PRELIMINARY HYDROGEOLOGIC EVALUATION OF THE COLORADO PLATEAU - MIDDLE RIO GRANDE BASIN TRANSITION NEW MEXICO BASIC DATA COMPILATION

prepared by

JOHN SHOMAKER & ASSOCIATES, INC.
Water-Resource & Environmental Consultants
2611 Broadbent Parkway NE
Albuquerque, New Mexico 87107
505-345-3407

prepared for

New Mexico
Interstate Stream Commission
Santa Fe

June 30, 2010

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prepared by

Erwin A. Melis, PhD

Annie M. McCoy, CPG

JOHN SHOMAKER & ASSOCIATES, INC.
Water-Resource and Environmental Consultants
2611 Broadbent Parkway NE
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505-345-3407
www.shomaker.com

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EXECUTIVE SUMMARY

The purpose of this hydrogeologic evaluation of the Colorado Plateau-Middle Rio Grande Basin transition is to provide basic data to help quantify the natural discharge from the saline bedrock aquifers along the transition to the Middle Rio Grande Basin. An improved understanding of the discharge from the saline bedrock aquifers along the transition will allow the flow in the various bedrock aquifers to be better estimated, will allow important and perhaps distinct recharge zones to be identified, and allow any nearby shallow wells to be identified as important to monitor eventual future saline groundwater withdrawals that would take away a portion of saline subsurface recharge from the Colorado Plateau to the Middle Rio Grande Basin (e.g., Hogan et al., 2007).

In the southwestern U.S., reliable bedrock aquifers are commonly found in Mesozoic-age sandstones or Paleozoic-age limestones (e.g., Dettinger et al., 1995). Saline groundwater makes up seven percent of the alluvial water along the Rio Puerco (Plummer et al., 2004aa). In this study, using a small part of the Plummer et al. (2004a) dataset groundwater collected from Rio Puerco alluvial wells has a higher specific conductance downstream from the confluence with the Rio San Jose possibly due to a large component of saline subsurface recharge that enters the Middle Rio Grande Basin (MRGB) from the northern Lucero Uplift. Field-determined spring flow rates combined with historical data suggest that the northern Lucero Uplift and Rio San Jose area saline springs discharge from bedrock aquifers is 1,780 ac-ft/yr. This is only a fraction of the subsurface recharge entering the MRGB.

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ABBREVIATIONS

ac-ft	acre-feet
ac-ft/yr	acre-feet per year
amsl	above mean sea level
bgl	below ground level
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
ºC	degrees Celsius
EPA	Environmental Protection Agency
cfs	cubic feet per second
Fig(s).	Figure(s)
ft	foot/feet
gal	gallon(s)
gpm	gallons per minute
hr(s)	hour(s)
in.	inch(es)
in./yr	inches per year
JSAI	John Shomaker & Associates, Inc.
MCL	maximum contaminant level
mg/L	milligrams per liter
min	minute(s)
ml	milliliters
MRGB	Middle Rio Grande Basin
NMBGMR	New Mexico Bureau of Geology and Mineral Resources
NMBMMR	New Mexico Bureau of Mines and Mineral Resources
NMISC	New Mexico Interstate Stream Commission
NMOSE	New Mexico Office of the State Engineer
NMSLO	New Mexico State Land Office
ppm	parts per million
RP	Rio Puerco
RPfz	Rio Puerco fault zone
RSJ	Rio San Jose
SCS	Soil Conservation Service of the U.S. Department of Agriculture
TDS	total dissolved solids
µS/cm	microSiemens per centimeter
USGS	U.S. Geological Survey

PRELIMINARY HYDROGEOLOGIC EVALUATION OF THE COLORADO PLATEAU-MIDDLE RIO GRANDE BASIN TRANSITION, NEW MEXICO

1.0 INTRODUCTION

John Shomaker & Associates, Inc. (JSAI) was contracted by the New Mexico Interstate Stream Commission (NMISC) to perform a hydrogeologic evaluation of the natural discharge from bedrock aquifers along the Colorado Plateau-Middle Rio Grande Basin transition, including the Rio Puerco fault zone (RPfz), Lucero Uplift, and Nacimiento Uplift / Pajarito fault areas in the southeastern San Juan Basin and part of the Middle Rio Grande Basin (Fig. 1). This stage of the evaluation, intended to result in this basic-data report, included the following three tasks:

1. field surveys of spring discharge and quality
    - Nacimiento Uplift / Pajarito fault area springs west of San Ysidro and near Rio Salado
    - springs near Rio San Jose (still pending Pueblo of Laguna approval for access)
2. groundwater-level and groundwater-quality measurements in the Rio Puerco valley
3. streamflow analysis
    - Rio Puerco from available U.S. Geological Survey (USGS) gaging station records
    - seepage runs along Rio Salado between Ojo del Espiritu Santo Grant boundary and the NM-550 bridge in San Ysidro
    - seepage runs along Rio San Jose from Correo to confluence with the Rio Puerco (still pending Pueblo of Laguna approval for access)

1.1 Purpose of Study

The purpose of the study is to summarize basic data and to advance the hydrogeologic evaluation of the Colorado Plateau-Middle Rio Grande Basin transition, in order to quantify the natural discharge from saline bedrock aquifers to the Middle Rio Grande Basin and provide a database of springs, surface water, and wells to assist in the study of possible changes in the groundwater over time. The lack of large, viable shallow alluvial aquifers in the area, and the fact that the Rio Grande is fully appropriated, have led to the exploration of the bedrock aquifer along the fault zone as a potential groundwater resource for future development in the area. Several deep test wells have been completed in the area, and saline groundwater demand of 43,200 acre-feet per year (ac-ft/yr; INTERA, 2008) has been estimated for the Rio West master-planned community in southwestern Sandoval County, immediately east of the study area. Notices of intent to drill a "deep well" under the provisions of Sec. 72-12-25 of the New Mexico statutes have been filed for many other locations in the area (Fig. 1).

1.2 Geographic Setting

The Rio Puerco fault zone (RPfz) comprises a large part of the study area, which extends to the Nacimiento Uplift / Pajarito fault area to the north, and the Lucero Uplift, to the south (Fig. 1). The RPfz is a vast and poorly-accessible area along the middle reach of the Rio Puerco and lying about 25 miles west and northwest of Albuquerque. For the purposes of this study, the RPfz is loosely defined as starting south of Mesa Prieta (south of the Jemez lineament/Puerco Necks area of Hallett et al., 1997) east of the Ignacio monocline of Kelley and Clinton (1960) or the westernmost of RPfz faults, north of the Rio San Jose, and west of the Sand Hill fault zone to San Ysidro in Sandoval County (Fig. 1).

The primary surface drainage of the study area is the Rio Puerco, a large north-to-south tributary to the Rio Grande, with a total watershed area of about 7,000 square miles. Large tributary drainages to the Rio Puerco, from north to south, include Arroyo Chico (1,390 square miles watershed area), Rio San Jose (3,660 square miles watershed area), and several smaller, ephemeral arroyos (http://waterdata.usgs.gov/nm/nwis/sw).

1.3 Land Ownership and Access

Land ownership in the RPfz includes the Pueblo of Laguna, the Tohajiilee community (formerly the Cañoncito Band of the Navajo Nation), Zia Pueblo, Jemez Pueblo, the Bureau of Land Management, the New Mexico State Land Office (NMSLO), King Ranch, and various other ranches. In the western Lucero Uplift, ownership includes the Pueblo of Laguna, Isleta Pueblo, and McKinley Ranch.

Best access to the northern part of the study area (Cabezon area: 70 miles driving distance) is via NM-550 and State Road 279. Access to the western part of the study area is via State Road 279 from NM-124 through Pueblo of Laguna and the turn off to Ceboyeta (La Gotera area: 79 miles driving distance). Alternatively, a slower, but more direct road cuts through the Cañoncito Navajo Reservation to the western part of the study area (La Gotera area: 48 miles driving distance). The southern part of the study area is best reached via a dirt road that parallels the Rio Puerco and starts at the gas station on the northern frontage road alongside I-40 at exit 140. This route ends at the Bernabe M. Montano Grant boundary (Pueblo of Laguna). The eastern part of the study area can be reached via Southern Boulevard SW in Rio Rancho, Encino Road NW, Frost Road NW, and Ranch Road NW to Alamo and Sandoval Ranch (about 32 miles driving distance). Additional access to this area is provided by taking Cabezon Road (BLM-administered Ojito Wilderness turnoff) from NM-550 just south of San Ysidro. Access to the Lucero Uplift is via Bernardo and Socorro County Road 12. This route was only open to the southern boundaries of the Comanche Ranch, owned by the Isleta Pueblo. Access to the northern part of the Lucero Uplift was gained through the Waste Management-operated Valencia County Regional Landfill, just south of NM-6 at Rio Puerco, and across the McKinley Ranch owned by Weldon and Margaret McKinley (phone 505-864-4055 before accessing and obtain written permission to enter at the landfill). Springs at the northern end of the Lucero Uplift can be accessed via NM-6 and the small communities of Correo, Suwannee, and South Garcia. Land in the northern Lucero Uplift is within the Pueblo of Laguna and at this time the Pueblo has not granted permission to access the Rio San Jose, or sample the saline springs on their land. According to the Bureau of Indian Affairs (BIA), one of the liaisons contacted during this study, the request for permission is being studied by the Pueblo.

2.0 HYDROGEOLOGIC SETTING

2.1 Regional Geology

The region that includes the Rio Puerco fault zone has exposed at the surface mostly Jurassic-age, and Cretaceous-age rocks typical of the San Juan Basin (Table 1; Fig. 2). Only in the north near the terminus of the southern Nacimiento Uplift, and in the south near the Lucero Uplift, are deeper, thick shale units of the Triassic-age Chinle Group exposed (Table 1; Fig. 2). Triassic and Paleozoic units are present at depth. The RPfz shares a similar early-Tertiary tectonic history with the uplifts along the western Middle Rio Grande Basin (MRGB).

These uplifts include the Lucero Uplift, the Nacimiento Uplift, and the Mt. Taylor area, where Pliocene-Pleistocene-age basalts cover Mesozoic-age sedimentary rocks. At its southeastern margin, the RPfz is deeply buried by Tertiary-age units associated with Laramide tectonism, Basin and Range faulting, and rifting of the MRGB (e.g., Tedford and Barghoorn, 1999). Presently, the RPfz is tectonically active, characterized by shallow earthquakes, rapid uplift rates, rapid erosion and high sediment yields in stream channels (http://esp.cr.usgs.gov/rio_puerco/).

The RPfz contains predominantly northeast-oriented normal faults with an overall southeast-side-down sense of displacement (Slack, 1975). The RPfz links opposite-polarity uplifts, the Nacimiento Uplift in the north, with a west-side-down geometry, and the Lucero Uplift to the south, with an east-side-down geometry. At its northwest end, the RPfz mostly contains small displacement faults of, at most, several hundred feet (Slack and Campbell, 1975). Faults alternate from steeply northwest-dipping to steeply southeast dipping, repeating a horst-and-graben morphology. Only at its southeastern end do larger displacement, southeast-side-down faults dominate. The Moquino fault, cut by Sandoval County-Recorp deep exploration Well 5 (RG-88934POD1; see Fig. 1), has 2,600 ft of displacement (Sengebush, 2008). Northeast-oriented faults are cut by, and trend into, north-oriented structures that possibly indicate Rio Grande-style rifting superimposed on the earlier-formed RPfz.

Table 1. Geologic units exposed at the surface in the Rio Puerco fault zone

Rio Puerco fault zone			
age (million years ago)		**units**	**map symbol**
0- 23	Neogene	Santa Fe Group sediments of the Middle Rio Grande Basin	QTs
66-101	Upper Cretaceous	Mesaverde Group to Point Lookout Sandstone	Kmv - Kpl
		Lower Mancos Shale	Kmm - Kmd
101 -132	Upper/Lower Cretaceous	Dakota Sandstone	Kd
132-145	Upper Jurassic	Morrison Formation	Jm
		Todilto Limestone	Jt
		Entrada Sandstone	Je
145-160	Upper Triassic	Chinle Group	Trc

2.2 Hydrogeologic Conditions

The average pan evaporation rate of 60 in./yr for the San Ysidro area (SCS, 1972), used for spring flow rate calculations in this study, is comparable with the average gross lake-surface evaporation rates of 50 in./yr for the uplands in the study area, and 65 in./yr along the Rio Puerco (http://www.nm.nrcs.usda.gov). Recharge in the study area occurs primarily as subsurface recharge from the San Juan Basin (Table 2; JSAI, 2009). Potentiometric-surface maps for bedrock aquifers in the study area suggest that the bedrock receives mountain-front recharge from the Zuni Mountains and the Mt. Taylor area (Frenzel, 1992; Baldwin and Anderholm, 1992).

Regional groundwater flow in the study area is eastward, away from the Colorado Plateau, with a head gradient in the San Andres-Glorieta aquifer of 0.008 ft /ft (Rio San Jose area; Frenzel, 1992). The gradient is less steep in the Acoma Sag.

Table 2. Various model estimates of groundwater flow (subsurface recharge) from the San Juan Basin bedrock aquifers to other parts of the basin and the MRGB

area represented in model	affected flow area and direction	estimated flow	reference
San Juan Basin	flow into the MRGB	1,200 ac-ft/yr west to east flow	Frenzel and Lyford, 1983
Acoma Embayment – Eastern Zuni Uplift	flow to the Rio Grande basin	2,949 ac-ft/yr west to east flow	Frenzel, 1992
MRGB	flow into the MRGB	13,598 ac-ft/yr west to east flow	Kernodle et al., 1995
MRGB	flow into the MRGB	13,500 ac-ft/yr west to east flow[1]	Tiedeman et al., 1998
Conceptual model of the MRGB	flow into the MRGB	2,000 ac-ft/yr west to east flow	Sanford et al., 2001
MRGB	flow from the Colorado Plateau into the MRGB	1,568 ac-ft/yr east to west flow	McAda and Barroll, 2002
San Juan Basin	flow to the MRGB	2,000 ac-ft/yr west to east flow	Petronis et al., 2005
MRGB	combined (Western Boundary and SJB) flow into the MRGB	8,442 ac-ft/yr east to west flow	Sanford et al., 2004

[1] includes Rio Puerco flow from model boundary to Rio San Jose confluence and Rio San Jose inflow
MRGB - Middle Rio Grande Basin
ac-ft/yr - acre-feet per year

2.3 Springs

A database of spring within the larger RPfz area was constructed to aid in the field assessment. Sources included Renick (1931), Wright (1946), Titus (1963), Summers (1976), Trainer (1978), Risser and Lyford (1983), Craigg (1984), White and Kues (1992), Newell et al. (2005) and USGS topographic maps of the study area (1:24,000 and 1:100,000 scale). The final database contains 199 springs organized according to geographic area (Fig. 3; Appendix A). Based on historical flow-rate information spanning the time period 1926 to 2000, and excluding the large Horace and Ojo del Gallo Springs near Grants, which are technically outside the study area, these springs typically produced 2,672 ac-ft/yr of saline groundwater with an average total dissolved solids (TDS) concentration of 10,887 milligrams/liter (mg/L) (Appendix A).

The six geographic areas used to organize the spring database include: southern Nacimiento Uplift/Pajarito fault area, Rio Puerco fault zone, Puerco Necks, Mt. Taylor/Acoma Sag, northern Lucero Uplift/Rio San Jose, and Lucero Uplift (Fig. 4 through 9). In the Lucero Uplift area, south of Pueblo of Laguna, springs were analyzed in detail, due to their easy access, and since it is the best exposed Permian-age and Pennsylvanian-age section. The Puerco Necks and the Mt. Taylor springs were not technically within the study area, and these springs were included in the database for completeness only. They will not be further mentioned. Each of the other areas is discussed in detail in the following sections.

2.3.1 Rio Puerco Fault Zone (RPfz)

The RPfz itself contains relatively few springs; the database includes just eight historic springs, of which only one, Sandoval Spring, was found to be flowing (Figs. 8 and 11). This water has a specific conductance of 1,170 microSiemens per centimeter (µS/cm). A calculation based on surface area and evaporation rate suggests that this spring flows at a rate of 36 gallons per minute (gpm). The field chemistry suggests that this spring contains relatively fresh groundwater, in comparison to deeper, saline groundwater with higher specific conductance. Five other visited springs in the RPfz are dry at the surface, though four are accompanied by abundant phreatophytes and salt encrustation that is consistent with evaporation of shallow groundwater and precipitation of dissolved salts.

Ojito Spring (RL-66) and an unnamed spring (topo 49), on Pueblo of Laguna and Zia Pueblo lands respectively, were not visited (Fig. 8). 'La Gotera spring' (informal name; topo 10) and three nearby springs at the intersection of the Ignacio monocline and the Jemez lineament/Puerco Necks (topo 7, topo 8, and topo 9), characterized by numerous Quaternary-age volcanic dikes, plugs, necks, and flows, were not visited.

2.3.2 Nacimiento Uplift/Pajarito Fault Area

At least 34 springs exist in this geographic area, mostly on Zia Pueblo and Jemez Pueblo lands (Fig. 6). Springs near Holy Ghost Spring emanate from a broad dome, referred to as the Holy Ghost – Warm Spring dome within the broader Jemez lineament of Neogene- to Quaternary age volcanism (Woodward and Martinez, 1974). All springs are near the Pajarito fault, marking the edge of the San Juan Basin and the Nacimiento Uplift. Based on historic

records, these springs contribute 49.5 gpm to the Rio Salado, which drains east to the Jemez River and the Rio Grande (Appendix A). The travertine mounds in this area are some of the most spectacular of all travertine deposits along the western MRGB, and the most extensive of the travertine deposits exists in the Peñasco – Cuchillo area, where a dozen springs occur (Appendix A; Craigg, 1984). Likewise, within the south-plunging Tierra Amarilla anticline (e.g., Newell et al., 2005), several springs issue forth from extensive travertine deposits.

Many of the travertine mounds associated with the springs, and some associated with dormant springs, appear on the geologic map of the San Ysidro quadrangle (Woodward and Ruetschilling, 1972). To quantify spring flow from the 31 mapped travertine deposits north of NM-550, and the three mapped travertine deposits south of NM-550, a planimeter was used to measure the areas of the travertine deposits. Travertine deposits in the Holy Ghost Spring quadrangle and other travertine deposits in the San Ysidro quadrangle, but within the Jemez River drainage were not measured. The total area of travertine bordering the reach of the Rio Salado along which the seepage run was conducted (between Ojo del Espiritu Santo Grant boundary and the NM-550 bridge in San Ysidro), is about 335 acres. If only the estimated 10 percent of the mapped area of travertine contributes groundwater to the surface, and using pan evaporation of 60 inches per year (in./yr) for the San Ysidro area (SCS, 1972), the travertine deposits contribute about 104 gpm to the surface flow of the Rio Salado in the area. The historically documented spring flow is 49.5 gpm (Summers, 1976; Trainer, 1978; Craigg, 1984).

The average specific conductance of water from all the springs in this area is 10,442 µS/cm, and the average TDS concentration is 7,983 mg/L. Four springs west of the Ojo del Espiritu Santo Grant/Zia Pueblo and along NM-550 were visited (Fig. 6; Table 3). These springs typically consist of a conical travertine spring mound encrusted with salt, with a surface area of 400 to 1,000 ft^2. The center of the mound is filled with water that supports marsh grass, floating on it. On June 4, 2010, discharge from three of the four springs had an average temperature of 23.1ºC, a pH of 6.27, and a specific conductance of 10,350 µS/cm, near the average of historic measurements in the area. The fourth spring had water only within the highway ditch about 100 ft downstream of its mound, which was dry. It is excluded from the averages.

Table 3. Summary of water quality at four selected springs, Tierra Amarilla anticline, west of San Ysidro, Sandoval County, New Mexico

appendix-listed spring no.[1]	pH	temperature, °C	specific conductance, µS/cm
sampling event on June 3, 2010			
nac 0	6.26	23.4	9,840
nac 1	6.32	25.3	9,640
field 2	6.22	20.6	11,570
field 5	7.25	30.4	12,330

°C - degrees Celsius µS/cm - microSiemens per centimeter
[1] – Appendix A

2.3.3 Northern Lucero Uplift-Rio San Jose

Forty-six springs are in this geographic area, mostly on the Pueblo of Laguna lands (Fig 3). The most prolific historic springs are along the Rio San Jose where Kelley and Wood (1946) mapped more than a dozen faults cutting Mesozoic-age bedrock. Eight springs are located along the Rio San Jose. The highest flow rate, at 400 gpm, is documented at Dipping Vat Spring (White and Kues, 1992). From historic records (see Appendix A), springs along this reach of the Rio San Jose contributed 520 gpm (839 ac-ft/yr; 1.2 cfs); whereas Risser and Lyford (1983) report a baseflow gain of 3 cfs (1,300 gpm, or 2,200 ac-ft/yr) in this reach, which doubtless represents some groundwater discharge that does not appear in the springs. Along the eastern margin of the Lucero Uplift in this area (Townships 7 and 8 North), travertine mounds are commonplace (e.g., Wright, 1946). They can best be seen by train, and on April 16, 2010 during an afternoon trip from Albuquerque to Grants, several of the drainages below these springs had surface water.

The average specific conductance of all the springs in this area is 19,883 µS/cm, and the average TDS concentration is 20,047 mg/L. In this area, two springs were visited: Lucero Spring and an unnamed spring on private land just west of Mesa Redondo and south of Suwannee. Lucero Spring (Figs. 9, 10 and 13) consists of a salt-encrusted area surrounding a travertine spring mound rising about 10 ft above the surrounding landscape. An orthophotograph of the area (Fig. 10) shows about 24 acres of saline spring deposits surrounding phreatophytes. Assuming the pan evaporation rate of 60 in./yr. (SCS, 1972), the area of 24 acres, and an estimated 10 percent of flow from the total area Lucero Spring is estimated to have a flow rate of 8.5 gpm, whereas the unnamed spring with a bubbling surface pond of about 1,080 ft^2 was estimated to have a flow rate of 5 gpm. Lucero Spring had a water temperature of 17.9ºC, pH of 7.05, and specific conductance of 4,760 µS/cm, whereas the unnamed spring had a water temperature of 22.4ºC, pH of 6.55, and specific conductance of 16,660 µS/cm.

One of the inaccessible springs, Lower Water Spring, has a large travertine deposit of almost 445 acres, which was visited, but not sampled. The spring is inaccessible, but from the road leading past it, several visible wet areas were noted and therefore its flow rate was evaluated using a possible evaporation of 10 percent of its surface. Using a pan evaporation rate of 60 in./yr. (SCS, 1972), this results in about 150 gpm of flow. Another spring that is currently inaccessible, Suwannee Spring, was visited for a hydrogeologic investigation in 2000, when its flow was estimated at 100 gpm (JSAI, 2000). The eight springs with measurable flow, plus Lower Water and Suwannee Springs, contribute a total of 353 gpm, or about 570 ac-ft/year to the MRGB. Adding the historic flow rates from springs not visited resulted in 656 gpm, or 1,059 ac-ft/yr, of total spring flow for the southern Lucero Uplift area. This compares well with the historic estimate of 599 gpm, or 966 ac-ft/yr using only referenced flow rates (White and Kues, 1992).

2.3.4 Lucero Uplift

A total of 61 springs are documented in the general Lucero Uplift area (Fig. 4). Of these, 39 historic springs are on the Pueblo of Laguna lands and have been separated into a north Lucero Uplift-Rio San Jose springs section of the database (Appendix A), as described in the preceding section. The remaining, accessible 22 springs in the Lucero Uplift area were targeted for survey during the spring of 2010 while we awaited access approval from the Pueblo of Laguna.

The 22 saline springs surveyed are distributed along the eastern boundary of the Lucero Uplift over a distance of about 20 miles (Figs. 4, 11, 12, and 13), and information was compiled from the literature (White and Kues, 1992; Titus, 1963; Wright, 1946; Newell et al., 2005). The list was cross-referenced with springs shown on USGS topographic maps (at 1:100,000, published by the BLM, 2009, and USGS published 1:24,000 scale). In the database, springs identified on topographic maps have a prefix "topo" and springs from the literature have a county "code" prefix referencing their database number in White and Kues (1992). In the Lucero Uplift, one seep was identified in the field and is noted (field) in the database (Appendix A).

Of the 22 springs in the database, 13 were visited, seven were inaccessible and two were duplicate records in the database likely describing the same spring or an area where a spring had historically emanated but is currently not flowing at the surface. The inaccessible springs are south of Mesa Aparejo and on Comanche Ranch (Fig. 4), a property owned by Isleta Pueblo and presently inaccessible. Of the 13 visited sites, five spring sites were dry. Three dry sites had evidence of older and inactive, often dissected, spring mounds or travertine deposits, and had springs within a 2-mile radius and within the same drainage. Two dry spring sites had evidence of surface drainage modification and are currently being used as surface impoundments for ranching.

Eight remaining saline springs had flows ranging from 0.5 to 36 gpm (Fig. 13). Flow was measured using a stopwatch and beaker or bucket, or a portable Parshall flume installed downstream of the spring. Springs that had spring mounds, travertine deposits, or surface salt encrustation also had additional flow calculated by multiplying the area of salt deposition (estimated from GoogleEarth aerial photographs) by the pan evaporation rate (SCS, 1972). This spring evaporation component was added to the flow measured by flume or bucket. The springs had a bimodal flow distribution, two seeps average 1.5 gpm, and six other springs averaged 16 gpm. In addition, six of the inaccessible springs not surveyed contribute from 0.1 to 30 gpm (White and Kues, 1992).

2.3.5 Spring Discharge, and Contribution to the MRGB

Estimates of the rate of discharge from the springs are most useful in understanding of the head and flow characteristics of the deep aquifers. Some spring discharge does contribute to the MRGB groundwater system, but much of the discharge is lost to evaporation before it becomes available for recharge. Many of the spring-flow estimates described above are based, at least in part on discharge area and evaporation rate, and to the extent that the discharge is evaporated at the spring, it cannot reach the MRGB.

The spring discharge along the southern Lucero Uplift occurs over a distance of about 20 miles. This amounts to about 53 ac-ft of saline groundwater per mile along the southern Lucero Uplift. An additional 446 gpm, or 721 ac-ft/yr, of saline groundwater is added in the northern Lucero area (Appendix A). This results in about 1,780 ac-ft/yr of total saline groundwater discharge over 30 to 40 miles along the Lucero Uplift, or an average of 45 to 57 ac-ft/yr per mile. This is similar to the subsurface recharge of 1,534 ac-ft/yr in the McAda and Barroll (2002) model, based on calibration to geochemical data (Sanford et al., 2004; table 2; Western Boundary). This in turn is about half of the Acoma Sag subsurface recharge estimate of 2,949 ac-ft/yr (Frenzel, 1992).

Springs add an additional 85 to 165 ac-ft/yr in the RPfz and the Rio Salado areas (Appendix A). The McAda and Barroll model (2002) represented an inflow to the MRGB of 1,185 ac-ft/yr in this area. A revised total subsurface recharge for the entire western MRGB was recently estimated to be about 8,442 ac-ft/yr (or 106 ac-ft/yr per mile of MRGB boundary; Sanford et al., 2004). This is about four times the spring-flow total estimated in this study. Perhaps three times as much saline groundwater is entering the MRGB in the subsurface, as at the surface. The sum of these would be equivalent to the combined flow through the deep aquifers.

The present companion study performed by the New Mexico Bureau of Geology and Mineral Resources, to investigate fault-zone juxtaposition of individual bedrock aquifers, could help identify additional components of subsurface recharge. Due to the unknown aquifer thickness and unknown fault and fracture characteristics at depth, an increased understanding of the third dimension might lead to revised rates for saline groundwater recharge across the boundary of the MRGB.

2.3.6 Existing Water-Well Data in the Rio Puerco Area

Water well data obtained from Plummer et al. (2004a), combined with wells encountered, checked in the field and cross-referenced with the Plummer et al. (2004a) database are presented in Appendix B. In the field, it was found that stock wells often had their casings welded shut, and about three quarters of the stock wells were found to be inoperable with damaged wellheads, preventing the collection of groundwater data. Seventy-four wells (Appendix B) were included in the water well/geochemistry database largely based on Plummer et al., (2004); whose hydrochemical zones are presented in Figure 15. Wells within Zone 5 (Rio Puerco) of Plummer et al. (2004a), mostly alluvial water wells along the Rio Puerco, had completion depths ranging from 50 to 720 feet below ground level (ft bgl) with a median of 200 ft bgl. Depth to water in these wells ranges from 14 to more than 599 ft bgl with a median of 165 ft bgl.

Three pairs of Rio Puerco valley wells, in close proximity and at similar elevations, were used to look at water level changes over time (Table 4). At least three well-casings were found at the location of stock Well No. 2 (S094/DB387) and the Benavidez Well (RG 24176; see Fig. 14). In the 30 years between measurements water levels in this area appear to have risen by about 47 ft. To the south, at the location of Wells DB175 (USGS 350158106563801) and S185 (Domestic No.31), in 39 years water levels may have risen about 6 ft, but the lack of an elevation for one of the wells renders this questionable. Farther south, at the location of Wells DB026 (USGS 342707106532201) and S032 (Windmill No. 17), on the inaccessible Comanche Ranch, in 43 years water levels may have risen about 0.6 ft, but again, the elevation for one of the wells of the pair is not known.

It would be useful to field-check additional USGS wells from the Plummer et al. (2004a) database, and to build a time series water-level dataset for the area. It could also be beneficial to create a separate database for the large number of domestic wells completed in the Correo-Suwanee area that are not included in the Plummer et al. (2004a) database. Perhaps some of the domestic wells have the potential to be monitoring wells.

Table 4. Wells completed in the Rio Puerco alluvium and historical water-level data from this study and Plummer et al. (2004a)

name/NMOSE File No.	use	distance of separation, ft	surface elevation, ft amsl	well depth ft	water level date	non-pumping water level ft	aquifer
Stock Well No. 02 (S094/DB387)	stk	250	5,700	120	6/20/1980	107.17	Qal
Benavidez Well (RG 24176)	stk	250	5,718	90	6/9/2010	77.5[1]	Qal
350158106563801 (DB175)	stk	1,390	nd	unk	1956	81.21	Qal
Domestic No.31 (S185)	dom	1,390	5,280	150	10/30/1995	75.25	Qal
342707106532201 (DB026)	dom stk	250	nd	70	11/21/1949	34.97	Qal
Windmill No. 17 (S032)	stk	250	4,771	61	2/2/1993	34.4	Qal

[1] - pumping water level
ft amsl - feet above mean sea level
NMOSE - New Mexico Office of the State Engineer
unk – unknown
Qal - Neogene- to Quaternary-age alluvium
stk - stock
dom - domestic

2.4 Groundwater Quality Along the Rio Puerco

The best groundwater quality along the Rio Puerco was found in the Benavidez Well (RG-24176) and Well DB235, within the southern RPfz. During a June 9, 2010 field visit, the Benavidez Well produced 4 gpm from the shallow alluvium east of the Rio Puerco, with a specific conductance of 884 µS/cm. In contrast, Windmill No. 1 (Table 5; Fig. 14), just west of the Rio Puerco and east of the Lucero Uplift (30 miles south of the Benavidez Well) had a specific conductance of 4,040 µS/cm. It appears that the aquifer at the Benavidez Well is recharged by fresher groundwater possibly from the east along the short west-draining streams that cut the western edge of the Llano de Albuquerque. This is also possibly the case for Sandoval Spring, which according to Plummer et al. (2004a) has dilute Rio Puerco and Western Boundary groundwater, or Lucero-sourced groundwater, as part of its make-up. Western Boundary groundwater of Plummer et al. (2004a) is characterized as NaCl-type water with indicative of long residence times in a limestone-evaporite aquifer (Fig. 16).

Wells north of the Rio San Jose confluence have variable specific conductance, ranging from 460 to 6,900 µS/cm and averaging about 3,000 µS/cm. This average value can be compared to the average value of Plummer et al. (2004a) Zone 5 (Rio Puerco), 2,731 µS/cm. There are also large variations in specific conductance downstream along the Rio Puerco (Table 5). The highest specific conductance along the Rio Puerco (DB114; Table 5) occurs just below the confluence of the Rio Puerco and the Rio San Jose, an area thought to be close to a major hydraulic boundary, because the predevelopment potentiometric surface is hypothesized to have had a steep gradient (Plummer et al., 2004a; p.22). This suggests inflow of brine water (NaCl-type) from the Rio San Jose and the Lucero Uplift area. Increases in specific conductance in alluvial wells along the Rio Puerco could also suggest however that a bedrock aquifer source may be discharging locally. Alternatively, differences in groundwater sampling procedures, or well completion in a bedrock unit, and not the alluvial aquifer, could have resulted in specific conductance increases. It would be highly beneficial to start a long-term baseline survey of Rio Puerco alluvial wells and understand in greater detail the contribution of bedrock aquifer-sourced groundwater to the MRGB.

2.5 Chemical Analyses of Saline and Mixed Groundwater

Plummer et al. (2004a) suggest that 7 percent of the groundwater within Zone 5 (Rio Puerco) has its origin at the Western Boundary zone (Table 6) and from a Colorado Plateau bedrock aquifer. Plummer et al. (2004a) also suggest that source rock variation can be detected from the average geochemical make-up of their samples, and not just their geographical location. However, this hypothesis is difficult to confirm due to the variation of bedrock sources, including Pennsylvanian-age and Permian-age rocks south of the Rio San Jose, Jurassic-age and Cretaceous-age rocks north of the Rio San Jose, and Triassic-age rocks in the Rio Salado area. Nonetheless, four geographic groupings of geochemistry data are presented in Table 6. Each of the groupings shows a distinct geochemical identity,

Table 5. Published specific conductance data for wells completed in the Rio Puerco alluvium from north to south (Plummer et al., 2004a, and this study)

name	date	specific conductance, µS/cm
north of Rio San Jose confluence		
Benavidez Well (RG 24176)	6/09/2010	884
350501106571201 (DB235)	6/06/1967	951
350158106563801 (DB175)	6/05/1975	4,360
Domestic No. 31 (S185)	6/16/1997	2,378
345632107003701 (DB132)	4/29/1957	4,910
Windmill No. 07 (S198)	8/21/1996	5,420
345230106591501 (DB114)	4/26/1956	8,540
south of Rio San Jose confluence		
343606106534201 (DB055)	1/09/1950	3,270
343459106535401 (DB051)	6/04/1980	5,100
Windmill No. 31 (S238)	6/24/1997	3,457
Windmill No. 1 (JSAI No. 3)	5/26/2010	4,040
Windmill No. 17 (S032)	6/24/1997	3,804
342707106532201 (DB026)	no date	3,520

Plummer et al., 2004a, appendix A2 µS/cm - microSiemens per centimeter

Table 6. Median values of selected water-quality parameters by hydrochemical zone, western MRGB (after Plummer et al., 2004a, table 8, with data added from Trainer, 1978; Craigg, 1984; Risser and Lyford, 1983; and this study)

constituent	Western Boundary (Lucero of this study)	Rio Puerco	Nacimiento Uplift	Rio San Jose
hydrochemical zone of Plummer et al. (2004a)	5	4	nac	RSJ
specific conductance (µS/cm)	4,572	2,731	11,133	16,144
field pH	7.70	7.50	7.35	7.87
water temperature (ºC)	22.0	20.0	23.2	20.0
dissolved oxygen (mg/L)	4.1	3.7	-	-
calcium (mg/L)	135	135	242	307
magnesium (mg/L)	56.4	42.7	50.5	132
sodium (mg/L)	589	290	2,250	4,030
potassium (mg/L)	15.2	10.4	71.8	111
alkalinity (mg/L as HCO_3)	300	190	1,060	1,180
sulfate (mg/L)[2]	**793**	**1,080**	**2,400**	**4,070**
chloride (mg/L)[2]	**820**	185	**1,940**	**4,410**
fluoride (mg/L)[1]	1.64	0.63	**2.70**	0.80
bromide (mg/L)	0.38	0.64	5.3	-
silica (mg/L)	22.5	21.8	18.7	22.5
nitrate (mg/L as N)	0.86	0.88	0.25	-
aluminum (µg/L)[2]	5.00	5.00	**839**	6.00
arsenic (µg/L)[1]	1.8	1.0	**36.5**	**10**

mg/L - milligrams per liter
µg/L – micrograms per liter
µS/cm - microSiemens per centimeter
ºC - degree Celsius
bold – exceeds the EPA-established MCL for public drinking water standards
[1] – subject to the national primary drinking water regulations
[2] – subject to the national secondary drinking water regulations

As mentioned previously, the best groundwater quality is found in the Rio Puerco area (Zone 5 of Plummer et al., 2004a), where recharge from arroyos and from better-quality surface water infiltrates the alluvium. Average groundwater quality in the Rio Puerco area most likely exceeds the EPA maximum contaminant level (MCL) aesthetic standard for TDS, sulfate, and chloride, but is likely below the EPA MCL standards for arsenic and fluoride. Groundwater in the bedrock of the Western Boundary (Lucero Uplift), Rio San Jose, and Nacimiento Uplift/Pajarito fault areas is all quite similar, having sodium, sulfate, and chloride concentrations that are nearly equal, and which make up the majority of the major ions. This suggests that these brines have long residence times, like the water from RG-88934POD1 (JSAI, 2009; see Fig. 1).

Plummer et al. (2004a) indicate that the Rio Salado and Jemez River-sourced groundwater have specific conductance ranging from 530 to more than 11,000 µS/cm, with a median SO_4/Cl concentration ratio of 0.56 and a median Ca/Na ratio of 0.28 for alluvial and Chinle Group groundwater sources. Additionally, Plummer et al. (2004a) indicate that the Triassic-age, Jurassic-age, and Cretaceous-age bedrock aquifers of the RPfz have specific conductance ranging from 1,650 to 41,500 µS/cm, a median SO_4/Cl ratio of 1.2 (and a maximum of 110), and a median Ca/Na ratio of 0.09 for Triassic-age, Jurassic-age, and Cretaceous-age bedrock aquifers within the RPfz. Permian-age and Pennsylvanian-age bedrock aquifers along the Western Boundary (Lucero Uplift) have specific conductance ranging from 3,000 to 45,000 µS/cm, a median SO_4/Cl ratio of 0.58 and a median Ca/Na ratio of 0.13. The similarity of the SO_4/Cl ratio in the saline groundwater geochemistry from the Rio Salado and the Western Boundary is striking. Plummer et al., (2004, p. 67) state that saline groundwater from bedrock aquifers along the Western Boundary with the MRGB is old, on the order of 10,000 years in age, with no tritium, chlorofluorocarbons, or "any other environmental tracer of anthropogenic origin" (Plummer et al., 2004a). It is here suggested that perhaps groundwater from the Western Boundary is oldest, water from the Nacimiento Uplift a bit younger, and groundwater in the Rio Puerco area is mixed (e.g., Plummer et al., 2004a), and possibly youngest. Groundwater in the Nacimiento Uplift could also be affected by volcanic/meteoric water associated with the Jemez lineament, based on the elevated concentrations of fluoride and arsenic in these waters.

2.6 Rio Puerco

According to Stone et al., (1983), the Rio Puerco downstream of its confluence with Arroyo Chico had a mean surface discharge of about 35 cubic feet per second (cfs), or 25,350 ac-ft/yr, based on data for the period of record 1951 to 1977 at the Rio Puerco above Arroyo Chico gage, and the period of record 1943 to 1977 at the Arroyo Chico near Guadalupe gage. Some of this surface water possibly recharges along the RPfz (Stone et al., 1983). To more directly address the nature of Rio Puerco surface flow, and whether there are any gains or losses to the stream across the RPfz, a more detailed year-by-year analysis was performed. This is described in the next section. The Rio Puerco has two major tributaries; Arroyo Chico, north of the RPfz, and Rio San Jose, which crosses the RPfz just north of the Lucero Uplift. Both of the tributaries also have gages (Fig. 17). Two stream gages are additionally present on the main stem of the Rio Puerco in the reach of interest, above the Arroyo Chico confluence, and below the Rio San Jose confluence. The Rio San Jose is documented to have a gain across the RPfz of about 3 cfs (1,300 gpm, or 2,200 ac-ft/yr) between Correo and its confluence with the Rio Puerco (Risser and Lyford, 1983, p. 40). Stone et al. (1983) suggests that vertical groundwater flow between the bedrock aquifers is limited by the many shale layers, except perhaps where faulted, which implies that the reported gain represented upward flow along faults and fractures.

2.6.1 Analysis of Rio Puerco Streamflow From Above Arroyo Chico to Rio Puerco, New Mexico

Rio Puerco streamflow data from the USGS stream gages were analyzed to determine gains or losses across the RPfz. Daily mean discharge at the Rio Puerco gage above Arroyo Chico near Guadalupe, and the gage at Rio Puerco, were compared for the period of overlapping record. Locations of the USGS stream gages used in this analysis are presented in Figure 9 and are about 40 miles apart. In order to directly compare Rio Puerco daily mean discharge upstream and downstream of the fault zone, Arroyo Chico inflow (Arroyo Chico near Guadalupe gage) was added to flow at the upstream gage (Rio Puerco above Arroyo Chico near Guadalupe gage), and Rio San Jose inflow (Rio San Jose at Correo gage) was subtracted from the flow at the downstream gage (Rio Puerco at Rio Puerco).

2.6.1.1 Rio Puerco Streamflow Data

Rio Puerco streamflow datasets used in the analysis are summarized in Table 7. Wherever possible, the USGS-computed daily mean discharge datasets were used in the analysis because these datasets provide a value for each day within the period of record and thus provide greater opportunity for direct comparison of daily mean discharge data. A computed continuous record of flow at a gage is made by the USGS using records of stage and the discharge rating for the gage following the methods of Carter and Davidian (1968). The overlapping period of record for which the corrected Rio Puerco discharge data were compared is February 1948 through December 1976.

Table 7. Summary of datasets used in Rio Puerco streamflow analysis

gaging station	period of record	daily mean discharge dataset
Rio Puerco above Arroyo Chico near Guadalupe, NM	2/28/1948 to 9/30/1951	USGS-measured [a]
Rio Puerco above Arroyo Chico near Guadalupe, NM	10/1/1951 to 6/8/2010	USGS-computed [b]
Arroyo Chico near Guadalupe, NM	10/1/1943 to 6/8/2010	USGS-computed [b]
Rio Puerco at Rio Puerco, NM	3/1/1934 to 12/31/1976	USGS-computed [b]
Rio San Jose at Correo, NM	4/1/1943 to 10/21/1994	USGS-computed [c]

[a] obtained from USGS water quality data for the Nation website
[b] obtained from Philip Bowman, Hydrologist, USGS New Mexico Water Science Center, 6/9/2010 email
[c] obtained from USGS surface-water data for the Nation website
USGS – U.S. Geological Survey

2.6.1.2 Rio Puerco Streamflow Analysis

Graphs of corrected streamflow data and gains/losses for the period of record as well as for individual years are presented in Appendix C. Gains and losses center around zero and fluctuate greatly. The Rio Puerco is an ephemeral reach from above Arroyo Chico south to Rio Puerco, NM, with many days of zero discharge in each year and instantaneous flow rates during monsoon-season storm runoff events peaking in the thousands of cubic feet per second (Stone et al., 1983).

Years with above-average water-year (October of previous year through September of current year) precipitation typically have a period of spring runoff in April and May during which flows greater than 10 cfs are maintained for a week or more. This period of spring runoff is typically absent or negligible in years with below-average water-year precipitation. Table 8 presents annual spring runoff statistics, water-year precipitation at the Albuquerque WSFO airport weather station (chosen for its long record, and only for the purpose of indicating which years were relatively wet or dry) , and average streamflow loss during spring runoff, for the overlapping period of record for which the corrected Rio Puerco discharge data were compared.

Both gains and losses can be observed in the Rio Puerco stream channel across the RPfz during storm runoff events, but during spring runoff seasons, estimated losses average about 27.8 cfs (Table 8). Although there is not a clear trend of increasing losses with increasing daily mean discharge during spring runoff, there appears to be a maximum loss associated with a given rate of discharge, and this maximum increases with increasing discharge (Appendix C, Fig. C31).

Another approach to the question of streamflow gain or loss across the Rio Puerco fault zone was to plot cumulative discharge at the upstream (Rio Puerco near Guadalupe, plus Arroyo Chico near Guadalupe) and downstream (Rio Puerco at Rio Puerco minus Rio San Jose at Correo) gages for the common periods of record between October 1951 and December 1976. That plot (Appendix C, Fig. C32) suggests a tendency for a gain of around 25,000 ac-ft to appear occasionally, then decay. This would be consistent with an occasional storm inflow from an ungaged tributary, but not with a consistent baseflow gain that might be attributed to upward flow from bedrock aquifers. That condition would lead to a greater slope for the cumulative-discharge plot representing the downstream gage.

The decay of the apparent occasional gains is attributable to recharge to shallow groundwater in the alluvium and Santa Fe Formation in the Puerco valley.

Table 8. Annual spring runoff statistics and water-year precipitation

water year	water-year precipitation at Albuquerque, inches	Rio Puerco above Arroyo Chico, spring runoff period (> 10 cfs)	Rio Puerco above Arroyo Chico, no. of days of spring runoff	Rio Puerco at Rio Puerco, spring runoff period (> 10 cfs)	Rio Puerco at Rio Puerco, no. of days of spring runoff	average loss during spring runoff period [b]
1948	7.20	nd	nd	4/21 to 5/13	23	nd
1949	8.51	nd	nd	nd	nd	nd
1950	4.82	nd	nd	nd	nd	nd
1951	4.60	nd	nd	nd	nd	nd
1952	8.15	4/27 to 5/21	25	5/6 to 5/13	8	40.3
1953	4.15	nr	nr	nr	nr	nr
1954	5.56	nr	nr	nr	nr	nr
1955	6.84	nr	nr	nr	nr	nr
1956	3.97	nr	nr	nr	nr	nr
1957	6.83	nr	nr	nr	nr	nr
1958	10.83	4/8 to 6/11	65	4/12 to 6/3	53	40.3
1959	9.96	nr	nr	nr	nr	nr
1960	8.40	4/7 to 5/22	46	4/12 to 4/30	19	25.7
1961	10.61	4/18 to 5/30	43	4/22 to 5/9 [a]	18	24.1
1962	5.12	4/3 to 5/22	50	4/17 to 5/17	31	30.1
1963	8.29	4/8 to 4/24	17	4/13 to 4/19	7	16.4
1964	7.75	nr	nr	nr	nr	nr
1965	7.41	4/22 to 6/7	47	5/5 to 5/29	25	13.4
1966	8.81	nr	nr	nr	nr	nr
1967	7.79	nr	nr	nr	nr	nr
1968	10.03	5/4 to 6/20	48	5/22 to 6/1	11	26.8
1969	8.99	4/2 to 6/1	61	5/5 to 5/28	24	13.7
1970	8.82	4/28 to 6/2	36	5/13 to 5/21	9	28.7
1971	5.39	nr	nr	nr	nr	nr
1972	9.20	nr	nr	nr	nr	nr
1973	14.55	2/24 to 6/29	126	4/25 to 6/20	57	54.6
1974	7.44	nr	nr	nr	nr	nr
1975	10.30	4/12 to 6/20	70	5/13 to 5/26	14	19.1
1976	5.28	nr	nr	nr	nr	nr
average	7.78	-	-	-	-	27.8

[a] two consecutive days with 8 cfs within spring runoff period
[b] average loss during spring runoff period at Rio Puerco above Arroyo Chico
nd - insufficient data
nr - negligible spring runoff
cfs - cubic feet per second

2.7 Rio Salado Seepage Runs

Five stations were chosen to measure streamflow along a 4.3-mile reach of the Rio Salado between the Ojo del Espiritu Santo Grant east boundary and the NM-550 highway bridge at San Ysidro (Fig. 18). Streamflow was measured using a portable Parshall flume as described by Kilpatrick and Schneider (p. 13; 1983). The flume was installed per USGS guidelines, as level as possible with dikes around the flume to prevent flow from passing by along the sides. Additionally, the flume was installed as near as parallel to the flow direction as possible. Given the braided nature of the Rio Salado in the study area, this often posed a challenge. With the exception of Station 5, the flume was installed away from the river banks. The coarseness of the stream bed material made underflow impossible to prevent, and considerable additional flow is likely at all the stations. Kilpatrick and Schneider (1983) warn of considerable overestimation of the streamflow at low heads, with errors of about 7 percent (p. 13; 1983). The Station 5 streamflow rate including the error, for example, would thus be 25.6 ± 1.8 gpm.

Streamflow on the Rio Salado was measured twice, on May 14 and June 3, 2010 (Table 9). Station 1 streamflow was remarkably consistent on both days at 93.4 and 97.9 gpm, respectively. Station 2 streamflow, measured northeast and downstream of the Tierra Amarilla anticline, was also consistent on both days at 107 and 121 gpm, respectively. The May 14, 2010 measurement at Station 2 is likely a minimum, due to considerable underflow and erosion necessitating repeated reconstruction. Station 3 streamflow differed considerably on the two days of measurement. On May 14, 2010, flow at Station 3 was 116 gpm, whereas on June 3, 2010, there was no surface flow at that location. However, on June 3, 2010, groundwater existed just beneath the surface at Station 3, and flow measured about 1,000 ft upstream from Station 3 was 28.3 gpm. Flow was measured only on June 3, 2010, at Stations 4 and 5 due to thunderstorms on May 13, 2010. Station 4 did not have any surface flow on June 3, 2010 and Station 5 had less than 25.6 gpm.

Water quality varied considerably from station to station, as shown in Table 1. From Station 1 through Station 4 specific conductances increases steadily whereas pH varies significantly only at Stations 4 and 5. Station 5 has a significantly lower specific conductance than the other stations. One well, a disconnected windmill with an open casing, well 1

(Fig. 18), surveyed in Section 2 of Township 15 North, Range 1 East, had a depth to water of 11.55 ft bgl on May 14, 2010, and a depth to water of 13.10 ft bgl on June 3, 2010, indicating a groundwater-level drop of 1.55 ft between the two surveying days. The groundwater elevation in this well, situated about 720 ft north of the Rio Salado at a place where the surface water elevation is about 5,482 feet above mean sea level (ft amsl) (when there is surface flow), is 5,474.45 ft amsl, indicating that the water table is 5.55 ft deeper to the north of the Rio Salado, with a hydraulic gradient (0.008 ft/ft). This suggests that the reach downstream of Station 3 is a losing section. This is supported by the lack of surface water at Station 3 and Station 4 on June 3, 2010, as well as the increase in specific conductance between Stations 3 and 4 from 17,920 µS to 30,800 µS. There appears to be evaporation from shallow groundwater beneath the channel, and infiltration of surface water into the streambed, and sediments of the MRGB, east of the San Ysidro fault. The total Rio Salado surface flow of about 107 to 121 gpm (average of 114 gpm – 184 ac-ft/yr) likely infiltrates into the coarse stream sand and recharges the northwestern part of the MRGB within Plummer et al., (2004) zone 3. The total historical spring discharge could also be evaluated with the total Rio Salado flow at Station 1. These two estimated flows differ by a factor of two. However the Rio Salado discharge roughly equals a spring flow calculation based on evaporation rates (Section 2.3.2).

Table 9. Summary of field measurements, Rio Salado del Norte, west of San Ysidro, Sandoval County, New Mexico

station	date	flow, cfs	pH	temperature, °C	specific conductance, µS/cm
UPSTREAM					
1	5/14/2010	0.208	8.30	19.5	13,840
1	6/3/2010	0.218	8.36	20.7	14,440
2	5/14/2010	0.238	8.43	19.4	14,530
2	6/3/2010	0.269	8.35	23.6	15,210
3a	5/14/2010	0.259	8.38	21.4	16,280
3b	6/3/2010	0.063	8.32	26.7	17,920
4	6/3/2010	0	7.71	22.2	30,800
5	6/3/2010	0.057	7.98	29.2	3,150
DOWNSTREAM					

cfs - cubic feet per second °C - degrees Celsius
µS/cm - microSiemens per centimeter

3.0 CONCLUSIONS

3.1 Saline Springs and Groundwater Recharge

- Based on spring surveying and historical discharge records of saline springs at the edge of the MRGB, at least 1,865 ac-ft/yr discharges from the deep aquifers (Fig. 19).
- Springs most commonly emanate from bedding planes, near basin-bounding faults, along Laramide-age faults or monoclines and along fractures
- The RPfz consists mostly of dry springs, but depending on subsurface geology and juxtaposition of productive aquifers across faults, the PRfz may contribute additional saline groundwater to the MRGB.

3.2 Groundwater Quality

- Brines, as evidence of long residence times within bedrock aquifers, generally originate in the San Juan Basin, and possibly show a regional similarity.
- Locally, better-quality groundwater (fresh-water) is found in the alluvium near areas that likely receive recharge from storm-water runoff, such as Sandoval Canyon and Benavidez Canyon, with storm-water runoff flowing off the Llano de Albuquerque.
- Plummer et al. (2004a) suggest that 7 percent of the water in the Rio Puerco area (Zone 5) is sourced from a deep, saline groundwater source. Well data suggest however that Rio Puerco water quality varies considerably. This could suggest local areas of upwelling where deeper groundwater discharges to the Rio Puerco alluvium. Large variations in groundwater quality could locally exist and wells in this zone might have significantly worse groundwater quality depending on their proximity to discharge sites for bedrock-sourced (saline) groundwater.

3.3 Surface Water

- The Rio Puerco loses surface water during spring run-off periods at an average rate of 27.8 cfs across the RPfz. This equals an annual loss across the RPfz that averaged 1,454 ac-ft/yr and ranged from 0 to 6,937 ac-ft/yr between 1952 and 1976 during spring runoff periods. On the other hand, cumulative discharge comparison for gages upstream and downstream from the RPfz do not suggest a consistent gain or loss.
- Rio Salado average surface water loss across the RPfz, and thus inflow to the MRGB, on two days in the late spring of 2010 was 184 ac-ft/yr. It is unknown how much this varies with season and from year to year. This compares well with an estimated spring contribution to the Rio Salado of between 85 and 165 ac-ft/yr (see Section 2.3.2).

4.0 RECOMMENDATIONS

4.1 Water Balance for the Mt. Taylor Area

A new effort could be made to calculate the water balance for the Mt. Taylor recharge area, since approximate spring discharge rates along the MRGB boundary have now been determined. This would involve calculation of precipitation and recharge for the entire Mt. Taylor and Mesa Chivato area, and comparison of calculated recharge with previous estimates for Mt. Taylor and nearby comparable highlands, including the Zuni Uplift (cf. Frenzel, 1992).

4.2 Continuation of Spring and Well Survey on Pueblo of Laguna Lands, if access permitted

- Several large springs have not been surveyed in detail in the area of the Rio San Jose.
- Characterize and sample the numerous travertine seeps and saline springs along the western Lucero Uplift between Rio Puerco and Suwannee.
- Make a reconnaissance survey of the springs in the Puerco Necks area, since no record of these springs currently exists (they were identified on a topographic map).
- Identify wells with largest saline groundwater components and propose long-term water-level and water-quality monitoring.

4.3 Model Update

- Modify the HFB (the barrier-to-horizontal-flow package) in the current JSAI model to allow for more detailed fault leakance and sealing in areas that act hydrogeologically as such.
- Calibrate the model to spring flow.

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ILLUSTRATIONS

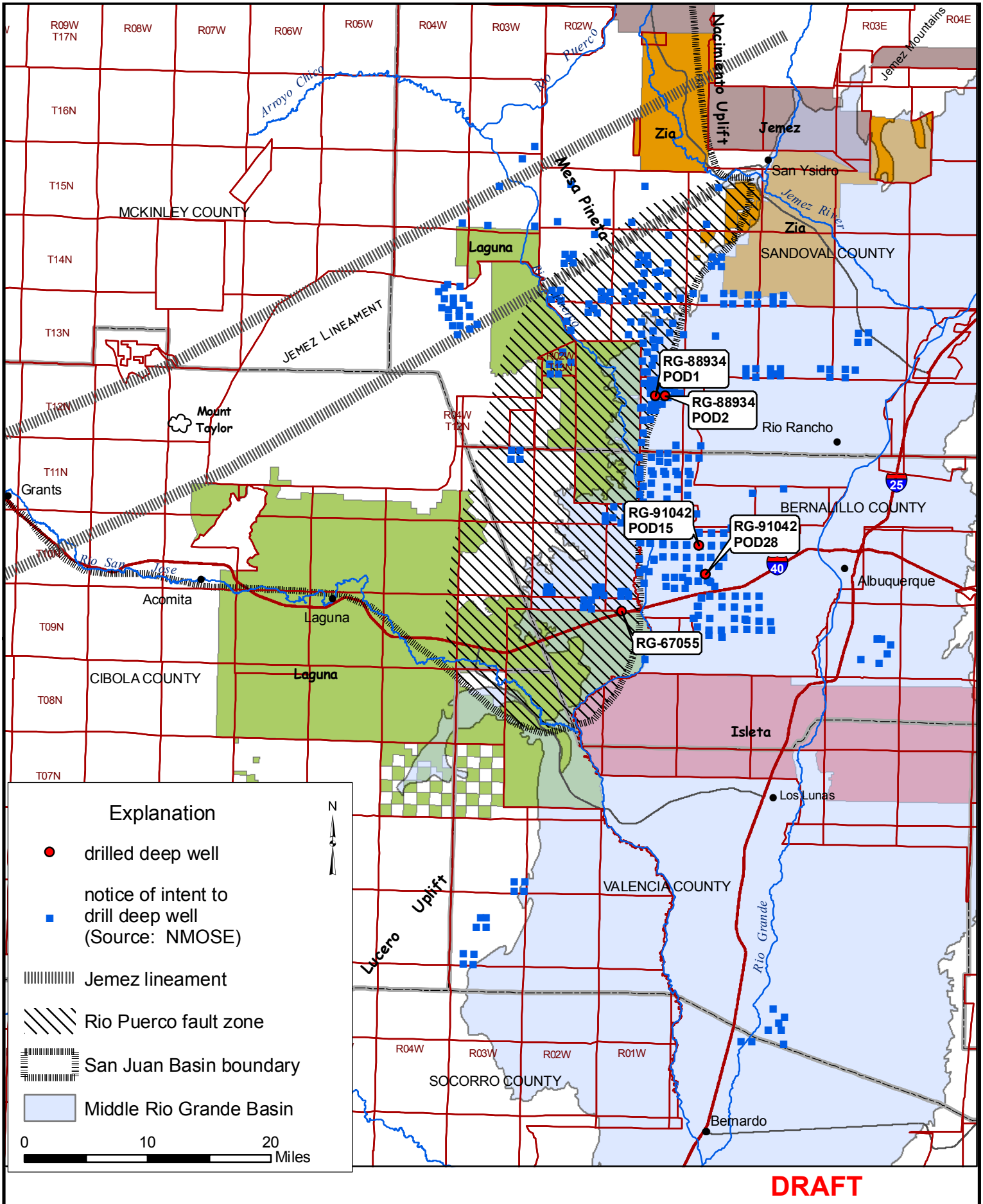

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Figure 1. Regional map showing study area, geographic features, and notices of intent to drill a deep well, part of the Middle Rio Grande Basin and the southeastern San Juan Basin.

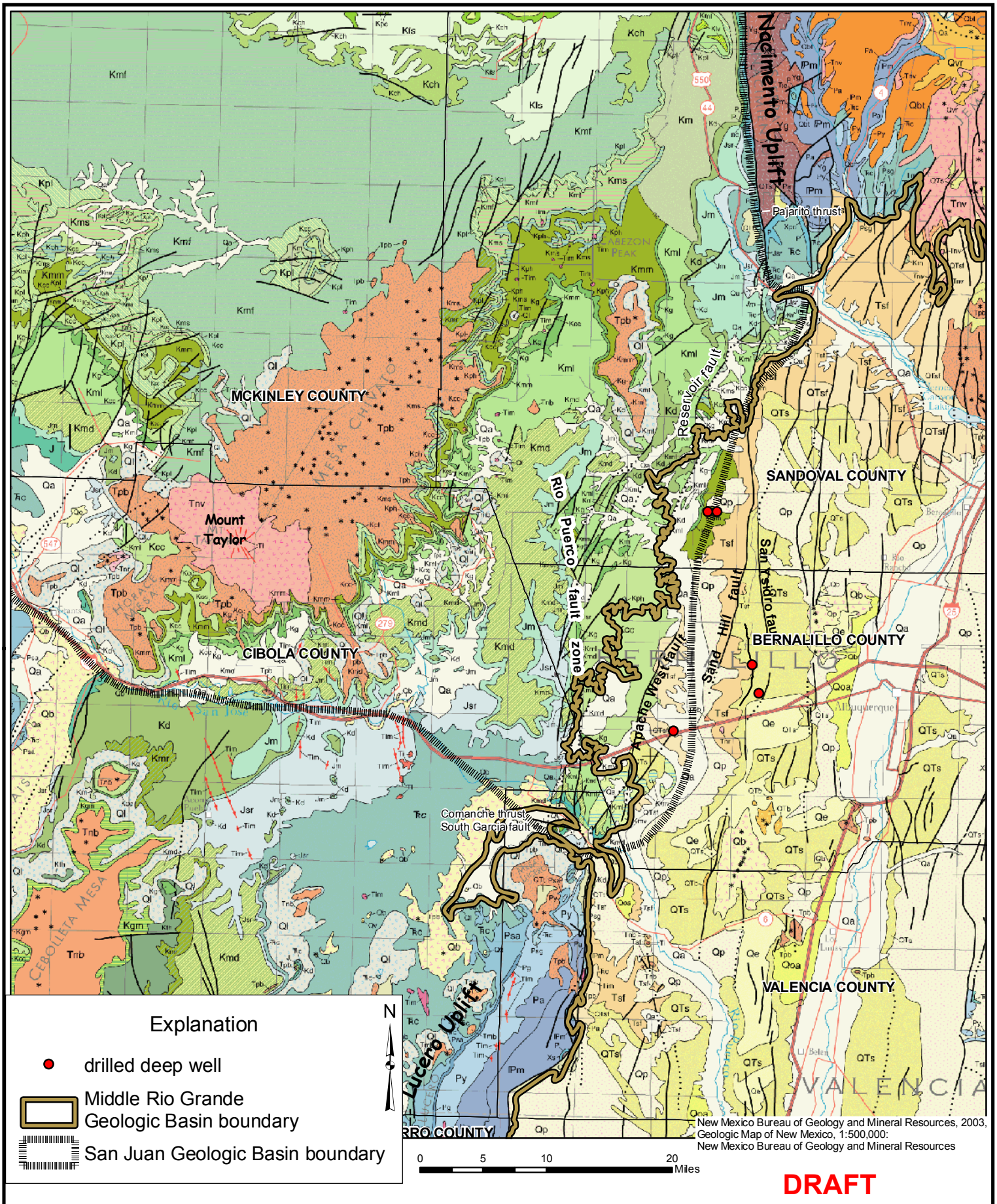

Figure 2. Geologic map of the study area, part of the Middle Rio Grande Basin and the southeastern San Juan Basin.

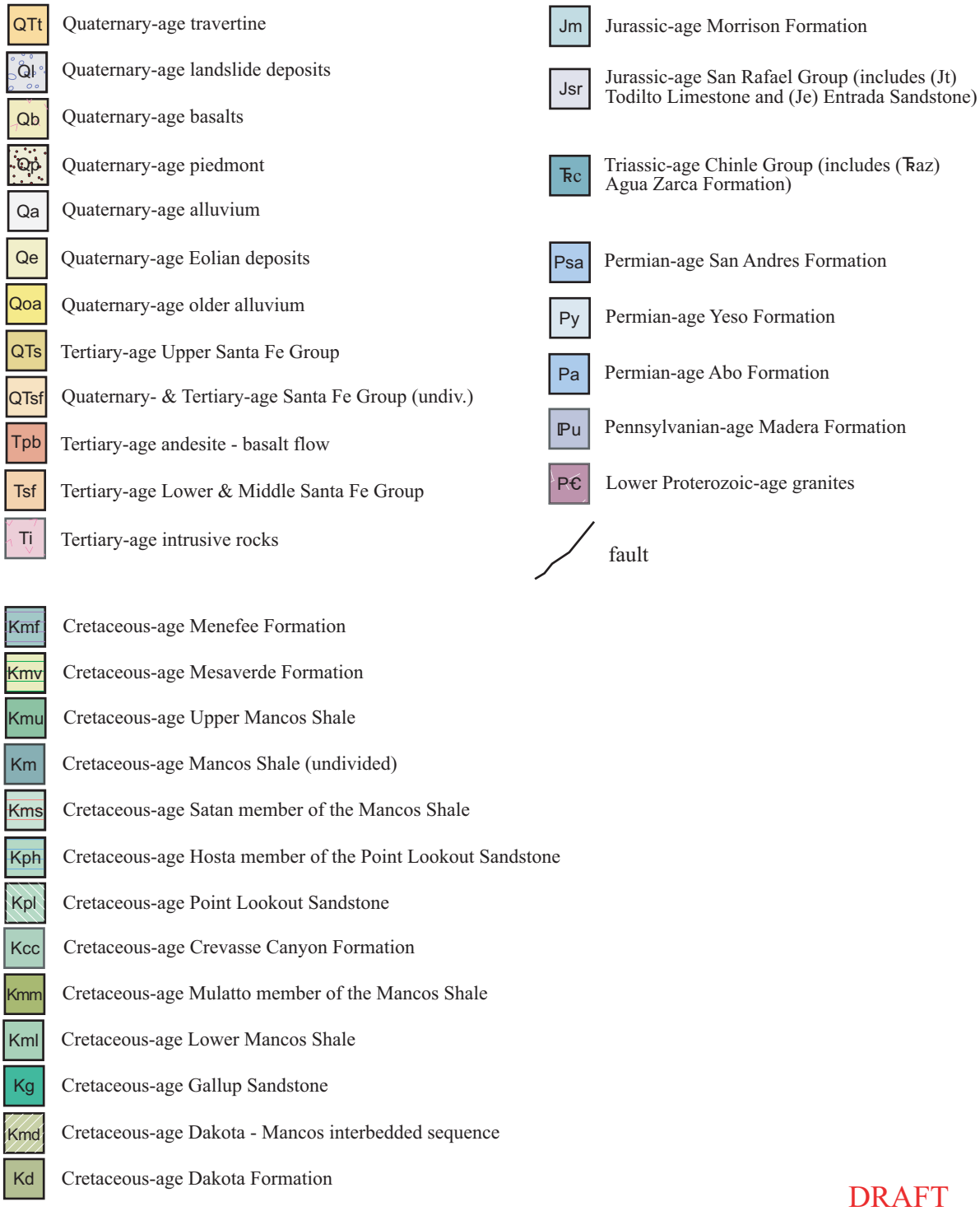

Figure 2a. Simplified explanation of units found on Figure 2 (from NM Bureau of Geology and Mineral Resources, 2003).

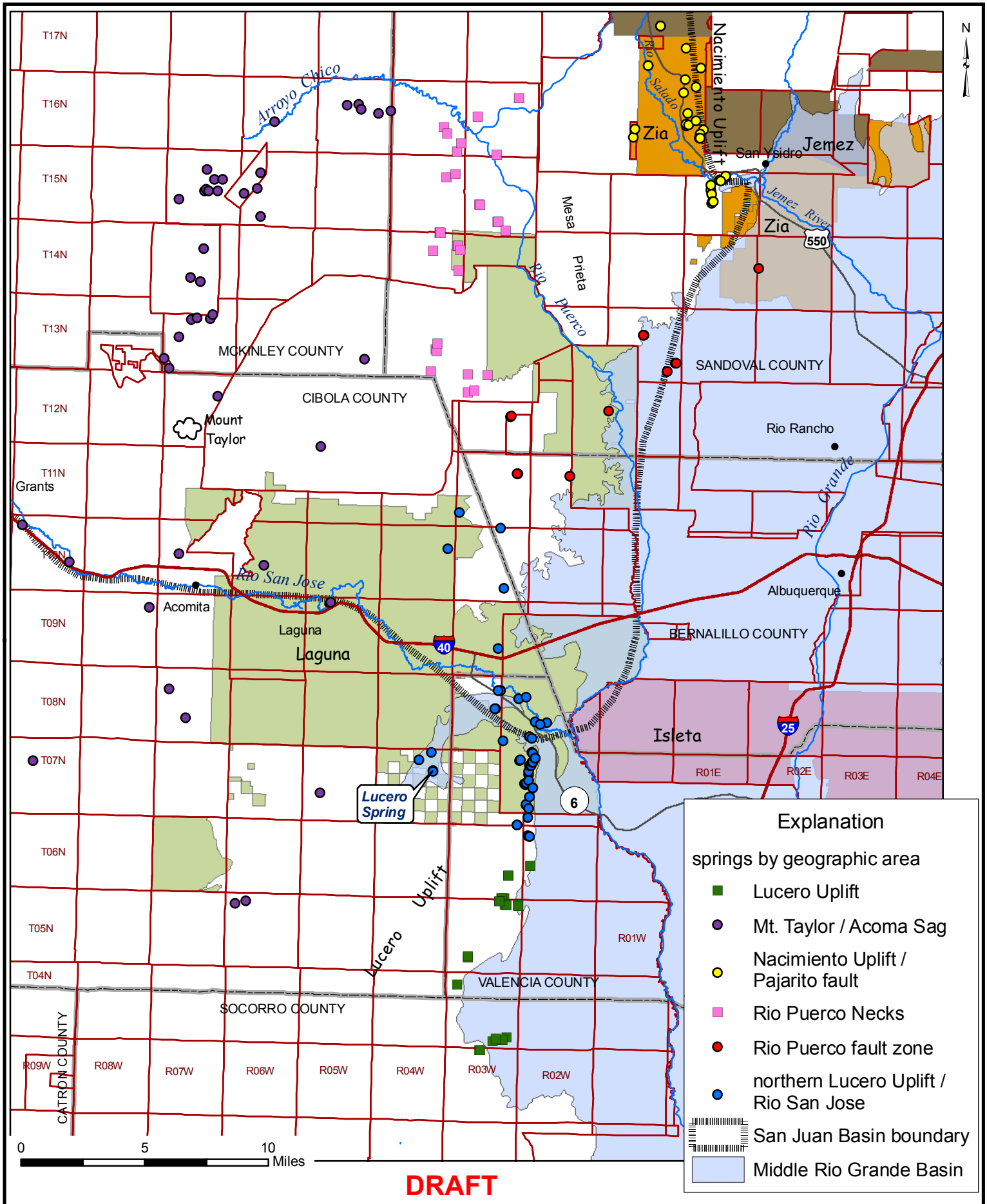

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Figure 3. Map showing all springs on record in and around the study area organized according to geographic area, part of the Middle Rio Grande Basin and southeastern San Juan Basin.

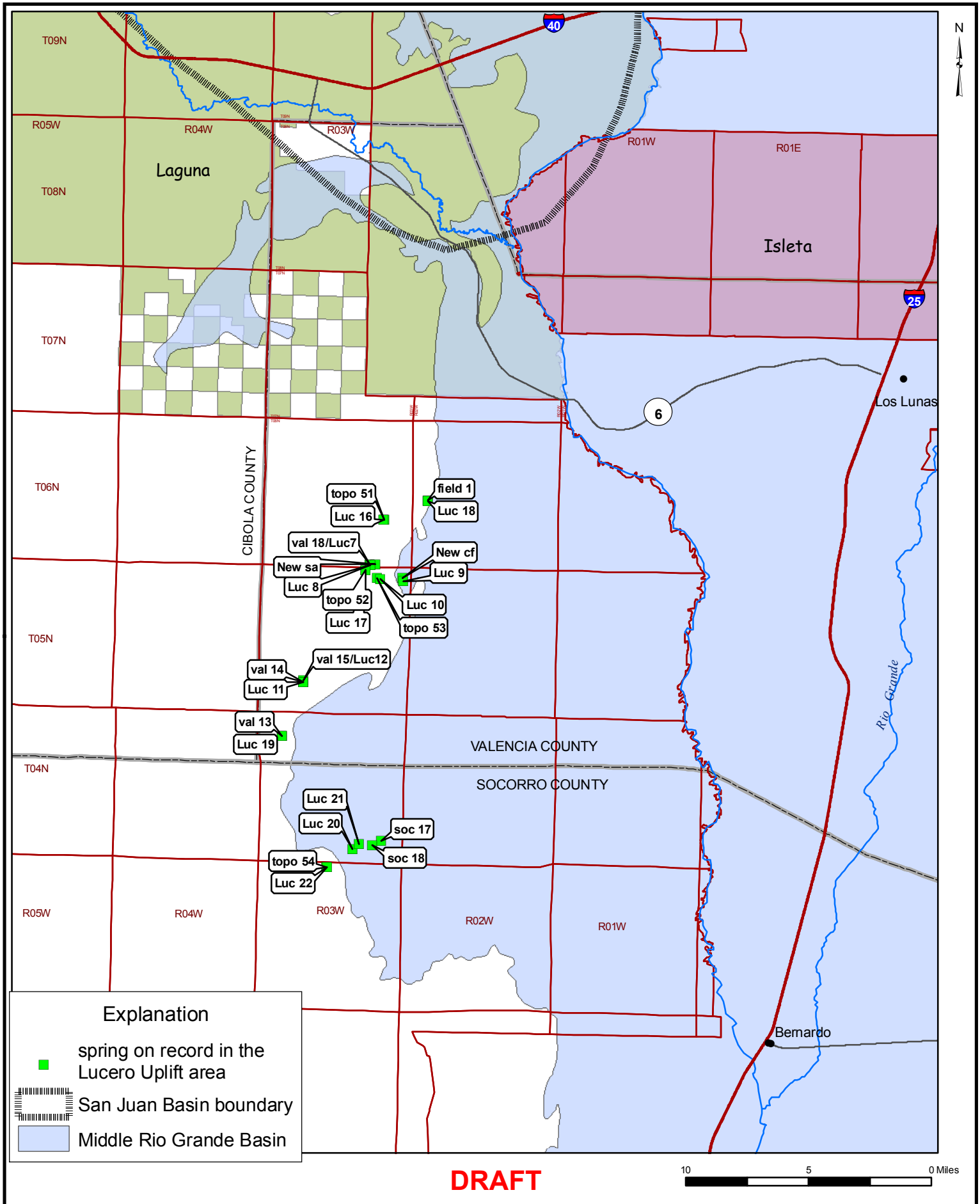

Figure 4. Map showing springs on record in the Lucero Uplift area.

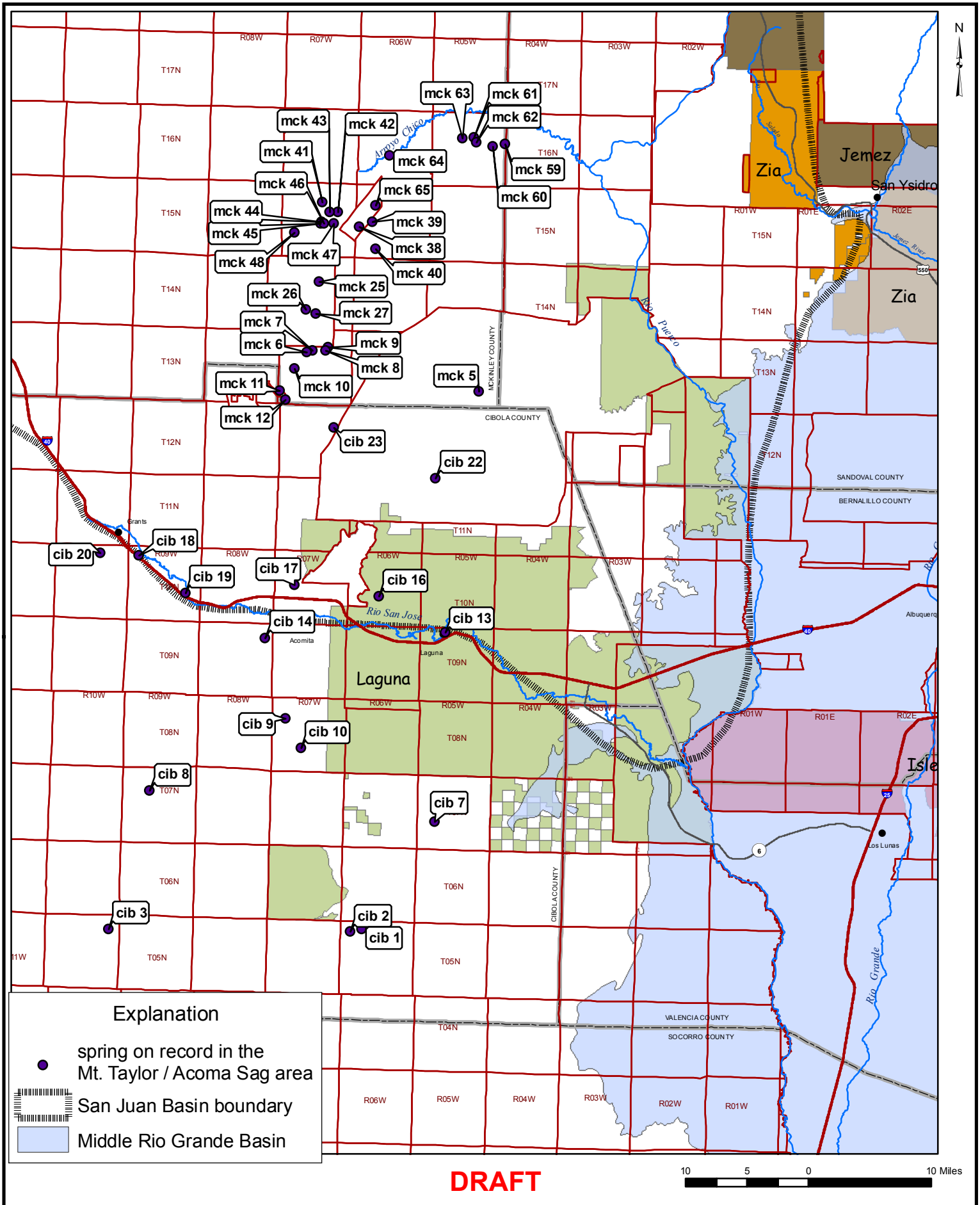

Figure 5. Map showing springs on record in the Mt. Taylor - Acoma Sag area.

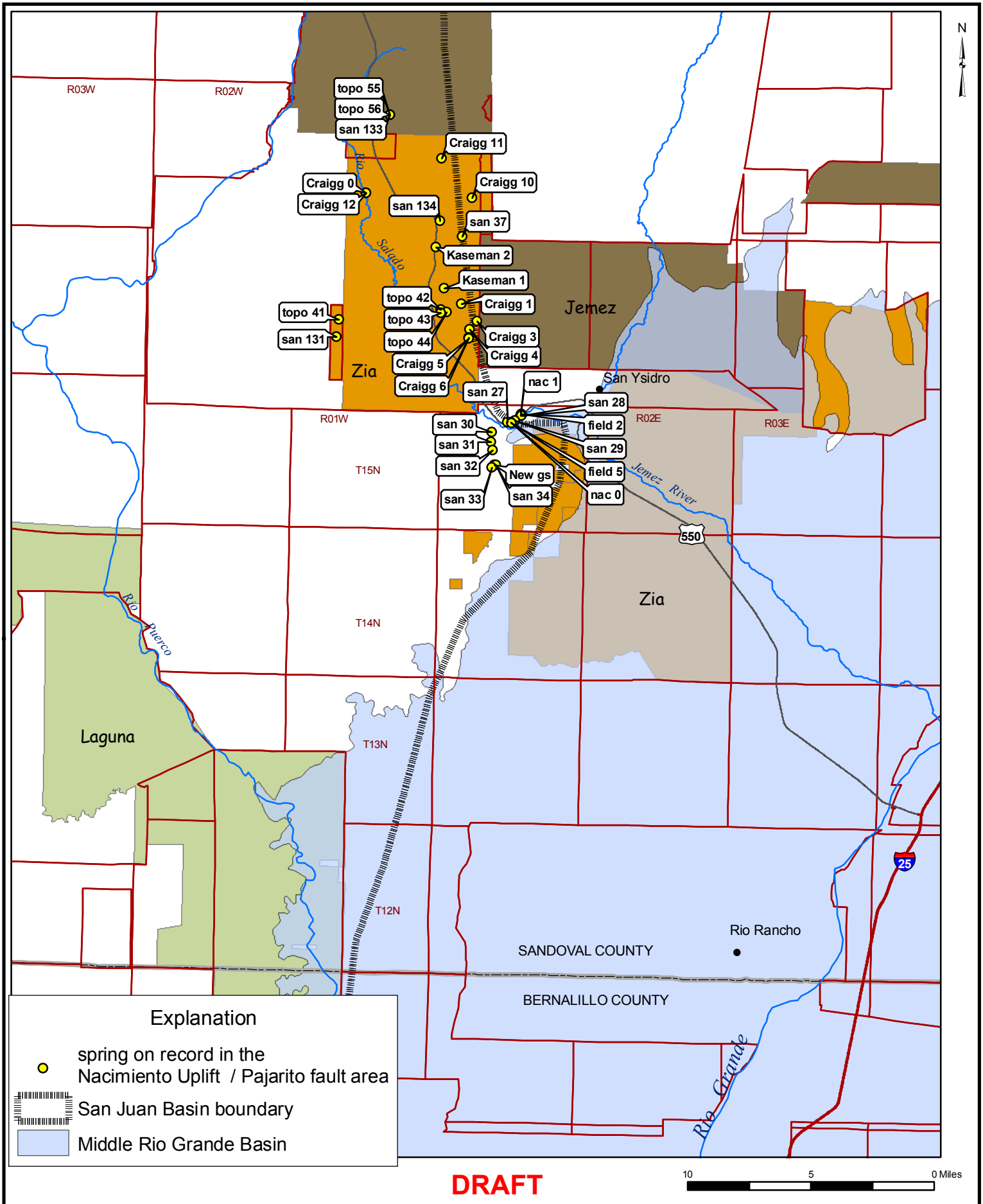

Figure 6. Map showing springs on record in the southern Nacimiento Uplift - Pajarito fault area.

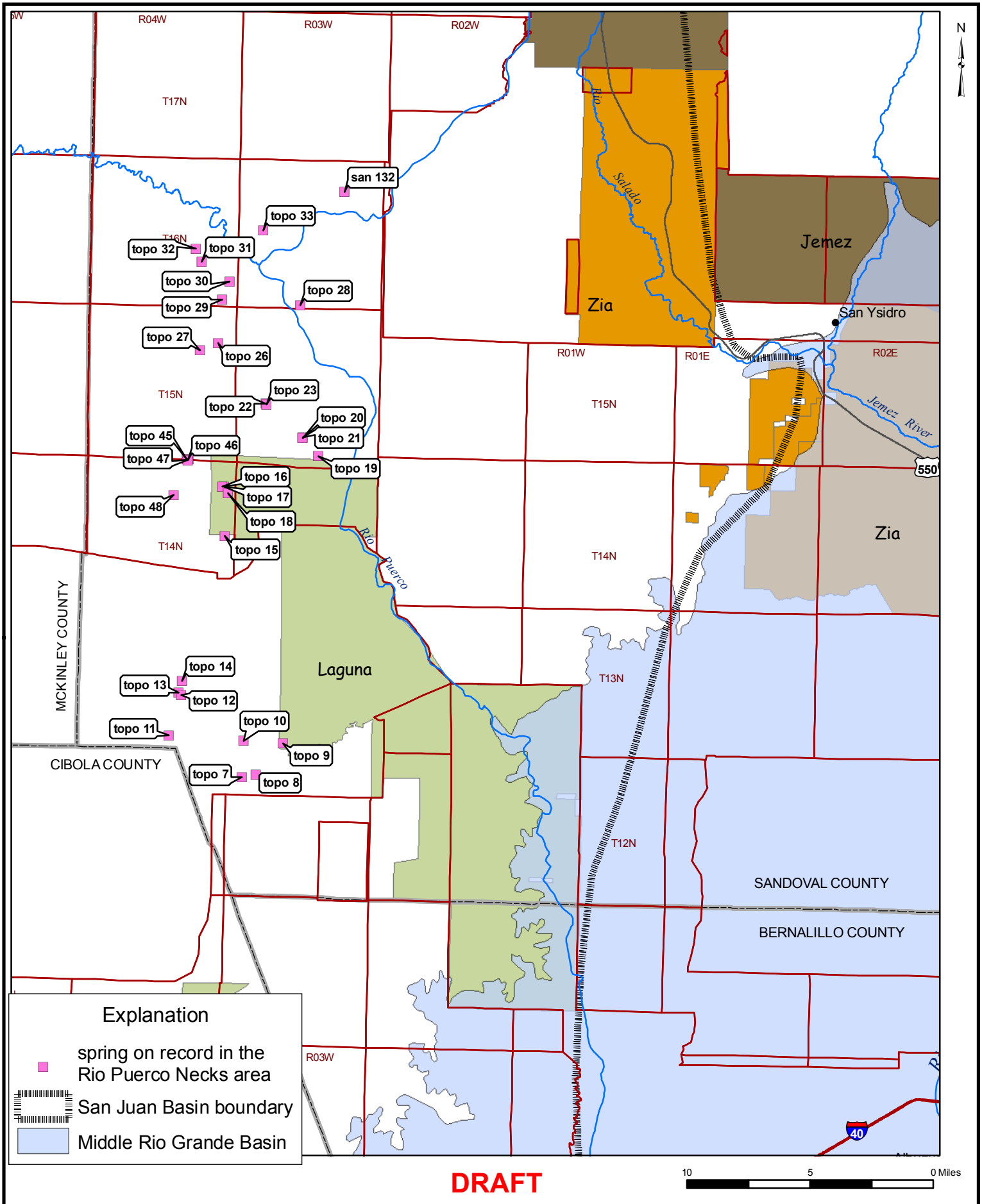

Figure 7. Map showing springs on record in the Rio Puerco Necks area.

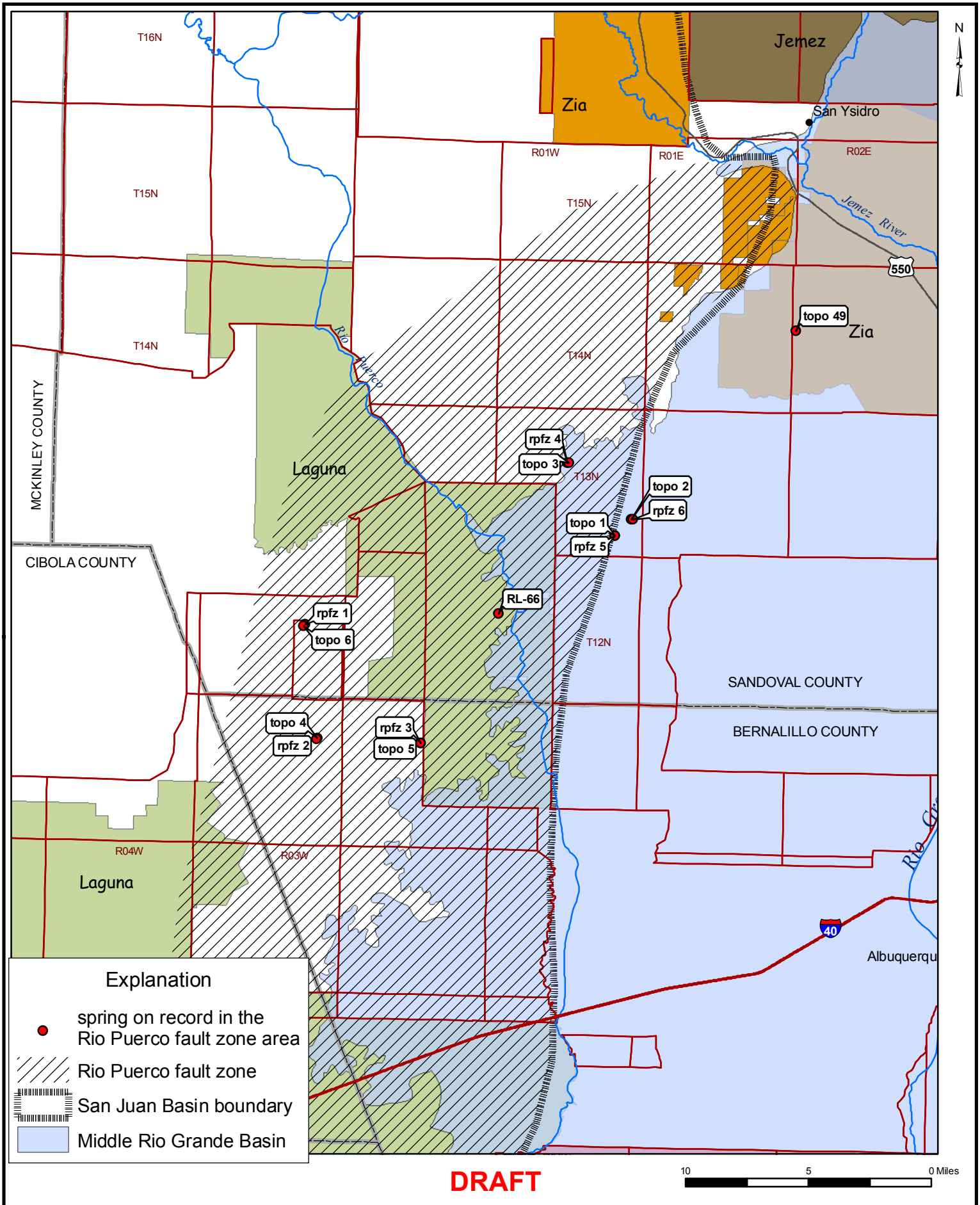

Figure 8. Map showing springs on record in the Rio Puerco fault zone.

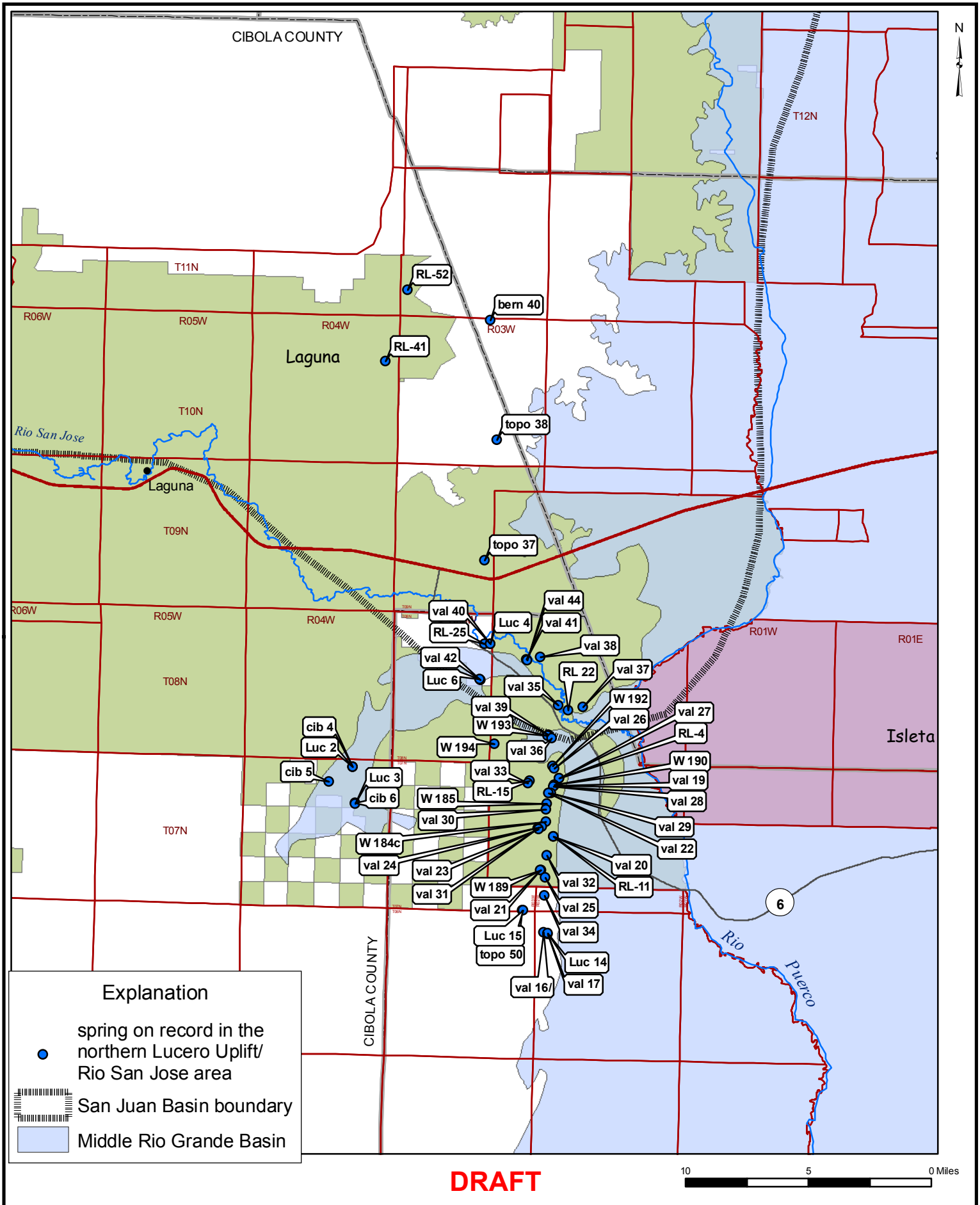

Figure 9. Map showing springs on record in the northern Lucero Uplift - Rio San Jose area.

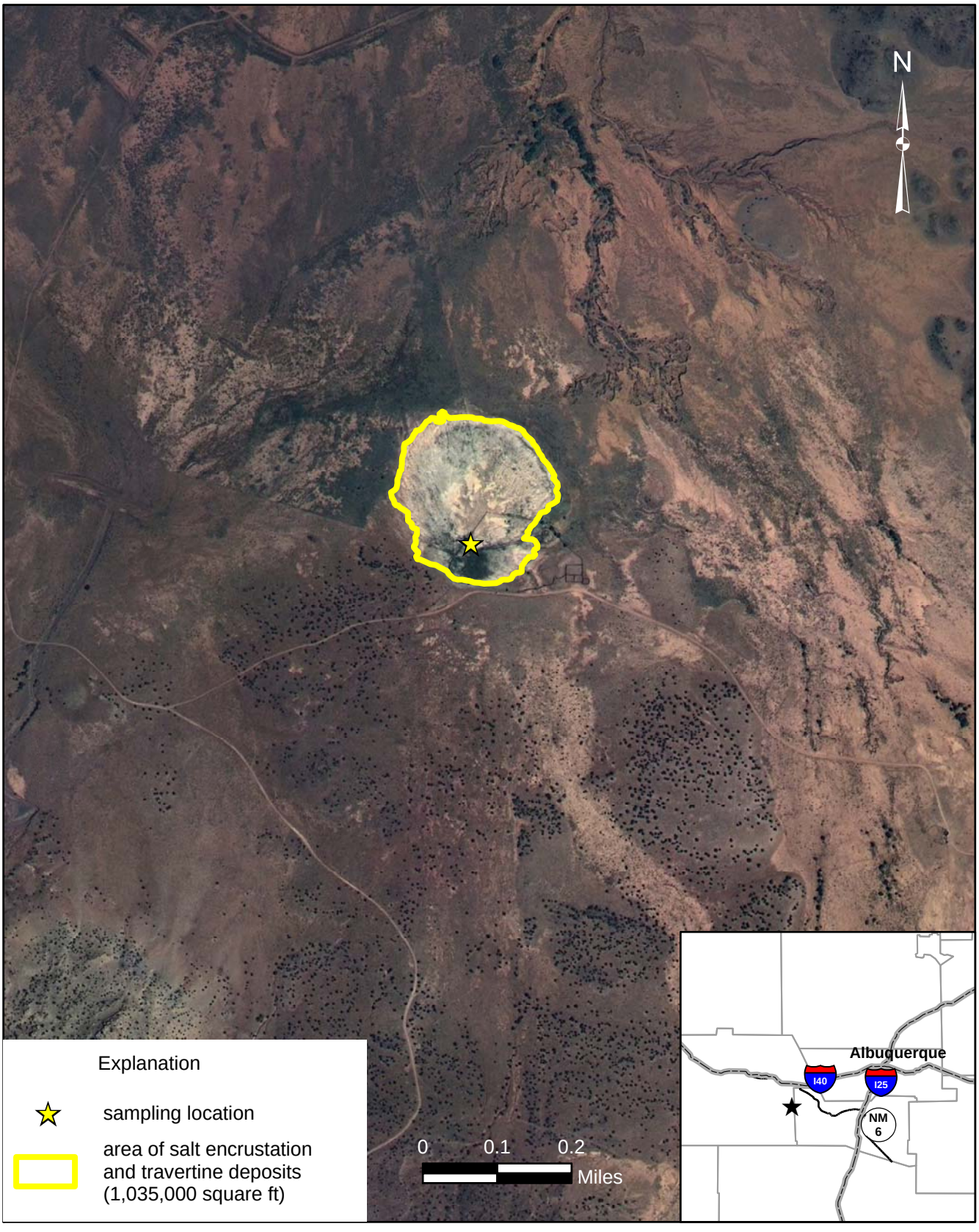

Figure 10. Orthophotograph showing Lucero Springs, New Mexico, and sampling location. Area of salt encrustation and travertine deposits was used to estimate a flow rate based on gross-annual lake-surface evaporation rates (SCS, 1972).

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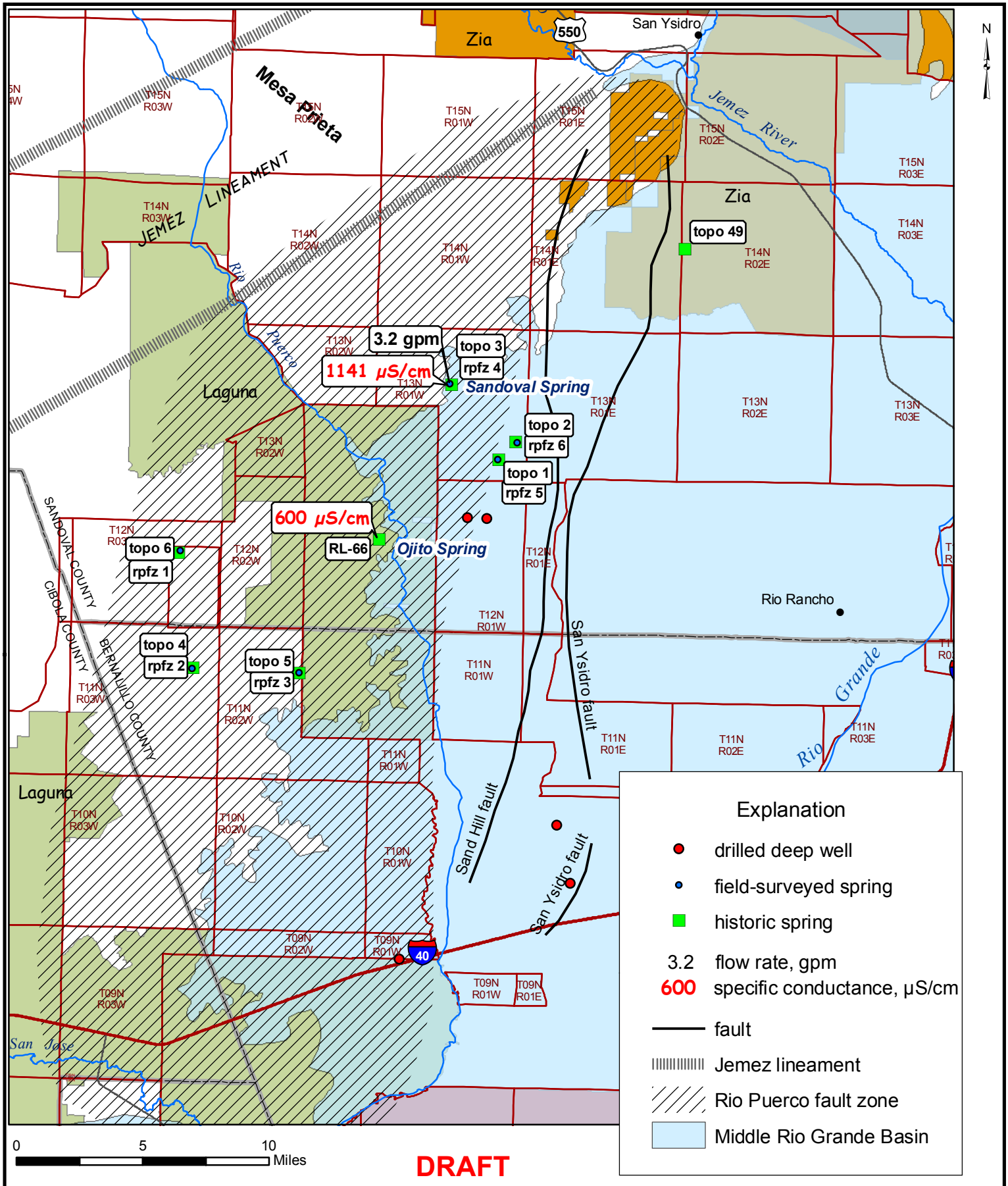

Figure 11. Map of historic and field-surveyed springs with specific conductance data and flow rate within the Rio Puerco fault zone.

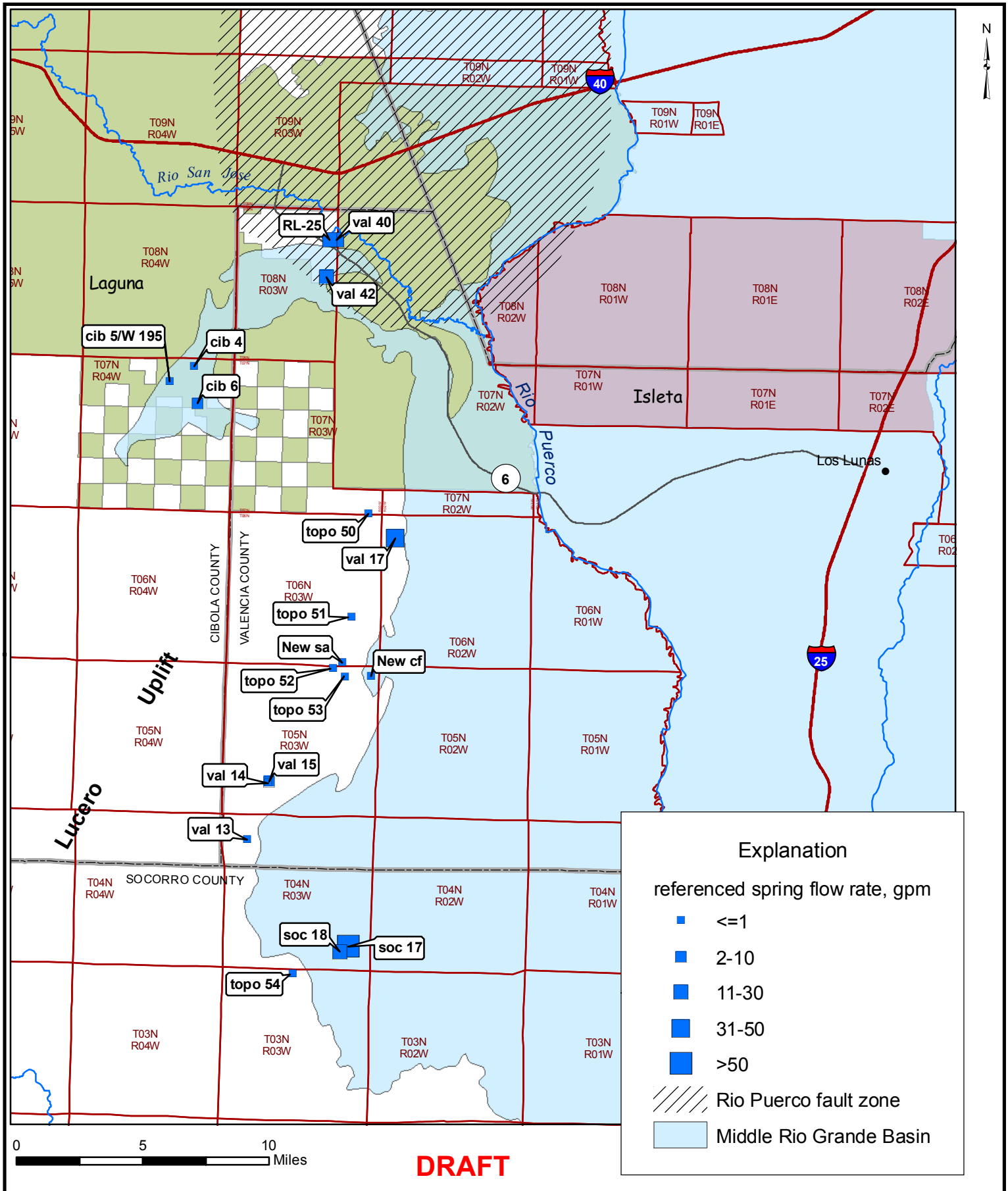

Figure 12. Map of referenced springs and flow rates along the southern Lucero Uplift.

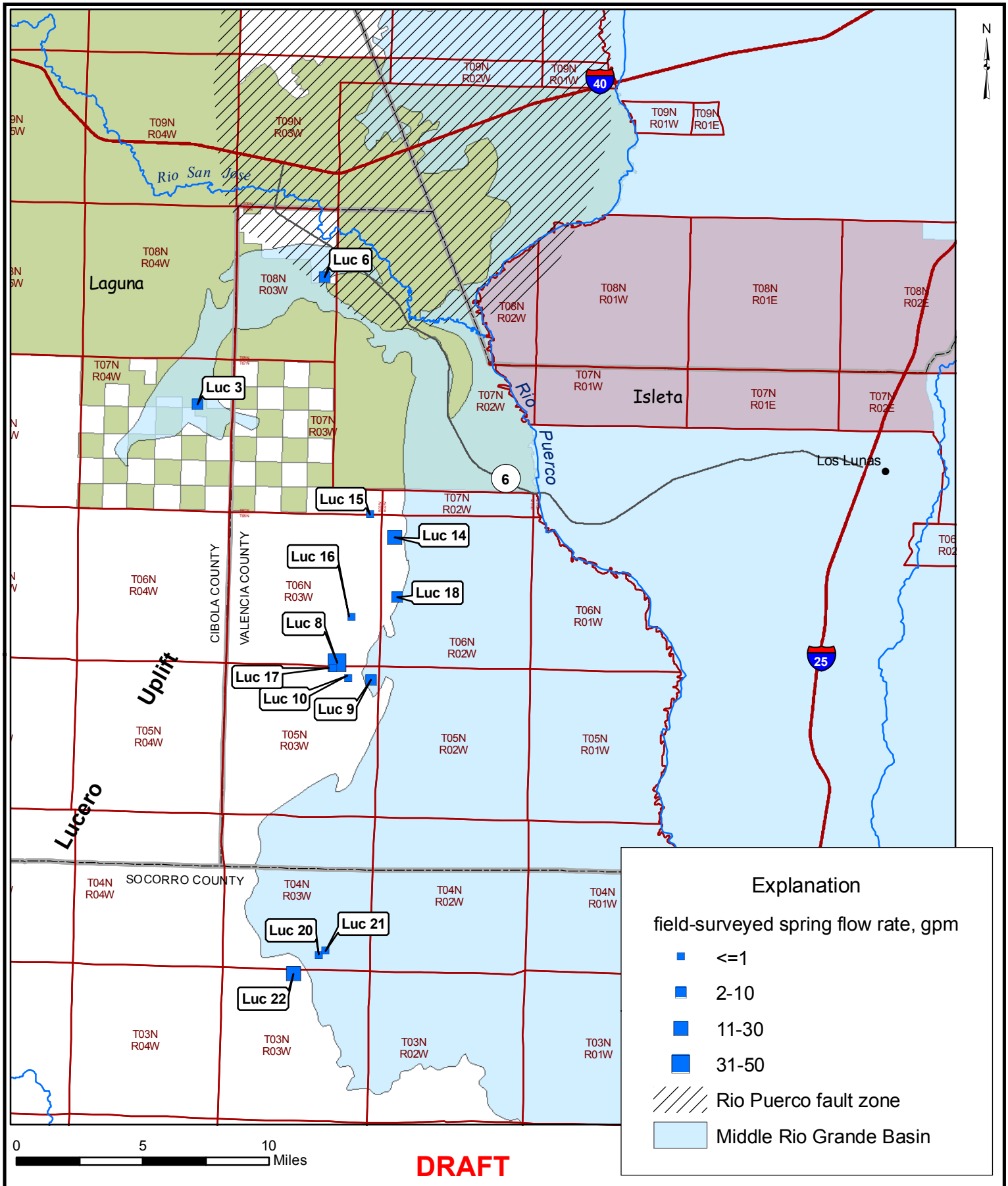

Figure 13. Map of field-surveyed springs and flow rates along the southern Lucero Uplift.

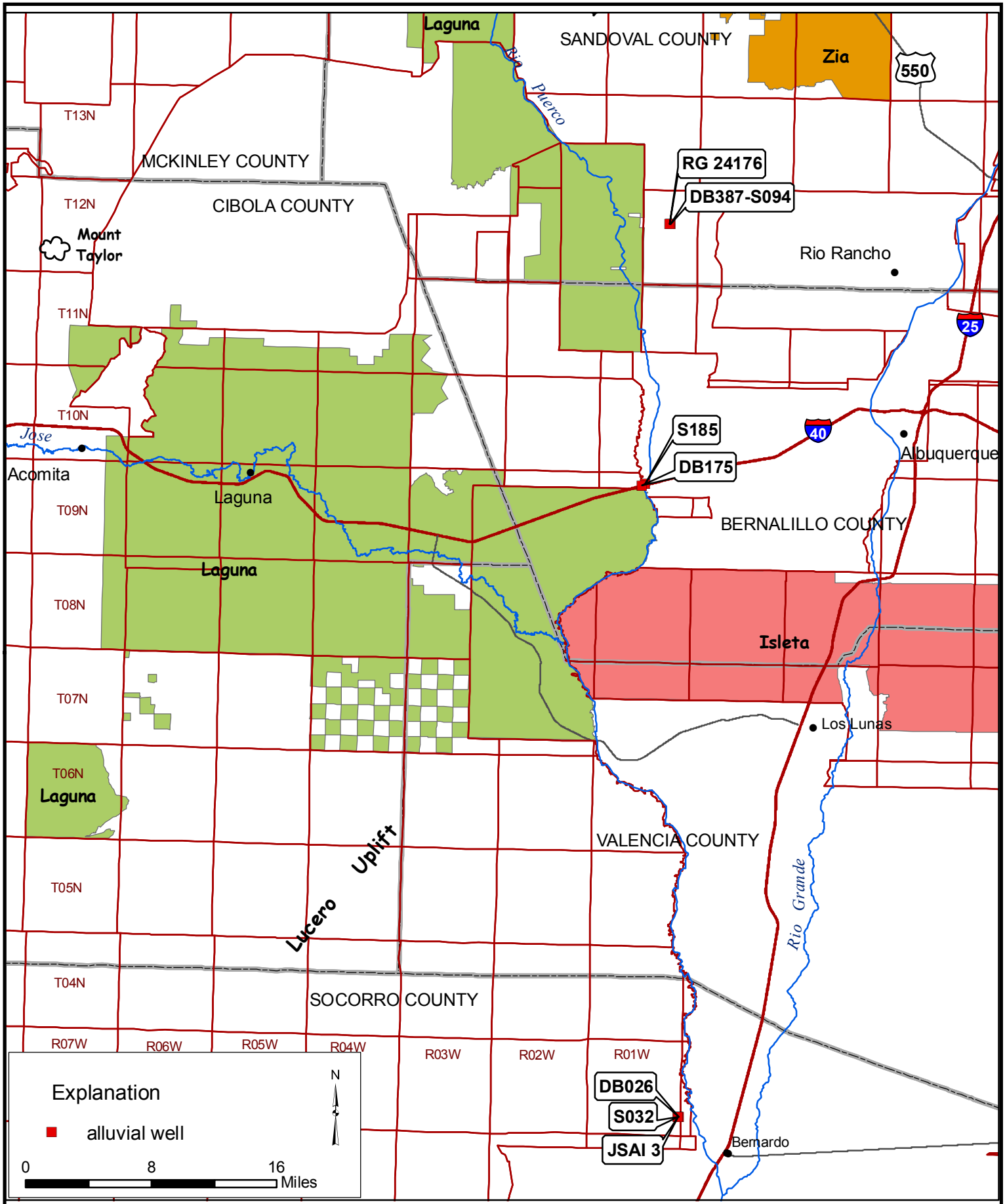

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Figure 14. Location map of selected alluvial wells (Table 4) along the Rio Puerco.

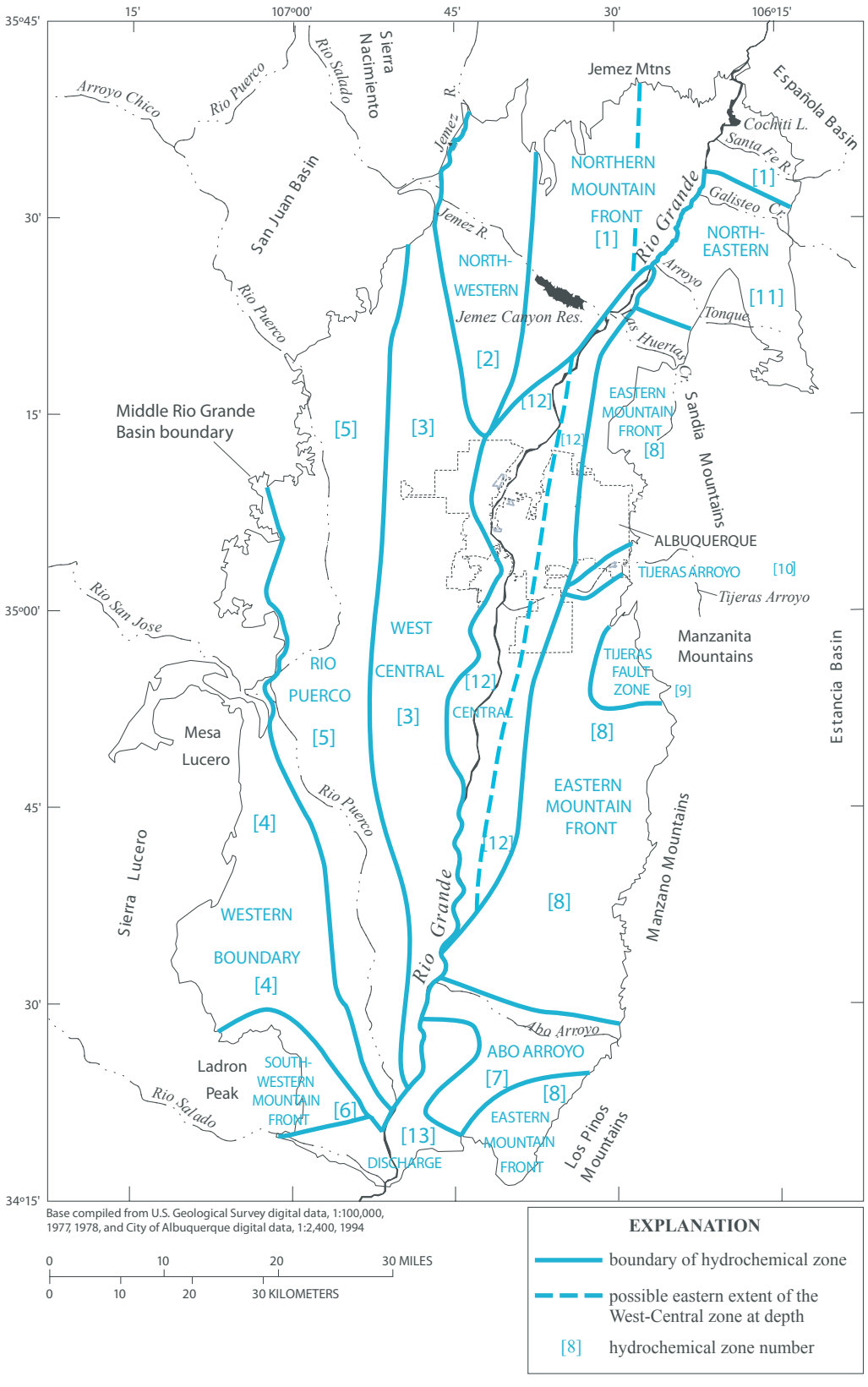

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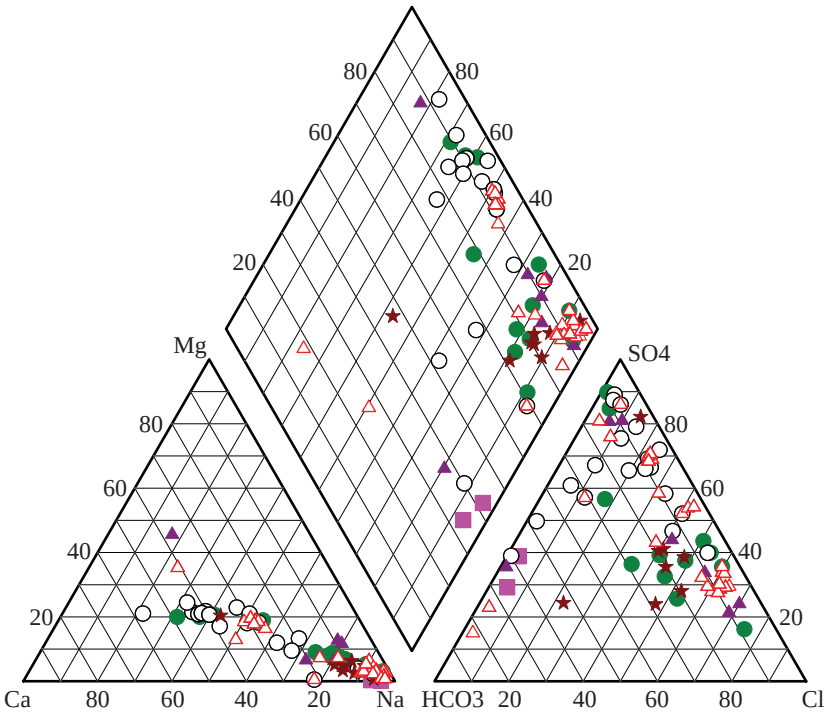
Figure 15. Hydrochemical zones (after Plummer et al., 2004a) for shallow groundwater within the Middle Rio Grande Basin.



Sources: Data from Newell et al. (2005), Plummer et al. (2004a), Risser and Lyford (1983), Trainer (1978), Craigg (1984), and this study.

EXPLANATION

- Zone 3 of Plummer et al. (2004a)
- Zone 4 (Western Boundary) of Plummer et al. (2004a)
- Zone 5 of Plummer et al. (2004a)
- Exotic Water of Plummer et al. (2004a)
- Rio Nacimiento/Rio Salado spring data of Trainer (2004) and this study
- Rio San Jose data of Risser and Lyford (1983)

Figure 16. Piper diagram showing variations in the major chemistry of saline and shallow Rio Puerco groundwater in the study area, central New Mexico.

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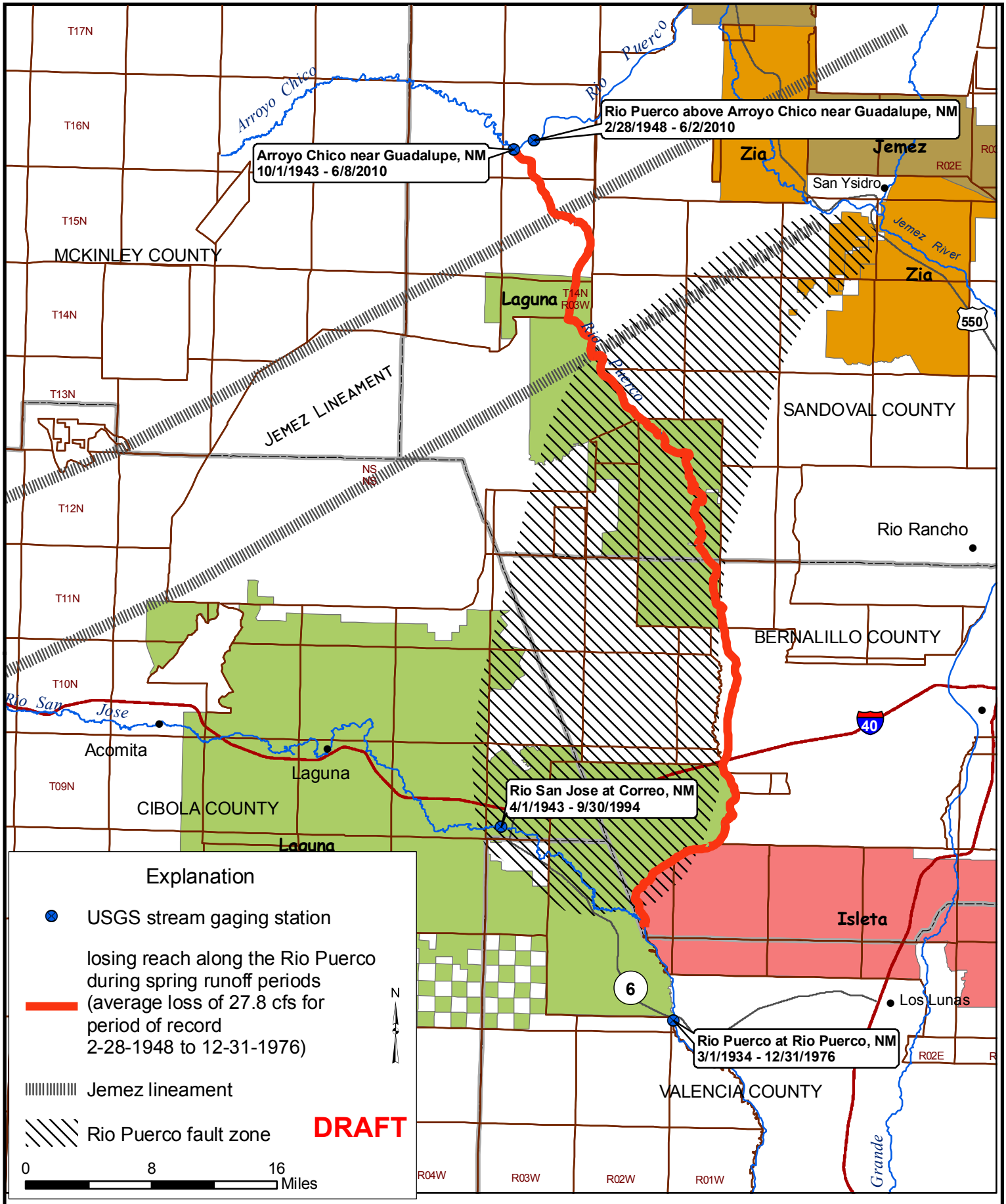

Figure 17. Map showing locations of USGS stream gaging stations and periods of record used in the analysis of Rio Puerco streamflow across the Rio Puerco fault zone.

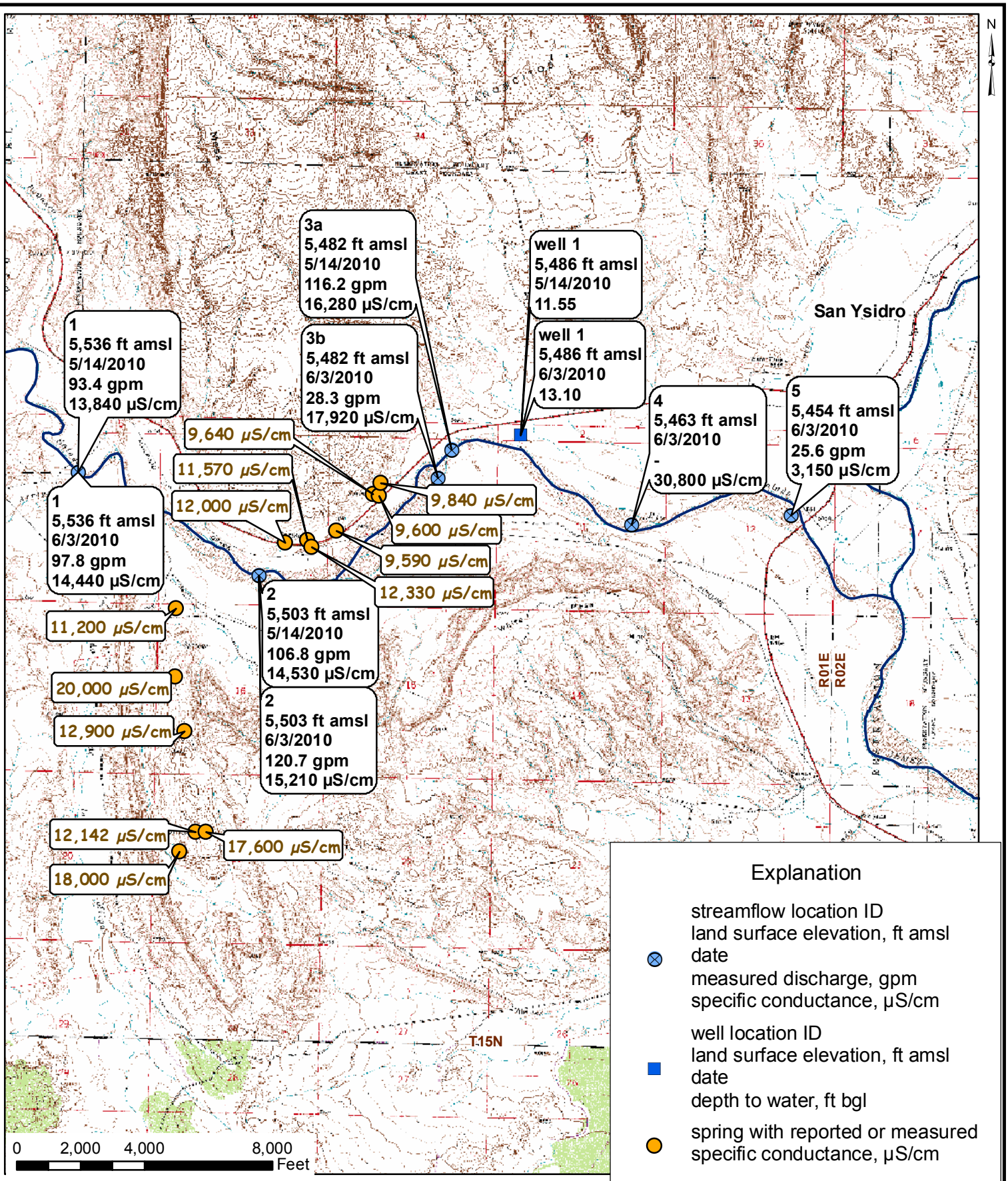

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Figure 18. Map showing 2010 streamflow and specific conductance data for the lower Rio Salado, 2010 groundwater-level data, and historic spring specific conductance data, Nacimiento Uplift - Pajarito fault area.

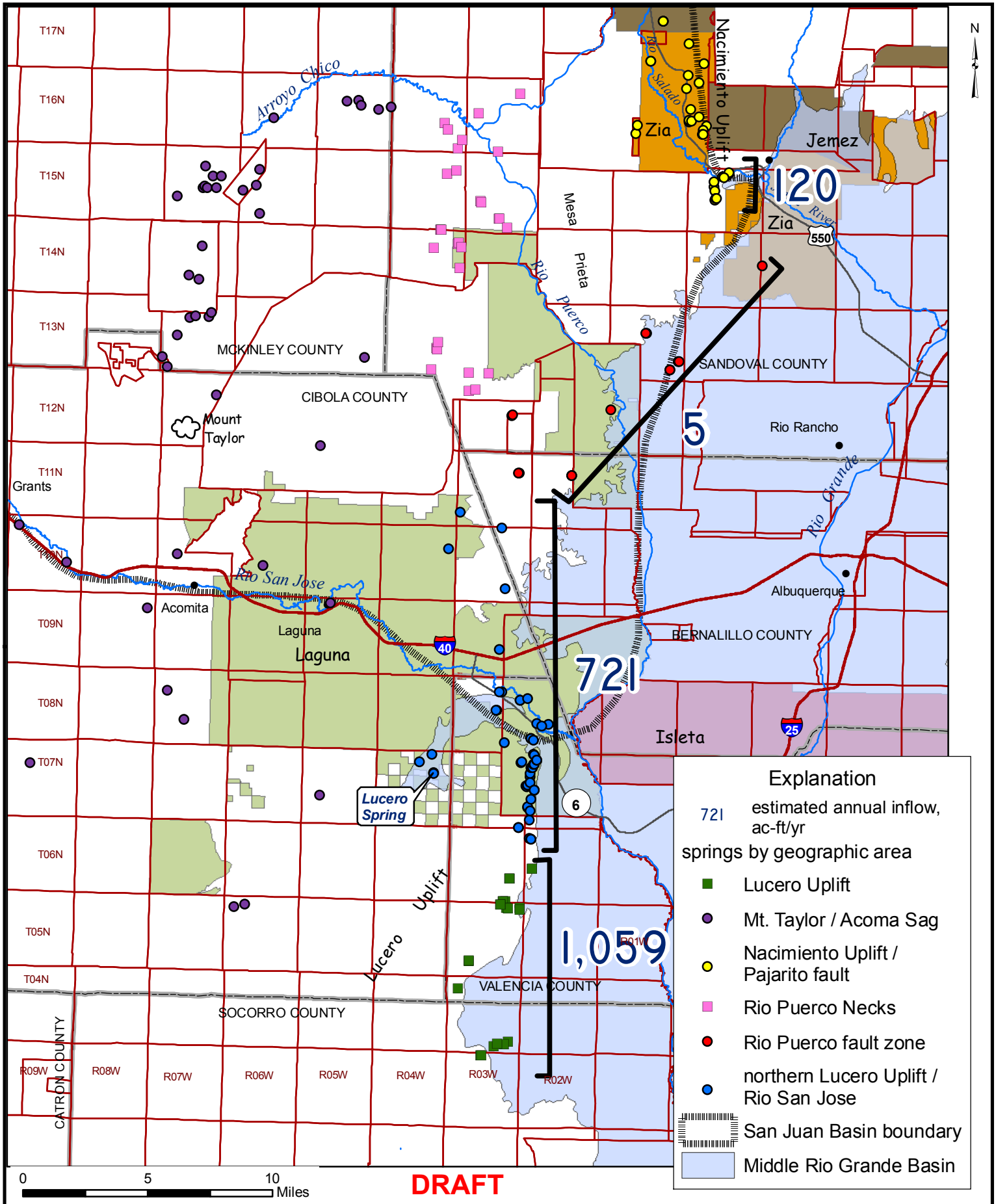

Figure 19. Regional map showing springs in the study area and estimated annual inflow in acre-feet per year at selected study sites along the Western Boundary of the Middle Rio Grande Basin.

APPENDICES

Appendix A.

Complete list of springs along the Western Boundary of the Middle Rio Grande Basin (MRGB) sorted by UTM number from north to south, and data sorted by geographic area

Table A1. Comprehensive inventory of springs along the western margin of the Middle Rio Grande Basin (MRGB)

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
san 133	historic	Holy Ghost Spring	Jemez Pueblo	Sandoval		9.5	Km	6,395	17N	1W	10.241	12/6/1983	spring	325,902	3,954,865		13.5		720	576	White & Kues, 1992; Trainer, 1978	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 55	topo	Soda Spring	Jemez Pueblo	Sandoval			Km	6,398						325,902	3,954,865						USGS topo, surveyed JSAI June 2010	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 56	topo	unnamed spring	Jemez Pueblo	Sandoval			Km	6,398						325,902	3,954,865						USGS topo, surveyed JSAI June 2010		Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 11	historic	"Upper Cuchana Arroyo Spring"	Zia Pueblo	Sandoval		-	Jm	6,700	17N	1W	13.322	-	spring	329,266	3,952,033						Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 12	historic	Chamisa Vega Spring	Jemez Pueblo	Sandoval		1	Km	6,100	17N	1W	28.243	8/1/1983	spring	324,341	3,949,765				2,450	1,960	USGS topo, surveyed JSAI June 2010	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 0	historic	Swimming Pool Spring	Jemez Pueblo	Sandoval		20	Pm	6,060	16N	1E	20.412	5/8/1984	spring	324,341	3,949,765		19.5		10,500		Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 10	historic	"Upper Cuchana Spring"	Zia Pueblo	Sandoval		-	PC	7,075	17N	1E	29.312	-	seep	331,225	3,949,467						Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
san 134	historic	Cachana Spring/ Trainer C5	Zia Pueblo	Sandoval		-	Qc	6,140	15N	1E		7/1/1946	spring	329,145	3,947,945		-		1,130	904	White & Kues, 1992; Trainer, 1978	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault				
san 37	historic	unnamed spring/ Trainer C1	Zia Pueblo	Sandoval		-	Trc	6,320	16N	1E	6.221	10/2/1973	spring	330,585	3,946,931		26.0		960	768	White & Kues, 1992; Trainer, 1978; Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
Kaseman 2	historic	"Warm Spring" Kaseman test well No. 2/ Trainer C3	Zia Pueblo	Sandoval			Pm	6,025	16N	1W	1.41			328,895	3,946,248						Renick, 1931	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 132	historic	unnamed spring	Aparcio Gurule	Sandoval		-	Km	6,080	16N	3W	11	5/26/1967	spring	307,457	3,945,551		-		9,940	7,952	White & Kues, 1992	Arroyo Empedrado	Puerco Necks			Rio Puerco (N bank)	
mck 61	historic	unnamed spring	J. Montoya	McKinley		2	Kmf	6,330	16N	5W	15.122	9/19/1962	spring	286,722	3,944,759		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 63	historic	unnamed spring	Sandoval	McKinley		2	Kmf	6,330	16N	5W	16.124	9/19/1962	spring	285,208	3,944,641		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 62	historic	Ojo Azabache	J. Montoya	McKinley		1	Kmf	6,330	16N	5W	15.233	9/19/1962	spring	287,033	3,944,074		20.5		1,150	920	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 59	historic	unnamed spring	E. Montoya	McKinley		0.1	Kmf	6,325	16N	5W	13.422	9/19/1962	spring	290,881	3,943,890		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
Kaseman 1	historic	Kaseman test well No. 1/ Trainer C2	Zia Pueblo	Sandoval			Trc	5,900	16N	1W	1.421			329,425	3,943,557						Renick, 1931	Ojito Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
mck 60	historic	unnamed spring	J. Montoya	McKinley		1	Kmf	6,360	16N	5W	14.442	9/19/1962	spring	289,210	3,943,529		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 33	topo	unnamed spring	Federal, state, or private lands	Sandoval					16 N	3 W	17		spring	302,150	3,943,049						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canada de la Lena		N off Rio Puerco	

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reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
Craigg 1	historic	"6092 Spring"	Zia Pueblo	Sandoval		-	Qt	6,092	16N	1E	18.441	-	seep	330,543	3,942,552						Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
mck 64	historic	unnamed spring	Fernandez Ranch	McKinley		5	Kpl	6,370	16N	5W	21.432	10/3/1962	spring	275,736	3,942,408		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 42	historic	Cuchillo "1"/ Craigg 8	Zia Pueblo	Sandoval	Pajarito fault	-	Trc	5,808	16N	1W	24.441		spring	329,230	3,942,154						USGS topo, surveyed JSAI Decenber 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Cuchilla Arroyo	NE off Rio Salado (N)		
topo 44	topo	Cuchillo "3"/ Craigg 2	Zia Pueblo	Sandoval	Pajarito fault			5,790	16N	1E	19.114		spring	329,590	3,941,979						USGS topo, surveyed JSAI Decenber 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Cuchilla Arroyo	NE off Rio Salado (N)		
topo 43	historic	Cuchillo "2"/ Craigg 9	Zia Pueblo	Sandoval	Pajarito fault	-	Trc	5,795	16N	1W	24.441		spring	329,225	3,941,959						USGS topo, surveyed JSAI Decenber 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Cuchilla Arroyo	NE off Rio Salado (N)		
topo 32	topo	unnamed spring	Federal, state, or private lands	Sandoval					16 N	4 W	23		spring	297,765	3,941,849						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canada de las Lomitas	SW off Arroyo Chico	W off Rio Puerco	
topo 41	topo	"Upper Ojito spring"/Trainer A6	Zia Pueblo	Sandoval		-		5,780	16N	1W	20.421		spring	322,560	3,941,534						USGS topo, surveyed JSAI April 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Arroyo Ojito	NW off Rio Salado (N)		
Craigg 3	historic	Penasco "1"	Zia Pueblo	Sandoval	Pajarito fault	-	Pm	6,000	16N	1E	20.322	-		331,557	3,941,418						Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 31	topo	Ojo Frio	Federal, state, or private lands	Sandoval					16 N	4 W	26		spring	298,165	3,940,984						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canada de las Lomitas	SW off Arroyo Chico	W off Rio Puerco	
Craigg 4	historic	Penasco "2"	Zia Pueblo	Sandoval	Pajarito fault	5	Pm	5,960	16N	1E	20.322	5/8/1984	spring	331,107	3,940,890		22.5		15,000		Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 131	historic	Ojito Spring/ Trainer C4	Zia Pueblo	Sandoval		2	Km	5,770	16N	1W	29.232	6/5/1973	spring	322,377	3,940,370		21.0		10,100	8,080	White & Kues, 1992; Trainer, 1978	Ojito Spring	Nacimiento Uplift / Pajarito fault	Arroyo Ojito	NW off Rio Salado (N)		
Craigg 6	historic	Penasco "4"	Zia Pueblo	Sandoval	Pajarito fault	-	Pm	5,830	16N	1E	29.114	-	seep	331,055	3,940,337						Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 5	historic	Penasco "3"	Zia Pueblo	Sandoval	Pajarito fault	10	Pm	5,830	16N	1E	29.113	5/8/1984	spring	331,011	3,940,306		27		12,000		Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 30	topo	Ojo Atascoso	Federal, state, or private lands	Sandoval					16 N	4 W	36		spring	299,950	3,939,694						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	unnamed western channel		W off Rio Puerco	
topo 29	topo	Ojo de las Yeguas	Federal, state, or private lands	Sandoval					16 N	4 W	36		spring	299,475	3,938,544						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	unnamed western channel		W off Rio Puerco	
topo 28	topo	Ojo de los Jaramillos	Federal, state, or private lands	Sandoval					16 N	3 W	33		spring	304,575	3,938,149						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks			Rio Puerco (E bank)	
mck 41	historic	Pena Spring	F. Lee (?)	McKinley		1	Kmf	6,535	15N	7W	10.411	10/16/1962	spring	266,961	3,936,250		12.0		780	624	White & Kues, 1992		Mt. Taylor / Acoma Sag				

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mck 65	historic	unnamed spring	Fernandez Ranch	McKinley		17	Kplh	6,410	16N	5W	29.231	10/3/1962	spring	273,907	3,935,825		13.0		1,350	1,080	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 26	topo	Cerro Chamisa Losa spring'	Federal, state, or private lands	Sandoval					15 N	4 W	12		spring	299,225	3,935,679						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Chamisa Losa		W off Rio Puerco	
field 2	field id	Tierra Amarilla springs	BLM	Sandoval	Pajarito fault		Trc					6/4/2010	seep	334,461	3,935,363		23.4	6.26	9,840	7,872	JSAI field checked June 2010	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
nac 1												6/4/2010	seep	334,389	3,935,252		25.2	6.32	9,640	7,712			Nacimiento Uplift / Pajarito fault		Rio Salado		
san 28	historic	Tierra Amarilla springs	BLM	Sandoval	Pajarito fault	-	Trc	5,500	15N	1E	10.141	5/22/1975	spring	334,443	3,935,237		16.0		9,600	7,680	White & Kues, 1992	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 27	topo	Chamisa Losa Spring	Federal, state, or private lands	Sandoval					15 N	4 W	11		spring	298,015	3,935,224						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Chamisa Losa		W off Rio Puerco	
mck 42	historic	Coal Mine Spring	Fernandez Ranch	McKinley		-	Kmf	6,550	15N	7W	14.131	10/15/1962	spring	268,995	3,934,964		13.5		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 43	historic	Burro Springs	Fernandez Ranch	McKinley		2	Kmf	6,555	15N	7W	15.243	10/115/1962	spring	267,886	3,934,962		13.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
san 29	historic	Tierra Amarilla anticline spring(s)/ Trainer A2	BLM	Sandoval	Pajarito fault	<1	Trc	5,500	15N	1E	10.311	1/25/1974	spring	334,034	3,934,906		14.5		9,590	7,672	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
nac 0												6/4/2010	seep	333,764	3,934,819		20.6	6.22	11,570	9,256			Nacimiento Uplift / Pajarito fault		Rio Salado		
san 27	historic	Tierra Amarilla anticline spring/ Trainer A1	BLM	Sandoval	Pajarito fault	2	Trc	5,520	15N	1E	9.414	5/22/1975	spring	333,553	3,934,792		15.0		12,000	9,600	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
field 5	field id	Tierra Amarilla springs	BLM	Sandoval	Pajarito fault		Trc					6/4/2010	seep	333,800	3,934,750		30.4	7.25	12,330	9,864	JSAI field checked June 2010	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 30	historic	Tierra Amarilla anticline spring/ Trainer A3	BLM	Sandoval	Pajarito fault	-		5,530	15N	1E	16.111	12/20/1974	spring	332,509	3,934,164		25.0		11,200	8,960	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
mck 39	historic	unnamed spring	A. Michael	McKinley		0.25	-	6,600	15N	6W	20.121	10/3/1962	spring	273,425	3,933,740		16.5		451	361	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 44	historic	unnamed spring "600"		McKinley		-	Kmf	6,569	15N	7W	22.114	10/11/1956	spring	266,819	3,933,694		13.5		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
san 31	historic	Tierra Amarilla anticline spring/ Trainer A4	BLM	Sandoval	Pajarito fault	-	Trc	5,740	15N	1E	16.233	10/18/1974	spring	332,497	3,933,517		18.0		20,000	16,000	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
mck 45	historic	Ojo Redondo	Fernandez Ranch	McKinley		2	Kmf	6,569	15N	7W	22.131	3/31/1961	spring	266,662	3,933,483		14.8		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 47	historic	Doctor Spring	Fernandez Ranch	McKinley		15	Kmf	6,588	15N	7W	23.132	10/3/1962	spring	268,376	3,933,469		14.0		350	280	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 46	historic	Montano Spring	Fernandez Ranch	McKinley		-	Kmf	6,586	15N	7W	22.141	10/31/1961	spring	267,114	3,933,440		20.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				

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mck 38	historic	El Dado Springs	Fernandez Ranch	McKinley		5	Kmf	6,595	15N	6W	19.321	7/21/1962	spring	271,770	3,933,073		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
san 32	historic	Tierra Amarilla anticline spring/ Trainer A5	BLM	Sandoval	Pajarito fault	-		5,810	15N	1E	16.313	12/20/1974	spring	332,588	3,932,991		11.0		12,900	10,320	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
mck 48	historic	San Ysidro Spring	Fernandez Ranch	McKinley		1	Kmf	6,655	15N	7W	29.431	3/31/1961	spring	263,253	3,932,339		14.0				White & Kues, 1992		Mt. Taylor / Acoma Sag				
New gs	historic	Grassy Spring			Pajarito fault	seep	Trc - anticl.						seep	332,692	3,932,039		21.4		12,142		Newell et al., 2005	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 34	historic	Tierra Amarilla anticline spring	BLM	Sandoval	Pajarito fault	-	Trc	5,820	15N	1E	21.141	5/22/1975	spring	332,796	3,932,032		19.0		17,600	14,080	White & Kues, 1992	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 33	historic	Tierra Amarilla anticline spring(s)	BLM	Sandoval	Pajarito fault	-	Trc	5,680	15N	1E	21.141	5/22/1975	spring	332,541	3,931,852		14.0		18,000	14,400	White & Kues, 1992	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 22	topo	unnamed spring (w)	Federal, state, or private lands	Sandoval					15 N	3 W	20		spring	302,300	3,931,714						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Salado		W off Rio	
topo 23	topo	unnamed spring (e)	Federal, state, or private lands	Sandoval					15 N	3 W	20		spring	302,390	3,931,654						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Salado		W off Rio	
mck 40	historic	Ojo de las Yuges	A. Michael	McKinley		2	Kmf	6,725	15N	6W	32.231	10/22/1962	spring	273,863	3,930,121		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 21	topo	Cerro Tinaja spring (n)'	state or private lands	Sandoval					14 N	4 W	28		spring	304,755	3,929,519						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	unnamed western		W off Rio	
topo 20	topo	Cerro Tinaja spring (s)'	state or private lands	Sandoval					14 N	4 W	28		spring	304,720	3,929,469						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	unnamed western		W off Rio	
topo 19	topo	Gonzales Ranch spring'	state or private lands	Sandoval					14 N	4 W	34		spring	305,770	3,928,274						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canoncito		W off Rio	
topo 45	topo	Rancho Viejo Spring (east)	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					15 N	4 W	35		spring	297,160	3,928,064						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 47	topo	Rancho Viejo Spring (west)	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					15 N	4 W	35		spring	297,305	3,928,054						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 46	topo	Rancho Viejo Spring (middle)	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					15 N	4 W	35		spring	297,225	3,928,029						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 17	topo	Sanchez Ranch spring (e)'	state or private lands	Sandoval					14 N	4 W	12		spring	299,590	3,926,324						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canada Ancha		W off Rio	
topo 16	topo	'Sanchez Ranch spring (w)'	state or private lands	Sandoval					14 N	4 W	12		spring	299,465	3,926,309						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canada Ancha		W off Rio	
mck 25	historic	Cerro Spring	Fernandez Ranch	McKinley		10	Kmf	6,822	14N	7W	10.333	10/23/1962	spring	266,515	3,925,901		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 18	topo	unnamed spring	state or private lands	Sandoval					14 N	4 W	12		spring	299,850	3,925,879						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canada Ancha		W off Rio	
topo 48	topo	Ojo Canoa	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					14 N	4 W	10		spring	296,330	3,925,769						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 49	topo	unnamed spring	Zia Pueblo	Sandoval				5,735	14N	2E	18		spring	338,655	3,923,314						USGS topo, surveyed JSAI December 2010	Sky Village NE	Rio Puerco fault zone	Arroyo Ojito		Jemez River	

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reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
topo 15	topo	Jara Loso Spring	state or private lands	Sandoval					14 N	4 W	24		spring	299,650	3,923,104						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Jara Loso	Canada Ancha	W off Rio	
mck 26	historic	Sap Hole Spring	Fernandez Ranch	McKinley		0.25	Kmf	6,908	14N	7W	28.134	10/23/1962	spring	264,802	3,922,183		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 27	historic	Ft Miguel Ruins Spring	Fernandez Ranch	McKinley		2	Kmf	6,950	14N	7W	28.424	3/31/1961	spring	266,025	3,921,657		14.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 9	historic	C.C.C. Spring	Fernadez Ranch	McKinley		75	Tb	7,950	13N	7W	11.131	12/12/1956	spring	267,656	3,917,329		11.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 7	historic	unnamed spring	U.S. Forest Service	McKinley		50	Te, Kmv	7,840	13N	7W	9.423	10/23/1962	spring	265,623	3,916,889		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 8	historic	unnamed spring		McKinley		50	Tb	8,130	13N	7W	10.423	10/23/1962	spring	267,313	3,916,814		11.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 6	historic	unnamed spring	U.S. Forest Service	McKinley		50	Te, Kmv	7,810	13N	7W	9.323	10/23/1962	spring	264,911	3,916,691		11.0		203	162	White & Kues, 1992		Mt. Taylor / Acoma Sag				
rpfz 4	visited	Sandoval Spring/ S215 of Plummer et al., (2004)			probable	3.20	Km	5,862				6/9/2010	spring	323,706	3,914,720	45,200	23.8	7.84	1,141				Rio Puerco fault zone				
topo 3	topo	Sandoval Spring	state or private lands	Bernalillo	probable	-	Km	5,862	13 N	1 W	16		spring	323,800	3,914,704						USGS topo, surveyed JSAI December 2010	San Felipe Mesa	Rio Puerco fault zone	Arroyo Bernardo		E off Rio Puerco	
mck 10	historic	San Lucas Spring	U.S. Forest Service	McKinley		20	Tb	7,850	13N	7W	20.123	8/29/1962	spring	263,262	3,914,484		12.0		255	204	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 14	topo	unnamed spring (n)	private (?)	Sandoval									spring	296,875	3,913,599						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	East Canon de Santa Rosa	Salado Canon	W off Rio Puerco	
topo 13	topo	unnamed spring(s)	private (?)	Sandoval									spring	296,615	3,912,824						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	East Canon de	Salado Canon	W off Rio	
topo 12	topo	Ojo de Santa Rosa	private (?)	Sandoval									spring	296,800	3,912,684						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	East Canon de	Salado Canon	W off Rio	
mck 11	historic	San Mateo Springs	Fernandez Ranch	McKinley		-	Tb	7,700	13N	7W	20.334	9/13/1956	spring	261,391	3,911,634		6.8		194	155	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 5	historic	Ojo Marquez	Village of Marquez	McKinley		25	Kmv	7,380	13N	5W	26.134	8/27/1962	spring	287,419	3,911,536		17.0		329	263	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 2	topo	Tortola Spring	state or private lands	Sandoval		0	Tcc	6,020	13 N	1 W	25		spring	327,875	3,911,019						USGS topo, surveyed JSAI December 2010	San Felipe Mesa	Rio Puerco fault zone	Alamo Arroyo		E off Rio Puerco	
rpfz 6	visited	Tortola Spring			Navajo-Moquino	0	Tcc	6,020						327,988	3,911,009								Rio Puerco fault zone				Spring not found at this location (6/9/2010)
mck 12	historic	San Mateo Springs	Fernandez Ranch & San Mateo	McKinley		275	Tb	8,120	13N	7W	31.414	10/24/1962	spring	262,041	3,910,414		13.5		117	94	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 11	topo	'Evans Ranch spring'	private (?)	Sandoval									spring	296,000	3,910,069						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Salado Creek	Salado Canon	W off Rio	
topo 1	topo	Alamo Spring (dry)	state or private lands	Sandoval	unknown	0	Km	5,880	13 N	1 W	35		spring	326,800	3,909,904						USGS topo, surveyed JSAI December 2010	San Felipe Mesa	Rio Puerco fault zone	Alamo Arroyo		E off Rio Puerco	
topo 10	topo	La Gotera spring'	private (?)	Sandoval	likely	0.96	Jm	6,120					spring	300,860	3,909,679						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Salado Creek	Salado Canon	W off Rio	
topo 9	topo	unnamed spring	Laguna Pueblo	Sandoval	likely	0	Jm	6,000					spring	303,430	3,909,514						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Salado Creek	Salado Canon	W off Rio	
topo 8	topo	Dorey Mine spring'	private (?)	Sandoval		0	Jm	6,120					spring	301,670	3,907,504						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Canon del Piojo	Salado Canon	W off Rio	

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reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
topo 7	topo	unnamed spring	private (?)	Sandoval		0	Jm	6,160					spring	300,795	3,907,309						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Canon del Piojo	Salado Canon	W off Rio	
cib 23	historic	Elkin's Spring	Summer Camp	Cibola		5	-	9,250	12N	7W	11.3	8/29/1962	spring	268,369	3,906,765		7.0		257	206	White & Kues, 1992		Mt. Taylor / Acoma Sag				
RL-66	historic	Ojito Spring	Laguna Pueblo			-	Qal	5,515	12N	1W	18.134	6/17/1974	spring	319,220	3,904,802				600		Risser & Lyford, 1983	San Felipe Mesa	Rio Puerco fault zone				
rpfz 1	visited	Pino Spring				0	Kg	6,210						306,526	3,904,139								Rio Puerco fault zone				Spring not found at this location - rockwall moist (6/3/2010)
topo 6	topo	Pino Spring	private (?)	Sandoval		0	Kg	6,210					spring	306,440	3,904,019						USGS topo, surveyed JSAI December 2010	La Gotera	Rio Puerco fault zone	Canada del Ojo		W off Rio	
cib 22	historic	unnamed spring	MDWSWA of Seboyeta	Cibola		10	Kmv	6,535	12N	5W	32.331	3/9/1965	spring	281,763	3,900,172		-		429	343	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 4	topo	'Herrera spring'	private (?)	Bernalillo	likely	0	Jm/Kd	5,930	11 N	3 W	11		spring	307,350	3,896,684						USGS topo, surveyed JSAI December 2010	Herrera	Rio Puerco fault zone	Canada del Ojo		W off Rio	
rpfz 2	visited	'Herrera spring'			likely	0	Jm/Kd	5,930						307,289	3,896,614								Rio Puerco fault zone				Spring not found at this location - soil muddy (6/3/2010)
rpfz 3	visited	unnamed spring			N-S fracture	0	Kd	5,770						314,093	3,896,343								Rio Puerco fault zone				Spring not found at this location - phreatophytes (6/3/2010)
topo 5	topo	unnamed spring	private (?)	Sandoval	N-S fracture	0	Kd	5,770	11 N	2 W	10		spring	314,090	3,896,339						USGS topo, surveyed JSAI December 2010	Herrera	Rio Puerco fault zone	unnamed western		W off Rio	
RL-52	historic	Hanging Grape Spring	Laguna Pueblo			0.5	Kd	6,260	11N	3W	30.343	10/15/1973	spring	299,740	3,891,587				560		Risser & Lyford, 1983	Arch Mesa	northern Lucero/ Rio San Jose				
cib 20	historic	Ojo de Gallo		Cibola		3,000	Psa	6,449	10N	10W	3.423	7/12/1946	spring	237,898	3,890,388		16.0		1,070	856	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 18	historic	unnamed spring	S. Gottlieb	Cibola		0.5	Qb	6,401	10N	9W	6.442	5/13/1958	spring	242,930	3,889,997		10.5		3,110	2,488	White & Kues, 1992		Mt. Taylor / Acoma Sag				
bern 40	historic	Jose Manuel Spring	Canoncito Navajo	Bernalillo		seep	Jm	-	10N	3W	3.212	1952, 1953	spring	305,139	3,889,620		-		372 - 389	311	White & Kues, 1992	Arch Mesa	northern Lucero/ Rio San Jose				
RL-41	historic	Cheromiah Spring	Joe Cheromiah			1	Jm	6,100	10N	4W	12.342	10/15/1973	spring	298,294	3,886,899				4,000		Risser & Lyford, 1983	Mesa Gigante	northern Lucero/ Rio San Jose				
cib 17	historic	unnamed spring		Cibola		100	-		10N	7W	20.411	2/20/1951	spring	263,305	3,886,205		8.5		571	457	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 19	historic	Horace Springs		Cibola		2,000	Qb	6,276	10N	9W	23.423	5/13/1957	spring	249,005	3,885,140		16.0		1,170	936	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 16	historic	unnamed spring	Laguna Indian Reservation	Cibola		50	-		10N	6W	21.4	5/12/1957	spring	274,344	3,884,691		11.0		204	163	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 38	topo	Alamos Spring	Canoncito Navajo	Cibola					10 N	3 W	26		spring	305,585	3,881,779						USGS topo, surveyed JSAI December 2010	Mesa Gigante	northern Lucero/ Rio San Jose	Canada de los Alamos	Canada de las Apaches	W off Rio Puerco	
cib 13	historic	AT & SF RR	AT &SF RR	Cibola			Qb	5,760	9N	5W	4.133	3/19/1965	spring	282,999	3,879,917		-		2,280	1,824	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 14	historic	Canipa Spring	Acoma Indian Reservation	Cibola		-	-	6,197	9N	8W	12.123	9/16/1952	spring	259,446	3,879,245		-		1,490	1,192	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 37	topo	Coyote Spring	Laguna Nation	Cibola			Trc	5,600	9 N	3 W	22	4/26/1973	spring	304,775	3,873,889				4,400		USGS topo, surveyed JSAI December 2010	Correo	northern Lucero/ Rio San Jose	unnamed northern channel	Rio San Jose	W off Rio Puerco	

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cib 9	historic	Acoma Springs		Cibola		10	Jm	6,275	8N	7W	8.331	1/28/1966	spring	262,037	3,868,693		-		1,050	840	White & Kues, 1992		Mt. Taylor / Acoma Sag				
RL-25/ Luc 5	historic	unnamed spring	Talavera Corp.	Valencia		30.00	Qb	5,400	8N	3W	10.214	10/4/1973	spring	304,762	3,868,432				3,800		Risser & Lyford, 1983	Correo	northern Lucero/ Rio San Jose		RSJ	RP (south)	1,300 ft west of Suwanee Spring; no access
val 40/ Luc 4	historic	Suwanee Spring	Day Ranch/ Laguna Pueblo	Valencia	Suwanee	30.00/ **100.00**	Jt	5,360	8N	3W	10.224	5/16/1958/ **3/10/2000**	spring	305,145	3,868,423		16.7		3,790	3,020	Titus, 1963; **JSAI, 2000**	Correo	northern Lucero/ Rio San Jose		RSJ	RP	Major Cattle and Land Co. contact stated spring is owned by the Pueblo of Laguna
val 38	historic	Miranda Spring	Laguna Pueblo	Valencia		-	Jm	5,240	8N	2W	7.314	4/21/1975	spring	308,424	3,867,541				30,100	24,080	White & Kues, 1992; Risser & Lyford, 1983	South Garcia	northern Lucero/ Rio San Jose	Arroyo de Miranda	Rio San Jose	W off Rio Puerco	
val 41	historic	Dipping Vat Spring	Laguna Nation	Valencia	YES	400	Jm (Qal?)	5,320	8N	3W	12.342	12/7/1957	spring	307,477	3,867,370				4,030	3,224	White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose		Rio San Jose	W off Rio Puerco	
val 44	historic	unnamed spring	Laguna Pueblo	Valencia			Jm					4/21/1975	spring	307,531	3,867,344						White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose				
val 42 Luc 6	historic visited	unnamed spring		Valencia	Suwanee	25 5.00	Jw Jw	5,550 5,555	8N 8N	3W 3W	15.413 15.413	4/21/1975 5/7/2010	spring	304,508 304,416	3,866,052 3,866,084	1,080	16.5 22.4	6.55	4,030 16,660	3,224	White & Kues, 1992	Correo	northern Lucero/ Rio San Jose	unnamed arroyo	RSJ		west of Mesa Redondo
cib 10	historic	unnamed spring		Cibola		-	Jz	-	8N	7W	28.124	1/28/1966	spring	264,096	3,864,847		-		474	379	White & Kues, 1992		Mt. Taylor / Acoma Sag				
val 35	historic	El Ojo Escondido	Laguna Pueblo	Valencia		20	Jm	5,203	8N	2W	19.421	9/8/1941	spring	309,580	3,864,372		22.8			239	Titus, 1963; Wright, 1946	South Garcia	northern Lucero/ Rio San Jose				
val 37	historic	Salt Spring	Laguna Pueblo	Valencia		0.5	Jm	5,180	8N	2W	20.423	4/21/1975	spring	311,174	3,864,278		24.0		32,600	26,080	White & Kues, 1992; Risser & Lyford, 1983	South Garcia	northern Lucero/ Rio San Jose				
RL 22	historic	Ojo Escondido	Laguna Pueblo	Valencia			Jm	5,250	8N	2W	20.332		spring	310,220	3,864,058						Risser and Lyford, 1983		northern Lucero/ Rio San Jose				
val 39	historic	DB 117 of Plummer et al., (2004)	Laguna Pueblo	Valencia			Jm					4/21/1975	spring	308,927	3,862,475				41,400	33,120	White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose				
W 193	historic	unnamed spring	Laguna Pueblo			5	Jm(?), Kd(?)	5,320(?)	8N	2W	30.34	1941	spring	308,881	3,862,419		22.2			20,900	Titus, 1963	South Garcia	northern Lucero/ Rio San Jose				
val 36	historic	DB 116 of Plummer et al., (2004)	Laguna Pueblo	Valencia		5	Jm					9/3/1941	spring	309,150	3,862,250		22.0				White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose				
W 194	historic	unnamed spring	Laguna Pueblo			1	Trc	5,800(?)	8N	3W	35.1	9/3/1941	spring	305,417	3,861,842		18.3			355	Titus, 1963	Correo	northern Lucero/ Rio San Jose				
W 192	historic	unnamed spring	Laguna Pueblo			0.3	Km	5480(?)	7N	2W	6.21	1941	spring	309,226	3,860,426					32,400	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
cib 4/ Luc 2	historic	Lower Water Spring	A. Harrington/ Diamond L Ranch	Cibola		0.01/ 150.00	Qal	5,720	7N	4W	2.144	9/4/1941	spring	296,104	3,860,378	19,375,000	18.5		-		White & Kues, 1992	White Ridge	northern Lucero/ Rio San Jose	Arroyo Lucero	RSJ		contact tried but not established

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gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
val 26	historic	unnamed spring	Laguna Pueblo	Valencia			Km, Kd					4/21/1975	spring	309,339	3,860,278				3,700	2,960	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 27	historic	unnamed spring	Laguna Pueblo	Valencia			Trc					4/22/1975	spring	309,630	3,859,625		13.5		36,500	29,200	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
RL-4	historic	Railroad Spring	Laguna Pueblo			-	Trc	5,300	7N	2W	6.42	4/22/1975	spring	309,630	3,859,624				36,500		Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
RL-15	historic	unnamed spring	Laguna Pueblo			1	Psa	5,580	7N	3W	1.41	2/12/1975	spring	307,721	3,859,424				10,000		Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
cib 5/ W 195/ Luc 1	historic	unnamed spring	A. Harrington/ Diamond L Ranch	Cibola		1.00	Trs	5,812	7N	4W	3.344	2/8/1957	spring	294,557	3,859,395		9.0		7,950		White & Kues, 1992; Wright, 1946	White Ridge	northern Lucero/ Rio San Jose	Arroyo Lucero	RSJ		Ranch land leased by Diamond L Cattle Co.; contact tried but not established
val 33	historic	Indian Ruins Spring	Laguna Pueblo	Valencia		5	Psa,Pg	5,580	7N	3W	1.43	4/21/1975	spring	307,616	3,859,297				8,530	6,824	White & Kues, 1992; Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
cib 8	historic	Cebollita Spring		Cibola				7,520	7N	9W	9.332	8/9/1978	spring	244,325	3,859,272		12.0		608	486	White & Kues, 1992		Mt. Taylor / Acoma Sag				
W 190	historic	unnamed spring	Laguna Pueblo			3	Kd(?)	5,350	7N	2W	6.434	1941	spring	309,304	3,859,156		14.4			27,100	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 19	historic	unnamed spring	Laguna Pueblo	Valencia					7N	2W	6.434	2/20/1956	spring	309,308	3,859,115		14.4		35,200	28,160	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 28	historic	unnamed spring	Laguna Pueblo	Valencia			Km,Kd					4/2/1975	spring	309,238	3,859,078				41,500	33,200	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 29	historic	Pipeline Spring	Laguna Pueblo	Valencia		-	Trc	5,360	7N	2W	7.21	4/22/1975	spring	309,102	3,858,649		14.0		34,100	27,280	White & Kues, 1992; Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
val 22/ W 186	historic	unnamed spring	Laguna Pueblo	Valencia		3	Trc	5,450	7N	2W	7.124	8/25/1941	spring	308,923	3,858,632		24.4		34,100	27,900	Titus, 1963; Wright, 1946	South Garcia SE	northern Lucero/ Rio San Jose				
cib 6 Luc 3	historic visited	Lucero Spring	A. Harrington Diamond L Ranch	Cibola	Alamosa	5 8.50	Trs Trs	5,825 5,815	7N 7N	4W 4W	11.431 11.431	6/4/1957 5/7/2010	spring	296,305 296,307	3,858,000 3,857,940	1,035,000	15.5 17.9	7.05	4,260 4,760	3,408	White & Kues, 1992	White Ridge	northern Lucero/ Rio San Jose	Arroyo Lucero	RSJ		Ranch land leased by Diamond L Cattle Co. Sampled on reconnaisance run
W 185	historic	unnamed spring	Laguna Pueblo			0.1	Trc	5,480(?)	7N	2W	7.32	1941	spring	308,809	3,857,956					36,700	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 30	historic	unnamed spring	Laguna Pueblo	Valencia			Trc					4/22/1975	spring	308,774	3,857,547		13.5		36,800	29,440	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
W 184c	historic	unnamed spring	Laguna Pueblo			0.2	Trc	5,500(?)	7N	2W	18.14	1941	spring	308,800	3,856,759					30,000	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				

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reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
val 24/W 184b	historic	unnamed spring	Laguna Pueblo	Valencia		0.05	Trc		7N	2W	18.312	1941	spring	308,493	3,856,456					27,800	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 31	historic	unnamed spring	Laguna Pueblo	Valencia			Psa,Pg					4/22/1975	spring	308,240	3,856,325				45,000	36,000	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 23/W 184a	historic	unnamed spring	Laguna Pueblo	Valencia		0.02	Ps		7N	2W	18.313	1941	spring	308,296	3,856,260		27.8			33,900	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
RL-11	historic	Mammoth Mound	Laguna Pueblo			-	Psa	5,440	7N	2W	18.43	4/22/1975	spring	309,275	3,855,818				34,300		Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
val 20	historic	unnamed spring	Laguna Pueblo	Valencia			Psa	5,460				4/22/1975	spring	309,271	3,855,810		11.5		1,150	920	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
cib 7	historic	unnamed spring		Cibola		3	-		7N	5W	20.34	12/2/1941	spring	281,647	3,855,131		20.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
val 32	historic	unnamed spring	Laguna Pueblo	Valencia			Psa, Pg					5/16/1975	spring	308,838	3,854,555		21.5		37,000	29,600	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
W 189	historic	unnamed spring	Laguna Pueblo			0.35	Ps	5,645	7N	2W	30.132	1941	spring	308,448	3,853,622		23.9			20,920	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 21	historic	unnamed spring	Laguna Pueblo	Valencia		0.35	Pc	5,645				9/2/1941	spring	308,411	3,853,578		24.0				White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 25/W 188	historic	unnamed spring	Laguna Pueblo	Valencia		0.05	Py	5,600(?)	7N	2W	30.32	1941	spring	308,741	3,853,133		30.0			25,700	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 34/W 187	historic	unnamed spring	Laguna Pueblo	Valencia		0.05	Py	5,560(?)	7N	2W	31.14	1941	spring	308,660	3,851,938		26.7			17,500	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
topo 50	topo	unnamed spring		Valencia	unknown	0.1	Pm	5,630	7N	3W	36.433		spring	307,230	3,850,980						USGS topo, surveyed JSAI April 2010	South Garcia SE	northern Lucero/ Rio San Jose	Charrizo Arroyo		RP (south)	Upstream from Carrizo Arroyo Spring
Luc 15	visited					0.50	Pa	5,620	7N	3W	36.433	4/30/2010		307,300	3,850,950		7.0	7.52	7,030								
val 16/ W 173/ Luc 13	historic	unnamed spring	unnamed	Valencia		0.10	Pm		6N	2W	6.34	8/7/1941	spring	308,616	3,849,520		25.5				White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose	Charrizo Arroyo		RP (south)	Should probably be T6 R2 Sect 6.43 same as val 17
val 17	historic	unnamed spring/Lower Carrizo Spring	F.B. Lovelace	Valencia	Comanche Fault	50	Py	5400	6N	2W	6.433	8/7/1941	spring	308,907	3,849,418		25.6			13,540	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose	Charrizo Arroyo		RP (south)	STOP 4 ISC fieldtrip - currently BLM land
Luc 14	visited					14.00	Pm		6N	2W	6.433	4/21/2010		308,867	3,849,479	62,970	19.5	7.60	19,280								
field 1	field id	unnamed spring		Valencia		2.5	Pm	5,600	6N	2W	19.213		spring	309,010	3,845,685						JSAI field checked April 2010	Mesas Mojinas	Lucero Uplift	unnamed arroyo		RP (south)	visual sighting from Mesa Mojinas
Luc 18	visited						Pm	5,575	6N	2W	19.241	4/30/2010		309,010	3,845,657	33,700	12.0	7.88	46,500								
topo 51	topo	unnamed spring		Valencia		0	Pm	5,810	6N	3W	26.222		spring	306,140	3,844,405						USGS topo, surveyed JSAI April 2010	Mesas Mojinas	Lucero Uplift	Comanche Arroyo		RP (south)	Spring not found at this location (4-30-2010)
Luc 16	visited						Pm		6N	3W	26.222			306,140	3,844,405												

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reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
val 18/ Luc 7	historic	unnamed spring	D.D. Romero	Valencia		30.00	Pm	5,790	6N	3W	35.341	2/6/1957	spring	305,182	3,841,532		14.5 & 21.7		26,700	15,630 - 19,700	Titus, 1963	Mesa Gallina	Lucero Uplift	Salado Arroyo		RP (south)	2,000 ft north of topo 52, and 1,500 ft NW of Newell's Salado Arroyo Spring; closest to main spring; see Luc 8 below
New sa	Newell	Salado Arroyo Spring		Valencia		0.1	Pm	5,780	6N	3W	35.43		seep	305,562	3,841,512		19.2		16,950		Newell et al., 2005	Mesas Mojinas	Lucero Uplift	Salado Arroyo		RP (south)	may be same as val 18 and Wright, 1946 listed W 172
Luc 8	visited					36.00	Pm	5,795	6N	3W	35.43	4/21/2010		305,239	3,841,471	350,000	13.4	6.62	31,000							
cib 3	historic	Cebolla Spring		Cibola		-	-	7,415	5N	10W	12.134	8/29/1978	spring	238,879	3,841,168		14.0		588	470	White & Kues, 1992		Mt. Taylor / Acoma Sag				
topo 52	topo	unnamed spring		Valencia			Pm	5,810	5N	3W	2.114		spring	304,945	3,841,123						USGS topo, surveyed JSAI April 2010	Mesa Gallina	Lucero Uplift	Salado Arroyo		RP (south)	Spring not found at this location (4-30-2010)
Luc 17	visited					0	Pm		5N	3W	2.114			304,945	3,841,123												
cib 1	historic	Salado Spring		Cibola		2	Trc	6,065	5N	6W	5.414	5/28/1975	spring	272,018	3,841,121		24.5		3,710	2,968	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 2	historic	unnamed spring		Cibola		1	Trc	6,135	5N	6W	6.443	5/28/1975	spring	270,533	3,840,788		17.0		4,000	3,200	White & Kues, 1992		Mt. Taylor / Acoma Sag				
New cf	Newell	Comanche Fault Spring		Valencia		0.1	Psa	5,700	5N	3W	1.234		seep	307,356	3,840,630		11.6		23,300		Newell et al., 2005	Mesas Mojinas	Lucero Uplift	Salado Arroyo		RP (south)	Small travertine benches and surface water flowing
Luc 9	visited					8.00	Psa	5,725	5N	3W	1.234	5/4/2010		307,397	3,840,398	1,054,000	19.3	6.51	46,500								
topo 53	topo	Ojito Spring		Valencia		0	Pm	5,900	5N	3W	2.244		spring	305,695	3,840,603						USGS topo, surveyed JSAI April 2010	Mesas Mojinas	Lucero Uplift	Salado Arroyo		RP (south)	Location is only on 100,000 scale map; 4,900 ft west of Comanche Fault Spring of Newell et al. (2005)
Luc 10	visited					0	Pm		5N	3W	2.244			305,902	3,840,546												Spring not found at this location (5-4-2010)
val 15/ Luc 12	historic	Coyote Spring	C.E. Darnell	Valencia		3.00/ 6.00	Pm	5,810	5N	3W	29.423	1941	spring	300,867	3,833,919	780,200	17.8			29,500	Titus, 1963; Wright, 1946	Mesa Gallina	Lucero Uplift	Arroyo Monte Largo			area marked Salt Flats on topo; inaccesible, Ranch owned by Isleta Pueblo
val 14	historic	unnamed spring	unnamed	Valencia		0.3	Pm	5,810	5N	3W	29.4	8/17/1941	spring	300,830	3,833,814		1				White & Kues, 1992; Wright, 1946	Mesa Gallina	Lucero Uplift	Arroyo Monte Largo			area marked Salt Flats on topo inaccesible, Ranch owned by Isleta Pueblo
Luc 11	not visited								5N	3W	29.4			300,830	3,833,814												
val 13	historic	unnamed spring	Ward and Dysart (?)	Valencia		0.1	Pm	5,840	4N	3W	6.444	4/30/1957	spring	299,473	3,830,250		20		31,000	22,700	Titus, 1963	Mesa Sarca	Lucero Uplift	Arroyo Pato			
Luc 19	not visited						Pm		4N	3W	6.444			299,473	3,830,250												inaccesible, Ranch owned by Isleta Pueblo
soc 17	historic	Coyote Spring		Socorro		100	Qal	5,455	4N	3W	25.334	1/5/1950	spring	305,916	3,823,400		16		5,200	4,160	White & Kues, 1992	Comanche Ranch	Lucero Uplift				
Luc 20	visited					0	Pm		4N	3W	25.344			304,065	3,822,880												Spring not found at this location (5-26-2010)
soc 18	historic	unnamed spring		Socorro		12	Qal	5,510	4N	3W	35.211	1/5/1950	spring	305,375	3,823,111		6.5		5,110	4,088	White & Kues, 1992		Lucero Uplift				
Luc 21	visited					0	Pm		4N	3W	35.211			304,500	3,823,165												Spring not found at this location (5-26-2010)
topo 54	topo	Saladito Spring		Socorro		0	Pm		3N	3W	4.223		spring	302,340	3,821,657						USGS topo, surveyed JSAI April 2010	Comanche Ranch	Lucero Uplift				
Luc 22	visited					28.50	Pm	5,605	3N	3W	4.233	5/26/2010		302,420	3,821,680	59,000	19.1	6.47	11,710								
rpfz 5	visited	Alamo Spring (dry)			unknown	0	Km	5,880															Rio Puerco fault zone				Spring not found at this location (6/9/2010)

Table A2. Inventory of springs in the Rio Puerco fault zone geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
topo 49	topo	unnamed spring	Zia Pueblo	Sandoval				5,735	14N	2E	18		spring	338,655	3,923,314						USGS topo, surveyed JSAI December 2010	Sky Village NE	Rio Puerco fault zone	Arroyo Ojito		Jemez River	
rpfz 4	visited	Sandoval Spring/ S215 of Plummer et al., (2004)			probable	3.20	Km	5,862				6/9/2010	spring	323,706	3,914,720	45,200	23.8	7.84	1,141				Rio Puerco fault zone				
topo 3	topo	Sandoval Spring	state or private lands	Bernalillo	probable	-	Km	5,862	13 N	1 W	16		spring	323,800	3,914,704						USGS topo, surveyed JSAI December 2010	San Felipe Mesa	Rio Puerco fault zone	Arroyo Bernardo		E off Rio Puerco	
topo 2	topo	Tortola Spring	state or private lands	Sandoval		0	Tcc	6,020	13 N	1 W	25		spring	327,875	3,911,019						USGS topo, surveyed JSAI December 2010	San Felipe Mesa	Rio Puerco fault zone	Alamo Arroyo		E off Rio Puerco	
rpfz 6	visited	Tortola Spring			Navajo-Moquino	0	Tcc	6,020						327,988	3,911,009								Rio Puerco fault zone				Spring not found at this location (6/9/2010)
topo 1	topo	Alamo Spring (dry)	state or private lands	Sandoval	unknown	0	Km	5,880	13 N	1 W	35		spring	326,800	3,909,904						USGS topo, surveyed JSAI December 2010	San Felipe Mesa	Rio Puerco fault zone	Alamo Arroyo		E off Rio Puerco	
RL-66	historic	Ojito Spring	Laguna Pueblo			-	Qal	5,515	12N	1W	18.134	6/17/1974	spring	319,220	3,904,802				600		Risser & Lyford, 1983	San Felipe Mesa	Rio Puerco fault zone				
rpfz 1	visited	Pino Spring				0	Kg	6,210						306,526	3,904,139								Rio Puerco fault zone				Spring not found at this location - rockwall moist (6/3/2010)
topo 6	topo	Pino Spring	private (?)	Sandoval		0	Kg	6,210					spring	306,440	3,904,019						USGS topo, surveyed JSAI December 2010	La Gotera	Rio Puerco fault zone	Canada del Ojo		W off Rio	
topo 4	topo	'Herrera spring'	private (?)	Bernalillo	likely	0	Jm/Kd	5,930	11 N	3 W	11		spring	307,350	3,896,684						USGS topo, surveyed JSAI December 2010	Herrera	Rio Puerco fault zone	Canada del Ojo		W off Rio	
rpfz 2	visited	'Herrera spring'			likely	0	Jm/Kd	5,930						307,289	3,896,614								Rio Puerco fault zone				Spring not found at this location - soil muddy (6/3/2010)
rpfz 3	visited	unnamed spring			N-S fracture	0	Kd	5,770						314,093	3,896,343								Rio Puerco fault zone				Spring not found at this location - phreatophytes (6/3/2010)
topo 5	topo	unnamed spring	private (?)	Sandoval	N-S fracture	0	Kd	5,770	11 N	2 W	10		spring	314,090	3,896,339						USGS topo, surveyed JSAI December 2010	Herrera	Rio Puerco fault zone	unnamed western		W off Rio	
rpfz 5	visited	Alamo Spring (dry)			unknown	0	Km	5,880															Rio Puerco fault zone				Spring not found at this location (6/9/2010)

Table A3. Inventory of springs in the Nacimiento Uplift / Pajarito fault geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
san 133	historic	Holy Ghost Spring	Jemez Pueblo	Sandoval		9.5	Km	6,395	17N	1W	10.241	12/6/1983	spring	325,902	3,954,865		13.5		720	576	White & Kues, 1992; Trainer, 1978	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 55	topo	Soda Spring	Jemez Pueblo	Sandoval			Km	6,398						325,902	3,954,865						USGS topo, surveyed JSAI June 2010	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 56	topo	unnamed spring	Jemez Pueblo	Sandoval			Km	6,398						325,902	3,954,865						USGS topo, surveyed JSAI June 2010		Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 11	historic	"Upper Cuchana Arroyo Spring"	Zia Pueblo	Sandoval		-	Jm	6,700	17N	1W	13.322	-	spring	329,266	3,952,033						Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 12	historic	Chamisa Vega Spring	Jemez Pueblo	Sandoval		1	Km	6,100	17N	1W	28.243	8/1/1983	spring	324,341	3,949,765				2,450	1,960	USGS topo, surveyed JSAI June 2010	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 0	historic	Swimming Pool Spring	Jemez Pueblo	Sandoval		20	Pm	6,060	16N	1E	20.412	5/8/1984	spring	324,341	3,949,765		19.5		10,500		Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 10	historic	"Upper Cuchana Spring"	Zia Pueblo	Sandoval		-	PC	7,075	17N	1E	29.312	-	seep	331,225	3,949,467						Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
san 134	historic	Cachana Spring/ Trainer C5	Zia Pueblo	Sandoval		-	Qc	6,140	15N	1E		7/1/1946	spring	329,145	3,947,945		-		1,130	904	White & Kues, 1992; Trainer, 1978	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault				
san 37	historic	unnamed spring/ Trainer C1	Zia Pueblo	Sandoval		-	Trc	6,320	16N	1E	6.221	10/2/1973	spring	330,585	3,946,931		26.0		960	768	White & Kues, 1992; Trainer, 1978; Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
Kaseman 2	historic	"Warm Spring" Kaseman test well No. 2/ Trainer C3	Zia Pueblo	Sandoval			Pm	6,025	16N	1W	1.41			328,895	3,946,248						Renick, 1931	Holy Ghost Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
Kaseman 1	historic	Kaseman test well No. 1/ Trainer C2	Zia Pueblo	Sandoval			Trc	5,900	16N	1W	1.421			329,425	3,943,557						Renick, 1931	Ojito Spring	Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 1	historic	"6092 Spring"	Zia Pueblo	Sandoval		-	Qt	6,092	16N	1E	18.441	-	seep	330,543	3,942,552						Craigg, 1984		Nacimiento Uplift / Pajarito fault		Rio Salado		
topo 42	historic	Cuchillo "1"/ Craigg 8	Zia Pueblo	Sandoval	Pajarito fault	-	Trc	5,808	16N	1W	24.441		spring	329,230	3,942,154						USGS topo, surveyed JSAI Decenber 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Cuchilla Arroyo	NE off Rio Salado (N)		
topo 44	topo	Cuchillo "3"/ Craigg 2	Zia Pueblo	Sandoval	Pajarito fault			5,790	16N	1E	19.114		spring	329,590	3,941,979						USGS topo, surveyed JSAI Decenber 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Cuchilla Arroyo	NE off Rio Salado (N)		
topo 43	historic	Cuchillo "2"/ Craigg 9	Zia Pueblo	Sandoval	Pajarito fault	-	Trc	5,795	16N	1W	24.441		spring	329,225	3,941,959						USGS topo, surveyed JSAI Decenber 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Cuchilla Arroyo	NE off Rio Salado (N)		
topo 41	topo	"Upper Ojito spring"/Trainer A6	Zia Pueblo	Sandoval		-		5,780	16N	1W	20.421		spring	322,560	3,941,534						USGS topo, surveyed JSAI April 2010	Ojito Spring	Nacimiento Uplift / Pajarito fault	Arroyo Ojito	NW off Rio Salado (N)		

Table A3. Inventory of springs in the Nacimiento Uplift / Pajarito fault geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
Craigg 3	historic	Penasco "1"	Zia Pueblo	Sandoval	Pajarito fault	-	Pm	6,000	16N	1E	20.322	-		331,557	3,941,418						Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 4	historic	Penasco "2"	Zia Pueblo	Sandoval	Pajarito fault	5	Pm	5,960	16N	1E	20.322	5/8/1984	spring	331,107	3,940,890		22.5		15,000		Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 131	historic	Ojito Spring/ Trainer C4	Zia Pueblo	Sandoval		2	Km	5,770	16N	1W	29.232	6/5/1973	spring	322,377	3,940,370		21.0		10,100	8,080	White & Kues, 1992; Trainer, 1978	Ojito Spring	Nacimiento Uplift / Pajarito fault	Arroyo Ojito	NW off Rio Salado (N)		
Craigg 6	historic	Penasco "4"	Zia Pueblo	Sandoval	Pajarito fault	-	Pm	5,830	16N	1E	29.114	-	seep	331,055	3,940,337						Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
Craigg 5	historic	Penasco "3"	Zia Pueblo	Sandoval	Pajarito fault	10	Pm	5,830	16N	1E	29.113	5/8/1984	spring	331,011	3,940,306		27		12,000		Craigg, 1984	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
field 2	field id	Tierra Amarilla springs	BLM	Sandoval	Pajarito fault		Trc					6/4/2010	seep	334,461	3,935,363		23.4	6.26	9,840	7,872	JSAI field checked June 2010	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
nac 1												6/4/2010	seep	334,389	3,935,252		25.2	6.32	9,640	7,712			Nacimiento Uplift / Pajarito fault		Rio Salado		
san 28	historic	Tierra Amarilla springs	BLM	Sandoval	Pajarito fault	-	Trc	5,500	15N	1E	10.141	5/22/1975	spring	334,443	3,935,237		16.0		9,600	7,680	White & Kues, 1992	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 29	historic	Tierra Amarilla anticline spring(s)/ Trainer A2	BLM	Sandoval	Pajarito fault	<1	Trc	5,500	15N	1E	10.311	1/25/1974	spring	334,034	3,934,906		14.5		9,590	7,672	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
nac 0												6/4/2010	seep	333,764	3,934,819		20.6	6.22	11,570	9,256			Nacimiento Uplift / Pajarito fault		Rio Salado		
san 27	historic	Tierra Amarilla anticline spring/ Trainer A1	BLM	Sandoval	Pajarito fault	2	Trc	5,520	15N	1E	9.414	5/22/1975	spring	333,553	3,934,792		15.0		12,000	9,600	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
field 5	field id	Tierra Amarilla springs	BLM	Sandoval	Pajarito fault		Trc					6/4/2010	seep	333,800	3,934,750		30.4	7.25	12,330	9,864	JSAI field checked June 2010	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 30	historic	Tierra Amarilla anticline spring/ Trainer A3	BLM	Sandoval	Pajarito fault	-		5,530	15N	1E	16.111	12/20/1974	spring	332,509	3,934,164		25.0		11,200	8,960	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 31	historic	Tierra Amarilla anticline spring/ Trainer A4	BLM	Sandoval	Pajarito fault	-	Trc	5,740	15N	1E	16.233	10/18/1974	spring	332,497	3,933,517		18.0		20,000	16,000	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 32	historic	Tierra Amarilla anticline spring/ Trainer A5	BLM	Sandoval	Pajarito fault	-		5,810	15N	1E	16.313	12/20/1974	spring	332,588	3,932,991		11.0		12,900	10,320	White & Kues, 1992; Trainer, 1978	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
New gs	historic	Grassy Spring			Pajarito fault	seep	Trc - anticl.						seep	332,692	3,932,039		21.4		12,142		Newell et al., 2005	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		

Table A3. Inventory of springs in the Nacimiento Uplift / Pajarito fault geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
san 34	historic	Tierra Amarilla anticline spring	BLM	Sandoval	Pajarito fault	-	Trc	5,820	15N	1E	21.141	5/22/1975	spring	332,796	3,932,032		19.0		17,600	14,080	White & Kues, 1992	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		
san 33	historic	Tierra Amarilla anticline spring(s)	BLM	Sandoval	Pajarito fault	-	Trc	5,680	15N	1E	21.141	5/22/1975	spring	332,541	3,931,852		14.0		18,000	14,400	White & Kues, 1992	San Ysidro	Nacimiento Uplift / Pajarito fault		Rio Salado		

Table A4. Inventory of springs in the northern Lucero Uplift / Rio San Jose geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
RL-52	historic	Hanging Grape Spring	Laguna Pueblo			0.5	Kd	6,260	11N	3W	30.343	10/15/1973	spring	299,740	3,891,587				560		Risser & Lyford, 1983	Arch Mesa	northern Lucero/ Rio San Jose				
bern 40	historic	Jose Manuel Spring	Canoncito Navajo	Bernalillo		seep	Jm	-	10N	3W	3.212	1952, 1953	spring	305,139	3,889,620		-		372 - 389	311	White & Kues, 1992	Arch Mesa	northern Lucero/ Rio San Jose				
RL-41	historic	Cheromiah Spring	Joe Cheromiah			1	Jm	6,100	10N	4W	12.342	10/15/1973	spring	298,294	3,886,899				4,000		Risser & Lyford, 1983	Mesa Gigante	northern Lucero/ Rio San Jose				
topo 38	topo	Alamos Spring	Canoncito Navajo	Cibola					10 N	3 W	26		spring	305,585	3,881,779						USGS topo, surveyed JSAI December 2010	Mesa Gigante	northern Lucero/ Rio San Jose	Canada de los Alamos	Canada de las Apaches	W off Rio Puerco	
topo 37	topo	Coyote Spring	Laguna Nation	Cibola			Trc	5,600	9 N	3 W	22	4/26/1973	spring	304,775	3,873,889				4,400		USGS topo, surveyed JSAI December 2010	Correo	northern Lucero/ Rio San Jose	unnamed northern channel	Rio San Jose	W off Rio Puerco	
RL-25/ Luc 5	historic	unnamed spring	Talavera Corp.	Valencia		30.00	Qb	5,400	8N	3W	10.214	10/4/1973	spring	304,762	3,868,432				3,800		Risser & Lyford, 1983	Correo	northern Lucero/ Rio San Jose		RSJ	RP (south)	1,300 ft west of Suwanee Spring; no access
val 40/ Luc 4	historic	Suwanee Spring	Day Ranch/ Laguna Pueblo	Valencia	Suwanee	30.00/ **100.00**	Jt	5,360	8N	3W	10.224	5/16/1958/ **3/10/2000**	spring	305,145	3,868,423		16.7		3,790	3,020	Titus, 1963; **JSAI, 2000**	Correo	northern Lucero/ Rio San Jose		RSJ	RP	Major Cattle and Land Co. contact stated spring is owned by the Pueblo of Laguna
val 38	historic	Miranda Spring	Laguna Pueblo	Valencia		-	Jm	5,240	8N	2W	7.314	4/21/1975	spring	308,424	3,867,541				30,100	24,080	White & Kues, 1992; Risser & Lyford, 1983	South Garcia	northern Lucero/ Rio San Jose	Arroyo de Miranda	Rio San Jose	W off Rio Puerco	
val 41	historic	Dipping Vat Spring	Laguna Nation	Valencia	YES	400	Jm (Qal?)	5,320	8N	3W	12.342	12/7/1957	spring	307,477	3,867,370				4,030	3,224	White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose		Rio San Jose	W off Rio Puerco	
val 44	historic	unnamed spring	Laguna Pueblo	Valencia			Jm					4/21/1975	spring	307,531	3,867,344						White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose				
val 42 Luc 6	historic visited	unnamed spring		Valencia	Suwanee	25 5.00	Jw Jw	5,550 5,555	8N 8N	3W 3W	15.413 15.413	4/21/1975 5/7/2010	spring	304,508 304,416	3,866,052 3,866,084	1,080	16.5 22.4	6.55	4,030 16,660	3,224	White & Kues, 1992	Correo	northern Lucero/ Rio San Jose	unnamed arroyo	RSJ		west of Mesa Redondo
val 35	historic	El Ojo Escondido	Laguna Pueblo	Valencia		20	Jm	5,203	8N	2W	19.421	9/8/1941	spring	309,580	3,864,372		22.8			239	Titus, 1963; Wright, 1946	South Garcia	northern Lucero/ Rio San Jose				
val 37	historic	Salt Spring	Laguna Pueblo	Valencia		0.5	Jm	5,180	8N	2W	20.423	4/21/1975	spring	311,174	3,864,278		24.0		32,600	26,080	White & Kues, 1992; Risser & Lyford, 1983	South Garcia	northern Lucero/ Rio San Jose				
RL 22	historic	Ojo Escondido	Laguna Pueblo	Valencia			Jm	5,250	8N	2W	20.332		spring	310,220	3,864,058						Risser and Lyford, 1983		northern Lucero/ Rio San Jose				
val 39	historic	DB 117 of Plummer et al., (2004)	Laguna Pueblo	Valencia			Jm					4/21/1975	spring	308,927	3,862,475				41,400	33,120	White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose				
W 193	historic	unnamed spring	Laguna Pueblo			5	Jm(?), Kd(?)	5,320(?)	8N	2W	30.34	1941	spring	308,881	3,862,419		22.2			20,900	Titus, 1963	South Garcia	northern Lucero/ Rio San Jose				

Table A4. Inventory of springs in the northern Lucero Uplift / Rio San Jose geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
val 36	historic	DB 116 of Plummer et al., (2004)	Laguna Pueblo	Valencia		5	Jm					9/3/1941	spring	309,150	3,862,250		22.0				White & Kues, 1992	South Garcia	northern Lucero/ Rio San Jose				
W 194	historic	unnamed spring	Laguna Pueblo			1	Trc	5,800(?)	8N	3W	35.1	9/3/1941	spring	305,417	3,861,842		18.3			355	Titus, 1963	Correo	northern Lucero/ Rio San Jose				
W 192	historic	unnamed spring	Laguna Pueblo			0.3	Km	5480(?)	7N	2W	6.21	1941	spring	309,226	3,860,426					32,400	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
cib 4/ Luc 2	historic	Lower Water Spring	A. Harrington/ Diamond L Ranch	Cibola		0.01/ 150.00	Qal	5,720	7N	4W	2.144	9/4/1941	spring	296,104	3,860,378	19,375,000	18.5		-		White & Kues, 1992	White Ridge	northern Lucero/ Rio San Jose	Arroyo Lucero	RSJ		contact tried but not established
val 26	historic	unnamed spring	Laguna Pueblo	Valencia			Km, Kd					4/21/1975	spring	309,339	3,860,278				3,700	2,960	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 27	historic	unnamed spring	Laguna Pueblo	Valencia			Trc					4/22/1975	spring	309,630	3,859,625		13.5		36,500	29,200	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
RL-4	historic	Railroad Spring	Laguna Pueblo			-	Trc	5,300	7N	2W	6.42	4/22/1975	spring	309,630	3,859,624				36,500		Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
RL-15	historic	unnamed spring	Laguna Pueblo			1	Psa	5,580	7N	3W	1.41	2/12/1975	spring	307,721	3,859,424				10,000		Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
cib 5/ W 195/ Luc 1	historic	unnamed spring	A. Harrington/ Diamond L Ranch	Cibola		1.00	Trs	5,812	7N	4W	3.344	2/8/1957	spring	294,557	3,859,395		9.0		7,950		White & Kues, 1992; Wright, 1946	White Ridge	northern Lucero/ Rio San Jose	Arroyo Lucero	RSJ		Ranch land leased by Diamond L Cattle Co.; contact tried but not established
val 33	historic	Indian Ruins Spring	Laguna Pueblo	Valencia		5	Psa,Pg	5,580	7N	3W	1.43	4/21/1975	spring	307,616	3,859,297				8,530	6,824	White & Kues, 1992; Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
W 190	historic	unnamed spring	Laguna Pueblo			3	Kd(?)	5,350	7N	2W	6.434	1941	spring	309,304	3,859,156		14.4			27,100	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 19	historic	unnamed spring	Laguna Pueblo	Valencia					7N	2W	6.434	2/20/1956	spring	309,308	3,859,115		14.4		35,200	28,160	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 28	historic	unnamed spring	Laguna Pueblo	Valencia			Km,Kd					4/2/1975	spring	309,238	3,859,078				41,500	33,200	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 29	historic	Pipeline Spring	Laguna Pueblo	Valencia		-	Trc	5,360	7N	2W	7.21	4/22/1975	spring	309,102	3,858,649		14.0		34,100	27,280	White & Kues, 1992; Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
val 22/ W 186	historic	unnamed spring	Laguna Pueblo	Valencia		3	Trc	5,450	7N	2W	7.124	8/25/1941	spring	308,923	3,858,632		24.4		34,100	27,900	Titus, 1963; Wright, 1946	South Garcia SE	northern Lucero/ Rio San Jose				
cib 6 Luc 3	historic visited	Lucero Spring	A. Harrington Diamond L Ranch	Cibola	Alamosa	5 8.50	Trs Trs	5,825 5,815	7N 7N	4W 4W	11.431 11.431	6/4/1957 5/7/2010	spring	296,305 296,307	3,858,000 3,857,940	1,035,000	15.5 17.9	7.05	4,260 4,760	3,408	White & Kues, 1992	White Ridge	northern Lucero/ Rio San Jose	Arroyo Lucero	RSJ		Ranch land leased by Diamond L Cattle Co. Sampled on reconnaisance run

Table A4. Inventory of springs in the northern Lucero Uplift / Rio San Jose geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
W 185	historic	unnamed spring	Laguna Pueblo			0.1	Trc	5,480(?)	7N	2W	7.32	1941	spring	308,809	3,857,956					36,700	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 30	historic	unnamed spring	Laguna Pueblo	Valencia			Trc					4/22/1975	spring	308,774	3,857,547		13.5		36,800	29,440	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
W 184c	historic	unnamed spring	Laguna Pueblo			0.2	Trc	5,500(?)	7N	2W	18.14	1941	spring	308,800	3,856,759					30,000	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 24/W 184b	historic	unnamed spring	Laguna Pueblo	Valencia		0.05	Trc		7N	2W	18.312	1941	spring	308,493	3,856,456					27,800	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 31	historic	unnamed spring	Laguna Pueblo	Valencia			Psa,Pg					4/22/1975	spring	308,240	3,856,325				45,000	36,000	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 23/W 184a	historic	unnamed spring	Laguna Pueblo	Valencia		0.02	Ps		7N	2W	18.313	1941	spring	308,296	3,856,260		27.8			33,900	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
RL-11	historic	Mammoth Mound	Laguna Pueblo			-	Psa	5,440	7N	2W	18.43	4/22/1975	spring	309,275	3,855,818				34,300		Risser & Lyford, 1983	South Garcia SE	northern Lucero/ Rio San Jose				
val 20	historic	unnamed spring	Laguna Pueblo	Valencia			Psa	5,460				4/22/1975	spring	309,271	3,855,810		11.5		1,150	920	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 32	historic	unnamed spring	Laguna Pueblo	Valencia			Psa, Pg					5/16/1975	spring	308,838	3,854,555		21.5		37,000	29,600	White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
W 189	historic	unnamed spring	Laguna Pueblo			0.35	Ps	5,645	7N	2W	30.132	1941	spring	308,448	3,853,622		23.9			20,920	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 21	historic	unnamed spring	Laguna Pueblo	Valencia		0.35	Pc	5,645				9/2/1941	spring	308,411	3,853,578		24.0				White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose				
val 25/W 188	historic	unnamed spring	Laguna Pueblo	Valencia		0.05	Py	5,600(?)	7N	2W	30.32	1941	spring	308,741	3,853,133		30.0			25,700	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
val 34/W 187	historic	unnamed spring	Laguna Pueblo	Valencia		0.05	Py	5,560(?)	7N	2W	31.14	1941	spring	308,660	3,851,938		26.7			17,500	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose				
topo 50 Luc 15	topo visited	unnamed spring		Valencia	unknown	0.1 0.50	Pm Pa	5,630 5,620	7N 7N	3W 3W	36.433 36.433	4/30/2010	spring	307,230 307,300	3,850,980 3,850,950		7.0	7.52	7,030		USGS topo, surveyed JSAI April 2010	South Garcia SE	northern Lucero/ Rio San Jose	Charrizo Arroyo		RP (south)	Upstream from Carrizo Arroyo Spring
val 16/ W 173/ Luc 13	historic	unnamed spring	unnamed	Valencia		0.10	Pm		6N	2W	6.34	8/7/1941	spring	308,616	3,849,520		25.5				White & Kues, 1992	South Garcia SE	northern Lucero/ Rio San Jose	Charrizo Arroyo		RP (south)	Should probably be T6 R2 Sect 6.43 same as val 17
val 17 Luc 14	historic visited	unnamed spring/Lower Carrizo Spring	F.B. Lovelace	Valencia	Comanche Fault	50 14.00	Py Pm	5400	6N 6N	2W 2W	6.433 6.433	8/7/1941 4/21/2010	spring	308,907 308,867	3,849,418 3,849,479	 62,970	25.6 19.5	 7.60	 19,280	13,540	Titus, 1963	South Garcia SE	northern Lucero/ Rio San Jose	Charrizo Arroyo		RP (south)	STOP 4 ISC fieldtrip - currently BLM land

Table A5. Inventory of springs in the Lucero Uplift geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
field 1	field id	unnamed spring		Valencia		2.5	Pm	5,600	6N	2W	19.213		spring	309,010	3,845,685						JSAI field checked April 2010	Mesas Mojinas	Lucero Uplift	unnamed arroyo		RP (south)	visual sighting from Mesa Mojinas
Luc 18	visited						Pm	5,575	6N	2W	19.241	4/30/2010		309,010	3,845,657	33,700	12.0	7.88	46,500								
topo 51	topo	unnamed spring		Valencia		0	Pm	5,810	6N	3W	26.222		spring	306,140	3,844,405						USGS topo, surveyed JSAI April 2010	Mesas Mojinas	Lucero Uplift	Comanche Arroyo		RP (south)	Spring not found at this location (4-30-2010)
Luc 16	visited						Pm		6N	3W	26.222			306,140	3,844,405												
val 18/ Luc 7	historic	unnamed spring	D.D. Romero	Valencia		30.00	Pm	5,790	6N	3W	35.341	2/6/1957	spring	305,182	3,841,532		14.5 & 21.7		26,700	15,630 - 19,700	Titus, 1963	Mesa Gallina	Lucero Uplift	Salado Arroyo		RP (south)	2,000 ft north of topo 52, and 1,500 ft NW of Newell's Salado Arroyo Spring; closest to main spring; see Luc 8 below
New sa	Newell	Salado Arroyo Spring		Valencia		0.1	Pm	5,780	6N	3W	35.43		seep	305,562	3,841,512		19.2		16,950		Newell et al., 2005	Mesas Mojinas	Lucero Uplift	Salado Arroyo		RP (south)	may be same as val 18 and Wright, 1946 listed W 172
Luc 8	visited					36.00	Pm	5,795	6N	3W	35.43	4/21/2010		305,239	3,841,471	350,000	13.4	6.62	31,000								
topo 52	topo	unnamed spring		Valencia			Pm	5,810	5N	3W	2.114		spring	304,945	3,841,123						USGS topo, surveyed JSAI April 2010	Mesa Gallina	Lucero Uplift	Salado Arroyo		RP (south)	Spring not found at this location (4-30-2010)
Luc 17	visited					0	Pm		5N	3W	2.114			304,945	3,841,123												
New cf	Newell	Comanche Fault Spring		Valencia		0.1	Psa	5,700	5N	3W	1.234		seep	307,356	3,840,630		11.6		23,300		Newell et al., 2005	Mesas Mojinas	Lucero Uplift	Salado Arroyo		RP (south)	Small travertine benches and surface water flowing
Luc 9	visited					8.00	Psa	5,725	5N	3W	1.234	5/4/2010		307,397	3,840,398	1,054,000	19.3	6.51	46,500								
topo 53	topo	Ojito Spring		Valencia		0	Pm	5,900	5N	3W	2.244		spring	305,695	3,840,603						USGS topo, surveyed JSAI April 2010	Mesas Mojinas	Lucero Uplift	Salado Arroyo		RP (south)	Location is only on 100,000 scale map; 4,900 ft west of Comanche Fault Spring of Newell et al. (2005)
Luc 10	visited					0	Pm		5N	3W	2.244			305,902	3,840,546												Spring not found at this location (5-4-2010)
val 15/ Luc 12	historic	Coyote Spring	C.E. Darnell	Valencia		3.00/ **6.00**	Pm	5,810	5N	3W	29.423	1941	spring	300,867	3,833,919	**780,200**	17.8			29,500	Titus, 1963; Wright, 1946	Mesa Gallina	Lucero Uplift	Arroyo Monte Largo			area marked Salt Flats on topo; inaccesible, Ranch owned by Isleta Pueblo
val 14	historic	unnamed spring	unnamed	Valencia		0.3	Pm	5,810	5N	3W	29.4	8/17/1941	spring	300,830	3,833,814		1				White & Kues, 1992; Wright, 1946	Mesa Gallina	Lucero Uplift	Arroyo Monte Largo			area marked Salt Flats on topo inaccesible, Ranch owned by Isleta Pueblo
Luc 11	not visited								5N	3W	29.4			300,830	3,833,814												
val 13	historic	unnamed spring	Ward and Dysart (?)	Valencia		0.1	Pm	5,840	4N	3W	6.444	4/30/1957	spring	299,473	3,830,250		20		31,000	22,700	Titus, 1963	Mesa Sarca	Lucero Uplift	Arroyo Pato			inaccesible, Ranch owned by Isleta Pueblo
Luc 19	not visited						Pm		4N	3W	6.444			299,473	3,830,250												
soc 17	historic	Coyote Spring		Socorro		100	Qal	5,455	4N	3W	25.334	1/5/1950	spring	305,916	3,823,400		16		5,200	4,160	White & Kues, 1992	Comanche Ranch	Lucero Uplift				Spring not found at this location (5-26-2010)
Luc 20	visited					0	Pm		4N	3W	25.344			304,065	3,822,880												
soc 18	historic	unnamed spring		Socorro		12	Qal	5,510	4N	3W	35.211	1/5/1950	spring	305,375	3,823,111		6.5		5,110	4,088	White & Kues, 1992		Lucero Uplift				Spring not found at this location (5-26-2010)
Luc 21	visited					0	Pm		4N	3W	35.211			304,500	3,823,165												
topo 54	topo	Saladito Spring		Socorro		0	Pm		3N	3W	4.223		spring	302,340	3,821,657						USGS topo, surveyed JSAI April 2010	Comanche Ranch	Lucero Uplift				
Luc 22	visited					28.50	Pm	5,605	3N	3W	4.233	5/26/2010		302,420	3,821,680	59,000	19.1	6.47	11,710								

Table A6. Inventory of springs in the Puerco Necks geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
san 132	historic	unnamed spring	Aparcio Gurule	Sandoval		-	Km	6,080	16N	3W	11	5/26/1967	spring	307,457	3,945,551		-		9,940	7,952	White & Kues, 1992	Arroyo Empedrado	Puerco Necks			Rio Puerco (N bank)	
topo 33	topo	unnamed spring	Federal, state, or private lands	Sandoval					16 N	3 W	17		spring	302,150	3,943,049						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canada de la Lena		N off Rio Puerco	
topo 32	topo	unnamed spring	Federal, state, or private lands	Sandoval					16 N	4 W	23		spring	297,765	3,941,849						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canada de las Lomitas	SW off Arroyo Chico	W off Rio Puerco	
topo 31	topo	Ojo Frio	Federal, state, or private lands	Sandoval					16 N	4 W	26		spring	298,165	3,940,984						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canada de las Lomitas	SW off Arroyo Chico	W off Rio Puerco	
topo 30	topo	Ojo Atascoso	Federal, state, or private lands	Sandoval					16 N	4 W	36		spring	299,950	3,939,694						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	unnamed western channel		W off Rio Puerco	
topo 29	topo	Ojo de las Yeguas	Federal, state, or private lands	Sandoval					16 N	4 W	36		spring	299,475	3,938,544						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	unnamed western channel		W off Rio Puerco	
topo 28	topo	Ojo de los Jaramillos	Federal, state, or private lands	Sandoval					16 N	3 W	33		spring	304,575	3,938,149						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks			Rio Puerco (E bank)	
topo 26	topo	Cerro Chamisa Losa spring'	Federal, state, or private lands	Sandoval					15 N	4 W	12		spring	299,225	3,935,679						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Chamisa Losa		W off Rio Puerco	
topo 27	topo	Chamisa Losa Spring	Federal, state, or private lands	Sandoval					15 N	4 W	11		spring	298,015	3,935,224						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Chamisa Losa		W off Rio Puerco	
topo 22	topo	unnamed spring (w)	Federal, state, or private lands	Sandoval					15 N	3 W	20		spring	302,300	3,931,714						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Salado		W off Rio	
topo 23	topo	unnamed spring (e)	Federal, state, or private lands	Sandoval					15 N	3 W	20		spring	302,390	3,931,654						USGS topo, surveyed JSAI December 2010	Guadalupe	Puerco Necks	Canon Salado		W off Rio	
topo 21	topo	Cerro Tinaja spring (n)'	state or private lands	Sandoval					14 N	4 W	28		spring	304,755	3,929,519						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	unnamed western		W off Rio	
topo 20	topo	Cerro Tinaja spring (s)'	state or private lands	Sandoval					14 N	4 W	28		spring	304,720	3,929,469						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	unnamed western		W off Rio	
topo 19	topo	Gonzales Ranch spring'	state or private lands	Sandoval					14 N	4 W	34		spring	305,770	3,928,274						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canoncito		W off Rio	
topo 45	topo	Rancho Viejo Spring (east)	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					15 N	4 W	35		spring	297,160	3,928,064						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 47	topo	Rancho Viejo Spring (west)	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					15 N	4 W	35		spring	297,305	3,928,054						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 46	topo	Rancho Viejo Spring (middle)	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					15 N	4 W	35		spring	297,225	3,928,029						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 17	topo	Sanchez Ranch spring (e)'	state or private lands	Sandoval					14 N	4 W	12		spring	299,590	3,926,324						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canada Ancha		W off Rio	
topo 16	topo	'Sanchez Ranch spring (w)'	state or private lands	Sandoval					14 N	4 W	12		spring	299,465	3,926,309						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canada Ancha		W off Rio	

Table A6. Inventory of springs in the Puerco Necks geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
topo 18	topo	unnamed spring	state or private lands	Sandoval					14 N	4 W	12		spring	299,850	3,925,879						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canada Ancha		W off Rio	
topo 48	topo	Ojo Canoa	U.S. Forest Service/Cibola Nat'l Forest	Sandoval					14 N	4 W	10		spring	296,330	3,925,769						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Tapia		SW off Rio Puerco	
topo 15	topo	Jara Loso Spring	state or private lands	Sandoval					14 N	4 W	24		spring	299,650	3,923,104						USGS topo, surveyed JSAI December 2010	Cerro Tinaja	Puerco Necks	Canon Jara Loso	Canada Ancha	W off Rio	
topo 14	topo	unnamed spring (n)	private (?)	Sandoval									spring	296,875	3,913,599						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	East Canon de Santa Rosa	Salado Canon	W off Rio Puerco	
topo 13	topo	unnamed spring(s)	private (?)	Sandoval									spring	296,615	3,912,824						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	East Canon de	Salado Canon	W off Rio	
topo 12	topo	Ojo de Santa Rosa	private (?)	Sandoval									spring	296,800	3,912,684						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	East Canon de	Salado Canon	W off Rio	
topo 11	topo	'Evans Ranch spring'	private (?)	Sandoval									spring	296,000	3,910,069						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Salado Creek	Salado Canon	W off Rio	
topo 10	topo	La Gotera spring'	private (?)	Sandoval	likely	0.96	Jm	6,120					spring	300,860	3,909,679						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Salado Creek	Salado Canon	W off Rio	
topo 9	topo	unnamed spring	Laguna Pueblo	Sandoval	likely	0	Jm	6,000					spring	303,430	3,909,514						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Salado Creek	Salado Canon	W off Rio	
topo 8	topo	Dorey Mine spring'	private (?)	Sandoval		0	Jm	6,120					spring	301,670	3,907,504						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Canon del Piojo	Salado Canon	W off Rio	
topo 7	topo	unnamed spring	private (?)	Sandoval		0	Jm	6,160					spring	300,795	3,907,309						USGS topo, surveyed JSAI December 2010	La Gotera	Puerco Necks	Canon del Piojo	Salado Canon	W off Rio	

Table A7. Inventory of springs in the Mount Taylor / Acoma Sag geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
mck 61	historic	unnamed spring	J. Montoya	McKinley		2	Kmf	6,330	16N	5W	15.122	9/19/1962	spring	286,722	3,944,759		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 63	historic	unnamed spring	Sandoval	McKinley		2	Kmf	6,330	16N	5W	16.124	9/19/1962	spring	285,208	3,944,641		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 62	historic	Ojo Azabache	J. Montoya	McKinley		1	Kmf	6,330	16N	5W	15.233	9/19/1962	spring	287,033	3,944,074		20.5		1,150	920	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 59	historic	unnamed spring	E. Montoya	McKinley		0.1	Kmf	6,325	16N	5W	13.422	9/19/1962	spring	290,881	3,943,890		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 60	historic	unnamed spring	J. Montoya	McKinley		1	Kmf	6,360	16N	5W	14.442	9/19/1962	spring	289,210	3,943,529		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 64	historic	unnamed spring	Fernandez Ranch	McKinley		5	Kpl	6,370	16N	5W	21.432	10/3/1962	spring	275,736	3,942,408		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 41	historic	Pena Spring	F. Lee (?)	McKinley		1	Kmf	6,535	15N	7W	10.411	10/16/1962	spring	266,961	3,936,250		12.0		780	624	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 65	historic	unnamed spring	Fernandez Ranch	McKinley		17	Kplh	6,410	16N	5W	29.231	10/3/1962	spring	273,907	3,935,825		13.0		1,350	1,080	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 42	historic	Coal Mine Spring	Fernandez Ranch	McKinley		-	Kmf	6,550	15N	7W	14.131	10/15/1962	spring	268,995	3,934,964		13.5		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 43	historic	Burro Springs	Fernandez Ranch	McKinley		2	Kmf	6,555	15N	7W	15.243	10/115/1962	spring	267,886	3,934,962		13.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 39	historic	unnamed spring	A. Michael	McKinley		0.25	-	6,600	15N	6W	20.121	10/3/1962	spring	273,425	3,933,740		16.5		451	361	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 44	historic	unnamed spring "600"		McKinley		-	Kmf	6,569	15N	7W	22.114	10/11/1956	spring	266,819	3,933,694		13.5		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 45	historic	Ojo Redondo	Fernandez Ranch	McKinley		2	Kmf	6,569	15N	7W	22.131	3/31/1961	spring	266,662	3,933,483		14.8		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 47	historic	Doctor Spring	Fernandez Ranch	McKinley		15	Kmf	6,588	15N	7W	23.132	10/3/1962	spring	268,376	3,933,469		14.0		350	280	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 46	historic	Montano Spring	Fernandez Ranch	McKinley		-	Kmf	6,586	15N	7W	22.141	10/31/1961	spring	267,114	3,933,440		20.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 38	historic	El Dado Springs	Fernandez Ranch	McKinley		5	Kmf	6,595	15N	6W	19.321	7/21/1962	spring	271,770	3,933,073		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 48	historic	San Ysidro Spring	Fernandez Ranch	McKinley		1	Kmf	6,655	15N	7W	29.431	3/31/1961	spring	263,253	3,932,339		14.0				White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 40	historic	Ojo de las Yuges	A. Michael	McKinley		2	Kmf	6,725	15N	6W	32.231	10/22/1962	spring	273,863	3,930,121		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 25	historic	Cerro Spring	Fernandez Ranch	McKinley		10	Kmf	6,822	14N	7W	10.333	10/23/1962	spring	266,515	3,925,901		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 26	historic	Sap Hole Spring	Fernandez Ranch	McKinley		0.25	Kmf	6,908	14N	7W	28.134	10/23/1962	spring	264,802	3,922,183		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 27	historic	Ft Miguel Ruins Spring	Fernandez Ranch	McKinley		2	Kmf	6,950	14N	7W	28.424	3/31/1961	spring	266,025	3,921,657		14.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 9	historic	C.C.C. Spring	Fernadez Ranch	McKinley		75	Tb	7,950	13N	7W	11.131	12/12/1956	spring	267,656	3,917,329		11.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 7	historic	unnamed spring	U.S. Forest Service	McKinley		50	Te, Kmv	7,840	13N	7W	9.423	10/23/1962	spring	265,623	3,916,889		-		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 8	historic	unnamed spring		McKinley		50	Tb	8,130	13N	7W	10.423	10/23/1962	spring	267,313	3,916,814		11.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 6	historic	unnamed spring	U.S. Forest Service	McKinley		50	Te, Kmv	7,810	13N	7W	9.323	10/23/1962	spring	264,911	3,916,691		11.0		203	162	White & Kues, 1992		Mt. Taylor / Acoma Sag				

Table A7. Inventory of springs in the Mount Taylor / Acoma Sag geographic area

gpm=gallons per minute; geological source Qal=Quaternary alluvium, Qb=Quaternary basalt, Qc=Quaternary colluvium, Qt=Quaternary travertine, Te=Tertiary extrusives, Tb=Tertiary basalt, Tcc=Tertiary Cerro Conejo, Kd=Cretaceous Dakota Sandstone, Kg=Cretaceous Gallup Sandstone, Km=Cretaceous Mancos Shale, Kmf=Cretaceous Menefee Formation, Kmv=Cretaceous Mesaverde Group, Kpl=Cretaceous Point Lookout Sandstone, Kplh=Cretaceous Hosta Tongue of Point Lookout, Jm=Jurassic Morrison Formation, Jw=Jurassic Westwater Canyon Member of Morrison, Js=Jurassic Summerville Formation, Jt=Jurassic Todilto Limestone, Trc=Triassic Chinle Formation, Trs=Triassic Santa Rosa Sandstone, Pc=Permian Cutler Formation, Pg=Permian Glorieta Sandstone, Psa=Permian San Andres Limestone, Py=Permian Yeso Formation, Pm=Pennsylvanian Madera Formation, Ps=Pennsylvanian Sandia Formation, PC=Precambrian rocks; ft amsl=feet above mean sea level; spec. cond=specific conductance; µS/cm=microSiemens per centimeter; TDS=total dissolved solids; mg/L=milligrams per liter; 3rd/2nd/1st drain= minor to major drainages; BLM=Bureau of Land Management; RPfz=Rio Puerco fault zone; RP=Rio Puerco; RSJ=Rio San Jose

reference no.	category	spring name/ informal name	owner	county	fault zone	esti-mated yield (gpm)	geo-logical source	altitiude (ft amsl)	Township	Range	Section.4q.16q.64q	date	sample type	easting, X (UTM NAD83, m)	northing, Y (UTM NAD83, m)	approx. area (sq ft)	temp (°C)	pH	spec cond (µS/cm)	TDS (mg/L)	data source	USGS topo-graphic quad. map	geographic area	3rd drain	2nd	1st	notes
mck 10	historic	San Lucas Spring	U.S. Forest Service	McKinley		20	Tb	7,850	13N	7W	20.123	8/29/1962	spring	263,262	3,914,484		12.0		255	204	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 11	historic	San Mateo Springs	Fernandez Ranch	McKinley		-	Tb	7,700	13N	7W	20.334	9/13/1956	spring	261,391	3,911,634		6.8		194	155	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 5	historic	Ojo Marquez	Village of Marquez	McKinley		25	Kmv	7,380	13N	5W	26.134	8/27/1962	spring	287,419	3,911,536		17.0		329	263	White & Kues, 1992		Mt. Taylor / Acoma Sag				
mck 12	historic	San Mateo Springs	Fernandez Ranch & San Mateo Village	McKinley		275	Tb	8,120	13N	7W	31.414	10/24/1962	spring	262,041	3,910,414		13.5		117	94	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 23	historic	Elkin's Spring	Summer Camp	Cibola		5	-	9,250	12N	7W	11.3	8/29/1962	spring	268,369	3,906,765		7.0		257	206	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 22	historic	unnamed spring	MDWSWA of Seboyeta	Cibola		10	Kmv	6,535	12N	5W	32.331	3/9/1965	spring	281,763	3,900,172		-		429	343	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 20	historic	Ojo de Gallo		Cibola		3,000	Psa	6,449	10N	10W	3.423	7/12/1946	spring	237,898	3,890,388		16.0		1,070	856	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 18	historic	unnamed spring	S. Gottlieb	Cibola		0.5	Qb	6,401	10N	9W	6.442	5/13/1958	spring	242,930	3,889,997		10.5		3,110	2,488	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 17	historic	unnamed spring		Cibola		100	-		10N	7W	20.411	2/20/1951	spring	263,305	3,886,205		8.5		571	457	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 19	historic	Horace Springs		Cibola		2,000	Qb	6,276	10N	9W	23.423	5/13/1957	spring	249,005	3,885,140		16.0		1,170	936	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 16	historic	unnamed spring	Laguna Indian Reservation	Cibola		50	-		10N	6W	21.4	5/12/1957	spring	274,344	3,884,691		11.0		204	163	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 13	historic	AT & SF RR	AT &SF RR	Cibola			Qb	5,760	9N	5W	4.133	3/19/1965	spring	282,999	3,879,917		-		2,280	1,824	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 14	historic	Canipa Spring	Acoma Indian Reservation	Cibola		-	-	6,197	9N	8W	12.123	9/16/1952	spring	259,446	3,879,245		-		1,490	1,192	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 9	historic	Acoma Springs		Cibola		10	Jm	6,275	8N	7W	8.331	1/28/1966	spring	262,037	3,868,693		-		1,050	840	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 10	historic	unnamed spring		Cibola		-	Jz	-	8N	7W	28.124	1/28/1966	spring	264,096	3,864,847		-		474	379	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 8	historic	Cebollita Spring		Cibola				7,520	7N	9W	9.332	8/9/1978	spring	244,325	3,859,272		12.0		608	486	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 7	historic	unnamed spring		Cibola		3	-		7N	5W	20.34	12/2/1941	spring	281,647	3,855,131		20.0		-		White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 3	historic	Cebolla Spring		Cibola		-	-	7,415	5N	10W	12.134	8/29/1978	spring	238,879	3,841,168		14.0		588	470	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 1	historic	Salado Spring		Cibola		2	Trc	6,065	5N	6W	5.414	5/28/1975	spring	272,018	3,841,121		24.5		3,710	2,968	White & Kues, 1992		Mt. Taylor / Acoma Sag				
cib 2	historic	unnamed spring		Cibola		1	Trc	6,135	5N	6W	6.443	5/28/1975	spring	270,533	3,840,788		17.0		4,000	3,200	White & Kues, 1992		Mt. Taylor / Acoma Sag				

Appendix B.

Geochemistry of selected wells and springs along the Western Boundary of the Middle Rio Grande Basin (MRGB)

Table B1. Location and well-construction information for sites with groundwater-quality data (this study and other studies)

[Monitoring Well ID, See figs. 58 and 69 from Plummer et al., 2004; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; dms=degrees/minutes/seconds; bls=below land surface; na=not applicable; nd=not determined; PVC=polyvinylchloride; PW=production well; WW=windmill; DW=domestic well; MW=monitoring well; SW=stock well; SP=spring; SXXX=No site number assigned; A sampling pump was used when a fixed pump was not available.]

site No.	monitoring well ID	site name	primary hydrochemical zone	secondary hydrochemical zone	source formation	northing, Y[1] (UTM NAD83, m)	easting, X[1] (UTM NAD83, m)	land surface altitude (ft)	local well No.	USGS site ID	septh (ft bls)	water level (ft bls)	water level date	depth to top of screen (ft bls)	depth to bottom of screen (ft bls)	screen length (ft)	well type	fixed pump type	sample pump type	casing material	casing diameter (inches)	date constructed
		Zone 3: West Central (after Plummer et al., 2004)																				
S188		Rio Rancho 13	3	na	LSF	3,905,031	335,986	6,055	12N.01E.14.212	351630106481201	1,920	1,101.15	12/20/1989	1,343	1,721	378	PW	turbine	na	steel	nd	12/20/1989
S193		Rio Rancho 9 (RG 26259 POD2)	3	na	Tao	3,910,332	337,725	6,054	13N.01E.25.432	351922106470601	1,540	1,082	10/31/1984	1,120	1,520	400	PW	turbine	na	steel	18	7/10/1984
		Zone 4: Western Boundary (after Plummer et al., 2004)																				
S031		Windmill No. 18	4	na	Qal	3,818,158	323,883	4,850	03N.01W.14.114	342922106550301	143	112.47	2/9/1995	nd	nd	nd	WW	windmill	na	steel	6	nd
S039		Windmill No. 20	4	na		3,829,885	315,186	5,249	04N.02W.02.433	343539107005501	439	nd	nd	nd	nd	nd	WW	pump jack	na	steel	nd	1947
S059		Windmill No. 21	4	na		3,836,190	320,558	5,190	05N.01W.20.222	343907106572901	395	349	3/24/1963	390	395	5	WW	pump jack	na	steel	5	nd
S074		Windmill No. 23	4	na		3,835,548	312,522	5,434	05N.02W.21.422	343839107024401	620	545.49	5/24/1956	nd	nd	nd	WW	pump jack	na	steel	8	1953
S201		Windmill No. 26	4	na		3,818,801	307,079	5,654	03N.03W.12.443	342934107060401	630	nd	nd	nd	nd	nd	WW	windmill	na	steel	nd	nd
S252		Windmill No. 10	4	na		3,831,943	320,247	5,188	05N.01W.32.423	343650106573501	428	370.5	10/18/1993	388	428	40	WW	pump jack	na	PVC	6	10/18/1993
S260		Windmill No. 33	4	na		3,823,948	320,882	5,004	04N.01W.28.323	343230106570301	281	207.33	5/8/1956	269	279	10	WW	windmill	na	steel	6	1956
DB026		342707106532201	4		Qal	3,813,888	326,432	nd	03N.01W.25.444	342707106532201	70	34.97	11/21/1949	nd	nd		well					
DB032		342802106572401	4			3,815,699	320,289	5,125	03N.01W.21.332	342802106572401	405	352	5/28/1980	nd	nd		well					
DB036		342947107064901	4			3,819,225	305,939	nd	03N.03W.12.313	342947107064901	nd	nd	nd	nd	nd		well					
DB038		soc 18 of W & K, 1992	4		Pm	3,823,098	304,975	nd	04N.03W.35.211	343152107073001	na	na	na	na	na		spring					
DB041		Coyote Sprg (soc 17,W & K, 1992)	4		Pm	3,823,602	305,903	nd	04N.03W.25.334	343209107065401	na	na	na	na	na		spring					
DB068		344201107050801	4			3,841,786	308,983	nd	06N.02W.31.400	344201107050801	nd	nd	nd	nd	nd		well					
DB069		344310106581801	4			3,821,518	319,024	nd	06N.01W.29.130	344310106581801	567	380	6/6/1980	434	564		well					
DB071		344449106594901	4			3,846,797	317,203	nd	06N.02W.13.234	344449106594901	133	74.49	4/26/1956	nd	nd		well					
DB116		val 36 spring of W & K, 1992	4		Jm	3,862,465	309,159	nd	LAND GRANT	345312107051801	na	na	na	na	na		spring					
DB117		val 39 spring of W & K, 1992	4		Jm	3,862,468	308,981	nd	LAND GRANT	345312107052501	na	na	na	na	na		spring					
DB433		353146106464401	4		Qal (?)	3,933,215	338,667	nd	15N.01E.13.422	353146106464401	12	4	6/3/1959	nd	nd		well					
JSAI 2		"Two Trailers" well			Qal	3,935,816	335,796	5,486			na	11.55	5/14/2010	nd	nd		well					
New cf		Comanche fault spring of Newell et al. (2005)			Psa	3,840,630	307,356	5,705			na	na	na	na	na		spring					
		Zone 5: Rio Puerco (after Plummer et al., 2004)																				
S032		Windmill No. 17	5	na	Qal	3,813,890	326,356	4,771	03N.01W.25.441	342707106532202	61	34.44	2/2/1993	nd	nd	nd	WW	windmill	na	steel	6	nd
S069		Domestic Well No. 06	5	na		3,833,551	331,411	5,191	05N.01E.28.41	343748106502101	590	385	10/31/1995	590	590	nd	DW	submersible	na	steel	5	10/31/1995
S073		Windmill No. 03	5	na	Qal	3,828,129	323,053	5,035	04N.01W.15.211	343447106554201	268	224.79	5/9/1956	nd	nd	nd	WW	windmill	na	steel	nd	1933
S082		Windmill No. 36	5	na		3,860,925	322,870	5,570	08N.01W.34.311	345231106561701	720	599.2	5/11/1993	nd	nd	nd	WW	windmill	na	steel	8	10/1/1960
S085		Windmill No. 35	5	na		3,859,066	324,993	5,423	07N.01W.02.342	345132106545201	700	580.2	1/25/1993	nd	nd	nd	WW	windmill	na	steel	8	11/1/1934
S111		Domestic Well No. 10	5	na		3,831,257	332,133	5,169	05N.01E.34.33	343634106495101	657	400	7/27/1994	637	657	20	DW	submersible	na	PVC	4	7/27/1994
S185		Domestic Well No. 31	5	na	Qal	3,878,583	323,060	5,280	09N.01W.04.424	350204106562301	150	75.25	10/30/1995	nd	nd	nd	DW	submersible	na	PVC	5	1957
S198		Windmill No. 07	5	na	Qal	3,860,645	316,742	5,125	08N.02W.36.341	345218107001801	212	133.6	5/7/1993	nd	nd	nd	WW	windmill	na	steel	6	5/1/1968
S215		Sandoval Spring	5	4		3,914,693	323,790	5,860	13N.01W.16.224	352136106562201	na	na	na	na	na	na	SP	na	peristaltic	na	na	nd
S237		Windmill No. 30	5	4	Qal	3,820,906	323,604	5,010	03N.01W.02.311	343053106551801	440	nd	nd	nd	nd	nd	WW	windmill	na	steel	nd	nd
S238		Windmill No. 31	5	na	Qal	3,822,492	326,134	4,849	04N.01W.36.233	343145106533601	90	52.1	11/21/1949	nd	nd	nd	WW	windmill	na	steel	6	1949
DB051		343459106535401	5		Qal	3,828,445	325,889	nd	04N.01W.12.341	343459106535401	77	58.43	1/23/1985	nd	nd		well					
DB055		343606106534201	5		Qal	3,830,503	326,233	nd	04N.01W.01.4111	343606106534201	nd	nd	nd	nd	nd		well					
DB063		343955106545001	5		Qal	3,837,591	324,635	nd	05N.01W.14.231	343955106545001	100	90.73	4/30/1956	nd	nd		well					

Table B1. Location and well-construction information for sites with groundwater-quality data (this study and other studies)

[Monitoring Well ID, See figs. 58 and 69 from Plummer et al., 2004; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; dms=degrees/minutes/seconds; bls=below land surface; na=not applicable; nd=not determined; PVC=polyvinylchloride; PW=production well; WW=windmill; DW=domestic well; MW=monitoring well; SW=stock well; SP=spring; SXXX=No site number assigned; A sampling pump was used when a fixed pump was not available.]

site No.	monitoring well ID	site name	primary hydrochemical zone	secondary hydrochemical zone	source formation	northing, Y[1] (UTM NAD83, m)	easting, X[1] (UTM NAD83, m)	land surface altitude (ft)	local well No.	USGS site ID	septh (ft bls)	water level (ft bls)	water level date	depth to top of screen (ft bls)	depth to bottom of screen (ft bls)	screen length (ft)	well type	fixed pump type	sample pump type	casing material	casing diameter (inches)	date constructed
DB086		344830107040401	5			3,853,737	310,859	nd	LAND GRANT	344830107040401	nd	nd	nd	nd	nd		well					
DB103		345028107014301	5		Qal	3,857,300	314,515	nd	LAND GRANT	345028107014301	nd	nd	nd	nd	nd		well					
DB114		345230106591501	5		Qal	3,852,290	318,431	nd	07N.01W.31.124	345230106591501	97	74.11	2/10/1956	nd	nd		well					
DB122		345420107003801	5		Qal	3,864,414	316,310	nd	08N.02W.24.131	345420107003801	nd	nd	nd	nd	nd		well					
DB124		345440107004001	5		Qal	3,865,032	316,271	nd	08N.02W.24.111	345440107004001	nd	nd	nd	nd	nd		well					
DB132		345632107003701	5		Qal	3,868,481	316,417	nd	08N.02W.12.111	345632107003701	nd	138.05	4/29/1957	nd	nd		well					
DB157		350109107022501	5		Qal	3,877,071	313,851	nd	09N.02W.10.300	350109107022501	nd	nd	nd	nd	nd		well					
DB175		350158106563801	5		Qal	3,878,405	322,676	nd	09N.01W.04.432	350158106563801	nd	81.21	1956	nd	nd		well					
DB201		350336106593401	5		Qal	3,881,513	318,276	nd	10N.02W.25.444	350336106593401	nd	nd	nd	nd	nd		well					
DB206		350343106594801	5		Qal	3,881,735	317,926	nd	10N.02W.25.432	350343106594801	193	nd	nd	nd	nd		well					
DB209		350346106594601	5		Qal	3,881,827	317,978	nd	10N.02W.24.4	350346106594601	nd	nd	nd	nd	nd		well					
DB235		350501106571201	5		Qal	3,884,060	321,925	nd	10N.01W.21.132	350501106571201	205	nd	nd	nd	nd		well					
DB387-S094		Stock Well No. 02 (same as S094)	5	E	Qal	3,905,134	325,574	5,700	12N.01W.14.111	351627106550401	120	107.17	6/20/1980	nd	nd	nd	SW	submersible	na	steel	nd	nd
JSAI 0		Laguna Windmill Well	5		Qal	3,897,330	322,610	nd			nd	105.95	6/2/2010	nd	nd		well					
DB407		352127106564201	5			3,914,426	323,280	nd	13N.01W.16.230	352127106564201	50	15.2	6/19/1980	nd	nd		well					
JSAI 1		Benavidez Well (RG 24176)			Qal	3,905,134	325,499	5,718	12N.01W.14.114		90	77.5	6/9/2010	nd	nd		well					
JSAI 3		"Windmill No. 1" Well			Qal	3,813,885	326,365	4,795			-	44.7	5/26/2010	nd	nd		well					
JSAI 4		"Windmill No. 2" Well			Qal	3,822,467	326,155	4,860			-	14.0	5/26/2010	nd	nd		well					
		No Zone: Exotic Water (after Plummer et al., 2004)																				
S009a		Arroyo Salado Spring	E	E	Pm	3,841,447	306,023	5,744	06N.03W.35.443	344148107070401	na	na	na	na	na	na	SP	na	peristaltic	na	na	nd
S009b		Arroyo Salado Spring	E	E	Pm	3,841,512	305,562	5,744	06N.03W.35.443	344148107070401	na	na	na	na	na	na	SP	na	peristaltic	na	na	nd
S028		Cerro Colorado Landfill MW	E	E		3,875,284	327,941	5,488	09N.01E.18.333	350021106531101	746	570	11/10/1988	555	616	61	MW	submersible	na	steel	4	1981
S038		Windmill No. 19	E	E		3,915,117	319,531	5,720	13N.01W.18.121	352147106591101	100	nd	nd	nd	nd	nd	WW	windmill	na	steel	nd	nd
S202		Windmill No. 27	E	E		3,816,091	299,619	5,911	03N.03W.20.314	342801107105401	nd	nd	nd	nd	nd	nd	WW	windmill	na	steel	nd	nd
San deep 5		RG-88934POD1 (Sandoval Cnty well)	E	E	Psa	3,905,554	335,500	5,720	12N.01W.10.24		6,450	flows		3,360	4,820	717	WW			steel	6	
San deep 6		RG-88934POD2 (Sandoval Cnty well)	E	E	Psa	3,906,414	335,080	5,850	12N.01W.11.33		3,850	-360		3,598	3,809	211	WW			steel	6	
		Zone Nac: Rio Salado (North) - (Trainer, 1978)																				
san 29	A2	Tierra Amarilla Spring A2			Trc	3,934,906	334,034	5,500	15N.01E.10.311		na	na	na	na	na	na	SP	na	na	na	na	nd
Kaseman 2	C3	"Warm Spring" Kaseman test well No. 2			Trc	3,946,248	328,895	6,025			94	.	3/14/1964	na	na	na	AS	na	na	steel	8.25	1927
Kaseman 1	C2	Kaseman test well No. 1			Trc	3,943,557	329,425	5,900			550		9/29/1926	na	na	na	AS	na	na	steel	nd	1927
san 131	C4	Ojito Spring				3,940,370	322,377	5,785	16N.01W.29.232	3535281065736	na	na	na	na	na	na	SP	na	na	na	na	nd
san 134	C5	Cachana Spring			Jm	3,947,945	329,145	6,140	17N.01W.36.243	3539381065313	na	na	na	na	na	na	SP	na	na	na	na	nd
san 37	C1	unnamed spring			Trc	3,946,907	330,588	6,320	16N.01W.6.221	3539061065215	na	na	na	na	na	na	SP	na	na	na	na	nd
san 27	A1	Tierra Amarilla Spring A1			Trc	3,934,792	333,553	5,520	15N.01E.9.414		na	na	na	na	na	na	SP	na	na	na	na	nd
san 30	A3	Tierra Amarilla Spring A3			Trc	3,934,164	332,509	5,530	15N.01E.16.111		na	na	na	na	na	na	SP	na	na	na	na	nd
san 31	A4	Tierra Amarilla Spring A4			Trc	3,933,517	332,497	5,740	15N.01E.16.223		na	na	na	na	na	na	SP	na	na	na	na	nd
san 32	A5	Tierra Amarilla Spring A5			Trc	3,932,992	332,588	5,810	15N.01E.16.313		na	na	na	na	na	na	SP	na	na	na	na	nd
topo 41	A6	Tierra Amarilla Spring A6			Trc	3,941,534	332,560	6,060	15N.01E.20.411		na	na	na	na	na	na	SP	na	na	na	na	nd
New gs	GS	Grassy Spring of Newell et al. (2005)			Trc	3,932,039	332,692	5,808			na	na	na	na	na	na	SP	na	na	na	na	nd

Table B1. Location and well-construction information for sites with groundwater-quality data (this study and other studies)

[Monitoring Well ID, See figs. 58 and 69 from Plummer et al., 2004; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; dms=degrees/minutes/seconds; bls=below land surface; na=not applicable; nd=not determined; PVC=polyvinylchloride; PW=production well; WW=windmill; DW=domestic well; MW=monitoring well; SW=stock well; SP=spring; SXXX=No site number assigned; A sampling pump was used when a fixed pump was not available.]

site No.	monitoring well ID	site name	primary hydrochemical zone	secondary hydrochemical zone	source formation	northing, Y[1] (UTM NAD83, m)	easting, X[1] (UTM NAD83, m)	land surface altitude (ft)	local well No.	USGS site ID	septh (ft bls)	water level (ft bls)	water level date	depth to top of screen (ft bls)	depth to bottom of screen (ft bls)	screen length (ft)	well type	fixed pump type	sample pump type	casing material	casing diameter (inches)	date constructed
Zone Nac: Rio Salado (North) - (Craigg, 1984)																						
Craigg 1		Swimming Pool Spring				3,941,360	331,859	6,060	16N.01E.20.412	3536061065120	na	na	na	na	na	na	SP	na	na	na	na	nd
san 133		Holy Ghost Spring			Km	3,954,865	325,902	6,395	17N.01W.10.241	3543211065528	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 1		"6092 Spring"				3,942,552	330,543	6,092	16N.01E.18.441	3536441065214	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 2		Cuchillo "3"				3,941,975	329,593	5,790	16N.01E.19.114	3536251065252	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 3		Penasco "1"			Trc	3,941,418	331,557	6,000	16N.01E.20.322	3536071065132	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 4		Penasco "2"			Trc	3,940,890	331,107	5,960	16N.01E.20.332	3535511065150	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 5		Penasco "3"			Trc	3,940,306	331,011	5,830	16N.01E.29.113	3535321065153	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 6		Penasco "4"			Trc	3,940,337	331,055	5,830	16N.01E.29.114	3535331065152	na	na	na	na	na	na	SP	na	na	na	na	nd
topo 41		"Upper Ojito Spring"				3,941,539	322,555	5,780	16N.01W.20.421	3536071065730	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 8		Cuchillo "1"				3,942,155	329,236	5,808	16N.01W.24.224a	3536301065305	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 9		Cuchillo "2"				3,941,957	329,277	5,795	16N.01W.24.224b	3536231065305	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 10		"Upper Cuchana Spring"				3,949,467	331,225	7,075	17N.01E.29.312	3540291065151	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 11		"Upper Cuchana Arroyo Spring"				3,952,033	329,266	6,700	17N.01W.13.322	3541511065311	na	na	na	na	na	na	SP	na	na	na	na	nd
Craigg 12		Chamisa Vega Spring			Km	3,949,765	324,341	6,100	17N.01W.28.243	3540341065625	na	na	na	na	na	na	SP	na	na	na	na	nd
Zone: Rio San Jose Entrant - (Risser and Lyford, 1983)																						
val 16		Salt Spring 173			Pm	3,849,520	308,616	5,465	06N.02W.06.431													
RL well 4		07N.01W.31.124			QTs	3,852,166	318,350	5,050	07N.01W.31.124		97	74	2/10/1956									
W 192		Salt Spring 192			Km	3,860,426	309,226	5,480	07N.02W.06.214													
W 190		Salt Spring 190			Kd	3,859,156	309,304	5,350	07N.02W.06.434													
RL 4		Railroad Spring (RL 4)			Trc	3,859,624	309,630	5,300	07N.02W.06.442													
val 22		Salt Spring 186 (W 186)			Trc	3,858,632	308,923	5,450	07N.02W.07.123													
val 29		Pipeline Spring (RL 6)			Trc	3,858,649	309,102	5,360	07N.02W.07.241													
W 185		Salt Spring 185			Trc	3,857,956	308,809	5,480	07N.02W.07.343													
RWP 5		07N.02W.10.444 (RWP 5)			Kmv	3,857,304	314,466	5,211	07N.02W.10.444		272	212.4	1/17/1957									1944
val 24		Salt Spring 184b (W184b)			Trc	3,856,456	308,493	5,600	07N.02W.18.134													
W 184c		Salt Spring 184c (W184c)			Trc	3,856,759	308,800	5,500	07N.02W.18.144													
val 23		Salt Spring 184a (W184a)			Psa	3,856,260	308,297	5,600	07N.02W.18.313													
RL 11		Mammouth Mound			Psa	3,855,818	309,275	5,440	07N.02W.18.431													
RWP 6		07N.02W.29.214 (RWP 6)			QTs	3,853,760	310,823	5,048	07N.02W.29.214		215	150	8/16/1973									1956
W 189		Salt Spring 189			Psa	3,853,622	308,448	5,645	07N.02W.30.124													
val 25		Salt Spring 188			Py	3,853,133	308,741	5,600	07N.02W.30.411													
val 34		Salt Spring 187			Py	3,851,938	308,660	5,560	07N.02W.31.144													
val 33		Indian Ruins Spring			Psa	3,859,297	307,616	5,580	07N.03W.01.432a													
cib 5		Salt Spring 195			Trc	3,859,395	294,557	5,820	07N.04W.03.344													
cib 6		Lucero Spring			Trc	3,857,940	296,307	5,825	07N.04W.11.431													
RWP 3		08N.02W.01.333 (RWP 3)			Kmv	3,868,502	316,475	5,184	08N.02W.01.333		170	135	6/29/1973									1967
val 38		Miranda Spring			Jm	3,867,541	308,424	5,240	08N.02W.07.314													
val 35		El Ojo Escondido			Kd	3,864,372	309,580	5,203	08N.02W.19.421													

Table B1. Location and well-construction information for sites with groundwater-quality data (this study and other studies)

[Monitoring Well ID, See figs. 58 and 69 from Plummer et al., 2004; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; dms=degrees/minutes/seconds; bls=below land surface; na=not applicable; nd=not determined; PVC=polyvinylchloride; PW=production well; WW=windmill; DW=domestic well; MW=monitoring well; SW=stock well; SP=spring; SXXX=No site number assigned; A sampling pump was used when a fixed pump was not available.]

site No.	monitoring well ID	site name	primary hydrochemical zone	secondary hydrochemical zone	source formation	northing, Y[1] (UTM NAD83, m)	easting, X[1] (UTM NAD83, m)	land surface altitude (ft)	local well No.	USGS site ID	septh (ft bls)	water level (ft bls)	water level date	depth to top of screen (ft bls)	depth to bottom of screen (ft bls)	screen length (ft)	well type	fixed pump type	sample pump type	casing material	casing diameter (inches)	date constructed
RL 22		Ojo Escondido			Jm	3,864,058	310,220	5,250	08N.02W.20.332													
val 37		Salt Spring			Jm	3,864,278	311,174	5,180	08N.02W.20.423													
W 193		Salt Spring 193			Jm	3,862,419	308,881	5,320	08N.02W.30.342													
val 40		Suwanee Spring			Qb	3,868,423	305,145	5,360	08N.03W.10.222													
CCC 1		08N.03W.11.232 (CCC 1)			Qal/Qb	3,868,136	306,327	5,418	08N.03W.11.232		79	64	8/16/1973									
val 41		Dipping Vat Spring			Jm	3,867,370	307,477	5,320	08N.03W.12.413													
RL well 23		08N.03W.15.413 (United Brokers)			Psa	3,866,000	304,390	5,550	08N.03W.15.413		1,250	0	4/3/1974									
W 194		Spring 194			Trc	3,861,842	305,417	5,800	08N.03W.35.114													
Stuckys		09N.01W.04.432 (Stuckys)			Qal/QTs	3,878,309	322,627	5,278	09N.01W.04.432		450	90.0	1/16/1975									
ECW 8		09N.02W.09.433 (ECW 8)			Kmv	3,876,679	312,757	5,585	09N.02W.09.433		445	98.6	6/29/1973									1940
BIA Sedillo		09N.02W.24.230 (BIA Sedillo)			QTs	3,874,168	316,761	5,560	09N.02W.24.230		443	288.0										1980
RWP 9		09N.02W.27.422 (RWP 9)			Kmv	3,872,473	314,780	5,360	09N.02W.27.422		131	69.5	8/17/1973									1958
topo 37		Coyote Spring			Trc	3,873,889	304,775	5,600	09N.03W.22.443													
P.S. 2		10N.02W.25.444 (Canoncito P.S. 2)			QTs	3,881,537	318,269	5,380	10N.02W.25.444		1,000	136	9/25/1974									1974
Con 17-10		Conoco 17-10			Jm	3,901,922	320,465	5,475	12N.01W.29.113		1,080											1971
Con 65A		Conoco 65A			Jm	3,901,164	319,511	5,490	12N.01W.30.324		1,100	0.0										1971
Con 22-10		Conoco 22-10			Jm	3,900,058	322,263	5,490	12N.01W.33.132		-											
Con 15-9		Conoco 15-9			Jm	3,902,547	318,682	5,505	12N.02W.24.442		1,200											
Con WW-101		Conoco WW-101			Jm	3,899,190	318,680	5,560	12N.02W.36.442		1,686	0.0										1976
Con 9-8		Conoco 9-8			Jm	3,910,509	316,868	5,600	13N.02W.26.434		710											

Table B2. Summary of field parameters and major-element chemistry

[SXXX, no site no. assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Temp., field water temperature; ºC=degrees Celsius; O_2=dissolved oxygen; mg/L=milligrams per liter; Spec Cond=specific conductance; µS/cm=microSiemens per centimeter at 25º C; Ca^{2+}=calcium; Mg^{2+}=magnesium, Na^{+}=sodium; K^{+}=potassium; Cl^{-}=chloride; Br^{-}=bromide; SO_4^{2-}=sulfate; HCO_3^{-}=total titration alkalinity as bicarbonate; na=not applicable; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date sampled	temp (ºC)	O_2 (mg/L)	pH	spec cond (µS/cm)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	Cl^{-} (mg/L)	Br^{-} (mg/L)	SO_4^{2-} (mg/L)	HCO_3^{-} (mg/L)	Na + K (mg/L as Na)
		Zone 3: West Central (after Plummer et al., 2004)																
S188	NM132	Rio Rancho 13	3	na	8/13/1996	28.0	6.5	8.7	424	3.0	0.08	88.1	1.7	4.6	0.08	75.2	142.7	
S193	NM129	Rio Rancho 9	3	na	8/13/1996	26.1	7.3	8.5	359	4.3	0.13	72.8	2.0	6.0	0.07	47.8	137.2	
		Zone 4: Western Boundary (after Plummer et al., 2004)																
S031	NM263	Windmill No. 18	4	na	6/24/1997	29.5	3.2	7.7	3,091	72.8	31.5	526	15.4	533	0.57	554	259.2	
S039	NM266	Windmill No. 20	4	na	6/21/1997	19.8	3.4	7.6	4,738	60.0	21.3	1,076	41.5	650	0.38	919	923.7	
S059	NM278	Windmill No. 21	4	na	6/23/1997	23.5	7.4	7.4	3,735	303	99.0	364	13.4	798	0.69	793	143.9	
S074	NM285	Windmill No. 23	4	na	6/21/1997	16.5	2.3	7.3	4,405	126	45.3	809	30.7	881	0.38	583	632.2	
S201	NM329	Windmill No. 26	4	na	7/2/1997	23.1	4.8	7.8	1,783	227	56.4	165	5.3	38.9	0.22	936	147.6	
S252	NM167	Windmill No. 10	4	na	8/29/1996	22.2	5.8	7.8	1,598	32.9	13.4	270	10.0	94.9	0.43	414	240.1	
S260	NM345	Windmill No. 33	4	na	6/25/1997	27.6	2.9	7.8	3,510	68.5	28.6	651	16.4	519	0.31	672	433.2	
DB026	DB026				nd	nd	nd	nd	3,520	110	50	nd	nd	610	nd	710	280	620
DB032	DB032				10/22/1982	22.0	nd	7.6	1,810	93	41	220	9.3	300	nd	290	246	nd
DB036	DB036				3/18/1981	18.5	nd	8.1	1,850	200	57	200	3.7	13	nd	1,000	122	nd
DB038	DB038	soc 18 spring of White & Kues, 1992			1/5/1950	6.5	nd	nd	5,110	128	69	nd	nd	1,240	nd	463	350	885
DB041	DB041	soc 17 (Coyote Spring) of White & Kues, 1992			1/5/1950	16.0	nd	nd	5,200	138	67	nd	nd	1,250	nd	471	354	887
DB068	DB068				9/13/1950	nd	nd	7.7	6,520	280	120	nd	nd	1,500	nd	1,100	280	1,100
DB069	DB069				6/6/1980	18.8	nd	8.0	5,400	220	71	1,100	15.0	1,200	nd	1,400	240	nd
DB071	DB071				5/29/1957	18.0	nd	8.3	5,800	9.1	9.8	nd	nd	820	nd	1,200	870	1,400
DB116	DB116	val 36 spring of White & Kues, 1992			9/3/1941	22.0	nd	nd	nd	523	165	6,716	194.0	6,250	nd	6,625	1,362	nd
DB117	DB117	val 39 spring of White & Kues, 1992			4/21/1975	nd	nd	7.3	41,400	560	350	11,000	320.0	11,000	27.000	8,900	1,530	nd
DB433	DB433				6/3/1959	nd	nd	8.0	23,000	580	150	nd	nd	4,600	nd	7,600	400	5,800
New cf		Comanche fault spring of Newell et al. (2005)				12		7	46,600	206	211	12,280	255	15,333		4,461	2,996	
		Zone 5: Rio Puerco (after Plummer et al., 2004)																
S032	NM262	Windmill No. 17	5	na	6/24/1997	25.0	4.3	7.6	3,804	153	64.2	610	15.0	582	0.60	903	309.4	
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	25.8	4.2	7.4	1,379	142	42.3	124	8.7	108	0.31	490	141.8	
S073	NM062	Windmill No. 03	5	na	8/16/1996	22.2	5.0	7.3	3,234	307	101	328	13.2	442	0.70	1,060	203.0	
S082	NM409	Windmill No. 36	5	na	9/10/1997	20.0	2.0	7.8	2,250	316	70.3	131	10.4	38.9	0.17	1,180	118.3	
S085	NM408	Windmill No. 35	5	na	9/10/1997	22.0	6.5	6.5	1,275	80.8	36.1	133	7.2	20.3	0.13	543	64.7	
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	26.0	<0.1	7.5	1,893	193	65.4	154	12.6	172	0.35	702	102.3	
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	18.0	0.2	7.3	2,378	298	88.6	290	8.3	118	0.28	1,107	485.7	

Table B2. Summary of field parameters and major-element chemistry

[SXXX, no site no. assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Temp., field water temperature; ºC=degrees Celsius; O_2=dissolved oxygen; mg/L=milligrams per liter; Spec Cond=specific conductance; µS/cm=microSiemens per centimeter at 25º C; Ca^{2+}=calcium; Mg^{2+}=magnesium, Na^{+}=sodium; K^{+}=potassium; Cl^{-}=chloride; Br^{-}=bromide; SO_4^{2-}=sulfate; HCO_3^{-}=total titration alkalinity as bicarbonate; na=not applicable; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date sampled	temp (ºC)	O_2 (mg/L)	pH	spec cond (µS/cm)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	Cl^{-} (mg/L)	Br^{-} (mg/L)	SO_4^{2-} (mg/L)	HCO_3^{-} (mg/L)	Na + K (mg/L as Na)
S198	NM137	Windmill No. 07	5	na	8/21/1996	19.5	0.4	7.1	5,420	372	149	831	15.2	591	1.19	2,130	350.6	
S215	NM335	Sandoval Spring	5	4	7/1/1997	21.3	1.2	7.5	1,120	60.3	16.9	165	3.3	11.5	0.09	291	354.6	
S237	NM341	Windmill No. 30	5	4	6/24/1997	19.0	4.7	7.7	2,502	150	53.5	279	14.4	486	0.73	490	102.2	
S238	NM342	Windmill No. 31	5	na	6/24/1997	21.5	4.1	7.2	3,457	339	105	341	18.0	346	0.68	1,303	256.9	
DB051	DB051				6/4/1980	15.2	nd	7.3	5,100	360	160	720	11.0	330	nd	2,400	240	nd
DB055	DB055				1/9/1950	nd	nd	nd	3,270	280	100	nd	nd	410	nd	1,100	200	340
DB063	DB063				5/27/1980	18.0	nd	7.0	3,600	380	120	430	12.0	220	nd	1,800	366	nd
DB086	DB086				5/16/1975	19.0	nd	7.7	4,660	410	110	520	34.0	480	0.900	1,900	117	nd
DB103	DB103				6/5/1975	nd	nd	8.3	9,420	92	30	2,200	33.0	1,500	4.800	2,600	464	nd
DB114	DB114				4/26/1956	18.0	nd	7.7	8,540	110	55	nd	nd	1,000	nd	2,400	910	1,900
DB122	DB122				5/28/1957	18.0	nd	7.3	5,290	330	140	nd	nd	500	nd	2,200	270	830
DB124	DB124				4/29/1957	16.5	nd	7.4	4,910	140	43	nd	nd	200	nd	1,900	680	1,000
DB132	DB132				4/29/1957	16.5	nd	7.4	4,910	140	43	nd	nd	200	nd	1,900	680	1,000
DB157	DB157				3/1/1965	nd	nd	8.4	5,870	24	13	nd	nd	78	nd	2,600	610	1,480
DB175	DB175				6/5/1975	nd	nd	8.1	4,360	45	13	1,000	7.1	200	0.800	1,300	897	nd
DB201	DB201				9/26/1974	nd	nd	8.0	2,180	92	1.2	380	6.0	53	nd	870	89	nd
DB206	DB206				6/6/1967	20.5	nd	8.3	919	58	26	nd	nd	21	nd	280	180	110
DB209	DB209				9/3/1953	nd	nd	nd	932	56	29	nd	nd	23	nd	300	150	110
DB235	DB235				6/6/1967	21.5	nd	8.4	951	47	6.	nd	nd	20	nd	300	160	160
DB387-S094	DB387				6/20/1980	20.0	nd	8.3	1,180	19	5.7	240	2.5	5	nd	210	410	nd
DB407	DB407				6/19/1980	16.0	nd	7.5	1,650	84	21.	280	4.6	39	nd	510	350	nd
JSAI 1	JSAI 1	Benavidez Well			6/9/2010	18.6		7.7	884									
JSAI 3	JSAI 3	"Windmill No. 1" Well			5/26/2010	20.0		7.9	4,040									
		No Zone: Exotic Water (after Plummer et al., 2004)																
S009a	NM485	Arroyo Salado Spring	E	E	8/6/1998	21.4	7.4	6.7	27,860	607	513	5,910	149	8,070	2.07	3,750	1,180	
S009b	NM485	Arroyo Salado Spring (Newell et al. 2005)	E	E		19.2		6.5	33,900	565	473	6,040	123	8,033		3,380	2,040	
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	25.4	0.8	6.2	11,680	561	108	2,190	135	2,680	3.09	2,190	861.5	
S038	NM265	Windmill No. 19	E	E	7/1/1997	17.1	0.6	8.4	5,180	32.5	4.77	1,177	7.5	195	0.28	2,134	302.2	
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	20.6	5.2	7.5	960	26.4	7.72	183	2.5	5.6	0.05	170	382.1	
S202	NM330	Windmill No. 27	E	E	7/2/1997	18.5	4.9	7.8	1,305	132	98.1	67.5	4.6	41.5	0.44	672	133.5	
San deep 6		RG-88934POD2 (Sandoval Cnty well)	E	E	11/20/2007	66.1		7.1	17,900	450	97.0	3,600.0	130.0	3,100	5.90	4,400	1,800	

Table B2. Summary of field parameters and major-element chemistry

[SXXX, no site no. assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Temp., field water temperature; ºC=degrees Celsius; O_2=dissolved oxygen; mg/L=milligrams per liter; Spec Cond=specific conductance; µS/cm=microSiemens per centimeter at 25º C; Ca^{2+}=calcium; Mg^{2+}=magnesium, Na^{+}=sodium; K^{+}=potassium; Cl^{-}=chloride; Br^{-}=bromide; SO_4^{2-}=sulfate; HCO_3^{-}=total titration alkalinity as bicarbonate; na=not applicable; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date sampled	temp (ºC)	O_2 (mg/L)	pH	spec cond (µS/cm)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	Cl^{-} (mg/L)	Br^{-} (mg/L)	SO_4^{2-} (mg/L)	HCO_3^{-} (mg/L)	Na + K (mg/L as Na)
		Zone Nac: Rio Salado (North) - (Trainer, 1978)																
san 29		Tierra Amarilla Spring A2			5/2/1973	16.5		6.5	9,930	300	68	2,000	81	1,900	8	1,300	1,970	-
Kaseman 2		"Warm Spring" Kaseman test No. 2 (C3)			3/14/1964	>50		7.3	15,300	345	56	3,550	87	2,990	4.6	3,260	1,450	nd
Kaseman 1		Kaseman test No. 1 (C2)			9/29/2026	46		-	-	400	73	-	-	2,660		3,645	1,498	450
san 131		Ojito Spring (C4)			6/5/1973	21		8.5	10,100	120	9	2,400	6.6	580	0.4	4,500	241	-
san 134		Cachana Spring (C5)			7/1/1946	-		-	1,130	44	10	-	-	82	-	91	470	210
san 37		unnamed spring (C1)			10/2/1973	-		7.9	960	77	26	100	5.5	82	0.50	120	333	-
san 27		Tierra Amarilla Spring A1			3/14/1964	15.0		7.6	8,560	157	70	1,760	71	1,680	8.30	1,220	1,080	-
san 30		Tierra Amarilla Spring A3			12/20/1974	25.0		-	11,200	390	65	3,000	91	2,400	-	2,600	1,855	-
san 31		Tierra Amarilla Spring A4			10/18/1974	-		-	20,000	-	-	3,900	140	2,800	10.00	-	-	-
san 32		Tierra Amarilla Spring A5			12/20/1974	11.0		-	12,900	220	110	3,800	140	2,700	-	3,700	2,260	-
topo 41		Tierra Amarilla Spring A6			9/14/1924	21.0		-	-	260	70	-	-	2,330	-	1,728	1,301	400
New gs	GS	Grassy Spring of Newell et al. (2005)				21.4		6.3	16,520	498	127	4,060	159	3,091		4,208	2,314	
		Zone Nac: Rio Salado (North) - (Craigg, 1984)																
Craigg 1		Swimming Pool Spring			4/19/1924	21.00				260	70	-	-				1301	
san 133		Holy Ghost Spring			9/22/1924	15.50				90	12	-	-				259	
san 133		Holy Ghost Spring			8/1/1983	-				80.1	7.29	34.5	1.65				256	
Craigg 2		Cuchillo "3"			9/22/1924	15.50			L	90	12	-	-				259	
Craigg 4		Penasco "2"			5/8/1984				15,000									
Craigg 5		Penasco "3"			5/8/1984				12,000									
Craigg 12		Chamisa Vega Spring			8/1/1983	-			2,450 L	539	23.1	101	7.43				143	
		Zone: Rio San Jose Entrant - (Risser and Lyford, 1983)																
val 16		Salt Spring 173			8/7/1941	25.5		-	-	540	450	3,700	36	5,200		2,700	1,390	
val 16		Salt Spring 173			6/5/1975	15.0		8.7	-	-	-	3,700	36	4,400		-	960	
RL well 4		07N.01W.31.124			4/26/1956	18.0		7.7	8,540	110	55	1,940	-	1,010		2,440	910	
W 192		Salt Spring 192			9/3/1941	-		-	-	230	190	-	-	12,000		8,000	2,100	
W 192		Salt Spring 192			4/21/1975	-		8.6	37,000	210	110	10,000	280	11,000		6,700	-	
W 190		Salt Spring 190			9/3/1941	-		-	-	320	130	-	-	9,800		6,500	2,140	
W 190		Salt Spring 190			4/22/1975	-		9.1	41,500	110	160	11,000	320	12,000		7,400	1,910	
RL 4		Railroad Spring			4/22/1975	13.5		6.9	36,500	350	350	9,300	260	10,000		6,200	2,460	
val 22		Salt Spring 186			8/25/1941	-		-	-	110	140	9,900	290	10,000		6,800	1,750	

Table B2. Summary of field parameters and major-element chemistry

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site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date sampled	temp (ºC)	O_2 (mg/L)	pH	spec cond (µS/cm)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	Cl^{-} (mg/L)	Br^{-} (mg/L)	SO_4^{2-} (mg/L)	HCO_3^{-} (mg/L)	Na + K (mg/L as Na)
val 29		Pipeline Spring			4/22/1975	14.0		7.7	34,100	490	140	9,100	260	9,000		5,600	2,950	
W 185		Salt Spring 185			8/25/1941	-		8.3	-	330	150	-	-	9,200		6,800	2,250	
W 185		Salt Spring 185			4/22/1975	13.5		8.3	36,800	140	160	9,400	320	10,000		6,200	1,920	
RWP 5		07N.02W.10.444 (RWP 5)			6/5/1975	-		8.3	9,340	92	30	2,200	33	1,500		2,600	460	
val 24		Salt Spring 184b			8/25/1941	-		-	-	580	190	-	-	9,400		7,500	2,070	
W 184c		Salt Spring 184c			8/25/1941	-		-	-	430	190	-	-	10,300		8,200	1,640	
val 23		Salt Spring 184a			8/25/1941	28.0		-	-	940	230	11,000	290	11,400		9,100	2,910	
val 23		Salt Spring 184a			4/22/1975	-		8.7	45,000	380	230	12,000	310	12,000		9,100	1,960	
RL 11		Mammouth Mound			4/22/1975	11.5		7.8	34,300	390	170	8,600	230	9,900		5,900	2,720	
RWP 6		07N.02W.29.214 (RWP 6)			5/16/1975	19.0		7.7	4,660	410	110	520	34	480		1,900	120	
W 189		Salt Spring 189			9/2/1941	24.0		-	-	710	220	6,600	170	6,700		5,700	2,210	
W 189		Salt Spring 189			5/16/1975	21.5		8.3	37,000	340	230	9,500	280	10,000		7,400	1,490	
val 25		Salt Spring 188			9/2/1941	30.0		-	-	300	230	-	-	9,000		6,800	1,390	
val 34		Salt Spring 187			9/2/1941	26.5		-	-	610	270	5,300	120	5,200		5,400	1,630	
val 33		Indian Ruins Spring			4/24/1975	-		7.6	8,530	540	200	1,300	31	1,100		2,800	640	
cib 5		Salt Spring 195			-	18.5		-	-	610	150	-	-	150		2,000	410	
cib 6		Lucero Spring			9/4/1941	16.5		-	-	640	180	300	26	330		2,000	630	
cib 6		Lucero Spring			5/28/1975	19.0		-	4,370	-	-	300	15	320		-	-	
RWP 3		08N.02W.01.333 (RWP 3)			6/5/1975	-		2.4	5,430	140	53	1,100	28	210		2,300	565	
val 38		Miranda Spring			4/21/1975	-		8.3	30,100	260	130	7,400	440	7,700		5,100	1,780	
val 35		El Ojo Escondido			9/24/1973	16.0		8.1	4,230	270	110	580	11	390		1,600	190	
RL 22		Ojo Escondido			9/8/1941	23.0		-	-	33	20	23	5.6	5.6		32	220	
RL 22		Ojo Escondido			9/24/1973	20.0		8.3	490	42	22	25	5.5	4.6		33	230	
val 37		Salt Spring			9/24/1973	25.0		7.7	32,300	630	120	8,100	6.3	8,100		5,500	2,810	
val 37		Salt Spring			4/24/1975	24.0		7.1	32,600	570	150	8,300	280	7,800		6,100	2,900	
W 193		Salt Spring 193			9/3/1941	22.0		-	-	520	170	6,700	200	6,300		6,600	1,360	
W 193		Salt Spring 193			4/24/1975	-		7.3	41,400	560	350	11,000	300	11,000		8,900	1,530	
val 40		Suwanee Spring			10/12/1948	-		-	3,810	260	120	500	-	300		1,500	230	
val 40		Suwanee Spring			9/24/1973	17.0		8.1	3,930	280	100	510	7.8	360		1,400	180	
CCC 1		08N.03W.11.232 (CCC 1)			4/21/1975	-		7.8	3,940	250	100	530	12	350		1,400	219	
val 41		Dipping Vat Spring			12/7/1957	-		7.7	4,030	270	110	600	11	380		1,600	220	
val 41		Dipping Vat Spring			9/14/1973	17.0		8.2	4,150	270	110	540	12	380		1,600	190	

Table B2. Summary of field parameters and major-element chemistry

[SXXX, no site no. assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Temp., field water temperature; ºC=degrees Celsius; O_2=dissolved oxygen; mg/L=milligrams per liter; Spec Cond=specific conductance; µS/cm=microSiemens per centimeter at 25º C; Ca^{2+}=calcium; Mg^{2+}=magnesium, Na^{+}=sodium; K^{+}=potassium; Cl^{-}=chloride; Br^{-}=bromide; SO_4^{2-}=sulfate; HCO_3^{-}=total titration alkalinity as bicarbonate; na=not applicable; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date sampled	temp (ºC)	O_2 (mg/L)	pH	spec cond (µS/cm)	Ca^{2+} (mg/L)	Mg^{2+} (mg/L)	Na^{+} (mg/L)	K^{+} (mg/L)	Cl^{-} (mg/L)	Br^{-} (mg/L)	SO_4^{2-} (mg/L)	HCO_3^{-} (mg/L)	Na + K (mg/L as Na)
val 41		Dipping Vat Spring			4/21/1975	16.5		7.9	4,030	270	100	560	12	380		1,500	230	
RL well 23		08N.03W.15.413 (United Brokers)			11/29/1963	20.1		7.3	15,800	680	180	3,500	120	2,800		4,300	2,390	
RL well 23		08N.03W.15.413 (United Brokers)			5/28/1975	-		-	15,800	-	-	3,300	110	2,700		-	-	
W 194		Spring 194			9/3/1941	18.5		-	-	65	18	43	3.9	31		13	380	
Stuckys		09N.01W.04.432 (Stuckys)			6/5/1975	-		8.1	4,360	45	13	1,000	7.1	200		1,300	900	
ECW 8		09N.02W.09.433 (ECW 8)			1940	-		-	-	28	10	1,600	-	84		2,800	510	
ECW 8		09N.02W.09.433 (ECW 8)			7/3/1974	-		8.4	6,900	26	11	1,300	7.8	83		2,300	550	
BIA Sedillo		09N.02W.24.230 (BIA Sedillo)			4/29/1980	-		8.8	1,600	8.0	T	380	10	60		320	440*	
RWP 9		09N.02W.27.422 (RWP 9)			9/24/1973	20.0		8.1	460	34	7.3	52	3.9	4.6		44	180	
topo 37		Coyote Spring			4/26/1973	-		8.3	4,400	220	24	890	T	63		2,100	150	
P.S. 2		10N.02W.25.444 (Canoncito P.S. 2)			9/26/1974	-		-	2,180	92	1.2	380	5.9	53		870	89	
Con 17-10		Conoco 17-10			-	-		7.6	-	-	-	-	-	-		-	-	
Con 65A		Conoco 65A			8/5/1971	-		7.6	14,000	-	-	-	-	2,100		4,000	420	
Con 65A		Conoco 65A			5/13/1974	-		8.2	16,000	94	14	3,100	4.7	2,100		3,700	430	
Con 65A		Conoco 65A			6/5/1975	26.0		8.2	12,900	-	-	3,200	10	2,100		-	500	
Con 65A		Conoco 65A			1976	-		8.0	-	74	12	3,300	9.4	2,130		3,840	380*	
Con 22-10		Conoco 22-10			-	-		7.1	-	-	-	-	-	-		-	-	
Con 15-9		Conoco 15-9			-	-		7.7	-	-	-	-	-	-		-	-	
Con WW-101		Conoco WW-101			5/29/1976	-		8.2	11,000	70	13	3,300	10	1,970		3,380	250*	
Con 9-8		Conoco 9-8			-	-		8.3	-	-	-	-	-	-		-	-	

Table B3. Summary of minor-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Sr=strontium, SiO_2=silica; Fe=iron; NO_3 as N=dissolved nitrate as nitrogen; Mn=manganese; F=fluoride; mg/L=milligrams per liter; nd=not determined; na=not applicable]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	Sr (mg/L)	SiO_2 (mg/L)	Fe (mg/L)	Mn (mg/L)	NO_3 as N (mg/L)	F (mg/L)
		Zone 3: West Central (after Plummer et al., 2004)									
S188	NM132	Rio Rancho 13	3	na	8/13/1996	0.08	21.8	0.05	<0.004	1.50	0.90
S193	NM129	Rio Rancho 9	3	na	8/13/1996	0.11	21.0	0.01	<0.004	2.11	0.54
		Zone 4: Western Boundary (after Plummer et al., 2004)									
S031	NM263	Windmill No. 18	4	na	6/24/1997	2.1	20.1	0.16	0.066	1.41	2.15
S039	NM266	Windmill No. 20	4	na	6/21/1997	1.6	64.2	0.56	0.047	0.59	3.92
S059	NM278	Windmill No. 21	4	na	6/23/1997	4.9	29.3	0.46	0.027	0.67	nd
S074	NM285	Windmill No. 23	4	na	6/21/1997	2.1	23.1	0.90	0.141	1.55	2.05
S201	NM329	Windmill No. 26	4	na	7/2/1997	12.	18.5	1.1	0.074	0.01	1.07
S252	NM167	Windmill No. 10	4	na	8/29/1996	0.84	18.4	0.01	0.008	1.09	1.64
S260	NM345	Windmill No. 33	4	na	6/25/1997	1.4	22.0	0.21	0.036	1.04	2.12
DB026	DB026						nd	nd	nd	0.86	nd
DB032	DB032						23.	0.016	0.064	nd	0.8
DB036	DB036						17.	0.590	0.060	nd	1.0
DB038	DB038						22.	nd	nd	2.00	1.0
DB041	DB041						24.	nd	nd	0.97	0.8
DB068	DB068						25.	nd	nd	0.86	nd
DB069	DB069						17.	0.220	0.060	nd	0.6
DB071	DB071						22.	nd	nd	0.18	5.0
DB116	DB116						20.	0.091	nd	nd	4.3
DB117	DB117						19.	0.020	0.220	nd	3.8
DB433	DB433						29.	nd	nd	0.29	5.7

Table B3. Summary of minor-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Sr=strontium, SiO_2=silica; Fe=iron; NO_3 as N=dissolved nitrate as nitrogen; Mn=manganese; F=fluoride; mg/L=milligrams per liter; nd=not determined; na=not applicable]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	Sr (mg/L)	SiO_2 (mg/L)	Fe (mg/L)	Mn (mg/L)	NO_3 as N (mg/L)	F (mg/L)
Zone 5: Rio Puerco (after Plummer et al., 2004)											
S032	NM262	Windmill No. 17	5	na	6/24/1997	4.2	26.3	0.26	0.028	1.64	1.68
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	2.5	24.6	0.23	0.033	1.96	0.44
S073	NM062	Windmill No. 03	5	na	8/16/1996	4.7	21.8	0.51	0.033	2.62	0.38
S082	NM409	Windmill No. 36	5	na	9/10/1997	5.1	28.0	0.40	0.033	0.42	0.22
S085	NM408	Windmill No. 35	5	na	9/10/1997	2.0	28.9	0.13	0.007	0.34	0.54
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	3.6	27.0	0.27	0.050	1.55	0.41
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	3.9	22.7	0.69	1.56	0.11	1.03
S198	NM137	Windmill No. 07	5	na	8/21/1996	6.2	21.8	1.6	0.121	1.10	0.63
S215	NM335	Sandoval Spring	5	4	7/1/1997	0.82	30.6	0.17	0.047	0.09	1.44
S237	NM341	Windmill No. 30	5	4	6/24/1997	3.9	22.9	0.31	0.031	1.72	1.22
S238	NM342	Windmill No. 31	5	na	6/24/1997	6.2	29.7	0.50	0.036	1.48	0.41
DB051	DB051						16.	0.100	0.010	nd	0.6
DB055	DB055						24.	nd	nd	2.70	0.1
DB063	DB063						17.	0.110	0.010	nd	0.5
DB086	DB086						13.	1.200	0.040	nd	1.3
DB103	DB103						15.	0.090	0.040	nd	1.3
DB114	DB114						27.	nd	nd	0.52	0.4
DB122	DB122						13.	nd	nd	0.75	0.8
DB124	DB124						16.	nd	nd	0.27	2.0
DB132	DB132						16.	nd	nd	0.27	2.0
DB157	DB157						7.7	nd	nd	0.07	2.9
DB175	DB175						13.	0.020	0.070	nd	3.4

Table B3. Summary of minor-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Sr=strontium, SiO_2=silica; Fe=iron; NO_3 as N=dissolved nitrate as nitrogen; Mn=manganese; F=fluoride; mg/L=milligrams per liter; nd=not determined; na=not applicable]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	Sr (mg/L)	SiO_2 (mg/L)	Fe (mg/L)	Mn (mg/L)	NO_3 as N (mg/L)	F (mg/L)
DB201	DB201						nd	<0.010	nd	nd	0.6
DB206	DB206						23.	nd	nd	2.30	0.9
DB209	DB209						21.	nd	nd	1.40	1.2
DB235	DB235						19.	nd	nd	0.02	0.3
DB387	DB387						27.	0.050	0.004	nd	1.9
DB407	DB407						22.	<0.010	0.002	nd	1.3
		No Zone: Exotic Water (after Plummer et al., 2004)									
S009a	NM485	Arroyo Salado Spring	E	E	8/6/1998	17.	17.2	1.5	0.019	0.02	0.50
S009b	NM485	Arroyo Salado Spring									
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	13.	22.2	2.7	1.01	0.01	0.73
S038	NM265	Windmill No. 19	E	E	7/1/1997	2.2	10.7	0.38	0.061	0.01	2.75
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	0.60	29.7	0.09	<0.004	7.64	1.32
S202	NM330	Windmill No. 27	E	E	7/2/1997	2.5	17.1	0.25	0.057	2.63	0.65
San deep 6		RG-88934POD2 (Sandoval Cnty well)	E	E	11/20/2007	8.8	32.0	3.30	0.078		4.80
		Zone Nac: Rio Salado (North) - (Trainer, 1978)									
san 29		Tierra Amarilla Spring A 2			5/2/1973		17.0	0.8	0.74	-	2.7
Kaseman 2		"Warm Spring" Kaseman test well No. 2			3/14/1964		31.0	1.4	nd	0	2.8
Kaseman 1		Kaseman test well No. 1			9/29/2026		18.0			0	
san 131		Ojito Spring (C4)			6/5/1973		4.0	0.03	0.02	-	2.90
san 134		Cachana Spring (C5)			7/1/1946		-	-	-	1.00	4.40
san 37		unnamed spring (C1)			10/2/1973		20.0	0.00	0.013	-	2.00
san 27		Tierra Amarilla Spring A1			3/14/1964		15.0	-	-	0.00	2.90

Table B3. Summary of minor-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Sr=strontium, SiO_2=silica; Fe=iron; NO_3 as N=dissolved nitrate as nitrogen; Mn=manganese; F=fluoride; mg/L=milligrams per liter; nd=not determined; na=not applicable]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	Sr (mg/L)	SiO_2 (mg/L)	Fe (mg/L)	Mn (mg/L)	NO_3 as N (mg/L)	F (mg/L)
san 30		Tierra Amarilla Spring A3			12/20/1974		15.0	0.42	-	-	4.00
san 32		Tierra Amarilla Spring A5			12/20/1974		18.0	-	-	-	2.00
topo 41		Tierra Amarilla Spring A6			9/14/1924		30.0	-	-	-	-
		Zone Nac: Rio Salado (North) - (Craigg, 1984)									
Craigg 2		Cuchillo "3"			9/22/1924			0.30	-		-
Craigg 12		Chamisa Vega Spring			8/1/1983			-	-		0.62
		Zone: Rio San Jose Entrant - (Risser and Lyford, 1983)									
val 16		Salt Spring 173			8/7/1941		21				
RL well 4		07N.01W.31.124			4/26/1956		27				
W 192		Salt Spring 192			4/21/1975		20				
W 190		Salt Spring 190			4/22/1975		30				
RL 4		Railroad Spring			4/22/1975		22				
val 22		Salt Spring 186			8/25/1941		38				
val 29		Pipeline Spring			4/22/1975		23				
W 185		Salt Spring 185			4/22/1975		32				
RWP 5		07N.02W.10.444 (RWP 5)			6/5/1975		15				
val 24		Salt Spring 184a			8/25/1941		35				
val 24		Salt Spring 184a			4/22/1975		26				
RL 11		Mammouth Mound			4/22/1975		27				
RWP 6		07N.02W.29.214 (RWP 6)			5/16/1975		13				
W 189		Salt Spring 189			9/2/1941		32				
W 189		Salt Spring 189			5/16/1975		23				

Table B3. Summary of minor-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Sr=strontium, SiO_2=silica; Fe=iron; NO_3 as N=dissolved nitrate as nitrogen; Mn=manganese; F=fluoride; mg/L=milligrams per liter; nd=not determined; na=not applicable]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	Sr (mg/L)	SiO_2 (mg/L)	Fe (mg/L)	Mn (mg/L)	NO_3 as N (mg/L)	F (mg/L)
val 34		Salt Spring 187			9/2/1941		20				
val 33		Indian Ruins Spring			4/24/1975		21				
cib 6		Lucero Spring			9/4/1941		20				
RWP 3		08N.02W.01.333 (RWP 3)			6/5/1975		9.5				
val 38		Miranda Spring			4/21/1975		17				
RL 22		Ojo Escondido			9/8/1941		12				
val 37		Salt Spring			4/21/1975		22				
W 193		Salt Spring 193			9/3/1941		20				
W 193		Salt Spring 193			4/21/1975		19				
CCC 1		08N.03W.11.232 (CCC 1)			4/21/1975		31				
val 41		Dipping Vat Spring			12/7/1957		30				
val 41		Dipping Vat Spring			4/21/1975		30				
RL well 23		08N.03W.15.413 (United Brokers)			11/29/1963		11				
W 194		Spring 194			9/3/1941		28				
Stuckys		09N.01W.04.432 (Stuckys)			6/5/1975		13				
Con 65A		Conoco 65A			1976		15	-	-		0.70
Con WW-101		Conoco WW-101			5/29/1976		17	-	-		0.90

Table B4. Summary of trace-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Al=aluminum; B=boron; Ba=barium; Li=lithium; Zn=zinc; Pb=lead; Cu=copper; Rb=rubidium; V=vanadium; Cr=chromium; Co=cobalt; Mo=molybdenum; As=arsenic; Se=selenium; U=uranium; mg/L=milligrams per liter; µg/L=micrograms per liter; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	Al (µg/L)	B (mg/L)	Ba (mg/L)	Li (mg/L)	Zn (µg/L)	Pb (µg/L)	Cu (µg/L)	Rb (µg/L)	V (µg/L)	Cr (µg/L)	Co (µg/L)	Mo (µg/L)	As (µg/L)	Se (µg/L)	U (µg/L)
		Zone 3: West Central (after Plummer et al., 2004)																		
S188	NM132	Rio Rancho 13	3	na	8/13/1996	9.	0.217	0.023	0.030	1.	0.1	0.4	nd	72.	11.	nd	7.4	45.	nd	1.7
S193	NM129	Rio Rancho 9	3	na	8/13/1996	7.	0.183	0.039	0.031	<1.	<0.1	0.3	nd	42.	6.	nd	6.2	39.	nd	1.9
		Zone 4: Western Boundary (after Plummer et al., 2004)																		
S031	NM263	Windmill No. 18	4	na	6/24/1997	<5.	0.382	0.006	0.174	25.	<0.1	1.1	4.4	2.2	11.	0.28	6.2	<1.	4.	2.3
S039	NM266	Windmill No. 20	4	na	6/21/1997	<5.	1.59	0.013	0.629	644.	1.9	11.	48.	16.	38.	<0.5	17.	<10.	<10.	3.2
S059	NM278	Windmill No. 21	4	na	6/23/1997	<5.	0.366	0.016	0.312	211.	0.2	2.9	6.6	5.4	12.	0.14	2.2	<1.	6.	4.8
S074	NM285	Windmill No. 23	4	na	6/21/1997	<5.	1.28	0.014	0.550	1,176.	0.1	9.6	86.	6.6	<2.	0.65	4.8	<1.	4.	5.5
S201	NM329	Windmill No. 26	4	na	7/2/1997	<5.	0.439	0.023	0.102	19.	<0.1	3.2	5.5	1.2	7.	0.13	18.	6.6	2.	0.5
S252	NM167	Windmill No. 10	4	na	8/29/1996	<1.	0.555	0.014	0.190	12.	<0.1	1.2	nd	4.3	10.	nd	25.	2.	nd	4.1
S260	NM345	Windmill No. 33	4	na	6/25/1997	<5.	1.11	0.010	0.433	275.	<1.	3.6	6.2	6.	11.	<0.5	12.	<10.	10.	10.
DB026	DB026					nd	nd	nd	nd								nd	nd		
DB032	DB032					nd	nd	0.040	nd								nd	<1		
DB036	DB036					nd	0.510	0.000	nd								nd	3		
DB038	DB038					nd	nd	nd	nd								nd	nd		
DB041	DB041					nd	nd	nd	nd								nd	nd		
DB068	DB068					nd	nd	nd	nd								nd	nd		
DB069	DB069					nd	0.900	nd	nd								nd	nd		
DB071	DB071					nd	nd	nd	nd								nd	nd		
DB116	DB116					nd	nd	nd	nd								nd	nd		
DB117	DB117					nd	14.000	nd	nd								nd	nd		
DB433	DB433					nd	8.100	nd	nd								nd	nd		
New cf		Comanche fault spring of Newell et al. (2005)																54		
		Zone 5: Rio Puerco (after Plummer et al., 2004)																		
S032	NM262	Windmill No. 17	5	na	6/24/1997	<5.	0.881	0.011	0.327	51.	<0.1	6.3	5.0	4.1	11.	0.15	7.2	1.3	19.	12.
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	3.	0.222	0.013	0.191	49.	0.1	1.4	nd	3.3	1.	nd	2.1	0.9	nd	3.1
S073	NM062	Windmill No. 03	5	na	8/16/1996	7.	0.394	0.017	0.295	1,480.	0.1	7.0	nd	3.1	9.	nd	1.9	0.8	nd	9.0
S082	NM409	Windmill No. 36	5	na	9/10/1997	11.	0.095	0.018	0.041	3,560.	1.4	4.6	5.5	3.3	2.	0.22	0.7	1.2	9.	6.0
S085	NM408	Windmill No. 35	5	na	9/10/1997	5.	0.139	0.014	0.069	886.	1.4	2.9	5.1	11.	14.	0.14	8.1	1.5	4.	1.0
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	4.	0.213	0.013	0.253	8.	<0.1	2.3	nd	4.	1.	nd	3.2	1.	nd	2.6
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	<5.	0.267	0.015	0.074	9.	<0.1	4.4	1.4	1.5	9.	0.23	7.0	<1.	3.	1.5
S198	NM137	Windmill No. 07	5	na	8/21/1996	7.	1.11	0.007	0.767	180.	0.2	0.7	nd	18.	<1.	nd	18.	6.2	nd	37.
S215	NM335	Sandoval Spring	5	4	7/1/1997	7.	0.210	0.038	0.067	18.	<0.1	0.7	0.5	3.7	<1.	0.13	7.5	1.6	2.	11.
S237	NM341	Windmill No. 30	5	4	6/24/1997	<5.	0.344	0.014	0.253	650.	<0.1	3.4	14.	3.4	3.	0.21	9.3	<1.	8.	2.1
S238	NM342	Windmill No. 31	5	na	6/24/1997	<5.	0.315	0.008	0.289	117.	<0.1	13.	5.3	3.2	4.	0.62	0.8	<1.	8.	13.
DB051	DB051					nd	0.730	nd	nd								nd	nd		
DB055	DB055					nd	nd	nd	nd								nd	nd		
DB063	DB063					nd	0.400	nd	nd								nd	nd		
DB086	DB086					nd	1.500	nd	nd								nd	nd		
DB103	DB103					nd	3.700	nd	nd								nd	nd		

Table B4. Summary of trace-element chemistry

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; Al=aluminum; B=boron; Ba=barium; Li=lithium; Zn=zinc; Pb=lead; Cu=copper; Rb=rubidium; V=vanadium; Cr=chromium; Co=cobalt; Mo=molybdenum; As=arsenic; Se=selenium; U=uranium; mg/L=milligrams per liter; µg/L=micrograms per liter; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	Al (µg/L)	B (mg/L)	Ba (mg/L)	Li (mg/L)	Zn (µg/L)	Pb (µg/L)	Cu (µg/L)	Rb (µg/L)	V (µg/L)	Cr (µg/L)	Co (µg/L)	Mo (µg/L)	As (µg/L)	Se (µg/L)	U (µg/L)
DB114	DB114					nd	nd	nd	nd								nd	nd		
DB122	DB122					nd	nd	nd	nd								nd	nd		
DB124	DB124					nd	nd	nd	nd								nd	nd		
DB132	DB132					nd	nd	nd	nd								nd	nd		
DB157	DB157					nd	nd	nd	nd								nd	nd		
DB175	DB175					nd	1.800	nd	nd								nd	nd		
DB201	DB201					nd	0.180	nd	nd								nd	nd		
DB206	DB206					nd	nd	nd	nd								nd	nd		
DB209	DB209					nd	nd	nd	nd								nd	nd		
DB235	DB235					nd	nd	nd	nd								nd	nd		
DB387	DB387					nd	0.230	nd	nd								nd	nd		
DB407	DB407					nd	0.230	nd	nd								nd	nd		
		No Zone: Exotic Water (after Plummer et al., 2004)																		
S009a	NM485	Arroyo Salado Spring	E	E	8/6/1998	326.	3.33	0.035	2.87	170.	4.2	<10.	300.	<10.	2,200.	<5.	4.1	13.	23.	24.
S009b	NM485	Arroyo Salado Spring																88.		
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	1.	1.65	0.019	1.70	76.	<1.	7.1	nd	36.	14.	nd	20.	610.	nd	5.5
S038	NM265	Windmill No. 19	E	E	7/1/1997	<5.	1.09	0.005	0.458	16.	<1.	6.2	2.9	2.2	33.	0.68	6.5	<10.	<10.	<1.
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	<5.	0.213	0.003	0.103	17.	<0.1	1.9	1.6	2.0	<2.	0.14	2.6	1.4	11.	15.
S202	NM330	Windmill No. 27	E	E	7/2/1997	4.	0.143	0.016	0.022	739.	<0.1	3.2	5.1	0.1	<1.	0.15	8.0	<1.	18.	3.1
San deep 6		RG-88934POD2 (Sandoval Cnty well)	E	E	11/20/2007		9.700	0.036		.								634		
		Zone Nac: Rio Salado (North) - (Trainer, 1978)																		
san 29		Tierra Amarilla Spring A2			5/2/1973	650.0	13.00	0.21	7.50	560.	2.00	20.00		-	3.0	17.00	2.00	160.00		0.80
Kaseman 2		"Warm Spring" Kaseman test No. 2			3/14/1964	2600	4.8	0.035	6.90	1,500.	60.00	40.00		35.0	2.0	2.00	7.00	0.60		3.20
san 131		Ojito Spring (C4)			6/5/1973	100.	0.4	0.025	1.2	25.	3	25.0		25	1	1	11	55		
san 37		unnamed spring (C1)			10/2/1973		0.29		0.21									0.002		
san 27		Tierra Amarilla Spring A1			3/14/1964		6.80		6.40											
san 30		Tierra Amarilla Spring A3			12/20/1974	7	6.90		5.20											
san 31		Tierra Amarilla Spring A4			10/18/1974		8.20		7.10									0.19		
san 32		Tierra Amarilla Spring A5			12/20/1974		8.00		6.30											
New gs	GS	Grassy Spring of Newell et al. (2005)																38.00		
		Zone Nac: Rio Salado (North) - (Craigg, 1984)																		
san 133		Holy Ghost Spring			4/19/1924		0.63	0.215	-	-	<1.00	-			<1.00			1.40	<2.00	-
Craigg 2		Cuchillo "3"			9/22/1924		-	-	-	-	-	-			-			-	-	-
Craigg 12		Chamisa Vega Spring			8/1/1983		0.89	1.325	-	-	<1.00	-			<1.00			<1.00	3.80	-
		Zone: Rio San Jose Entrant - (Risser and Lyford, 1983)																		
Con 65A		Conoco 65A			5/29/1905	<100		-	-	10	-	-		<10	<1	-	-	<10	-	
Con WW-101		Conoco WW-101			5/29/1976	6		-	-	20	-	-		<10	7	-	-	10	-	

Table B5. Summary of dissolved gases (nitrogen, argon, oxygen, carbon dioxide, and methane)

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; N_2=nitrogen; Ar=argon; °C=degrees Celsius; mg/kg=milligrams per kilogram; cc STP/kg=cubic centimeters at standard temperature and pressure per kilogram of water; kg=kilogram; O_2=oxygen; CO_2=carbon dioxide; CH_4=methane; na=not applicable; nd=not determined; negative excess air indicates degassing]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	N_2 (mg/kg)	Ar (mg/kg)	lab O_2 (mg/kg)	field O_2 (mg/kg)	lab CO_2 (mg/kg)	CH_4 (mg/kg)	assigned recharge altitude (feet)	excess N_2 (mg/kg)	recom-mended recharge temp-erature (ºC)	recom-mended excess air (cc STP/kg)
Zone 3: West Central (after Plummer et al., 2004)															
S188	NM132	Rio Rancho 13	3	na	8/13/1996	15.71	0.5631	0.1	6.5	0.9	<0.0001	8,000	0.5	6.9	0.7
S193	NM129	Rio Rancho 9	3	na	8/13/1996	20.64	0.6188	1.0	7.3	2.5	<0.0001	8,000	4.0	3.2	0.8
Zone 4: Western Boundary (after Plummer et al., 2004)															
S039	NM266	Windmill No. 20	4	na	6/21/1997	14.98	0.5019	<0.1	3.4	33.1	<0.0001	5,000	1.0	17.3	1.0
S059	NM278	Windmill No. 21	4	na	6/23/1997	13.82	0.5191	4.7	7.4	9.4	0.0004	5,000	nd	14.2	0.0
S074	NM285	Windmill No. 23	4	na	6/21/1997	12.26	0.4466	0.4	2.3	45.1	<0.0001	5,000	nd	21.9	0.3
Zone 5: Rio Puerco (after Plummer et al., 2004)															
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	35.65	0.8533	1.4	4.2	10.1	<0.0001	5,000	nd	20.5	nd
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	17.12	0.5538	0.1	<0.1	3.6	<0.0001	5,000	1.8	12.8	1.1
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	23.73	0.7031	0.1	0.2	33.2	0.0034	5,000	nd	12.0	nd
S198	NM137	Windmill No. 07	5	na	8/21/1996	20.27	0.6329	0.0	0.4	34.5	<0.0001	5,000	3.0	7.0	1.1
S237	NM341	Windmill No. 30	5	4	6/24/1997	12.64	0.4643	3.9	4.7	2.6	<0.0001	5,000	nd	19.8	0.2
S238	NM342	Windmill No. 31	5	na	6/24/1997	14.09	0.4965	1.2	4.1	20.8	<0.0001	5,000	nd	18.5	1.4
No Zone: Exotic Water (after Plummer et al., 2004)															
S009	NM485	Arroyo Salado Spring	E	E	8/6/1998	10.72	0.4016	4.0	7.4	155.8	<0.0001	5,000	nd	nd	nd
S038	NM265	Windmill No. 19	E	E	7/1/1997	21.41	0.6898	<0.1	0.6	2.7	0.0086	5,000	nd	8.6	nd
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	21.91	0.6057	4.6	5.2	20.0	<0.0001	5,000	nd	23.0	nd
Zone Nac: Rio Salado (North) - (Trainer, 1978)															
san 29	A2	Tierra Amarilla Spring A2			9/15/2025	20.00	-	5.0		975.0	-		20.00		
san 31	A4	Tierra Amarilla Spring A4			9/15/2025	27.00	-	6.0		967.0	-		27.00		
san 41	A6	Tierra Amarilla Spring A6			9/15/2025	21.30	-	83.0		704.0	-		213.00		

Table B5. Summary of dissolved gases (nitrogen, argon, oxygen, carbon dioxide, and methane)

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; N_2=nitrogen; Ar=argon; ^{o}C=degrees Celsius; mg/kg=milligrams per kilogram; cc STP/kg=cubic centimeters at standard temperature and pressure per kilogram of water; kg=kilogram; O_2=oxygen; CO_2=carbon dioxide; CH_4=methane; na=not applicable; nd=not determined; negative excess air indicates degassing]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	N_2 (mg/kg)	Ar (mg/kg)	lab O_2 (mg/kg)	field O_2 (mg/kg)	lab CO_2 (mg/kg)	CH_4 (mg/kg)	assigned recharge altitude (feet)	excess N_2 (mg/kg)	recom-mended recharge temp-erature (ºC)	recom-mended excess air (cc STP/kg)
Zone Nac: Rio Salado (North) - (Craigg, 1984)															
Craigg 1		Swimming Pool Spring			4/19/1924										
san 133		Holy Ghost Spring			9/22/1924										
san 133		Holy Ghost Spring			8/1/1983										
Craigg 1															
Craigg 2		Cuchillo "3"													
Craigg 3		Penasco "1"													
Craigg 4		Penasco "2"													
Craigg 5		Penasco "3"													
Craigg 6		Penasco "4"													
Craigg 7															
Craigg 8		Cuchillo "1"													
Craigg 9		Cuchillo "2"													
Craigg 10															
Craigg 11															
Craigg 12		Chamisa Vega Spring			8/1/1983										

Table B6. Sensitivity analysis for recharge temperatures calculated from dissolved gases

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; N_2=nitrogen; Ar=argon; Alt.=altitude; ºC=degrees Celsius; mg/kg=milligrams per kilogram; cc STP/kg=cubic centimeters at standard temperature and pressure per kilogram of water; na=not applicable; nd=not determined; negative excess air indicates degassing]

									assuming no excess N_2							assuming calculated excess N_2					
									Alt. 5,000 ft		Alt. 6,500 ft		Alt. 8,000 ft			Alt. 5,000 ft		Alt. 6,500 ft		Alt. 8,000 ft	
site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	N_2 (mg/kg)	Ar (mg/kg)	assigned recharge altitude (ft)	recharge temp-erature (ºC)	excess air (cc STP/kg)	recharge temp-erature (ºC)	excess air (cc STP/kg)	recharge temp-erature (ºC)	excess air (cc STP/kg)	calcu-lated excess N_2 (mg/kg)	recharge temp-erature (ºC)	excess air (cc STP/kg)	recharge temp-erature (ºC)	excess air (cc STP/kg)	recharge temp-erature (ºC)	excess air (cc STP/kg)
		Zone 3: West Central (after Plummer et al., 2004)																			
S188	NM132	Rio Rancho 13	3	na	8/13/1996	15.71	0.5631	8,000	12.5	1.4	10.2	1.5	8.0	1.6	0.5	11.3	0.5	9.1	0.6	6.9	0.7
S193	NM129	Rio Rancho 9	3	na	8/13/1996	20.64	0.6188	8,000	16.8	7.7	14.4	7.8	12.0	7.9	4.0	7.4	0.6	5.3	0.7	3.2	0.8
		Zone 4: Western Boundary (after Plummer et al., 2004)																			
S039	NM266	Windmill No. 20	4	na	6/21/1997	14.98	0.5019	5,000	20.2	2.7	17.7	2.8	15.3	2.9	1.0	17.3	1.0	14.9	1.1	12.5	1.2
S059	NM278	Windmill No. 21	4	na	6/23/1997	13.82	0.5191	5,000	14.2	0.0	11.8	0.1	9.6	0.2	nd	14.2	0.0	11.8	0.1	9.6	0.2
S074	NM285	Windmill No. 23	4	na	6/21/1997	12.26	0.4466	5,000	21.9	0.3	19.3	0.4	16.9	0.5	nd	21.9	0.3	19.3	0.4	16.9	0.5
		Zone 5: Rio Puerco (after Plummer et al., 2004)																			
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	35.65	0.8533	5,000	20.5	23.9	18.0	24.1	15.5	24.2	nd	20.5	23.9	18.0	24.1	15.5	24.2
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	17.12	0.5538	5,000	17.5	4.2	15.1	4.4	12.8	4.5	1.8	12.8	1.1	10.5	1.2	8.3	1.3
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	23.73	0.7031	5,000	12.0	9.5	9.8	9.6	7.6	9.7	nd	12.0	9.5	9.8	9.6	7.6	9.7
S198	NM137	Windmill No. 07	5	na	8/21/1996	20.27	0.6329	5,000	13.6	6.4	11.3	6.5	9.1	6.6	3.0	7.0	1.1	4.9	1.2	2.9	1.3
S237	NM341	Windmill No. 30	5	4	6/24/1997	12.64	0.4643	5,000	19.8	0.2	17.3	0.3	14.9	0.4	nd	19.8	0.2	17.3	0.3	14.9	0.4
S238	NM342	Windmill No. 31	5	na	6/24/1997	14.09	0.4965	5,000	18.5	1.4	16.1	1.5	13.7	1.6	nd	18.5	1.4	16.1	1.5	13.7	1.6
		No Zone: Exotic Water (after Plummer et al., 2004)																			
S009	NM485	Arroyo Salado Spring	E	E	8/6/1998	10.72	0.4016	5,000	25.7	- 0.5	23.1	- 0.4	20.5	- 0.3	nd	25.7	- 0.5	23.1	- 0.4	20.5	- 0.3
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	8.100	0.3299	5,000	32.0	- 2.1	29.2	- 2.0	26.5	- 1.8	nd	32.0	- 2.1	29.2	- 2.0	26.5	- 1.8
S038	NM265	Windmill No. 19	E	E	7/1/1997	21.41	0.6898	5,000	8.6	6.0	6.5	6.1	4.4	6.2	nd	8.6	6.0	6.5	6.1	4.4	6.2
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	21.91	0.6057	5,000	23.0	10.4	20.4	10.5	17.9	10.7	nd	23.0	10.4	20.4	10.5	17.9	10.7

Table B7. Summary of chlorofluorocarbon concentrations in water from wells and springs

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; CFC-11=trichlorofluoromethane ($CFCl_3$); CFC-12=dichlorodifluoromethane (CF_2Cl_2); CFC-113=trichlorotrifluoroethane ($C_2F_3Cl_3$); pg/kg=picograms per kilogram; pptv=parts per trillion by volume; na=not applicable; Modern concentrations of CFC-11, CFC-12, and CFC-113 assumed to be 271, 532, and 84.5 pptv, respectively, in calculation of Percent modern CFC.]

site No.	sample No.	site name	primary hydro-chemical zone	secon-dary hydro-chemical zone	date	CFC-11 (pg/kg)	CFC-12 (pg/kg)	CFC-113 (pg/kg)	calculated atmospheric partial pressure of CFC-11 (pptv)	calculated atmospheric partial pressure of CFC-12 (pptv)	calculated atmospheric partial pressure of CFC-113 (pptv)	percent modern CFC-11	percent modern CFC-12	percent modern CFC-113
Zone 3: West Central (after Plummer et al., 2004)														
S188	NM132	Rio Rancho 13	3	na	8/13/1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S193	NM129	Rio Rancho 9	3	na	8/13/1996	16.0	25.7	5.2	8.1	55.9	6.4	3.0	10.5	7.6
Zone 4: Western Boundary (after Plummer et al., 2004)														
S059	NM278	Windmill No. 21	4	na	6/23/1997	18.2	13.8	0.0	9.2	30.1	0.0	3.4	5.7	0.0
Zone 5: Rio Puerco (after Plummer et al., 2004)														
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	20.1	52.2	11.7	10.5	116.6	14.8	3.9	21.9	17.6
S082	NM409	Windmill No. 36	5	na	9/10/1997	95.5	42.0	6.5	48.5	91.4	8.0	17.9	17.2	9.4
S085	NM408	Windmill No. 35	5	na	9/10/1997	211.6	98.5	18.5	107.4	214.5	22.7	39.6	40.3	26.9
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	5.4	12.2	0.0	2.8	27.2	0.0	1.0	5.1	0.0
S198	NM137	Windmill No. 07	5	na	8/21/1996	73.1	43.8	8.1	37.1	95.5	10.0	13.7	17.9	11.8
No Zone: Exotic Water (after Plummer et al., 2004)														
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	32.7	37.0	623.0	16.6	81.5	764.2	6.1	15.3	904.4
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	319.5	172.5	36.8	162.1	375.6	45.1	59.8	70.6	53.4

Table B8. Summary of sulfur hexafluoride and helium concentrations in water samples from wells and springs

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; SF_6=sulfur hexafluoride; He=helium; fMol/kg=femtomoles per kilogram; GC=gas chromotography; MS=mass spectrometry; ccSTP/g=cubic centimeters at standard temperature and pressure per gram; LDEO=Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY; na=not available; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	SF_6 (fMol/kg)	USGS He by GC ($ccSTP/gx10^8$)	LDEO He by MS ($ccSTP/gx10^8$)	Replicate 1 LDEO He by MS ($ccSTP/gx10^8$)	Replicate 2 LDEO He by MS ($ccSTP/gx10^8$)
Zone 3: West Central (after Plummer et al., 2004)										
S188	NM132	Rio Rancho 13	3	na	8/13/1996	0.620	nd			
Zone 4: Western Boundary (after Plummer et al., 2004)										
S039	NM266	Windmill No. 20	4	na	6/21/1997	1.433	14.3			
S059	NM278	Windmill No. 21	4	na	6/23/1997	1.809	13.8			
S074	NM285	Windmill No. 23	4	na	6/21/1997	1.450	nd			
Zone 5: Rio Puerco (after Plummer et al., 2004)										
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	1.832	nd			
S085	NM408	Windmill No. 35	5	na	9/10/1997	0.485	nd			
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	nd	2,285			
S198	NM137	Windmill No. 07	5	na	8/21/1996	25.206	nd			
S237	NM341	Windmill No. 30	5	4	6/24/1997	0.322	73.9			
No Zone: Exotic Water (after Plummer et al., 2004)										
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	1.482	nd			
S038	NM265	Windmill No. 19	E	E	7/1/1997	0.359	12,234			
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	2.428	10.1			
S202	NM330	Windmill No. 27	E	E	7/2/1997	0.764	nd			

Table B9. Summary of stable hydrogen, oxygen, and sulfur isotopic data from wells and springs

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; d^2H=hydrogen-2; $d^{18}O$=oxygen-18; SO_4^{2-}=sulfate; $d^{34}S$=sulfur-34; $d=((R_{sample}/R_{standard}) -1)x1000$, where R is an isotope ratio; per mil=parts per thousand; mg/L=milligrams per liter; na=not applicable; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	d^2H (per mil)	$d^{18}O$ (per mil)	^2H excess (per mil)	SO_4^{2-} (mg/L)	$d^{34}S$ (per mil)
Zone 3: West Central (after Plummer et al., 2004)										
S188	NM132	Rio Rancho 13	3	na	8/13/1996	-118.	-15.6	6.3	75.2	- 3.1
S193	NM129	Rio Rancho 9	3	na	8/13/1996	-105.	-13.8	5.0	47.8	nd
Zone 4: Western Boundary (after Plummer et al., 2004)										
S031	NM263	Windmill No. 18	4	na	6/24/1997	-64.0	-9.12	8.9	554.	nd
S039	NM266	Windmill No. 20	4	na	6/21/1997	-79.5	-10.8	6.9	919.	nd
S059	NM278	Windmill No. 21	4	na	6/23/1997	-72.9	-9.50	3.1	793.	nd
S074	NM285	Windmill No. 23	4	na	6/21/1997	-53.5	-8.12	11.5	583.	nd
S201	NM329	Windmill No. 26	4	na	7/2/1997	-81.4	-11.3	9.3	936.	9.4
S252	NM167	Windmill No. 10	4	na	8/29/1996	-56.5	-7.84	6.2	414.	nd
S260	NM345	Windmill No. 33	4	na	6/25/1997	-64.8	-9.12	8.2	672.	nd
Zone 5: Rio Puerco (after Plummer et al., 2004)										
S032	NM262	Windmill No. 17	5	na	6/24/1997	-64.0	-8.65	5.3	903.	nd
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	-68.2	-8.95	3.5	490.	nd
S073	NM062	Windmill No. 03	5	na	8/16/1996	-60.6	-7.74	1.3	1,060.	- 2.1
S082	NM409	Windmill No. 36	5	na	9/10/1997	-59.8	-8.21	5.9	1,180.	nd
S085	NM408	Windmill No. 35	5	na	9/10/1997	-72.4	-9.56	4.1	543.	nd
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	-60.0	-7.81	2.5	702.	- 4.4
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	-73.5	-9.75	4.5	1,107.	nd
S198	NM137	Windmill No. 07	5	na	8/21/1996	-61.6	-7.59	- 0.8	2,130.	- 0.1
S215	NM335	Sandoval Spring	5	4	7/1/1997	-59.2	-8.51	8.9	291.	nd
S237	NM341	Windmill No. 30	5	4	6/24/1997	-63.5	-8.73	6.3	490.	nd
S238	NM342	Windmill No. 31	5	na	6/24/1997	-59.4	-7.66	1.9	1,303.	nd

Table B9. Summary of stable hydrogen, oxygen, and sulfur isotopic data from wells and springs

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; d^2H=hydrogen-2; $d^{18}O$=oxygen-18; SO_4^{2-}=sulfate; $d^{34}S$=sulfur-34; $d=((R_{sample}/R_{standard}) -1)x1000$, where R is an isotope ratio; per mil=parts per thousand; mg/L=milligrams per liter; na=not applicable; nd=not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	d^2H (per mil)	$d^{18}O$ (per mil)	^2H excess (per mil)	SO_4^{2-} (mg/L)	$d^{34}S$ (per mil)
No Zone: Exotic Water (after Plummer et al., 2004)										
S009	NM485	Arroyo Salado Spring	E	E	8/6/1998	-65.2	-7.66	- 3.9	3,750.	nd
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	-79.8	-9.45	- 4.2	2,190.	7.4
S038	NM265	Windmill No. 19	E	E	7/1/1997	-99.7	-13.3	6.4	2,134.	13.9
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	-58.5	-8.07	6.1	170.	0.
S202	NM330	Windmill No. 27	E	E	7/2/1997	-61.5	-9.03	10.7	672.	nd
Zone Nac: Rio Salado (North) - (Trainer, 1978)										
san 29	A2	Tierra Amarilla Spring A2			9/15/2025	-				
san 31	A4	Tierra Amarilla Spring A4			9/15/2025	-				
san 41	A6	Tierra Amarilla Spring A6			9/15/2025	-				

Table B10. Summary of tritium, CFC-12, ^{13}C, and ^{14}C data for wells and springs

[SXXX, no site number assigned; Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; CFC-12=dichlorodifluoromethane (CF_2Cl_2); $\delta^{13}C$=carbon-13; ^{14}C=carbon-14; per mil=parts per thousand; pmC=percent modern carbon; TU=tritium unit, 1 TU=1 atom of ^{3}H in 10^{18} atoms of H; 1σ=one standard deviation; pg/kg=picograms per kilogram; $\delta=((R_{sample}/R_{standard})-1)x1000$=where R is an isotope ratio; Sources of tritium data: L, Noble Gas Laboratory of Lamont-Doherty Earth Observatory, Palisades New York, by ^{3}He ingrowth; M, US Geological Survey Low-Level Tritium Laboratory in Menlo Park, California, by liquid scintillation counting of enriched samples; all ground-water tritium data from source M included in this table. See table A12 for additional tritium data from source L; na, not applicable; nd, not determined]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	tritium (TU)	tritium error ± 1σ (TU)	source of tritium data L or M	CFC-12 (pg/kg)	$\delta^{13}C$ (per mil)	^{14}C (pmC)	^{14}C error (pmC)	unadjusted ^{14}C age, Libby half-life (years)
		Zone 3: West Central (after Plummer et al., 2004)											
S188	NM132	Rio Rancho 13	3	na	8/13/1996	nd	nd	na	0	-7.10	3.00	0.1	28,168
S193	NM129	Rio Rancho 9	3	na	8/13/1996	0.0	0.3	M	26	-7.81	7.72	0.1	20,575
		Zone 4: Western Boundary (after Plummer et al., 2004)											
S031	NM263	Windmill No. 18	4	na	6/24/1997	-0.7	0.2	M	nd	-4.60	8.14	0.1	20,150
S039	NM266	Windmill No. 20	4	na	6/21/1997	-0.1	0.3	M	nd	-1.70	0.79	0.1	38,887
S059	NM278	Windmill No. 21	4	na	6/23/1997	0.1	0.3	M	14	-6.90	9.80	0.1	18,659
S074	NM285	Windmill No. 23	4	na	6/21/1997	0.1	0.3	M	nd	-0.90	4.24	0.1	25,389
S201	NM329	Windmill No. 26	4	na	7/2/1997	0.0	0.3	M	nd	-4.80	2.68	0.1	29,074
S252	NM167	Windmill No. 10	4	na	8/29/1996	0.5	0.3	M	nd	-6.17	9.69	0.2	18,749
S260	NM345	Windmill No. 33	4	na	6/25/1997	0.5	0.3	M	nd	-3.20	3.29	0.1	27,427
		Zone 5: Rio Puerco (after Plummer et al., 2004)											
S032	NM262	Windmill No. 17	5	na	6/24/1997	0.3	0.3	M	nd	-3.50	29.8	0.2	9,736
S069	NM058	Domestic Well No. 06	5	na	8/16/1996	0.2	0.3	M	52	-9.31	36.5	0.4	8,107
S073	NM062	Windmill No. 03	5	na	8/16/1996	-0.2	0.3	M	nd	-6.99	49.1	0.4	5,720
S082	NM409	Windmill No. 36	5	na	9/10/1997	0.1	0.3	M	42	-12.3	43.3	0.4	6,733
S085	NM408	Windmill No. 35	5	na	9/10/1997	0.2	0.3	M	99	-9.80	13.2	0.1	16,254
S111	NM079	Domestic Well No. 10	5	na	8/16/1996	nd	nd	na	0	-6.76	54.7	0.5	4,842
S185	NM324	Domestic Well No. 31	5	na	6/16/1997	nd	nd	na	12	-10.6	36.3	0.4	8,134
S198	NM137	Windmill No. 07	5	na	8/21/1996	7.3	0.4	M	44	-4.65	84.5	0.7	1,354
S237	NM341	Windmill No. 30	5	4	6/24/1997	0.0	0.3	M	nd	-7.40	23.8	0.3	11,538
S238	NM342	Windmill No. 31	5	na	6/24/1997	-0.3	0.3	M	nd	-7.90	32.9	0.4	8,935
		No Zone: Exotic Water (after Plummer et al., 2004)											
S009	NM485	Arroyo Salado Spring	E	E	8/6/1998	2.6	0.3	M	nd	1.79	7.64	0.2	20,659
S028	NM014	Cerro Colorado Landfill MW	E	E	8/12/1996	nd	nd	na	37	2.00	1.59	0.1	33,268
S038	NM265	Windmill No. 19	E	E	7/1/1997	-0.1	0.3	M	nd	-10.90	6.68	0.1	21,738
DB387-S094	NM293	Stock Well No. 02	E	E	6/20/1997	nd	nd	na	173	-5.50	79.3	0.6	1,866
S202	NM330	Windmill No. 27	E	E	7/2/1997	6.4	0.4	M	nd	-4.70	47.2	0.4	6,036
		Zone Nac: Rio Salado (North) - (Trainer, 1978)											
san 27	A1	Tierra Amarilla Spring A1			5/16/1973	0.0	0.4	Res					

Table B11. Data on Tritium, Helium-3, Helium-4, Neon, and Estimation of $^{3}H/^{3}He$ Age

[Hydrochemical Zone "E", exotic water, no primary or secondary zone assigned; $d^{3}He$=helium-3; $d^{3}He=(R_s/R_{air} - 1)100$; R= $^{3}He/^{4}He$; R_s, $^{3}He/^{4}He$ of sample; ^{4}He=helium; TU=Tritium Unit, 1 TU=1 atom of ^{3}H in 10^{18} atoms of H; ^{4}He=Helium-4; Ne=Neon; ccSTP/g=cubic centimeters at standard temperature and pressure per gram; D=percent difference from concentration at solubility equilibrium; Uncorrected age=age not corrected for terrigenic He; Corrected age=age corrected for terrigenic helium assuming R(terrigenic)=$2x10^{-8}$; nd=not determined; Note- Calculated age applies to the young fraction in mixtures. Tritium by helium-3 ingrowth from Lamont-Doherty Earth Observatory, except for values in parentheses which are from the USGS Low-Level Tritium Laboratory by liquid-scintillation counting on enriched samples.]

site No.	sample No.	site name	primary hydro-chemical zone	secondary hydro-chemical zone	date	tritium (TU)	tritium error (TU)	$d^{3}He$ (percent)	$d^{3}He$ error (percent)	$^{3}He/^{4}He$ ratiox10^{-6}	$^{3}He/^{4}He$ ratio error (percent)	^{4}He (ccSTP/g)	^{4}He error (ccSTP/g)	Ne (ccSTP/g)	Ne error (ccSTP/g)	?^{4}He (percent)	?Ne (percent)	uncorrected age (years)	uncorrected age error (years)	corrected age (years)	corrected age error (years)
Zone 3: West Central																					
NO DATA FOR WELLS AND SPRINGS IN THE STUDY AREA																					
No Zone: Exotic Water																					
NO DATA FOR WELLS AND SPRINGS IN THE STUDY AREA																					

Appendix C.

Graphs of streamflow data and gains/losses for the period of record, and for individual years, with stream data files of the Rio Puerco and its tributaries in the study area provided on CD

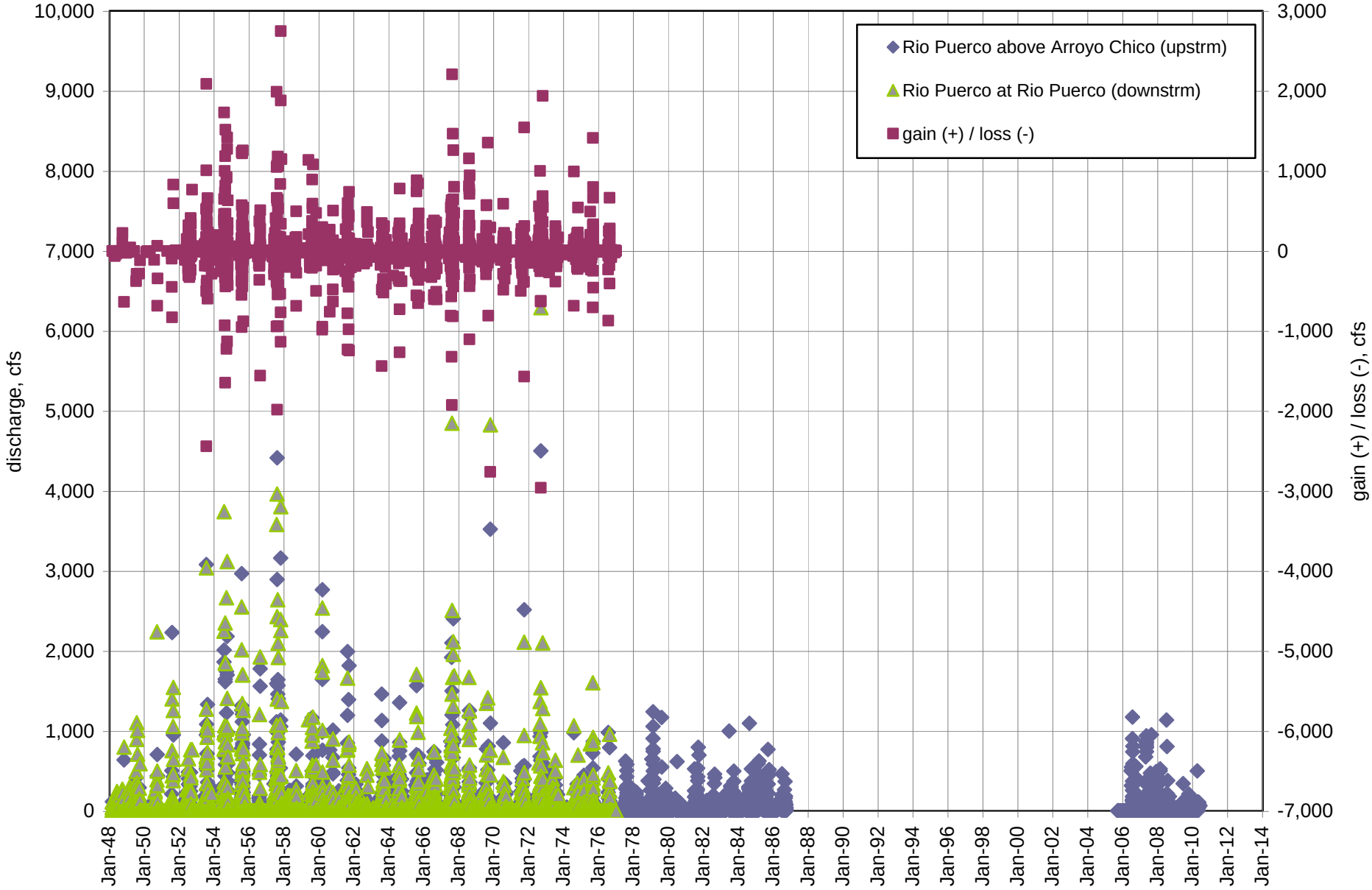

Figure C1. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, for the period of record 1948 through 2010.

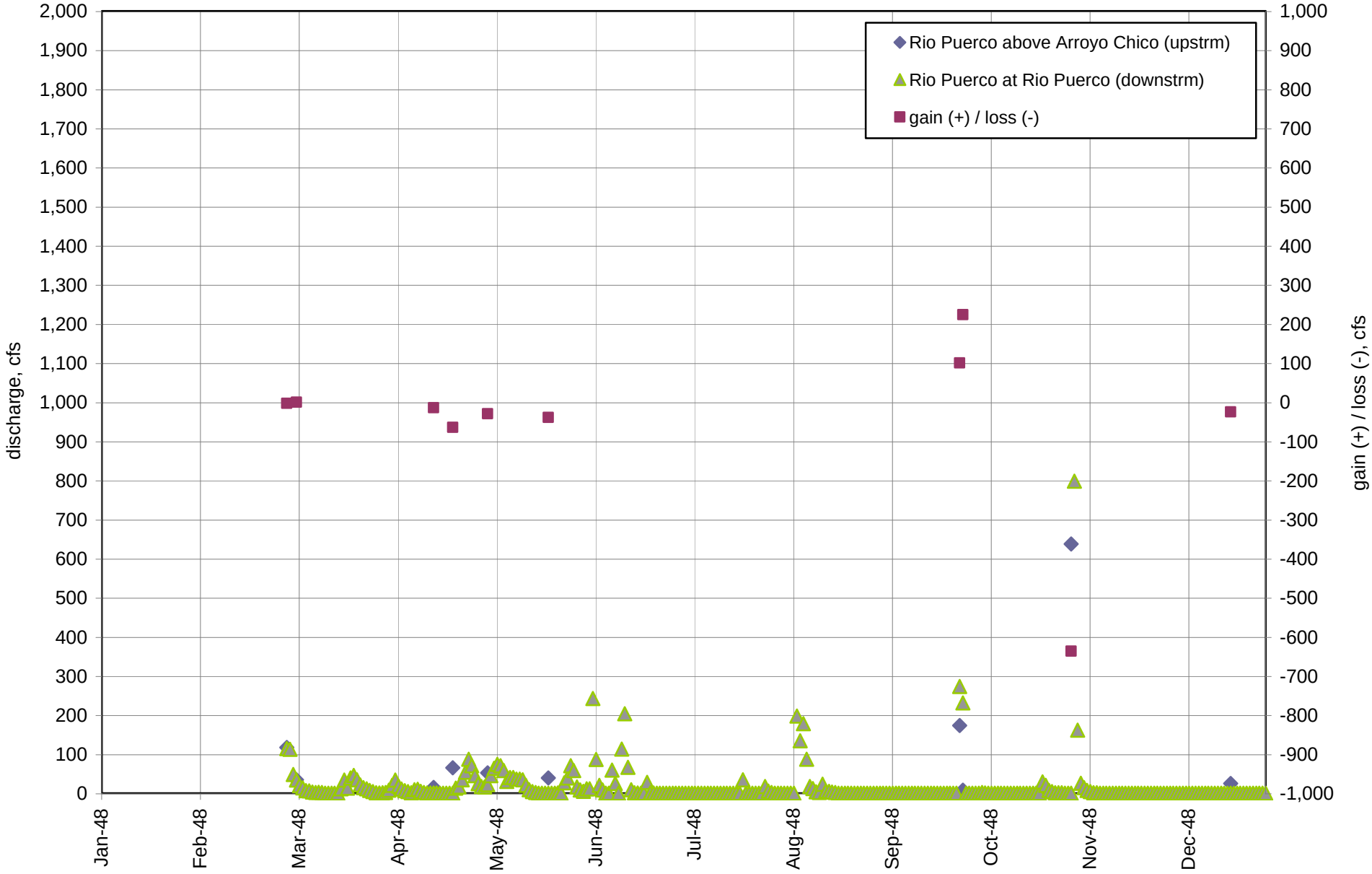

Figure C2. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1948.

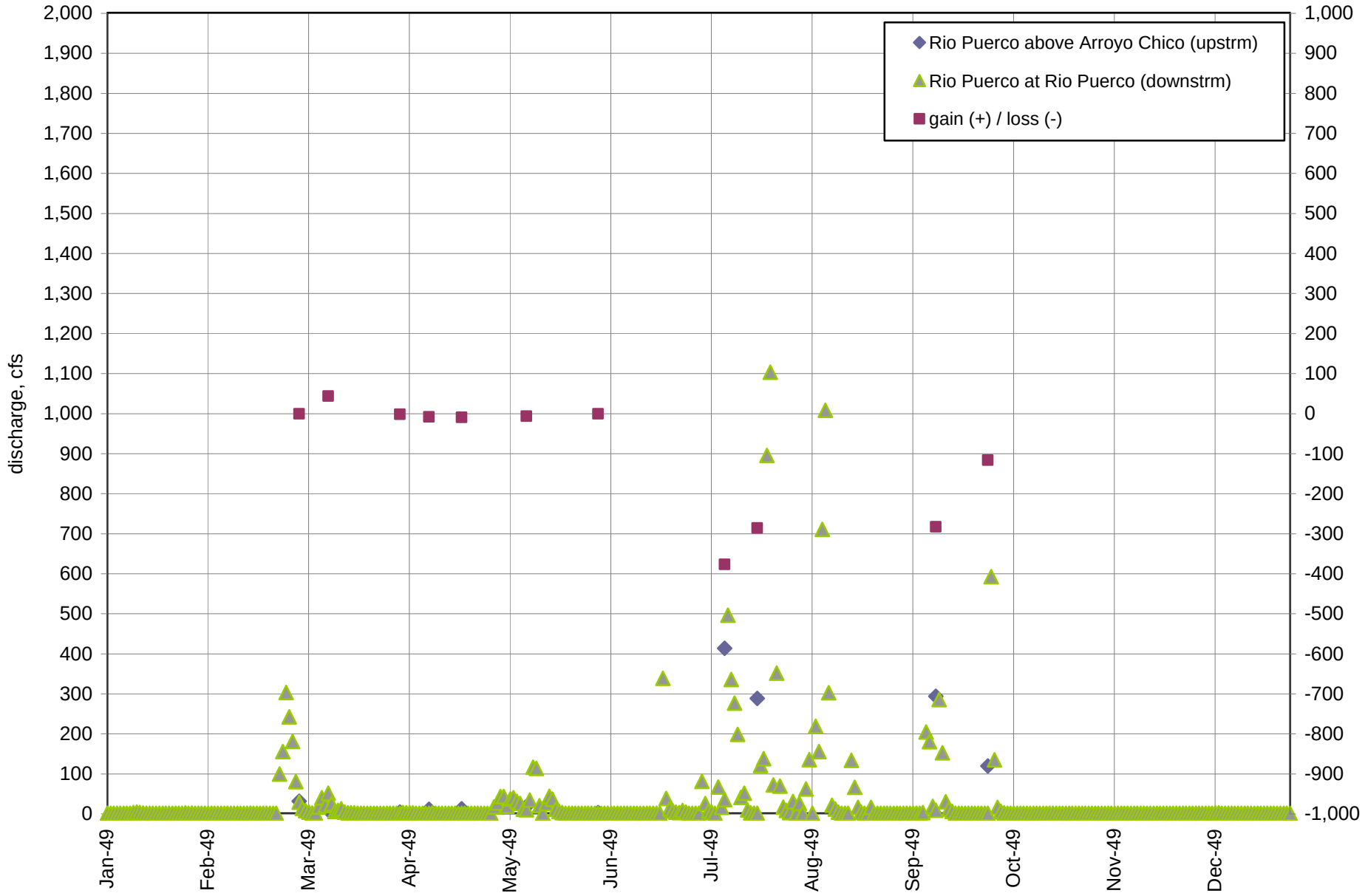

Figure C3. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1949.

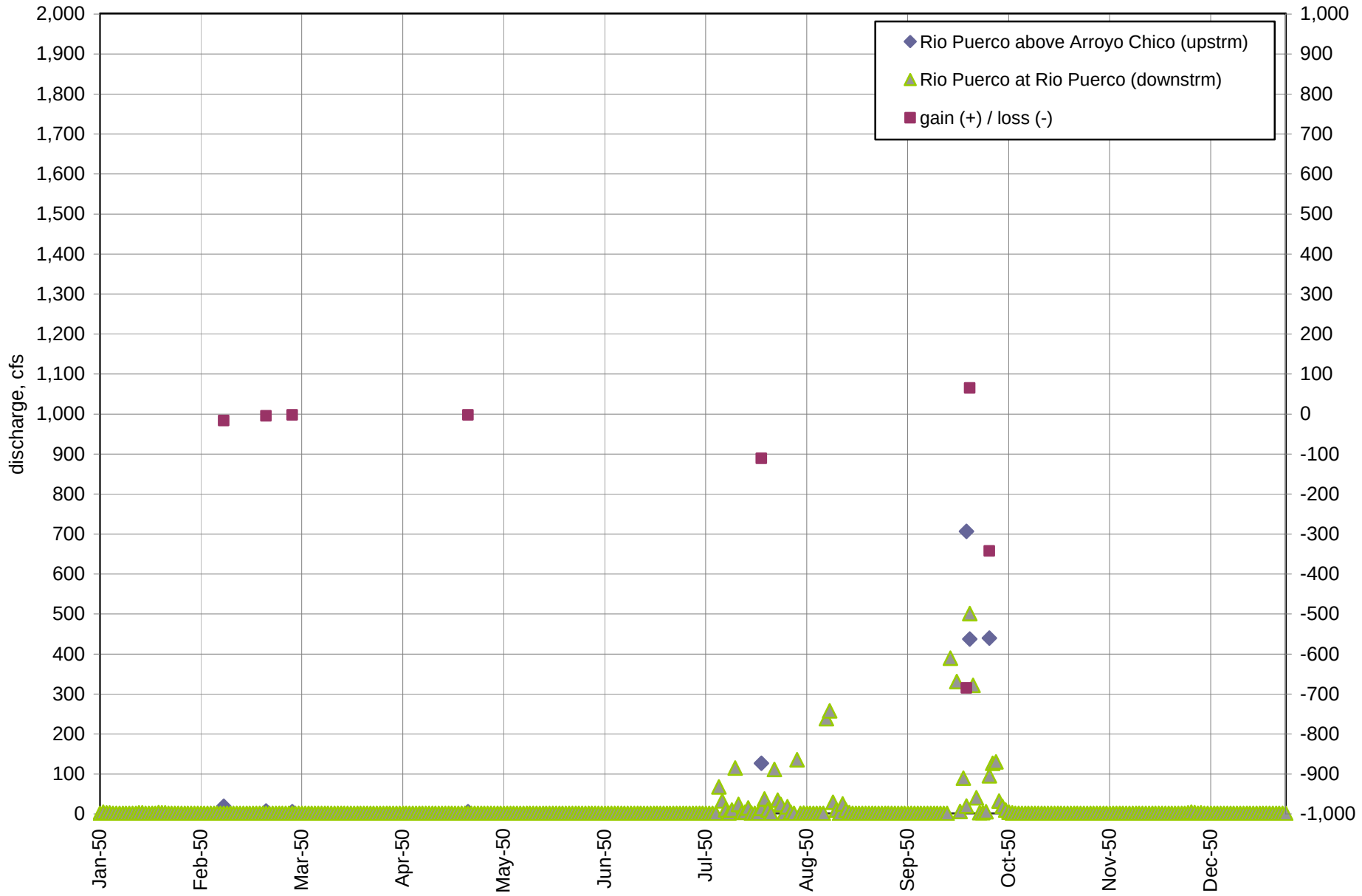

Figure C4. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1950.

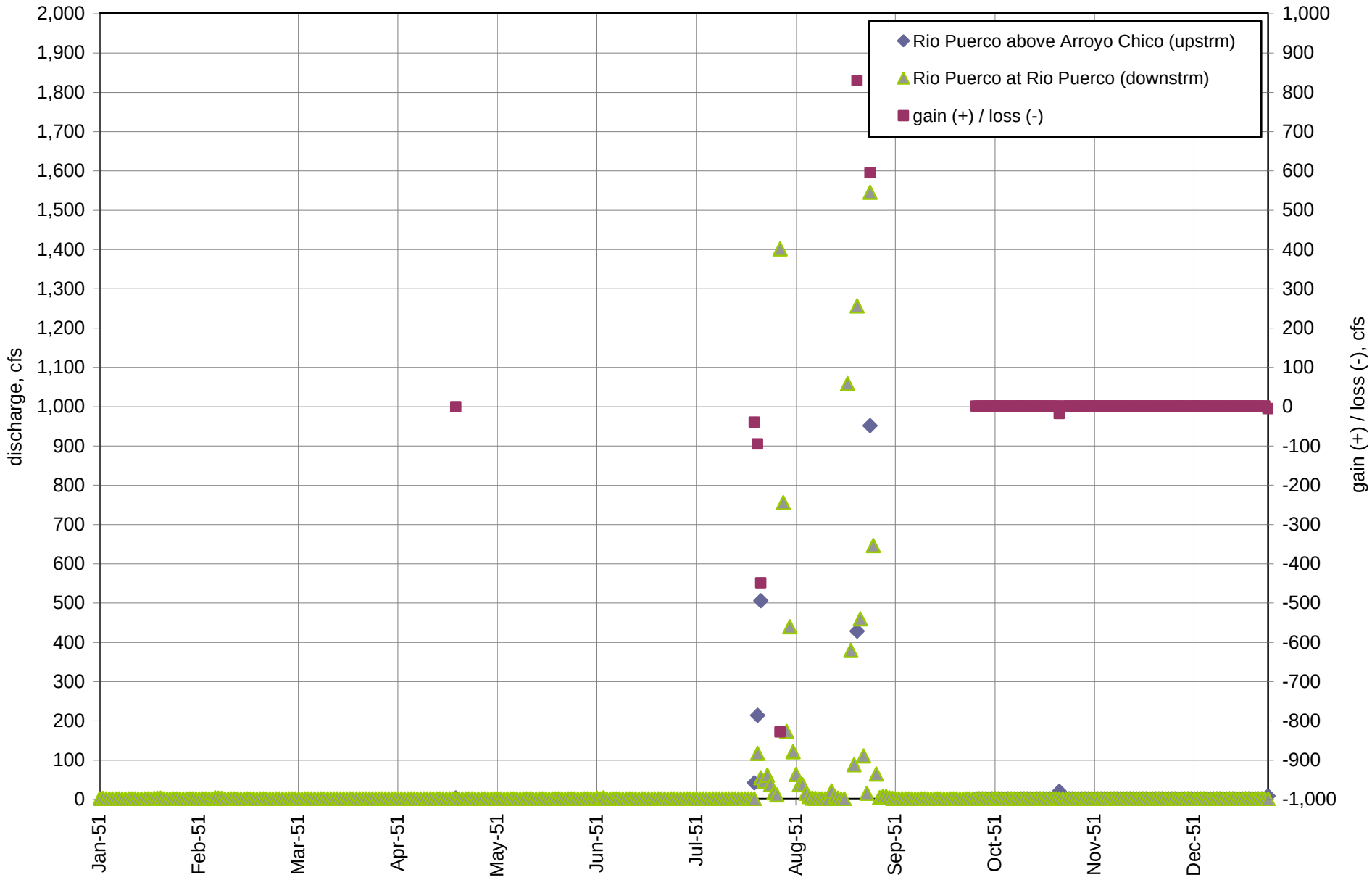

Figure C5. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1951.

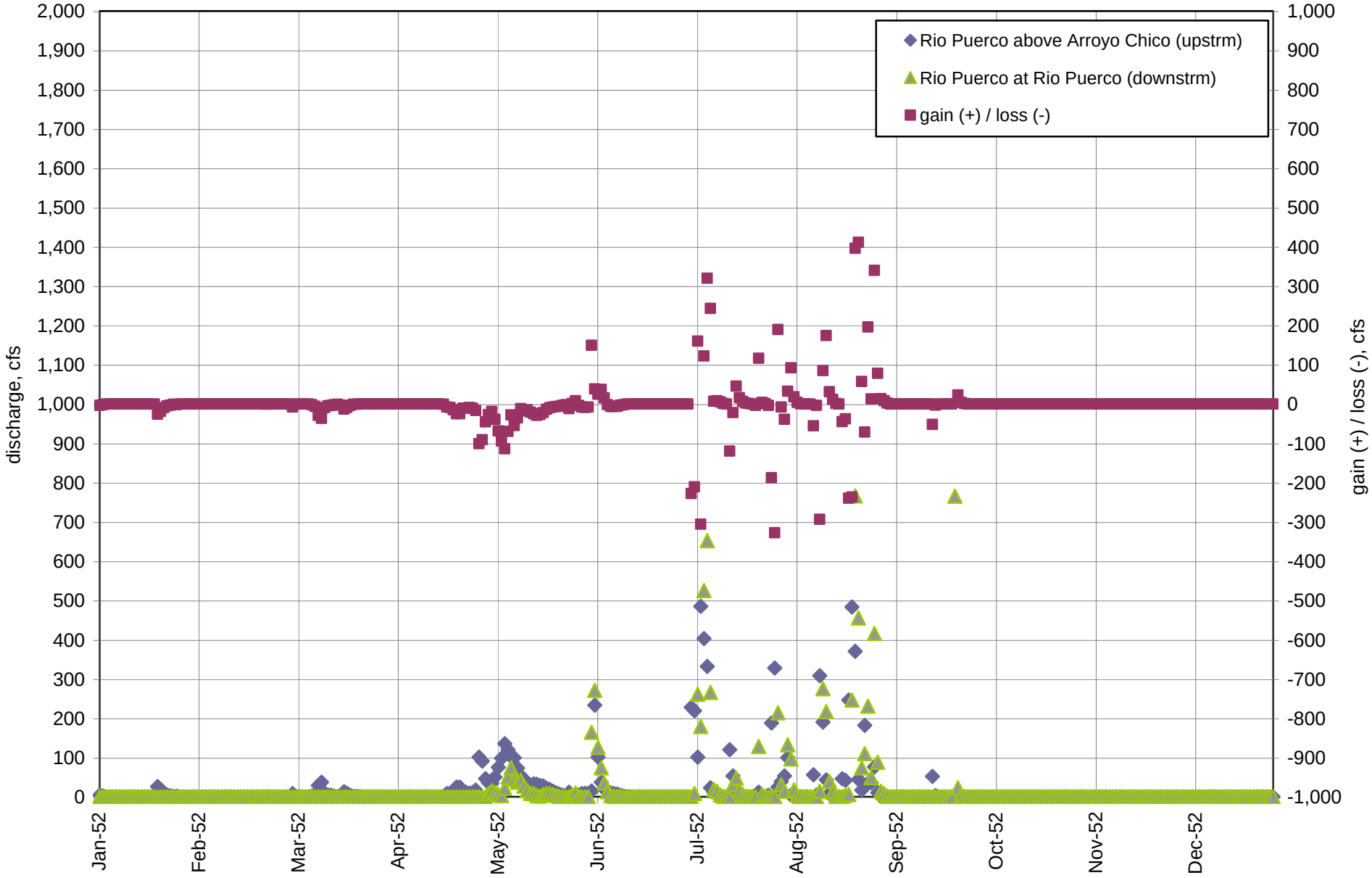

Figure C6. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1952.

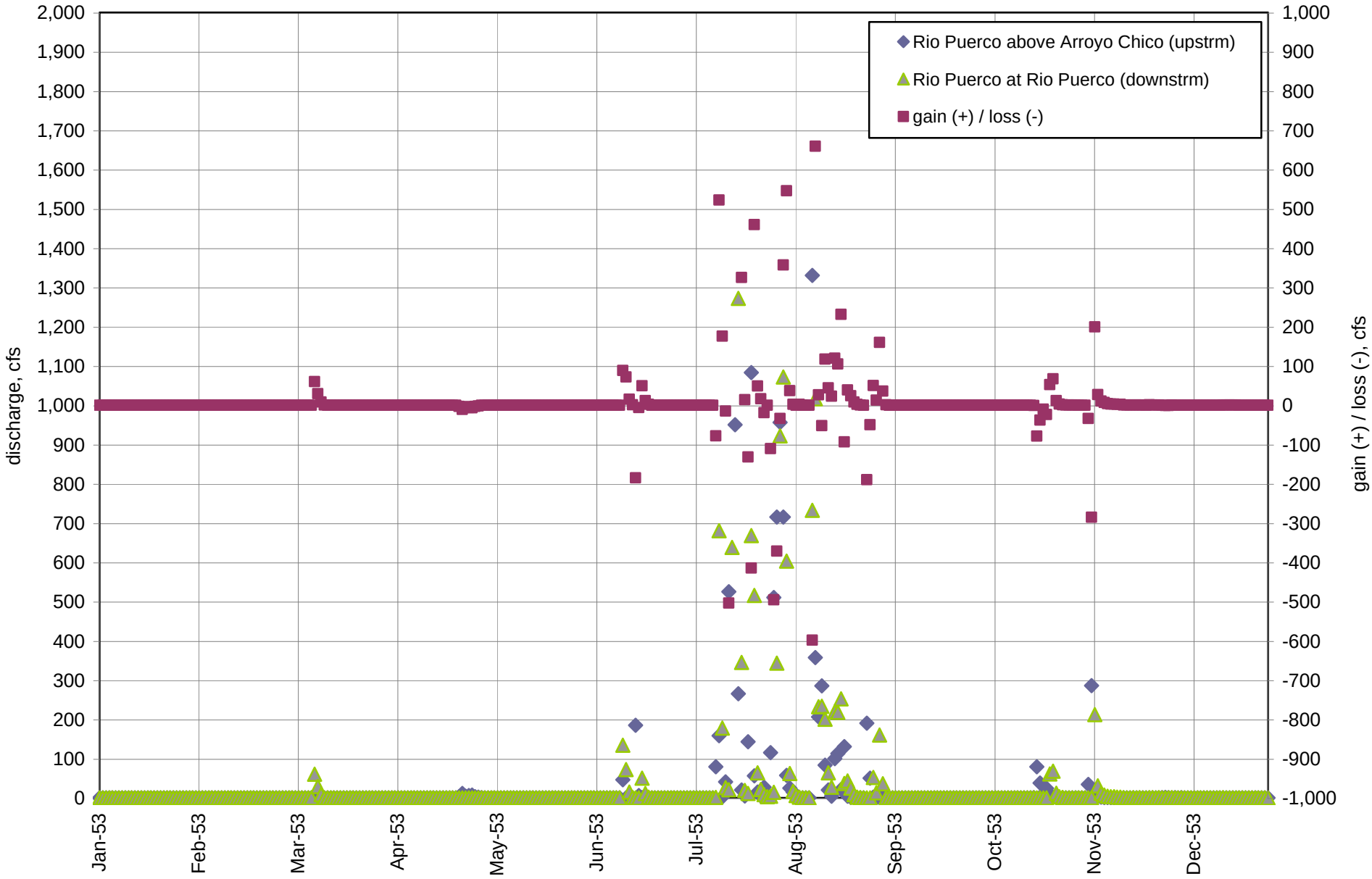

Figure C7. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1953.

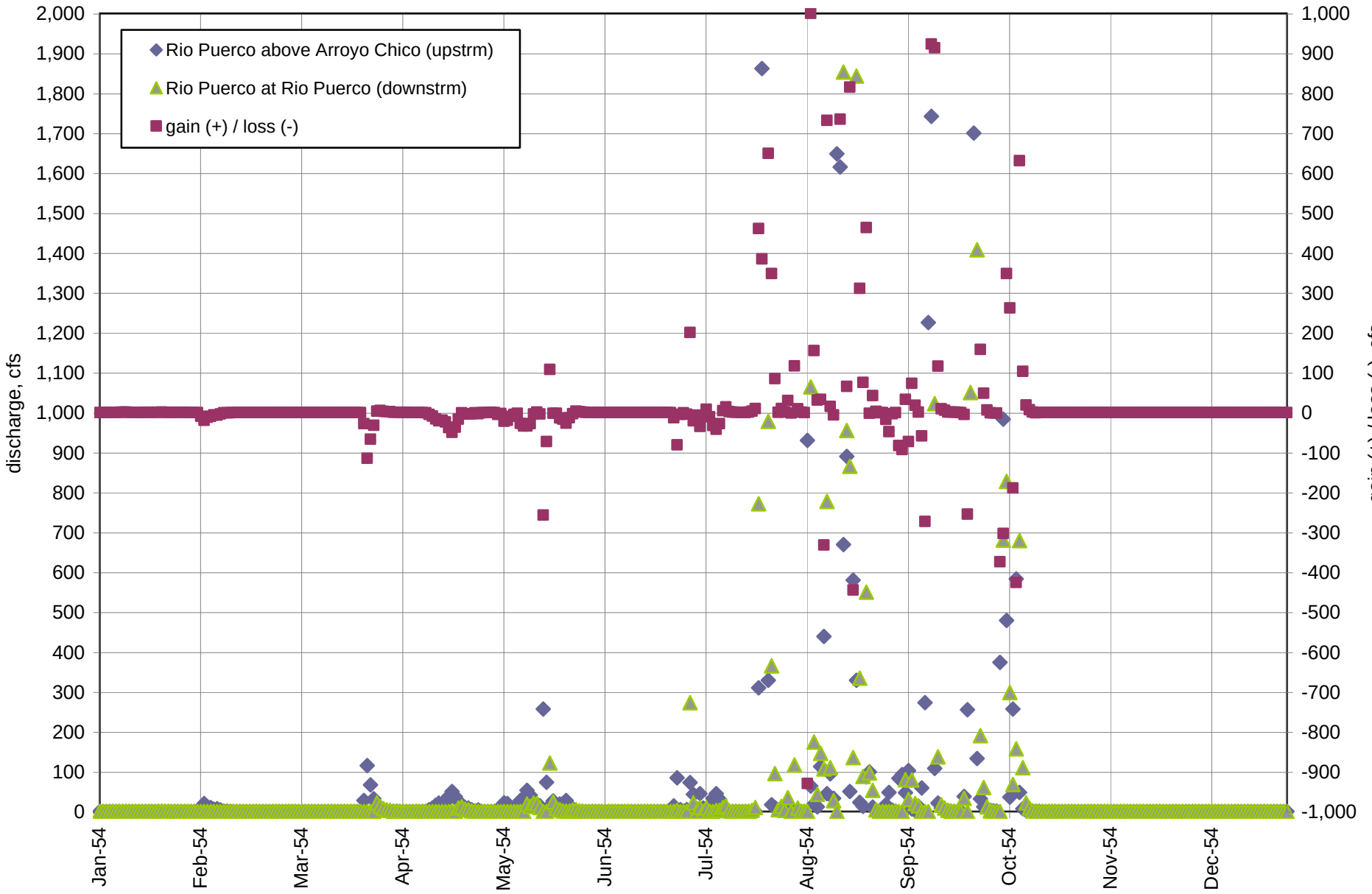

Figure C8. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1954.

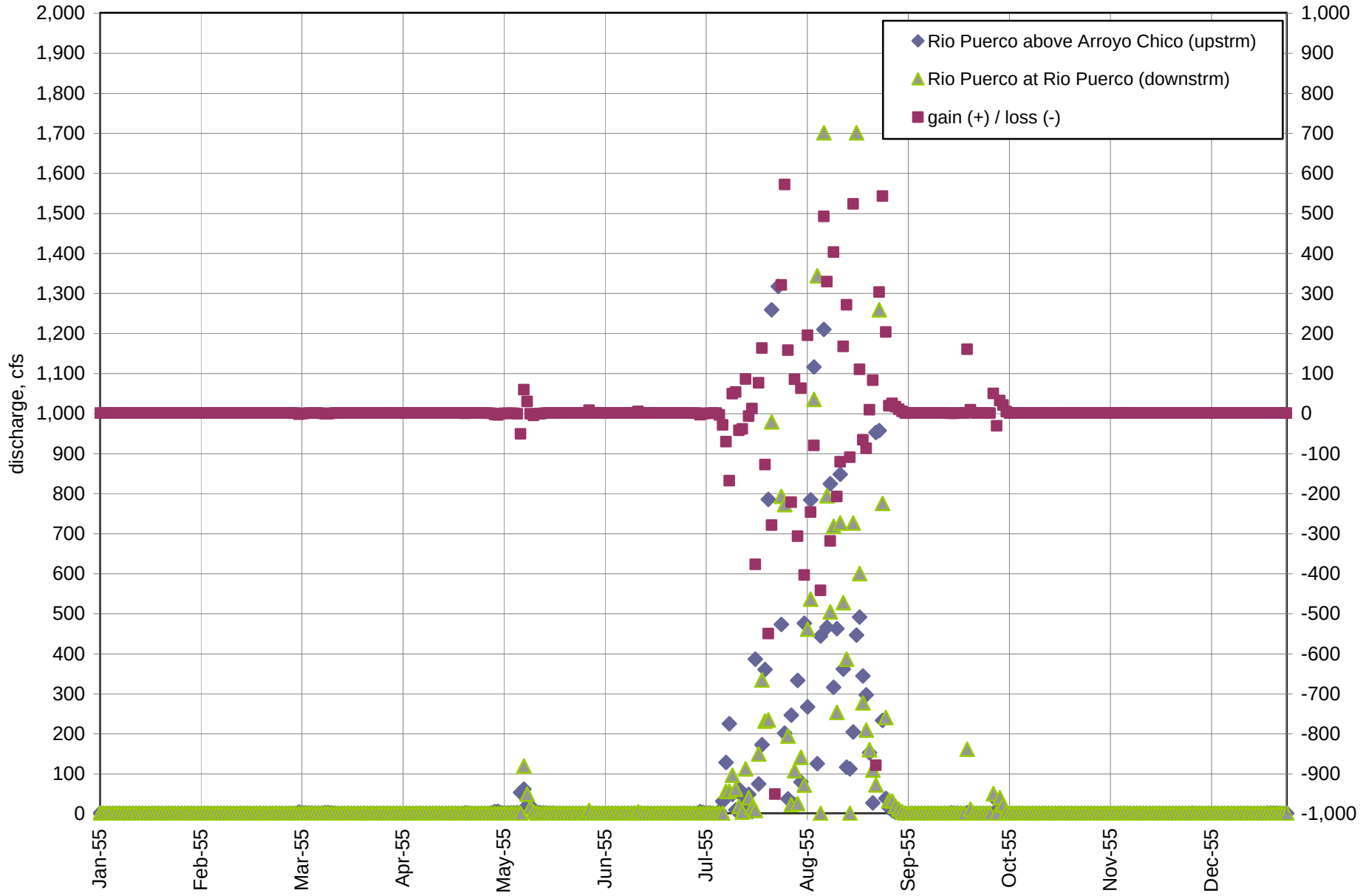

Figure C9. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1955.

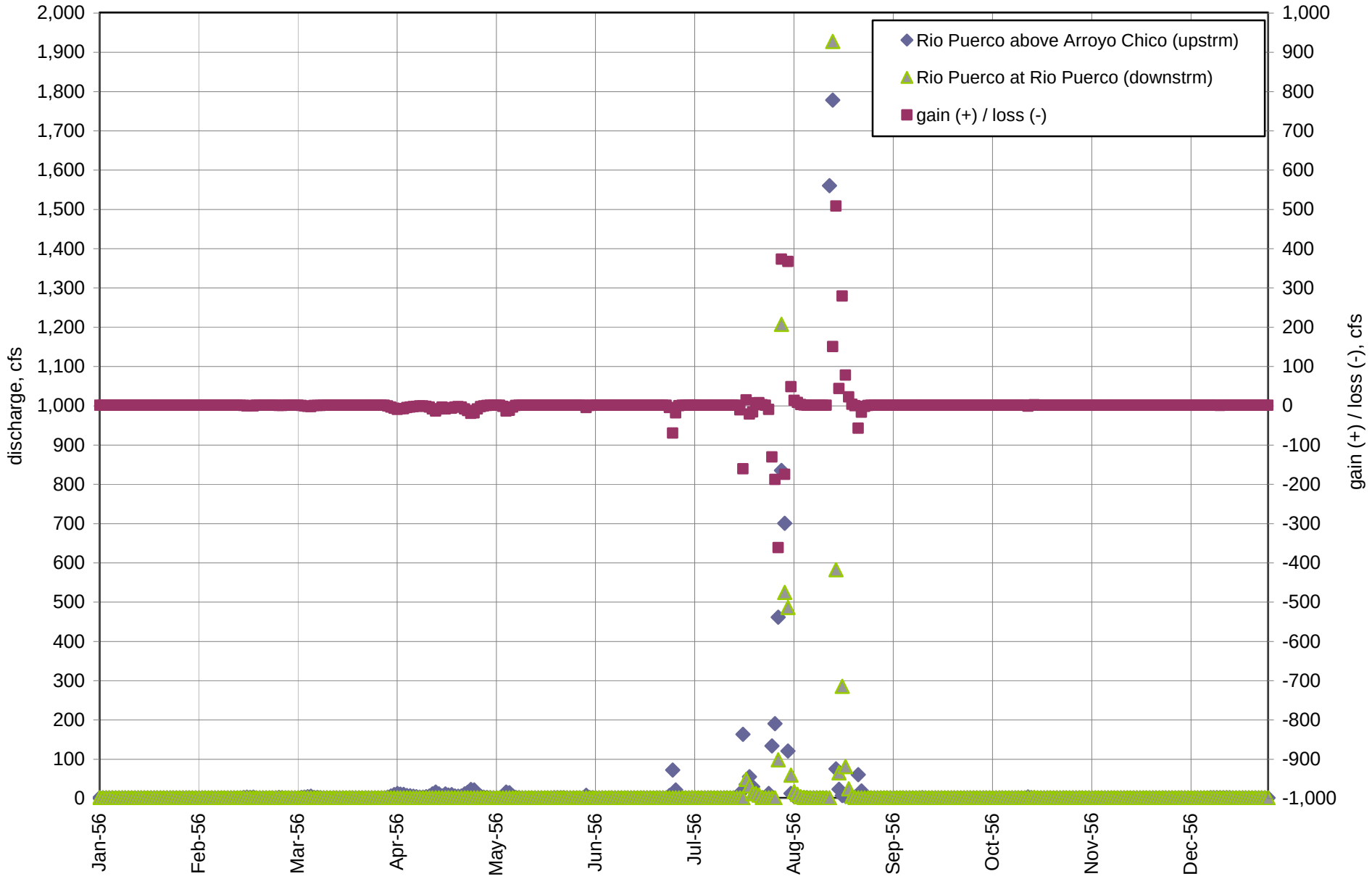

Figure C10. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1956.

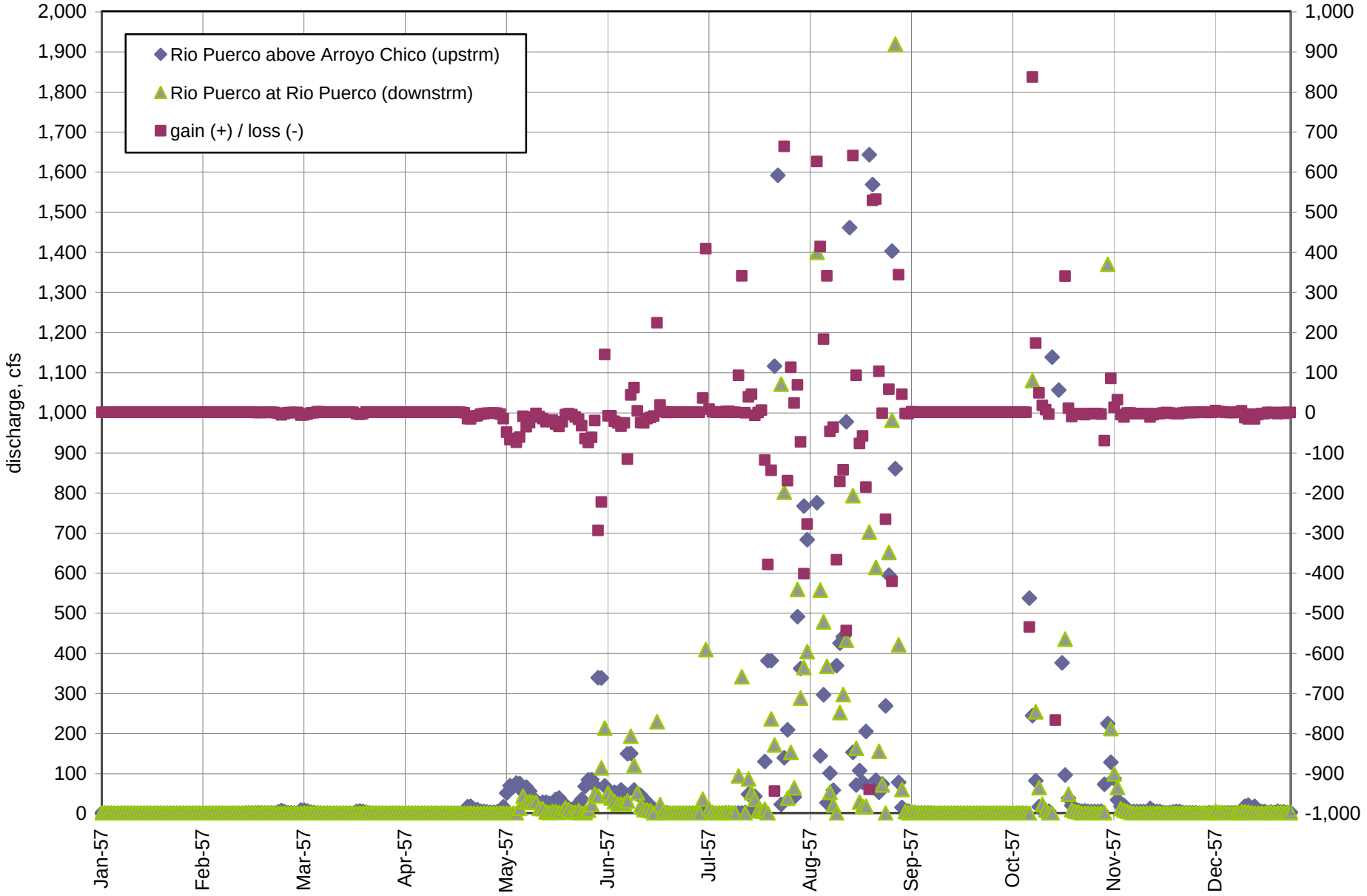

Figure C11. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1957.

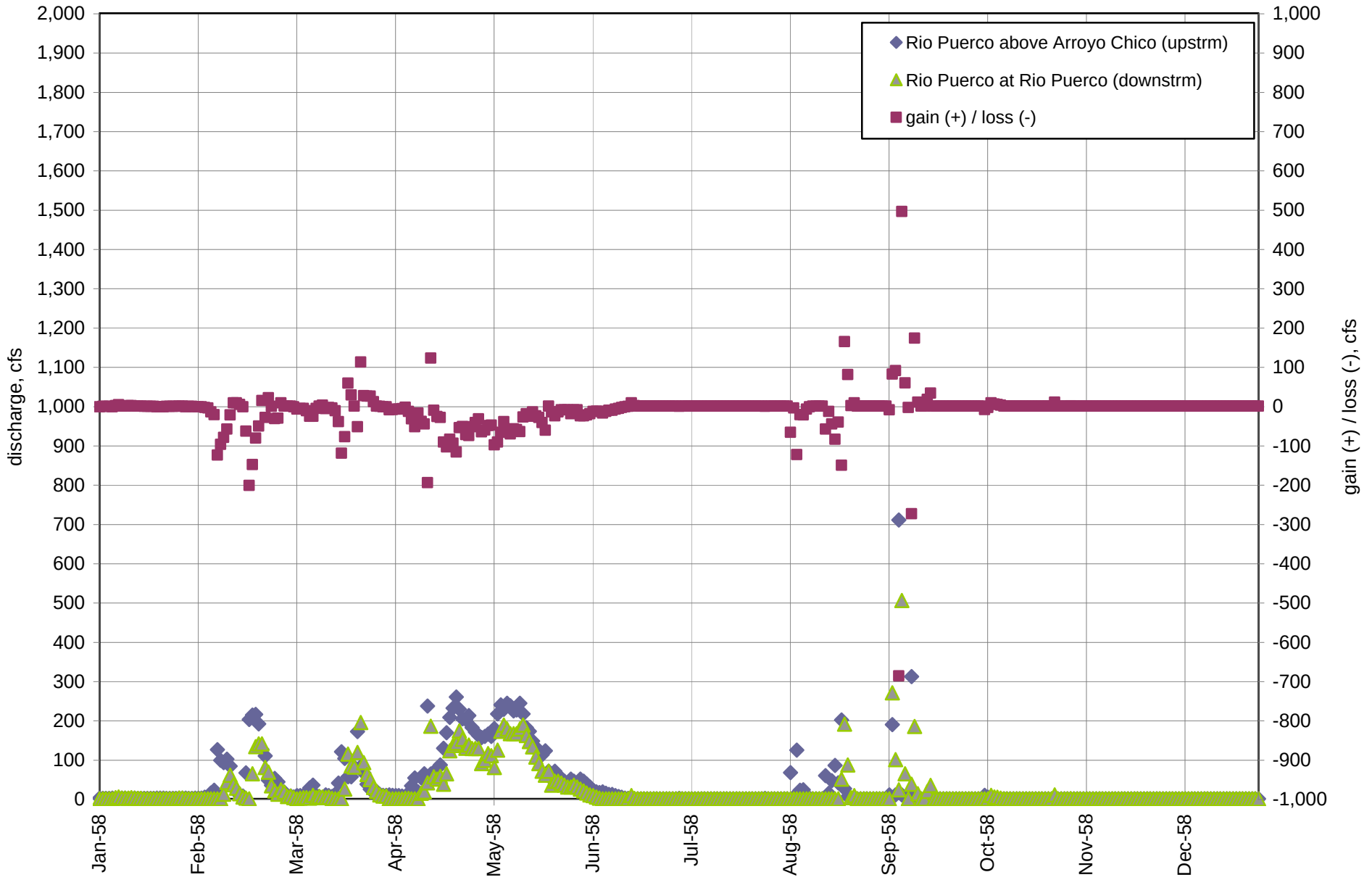

Figure C12. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1958.

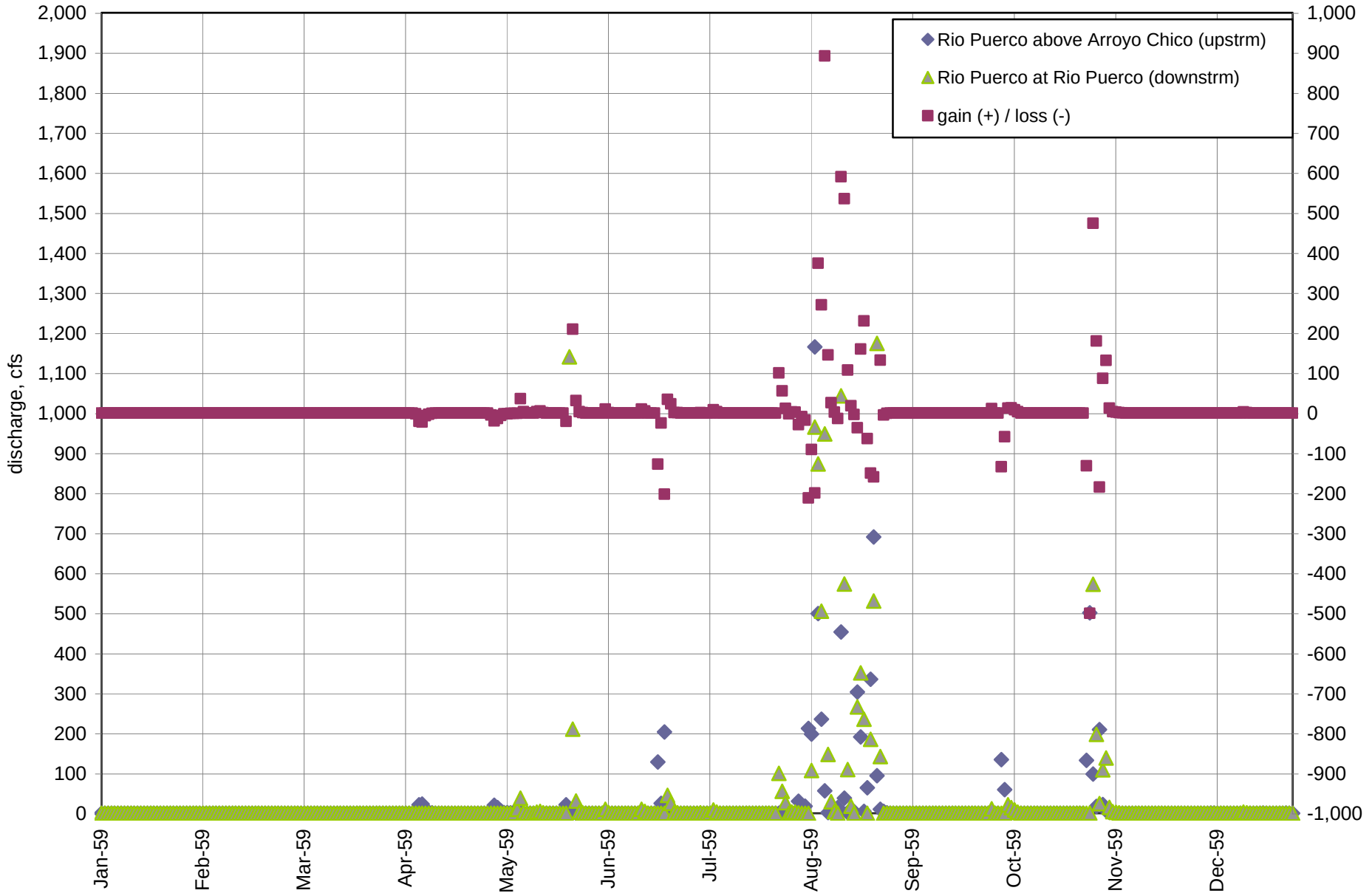

Figure C13. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1959.

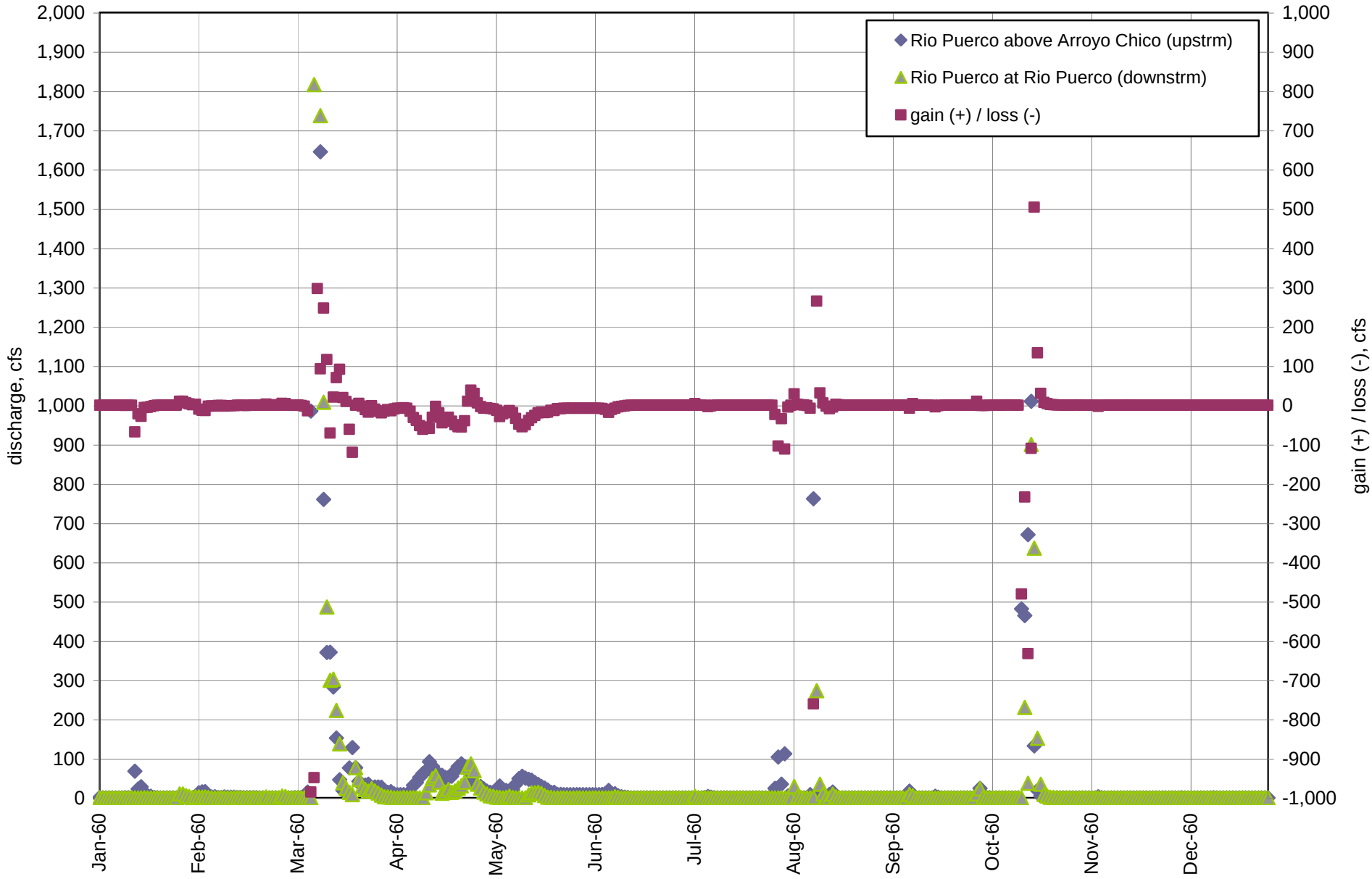

Figure C14. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1960.

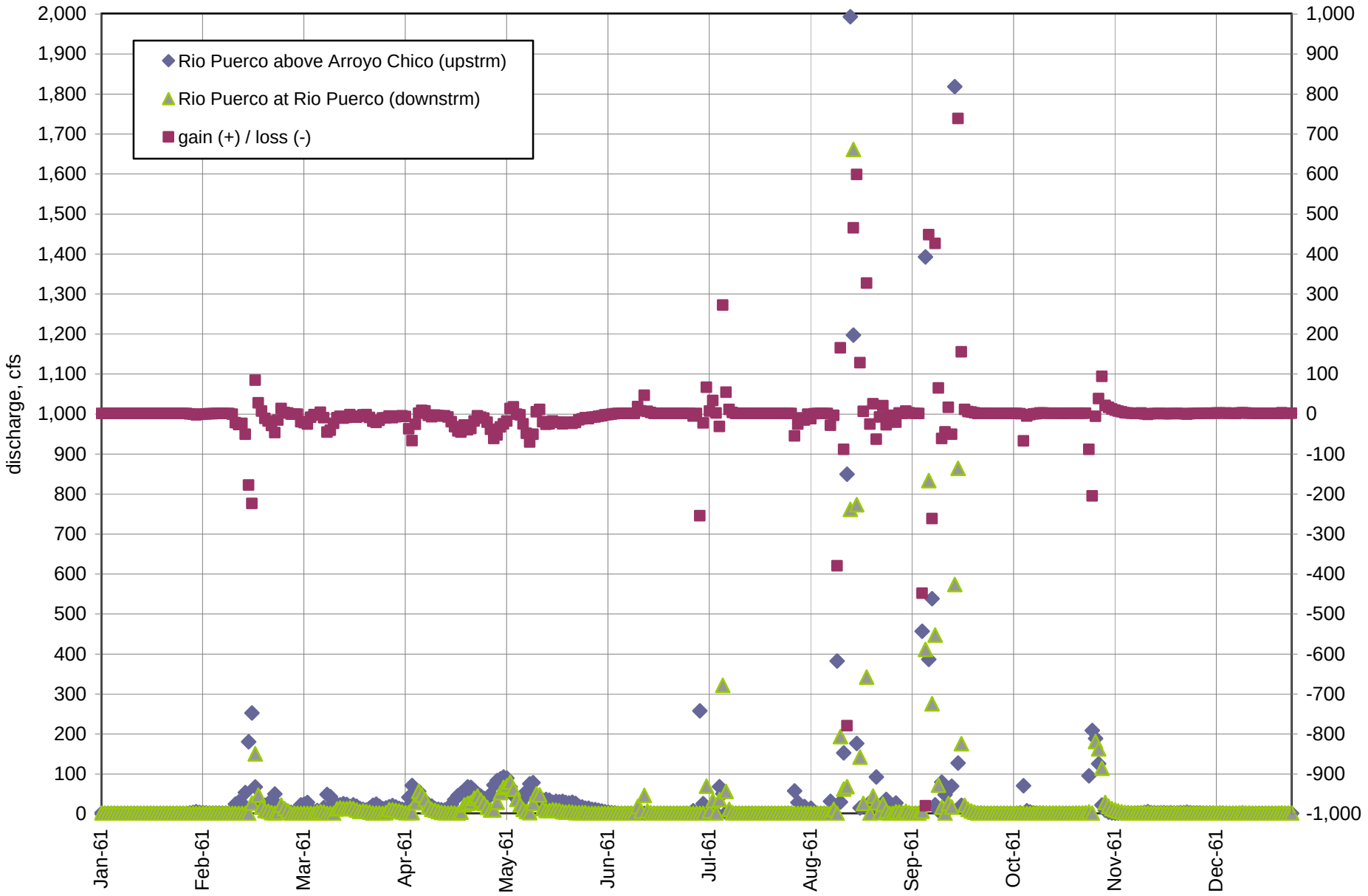

Figure C15. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1961.

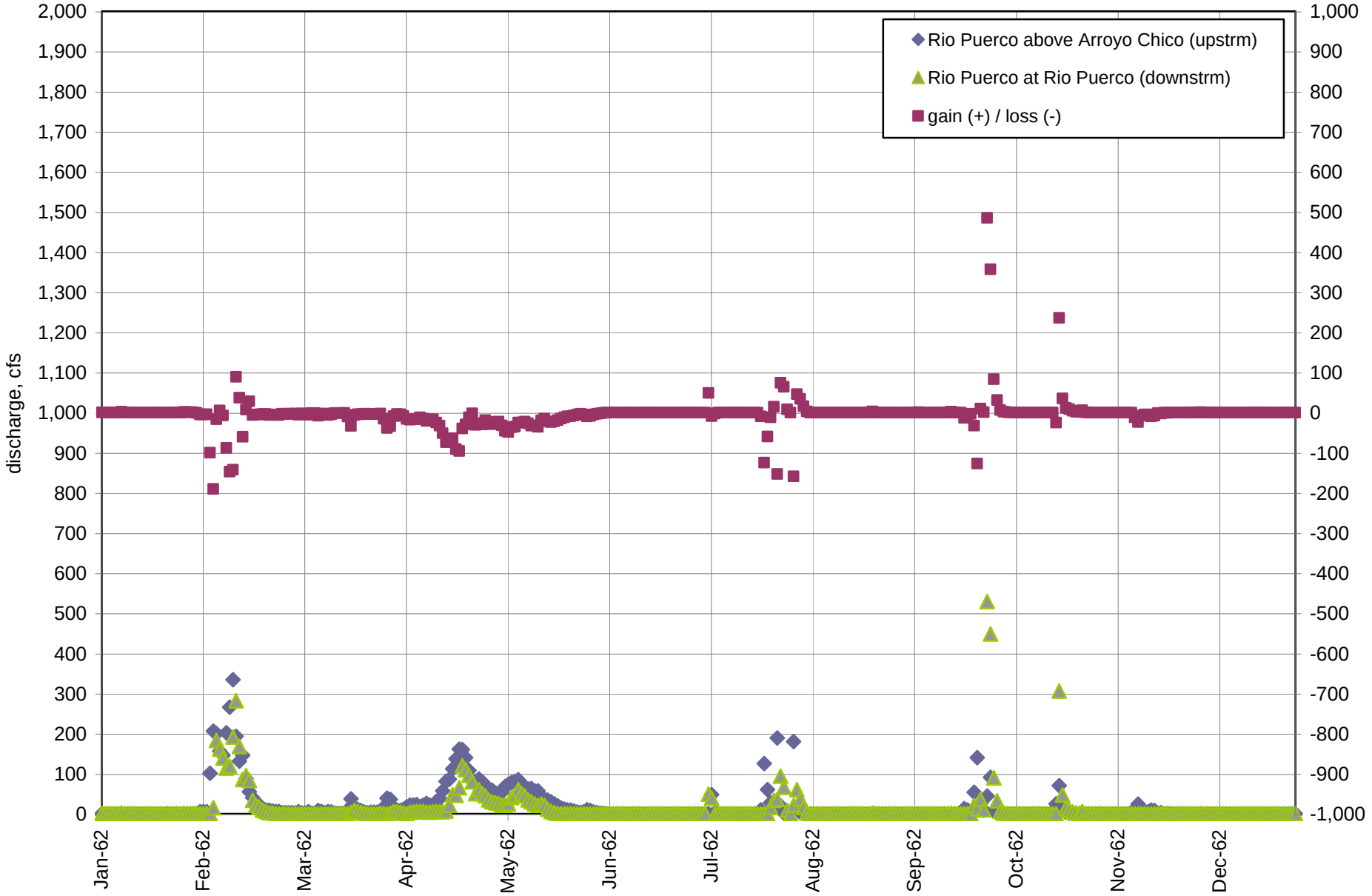

Figure C16. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1962.

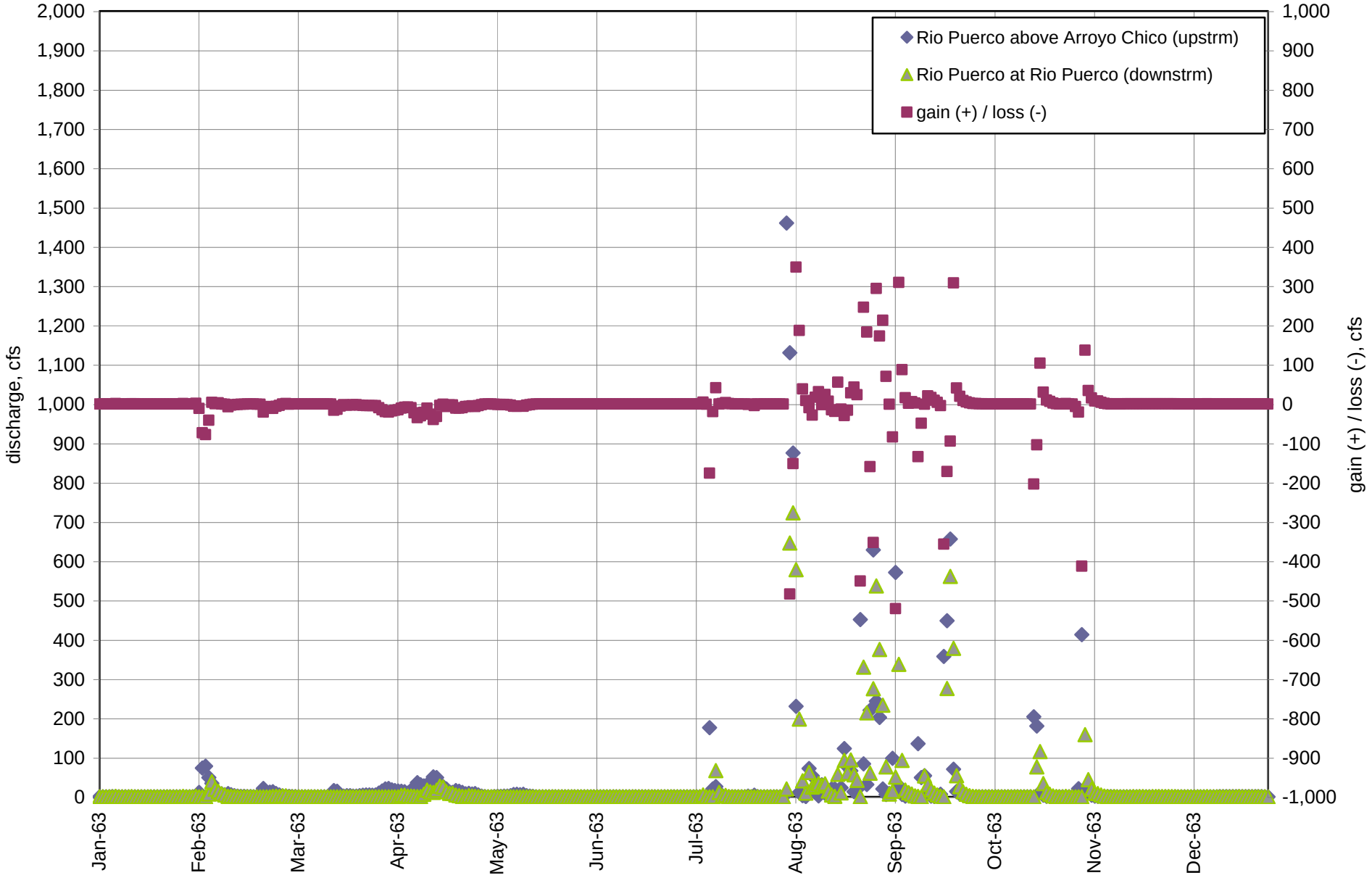

Figure C17. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1963.

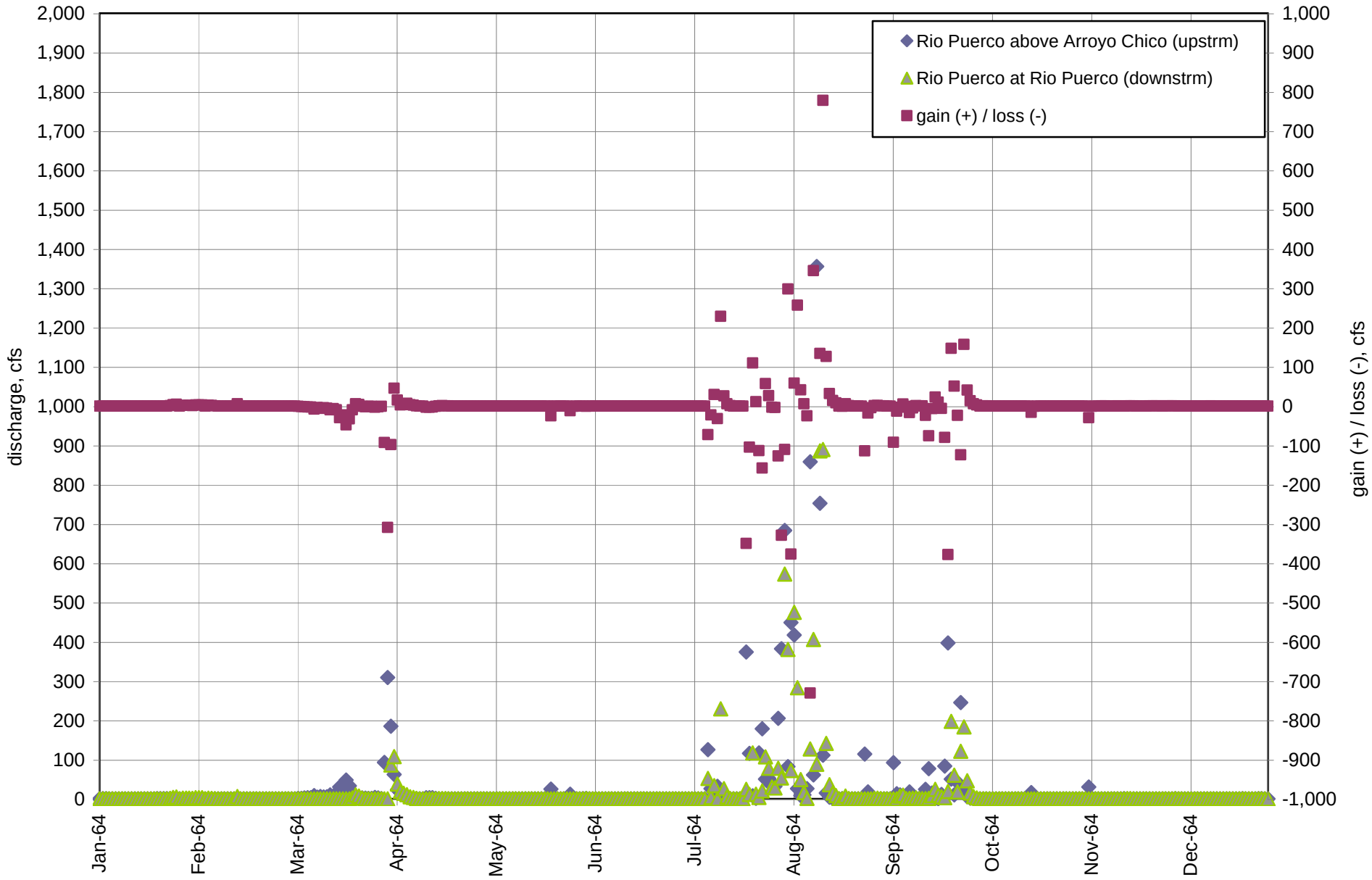

Figure C18. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1964.

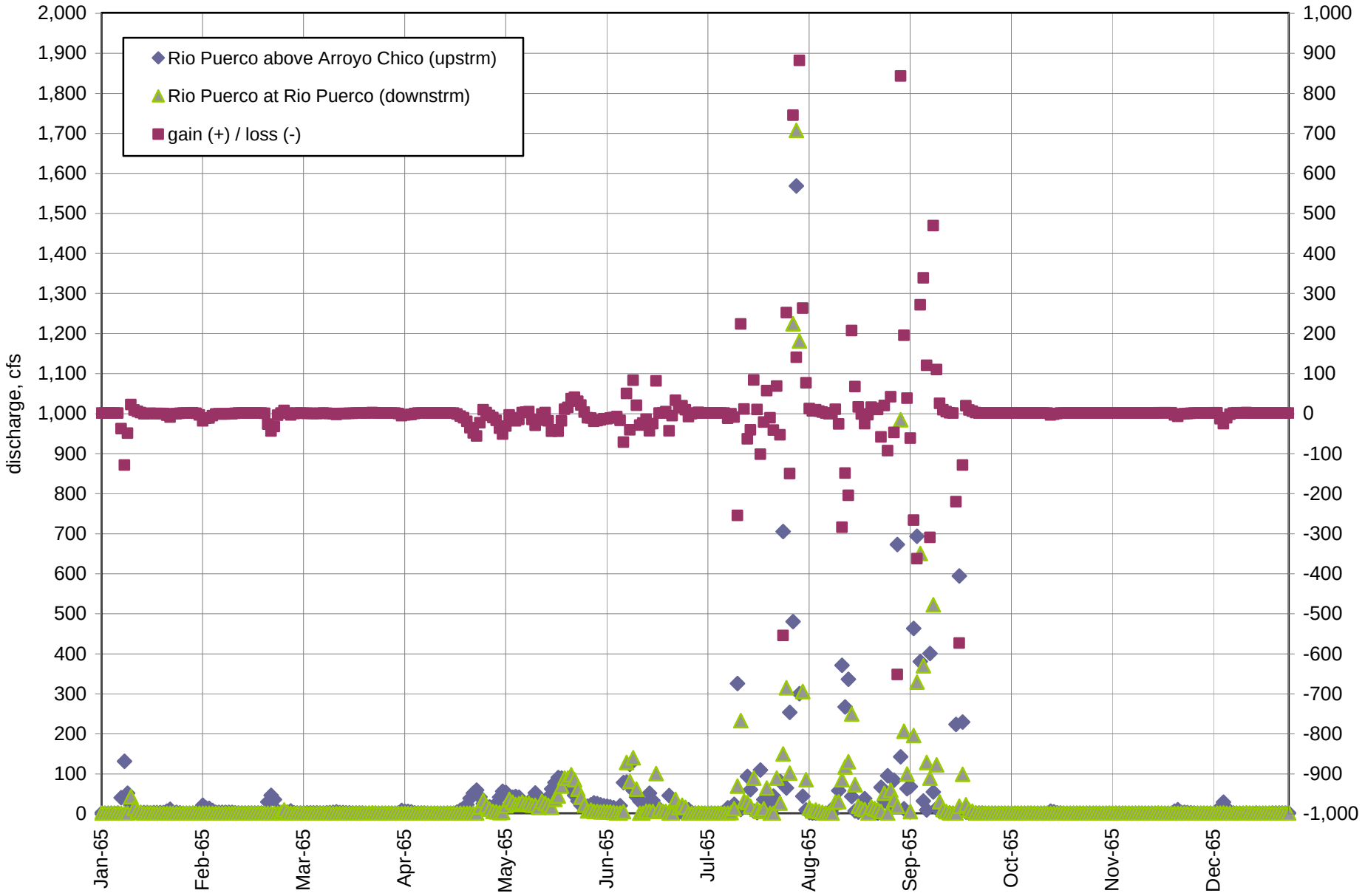

Figure C19. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1965.

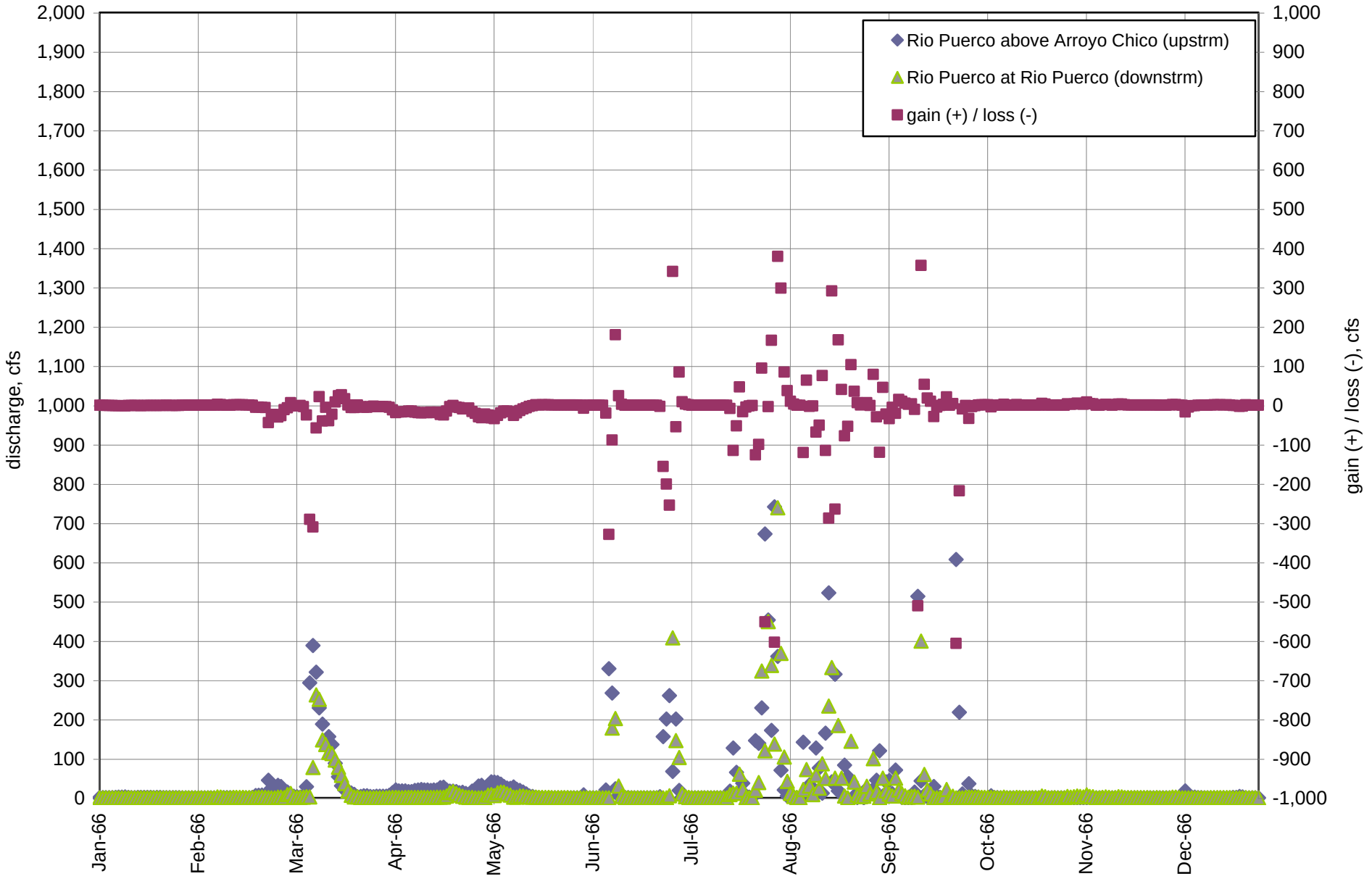

Figure C20. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1966.

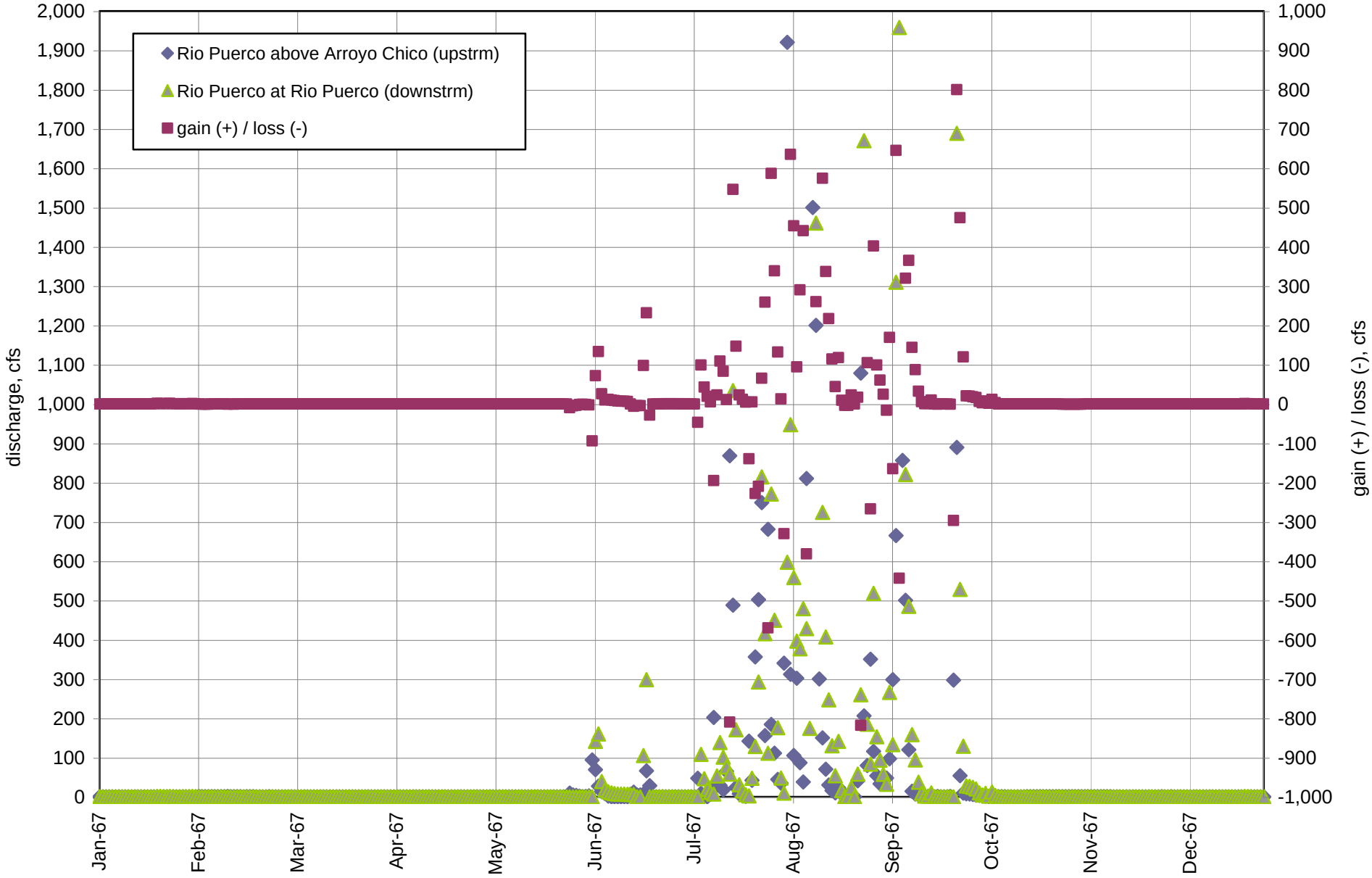

Figure C21. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1967.

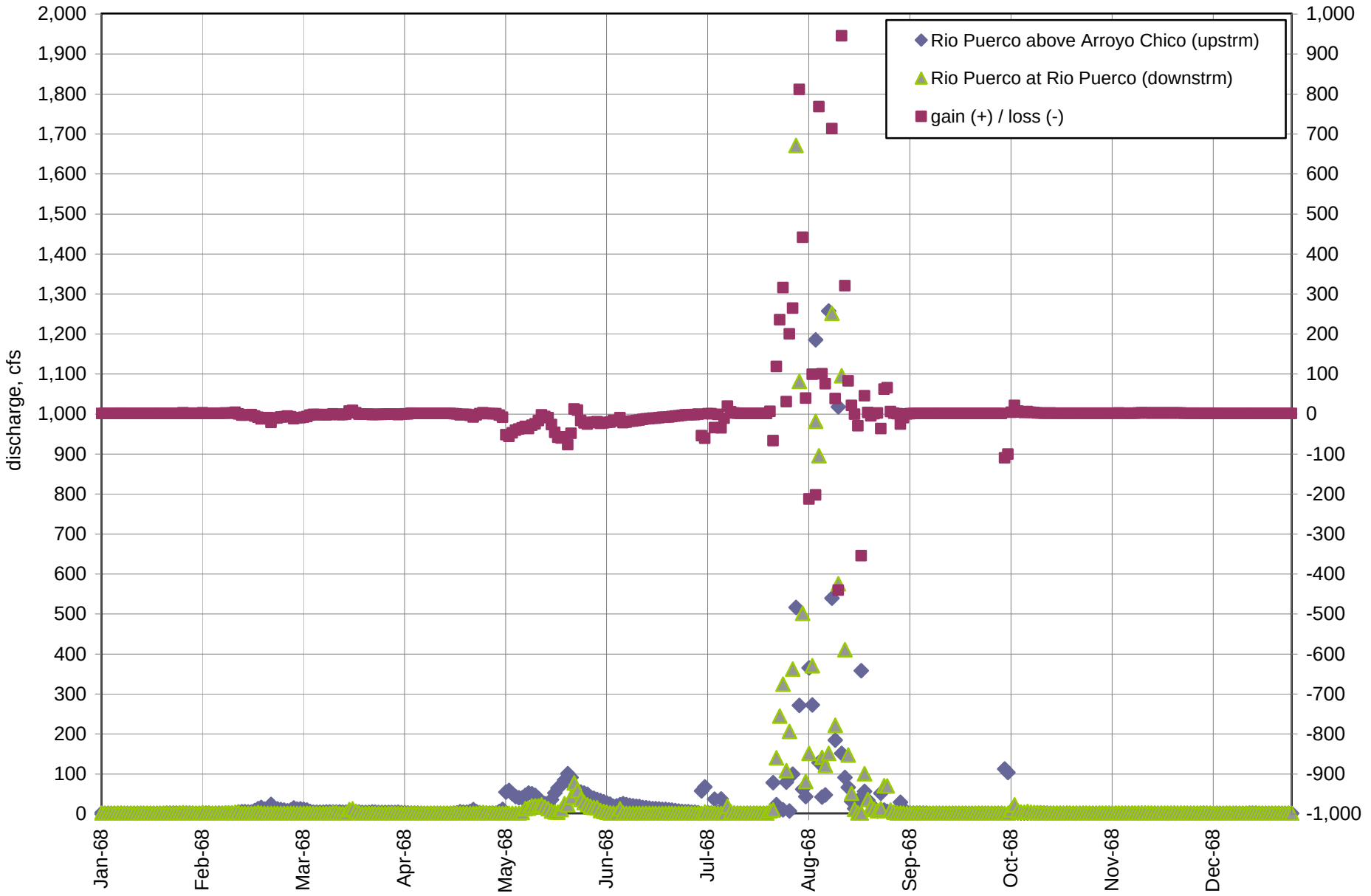

Figure C22. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1968.

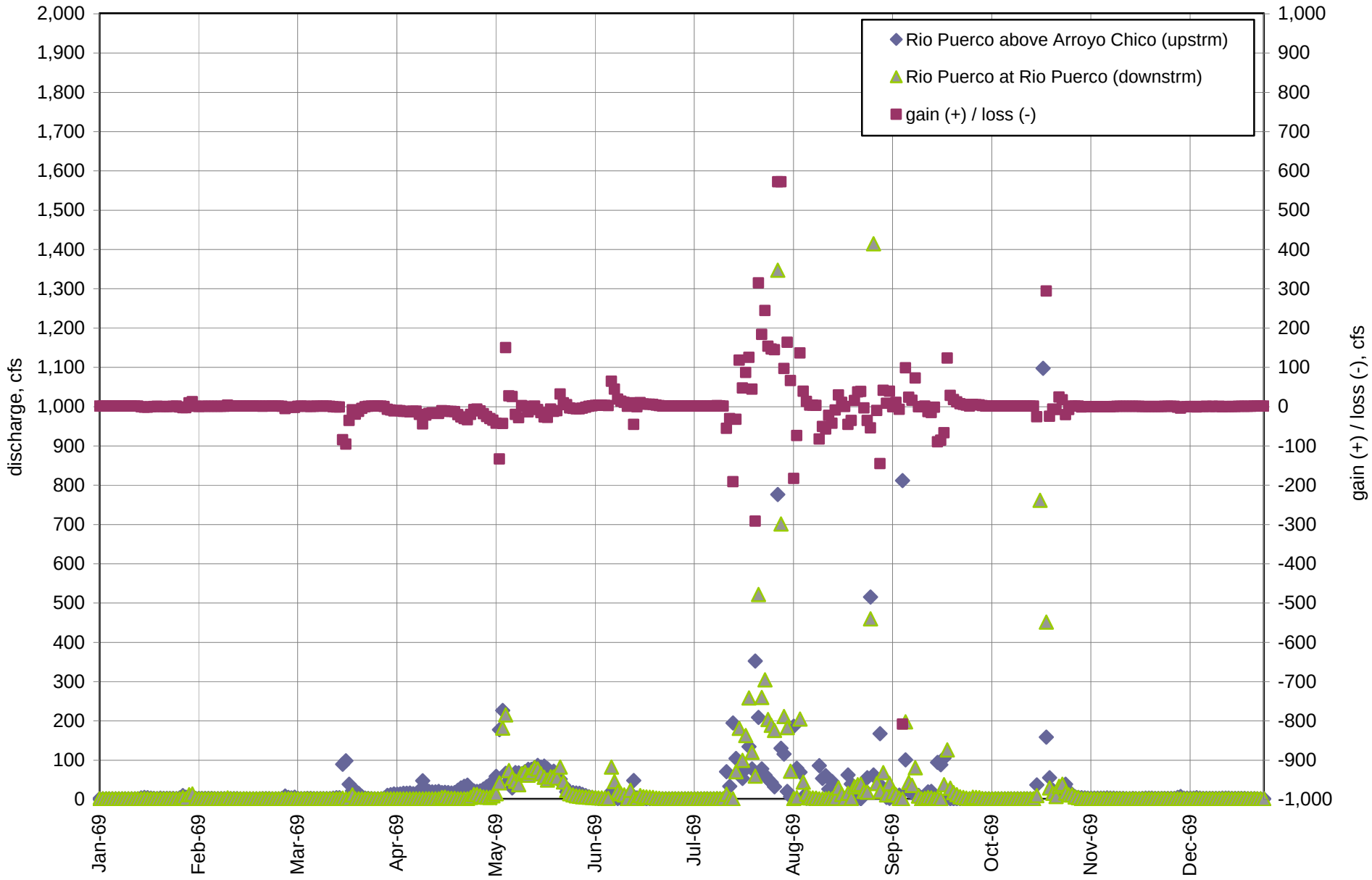

Figure C23. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1969.

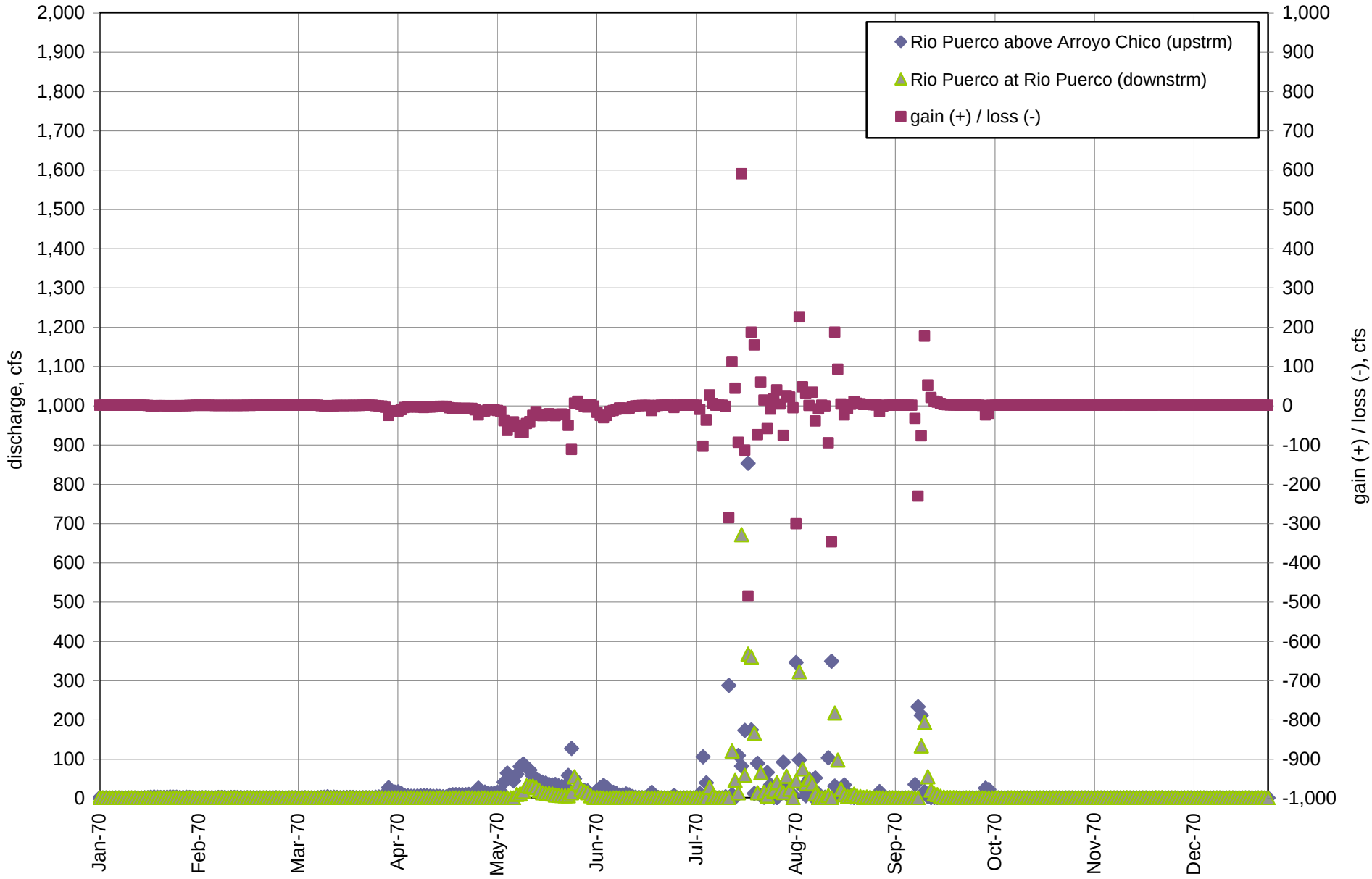

Figure C24. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1970.

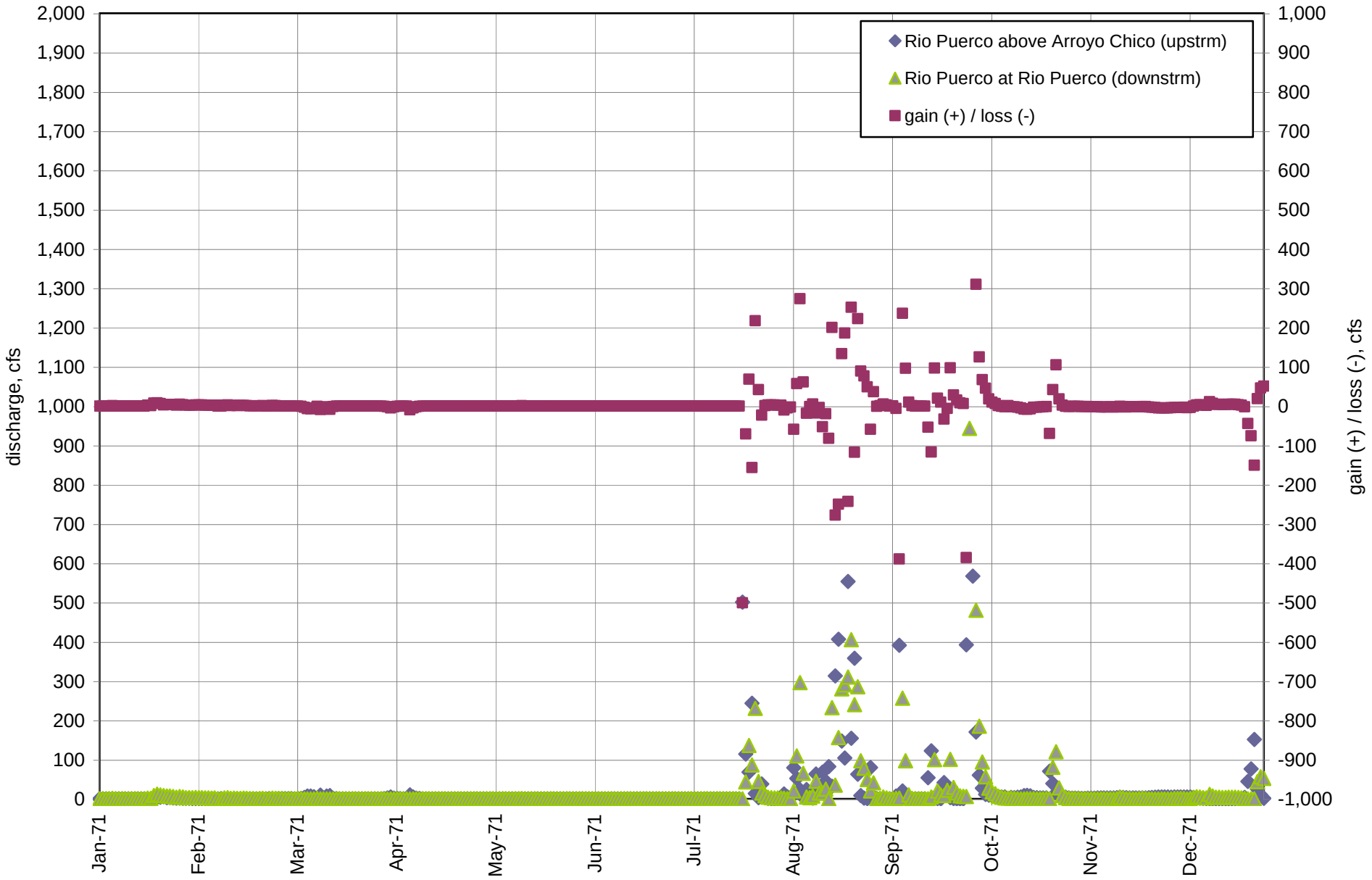

Figure C25. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1971.

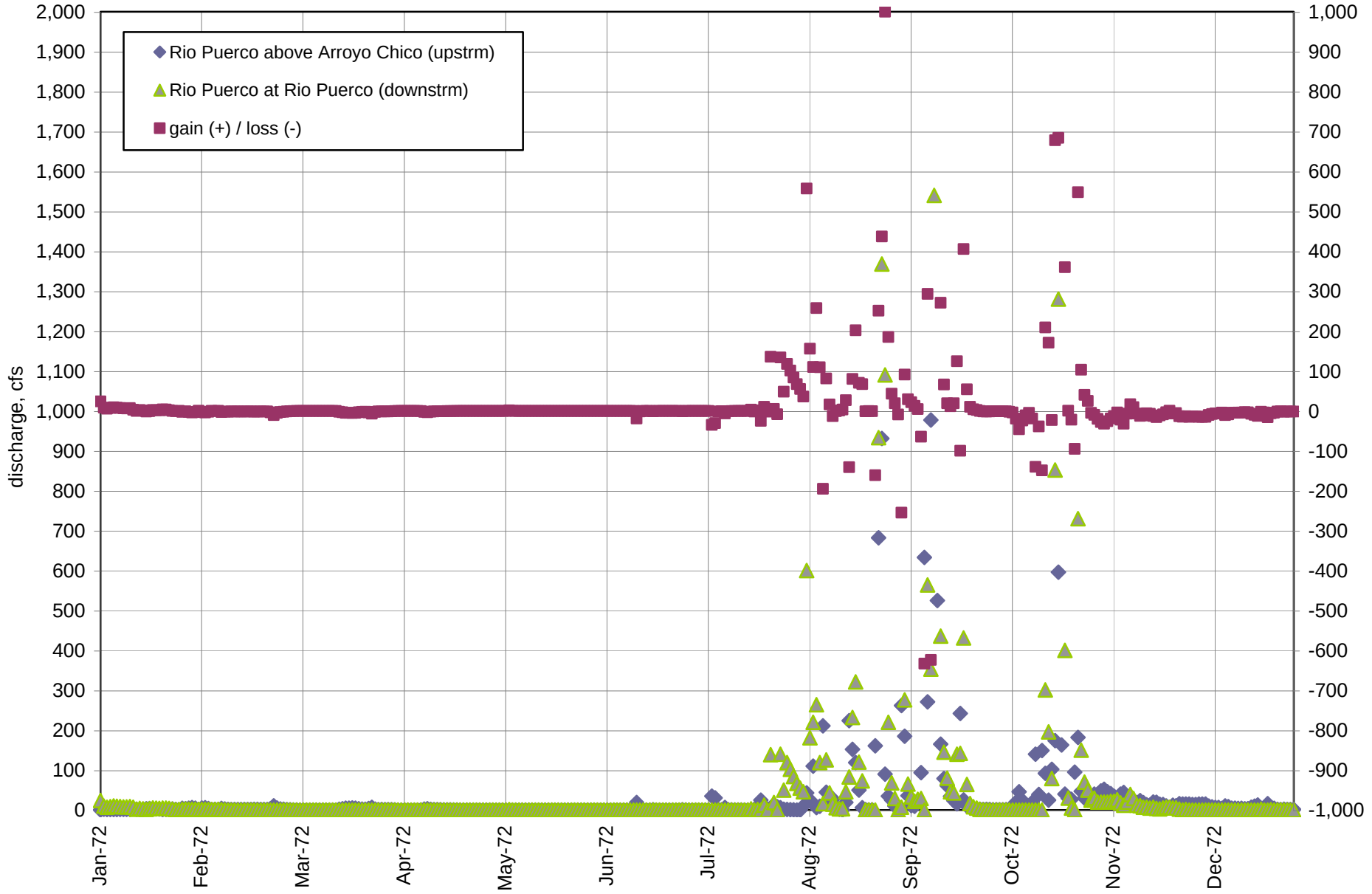

Figure C26. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1972.

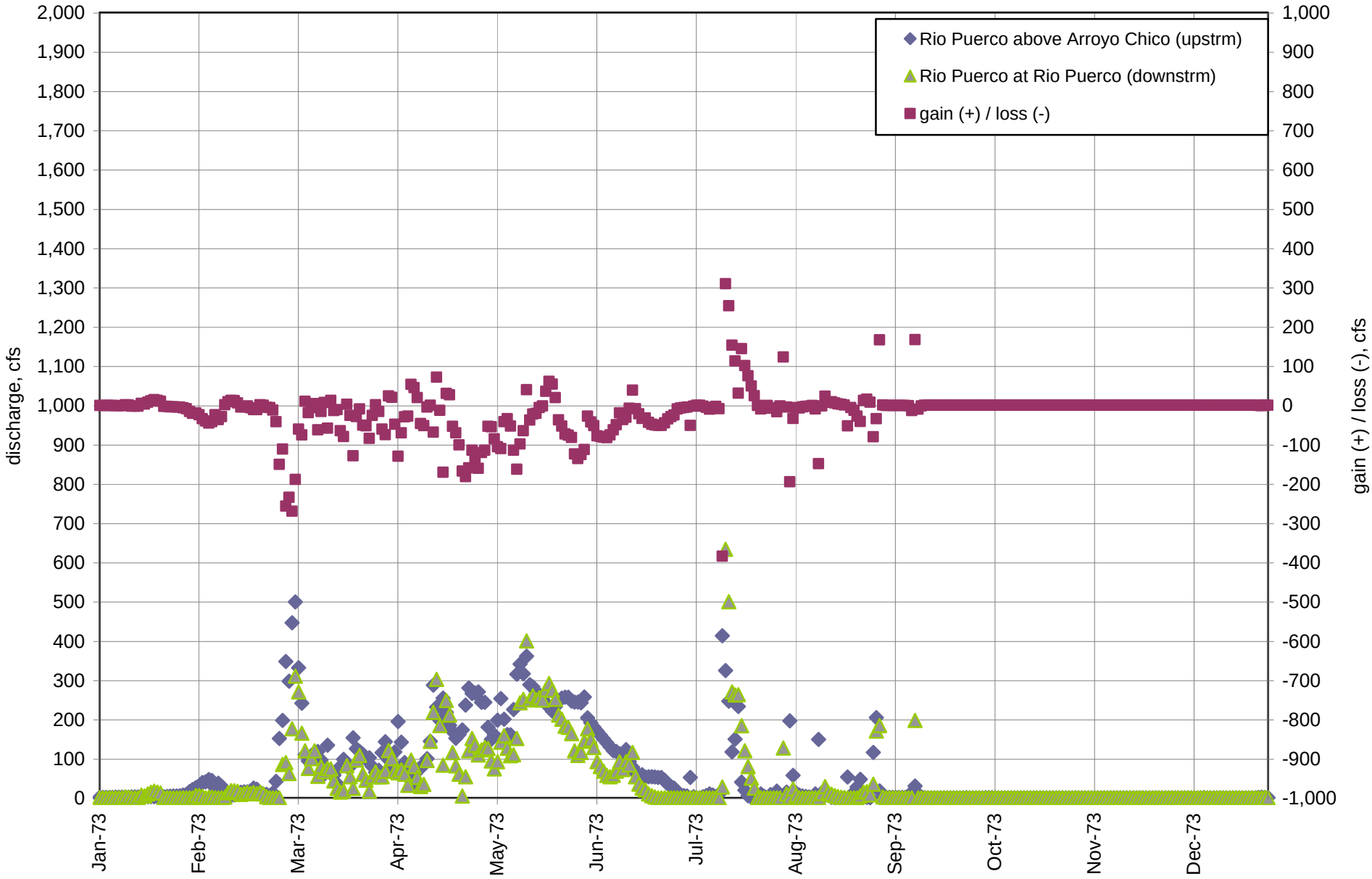

Figure C27. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1973.

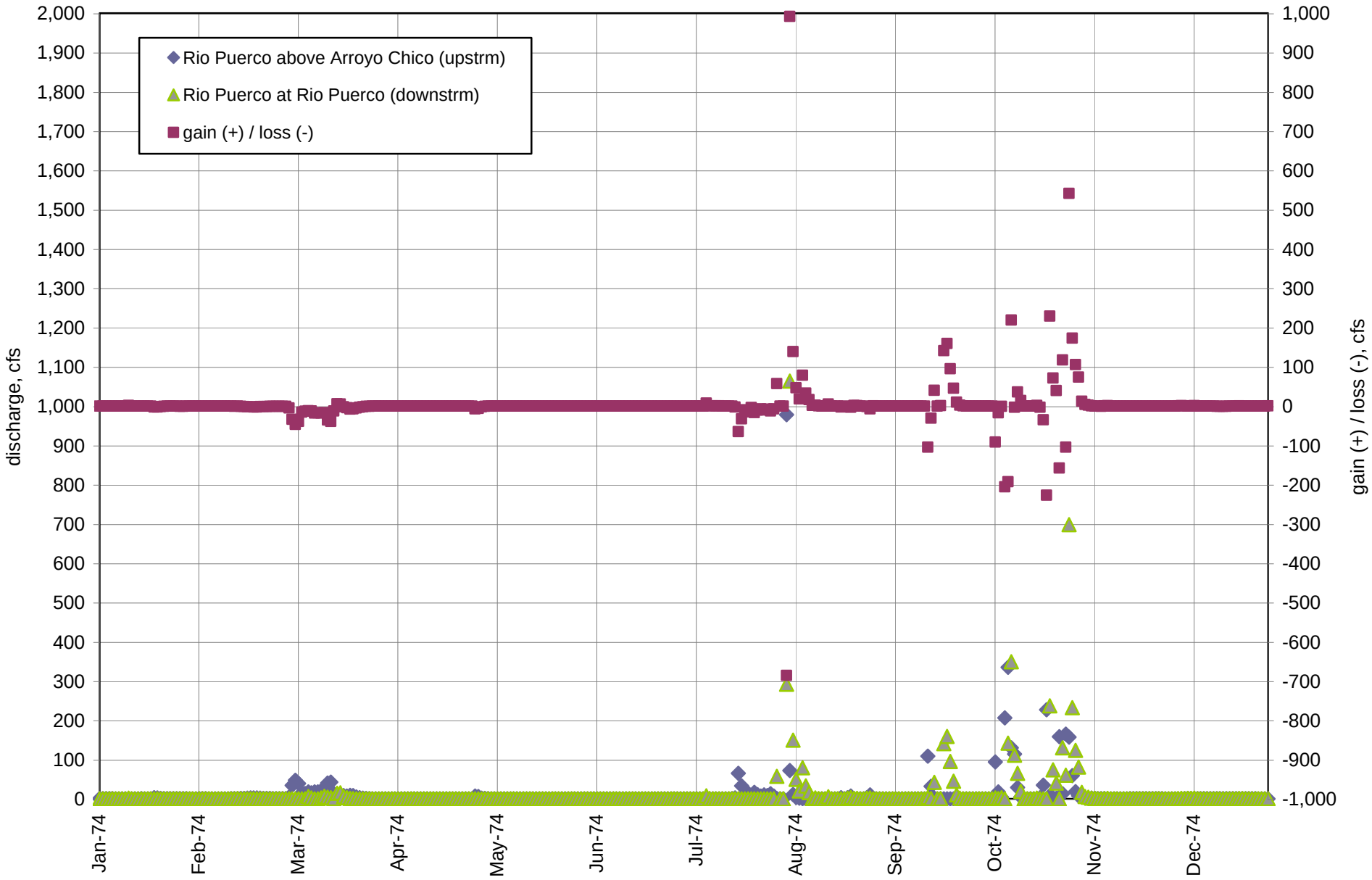

Figure C28. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1974.

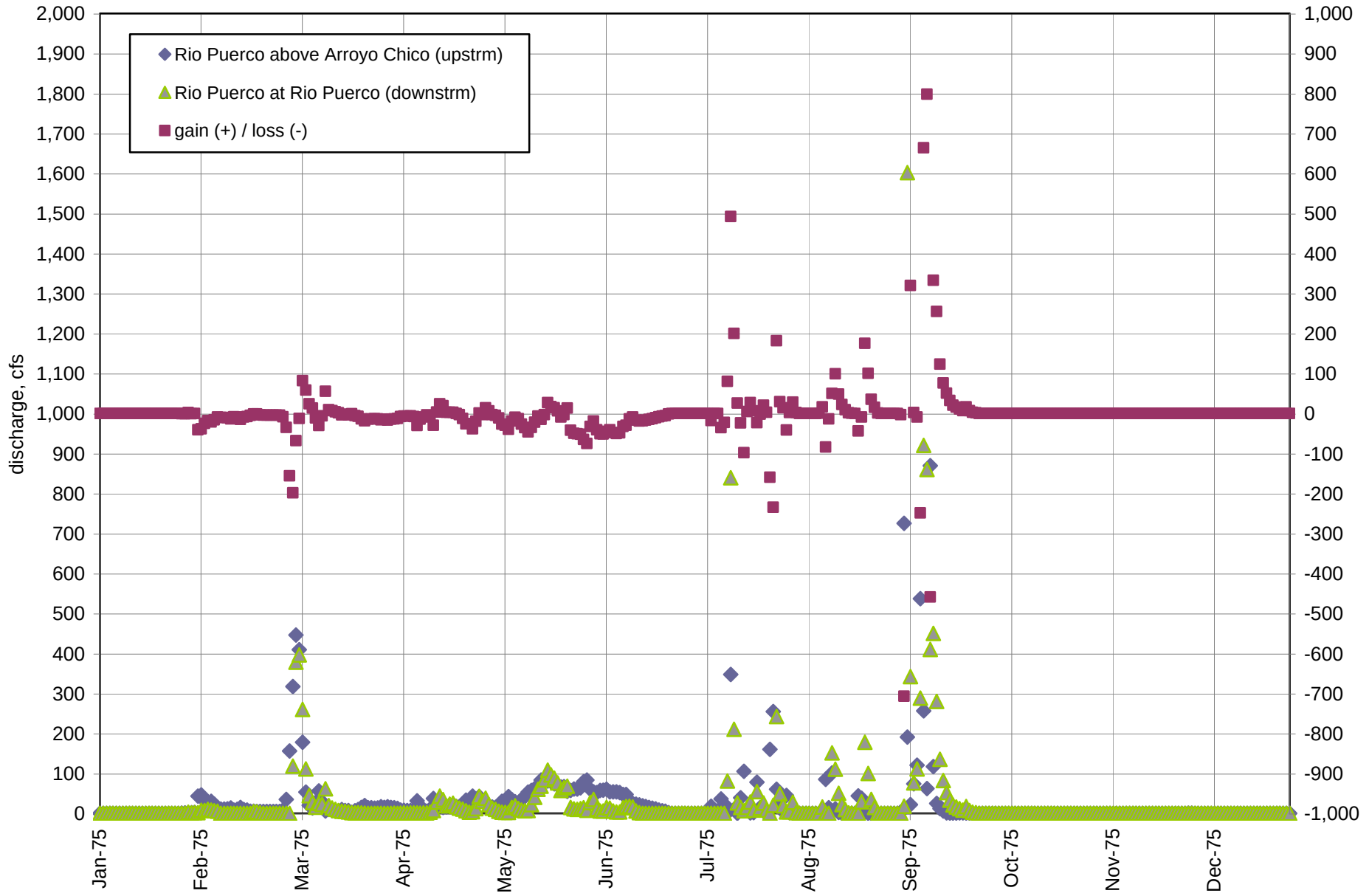

Figure C29. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1975.

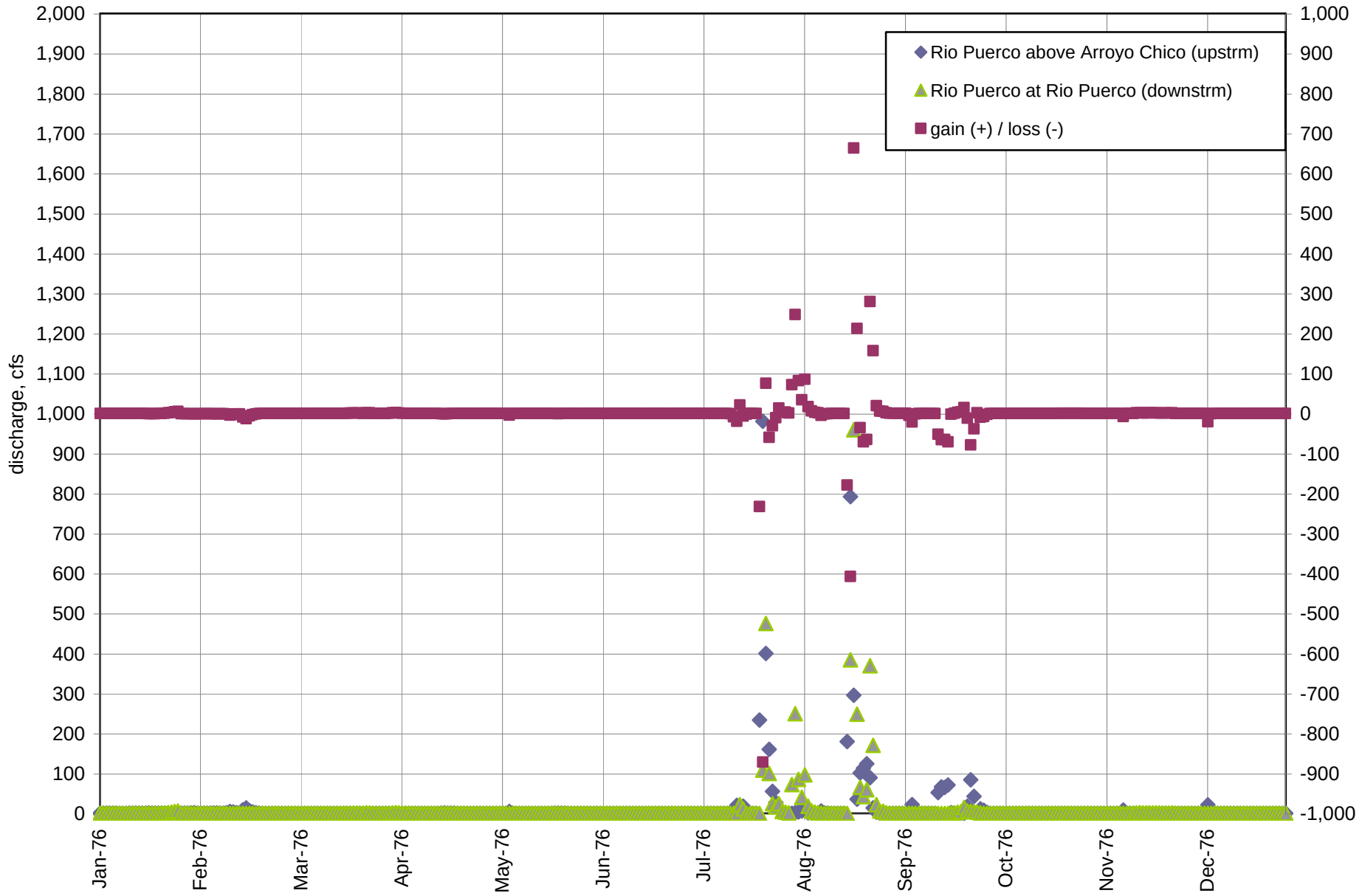

Figure C30. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] and [Rio Puerco at Rio Puerco] minus [Rio San Jose at Correo] daily mean discharge, and gain/loss, in 1976.

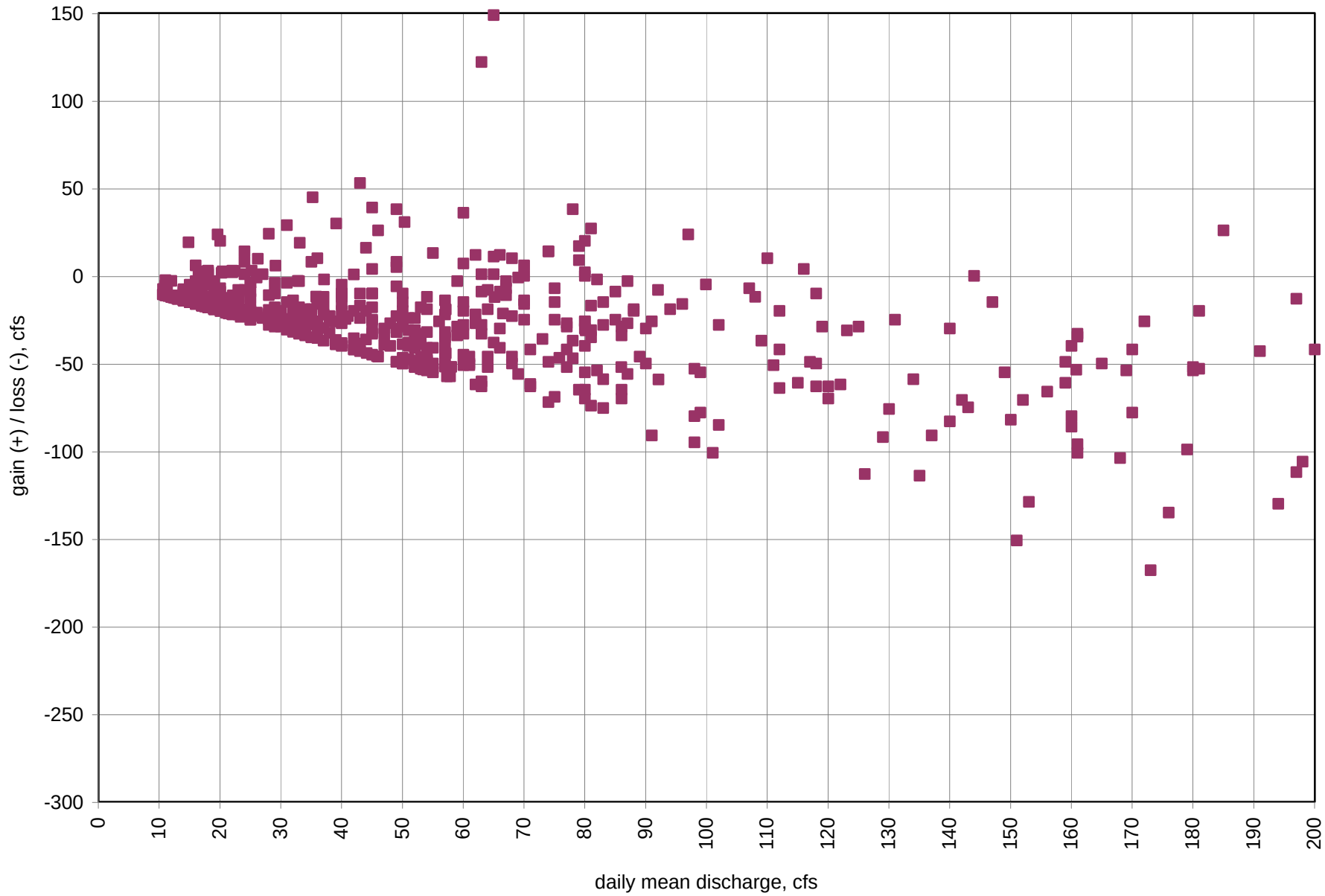

Figure C31. Graph of [Rio Puerco above Arroyo Chico near Guadalupe, NM] plus [Arroyo Chico near Guadalupe, NM] daily mean discharge versus gain/loss across Rio Puerco fault zone during spring runoff periods.

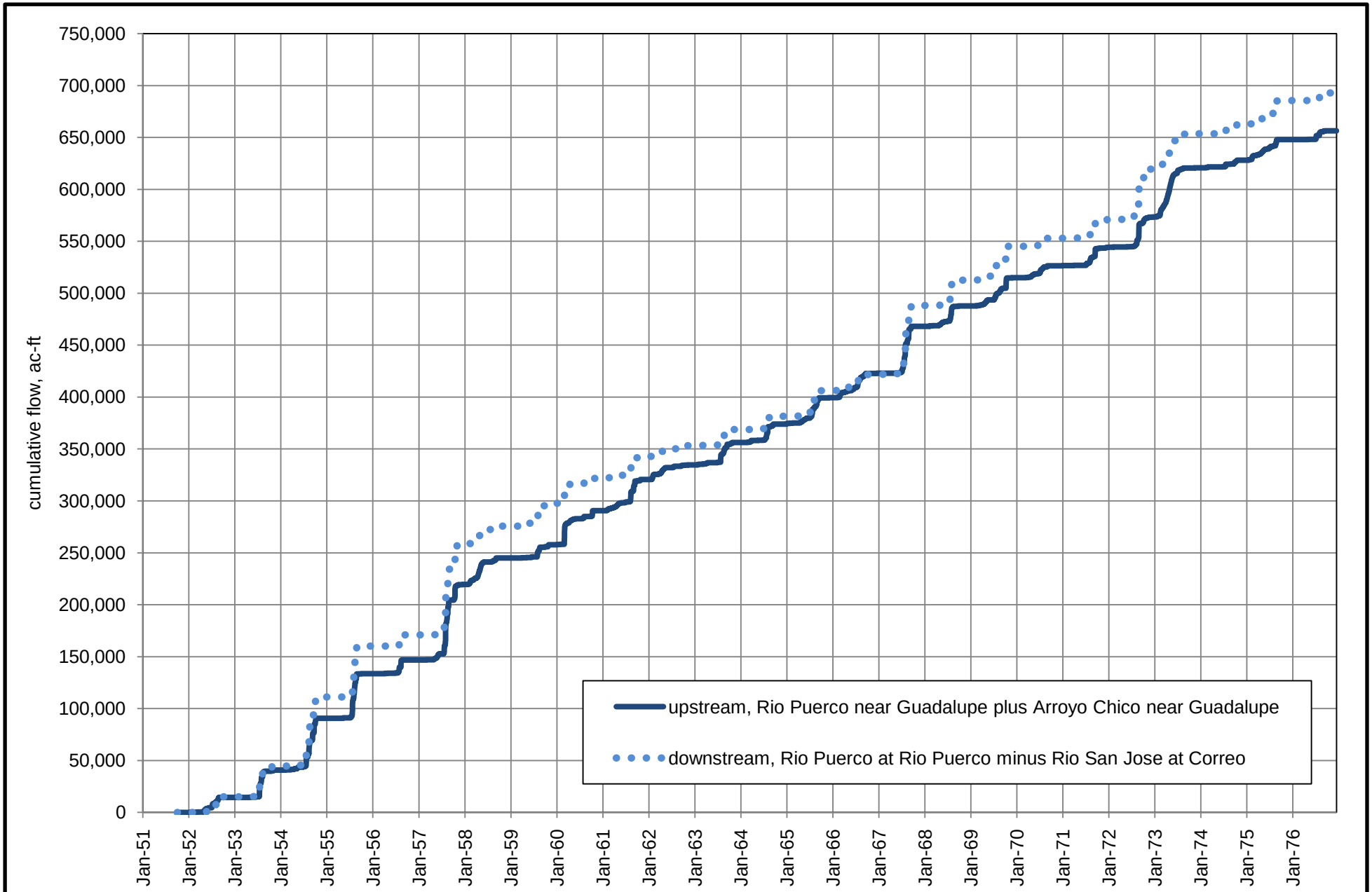

Figure C32. Graph showing cumulative flow, in acre-feet, at stream gaging stations upstream (Rio Puerco near Guadalupe plus Arroyo Chico near Guadalupe) and downstream (Rio Puerco at Rio Puerco minus Rio San Jose at Correo) of the Rio Puerco fault zone.