	4,369,115	5,616	
Unnamed Spring	714,918	4,369,201	5,618	National Hydrography Dataset
Unnamed Spring	714,921	4,369,345	5,616	
Unnamed Spring	714,894	4,369,601	5,617	
Unnamed Spring	714,959	4,369,707	5,612	
Unnamed Spring	714,956	4,369,861	5,609	
Unnamed Springs	705,658	4,370,454	9,174	24K Topographic Map
Unnamed Spring	714,767	4,370,799	5,614	National Hydrography Dataset
Unnamed Spring	714,774	4,371,017	5,616	
Unnamed Spring	714,678	4,371,266	5,625	
Unnamed Spring	714,574	4,372,539	5,623	24K Topographic Map
Unnamed Spring	714,245	4,372,578	5,649	National Hydrography Dataset
Unnamed Spring	714,240	4,372,665	5,650	
Unnamed Spring	714,240	4,372,819	5,655	
Unnamed Spring	714,333	4,372,909	5,649	
Unnamed Spring	707,262	4,372,956	8,354	24K Topographic Map

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 13 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	714,396	4,373,036	5,646	National Hydrography Dataset
Unnamed Spring	714,385	4,373,134	5,651	
Unnamed Spring	714,645	4,373,173	5,630	
Unnamed Spring	714,503	4,373,285	5,642	
Unnamed Spring	714,596	4,373,323	5,637	
Unnamed Spring	714,429	4,373,386	5,654	24K Topographic Map
Unnamed Spring	714,604	4,373,447	5,639	National Hydrography Dataset
Unnamed Spring	714,692	4,373,455	5,631	
Unnamed Spring	714,681	4,373,578	5,637	
Unnamed Spring	710,724	4,373,740	6,694	
Unnamed Spring	731,290	4,374,018	7,774	24K Topographic Map
Unnamed Spring	715,262	4,374,035	5,610	National Hydrography Dataset
Unnamed Spring	715,155	4,374,148	5,612	
Unnamed Spring	715,555	4,374,222	5,605	24K Topographic Map
Unnamed Spring	715,114	4,374,233	5,614	
Unnamed Spring	715,218	4,374,244	5,611	
Unnamed Spring	715,171	4,374,454	5,614	
Unnamed Spring	715,136	4,374,487	5,618	
Unnamed Spring	715,029	4,374,619	5,631	National Hydrography Dataset
Unnamed Spring	737,398	4,378,564	7,317	24K Topographic Map
Unnamed Spring	709,356	4,378,868	7,007	
Cain Springs	738,480	4,380,667	6,964	Geographic Names Information System
Unnamed Spring	738,425	4,380,875	6,955	24K Topographic Map
Unnamed Spring	702,482	4,381,896	8,795	
Unnamed Spring	709,047	4,382,115	6,494	
Fera Ninety Four Spring	703,737	4,383,701	8,010	Geographic Names Information System
Ice Cream Springs	703,424	4,384,021	8,131	
Muncy Spring	711,666	4,385,896	5,966	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	702,086	4,388,686	8,833	24K Topographic Map
Teapot Spring	701,903	4,388,944	8,840	
Unnamed Spring	701,856	4,389,572	8,816	
Unnamed Spring	702,496	4,389,736	8,794	
Unnamed Spring	703,316	4,389,793	8,326	
Teapot Spring	701,909	4,389,853	8,799	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	703,231	4,389,881	8,408	24K Topographic Map
Unnamed Spring	702,095	4,389,897	8,852	
Unnamed Spring	701,717	4,390,111	8,962	
Unnamed Spring	701,685	4,390,143	8,970	
Unnamed Spring	739,016	4,390,259	7,001	
Unnamed Spring	703,407	4,390,688	8,768	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 14 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Unnamed Spring	702,732	4,390,742	8,898	24K Topographic Map
Mike Springs	739,850	4,391,938	7,261	National Hydrography Dataset/Geographic Names Information System
Unnamed Spring	703,223	4,392,090	8,457	24K Topographic Map
Unnamed Spring	703,068	4,392,096	8,495	
Fera Ninety Five Spring	706,521	4,392,147	7,347	Geographic Names Information System
Unnamed Spring	703,040	4,392,329	8,564	24K Topographic Map
Unnamed Spring	702,384	4,393,197	8,697	
Unnamed Spring	701,709	4,393,591	8,488	
Unnamed Spring	701,545	4,393,748	8,559	
Unnamed Spring	701,551	4,393,811	8,529	
Unnamed Spring	701,633	4,393,947	8,480	
Unnamed Spring	740,818	4,394,161	7,568	
Unnamed Spring	702,869	4,394,231	8,377	
Unnamed Spring	739,724	4,394,493	7,593	
Unnamed Spring	739,730	4,394,549	7,600	
Unnamed Spring	705,209	4,395,474	7,517	
Unnamed Spring	702,668	4,395,540	8,467	
Fera One Hundred Five Spring	706,330	4,395,984	7,615	Geographic Names Information System
Unnamed Spring	740,903	4,396,192	7,893	24K Topographic Map
Unnamed Spring	713,496	4,396,276	5,984	
Unnamed Spring	707,588	4,396,840	6,894	
Unnamed Spring	740,604	4,396,961	8,080	
Unnamed Spring	738,652	4,398,109	8,636	
Unnamed Spring	707,249	4,398,360	7,096	
Osborne Springs	711,965	4,398,793	6,120	
Osborne Springs	711,864	4,398,867	6,129	
Osborne Springs	711,996	4,398,885	6,120	Geographic Names Information System
Osborne Springs	711,873	4,398,928	6,132	National Hydrography Dataset
Unnamed Springs	711,930	4,399,040	6,131	
Osborne Springs	711,971	4,399,086	6,128	24K Topographic Map
Mud Springs	707,350	4,399,477	7,022	Geographic Names Information System
Sliderock Spring	703,143	4,399,756	9,397	
Unnamed Spring	705,405	4,400,182	7,727	24K Topographic Map
Unnamed Spring	704,795	4,401,540	7,494	
Unnamed Spring	702,375	4,401,736	9,221	
Unnamed Spring	704,717	4,401,969	7,445	
Pierce Ranch Spring	711,358	4,402,385	6,148	
Unnamed Spring	711,639	4,402,471	6,228	
Unnamed Spring	703,066	4,402,976	8,650	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 15 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Mud Springs	704,307	4,404,271	7,420	Geographic Names Information System
Unnamed Spring	707,335	4,404,860	6,707	24K Topographic Map
Unnamed Spring	710,889	4,405,106	6,231	
Unnamed Spring	701,945	4,405,356	8,197	
Unnamed Spring	702,008	4,405,410	8,153	
Unnamed Springs	702,277	4,405,436	8,053	
Unnamed Springs	702,119	4,405,439	8,109	
Unnamed Springs	702,217	4,405,451	8,064	
Unnamed Spring	702,923	4,405,643	7,809	
Unnamed Spring	702,950	4,405,694	7,834	
Unnamed Spring	703,036	4,405,720	7,785	
Dipping Tank Springs	716,266	4,405,865	7,032	Geographic Names Information System
Unnamed Spring	703,419	4,406,121	7,646	24K Topographic Map
Unnamed Spring	710,598	4,406,533	6,271	
Unnamed Spring	702,812	4,406,557	7,838	
Unnamed Sp[ring	710,204	4,406,628	6,269	
Unnamed Spring	702,292	4,406,635	7,906	
Unnamed Spring	702,618	4,406,665	7,817	
Unnamed Spring	702,334	4,406,683	7,866	
Unnamed Spring	702,549	4,406,683	7,835	
Unnamed Spring	702,400	4,406,734	7,834	
Unnamed Spring	702,468	4,406,805	7,799	
Unnamed Springs	710,341	4,406,813	6,272	
Unnamed Spring	702,510	4,406,847	7,765	
Unnamed Spring	702,570	4,406,847	7,740	
Unnamed Spring	704,319	4,406,901	7,401	
Unnamed Spring	704,417	4,406,952	7,371	
Unnamed Spring	710,161	4,407,133	6,277	
Crystal Spring	703,714	4,407,404	7,438	Geographic Names Information System
Basin Spring	701,860	4,407,623	7,635	24K Topographic Map
Basin Spring	702,104	4,407,719	7,533	Geographic Names Information System
Unnamed Spring	714,158	4,408,326	6,899	24K Topographic Map
Twin Springs	705,039	4,408,416	7,102	Geographic Names Information System
Golden Springs	712,765	4,408,416	6,635	
Unnamed Spring	712,413	4,408,515	6,629	National Hydrography Dataset
Unnamed Spring	714,275	4,408,806	7,017	24K Topographic Map
Unnamed Springs	705,608	4,409,164	6,901	
Unnamed Spring	701,747	4,409,198	7,405	
Unnamed Spring	701,877	4,409,221	7,363	
Unnamed Springs	712,412	4,409,227	6,700	National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 16 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 184 - Spring Valley (Continued)				
Garden Springs	712,742	4,409,255	6,777	Geographic Names Information System
Mud Spring	702,198	4,409,417	7,277	
Unnamed Spring	702,817	4,409,630	7,146	24K Topographic Map
Unnamed Spring	709,412	4,409,681	6,313	
Unnamed Spring	709,380	4,409,718	6,317	
Unnamed Spring	706,303	4,409,741	6,799	
Unnamed Spring	703,850	4,409,868	6,964	
Long Spring	715,740	4,410,777	7,618	Geographic Names Information System
Unnamed Spring	709,111	4,410,842	6,354	24K Topographic Map
Unnamed Spring	709,314	4,411,785	6,360	National Hydrography Dataset
Unnamed Spring	709,169	4,411,841	6,355	
Unnamed Spring	708,343	4,412,511	6,470	
Unnamed Spring	708,425	4,412,739	6,460	
Unnamed Spring	709,132	4,412,804	6,372	
Unnamed Spring	708,993	4,412,832	6,376	
Rock Springs	716,168	4,415,271	7,448	Geographic Names Information System
Unnamed Spring	700,395	4,415,287	8,317	24K Topographic Map
Unnamed Spring	700,243	4,415,316	8,195	
Upper Gulch Spring	700,154	4,415,477	8,130	Geographic Names Information System
Unnamed Spring	707,413	4,415,559	6,509	24K Topographic Map
Unnamed Spring	707,264	4,415,635	6,511	
Unnamed Spring	700,575	4,416,079	8,001	National Hydrography Dataset
Cold Spring	699,999	4,416,304	8,011	Geographic Names Information System
Sidehill Spring	699,663	4,416,506	7,961	
Unnamed Spring	699,331	4,417,040	7,790	24K Topographic Map
Unnamed Spring	699,214	4,417,081	7,819	
Unnamed Spring	699,442	4,417,087	7,749	
Unnamed Spring	699,572	4,417,122	7,728	
Dolans Trap Spring	703,183	4,422,808	7,945	Geographic Names Information System
Lost Spring	720,272	4,424,310	8,414	
Skull Spring	705,385	4,424,689	8,148	
Grouse Spring	704,781	4,424,953	8,214	
Mustang Spring	705,903	4,425,562	8,293	
Horse Spring	705,711	4,426,205	8,125	
Gravel Spring	705,428	4,426,239	8,280	
Unnamed Springs	718,702	4,426,451	7,601	24K Topographic Map
Middle Creek Spring	718,644	4,428,766	7,596	Geographic Names Information System
Unnamed Spring	719,651	4,429,159	7,846	24K Topographic Map
Unnamed Spring	719,025	4,429,182	7,688	
Unnamed Springs	719,063	4,429,447	7,736	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
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Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley				
South Little Springs	751,341	4,285,352	5,578	24K Topographic Map
North Little Springs	751,096	4,286,211	5,569	
Big Springs	749,794	4,287,127	5,565	National Hydrography Dataset
Unnamed Spring	750,264	4,289,436	5,550	
Unnamed Springs	750,270	4,289,589	5,567	
Unnamed Springs	750,525	4,290,642	5,552	
Unnamed Springs	750,516	4,290,765	5,548	
Unnamed Spring	750,688	4,291,192	5,548	
Tunnel Spring	780,518	4,292,285	7,069	Geographic Names Information System/National Hydrography Dataset
The Pots	754,648	4,292,411	5,475	
Needle Point Spring	758,117	4,293,839	5,460	
Unnamed Spring	756,740	4,295,857	5,429	National Hydrography Dataset
South Spring	745,256	4,298,826	7,452	Geographic Names Information System/National Hydrography Dataset
North Spring	745,027	4,299,638	7,647	
Unnamed Spring	743,353	4,302,228	7,891	24K Topographic Map
Unnamed Spring	740,818	4,303,680	8,413	National Hydrography Dataset
Unnamed Spring	741,084	4,303,713	8,378	24K Topographic Map
Unnamed Spring	740,998	4,303,780	8,329	
Unnamed Spring	745,688	4,303,973	6,947	
Unnamed Spring	745,578	4,304,053	6,942	
Unnamed Spring	745,604	4,304,116	7,073	National Hydrography Dataset
Unnamed Spring	744,006	4,304,256	7,428	24K Topographic Map
Unnamed Spring	741,084	4,304,643	8,175	National Hydrography Dataset
Unnamed Spring	741,048	4,304,743	8,266	24K Topographic Map
Lexington Spring	751,738	4,305,169	6,161	Geographic Names Information System
Unnamed Spring	740,254	4,305,714	8,028	National Hydrography Dataset
Clay Spring	760,875	4,306,147	5,446	24K Topographic Map
Unnamed Spring	740,765	4,306,347	7,768	
Unnamed Spring	743,114	4,307,338	7,007	National Hydrography Dataset
Unnamed Spring	743,796	4,307,613	6,900	24K Topographic Map
Big Wash Spring	736,112	4,310,513	9,564	Geographic Names Information System/National Hydrography Dataset
Tilford Spring	743,188	4,312,000	7,375	Geographic Names Information System
Unnamed Spring	742,542	4,312,278	7,684	National Hydrography Dataset
Unnamed Spring	734,378	4,312,489	10,264	24K Topographic Map
Unnamed Spring	734,821	4,313,514	10,407	National Hydrography Dataset
Unnamed Spring	735,017	4,313,900	10,459	
Unnamed Spring	734,145	4,313,912	10,770	
Clay Spring	748,339	4,314,670	6,427	Geographic Names Information System/National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 18 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	733,760	4,314,869	10,700	24K Topographic Map
Unnamed Spring	736,990	4,314,888	9,518	
Unnamed Spring	737,446	4,314,894	9,710	
Unnamed Spring	744,330	4,315,564	7,516	National Hydrography Dataset
Unnamed Spring	741,904	4,315,653	8,408	
Unnamed Spring	739,038	4,315,824	8,211	24K Topographic Map
Unnamed Spring	739,057	4,315,919	8,183	National Hydrography Dataset
Unnamed Spring	741,204	4,315,928	8,474	
Mahogany Spring	746,764	4,316,126	6,464	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	745,040	4,316,240	6,888	24K Topographic Map
Unnamed Spring	745,988	4,316,665	6,476	National Hydrography Dataset
Unnamed Spring	737,181	4,316,711	8,845	24K Topographic Map
Unnamed Spring	738,943	4,316,785	8,253	National Hydrography Dataset
Unnamed Spring	735,352	4,316,861	9,530	
Unnamed Spring	735,689	4,316,944	9,316	
Unnamed Spring	746,319	4,317,078	6,324	
Unnamed Spring	744,235	4,317,241	6,892	
Unnamed Spring	736,098	4,317,608	9,316	24K Topographic Map
Unnamed Spring	743,596	4,317,678	6,926	National Hydrography Dataset
Kious Spring	746,028	4,318,999	6,020	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	743,302	4,320,407	6,386	National Hydrography Dataset
Unnamed Spring	751,840	4,320,410	5,204	24K Topographic Map
Unnamed Spring	732,461	4,321,205	10,271	
Bone Spring	745,149	4,321,451	5,921	Geographic Names Information System
Unnamed Spring	739,214	4,322,109	7,277	24K Topographic Map
Unnamed Spring	739,272	4,322,118	7,262	
Unnamed Spring	739,309	4,322,127	7,257	
Unnamed Spring	735,323	4,322,525	9,083	
Unnamed Spring	743,809	4,323,219	6,049	National Hydrography Dataset
Unnamed Spring	743,855	4,323,675	6,039	
Unnamed Spring	743,634	4,323,782	6,100	
Unnamed Spring	743,796	4,323,785	6,061	
Unnamed Spring	744,209	4,323,791	5,910	24K Topographic Map
Unnamed Spring	744,133	4,323,828	5,926	
Unnamed Spring	743,582	4,323,981	6,028	National Hydrography Dataset
Unnamed Spring	743,380	4,324,217	6,080	24K Topographic Map
Unnamed Spring	743,408	4,324,293	6,076	National Hydrography Dataset
Unnamed Spring	743,289	4,324,486	6,057	24K Topographic Map
Unnamed Spring	742,619	4,324,957	6,187	
Unnamed Spring	737,045	4,325,125	7,847	National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 19 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	734,197	4,325,832	8,348	24K Topographic Map
Unnamed Spring	742,392	4,325,963	6,162	National Hydrography Dataset
Strawberry Spring	742,408	4,326,028	6,094	Geographic Names Information System
Unnamed Spring	742,102	4,326,092	6,235	National Hydrography Dataset
Unnamed Spring	733,552	4,326,440	7,854	24K Topographic Map
Unnamed Spring	735,320	4,326,471	7,746	
Unnamed Springs	732,015	4,327,146	7,851	
Unnamed Spring	729,127	4,327,323	8,464	
Unnamed Spring	728,846	4,327,696	8,428	
Unnamed Spring	738,117	4,327,791	6,673	
Unnamed Spring	738,041	4,327,806	6,685	
Unnamed Spring	738,020	4,327,816	6,687	
Unnamed Spring	730,170	4,327,831	7,788	
Unnamed Spring	738,004	4,327,852	6,688	
Unnamed Springs	730,760	4,328,002	7,725	
Unnamed Spring	737,946	4,328,017	6,637	
Unnamed Spring	733,994	4,328,097	7,537	
Unnamed Spring	733,379	4,328,100	7,568	
Unnamed Spring	737,328	4,328,681	6,673	National Hydrography Dataset
Unnamed Spring	729,130	4,330,235	7,756	24K Topographic Map
Monroe Spring	728,237	4,330,593	8,224	Geographic Names Information System
Unnamed Spring	740,722	4,330,686	5,970	24K Topographic Map
Mud Spring	729,333	4,331,032	7,617	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	756,684	4,331,280	5,076	National Hydrography Dataset
Unnamed Spring	756,528	4,331,448	5,076	
Unnamed Spring	744,200	4,332,549	5,841	
Willow Patch Spring	734,210	4,333,632	6,619	Geographic Names Information System/National Hydrography Dataset
Waking Spring	730,092	4,333,709	7,082	Geographic Names Information System
Unnamed Spring	755,580	4,333,975	5,057	24K Topographic Map
Want Spring	734,369	4,334,376	6,700	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	740,092	4,334,541	6,287	24K Topographic Map
Sacramento Springs	729,398	4,335,380	7,267	Geographic Names Information System
Unnamed Spring	754,756	4,335,571	5,060	National Hydrography Dataset
Unnamed Spring	754,815	4,335,697	5,056	
Pipe Spring	754,829	4,335,770	5,055	Geographic Names Information System
Pipe Spring	754,812	4,335,817	5,055	National Hydrography Dataset
Unnamed Spring	755,096	4,336,286	5,027	
Coyote Spring	744,829	4,337,273	6,507	Geographic Names Information System
Unnamed Spring	743,921	4,337,569	6,650	24K Topographic Map
Unnamed Spring	735,645	4,338,794	7,086	National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 20 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Red Spring	749,073	4,339,758	6,444	Geographic Names Information System
Unnamed Spring	734,517	4,340,048	7,382	24K Topographic Map
Rhodes Spring	746,816	4,340,081	7,084	Geographic Names Information System
Unnamed Spring	758,388	4,340,529	4,969	National Hydrography Dataset
Rabbit Brush Spring	735,508	4,340,708	7,576	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	746,783	4,341,673	8,000	24K Topographic Map
Pipe Spring	734,769	4,342,287	8,002	Geographic Names Information System/National Hydrography Dataset
Rock Spring	734,447	4,342,604	8,073	
Unnamed Spring	733,149	4,342,765	8,083	24K Topographic Map
Conger Spring	782,909	4,342,976	6,701	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	737,180	4,343,157	7,817	24K Topographic Map
Unnamed Spring	736,904	4,343,577	7,832	National Hydrography Dataset
Unnamed Spring	754,045	4,343,703	5,539	
Unnamed Spring	731,685	4,344,072	8,309	
Miller Basin Spring	731,906	4,344,107	8,263	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	736,559	4,345,464	8,048	National Hydrography Dataset
Unnamed Spring	736,693	4,345,622	7,974	
Unnamed Spring	736,456	4,345,774	7,986	
Unnamed Spring	737,033	4,346,454	8,270	24K Topographic Map
Silver Creek Spring	735,533	4,348,066	8,979	Geographic Names Information System/National Hydrography Dataset
Unnamed Spring	769,380	4,348,116	4,877	National Hydrography Dataset
Horse Trap Spring	770,153	4,348,719	4,892	24K Topographic Map
Unnamed Spring	769,750	4,348,979	4,889	
Unnamed Spring	769,979	4,349,023	4,895	National Hydrography Dataset
Knoll Springs	769,356	4,349,037	4,866	24K Topographic Map
Unnamed Spring	769,434	4,349,070	4,867	National Hydrography Dataset
Unnamed Spring	769,443	4,349,108	4,866	24K Topographic Map
Unnamed Spring	769,437	4,349,210	4,867	National Hydrography Dataset
Unnamed Spring	769,724	4,349,257	4,876	
Unnamed Spring	769,791	4,349,339	4,877	
Unnamed Spring	769,826	4,349,454	4,876	24K Topographic Map
Tiarnleys Spring	743,143	4,349,719	9,757	Geographic Names Information System
Unnamed Spring	746,692	4,349,871	9,334	24K Topographic Map
Unnamed Spring	746,598	4,349,953	9,332	
Unnamed Spring	757,747	4,350,160	4,978	
Unnamed Spring	746,411	4,350,806	9,942	
North Knoll Spring	770,374	4,351,047	4,875	
Unnamed Spring	742,904	4,352,340	10,980	
Ungopah Spring	747,362	4,352,662	8,649	Geographic Names Information System
Unnamed Spring	742,424	4,352,668	10,949	24K Topographic Map

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Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 21 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	757,970	4,354,474	4,927	National Hydrography Dataset
Unnamed Spring	740,024	4,354,599	9,193	24K Topographic Map
Unnamed Spring	758,001	4,354,756	4,938	National Hydrography Dataset
Unnamed Spring	757,999	4,354,841	4,941	
Unnamed Spring	740,701	4,355,095	9,029	24K Topographic Map
Unnamed Spring	754,321	4,355,248	5,417	
Unnamed Spring	757,819	4,355,355	4,961	National Hydrography Dataset
Unnamed Spring	735,345	4,356,024	9,144	24K Topographic Map
Unnamed Spring	739,068	4,356,133	8,685	
Mud Spring	735,575	4,356,468	8,884	National Hydrography Dataset/Geographic Names Information System
Unnamed Spring	741,154	4,357,156	8,622	24K Topographic Map
Unnamed Spring	736,701	4,357,623	8,625	National Hydrography Dataset
Chalk Spring	738,246	4,357,995	8,332	Geographic Names Information System
Unnamed Seeps	769,251	4,365,240	4,803	National Hydrography Dataset
Unnamed Seeps	769,415	4,365,310	4,804	
Unnamed Spring	733,894	4,366,658	9,396	
Ptomaine Springs	733,920	4,367,098	9,345	National Hydrography Dataset/Geographic Names Information System
Bishop Springs Area	769,238	4,367,128	4,816	Geographic Names Information System
Unnamed Spring	768,467	4,367,148	4,793	24K Topographic Map
Unnamed Spring	768,522	4,367,339	4,796	
Unnamed Spring	733,870	4,367,643	9,210	National Hydrography Dataset
Unnamed Spring	733,754	4,367,837	9,195	
Unnamed Spring	762,440	4,370,026	4,821	
Unnamed Spring	762,162	4,370,103	4,833	
Marble Spring	733,952	4,370,985	8,890	Geographic Names Information System
Cold Spring	761,945	4,371,702	4,860	24K Topographic Map
Unnamed Spring	763,349	4,372,026	4,805	National Hydrography Dataset
Unnamed Spring	764,674	4,372,251	4,781	
Unnamed Spring	764,447	4,372,333	4,781	
Unnamed Spring	764,328	4,372,556	4,784	
Unnamed Spring	764,419	4,372,633	4,781	
Unnamed Spring	764,484	4,372,709	4,781	
Unnamed Spring	764,390	4,372,754	4,783	
Unnamed Spring	764,315	4,372,806	4,784	
Unnamed Spring	764,308	4,372,915	4,783	
Unnamed Spring	764,318	4,373,114	4,781	
Unnamed Spring	764,379	4,373,178	4,781	
Unnamed Spring	764,318	4,373,254	4,781	
Unnamed Spring	764,311	4,373,464	4,784	
Unnamed Spring	764,405	4,374,086	4,781	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 22 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	764,389	4,374,195	4,781	National Hydrography Dataset
Unnamed Spring	764,434	4,374,283	4,781	
Unnamed Spring	764,517	4,374,342	4,781	
Unnamed Spring	764,609	4,374,505	4,781	
Unnamed Spring	764,798	4,374,628	4,781	
Unnamed Spring	763,989	4,374,775	4,802	
Unnamed Spring	764,957	4,374,874	4,781	
Unnamed Spring	765,149	4,375,190	4,781	
Unnamed Spring	765,114	4,375,545	4,781	
Unnamed Spring	765,249	4,376,172	4,781	
Unnamed Spring	765,197	4,376,250	4,781	
Unnamed Spring	767,101	4,378,289	4,787	24K Topographic Map
Unnamed Spring	767,155	4,378,457	4,785	National Hydrography Dataset
Unnamed Spring	767,749	4,380,146	4,781	24K Topographic Map
Unnamed Spring	767,796	4,380,292	4,781	National Hydrography Dataset
Unnamed Spring	767,740	4,380,481	4,781	24K Topographic Map
Unnamed Spring	766,417	4,381,536	4,781	
Unnamed Spring	766,369	4,381,609	4,781	
Tin Spring	748,446	4,381,951	6,149	Geographic Names Information System
Unnamed Spring	766,598	4,382,359	4,781	24K Topographic Map
Unnamed Spring	766,548	4,382,513	4,781	
Unnamed Spring	766,611	4,382,601	4,781	
Unnamed Spring	766,591	4,382,749	4,779	
Unnamed Spring	769,314	4,385,868	4,774	National Hydrography Dataset
Unnamed Spring	770,203	4,387,638	4,761	
Unnamed Spring	770,216	4,387,696	4,761	24K Topographic Map
Unnamed Spring	770,246	4,387,794	4,761	National Hydrography Dataset
Unnamed Spring	745,569	4,387,807	6,819	24K Topographic Map
Sulphur Spring	749,611	4,388,215	6,835	National Hydrography Dataset/Geographic Names Information System
Unnamed Spring	770,510	4,388,317	4,761	24K Topographic Map
Unnamed Spring	770,455	4,388,355	4,761	
Unnamed Spring	770,498	4,388,411	4,761	
Unnamed Spring	769,630	4,390,049	4,744	National Hydrography Dataset
Upper Sulphur Spring	750,177	4,390,731	7,395	National Hydrography Dataset/Geographic Names Information System
Unnamed Spring	769,583	4,390,734	4,744	24K Topographic Map
Unnamed Spring	743,629	4,390,953	7,272	
Unnamed Spring	769,673	4,391,125	4,741	National Hydrography Dataset
Unnamed Spring	747,307	4,392,402	8,121	24K Topographic Map
Mill Spring	743,991	4,393,062	7,822	Geographic Names Information System

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	743,263	4,393,601	7,673	24K Topographic Map
Unnamed Spring	743,197	4,393,650	7,684	
Unnamed Spring	762,408	4,394,749	5,575	National Hydrography Dataset
Unnamed Spring	762,328	4,394,910	5,634	
Unnamed Spring	762,416	4,394,930	5,640	
Unnamed Spring	759,676	4,396,886	6,301	24K Topographic Map
Unnamed Spring	759,136	4,397,901	6,845	National Hydrography Dataset
Unnamed Spring	760,757	4,398,258	6,764	24K Topographic Map
Unnamed Spring	764,586	4,406,409	7,808	National Hydrography Dataset
Unnamed Spring	765,674	4,409,651	7,448	
Unnamed Spring	765,969	4,409,699	7,266	
Unnamed Spring	766,928	4,409,762	6,976	
Unnamed Spring	765,569	4,410,069	7,490	
Unnamed Spring	764,620	4,411,013	8,293	
Unnamed Spring	764,888	4,411,228	8,512	
Unnamed Spring	773,226	4,413,780	5,290	
Unnamed Spring	773,347	4,414,273	5,218	
Kent Spring	773,839	4,415,363	5,167	Geographic Names Information System
Unnamed Spring	766,838	4,418,421	8,193	National Hydrography Dataset
Unnamed Spring	769,038	4,419,705	7,709	
Unnamed Spring	766,398	4,419,953	8,020	
Unnamed Spring	767,662	4,420,046	7,780	
Unnamed Spring	765,368	4,420,391	8,438	
Unnamed Spring	766,167	4,420,443	8,140	
Unnamed Spring	766,131	4,420,533	8,152	24K Topographic Map
Unnamed Spring	764,569	4,420,580	8,731	National Hydrography Dataset
Unnamed Spring	765,316	4,420,599	8,517	
Unnamed Spring	782,268	4,421,344	4,329	
Unnamed Spring	782,320	4,421,437	4,328	
Unnamed Spring	783,269	4,421,569	4,321	
Unnamed Spring	782,157	4,421,589	4,328	
Unnamed Spring	782,177	4,421,633	4,328	
Unnamed Spring	782,084	4,421,689	4,328	
Unnamed Spring	782,198	4,421,719	4,328	
Unnamed Spring	782,111	4,421,733	4,328	
Unnamed Spring	782,088	4,421,776	4,328	
Unnamed Spring	782,200	4,422,219	4,323	
Unnamed Spring	780,793	4,422,256	4,335	
Unnamed Spring	805,007	4,422,426	4,315	

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 24 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	780,582	4,422,429	4,336	24K Topographic Map
Unnamed Spring	780,670	4,422,449	4,334	
Unnamed Spring	780,927	4,422,470	4,331	
Unnamed Spring	780,946	4,422,513	4,331	
Unnamed Spring	771,284	4,422,542	6,509	National Hydrography Dataset
Unnamed Spring	780,786	4,422,556	4,332	24K Topographic Map
Unnamed Spring	780,852	4,422,561	4,331	
Unnamed Spring	780,454	4,422,570	4,337	
Unnamed Spring	780,577	4,422,586	4,333	
Unnamed Spring	780,645	4,422,586	4,333	
Unnamed Spring	780,736	4,422,622	4,331	
Unnamed Spring	803,794	4,422,633	4,301	National Hydrography Dataset
Unnamed Spring	780,734	4,422,663	4,331	24K Topographic Map
Unnamed Spring	803,428	4,422,781	4,286	National Hydrography Dataset
Big Spring	780,477	4,422,797	4,333	National Hydrography Dataset/Geographic Names Information System
Unnamed Spring	780,463	4,422,868	4,333	24K Topographic Map
Unnamed Spring	780,284	4,422,877	4,338	
Unnamed Spring	780,420	4,422,934	4,334	
Unnamed Spring	780,393	4,422,981	4,334	
Unnamed Spring	780,424	4,423,006	4,333	
Unnamed Spring	780,369	4,423,052	4,332	
Unnamed Spring	780,326	4,423,079	4,333	National Hydrography Dataset
Unnamed Spring	780,676	4,423,102	4,328	24K Topographic Map
Unnamed Spring	780,267	4,423,252	4,334	
Unnamed Spring	769,311	4,423,368	7,912	National Hydrography Dataset
Unnamed Spring	805,030	4,423,461	4,293	24K Topographic Map
Unnamed Spring	805,053	4,423,482	4,294	National Hydrography Dataset
Unnamed Spring	780,712	4,423,552	4,323	
Wilson Health Springs	805,158	4,423,580	4,298	National Hydrography Dataset/Geographic Names Information System
Unnamed Spring	805,339	4,423,700	4,298	National Hydrography Dataset
Unnamed Spring	780,712	4,423,946	4,322	
Unnamed Spring	805,476	4,423,987	4,294	
Unnamed Spring	771,088	4,426,073	6,695	
Unnamed Spring	771,361	4,426,114	6,541	
Unnamed Spring	776,054	4,427,852	4,771	
Unnamed Spring	776,054	4,427,881	4,767	24K Topographic Map
Unnamed Spring	776,024	4,427,911	4,772	
Unnamed Spring	776,021	4,427,937	4,770	
Unnamed Spring	775,962	4,427,944	4,787	National Hydrography Dataset

Table E.1-2
Additional Springs Inventoried from the National Hydrography Dataset, Geographic Names Information System, and USGS 1:24,000 Topographic Maps
(Page 25 of 25)

Spring Name	UTM Easting (m)	UTM Northing (m)	Elevation (ft-amsl)	Source
Hydrographic Area 195 - Snake Valley (Continued)				
Unnamed Spring	775,955	4,427,977	4,786	24K Topographic Map
Unnamed Spring	775,943	4,428,001	4,787	
Unnamed Spring	775,967	4,428,024	4,780	
Unnamed Spring	775,943	4,428,029	4,786	
Unnamed Spring	775,941	4,428,055	4,786	National Hydrography Dataset
Unnamed Spring	775,885	4,428,189	4,794	24K Topographic Map
Unnamed Spring	775,856	4,428,408	4,794	
Unnamed Spring	769,708	4,429,605	6,407	National Hydrography Dataset
Unnamed Spring	781,851	4,431,909	4,293	
Hydrographic Area 210 - Coyote Springs Valley				
Unnamed Spring	673,395	4,066,407	4,455	24K Topographic Map
Perkins Spring	680,345	4,073,201	2,827	Geographic Names Information System
Grapevine Spring	669,497	4,080,046	6,038	National Hydrography Dataset/Geographic Names Information System
Cherry Spring	669,264	4,081,017	5,824	
Lamb Spring	688,021	4,093,555	2,737	Geographic Names Information System
Granger Spring	688,983	4,094,019	2,803	
Coyote Spring	679,089	4,095,722	2,529	National Hydrography Dataset/Geographic Names Information System
Elderberry Spring	669,423	4,096,929	4,402	Geographic Names Information System
Coyote Springs	685,713	4,097,183	2,748	
Evergreen Spring	674,530	4,116,925	4,044	

Muddy River Tributary Conservation Intentionally Created Surplus Certification Report Calendar Year 2008

SOUTHERN NEVADA WATER AUTHORITY

SE ROA 43840

JA_13569

Cover: Background image is the Lower Muddy River near Logandale, Nevada. The individual photos are within the Muddy Valley Irrigation Company's service area.

SE ROA 43841

Muddy River Tributary Conservation Intentionally Created Surplus Certification Report

Calendar Year 2008

Southern Nevada Water Authority
100 City Parkway, Suite 700
Las Vegas, Nevada 89106

Surface Water Resources Department
Water Management and Accounting Division

June 2009

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United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

IN REPLY REFER TO:
LC-4212
WTR-4.03

MAY 0 3 2010

CERTIFIED - RETURN RECEIPT REQUESTED

Ms. Kay Brothers
Deputy General Manager
Engineering and Operations
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956

Subject: Verification of 2008 Muddy River and Virgin River Tributary Conservation Intentionally Created Surplus (ICS) Created by the Southern Nevada Water Authority (SNWA)

Dear Ms. Brothers:

The Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines) establish the requirements for the creation, delivery, and accounting for Intentionally Created Surplus (ICS). Section 3.B.1 of the Interim Guidelines requires the contractor to submit a plan for the creation of ICS to the Secretary of the Interior (Secretary) for review and approval prior to the creation of ICS. Section 3.D.1 requires the contractor to submit a Certification Report containing the information required to demonstrate that the amount of ICS created and that the method of creation is consistent with the contractor's approved ICS plan, a forbearance agreement, and a delivery agreement. Section 3.D.2 requires the Secretary, acting through the Lower Colorado Regional Director, to verify the information submitted and to provide a written decision to the contractor regarding the amount of ICS created.

The following chronology documents the key steps in the process followed to meet the requirements of the Interim Guidelines:

- On September 10, 2008, SNWA submitted plans to Reclamation for the creation of Tributary Conservation ICS on the Muddy and Virgin rivers.
- In November 2008, Reclamation and SNWA staff conducted on-the-ground inspections of the Muddy River and Virgin River ICS project areas.
- After consultation with the Lower and Upper Division states, Reclamation approved the Muddy River and Virgin River ICS creation plans on December 9, 2008.
- On May 5, 2009, SNWA provided draft certification reports to Reclamation and to the Nevada State Engineer documenting the method of ICS creation for the Muddy River and Virgin River ICS projects and provided the electronic files used for calculating the amount of ICS

created. The files included satellite imagery, geographic information system (GIS) coverages and Excel spread sheets showing evapotranspiration (ET), water rights, and water balance calculations.

- Reclamation performed a thorough technical review of these data and on May 21, 2009, Reclamation and SNWA staff met to discuss questions and comments. SNWA addressed Reclamation's questions and comments and subsequently incorporated appropriate changes to the draft certification reports.
- On July 15, 2009, SNWA received confirmation from the Nevada State Engineer that the Tributary Conservation ICS created by SNWA was consistent with Nevada Revised Statues and State Engineers Orders 1193 and 1194 and that the water rights on the Muddy and Virgin Rivers are owned or controlled by SNWA.
- SNWA submitted final 2008 Tributary Conservation ICS certification reports (*Muddy River Tributary Conservation Intentionally Created Surplus Certification Report Calendar Year 2008* and *Virgin River Tributary Conservation Intentionally Created Surplus Certification Report Calendar Year 2008*) to Reclamation on July 22, 2009 and sent its final data used in the compilation of the Certifications Reports to Reclamation for archiving on August 10, 2009.

In accordance with Section 3.D.2 of the (Interim Guidelines) and following the process outlined in this letter, Reclamation verifies that in 2008 SNWA created 7,095 acre-feet of Muddy River and 3,362 acre-feet of Virgin River Tributary Conservation ICS as represented in SNWA's Tributary Conservation ICS certification reports.

If you have questions, please contact Mr. Paul J. Matuska at 702-293-8164.

Sincerely,

Lorri Gray-Lee
Regional Director

Enclosure:

Mr. Gerald R. Zimmerman
Executive Director
Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1035

Mr. Herb Guenther
Director
Arizona Department of Water Resources
3550 North Central Avenue
Phoenix, AZ 85012-2105

cc: Continued on next page

cc: Continued from previous page

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Executive Director
Colorado River Commission of
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Mr. Brian J. Brady
General Manager
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Mr. Roger K. Patterson
Assistant General
The Metropolitan Water District
of Southern California
P.O Box 54153
Los Angeles, CA 90054-0153

SOUTHERN NEVADA WATER AUTHORITY

1001 South Valley View Boulevard • Las Vegas, NV 89153
(702) 258-3939 • snwa.com

July 22, 2009

Ms. Lorri Gray-Lee, Regional Director
Bureau of Reclamation
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, Nevada 89006

Dear Ms. Gray-Lee:

SUBJECT: SOUTHERN NEVADA WATER AUTHORITY MUDDY AND VIRGIN RIVER TRIBUTARY CONSERVATION INTENTIONALLY CREATED SURPLUS CERTIFICATION REPORTS, CALENDAR YEAR 2008

Enclosed are the Southern Nevada Water Authority's (Authority) Calendar Year (CY) 2008 Certification Reports for Intentionally Created Surplus (ICS) Tributary Conservation for the Muddy and Virgin Rivers in Nevada. These final reports have been approved by the Nevada State Engineer's Office. The Certification Reports demonstrate the amount of Tributary Conservation ICS created, and that the method of creation was consistent with Nevada Water Law (specifically State Engineer Orders 1193 and 1194), the Authority's approved ICS Plans of Creation, and requirements as outlined in Section 3 of the *Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead* (Guidelines).

As you know, the Guidelines require a Contractor to obtain an approved Plan of Creation for ICS, enter into a Delivery Agreement with the United States of America (United States) and a Forbearance Agreement with Lower Colorado River Basin (Lower Basin) Contract holders to create and take Tributary Conservation ICS. The Authority received approval for its CY 2008 and CY 2009 Plans of Creation for both the Muddy and Virgin Rivers via letter from you dated December 9, 2008. The Authority and the Colorado River Commission entered into a Delivery Agreement with the United States and a Forbearance Agreement with Lower Basin Contract holders on December 13, 2007.

As documented in the Certification Reports, the Authority created Tributary Conservation ICS during CY 2008 in the volumes indicated below, prior to accounting for the one-time deduction of 5% for the benefit of additional system storage in Lake Mead, as outlined in the Guidelines.

Calendar Year 2008	Volume, in acre-feet/year Cited in Certification Reports	
	Muddy River	Virgin River
Created ICS	7,095	3,362

If you have any questions, please contact William Rinne at 702-691-5255.

Sincerely,

Kay Brothers
Deputy General Manager
Engineering and Operations

KB:WR:JJ:lmv
Enclosures (8)

cc: William E. Rinne, Director, Surface Water Resources
Jeffrey Johnson, Division Manager, Surface Water Resources w/out attachment
George Caan, Director, Colorado River Commission of Nevada

JIM GIBBONS
Governor

STATE OF NEVADA

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Kay Brothers
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Las Vegas, NV 89153

Subject: Southern Nevada Water Authority Muddy and Virgin River Tributary Conservation Intentionally Created Surplus Certification Reports, Calendar Year 2008

Dear Ms. Brothers:

The Nevada State Engineer's Office has reviewed the updated Southern Nevada Water Authority's (Authority) Calendar Year 2008 Certification Reports for Intentionally Created Surplus (ICS) Tributary Conservation for the Muddy and Virgin Rivers in Nevada, dated June, 2009. These Certification Reports demonstrate that the amount of Tributary Conservation ICS created by the Authority and conveyed to Lake Mead's full pool elevation of 1,220 feet above sea level are consistent with Nevada Revised Statutes and State Engineer's Orders 1193 and 1194.

The Nevada State Engineer's Office concurs that the Muddy and Virgin River water rights outlined in said reports are owned or controlled by the Authority, have a priority date prior to June 25, 1929 and were conveyed to the Colorado River mainstream (i.e., Lake Mead full pool elevation of 1,220 above mean sea level) in the following amounts:

Calendar Year 2008	Volume, in Acre-Feet Cited in Certification Reports	
	Muddy River	Virgin River
Created ICS	7,095	3,362

If you have any questions, please contact Deputy State Engineer, Robert Coache, P.E. at (702) 486-2770.

Sincerely,

Tracy Taylor, P.E.
State Engineer

TT:RC:tlp

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Introduction

The Secretary of Interior (Secretary) issued a Record of Decision for *Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead* (Guidelines) on December 13, 2007, which established criteria for the development and delivery of Intentionally Created Surplus (ICS). One type of ICS is Tributary Conservation, which allows a Contractor to increase tributary flows into the mainstream of the Colorado River within its state for ICS credits. The conservation of tributary flows into the mainstream of the Colorado River is limited to water rights that have been used for a significant period of years and were perfected prior to June 25, 1929, the effective date of the Boulder Canyon Project Act (BCPA).

To generate ICS, the Guidelines require a Contractor to enter into a Delivery Agreement with the United States of America and a Forbearance Agreement with Lower Basin Contractors. The Southern Nevada Water Authority (SNWA) and Colorado River Commission of Nevada entered into a Forbearance Agreement with Lower Basin Contractors on December 13, 2007. Exhibit A of the Forbearance Agreement describes the surface water rights on the Muddy and Virgin Rivers, pre-dating June 25, 1929, which SNWA plans to use to create Tributary Conservation ICS, and how the Muddy River flows reaching Lake Mead will be calculated (Appendix A).

The Guidelines, Forbearance Agreement, and Delivery Agreement require a plan for the creation of ICS (ICS Plan). An ICS Plan for Muddy River ICS was submitted to the Bureau of Reclamation (Reclamation) for Calendar Years (CY) 2008 and 2009 in September 2008. SNWA received a letter from Reclamation in December 2008 approving the ICS Plans for CY 2008 and 2009 (Appendix B).

This report satisfies the requirements of Nevada State Engineer Order 1194 (Appendix C) and the Guidelines as follows:

- Under Nevada State Engineer Order 1194, an annual report will be submitted to the Nevada Division of Water Resources giving a "full accounting of adjudicated water rights on the Muddy River or its tributaries owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Muddy River system to the Colorado River mainstream for the creation of ICS." After review of the annual report, the Nevada State Engineer shall issue a letter verifying the quantity of water conveyed through the Muddy River system to the Colorado River mainstream for the purpose of creating ICS.

- Based on the Guidelines, an annual certification report will be submitted for the Secretary of Interior's review and verification to demonstrate the amount of Tributary Conservation ICS created in the preceding year, and that the method of creation was consistent with SNWA's approved ICS Plan.

Project Description

Muddy River water rights that are being utilized to create Tributary Conservation ICS pursuant to the approved ICS Plan and Exhibit A of the Forbearance Agreement are decreed Nevada state water rights with an established history of use prior to 1929, but that have experienced periods of non-use in the interim. Per Exhibit A of the Forbearance Agreement, SNWA is specifically allowed to utilize any and all pre-June 25, 1929, Muddy River water rights to create Tributary Conservation ICS regardless of those water rights history of use after 1928.

The Muddy River originates from regional springs in the Muddy River Springs Area in Nevada and flows into the Overton Arm of Lake Mead (Figure 1). Muddy River flows are relatively constant because the springs that form the river discharge water from the regional carbonate aquifer system of eastern Nevada. The average annual flow of the Muddy River at U.S. Geological Survey (USGS) gaging station 09419000 *Muddy River near Glendale, Nevada* (Glendale gage) for Water Years 1950 to 2007 was 30,760 acre-feet per year (afy).

On the Muddy River, water rights were decreed in 1920 and the decree allocated the entire flow of the Muddy River (Appendix D). The Order of Determination, attached to the decree as Exhibit A, explicitly outlines the Place-of-Use (POU) for the water rights and established summer and winter diversion rates. For the most part, the summer season is May 1 to September 30 with a diversion rate of 1 cubic-foot per second (cfs) per 70 acres of land and the winter season is October 1 to April 30 with a diversion rate of 1 cfs per 100 acres of land. These diversion rates equate to an annual rate of 8.54 afy per acre (afy/acre).

Water rights on the upper reach of the Muddy River, from the Muddy River Springs to the Glendale gage, are owned and controlled by individual right holders. On the Lower Muddy River, downstream of the Glendale gage, water rights are held by the Muddy Valley Irrigation Company (MVIC) for use by its shareholders. In CY 2008, SNWA owned and leased individual water rights on the Upper Muddy River and owned and leased shares of stock (shares) in MVIC on the Lower Muddy River.

The decreed Muddy River surface water rights owned and leased by SNWA are no longer being utilized for agriculture and are being conveyed to Lake Mead. The pre-June 25, 1929, water rights conveyed to Lake Mead represent the full right that is and has been historically used for agriculture or could have otherwise been diverted from the Muddy River and fully consumed by SNWA within Nevada.

Muddy River rights conveyed to Lake Mead passed through their historic points of diversion and either flowed through the irrigation company ditches and returned to the mainstream of the Muddy River further downstream or remained in the mainstream of the Muddy River. The full rights owned and leased by SNWA documented to flow to Lake Mead have been accounted for as Tributary Conservation ICS.

Figure 1 - Location Map for the Muddy River -- Upper and Lower Reaches are Separated by the Glendale Gage

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Summary of Results for CY 2008

The total volume of Muddy River water for which SNWA created Tributary Conservation ICS in CY 2008 under the Guidelines was 7,095 af, prior to the one-time deduction of 5% for the benefit of additional system storage in Lake Mead, as outlined in the Guidelines (Table 1). This volume is within the 11,000 af outlined in the approved ICS Plan. Detailed data and calculations are described in subsequent sections of this report.

Table 1 - Summary of SNWA Muddy River Water Rights Conserved During CY 2008 for the Creation of Tributary Conservation ICS Credit

Water Right	**Permits**	**Acre Feet Conserved in 2008**
Muddy Valley Irrigation Company	*21873 - 21877*	4,983
LDS Church Rights Lease	*6419, 25861, 26316- 26318*	2,001
SNWA Aquired Cox Right		85
SNWA Aquired Mitchell Right		26
SNWA Muddy River ICS Credit		**7,095**

SNWA Conservation of Muddy River Rights

On the Muddy River, there are two distinct reaches divided by the Glendale gage. By controlling water rights on the Muddy River within these two reaches, SNWA successfully conserved Muddy River water in CY 2008 that was conveyed to Lake Mead for Tributary Conservation ICS credits. The sections below describe the water rights and conservation of the rights.

Upper Muddy River Rights

Background

The Upper Muddy River, for the purposes of this report, is defined as the reach from the Muddy River Springs Area to the Glendale gage. Within this reach, decreed water rights are owned individually with specific POUs describing the lands irrigated by the rights.

In 2006, the Southern Nevada Water Authority in partnership with the Moapa Valley Water District (MVWD) agreed to lease 2,001 af out of 2,046 af of decreed Muddy River water rights held by the Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter-day Saints (LDS Church). This water had been historically used to irrigate approximately 228 acres of agricultural lands in the Muddy River Springs Area, located near the headwaters of the Muddy River. The lease agreement allows MVWD to utilize up to 50% of the water leased based on coordination with SNWA. In CY 2008, MVWD did not exercise their 50% option on the LDS Church lease, and SNWA retained the entire 2,001 af.

In 2007, SNWA purchased the vast majority of land associated with the LDS Church water rights for the primary purpose of restoring the habitat of the Moapa Dace, an endangered fish species endemic to the warm waters of the Muddy River Springs. The management of this land, referred to as the Warm Springs Natural Area (WNSA), in combination with the U.S. Fish and Wildlife's management of the adjacent Moapa Wildlife Refuge, will protect the majority of the springs that make up the headwaters of the Muddy River. A key component of activities to preserve the Moapa Dace's habitat is leaving the warm water that emanates from the regional springs, which was previously used for agricultural purposes, in the natural channels that meander through the WSNA and Moapa Wildlife Refuge. This preservation activity supports the creation of Tributary Conservation ICS on the Muddy River.

When SNWA purchased the WSNA in 2007, it also acquired two decreed water rights not related to the 2,001 afy lease. These rights were originally decreed to Cox (V01619) and Mitchell (V01631) in 1920 for 85 afy and 26 afy, respectively. The combination of the LDS Church lease and the owned Cox and Mitchell rights enabled SNWA to control 2,112 af of Upper Muddy River water rights in CY 2008.

Water Rights Summary and Documentation of Conserved Water

Table 2 shows the Upper Muddy River water rights SNWA controlled in CY 2008. Note that the LDS Church retained 45 afy of the total 2,046 afy which they owned. The current Certificates leased by SNWA are in Appendix E.

Table 2 - SNWA Controlled Upper Muddy River Water Rights

Decreed Right	Change App.	Certificate	POU Acres	Total Volume AFY
V10621	*6419*	6795	14	120
Cert 258	*25861*	10944	114	971
V01623	*26316*	10951	58	601
	26317	10952	4	34
	26318	10953	38	320
LDS Water Rights Total				2,046
LDS Portion of Right				(45)
SNWA LDS Lease				*2,001*
V01619 (Cox)			10	85
V01631 (Mitchell)			3	26
Total				**2,112**

In the 1970s, Change Application Permits were filed on the LDS Church owned water rights to clarify the POU. The volume of water from the original decreed rights remained the same as did the 1920 priority date. In the 1980s, the LDS Church filed a Proof-of-Beneficial-Use (PBU) map for the purpose of certificating the water rights. The PBU map shows the locations where the decreed water rights were put to beneficial use within the defined POU. The POU and PBU maps, when compared to recent aerial photography, serve as the baseline for proof of fallowed lands, demonstrating conservation of the water.

The Cox and Mitchell rights, now owned by SNWA, have the same POU as referenced in the decree and, when compared to recent aerial photography, serve as the baseline for proof of fallowed lands, demonstrating conservation of water.

The agricultural areas along the Muddy River were digitized using the 2006 National Agricultural Imagery Program (NAIP) data. Prior to CY 2008, SNWA has utilized available annual 1- foot (ft) pixel resolution imagery to verify agricultural practices. During the summer of 2008, SNWA funded aerial photography flights specifically for the purpose of Tributary Conservation ICS verification. These flights have been strategically scheduled to occur 4-times per year to assure they are capturing the agricultural activities during the summer and winter seasons. The flights flown in 2008 are at a resolution of 6-inch (in) per pixel. This high quality photography allows for more accurate determinations of fallowed vs. active agricultural fields.

Figure 2 compares the PBU map for the LDS Church water rights with the aerial photography taken in November 2008. The POU boundary overlaid on the aerial image depicts land fallowing over the vast majority of the POU. The fallowed lands are further emphasized in Figure 3, which compares the POU area as of November 2008 with an aerial photograph of the area from 1976. The 1976 map shows cultivated fields indicative of active agricultural irrigation, while the November 2008 photograph demonstrates irrigation has not occurred on much of the lands for several years, including CY 2008, and that some (non-irrigated) natural vegetation has replaced previously cultivated/irrigated fields. These naturally vegetated areas are located in the heart of the Muddy River Springs Area. This vegetation is being supported directly by groundwater seeps and the relatively shallow depths to groundwater. Since SNWA acquired the WSNA property in September 2007, SNWA has ensured that none of the fields associated with either the LDS Church lease or the Cox and Mitchell rights were irrigated during CY 2008.

Figure 4 documents the sections designated for the POU for the Cox and Mitchell rights and demonstrate that no agriculture took place within the POU. Also depicted on Figure 4, is the in-holding of land owned by the LDS Church, which has retained 45 afy of water rights for landscape requirements on their property.

Figures 2 through 4 demonstrate lands associated with the 2,001 afy LDS Church lease as well as the 111 afy Cox and Mitchell rights were fallowed during CY 2008. The 2,112 af of conserved water was allowed to flow into the mainstream of the Muddy River and downstream to the Glendale gage and then to Lake Mead. No evapotranspiration (ET) losses were deducted from the 2,112 af between the springs and the Glendale gage, because the prior existing flows of the Muddy River to the Glendale gage already account for all ET losses –the 2,112 af merely "rides on top" of the existing flows. The conveyance of these rights from the Glendale gage to Lake Mead is accounted for in the calculations for the Lower Muddy River in subsequent sections of this report, again without ET losses.

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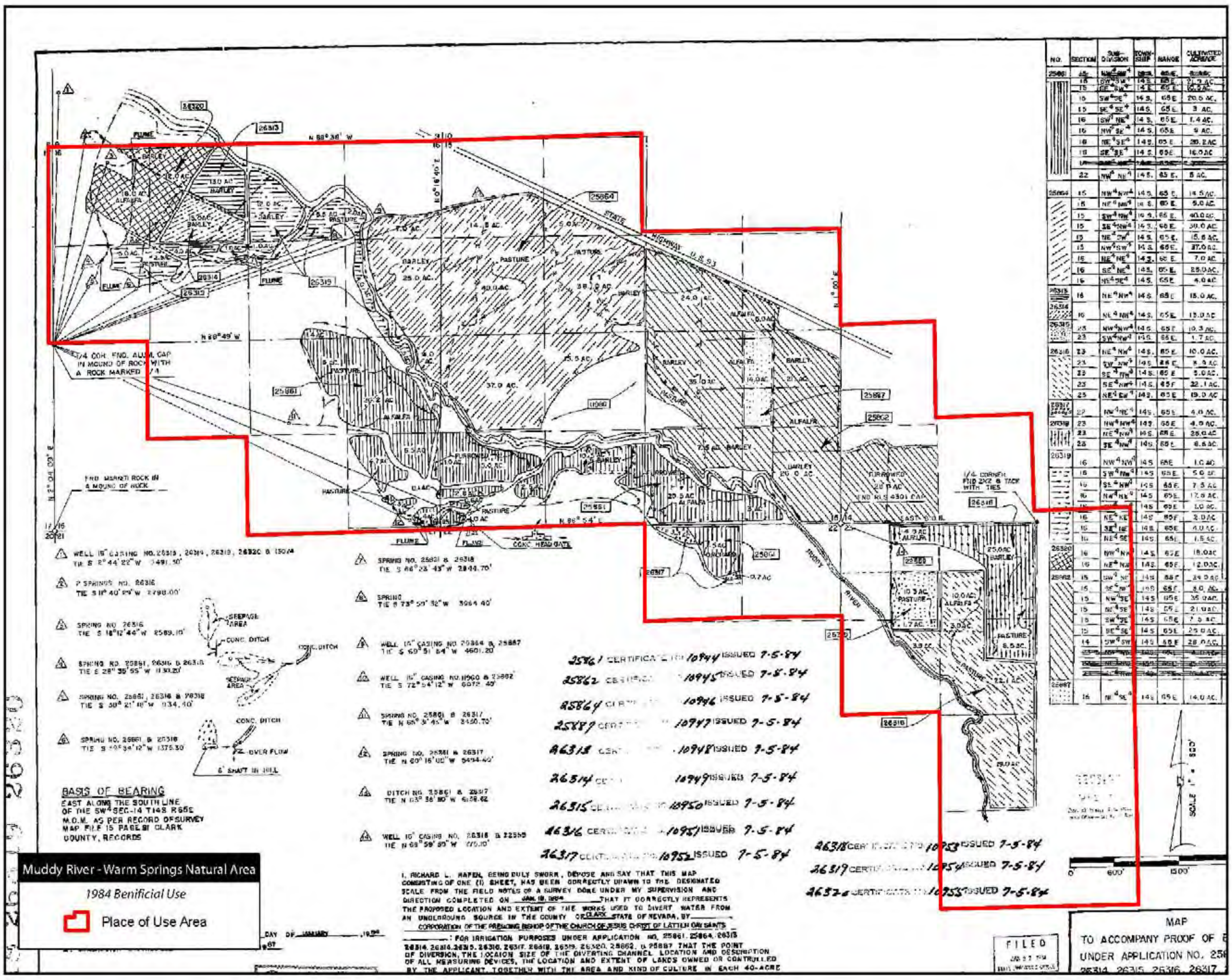

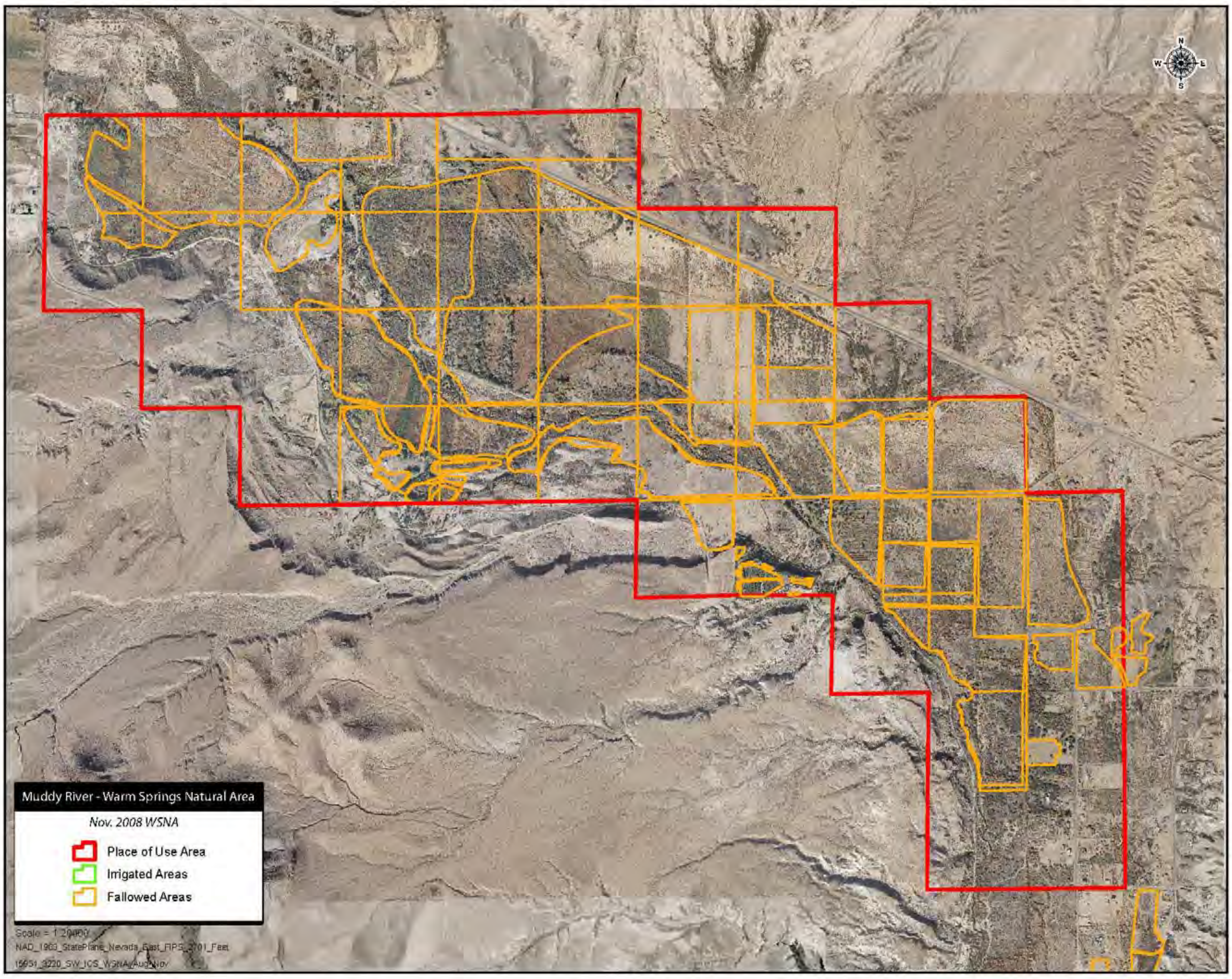

Figure 2 - 1984 Proof-of-Beneficial-Use Map for the LDS Church Rights and November 2008 Aerial Photography Overlaid with the 1984 PBU Map; 2006 NAIP Imagery Comprises the Area Beyond the November 2008 Photography

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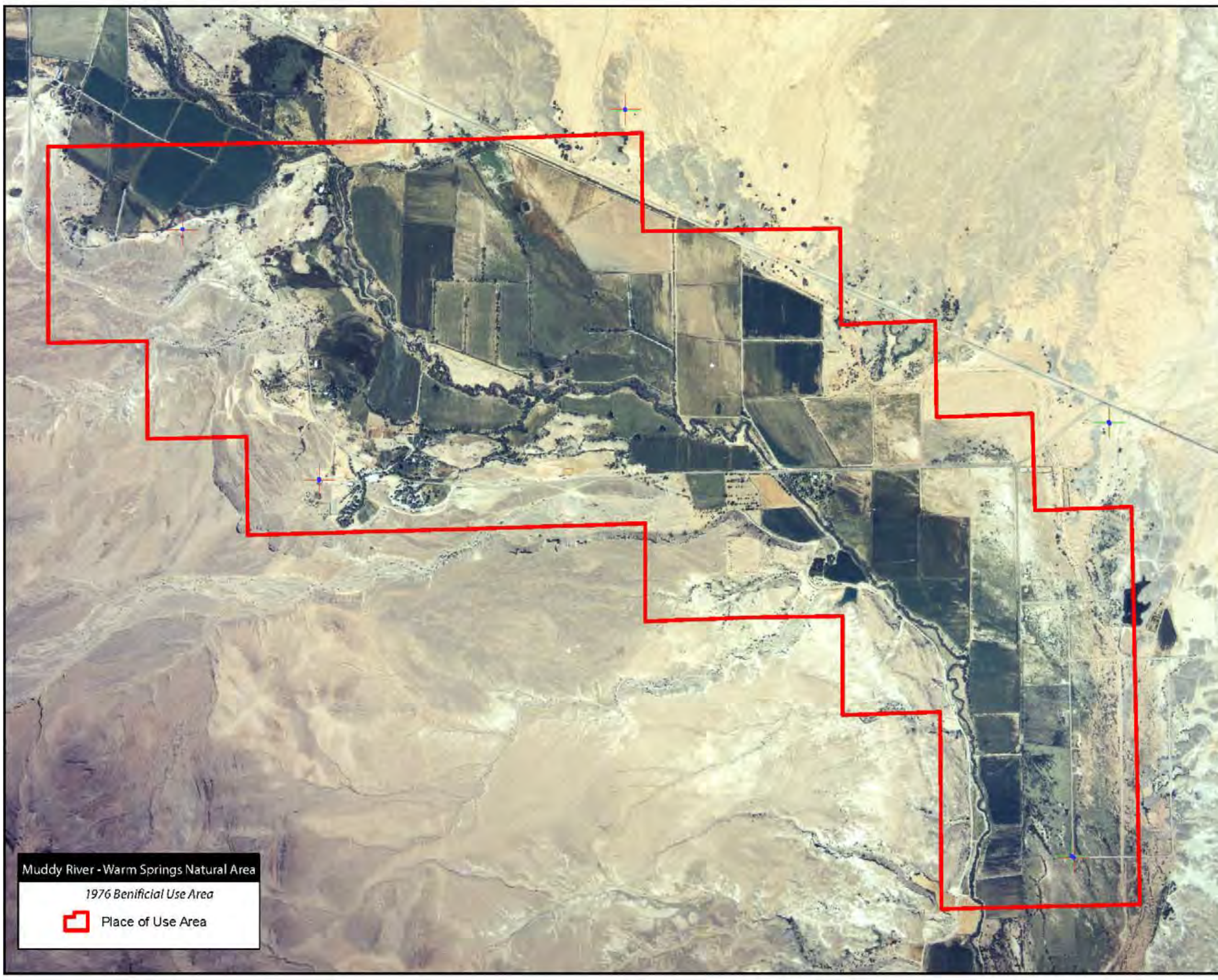

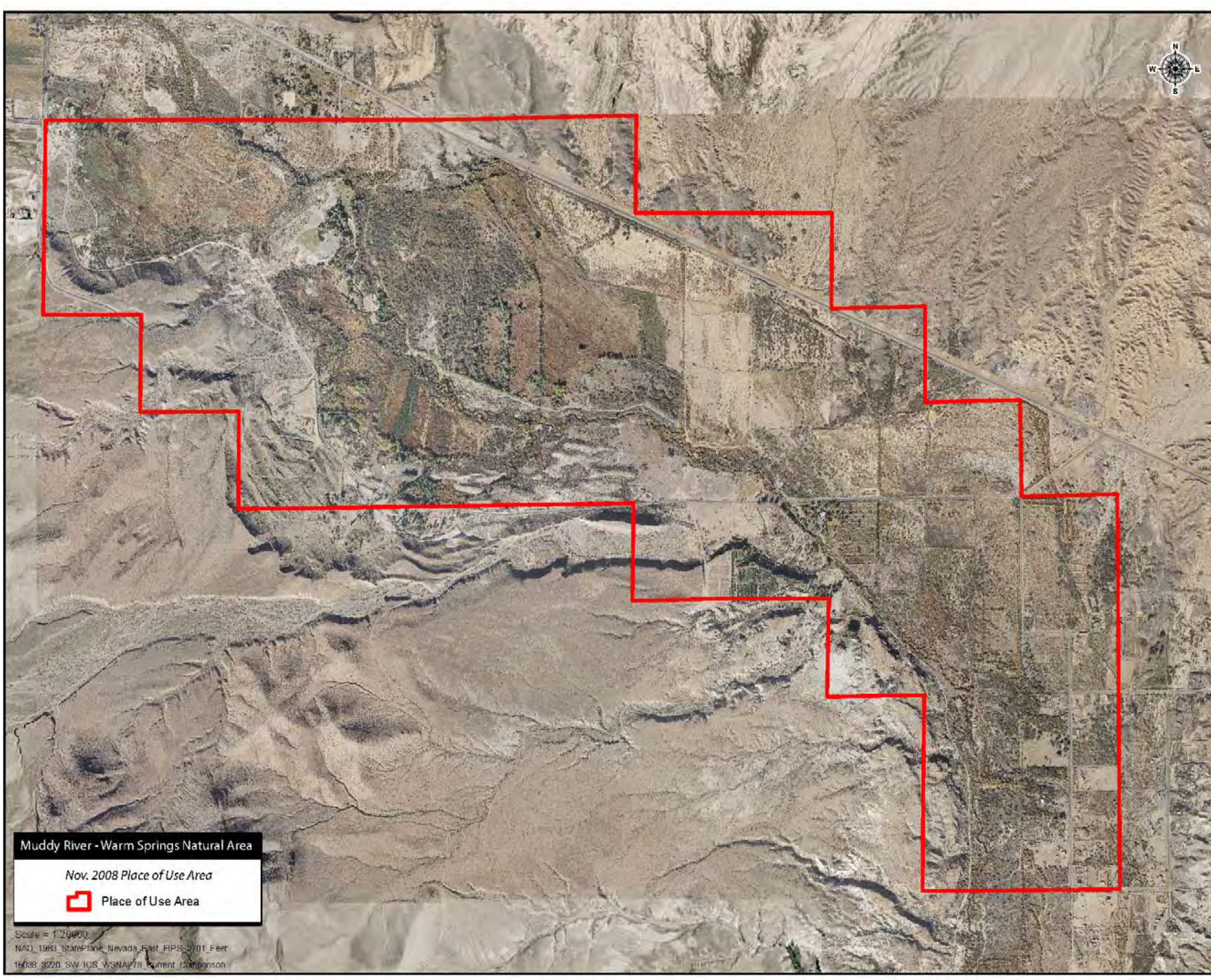

Figure 3 - Place-of-Use for the LDS Church Water Rights Overlaid on a 1976 Aerial Photograph (Top), and the November 2008 Aerial Photograph (Bottom) --2006 NAIP Imagery Comprises the Area Beyond the November 2008 Photography in the Bottom Image

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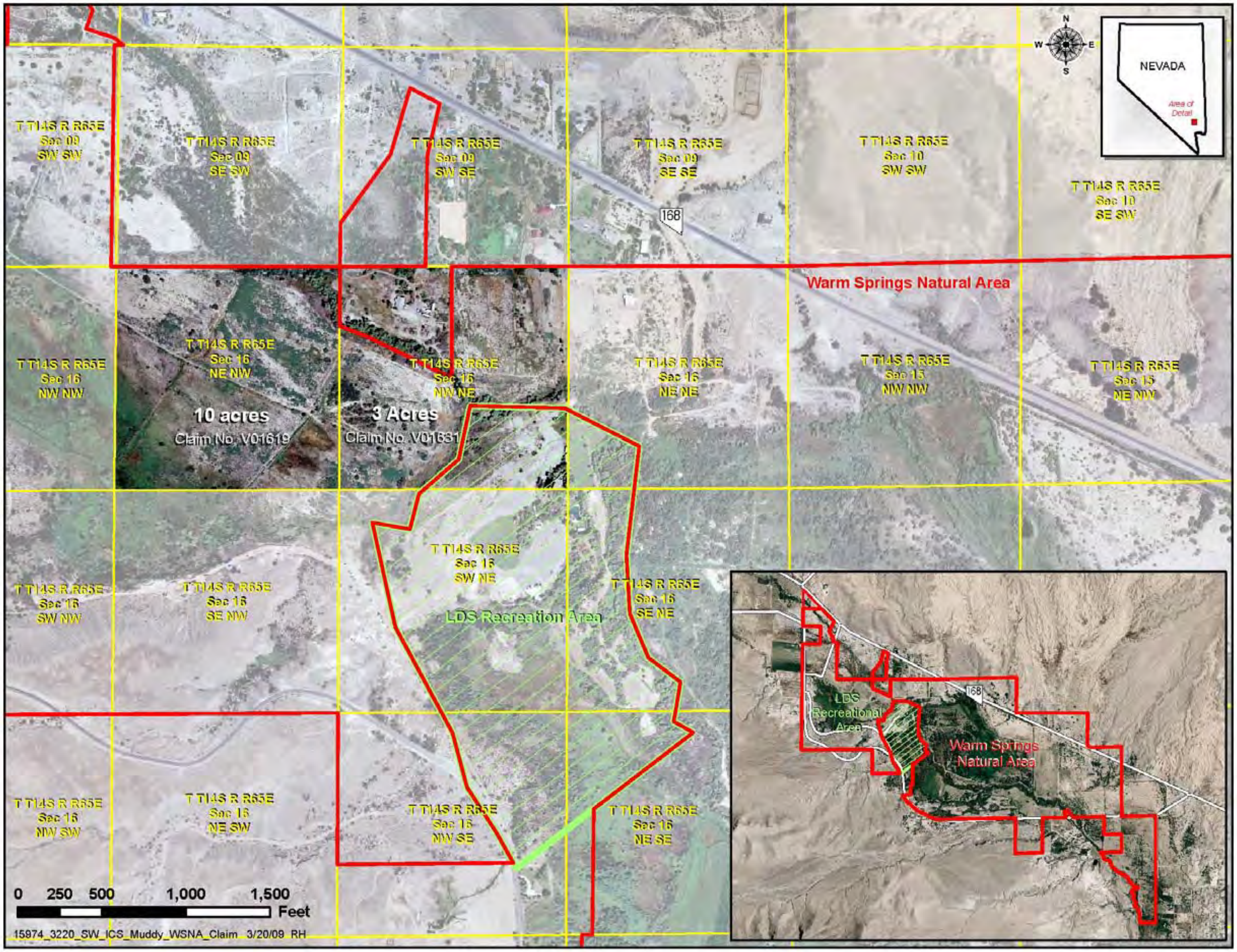

Figure 4 - Place-of-Use for the Cox and Mitchell Decreed Rights Overlaid on the November 2008 Aerial Photograph, with an Inset Depicting the Boundary of the Warm Spring Natural Area and LDS Church In-Holding (hatched area)

SNWA's Lower Muddy River Rights

Background

The Lower Muddy River, for the purposes of this report, is defined as the reach from the Glendale gage to Lake Mead. Within this reach water rights are held by MVIC, which holds the largest quantity of decreed rights on the Muddy River. MVIC's service area begins just downstream of the Glendale gage where MVIC diverts their decreed water rights, along with unused Upper Muddy River rights, at their Wells Siding diversion structure (Wells Siding). MVIC delivers water to its shareholders through a network of concrete lined ditches and pipes within the Lower Muddy River Valley.

MVIC decreed water rights are owned by its shareholders through ownership of MVIC preferred and common of stock. There are 2,432 preferred shares and 5,044 common shares in MVIC. Each share represents a pro-rata apportionment of the Muddy River decreed rights available to MVIC for diversion at Wells Siding.

The SNWA began purchasing shares in MVIC in 1997 with the most recent request for purchases and leases (Appendix F) being effective October 1, 2008.

MVIC Water Rights Summary

This section summarizes the decreed Muddy River water rights owned by MVIC and the water represented by preferred and common shares.

In 1974, MVIC filed PBU maps on their decreed rights. The certificates issued in 1974, based on the proofs are listed in Table 3 (Appendix G). Although these certificates were issued in 1974, they retain their original pre-1920 priority date. These PBU maps, when compared to recent aerial photography, serve as the baseline for proof of fallowed lands, demonstrating conservation of water supporting SNWA's accounting of Tributary Conservation ICS on the Lower Muddy River.

Table 3 - Muddy Valley Irrigation Company Decreed Water Rights

Decree Certificate	Permit	Certificate
59	21874	8326
	21877	8329
267	21875	8327
1199	21873	8325
58	73482	
	21876	8328

The irrigable lands along the Lower Muddy River under the 1974 PBU maps totaled 3,498.86 acres, however the amount of land that can be irrigated under MVIC's water rights can not exceed 2,784.75 acres with a decreed duty of 8.54 afy/acre. MVIC's water rights are tied to their service area and not individually owned parcels. This means that the shares can be used anywhere within MVIC's service area, regardless of land ownership. Therefore, the breakdown of the fields is not as important as the total irrigated acreage within the POU.

Since the 1974 PBU maps were filed, land use in Lower Moapa Valley has undergone a gradual transformation from predominately agricultural to a mix of residential and commercial property interspersed among the agriculture. This gradual urbanization can be seen on Figure 5, which compares aerial photography of the Lower Muddy River from 1953 with aerial photography from November 2008.

The MVIC has and is leasing a portion of their decreed rights to users in the Upper Muddy River (e.g. NV Energy for power plant cooling; MVWD for culinary use at spring boxes; and recently, the Moapa Band of Paiute Indians for agricultural irrigation). These leased rights are diverted and consumed within the upper reach of the Muddy River. The flows measured at the Glendale gage account for these leased rights, since the water reaching the gage and MVIC's Wells Siding has been depleted by these leases. In the same respect, the unused water from MVIC's leases is also measured by the Glendale gage and is available for diversion by MVIC.

The MVIC's operations and covenants define preferred shares as 100% of the Muddy River's summer flow (May – September) plus 75% of the winter flow (October – April). Common shares represent the remaining 25% of the winter flow. The amount of water represented by preferred and common shares, therefore, varies slightly year-to-year based on changes in river flow due to changes in unused Upper Muddy River rights and unused MVIC leases that reach Wells Siding. SNWA's Upper Muddy River rights are not divertible by MVIC and are excluded from the acre-feet per share calculations.

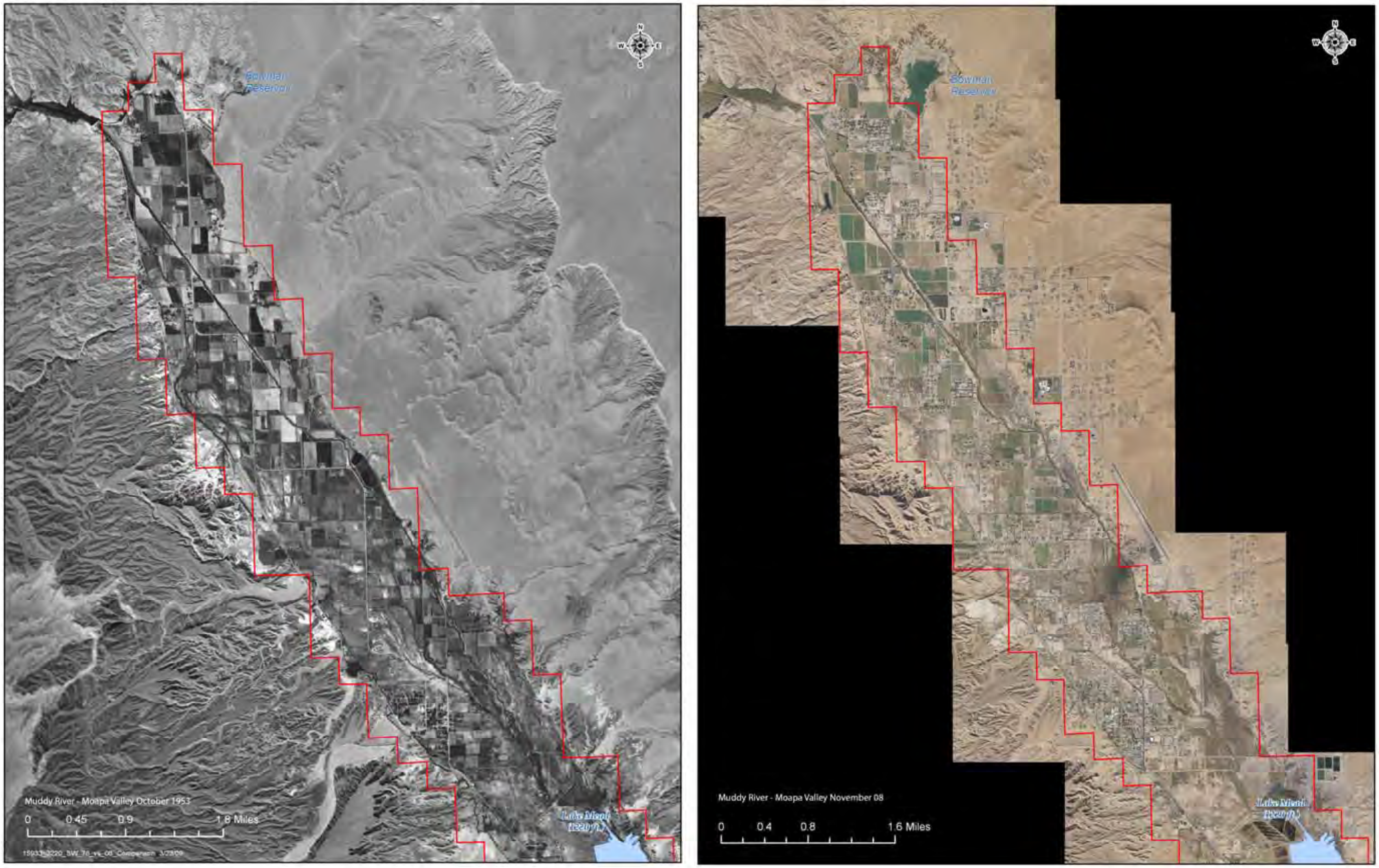

Figure 5 - Comparison of Lower Moapa Valley Using 1953 Imagery (left) and November 2008 Imagery (right)

Quantification of SNWA MVIC Water Rights

By the end of CY 2008, SNWA controlled a total of 777.66 preferred and 2,283.668 common MVIC shares. Since the amount of water represented by a share can vary annually, the volume of water that SNWA holds in MVIC can vary as well. To calculate the amount of water represented by each share in MVIC during CY 2008, the volume of water rights available to MVIC (referred to as divertible flows) must be determined, and this volume then distributed to each preferred and common share. This section details these calculations.

Divertible flows by MVIC at Wells Siding

The Glendale gage, which is located just upstream of Wells Siding, has been used to accurately derive the amount of divertible water that reaches the diversion. The divertible flows at Wells Siding, equate to the flows at the Glendale gage less: 1) channel losses from ET between the Glendale gage and Wells Siding, 2) flood flows that exceed the Wells Siding capacity of about 70 cfs, and 3) Upper Muddy River rights being conveyed to Lake Mead for Tributary Conservation ICS credit (i.e., SNWA's LDS Church lease and SNWA owned Cox and Mitchell rights).

ET losses between the Glendale gage and Wells Siding were determined to be 1,094 af, as discussed in subsequent sections. To subtract non-divertable flood flows, mean daily flows greater than 70 cfs were identified and replaced with 70 cfs, the maximum diversion rate at Wells Siding. Monthly and annual flow statistics were then recalculated with the non-divertable flood flows removed. During CY 2008, only one day exceeded the 70 cfs threshold, October 5, 2008, at 189 cfs. This day was replaced with 70 cfs as depicted in Tables 4 and 5.

The non-divertible Upper Muddy River rights being conveyed to Lake Mead for Tributary Conservation ICS credit which pass through the Glendale gage and Wells Siding were subtracted from the Glendale gage data on a monthly time-step. Proportioning the 2,112 af according to the decreed seasonal diversion rates results in a monthly summer rate of 204 af/month and a winter rate of 156 af/month. These monthly rates representing SNWA's Upper Muddy River rights were subtracted from the Glendale gage flows prior to estimating the amount of water represented by MVIC shares.

The annual Glendale gage flows for CY 2008 were therefore reduced by 1,149 af for ET, 236 af for flood flows, and 2,112 af for SNWA's Upper Muddy River rights.

Table 4 - Daily Mean CFS Values and Monthly Statistics for the Glendale Gage

USGS Muddy River near Glendale Gage (09419000)

Day	*Jan-08*	*Feb-08*	*Mar-08*	*Apr-08*	*May-08*	*Jun-08*	*Jul-08*	*Aug-08*	*Sep-08*	*Oct-08*	*Nov-08*	*Dec-08*	*Total*
1	41	35	33	34	36	34	29	25	24	26	30	33	
2	41	34	36	34	36	34	29	25	21	25	31	32	
3	37	34	34	35	36	33	29	25	24	25	31	33	
4	35	33	35	35	35	33	30	26	25	25	31	32	
5	37	32	36	35	35	33	30	26	25	**189**	30	32	
6	39	37	36	35	35	33	29	26	23	30	30	32	
7	38	34	36	35	35	33	30	30	23	30	30	32	
8	38	32	37	35	34	32	29	27	25	29	31	33	
9	38	37	38	35	36	32	29	26	25	26	33	33	
10	38	34	32	35	37	32	29	26	25	27	33	33	
11	38	32	38	35	36	32	31	26	25	26	32	33	
12	38	34	37	36	36	31	46	26	24	28	32	32	
13	38	34	37	36	36	31	30	26	24	28	32	33	
14	37	35	36	36	35	31	29	25	24	29	32	33	
15	37	35	38	36	35	31	28	25	24	30	31	35	
16	37	36	37	37	35	31	28	25	24	30	31	36	
17	35	36	36	36	35	31	28	25	24	30	29	34	
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21	34	40	36	37	35	30	28	26	26	29	30	34	
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27	40	38	34	35	38	31	27	25	25	30	34	33	
28	33	38	34	33	36	29	27	24	26	30	33	33	
29	34	36	34	32	36	29	26	24	26	30	32	33	
30	34	0	34	33	35	29	26	24	26	30	33	33	
31	34	0	34	0	33	0	25	24	0	31	0	33	
Mean	36	34	36	34	35	30	29	26	24	34	30	33	
Median	37	36	36	35	35	31	28	26	25	29	31	33	
Count	31	31	31	31	31	31	31	31	31	31	31	31	
Minimum	32	0	32	0	33	0	25	24	0	25	0	32	
Maximum	41	41	38	38	38	34	46	30	26	189	34	36	
Acre-Feet	**2,239**	**2,063**	**2,186**	**2,106**	**2,174**	**1,861**	**1,767**	**1,577**	**1,468**	**2,081**	**1,863**	**2,047**	**23,432**

Table 5 - Results of Calculations that Remove Flood Flows Greater Than or Equal to 70 CFS from the Daily Flows at the Glendale Gage

Glendale Gage with 70 cfs Limit

Day	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Total
1	41	35	33	34	36	34	29	25	24	26	30	33	
2	41	34	36	34	36	34	29	25	21	25	31	32	
3	37	34	34	35	36	33	29	25	24	25	31	33	
4	35	33	35	35	35	33	30	26	25	25	31	32	
5	37	32	36	35	35	33	30	26	25	**70**	30	32	
6	39	37	36	35	35	33	29	26	23	30	30	32	
7	38	34	36	35	35	33	30	30	23	30	30	32	
8	38	32	37	35	34	32	29	27	25	29	31	33	
9	38	37	38	35	36	32	29	26	25	26	33	33	
10	38	34	32	35	37	32	29	26	25	27	33	33	
11	38	32	38	35	36	32	31	26	25	26	32	33	
12	38	34	37	36	36	31	46	26	24	28	32	32	
13	38	34	37	36	36	31	30	26	24	28	32	33	
14	37	35	36	36	35	31	29	25	24	29	32	33	
15	37	35	38	36	35	31	28	25	24	30	31	35	
16	37	36	37	37	35	31	28	25	24	30	31	36	
17	35	36	36	36	35	31	28	25	24	30	29	34	
18	36	37	36	36	35	30	28	26	25	29	29	34	
19	35	38	35	36	35	30	27	25	25	29	30	33	
20	36	39	37	36	35	30	27	25	25	29	30	33	
21	34	40	36	37	35	30	28	26	26	29	30	34	
22	34	41	35	38	35	29	27	26	26	29	31	34	
23	36	38	34	37	35	30	27	26	26	30	31	34	
24	32	37	35	36	35	31	28	26	25	30	32	34	
25	36	37	36	37	35	32	28	26	25	30	32	35	
26	33	37	36	36	35	31	27	28	25	30	33	35	
27	40	38	34	35	38	31	27	25	25	30	34	33	
28	33	38	34	33	36	29	27	24	26	30	33	33	
29	34	36	34	32	36	29	26	24	26	30	32	33	
30	34	0	34	33	35	29	26	24	26	30	33	33	
31	34	0	34	0	33	0	25	24	0	31	0	33	
Mean	36	34	36	34	35	30	29	26	24	30	30	33	
Count	31	31	31	31	31	31	31	31	31	31	31	31	
Minimum	32	0	32	0	33	0	25	24	0	25	0	32	
Maximum	41	41	38	38	38	34	46	30	26	70	34	36	
Acre-Feet	2,239	2,063	2,186	2,106	2,174	1,861	1,767	1,577	1,468	1,845	1,863	2,047	23,196
Phreatophyte Consumptive Use Glendale to Wells Siding	18	21	37	76	160	202	191	173	141	86	31	13	1,149
SNWA Upper Rights	156	156	156	156	204	204	204	204	204	156	156	156	2,112
Acre-Foot Per Share Basis	**2,065**	**1,886**	**1,993**	**1,874**	**1,810**	**1,455**	**1,372**	**1,200**	**1,123**	**1,603**	**1,676**	**1,878**	**19,935**

MVIC Acre-Feet per Share Calculations

Table 6 summarizes the percent of divertible flows available to each MVIC share class. Using the divertible flows derived for CY 2008 in the previous section, the acre-foot per share value for preferred and common shares has been calculated in Table 7.

Table 6 - Percentage of Divertible Wells Siding Flow that Each Type of MVIC Share Class is Entitled to by Season

Share Type	Number of Shares	Percent of Summer Flow	Percent of Winter Flow
		(May - September)	*(October - April)*
Preferred	2,432	100%	75%
Common	5,044	0%	25%

Table 7 - Acre-Foot per Share Calculation Results

Calculations for AF/Share						
Calendar Year	*Jan-Apr and Oct-Dec Flows (af)*	*May-Sep Flows (af)*	*100% Summer and 75% Winter Flow (af)*	*25% Winter Flow (af)*	*Preferred-af divided by 2,432 shares (af / share)*	*Common-af divided by 5,044 shares (af / share)*
2008	12,974	6,961	16,691	3,243	6.86	0.64

MVIC Water Controlled by SNWA

The amount of MVIC water controlled by SNWA is calculated using the derived acre-foot per share values from Table 7. To account for month to month variability in SNWA controlled MVIC water rights due to purchases and leases, Table 8 derives SNWA's controlled water rights in acre-feet per month. A letter of concurrence signed by Scott Millington, MVIC General Manager, in Appendix H, verifies that SNWA controlled the number of shares outlined in Table 8 during CY 2008. The preferred and common acre-foot per share values were divided by the number of months in which they can be used; for preferred shares it is 12 months and for common shares it is 7 months. The shares controlled by SNWA during each month (using only the number of shares controlled for the entire month) are multiplied by the acre-foot per share per month to obtain an acre-foot value of MVIC water controlled by SNWA per month for CY 2008.

The MVIC shares controlled by SNWA were either not diverted into MVIC's system at Wells Siding or allowed to flow into their distribution system for the purpose of maintaining head on the ditches before being returned back to the mainstream of the Muddy River. Any water represented by SNWA controlled shares, which were diverted at Wells Siding, are included on MVIC's seasonal (winter and summer) water schedules (Appendix I). Based on these schedules, SNWA received a "turn" on the various ditches, and SNWA's shares were delivered to the Muddy River channel.

Table 8 - Quantification of SNWA Controlled MVIC Shares in CY 2008

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Water Availiable to MVIC (AF From Table 5)	2,065	1,886	1,993	1,874	1,810	1,455	1,372	1,200	1,123	1,603	1,676	1,878	19,935
Acre-Feet Per Share Per Month													
Common AF/S	0.10	0.09	0.10	0.09	-	-	-	-	-	0.08	0.08	0.09	0.64
Preferred AF/S	0.64	0.58	0.61	0.58	0.74	0.60	0.56	0.49	0.46	0.49	0.52	0.58	6.86
Owned by SNWA													
Common Shares	1,921	1,921	1,921	1,921	1,921	1,932	1,932	2,071	2,077	2,098	2,098	2,098	
Preferred Shares	682	682	682	682	682	696	707	746	747	762	762	763	
Leased Back to Seller													
Common Shares	304	304	304	304	304	304	304	304	304	376	376	376	
Preferred Shares	217	217	217	217	217	217	217	217	217	228	228	228	
Leased by SNWA													
Common Shares	-	-	-	-	-	-	-	-	-	562	562	562	
Preferred Shares	-	-	-	-	-	-	-	-	-	243	243	243	
Controlled = (Owned - Leased Back + Leased)													
Common Shares	1,617	1,617	1,617	1,617	1,617	1,628	1,628	1,767	1,772	2,284	2,284	2,284	
Preferred Shares	465	465	465	465	465	479	490	530	530	777	777	778	
Water Controlled (AF) = (Shares Controlled x Acre Foot Per Share)													
Common (AF)	166	151	160	150	-	-	-	-	-	181	190	213	1,211
Preferred (AF)	296	270	286	269	346	287	276	261	245	384	402	450	3,772
Total (AF)	462	421	446	419	346	287	276	261	245	565	592	663	**4,983**

Land Fallowing within MVIC's Place-of-Use

As described in the Upper Muddy River section of this report, the agricultural areas along the Muddy River were digitized using the 2006 NAIP data. Prior to CY 2008, SNWA has utilized available annual 1-ft pixel resolution imagery to determine agricultural practices within MVIC and refine the agricultural polygons. During the summer of 2008, SNWA funded 6-inch pixel resolution aerial photography specifically for the purpose of Tributary Conservation ICS verification. The aerial photography flights have been strategically scheduled to occur 4-times per year to assure they are capturing the agricultural activities during the summer and winter seasons. As seen on Figure 6, the high quality photography allows for an extremely accurate determination of fallowed vs. irrigated field. The aerial photography combined with ground-truthing and discussions with, MVIC's General Manager, ensure the highest degree of accuracy in determining the actual irrigated acreage on the Lower Muddy River. Reclamation staff accompanied SNWA staff during the ground-truthing of the November 2008 flight to observe the methods being used and to assist in verifying fallowed and irrigated acreage.

Figure 7 illustrates MVIC's service area and depicts the extent of the 1974 PBU map which is comprised of three individual maps which were accepted by the Nevada State Engineer's office as part of MVIC's water right certificates. Figures 8 through 13 depict these PBU maps, as well as the August and November 2008 aerial photography overlaid with the ground-truthed fallowed and irrigated acreage.

The November and August 2008 6-inch aerial photography have been used to determine the fallowed and irrigated acreage within MVIC's service area during the summer and winter seasons of CY 2008. For the January to April 2008 portion of the winter season, aerial photography from August 2008 was used to calculate the irrigated acreage within MVIC. The August 2008 imagery was used because 6-inch aerials were not available during this early winter period of CY 2008, and the August photography ensures a clear distinction between irrigated fields and fallowed fields with natural, weedy vegetation, since the summer heat dries or extremely stresses the weeds. Use of the August imagery also provides a conservative estimate of the irrigated acreage during this early winter period, because there was no doubt less agriculture occurring in the winter than the more active summer season.

For the summer 2008 irrigation season (May 1 to September 30), aerial photography from August 2008 was used to directly determine the summer season irrigated acreage. This photography, as mentioned above, provided the best data for identifying actively irrigated acreage compared to fallowed fields with natural, weedy vegetation. For the winter irrigation season (October 1 to December 31), aerial photography from November 2008 was used to accurately determine irrigated acreage, following the initiation of SNWA's recent leases and purchases of MVIC shares.

Table 9 details the irrigated and fallowed acreage by season (on a monthly basis) and crop type as measured and ground-truthed by SNWA. This acreage was verified by MVIC's General Manager during various meetings. Land determined not irrigable either from urbanization or dense overgrowth was derived by subtracting the measured irrigated and fallowed lands from the certificated maximum acreage within MVIC's POU of 2,784.75 acres.

Table 9 - Irrigated, Fallowed, and Non-Irrigable Lands within MVIC's POU

	2008											
	January	February	March	April	May	June	July	August	September	October	November	December
MVIC Ag:	-	-	-	-	-	-	-	-	-	-	-	-
Alfalfa	634.19	634.19	634.19	634.19	634.19	634.19	634.19	634.19	634.19	631.85	631.85	631.85
Sudan	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06
Bermuda	172.72	172.72	172.72	172.72	172.72	172.72	172.72	172.72	167.83	167.83	167.83	167.83
Orchard	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.79	41.80	41.80	41.80
Total Ag	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*870.87*	*868.54*	*868.54*	*868.54*
Total Fallow	1,506.53	1,506.53	1,506.53	1,506.53	1,312.43	1,312.43	1,312.43	1,312.43	1,312.43	1,327.01	1,327.01	1,327.01
Not Irrigable	402.45	402.45	402.45	402.45	596.55	596.55	596.55	596.55	601.45	589.20	589.20	589.20
Total POU	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75	2,784.75

Figure 6 - Example of Detailed 6-inch Aerial Photography on the Lower Muddy River

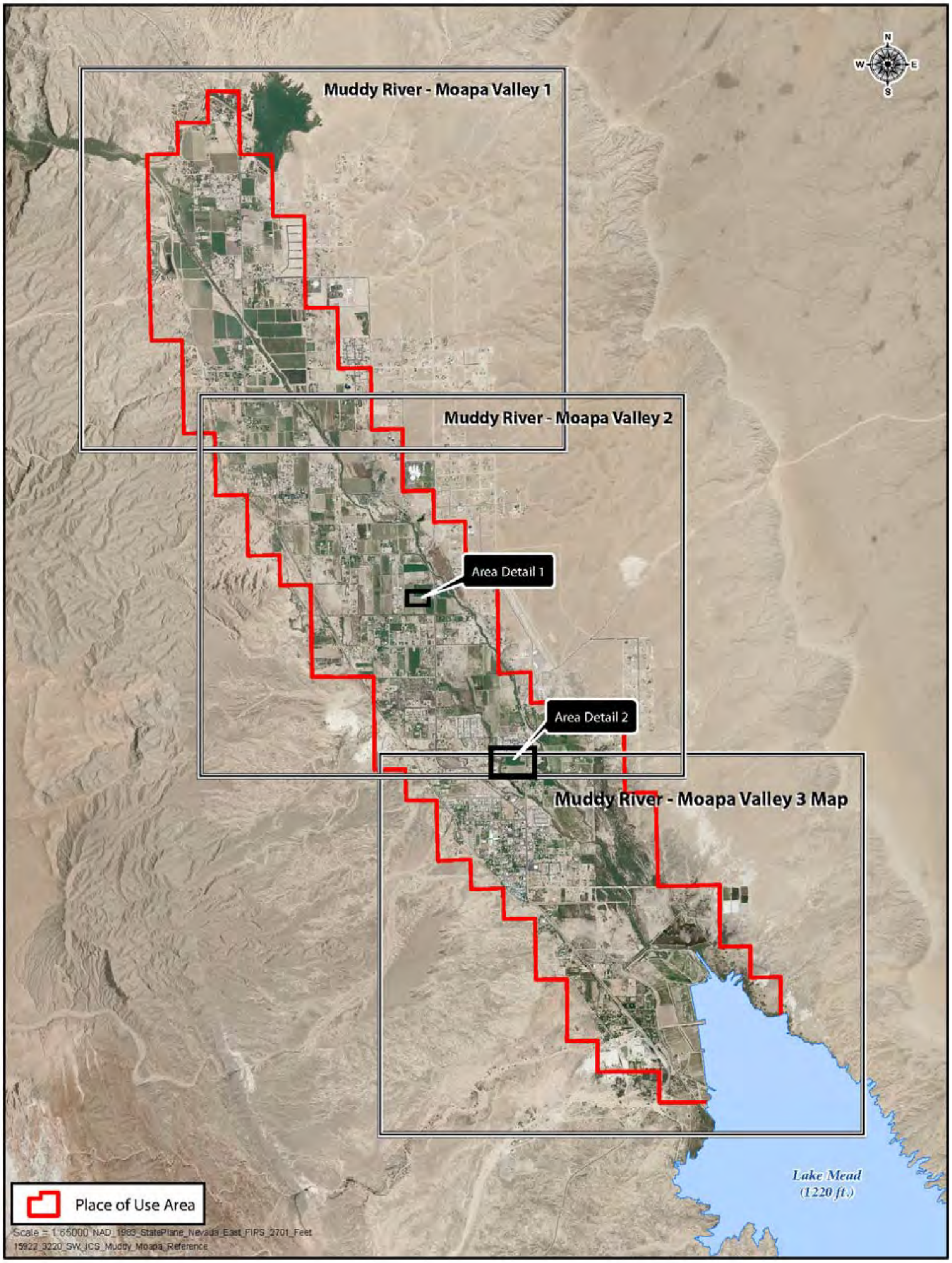

Figure 7 - Muddy Valley Irrigation Company (MVIC) Service Area and Extent of Each Individual 1974 PBU Map Depicted in Figures 7 through 12. Detailed Areas Highlighted in the Black Boxes Reference the Location of the Detailed Photography in Figure 6

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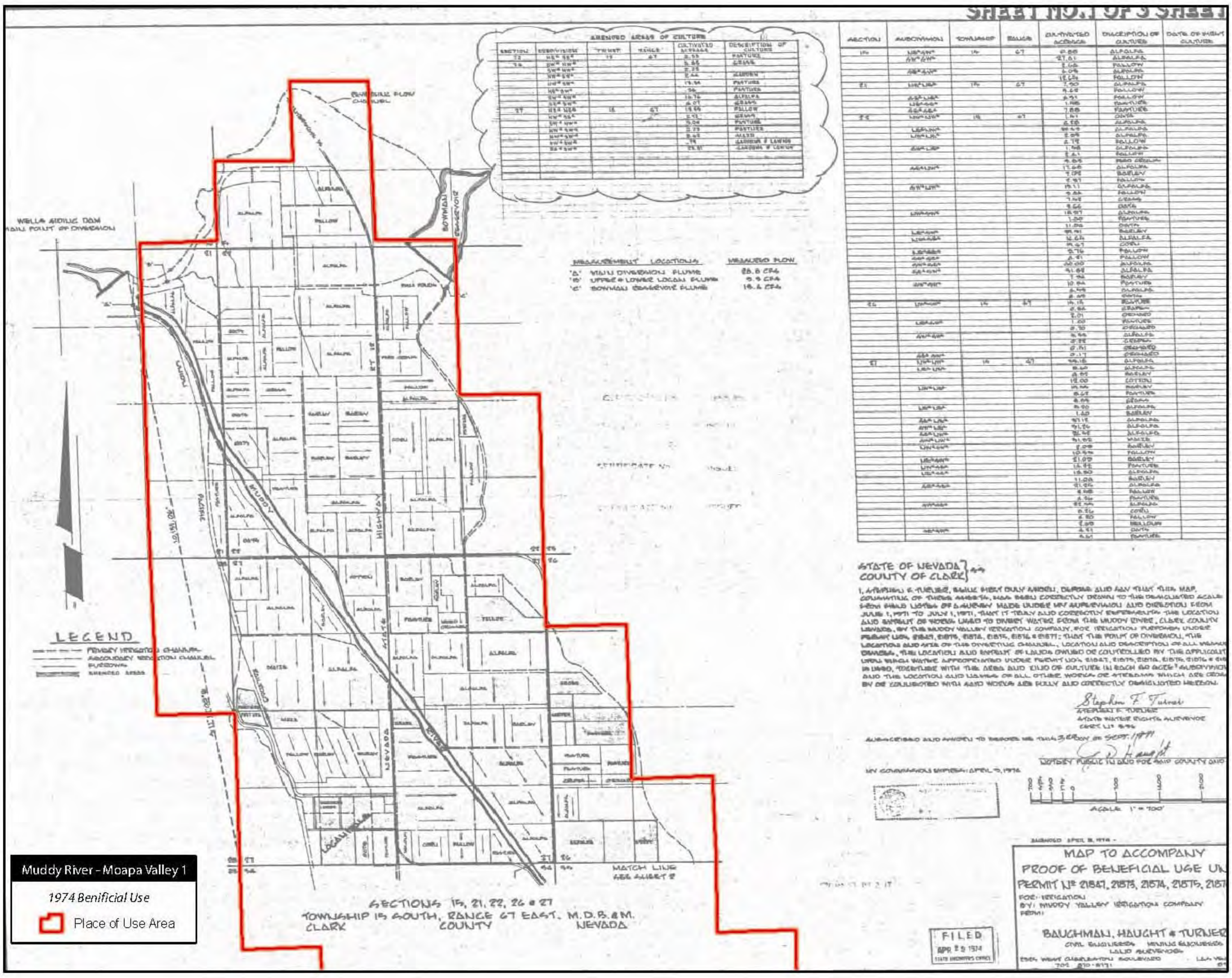


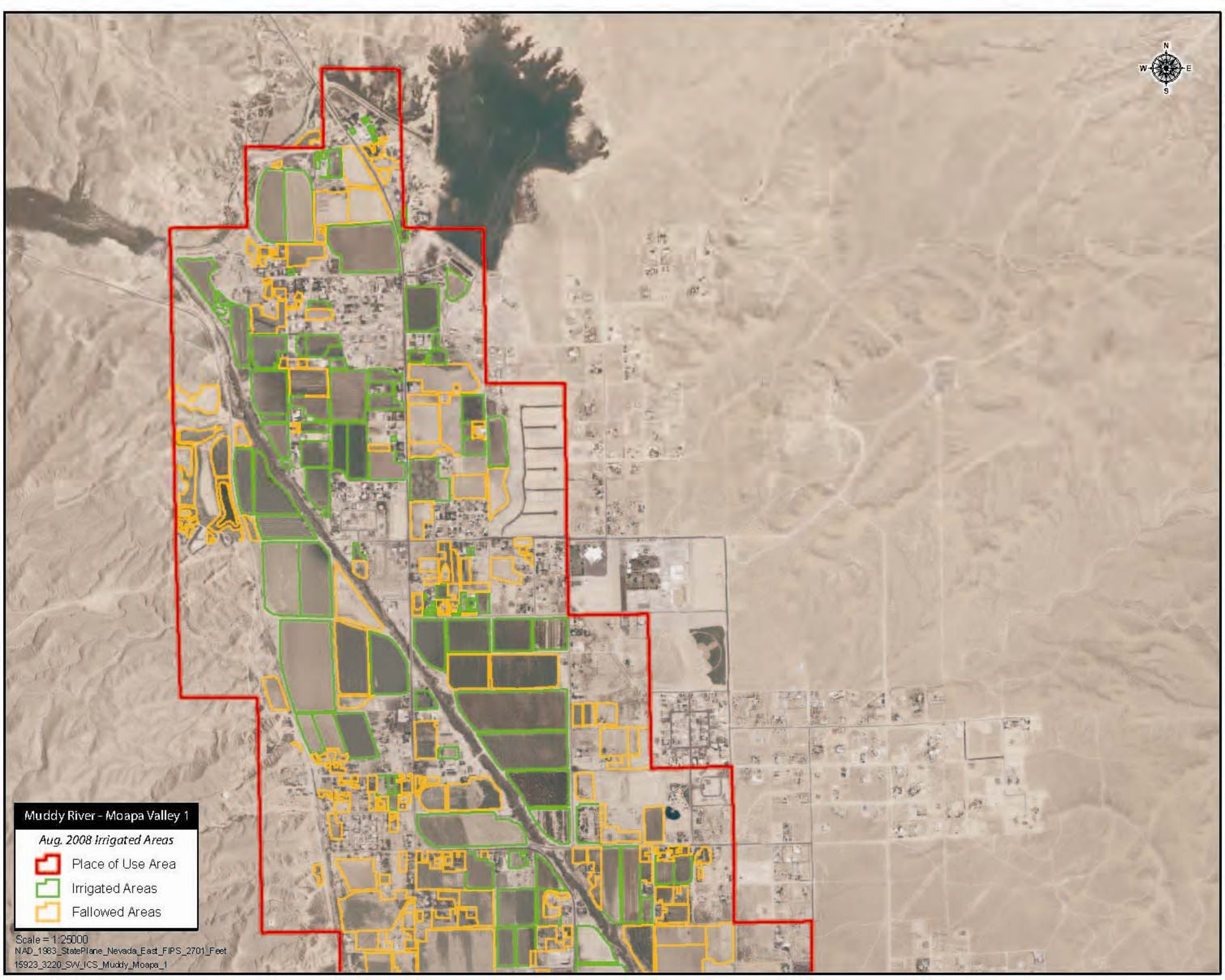
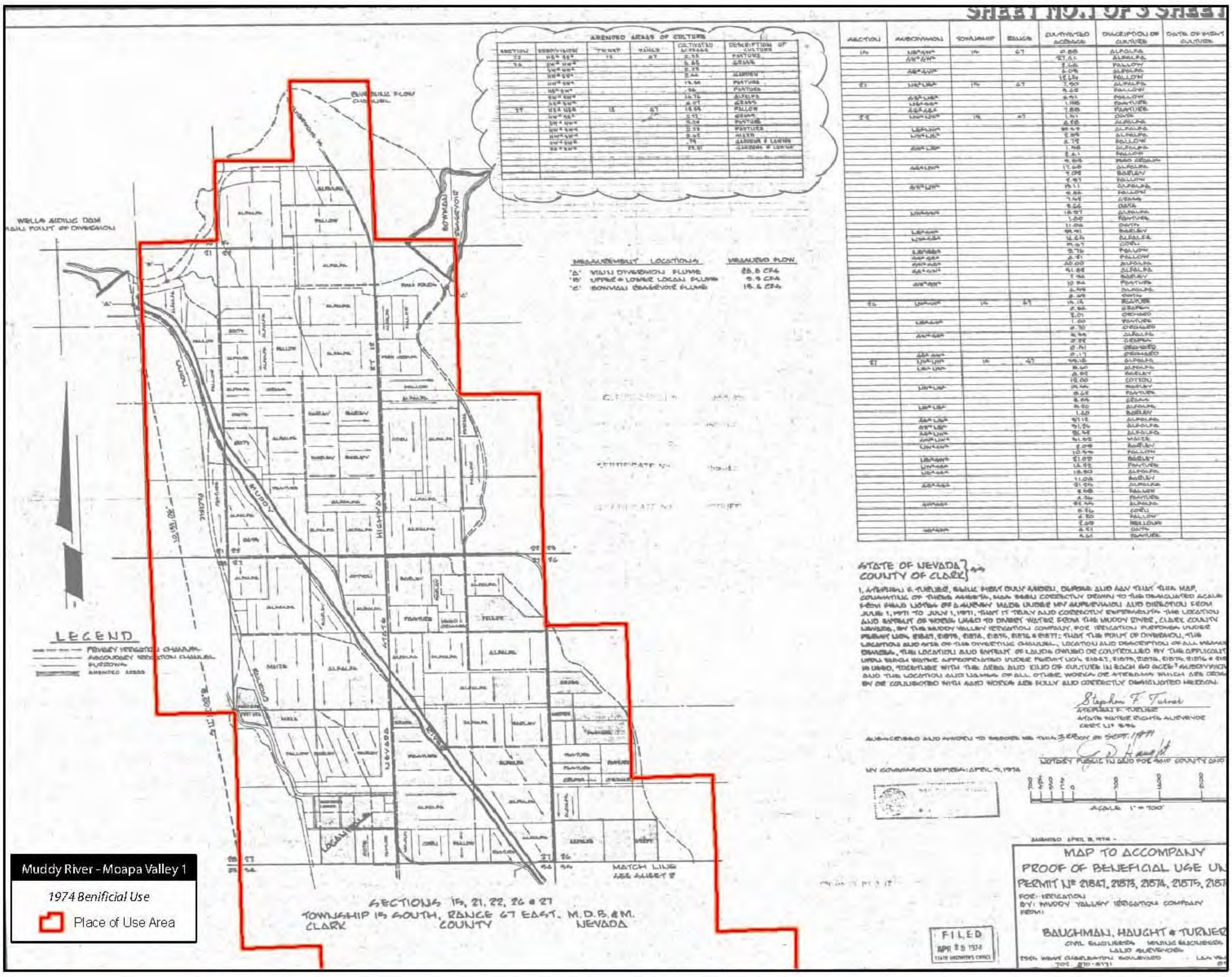


Figure 8 - Upper Section of MVIC Service Area Showing 1974 Proof-of-Beneficial-Use (top) Overlaid on the August 2008 Aerial Photography with Mapped Agricultural Land Use (bottom)

SE ROA 43883



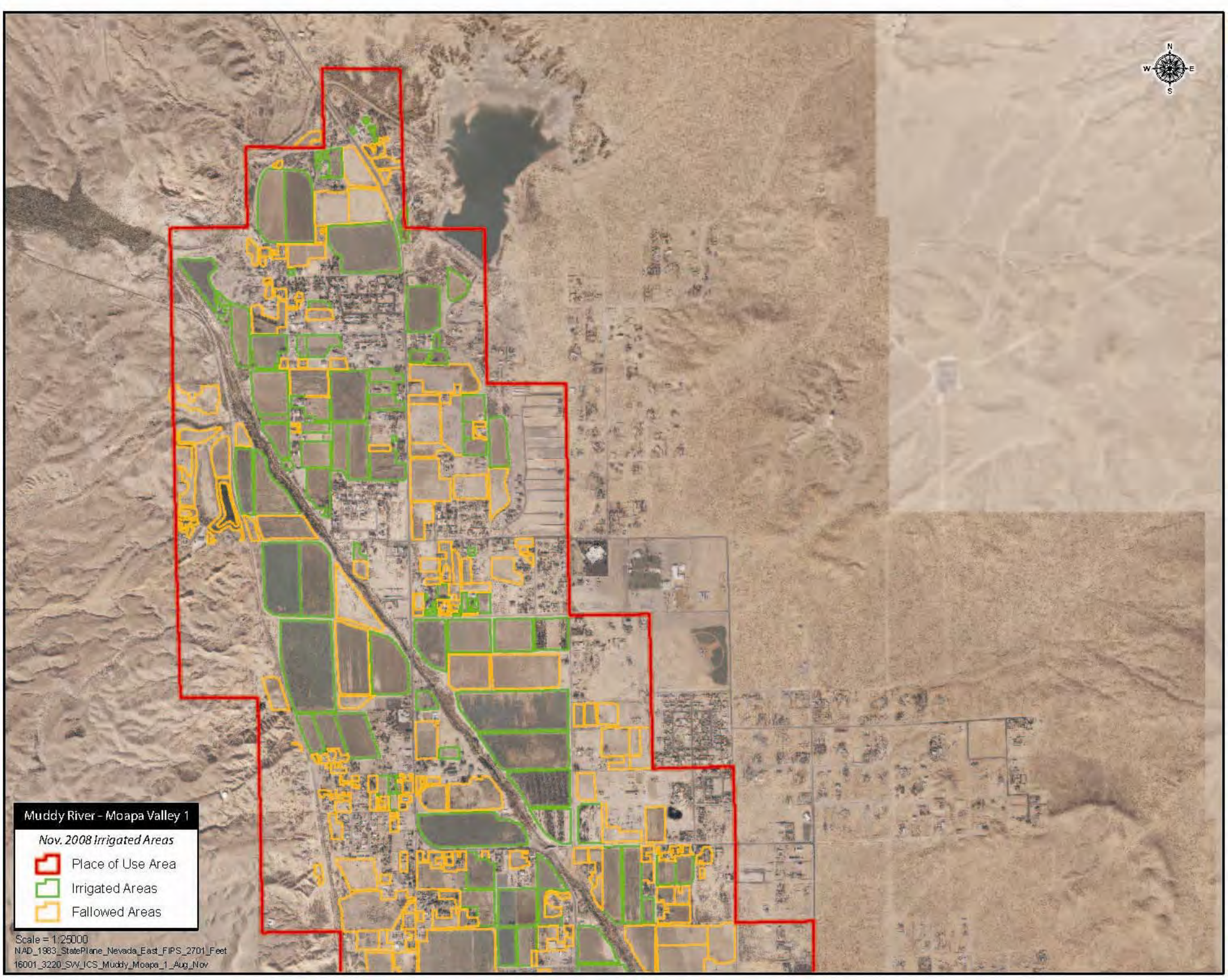
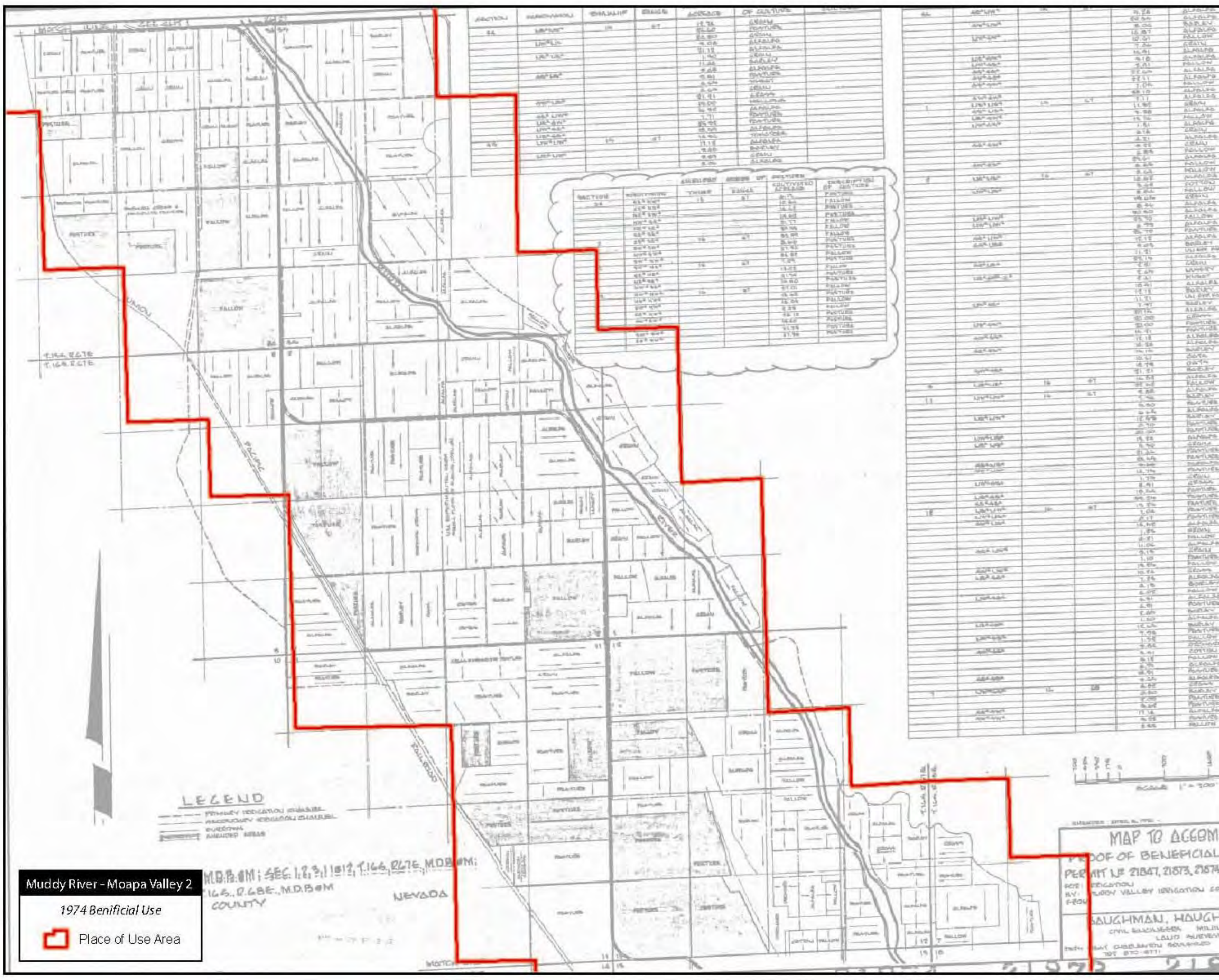


Figure 9 - Upper Section of MVIC Service Area Showing 1974 Proof-of-Beneficial-Use (top) Overlaid on the November 2008 Aerial Photography with Mapped Agricultural Land Use (bottom)

SE ROA 43885



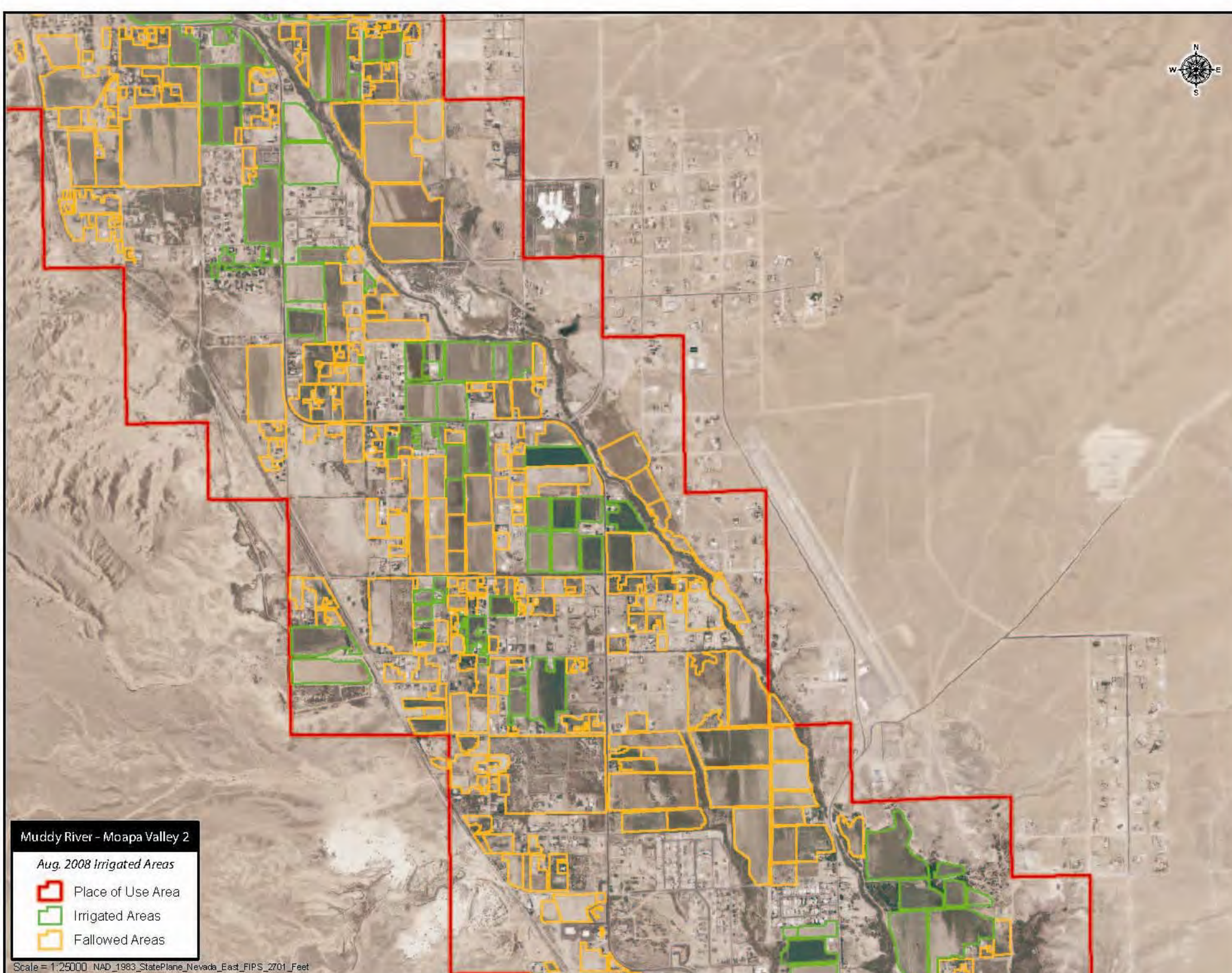
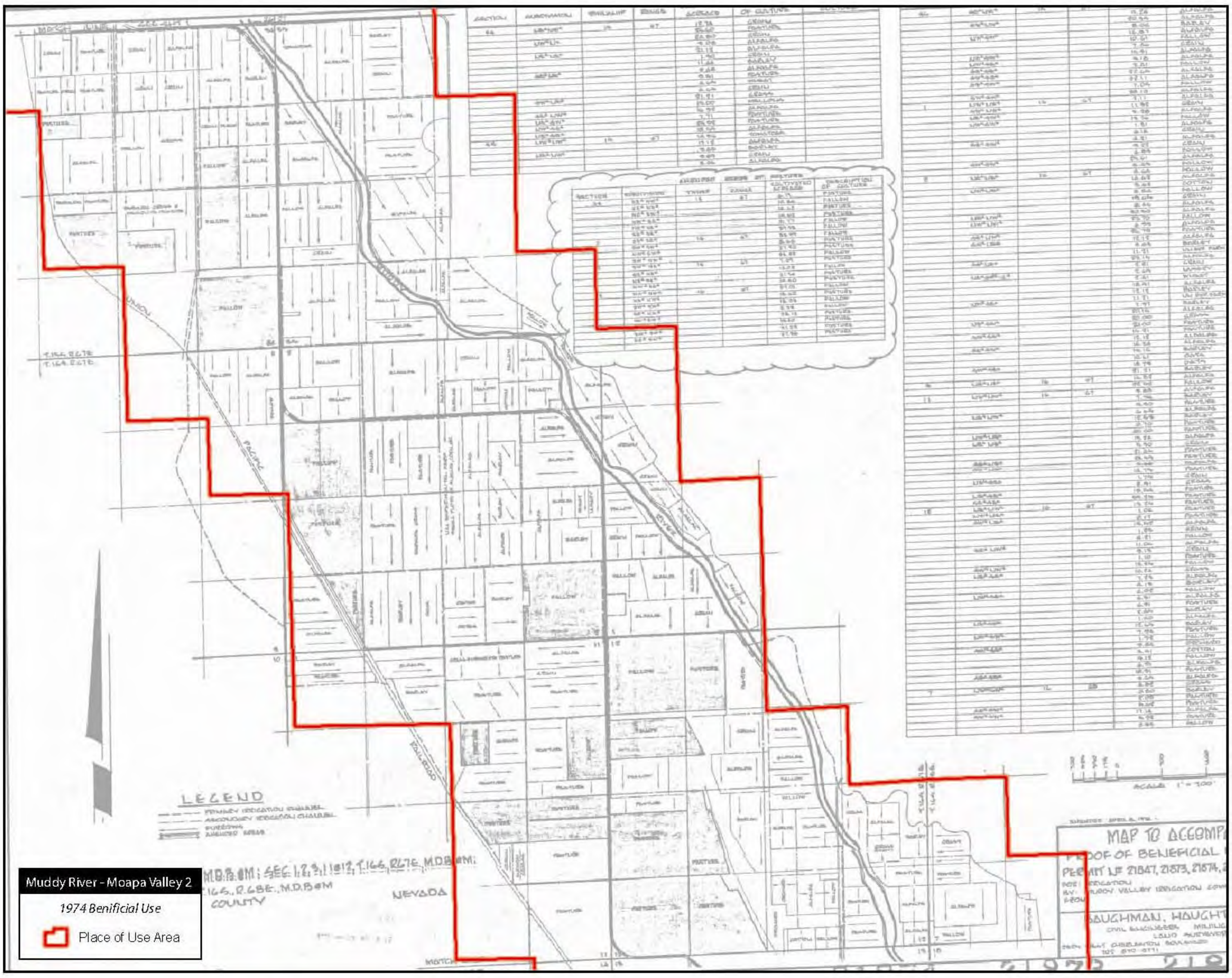


Figure 10 - Middle Section of MVIC Service Area Showing 1974 Proof-of-Beneficial-Use (top) Overlaid on the August 2008 Aerial Photography with Mapped Agricultural Land Use (bottom)

SE ROA 43887



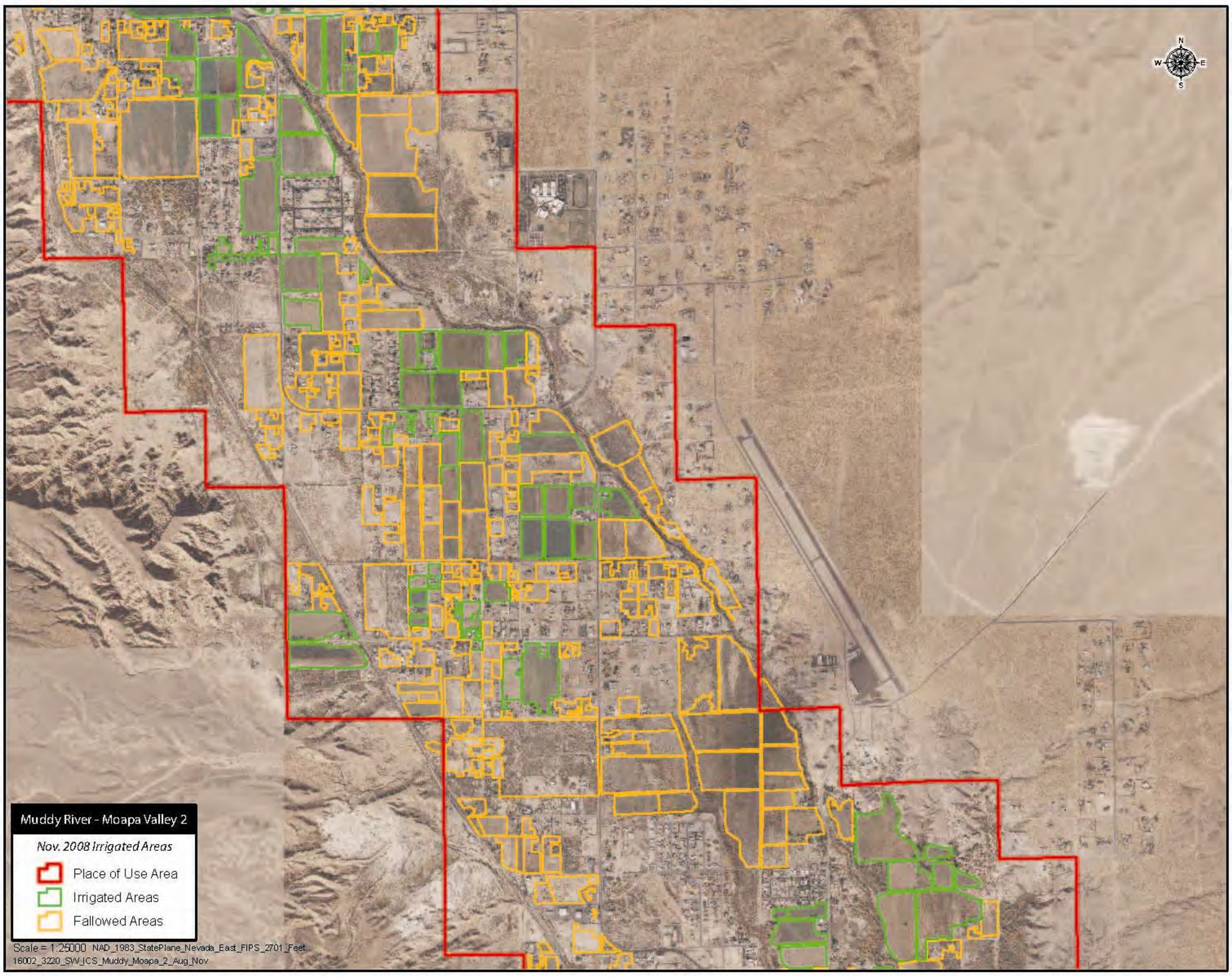
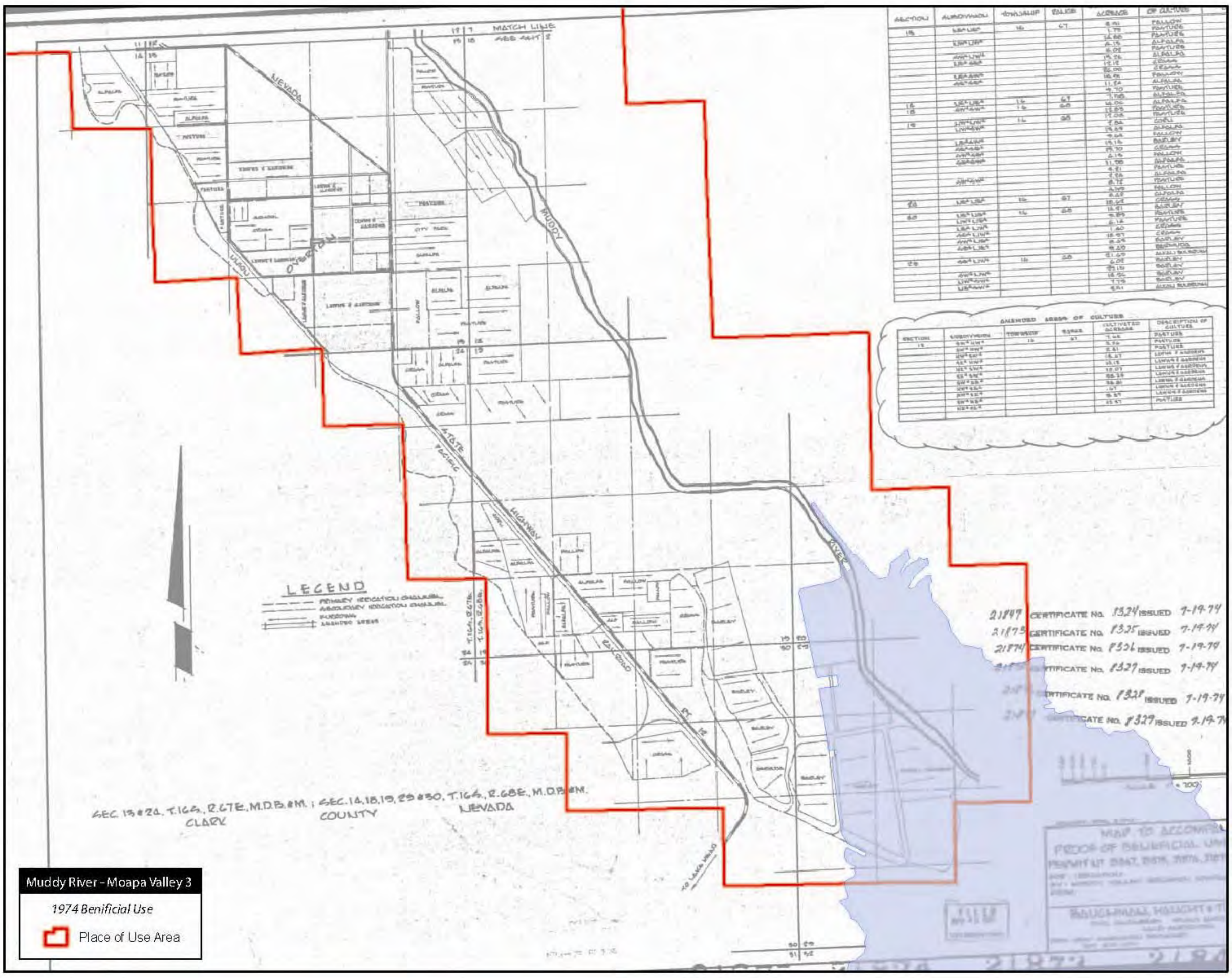


Figure 11 - Middle Section of MVIC Service Area Showing 1974 Proof-of-Beneficial-Use (top) Overlaid on the November 2008 Aerial Photography with Mapped Agricultural Land Use (bottom)

SE ROA 43889



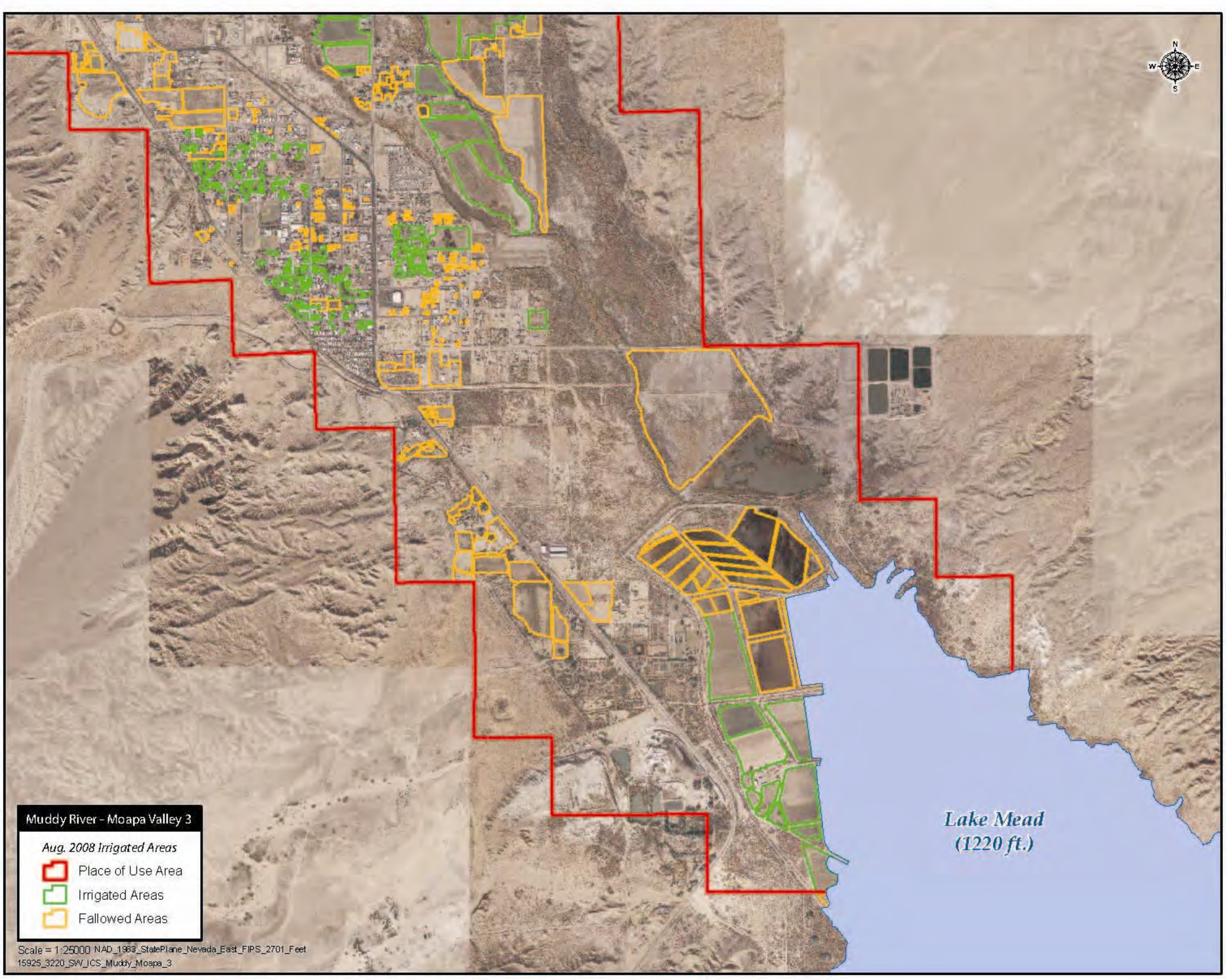


Figure 12 - Lower Section of MVIC Service Area Showing 1974 Proof of Beneficial Use (top) Overlaid on the August 2008 Aerial Photography with Mapped Agricultural Land Use (bottom)

SE ROA 43891

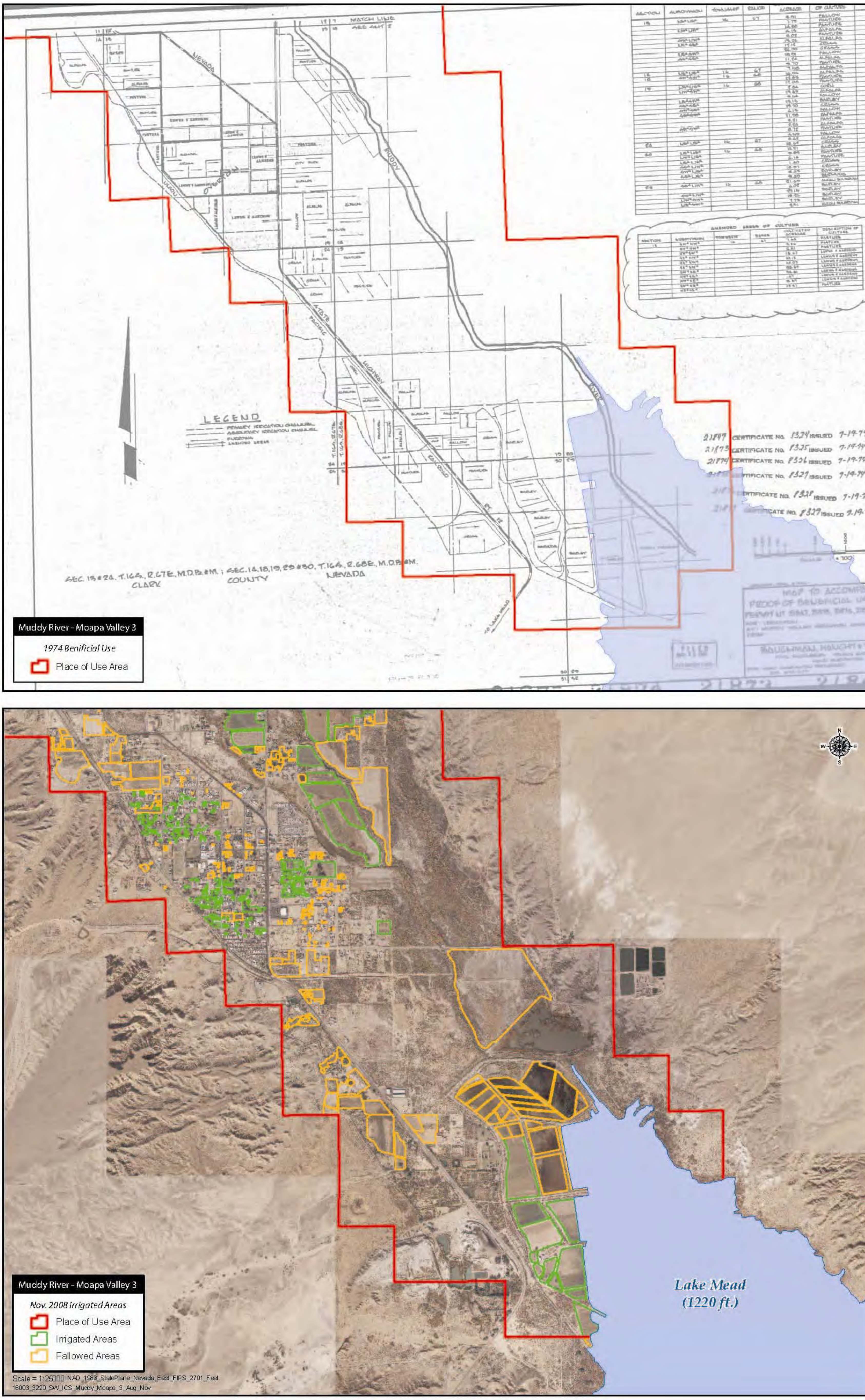


Figure 13 - Lower Section of MVIC Service Area Showing 1974 Proof-of-Beneficial-Use (top) Overlaid on the November 2008 Aerial Photography with Mapped Agricultural Land Use (bottom)

SE ROA 43893

Verification of ICS Water Reaching Lake Mead

Since the entire flow of the Muddy River is decreed, it is important to perform a water balance on the Lower Muddy River to verify that the water to which SNWA is claiming Tributary Conservation ICS credits is reaching Lake Mead. This water balance is outlined in Exhibit A of the Forbearance Agreement and approved ICS Plan as follows:

Flows measured by USGS at the Glendale gage
- (minus) consumptive uses by agriculture below the Glendale gage
- (minus) direct uses by industry below the Glendale gage
- (minus) channel evapotranspiration below Glendale gage to Lake Mead
- (minus) evapotranspiration from the managed acreage on the Overton Wildlife Management Area (OWMA)

= Total Flow to Lake Mead (Elevation 1,220 AMSL)

This comprehensive water balance uses the Muddy River at Glendale gage as the input, which was also used to calculate the acre-feet per share associated with MVIC shares. To account for consumptive uses in the riparian corridor and agricultural areas, detailed GIS coverages delineating the ground-truthed fields and mapped riparian corridors, combined with Lower Colorado River Accounting System (LCRAS) data were used to derive consumptive uses by crops and plants influenced by the Muddy River. Other consumptive uses by industry and open water evaporation were also calculated. The resulting outflow is a combination of surface flow measured at the USGS gage *09419507 Muddy River at Lewis Avenue near Overton Nevada* (Lewis Avenue gage) and underflow to Lake Mead, bypassing this gage. Downstream of the Lewis Avenue gage, consumptive uses of Muddy River water by the Nevada Division of Wildlife's Overton Wildlife Management Area (OWMA) are deducted from the total flows to Lake Mead. A final comparison is then made to ensure that the conserved Muddy River water reaching Mead exceeds or is equal to SNWA's Muddy River ownership.

An itemized seasonal calculation of the water balance is presented in Table 15. The following sub-sections describe each component of the water balance. When data used in the water balance is described, a reference is given to the row in Table 15 where the data was applied.

Glendale Gage Flows

As previously discussed in the Section "Divertible Flows by MVIC at Wells Siding," the water used by MVIC equals the Glendale gage flows minus: 1) flood flows, 2) consumptive uses by phreatophytes in the riparian corridor between the Glendale gage and Wells Siding, and 3) Upper Muddy River rights owned or leased by SNWA. This "divertible flow" is used as the inflow component of the water balance verification.

The Glendale gage, for the purposes of calculating Tributary Conservation ICS credits, is believed to capture all surface water flows entering the lower reach of the Muddy River. The gage is located in a narrow cut of carbonate rocks that are tilted almost vertically due to a thrust fault. Any shallow alluvial underflow is thought to ramp up and be measured by the gage. Downstream of the narrows, the Muddy River enters the lower reach of the Muddy River and the floodplain begins to widen, until reaching Wells Siding. The Muddy River, downstream of Wells Siding, is an incised narrow channel that has artificially been constrained to facilitate farming on the river's historic floodplain. The Glendale gage, Wells Siding, vegetated areas, and open water bodies discussed in this section are shown on Figure 14.

Figure 14 - Map of Lower Muddy River Depicting Phreatophyte Areas, Open Water Bodies, and the Overton Wildlife Management Area

Crop, Phreatophyte, and Open Water Consumptive Use

Lower Colorado River Accounting Study (LCRAS)

To calculate ET demands by crops and phreatophytes on the Muddy River, a literature search for ET data with a long period-of-record and monthly time-step data was performed. The LCRAS was chosen because it contained monthly data in a similar climate for a relatively long period, 1995-2006.

LCRAS is conducted annually by Reclamation to assist with determining consumptive water use along the Lower Colorado River. The LCRAS ET rates are determined by collecting data from meteorological towers, determining potential ET, and applying various crop coefficients to the ET values.

The LCRAS data chosen for use in this analysis are from the Fort Mojave Indian Reservation along the Lower Colorado River in California (Figure 15). This is the most northern area examined in LCRAS and most closely represents climatic conditions of the Lower Muddy River. The Fort Mojave Area is, however, at a lower elevation and experiences higher temperatures than the Lower Muddy River, resulting in higher ET values. This makes the Fort Mojave ET values conservative, overestimating the actual ET demand in the Lower Muddy River.

Application of LCRAS to the Lower Muddy River

Phreatophyte vegetation on the Lower Muddy River has been mapped and classified using the Anderson-Ohmart classification system. LCRAS uses a classification system that slightly differs from the Anderson-Ohmart system. To apply ET rates from LCRAS to the Lower Muddy River, the two vegetation classification systems were correlated. Table 10 shows the correlation and gives the relative acreage of each vegetation type mapped between Wells Siding and Lake Mead.

The equation used in this analysis for calculating ET by phreatophytes is therefore:

Phreatophyte ET Demand in af = (Riparian Phreatophyte Acreage) x [(Correlated LCRAS ET Rate)

The LCRAS "Sc-low" phreatophyte classification was used for all of the salt-cedar classifications in the Anderson-Omart classification and is supported by a recent USGS Scientific Investigations Report 2008-5116 titled *Quantifying Ground-Water and Surface-Water Discharge from Evapotranspiration Processes in 12 Hydrographic Areas of the Colorado Regional Ground-Water Flow System, Nevada, Utah, and Arizona*. The purpose of the report is to estimate ground and surface water discharge from the 12 hydrographic basins via ET. For this study the USGS placed ET measurement sites in various locations in Utah, Arizona, and Nevada including in the Upper Muddy and Lower Virgin Rivers. The Virgin River ET station was placed in a "dense woodland vegetation" area which was predominantly salt-cedar. The Virgin River site measured an annual ET rate of 3.9 feet per year without subtracting precipitation. This rate is less than the LCRAS SC-Low value of 4.39 feet per year using LCRAS Fort Mojave data. The USGS's Muddy River ET site was located in a stand of Mesquite trees, in the Upper Muddy River. The USGS value of 3.6 feet per year (without subtracting precipitation) is more than 1 ft less than the LCRAS "Ms-high" value of 5.0 feet per year.

The USGS study demonstrates that by correlating the LCRAS Sc-low and Ms-high classifications to salt cedar and mesquite on Lower Muddy River a conservative estimate of ET can be determined. These variations in ET rates demonstrate the challenges of trying to estimate ET over large areas, as ET can only be physically measured at a single point. Conditions such as soil type, depth to groundwater below land surface, and calculation method used can all affect ET rates greatly. Comparison of the LCRAS rates used by SNWA (Sc-low) in the water balance (in this analysis) to the measurements performed by the USGS show that using the LCRAS rates tend to slightly overestimate ET along the Lower Muddy River based these recent reports.

The agricultural crop types in LCRAS were directly correlated with crops types on the Muddy River. Water use by crop type in LCRAS is adjusted for precipitation by using an effective precipitation coefficient. To more accurately represent conditions on the Lower Muddy River, provisional precipitation data recorded for CY 2008 by the Overton Nevada Community Environmental Monitoring Program (CEMP) Weather Station (http://www.cemp.dri.edu/) was used for calculating the effective precipitation used to derive crop consumptive uses. The equation for calculating Crop ET is listed below. The crop rates adjusted to Overton Nevada Precipitation are shown in Table 11.

Crop ET Demand in af = (Crop Acreage) x [(Correlated LCRAS ET Rate) – (Overton CEMP Effective Precipitation)]

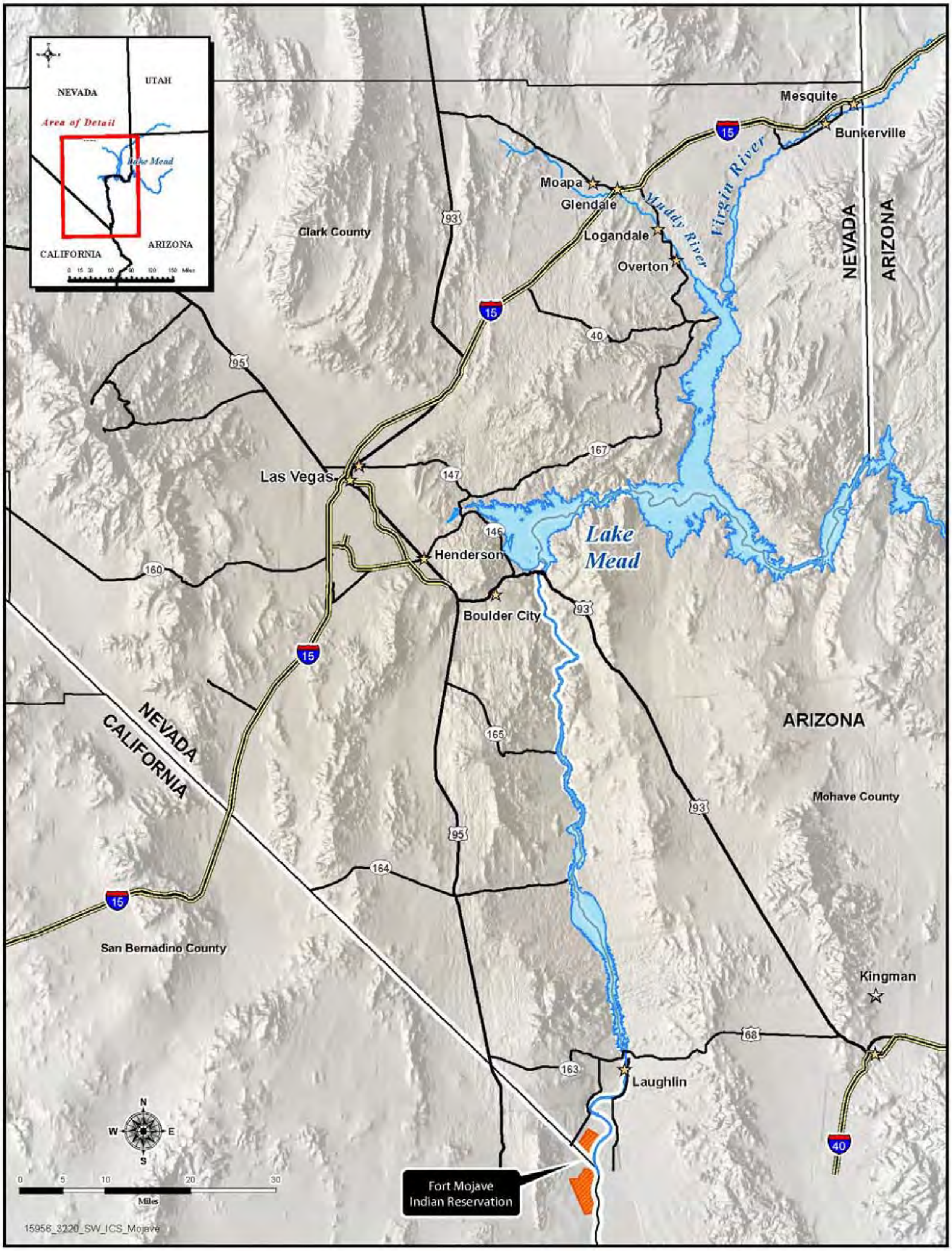


Figure 15 - Fort Mojave LCRAS Area in Relation to the Lower Muddy River

Table 10 - LCRAS Vegetation Types Used to Correlate Anderson-Omart Vegetation Types with Acreages of Riparian Corridor from Wells Siding to Lake Mead

Anderson Ohmart Mapped Class	Correlating LCRAS Class	Acres
A	Low Veg	15.53
AW	AW	7.85
Acacia	Ms-high	0.81
Baccharis	Low Veg	1.37
C	CW	0.13
CW	CW	6.60
HM	Ms-high	4.26
I	Ms-high	2.03
L	Ms-high	0.83
MA	Marsh	20.00
RIV	Open Water	2.11
SC	Sc-low	97.73
SM	Sc/ms	8.94

Tables 11 through 13 in this section detail the calculations performed to estimate the amount of consumptive uses by crops, phreatophytes, and open water. The Fort Mojave monthly ET rates for the crops and phreatophytes adjusted for Overton, Nevada precipitation are in Table 11.

The measured acreages of each vegetation type and open water are in Table 12. Vegetation mapping of the Muddy River riparian corridor was performed in 2006. Given the incised nature of the channel, the total vegetated acreage along the riparian corridor has remained the same and is anticipated to remain the same into the future. The phreatophyte acreages were mapped in the field by biologists and verified using the high resolution 6-in aerial photography. The exact acreage values for the phreatophytes and crops are shown in Table 12. The final consumptive use calculations for the phreatophytes and crops are shown monthly in Table 13 and these results are then shown seasonally on Rows B, F, and H in Table 15.

Vegetation acreage mapped for OWMA is also shown in Table 12. OWMA is the downstream extent of MVIC's service area and is located immediately above the full pool elevation of Lake Mead. Water use by OWMA is described in the subsequent sections of this report.

Future ET Studies

To enhance the accuracy of ET consumptive use calculations along the Lower Muddy River, SNWA has installed a meterological (MET) tower in the WSNA on the Upper Muddy River. The primary purpose of this MET tower is to measure the meteorological parameters necessary to calculate reference ET using the ASCE Standardized Reference ET Equation, the same method used by The Arizona Meteorological Network (AZMET) and California Meteorological Information System (CMIS) for the LCRAS program. The reference ET calculated from the WSNA MET tower could then be multiplied by the LCRAS crop coefficients to obtain a more accurate ET consumptive use estimate for the Lower Muddy River.

SNWA's MET tower has been operational since June 2008. The reference ET data collected compared to the Fort Mojave Reference ET exhibits a similar trend although with slightly lower values as shown on Figure 16. These slightly lower values are to be expected as the Muddy River is at a higher elevation and latitude than Fort Mojave. SNWA will continue collecting MET data and is anticipating using the data from the Upper Muddy River MET tower in the CY 2009 ICS Certification Report.

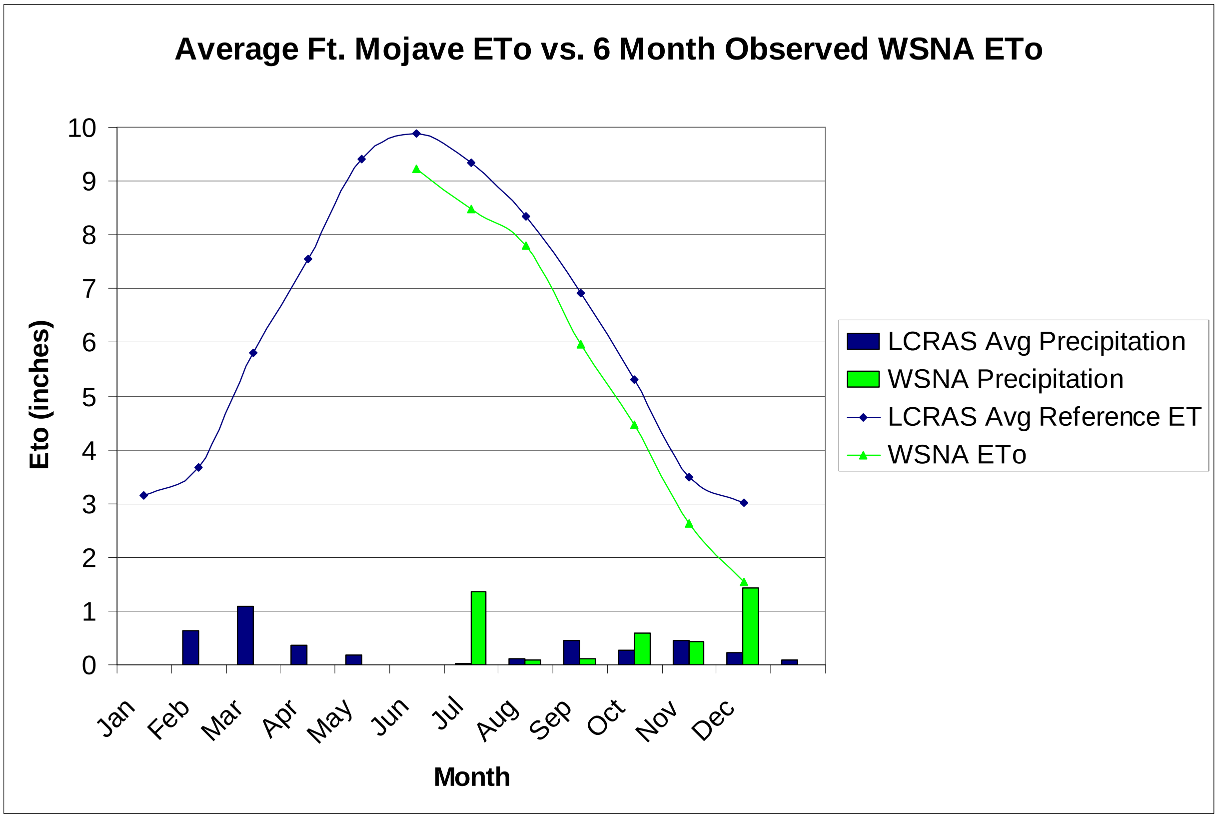


Figure 16 - SNWA Reference ET and Precipitation Compared to Fort Mojave

Open Water Evaporation

Open water bodies on the Lower Muddy River include Bowman Reservoir, the Muddy River channel, and a few small ponds on the OWMA. Bowman Reservoir is used by MVIC to augment irrigation flows during the summer irrigation season. The 3,000 to 4,000 af capacity reservoir is filled during the winter irrigation season with no outflows. Filling usually begins in December or January and is completed by March. In the summer season, water is released from the reservoir to supplement agricultural demands of the irrigation system and help manage the distribution system to meet water orders. By November the outflow of the reservoir is generally turned off and refilling begins again.

The open water evaporation rate used for Bowman Reservoir, the Muddy River channel, and the ponds on the OWMA was 7.50 feet per year. This value is the open water evaporation rate determined and published by the USGS for Lake Mead. The monthly average evaporation data was published in the USGS SIR 2006-5252 titled *Evaporation from Lake Mead, Arizona, and Nevada, 1997-99*. The average monthly evaporation data from the report can be found in Table 11. The acreage of Bowman Reservoir and other open water can be found in Table 12, and the total evaporative loss can be found in Table 13 and in Row G of Table 15. It is important to note that the water surface elevation of Bowman Reservoir was not tracked during CY 2008, so the maximum surface area was assumed for all 12 months of the year, providing a conservative determination of the actual ET by over-estimating the surface area in the summer months. The filling and emptying of Bowman Reservoir is shown in Rows J and K of Table 15. Since there are not any measuring devices on the inlet or outlet of the reservoir a filling and emptying value of 1,868 afy was estimated by estimating the number of days it took to fill the reservoir times the estimated inflow rate of 10cfs.

Table 11 - ET Rates in Feet for the Lower Muddy River from LCRAS USGS, and CEMP

	Fort Mohave ET Rates in feet												
	Average 1995 - 2007 Minus Overton 2008 Precipitation Data												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Crops:													
Alfalfa Perennial	0.20	0.33	0.42	0.56	0.68	0.73	0.69	0.66	0.56	0.40	0.23	0.24	5.70
Alfalfa-Annual	0.14	0.28	0.34	0.39	0.65	0.50	0.57	0.29	0.23	0.25	0.11	0.18	3.93
Small Grain	0.24	0.38	0.58	0.68	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.08	2.23
Orchard	0.13	0.18	0.28	0.45	0.66	0.70	0.67	0.64	0.51	0.38	0.23	0.15	4.98
Sudan Grass	0.00	0.00	0.14	0.43	0.83	0.97	0.89	0.35	0.03	0.00	0.00	0.00	3.64
Bermuda Grass	0.00	0.00	0.00	0.27	0.65	0.71	0.68	0.63	0.50	0.05	0.00	0.00	3.49
Seasonal Wetland	0.29	0.36	0.37	0.34	0.33	0.21	0.40	0.41	0.33	0.44	0.27	0.22	3.97
Phreatophytes:													
AW	0.08	0.10	0.20	0.41	0.69	0.80	0.76	0.68	0.51	0.31	0.12	0.07	4.73
CW	0.08	0.10	0.21	0.44	0.74	0.84	0.79	0.71	0.53	0.33	0.13	0.07	4.97
Low Veg	0.09	0.10	0.20	0.37	0.61	0.67	0.67	0.59	0.50	0.32	0.14	0.07	4.33
Marsh	0.07	0.08	0.37	0.74	0.92	0.96	0.91	0.82	0.67	0.27	0.07	0.06	5.94
Ms-High	0.08	0.10	0.21	0.43	0.71	0.82	0.77	0.70	0.57	0.38	0.16	0.07	5.00
Sc-ms	0.08	0.10	0.20	0.46	0.81	0.95	0.89	0.80	0.61	0.36	0.14	0.07	5.47
Sc-Low	0.07	0.08	0.14	0.29	0.61	0.77	0.73	0.66	0.54	0.33	0.12	0.05	4.39
Open Water Evaporation [1]	0.30	0.40	0.60	0.60	0.80	0.80	0.80	0.70	0.80	0.70	0.60	0.40	7.50
Precipitation [2]	0.04	0.01	0.00	0.00	0.03	0.00	0.01	0.02	0.00	0.03	0.04	0.04	0.22

1 - USGS SIR 2006-5252 *Evaporation from Lake Mead, Arizona, and Nevada, 1997-99*.

2 - Overton Nevada Community Environmental Monitoring Program (CEMP) Weather Station (http://www.cemp.dri.edu/)

Table 12 - Measured Acreages of Crops, Phreatophytes, and Open Water on the Lower Muddy River

	Acreages of Agriculture, Phreatophytes, and Open Water in the Lower Muddy River											
	2008											
	January	February	March	April	May	June	July	August	September	October	November	December
Bowman Reservoir	150.28	150.28	150.28	150.28	150.28	150.28	150.28	150.28	150.28	150.28	150.28	150.28
Riparian:												
Sc_Low above Wells Siding	261.77	261.77	261.77	261.77	261.77	261.77	261.77	261.77	261.77	261.77	261.77	261.77
AW	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85	7.85
CW	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73	6.73
Ms-High	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92	7.92
Low Veg	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90	16.90
Marsh	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sc-Low	97.73	97.73	97.73	97.73	97.73	97.73	97.73	97.73	97.73	97.73	97.73	97.73
Sc/ms	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94	8.94
Open Water	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11	2.11
Subtotal Below Wells Siding	168.18	168.18	168.18	168.18	168.18	168.18	168.18	168.18	168.18	168.18	168.18	168.18
Total	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*	*429.95*
MVIC Ag:												
Alfalfa	634.19	634.19	634.19	634.19	634.19	634.19	634.19	634.19	634.19	631.85	631.85	631.85
Sudan	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06	27.06
Bermuda	172.72	172.72	172.72	172.72	172.72	172.72	172.72	172.72	167.83	167.83	167.83	167.83
Orchard	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.80	41.79	41.80	41.80	41.80
Total	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*875.77*	*870.87*	*868.54*	*868.54*	*868.54*
OWMA:												
Alfalfa / Small Grain	92.47	92.47	92.47	92.47	92.47	119.72	119.72	119.72	119.72	64.64	64.64	64.64
Seasonal Wetland	155.16	155.16	155.16	155.16	-	-	-	-	-	155.16	155.16	155.16
Sudan	-	-	-	-	8.43	8.43	8.43	8.43	8.43	8.43	8.43	8.43
Open Water	31.88	31.88	31.88	31.88	31.88	31.88	31.88	31.88	31.88	31.88	31.88	31.88
Total	*279.51*	*279.51*	*279.51*	*279.51*	*132.78*	*160.03*	*160.03*	*160.03*	*160.03*	*260.11*	*260.11*	*260.11*

Table 13 - Acre-Foot Values for Consumptive Uses of Crops, Phreatophytes, and Open Water on the Lower Muddy River

	Total ET in Acre Feet												
	2008												
	January	February	March	April	May	June	July	August	September	October	November	December	Total
Bowman Reservoir	38.57	58.23	90.17	90.17	116.34	120.22	119.47	102.82	120.22	100.56	83.53	54.23	1,095
Riparian:													
Sc_Low above Wells Siding	18.32	20.94	36.65	75.91	159.68	201.56	191.09	172.77	141.36	86.38	31.41	13.09	1,149
AW	0.63	0.79	1.57	3.22	5.42	6.28	5.97	5.34	4.00	2.43	0.94	0.55	37
CW	0.54	0.67	1.41	2.96	4.98	5.65	5.32	4.78	3.57	2.22	0.87	0.47	33
Ms-High	0.63	0.79	1.66	3.41	5.62	6.49	6.10	5.54	4.51	3.01	1.27	0.55	40
Low Veg	1.52	1.69	3.38	6.25	10.31	11.32	11.32	9.97	8.45	5.41	2.37	1.18	73
Marsh	1.40	1.60	7.40	14.80	18.40	19.20	18.20	16.40	13.40	5.40	1.40	1.20	119
Sc-Low	6.84	7.82	13.68	28.34	59.62	75.25	71.34	64.50	52.77	32.25	11.73	4.89	429
Sc/ms	0.72	0.89	1.79	4.11	7.24	8.49	7.96	7.15	5.45	3.22	1.25	0.63	49
Open Water	0.54	0.82	1.27	1.27	1.63	1.69	1.68	1.44	1.69	1.41	1.17	0.76	15
Subtotal Below Wells Siding	12.82	15.07	32.16	64.36	113.22	134.37	127.89	115.12	93.84	55.35	21.00	10.23	795
Total	**31.14**	**36.01**	**68.81**	**140.27**	**272.90**	**335.93**	**318.98**	**287.89**	**235.20**	**141.73**	**52.41**	**23.32**	**1,944**
MVIC Ag:													
Alfalfa	128.53	206.11	266.36	355.15	431.25	462.96	437.59	418.57	355.15	251.27	146.80	154.38	3,614
Sudan	-	-	3.79	11.64	22.46	26.25	24.08	9.47	0.81	-	-	-	99
Bermuda	-	-	-	46.63	112.27	122.63	117.45	108.81	83.92	8.00	-	-	600
Orchard	5.55	7.32	11.70	18.81	27.59	29.26	28.01	26.75	21.31	15.79	9.71	6.45	208
Total	**134.08**	**213.43**	**281.85**	**432.23**	**593.57**	**641.10**	**607.13**	**563.60**	**461.19**	**275.06**	**156.51**	**160.83**	**4,521**
OWMA:													
Alfalfa / Small Grain	22.44	34.68	53.63	36.06	60.11	59.86	68.24	34.72	27.54	16.01	0.15	5.45	419
Seasonal Wetland	45.41	55.08	57.41	52.75	-	-	-	-	-	67.91	42.26	34.81	356
Sudan	-	-	-	-	7.00	8.18	7.50	2.95	0.25	-	-	-	26
Open Water	8.18	12.35	19.13	19.13	24.68	25.50	25.34	21.81	25.50	21.33	17.72	11.50	232
Total	**76.00**	**102.11**	**130.17**	**107.94**	**91.79**	**93.54**	**101.08**	**59.48**	**53.29**	**105.25**	**60.13**	**51.76**	**1,033**

Industrial Consumptive Use

A portion of MVIC's shares have been purchased and leased by Simplot, a sand and minerals operation in Overton, Nevada, which is using the water represented by the shares they control for slurrying and washing sand for glass production. The water is 100% consumptively used, so the water represented by the shares controlled by Simplot is subtracted in its entirety from the water balance.

In 2008, Simplot controlled 235.003 preferred and 315.67 common shares (personal communication with Scott Millington, MVIC Manager, April 2009). Using the acre-foot per share values of 6.86 af/share preferred and 0.64 af/share common, Simplot consumptively used 1,816 af of MVIC water in CY 2008. While the water delivered to Simplot is not directly measured, they are located at the end of the ditch and are subject all users upstream obtaining their rights. Even SNWA's rights are taken on turn and returned to the natural channel above Simplot. Therefore, calculating their use as 100% of their controlled shares, ensures a conservative estimate for their annual use. The monthly breakdown of Simplot's consumptive use is shown in Row E of the Water Budget Table 15.

Total Flows Passing Lewis Avenue Gage

Lewis Avenue in Overton is generally considered to be the lower most extent of agricultural uses within MVIC's. The OWMA is located downstream of the Lewis Avenue gage and abuts Lake Mead. Discharge data for CY 2008 at the Lewis Avenue gage is shown in Table 14, which measured approximately 10,700 af in CY 2008. The flow data from this gage was not filtered for flood flows since the flow data merely represents an intermediate measurement point between the Glendale gage and Lake Mead and is not a direct input into the water balance.

Table 14 - USGS Muddy River at Lewis Avenue at Overton NV Gage Record for CY 2008

09419507 Muddy River at Lewis Avenue at Overton, NV - Units cfs

Day	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08	Total
1	8	5	30	15	10	12	5	12	15	15	17	8	
2	11	5	26	16	10	10	6	24	8	12	21	7	
3	11	5	23	12	19	15	13	16	4	10	24	7	
4	8	7	19	20	17	18	24	12	7	13	22	7	
5	5	5	16	16	19	23	18	7	9	45	28	7	
6	6	7	14	17	16	17	14	7	12	40	26	7	
7	8	7	18	13	9	14	10	17	18	28	26	7	
8	4	7	22	11	13	9	8	17	16	16	24	9	
9	6	5	21	14	16	9	8	24	13	12	21	10	
10	8	7	16	15	16	11	13	19	10	9	26	10	
11	8	9	13	16	16	10	20	15	8	10	31	11	
12	6	7	10	16	12	15	20	10	6	9	27	11	
13	5	7	26	18	12	20	29	11	6	25	30	11	
14	4	14	28	17	19	15	17	11	18	25	31	11	
15	7	13	20	12	22	10	17	9	19	26	29	15	
16	4	15	12	16	14	9	14	19	13	26	28	18	
17	5	15	10	12	10	8	12	18	9	21	32	18	
18	4	17	10	12	9	9	21	10	9	17	27	16	
19	4	16	17	15	9	18	20	7	9	14	22	15	
20	4	20	21	16	10	18	14	6	9	21	18	15	
21	4	31	17	16	17	13	10	5	19	26	16	16	
22	4	29	16	15	25	9	7	5	25	26	22	17	
23	4	26	10	17	15	8	10	15	18	21	25	14	
24	7	28	12	15	18	7	12	20	16	16	25	14	
25	6	21	15	15	14	10	19	15	11	18	29	15	
26	6	26	17	18	14	20	22	14	12	16	21	19	
27	7	25	20	17	10	19	17	6	11	20	9	18	
28	6	27	22	18	21	13	11	6	18	28	9	14	
29	7	24	15	14	26	8	6	6	28	26	9	13	
30	6	0	14	14	20	5	5	11	18	26	8	13	
31	5	0	14	0	14	0	7	19	0	26	0	14	
					4								
Mean	6	14	18	15	15	12	14	13	13	21	22	12	
Cnt	31	31	31	31	31	31	31	31	31	31	31	31	
Min	4	0	10	0	9	0	5	5	0	9	0	7	
Max	11	31	30	20	26	23	29	24	28	45	32	19	
Acre Feet	**370**	**852**	**1,077**	**908**	**933**	**755**	**848**	**775**	**779**	**1,275**	**1,354**	**765**	**10,691**

Overton Wildlife Management Area

The OWMA is located just above the Muddy River's confluence with Lake Mead, downstream of the Lewis Avenue gage. OWMA is managed for migrating birds, hunting, and, most recently, a refugia for Razorback suckers in a small impoundment called Honey Bee Pond. The managed part of the facility, located above Lake Mead, is about 280 acres in size and consists of a series of seasonal wetlands that are flooded in the winter for migrating waterfowl, along with several fields of Alfalfa, Sudan grass, and Bermuda grass for bird habitat and minor farming, along with Honey Bee Pond and a couple other small impoundments.

The OWMA receives most of its water directly from the Muddy River and is permitted to do so under tail-water permits. In addition to the tailwater rights, OWMA owns shares in MVIC. In 2008, OWMA owned 398 afy of MVIC rights represented by 51.25 preferred and 80.50 common shares (personal communication with Scott Millington, MVIC General Manager, April 2009). MVIC water delivered to OWMA is diverted at Wells Siding and travels via ditch to OWMA, therefore bypassing the Lewis Avenue gage.

The managed area of OWMA above Lake Mead uses approximately 1,032 afy, in addition to the 398 afy from MVIC shares, (Row O of Table 15) based on the type of vegetation/management practices for OWMA lands above Lake Mead. Aerial photography and discussions with Keith Brose, the OWMA Manager, were used to determine the appropriate LCRAS Vegetation ET rates to apply to the managed areas.

Flows Entering Lake Mead and SNWA Tributary Conservation ICS

After OWMA consumptive uses from the Muddy River are subtracted from the total flows measured at the Lewis Avenue gage, the total outflows to Lake Mead as both surface- and under-flows can be derived (Row P of Table 15). As outlined in Table 15, 12,794 af of Muddy River water entered Lake Mead in CY 2008. In CY 2008, SNWA controlled 7,095 af of Muddy River water rights (Row S). The difference between the total outflows to Lake Mead and rights held by SNWA is 5,699 af (Row T). Since SNWA's rights fall within the total flow volume of water reaching Lake Mead, SNWA created Tributary Conservation ICS with the full volume of rights owned and controlled on the Muddy River – 7,095 af prior to the one-time deduction of 5% for the benefit of additional system storage in Lake Mead.

Table 16 applies the results shown in Table 15 in the format of the Water Balance from Exhibit A of the Forbearance Agreement.

Table 15 - 2008 Muddy River Intentionally Created Surplus Water Balance Sheet

2008 Muddy River Intentionally Created Surplus Water Balance Sheet (all units in Acre-Feet)						
		Winter (Jan - Apr)	Summer (May-Sep)	Winter (Oct Dec)	Total	Row Reference
Total Inflows To Lower Muddy River	Muddy River at Glendale Gage	8,594	8,847	5,755	23,196	A
	Phreatophyte Consumptive use to Wells Siding	152	866	131	1,149	B
	Leased Upper Muddy River Water Rights	625	1,019	468	2,112	C
	Acre-feet per Share Basis	**7,817**	**6,962**	**5,156**	**19,935**	D = A - B - C
Consumptive Uses Above Lewis Avenue	Simplot	652	670	489	1,811	E
	MVIC Crop Use	1,062	2,867	592	4,521	F
	Bowman Reservoir Evaporation	277	579	238	1,094	G
	Phreatophyte Consumptive Use (Wells Siding to Lake Mead)	124	584	87	795	H
	MVIC Consumptive Uses above Lewis Ave	2,115	4,700	1,406	8,221	I = E + F + G + H
Bowman Reservoir Operations	Bowman Fill	934	-	934	1,868	J
	Bowman Release	-	1,868	-	1,868	K
Outflows from MVIC Service Area	Total Calculated Flows Passing Lewis Avenue	5,393	5,149	3,284	13,826	L = A -B- I - J + K
	Flows Measured at USGS Lewis Avenue Gage	3,207	4,090	3,346	10,643	M
	Calculated Unmeasured Sub-Surface Flows	2,186	1,059	-	3,183	N = L - M
	Total Calculated Flows Passing Lewis Avenue	5,393	5,149	3,284	13,826	L
Overton Wildlife Management Area Water Use	OWMA Consumptive Use	416	399	217	1,032	O
	Total Flows to Lake Mead	4,977	4,750	3,067	12,794	P = L - O
SNWA Water Rights	Leased Upper Muddy River Water Rights	625	1,019	468	2,112	Q
	MVIC Rights	1,748	1,415	1,820	4,983	R
	Total Muddy River Water Rights Controlled by SNWA	**2,373**	**2,434**	**2,288**	**7,095**	S = Q + R
Flow Check	Difference Between total Flows to Lake Mead and SNWA Water Rights	2,604	2,314	778	5,699	T = P - S

Table 16 - Water Balance on Lower Muddy River as Defined in Exhibit A from the Forbearance Agreement Depicting the Volume of Tributary Conservation ICS Created by SNWA in CY 2008

Water Balance from Exhibit A of Forbearance Agreement with CY 2008 Data (afy)		
	Flows measured by USGS at the Glendale gage	23,196
-	consumptive uses by agriculture below the Glendale gage	4,521
-	direct uses by industry below the Glendale gage	1,811
-	channel evapotranspiration below Glendale gage to Lake Mead	3,038
-	evapotranspiration from the managed acreage on the Overton Wildlife Management Area (OWMA)	1,032
=	Total Flow to Lake Mead (Elevation 1,220 AMSL)	12,794
-	Total Muddy River Water Rights Controlled by SNWA	**7,095**
=	**Total Flows to Lake Mead are greater than SNWA Water Rights -------------->**	**YES**

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Appendix A

Muddy River Exhibit A from Forbearance Agreement

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Exhibit A
Southern Nevada Water Authority
Virgin and Muddy Rivers Tributary Conservation,
Intentionally Created Surplus (ICS) Project

Summary: Nevada state water rights that predate the Boulder Canyon Project Act (BCPA) on the Virgin River have a priority date of pre-1905 and were decreed by the Nevada Supreme Court in 1927. The decree allocated 17,785 acre-feet per year (afy) to the Bunkerville and Mesquite Irrigation Companies, which represents approximately 10% of the annual average flow in the Virgin River above the Irrigation Companies.[1] The Southern Nevada Water Authority (SNWA) currently owns shares in the Bunkerville Irrigation Company representing approximately 3,700 afy of surface water rights.

On the Muddy River, water rights were decreed in 1920 and that decree allocated the entire flow of the Muddy River. On the Lower Muddy River, the entire flow of the river is diverted by the Muddy Valley Irrigation Company (MVIC) for agricultural use. SNWA currently owns shares in the Muddy Valley Irrigation Company representing approximately 7,000 afy of surface water rights and leases approximately 2,000 afy from the LDS Church, which are not represented by MVIC shares. The LDS Church lease is for a term of 20 years, with the option to renew the lease for an additional 20 years.

SNWA anticipates acquiring a total of approximately 30,000 afy of pre-BCPA water rights from entities with rights on the Virgin and Muddy Rivers. Approximately one-third of this amount is expected to come from the Virgin River and two-thirds from the Muddy River. This is consistent with the flow volumes that were analyzed in the Final Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead and in the analysis for Lake Mead for the Lower Colorado River Multi-Species Conservation Program.

Retired agricultural water rights will be conveyed to Lake Mead's Overton Arm. The pre-BCPA water rights conveyed to Lake Mead represent the full right that is and has been historically used for agricultural purposes and could have otherwise been diverted from the Virgin or Muddy River and fully consumed by SNWA for municipal purposes.

Virgin and Muddy River rights conveyed to Lake Mead will either pass through their historic points of diversion, flow through the irrigation company ditches and return to the mainstream of the Virgin or Muddy River further downstream or will remain in the mainstream of the Virgin or Muddy River. The full right documented to flow to Lake Mead will be accounted for as Tributary Conservation ICS.

Virgin and Muddy River water rights that will be utilized to create Tributary Conservation pursuant to this Exhibit A of this Forbearance Agreement include both decreed Nevada state water rights that have been in continuous use since at least 1927 and decreed Nevada state water rights with an established history of use prior to 1927 but that have experienced periods of non-

[1] Annual average Virgin River flow for water years 1931 to 2006 at the U.S. Geological Survey (USGS) Virgin River at Littlefield, AZ gage, No. 09415000 was 176,000 afy.

use in the interim. Per this Exhibit A of this Forbearance Agreement, SNWA is specifically allowed to utilize any and all pre-BCPA Virgin and Muddy River water rights decreed by a Nevada State Court prior to 1928 to create Tributary Conservation ICS regardless of those water rights history of use after 1928.

Specific Water Rights: The sources of water that would create Tributary Conservation ICS credits covered by these two projects include:

i. Estimated 5,702 afy pursuant to 682 preferred shares in the Muddy Valley Irrigation Company[2]

ii. Estimated 1,460 afy pursuant to 1,921 common shares in the Muddy River Irrigation Company

iii. 2,001 afy pursuant to Certificate Nos. 6419, 25861, 26316, 26317 and 26318 (decreed Muddy River right not represented by MVIC shares).

iv. 3,710 afy pursuant to 350 shares of Bunkerville Irrigation Company stock[3]

v. Any other water rights represented by shares in the Bunkerville, Mesquite and Muddy Valley Irrigation Companies and other pre-1929 decreed rights to the Muddy and Virgin Rivers purchased or contractually acquired by SNWA.

Annual variations in the flow of the Muddy River from any cause will cause fluctuations in the quantity of water available per share in the Muddy Valley Irrigation Company and reduce or increase the quantity of Tributary Conservation ICS that is available.

Nevada State Approval: SNWA will acquire necessary approvals from the Nevada Division of Water Resources to allow the Nevada state water rights to be conveyed to Lake Mead to create Tributary Conservation ICS.

Plan for Creation and Verification of ICS: Pursuant to Sections 3.B. and 3.D. of the Interim Guidelines for the Operation of Lake Powell and Lake Mead, SNWA shall annually submit a plan to the Secretary of Interior. The annual plan will demonstrate the volume of water rights

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[2] Muddy River water rights were decreed in 1920 by the Tenth (now Eighth) Judicial District Court. Water rights on the lower Muddy River are divided into 2,432 preferred and 5,044 common shares of stock in the Muddy Valley Irrigation Company.

[3] Uses of surface water in Nevada prior to the water law of 1905 are considered vested rights, the quantification of which can only be judicially determined by a Nevada District Court in an adjudication proceeding. The Virgin River surface water uses prior to 1905 have been adjudicated by the Virgin River Decree pursuant to Proof No. 02038 filed by the Bunkerville Irrigation Company, and Proof No. 01968 filed by the Mesquite Irrigation Company. The Virgin River Decree was entered by the Tenth (now Eighth) Judicial District Court on May 14, 1927.

The Decree adjudicated water rights to Virgin River surface flow for irrigation of 1,963.08 acres for a total of 17,785.50 acre feet per year (AFY). The summer duty equals 1.0 cfs of flow for each 70 acres and the winter duty equals 1.0 cfs of flow for each 100 acres for a total duty of 9.06 afy per acre. The summer period is the months of March through September and the winter period is the months of October through February.

owned and/or contractually controlled by SNWA on the Virgin and Muddy Rivers, including any water rights in addition to those specified above that SNWA acquires subsequent to the execution of this Forbearance Agreement. The annual plan will also demonstrate how the Tributary Conservation ICS, as described in this Exhibit A will be created and accounted for to Lake Mead. Such verification plan will, at a minimum, include:

Muddy River

The 1920 Muddy River Decree allocated the entire flow of the Muddy River; therefore it is anticipated that accounting for Muddy River water at Lake Mead will require an annual accounting of the rights owned by SNWA based on actual USGS gage flows and a water budget of the flows on the Lower Muddy River as follows:

A. *Muddy River Rights Owned by SNWA:*

1. Upper Muddy River rights owned or contractually controlled by SNWA as quantified in the Muddy River Decree.

2. Shares of the Muddy Valley Irrigation Company owned or contractually controlled by SNWA. MVIC shares are quantified based on a percentage of the total flows (divided by total shares) in the Muddy River at the USGS Muddy River near Glendale, NV gage less the Upper Muddy River rights owned or controlled by SNWA that reach the gage.

3. Nos. 1 and 2 represent the water SNWA would release into the Lower Muddy River for the creation of ICS credits.

B. *Muddy River Flows reaching Lake Mead will be calculated as follows:*

Flows measured by USGS at Muddy River near Glendale, NV gage
- (minus) consumptive uses by agriculture below the Glendale gage
- (minus) direct uses by industry below the Glendale gage
- (minus) channel evapotranspiration below Glendale gage to Lake Mead
- (minus) evapotranspiration from the managed acreage on the Overton Wildlife Management Area (WMA)

= Total Flow to Lake Mead

C. If the total amount represented in A is equal to or greater than the amount calculated to reach Lake Mead in B, then SNWA shall be credited with the amount in B.

D. If the total amount in A is less than the amount in B, SNWA shall be credited with the amount in A.

E. Because the total volume of water SNWA currently owns and controls on the Muddy River represents a relatively small percentage of the total flow, conveyance losses of SNWA's current rights are negligible.

F. The total Muddy River flow reaching Lake Mead as calculated in B Above includes flows at the USGS Muddy River at Lewis Avenue at Overton, NV gage located just upstream of the Overton Wildlife Management Area and unmeasured underflow.

Virgin River

Because the Virgin River Decree allocated just 10% of the average annual flow in the Virgin River (17,785.50 afy) to irrigate 1,963.08 acres, Tributary Conservation ICS from the Virgin River can be calculated based on the reduction in agricultural acreage as follows:

Virgin River Calculation:

Decrease in total agricultural acreage decreed in the Bunkerville or Mesquite Irrigation Companies calculated using remote sensing and a Geographic Information System (as limited by the shares controlled by SNWA and the acreage it represents)
x the decreed duty per acre (9.06 acre-feet per acre)
= Flows to Lake Mead

Maximum ICS Created Under this Exhibit: Maximum amount of ICS that may be created by SNWA from these projects in one calendar year is limited to 50,000 acre-feet of Virgin and Muddy River water.

Use of SNWA 1989 Virgin River Rights: SNWA will not use Permit Nos. 54077 and 58591 (Nevada state permits for combined duty of 113,000 afy) in the future to support new development on the lands being fallowed near the Virgin River, excepting 5,000 acre-feet of such rights that SNWA is obligated to transfer to the Virgin Valley Water District and which SNWA cannot encumber.

In Witness of this Exhibit A to the Forbearance Agreement executed contemporaneously herewith, the Parties affix their official signatures below, acknowledging approval of this document on the 13th day of December, 2007.

Approved as to form:

By: [signature]
W. Patrick Schiffer
Chief Counsel

THE STATE OF ARIZONA acting through the ARIZONA DEPARTMENT OF WATER RESOURCES

By: [signature]
Herbert Guenther
Director

Attest:

By: ______________________
Edward W. Smith
General Manager

PALO VERDE IRRIGATION DISTRICT

By: ______________________
Charles VanDyke
Chair

Attest and Approved:

By: ______________________
John Penn Carter
Legal Counsel

IMPERIAL IRRIGATION DISTRICT

By: ______________________
Stella Altamirano-Mendoza
President

Approved as to form:

By: ______________________
Robert Hargreaves
City Attorney

THE CITY OF NEEDLES

By: ______________________
Jeff Williams
Mayor

Approved as to form:

By: ______________________
Steven B. Abbott
Legal Counsel

COACHELLA VALLEY WATER DISTRICT

By: ______________________
Steven B. Robbins
General Manager/Chief Engineer

Approved as to form:

By: ______________________
Karen L. Tachiki
General Counsel

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

By: ______________________
Jeffrey Kightlinger
General Manager

Approved as to form:

By: ______________________
John J. Entsminger
Deputy General Counsel

SOUTHERN NEVADA WATER AUTHORITY

By: ______________________
Patricia Mulroy
General Manager

Approved as to form:

By: ______________________
Jennifer T. Crandell
Deputy Attorney General

COLORADO RIVER COMMISSION OF NEVADA

By: ______________________
George M. Caan
Executive Director

Appendix B

Plan of Creation
Submitted to the Bureau of Reclamation and
Letter of Acceptance

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SE ROA 43921

SOUTHERN NEVADA WATER AUTHORITY
1001 South Valley View Boulevard • Las Vegas, NV 89153
(702) 258-3939 • snwa.com

September 10, 2008

Ms. Lorri Gray, Regional Director
Bureau of Reclamation
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, Nevada 89006

Dear Ms. Gray:

SUBJECT: SOUTHERN NEVADA WATER AUTHORITY PLANS OF CREATION FOR MUDDY AND VIRGIN RIVER TRIBUTARY CONSERVATION INTENTIONALLY CREATED SURPLUS, CALENDAR YEARS 2008 AND 2009

Enclosed are the Southern Nevada Water Authority's (Authority) 2008 and 2009 Intentionally Created Surplus (ICS) Tributary Conservation Plans of Creation (Plans) for the Muddy and Virgin Rivers in Nevada. Our Plans describe how we intend to meet all the requirements as outlined in Section 3 of the *Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead* (Guidelines).

As you know, the Guidelines require a Contractor to enter into a Delivery Agreement with the United States of America (United States) and a Forbearance Agreement with Lower Colorado River Basin (Lower Basin) Contract holders to create and take Tributary Conservation ICS. The Authority and Colorado River Commission entered into a Delivery Agreement with the United States and a Forbearance Agreement with Lower Basin Contract holders on December 13, 2007. Exhibit A of the Forbearance Agreement describes the surface water rights on the Muddy and Virgin Rivers, pre-dating June 25, 1929, which the Authority plans to use to create Tributary Conservation ICS, and describes how the flows reaching Lake Mead will be calculated.

The attached Plans are consistent with the Guidelines, Forbearance Agreement, and Delivery Agreement. The Authority anticipates creating Tributary Conservation ICS during calendar years 2008 and 2009 in the volumes indicated below:

Calendar Year	**Potential Volume, in acre-feet/year** Cited in Plans of Creation		
	Virgin	Muddy	Total
2008	5,000	11,000	16,000
2009	14,000	16,000	30,000

If you have any questions, please contact William Rinne at 702-691-5255.

Sincerely,

Kay Brothers
Deputy General Manager
Engineering and Operations

KB:WR:JJ:cc
Enclosures

cc: William E. Rinne, Director, Surface Water Resources, SNWA
George Caan, Director Colorado River Commission of Nevada

SE ROA 43923

Muddy River Intentionally Created Surplus (ICS) Tributary Conservation Plan of Creation Calendar Year 2008 and 2009

Introduction

The Secretary of Interior (Secretary) issued a Record of Decision for *Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead* (Guidelines) on December 13, 2007, which established criteria for the development and delivery of Intentionally Created Surplus (ICS). One type of ICS is Tributary Conservation, which allows a Contractor[1] to increase tributary flows into the Mainstream of the Colorado River within its state for ICS credits. The conservation of tributary flows into the Mainstream of the Colorado River is limited to water rights that have been used for a significant period of years and were perfected prior to June 25, 1929, the effective date of the Boulder Canyon Project Act.

To generate ICS, the Guidelines require a Contract holder to enter into a Delivery Agreement with the United States of America and a Forbearance Agreement with Lower Basin Contract holders. Southern Nevada Water Authority (SNWA) and Colorado River Commission of Nevada (CRC) entered into a Forbearance Agreement with Lower Basin Contract holders on December 13, 2007. Exhibit A of the Forbearance Agreement describes the surface water rights on the Muddy and Virgin Rivers, pre-dating June 25, 1929, which SNWA plans to use to create Tributary Conservation ICS, and how the Muddy River flows reaching Lake Mead will be calculated.

SNWA and CRC entered into a Delivery Agreement with the United States of America on December 13, 2007. Exhibit A from the Forbearance Agreement is attached to the Delivery Agreement.

The Guidelines, Forbearance Agreement, and Delivery Agreement require a plan for the creation of ICS (ICS Plan) be submitted to the Secretary of Interior demonstrating how all requirements of the Guidelines will be met. Section G.3.B.1 of the Guidelines outline that an ICS plan will consist of at a minimum the following information:

a. Project Description including what extraordinary measures will be taken to conserve or import the water

b. Term of Activity

[1] "Contractor" in the Guidelines "shall mean an entity holding an entitlement to Mainstream water under (a) the Consolidated Decree, (b) a water delivery contract with the United States through the Secretary, or (c) a reservation of water by the Secretary, whether the entitlement is obtained under (a), (b) or (c) before or after the adoption of the Guidelines.

c. Estimate of the amount of water that will be conserved

d. Proposed methodology for verification of the amount of water conserved

e. Documentation regarding any state or federal permits or other regulatory approvals that have already been obtained by the Contractor or that need to be obtained prior to the creation of ICS

The following sections document each of these requirements. It is important to note that the majority of the information presented below is reiterated from Exhibit A of the Forbearance Agreement and Delivery Agreement.

Project Description

Muddy River water rights that will be utilized to create Tributary Conservation pursuant to this ICS Plan and Exhibit A of the Forbearance Agreement are decreed Nevada state water rights with an established history of use prior to 1927, but that have experienced periods of non-use in the interim. Per Exhibit A of the Forbearance Agreement, SNWA is specifically allowed to utilize any and all pre-June 25, 1929, Muddy River water rights to create Tributary Conservation ICS regardless of those water rights history of use after 1928.

The Muddy River originates from regional springs in the Muddy Springs Area in Nevada and flows into the Overton Arm of Lake Mead (Figure 1). Muddy River flows are relatively constant because the springs that form the river discharge water from the regional carbonate aquifer system of eastern Nevada. The average annual flow of the Muddy River at U.S. Geological Survey (USGS) gaging station 09419000 *Muddy River near Glendale, NV* for water years 1950 to 2007 was 30,760 acre-feet per year (afy).

On the Muddy River, water rights were decreed in 1920 and the decree allocated the entire flow of the Muddy River. On the Lower Muddy River, the entire flow of the river is diverted by the Muddy Valley Irrigation Company (MVIC) for agricultural use. SNWA currently owns shares in the Muddy Valley Irrigation Company representing approximately 7,000 afy of surface water rights and leases approximately 2,000 afy from the LDS Church, which are not represented by MVIC shares. The LDS Church lease is for a term of 20 years, with the option to renew the lease for an additional 20 years.

Retired agricultural water rights acquired by SNWA will be conveyed to Lake Mead along Lake Mead's Overton Arm. The pre-June 25, 1929, water rights conveyed to Lake Mead represent the full right that is and has been historically used for agricultural or could have otherwise been diverted from the Muddy River and fully consumed by SNWA within Nevada.

Muddy River rights conveyed to Lake Mead will pass through their historic points of diversion and either flow through the irrigation company ditches and return to the mainstream of the Muddy River further downstream or will remain in the mainstream of the Muddy River. The full right documented to flow to Lake Mead will be accounted for as Tributary Conservation ICS.

Term of Activity

The term of activity for this plan is calendar years 2008 and 2009. SNWA anticipates receiving ICS Tributary Conservation credit for Muddy River water into the foreseeable future. As more water rights are acquired and more land is fallowed, the amount of water claimed as ICS Tributary Conservation is anticipated to increase. Subsequent plans will be updated to reflect the acquired pre-June 25, 1929, water rights.

Estimate of Water Conserved

SNWA currently owns or controls the following Muddy River water rights:

1. *MVIC Shares*. The volume of water represented by MVIC shares is quantified based on a percentage of the total flows (divided by total shares) in the Muddy River at the USGS gage *Muddy River near Glendale, NV* (Glendale gage) less the Upper Muddy River rights owned or controlled by SNWA that reach the gage (Figure 2).

    a. Owned MVIC shares[2]

        i. 682 preferred shares in the MVIC estimated to represent up to 5,700 afy

        ii. 1,921 common shares in the MVIC estimated to represent up to 1,460 afy

        iii. Additional MVIC shares are actively being purchased by SNWA through an open "request for offers." As shares are acquired, the water rights represented by the shares will be included in the year-end Certification Report.

    b. Leased MVIC shares[3]

        i. Approximately 400 preferred shares in the MVIC. In 2008, a portion of the water represented by these shares will be available for the creation of Tributary Conservation ICS, since the effective

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[2] Muddy River water rights were decreed in 1920 by the Tenth (now Eighth) Judicial District Court. Water rights on the lower Muddy River are divided into 2,432 preferred and 5,044 common shares of stock in the Muddy Valley Irrigation Company.

[3] SNWA has entered into lease agreements with individual share holders for terms ranging between 1 and 10 years.

date of the leased shares is October 1, 2008. These shares are estimated to represent about 4,000 acre-feet (af) in 2009.

ii. Approximately 1,200 common shares in the MVIC. In 2008, a portion of the water represented by these shares will be available for the creation of Tributary Conservation ICS, since the effective date of the leased shares is October 1, 2008. These shares are estimated to represent about 800 af in 2009.

2. Up to 2,001 afy pursuant to Certificate Nos. 6795, 10944, 10951, 10952, and 10953 (decreed Muddy River rights not represented by MVIC shares) in 2008 and 2009 (Figure 3).

3. Up to 1,367 afy pursuant to the Muddy River decree (not represented by MVIC shares, commonly referred to as the Hidden Valley rights) (Figure 4). These rights are in the process of being acquired by SNWA. A portion of the rights would be available in calendar year 2008, and the full right is anticipated to be available in 2009 for the creation of Tributary Conservation ICS.

For calendar year 2008, SNWA may create up to 11,000 acre-feet of Tributary Conservation ICS from these pre-June 25, 1929, water rights.

For calendar year 2009, SNWA anticipates creating up to 16,000 acre-feet of Tributary Conservation ICS from these pre-June 25, 1929, water rights.

Methodology

Muddy River Flows reaching Lake Mead will be calculated as follows:

Flows measured by USGS at the Glendale gage
- (minus) consumptive uses by agriculture below the Glendale gage
- (minus) direct uses by industry below the Glendale gage
- (minus) channel evapotranspiration below Glendale gage to Lake Mead
- (minus) evapotranspiration from the managed acreage on the Overton Wildlife Management Area (WMA)

= Total Flow to Lake Mead (Elevation 1,220 AMSL)

- To calculate the consumptive uses of crops and phreatophytes in the lower Muddy River, data from the Lower Colorado River Accounting Study (LCRAS) and other areas with similar climatic conditions and elevation as the Muddy River will be used. Specifically, the 12-year average LCRAS consumptive use value from the Fort Mohave Indian Reservation from 1995 to 2006 will be used along with a potential adjustment to use-rates based on the elevation and climate conditions of the Muddy River.

- If the total amount of water represented by the rights controlled by SNWA described in this plan of creation and documented in the Certification Report (described below) is found to be equal to or less than the amount of water calculated to reach Lake Mead, then SNWA shall be credited with the full amount of water rights described in the plan of creation.

- If the total amount of water rights described in this Plan of Creation and documented in the Certification Report is more than the amount calculated to reach Lake Mead, SNWA shall be credited with only the amount calculated to reach Lake Mead.

- The total Muddy River flow reaching Lake Mead as calculated above includes flows at the USGS gage *Muddy River at Lewis Avenue at Overton, NV* located just upstream of the Overton Wildlife Management Area and unmeasured underflow.

A. Proof of Fallowed Land:

To demonstrate the fallowing of land and the conservation of water, quarterly aerial photography will be flown, ground-truthed and analyzed during the calendar year. A Geographic Information System (GIS) will be used to compare the current irrigated acreage with acreage defined by the water rights as approved by the Nevada Division of Water Resources and the Muddy River decree.

B. Certification Report

i. In compliance with Section G.3.D of the Guidelines, a Certification Report will be submitted for the Secretary's review and verification demonstrating the amount of ICS created and that the method of creation was consistent with this plan of creation, the Forbearance Agreement, and Delivery Agreement. The Certification Report will be submitted to the Secretary in the year following the creation of the ICS.

ii. The Certification report at a minimum will include:

- Proof of acreage fallowed using aerial photography and GIS
- Gage reports showing inflows and measured returns
- Calculations of the amount of pre-June 25, 1929, water rights reaching Lake Mead
- Documentation and calculations of the amount of pre-June 25, 1929, water rights reaching Lake Mead owned or controlled by SNWA
- Letter from the Nevada Division of Water Resources verifying the quantity of water conveyed through the Muddy River system to the Colorado River mainstream for the purpose of creating ICS

Regulatory Approvals

Tributary Conservation ICS on the Muddy River was evaluated in the Environmental Impact Statement and Record of Decision (dated December 13, 2007) for the Guidelines. Similarly, compliance for Muddy River Tributary Conservation ICS was also obtained under section 7 of the Endangered Species Act through formal consultation with the U.S. Fish and Wildlife Service. The Final Biological Opinion for the Guidelines was issued December 12, 2007.

The Nevada Division of Water Resources issued State Engineer Order 1194 on July 15, 2008, regarding Tributary Conservation ICS on the Muddy River (attached). The Order outlines the Nevada water rights on the Muddy River and the following process for verification of Muddy River rights being conveyed to the Colorado River mainstream:

> Nevada State Engineer Order 1194 states… "An entity with an ICS Delivery Contract, which uses water rights adjudicated under the Muddy River Decree for the creation of ICS, shall file an annual report with the State Engineer's Office. The annual report shall give a full accounting of adjudicated water rights on the Muddy River or its tributaries owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Muddy River system to the Colorado River mainstream for the creation of ICS. After review of the annual report, the State Engineer shall issue a letter verifying the quantity of water conveyed through the Muddy River system to the Colorado River mainstream for the purpose of creating ICS."

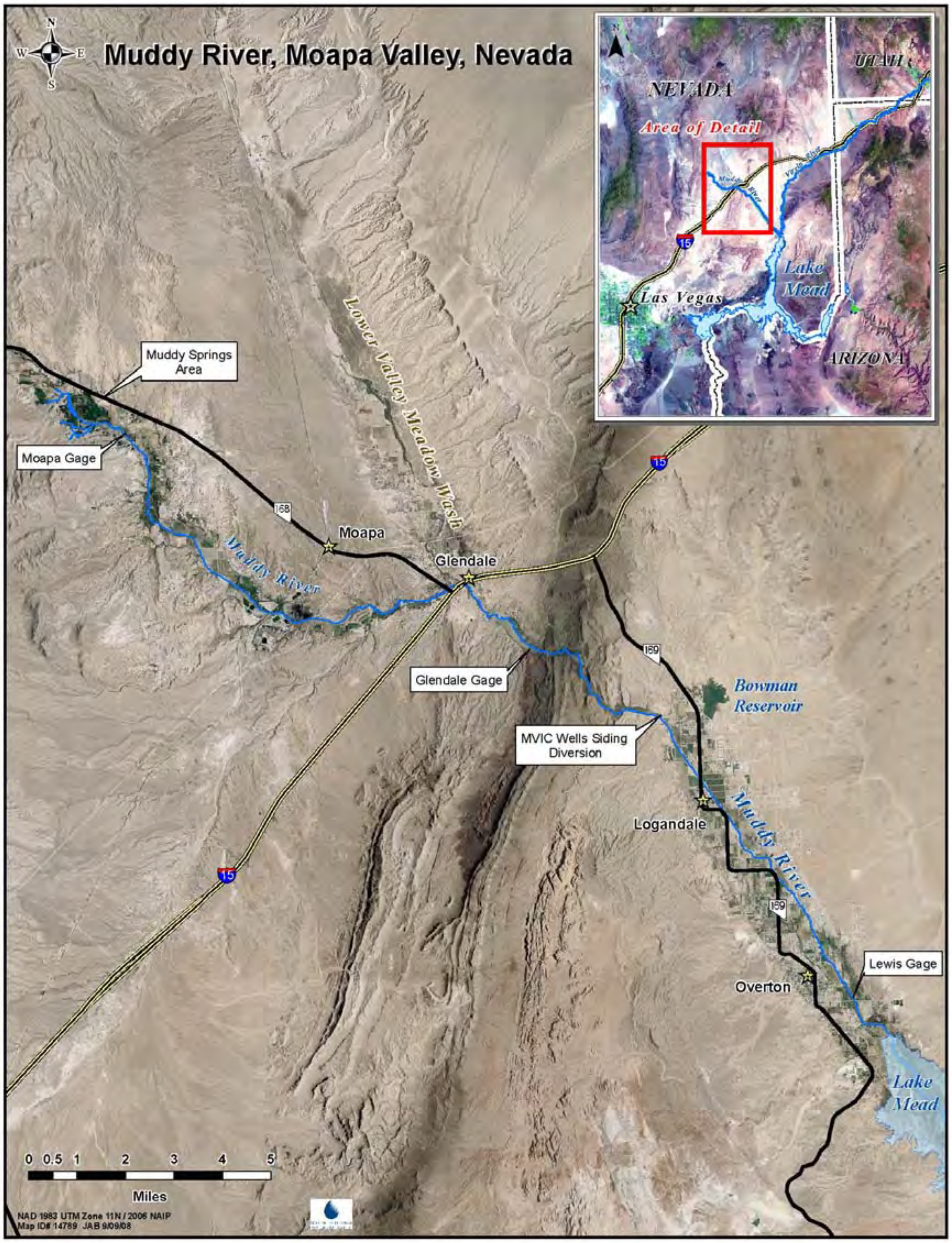

Figure 1. Muddy River.

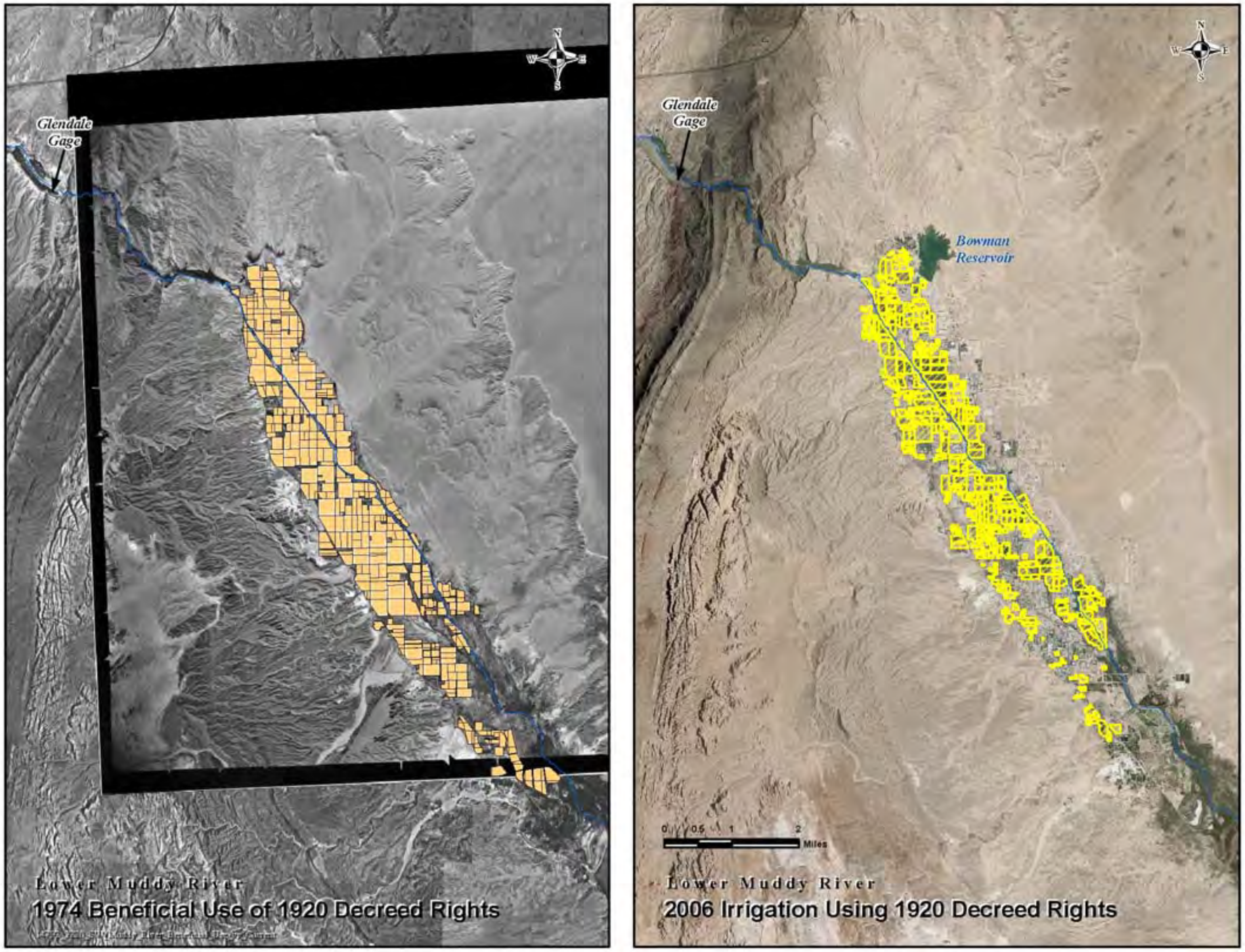

Figure 2. Muddy Valley Irrigation Company.

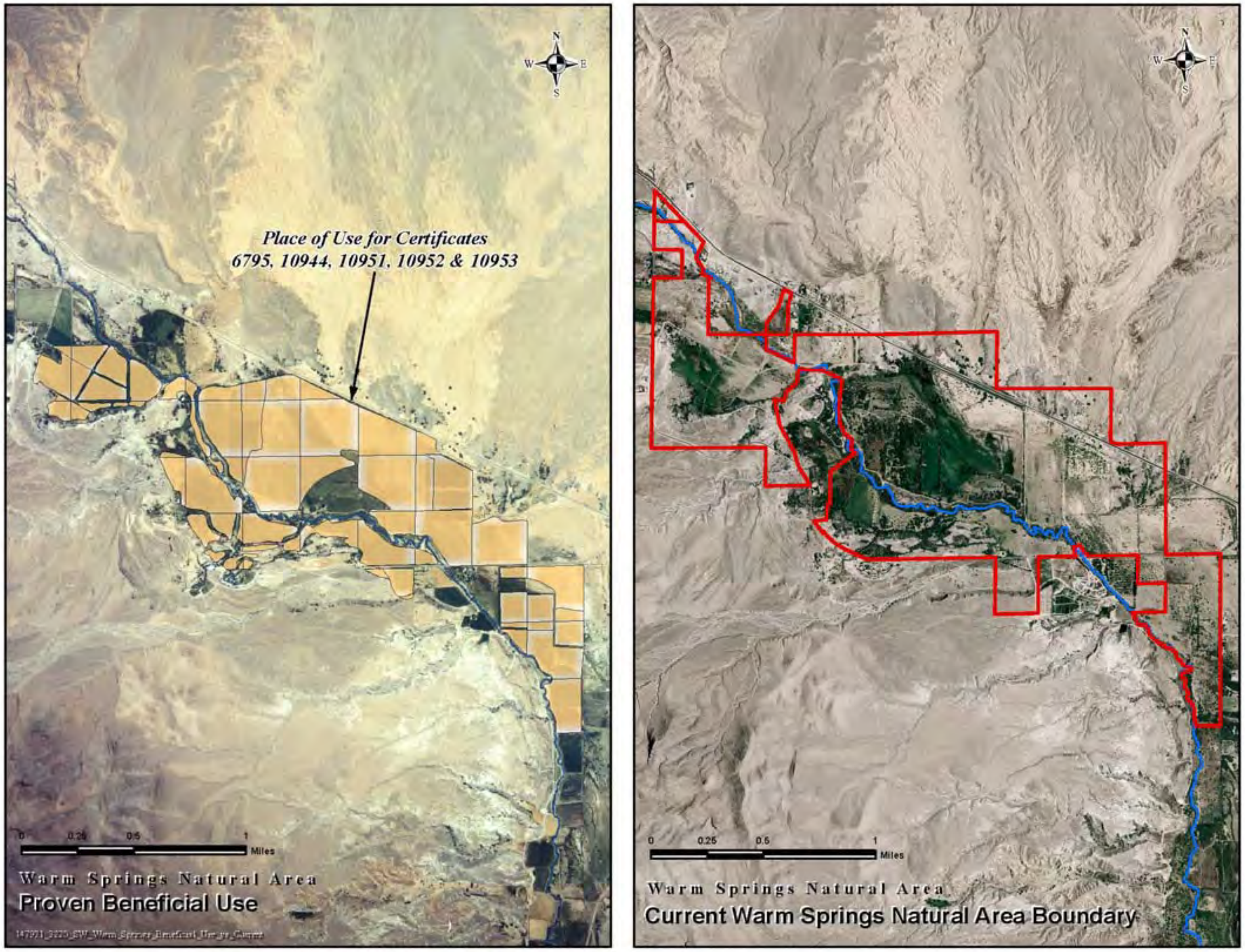

Figure 3. Warm Springs Natural Area.

Figure 4. Hidden Valley, Decreed Muddy River rights Place of Use

IN THE OFFICE OF THE STATE ENGINEER

OF THE STATE OF NEVADA

1194

ORDER

REGARDING TRIBUTARY CONSERVATION INTENTIONALLY CREATED SURPLUS FOR THE MUDDY RIVER

WHEREAS, the Nevada State Engineer is designated by the Nevada Legislature to perform duties related to the management and appropriation of the water resources belonging to the people of the State of Nevada;[1]

WHEREAS, pursuant to Nevada Revised Statute (NRS) chapter 533 the Nevada State Engineer acts as an officer of the court for administration and distribution of water from a stream system that has been adjudicated by a district court decree;

WHEREAS, the Muddy River Decree was entered on March 12, 1920, by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada;

WHEREAS, individuals named under the Muddy River Decree or their successors own water rights on the upper Muddy River;

WHEREAS, under the Muddy River Decree, the Muddy Valley Irrigation Company (MVIC) owns water rights on the lower Muddy River and said water is distributed by MVIC to the individual shareholders of MVIC;

WHEREAS, pursuant to NRS 533.060 rights to the use of surface water cannot be lost through forfeiture;

WHEREAS, pursuant to NRS 533.060 a surface water right that is appurtenant to land formerly used primarily for agricultural purposes is not subject to abandonment if the land has been converted to urban use or the water right has been acquired by a water purveyor for municipal use;

WHEREAS, pursuant to NRS 538.171 any appropriation or use of waters of the Colorado River by the Colorado River Commission of Nevada or an entity with whom the Colorado River Commission of Nevada has contracted is not subject to regulation by the State Engineer;

[1] *See* Nevada Revised Statutes chapters 532, 533, 534, 535, and 536.

WHEREAS, the Attorney General of the State of Nevada determined in Attorney General Opinion Number 88-16 that a permit from the State Engineer is not required for appropriation and use of Colorado River water for entities that have water delivery contracts with the Secretary of the Interior (Secretary), nor is a permit from the State Engineer necessary for use of such water merely to provide the State Engineer with information regarding such use if information is timely supplied upon request;

WHEREAS, pursuant to Section 2 of Chapter 393 of the Statutes of Nevada 1995, the powers, duties, rights and obligations of the State of Nevada and the Colorado River Commission of Nevada relating to contracts for delivery of Colorado River water were assumed by the Southern Nevada Water Authority;

WHEREAS, the Boulder Canyon Project Act (BCPA), 43 U.S.C. § 617, became effective on June 25, 1929;

WHEREAS, the Secretary has a broad and unique legal role in managing the lower Colorado River system in accordance with federal law, including the Boulder Canyon Project Act of 1928, the 1963 decision of the U.S. Supreme court in *Arizona v. California*, the 2006 Consolidated Decree of the U.S. Supreme Court in *Arizona v. California*, the Colorado River Basin Project Act of 1968, and other applicable provisions of federal law. Within this legal framework, the Secretary makes annual determinations regarding the availability of water to be delivered to Colorado River contract holders from Lake Mead;

WHEREAS, on December 13, 2007, the Secretary adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Guidelines). The Guidelines provide for the creation and delivery of Tributary Conservation Intentionally Created Surplus and Developed Shortage Supply (for convenience, both referred to hereinafter as ICS) to entities with a contract or entitlement to Colorado River water with the Bureau of Reclamation provided said entities have also entered into a delivery agreement with the Bureau of Reclamation for delivery of ICS (ICS Delivery Contract);

WHEREAS, pursuant to Sections 3 and 4 of the Guidelines, the holder of a valid ICS Delivery Contract who purchases documented water rights on a tributary of the Colorado River, perfected prior to June 25, 1929, (the effective date of the BCPA) may convey said water to the Colorado River mainstream so that said water may be diverted from the Colorado River mainstream by the ICS Delivery Contract holder as Tributary Conservation ICS;

WHEREAS, the Guidelines and the consolidated decree in *Arizona v. California*, 547 U.S. 150 (2006), define the Colorado River mainstream to include the reservoirs located on the Colorado River downstream from Lee Ferry within the United States; and

WHEREAS, Lake Mead is located on the Colorado River mainstream downstream from Lee Ferry and full pool elevation of Lake Mead is 1,220 feet above mean sea level.

NOW THEREFORE, the State Engineer finds that:

1. The Order of Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries was certified on January 21, 1920.
2. The Judgment and Decree in the Matter of the Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries (Muddy River Decree) was entered on March 12, 1920 by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada.
3. All water rights adjudicated in the Muddy River Decree were acquired by valid appropriation prior to March 1, 1905, and were determined to be in good standing and in use prior to March 1, 1905 as affirmed by the Muddy River Decree.
4. The Muddy River Decree adjudicated the entire flow of the Muddy River and its tributaries, and that there is insufficient flow in the Muddy River to grant any new appropriations.
5. As of the date of this Order there has been no declaration or finding of forfeiture or abandonment regarding any water rights adjudicated under the Muddy River Decree.
6. As of the date of this Order, no proceedings for forfeiture or abandonment have been initiated regarding any water rights adjudicated under the Muddy River Decree.
7. In accordance with NRS 538.171 and Attorney General Opinion 88-16 a permit is not required for the creation or use of Tributary Conservation ICS when an ICS Delivery Contract exists with the Secretary.
8. The creation of ICS as defined in the current Guidelines promulgated by the Secretary and as those Guidelines may hereinafter be amended, is beneficial to the state of Nevada.

NOW THEREFORE, the State Engineer orders:

1. The Muddy River and its tributaries are closed to new appropriations.
2. An entity with an ICS Delivery Contract, which uses water rights adjudicated under the Muddy River Decree for the creation of ICS, shall file an annual report with the State Engineer's Office. The annual report shall give a full accounting of adjudicated water rights on the Muddy River or its tributaries owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Muddy River system to the Colorado River mainstream for the creation of ICS. After review of the annual report, the State Engineer shall issue a letter verifying the quantity of water conveyed through the Muddy River system to the Colorado River mainstream for the purpose of creating ICS.

TRACY TAYLOR, P.E.
State Engineer

Dated at Carson City, Nevada
this 15 day of July, 2008.

Virgin River Intentionally Created Surplus (ICS) Tributary Conservation Plan of Creation Calendar Year 2008 and 2009

Introduction

The Secretary of Interior (Secretary) issued a Record of Decision for *Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead* (Guidelines) on December 13, 2007, which established criteria for the development and delivery of Intentionally Created Surplus (ICS). One type of ICS is Tributary Conservation, which allows a Contractor[1] to increase tributary flows into the Mainstem of the Colorado River within its state for ICS credits. The conservation of tributary flows into the Mainstream of the Colorado River is limited to water rights that have been used for a significant period of years and were perfected prior to June 25, 1929, the effective date of the Boulder Canyon Project Act.

To generate ICS, the Guidelines require a Contract holder to enter into a Delivery Agreement with the United States of America and a Forbearance Agreement with Lower Basin Contract holders. Southern Nevada Water Authority (SNWA) and Colorado River Commission of Nevada (CRC) entered into a Forbearance Agreement with Lower Basin Contract holders on December 13, 2007. Exhibit A of the Forbearance Agreement describes the surface water rights on the Muddy and Virgin Rivers, pre-dating June 25, 1929, which SNWA plans to use to create Tributary Conservation ICS, and how the Virgin River flows reaching Lake Mead will be calculated.

SNWA and CRC entered into a Delivery Agreement with the United States of America on December 13, 2007. Exhibit A from the Forbearance Agreement is attached to the Delivery Agreement.

The Guidelines, Forbearance Agreement, and Delivery Agreement require a plan for the creation of ICS (ICS Plan) be submitted to the Secretary of Interior demonstrating how all requirements of the Guidelines will be met. Section G.3.B.1 of the Guidelines outline that an ICS plan will consist of at a minimum the following information:

a. Project Description including what extraordinary measures will be taken to conserve or import the water

b. Term of Activity

c. Estimate of the amount of water that will be conserved

[1] "Contractor" in the Guidelines "shall mean an entity holding an entitlement to Mainstream water under (a) the Consolidated Decree, (b) a water delivery contract with the United States through the Secretary, or (c) a reservation of water by the Secretary, whether the entitlement is obtained under (a), (b) or (c) before or after the adoption of the Guidelines.

d. Proposed methodology for verification of the amount of water conserved

e. Documentation regarding any state or federal permits or other regulatory approvals that have already been obtained by the Contractor or that need to be obtained prior to the creation of ICS.

The following sections document each of these requirements. It is important to note that the majority of the information presented below is reiterated from Exhibit A of the Forbearance Agreement and Delivery Agreement.

Project Description

Virgin River water rights that will be utilized to create Tributary Conservation pursuant to this ICS Plan and Exhibit A of the Forbearance Agreement are decreed and permitted Nevada state water rights with an established history of use prior to 1927, but that have experienced periods of non-use in the interim. Per Exhibit A of the Forbearance Agreement, SNWA is specifically allowed to utilize any and all pre-June 25, 1929, Virgin River water rights to create Tributary Conservation ICS regardless of those water rights history of use after 1928.

The Virgin River begins in southwestern Utah, flows through Arizona and Nevada, and terminates in Lake Mead (Figure 1). The average annual flow of the Virgin River at USGS gaging station *09415000 Virgin River at Littlefield, AZ* for water years 1931 to 2007 was 175,200 acre-feet per year (afy).

Nevada state water rights that predate the Boulder Canyon Project Act (BCPA) on the Virgin River are comprised of pre-1905 priority surface water rights decreed by the Nevada Supreme Court in 1927 for 17,785 afy to the Bunkerville and Mesquite Irrigation Companies, and additional permitted and certificated rights authorized by the Nevada Division of Water Resources.

Retired agricultural water rights acquired by SNWA will be conveyed to Lake Mead along Lake Mead's Overton Arm. The pre-June 25, 1929, water rights conveyed to Lake Mead represent the full right that is and has been historically used for agricultural or could have otherwise been diverted from the Virgin River and fully consumed by the SNWA in Nevada.

Virgin River rights conveyed to Lake Mead will pass through their historic points of diversion and either flow through the irrigation company ditches and return to the mainstream of the Virgin River further downstream or will remain in the mainstream of the Virgin River. The full right documented to flow to Lake Mead will be accounted for as Tributary Conservation ICS.

Term of Activity

The term of activity for this plan is calendar years 2008 and 2009. SNWA anticipates receiving ICS Tributary Conservation credit for Virgin River water into the foreseeable future. As more water rights are acquired and more land is fallowed, the amount of water claimed as ICS Tributary Conservation is anticipated to increase. Subsequent plans will be updated to reflect the acquired pre-June 25, 1929, water rights.

Estimate of Water Conserved

SNWA currently owns or controls the following Virgin River rights:

- A portion of Certificate 1153 with a priority date of 1914 for 601.97 afy designated to irrigate a portion of 177.044 acres of land (Figure 2). A portion of this water will be available in calendar year 2008, and in 2009 the full right will be available for creation of Tributary Conservation ICS.

- Bunkerville Irrigation Company: 946 shares representing up to approximately 11,300 afy of surface water rights. In 2008, a portion of the water represented by these shares will be available for the creation of Tributary Conservation ICS, since the effective date of the leased shares is October 1, 2008. In 2009 the full rights will be available for creation of ICS.

- Mesquite Irrigation Company: 694.75 shares representing up to 7,300 afy of surface water rights. In 2008, a portion of the water represented by these shares will be available for the creation of Tributary Conservation ICS, since the effective date of the leased shares is October 1, 2008. In 2009, the full rights will be available for creation of ICS.

- Additional Bunkerville and Mesquite Irrigation Company rights are actively being purchased by SNWA through an open “request for offers.” As shares are acquired, the water rights represented by the shares will be included in the year-end Certification Report.

For calendar year 2008, SNWA anticipates creating up to 5,000 acre-feet (af) of Tributary Conservation ICS with the above rights which pre-date June 25, 1929.

For calendar year 2009, SNWA anticipates creating up to 14,000 af of Tributary Conservation ICS with the above rights which pre-date June 25, 1929.

Methodology

Because the acreage represented by the water rights SNWA owns are such a small percentage (< 15%) of the total annual flow of the Virgin River, Tributary Conservation ICS on the Virgin River can be calculated based on the reduction in agricultural acreage as follows:

Virgin River Calculation:

Decrease in total agricultural acreage permitted by the Nevada Division of Water Resources calculated using remote sensing & GIS
x The duty per acre specified by the water right

= Flows to Lake Mead (Elevation 1,220 AMSL)

A. Proof of Fallowed Land

To demonstrate the fallowing of land and the conservation of water, quarterly aerial photography will be flown, ground-truthed and analyzed during the calendar year. A Geographic Information System (GIS) will be used to compare the current irrigated acreage with acreage defined by the water rights as approved by the Nevada Division of Water Resources.

B. Certification Report

i. In compliance with Section G.3.D of the Guidelines, a Certification Report will be submitted for the Secretary's review and verification demonstrating the amount of ICS created and that the method of creation was consistent with this plan of creation, the Forbearance Agreement, and Delivery Agreement. The Certification Report will be submitted to the Secretary in the year following the creation of the ICS.

ii. The Certification report at a minimum will include:

- Proof of acreage fallowed using aerial photography and GIS
- Gage reports showing Virgin River flows and diversion
- Calculations of the amount of pre-June 25, 1929, water rights reaching Lake Mead
- Documentation and calculations of the amount of the pre-June 25, 1929, water rights reaching Lake Mead owned or controlled by SNWA
- Letter from the Nevada Division of Water Resources verifying the quantity of water conveyed through the Virgin River to the Colorado River mainstream for the purpose of creating ICS

Regulatory Approvals

Tributary Conservation ICS on the Virgin River was evaluated in the Environmental Impact Statement and Record of Decision (dated December 13, 2007) for the Guidelines. Similarly, compliance for Virgin River Tributary Conservation ICS was also obtained under section 7 of the Endangered Species Act through formal consultation with the U.S. Fish and Wildlife Service. The Final Biological Opinion for the Guidelines was issued December 12, 2007.

The Nevada Division of Water Resources issued State Engineer Order 1193 on July 15, 2008, regarding Tributary Conservation ICS on the Virgin River (attached). The Order outlines the Nevada water rights on the Virgin River and the following process for verification of Virgin River rights being conveyed to the Colorado River mainstream:

> Nevada State Engineer Order 1193 states… "An entity with an ICS Delivery Contract, which uses water rights adjudicated under the Virgin River Decree or water rights on the Virgin River issued by the State Engineer with a priority date prior to June 25, 1929 for the creation of ICS, shall file an annual report with the State Engineer's Office. The annual report shall give a full accounting of water rights on the Virgin River owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Virgin River system to the Colorado River mainstream for the creation of ICS. After review of the annual report, the State Engineer shall issue a letter verifying the quantity of water conveyed through the Virgin River system to the Colorado River mainstream for the purpose of creating ICS."

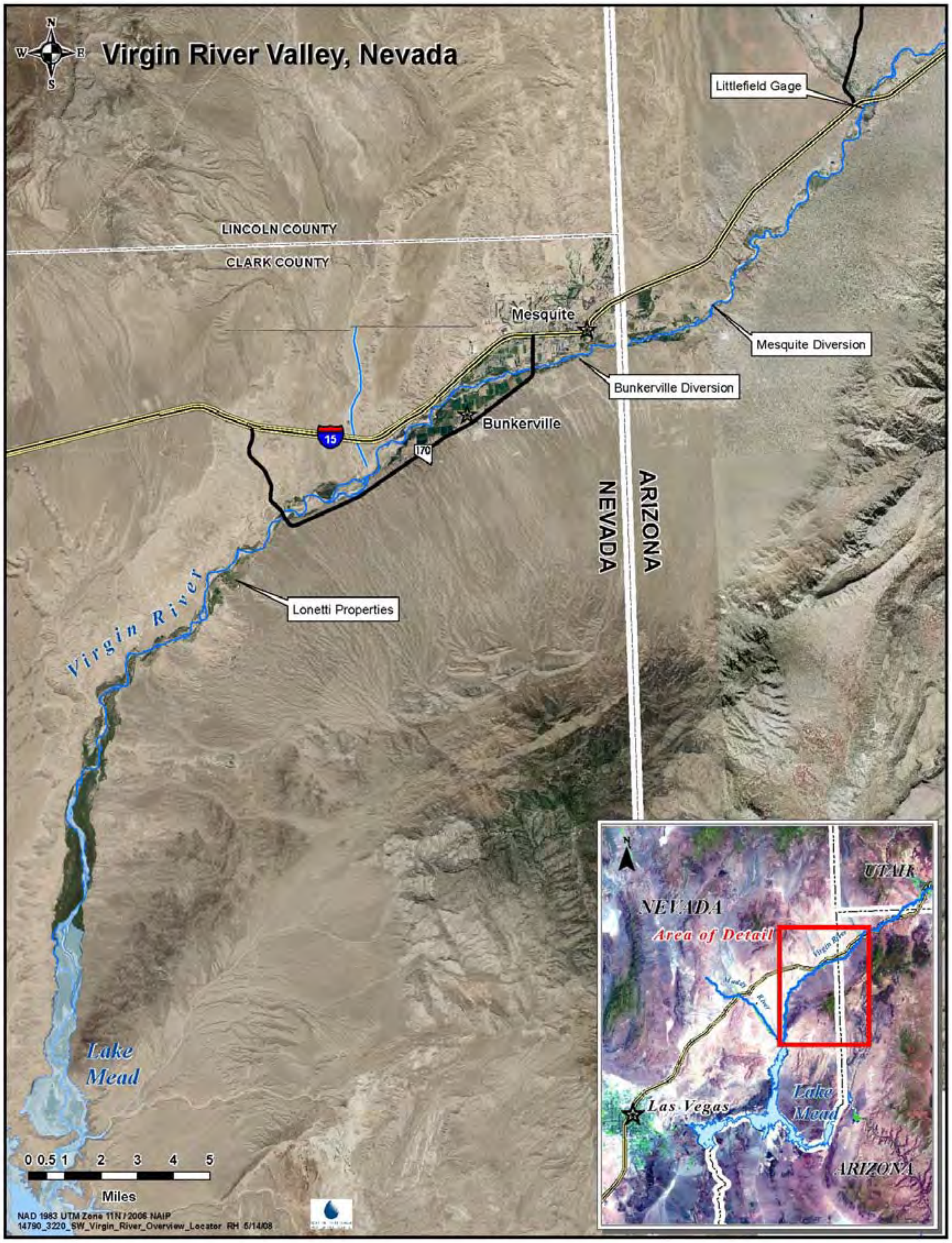

Figure 1 – Lower Virgin River

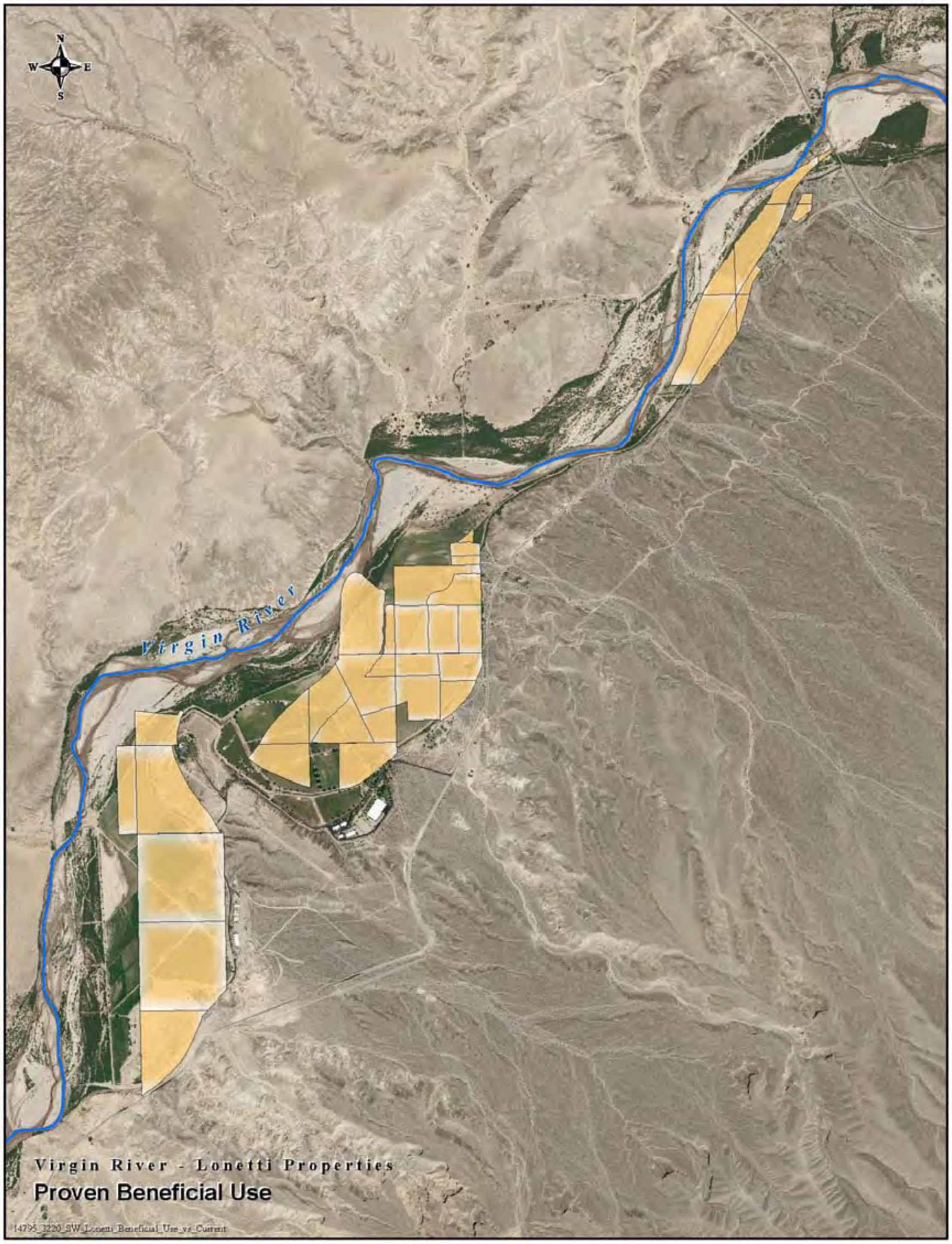

Figure 2 – Lonetti Properties Water Rights Place of Use Comparison, Certificates 1153

SE ROA 43945

IN THE OFFICE OF THE STATE ENGINEER

OF THE STATE OF NEVADA

1193

ORDER

REGARDING TRIBUTARY CONSERVATION INTENTIONALLY CREATED SURPLUS FOR THE VIRGIN RIVER

WHEREAS, the Nevada State Engineer is designated by the Nevada Legislature to perform duties related to the management and appropriation of the water resources belonging to the people of the State of Nevada;[1]

WHEREAS, pursuant to Nevada Revised Statute (NRS) chapter 533, the Nevada State Engineer acts as an officer of the court for administration and distribution of water from a stream system that has been adjudicated by a district court decree;

WHEREAS, the Virgin River Decree was entered on May 14, 1927, by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada;

WHEREAS, under the Virgin River Decree, the Bunkerville Irrigation Company (BIC) and Mesquite Irrigation Company (MIC) own water rights on the Virgin River and said water is distributed by BIC and MIC to the individual shareholders of said irrigation companies;

WHEREAS, in addition to the Virgin River Decree, other water rights for the diversion of the waters of the Virgin River have been granted through the permitting and certification process administered by the Nevada State Engineer;

WHEREAS, pursuant to NRS 533.060 rights to the use of surface water cannot be lost through forfeiture;

WHEREAS, pursuant to NRS 533.060 a surface water right that is appurtenant to land formerly used primarily for agricultural purposes is not subject to abandonment if the land has been converted to urban use or the water right has been acquired by a water purveyor for municipal use;

WHEREAS, pursuant to NRS 538.171 any appropriation or use of the waters of the Colorado River by the Colorado River Commission of Nevada or an entity with whom the Colorado River Commission of Nevada has contracted is not subject to regulation by the State Engineer;

WHEREAS, the Attorney General of the State of Nevada determined in Attorney General Opinion Number 88-16 that a permit from the State Engineer is not required for appropriation and use of Colorado River water for entities that have water delivery contracts with the Secretary of the Interior (Secretary), nor is a permit from the State Engineer necessary for use of such water merely to provide the State Engineer with information regarding such use if information is timely supplied upon request;

WHEREAS, pursuant to Section 2 of Chapter 393 of the Statutes of Nevada 1995, the powers, duties, rights and obligations of the State of Nevada and the Colorado River Commission of Nevada relating to contracts for delivery of Colorado River water were assumed by the Southern Nevada Water Authority;

WHEREAS, the Boulder Canyon Project Act (BCPA). 43 U.S.C. § 617, became effective on June 25, 1929;

WHEREAS, the Secretary of the Interior (Secretary) has a broad and unique legal role in managing the lower Colorado River system in accordance with federal law, including the Boulder Canyon Project Act of 1928, the 1963 decision of the U.S. Supreme court in *Arizona v. California*, the 2006 Consolidated Decree of the U.S. Supreme Court in *Arizona v. California*, the Colorado River Basin Project Act of 1968, and other applicable provisions of federal law. Within this legal framework, the Secretary makes annual determinations regarding the availability of water to be delivered to Colorado River contract holders from Lake Mead;

WHEREAS, on December 13, 2007, the Secretary adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Guidelines). The Guidelines provide for the creation and delivery of Tributary Conservation Intentionally Created Surplus and Developed Shortage Supply (for convenience, both referred to hereinafter as ICS) to entities with a contract or entitlement to Colorado River water with the Bureau of Reclamation provided said entities have also entered into a delivery agreement with the Bureau of Reclamation for delivery of ICS (ICS Delivery Contract);

WHEREAS, pursuant to Sections 3 and 4 of the Guidelines, the holder of a valid ICS Delivery Contract who purchases documented water rights on a tributary of the Colorado River, perfected prior to June 25, 1929, (the effective date of the BCPA) may convey said water to the Colorado River mainstream so that said water may be diverted from the Colorado River mainstream by the ICS Delivery Contract holder as Tributary Conservation ICS;

WHEREAS, the Guidelines and the consolidated decree in *Arizona v. California*, 547 U.S. 150 (2006), define the Colorado River mainstream to include the reservoirs located on the Colorado River downstream from Lee Ferry within the United States; and

WHEREAS, Lake Mead is located on the Colorado River mainstream downstream from Lee Ferry and full pool elevation of Lake Mead is 1,220 feet above mean sea level.

NOW THEREFORE, the State Engineer finds that:

1. The Judgment and Decree in the Matter of the Determination of the Relative Rights in and to the Waters of the Virgin River (Virgin River Decree) was entered on May 14, 1927 by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada.
2. All water rights adjudicated in the Virgin River Decree were acquired by valid appropriation prior to March 1, 1905, and were determined to be in good standing and in use prior to March 1, 1905 as affirmed by the Virgin River Decree.
3. That Permit No. 3085 (Certificate No. 1153) is for the diversion of the waters of the Virgin River with a priority date of August 17, 1914 and was acquired by valid appropriation prior to June 25, 1929.
4. Permit No. 6061 (Certificate No. 1408) is for the diversion of the waters of the Virgin River with a priority date of April 21, 1920 and was acquired by valid appropriation prior to June 25, 1929.
5. Permit No. 7624 (Certificate No. 4509) is for the diversion of the waters of the Virgin River with a priority date of January 21, 1926 and was acquired by valid appropriation prior to June 25, 1929.
6. The Virgin River Decree and issuance of subsequent permits and certificates by the State Engineer have appropriated the entire flow of the Virgin River, and that there is insufficient flow in the Virgin River to grant any new appropriations.
7. As of the date of this Order there has been no declaration or finding of forfeiture or abandonment regarding any water rights adjudicated under the Virgin River Decree or certificated by the State Engineer for the diversion of the waters of the Virgin River.

8. As of the date of this Order, no proceedings for forfeiture or abandonment have been initiated regarding any water rights adjudicated under the Virgin River Decree or certificated by the State Engineer for the diversion of the waters of the Virgin River.
9. In accordance with NRS 538.171 and Attorney General Opinion 88-16 a permit is not required for the creation or use of Tributary Conservation ICS when an ICS Delivery Contract exists with the Secretary.
10. The creation of ICS as defined in the current Guidelines promulgated by the Secretary and as those Guidelines may hereinafter be amended, is beneficial to the state of Nevada.

NOW THEREFORE, the State Engineer orders:

1. The Virgin River is closed to new appropriations.
2. An entity with an ICS Delivery Contract, which uses water rights adjudicated under the Virgin River Decree or water rights on the Virgin River issued by the State Engineer with a priority date prior to June 25, 1929 for the creation of ICS, shall file an annual report with the State Engineer's Office. The annual report shall give a full accounting of water rights on the Virgin River owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Virgin River system to the Colorado River mainstream for the creation of ICS. After review of the annual report, the State Engineer shall issue a letter verifying the quantity of water conveyed through the Virgin River system to the Colorado River mainstream for the purpose of creating ICS.

TRACY TAYLOR, P.E.
State Engineer

Dated at Carson City, Nevada
this 15 day of July, 2008.

United States Department of the Interior
BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

IN REPLY REFER TO:

BCOO-4230
WTR-4.03 (BCP)

DEC 0 9 2008

CERTIFIED – RETURN RECEIPT REQUESTED

Ms. Kay Brothers
Deputy General Manager
Engineering and Operations
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956

Subject: Southern Nevada Water Authority (SNWA) Plans of Creation for Muddy and Virgin River Tributary Conservation Intentionally Created Surplus (ICS), Calendar Years 2008 and 2009 (Your Letter Dated September 10, 2008)

Dear Ms. Brothers:

The Secretary of the Interior issued a Record of Decision (ROD) on December 13, 2007, for the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines). Among other things, the Interim Guidelines establish criteria for the development and delivery of ICS. Prior to creating ICS, the Interim Guidelines require a contract holder to enter into a Delivery Agreement and a Forbearance Agreement.

On December 13, 2007, SNWA and the Colorado River Commission of Nevada entered into a Delivery Agreement with the United States and a Forbearance Agreement with the Lower Basin Contract holders. Section 3.B.1 of the Interim Guidelines requires that a plan for the creation of ICS be submitted for the Secretary's approval demonstrating how the requirements of the Interim Guidelines will be met in the contractor's creation of ICS. SNWA is proposing the creation of up to 16,000 and 30,000 acre-feet of tributary conservation ICS credits in 2008 and 2009, respectively, on the Muddy and Virgin Rivers.

We have reviewed the ICS plan submitted by SNWA and confirm that it contains the following information required by the Interim Guidelines:

a. Project description, including what extraordinary measures will be taken to conserve or import water.
b. Term of the activity.
c. Estimate of the amount of water that will be conserved or imported.
d. Proposed methodology for verification of the amount of water conserved or imported.

e. Documentation regarding any state or Federal permits or other regulatory approvals that have already been obtained by the Contractor or that need to be obtained prior to creation of ICS.

Pursuant to Section 7.B.5 of the Interim Guidelines, the Secretary is required to consult with the Basin States regarding administration of ICS. We have conducted appropriate consultation with both the Upper and Lower Division States on SNWA's ICS plans.

Based upon our review of SNWA's proposed ICS plans and completion of the consultation process, we hereby approve SNWA's plan for the creation of Muddy and Virgin River tributary conservation ICS for 2008 and 2009 in accordance with Section 3.B.1 of the Interim Guidelines and Article VI of the Delivery Agreement.

The Interim Guidelines provide for the submittal of a certification report by SNWA to the Bureau of Reclamation, in the year following creation of ICS, to demonstrate the amount of ICS created and that the method of creation was consistent with the approved ICS plan. Any technical issues associated with the actual creation of ICS will be dealt with in this verification process.

If you have questions, please contact Ms. Ruth Thayer at 702-293-8426.

Sincerely,

Lorri Gray
Regional Director

cc: Mr. Gerald Zimmerman
Executive Director
Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1035

Mr. Herb Guenther
Director
Arizona Department of Water Resources
3550 North Central Avenue
Phoenix, AZ 85012-2105

Mr. Dennis Strong
Director
Utah Division of Water Resources
P.O. Box 146201
Salt Lake City, UT 84114-6201

Mr. George M. Caan
Director
Colorado River Commission of Nevada
555 East Washington Ave, Suite 3100
Las Vegas, NV 89101-1065

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Continued from previous page.

Mr. Don Ostler
Executive Director
Upper Colorado River Commission
355 South 400 East Street
Salt Lake City, UT 84111

Mr. Patrick T. Tyrrell
State Engineer
State of Wyoming
Herschler Building, 4th Floor East
Cheyenne, WY 82002-0370

Mr. John D'Antonio
State Engineer
Office of the State Engineer
P.O. Box 25102
Santa Fe, NM 87504-5102

Ms. Jennifer Gimbel
Director
Colorado Water Conservation Board
1313 Sherman Street, Suite 721
Denver, CO 80123

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Appendix C
Nevada State Engineer Order 1194

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SE ROA 43955

IN THE OFFICE OF THE STATE ENGINEER

OF THE STATE OF NEVADA

1194

ORDER

REGARDING TRIBUTARY CONSERVATION INTENTIONALLY CREATED SURPLUS FOR THE MUDDY RIVER

WHEREAS, the Nevada State Engineer is designated by the Nevada Legislature to perform duties related to the management and appropriation of the water resources belonging to the people of the State of Nevada;[1]

WHEREAS, pursuant to Nevada Revised Statute (NRS) chapter 533 the Nevada State Engineer acts as an officer of the court for administration and distribution of water from a stream system that has been adjudicated by a district court decree;

WHEREAS, the Muddy River Decree was entered on March 12, 1920, by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada;

WHEREAS, individuals named under the Muddy River Decree or their successors own water rights on the upper Muddy River;

WHEREAS, under the Muddy River Decree, the Muddy Valley Irrigation Company (MVIC) owns water rights on the lower Muddy River and said water is distributed by MVIC to the individual shareholders of MVIC;

WHEREAS, pursuant to NRS 533.060 rights to the use of surface water cannot be lost through forfeiture;

WHEREAS, pursuant to NRS 533.060 a surface water right that is appurtenant to land formerly used primarily for agricultural purposes is not subject to abandonment if the land has been converted to urban use or the water right has been acquired by a water purveyor for municipal use;

WHEREAS, pursuant to NRS 538.171 any appropriation or use of waters of the Colorado River by the Colorado River Commission of Nevada or an entity with whom the Colorado River Commission of Nevada has contracted is not subject to regulation by the State Engineer;

[1] *See* Nevada Revised Statutes chapters 532, 533, 534, 535, and 536.

WHEREAS, the Attorney General of the State of Nevada determined in Attorney General Opinion Number 88-16 that a permit from the State Engineer is not required for appropriation and use of Colorado River water for entities that have water delivery contracts with the Secretary of the Interior (Secretary), nor is a permit from the State Engineer necessary for use of such water merely to provide the State Engineer with information regarding such use if information is timely supplied upon request;

WHEREAS, pursuant to Section 2 of Chapter 393 of the Statutes of Nevada 1995, the powers, duties, rights and obligations of the State of Nevada and the Colorado River Commission of Nevada relating to contracts for delivery of Colorado River water were assumed by the Southern Nevada Water Authority;

WHEREAS, the Boulder Canyon Project Act (BCPA), 43 U.S.C. § 617, became effective on June 25, 1929;

WHEREAS, the Secretary has a broad and unique legal role in managing the lower Colorado River system in accordance with federal law, including the Boulder Canyon Project Act of 1928, the 1963 decision of the U.S. Supreme court in *Arizona v. California*, the 2006 Consolidated Decree of the U.S. Supreme Court in *Arizona v. California*, the Colorado River Basin Project Act of 1968, and other applicable provisions of federal law. Within this legal framework, the Secretary makes annual determinations regarding the availability of water to be delivered to Colorado River contract holders from Lake Mead;

WHEREAS, on December 13, 2007, the Secretary adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Guidelines). The Guidelines provide for the creation and delivery of Tributary Conservation Intentionally Created Surplus and Developed Shortage Supply (for convenience, both referred to hereinafter as ICS) to entities with a contract or entitlement to Colorado River water with the Bureau of Reclamation provided said entities have also entered into a delivery agreement with the Bureau of Reclamation for delivery of ICS (ICS Delivery Contract);

WHEREAS, pursuant to Sections 3 and 4 of the Guidelines, the holder of a valid ICS Delivery Contract who purchases documented water rights on a tributary of the Colorado River, perfected prior to June 25, 1929, (the effective date of the BCPA) may convey said water to the Colorado River mainstream so that said water may be diverted from the Colorado River mainstream by the ICS Delivery Contract holder as Tributary Conservation ICS;

WHEREAS, the Guidelines and the consolidated decree in *Arizona v. California*, 547 U.S. 150 (2006), define the Colorado River mainstream to include the reservoirs located on the Colorado River downstream from Lee Ferry within the United States; and

WHEREAS, Lake Mead is located on the Colorado River mainstream downstream from Lee Ferry and full pool elevation of Lake Mead is 1,220 feet above mean sea level.

NOW THEREFORE, the State Engineer finds that:

1. The Order of Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries was certified on January 21, 1920.
2. The Judgment and Decree in the Matter of the Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries (Muddy River Decree) was entered on March 12, 1920 by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada.
3. All water rights adjudicated in the Muddy River Decree were acquired by valid appropriation prior to March 1, 1905, and were determined to be in good standing and in use prior to March 1, 1905 as affirmed by the Muddy River Decree.
4. The Muddy River Decree adjudicated the entire flow of the Muddy River and its tributaries, and that there is insufficient flow in the Muddy River to grant any new appropriations.
5. As of the date of this Order there has been no declaration or finding of forfeiture or abandonment regarding any water rights adjudicated under the Muddy River Decree.
6. As of the date of this Order, no proceedings for forfeiture or abandonment have been initiated regarding any water rights adjudicated under the Muddy River Decree.
7. In accordance with NRS 538.171 and Attorney General Opinion 88-16 a permit is not required for the creation or use of Tributary Conservation ICS when an ICS Delivery Contract exists with the Secretary.
8. The creation of ICS as defined in the current Guidelines promulgated by the Secretary and as those Guidelines may hereinafter be amended, is beneficial to the state of Nevada.

NOW THEREFORE, the State Engineer orders:

1. The Muddy River and its tributaries are closed to new appropriations.
2. An entity with an ICS Delivery Contract, which uses water rights adjudicated under the Muddy River Decree for the creation of ICS, shall file an annual report with the State Engineer's Office. The annual report shall give a full accounting of adjudicated water rights on the Muddy River or its tributaries owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Muddy River system to the Colorado River mainstream for the creation of ICS. After review of the annual report, the State Engineer shall issue a letter verifying the quantity of water conveyed through the Muddy River system to the Colorado River mainstream for the purpose of creating ICS.

Tracy Taylor, P.E.

TRACY TAYLOR, P.E.
State Engineer

Dated at Carson City, Nevada
this 15 day of July, 2008.

Appendix D

Copy of Muddy River Decree and Order of Determination

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HS-14

NEVADA

EXHIBIT NO.________

IDEN.________ ADM.________

COPY OF DECREE

"In the Matter of the Determination of the Relative Rights in and to the Waters of the Muddy River and Its Tributaries in Clark County, State of Nevada

IN THE TENTH JUDICIAL DISTRICT COURT OF THE STATE OF NEVADA,

IN AND FOR THE COUNTY OF CLARK.

MUDDY VALLEY IRRIGATION COMPANY, a corporation, NEVADA LAND & LIVESTOCK COMPANY, a corporation, SAMUEL H. WELLS, JOHN F. PERKINS and ELLEN C. PERKINS, his wife,

Plaintiffs

Vs.

MOAPA & SALT LAKE PRODUCE COMPANY, a corporation, GEORGE BALDWIN and ALETHA L. BALDWIN, his wife, ISAIAH COX and ANNA M. COX, his wife, JOSEPH PERKINS and KATHRYN PERKINS, his wife, D. H. LIVINGSTON and RICHARD SMITH, G. S. HOLMES and JULIA MAY KNOX, W. J. POWERS and MARY A. POWERS, his wife, SADIE GEORGE, LOS ANGELES & SALT LAKE RAILROAD COMPANY, a corporation, and WALKER D. HINES, as Director General of Railroads, and JACOB BLOEDEL.

Defendants.

AND

IN THE MATTER OF THE DETERMINATION OF THE RELATIVE RIGHTS IN AND TO THE WATERS OF THE MUDDY RIVER AND ITS TRIBUTARIES IN CLARK COUNTY, STATE OF NEVADA

)) ---------------------------000--------------------------- ((

JUDGMENT AND DECREE.

The above entitled action and the above entitled matter having come on for hearing before the Court on the 10th day of March, 1920, all of the parties to said action, appearing and being represented in court by their respective attorneys, and J. G. Scrugham, the State Engineer of the State of Nevada, appearing in person, and after hearing and the taking of testimony and evidence, and the making of an order for a further determination by the State Engineer, as hereinafter set forth in the said action and matter having been continued for further hearing and determination and have now come on for hearing this 12 th day of March, 1920, all of the parties to the above entitled action appearing and being represented in open court by their respective attorneys;

And it appearing that on the 23rd day of April, 1919, a stipulation was made and filed herein by and on behalf of all of the parties who had then appeared in said action, signed by their respective attorneys, which said stipulation, after the title of the court and cause was in words and figures following to-wit:

STIPULATION

The parties to the above entitled action, by their respective attorneys, for the purpose of settling and determining as between themselves the issues in said action, do hereby stipulate and agree as follows:

1. That the defendants in this paragraph named, their grantors and predecessors in interest, have diverted and appropriated from the Muddy River, its head waters, sources of supply and tributaries, for use upon the lands herein described or referred to, and that said defendants are respectively entitled to divert to their said lands for use thereon, the respective amounts of water herein speciified.

The defendants, George Baldwin, and Aletha L. Baldwin, his wife, for use on the lands described in their Amended and Supplemental Answer, other than those described in their original answer, 16/70 of one cubic foot of water per second.

The defendant, Moapa and Salt Lake Produce Company, for use on the lands described in its separate Answer, 2 and 15/70 cubic feet of water per second.

The defendants, D. H. Livingston and Richard Smith, for use upon the said lands described in their separate Answer, 2 and 20/70 cubic feet of water per second.

The defendants, Joseph Perkins and Kathryn Perkins, his wife, for use upon the lands described in their separate Answer, 30/70 of a cubic foot of water per second.

The defendants, G. S. Holmes and Julia May Knox, for use upon the lands described in their separate Answer, 1 and 25/70 of a cubic foot of water per second.

The defendants, Isaiah Cox and Annie Cox, his wife, for use on ten acres of land described in their separate Answer, 10/70 of a cubic foot of water per second. Provided, that if the State Engineer in his adjudication shall find that because of the situation of said land, and the small stream or small head of water diverted, or other causes, said defendants need more than said amount to properly irrigate said land, the said defendants shall be entitled to divert such amount of water as the State Engineer may find necessary for said purpose.

The defendants, W. J. Powers and Mary Powers, his wife, for use on the land described in their separate Answer, and for 2 and 8/10 acres situate in the NW 1/4 of the SE 1/4 and the N. E. 1/4 of the S. W. 1/4, of Section 27, Township 14 South, Range 65 East, 29/70 of a cubic foot of water per second. Provided, however, that if the State Engineer in his adjudication shall find that because of the situation and character of said lands, the length of the ditch, or other causes, said defendants need more than said amount to properly irrigate, twenty-nine acres of said lands, being the lands heretofore irrigated, said defendants shall be entitled to divert such amount of water as the State Engineer may find necessary for said purposes.

The defendant, Sadie George, for use on 2.1 acres of land situate in the West side of the S. E. 1/4 of the N. E. 1/4, of Section 1, Township 15, South, Range 65 East, 21/700 of a cubic foot of water per second.

The defendants, Los Angeles and Salt Lake Railway and Walker D. Hines, as Director General of Railroads, are entitled to take from the Muddy River, by the pumping plant of said Railroad at Moapa, such amount of water as the State Engineer may find has by said Railroad been lawfully appropriated for any beneficial use at Moapa. Subject, however, to contest by any party hereto and to an appeal from such finding and review thereof by the Court.

The above volumes or amounts of water to which it is agreed the respective parties are entitled shall be understood to include and define the amount of all the waters now or heretobefore rightfully used on said lands, whether diverted directly from said Muddy River, or from its tributaries, springs, head waters or other sources of supply, including the waters claimed to have been developed heretofore by any of the said parties. All measurements of amounts diverted are to be made at the places of diversion, or as near thereto as practicable or convenient, as the State Engineer or Water Commissioner may select or approve.

2. That the waters now and heretofore used by defendants, George Baldwin and Aletha L. Baldwin, his wife, upon the lands described in their original separate Answer, are waters which have been developed and appropriated by said defendants in the manner and by the means alleged in their said Answer, and that such development and use has not and does not diminish the flow or volume of the Muddy River, or interfere with the rights of any of the other parties to this action.

The said defendants Baldwin shall during the present 1919 irrigating season permit the plaintiffs, or any agent or agents of plaintiffs, to enter upon the said lands of said defendants and make measurements of the cultivated areas and of the waters now developed or used thereon. The said defendants Baldwin shall not make any attempt to develop any additional water upon said land before October 1, 1919, and thereafter no further development of water, or additional use of water, shall be made on or for said lands which in any way diminishes the flow of the waters of the Muddy River, or impairs the rights therein or thereto of the other parties to this action.

3. The Indian Reservation, situated above Moapa, and the inhabitants thereof, are entitled to divert from the waters of said Muddy River, and to use upon lands on said reservation, 1.25 of a cubic foot of water per second, and no more, measured at place of diversion or such place as the State Engineer or Water Commissioner may select.

4. That the Plaintiff, Muddy Valley Irrigation Company, and the Plaintiffs John F. Perkins, and Ellen C. Perkins, his wife and their grantors and predecessors in interest, have diverted and appropriated from the Muddy River, its head waters, sources of supply and tributaries, for use on the lands hereinafter described or referred to, all of the waters flowing therein or therefrom, save and except the several amounts specified in paragraph 1 and 3 hereof. The said plaintiffs Perkins are entitled to water for the irrigation of two acres of ground at or near St. Thomas, in the N. E 1/4 of the S. E. 1/4, of Section 10, Township 17 South, Range 68 East, which water is diverted from the River and conveyed to their land by said Muddy Valley Irrigation Company.

The said Muddy Valley Irrigation Company is and at the time of the commencement of this action was the legal owner of the rights to divert, convey and use all of said waters of said River, its head waters, sources of supply and tributaries, save and except the rights hereinbefore specified and described, and to divert said waters, convey and distribute the same to its present stockholders, and future stockholders, and other persons who may have acquired or who may acquire temporary or permanent rights through said Company, for the various purposes described in the Complaint, and upon the land situated as stated in the Complaint; and that its stockholders are the equitable owners of rights to use said waters in accordance with its articles and amended Articles of Incorporation, and its By Laws, and the accepted uses and practices of said corporation.

5. That the parties named in paragraphs 1 and 3 of this Stipulation shall not be required to take or use the waters of said River in continuous flow, but may cumulate the same or any part thereof in rotation and in turn periods, with the approval of the Water Commissioner, and subject to his control and direction, and under such rules and regulations as may be prescribed by the State Engineer and the statutes of the State of Nevada. The whole amount of water diverted from the River at any one time by all of the parties named in paragraph 1 shall not exceed in the aggregate the total of the amounts of water awarded to the several parties named in said paragraph 1. Below the lowest diversion of the defendants Holmes and Knox the flow in the stream shall be maintained substantially constant, subject to seasonal variations, but only in so far as the parties named in paragraph 1 can be held to be responsible for the fluctuations of said stream. The whole of said River system shall be under the supervision, rules and regulations of the State Engineer, and the direction and control of the Water Commissioner, to be appointed as hereafter provided or as provided by law, as a fully adjudicated stream; but it is the intention hereof that so far as practicable the stream shall be treated as divided into two parts, that above and that below the lowest diversion of the ranch now belonging to the defendants Holmes and Knox; and the Muddy Valley Irrigation Company, although under the supervision and control of the State Engineer and Water Commissioner, will, subject to said supervision and general control, distribute and control the distribution of the waters diverted and conveyed by its works to its stockholders and other persons obtaining water by means thereof. Such head gates, measuring devices, etc., as the State Engineer or Water Commissioner may order shall be installed by all who divert or use the waters of said stream system.

6. The owners of land on the upper part of said River, as in the last paragraph defined, shall keep the channels through their respective lands clear of all ordinary obstructions, but

in case of of extraordinary obstruction, such as the formation of lime beds or deposits, in the channel of the stream, the same shall be removed under the direction of the Water Commissioner, and the expense thereof paid as he or the State Engineer may assess the same.

7. All the water rights hereinbefore specified shall be deemed and held to be vested rights, acquired by valid appropriation and beneficial use prior to March 1, 1905, and by continued, uninterrupted use since said date, and shall be considered as equal in rank, without one having any priority over any other. This stipulation shall apply to and include whatever rights are held or possessed by the Muddy Valley Irrigation Company under the certificates of appropriation issued to the plaintiff, Nevada Land and Live Stock Company, as set forth in paragraph twelve of the Complaint herein.

8. All abnormal losses from the flow of said stream shall be pro rated and shared among the parties hereto. Abnormal losses shall include such as any substantial loss from the permanent flow of the stream, caused by some cataclysm of nature, as a cloud-burst, destroying or obstructing the channel thereof, or as the opening up of a fissure in the bed of the stream, or in one of the courses of supply, and the disappearance therein of a substantial amount of the waters, thereby causing a substantial diminution in the flow available for appropriation by any of the parties. Any diversion of water by the Indian Reservation, or the inhabitants thereof, in excess of the 1.25 cubic foot per second, specified in paragraph 3, or any award by the State Engineer to or for the lands of the Indian Reservation in excess of said 1.25 cubic foot per second, and any water in excess of such amount, which in any suit or action may be awarded or decreed to or for the lands on said Indian Reservation, or any water which in the final adjudication of this action or any other may be awarded or decreed to any party not a party to this action, shall also be deemed an abnormal loss from the stream.

If any such abnormal loss occur at any time the pro-rata share of such loss to be borne by each party shall be as follows:

The defendants Baldwin and wife shall bear 16/3169 of such loss.

The defendant, Moapa and Salt Lake Produce Company, 155/3169 thereof.

The defendants, Livingston and Smith, 160/3169 thereof.

The defendants, Perkins and wife, 30/3169 thereof.

The defendants Holmes and Knox 95/3169 thereof.

The defendants, Cox and wife, 10/3169 thereof.

The defendants, Powers and wife, 29/3169 thereof.

The defendant, Sadie George, 2/3169 thereof.

And the Plaintiff, Muddy Valley Irrigation Company 2672/3169 of such loss.

9. An order may be entered by the Court referring this suit to the State Engineer for an adjudication of the water rights on the Muddy River, in accordance with the provision of Chapter 140 of the Statutes of Nevada, of 1913, approved March 22, 1913, and all acts amendatory thereof. The order shall direct that said State Engineer in making such adjudication shall as between the parties to this Stipulation, and in determining their relative rights as between themselves, be bound by and give effect to the terms and conditions of this Stipulation, and the division of the waters which said parties have made between themselves.

And the parties further stipulate and agree that any final Decree entered herein shall, in determining the relative rights of the parties hereto, follow and give effect to the terms and conditions of this Stipulation.

10. Pending the final adjudication of said River, and final Decree in this action, and the legal organization of a Water District embracing the Muddy River Valley, and the legal appointment of a Water Commissioner, therefor, the parties themselves shall select and employ a Water Commissioner to act under the terms of this

Stipulation, subject to the supervision of the State Engineer, and such rules and regulations as he may prescribe not inconsistent with this Stipulation. Said Water Commissioner shall be selected by a representative of the Muddy Valley Irrigation Company and a representative chosen by a majority in interest of the defendants, and if such representatives cannot agree then the State Engineer shall have the selection and appointment of the Water Commissioner. The salary and expenses of such Water Commissioner shall be borne by the parties hereto in the same proportion as fixed in paragraph eight hereof for the sharing of losses. The representatives of the respective parties who are to select the Water Commissioner shall agree on the time and manner and person through whom each party shall pay his share of such salary and expenses, and such agreement shall be binding on each party and become a legal obligation.

11. An Order shall also be entered, binding on all of the parties hereto, modifying the terms of the temporary injunction heretofore made and granted, in accordance with the terms of this Stipulation, so that during the pendency of this action and until the final adjudication and final Decree each party shall be injoined from interfering with or impairing any right given by this Stipulation to any other party and from violating any of the terms and conditions and agreements of this Stipulation, or any part thereof.

12. Each party shall pay its or his own costs in this action, but the costs and expenses of the adjudication of the State Engineer, including any surveys or maps made by him, shall be borne by the respective parties, in accordance with the Statutes of this State. But in determining the Water Right and acreage against which such expense shall be assessed the numerators in the fractions in paragraph eight shall as between these parties be deemed to be the number of acres to be irrigated by the respective parties.

Dated this 23rd day of April, A. D., 1919.

A. S. Henderson,
Brown & Belford
Attorneys for Plaintiffs.

F. R. McNamee and
Leo A. McNamee
Attorneys for all defendants, except W. J. Powers and Mary Powers.

C. D. Breeze
Attorney for Defendants, W. J. Powers and Mary Powers.

That on the said 23rd day of April, 1919, an order was made and entered by the Court in the above entitled action referring to the State Engineer of the State of Nevada the said action for an adjudication of the water rights of the Muddy River, its head waters and tributaries and providing that the said State Engineer in making such adjudication should, as between the parties to said Stipulation, in determining their relative rights, as between themselves, be bound by, and give affect to, the terms and conditions of said stipulation and the division of the waters which said parties have made between themselves. That a copy of said Order of reference, duly certified, was delivered to said State Engineer and thereupon the said State Engineer proceeded in accordance with said order and with the provisions of the Statutes of the State of Nevada to make an adjudication of said Muddy River; that the various notices as required by Statute were given by said State Engineer and that claims were filed by various claimants for the use of water on said river and proofs taken and used by said State Engineer in accordance with the provisions of said Statute. That thereafter and on the 21st day of January 1920, said State Engineer made his order of determination entitled "In the matter of the determination of the relative rights in and to the waters of the Muddy River and its tributaries in Clark County, State of Nevada."

That on the 26th day of January, 1920, a copy of the said Order of Determination, duly certified by the State Engineer was filed with the Clerk of the above entitled court and an order made and entered by the Judge of said Court appointing the 10th day of March, 1920, 10 o'clock A.M. of said day, as the time for hearing the matter of said determination and that a certified copy of such order and a notice of such hearing was duly published and served as required by law and that thereafter, and within the time provided by law, various parties to the above entitled action, claimants of water rights in said Muddy River, duly filed with the clerk of said court and served upon the State Engineer their exceptions to the said order of determination.

That on the 10th day of March, 1920, the defendant Jacob Bloedel, a claimant of a water right on said river who had not theretobefore been a party to said action, was by stipulation made a party defendant thereto and duly appeared by his attorneys and it was stipulated that he should be deemed to have made a claim for water right in said Muddy River without further pleading; and also on said date it was stipulated that the defendants Isaiah Cox and Anna Cox his wife, who appeared to the satisfaction of the court to have become the owners of and entitled to land and water rights of J. H. Mitchell, should be deemed to have made a claim in said action for the water rights for said land so acquired by them without further pleading. That on the said 10th day of March, 1920 there was made and filed in said action a stipulation supplemental to said stipulation of April 23rd, 1919 which said stipulation after the entitlement of the court and cause is in words and figures following, to-wit:

STIPULATION SUPPLEMENTAL TO STIPULATION OF APRIL 23, 1919.

WHEREAS, since the making and filing of a stipulation by all of the parties to the above entitled action, who has then appeared therein under date of April 23rd, 1919, Jacob Bloedel has been made a party defendant to said action and has duly appeared therein by F. R. McNamee and Leo A. McNamee, his attorneys;

AND, WHEREAS, since the making of said stipulation the rights of J. H. Mitchell, and the lands belonging to him have been sold and conveyed to Isaiah Cox and Annie M. Cox, his wife, two of said defendants, and whereas a stipulation has been filed herein providing and allowing water rights in behalf of the land so sold by Mitchell to Cox and wife, and providing that the same may be considered as having been made in this action without further pleading,

AND WHEREAS, in view of the foregoing premises it is deemed desirable to supplement and amend the said stipulation of April 23rd, 1919.

The parties to the above entitled action by their respective attorneys do hereby agree and stipulate as follows:

1. The said defendant, Jacob Bloedel, and the said defendants, Isaiah Cox and Anna M. Cox, his wife, in behalf of the land and water rights so acquired from Mitchell, do hereby assent to and make themselves parties in all respects to the said stipulation of April 23rd, 1919, except as the same is changed and amended hereinafter.

2. The said defendant, Jacob Bloedel, his grantors and predecessors in interest have diverted and appropriated from the Muddy River, its headwaters, sources of supply and tributaries, and the said defendant, Bloedel, is entitled to divert from said river 2/70 of one cubic foot of water per second, for use upon the NE 1/4 of the NE 1/4 of Sec. 21, T. 14 S. R. 65 E. M. D. B. & M.

The defendants, Isaiah Cox and Anna M. Cox, his wife, their grantors and predecessors in interest have diverted and appropriated from the said Muddy River, its headwaters, tributaries and sources of supply and are entitled to divert, in addition to the quantity of water described in the said original stipulation of April 23rd, 1919, 3/70 of one cubic foot of water per second for use upon said land in the N.W1/4 of the NE 1/4 of the N. E. 1/4 of Section 16 T. 14 S. R. 65 E. M. D. B. & M., the same being the land acquired by said defendants Cox and wife from J. H. Mitchell.

3. Paragraph 3 of said stipulation of April 23rd, 1919, is amended to read as follows:

""the Indian Reservation, situate above Moapa, and the inhabitants thereof, are entitled to divert from the waters of said Muddy River, and to use upon said land on said Reservation 1.242 of a cubic foot of water per second, and no more, measured at the place of diversion, or such place as the State Engineer or Water Commissioner, may select."

4. That portion of Paragraph 8 of said stipulation of April 23rd, 1919, fixing the pro rata share of any abnormal loss to be borne by each party, is amended to read as follows:

"If any such abnormal loss occurs at any time the pro-rata share of such loss to be borne by each party shall be as follows:

The defendants, Baldwin and Wife, shall bear 16/3169 of such loss;

The defendant Moapa and Salt Lake Produce Company 155/3169 thereof;

The defendants Livingston & Smith 160/3169 thereof;

The defendants Perkins and wife 30/3169 thereof;

The defendants Knox and Holmes 95/3169 thereof;

The defendants Cox and wife 13/3169 thereof;

The defendants Powers and wife 29/3169 thereof;

The defendant Sadie George 2/3169 thereof;

The defendant Jacob Bloedel 2/3169 thereof; and

The Plaintiff Muddy Valley Irrigation Company 2667/3169 thereof."

5. In Paragraph 8 of said stipulation of April 23rd, 1919, is amended, so that the definition of abnormal losses from the flow of said stream wherever the figures 1.25 occur, the same shall be struck out and the figures 1.242 substituted therefor. The parties hereto do not admit or recognize any rights to the use of the

Muddy River by or for the Indian Reservation and the inhabitants thereof, except the amount awarded and found to belong to such reservation by the State Engineer. The parties have included in their definition of abnormal losses a possible diversion of a greater amount by said reservation or possible acquisition of an increase right, only as a measure of security against a possible contingency which might arise through the uncertainty of litigation.

6. Paragraph 7 of said stipulation of April 23rd, 1919, is amended to read as follows:

"All of the water rights hereinbefore specified shall be deemed and held to be vested rights acquired by valid appropriation and beneficial use prior to March 1, 1905, and by continued and uninterrupted use since said date, and shall be considered as equal in right, without one having any priority over any other. This stipulation shall apply to and include whatever rights are held or possessed by the Muddy Valley Irrigation Company under the certificates of appropriation issued to the plaintiff Nevada Land & Live Stock Company as set forth in paragraph twelve of the amended complaint herein and under any certificate of appropriation which may be issued to the Muddy Valley Irrigation Company under its application to the State Engineer numbered 1611.

7. The amount of water awarded in the said stipulation of April 23rd, 1919, and in this stipulation to the respective parties shall be deemed a continuous right during the entire year, it being understood that the minimum duty of water during the summer season shall be one cubic foot per second for 70 acres of land; during the winter season, one cubic foot per second for 100 acres of land, and that by the summer season is meant the period between and including the first day of May of each year up to and including the 30th day of September of each year, and by the winter season is meant the period from and including the 1st day of October to and including the following 30th day of April.

8. It is understood and agreed that the amounts of water awarded by this stipulation to the respective parties and to the Indian Reservation absorbs and exhausts all of the flow of the said stream, its sources of supply, headwaters and tributaries during the entire year.

9. The order of determination of the State Engineer and any further or supplemental order of determination made by him under order of the court shall give effect to the terms and conditions of said stipulation of April 23rd, 1919 and of this supplemental stipulation as said order of determination may define or effect the rights of the parties to the above entitled action and any final decree entered herein shall, in determining the relative rights of the parties hereto follow and give effect to the terms of the said new stipulation.

DATED this 10th day of March, 1920.

A. S. Henderson
Brown & Belford
Attorneys for Plaintiff

F. R. McNamee &
Leo A. McNamee
Attorneys for Defendants other than W. J. and Mary Powers.

C. D. Breeze
Attorney for W. J. and Mary Powers.

That the said exceptions of the respective parties to the order of determination came regularly on for hearing on said 10th day of March, 1920 and witnesses were sworn and testified for and on behalf of the said excepting parties and documentary and other evidence was introduced in support of said exceptions and thereupon the court made and entered an order requiring the State Engineer to make a further determination of the waters of the said Muddy River and its tributaries, subject to instructions of the court which were embodied in such order; and thereafter, to-wit, on the 11th day of March, 1920 said State Engineer did make and file in his office a further and supplemental order of determination and has filed a duly certified copy thereof with the Clerk of this Court.

And the above entitled action and the above entitled matter and the said original and said further and supplemental order of determination of the State Engineer in said matter having now come on for hearing and the Court having considered the pleadings of the parties, the oral and documentay evidence heretofore taken herein, and the stipulations of the parties filed herein, and written findings having been waived by attorneys for the respective parties, thereupon, upon motion of the attorneys for plaintiffs and defendants,

It is by the Court ORDERED, ADJUDGED AND DECREED as follows:

First: That the said order of determination of the State Engineer in the matter of the determination of the relative rights in and to the waters of the Muddy River and tributaries in Clark County, State of Nevada, as amended and modified by the said further and supplemental order of determination, and the said further and supplemental order of determination be and the same hereby are affirmed and confirmed. Wherever the said further and supplemental order of determination differs from, changes, modifies, or is in conflict with the original order of determination, the said original order of determination is and shall be deemed to be modified by the said further and supplemental order of determination and by the order and decree of this court and the same as so modified is hereby affirmed. A copy of said original order of determination marked "Exhibit "A" and a copy of said further and supplemental order of determination marked "Exhibit 'B" are annexed to this decree and are made parts hereof as if set forth at length herein. Hereinafter in this decree whenever the order of determination is referred to it shall, unless otherwise specified, be understood to include both the original order of determination and the further and supplemental order of determination and the former as amended, changed and modified by the latter. Said order of determination shall and does define the rights of the parties named therein except as hereinafter in this decree provided.

Second: That the parties to the above entitled action, their grantors and predecessors in interest have diverted and appropriated from the Muddy River, its headwaters, sources of supply and tributaries for use upon the lands described in their several answers and specifically described in the order of determination and the said parties are respectively entitled to divert to said lands for use in the irrigation thereof, the respective amounts of water herein setforth:

The defendants George Baldwin and Aletha Baldwin his wife, .2286 of one cubic foot of water per second.

The defendant Moapa and Salt Lake Produce Company 2.215 cubic feet per second.

The defendants D. H. Livingston and Richard Smith, 2.286 cubic feet'per second.

The defendants Joseph Perkins and Kathyrn Perkins, his wife, .428 cubic feet per second.

The defendants G. S. Holmes and Julia May Knox, 1.357 cubic feet per second.

The defendants Isaiah Cox and Anna Cox his wife for use on 10 acres of land described in their separate answer .143 of a cubic foot per second.

The defendants Isaiah Cox and Anna Cox his wife for use upon the lands formerly belonging to J. H. Mitchell, described in the order of determination .043 of a cubic foot per second.

The defendants, W. J. Powers and Mary Powers his wife, .4143 of a cubic foot per second.

The defendant, Sadie George for use on the land described in the order of determination, .03 of a cubic foot per second.

The defendant, Los Angeles & Salt Lake Railroad Company for the use specified in the order of determination, .04646 of a cubic foot per second.

The defendant, Jacob Bloedel for use upon the land described in the order of determination, .0286 of a cubic foot per second.

The plaintiff, John F. Perkins, .0286 of a cubic foot per second.

The plaintiff, Muddy Valley Irrigation Company, for use during the summer season, as hereinafter defined and as defined in said order of determination, upon the lands described in said order of determination, 36.2588 cubic feet per second, which said amount includes the amount of water for summer use allowed by State Engineer's certificate No. 59. Said company is also the owner of the right to and entitled to divert during the winter season for use upon the lands described in said order of determination and in State Engineer's Certificate Nos. 58, 59 and 60, and also upon the lands described in any certificate or permit granted or issued by said State Engineer upon said Company's application No. 1611 - the several amounts of water allowed by said certificate or permits for winter use.

Third: That the Moapa Indian Reservation has diverted and appropriated from the said Muddy River for use upon the lands of said reservation and is entitled to divert upon said lands for use thereon 1.242 cubic feet per second during the summer season and .87 of a cubic foot per second during the winter season.

Fourth: That all of the defendants to the above entitled action and the plaintiff John F. Perkins are and shall be entitled to use the several amounts of water which they have appropriated as aforesaid during both the summer and winter seasons.

Fifth: That the duty of water allowed for all land in the Muddy Valley except on the Moapa Indian Reservation shall be one cubic foot per second of flow to 70 acres for the summer irrigation season which is defined as extending from May 1st to October 1st, and one cubic foot per second flow to 100 acres for the winter irrigation season which is defined as extending from October 1st to May 1st. On said Indian Reservation the duty of water allowed is 1 cubic foot per second flow to 70 acres for the summer irrigation season which is defined as from April 1st to October 1st, and one cubic foot per second flow to 100 acres for the winter irrigation season which is defined as from October 1st to April 1st.

The volumes or amounts of water awarded and allotted by this decree to the parties hereinbefore named and to which they are entitled shall be understood to include and define the amount of all the waters now or heretofore rightfully used on the lands given in the tabulation in the original order of determination whether diverted directly from said Muddy River or from its tributaries, springs, head waters or other sources of supply, including waters claimed to have been developed heretofore by any of the said parties. All measurements of amounts to which the said several parties are entitled except that awarded to the Moapa Indian Reservation shall be made at the places of diversion or as near thereto as practicable or convenient, as the State Engineer or Water Commissinner may select or approve. On said Indian Reservation all measurements of amounts diverted are to be made at the point where the main ditch enters or becomes adjacent to the land irrigated or as near thereto as practicable as the State Engineer or Water Commissioner may select or approve.

Sixth: That the waters now and heretofore used by the defendants George Baldwin and Aletha Baldwin his wife, upon the lands described in their original separate answer, and which are the waters of what is known as the George Baldwin Spring, the maximum flow of which is found to be .8298 of a cubic foot per second of water are waters which have been developed and appropriated by said defendants in the manner and by the means alleged in their said answer; and that such development and use has not and does not diminish the flow or volume of the Muddy River or interfere with the rights of any of the other parties to the above entitled action or the Moapa Indian Reservation.

Seventh: That, as between the parties to the above entitled action, the Muddy Valley Irrigation Company is declared and decreed to have acquired by valid appropriations and beneficial use and to be entitled to divert and use upon the lands described in the amended complaint and more particularly described in the order of determination, all the waters of said Muddy River, its head waters, sources of supply and tributaries, save and except the several amounts and rights hereinbefore specified and described as awarded and decreed to the other parties to this action and to the Moapa Indian Reservation, and said Company is to divert said waters, convey and distribute the same to its present stockholders and to its future stockholders and to other persons who have acquired or who may hereafter acquire temporary or permanent rights from said Company, for the various purposes described in the complaint and upon the lands situated as stated in the complaint and specifically designated in the order of determination and that the stock holders of said Company are the equitable owners of rights to use said waters in this decree and by the order of determination allotted and decreed to said Company, in accordance with its articles and amended articles of incorporation, or its by-laws or the accepted uses and practices of said corporation.

Eighth: As between the parties to this action and except against the rights awarded the Indian Reservation and the Inhabitants thereof, all of the water rights enumerated as belonging to the parties to the action shall be deemed and held to be and are hereby decreed to be vested rights acquired by valid appropriation and beneficial use prior to March 1st, 1905, and by continued uninterrupted use since said date and shall be considered as equal in rank without anyone having any priority over another and that this shall apply to and include the rights held by the Muddy Valley Irrigation Company as grantee or assignee of Nevada Land & Live Stock Company under the State Engineer's certificates, 58, 59 and 60, and under such permit or certificate as may hereafter be granted by the State Engineer to the Muddy Valley Irrigation Company under its application No. 1611. That, as against the water right granted and allotted to the said Indian Reservation, the water rights held by the Muddy Valley Irrigation Company under said certificates or permits shall be deemed to be subsequent to the water rights allotted and decreed the said Indian Reservation. The water right allotted and decreed the Indian Reservation shall be deemed and held to be vested rights acquired by valid appropriation prior to March 1st, 1905 and by uninterrupted use thereafter and shall, to the extent decreed and allotted, rank, as equal in priority with all the other rights, allotted, awarded and decreed to the said several parties, except those granted by the said certificates or permits.

Ninth: That the defendants in said action shall not be required to take or use the waters in said river in continuous flow, but may cumulate the same or any part thereof in rotation and turn periods, with the approval of the Water Commissioner, and subject to his control and direction and under such rules and regulations as may be prescribed by the State Engineer and the statutes of the State of Nevada. That the whole amount of water diverted from said river at any one time by all of the defendants shall not exceed in the aggregate the total of the amounts of water awarded to the said defendants. Below the lowest diversion of the defendants Holmes and Knox, the flow in the stream shall be maintained substantially constant, subject to seasonal variations, only, however, in so far as the defendants can be held to be responsible for the fluctuations of the stream. The whole of said river system shall be under the supervision, rules and regulations of the State Engineer, and the direction and control of the water commissioner to be appointed as provided by law, as a fully adjudicated stream; but it is the intention hereof, and it is hereby decreed that, so far as practicable, the stream shall be treated as divided into two parts, that above and that below the lowest diversion on the ranch now belonging to Knox and Holmes. The Muddy Valley Irrigation Company, although under the supervision and control of the state engineer and water commissioner, shall, subject to said supervision and general control, distribute and control the distribution of the waters diverted and conveyed by its works to its stockholders and other persons obtaining water by means thereof. Substantial headgates, weirs or other measuring devices and sand boxes, as the State Engineer, through the water commissioner may direct or require, shall be installed and maintained in good order by all who divert or use the waters of said stream system.

Tenth: That the owners of land on the upper part of said river as in the last paragraph defined, and defined in the said order of determination, as that part of said river above the "narrows", shall keep the channel through their respective lands cleared, of all ordinary obstructions, but in case of extraordinary obstructions, such as the formation of lime beds or deposits in the channel of the stream, the same shall be removed under the direction of the water commissioner and the expenses thereof paid pro rata by all parties to the determination in proportion to the acreage owned or controlled by them as defined in said order of determination.

Eleventh: That all abnormal losses from the flow of the stream shall be pro rated and shared among the parties holding water rights on the stream, but as between the parties to the above entitled action, abnormal losses shall be defined as in paragraph 8 of said stipulation of April 23rd, 1919, as amended by paragraph 5 of the stipulation supplemental thereto, and, as between the parties to said action, such abnormal losses shall be borne by the parties to said action, pro rata in the proportions named and set forth in paragraph 4 of said supplemental stipulation.

Twelfth: That the aggregate volume of the several amounts and quantities of water awarded and allotted to the parties named in said order of determination, which include all of the parties to said action and the said Moapa Indian Reservation, is the total available flow of the said Muddy River and consumes and exhausts all of the available flow of the said Muddy River, its head waters, sources of supply and tributaries.

Thirteenth: That the salary and the expenses of any water commissioner, who may be appointed to supervise, control and regulate the distribution of the waters of said Muddy River in accordance with the provisions of said order of determination and this decree, shall be paid pro-rata by the parties to the said stipulation supplemental to the stipulation of April 23rd, 1919, in the same proportion as for the sharing of abnormal losses set forth in paragraph 4 of said supplemental stipulation. If in the opinion of the State Engineer a suitable and competent water commissioner cannot be employed at the salary fixed by statute, the State Engineer is authorized to fix the salary of the Water Commissioner in such amount as he may determine to be reasonable, subject, in case of objection by any of the water users, to the approval of the Judge of the above entitled Court. The State Engineer may also allow such expenses of such water commissioner as he may deem necessary or proper to be incurred in the performance of the duties of such water commissioner, subject, also, in case of objection, to the approval of the Judge of said Court.

That any money due or which may hereafter become due from any party for his, her or its pro rata share of such salary or such expenses of the water commissioner shall be paid by the party at the times and in the manner provided by law for the payment of the salary of the water commissioner, and any neglect or failure of any party to make any such payment shall be deemed a violation of this decree and a contempt of Court, and shall be punished accordingly, or the same may be deemed a debt and collected by civil process.

Fourteenth: That each of the parties to this action his, her or its grantees and successors in interest and every person acting under his, her or its direction or control be and hereby is perpetually restrained and enjoined from in any way interfering with or in any way impairing any right given or awarded or decreed by this decree to any other party and from violating any of the provisions of this decree, and is also perpetually restrained and enjoined from opening, closing, changing or interfering with any headgate or water box established by or under the order of the State Engineer or Water Commissioner without the authority of said State Engineer or Water Commissioner, and also from using water or conducting water into or through his, her or its ditch which has not been awarded to such party by this decree.

Fifteenth: Each party shall pay his or its own costs in this action, but the costs and expenses of the adjudication by the State Engineer, including any surveys or maps made by him, shall be borne by the respective parties in accordance with the Statutes of this State. But in determining the water right and acreage, against which said expense shall be assessed the numerators in the fractions in said paragraph 4 of said supplemental stipulation, shall, as between said parties, be deemed to be the number of acres to be irrigated by the said respective parties.

Done in open Court this 12th day of March, A. D. 1920.

/s/ Wm. E. Orr
District Judge.

SE ROA 43987

EXHIBIT "A"

STATE OF NEVADA

ORDER OF DETERMINATION OF RELATIVE RIGHTS

TO THE

Waters of the Muddy River and Its Tributaries

J. G. SCRUGHAM, State Engineer

CARSON CITY, NEVADA
STATE PRINTING OFFICE : : : JOE FARNSWORTH, SUPERINTENDENT
1920

1[60]

ORDER OF DETERMINATION

In the Matter of the Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries in Clark County, State of Nevada.

In accordance with stipulated agreement entered into by the Muddy Valley Irrigation Company, et al., v. Moapa and Salt Lake Produce Company, et al., on the 23d day of April, 1919, an order was entered in the Tenth Judicial District Court of the State of Nevada referring the above-entitled action to the State Engineer for an adjudication of the water rights on the Muddy River stream-system as provided for in Chapter 140, Statutes of 1913, and all Acts amendatory thereof.

The tabulation of the allotments of the waters of the Muddy River stream-system, as attached hereto, covers all claims filed in the office of the State Engineer as provided for by law, and also an allotment to the Moapa Indian Reservation. Although duly notified of the pending adjudication proceedings in the statutory manner, the United States Indian Service authorities did not file a claim and state that they refuse to recognize the authority of the State of Nevada to determine the water rights of the Moapa Indian Reservation. In the absence of any showing on part of the United States Indian Service, the State Engineer has based the Moapa Indian Reservation allotment on the official investigations and reports made in the year 1906 by Henry Thurtell, at that time State Engineer of Nevada. These reports gave the Moapa Indian Reservation an allotment of water sufficient to properly irrigate an area of 87 acres, which was found to be the full area on the Reservation entitled to a vested water right under the law of the State.

(a) *Duty and point of diversion defined.*

The duty of water allowed for all land in the Muddy River Valley shall be 1 c.f.s. flow to 70 acres for the summer irrigation season from April 1 to October 1 and 1 c.f.s. flow to 100 acres for the winter irrigation season from October 1 to April 1.

The volumes or amounts of water allotted and to which it is agreed the respective parties are entitled shall be understood to include and define the amount of all the waters now or heretofore rightfully used on the lands given in the tabulation whether diverted directly from said Muddy River or from its tributaries, springs, headwaters or other sources of supply, including water claimed to have been developed heretofore by any of the said parties. All measurements of amounts diverted are to be made at the point where the main ditch enters or becomes adjacent to the land to be irrigated or as near thereto as practicable, as the State Engineer or water commissioner may select or approve.

(b) *Baldwin Spring flow defined.*

The maximum flow of .8298 c.f.s. of water of the George Baldwin Spring now and heretofore used by George Baldwin and Aletha L. Baldwin, his wife, is water which has been developed by said parties.

c.f.s. signifies cubic foot per second.

Such development and use of this amount of water has not and does not diminish the flow or volume of the Muddy River, or interfere with the rights of any other water users on the stream-system. No further development of water on the head of the Muddy River stream-system shall be made which in any way diminishes the flow of the waters of the Muddy River or impairs rights defined and referred to in this order.

(c) *Method of use.*

The parties named in this order shall not be required to take or use the water of said river in continuous flow, but may cumulate same or any part thereof in rotation and in periodic turn, with the approval of the water commissioner, subject to his control and direction and under such rules and regulations as are prescribed by the State Engineer and the statutes of the State of Nevada.

The whole amount of water diverted from the river at any one time by all the parties allotted water for use above the "narrows" is not to exceed in the aggregate the total amount of water allotted to the several parties resident in the Upper Muddy Valley. Below the lowest diversion of Knox and Holmes the flow in the stream shall be maintained substantially constant subject to seasonal variation. The whole of said river system shall be under supervision of the rules and regulations of the State Engineer and the direction and control of the water commissioner, to be appointed as provided by law. Substantial headgates, weirs, and sand-boxes, as the State Engineer through the water commissioner may order, shall be installed and maintained in good order by all who divert or use the waters of said stream-system.

(d) *Channel upkeep, responsibility for.*

The owners of land on that part of said river above the "narrows" shall keep the channel through their respective lands cleared of all ordinary obstructions, but in case of extraordinary obstruction, such as the formation of lime deposits in the channel of the stream, the same shall be removed under the direction of the water commissioner and the expenses thereof paid pro rata by all parties to this determination in proportion to the acreage owned or controlled by them as defined in this order.

(e) *Priority—Vested and granted rights.*

All the water rights enumerated in this order of determination, except those held under permit from the State Engineer's office, shall be deemed and held to be vested rights acquired by valid appropriation and beneficial use prior to March 1, 1905, and by continued uninterrupted use since said date and shall be considered as equal in rank without having any priority over one another.

Permits Nos. 31 and 1372, which are the basis for certificates Nos. 58, 59, and 60, granted by the State Engineer, cover certain water rights which are enumerated in the appended tabulation of allotments. These granted rights are next in priority to the vested rights on the Muddy River stream-system.

(f) *Losses, apportionment of.*

All abnormal losses from the flow of said stream shall be pro-rated and shared among the parties holding water rights on the stream. Abnormal losses shall include any substantial loss from the permanent flow of the stream, such as a cloudburst destroying or obstructing the channel thereof or an opening up of a fissure in the bed of the stream or in one of the sources of supply and the disappearance therein of a substantial amount of the waters, thereby causing a diminution in the available flow.

If any such abnormal loss occurs at any time, the pro-rata share of such loss to be borne by each party to this order shall be as follows:

George Baldwin and Aletha Baldwin, his wife	16/2839
Moapa & Salt Lake Produce Co	155/2839
Livingston & Smith	160/2839
Joseph Perkins and wife	30/2839
Knox and Holmes	95/2839
Isaiah Cox and wife	10/2839
W. J. Powers and wife	29/2839
Sadie George	2.1/2839
Jacob Bloedel	2/2839
J. H. Mitchell	3/2839
U. S. Indian Service, Moapa Reservation	87/2839
John F. Perkins	2/2839
Muddy Valley Irrigation Co	2244.80/2839

(g) *Expense of commissioner.*

The salary and expenses of the water commissioner shall be paid pro rata by all parties to this adjudication in the proportion of acreage owned and controlled by them as defined in this order.

SUMMARY OF ALLOTMENTS AND CERTIFICATES

Claimant	*Acreage*	*C.F.S. flow* *Summer*	*Winter*
Jacob Bloedel	2	.0286	.02
Moapa & Salt Lake Produce Co	155	2.215	0
Isaiah Cox and wife	10	.143	0
J. H. Mitchell	3	.043	0
George Baldwin	16	.2286	0
Sadie George	2.1	.0300	0
John F. Perkins	2	.0286	.02
Los Angeles & Salt Lake Ry		.04646	.04646
Livingston and Smith	160	2.286	0
Knox and Holmes	95	1.357	0
W. J. Powers	29	.4143	.29
Muddy Valley Irr. Co	2244.80	32.0068	22.448
Muddy Valley Irr. Co. (Cert. 58)	308.11	....	3.98
Muddy Valley Irr. Co. (Cert. 59)	425.2	4.252	....
	846.6	....	8.466
Muddy Valley Irr. Co. (Cert. 60)	80	....	.8
Joseph Perkins	30	.428	0
Moapa Indian Reservation	87	1.242	.87

01625

Appropriator—Jacob Bloedel.

Source—Muddy River Tributary (Bloedel Spring).

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Morris & Jones Ditches	1896		2.00	21	NE¼NE¼	14	65

Domestic use allowed.

2/70 c.f.s. allowed for irrigation.

Appropriator—Moapa and Salt Lake Produce Co.

Source—Muddy River and Tributaries.

Big Spring, Jones Spring, High Springs, and Rock Cabin Spring Ditches.				14	W½SW¼	14	65
				15	S½	14	65
				15	S½N½NW¼	14	65
				15	S½N½	14	65
				16	NE¼	14	65
				16	E½SE¼	14	65
Excepting and excluding from the above description the				16	NE¼ NW¼NE¼	14	65
				16	NW¼ NE¼NE¼	14	65

Domestic use allowed.

Total acreage allotted water, 155 acres.

2 and 15/70 c.f.s. allowed for irrigation.

Appropriator—Isaiah Cox and Anna Cox, His Wife.

Source—Muddy River and Tributaries.

Cox Ditch and Cox Spring Ditch			10.00	16	NE¼ NW¼NE¼	14	65

Domestic use allowed.

10/70 c.f.s. allowed for irrigation.

Appropriator—J. H. Mitchell.

Source—Muddy River.

Mowry & Mitchell or Cox Ditch			3.00	16	NW¼ NE¼NE¼	14	65

Domestic use allowed.

3/70 c.f.s. allowed for irrigation.

Appropriator—U. S. Indian Service (Moapa Indian Reservation).

Source—Muddy River.

Indian Ditches			87.00	36		14	65
				35		14	65
				31		14	66
				1		15	66
				6		15	66
Total			87.00				

This allotment is based on the Thurtell findings as covered in Certificate No. 479, issued by **Henry** Thurtell on March 30, 1907.

Domestic use allowed.

87/70 c.f.s. allowed for irrigation.

Appropriator—**George Baldwin.**

Source—**Muddy River and Tributaries.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
George A. Davis and Dry Ditch....			16.00	25	SE¼SW¼	14	65
				25	SW¼SE¼	14	65
				36	Lots 2 and 3 NE¼	14	65

Domestic use allowed.
16/70 c.f.s. allowed for irrigation.

Appropriator—**Sadie George.**

Source—**Muddy River and Tributaries.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Indian Ditch......................................			2.10	1	SE¼NE¼	15	65

Domestic use allowed.
21/700 c.f.s. allowed fpr irrigation.

Appropriator—**Joseph Perkins.**

Source—**Muddy River and Tributaries.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Barnes & Harris Ditch and Bradfute Ditch.			30.00	6	Lots 4 and 5 NW¼	15	66
				6	Lot 6 SW¼	15	66
				6	SE¼NE¼	15	66
				6	SW¼NE¼	15	66
				6	Lots 2 and 3	15	66

Domestic use allowed.
30/70 c.f.s. allowed for irrigation.

Appropriator—**Los Angeles and Salt Lake Ry. Co.**

Source—**Muddy River.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Pipe Line..			equiv. to .0322	32	NE¼	14	66

NOTE—Water used for locomotives, cars, depot, stock yards, and town supply.
.04646 c.f.s. allowed.

Appropriator—**D. H. Livingston and Richard Smith.**

Source—**Muddy River and Tributaries.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
White, Livingston, and Crosby Ditches.				5	S½SE¼	15	66
				8	N½NE¼	15	66
				9	N½NW¼	15	66
				9	NW¼NE¼	15	66
				4	SW¼SE¼	15	66
				4	SE¼SW¼	15	66
			20.00	4	N½SE¼	15	66
				9	NE¼NE¼	15	66
				4	SE¼SE¼	15	66
				3	W½SW¼	15	66
				8	N½NW¼	15	66
				5	S½SW¼	15	66
All that portion of..				6	S½SE¼ situated east of the R. R. track		
Total..			160.00				

Domestic use allowed.
2 and 20/70 c.f.s. allowed for irrigation.

Appropriator—G. S. Holmes and Julia May Knox.

Source—Muddy River and Tributaries.

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Weiser Ditch			95.00	1	S½NW¼SW¼	15	66
				1	S½SW¼	15	66
				1	S½SE¼	15	66
				12	NE¼	15	66
				12	NE¼SE¼	15	66
				7	SW¼NW¼	15	67
				7	NE¼SW¼	15	67
				7	Frac. ½SW¼	15	67

Domestic use allowed.

1 and 25/70 c.f.s. allowed for irrigation.

Appropriator—W. J. Powers.

Source—Muddy River.

Cook Ditch			29.00	4	NW¼SE¼	15	66
				4	NE¼SE¼	15	66
				4	NW¼SE¼& NE¼SW¼	15	66
				4	NE¼SE¼	15	66
				4	SE¼NE¼	15	66
				3	NW¼SW¼	15	66

Domestic use allowed.

29/70 c.f.s. allowed for irrigation.

Appropriator—Muddy Valley Irrigation Co.

Source—Muddy River.

St. Joe Ditch			20.00	15	SE¼SW¼		
			14.00	15	SW¼SW¼		
			34.00	15		15	67
			20.00	21	SE¼NE¼		
			7.25	21	NE¼NE¼		
			27.25	21		15	67
			20.00	22	NE¼NW¼		
			24.00	22	SE¼NW¼		
			14.00	22	NW¼NW¼		
			14.00	22	SW¼NW¼		
			14.00	22	NW¼SW¼		
			14.00	22	NE¼SW¼		
			15.00	22	SW¼SW¼		
			20.00	22	NW¼NE¼		
			20.00	22	SW¼NE¼		
			15.00	22	NW¼SE¼		
			14.00	22	SE¼SW¼		
			184.00	22		15	67
			14.00	27	NE¼NW¼		
			14.00	27	NW¼NE¼		
			16.50	27	SW¼NE¼		
			30.00	27	SE¼NE¼		
			26.00	27	NE¼SE¼		
			10.00	27	SE¼SE¼		
			110.50	27		15	67
			2.60	26	SW¼NW¼		
			24.40	26	NW¼SW¼		
			3.00	26	SW¼SW¼		
			30.00	26		15	67
			17.50	35	SE¼NW¼		
			40.00	35	NW¼NW¼		
			20.00	35	NE¼NW¼		
			77.50	35		15	67
Total			463.25				

46325/7000 c.f.s. allowed for irrigation.

Appropriator—**Muddy Valley Irrigation Co.**

Source—**Muddy River.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Sprole-Averitt			22.25	27	NW¼NW¼		
			25.00	27	SW¼NW¼		
			10.00	27	SE¼NW¼		
			35.50	27	NE¼SW¼		
			22.50	27	SE¼SW¼		
			28.00	27	SW¼SE¼		
			143.25	27		15	67
			6.00	34	NE¼NW¼		
			15.00	34	SE¼NW¼		
			17.75	34	NE¼NE¼		
			40.00	34	NE¼NE¼		
			13.75	34	SW¼NE¼		
			6.50	34	SE¼SE¼		
			99.00	34		15	67
Total			242.25				

24225/7000 c.f.s. allowed for irrigation.

Appropriator—**Muddy Valley Irrigation Co.**

Source—**Muddy River.**

Kapalapa Ditch			10.00	2	NW¼NW¼		
			20.00	2	NE¼NW¼		
			20.00	2	SE¼NW¼		
			20.00	2	NW¼NE¼		
			7.50	2	NE¼NE¼		
			20.00	2	SE¼NE¼		
			20.00	2	SW¼NE¼		
			20.00	2	NW¼SE¼		
			20.00	2	NE¼SW¼		
Total			157.50	2		16	67

15750/7000 c.f.s. allowed for irrigation.

Appropriator—**Muddy Valley Irrigation Co.**

Source—**Muddy River.**

Stringtown Ditch			17.80	12	NE¼NW¼		
			12.50	12	SW¼NW¼		
			12.50	12	SE¼NW¼		
			7.50	12	SW¼NE¼		
			12.00	12	NE¼SE¼		
			30.00	12	NW¼SE¼		
			36.20	12	SW¼SE¼		
			24.10	12	SE¼SE¼		
			7.00	12	NE¼SW¼		
			15.00	12	SE¼SW¼		
			8.00	12	SW¼SW¼		
			182.60	12		16	67
			21.40	13	NW¼NE¼		
			25.80	13	NE¼NE¼		
			47.20	13		16	67
			5.00	18	SW¼NW¼		
			5.00	18	NW¼NW¼		
			10.00	18		16	68
Total			239.80				

23980/7000 c.f.s. allowed for irrigation.

Appropriator—Muddy Valley Irrigation Co.

Source—Muddy River.

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
Sparks Canal			13.00	1	SE¼SW¼	16	67
			21.80	7	SW¼SW¼		
			1.20	7	NW¼SW¼		
			23.00	7		16	68
			1.80	12	NE¼SE¼		
			8.20	12	SE¼SE¼		
			10.00	12		16	67
Total			46.00				

46/70 c.f.s. allowed for irrigation.

Appropriator—Muddy Valley Irrigation Co.

Source—Muddy River.

Overton Canal			18.00	2	SW¼SE¼		
			20.00	2	SE¼SW¼		
			12.00	2	SW¼SW¼		
			50.00	2		16	67
			7.00	3	SE¼SE¼	16	67
			5.00	10	NE¼NE¼	16	67
			10.00	11	NW¼NW¼		
			20.00	11	NE¼NW¼		
			20.00	11	NW¼NE¼		
			13.475	11	NE¼NE¼		
			7.50	11	SE¼NE¼		
			7.50	11	SW¼NE¼		
			10.00	11	NE¼SE¼		
			10.00	11	NW¼SE¼		
			27.525	11	SE¼SE¼		
			126.00	11		16	67
			13.00	13	NW¼NW¼		
			5.00	13	NE¼NW¼		
			20.00	13	SW¼NW¼		
			15.00	13	SE¼NW¼		
			4.50	13	SW¼NE¼		
			7.50	13	SE¼NE¼		
			24.50	13	NW¼SE¼		
			32.75	13	NE¼SE¼		
			26.40	13	SE¼SE¼		
			31.35	13	SW¼SE¼		
			24.50	13	NE¼SW¼		
			12.00	13	SE¼SW¼		
			216.50	13		16	67
			7.50	14	NE¼NE¼	16	67
			5.00	18	SW¼SW¼	16	68
			3.00	19	SW¼SE¼		
			6.00	19	NE¼SW¼		
			5.00	19	SE¼SW¼		
			14.00	19		16	68
			3.00	24	NW¼NE¼		
			20.00	24	NE¼NE¼		
			5.00	24	SW¼NE¼		
			4.00	24	SE¼NE¼		
			32.00	24		16	67
			3.00	30	NW¼NE¼	16	68
Total			466.00				

466/70 c.f.s. allowed for irrigation.

Appropriator—**Muddy Valley Irrigation Co.**

Source—**Muddy River.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S*	*R.E.*
Kaolin Ditch			28.00	19	SE¼SE¼	16	68
			20.00	30	SW¼NE¼		
			20.00	30	NW¼SE¼		
			7.00	30	NE¼NE¼		
			47.00	30		16	68
			20.00	32	NE¼SE¼		
			20.00	32	NW¼SE¼		
			40.00	32		16	68
			4.00	29	NE¼NW¼	16	68
Total			119.00				

119/70 c.f.s. allowed for irrigation.

Appropriator—**Muddy Valley Irrigation Co.**

Source—**Muddy River.**

Ditch Title	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S*	*R.E.*
St. Thomas Ditch	15.00	10	SE¼NW¼		
	20.05	10	NW¼NE¼		
	19.00	10	NE¼NE¼		
	23.00	10	SW¼NE¼		
	13.50	10	SE¼NE¼		
	17.25	10	NE¼SE¼		
	2.50	10	SE¼SE¼		
	110.30	10		17	68
	5.00	11	NW¼NW¼		
	28.00	11	SW¼NW¼		
	30.25	11	NW¼SW¼		
	20.25	11	NE¼SW¼		
	34.00	11	SW¼SW¼		
	37.75	11	SE¼SW¼		
	20.80	11	SW¼SE¼		
	176.05	11		17	68
	17.80	14	NW¼NW¼		
	37.00	14	NE¼NW¼		
	25.20	14	NW¼NE¼		
	24.20	14	NE¼NE¼		
	10.50	14	SW¼NE¼		
	19.40	14	SE¼NE¼		
	134.10	14		17	68
Total	420.45				

42045/7000 c.f.s. allowed for irrigation.

Appropriator—**Muddy Valley Irrigation Co.**

Source—**Muddy River.**

Ditch Title	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S*	*R.E.*
East St. Thomas Ditch	4.00	2	SW¼SW¼	17	68
	17.00	3	SE¼SE¼		
	7.00	3	NE¼SE¼		
	24.00	3		17	68
	15.85	11	NW¼NW¼		
	16.10	11	NE¼NW¼		
	8.00	11	SW¼NW¼		
	12.00	11	SE¼NW¼		
	10.60	11	NW¼SE¼		
	62.55	11		17	68
Total	90.55				

Domestic use allowed from all Muddy Valley Irrigation Company Ditches.

9055/7000 c.f s. allowed for irrigation.

Appropriator—John F. Perkins.

Source—Muddy River.

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
St. Thomas Ditch			2.00	10	E part of NE¼SE¼		
				11	W part of NW¼SW¼	17	68

Domestic use allowed.

2/70 c.f.s. allowed for irrigation.

Appropriator—Muddy Valley Irrigation Co., Assignee of Nevada Land and Livestock Co., Under Certificate No. 58.

Source—Muddy River.

Overton Canal	20.00	2	W½ NW¼NW¼		
	5.00	2	SW¼SE¼ and SE¼SE¼		
	115.00	11	NE¼NE¼ and SE¼		
	40.00	12	W½SW¼		
	25.00	12	E½SW¼		
	40.00	13	NW¼NW¼		
	6.50	13	NW¼SW¼		
	25.36	13	NW¼		
	7.09	13	NW¼SE¼		
	16.00	14	NE¼NE¼	16	67
	27.36	19	SW¼		
	34.00	30	SW¼NE¼		
	20.00	30	N½SE¼		
	16.80	30	SE¼SE¼	16	68
Total	398.11				

2.98 c.f.s. allowed for irrigation.

The use of this water is determined as a winter use; diversion to commence October 1 of each year and to extend to April 1 of the year following. The use is limited to irrigation, stockwatering, and domestic purposes.

Appropriator—Muddy Valley Irrigation Co., Assignee of Nevada Land and Livestock Co., Under Certificate No. 59.

Source—Muddy River.

	Winter Use				
Kaolin Ditch	40.00	20	SW¼SW¼	16	68
	150.00	29	SW¼	16	68
	210.00	32	N½	16	68
	35.20	32	N½SW¼	16	68
	111.61	32	SE¼	16	68
	70.00	33	S½SW¼	16	68
	26.36	33	NW¼SW¼	16	68
	24.43	31	E½NE¼	16	68
	52.70	3	W½SW¼&	17	68
		4	SE¼	17	68
	16.35	4	NE¼NW¼	17	68
	Summer Use				
	140.00	29	SW¼	16	68
	250.00	32	N½	16	68
	35.20	32	N½SW¼	16	68
Total summer use	425.20				
Total winter use	846.65				

Summer use—4.252 c.f.s.

Winter use—8.466 c.f.s.

The use is limited to irrigation, stockwatering, and domestic purposes.

Appropriator—**Muddy Valley Irrigation Co., Assignee of Nevada Land and Livestock Co., Under Certificate No. 60.**

Source—**Muddy River.**

Ditch Title	*Date when construction commenced*	*Date when land first irrigated*	*Number of acres irrigated*	*Sec.*	*Subdivision*	*Tp.S.*	*R.E.*
St. Joe or Logan Ditch..................			20.00	26	SE¼SW¼		
			20.00	35	E½NE¼		
			40.00	35	SE¼NW¼	15	67
Total..........			80.00				

The use of this water is determined as a winter use; diversion to commence October 1 of each year, and to extend to April 1 of the year following. Use limited to irrigation, stock-watering and domestic purposes.

0.8 c.f.s. allowed for irrigation.

STATE OF NEVADA
STATE ENGINEER'S OFFICE

I, J. G. Scrugham, State Engineer of the State of Nevada, duly appointed and qualified, having charge of the records and files of the office of the State Engineer, do hereby certify that the foregoing is a full, complete and true copy of the Order of Determination of the Relative Rights in and to the Waters of Muddy River and its Tributaries in Clark County, Nevada, prepared and filed in said office on the 21st day of January, 1920, as appears by the records and files of the office of the State Engineer of Nevada, and nothing more or less.

In Witness Whereof, I have hereunto set my hand and affixed my seal of office at the City of Carson, State of Nevada, this 21st day of January, A. D. 1920.

J. G. SCRUGHAM,
State Engineer.

[SEAL]

EXHIBIT "B"

IN THE MATTER OF THE DETERMINATION OF THE RELATIVE RIGHTS IN AND TO THE WATERS OF THE MUDDY RIVER AND ITS TRIBUTARIES IN CLARK COUNTY, STATE OF NEVADA.

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FURTHER AND SUPPLEMENTAL ORDER OF DETERMINATION.

In accordance with a stipulated agreement entered into by the parties in the suit of Muddy Valley Irrigation Company, et al, Vs. Moapa and Salt Lake Produce Company, et al, on the 23rd day of April, 1919, an order was entered in the Tenth Judicial District Court of the State of Nevada, in and for the County of Clark referring the above entitled action to the State Engineer for an adjudication of the water rights on the Muddy River stream system as provided for in Chapter 140, Statutes of 1913, and all Acts amendatory thereof.

On the 10th day of March, 1920, the matter having come on for hearing before the Court upon exceptions duly filed with the Clerk of the Court and served as required by law on the State Engineer, said exceptions having been filed by various parties to the said suit of Muddy Valley Irrigation Company et al. Vs. Moapa and Salt Lake Produce Company, et al., and the Court having heard said exceptions and proofs adduced by and on behalf of the excepting parties, the Court made and entered an order requiring the State Engineer to make a further determination of the waters of the said Muddy River and its tributaries subject to the Court's instructions which were set forth in said order, the said order being made by said District Court and entered in said suit.

In accordance with the said order of said Court and the said instructions the State Engineer makes the following:

FURTHER AND SUPPLEMENTAL ORDER OF DETERMINATION.

The tabulation of the allotments of the waters of the Muddy River stream system as set forth in the original order of determination with the changes herein made in this order, cover all claims filed in the office of the State Engineer as provided by law, and also an allotment to the Moapa Indian Reservation. Although duly notified of the pending adjudication proceedings in the statutory manner, the United States Indian Service authorities, did not file a claim and state that they refuse to recognize the authority of the State of Nevada to determine the water rights of the Moapa Indian Reservation. In the absence of any showing on the part of the United States Indian Service, the State Engineer has based the Moapa Indian Reservation allotment on the official investigations and reports made in the year 1906 by Henry Thurtell, at that time State Engineer of Nevada. These reports gave the Moapa Indian Reservation an allotment of water sufficient to properly irrigate an area of 87 acres, which was found to be the full area on the Reservation entitled to a vested water right under the law of this State.

(a) DUTY AND POINT OF DIVERSION DEFINED.

The duty of water allowed for all lands in the Muddy Valley, except on the Indian Reservation, shall be 1 c.f.s. flow to 70 acres for the summer irrigation season from May 1st to October 1st, and 1 c.f.s. flow to 100 acres for the winter irrigation season from October 1st to May 1st. On the Reservation, the duty of water allowed shall be 1 c.f.s. flow to 70 acres for the summer irrigation season from April 1st to October 1st, and 1 c.f.s. flow to 100 acres for the winter irrigation season from October 1st to April 1st.

The volumes or amounts of water alloted and to which it is agreed the respective parties are entitled shall be understood to include and define the amount of all the waters now or heretofore rightfully used on the lands given in the tabulation in the original order of determination whether diverted directly from said Muddy River or from its tributaries, springs, head-waters or other sources of supply, including waters claimed to have been developed heretofore by any of the said parties. All measurements of amounts except that awarded to the Indian Reservation shall be made at the places of diversion or as near thereto as practicable or convenient as the State Engineer or Water Commissioner may select or approve. On the Indian Reservation, all measurements of amounts diverted are to be made at the point where the main ditch enters or becomes adjacent to the land irrigated or as near thereto as practicable, as the State Engineer or Water Commissioner may select or approve.

(b) BALDWIN SPRING FLOW DEFINED.

The maximum flow of .8298 c. f. s. of water of the George Baldwin Spring now and heretofore used by George Baldwin and Aletha L. Baldwin, his wife, is water which has been developed by said parties. Such development and use of this amount of water has not and does not diminish the flow or volume of the Muddy River, or interfere with the rights of any other water users on the stream system. No further development of water on the head of the Muddy River stream system shall be made which in any way diminishes the flow of waters of the Muddy River or impairs rights defined and referred to in this order.

(c) METHOD OF USE.

The Muddy Valley Irrigation Company, subject to the supervision and general control of the State Engineer or Water Commissioner, shall distribute and control the distribution of the water alloted to it, and diverted and conveyed by its work to its stockholders and other persons obtaining water by means thereof.

All other parties named in this order shall not be required to take or use the water of said River in continuous flow but may cumulate the same or any part thereof in rotation and in periodic turn, with the approval of the water commissioner, subject to his control and direction and under such rules and regulations as are prescribed by the State Engineer and the statutes of the State of Nevada.

The whole amount of water diverted from the river at any one time by all the parties alloted water for use above the "narrows" is not to exceed in the aggregate the total amount of water alloted to the several parties resident in the Upper Muddy Valley. Below the lowest diversion of Knox and Holmes the flow in the stream shall be maintained substantially constant subject to seasonal variation. The whole of said river system shall be under the supervision and the rules and regulations of the State Engineer and the direction and control of the Water Commissioner, to be appointed as provided by law, except as hereinbefore specified as to the Muddy Valley Irrigation Company. Substantial headgates, weirs and sand-boxes, as the State Engineer through the Water Commissioner may order, shall be installed and maintained in good order by all who divert or use the waters of said stream system.

(d) Channel upkeep, responsibility for.

The owners of land on that part of said river above the "narrows" shall keep the channel through their respective lands cleared of all ordinary obstructions, but in case of extraordinary obstruction, such as the formation of lime deposits in the channel of the stream, the same shall be removed under the direction of the water commissioner and the expenses thereof paid pro rata by all parties to this determination in proportion to the acreage owned or controlled by them as defined in this order.

(e) Priority, vested and granted rights.

As between the parties to the above entitled suit and except against the rights awarded the Indian Reservation and the inhabitants thereof, all of the water rights enumerated as belonging to the parties to the suit shall be deemed and held to be vested rights acquired by valid appropriation and beneficial use prior to March 1, 1905, and by continued uninterrupted use since said date and shall be considered as equal in rank without anyone having any priority over another; this shall apply to and include the rights held by the Muddy Valley Irrigation Company as grantee or assignee of Nevada Land & Live Stock Company under certificates Nos. 58, 59 and 60 and to such permit or certificate as may be granted by the State Engineer to the Muddy Valley Irrigation Company under its application No. 1611. Against the right granted and alloted to the Indian Reservation, the rights held by the Muddy Valley Irrigation Company, under said certificates or permits, shall be deemed to be subsequent to the right by this order alloted to said Indian Reservation. The right allowed the Indian Reservation shall be deemed and held to be a vested right acquired by valid appropriation prior to March 1st, 1905, and uninterrupted use thereafter and shall to the extent allowed rank as of equal priority with all the other rights alloted and awarded to the various parties except those granted by the said certificates or permits.

(f) Losses, apportionments of.

All abnormal losses from the flow of said stream shall be pro-rated and shared among the parties holding water rights on the stream. Abnormal losses shall include any substantial loss from the permanent flow of the stream, such as a cloudburst destroying or obstructing the channel thereof or an opening up of a fissure in the bed of the stream or in one of the sources of supply and the disappearance therein of a substantial amount of the waters, thereby causing a diminution in the available flow.

If and such abnormal loss occurs at any time, the pro-rata share of such loss to be borne by each party to this order shall be as follows:

George Baldwin and Aletha L. Baldwin, his wife	16/2839
Moapa & Salt Lake Produce Co.	155/2839
Livingston and Smith	160/2839
Joseph Perkins and wife	30/2839
Knox and Holmes	95/2839
Issiah Cox and wife	10/2839
W. J. Powers and wife	29/2839
Sadie George	2.1/2839
Jacob Bloedel	2/2839

J. H. Mitchell	3/2839
U. S. Indian Service, Moapa Reservation	87/2839
John F. Perkins	2/2839
Muddy Valley Irrigation Company	2244.80/2839

As between the parties to the said suit the definition of abnormal losses shall be as contained in paragraph 8 of a stipulation filed in said court and suit on April 23rd, 1919, and the stipulation supplemental thereto filed in said court and suit and dated March 10th, 1920; and as between the parties to said suit the pro rata share of such abnormal losses shall be as set forth in paragraph 4 of the said stipulation supplemental to the stipulation of April 23rd, 1919.

(g) Expense of Commissioner.

The salary and expenses of the Water Commissioner shall be paid pro rata by the parties to the stipulation supplemented to the stipulation of April 23rd, 1919, made and filed in said suit March 10th, 1920, in the same proportion as for the sharing of abnormal losses set forth in paragraph 4 of said supplemental stipulation.

(h) All the waters of the stream system appropriated and alloted.

The aggregate volume of the several amounts and quantities of water awarded and alloted to the parties named in this order of determination which includes all the parties to said suit and the Indian Reservation is the total available flow of the said Muddy River and consumes and exhausts all of the available flow of the said Muddy River, its headwaters, sources of supply and tributaries.

(i) Water alloted to Muddy Valley Irrigation Company.

In accordance with the said stipulation and supplemental stipulation filed in said suit and the instructions of the Court requiring a further order of determination, as between the parties of the suit, the Muddy Valley Irrigation Company is hereby declared to be entitled to divert and use upon its lands all the waters of the said stream except the amounts specifically awarded and alloted to the other parties to said suit and to the Indian Reservation. In addition to the certificate rights belonging to the Muddy Valley Irrigation Company set forth in the original order of determination the Muddy Valley Irrigation Company is entitled to such rights as have accrued to it under its water application No. 1611 and which will be specifically defined in the certificate or permit to be issued by the State Engineer upon said application No. 1611, which said permit will be for approximately 10 C. F. S. of water (more or less) for use upon approximately 1000 acres of land (more or less) during the winter season.

The summary of allotments and certificates, contained in the original order of determination is amended so as to allow winter use of water to the parties hereinafter named and for the amounts hereinafter specified:

To	c.f.s. flow.
Moapa & Salt Lake Produce Company	2.215
Isaiah Cox and wife	.143
Isaiah Cox and wife (as grantees of J. H. Mitchell)	.043
George Baldwin	.2286
Sadie George	.03
John F. Perkins	.0286
Livingston and Smith	2.286
Knox and Holmes	1.357
Joseph Perkins	.428
W. J. Powers and wife	.4143

The amount allowed for winter use is allowed under a duty of water of 1 c. f. s. for 100 acres.

There is also the additional allotment to the Muddy Valley Irrigation Company for winter use under its application No. 1611. Except as hereinbefore changed the summary of allotments and certificates shall be as stated in the original order of determination.

The names of the respective appropriators, the sources of their appropriation, the titles of the ditches, the number of acres irrigated and the description of the land to which the water is appurtenant, the uses allowed and the amounts of water allowed for irrigation shall be as set forth in the original order of determination, except that it is understood that the rights of J. H. Mitchell have been acquired by and conveyed to Isaiah Cox and Anna M. Cox, his wife, and except that the periods of winter and summer use, as between the parties to said suit, shall be as hereinbefore defined in this further and supplemental order of determination.

/s/ J. G. Scrugham
State Engineer.

STATE OF NEVADA

STATE ENGINEER'S OFFICE.

I, J. G. SCRUGHAM, State Engineer of the State of Nevada, duly appointed and qualified, having charge of the records and files of the office of the State Engineer, do hereby certify that the foregoing is a full, complete and true copy of the further and supplemental order of determination of the relative rights in and to the waters of Muddy River and its tributaries in Clark County, Nevada, made under order of the Tenth Judicial District Court of the State of Nevada in and for the County of Clark, and in accordance with the instructions of said Court and filed in said office on the 11th day of March, 1920, as appears by the records and files of the office of the State Engineer of Nevada, and nothing more or less.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal of office this 11th day of March, A. D. 1920.

/s/ J. G. Scrugham
State Engineer.

SEAL

CERTIFICATION OF COPY

STATE OF NEVADA,)
) SS.
COUNTY OF CLARK,)

I, HARLEY A. HARMON, the duly elected, qualified and acting Clerk of Clark County, in the State of Nevada, and Ex-Officio Clerk of the District Court, do hereby certify that the foregoing is a true, full and correct copy of the original

JUDGMENT AND DECREE IN THE CASE ENTITLED

MUDDY VALLEY IRRIGATION COMPANY ET AL.,

Plaintiffs

VS.

MOAPA & SALT LAKE PRODUCE COMPANY, ET AL.

Defendants.

and

IN THE MATTER OF THE DETERMINATION OF THE RELATIVE RIGHTS IN AND TO THE WATERS OF THE MUDDY RIVER AND ITS TRIBUTARIES IN CLARK COUNTY, STATE OF NEVADA.

now on file and of record in this office.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the Seal of the Court at my office, Las Vegas, Nevada, the 12th day of March, , A. D. 19 20.

(SEAL)

/s/ Harley A. Harmon
CLERK.

/s/ Margaret Ireland
DEPUTY CLERK.

STATE OF NEVADA)
) ss.
COUNTY OF CLARK)

I, Helen Scott Reed, the duly elected, qualified and acting County Clerk of the County of Clark, State of Nevada, and ex-officio Clerk of the District Court of the Eighth Judicial District of the State of Nevada, in and for the County of Clark, do hereby certify and attest the foregoing to be a full, true and correct copy of the original: "JUDGMENT AND DECREE" in the action entitled;
MUDDY VALLEY IRRIGATION COMPANY, a corporation, NEVADA LAND & LIVESTOCK COMPANY, a corporation, SAMUEL H. WELLS, JOHN F. PERKINS and ELLEN C. PERKINS, his wife, Plaintiffs Vs.

MOAPA & SALT LAKE PRODUCE COMPANY, a corporation, GEORGE BALDWIN and ALETHA L. BALDWIN, his wife, ISAIAH COX and ANNA M. COX, his wife, JOSEPH PERKINS and KATHRYN PERKINS, his wife, D.H. LIVINGSTON and RICHARD SMITH, G. S. HOLMES and JULIA MAY KNOX, W. J. POWERS and MARY A. POWERS, his wife, SADIE GEORGE, LOS ANGELES & SALT LAKE RAILROAD COMPANY, a corporation, and WALKER D. HINES, as Director General of Railroads, and JACOB BLOEDEL, Defendants. and IN THE MATTER OF THE DETERMINATION OF THE RELATIVE RIGHTS IN AND TO THE WATERS OF THE MUDDY RIVER AND ITS TRIBUTARIES IN CLARK COUNTY, STATE OF NEVADA

Case No. 377

together with the endorsements thereon, now on file in my office, and that I have carefully compared the same with the original.

IN WITNESS WHEREOF, I have hereunto set my hand and annexed the Seal of the District Court of the Eighth Judicial District of the State of Nevada, in and for the County of Clark, this 16th day of May, 19 56

Helen Scott Reed
COUNTY CLERK OF THE COUNTY OF CLARK, STATE OF NEVADA, AND EX-OFFICIO CLERK OF THE DISTRICT COURT OF THE EIGHTH JUDICIAL DISTRICT OF THE STATE OF NEVADA, IN AND FOR THE COUNTY OF CLARK.

STATE OF NEVADA)
) ss.
COUNTY OF CLARK)

I, Frank McNamee, Judge of the District Court of the Eighth Judicial District of the State of Nevada, in and for the County of Clark, do hereby certify that Helen Scott Reed is County Clerk of the County of Clark, State of Nevada, and ex-officio Clerk of the District Court of the Eighth Judicial District of the State of Nevada, in and for the County of Clark (which Court is a Court of Record having a seal); that the signature to the foregoing certificate and attestation is the genuine signature of the said Helen Scott Reed, as such officer; that the seal annexed thereto is the seal of said District Court; that said Helen Scott Reed, as such clerk, is the proper officer to execute the said certificate of attestation, and that such attestation is in due form according to the laws of the State of Nevada.

IN WITNESS WHEREOF, I have hereunto set my hand in my official character as such Judge, at the City of Las Vegas, County and State aforesaid, this 16th day of May, A. D. 19 56

Frank McNamee
JUDGE OF THE DISTRICT COURT OF THE EIGHTH JUDICIAL DISTRICT OF THE STATE OF NEVADA, IN AND FOR THE COUNTY OF CLARK.

STATE OF NEVADA)
) ss.
COUNTY OF CLARK)

I, Helen Scott Reed, County Clerk of the County of Clark, State of Nevada, and ex-officio Clerk of the District Court of the Eighth Judicial District of the State of Nevada, in and for the County of Clark (which Court is a Court of Record, having a seal, which is annexed hereto) do hereby certify that Frank McNamee, whose name is subscribed to the foregoing certificate of due attestation was, at the time of signing the same, Judge of the District Court aforesaid, and was duly commissioned, qualified and authorized by law to execute said certificate. And I do further certify that the signature of the Judge above named to the said certificate of due attestation is genuine.

IN WITNESS WHEREOF, I have hereunto set my hand and annexed the Seal of the District Court of the Eighth Judicial District of the State of Nevada, in and for the County of Clark, this 16th day of May, 19 56

Helen Scott Reed
COUNTY CLERK OF THE COUNTY OF CLARK, STATE OF NEVADA, AND EX-OFFICIO CLERK OF THE DISTRICT COURT OF THE EIGHTH JUDICIAL DISTRICT OF THE STATE OF NEVADA, IN AND FOR THE COUNTY OF CLARK.

CC-51

Appendix E

Certificates for Upper Muddy River Water Rights Leased from LDS Church

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SE ROA 44011

ASSIGNED

Application No. 6419 Certificate Record No. 6795 Book 21 Page 6795

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Geo. C. Baldwin has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Muddy River through diversion dam and ditches for irrigation purposes. The point of diversion of water from the source is as follows: NW¼ NW¼ Section 15, T. 14S., R. 65E., M.D.B.&M., or at a point from which the NW corner of said Section 15 bears N. 16° W., a distance of 950.0 feet.

situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of Section 72, Chapter 140, Statutes of 1913, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Francis Taylor

Post-office address ~~(unknown)~~ Las Vegas, Nevada

Amount of appropriation 0.14 c.f.s. winter use 0.20 c.f.s. summer use

Period of use, from ~~October 1st~~ May 1st to ~~May 1st (winter)~~ October 1st (summer) of each year and following year.

* Date of priority of appropriation as decreed

Description of land to which the water is appurtenant:

14.0 acres in the W½ NE¼ SE¼ of Section 15, T. 14S., R. 65E., M.D.B.&M.

This certificate is issued subject to the terms of the permit.

This certificate changes the place of use of a portion of water of Proof 01621 under the Muddy River Decree in the Tenth Judicial District Court of the State of Nevada in and for the County of Clark, hence the priority of appropriation of this certificate is the same as Proof 01621 under said decree.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I, ROLAND D. WESTERGARD, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 1st day of October, A. D. 1968.

Compared jh/jw

Recorded 10-10-68 Bk. 905 Page 726614

Clark County Records.

(signature)
State Engineer.

1923

SE ROA 44012

Application No. 25861 Certificate Record No. 10944 Book 37 Page 10944

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Richard L. Hafen, Agent has presented to the State Enginee[r] of the State of Nevada Proof of Application of Water to Beneficial Use, from Various Springs being Tributary to the Muddy River through dams, headgates and ditch system fo[r] Irrigation and Domestic (As Decreed) purposes. The point of diversion of water from the source is as follows: SEE ATTACHED SHEET FOR POINT OF DIVERSION

situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter Day Saints

Post-office address Salt Lake City, Utah

Amount of appropriation 1.62 c.f.s., Summer; 1.14 c.f.s., Winter - As Decreed

Period of use, from Summer - May 1st to October 1st Winter - October 1st to May 1st As Decreed of each year

*Date of priority of appropriation As Decreed

Description of land to which the water is appurtenant:

21.9	Acres	in	the	SW¼	SW¼	of	Section	15,	T.14S.,	R.65E.,	M.D.B.&M.
10.5	"	"	"	SE¼	SW¼	"	"	"	"	"	"
20.5	"	"	"	SW¼	SE¼	"	"	"	"	"	"
3.0	"	"	"	SE¼	SE¼	"	"	"	"	"	"
1.4	"	"	"	SW¼	NE¼	"	"	16	"	"	"
9.0	"	"	"	NW¼	SE¼	"	"	"	"	"	"
26.2	"	"	"	NE¼	SE¼	"	"	"	"	"	"
16.0	"	"	"	SE¼	SE¼	"	"	"	"	"	"
5.0	"	"	"	NW¼	NE¼	"	"	22	"	"	"

113.5 Acres Total

*This certificate changes the point of diversion and place of use of Certificate 265, Muddy River Decree, therefore, the date of priority remains the same as Certificate 265, Muddy River Decree.

This certificate is issued subject to the terms of the Permit and the Muddy River Decree.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I PETER G. MORROS, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 5th day of JULY, A.D. 19 84

Compared bc/bd

Recorded .... Bk ...... Page ......

.... County Records.

1923

[signature]

State Engineer

The point of diversion of water from the source is as follows:

(1) Spring in the SW¼ NW¼ Section 16, Township 14 South, Range 65 East M.D.M., at a point from which the W¼ of said Section 16 bears S. 28° 35' 56" W., a distance of 1130.20 feet; (2) Spring in the SW¼ NW¼ Section 16, Township 14 South, Range 65 East M.D.M., at a point from which the W¼ of said Section 16 bears S. 38° 21' 18" W., a distance of 934.40 feet; (3) Spring in the SW¼ NW¼ Section 16, Township 14 South, Range 65 East M.D.M., at a point from which the W¼ of said Section 16 bears S. 59° 34' 12" W., a distance of 1375.30 feet; (4) Spring in the SE¼ NW¼ Section 16, Township 14 South, Range 65 East M.D.M., at a point from which the W¼ of said Section 16 bears S. 66° 23' 43" W., a distance of 2844.70 feet; (5) Spring in the NW¼ SE¼ Section 16, Township 14 South, Range 65 East M.D.M., at a point from which the W¼ of said Section 16 bears N. 65° 31' 43" W., a distance of 3430.70 feet; (6) Spring in the SE¼ SE¼ Section 16, Township 14 South, Range 65 East M.D.M., from which the W¼ of said Section 16 bears N. 60° 16' 00" W., a distance of 5494.40 feet; (7) Spring in the SW¼ SW¼ Section 15, Township 15 South, Range 65 East M.D.M., at a point from which the W¼ of Section 16, Township 14 South, Range 65 East M.D.M. bears N. 63° 38' 50" W., a distance of 6138.62 feet.

Application No. 26316 Certificate Record No. 10951 Book 37 Page 10951

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Richard L. Hafen, Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Baldwin Springs being Tributary to the Muddy River through dams, headgates and ditch system for Irrigation and Domestic (As Decreed) purposes. The point of diversion of water from the source is as follows: SEE ATTACHED SHEET FOR POINT OF DIVERSION

situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter Day Saints

Post-office address Salt Lake City, Utah

Amount of appropriation 0.8298 As Decreed

Period of use, from As Decreed to .... of each year

* Date of priority of appropriation As Decreed

Description of land to which the water is appurtenant:

10.0 Acres in the NE¼ NW¼ of Section 23, T.14S., R.65E., M.D.B.&M.
3.9 " " " SW¼ NW¼ " " " " " "
3.0 " " " SE¼ NW¼ " " " " " "
22.1 " " " SE¼ NW¼ " " " " " "
19.0 " " " NE¼ SW¼ " " " " " "

58.0 Acres Total

*This certificate changes the place of use of Permit 25860 which changed the point of diversion and place of use of Certificate 258 Muddy River Judgment and Decree BK 2, page 258, therefore, the date of priority remains the same as Certificate 258 Muddy River Judgment and Decree.

The issuance of this certificate corrects the permit terms to read "change the place of use" only and is issued subject to the terms and conditions of a Ruling by the State Engineer dated January 13, 1975.

This certificate is issued subject to the terms of the permit and the Muddy River Decree.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I PETER G. MORROS, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 5th day of JULY, A.D. 19 84

Peter G. Morros
State Engineer

Compared bc/bd

Recorded .... Bk. ...... Page ......

.... County Records.

1923

SE ROA 44016

The point of diversion of water from the source is as follows:

(1) Spring in the SW¼ SW¼ Section 9, Township 14 South, Range 65 East, M.D.M., at a point from which the W¼ of Section 16, Township 14 South, Range 65 East, M.D.M., bears S. 11° 40' 29" W., a distance of 2798.00 feet; (2) Spring in the NW¼ NW¼ Section 16, Township 14 South, Range 65 East, M.D.M., at a point from which the W¼ of said Section 16 bears S. 18° 12' 44" W., a distance of 2589.10 feet; (3) Spring in the SW¼ NW¼ Section 16, at a point from which the W¼ of said Section 16 bears S. 28° 35' 56" W., a distance of 1130.20 feet; (4) Spring in the SW¼ NW¼ of Section 16 at a point from which the W¼ of said Section 16 bears S. 38° 21' 18" W., a distance of 934.40 feet.

Application No. 26317 Certificate Record No. 10952 Book 37 Page 10952

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Richard L. Hafen, Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Various Springs being Tributary to the Muddy River through dams, headgates and ditch system for Irrigation and Domestic (As Decreed) purposes. The point of diversion of water from the source is as follows: SEE ATTACHED SHEET FOR POINT OF DIVERSION

situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter Day Saints

Post-office address Salt Lake City, Utah

Amount of appropriation 0.057 c.f.s.-Summer; 0.040 c.f.s.-Winter - As Decreed

Period of use, from Summer-May 1st to October 1st; Winter-October 1st to May 1st As Decreed of each year

* Date of priority of appropriation As Decreed

Description of land to which the water is appurtenant:

4.0 Acres in the NW¼ NE¼ of Section 22, T.14S., R.65E., M.D.B.&M.

*This certificate changes the point of diversion and place of use of a portion of Permit 25861 which changed the point of diversion and place of use of Certificate 265, Muddy River Decree, therefore, the date of priority remains the same as Certificate 265 Muddy River Decree.

The issuance of this certificate corrects the rate of diversion on the permit terms to read as follows, "0.057 (summer), 0.040 (winter)".

This certificate is issued subject to the terms of the permit and the Muddy River Decree.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I, PETER G. MORROS, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 5th day of JULY, A.D. 19 84.

Peter G. Morros
State Engineer

Compared bc/bd

Recorded .... Bk. ...... Page ......

.... County Records.

1923

The point of diversion of water from the source is as follows:

(1) Spring in the NW¼ SE¼ Section 16, Township 14 South, Range 65 East, M.D.M., at a point from which the West Quarter (W¼) Corner of said Section 16 bears N. 65° 31' 43" W., a distance of 3430.70 feet; (2) Warm Springs ditch in the SE¼ SE¼ of said Section 16 at a point from which the West Quarter (W¼) Corner of said Section 16 bears N. 60° 16' 00" W., a distance of 5494.40 feet; (3) Warm Springs ditch in the SW¼ SW¼ Section 15, Township 14 South, Range 65 East, M.D.M., at a point from which the West Quarter (W¼) Corner of Section 16, Township 14 South, Range 65 East, M.D.M., bears N. 63° 38' 50" W., a distance of 6138.62 feet.

Application No. 26318 Certificate Record No. 10953 Book 37 Page 10953

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Richard L. Hafen, Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Various Springs being Tributary to the Muddy River through dams, headgates and ditch system for Irrigation and Domestic (As Decreed) purposes. The point of diversion of water from the source is as follows: SEE ATTACHED SHEET FOR POINT OF DIVERSION

situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Corporation of the Presiding Bishop of the Church of Jesus Christ of Latter Day Saints

Post-office address Salt Lake City, Utah

Amount of appropriation 0.536 c.f.s.,-Summer; 0.375 c.f.s.,-Winter - As Decreed

Period of use, from Summer-May 1st to October 1st Winter-October 1st to May 1st - As Decreed of each year

* Date of priority of appropriation As Decreed

Description of land to which the water is appurtenant:

4.0 Acres in the NW¼ NW¼ of Section 23, T.14S., R.65E., M.D.B.&M.
25.0 Acres in the NE¼ NW¼ of Section 23, T.14S., R.65E., M.D.B.&M.
8.5 Acres in the SE¼ NW¼ of Section 23, T.14S., R.65E., M.D.B.&M.
37.5 Acres Total

*This certificate changes the place of use of a portion of Permit 25861 which changed the point of diversion and place of use of Certificate 265, Muddy River Decree, therefore, the date of priority remains the same as Certificate 265 Muddy River Decree.

This certificate is issued subject to the terms and conditions of a Ruling by the State Engineer dated January 13, 1975.

This certificate is issued subject to the terms of the permit and the Muddy River Decree.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I PETER G. MORROS, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 5th day of JULY, A.D. 19 84

Compared bc/bd

Recorded ______ Bk. ______ Page ______

______ County Records.

[signature]
State Engineer

1923

The point of diversion of water from the source is as follows:

(1) Spring in the SW¼ NW¼ Section 16, Township 14 South, Range 65 East, M.D.M., at a point from which the W¼ of said Section 16 bears S. 28° 35' 56" W., a distance of 1130.20 feet; (2) Spring in the SW¼ NW¼ Section 16, Township 14 South, Range 65 East, M.D.M., at a point from which the W¼ of said Section 16 bears S. 38° 21' 18" W., a distance of 934.40 feet; (3) Spring in the SW¼ NW¼ Section 16, Township 14 South, Range 65 East, M.D.M., at a point from which the W¼ of said Section 16 bears S. 59° 34' 12" W., a distance of 1375.30 feet; (4) Spring ditch in the SE¼ NW¼ of Section 16, Township 14 South, Range 65 East, M.D.M., at a point from which the W¼ of said Section 16 bears S. 66° 23' 43" W., a distance of 2844.70 feet.

Appendix F

SNWA Request for Offers to Purchase or Lease MVIC Shares

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REQUEST FOR OFFERS TO SELL PREFERRED AND/OR COMMON SHARES OF STOCK IN THE MUDDY VALLEY IRRIGATION COMPANY

The Southern Nevada Water Authority ("SNWA") requests that owners of preferred and common shares of stock in the Muddy Valley Irrigation Company ("MVIC") who desire to sell some or all of their shares, submit a completed and signed copy of the attached Offer to Sell Preferred and/or Common Shares of Stock ("OFFER" or "Offer(s) to Sell") to the Southern Nevada Water Authority, 100 City Parkway, Suite 700, Las Vegas, Nevada 89106, ATTENTION: Jeffrey Johnson, SNWA Division Manager, Water Management and Accounting Division on or before 5:00 p.m. on July 21, 2009. OFFERS may be mailed to P.O. Box 99956, Las Vegas, NV 89193-9956. The signed OFFER must be RECEIVED by SNWA at the above offices on or before 5:00 p.m. on July 21, 2009. Please call Jeff Johnson or Lisa Von Heeder at 702-862-3752 with any questions. SNWA intends to purchase preferred and/or common shares in MVIC on a first come, first served basis, subject to appropriation of funds by its Board of Directors for such purposes.

The terms of this Request for Offers to Sell are as follows:

1. SNWA is requesting OFFERS from all MVIC shareholders. SNWA will also consider Offers to Sell fractional shares.

2. SNWA will only consider accepting an OFFER if it is made on the attached form with no alterations to the terms contained in it.

3. Each signed OFFER returned to SNWA must also be signed by MVIC certifying that the stock certificates for the number of shares of stock offered for sale are on deposit with the Muddy Valley Irrigation Company, and are endorsed for transfer by the signature of all owners whose names appear on the stock certificates and that the certificates do not reflect any liens or encumbrances that would prevent the shareholder from executing the sale and/or prevent SNWA from utilizing the water represented by the shares to its full extent.

4. SNWA requests Offers to Sell preferred shares of stock at $50,000 per share and common shares of stock at $4,545 per share. Sellers have three payment options to choose from, and the same payment plan will apply to both preferred and common shares:

A. Lump sum payment. SNWA will pay all money to the Seller within sixty (60) days of SNWA's acceptance.

B. 5-year payment option. SNWA will pay annual payments no later than September 1 of every year for five (5) years based on the payment table below. The initial payment amount will be escalated by 3% each year. The Seller will have no right to use the water during the payment period.

Payment Table		
	Five-Year Term	Five-Year Term
Payment	Payment per Preferred Share *	Payment per Common Share *
1	$10,000.00	$909.00
2	$10,300.00	$936.27
3	$10,609.00	$964.36
4	$10,927.27	$993.29
5	$11,255.09	$1,023.09
Total	$53,091.36	$4,826.00

* Amounts increase at 3% per year.

C. 10-year payment option. SNWA will pay annual payments no later than September 1 of every year for ten (10) years based on the payment table below. The initial payment amount will be escalated by 3% each year. The Seller will have no right to use the water during the payment period.

Payment Table		
	Ten-Year Term	Ten-Year Term
Payment	Payment per Preferred Share *	Payment per Common Share *
1	$5,000.00	$454.50
2	$5,150.00	$468.14
3	$5,304.50	$482.18
4	$5,463.64	$496.64
5	$5,627.54	$511.54
6	$5,796.37	$526.89
7	$5,970.26	$542.70
8	$6,149.37	$558.98
9	$6,333.85	$575.75
10	$6,523.87	$593.02
Total	$57,319.40	$5,210.33

* Amounts increase at 3% per year.

5. On receipt of notification of SNWA's acceptance of a shareholder's Offer to Sell, MVIC will record the name of Muddy River Water Holdings, Inc. as the record owner of the shares in the Irrigation Company's records and shall deliver stock certificates evidencing the transfer to SNWA.

6. All OFFERS made to SNWA must be signed by all persons whose name(s) appear as owners on the stock certificates for the shares offered for sale.

7. The name of the ditch through which the water represented by the shares offered for sale is conveyed shall be listed in the OFFER.

8. Conveyance to Lake Mead of the water represented by the shares sold may require authorization from the Nevada State Engineer. The Seller expressly agrees not to take any actions to protest or otherwise prevent the conveyance of this water to Lake Mead.

9. The Seller agrees to identify all real property, if any, within the Moapa Valley that is either currently, or has been historically, irrigated with water represented by the shares sold, together with any documentation, including leases, regarding the use of the Seller's shares during the last five (5) years. Such obligation will be satisfied by completing the "Description of Land and Share Usage" form attached to this Request for Offers to Sell.

10. MVIC will not deliver the water covered by the sold shares for irrigation, but may either leave the water in the Muddy River or divert such water into its diversion ditches and allow such water to pass through its ditches into the Muddy River for discharge into Lake Mead.

11. By returning a signed OFFER to SNWA, each Seller warrants and represents that the shares of stock in MVIC offered for sale are free and clear of all encumbrances and obligations, except for balances owing for prior purchase of shares, and that the Seller(s) have the absolute right to transfer such shares pursuant to the terms of the OFFER and this Request for Offers to Sell. In the event of an encumbrance due to the unpaid purchase price of shares arising from a prior purchase and sale, the person to whom money is owed ("Encumbrancer") shall countersign the OFFER and agree to be bound by the terms of the sale. Both the Seller and the Encumbrancer shall give instructions to SNWA in the space provided on the OFFER regarding payment of funds. In lieu of the Encumbrancer countersigning the OFFER, the Seller(s) may present documentation acceptable to the SNWA showing that the Seller(s) have the absolute right to transfer such shares pursuant to the terms of this Request for Offers to Sell.

12. Each completed OFFER *MUST BE SIGNED BY THE MUDDY VALLEY IRRIGATION COMPANY.*

13. For any OFFER received by July 21, 2008, SNWA will notify all persons who submitted an OFFER whether or not their OFFER has been accepted by September 1, 2008. For any OFFER received after July 21, 2008, SNWA will notify all persons who submitted an OFFER whether or not their OFFER has been accepted no later than 60 days after the OFFER was received. No OFFER will be accepted if it is received after July 21, 2009. SNWA will also promptly notify MVIC of the name(s) of the Seller(s) and of the shares for which the OFFER has been accepted. The endorsed stock certificates will be returned by MVIC to the persons whose OFFERS are not accepted.

14. SNWA will pay all stock transfer fees and other MVIC costs resulting from an accepted OFFER.

15. SNWA reserves the right to reject an OFFER if in SNWA's sole judgment the aggregate amount of water represented by shares from a particular ditch is not sufficient to enable convenient monitoring of the conveyance of such water through the ditches of the MVIC to Lake Mead.

16. For all purposes of this OFFER, endorsed stock certificates will be held by MVIC in accordance with the provisions hereof.

17. No OFFER is a binding sale unless and until accepted by SNWA.

DATED this 12th day of May, 2008.

SOUTHERN NEVADA WATER AUTHORITY
100 City Parkway, Suite 700
Las Vegas, Nevada 89106

By: [signature]
Authorized Representative

REQUEST FOR OFFERS TO LEASE PREFERRED AND/OR COMMON SHARES OF STOCK IN THE MUDDY VALLEY IRRIGATION COMPANY

The Southern Nevada Water Authority ("SNWA") requests that owners of preferred and common shares of stock in the Muddy Valley Irrigation Company ("MVIC") who desire to lease some or all of their shares, submit a completed and signed copy of the attached Offer to Lease Preferred and/or Common Shares of Stock ("OFFER") to the Southern Nevada Water Authority, 100 City Parkway, Suite 700, Las Vegas, Nevada 89106, ATTENTION: Jeffrey Johnson, SNWA Division Manager, Water Management and Accounting Division on or before 5:00 p.m. on July 21, 2008. OFFERS may be mailed to P.O. Box 99956, Las Vegas, NV 89193-9956. The signed OFFER must be RECEIVED by SNWA at the above offices on or before 5:00 p.m. on July 21, 2008. Please call Jeff Johnson or Lisa Von Heeder at 702-862-3752 with any questions. SNWA intends to lease preferred and/or common shares in MVIC on a first come, first served basis, subject to appropriation of funds by its Board of Directors for such purposes.

The terms of this Request for Offers to Lease are as follows:

1. SNWA is requesting OFFERS from all MVIC shareholders. No OFFER will be accepted for lease of less than one (1) preferred share or one (1) common share. SNWA will only lease common shares from shareholders who lease to SNWA at least 75% of the preferred shares they own, or from shareholders who do not own any preferred shares.

2. SNWA will only consider accepting an OFFER if it is made on the attached form with no alterations to the terms contained in it.

3. The Lessor may choose to begin the lease either on October 1, 2008 or on October 1, 2009. The term of each Lease will begin on October 1 and end on September 30 of the year specified by the Lessor. The minimum lease term is one year, and all leases must end on or before September 30, 2018.

4. By mutual agreement of the Lessor and SNWA, any lease may be extended on a year-to-year basis, so long as the lease term does not extend after September 30, 2018. The Lessor shall give written notice of the Lessor's desire to extend the lease to SNWA no later than July 1 of the year the initial lease term expires. SNWA will notify the Lessor no later than September 1 whether or not SNWA agrees to extend the lease.

5. The annual rent for the lease and the latest date by which the lease payment will be mailed by SNWA to the Lessor is described in the table below. The initial lease payment amount will be escalated by 3% each year, as shown in the table below.

Water Year	Date of Annual Lease Payment	Annual Lease Payment per Preferred Share	Lease Payment per Common Share
2009 October 1, 2008 – September 30, 2009	9/1/2008	$1,700.00	$155.00
2010 October 1, 2009 – September 30, 2010	9/1/2009	$1,751.00	$159.65
2011 October 1, 2010 – September 30, 2011	9/1/2010	$1,803.53	$164.44
2012 October 1, 2011– September 30, 2012	9/1/2011	$1,857.64	$169.37
2013 October 1, 2012 – September 30, 2013	9/1/2012	$1,913.36	$174.45
2014 October 1, 2013 – September 30, 2014	9/1/2013	$1,970.77	$179.69
2015 October 1, 2014 – September 30, 2015	9/1/2014	$2,029.89	$185.08
2016 October 1, 2015 – September 30, 2016	9/1/2015	$2,090.79	$190.63
2017 October 1, 2016 – September 30, 2017	9/1/2016	$2,153.51	$196.35
2018 October 1, 2017 – September 30, 2018	9/1/2017	$2,218.11	$202.24

6. The Lessor agrees not to use, order or divert any portion of the water leased to SNWA during the lease term.

7. Each signed OFFER returned to SNWA must also be signed by MVIC certifying that all record owners of the stock certificate have signed the OFFER, and that the stock certificates do not reflect any liens or encumbrances that would prevent the shareholder from executing the lease and/or prevent SNWA from utilizing the water represented by the shares to its full extent.

8. All OFFERS made to SNWA must be signed by all persons whose name(s) appear as owners on the stock certificates for the shares offered for lease.

9. The name of the ditch through which the water represented by the shares offered for lease is conveyed shall be listed in the OFFER.

10. Conveyance to Lake Mead of the water represented by the leased shares may require authorization from the Nevada State Engineer. The Lessor expressly agrees not to take any actions to protest or otherwise prevent the conveyance of this water to Lake Mead.

11. The Lessor agrees to identify all real property, if any, within the Moapa Valley that is either currently, or has been historically, irrigated with water represented by the leased shares, together with any documentation, including leases, regarding the use of the Lessor's shares during the last five (5) years. Such obligation will be satisfied by completing the "Description of Land and Share Usage" form attached to this Request for Offers to Lease.

12. MVIC will not deliver the water covered by the leased shares for irrigation, but may either leave the water in the Muddy River or divert such water into its diversion ditches and allow such water to pass through its ditches into the Muddy River for discharge into Lake Mead.

13. By returning a signed OFFER to SNWA, each Lessor warrants and represents that the shares of stock in MVIC offered for lease are free and clear of all encumbrances and obligations that would prevent the shareholder from executing the lease and/or prevent SNWA from utilizing the water represented by the shares to its full extent during the lease term.

14. Each completed OFFER *MUST BE SIGNED BY THE MUDDY VALLEY IRRIGATION COMPANY.*

15. By September 1, 2008, SNWA will notify all persons who submitted an OFFER whether or not their OFFER has been accepted. SNWA will also promptly notify

MVIC of the name(s) of the Lessor(s) and of the shares for which the OFFER has been accepted.

16. SNWA will pay any MVIC fees and assessments due for each leased share during the lease term.

17. On receipt of notification of SNWA's acceptance of a shareholder's OFFER, MVIC will record the name of Muddy River Water Holdings, Inc. as the record lessee of the shares in the Irrigation Company's records and shall deliver stock certificates or other documentation evidencing the lease to SNWA.

18. SNWA reserves the right to reject an OFFER if in SNWA's sole judgment the aggregate amount of water represented by shares from a particular ditch is not sufficient to enable convenient monitoring of the conveyance of such water through the ditches of the MVIC to Lake Mead.

19. No OFFER is a binding lease unless and until accepted by SNWA.

DATED this 12th day of May, 2008.

SOUTHERN NEVADA WATER AUTHORITY
100 City Parkway, Suite 700
Las Vegas, Nevada 89106

By: ______________________
Authorized Representative

Appendix G

Water Right Certificates Held by MVIC

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Application No. 21873 Certificate Record No. 8325 Book 26 Page 8325

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Stephen F. Turner - Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Muddy River through company ditches and irrigation system for irrigation and domestic purposes. The point of diversion of water from the source is as follows: NW¼ NE¼ Sec. 21, T. 15 S., R. 67 E., M.D.B.&M., or at a point from which the SE corner of Sec. 28, T. 15 S., R. 67 E., M.D.B.&M., bears S. 11° 12' E., a distance of 10,131.06 feet, situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Muddy Valley Irrigation Co.

Post-office address Overton, Nevada

Amount of appropriation 9.70 cfs

Period of use, from October 1st to May 1st of the following year

* Date of priority of appropriation January 1, 1905

Description of land to which water is appurtenant:

See Exhibit "A" attached

This certificate is issued subject to the terms of the permit.

* This certificate changes the point of diversion and place of use of waters heretofore appropriated under Application 1611, Certificate 1199, hence the date of priority of appropriation is the same as that of Certificate 1199.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I ROLAND D. WESTERGARD, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 19th day of July, A. D. 19 74

Compared dp/ jw

Recorded 7-23-74 Bk. 445 Inst.# 404123

Clark County Records

[signature]
State Engineer

1923

Application No.................... Certificate Record No.................... Book.................... Page....................

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, ...has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from..
....
through..for
....
purposes. The point of diversion of water from the source is as follows:..
....
....
situated in..County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator..

Post-office address..

Amount of appropriation..

Period of use, from..................................to..of each year

Date of priority of appropriation..

Description of..
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The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I.., State Engineer of Nevada, have hereunto set my hand and the seal of my office, this ....day of......................................., A. D. 19........

....
State Engineer

Compared..

Recorded.................... Bk............ Page............

....County Records.

EXHIBIT "A"

0.88	acres in	NE¼ SW¼	Section 15,	T. 15 S.,	R. 67 E.,	M.D.B.&M.
30.05	"	SW¼ SW¼	"	"	"	"
18.68	"	SE¼ SW¼	"	"	"	"
11.52	"	NE¼ NE¼	Section 21,	"	"	"
6.31	"	SE¼ NE¼	"	"	"	"
1.58	"	NE¼ SE¼	"	"	"	"
7.88	"	SE¼ SE¼	"	"	"	"
5.79	"	NW¼ NW¼	Section 22,	"	"	"
39.39	"	NE¼ NW¼	"	"	"	"
7.55	"	NW¼ NE¼	"	"	"	"
13.82	"	SW¼ NE¼	"	"	"	"
27.07	"	SE¼ NW¼	"	"	"	"
39.73	"	SW¼ NW¼	"	"	"	"
31.41	"	NW¼ SW¼	"	"	"	"
33.91	"	NE¼ SW¼	"	"	"	"
32.32	"	NW¼ SE¼	"	"	"	"
9.76	"	NE¼ SE¼	"	"	"	"
4.21	"	SE¼ SE¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.76	"	SE¼ SW¼	"	"	"	"
25.86	"	SW¼ SW¼	"	"	"	"
18.00	"	NW¼ SW¼	Section 26,	"	"	"
1.70	"	NE¼ SW¼	"	"	"	"
6.06	"	SW¼ SW¼	"	"	"	"
0.17	"	SE¼ SW¼	"	"	"	"
35.18	"	NW¼ NW¼	Section 27,	"	"	"
25.42	"	NE¼ NW¼	"	"	"	"
28.00	"	NW¼ NE¼	"	"	"	"
6.60	"	NE¼ NE¼	"	"	"	"
37.12	"	SE¼ NE¼	"	"	"	"
31.26	"	SW¼ NE¼	"	"	"	"
26.52	"	SE¼ NW¼	"	"	"	"
31.82	"	SW¼ NW¼	"	"	"	"
12.42	"	NW¼ SW¼	"	"	"	"
21.09	"	NE¼ SW¼	"	"	"	"
14.22	"	NW¼ SE¼	"	"	"	"
29.84	"	NE¼ SE¼	"	"	"	"
29.09	"	SE¼ SE¼	"	"	"	"
39.70	"	SW¼ SE¼	"	"	"	"
9.82	"	SE¼ SW¼	"	"	"	"
38.34	"	NE¼ NW¼	Section 34,	"	"	"
33.88	"	NW¼ NE¼	"	"	"	"
33.86	"	NE¼ NE¼	"	"	"	"
28.29	"	SE¼ NE¼	"	"	"	"
36.21	"	SW¼ NE¼	"	"	"	"
16.32	"	SE¼ NW¼	"	"	"	"
7.71	"	NE¼ SW¼	"	"	"	"
25.32	"	NW¼ SE¼	"	"	"	"
18.55	"	NE¼ SE¼	"	"	"	"
31.48	"	NW¼ NW¼	Section 35	"	"	"
22.37	"	NE¼ NW¼	"	"	"	"
33.95	"	SE¼ NW¼	"	"	"	"
28.39	"	SW¼ NW¼	"	"	"	"
34.94	"	NW¼ SW¼	"	"	"	"
15.91	"	NE¼ SW¼	"	"	"	"
5.18	"	NW¼ SE¼	"	"	"	"
2.41	"	SE¼ SE¼	"	"	"	"
22.65	"	SW¼ SE¼	"	"	"	"
29.16	"	SE¼ SW¼	"	"	"	"
38.10	"	SW¼ SW¼	"	"	"	"

Application 21873 Cert. #8325, Book 26, Page 8325
(Continutation)

EXHIBIT "A"

2.11	acres in	NW¼ NW¼	Section 1,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
11.32	"	SW¼ NW¼	"	"	"	"
3.28	"	NE¼ SW¼	"	"	"	"
21.21	"	NW¼ SW¼	"	"	"	"
20.26	"	SE¼ SW¼	"	"	"	"
34.04	"	SW¼ SW¼	"	"	"	"
23.26	"	NE¼ NE¼	Section 2,	"	"	"
34.57	"	NW¼ NE¼	"	"	"	"
30.30	"	NE¼ NW¼	"	"	"	"
30.69	"	NW¼ NW¼	"	"	"	"
26.79	"	SE¼ NW¼	"	"	"	"
32.36	"	SW¼ NE¼	"	"	"	"
31.96	"	SE¼ NE¼	"	"	"	"
35.69	"	NE¼ SW¼	"	"	"	"
38.73	"	NW¼ SE¼	"	"	"	"
40.00	"	NE¼ SW¼	"	"	"	"
27.33	"	SW¼ SW¼	"	"	"	"
40.00	"	SE¼ SW¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.34	"	NE¼ NE¼	Section 3,	"	"	"
17.12	"	NW¼ NW¼	Section 11,	"	"	"
19.88	"	NE¼ NW¼	"	"	"	"
40.00	"	NW¼ NE¼	"	"	"	"
40.00	"	NE¼ NE¼	"	"	"	"
23.55	"	SE¼ NE¼	"	"	"	"
24.39	"	SW¼ NE¼	"	"	"	"
5.26	"	NW¼ SE¼	"	"	"	"
18.54	"	NE¼ SE¼	"	"	"	"
33.25	"	SE¼ SE¼	"	"	"	"
13.25	"	NE¼ NW¼	Section 12,	"	"	"
1.04	"	NW¼ NE¼	"	"	"	"
19.13	"	SW¼ NE¼	"	"	"	"
21.29	"	SE¼ NW¼	"	"	"	"
13.25	"	SW¼ NW¼	"	"	"	"
21.60	"	NE¼ SE¼	"	"	"	"
21.69	"	NW¼ SE¼	"	"	"	"
14.05	"	NE¼ SW¼	"	"	"	"
9.86	"	NW¼ SW¼	"	"	"	"
25.38	"	SW¼ SE¼	"	"	"	"
28.56	"	SE¼ SE¼	"	"	"	"
7.71	"	NW¼ SW¼	Section 7,	"	68	"
5.62	"	SE¼ SW¼	"	"	"	"
25.71	"	SW¼ SW¼	"	"	"	"
5.30	"	NE¼ NE¼	Section 13,	"	67	"
19.01	"	NW¼ NW¼	"	"	"	"
6.02	"	SW¼ NW¼	"	"	"	"
25.36	"	NE¼ SE¼	"	"	"	"
26.00	"	NE¼ SW¼	"	"	"	
36.85	"	SE¼ SE¼	"	"	"	"
7.58	"	NE¼ NE¼	Section 14,	"	"	"
26.89	"	SW¼ SW¼	Section 18,	"	68	"
12.08	"	NW¼ NW¼	Section 19,	"	"	"
16.33	"	NW¼ SW¼	"	"	"	"
9.64	"	NE¼ SW¼	"	"	"	"
13.15	"	SE¼ SE¼	"	"	"	"
13.70	"	SW¼ SE¼	"	"	"	"
21.32	"	SE¼ SW¼	"	"	"	"
15.55	"	SW¼ SW¼	"	"	"	"

Exhibit "A"

27.04	acres in	NE¼ NE¼	Section 24,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
14.21	"	NE¼ NE¼	Section 30,	"	68	"
9.83	"	NW¼ NE¼	"	"	"	"
6.14	"	NE¼ NW¼	"	"	"	"
1.40	"	SE¼ NW¼	"	"	"	"
18.97	"	SW¼ NE¼	"	"	"	"
17.92	"	SE¼ NE¼	"	"	"	"
27.71	"	SE¼ NW¼	Section 29,	"	"	"
29.15	"	SW¼ NW¼	"	"	"	"
18.26	"	NW¼ SW¼	"	"	"	"
11.24	"	NE¼ SW¼	"	"	"	"
2.53	"	NE¼ SE¼	Section 22,	T. 15 S.,	R. 67 E.,	"
5.85	"	SW¼ NW¼	Section 26,	"	"	"
2.25	"	SW¼ NW¼	"	"	"	"
2.66	"	NW¼ SW¼	"	"	"	"
13.54	"	NW¼ SW¼	"	"	"	"
.56	"	NE¼ SW¼	"	"	"	"
16.76	"	SW¼ SW¼	"	"	"	"
6.07	"	SE¼ SW¼	"	"	"	"
13.55	"	NE¼ NE¼	Section 27,	"	"	"
2.92	"	NW¼ SE¼	"	"	"	"
3.04	"	SW¼ NW¼	"	"	"	"
2.25	"	NW¼ SW¼	"	"	"	"
5.62	"	NW¼ SW¼	"	"	"	"
.79	"	SW¼ SW¼	"	"	"	"
23.51	"	SE¼ SW¼	"	"	"	"
6.19	"	SE¼ NW¼	Section 34,	"	"	"
10.86	"	SE¼ NE¼	"	"	"	"
18.62	"	NE¼ SW¼	"	"	"	"
14.62	"	NW¼ SE¼	"	"	"	"
21.77	"	NE¼ SE¼	"	"	"	"
39.93	"	SE¼ SE¼	"	"	"	"
35.99	"	SE¼ SE¼	Section 2,	T. 16 S.	"	"
8.66	"	SW¼ SW¼	"	"	"	"
27.90	"	NW¼ SW¼	"	"	"	"
35.32	"	SW¼ NW¼	"	"	"	"
7.09	"	SW¼ NE¼	Section 11,	"	"	"
15.02	"	SE¼ NE¼	"	"	"	"
21.94	"	NE¼ SE¼	"	"	"	"
14.40	"	NW¼ SE¼	"	"	"	"
37.01	"	NW¼ NW¼	Section 12,	"	"	"
18.62	"	NE¼ NW¼	"	"	"	"
18.05	"	SW¼ NW¼	"	"	"	"
2.25	"	SE¼ NW¼	"	"	"	"
28.12	"	NW¼ SW¼	"	"	"	"
13.50	"	NE¼ SW¼	"	"	"	"
37.23	"	SW¼ SW¼	"	"	"	"
27.56	"	SE¼ SW¼	"	"	"	"
7.65	"	SW¼ NW¼	Section 13	"	"	"
3.26	"	SW¼ NW¼	"	"	"	"
2.81	"	NW¼ SW¼	"	"	"	"
18.67	"	SE¼ NW¼	"	"	"	"
10.12	"	NE¼ SW¼	"	"	"	"
10.07	"	SE¼ SW¼	"	"	"	"
38.24	"	SW¼ SE¼	"	"	"	"
38.81	"	NW¼ SE¼	"	"	"	"
.67	"	NW¼ SE¼	"	"	"	"
8.89	"	SW¼ NE¼	"	"	"	"
12.37	"	NE¼ SE¼	"			
3,498.86	Total Acres					

The place of use under this certificate shall not exceed 2784.75 acres within the lands described under the place of use of this certificate.

Application No. 21874 Certificate Record No. 8326 Book 26 Page 8326

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Stephen F. Turner - Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Muddy River through company ditches and irrigation system for irrigation & domestic purposes. The point of diversion of water from the source is as follows: NW¼ NE¼ Sec. 21, T. 15 S., R. 67 E., M.D.B.&M., or at a point from which the SE corner of Sec. 28 T. 15 S., R. 67 E., M.D.B.&M., bears S. 11° 12' E., a distance of 10,131.06 feet, situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Muddy Valley Irrigation Co.

Post-office address Overton, Nevada

Amount of appropriation 0.0286 cfs from May 1st to October 1st of ea. yr. 0.02 cfs from October 1st to May 1st of the following year

Period of use, from see above to of each year

* Date of priority of appropriation January 1, 1905

Description of land to which water is appurtenant:

See Exhibit "A" attached

This certificate is issued subject to the terms of the permit.

* This certificate changes the point of diversion and place of use of waters heretofore appropriated under Certificate 267, Tenth Judicial District Court Decree, March 12, 1920, Muddy River Decree, hence the date of priority of appropriation is the same as that of Certificate 267.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I ROLAND D. WESTERGARD State Engineer of Nevada, have hereunto set my hand and the seal of my office this 19th day of July A. D. 19

Compared dp/jw

Recorded 7 23 74 Bk. 445 Page 404124

Clark County Records

Roland D. Westergard
State Engineer

SE ROA 44040

EXHIBIT "A"

0.88 acres	in	NE¼ SW¼	Section 15,	T. 15 S.,	R. 67 E.,	M.D.B.&M.
30.05	"	SW¼ SW¼	"	"	"	"
18.68	"	SE¼ SW¼	"	"	"	"
11.52	"	NE¼ NE¼	Section 21,	"	"	"
6.31	"	SE¼ NE¼	"	"	"	"
1.58	"	NE¼ SE¼	"	"	"	"
7.88	"	SE¼ SE¼	"	"	"	"
5.79	"	NW¼ NW¼	Section 22,	"	"	"
39.39	"	NE¼ NW¼	"	"	"	"
7.55	"	NW¼ NE¼	"	"	"	"
13.82	"	SW¼ NE¼	"	"	"	"
27.07	"	SE¼ NW¼	"	"	"	"
39.73	"	SW¼ NW¼	"	"	"	"
31.41	"	NW¼ SW¼	"	"	"	"
33.91	"	NE¼ SW¼	"	"	"	"
32.32	"	NW¼ SE¼	"	"	"	"
9.76	"	NE¼ SE¼	"	"	"	"
4.21	"	SE¼ SE¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.76	"	SE¼ SW¼	"	"	"	"
25.86	"	SW¼ SW¼	"	"	"	"
18.00	"	NW¼ SW¼	Section 26,	"	"	"
1.70	"	NE¼ SW¼	"	"	"	"
6.06	"	SW¼ SW¼	"	"	"	"
0.17	"	SE¼ SW¼	"	"	"	"
35.18	"	NW¼ NW¼	Section 27,	"	"	"
25.42	"	NE¼ NW¼	"	"	"	"
28.00	"	NW¼ NE¼	"	"	"	"
6.60	"	NE¼ NE¼	"	"	"	"
37.12	"	SE¼ NE¼	"	"	"	"
31.26	"	SW¼ NE¼	"	"	"	"
26.52	"	SE¼ NW¼	"	"	"	"
31.82	"	SW¼ NW¼	"	"	"	"
12.42	"	NW¼ SW¼	"	"	"	"
21.09	"	NE¼ SW¼	"	"	"	"
14.22	"	NW¼ SE¼	"	"	"	"
29.84	"	NE¼ SE¼	"	"	"	"
29.09	"	SE¼ SE¼	"	"	"	"
39.70	"	SW¼ SE¼	"	"	"	"
9.82	"	SE¼ SW¼	"	"	"	"
38.34	"	NE¼ NW¼	Section 34,	"	"	"
33.88	"	NW¼ NE¼	"	"	"	"
33.86	"	NE¼ NE¼	"	"	"	"
28.29	"	SE¼ NE¼	"	"	"	"
36.21	"	SW¼ NE¼	"	"	"	"
16.32	"	SE¼ NW¼	"	"	"	"
7.71	"	NE¼ SW¼	"	"	"	"
25.32	"	NW¼ SE¼	"	"	"	"
18.55	"	NE¼ SE¼	"	"	"	"
31.48	"	NW¼ NW¼	Section 35	"	"	"
22.37	"	NE¼ NW¼	"	"	"	"
33.95	"	SE¼ NW¼	"	"	"	"
28.39	"	SW¼ NW¼	"	"	"	"
34.94	"	NW¼ SW¼	"	"	"	"
15.91	"	NE¼ SW¼	"	"	"	"
5.18	"	NW¼ SE¼	"	"	"	"
2.41	"	SE¼ SE¼	"	"	"	"
22.65	"	SW¼ SE¼	"	"	"	"
29.16	"	SE¼ SW¼	"	"	"	"
38.10	"	SW¼ SW¼	"	"	"	"

Application 21874 Cert.# 8326 Book 26, Page 8326
(Continuation)

Exhibit "A"

27.04 acres	in	NE¼ NE¼	Section 24,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
14.21	"	NE¼ NE¼	Section 30,	"	68	"
9.83	"	NW¼ NE¼	"	"	"	"
6.14	"	NE¼ NW¼	"	"	"	"
1.40	"	SE¼ NW¼	"	"	"	"
18.97	"	SW¼ NE¼	"	"	"	"
17.92	"	SE¼ NE¼	"	"	"	"
27.71	"	SE¼ NW¼	Section 29,	"	"	"
29.15	"	SW¼ NW¼	"	"	"	"
18.26	"	NW¼ SW¼	"	"	"	"
11.24	"	NE¼ SW¼	"	"	"	"
2.53	"	NE¼ SE¼	Section 22,	T. 15 S.,	R. 67 E.,	"
5.85	"	SW¼ NW¼	Section 26,	"	"	"
2.25	"	SW¼ NW¼	"	"	"	"
2.66	"	NW¼ SW¼	"	"	"	"
13.54	"	NW¼ SW¼	"	"	"	"
.56	"	NE¼ SW¼	"	"	"	"
16.76	"	SW¼ SW¼	"	"	"	"
6.07	"	SE¼ SW¼	"	"	"	"
13.55	"	NE¼ NE¼	Section 27,	"	"	"
2.92	"	NW¼ SE¼	"	"	"	"
3.04	"	SW¼ NW¼	"	"	"	"
2.25	"	NW¼ SW¼	"	"	"	"
5.62	"	NW¼ SW¼	"	"	"	"
.79	"	SW¼ SW¼	"	"	"	"
23.51	"	SE¼ SW¼	"	"	"	"
6.19	"	SE¼ NW¼	Section 34,	"	"	"
10.86	"	SE¼ NE¼	"	"	"	"
18.62	"	NE¼ SW¼	"	"	"	"
14.62	"	NW¼ SE¼	"	"	"	"
21.77	"	NE¼ SE¼	"	"	"	"
39.93	"	SE¼ SE¼	"	"	"	"
35.99	"	SE¼ SE¼	Section 2,	T. 16 S.	"	"
8.66	"	SW¼ SW¼	"	"	"	"
27.90	"	NW¼ SW¼	"	"	"	"
35.32	"	SW¼ NW¼	"	"	"	"
7.09	"	SW¼ NE¼	Section 11,	"	"	"
15.02	"	SE¼ NE¼	"	"	"	"
21.94	"	NE¼ SE¼	"	"	"	"
14.40	"	NW¼ SE¼	"	"	"	"
37.01	"	NW¼ NW¼	Section 12,	"	"	"
18.62	"	NE¼ NW¼	"	"	"	"
18.05	"	SW¼ NW¼	"	"	"	"
2.25	"	SE¼ NW¼	"	"	"	"
28.12	"	NW¼ SW¼	"	"	"	"
13.50	"	NE¼ SW¼	"	"	"	"
37.23	"	SW¼ SW¼	"	"	"	"
27.56	"	SE¼ SW¼	"	"	"	"
7.65	"	SW¼ NW¼	Section 13	"	"	"
3.26	"	SW¼ NW¼	"	"	"	"
2.81	"	NW¼ SW¼	"	"	"	"
18.67	"	SE¼ NW¼	"	"	"	"
10.12	"	NE¼ SW¼	"	"	"	"
10.07	"	SE¼ SW¼	"	"	"	"
38.24	"	SW¼ SE¼	"	"	"	"
38.81	"	NW¼ SE¼	"	"	"	"
.67	"	NW¼ SE¼	"	"	"	"
8.89	"	SW¼ NE¼	"	"	"	"
12.37	"	NE¼ SE¼				
3,498.86 Total Acres						

The place of use under this certificate shall not exceed 2784.75 acres within the lands described under the place of use of this certificate.

Application No. 21875 Certificate Record No. 8327 Book 26 Page 8327

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Stephen F. Turner - Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Muddy River through company ditches and irrigation system for irrigation and domestic purposes. The point of diversion of water from the source is as follows: NW¼ NE¼ Sec. 21, T. 15 S., R. 67 E., M.D.B.&M., or at a point from which the SE corner of Sec. 28 T. 15 S., R. 67 E., M.D.B.&M., bears S. 11° 12' E., a distance of 10,131.06 feet, situated in Clark County, State of Nevada;

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator: Muddy Valley Irrigation Co.

Post-office address: Overton, Nevada

Amount of appropriation: 0.80 cfs

Period of use, from October 1st to April 1st of the following year.

* Date of priority of appropriation: January 1st, 1905

Description of land to which water is appurtenant:

See Exhibit "A" attached

This certificate is issued subject to the terms of the permit.

* This certificate changes the point of diversion and place of use of waters heretofore appropriated under Application 1372, Certificate 273, hence the date of priority of appropriation is the same as that of Certificate 273.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I, ROLAND D. WESTERGARD, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 19th day of July, A.D. 19 74

Compared dp/jw

Recorded 7 23 74 Bk. 445 Inst. Page 404125

Clark County Records.

(signature) State Engineer

1921

SE ROA 44044

Application 21875 Cert. #8327, Book 26, Page 8327.
(Continuation)

EXHIBIT "A"

0.88	acres in	NE¼ SW¼	Section 15,	T. 15 S.,	R. 67 E.,	M.D.B.&M.
30.05	"	SW¼ SW¼	"	"	"	"
18.68	"	SE¼ SW¼	"	"	"	"
11.52	"	NE¼ NE¼	Section 21,	"	"	"
6.31	"	SE¼ NE¼	"	"	"	"
1.58	"	NE¼ SE¼	"	"	"	"
7.88	"	SE¼ SE¼	"	"	"	"
5.79	"	NW¼ NW¼	Section 22,	"	"	"
39.39	"	NE¼ NW¼	"	"	"	"
7.55	"	NW¼ NE¼	"	"	"	"
13.82	"	SW¼ NE¼	"	"	"	"
27.07	"	SE¼ NW¼	"	"	"	"
39.73	"	SW¼ NW¼	"	"	"	"
31.41	"	NW¼ SW¼	"	"	"	"
33.91	"	NE¼ SW¼	"	"	"	"
32.32	"	NW¼ SE¼	"	"	"	"
9.76	"	NE¼ SE¼	"	"	"	"
4.21	"	SE¼ SE¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.76	"	SE¼ SW¼	"	"	"	"
25.86	"	SW¼ SW¼	"	"	"	"
18.00	"	NW¼ SW¼	Section 26,	"	"	"
1.70	"	NE¼ SW¼	"	"	"	"
6.06	"	SW¼ SW¼	"	"	"	"
0.17	"	SE¼ SW¼	"	"	"	"
35.18	"	NW¼ NW¼	Section 27,	"	"	"
25.42	"	NE¼ NW¼	"	"	"	"
28.00	"	NW¼ NE¼	"	"	"	"
6.60	"	NE¼ NE¼	"	"	"	"
37.12	"	SE¼ NE¼	"	"	"	"
31.26	"	SW¼ NE¼	"	"	"	"
26.52	"	SE¼ NW¼	"	"	"	"
31.82	"	SW¼ NW¼	"	"	"	"
12.42	"	NW¼ SW¼	"	"	"	"
21.09	"	NE¼ SW¼	"	"	"	"
14.22	"	NW¼ SE¼	"	"	"	"
29.84	"	NE¼ SE¼	"	"	"	"
29.09	"	SE¼ SE¼	"	"	"	"
39.70	"	SW¼ SE¼	"	"	"	"
9.82	"	SE¼ SW¼	"	"	"	"
38.34	"	NE¼ NW¼	Section 34,	"	"	"
33.88	"	NW¼ NE¼	"	"	"	"
33.86	"	NE¼ NE¼	"	"	"	"
28.29	"	SE¼ NE¼	"	"	"	"
36.21	"	SW¼ NE¼	"	"	"	"
16.32	"	SE¼ NW¼	"	"	"	"
7.71	"	NE¼ SW¼	"	"	"	"
25.32	"	NW¼ SE¼	"	"	"	"
18.55	"	NE¼ SE¼	"	"	"	"
31.48	"	NW¼ NW¼	Section 35	"	"	"
22.37	"	NE¼ NW¼	"	"	"	"
33.95	"	SE¼ NW¼	"	"	"	"
28.39	"	SW¼ NW¼	"	"	"	"
34.94	"	NW¼ SW¼	"	"	"	"
15.91	"	NE¼ SW¼	"	"	"	"
5.18	"	NW¼ SE¼	"	"	"	"
2.41	"	SE¼ SE¼	"	"	"	"
22.65	"	SW¼ SE¼	"	"	"	"
29.10	"	SE¼ SW¼	"	"	"	"
38.10	"	[illegible] SW¼	"	"	"	"

SE ROA 44045

Application 21875 Cert.#8327, Book 26, Page 8327
(Continuation)

Exhibit "A"

27.04	acres in	NE¼ NE¼	Section 24,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
14.21	"	NE¼ NE¼	Section 30,	"	68	"
9.83	"	NW¼ NE¼	"	"	"	"
6.14	"	NE¼ NW¼	"	"	"	"
1.40	"	SE¼ NW¼	"	"	"	"
18.97	"	SW¼ NE¼	"	"	"	"
17.92	"	SE¼ NE¼	"	"	"	"
27.71	"	SE¼ NW¼	Section 29,	"	"	"
29.15	"	SW¼ NW¼	"	"	"	"
18.26	"	NW¼ SW¼	"	"	"	"
11.24	"	NE¼ SW¼	"	"	"	"
2.53	"	NE¼ SE¼	Section 22,	T. 15 S.,	R. 67 E.,	"
5.85	"	SW¼ NW¼	Section 26,	"	"	"
2.25	"	SW¼ NW¼	"	"	"	"
2.66	"	NW¼ SW¼	"	"	"	"
13.54	"	NW¼ SW¼	"	"	"	"
.56	"	NE¼ SW¼	"	"	"	"
16.76	"	SW¼ SW¼	"	"	"	"
6.07	"	SE¼ SW¼	"	"	"	"
13.55	"	NE¼ NE¼	Section 27,	"	"	"
2.92	"	NW¼ SE¼	"	"	"	"
3.04	"	SW¼ NW¼	"	"	"	"
2.25	"	NW¼ SW¼	"	"	"	"
5.62	"	NW¼ SW¼	"	"	"	"
.79	"	SW¼ SW¼	"	"	"	"
23.51	"	SE¼ SW¼	"	"	"	"
6.19	"	SE¼ NW¼	Section 34,	"	"	"
10.86	"	SE¼ NE¼	"	"	"	"
18.62	"	NE¼ SW¼	"	"	"	"
14.62	"	NW¼ SE¼	"	"	"	"
21.77	"	NE¼ SE¼	"	"	"	"
39.93	"	SE¼ SE¼	"	"	"	"
35.99	"	SE¼ SE¼	Section 2,	T. 16 S.	"	"
8.66	"	SW¼ SW¼	"	"	"	"
27.90	"	NW¼ SW¼	"	"	"	"
35.32	"	SW¼ NW¼	"	"	"	"
7.09	"	SW¼ NE¼	Section 11,	"	"	"
15.02	"	SE¼ NE¼	"	"	"	"
21.94	"	NE¼ SE¼	"	"	"	"
14.40	"	NW¼ SE¼	"	"	"	"
37.01	"	NW¼ NW¼	Section 12,	"	"	"
18.62	"	NE¼ NW¼	"	"	"	"
18.05	"	SW¼ NW¼	"	"	"	"
2.25	"	SE¼ NW¼	"	"	"	"
28.12	"	NW¼ SW¼	"	"	"	"
13.50	"	NE¼ SW¼	"	"	"	"
37.23	"	SW¼ SW¼	"	"	"	"
27.56	"	SE¼ SW¼	"	"	"	"
7.65	"	SW¼ NW¼	Section 13	"	"	"
3.26	"	SW¼ NW¼	"	"	"	"
2.81	"	NW¼ SW¼	"	"	"	"
18.67	"	SE¼ NW¼	"	"	"	"
10.12	"	NE¼ SW¼	"	"	"	"
10.07	"	SE¼ SW¼	"	"	"	"
38.24	"	SW¼ SE¼	"	"	"	"
38.81	"	NW¼ SE¼	"	"	"	"
.67	"	NW¼ SE¼	"	"	"	"
8.89	"	SW¼ NE¼	"	"	"	"
12.37	"	NE¼ SE¼				
3,498.86	Total Acres					

The place of use under this certificate shall not exceed 2784.75 acres within the lands described under the place of use of this certificate.

Application No. 21876 Certificate Record No. 8328 Book 26 Page 8328

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Stephen F. Turner - Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from Muddy River through company ditches and irrigation system for irrigation and domestic purposes. The point of diversion of water from the source is as follows: NW¼ NE¼ Sec. 21, T. 15 S., R. 67 E., M.D.B.&M., or at a point from which the SE corner of Sec. 28, T. 15 S., R. 67 E., M.D.B.&M., bears S. 11° 12' E., a distance of 10,131.06 feet, situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Muddy Valley Irrigation Co.

Post-office address Overton, Nevada

Amount of appropriation 24.0068 cfs from May 1st to May 15th of each year.
31.0068 cfs from May 15th to October 1st of ea. yr.
14.448 cfs from October 1st to May 1st of the following year.

Period of use, from See above to of each year

* Date of priority of appropriation January 1, 1905

Description of land to which water is appurtenant:

See Exhibit "A" attached

This certificate is issued subject to the terms of the permit.

* This certificate changes the point of diversion and place of use of waters heretofore appropriated under Certificate 266, Tenth Judicial District Court Decree, March 12, 1920, Muddy River Decree, hence the date of priority of appropriation is the same as that of Certificate 266.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein

IN TESTIMONY WHEREOF, I ROLAND D. WESTERGARD, State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 19th day of July, A.D. 19 74

Compared dp/jw

Recorded 7-23-74 Bk. 445 Page 404126

Clark County Records.

Roland D. Westergard
State Engineer

1923

SE ROA 44048

Application 21876

Cert. #8328, Book 26, Page 8328
(Continuation)

EXHIBIT "A"

0.88 acres	in	NE¼ SW¼	Section 15,	T. 15 S.,	R. 67 E.,	M.D.B.&M.
30.05	"	SW¼ SW¼	"	"	"	"
18.68	"	SE¼ SW¼	"	"	"	"
11.52	"	NE¼ NE¼	Section 21,	"	"	"
6.31	"	SE¼ NE¼	"	"	"	"
1.58	"	NE¼ SE¼	"	"	"	"
7.88	"	SE¼ SE¼	"	"	"	"
5.79	"	NW¼ NW¼	Section 22,	"	"	"
39.39	"	NE¼ NW¼	"	"	"	"
7.55	"	NW¼ NE¼	"	"	"	"
13.82	"	SW¼ NE¼	"	"	"	"
27.07	"	SE¼ NW¼	"	"	"	"
39.73	"	SW¼ NW¼	"	"	"	"
31.41	"	NW¼ SW¼	"	"	"	"
33.91	"	NE¼ SW¼	"	"	"	"
32.32	"	NW¼ SE¼	"	"	"	"
9.76	"	NE¼ SE¼	"	"	"	"
4.21	"	SE¼ SE¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.76	"	SE¼ SW¼	"	"	"	"
25.86	"	SW¼ SW¼	"	"	"	"
18.00	"	NW¼ SW¼	Section 26,	"	"	"
1.70	"	NE¼ SW¼	"	"	"	"
6.06	"	SW¼ SW¼	"	"	"	"
0.17	"	SE¼ SW¼	"	"	"	"
35.18	"	NW¼ NW¼	Section 27,	"	"	"
25.42	"	NE¼ NW¼	"	"	"	"
28.00	"	NW¼ NE¼	"	"	"	"
6.60	"	NE¼ NE¼	"	"	"	"
37.12	"	SE¼ NE¼	"	"	"	"
31.26	"	SW¼ NE¼	"	"	"	"
26.52	"	SE¼ NW¼	"	"	"	"
31.82	"	SW¼ NW¼	"	"	"	"
12.42	"	NW¼ SW¼	"	"	"	"
21.09	"	NE¼ SW¼	"	"	"	"
14.22	"	NW¼ SE¼	"	"	"	"
29.84	"	NE¼ SE¼	"	"	"	"
29.09	"	SE¼ SE¼	"	"	"	"
39.70	"	SW¼ SE¼	"	"	"	"
9.82	"	SE¼ SW¼	"	"	"	"
38.34	"	NE¼ NW¼	Section 34,	"	"	"
33.88	"	NW¼ NE¼	"	"	"	"
33.86	"	NE¼ NE¼	"	"	"	"
28.29	"	SE¼ NE¼	"	"	"	"
36.21	"	SW¼ NE¼	"	"	"	"
16.32	"	SE¼ NW¼	"	"	"	"
7.71	"	NE¼ SW¼	"	"	"	"
25.32	"	NW¼ SE¼	"	"	"	"
18.55	"	NE¼ SE¼	"	"	"	"
31.48	"	NW¼ NW¼	Section 35	"	"	"
22.37	"	NE¼ NW¼	"	"	"	"
33.95	"	SE¼ NW¼	"	"	"	"
28.39	"	SW¼ NW¼	"	"	"	"
34.94	"	NW¼ SW¼	"	"	"	"
15.91	"	NE¼ SW¼	"	"	"	"
5.18	"	NW¼ SE¼	"	"	"	"
2.41	"	SE¼ SE¼	"	"	"	
22.65	"	SW¼ SE¼	"	"	"	
29.16	"	SE¼ SW¼	"	"	"	"
38.10	"	SW¼ SW¼	"			

SE ROA 44049

Exhibit "A"

27.04	acres in	NE¼ NE¼	Section 24,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
14.21	"	NE¼ NE¼	Section 30,	"	68	"
9.83	"	NW¼ NE¼	"	"	"	"
6.14	"	NE¼ NW¼	"	"	"	"
1.40	"	SE¼ NW¼	"	"	"	"
18.97	"	SW¼ NE¼	"	"	"	"
17.92	"	SE¼ NE¼	"	"	"	"
27.71	"	SE¼ NW¼	Section 29,	"	"	"
29.15	"	SW¼ NW¼	"	"	"	"
18.26	"	NW¼ SW¼	"	"	"	"
11.24	"	NE¼ SW¼	"	"	"	"
2.53	"	NE¼ SE¼	Section 22,	T. 15 S.,	R. 67 E.	"
5.85	"	SW¼ NW¼	Section 26,	"	"	"
2.25	"	SW¼ NW¼	"	"	"	"
2.66	"	NW¼ SW¼	"	"	"	"
13.54	"	NW¼ SW¼	"	"	"	"
.56	"	NE¼ SW¼	"	"	"	"
16.76	"	SW¼ SW¼	"	"	"	"
6.07	"	SE¼ SW¼	"	"	"	"
13.55	"	NE¼ NE¼	Section 27,	"	"	"
2.92	"	NW¼ SE¼	"	"	"	"
3.04	"	SW¼ NW¼	"	"	"	"
2.25	"	NW¼ SW¼	"	"	"	"
5.62	"	NW¼ SW¼	"	"	"	"
.79	"	SW¼ SW¼	"	"	"	"
23.51	"	SE¼ SW¼	"	"	"	"
6.19	"	SE¼ NW¼	Section 34,	"	"	"
10.86	"	SE¼ NE¼	"	"	"	"
18.62	"	NE¼ SW¼	"	"	"	"
14.62	"	NW¼ SE¼	"	"	"	"
21.77	"	NE¼ SE¼	"	"	"	"
39.93	"	SE¼ SE¼	"	"	"	"
35.99	"	SE¼ SE¼	Section 2,	T. 16 S.	"	"
8.66	"	SW¼ SW¼	"	"	"	"
27.90	"	NW¼ SW¼	"	"	"	"
35.32	"	SW¼ NW¼	"	"	"	"
7.09	"	SW¼ NE¼	Section 11,	"	"	"
15.02	"	SE¼ NE¼	"	"	"	"
21.94	"	NE¼ SE¼	"	"	"	"
14.40	"	NW¼ SE¼	"	"	"	"
37.01	"	NW¼ NW¼	Section 12,	"	"	"
18.62	"	NE¼ NW¼	"	"	"	"
18.05	"	SW¼ NW¼	"	"	"	"
2.25	"	SE¼ NW¼	"	"	"	"
28.12	"	NW¼ SW¼	"	"	"	"
13.50	"	NE¼ SW¼	"	"	"	"
37.23	"	SW¼ SW¼	"	"	"	"
27.56	"	SE¼ SW¼	"	"	"	"
7.65	"	SW¼ NW¼	Section 13	"	"	"
3.26	"	SW¼ NW¼	"	"	"	"
2.81	"	NW¼ SW¼	"	"	"	"
18.67	"	SE¼ NW¼	"	"	"	"
10.12	"	NE¼ SW¼	"	"	"	"
10.07	"	SE¼ SW¼	"	"	"	"
38.24	"	SW¼ SE¼	"	"	"	"
38.81	"	NW¼ SE¼	"	"	"	"
.67	"	NW¼ SE¼	"	"	"	"
8.89	"	SW¼ NE¼	"			
12.37	"	NE¼ SE¼				
3,498.86	Total Acres					

The place of use under this certificate shall not exceed 2784.75 acres within the lands described under the place of use of this certificate.

Application No. 21877 Certificate Record No. 8329 Book 26 Page 8329

THE STATE OF NEVADA
CERTIFICATE OF APPROPRIATION OF WATER

WHEREAS, Stephen F. Turner - Agent has presented to the State Engineer of the State of Nevada Proof of Application of Water to Beneficial Use, from the Muddy River through company ditches and irrigation system for irrigation, stockwatering and domestic purposes. The point of diversion of water from the source is as follows: NW¼ NE¼ Sec. 21, T. 15 S., R. 67 E., M.D.B.&M., or at a point from which the SE corner of Sec. 28 T. 15 S., R. 67 E., M.D.B.&M., bears S. 11° 12' E., a distance of 10,131.06 feet, situated in Clark County, State of Nevada.

NOW KNOW YE, That the State Engineer, under the provisions of NRS 533.425, has determined the date, source, purpose, amount of appropriation, and the place where such water is appurtenant, as follows:

Name of appropriator Muddy Valley Irrigation Co.

Post-office address Overton, Nevada

Amount of appropriation 4.252 cfs from April 1st to October 31st ea. yr. 8.466 cfs from October 1st to April 1st of the following year.

Period of use, from See above to of each year

* Date of priority of appropriation January 1st, 1905

Description of land to which water is appurtenant:

See Exhibit "A" attached

This certificate is issued subject to the terms of the permit.

* This certificate changes the point of diversion and place of use of waters heretofore appropriated under Permit 31, Certificate 272, hence the date of priority of appropriation is the same as that of Certificate 272.

The right to water hereby determined is limited to the amount which can be beneficially used, not to exceed the amount above specified, and the use is restricted to the place and for the purpose as set forth herein.

IN TESTIMONY WHEREOF, I ROLAND D. WESTERGARD State Engineer of Nevada, have hereunto set my hand and the seal of my office, this 19th day of July A.D. 1974

Roland D. Westergard
State Engineer

Compared dp/jw

Recorded 7-23-74 Bk. 445 Page 404127 Clark County Records.

1921

EXHIBIT "A"

0.88	acres in	NE¼ SW¼	Section 15,	T. 15 S.,	R. 67 E.,	M.D.B.&M.
30.05	"	SW¼ SW¼	"	"	"	"
18.68	"	SE¼ SW¼	"	"	"	"
11.52	"	NE¼ NE¼	Section 21,	"	"	"
6.31	"	SE¼ NE¼	"	"	"	"
1.58	"	NE¼ SE¼	"	"	"	"
7.88	"	SE¼ SE¼	"	"	"	"
5.79	"	NW¼ NW¼	Section 22,	"	"	"
39.39	"	NE¼ NW¼	"	"	"	"
7.55	"	NW¼ NE¼	"	"	"	"
13.82	"	SW¼ NE¼	"	"	"	"
27.07	"	SE¼ NW¼	"	"	"	"
39.73	"	SW¼ NW¼	"	"	"	"
31.41	"	NW¼ SW¼	"	"	"	"
33.91	"	NE¼ SW¼	"	"	"	"
32.32	"	NW¼ SE¼	"	"	"	"
9.76	"	NE¼ SE¼	"	"	"	"
4.21	"	SE¼ SE¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.76	"	SE¼ SW¼	"	"	"	"
25.86	"	SW¼ SW¼	"	"	"	"
18.00	"	NW¼ SW¼	Section 26,	"	"	"
1.70	"	NE¼ SW¼	"	"	"	"
6.06	"	SW¼ SW¼	"	"	"	"
0.17	"	SE¼ SW¼	"	"	"	"
35.18	"	NW¼ NW¼	Section 27,	"	"	"
25.42	"	NE¼ NW¼	"	"	"	"
28.00	"	NW¼ NE¼	"	"	"	"
6.60	"	NE¼ NE¼	"	"	"	"
37.12	"	SE¼ NE¼	"	"	"	"
31.26	"	SW¼ NE¼	"	"	"	"
26.52	"	SE¼ NW¼	"	"	"	"
31.82	"	SW¼ NW¼	"	"	"	"
12.42	"	NW¼ SW¼	"	"	"	"
21.09	"	NE¼ SW¼	"	"	"	"
14.22	"	NW¼ SE¼	"	"	"	"
29.84	"	NE¼ SE¼	"	"	"	"
29.09	"	SE¼ SE¼	"	"	"	"
39.70	"	SW¼ SE¼	"	"	"	"
9.82	"	SE¼ SW¼	"	"	"	"
38.34	"	NE¼ NW¼	Section 34,	"	"	"
33.88	"	NW¼ NE¼	"	"	"	"
33.86	"	NE¼ NE¼	"	"	"	"
28.29	"	SE¼ NE¼	"	"	"	"
36.21	"	SW¼ NE¼	"	"	"	"
16.32	"	SE¼ NW¼	"	"	"	"
7.71	"	NE¼ SW¼	"	"	"	"
25.32	"	NW¼ SE¼	"	"	"	"
18.55	"	NE¼ SE¼	"	"	"	"
31.48	"	NW¼ NW¼	Section 35	"	"	"
22.37	"	NE¼ NW¼	"	"	"	"
33.95	"	SE¼ NW¼	"	"	"	"
28.39	"	SW¼ NW¼	"	"	"	"
34.94	"	NW¼ SW¼	"	"	"	"
15.91	"	NE¼ SW¼	"	"	"	"
5.18	"	NW¼ SE¼	"	"	"	"
2.41	"	SE¼ SE¼	"	"	"	"
22.65	"	SW¼ SE¼	"	"	"	"
29.16	"	SE¼ SW¼	"	"	"	"
38.10	"	SW¼ SW¼	"	"	"	"

Application 21877

Cert. #8329, Book 26, Page 8329
(Continuation)

EXHIBIT "A"

2.11	acres in	NW¼ NW¼	Section 1,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
11.32	"	SW¼ NW¼	"	"	"	"
3.28	"	NE¼ SW¼	"	"	"	"
21.21	"	NW¼ SW¼	"	"	"	"
20.26	"	SE¼ SW¼	"	"	"	"
34.04	"	SW¼ SW¼	"	"	"	"
23.26	"	NE¼ NE¼	Section 2,	"	"	"
34.57	"	NW¼ NE¼	"	"	"	"
30.30	"	NE¼ NW¼	"	"	"	"
30.69	"	NW¼ NW¼	"	"	"	"
26.79	"	SE¼ NW¼	"	"	"	"
32.36	"	SW¼ NE¼	"	"	"	"
31.96	"	SE¼ NE¼	"	"	"	"
35.69	"	NE¼ SW¼	"	"	"	"
38.73	"	NW¼ SE¼	"	"	"	"
40.00	"	NE¼ SW¼	"	"	"	"
27.33	"	SW¼ SW¼	"	"	"	"
40.00	"	SE¼ SW¼	"	"	"	"
40.00	"	SW¼ SE¼	"	"	"	"
39.34	"	NE¼ NE¼	Section 3,	"	"	"
17.12	"	NW¼ NW¼	Section 11,	"	"	"
19.88	"	NE¼ NW¼	"	"	"	"
40.00	"	NW¼ NE¼	"	"	"	"
40.00	"	NE¼ NE¼	"	"	"	"
23.55	"	SE¼ NE¼	"	"	"	"
24.39	"	SW¼ NE¼	"	"	"	"
5.26	"	NW¼ SE¼	"	"	"	"
18.54	"	NE¼ SE¼	"	"	"	"
33.25	"	SE¼ SE¼	"	"	"	"
13.25	"	NE¼ NW¼	Section 12,	"	"	"
1.04	"	NW¼ NE¼	"	"	"	"
19.13	"	SW¼ NE¼	"	"	"	"
21.29	"	SE¼ NW¼	"	"	"	"
13.25	"	SW¼ NW¼	"	"	"	"
21.60	"	NE¼ SE¼	"	"	"	"
21.69	"	NW¼ SE¼	"	"	"	"
14.05	"	NE¼ SW¼	"	"	"	"
9.86	"	NW¼ SW¼	"	"	"	"
25.38	"	SW¼ SE¼	"	"	"	"
28.56	"	SE¼ SE¼	"	"	68	"
7.71	"	NW¼ SW¼	Section 7,	"	"	"
5.62	"	SE¼ SW¼	"	"	"	"
25.71	"	SW¼ SW¼	"	"	67	"
5.30	"	NE¼ NE¼	Section 13,	"	"	"
19.01	"	NW¼ NW¼	"	"	"	"
6.02	"	SW¼ NW¼	"	"	"	"
25.36	"	NE¼ SE¼	"	"	"	
26.00	"	NE¼ SW¼	"	"	"	"
36.85	"	SE¼ SE¼	"	"	"	"
7.58	"	NE¼ NE¼	Section 14,	"	68	"
26.89	"	SW¼ SW¼	Section 18,	"	"	"
12.08	"	NW¼ NW¼	Section 19,	"	"	"
16.33	"	NW¼ SW¼	"	"	"	"
9.64	"	NE¼ SW¼	"	"	"	"
13.15	"	SE¼ SE¼	"	"	"	"
13.70	"	SW¼ SE¼	"	"	"	"
21.32	"	SE¼ SW¼	"	"	"	"
15.55	"	SW¼ SW¼				

SE ROA 44054

Application 21877 Cert.# 8329 Book 26, Page 8329
(Continuation)

Exhibit "A"

27.04	acres in	NE¼ NE¼	Section 24,	T. 16 S.,	R. 67 E.,	M.D.B.&M.
14.21	"	NE¼ NE¼	Section 30,	"	68	"
9.83	"	NW¼ NE¼	"	"	"	"
6.14	"	NE¼ NW¼	"	"	"	"
1.40	"	SE¼ NW¼	"	"	"	"
18.97	"	SW¼ NE¼	"	"	"	"
17.92	"	SE¼ NE¼	"	"	"	"
27.71	"	SE¼ NW¼	Section 29,	"	"	"
29.15	"	SW¼ NW¼	"	"	"	"
18.26	"	NW¼ SW¼	"	"	"	"
11.24	"	NE¼ SW¼	"	"	"	"
2.53	"	NE¼ SE¼	Section 22,	T. 15 S.,	R. 67 E.,	"
5.85	"	SW¼ NW¼	Section 26,	"	"	"
2.25	"	SW¼ NW¼	"	"	"	"
2.66	"	NW¼ SW¼	"	"	"	"
13.54	"	NW¼ SW¼	"	"	"	"
.56	"	NE¼ SW¼	"	"	"	"
16.76	"	SW¼ SW¼	"	"	"	"
6.07	"	SE¼ SW¼	"	"	"	"
13.55	"	NE¼ NE¼	Section 27,	"	"	"
2.92	"	NW¼ SE¼	"	"	"	"
3.04	"	SW¼ NW¼	"	"	"	"
2.25	"	NW¼ SW¼	"	"	"	"
5.62	"	NW¼ SW¼	"	"	"	"
.79	"	SW¼ SW¼	"	"	"	"
23.51	"	SE¼ SW¼	"	"	"	"
6.19	"	SE¼ NW¼	Section 34,	"	"	"
10.86	"	SE¼ NE¼	"	"	"	"
18.62	"	NE¼ SW¼	"	"	"	"
14.62	"	NW¼ SE¼	"	"	"	"
21.77	"	NE¼ SE¼	"	"	"	"
39.93	"	SE¼ SE¼	"	"	"	"
35.99	"	SE¼ SE¼	Section 2,	T. 16 S.	"	"
8.66	"	SW¼ SW¼	"	"	"	"
27.90	"	NW¼ SW¼	"	"	"	"
35.32	"	SW¼ NW¼	"	"	"	"
7.09	"	SW¼ NE¼	Section 11,	"	"	"
15.02	"	SE¼ NE¼	"	"	"	"
21.94	"	NE¼ SE¼	"	"	"	"
14.40	"	NW¼ SE¼	"	"	"	"
37.01	"	NW¼ NW¼	Section 12,	"	"	"
18.62	"	NE¼ NW¼	"	"	"	"
18.05	"	SW¼ NW¼	"	"	"	"
2.25	"	SE¼ NW¼	"	"	"	"
28.12	"	NW¼ SW¼	"	"	"	"
13.50	"	NE¼ SW¼	"	"	"	"
37.23	"	SW¼ SW¼	"	"	"	"
27.56	"	SE¼ SW¼	"	"	"	"
7.65	"	SW¼ NW¼	Section 13	"	"	"
3.26	"	SW¼ NW¼	"	"	"	"
2.81	"	NW¼ SW¼	"	"	"	"
18.67	"	SE¼ NW¼	"	"	"	"
10.12	"	NE¼ SW¼	"	"	"	"
10.07	"	SE¼ SW¼	"	"	"	"
38.24	"	SW¼ SE¼	"	"	"	"
38.81	"	NW¼ SE¼	"	"	"	"
.67	"	NW¼ SE¼	"	"	"	"
8.89	"	SW¼ NE¼	"	"	"	"
12.37	"	NE¼ SE¼				
3,498.86	Total Acres					

The place of use under this certificate shall not exceed 2784.75 acres within the lands described under the place of use of this certificate.

Appendix H
MVIC Letter of Concurrence

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SOUTHERN NEVADA WATER AUTHORITY
100 City Parkway, Suite 700 • Las Vegas, NV 89106
MAILING ADDRESS: P.O. Box 99956 • Las Vegas, NV 89193-9956
(702) 862-3400 • snwa.com

May 4, 2009

Scott Millington, General Manager
Muddy Valley Irrigation Company
P.O. Box 665
Overton, Nevada 89040

Dear Mr. Millington:

SNWA would like to confirm the number of Muddy Valley Irrigation Company (MVIC) shares it owned and leased during Calendar Year (CY) 2008 and the shares in the lower most row in the table below were not utilized for irrigation during CY 2008. This letter of concurrence verifying the number of shares controlled will be provided to the Bureau of Reclamation and the Nevada State Engineer's Office in support of SNWA's accounting of its MVIC water rights, in lieu of providing them copies of owned share certificates and numerous lease agreements. Please review the number of shares below that SNWA has described it controlled during CY 2008 and sign this letter if MVIC concurs with numbers and time periods of non-use.

2008

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Owned												
Common	1921.3717	1921.3717	1921.3717	1921.3717	1921.3717	1932.3717	1932.3717	2071.0387	2076.5387	2097.5427	2097.5427	2097.5427
Preferred	681.6487	681.6487	681.6487	681.6487	681.6487	695.6487	706.6487	746.4407	747.2487	762.4187	762.4187	762.9187
Leased Back												
Common	304.1247	304.1247	304.1247	304.1247	304.1247	304.1247	304.1247	304.1247	304.1247	376.1247	376.1247	376.1247
Preferred	216.7917	216.7917	216.7917	216.7917	216.7917	216.7917	216.7917	216.7917	216.7917	228.0417	228.0417	228.0417
Leased												
Common	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	562.2500	562.2500	562.2500
Preferred	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	242.7830	242.7830	242.7830
Controlled												
Common	1617.2470	1617.2470	1617.2470	1617.2470	1617.2470	1628.2470	1628.2470	1766.9140	1772.4140	2283.6680	2283.6680	2283.6680
Preferred	464.8570	464.8570	464.8570	464.8570	464.8570	478.8570	489.8570	529.6490	530.4570	777.1600	777.1600	777.6600

Thank you for your assistance. If you have any questions, please contact me at (702) 862-3748 or Sean Collier at (702) 691-5375.

Sincerely,

[signature]

Jeffrey Johnson, SNWA Division Manager
Water Management and Accounting Division

JJ:lmv

Concurrence by:

[signature] 5/4/09

Scott Millington, General Manager Date
Muddy Valley Irrigation Company

SE ROA 44059

Appendix I
Muddy Valley Irrigation Company Water Schedule

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Muddy Valley Irrigation
PO Box 665
Overton, NV 89040

Water Schedule
Winter 2008
Lower Logan Ditch

Account: SNWA
Preferred Shares: 277.504
Common Shares: 900.000
Runtime: 150

SNWA
P.O. Box 99956
LAS VEGAS, NV 89193-9956

Week	Starting Date	Starting Time	Ending Date	Ending Time
1	Sunday, Oct 12, 2008	6:00 PM	Saturday, Oct 18, 2008	2:39 PM
2	Monday, Oct 20, 2008	12:00 AM	Saturday, Oct 25, 2008	8:39 PM
3	Monday, Oct 27, 2008	6:00 AM	Sunday, Nov 2, 2008	2:39 AM

Water on Call

Please call the office at

398-7310

to arrange for water.

Week	Starting Date	Starting Time	Ending Date	Ending Time
22	Saturday, Mar 14, 2009	12:00 AM	Thursday, Mar 19, 2009	8:39 PM
23	Saturday, Mar 21, 2009	6:00 AM	Friday, Mar 27, 2009	2:39 AM
24	Saturday, Mar 28, 2009	12:00 PM	Friday, Apr 3, 2009	8:39 AM
25	Saturday, Apr 4, 2009	6:00 PM	Friday, Apr 10, 2009	2:39 PM
26	Sunday, Apr 12, 2009	12:00 AM	Friday, Apr 17, 2009	8:39 PM
27	Sunday, Apr 19, 2009	6:00 AM	Saturday, Apr 25, 2009	2:39 AM
28	Sunday, Apr 26, 2009	12:00 PM	Saturday, May 2, 2009	8:39 AM
29	Sunday, May 3, 2009	6:00 PM	Saturday, May 9, 2009	2:39 PM

Muddy Valley Irrigation
PO Box 665
Overton, NV 89040

Water Schedule
Winter 2008
Cappalappa 1 Ditch

Account: SNWA
Preferred Shares: 257.616
Common Shares: 479.247
Runtime: 75

SNWA
P.O. Box 99956
LAS VEGAS, NV 89193-9956

Week	Starting Date	Starting Time	Ending Date	Ending Time
1	Sunday, Oct 12, 2008	6:00 PM	Friday, Oct 17, 2008	3:07 PM
2	Monday, Oct 20, 2008	12:00 AM	Friday, Oct 24, 2008	9:07 PM
3	Monday, Oct 27, 2008	6:00 AM	Saturday, Nov 1, 2008	3:07 AM

Water on Call

Please call the office at

398-7310

to arrange for water.

Week	Starting Date	Starting Time	Ending Date	Ending Time
22	Saturday, Mar 14, 2009	12:00 AM	Wednesday, Mar 18, 2009	9:07 PM
23	Saturday, Mar 21, 2009	6:00 AM	Thursday, Mar 26, 2009	3:07 AM
24	Saturday, Mar 28, 2009	12:00 PM	Thursday, Apr 2, 2009	9:07 AM
25	Saturday, Apr 4, 2009	6:00 PM	Thursday, Apr 9, 2009	3:07 PM
26	Sunday, Apr 12, 2009	12:00 AM	Thursday, Apr 16, 2009	9:07 PM
27	Sunday, Apr 19, 2009	6:00 AM	Friday, Apr 24, 2009	3:07 AM
28	Sunday, Apr 26, 2009	12:00 PM	Friday, May 1, 2009	9:07 AM
29	Sunday, May 3, 2009	6:00 PM	Friday, May 8, 2009	3:07 PM

Muddy Valley Irrigation
PO Box 665
Overton, NV 89040

Water Schedule
Winter 2008
Stringtown Ditch

Account: SNWA
Preferred Shares: 124.277
Common Shares: 450.000
Runtime: 0

SNWA
P.O. Box 99956
LAS VEGAS, NV 89193-9956

Week	Starting Date	Starting Time	Ending Date	Ending Time
1	Sunday, Oct 12, 2008	6:00 PM	Wednesday, Oct 15, 2008	7:18 PM
2	Monday, Oct 20, 2008	12:00 AM	Thursday, Oct 23, 2008	1:18 AM
3	Monday, Oct 27, 2008	6:00 AM	Thursday, Oct 30, 2008	7:18 AM

Water on Call

Please call the office at

398-7310

to arrange for water.

Week	Starting Date	Starting Time	Ending Date	Ending Time
22	Saturday, Mar 14, 2009	12:00 AM	Tuesday, Mar 17, 2009	1:18 AM
23	Saturday, Mar 21, 2009	6:00 AM	Tuesday, Mar 24, 2009	7:18 AM
24	Saturday, Mar 28, 2009	12:00 PM	Tuesday, Mar 31, 2009	1:18 PM
25	Saturday, Apr 4, 2009	6:00 PM	Tuesday, Apr 7, 2009	7:18 PM
26	Sunday, Apr 12, 2009	12:00 AM	Wednesday, Apr 15, 2009	1:18 AM
27	Sunday, Apr 19, 2009	6:00 AM	Wednesday, Apr 22, 2009	7:18 AM
28	Sunday, Apr 26, 2009	12:00 PM	Wednesday, Apr 29, 2009	1:18 PM
29	Sunday, May 3, 2009	6:00 PM	Wednesday, May 6, 2009	7:18 PM

Muddy Valley Irrigation
PO Box 665
Overton, NV 89040

Water Schedule
Winter 2008
Upper Logan Ditch

Account: SNWA
Preferred Shares: 212.492
Common Shares: 900.000
Runtime: 0

SNWA
P.O. Box 99956
LAS VEGAS, NV 89193-9956

Week	Starting Date	Starting Time	Ending Date	Ending Time
1	Sunday, Oct 12, 2008	6:00 PM	Thursday, Oct 16, 2008	11:50 PM
2	Monday, Oct 20, 2008	12:00 AM	Friday, Oct 24, 2008	5:50 AM
3	Monday, Oct 27, 2008	6:00 AM	Friday, Oct 31, 2008	11:50 AM

Water on Call

Please call the office at

398-7310

to arrange for water.

Week	Starting Date	Starting Time	Ending Date	Ending Time
22	Saturday, Mar 14, 2009	12:00 AM	Wednesday, Mar 18, 2009	5:50 AM
23	Saturday, Mar 21, 2009	6:00 AM	Wednesday, Mar 25, 2009	11:50 AM
24	Saturday, Mar 28, 2009	12:00 PM	Wednesday, Apr 1, 2009	5:50 PM
25	Saturday, Apr 4, 2009	6:00 PM	Wednesday, Apr 8, 2009	11:50 PM
26	Sunday, Apr 12, 2009	12:00 AM	Thursday, Apr 16, 2009	5:50 AM
27	Sunday, Apr 19, 2009	6:00 AM	Thursday, Apr 23, 2009	11:50 AM
28	Sunday, Apr 26, 2009	12:00 PM	Thursday, Apr 30, 2009	5:50 PM
29	Sunday, May 3, 2009	6:00 PM	Thursday, May 7, 2009	11:50 PM

Exhibit A
Southern Nevada Water Authority
Virgin and Muddy Rivers Tributary Conservation,
Intentionally Created Surplus (ICS) Project

Summary: Nevada state water rights that predate the Boulder Canyon Project Act (BCPA) on the Virgin River have a priority date of pre-1905 and were decreed by the Nevada Supreme Court in 1927. The decree allocated 17,785 acre-feet per year (afy) to the Bunkerville and Mesquite Irrigation Companies, which represents approximately 10% of the annual average flow in the Virgin River above the Irrigation Companies.[1] The Southern Nevada Water Authority (SNWA) currently owns shares in the Bunkerville Irrigation Company representing approximately 3,700 afy of surface water rights.

On the Muddy River, water rights were decreed in 1920 and that decree allocated the entire flow of the Muddy River. On the Lower Muddy River, the entire flow of the river is diverted by the Muddy Valley Irrigation Company (MVIC) for agricultural use. SNWA currently owns shares in the Muddy Valley Irrigation Company representing approximately 7,000 afy of surface water rights and leases approximately 2,000 afy from the LDS Church, which are not represented by MVIC shares. The LDS Church lease is for a term of 20 years, with the option to renew the lease for an additional 20 years.

SNWA anticipates acquiring a total of approximately 30,000 afy of pre-BCPA water rights from entities with rights on the Virgin and Muddy Rivers. Approximately one-third of this amount is expected to come from the Virgin River and two-thirds from the Muddy River. This is consistent with the flow volumes that were analyzed in the Final Environmental Impact Statement, Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead and in the analysis for Lake Mead for the Lower Colorado River Multi-Species Conservation Program.

Retired agricultural water rights will be conveyed to Lake Mead's Overton Arm. The pre-BCPA water rights conveyed to Lake Mead represent the full right that is and has been historically used for agricultural purposes and could have otherwise been diverted from the Virgin or Muddy River and fully consumed by SNWA for municipal purposes.

Virgin and Muddy River rights conveyed to Lake Mead will either pass through their historic points of diversion, flow through the irrigation company ditches and return to the mainstream of the Virgin or Muddy River further downstream or will remain in the mainstream of the Virgin or Muddy River. The full right documented to flow to Lake Mead will be accounted for as Tributary Conservation ICS.

Virgin and Muddy River water rights that will be utilized to create Tributary Conservation pursuant to this Exhibit A of this Forbearance Agreement include both decreed Nevada state water rights that have been in continuous use since at least 1927 and decreed Nevada state water rights with an established history of use prior to 1927 but that have experienced periods of non-

---

[1] Annual average Virgin River flow for water years 1931 to 2006 at the U.S. Geological Survey (USGS) Virgin River at Littlefield, AZ gage, No. 09415000 was 176,000 afy.

use in the interim. Per this Exhibit A of this Forbearance Agreement, SNWA is specifically allowed to utilize any and all pre-BCPA Virgin and Muddy River water rights decreed by a Nevada State Court prior to 1928 to create Tributary Conservation ICS regardless of those water rights history of use after 1928.

Specific Water Rights: The sources of water that would create Tributary Conservation ICS credits covered by these two projects include:

i. Estimated 5,702 afy pursuant to 682 preferred shares in the Muddy Valley Irrigation Company[2]

ii. Estimated 1,460 afy pursuant to 1,921 common shares in the Muddy River Irrigation Company

iii. 2,001 afy pursuant to Certificate Nos. 6419, 25861, 26316, 26317 and 26318 (decreed Muddy River right not represented by MVIC shares).

iv. 3,710 afy pursuant to 350 shares of Bunkerville Irrigation Company stock[3]

v. Any other water rights represented by shares in the Bunkerville, Mesquite and Muddy Valley Irrigation Companies and other pre-1929 decreed rights to the Muddy and Virgin Rivers purchased or contractually acquired by SNWA.

Annual variations in the flow of the Muddy River from any cause will cause fluctuations in the quantity of water available per share in the Muddy Valley Irrigation Company and reduce or increase the quantity of Tributary Conservation ICS that is available.

Nevada State Approval: SNWA will acquire necessary approvals from the Nevada Division of Water Resources to allow the Nevada state water rights to be conveyed to Lake Mead to create Tributary Conservation ICS.

Plan for Creation and Verification of ICS: Pursuant to Sections 3.B. and 3.D. of the Interim Guidelines for the Operation of Lake Powell and Lake Mead, SNWA shall annually submit a plan to the Secretary of Interior. The annual plan will demonstrate the volume of water rights

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[2] Muddy River water rights were decreed in 1920 by the Tenth (now Eighth) Judicial District Court. Water rights on the lower Muddy River are divided into 2,432 preferred and 5,044 common shares of stock in the Muddy Valley Irrigation Company.

[3] Uses of surface water in Nevada prior to the water law of 1905 are considered vested rights, the quantification of which can only be judicially determined by a Nevada District Court in an adjudication proceeding. The Virgin River surface water uses prior to 1905 have been adjudicated by the Virgin River Decree pursuant to Proof No. 02038 filed by the Bunkerville Irrigation Company, and Proof No. 01968 filed by the Mesquite Irrigation Company. The Virgin River Decree was entered by the Tenth (now Eighth) Judicial District Court on May 14, 1927.

The Decree adjudicated water rights to Virgin River surface flow for irrigation of 1,963.08 acres for a total of 17,785.50 acre feet per year (AFY). The summer duty equals 1.0 cfs of flow for each 70 acres and the winter duty equals 1.0 cfs of flow for each 100 acres for a total duty of 9.06 afy per acre. The summer period is the months of March through September and the winter period is the months of October through February.

owned and/or contractually controlled by SNWA on the Virgin and Muddy Rivers, including any water rights in addition to those specified above that SNWA acquires subsequent to the execution of this Forbearance Agreement. The annual plan will also demonstrate how the Tributary Conservation ICS, as described in this Exhibit A will be created and accounted for to Lake Mead. Such verification plan will, at a minimum, include:

Muddy River

The 1920 Muddy River Decree allocated the entire flow of the Muddy River; therefore it is anticipated that accounting for Muddy River water at Lake Mead will require an annual accounting of the rights owned by SNWA based on actual USGS gage flows and a water budget of the flows on the Lower Muddy River as follows:

A. *Muddy River Rights Owned by SNWA:*

1. Upper Muddy River rights owned or contractually controlled by SNWA as quantified in the Muddy River Decree.

2. Shares of the Muddy Valley Irrigation Company owned or contractually controlled by SNWA. MVIC shares are quantified based on a percentage of the total flows (divided by total shares) in the Muddy River at the USGS Muddy River near Glendale, NV gage less the Upper Muddy River rights owned or controlled by SNWA that reach the gage.

3. Nos. 1 and 2 represent the water SNWA would release into the Lower Muddy River for the creation of ICS credits.

B. *Muddy River Flows reaching Lake Mead will be calculated as follows:*

Flows measured by USGS at Muddy River near Glendale, NV gage
- (minus) consumptive uses by agriculture below the Glendale gage
- (minus) direct uses by industry below the Glendale gage
- (minus) channel evapotranspiration below Glendale gage to Lake Mead
- (minus) evapotranspiration from the managed acreage on the Overton Wildlife Management Area (WMA)

= Total Flow to Lake Mead

C. If the total amount represented in A is equal to or greater than the amount calculated to reach Lake Mead in B, then SNWA shall be credited with the amount in B.

D. If the total amount in A is less than the amount in B, SNWA shall be credited with the amount in A.

E. Because the total volume of water SNWA currently owns and controls on the Muddy River represents a relatively small percentage of the total flow, conveyance losses of SNWA's current rights are negligible.

F. The total Muddy River flow reaching Lake Mead as calculated in B Above includes flows at the USGS Muddy River at Lewis Avenue at Overton, NV gage located just upstream of the Overton Wildlife Management Area and unmeasured underflow.

Virgin River

Because the Virgin River Decree allocated just 10% of the average annual flow in the Virgin River (17,785.50 afy) to irrigate 1,963.08 acres, Tributary Conservation ICS from the Virgin River can be calculated based on the reduction in agricultural acreage as follows:

Virgin River Calculation:

Decrease in total agricultural acreage decreed in the Bunkerville or Mesquite Irrigation Companies calculated using remote sensing and a Geographic Information System (as limited by the shares controlled by SNWA and the acreage it represents)
x the decreed duty per acre (9.06 acre-feet per acre)
= Flows to Lake Mead

Maximum ICS Created Under this Exhibit: Maximum amount of ICS that may be created by SNWA from these projects in one calendar year is limited to 50,000 acre-feet of Virgin and Muddy River water.

Use of SNWA 1989 Virgin River Rights: SNWA will not use Permit Nos. 54077 and 58591 (Nevada state permits for combined duty of 113,000 afy) in the future to support new development on the lands being fallowed near the Virgin River, excepting 5,000 acre-feet of such rights that SNWA is obligated to transfer to the Virgin Valley Water District and which SNWA cannot encumber.

In Witness of this Exhibit A to the Forbearance Agreement executed contemporaneously herewith, the Parties affix their official signatures below, acknowledging approval of this document on the 13th day of December, 2007.

Approved as to form:

By: [signature]
W. Patrick Schiffer
Chief Counsel

THE STATE OF ARIZONA acting through the ARIZONA DEPARTMENT OF WATER RESOURCES

By: [signature]
Herbert Guenther
Director

Attest:	**PALO VERDE IRRIGATION DISTRICT**
By: ______________________ Edward W. Smith General Manager	By: ______________________ Charles VanDyke Chair
Attest and Approved:	**IMPERIAL IRRIGATION DISTRICT**
By: ______________________ John Penn Carter Legal Counsel	By: ______________________ Stella Altamirano-Mendoza President
Approved as to form:	**THE CITY OF NEEDLES**
By: ______________________ Robert Hargreaves City Attorney	By: ______________________ Jeff Williams Mayor
Approved as to form:	**COACHELLA VALLEY WATER DISTRICT**
By: ______________________ Steven B. Abbott Legal Counsel	By: ______________________ Steven B. Robbins General Manager/Chief Engineer
Approved as to form:	**THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA**
By: ______________________ Karen L. Tachiki General Counsel	By: ______________________ Jeffrey Kightlinger General Manager

Approved as to form:

By: ______________________
John J. Entsminger
Deputy General Counsel

SOUTHERN NEVADA WATER AUTHORITY

By: ______________________
Patricia Mulroy
General Manager

Approved as to form:

By: ______________________
Jennifer T. Crandell
Deputy Attorney General

COLORADO RIVER COMMISSION OF NEVADA

By: ______________________
George M. Caan
Executive Director

United States Department of the Interior
BUREAU OF RECLAMATION
Lower Colorado Regional Office
P.O. Box 61470
Boulder City, NV 89006-1470

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:

BCOO-4230
WTR-4.03 (BCP)

DEC 09 2008

CERTIFIED – RETURN RECEIPT REQUESTED

Ms. Kay Brothers
Deputy General Manager
Engineering and Operations
Southern Nevada Water Authority
P.O. Box 99956
Las Vegas, NV 89193-9956

Subject: Southern Nevada Water Authority (SNWA) Plans of Creation for Muddy and Virgin River Tributary Conservation Intentionally Created Surplus (ICS), Calendar Years 2008 and 2009 (Your Letter Dated September 10, 2008)

Dear Ms. Brothers:

The Secretary of the Interior issued a Record of Decision (ROD) on December 13, 2007, for the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines). Among other things, the Interim Guidelines establish criteria for the development and delivery of ICS. Prior to creating ICS, the Interim Guidelines require a contract holder to enter into a Delivery Agreement and a Forbearance Agreement.

On December 13, 2007, SNWA and the Colorado River Commission of Nevada entered into a Delivery Agreement with the United States and a Forbearance Agreement with the Lower Basin Contract holders. Section 3.B.1 of the Interim Guidelines requires that a plan for the creation of ICS be submitted for the Secretary's approval demonstrating how the requirements of the Interim Guidelines will be met in the contractor's creation of ICS. SNWA is proposing the creation of up to 16,000 and 30,000 acre-feet of tributary conservation ICS credits in 2008 and 2009, respectively, on the Muddy and Virgin Rivers.

We have reviewed the ICS plan submitted by SNWA and confirm that it contains the following information required by the Interim Guidelines:

a. Project description, including what extraordinary measures will be taken to conserve or import water.
b. Term of the activity.
c. Estimate of the amount of water that will be conserved or imported.
d. Proposed methodology for verification of the amount of water conserved or imported.

e. Documentation regarding any state or Federal permits or other regulatory approvals that have already been obtained by the Contractor or that need to be obtained prior to creation of ICS.

Pursuant to Section 7.B.5 of the Interim Guidelines, the Secretary is required to consult with the Basin States regarding administration of ICS. We have conducted appropriate consultation with both the Upper and Lower Division States on SNWA's ICS plans.

Based upon our review of SNWA's proposed ICS plans and completion of the consultation process, we hereby approve SNWA's plan for the creation of Muddy and Virgin River tributary conservation ICS for 2008 and 2009 in accordance with Section 3.B.1 of the Interim Guidelines and Article VI of the Delivery Agreement.

The Interim Guidelines provide for the submittal of a certification report by SNWA to the Bureau of Reclamation, in the year following creation of ICS, to demonstrate the amount of ICS created and that the method of creation was consistent with the approved ICS plan. Any technical issues associated with the actual creation of ICS will be dealt with in this verification process.

If you have questions, please contact Ms. Ruth Thayer at 702-293-8426.

Sincerely,

Lorri Gray
Regional Director

cc: Mr. Gerald Zimmerman
Executive Director
Colorado River Board of California
770 Fairmont Avenue, Suite 100
Glendale, CA 91203-1035

Mr. Herb Guenther
Director
Arizona Department of Water Resources
3550 North Central Avenue
Phoenix, AZ 85012-2105

Mr. Dennis Strong
Director
Utah Division of Water Resources
P.O. Box 146201
Salt Lake City, UT 84114-6201

Mr. George M. Caan
Director
Colorado River Commission of Nevada
555 East Washington Ave, Suite 3100
Las Vegas, NV 89101-1065

Continued on next page.

Continued from previous page.

Mr. Don Ostler
Executive Director
Upper Colorado River Commission
355 South 400 East Street
Salt Lake City, UT 84111

Mr. John D'Antonio
State Engineer
Office of the State Engineer
P.O. Box 25102
Santa Fe, NM 87504-5102

Mr. Patrick T. Tyrrell
State Engineer
State of Wyoming
Herschler Building, 4th Floor East
Cheyenne, WY 82002-0370

Ms. Jennifer Gimbel
Director
Colorado Water Conservation Board
1313 Sherman Street, Suite 721
Denver, CO 80123

IN THE OFFICE OF THE STATE ENGINEER

OF THE STATE OF NEVADA

1194

ORDER

REGARDING TRIBUTARY CONSERVATION INTENTIONALLY CREATED SURPLUS FOR THE MUDDY RIVER

WHEREAS, the Nevada State Engineer is designated by the Nevada Legislature to perform duties related to the management and appropriation of the water resources belonging to the people of the State of Nevada;[1]

WHEREAS, pursuant to Nevada Revised Statute (NRS) chapter 533 the Nevada State Engineer acts as an officer of the court for administration and distribution of water from a stream system that has been adjudicated by a district court decree;

WHEREAS, the Muddy River Decree was entered on March 12, 1920, by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada;

WHEREAS, individuals named under the Muddy River Decree or their successors own water rights on the upper Muddy River;

WHEREAS, under the Muddy River Decree, the Muddy Valley Irrigation Company (MVIC) owns water rights on the lower Muddy River and said water is distributed by MVIC to the individual shareholders of MVIC;

WHEREAS, pursuant to NRS 533.060 rights to the use of surface water cannot be lost through forfeiture;

WHEREAS, pursuant to NRS 533.060 a surface water right that is appurtenant to land formerly used primarily for agricultural purposes is not subject to abandonment if the land has been converted to urban use or the water right has been acquired by a water purveyor for municipal use;

WHEREAS, pursuant to NRS 538.171 any appropriation or use of waters of the Colorado River by the Colorado River Commission of Nevada or an entity with whom the Colorado River Commission of Nevada has contracted is not subject to regulation by the State Engineer;

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[1] *See* Nevada Revised Statutes chapters 532, 533, 534, 535, and 536.

WHEREAS, the Attorney General of the State of Nevada determined in Attorney General Opinion Number 88-16 that a permit from the State Engineer is not required for appropriation and use of Colorado River water for entities that have water delivery contracts with the Secretary of the Interior (Secretary), nor is a permit from the State Engineer necessary for use of such water merely to provide the State Engineer with information regarding such use if information is timely supplied upon request;

WHEREAS, pursuant to Section 2 of Chapter 393 of the Statutes of Nevada 1995, the powers, duties, rights and obligations of the State of Nevada and the Colorado River Commission of Nevada relating to contracts for delivery of Colorado River water were assumed by the Southern Nevada Water Authority;

WHEREAS, the Boulder Canyon Project Act (BCPA), 43 U.S.C. § 617, became effective on June 25, 1929;

WHEREAS, the Secretary has a broad and unique legal role in managing the lower Colorado River system in accordance with federal law, including the Boulder Canyon Project Act of 1928, the 1963 decision of the U.S. Supreme court in *Arizona v. California*, the 2006 Consolidated Decree of the U.S. Supreme Court in *Arizona v. California*, the Colorado River Basin Project Act of 1968, and other applicable provisions of federal law. Within this legal framework, the Secretary makes annual determinations regarding the availability of water to be delivered to Colorado River contract holders from Lake Mead;

WHEREAS, on December 13, 2007, the Secretary adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Guidelines). The Guidelines provide for the creation and delivery of Tributary Conservation Intentionally Created Surplus and Developed Shortage Supply (for convenience, both referred to hereinafter as ICS) to entities with a contract or entitlement to Colorado River water with the Bureau of Reclamation provided said entities have also entered into a delivery agreement with the Bureau of Reclamation for delivery of ICS (ICS Delivery Contract);

WHEREAS, pursuant to Sections 3 and 4 of the Guidelines, the holder of a valid ICS Delivery Contract who purchases documented water rights on a tributary of the Colorado River, perfected prior to June 25, 1929, (the effective date of the BCPA) may convey said water to the Colorado River mainstream so that said water may be diverted from the Colorado River mainstream by the ICS Delivery Contract holder as Tributary Conservation ICS;

WHEREAS, the Guidelines and the consolidated decree in *Arizona v. California*, 547 U.S. 150 (2006), define the Colorado River mainstream to include the reservoirs located on the Colorado River downstream from Lee Ferry within the United States; and

WHEREAS, Lake Mead is located on the Colorado River mainstream downstream from Lee Ferry and full pool elevation of Lake Mead is 1,220 feet above mean sea level.

NOW THEREFORE, the State Engineer finds that:

1. The Order of Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries was certified on January 21, 1920.
2. The Judgment and Decree in the Matter of the Determination of the Relative Rights in and to the Waters of the Muddy River and its Tributaries (Muddy River Decree) was entered on March 12, 1920 by the Tenth (now Eighth) Judicial District Court, Clark County, Nevada.
3. All water rights adjudicated in the Muddy River Decree were acquired by valid appropriation prior to March 1, 1905, and were determined to be in good standing and in use prior to March 1, 1905 as affirmed by the Muddy River Decree.
4. The Muddy River Decree adjudicated the entire flow of the Muddy River and its tributaries, and that there is insufficient flow in the Muddy River to grant any new appropriations.
5. As of the date of this Order there has been no declaration or finding of forfeiture or abandonment regarding any water rights adjudicated under the Muddy River Decree.
6. As of the date of this Order, no proceedings for forfeiture or abandonment have been initiated regarding any water rights adjudicated under the Muddy River Decree.
7. In accordance with NRS 538.171 and Attorney General Opinion 88-16 a permit is not required for the creation or use of Tributary Conservation ICS when an ICS Delivery Contract exists with the Secretary.
8. The creation of ICS as defined in the current Guidelines promulgated by the Secretary and as those Guidelines may hereinafter be amended, is beneficial to the state of Nevada.

NOW THEREFORE, the State Engineer orders:

1. The Muddy River and its tributaries are closed to new appropriations.
2. An entity with an ICS Delivery Contract, which uses water rights adjudicated under the Muddy River Decree for the creation of ICS, shall file an annual report with the State Engineer's Office. The annual report shall give a full accounting of adjudicated water rights on the Muddy River or its tributaries owned or controlled by the entity with an ICS Delivery Contract, which have been conveyed through the Muddy River system to the Colorado River mainstream for the creation of ICS. After review of the annual report, the State Engineer shall issue a letter verifying the quantity of water conveyed through the Muddy River system to the Colorado River mainstream for the purpose of creating ICS.

TRACY TAYLOR, P.E.
State Engineer

Dated at Carson City, Nevada
this 15 day of July , 2008.