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Scientific Investigations Report 2006-5237

U.S. Department of the Interior
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U.S. Geological Survey
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Conversion Factors and Datums

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
foot (ft)	0.3048	meter (m)
inch (in.)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer (km)
mile per hour (mi/h)	1.609	kilometer per hour (km/h)
square mile (mi^2)	2.590	square kilometer (km^2)

Temperature: Degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the formula °F = (1.8 x °C) + 32.

Discharge or flow: The rate that matter passes through a cross section of a stream channel or other water body per unit of time. The term commonly refers to the volume of water (including, unless otherwise stated, any sediment or other constituents suspended or dissolved in the water) that passes a cross section in a stream channel, flume, weir, canal, pipeline, etc., within a given period of time (cubic feet per second).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1988 (NGVD of 1988, formerly called “Sea-level Datum of 1988”), which is derived from a general adjustment of the first-order leveling networks of the United States and Canada.

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

Synoptic Discharge, Water-Property, and pH Measurements for Muddy River Springs Area and Muddy River, Nevada, February 7, 2001

By David A. Beck and Jon W. Wilson

Abstract

On February 7, 2001, synoptic discharge measurements at selected sites along the Muddy River in Nevada, indicated three trends in discharge resulting from contributions of spring discharge, influences of diversionary flow, and contributions from shallow ground water. Effects from diversionary and tributary flow were local in nature and resulted in a net gain of 2.6 cubic feet per second throughout the measured reach. The minor increase in discharge may be the result of contributions from ground-water flow and measurement error. Comparison of 1963 and 2001 discharge measurements within the Muddy River Springs area indicated that discharge rates and trends from these source waters were similar. Along the mainstem of the Muddy River, water-temperature measurements indicated a net decrease of 8.8 degrees Celsius. Water samples collected and analyzed for specific conductance indicated a net increase of 390 microsiemens per centimeter at 25 degrees Celsius, whereas pH measurements remained relatively constant.

Introduction

This report contains an examination of discharge, water property, and pH data collected in the Muddy River Springs area and Muddy River on February 7, 2001. Muddy River originates from numerous seeps and springs at the northwest corner of Moapa Valley, and flows in a southeast direction discharging into Lake Mead (fig. 1). The Muddy River Springs area is defined as the terminal discharge point of the White River ground-water flow system (Eakin, 1966), which is part of the Regional Carbonate-Rock Province that encompasses about 100,000 mi² of eastern Nevada, western Utah, and parts of southeastern Idaho and California (Harrill and others, 1983; fig. 1). The riparian habitat within the Muddy River area contains diverse wildlife, including the endangered Moapa dace (*Moapa coriacea*).

The Nevada State Engineer's Office is considering applications to develop ground-water resources near the Muddy River and its source waters. Resource managers are concerned about the potential effects of these proposed withdrawals on the Moapa Valley National Wildlife Refuge and other riparian ecosystems and spring-discharge areas adjacent to the river.

This study is limited to the Muddy River Springs area (fig. 2) and to the upper 18-mile reach of the Muddy River ending just south of Overton, Nev. (fig. 3). For the purposes of this report, site names in the text have been abbreviated, but are listed in tables 1 and 2. All references to the Muddy River Springs area are defined as that part of the valley upstream of the U.S. Geological Survey (USGS) surface-water gaging station, MR Moapa (site 09416000). References to the Muddy River indicate the river between MR Moapa (site 09416000) and the Southern Nevada Water Authority (SNWA) surface-water gaging station, MR at Lewis Ave. (site 09419507).

This investigation was developed, in cooperation with the National Park Service and the U.S. Fish and Wildlife Service, to provide measured discharge, water temperature, specific conductance, and pH at multiple sites within the Muddy River Springs area and the Muddy River.

Acknowledgments

The authors acknowledge the Bureau of Indian Affairs, the Nature Conservancy, Southern Nevada Water Authority, Nevada Division of Water Resources, Moapa Valley Water District, Nevada Power Company, and the Moapa Band of Paiutes-Tribal for their participation in this effort.

Purpose and Scope

The purpose of this report is to present synoptic measurements collected within the Muddy Springs area and along the Muddy River, and to characterize changes in discharge within these areas. Data collected on February 7, 2001, include measurements of discharge, water temperature, and specific conductance from 15 sites within the Muddy River Springs area; measurements of discharge, water temperature, specific conductance, and pH from 14 sites along the Muddy River; and discharge measurements from 1 municipal and 4 agricultural diversions.

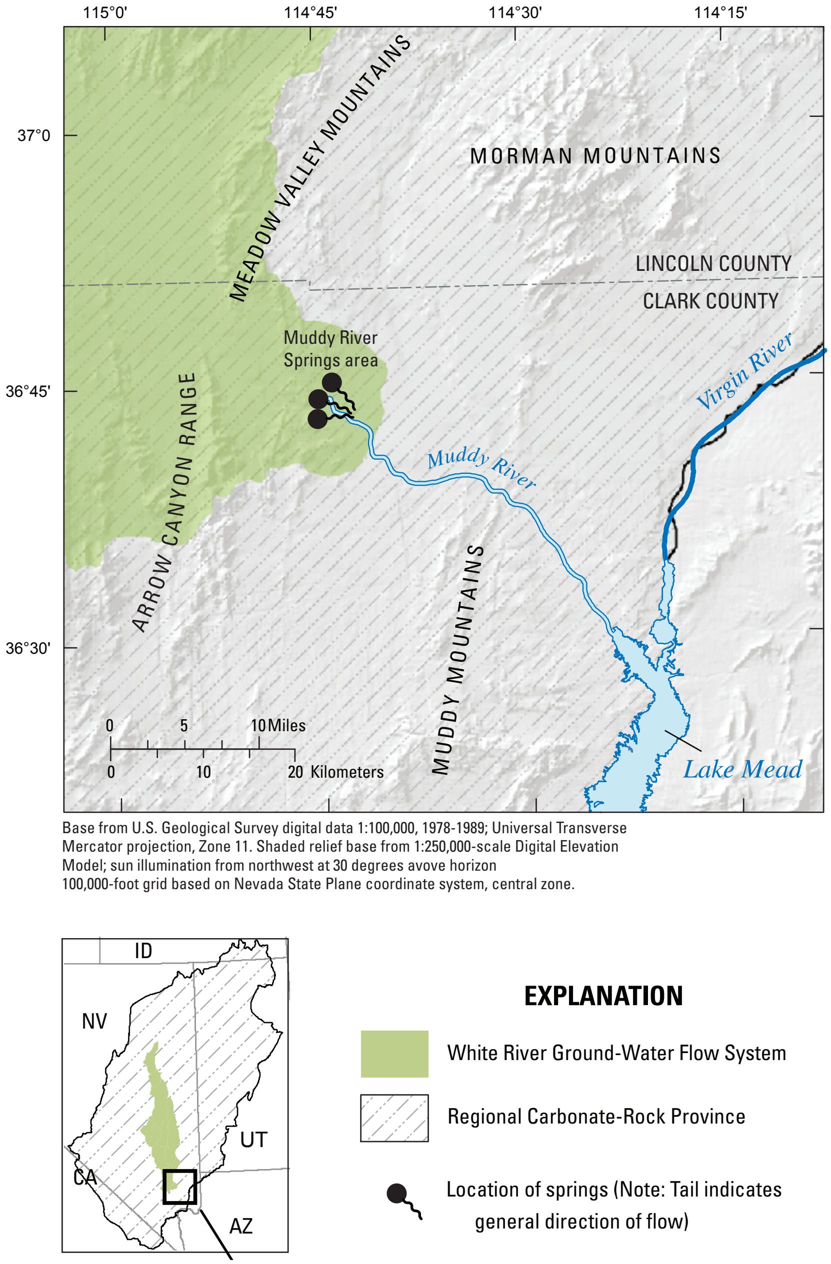


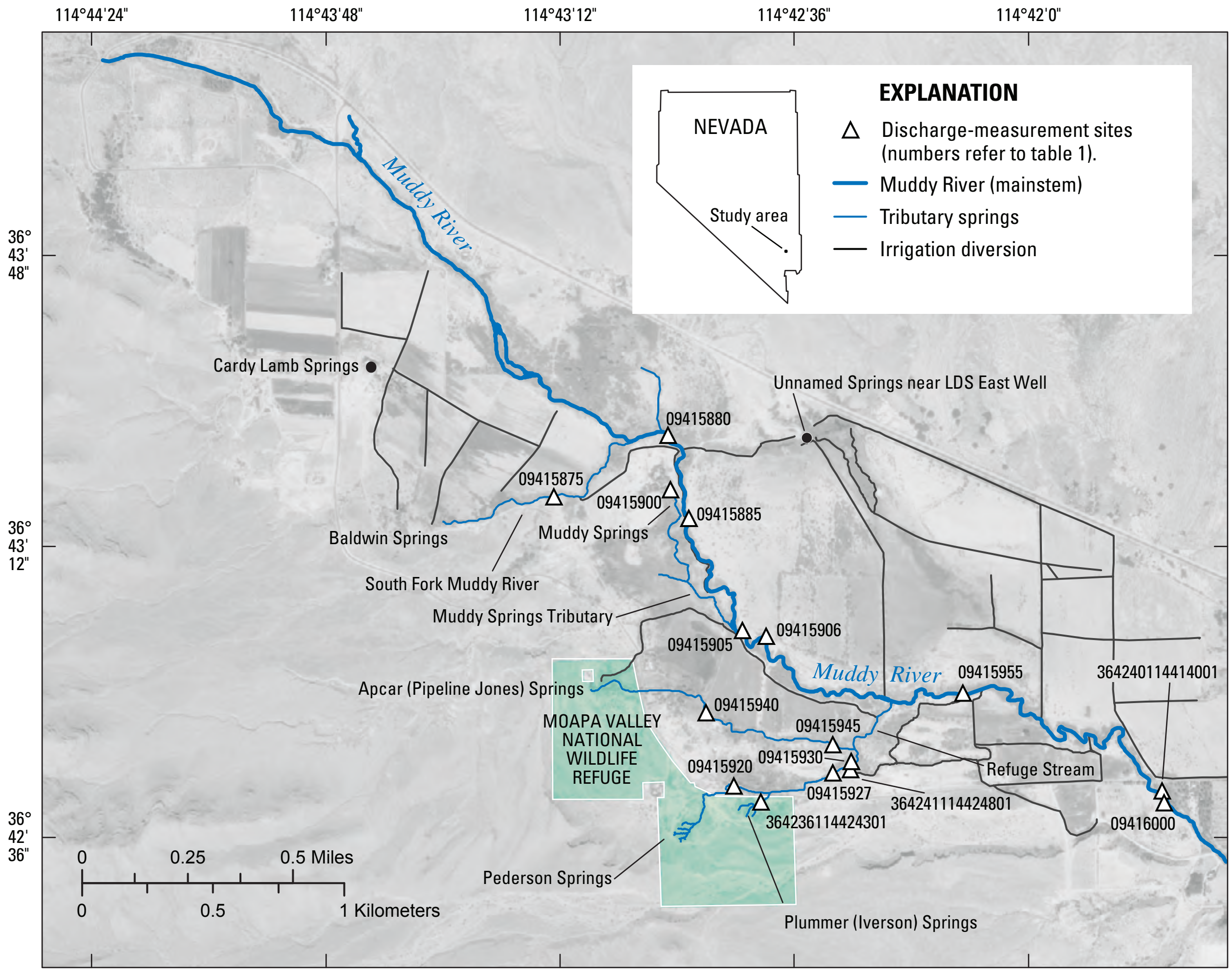
Figure 1. Location of study area.

Discharge, water-property, and pH data were collected during a period of minimal evapotranspiration, and municipal and agricultural diversions. An evaluation of changes in these data helps to: (1) assess surface-water and ground-water interaction and (2) account for losses or gains of river discharge within the spring and river areas.

Description of Study Area

The location of the study area is considered the terminal drainage area of the White River ground-water flow system (Eakin, 1966), located within the Regional Carbonate-Rock Province (fig. 1). The Muddy River Springs area and the Muddy River are bounded by the Meadow Valley Mountains to the north, the Morman Mountains to the northeast, the Muddy Mountains to the south, and Arrow Canyon Range to the west (fig. 1).

The Muddy River originates from a system of spring tributaries described by Eakin (1964), which are clustered along the northeast slope of Arrow Canyon Range (fig. 2). These tributaries generally consist of warm-water springs and seeps that emanate from alluvial deposits, occuring near surface exposures of carbonate rocks. These springs and seeps discharge into the mainstem of the Muddy River through three spring tributaries that include South Fork Muddy River, Muddy Springs Tributary, and Refuge Stream



Base from U.S. Geological Survey digital data 1:100,000, 1978-1989; Universal Transverse Mercator projection, Zone 11. Shaded relief base from 1:250,000-scale Digital Elevation Model; sun illumination from northwest at 30 degrees avove horizon
100,000-foot grid based on Nevada State Plane coordinate system, central zone.

Figure 2. Location of discharge-measurement sites and tributary springs to the Muddy River.

(fig. 2). Streams in the Muddy River Springs area typically are meandering, shallow channels consisting mainly of mud and organic debris. Most banks are thickly overgrown by Saltcedar (*Tamarix ramosissima*), cattails (*Typha latifolia*), and reeds (*Phragmites communis*).

Many irrigation diversions and ditches previously existed in the Muddy River Springs area. Most of the ditches have been abandoned with the exception of channels near Cardy Lamb Springs and Unnamed Springs near LDS East Well (fig. 2).

The Muddy River flows through four farming communities (Moapa, Glendale, Logandale, and Overton) and through the northeast corner of the Moapa River Indian Reservation draining about 6,940 mi² (fig. 3). Diversions from the Muddy River primarily are used to irrigate nearby farm land and to supply water for the Reid Gardner Power Generating Station and Moapa Valley Dairy (fig. 3). The Muddy River is incised moderately (about 20 ft deep), with the channel consisting of mud, sand, gravel, and organic debris. Most banks of the river are overgrown thickly with Saltcedar and other vegetation.

California Wash and Meadow Valley Wash systems contribute surface water to the Muddy River during periods of heavy rainfall. These two systems enter the Muddy River near the towns of Moapa and Glendale, respectively (fig. 3).

Discharge Measurements

Data-collection sites were selected to match locations of previous measurements (as indicated in earlier reports), and to document changes in discharge at points of inflow and diversion. Furthermore, measurements were collected during a period of expected minimal evapotranspiration and steady base flow to constrain human and natural influences on streamflow.

With the exception of several flume sites, all discharge measurements were made with a current meter using standard methods of the USGS (Buchanan and Somers, 1969). An average discharge for each site was computed from synoptic measurements made at each site in the Muddy River Springs area and the mainstem of the Muddy River and are listed in

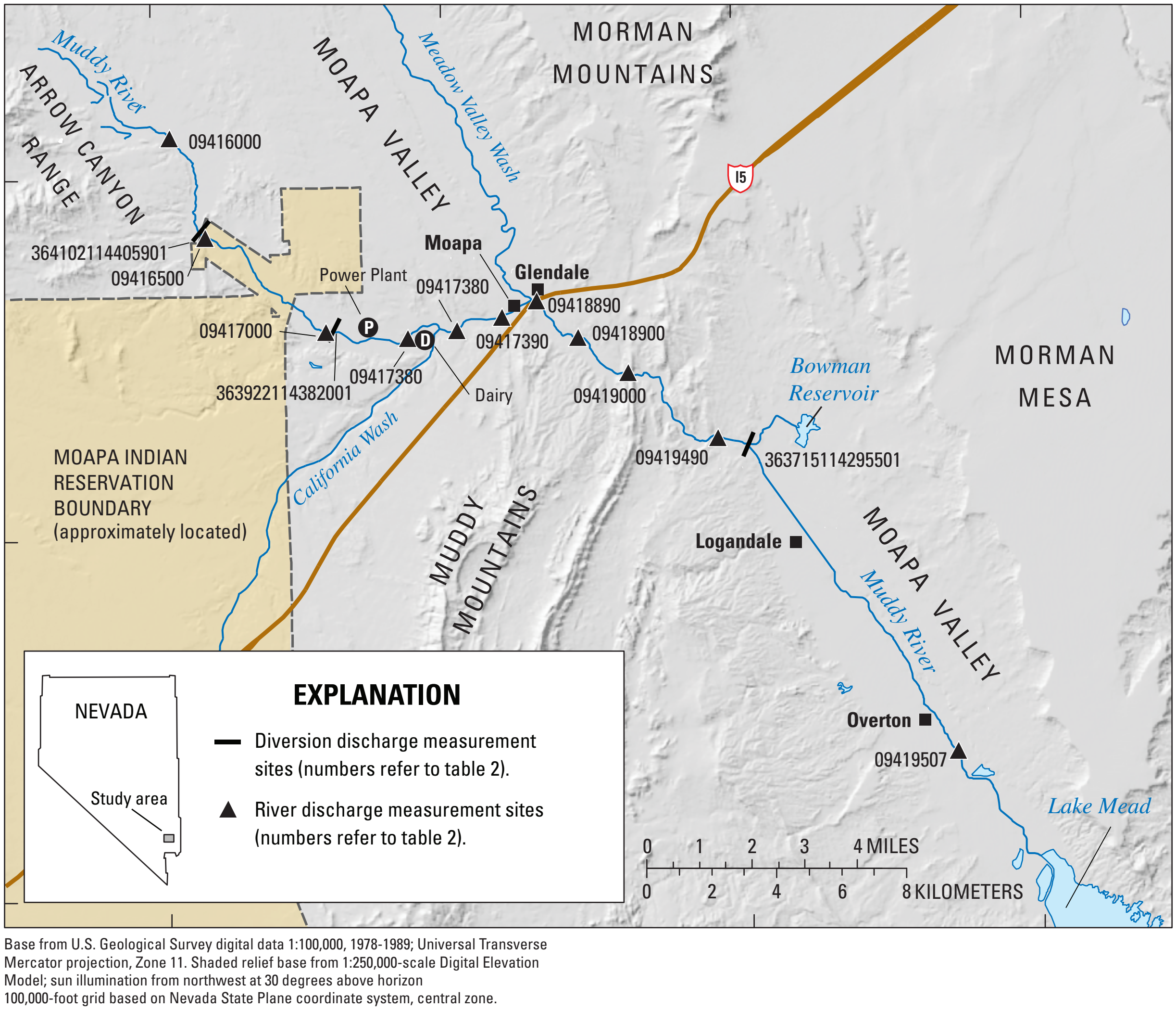


Figure 3. Location of discharge-measurement sites along the mainstem of the Muddy River.

tables 1 and 2, respectively. Discharge measurements made within the Muddy River Springs area were rated fair or good (within 5 percent or 8 percent of actual flow, respectively), and discharge measurements made in the Muddy River were all rated good (within 5 percent of actual flow). Discharge ratings are based on estimates of the standard error for each current-meter discharge measurement (Sauer and Meyer, 1992).

Staff gages were installed at selected sites and used to monitor changes in water stage during periods of data collection. Stage at most sites remained steady (within a few hundredths of a foot) during the measurement period as documented by field observations. Stage was unsteady at several sites, and is discussed later in this report.

Evaluation of Discharge Measurements

Measurements of discharge on the Muddy River Springs area and the mainstem of the Muddy River are discussed in the following sections. Measurements on February 7, 2001, in the Muddy River Springs area range from a minimum average discharge of 2.39 ft^3/s at WS East (site 364236114424301) to a maximum average discharge of 41.8 ft^3/s at MR below Refuge (site 09415955; table 1). Measurements from sites along the mainstem of the Muddy River range from a minimum average discharge of 32.2 ft^3/s at MR at Narrows (site 09416500) to a maximum average discharge of 41.3 ft^3/s at MR below Anderson Wash (site 09419490; table 2). A comparison of discharges shows a net increase of 2.6 ft^3/s between the terminous of the spring tributaries within Muddy River Springs area (MR below Refuge, site 09415955) and the site upstream of the flow diversion into Bowman Reservoir (MR below Anderson Wash, site 09419490; fig. 3).

Muddy River Springs Area

Discharge measurements were made at 15 sites within the Muddy River Springs area. Included are three major tributaries—South Fork Muddy River, Muddy Springs Tributary, and Refuge Stream—and five sites along the mainstem of the Muddy River (fig. 2, table 1).

An average of two discharge measurements per site were made between 9 a.m. and 3 p.m. on February 7, 2001. Measurements were made using standard methods described above with the exception of discharge values obtained from three flume sites: Baldwin Springs (site 09415875), MS at LDS (site 09415900), and WS West (site 09415920). At these sites, discharge was computed using measured depths of water within flume structures and standard flume ratings (Rantz and others, 1982).

A net increase of 26.2 ft³/s occurred between MR below Upper Confluence (site 09415880) and MR below Refuge (site 09415955; fig. 2). Flows from Muddy Springs Tributary and Refuge Stream accounted for approximately 16 ft³/s (about 60 percent) of this increase in discharge.

Eleven sites from table 1, including MR Moapa (site 09416000), were available to compare discharge measurements from February 2001 to measurements from September 10–12, 1963 (Eakin, 1964). Graphical comparison of 1963 and 2001 discharge measurements are shown in figure 4. Maximum differences between 1963 and 2001 measurements are within the mainstem of the Muddy River and range between 1.9 ft³/s and 4.2 ft³/s. Differences within the spring-tributary sites were less than 1 ft³/s with the exception of Refuge Stream above Confluence (site 09415930) which had a difference of -1.3 ft³/s (table 1). Minimum differences in discharge measurements made between 1963 and 2001 were -0.08 ft³/s and 0.04 ft³/s at MS at LDS (site 09415900) and WS West (site 09415920) in the Refuge Stream, respectively. Discharge measurements made in 1963 remained about the same between MR below Refuge (site 09415955) and MR Moapa (site 09416000) with discharge values of 43.7 ft³/s and 42.8 ft³/s, respectively; however, in 2001, discharge between the same sites decreased by 3.2 ft³/s, after accounting for MR Power Diversion (fig. 4). This value is based on the difference between 41.8 ft³/s measured at MR below Refuge (site 09415955) and a discharge of 35.5 ft³/s measured at MR Moapa (site 09416000) combined with 3.10 ft³/s at MR Power Diversion (site 09415950).

Muddy River

On February 7, 2001, discharge measurements were made at 11 sites downstream of and including MR Moapa (site 09416000), and at three diversions (fig. 3; table 2).

Twelve of the measurement sites (upstream of Logandale Diversion, site 363715114295501) are upstream of Bowman Reservoir, where a majority of flow was diverted during the study period (fig. 3). Six discharge measurements were made at most sites on the Muddy River between 9 a.m. and 3 p.m. on February 7, 2001. Discharge measurements also were collected at three irrigation diversions (Moapa Indian Diversion, site 364102114405901; Dairy Diversion, site 363922114382001; and Logandale Diversion, site 363715114295501). Water pumped from the river at MR Power Diversion (site 09415950) was determined from hourly observations of the flowmeter on the transmission pipe (table 2).

An irrigation-diversion gate was opened upstream of MR at Narrows (site 09416500) during the time of data collection. Approximately 12 percent of the total flow was diverted from the river based on measurements made at Moapa Indian Diversion (site 364102114405901) and MR at Narrows (site 09416500). This diversion of flow is believed to have temporarily affected discharge measurements at MR at Railroad (site 09417000), MR above California Wash (site 09417270), MR below California Wash (site 09417380), and MR above Meadow Valley Wash (site 09417390). Differences between maximum and minimum discharge measurements at these sites ranged from 11 to 14 percent (table 3). Although the individual discharge measurements at these sites are rated good, the computed average discharges are not considered to accurately represent base flow conditions as well as average measurements for the other sites. These average discharges are included in this report to help approximate changes in discharge and trends within the affected reach of the river. The diversion of water upstream of MR at White Narrows (site 09416500) is not considered to have affected sites at and below MR at I-15 (site 09418890) during the period of data collection.

Discharge measurements in February 2001 along the Muddy River show three trends (fig. 5). Between MR Moapa (site 09416000) and MR above California Wash (site 09417270), measured discharge indicated an approximate net decrease of 3 ft³/s. Diverted water between this section of the Muddy River totaled 6.0 ft³/s; however, on the day of the measurements, most of the flow diverted by the Dairy Diversion (site 363922114382001, 1.5 ft³/s), discharged directly back to the river just upstream of MR above California Wash (site 09417270).

Between MR above California Wash (site 09417270) and MR at I-15 (site 09418890), measured discharge indicated an approximate net increase of 6.2 ft³/s, which is 0.2 ft³/s more than the sum of all upstream diverted flows, excluding water used by Nevada Power Company, which was not returned to the river. Finally, discharge measurements made between MR at I-15 (site 09418890) and MR below Anderson Wash (site 09419490) had an increase of 2.6 ft³/s.

Discharge measured at MR below Anderson Wash (site 09419490) is equivalent nearly to the discharge obtained at the outflow of springs in the Muddy River Springs area (at MR below Refuge, site 09415955) with values of 41.3 ft³/s and 41.8 ft³/s, respectively. Because 3.10 ft³/s was diverted at Muddy River Power Diversion (site 09415950) and was not returned to the river, flow downstream of this diversion from the Muddy River Springs area was 38.7 ft³/s (41.8 ft³/s minus 3.10 ft³/s). By taking the diversion into account, the net change in discharge between the Muddy River Springs area and MR below Anderson Wash (site 09419490) is an increase of 2.6 ft³/s. The maximum computed error for the discharge measurements made at the two sites is about 4.2 ft³/s, which is

Table 1. Discharge and water-property measurements in the Muddy River Springs area near Moapa, Nevada, September 1963 and February 2001.

[Site altitude in feet above mean sea level. Abbreviations: ft, feet; ft³/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius]

Site number	Site name	Abbreviated name	Latitude	Longitude	Site altitude, in ft	Discharge: Average 9/10–12/1963,[1] in ft³/s	Discharge: Average 2/7/2001,[2] in ft³/s	Discharge: Difference,[3] in ft³/s	Specific conductance: field 9/10–12/1963,[4] in µS/cm	Specific conductance: laboratory 2/7/2001,[5] in µS/cm	Water temperature, 2/7/2001 in °C
South Fork Muddy River											
09415875	Baldwin Springs Flume near Moapa	Baldwin Springs	36°43'16"	114°43'14"	1,770	NA	4.11	NA	NA	977	27
Muddy Springs Tributary											
09415900	Muddy Spring at LDS Farm near Moapa	MS at LDS	36°43'18"	114°42'53"	1,745	7.25	7.17	[-0.08]	NA	974	27
09415905	Muddy Springs Tributary above Confluence with Muddy River near Moapa	MS Tributary	36°43'00"	114°42'45"	1,760	8.32	9.16	0.84	NA	999	NA
Refuge Stream											
09415940	Apcar Stream at Pipeline Jones Flume near Moapa	Apcar at PJF	36°42'51"	114°42'50"	1,735	NA	2.54	NA	NA	1,010	NA
09415945	Apcar Stream above Confluence with Refuge Stream near Moapa	Apcar above Confluence	36°42'46"	114°42'32"	1,770	2.94	3.86	0.92	1,160	1,060	NA
09415920	Warm Springs West near Moapa	WS West	36°42'41"	114°42'48"	1,770	3.78	3.82	0.04	NA	969	27
364236114424301	Warm Springs East (Plummer Main) near Moapa	WS East	36°42'36"	114°42'43"	1,750	2.26	2.39	0.13	1,040	1,000	27
09415927	Warm Springs Confluence at Iverson Flume near Moapa	WS Confluence	36°42'41"	114°42'32"	1,745	NA	8.00	NA	NA	1,000	NA
09415930	Refuge Stream above Confluence with Apcar Stream near Moapa	Refuge Stream above Confluence	36°42'42"	114°42'30"	1,770	8.37	7.04	[-1.33]	1,050	1,000	NA
364241114424801	Warm Springs Irrigation Diversion below Warm Springs Road near Moapa	WS Diversion	36°42'41"	114°42'48"	1,770	(0.74)	(1.13)	0.39	1,050	NA	NA

Table 1. Discharge and water-property measurements in the Muddy River Springs area near Moapa, Nevada, September 1963 and February 2001—Continued.

[Site altitude in feet above mean sea level. Abbreviations: ft, feet; ft³/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius]

Site number	Site name	Abbreviated name	Latitude	Longitude	Site altitude, in ft	Discharge: Average 9/10–12/1963,[1] in ft³/s	Discharge: Average 2/7/2001,[2] in ft³/s	Discharge: Difference,[3] in ft³/s	Specific conductance: field 9/10–12/1963,[4] in µS/cm	Specific conductance: laboratory 2/7/2001,[5] in µS/cm	Water temperature, 2/7/2001 in °C
Mainstem—Muddy River											
09415880	Muddy River below North and South Fork Confluence near Moapa	MR below Upper Confluence	36°43'23"	114°42'54"	1,755	NA	15.6	NA	NA	989	26
09415885	Muddy River near LDS Farm near Moapa	MR near LDS	36°43'14"	114°42'52"	1,750	19.5	16.0	[-3.5]	1,290	988	26
09415906	Muddy River below Confluence with Muddy Springs Tributary near Moapa	MR below Spring Confluence	36°42'59"	114°42'42"	1,745	31.8	28.0	[-3.8]	1,190	990	NA
09415955	Muddy River below Confluence with Refuge Stream near Moapa	MR below Refuge	36°42'51"	114°42'13"	1,730	43.7	41.8	[-1.9]	1,120	1,000	NA
09415950	Muddy River Power Diversion near Moapa	MR Power Diversion	36°42'40"	114°41'40"	1,710	NA	(3.10)	NA	NA	NA	NA
09416000	Muddy River near Moapa[6]	MR Moapa	36°42'40"	114°41'40"	1,710	42.8	35.5	[-4.20][7]	NA	1,010	26

[1] Discharge measurements made by the U.S. Geological Survey during September 10–12, 1963. A value in parentheses denotes diverted discharge.

[2] Discharge is mean of multiple instantaneous discharge measurements made at each site. A value in parentheses denotes diverted discharge.

[3] Difference is expressed as the result of the 1963 discharge value minus the 2001 discharge value. Value in brackets denotes a loss in discharge.

[4] Specific-conductance measurements made in the field, September 10–12, 1963.

[5] Specific-conductance measurements made in the U.S. Geological Survey laboratory in Henderson, Nev., February 8, 2001.

[6] River site is not part of Muddy River Springs area, but is included in table for comparison with 1963 measurements.

[7] Difference is 2001 discharge values for MR Moapa and MR power diversion minus 1963 discharge value for MR Moapa.

Table 2. Synoptic discharge, water-property, and pH measurements in the mainstem of the Muddy River, February 7, 2001.

[Site altitude in feet above mean sea level. Abbreviations: ft, feet; ft³/s, cubic feet per second; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius]

Site number	Site name	Abbreviated site name	Latitude	Longitude	Site altitude, in ft	Average discharge,[1] in ft³/s	Specific conductance,[2] laboratory, in µS/cm	Water temperature, in °C	pH,[3] field, in standard units
09416000	Muddy River near Moapa	MR Moapa	36°42'40"	114°41'40"	1,710	35.5	1,010	26.0	8.2
364102114405901	Moapa Indian Reservation Irrigation Diversion (north gage) at White Narrows near Moapa	Moapa Indian Diversion	36°41'02"	114°40'59"	1,675	(4.50)	NA	NA	NA
09416500	Muddy River at White Narrows near Moapa	MR at Narrows	36°41'02"	114°40'59"	1,670	32.2	1,020	23.4	8.4
09417000	Muddy River at Railroad Pump Plant near Moapa	MR at Railroad	36°39'22"	114°38'32"	1,585	34.1	1,020	21.4	8.5
363922114382001	Dairy Irrigation Diversion below Railroad Pump Plant near Moapa	Dairy Diversion	36°39'22"	114°38'20"	1,575	(1.50)[4]	NA	NA	NA
09417270	Muddy River above California Wash near Moapa	MR above California Wash	36°39'12"	114°36'52"	1,555	32.5	1,090	20.6	8.5
09417380	Muddy River below California Wash near Moapa	MR below California Wash	36°39'21"	114°35'50"	1,530	35.0	1,150	19.6	8.4
09417390	Muddy River above Meadow Valley Wash near Glendale	MR above Meadow Valley Wash	36°39'33"	114°34'54"	1,510	35.6	1,260	19.4	8.4
09418890	Muddy River at I-15 near Glendale	MR at I-15	36°39'48"	114°34'11"	1,500	38.7	1,360	18.8	8.4
09418900	Muddy River near Lewis Ranch near Glendale	MR near Lewis Ranch	36°39'10"	114°33'20"	1,490	39.3	1,380	18.2	8.4
09419000	Muddy River near Glendale	MR near Glendale	36°38'35"	114°32'20"	1,460	37.4	1,380	17.8	8.3
09419490	Muddy River below Anderson Wash near Logandale	MR below Anderson Wash	36°37'26"	114°30'29"	1,430	41.3	1,400	17.2	8.4
363715114295501	Irrigation Diversion near Logandale	Logandale Diversion	36°37'15"	114°29'55"	1,380	(5.00)	NA	NA	NA
09419507	Muddy River at Lewis Avenue at Overton	MR at Lewis Ave.	36°32'07"	114°25'42"	1,250	4.17	3,390	10.7	8.0

[1] Discharge is mean of multiple instantaneous measurements made at site on February 7, 2001. A value in parentheses denotes diverted discharge.

[2] Specific-conductance measurements made in the U.S. Geological Survey laboratory in Henderson, Nev., February 8, 2001.

[3] Field pH measurements made by National Park Service.

[4] Discharge measurement made on February 6, 2001.

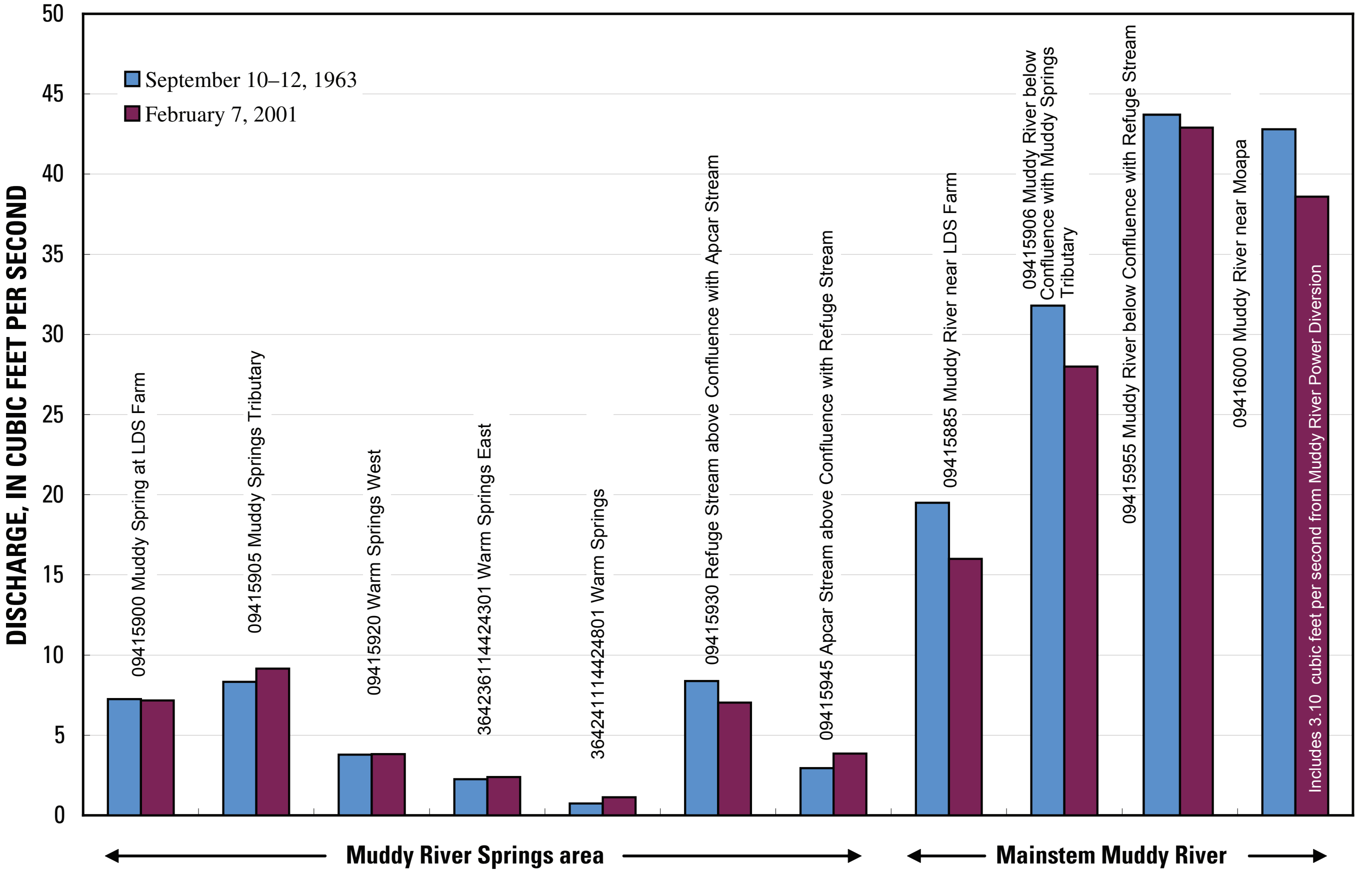


Figure 4. Comparison of discharge measurements in the Muddy River Springs area and mainstem of the Muddy River and Moapa, Nevada, September 1963 and February 2001.

Table 3. Maximum, minimum, and percent difference of discharge and stage measurements collected in the mainstem of the Muddy River, February 7, 2001.

Site number	Site name	Discharge measurements maximum (in cubic feet per second)	Discharge measurements minimum (in cubic feet per second)	Discharge measurements Percent range[1]	Stage measurements maximum (in cubic feet per second)	Stage measurements minimum (in cubic feet per second)	Stage measurements Percent range[1]
09416000	Muddy River near Moapa	37.1	33.8	9	0.78	0.77	1
09416500	Muddy River at White Narrows near Moapa	33.3	30.4	9	9.30	9.30	1
09417000	Muddy River at Railroad Pump Plant near Moapa	37.6	32.3	14	8.32	8.24	1
09417270	Muddy River above California Wash near Moapa	34.8	31.0	11	9.28	9.16	1
09417380	Muddy River below California Wash near Moapa	37.2	32.9	12	9.56	9.35	2
09417390	Muddy River above Meadow Valley Wash near Glendale	37.3	32.7	12	7.84	7.68	2
09418890	Muddy River at I-15 near Glendale	39.2	36.9	6	8.89	8.83	1
09418900	Muddy River near Lewis Ranch near Glendale	39.6	38.8	2	9.13	9.11	0
09419000	Muddy River near Glendale	38.8	36.5	5	5.22	5.20	0
09419490	Muddy River below Anderson Wash near Logandale	43.3	40.2	7	8.31	8.28	0

[1] Denotes percent difference from "maximum" to "minimum" measured value.

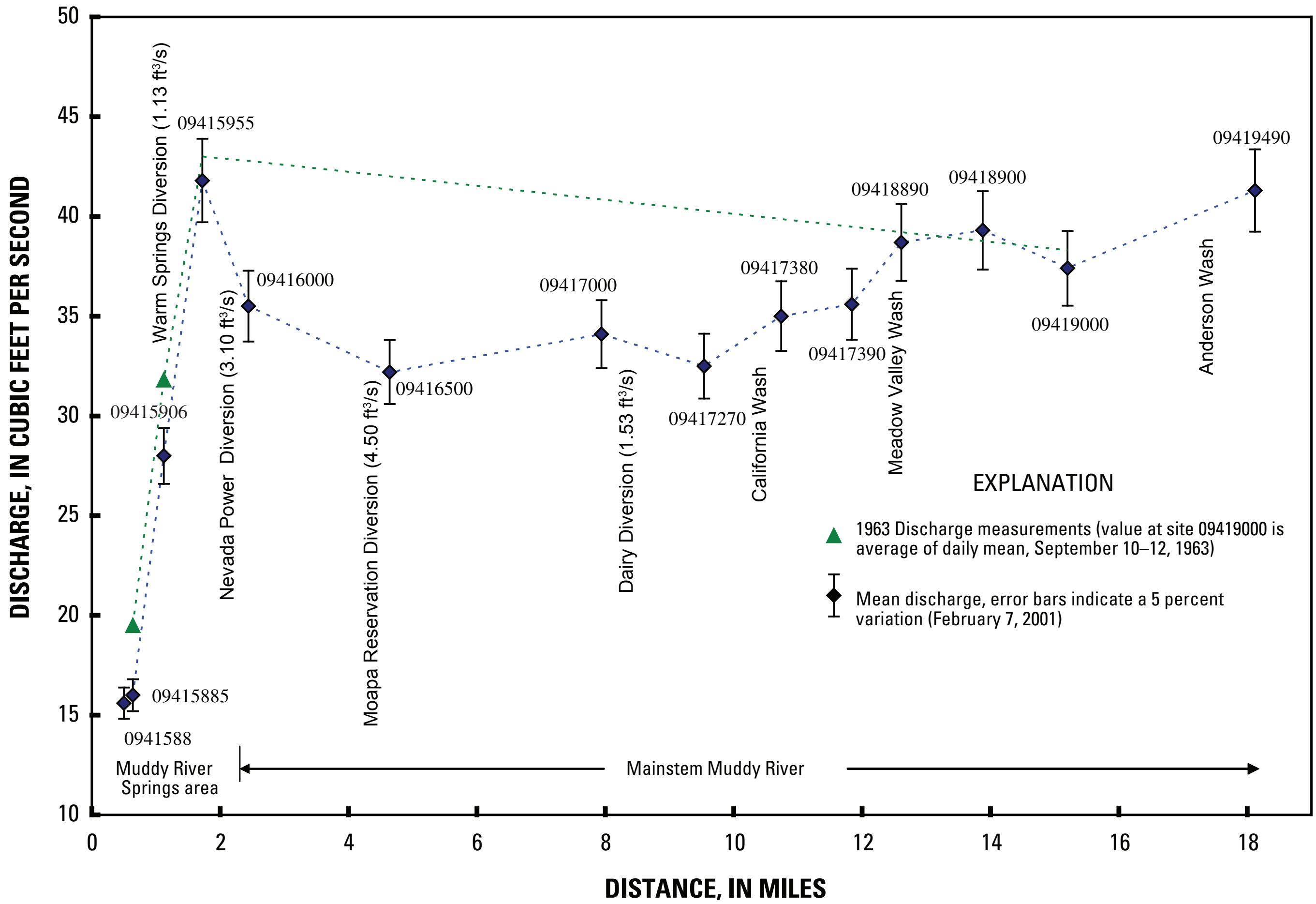


Figure 5. Mean discharge at selected sites in the Muddy River Springs area and mainstem of the Muddy River, Nevada, September 10–12, 1963—February 7, 2001.

larger than the increase in flow between the two sites. Therefore, no measurable change in discharge as a result of groundwater inflow or evapotranspiration was observed between the Muddy River Springs area and MR below Anderson Wash (site 09419490).

River discharge below MR below Anderson Wash (site 09419490) is affected by diversion into Bowman Reservoir (fig. 3) and the Irrigation Diversion near Logandale (site 363715114295501). Between MR below Anderson Wash (site 09419490) and Muddy River at Lewis Avenue at Overton (site 09419507), the total decrease in discharge is 37.1 ft³/s (table 2).

Water-Property and pH Measurements

Water samples were collected concurrently with synoptic discharge measurements for the Muddy River Springs area and Muddy River and analyzed for specific conductance at the USGS laboratory in Henderson, Nevada. Water temperature was measured at many of the sites; whereas, field pH readings were obtained only at selected Muddy River sites. Mean values were computed for specific conductance and water temperature where multiple measurements were collected.

Water-temperature, specific-conductance, and pH data for the Muddy River Springs area and the Muddy River are listed in tables 1 and 2. Figure 6 shows water-temperature and specific-conductance measurements made between MR below Upper Confluence (site 09415880) and MR below Anderson Wash (site 09419490).

In the Muddy River Springs area, water-temperature and specific-conductance measurements ranged from 26 to 27ºC and 969 to 1,060 µS/cm, respectively (table 1). These measurements indicate that waters within the Muddy River Springs area have similar temperatures and specific conductance. Water temperature in the Muddy River remained stable and specific conductance increased slightly by the time discharge reached MR Moapa (site 09416000; fig. 6).

Specific-conductance, water-temperature, and pH data collected at Muddy River sites between MR Moapa (site 09416000) and MR below Anderson Wash (site 09419490) ranged from 1,010 to 1,400 µS/cm, from 10.7 to 26.0ºC, and from 8.2 to 8.5, respectively (table 2). A specific conductance of 3,390 µS/cm was measured at MR at Lewis Ave. (site 09419507), which is downstream of Bowman Reservoir. Specific-conductance measurements made at sites between the MR Moapa (site 09416000) and MR below Anderson Wash

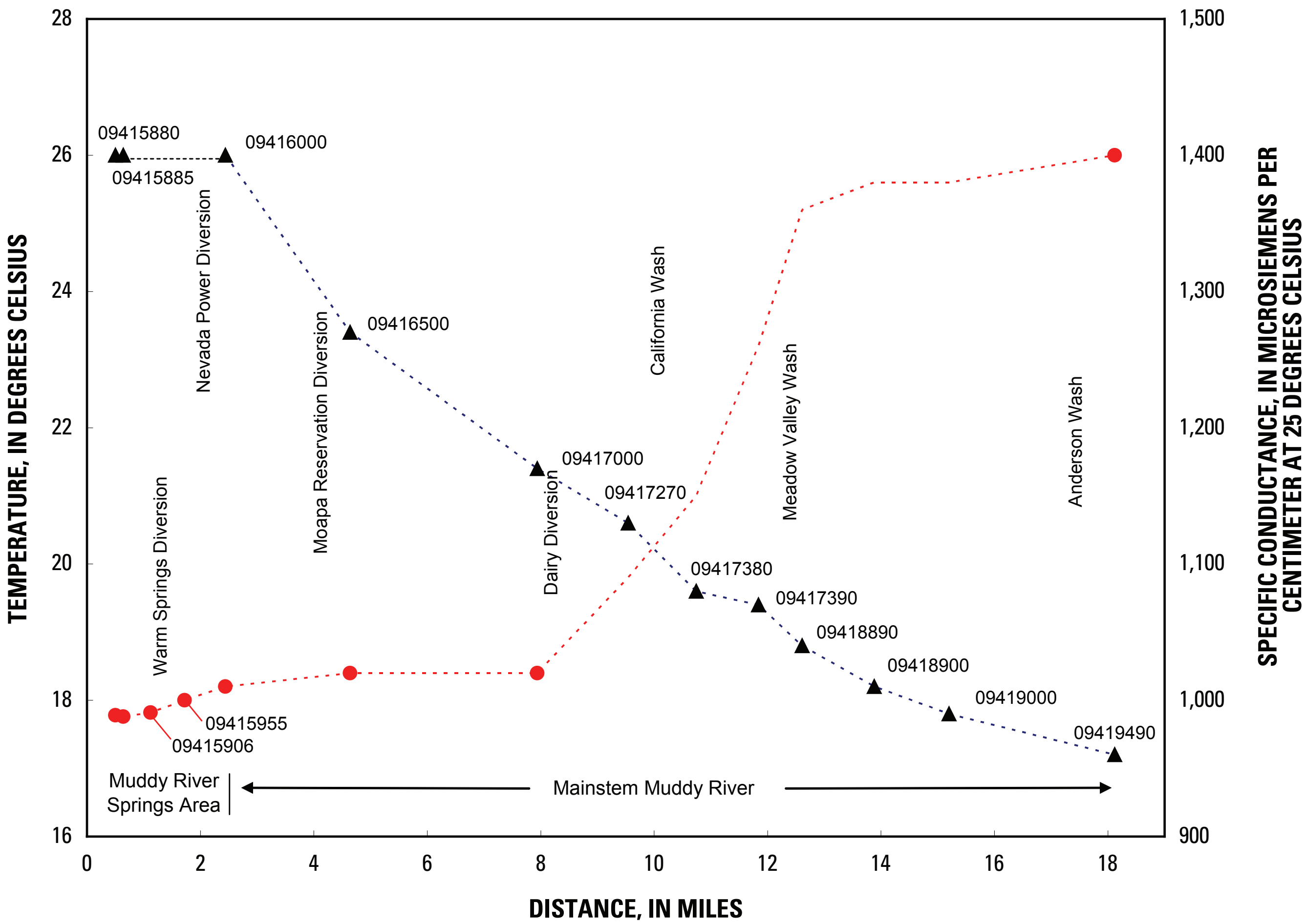


Figure 6. Water-temperature and specific-conductance measurements at selected sites in the Muddy River Springs area and mainstem of the Muddy River, Nevada, February 7, 2001.

(site 09419490) indicated three trends: (1) specific conductance was stable or increased slightly between MR Moapa (site 09416000) and MR at Railroad (site 09417000), (2) specific conductance increased by 340 µS/cm between MR at Railroad (site 09417000) and MR at I-15 (site 09418890), and (3) specific conductance increased by 40 µS/cm between MR at I-15 (site 09418890) and MR below Anderson Wash (site 09419490). The increase in specific conductance between sites MR at Railroad (site 09417000) and MR at I-15 (site 09418890) is indicative of water entering the river through a shallow ground-water system. A net decrease in water temperature of 8.8°C was noted between MR Moapa (site 09416000) and MR below Anderson Wash (site 09419490). Between these sites, measurements of pH remained relatively stable and ranged from 8.2 to 8.5 (table 2).

Summary

Synoptic discharge, specific-conductance, water-temperature, and pH measurements were made between 9 a.m. and 3 p.m. on February 7, 2001, in the Muddy River Springs area and mainstem of the Muddy River. These data were collected at 29 sites to help assess the spatial variability of discharge in the tributary springs and river during a period of low evapotranspiration, and municipal and agricultural diversion. Two discharge measurements were made at most sites within the Muddy River Springs area and six discharge measurements were made at most sites on the Muddy River. An average discharge was computed and used to represent the discharge rate at each measurement site. For the Muddy River Springs area, the lowest discharge, 2.39 ft^3/s, occurred at WS East (site 364236114424301) and the highest discharge, 41.8 ft^3/s, occurred at MR below Refuge (site 09415955). Along the mainstem of the Muddy River, downstream of MR Moapa (site 09416000), the lowest discharge, 32.2 ft^3/s, occurred at MR at Narrows (site 09416500) and the highest discharge, 41.3 ft^3/s, occurred at MR below Anderson Wash (site 09419490). Within the Muddy River Springs area, discharge measurements made on February 7, 2001, were compared with measurements made during September 10–12, 1963.

Discharge data indicated a net increase of 26.2 ft^3/s between MR below Upper Confluence (site 09415880) and MR below Refuge (site 09415955). This increase in discharge primarily is the result of tributary inflow from Muddy Springs Tributary and Refuge Stream. An approximate net decrease in discharge of 10.4 ft^3/s, occurred between MR below Refuge (site 09415955) and MR above California Wash (site 09417270) primarily because of water diversions. An approximate net increase in discharge of 9.9 ft^3/s occurred between MR above California Wash (site 09417270) and MR below Anderson Wash (site 09419490) primarily because of return flows. Measurements of discharge within the mainstem of the Muddy River indicate a net loss of 0.5 ft^3/s between MR below Refuge (site 09415955) and MR below Anderson Wash (site 09419490). However, when the diverted flow into the Nevada Power Pump Station near Moapa (site 364240144414001) is subtracted from the discharge measured at the Refuge Stream site, change in discharge for the same reach indicates a net gain of 2.6 ft^3/s. This increase in discharge falls within the maximum computed-measurement error.

Specific-conductance, water-temperature, and pH data also were collected and analyzed for trends between measurement sites. Specific-conductance measurements were similar within the Muddy River Springs area. An increase of 390 µS/cm was evident between MR Moapa (site 09416000) and MR below Anderson Wash (site 09419490), with most of that increase occurring between the MR at Railroad (site 09417000) and MR at I-15 (site 09418890). Water-temperature measurements also were similar within the Muddy River Springs area, but decreased downstream along the Muddy River. Measurements of pH within the river remained relatively constant.

The net increases in discharge and specific conductance for the selected reach of the Muddy River between MR below Refuge (site 09415955) and MR below Anderson Wash (site 09419490), indicate contribution from a shallow ground-water system. Measurements of discharge from the Muddy River Springs area to the diversion into Bowman Reservoir indicate the local influences from diversions and tributaries. However, no measurable net gain or loss in streamflow was observed along the entire reach.

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