Ambient Groundwater Quality of the

Lower Gila Basin

A 2013-2017 Baseline Study

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ADEQ
Arizona Department of Environmental Quality

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Arizona Department of Environmental Quality
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ADEQ Ambient Groundwater Quality Open-File Reports (OFR) and Factsheets (FS):

20-Year Groundwater Quality in Arizona	OFR 16-02, 26 p.	-
Salt River Basin	OFR 16-01, 74 p.	FS 16-15, 6 p.
Gila Bend Basin	OFR 15-07, 77 p.	FS 15-05, 6 p.
Tiger Wash Basin	OFR 14-07, 33 p.	FS 14-20, 4 p.
Avra Valley Sub-basin of the Tucson AMA	OFR 14-06, 63 p.	FS 14-11, 5 p.
Harquahala Basin	OFR 14-04, 62 p.	FS 14-09, 5 p.
Tonto Creek Basin	OFR 13-04, 50 p.	FS 13-18, 4 p.
Upper Hassayampa Basin	OFR 13-03, 52 p.	FS 13-11, 3 p.
Aravaipa Canyon Basin	OFR 13-01, 46 p.	FS 13-04, 4 p.
Butler Valley Basin	OFR 12-06, 44 p.	FS 12-10, 5.p.
Cienega Creek Basin	OFR 12-02, 46 p.	FS 12-05, 4.p.
Ranegras Plain Basin	OFR 11-07, 63 p.	FS 12-01, 4.p.
15-Year Groundwater Quality in Arizona	OFR 11-04, 26 p.	-
Bill Williams Basin	OFR 11-06, 77 p.	FS 12-01, 4.p.
San Bernardino Valley Basin	OFR 10-03, 43 p.	FS 10-31, 4 p.
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Meadview Basin	OFR 05-01, 29 p.	FS 05-01, 4 p.
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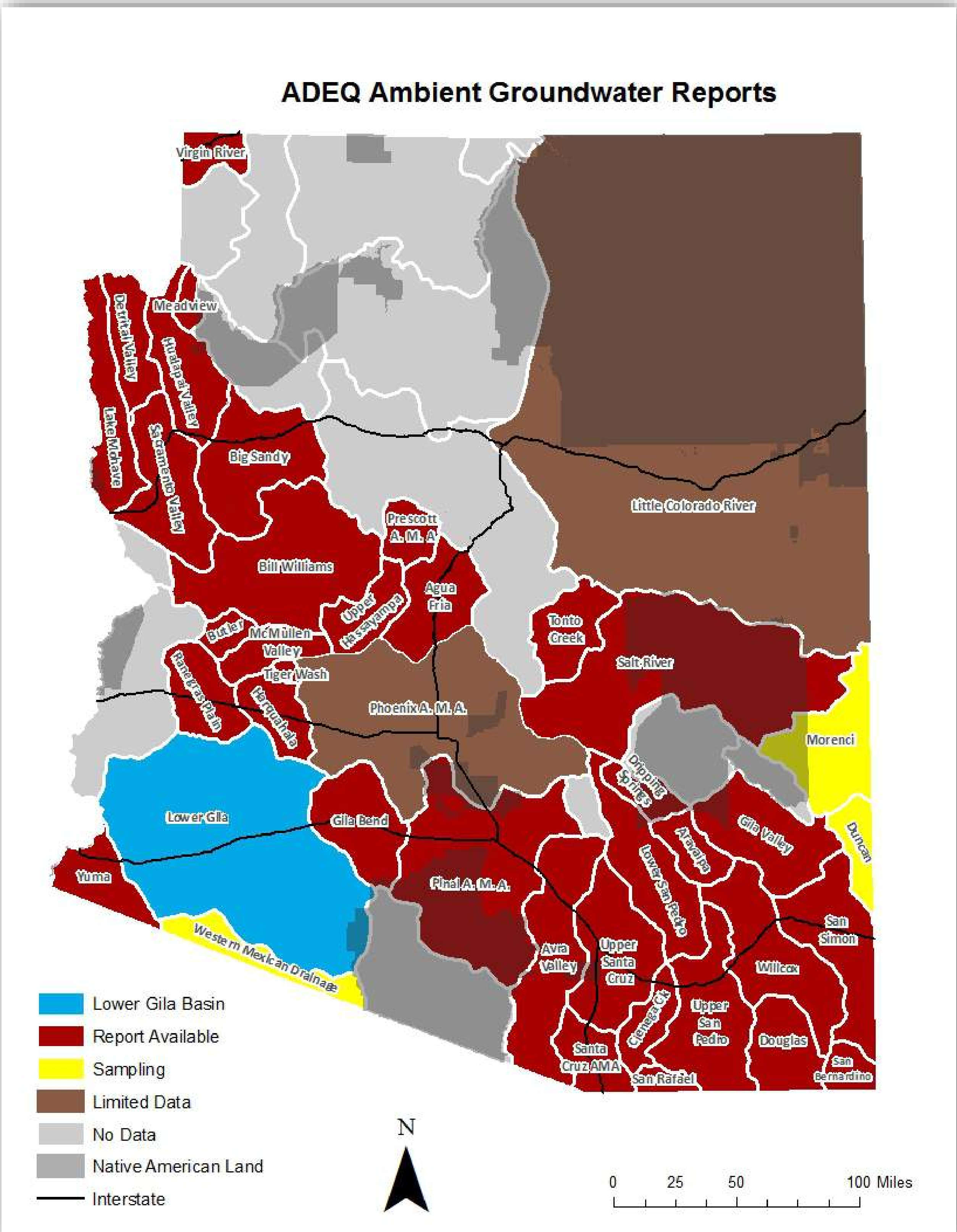
Upper San Pedro Basin (w/ USGS)	OFR 99-12, 50 p.	FS 97-08, 2 p.
Douglas Basin	OFR 99-11, 155 p.	FS 00-08, 4 p.
Virgin River Basin	OFR 99-04, 98 p.	FS 01-02, 4 p.
Yuma Basin	OFR 98-07, 121 p.	FS 01-03, 4 p.

These are available at: www.azdeq.gov/environ/water/assessment/ambient.html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Abbreviations

amsl	above mean sea level
ac-ft	acre-feet
af/yr	acre-feet per year
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
ADWR	Arizona Department of Water Resources
AMA	Active Management Area
ARRA	Arizona Radiation Regulatory Agency
AZGS	Arizona Geological Survey
As	arsenic
bls	below land surface
BLM	U.S. Department of the Interior Bureau of Land Management
^oC	degrees Celsius
$CI_{0.95}$	95 percent Confidence Interval
Cl	chloride
EPA	U.S. Environmental Protection Agency
F	fluoride
Fe	iron
gpm	gallons per minute
HCl	hydrochloric acid
LGB	Lower Gila basin
LLD	Lower Limit of Detection
Mn	manganese
MCL	Maximum Contaminant Level
ml	milliliter
msl	mean sea level
ug/L	micrograms per liter
um	micron
µS/cm	microsiemens per centimeter at 25° Celsius
mg/L	milligrams per liter
MRL	Minimum Reporting Level
ns	not significant
ntu	nephelometric turbidity unit
pCi/L	picocuries per liter
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
SAR	Sodium Adsorption Ratio
SDW	Safe Drinking Water
SC	Specific Conductivity
su	standard pH units
SO_4	sulfate
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
WQARF	Water Quality Assurance Revolving Fund
*	significant at $p \leq 0.05$ or 95% confidence level
**	significant at $p \leq 0.01$ or 99% confidence level

Abstract

The Arizona Department of Environmental Quality (ADEQ) conducted a baseline groundwater quality study of the Lower Gila basin located in southwestern Arizona. The basin comprises 7,309 square miles within Yuma, Maricopa, Pima, and La Paz counties and consists of desert plains and valleys surrounded by low elevation mountains.[1] The basin is composed of three sub-basins and is drained by the Gila River, an ephemeral stream. The basin extends from Painted Rock Dam, which impounds floodwaters, downstream to where the floodplain narrows at Dome, located 30 miles east of Yuma.

Land ownership consists of federal lands (48 percent) managed by the U.S. Fish and Wildlife Service, Bureau of Land Management, and National Park Service, military facilities (39 percent) including the Yuma Proving Ground and Barry Goldwater Air Force Range, private lands (six percent), State Trust land (five percent), and tribal lands (two percent).[2] The basin's population was 11,097 in 2000, most of who lived in the small communities of Ajo, Dateland, Fischer's Landing, Hyder, Sentinel, Tacna, Wellton, and Why.[3] Land uses include military, wildlife, recreation, farming, livestock grazing, and, near Ajo, mining.

ADEQ sampled 108 wells in three sub-basins: Childs Valley (9), Dendora Valley (9), and Wellton-Mohawk (90). Inorganic constituents and isotopes of oxygen, deuterium, and nitrogen were collected at all sites, while fewer samples were collected for radon (51) and radionuclide (39) sites.

Groundwater is commonly calcium-bicarbonate chemistry, slightly-alkaline, fresh, with varying hardness levels.[4] [5] Based on sample results, groundwater in the basin is generally not suitable for drinking water uses without treatment. Of the 108 sites sampled, nine sites (eight percent) met all drinking water quality standards.

Health-based, Primary Maximum Contaminant Levels (MCLs) were exceeded at 78 sites (72 percent) and included arsenic (72 sites), fluoride (34 sites), and nitrate (10 sites). These are enforceable standards for drinking water purposes supplied by a public water system.[6] Aesthetics-based Secondary MCL water quality guidelines were exceeded at 97 sites (90 percent). Constituents above Secondary MCLs include total dissolved solids (TDS) (95 sites), chloride (77 sites), fluoride (66 sites), sulfate (62 sites), manganese (22 sites), iron (14 sites), and pH-field (six sites).

A few constituent concentrations significantly differed by sub-basin, but many did so when compared by recharge source. Colorado River water recharged from irrigation applications generally had higher constituent concentrations then recharge from the Gila River, which had significantly higher concentrations than from local precipitation. (Kruskal-Wallis with Tukey test, $p \leq 0.05$). Constituents following this general pattern include TDS, major ions, boron, and strontium.

This pattern of elevated TDS concentrations and major ions is influenced by saline recharge from excess irrigation water applied to the extensive agricultural fields that are found along the Gila River. Salinity inputs are especially severe within the Wellton-Mohawk Irrigation and Drainage District, which imports fresh Colorado River water for irrigation and uses drainage wells to withdraw groundwater so that the shallow water table remains below the root zone of the crops.[7]

Introduction

Purpose and Scope

The Lower Gila basin comprises 7,309 square miles in southwestern Arizona within Yuma, Maricopa, Pima, and La Paz counties (Figure 1).[8] The basin extends from Painted Rock Dam west along the Gila River to where the floodplain narrows at Dome, located 30 miles east of Yuma.

The basin includes the small communities of Ajo, Dateland, Martinez Lake, Hyder, Sentinel, Tacna, Wellton, and Why.[9] The land is used for military purposes, wildlife refuges, recreation, livestock grazing, and, especially along the Gila River, irrigated agriculture and residential purposes. Extensive copper mining has also occurred near Ajo.

The basin is physically characterized by desert plains and valleys surrounded by low elevation mountains. Groundwater is predominantly pumped for irrigation and drainage purposes with minor amounts used for public water, domestic, industrial, mining, and stock uses.

Sampling by the Arizona Department of Environmental Quality (ADEQ) Ambient Groundwater Monitoring program is authorized by legislative mandate in the Arizona Revised Statutes §49-225, specifically: "*...ongoing monitoring of waters of the state, including...aquifers to detect the presence of new and existing pollutants, determine compliance with applicable water quality standards, determine the effectiveness of best management practices, evaluate the effects of pollutants on public health or the environment, and determine water quality trends*."[10]

Study Benefits

This study is designed to provide the following benefits:

- Characterize regional groundwater quality in the Lower Gila basin.
- Identify significant water quality differences among groundwater recharge groups and sub-basins.
- Investigate potential groundwater quality impacts arising from mineralization, mining, irrigation, livestock, septic tanks, and improper well construction.
- Identify further groundwater quality research needs and data gaps.

Physical and Cultural Resources

Geography

The Lower Gila basin is located within the Basin and Range physiographic province in southwestern Arizona. The basin is drained by the Gila River, and its boundaries are formed by the following physiographic features:

- To the west by the Colorado River, and the Gila, Tinajas Alta, and Chocolate mountains,
- To the north by the Kofa, Little Horn, and Gila Bend mountains,
- To the east by the Saucedo and Ajo mountains, and
- To the south by the Puerto Blanco and Cabeza Prieta mountains.

The Castle Dome, Tank, Kofa, and Gila Bend mountains along with the Castle Dome, Palomas Plains, King, and Hyder valleys are

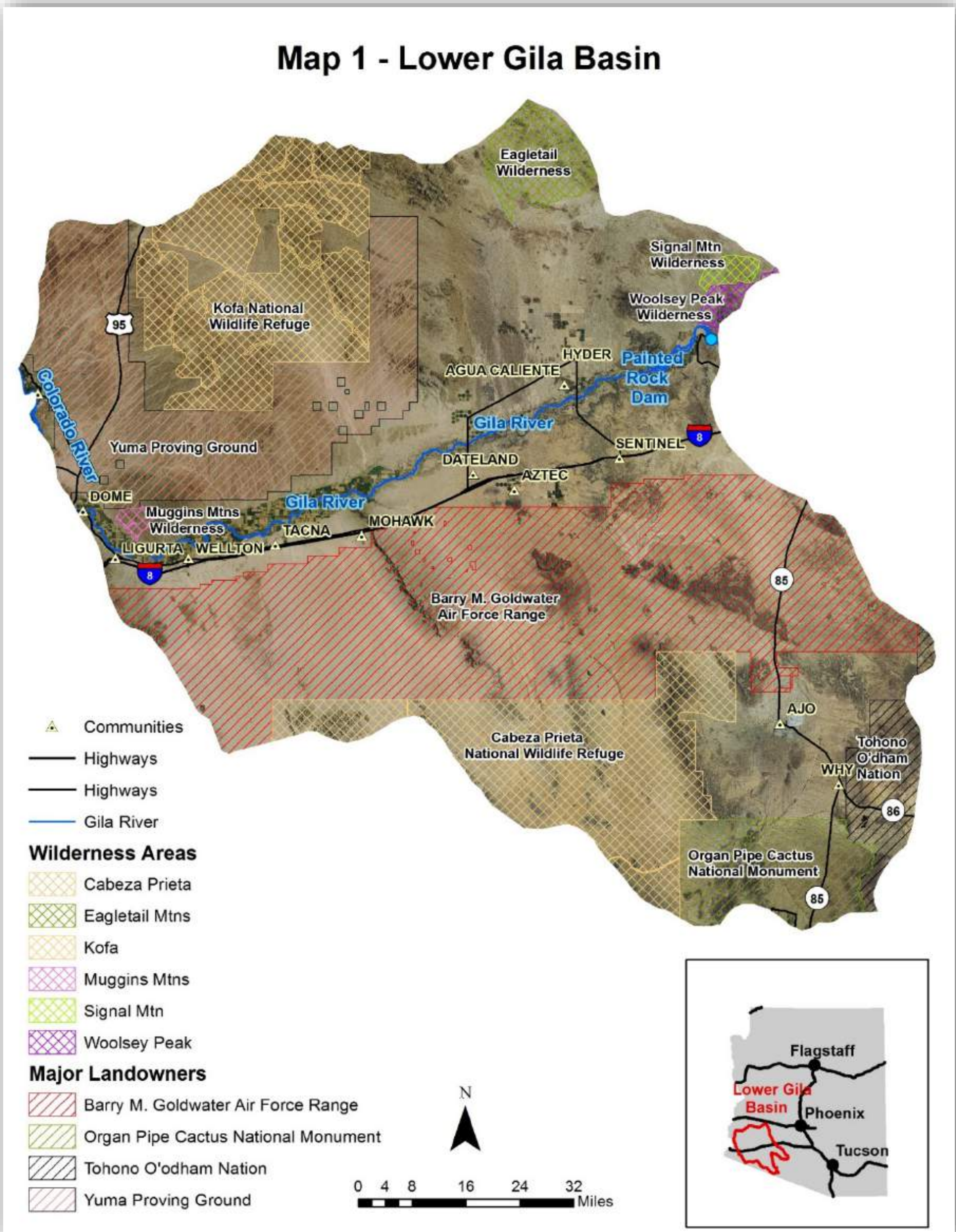


Figure 1 – Geography of Lower Gila basin.

Figure 2 - ADEQ's Elizabeth Boettcher samples a private domestic well (LGB-80/81), located at the base of the Mohawk Mountains.

north of the Gila River.[11] Cabeza Prieta, Mohawk, Granite, and Growler mountains along with the Mohawk, San Cristobal, Growler, and Childs valleys are in southern part of the basin.

Elevations range from the Castle Dome Peak at 3,788 feet above mean sea level (amsl) to approximately 160 feet amsl at near Dome where the Gila River exits the basin (Figure 2).

Vegetation types in the basin include Lower Colorado River Valley and Arizona upland Sonoran desert scrub.

Land Ownership

Land ownership consists mostly of federal lands (88 percent) used for military, wildlife, recreation, and grazing purposes. Lands managed by the U.S. military include the Yuma Proving Ground and Barry Goldwater Air Force Range, which consist of 39 percent of the basin.

The U.S. Fish and Wildlife Service manages 23 percent of the basin, including portions of three National Wildlife Refuges (NWR). These include most of the 665,000-acre Kofa NWR, the 857,000-acre Cabeza Prieta NWR, and part of the Imperial NWR.

The U.S. Bureau of Land Management (BLM) manages 21 percent of the basin. BLM lands include 138,700 acres of wilderness in four wilderness areas: the Eagletail Wilderness (64,000 acres of the area's 10,000 acres), Muggins Mountains Wilderness (38,000 acres), the Woolsey Peak Wilderness (15,000 acres of the 64,000 acres), and the Signal Mountain Wilderness (12,000 of the 13,000 acres).

Private lands comprise six percent of the basin while State Trust lands compose five percent of the basin. Both are found mainly along the Gila River. The remainder of lands in the basin consist of National Park Service lands in the Organ Pipe Cactus National Monument, and tribal lands of the Tohono O'odham Nation, which are both located in the southern part of the basin.[12]

Climate

Precipitation in the Lower Gila basin varies from almost eight inches in Ajo to just above four inches in communities along the Gila River.[13] Precipitation is heaviest in July and August with late summer thunderstorms. The winter months typically have moderate amounts of precipitation. These low-intensity winter storms provide more infiltration than the intense, monsoon thunderstorms that produce large amounts of runoff.

Surface Water Resources

The basin is drained by the Gila River, an ephemeral stream which runs east to west through the central part of the Lower Gila basin. The river is typically dry except where agricultural discharge, major storms, or releases from Painted Rock Dam creates flow.[14] Far upgradient of the basin, the Gila River is impounded by San Carlos Dam and released for irrigation purposes to the Ashurst-Hayden Diversion Dam near Florence more than 100 miles upstream.

Downgradient flood flows in the Gila River, which the Agua Fria, Hassayampa, Salt, and Verde rivers may contribute, are impounded by Painted Rock Dam. This flood-control structure forms the Lower Gila basin's eastern border (Figure 3).

All natural waterways are ephemeral, with the exception of the perennial Colorado River which forms a short stretch of the basin's western boundary.

Two reservoirs are located within the basin, that border the Colorado River to the west. Both dams were formed by the construction of the Imperial Diversion Dam across the Colorado River. Imperial Reservoir is a water-body with a 160,000 acre-feet capacity, while Martinez Lake has a maximum surface area of 640 acres.[15]

Surface water from the Colorado River is used for irrigation within the Wellton-Mohawk Irrigation and Drainage District (WMIDD). The first water was delivered to the WMIDD in 1952.

Groundwater Resources

The Lower Gila basin is characterized by numerous elongated fault-block mountain ranges with intervening alluvial valleys. These mountain ranges and the accompanying alluvial valleys are narrower in the southern portion of the basin. The northern and central portions are characterized by widely separated mountain ranges separated by broad alluvial plains.

Groundwater in the basin occurs in the floodplain alluvium and basin-fill.

Alluvial deposits of sand, gravel, and larger sediments are located in the floodplain of the Gila River and the larger washes in the basin. Floodplain alluvium can be as large as 110-feet thick along the Gila River (Figure 4).[16]

The basin-fill has three units:

- An upper sandy unit, which averages 200-380 feet thick composed of sand, gravel, and some silt and clay layers;

Figure 3 – Painted Rock Dam on the Gila River is used for flood control purposes. Painted Rock Reservoir is normally dry but during high precipitation can become the state's second-largest lake.

Figure 4 - ADEQ's Elizabeth Boettcher collects a sample (LGB-36) from a shallow irrigation well tapping the Gila River floodplain aquifer.

- A middle fine-grained unit, which averages 250-750 thick, is composed of silts and clays with some thin sand and gravel layers, and
- A lower unit, which has an extremely variable thickness that extends to the bedrock. Composed of coarse sand and gravel, some zones are well-cemented.[17]

ADWR has divided the Lower Gila basin into two sections based on the development of groundwater resources.[18] The Mohawk Mountains form the demarcation between the Eastern and Western sections. The basin is also subdivided into three sub-basins: Childs Valley, Dendora Valley, and Wellton-Mohawk (Figure 13). Wellton-Mohawk is by far the largest sub-basin and where most of the groundwater development has occurred (Figure 2).

Eastern Section

Groundwater development has occurred primarily for agricultural irrigation in the Eastern section's broad alluvial plains. Wells produce water from discontinuous sand and gravel lenses in the basin-fill sediments. Groundwater is generally unconfined, though clay layers and interbedded lava flows may cause localized confining conditions. The middle fine-grained basin-fill unit typically only produces enough water for low-yield stock and domestic wells.[19]

Agricultural development is concentrated in Hyder Valley, Dendora Valley, Palomas Plain, and Sentinel Plain.

Groundwater levels were less than 10 feet below land surface (bls) near the Gila River and less than 250 feet bls in the alluvial plains before irrigation development in the 1920s. Levels have subsequently declined, especially in agricultural areas.[20] In locations distant from the Gila River, water level depths extend more than 700 feet in the Kofa Wildlife Refuge (Figure 5) and 800 feet near the community of Why in the extreme southeastern part of the basin.[21]

Before agricultural development, groundwater moved from the north and southeast toward the Gila River and then downstream to the southwest. Cones of depression caused by heavy irrigation pumping have changed the direction of flow in localized areas.[22]

Recharge to the Eastern section occurs from four sources: runoff, underflow, irrigation applications, and precipitation. Runoff is the most important source but has been reduced by upstream water use and dams on the Gila River. Underflow from the Painted Rock Dam area is also an important recharge source. Irrigation applications only impact shallow aquifers. Recharge from precipitation is negligible.[23]

Western Section

Groundwater development in the Western section is largely confined to the Gila River floodplain. The main aquifer is the streambed alluvium with two shallow units: an upper sandy unit and a lower gravel unit. The streambed alluvium, which is up to 150 feet thick, overlies a thick, fine-grained unit composed of clay, silt, and sand lenses, which typically doesn't provide sufficient water for irrigation wells. There has been little groundwater development outside the Gila River floodplain, and groundwater resources in these areas is largely unknown.[24]

Irrigated agriculture along the Gila River began in the 1880s using surface water diversions. As flow in the Gila River declined, groundwater development began around 1915, especially in the Western section. By the 1940s, reuse of shallow groundwater had increased salinity concentrations to levels unsuitable for irrigation. Starting in 1952, water was diverted and pumped from the Colorado River through the 18.5-mile Wellton-Mohawk Canal for use on 75,000 acres in the Wellton-Mohawk Irrigation and Drainage District (WMIDD). Groundwater pumping for irrigation declined until rising groundwater levels threatened crop production.

Drainage wells, averaging 100 feet in depth, were subsequently drilled beginning in 1961 to lower groundwater levels. The wells pump groundwater into the concrete-lined Wellton-Mohawk Main Conveyance Channel, which discharged the drainage water into the Colorado River near Yuma.[25] The river's increased salinity concentrations adversely impacted agriculture in Mexico. The drainage water is now diverted into the Santa Clara Cienega in Mexico, where it supports wetland habitat.[26]

Predevelopment groundwater levels in the Gila River floodplains were less than 20 feet bls. With the importation of Colorado River water for irrigation, groundwater levels continue to be shallow, in some cases less than five feet bls.[27]

Figure 5 – Kofa Deep Well serves the Sonoran pronghorn captive breeding program. The sample (LGB-51) from the remote 1,080-feet-deep well met all health-based standards.

Groundwater flow is towards the Gila River, then downstream to the west. The direction of movement has been impacted locally by groundwater mounding from irrigation applications of Colorado River water.[28] Recharge occurs from four sources: runoff, underflow, irrigation applications, and precipitation. However, recharge from irrigation applications is the largest source of recharge. Underflow from the Eastern section of the basin is also an important source of recharge. Recharge from flow in the Gila River is usually insignificant, though occasional high flows from water releases during floods from Painted Rock Dam provide significant recharge.[29]

Discharge from the Western section occurs, in lessening importance, through plant evapotranspiration, pumped drainage water, and underflow into the downgradient Yuma groundwater basin.[30]

Investigation Methods

ADEQ sampled 108 wells to characterize the regional groundwater quality in the Lower Gila basin (Figure 6). The following types and numbers of samples were collected:

- Inorganics at 108 sites,
- Stable isotopes of oxygen, deuterium, and nitrogen at 108 sites, and
- Radon at 51 sites, and
- Radionuclides at 39 sites.

The 108 wells were powered by submersible pumps (57), turbine pumps (48), and there were three windmills (Figure 9).

Each well was evaluated before sampling to determine if it met ADEQ requirements. A well was considered suitable for sampling when the following general conditions were met: the owner had given permission to sample, a sampling point existed near the wellhead, and the well casing and surface seal appeared to be intact and undamaged.[31] Additional information on groundwater sample sites compiled from the Arizona Department of Water Resources (ADWR) well registry is available in Appendix A.

Sample Collection

The sample collection methods for this study conformed to the Quality Assurance Project Plan (QAPP)[32] and the Field Manual for Water Quality Sampling.[33] While these sources should be consulted as references to specific sampling questions, a brief synopsis of the sample collection procedures is provided.

After obtaining permission from the well owner, the volume of water needed to purge the well three borehole volumes was calculated from well log and on-site information. Physical parameters: temperature, pH, and specific conductivity (SC), were monitored approximately every five minutes using a YSI multi-parameter instrument.

To assure obtaining fresh water from the aquifer, after pumping three bore volumes and physical parameter measurements were stabilized within 10 percent, a sample representative of the aquifer was collected from a point as close to the wellhead as possible. In some instances, it was not possible to purge three bore volumes. In these cases, at least one bore volume was evacuated, and the physical parameters had stabilized within 10 percent. Sample bottles were labeled with the Lower Gila basin prefix (LGB) and filled in the following order based on their volatility:

- Radon
- Inorganics
- Radionuclides
- Isotopes

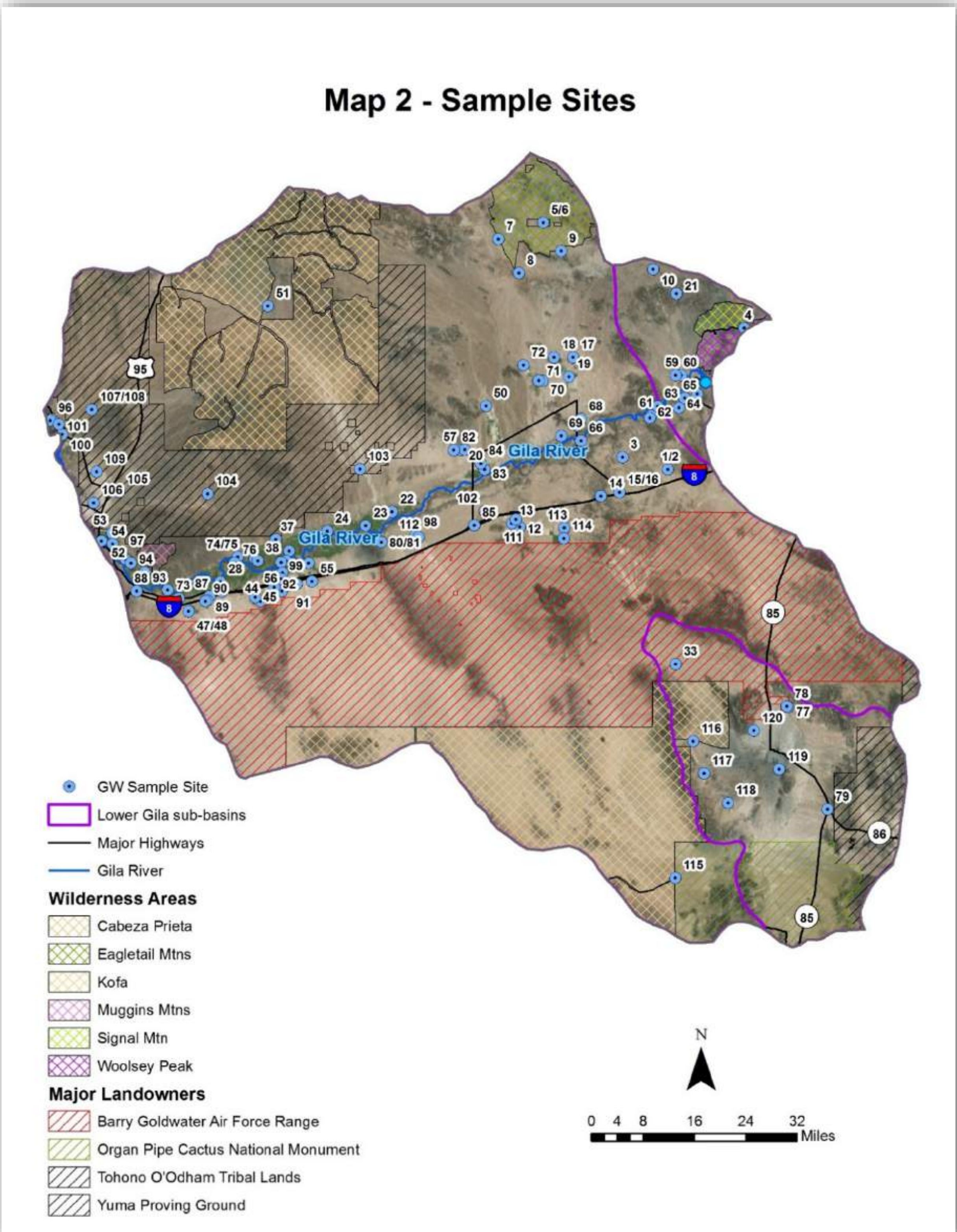


Figure 6 - Sample Sites in the Lower Gila basin.

Radon, a naturally occurring, intermediate breakdown from the radioactive decay of uranium-238 to lead-206, was collected in two unpreserved, 40 ml clear glass vials. Radon samples were filled to minimize volatilization and sealed so that no headspace remained.[34]

The inorganic constituents were collected in three, one-liter polyethylene bottles. Samples to be analyzed for dissolved metals were filtered into a bottle using a positive-pressure filtering apparatus with a 0.45 micron (µm) pore-size groundwater capsule filter and preserved with 5 ml nitric acid (70 percent). Samples to be analyzed for nutrients were preserved with 2 ml sulfuric acid (95.5 percent). Samples to be analyzed for other inorganic parameters were unpreserved.[35]

Radiochemistry samples were collected in a collapsible four-liter plastic container.[36]

Oxygen and hydrogen isotope samples were collected in a 250 ml polyethylene bottle with no preservative or refrigeration. Nitrogen isotope samples were collected in a 500 ml polyethylene bottle and filled ¾ full for expansion room when subsequently frozen.[37]

All samples were kept at 4 degrees Celsius with ice in an insulated cooler, except the radionuclide, and oxygen and hydrogen isotope samples. Nitrogen samples were frozen upon returning from the field and maintained in that manner until submitted to the laboratory.[38]

Chain of custody procedures were followed in sample handling. Samples for this study were collected during 20 field trips conducted between February 2013 and February 2017.

Laboratory Methods

Inorganic analyses for the study were conducted by two laboratories.

The initial 12 inorganic samples (LGB-1 to LGB-16) were analyzed by Test America Laboratory of Phoenix, Arizona. Inorganic analyses for the next 63 samples (LGB-17 to LGB-85) were analyzed by the Accutest Northern California Laboratory in San Jose, California. The subsequent 33 inorganic samples (LGB-86 to LGB-120) were, once again, analyzed by Test America Laboratory of Phoenix, Arizona.

Two inorganic splits were conducted between the laboratories.

A complete listing of inorganic parameters, including laboratory method and Minimum Reporting Level (MRL) for both laboratories is provided in Table 1 and Table 2.

Figure 7 - Former ADEQ employee Amy Garcia collects an isotope sample (LGB-44) from a domestic well located south of Wellton near the Barry Goldwater Air Force Range.

Table 1 - Laboratory Water Methods and Minimum Reporting Levels Used in the Study

Constituent	Instrumentation	Test AM / Accutest Water Method	Test AM / Accutest Minimum Reporting Level
Physical Parameters and General Mineral Characteristics			
Alkalinity	Electrometric Titration	SM 2320B	6 / 5
SC (µS/cm)	Electrometric	EPA 120.1 / SM 2510 B	2 / 1
Hardness	Calculation	SM 2340B / SW 846	13 / 33
pH (su)	Electrometric	EPA 150.1 / SM 4500H+	1.7 / -
TDS	Gravimetric	EPA 160.1 / SM 2540C	20 / 10
Major Ions			
Calcium	ICP-AES	EPA 200.7	2* 1 / 5
Magnesium	ICP-AES	EPA 200.7	2* 1 / 5
Sodium	ICP-AES	EPA 200.7 / EPA 200.8	2* 0.5 / 10
Potassium	Flame AA	EPA 200.7 / EPA 200.8	2* 0.5 / 0.5
Bicarbonate	Calculation	Calculation - SM 2320B	6 / 5
Carbonate	Calculation	Calculation - SM 2320B	6 / 5
Chloride	Potentiometric Titration	SM 4500CLD / EPA 300.0	20* 2 / 50
Sulfate	Colorimetric	EPA 300.0	2 / 5
Nutrients			
Nitrate as N	Colorimetric	EPA 300.0	0.2* 0.1 / 0.1
Nitrite as N	Colorimetric	EPA 353.2 / EPA 300.0	0.2* 0.1 / 0.1
Ammonia	Colorimetric	EPA350.1 / SM 4500NH-3D	0.05 / 1.0
TKN	Colorimetric	EPA 351.2 / SM 4500	1.0* 0.5 / 0.2
Total Phosphorus	Colorimetric	EPA 365.4 / SM 4500	0.1 / 0.02

All units mg/L unless noted otherwise

*= MRL for Test AM samples (LGB-1 to LGB-16) and MRL for Test AM samples (LGB-86 to LGB-120)

Table 2 - Laboratory Water Methods and Minimum Reporting Levels Used in the Study

Constituent	Instrumentation	Test AM / Accutest Water Method	Test AM / Accutest Minimum Reporting Level
Trace Elements			
Aluminum	ICP-AES	EPA 200.7	0.2
Antimony	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.003* 0.0001 / 0.006
Arsenic	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.003* 0.0005 / 0.01
Barium	ICP-AES	EPA 200.7 / EPA 200.8	0.001* 0.002 / 0.2
Beryllium	Graphite Furnace AA	EPA 200.9 / EPA 200.7	0.001* 0.005 / 0.005
Boron	ICP-AES	EPA 200.7	0.2* 0.1 / 0.1
Cadmium	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.001* 0.5 / 0.002
Chromium	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.002 / 0.01
Copper	Graphite Furnace AA	EPA 200.7 / EPA 200.8	0.003* 0.0005 / 0.01
Fluoride	Ion Selective Electrode	SM 4500F-C / EPA 300.0	0.4* 0.1 / 0.1
Iron	ICP-AES	EPA 200.7	0.1* 0.2 / 0.2
Lead	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.001* 0.005 / 0.01
Manganese	ICP-AES	EPA 200.7	0.01* 0.15 / 0.015
Mercury	Cold Vapor AA	SM 3112B / EPA 245.1	0.0002
Nickel	ICP-AES	EPA 200.7	0.01* 0.005 / 0.005
Selenium	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.002* 0.001 / 0.01
Silver	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.001* 0.002 / 0.005
Strontium	ICP-AES	- / EPA 200.7	0.1* 0.01 / 0.01
Thallium	Graphite Furnace AA	EPA 200.9 / EPA 200.8	0.001* 0.002 / 0.01
Zinc	ICP-AES	EPA 200.7	0.05* 0.0125 / 0.02
Radionuclides			
Gross alpha (activity)	Gas flow counter	EPA 600 / 00.02	1
Gross alpha (adjusted)	Gas flow counter	EPA 600 / 00.02	1
Radon	Liquid scantill. counter	EPA 913.1	1
Uranium (activity)	ICP-AES	D6239-09 7500UC	1
Uranium (adjusted)	ICP-AES	EPA 200.8	1

All units mg/L unless noted otherwise

*= MRL for Test AM samples (LGB-1 to LGB-16) and MRL for Test AM samples (LGB-86 to LGB-120)

Radionuclide and radon analyses were conducted by the Radiation Safety Engineering, Inc. Laboratory in Chandler, Arizona.

Isotope samples were analyzed by the Laboratory of Isotope Geochemistry at the University of Arizona in Tucson, Arizona (Figure 7).

Data Evaluation

Quality Assurance

Quality-assurance (QA) procedures were followed, and quality-control (QC) samples were collected to quantify data bias and variability for the Lower Gila basin study. The design of the QA/QC plan was based on recommendations provided in the *Quality Assurance Project Plan* (*QAPP*)[39] and *the Field Manual for Water Quality Sampling*.[40]

The following types and numbers of QC inorganic samples collected for this study:

- one equipment blank,
- five duplicate samples, and
- three split samples.

Blank Samples

One equipment blank for inorganic analysis was collected for the study to ensure adequate decontamination of sampling equipment, and that the filter apparatus and de-ionized water were not impacting groundwater quality sampling.[41]

The equipment blank sample for major ion and nutrient analyses were collected by filling unpreserved bottles with de-ionized water. The nutrient bottle was subsequently preserved with sulfuric acid. The equipment blank sample for dissolved metal analysis was collected using de-ionized water that had been filtered into a bottle and preserved with nitric acid.

The equipment blank was submitted to the Test America laboratory (LGB-88). No constituents were detected in the equipment blank except for antimony at 0.00022 mg/L and copper at 0.0046 mg/L, which were attributed to trace levels in the filters.[42]

Figure 8 - ADEQ's Elizabeth Boettcher collects a duplicate sample from Tartan Well (LGB-1/2), used for stock watering in a remote area near the Painted Rock Mountains.

Duplicate Samples

Duplicates are identical sets of samples collected from the same source at the same time and submitted to the same laboratory with different identification numbers, dates, and times (Figure 8). Data from duplicate samples provide a measure of variability from the combined effects of field and laboratory procedures.[43]

Duplicate samples were collected from sampling sites that were believed to have elevated or unique constituent concentrations as evaluated by SC and pH field values.

Five duplicate samples were collected for this study. Four duplicate samples were submitted to the Test America laboratory and one duplicate sample to the Accutest laboratory. The analytical results were evaluated by examining the variability in constituent concentrations regarding absolute levels and as the percent difference.

Analytical results from the Test America laboratory duplicate samples indicate that of the 40 constituents examined, 27 had concentrations above the MRL. The duplicate samples had a maximum variation or percent difference between constituents less than 10 percent. The only constituent exceeding this acceptable level was selenium in one sample (13 percent) (Table 3).

Analytical results from the Accutest duplicate sample indicate that of the 40 constituents examined, 21 had concentrations above the MRL. The duplicate samples all had a maximum variation between constituents less than five percent. The only constituents exceeding this acceptable level were total phosphorus (19 percent) and TKN (17 percent) (Table 4). In addition, one constituent, zinc, was detected in one of the duplicate samples near the MRL but not in the other duplicate.

Split Samples

Splits are identical sets of samples collected from the same source at the same time that are submitted to two different laboratories to check for laboratory differences.[44] The analytical results were evaluated by examining the variability in constituent concentrations regarding absolute levels and as the percent difference.

Three inorganic split samples were collected for this study and distributed between the Accutest Laboratory and Test America laboratories.

Figure 9 – Woolsey Windmill, located west of Woolsey Peak in the Dendora Valley sub-basin was one of three windmills sampled for the study. The sample (LGB-4) met all water quality standards.

Table 3 - Summary Results of Four Duplicate Samples from Test America Laboratory

Parameter	Number of Dup. Samples	Difference in Percent			Difference in Concentrations		
		Minimum	Maximum	Median	Minimum	Maximum	Median
Alk., Total	4	0 %	0 %	0 %	0	0	0
SC (µS/cm)	4	0 %	0 %	0 %	0	0	0
Hardness	4	0 %	4 %	0 %	0	5	0
pH (su)	4	0 %	0 %	0 %	0	0.04	0.03
TDS	4	0 %	2 %	0 %	0	10	0
Turbidity (ntu)	2	0 %	2 %	-	0	0.2	-
Calcium	4	0 %	3 %	0 %	0	1	0
Magnesium	3	0 %	4 %	0 %	0	0.4	0
Sodium	4	0 %	3 %	0 %	0	10	0
Potassium	4	0 %	4 %	0 %	0	1	0
Chloride	4	0 %	0 %	0 %	0	0	0
Sulfate	4	0 %	0 %	0 %	0	0	0
Nitrate (as N)	4	0 %	4 %	0 %	0	0.1	0
T. Phosphorus	1	-	-	6 %	-	-	0.003
Ammonia	2	4 %	9 %	-	0.002	0.0009	-
Arsenic	3	2 %	5 %	4 %	0.0005	0.002	0.001
Barium	4	0 %	2 %	0 %	0	0.0003	0
Boron	4	0 %	4 %	0 %	0	0.04	0
Chromium	4	0 %	4 %	3 %	0	0.002	0.0003
Copper	3	0 %	8 %	4 %	0	0.004	0.0002
Fluoride	4	0 %	2 %	1%	0	0.1	0.02
Iron	1	-	-	3 %	-	-	0.01
Lead	1	-	-	4 %	-	-	0.0012
Manganese	2	0 %	1 %	-	0	0.0576	-
Selenium	4	0 %	13 %	0 %	0	0.00021	0
Strontium	4	0 %	4 %	0 %	0	0.007	0
Zinc	3	2 %	5 %	2 %	0.001	0.002	0.001

All concentration units are mg/L except as noted with certain physical parameters.

Table 4 - Summary Results of the Duplicate Sample from Accutest Laboratory

Parameter	Number of Dup. Samples	Difference in Percent			Difference in Concentrations		
		Minimum	Maximum	Median	Minimum	Maximum	Median
Physical Parameters and General Mineral Characteristics							
Alk., Total	1	-	-	1 %	-	-	6
SC (µS/cm)	1	-	-	1 %	-	-	70
Hardness	1	-	-	1 %	-	-	20
pH (su)	1	-	-	0 %	-	-	0.03
TDS	1	-	-	3 %	-	-	220
Major Ions							
Calcium	1	-	-	1 %	-	-	7
Magnesium	1	-	-	1 %	-	-	1.4
Sodium	1	-	-	0 %	-	-	1
Potassium	1	-	-	2 %	-	-	0.27
Chloride	1	-	-	4 %	-	-	90
Sulfate	1	-	-	4 %	-	-	77
Nutrients							
Nitrate (as N)	1	-	-	0 %	-	-	0
TKN	1	-	-	19 %	-	-	0.15
Phosphorus	1	-	-	17 %	-	-	0.014
Trace Elements							
Arsenic	1	-	-	2 %	-	-	0.0003
Barium	1	-	-	2 %	-	-	0.0013
Boron	1	-	-	2 %	-	-	0.04
Fluoride	1	-	-	1 %	-	-	0.01
Manganese	1	-	-	0 %	-	-	0.05
Strontium	1	-	-	1 %	-	-	0.11
Zinc	1	-	-	1 %	-	-	0.0005

All concentration units are mg/L except as noted with certain physical parameters.

Table 5 - Summary Results of Three Split Samples between Accutest / Test America Labs

Parameter	Number of Dup. Samples	Difference in Percent			Difference in Concentrations		
		Minimum	Maximum	Median	Minimum	Maximum	Median
Physical Parameters and General Mineral Characteristics							
Alk., Total	3	1 %	6 %	4 %	0.8	55	4
SC (µS/cm)	3	1 %	10 %	5 %	90	600	340
Hardness	3	1 %	4 %	1 %	9	20	20
pH (su)	3	1 %	3 %	1 %	0.16	0.36	0.2
TDS	3	0 %	7 %	1 %	20	310	50
Turbidity	1	-	-	1 %	-	-	0.2
Major Ions							
Calcium	3	0 %	5 %	2 %	2	8.8	5
Magnesium	3	1 %	5 %	1 %	0.3	0.78	0.3
Sodium	3	1 %	12 %	2 %	11	154	20
Potassium	3	2 %	10 %	3 %	0.33	1.71	0.43
Chloride	3	2 %	9 %	6 %	17	175	44
Sulfate	3	1 %	3 %	1 %	11	64	17
Nutrients							
Nitrate (as N)	2	3 %	4 %	3 %	0.1	0.3	0.2
Phosphorus	1	-	-	12 %	-	-	0.017
TKN	1	-	-	0 %	-	-	0
Trace Elements							
Arsenic	3	4 %	13 %	8 %	0.0004	0.0056	0.0011
Barium	3	2 %	4 %	3 %	0.0007	0.0019	0.0018
Boron	3	1 %	4 %	2 %	0.009	0.12	0.1
Chromium	1	-	-	3 %	-	-	0.0008
Fluoride	3	4 %	6 %	6 %	0.09	0.4	0.03
Iron	1	-	-	3 %	-	-	0.044
Manganese	1	-	-	1 %	-	-	0.051
Strontium	3	1 %	3 %	3 %	0.06	0.17	0.13
Zinc	1	-	-	3 %	-	-	0.008

All units are mg/L except as noted [31, 32]

Analytical results indicate that of the 40 constituents examined, 24 had concentrations above MRLs for both the Accutest and Test America labs. The maximum variation between constituents was acceptable at below 15 percent for all the 24 constituents (Table 5).

Based on the results of the equipment blank, duplicate, and split samples collected for this study, no significant QA/QC were found with the groundwater quality data.

Data Validation

The analytical work for this study was subjected to four QA/QC correlations.

Cation/Anion Balances

Water samples should theoretically exhibit electrical neutrality. Therefore, the sum of milliequivalents per liter (meq/L) of cations should equal the sum of meq/L of anions. However, this neutrality rarely occurs due to unavoidable variation inherent in all water quality analyses. Still, if the cation/anion balance is found to be within acceptable limits, it can be assumed there are no gross errors in concentrations reported for major ions.[45]

Overall, cation/anion meq/L balances of Lower Gila basin samples were significantly correlated (regression analysis, $p \leq 0.01$). Of the 108 samples, 99 samples were within +/-10 percent, and 72 samples were within +/- 5 percent. The highest variation was 25 percent at LGB-99. Most of the samples (92) had low cation/high anion sums while 16 samples had high cation/low anion sums. All the samples collected after LGB-57 except one (LGB-96) had low cation/high anion sums.

SC-TDS Correlations and Ratio

Specific conductivity measured both in the field and in the lab was significantly correlated with total dissolved solids (TDS) concentrations measured by contract laboratories (regression analysis, $r = 0.98$, $p \leq 0.01$).

Specific conductivity measured by laboratories was significantly correlated with TDS concentrations measured by laboratories (regression analysis, $r = 0.99$, $p \leq 0.01$).

Figure 10 - ADEQ's Jason Jones collects a duplicate sample (LGB-5/6) from O'Brien's Anvil Well located in the Eagletail Mountains Wilderness.

The TDS concentration in mg/L should be from 0.55 to 0.75 times the SC in µS/cm for groundwater up to several thousand TDS mg/L. The relationship of TDS to SC becomes undefined with very high or low concentrations of dissolved solids.[46] Most of the 108 samples were within this ratio and some that were not could be attributed to elevated TDS concentrations.

Other samples outside the ratio were attributed to elevated concentrations of specific anions. Groundwater high in bicarbonate and chloride will have a multiplication factor near the lower end of this range; groundwater high in sulfate may reach or even exceed the higher factor.[47]

SC Correlation

The SC measured in the field at the time of sampling was significantly correlated with the SC measured by contract laboratories (regression analysis, $r = 0.98$, $p \leq 0.01$).

pH Correlations

The pH values measured in the field using a YSI meter at the time of sampling were significantly correlated with laboratory pH values (regression analysis, $r = 0.90$, $p \geq 0.01$) (Figure 11).

Data Validation Conclusions

Based on the results of the four QA/QC checks, the groundwater quality data collected for the study was considered valid.

Statistical Considerations

Data Normality

Data associated with 27 constituents were tested for non-transformed normality using the Kolmogorov-Smirnov one-sample test with the Lilliefors option.[48] Results of this test revealed that two of the 27 constituents examined were normally distributed: pH-field and pH-lab.

Spatial Relationships

The non-parametric Kruskal-Wallis test using untransformed data was applied to investigate the hypothesis that constituent concentrations from sample sites having different sub-basins were the same. The Kruskal-Wallis test uses the differences, but also incorporates information about the magnitude of each difference. The null hypothesis of identical mean values for all

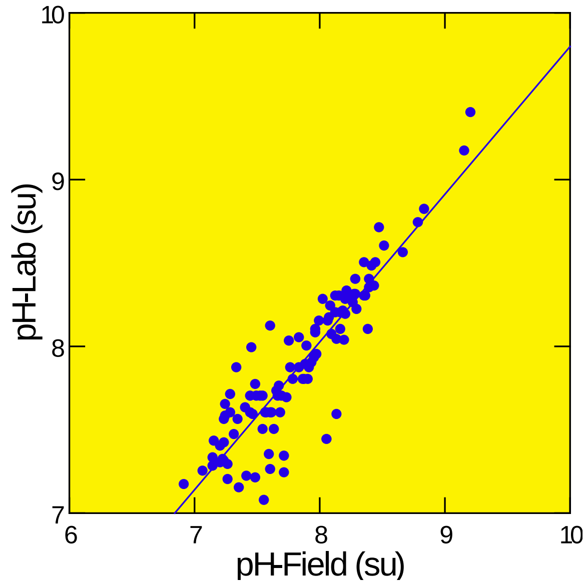


Figure 11 - pH field and lab values are described by the equation: $y = 0.92x + 0.6$. The pH value is related to the environment of the water and is often altered by storage.[49]

data sets within each test was rejected if the probability of obtaining identical means by chance was less than or equal to 0.05.[50]

If the null hypothesis was rejected for the tests conducted on the sub-basin group, the Tukey method of multiple comparisons on the ranks of data was applied. The Tukey test identified significant differences between constituent concentrations when compared to each possibility with each of the tests. Both the Kruskal-Wallis and Tukey tests are not valid for data sets with greater than 50 percent of the constituent concentrations below the MRL.[51]

Constituent Concentrations

To assess the strength of association between constituents, their concentrations were compared to each other using the non-parametric Kendall's tau-b test. Kendall's correlation coefficient varies between -1 and +1; with a value of +1 indicating that a variable can be predicted perfectly by a positive linear function of the other. A value of -1 indicates a perfect inverse or negative relationship.[52]

The Kendall's tau-b test results were subjected to a probability test to determine which of the individual pairwise correlations were significant.[34] The Kendall's tau-b test is not valid for data sets with more than 50 percent of the constituent concentrations below the MRL.[53]

Groundwater Sampling Results

Water Quality Standards

The ADEQ ambient groundwater program characterizes regional groundwater quality. An important determination ADEQ makes concerning the collected samples is how the analytical results compare to various drinking water quality standards. ADEQ used three sets of drinking water standards that reflect the best current scientific and technical judgment available to evaluate the suitability of groundwater for drinking water use:

Federal Safe Drinking Water Act (SDWA) Primary Maximum Contaminant Levels (MCLs): These enforceable health-based standards establish the maximum concentration of a constituent allowed in water supplied by public systems.[54]

State of Arizona Aquifer Water Quality Standards: These apply to aquifers that are classified for drinking water protected use. All aquifers within Arizona are currently classified and protected for drinking water use. These enforceable state standards are identical to the federal Primary MCLs except for arsenic which is at 0.05 mg/L compared with the federal Primary MCL of 0.01 mg/L.[55]

Federal SDWA Secondary MCLs: These non-enforceable aesthetics-based guidelines define the maximum concentration of a constituent that can be present without imparting an unpleasant taste, color, odor, or other aesthetic effects on the water.[56]

Health-based drinking water quality standards (such as Primary MCLs) are based on the lifetime consumption (70 years) of two liters of water per day and, as such, are chronic rather than acute standards.[57] Specific constituent concentrations for each groundwater site are in Appendix B.

Overall Results

The 108 sites sampled in the Gila River study had the following water quality results:

All health-based and aesthetics-based water quality standards were met at nine sites (eight percent). Health-based water quality standards were exceeded at 78 sites (72 percent). Aesthetics-based water quality standards were exceeded at 97 sites (90 percent).

Inorganic Results

Of the 108 sites sampled for the full suite of inorganic constituents (excluding radionuclide sample results), nine sites (eight percent) met all health-based and aesthetics-based, water quality standards.

Health-based Primary MCL water quality standards were exceeded at 78 of the 102 sites (72 percent) (Figure 12; Table 6). Constituents above Primary MCLs include arsenic (72 sites), fluoride (34 sites), and nitrate (10 sites).

Potential health impacts of these Primary MCL exceedances are also provided in Table 6.

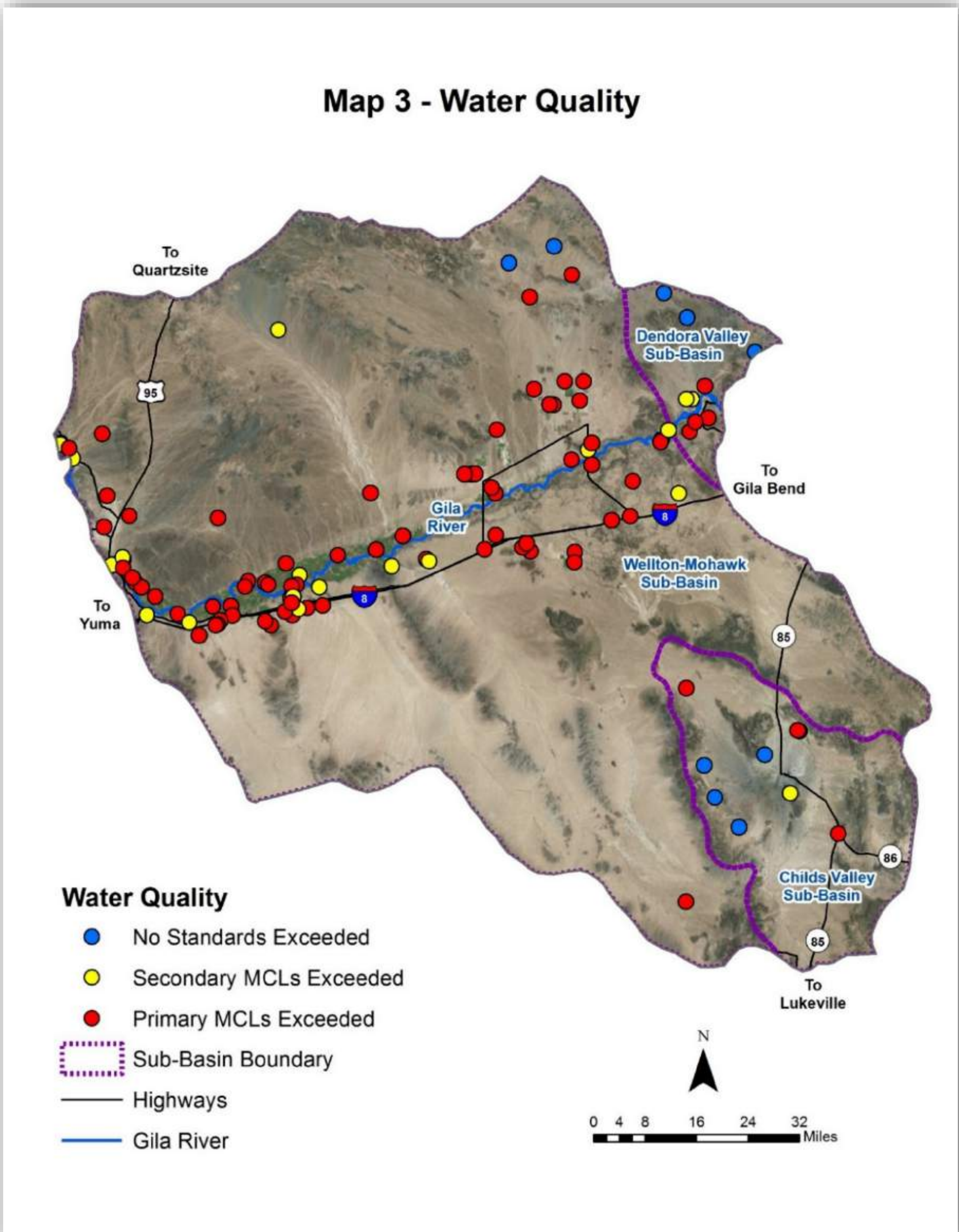


Figure 12 - Water Quality of the Lower Gila basin.

Table 6 - Sites Exceeding Health-based Water Quality Standards or Primary MCLs

Constituent	Primary MCL	Number of Sites Exceeding Primary MCL	Maximum Concentration	Potential Health Effects of MCL Exceedances *
Nutrients				
Nitrite (NO_2-N)	1.0	0	-	-
Nitrate (NO_3-N)	10.0	**10**	**35.7**	Methemoglobinemia
Trace Elements				
Antimony (Sb)	0.006	0	-	-
Arsenic (As)	0.01	**72**	**0.188**	dermal and nervous system toxicity
Arsenic (As)	0.05	**11**	**0.188**	dermal and nervous system toxicity
Barium (Ba)	2.0	0	-	-
Beryllium (Be)	0.004	0	-	-
Cadmium (Cd)	0.005	0	-	-
Chromium (Cr)	0.1	0	-	-
Copper (Cu)	1.3	0	-	-
Fluoride (F)	4.0	**34**	**9.55**	skeletal damage
Lead (Pb)	0.015	0	-	-
Mercury (Hg)	0.002	0	-	-
Nickel (Ni)	0.1	0	-	-
Selenium (Se)	0.05	0	-	-
Thallium (Tl)**	0.002	0	-	-
Radiochemistry Constituents				
Gross Alpha	15	0	-	-
Ra-226+Ra-228	5	0	-	-
Radon **	300	**23**	**1496**	cancer
Radon **	4,000	0	-	-
Uranium	30	0	-	-

All units are mg/L except gross alpha, radium-226+228 and radon (pCi/L), and uranium (ug/L).
* Health-based drinking water quality standards are based on a lifetime consumption of two liters of water per day over a 70-year life span.[58]
** Proposed EPA Safe Drinking Water Act standards for radon in drinking water.[59]

Aesthetics-based Secondary MCL water quality guidelines were exceeded at 95 sites (93 percent; Figure 12; Table 7). Constituents above Secondary MCLs include total dissolved solids (TDS) (95 sites), chloride (77 sites), fluoride (65 sites), sulfate (62 sites), manganese (22 sites), iron (14 sites), and pH-field (six sites).

Potential health impacts of these Secondary MCL exceedances are given in Table 7.

Table 7 - Sites Exceeding Aesthetics-based Water Quality Guidelines/Secondary MCLs

Constituents	Secondary MCL	Number of Sites Exceeding Secondary MCLs	Maximum Concentration	Aesthetic Effects of MCL Exceedances
Physical Parameters				
pH - field	< 6.5	0	-	bitter metallic taste; corrosion
pH - field	> 8.5	**6**	9.21	slippery feel; soda taste; deposits
General Mineral Characteristics				
TDS	500	**95**	20,000	hardness; deposits; colored water; staining; salty taste
Major Ions				
Chloride (Cl)	250	**77**	5,900	salty taste
Sulfate (SO_4)	250	**62**	8,200	salty taste
Trace Elements				
Aluminum (Al)	0.05 to 0.2	0	-	colored water
Fluoride (F)	2.0	**65**	9.55	tooth discoloration
Iron (Fe)	0.3	**14**	0.946	rusty color; sediment; metallic taste; reddish or orange staining
Manganese (Mn)	0.05	**22**	4.45	black to brown color; black staining; bitter metallic taste
Silver (Ag)	0.1	0	-	-
Zinc (Zn)	5.0	0	-	metallic taste

All units mg/L except pH is in standard units (su).

Radionuclide Results

Of the 39 sites sampled for radionuclides, there were no health-based Primary MCL water quality standards for either gross alpha or uranium.

Radon Results

The 51 sites sampled for radon had the following water quality results (Map 4):

The proposed 4,000 picocuries per liter (pCi/L) standard that would apply if Arizona establishes an enhanced multimedia program to address the health risks from radon in indoor air was not exceeded at any sites.

The proposed 300 pCi/L standard that would apply if Arizona doesn't develop a multimedia program was exceeded at 23 sites (45 percent).[60]

Analytical Results

Analytical inorganic and radiochemistry results of the Lower Gila basin sample sites are summarized (Table 8 and Table 9) using the following indices: MRLs, the number of sample sites over the MRL, upper and lower 95 percent confidence intervals ($CI_{95\%}$), median, and mean. Confidence intervals are a statistical tool which indicates that 95 percent of a constituent's population lies within the stated confidence interval.[34]

Specific constituent information for each sampled groundwater site is in Appendix B.

Figure 13 - ADEQ's Jason Jones samples the Poco Dinero domestic well in the Dendora Valley sub-basin. The sample (LGB-59) met all health-based water quality standards.

Table 8 - Summary Statistics for Groundwater Quality Data

Constituent	Minimum Reporting Limit (MRL)**	# of Samples / Samples Over MRL	Median	Lower 95% Confidence Interval	Mean	Upper 95% Confidence Interval
Physical Parameters						
Temperature (ºC)	0.1	108 / 108	28.0	28.0	29.0	30.1
pH-field (su)	0.01	108 / 108	7.84	7.76	7.85	7.94
pH-lab (su)	1.68 / -	108 / 108	7.87	7.80	7.89	7.94
General Mineral Characteristics						
T. Alkalinity	6.0 / 5.0	108 / 108	105	147	175	204
SC-field (µS/cm)	N/A	108 / 108	2317	2296	2811	3325
SC-lab (µS/cm)	2.0 / 1.0	108 / 108	2450	2418	2945	3472
Hardness-lab	13 / 33	108 / 106	270	339	414	489
TDS	20 / 10	108 / 108	1490	1543	1961	2379
Major Ions						
Calcium	*2 or 1 / 5	108 / 107	82	98	119	140
Magnesium	*2 or 1 / 5	108 / 80	11	22	29	35
Sodium	*2 or 0.5 / 10	108 / 108	362	382	496	610
Potassium	2 or 0.5 / 0.5	108 / 106	4.5	4.7	5.3	5.9
Bicarbonate	6.0 / 5.0	108 / 108	130	180	215	249
Carbonate	6.0 / 5.0	108 / 2	> 50 percent of data below MRL			
Chloride	*20 or 2 / 50	108 / 108	422	469	600	729
Sulfate	2 / 5	108 / 108	320	400	568	737
Nutrients						
Nitrate (as N)	*0.2 or 0.1 / 0.1	108 / 102	2.0	2.7	3.8	4.9
Nitrite (as N)	*0.2 or 0.1 / 0.1	75 / 2	> 50% of data below MRL			
TKN	*1.0 or 0.2 / 0.2	108 / 26	> 50% of data below MRL			
Ammonia	0.05 / 1.0	108 / 14	> 50% of data below MRL			
T. Phosphorus	0.1 / 0.02	108 / 38	> 50% of data below MRL			

** = Standard Test America / Accutest MRL All units mg/L except where noted.
*= MRL for Test AM samples (LGB-1 to LGB-16) and MRL for Test AM samples (LGB-86-120)

Table 9 - Summary Statistics for Groundwater Quality Data

Constituent	Minimum Reporting Limit (MRL)*	# of Samples / Samples Over MRL	Median	Lower 95% Confidence Interval	Mean	Upper 95% Confidence Interval
Trace Elements						
Aluminum	0.2	108 / 1	> 50% of data below MRL			
Antimony	*0.003 or 0.0001 / 0.006	108 / 17	> 50% of data below MRL			
Arsenic	* 0.003 or 0.0005 / 0.01	108 / 98	0.016	0.016	0.034	0.053
Barium	*0.001 or 0.002 / 0.2	108 / 105	0.022	0.021	0.026	0.031
Beryllium	*0.001 or 0.005 / 0.005	108 / 0	> 50% of data below MRL			
Boron	*0.2 or 0.1 / 0.1	108 / 107	1.1	1.2	1.8	2.4
Cadmium	*0.001 or 0.5 / 0.002	108 / 3	> 50% of data below MRL			
Chromium	0.002 / 0.01	108 / 58	> 50% of data below MRL			
Copper	*0.003 or 0.0005 / 0.01	108 / 34	> 50% of data below MRL			
Fluoride	*0.4 or 0.1 / 0.1	108 / 104	2.7	2.5	3.0	3.4
Iron	*0.1 or 0.2 / 0.2	108 / 19	> 50% of data below MRL			
Lead	*0.001 or 0.005 / 0.01	108 / 8	> 50% of data below MRL			
Manganese	*0.01 or 0.015 / 0.015	108 / 29	> 50% of data below MRL			
Mercury	0.0002	108 / 0	> 50% of data below MRL			
Nickel	*0.01 or 0.005 / 0.005	108 / 0	> 50% of data below MRL			
Selenium	*0.002 or 0.001 / 0.01	108 / 52	> 50% of data below MRL			
Silver	*0.001 or 0.002 / 0.005	108 / 1	> 50% of data below MRL			
Strontium	0.1 or 0.01 / 0.01	108/ 105	1.08	1.45	1.84	2.23
Thallium	*0.001 or 0.002 / 0.01	108 / 2	> 50% of data below MRL			
Zinc	*0.05or 0.0125 / 0.02	108 / 30	> 50% of data below MRL			
Radiochemical						
Gross α (pCi/L)	1	38/ 20	0.5	0.6	0.9	1.2
Uranium (ug/L)	1	34 / 23	2.6	2.8	4.1	5.4
Radon (pCi/L)	1	52 / 50	286	281	407	534
Isotopes						
O-18 (0/00)	Varies	108 / 108	-8.5	-9.2	-8.9	-8.7
D (0/00)	Varies	108 / 108	-64.0	-71.4	-68.8	-66.1
$\delta^{15}N$ (0/00)	Varies	108 / 108	9.3	9.6	10.8	12.0

Groundwater Composition

General Summary

Water chemistry in the Lower Gila basin was predominantly sodium-chloride (60 sites) and sodium-mixed (23 sites).

Other water types included sodium-sulfate (seven sites), sodium-bicarbonate (six sites), mixed-mixed (five sites), mixed-bicarbonate and mixed- sulfate (two sites apiece), and one site apiece for calcium-bicarbonate, mixed-bicarbonate, and mixed-chloride (Figure 14 – middle diagram) (Map 5).

The dominant cation was sodium at 96 sites (Diagram 2 – left figure). The dominant anion was chloride at 61 sites (Figure 14 – right diagram).

The distribution of water chemistry throughout the basin is shown in Figure 15.

The water chemistry of samples varied by recharge source: Gila River (sodium-chloride), local (mixed-bicarbonate), and Colorado River (sodium-chloride with a higher concentration of sulfate).

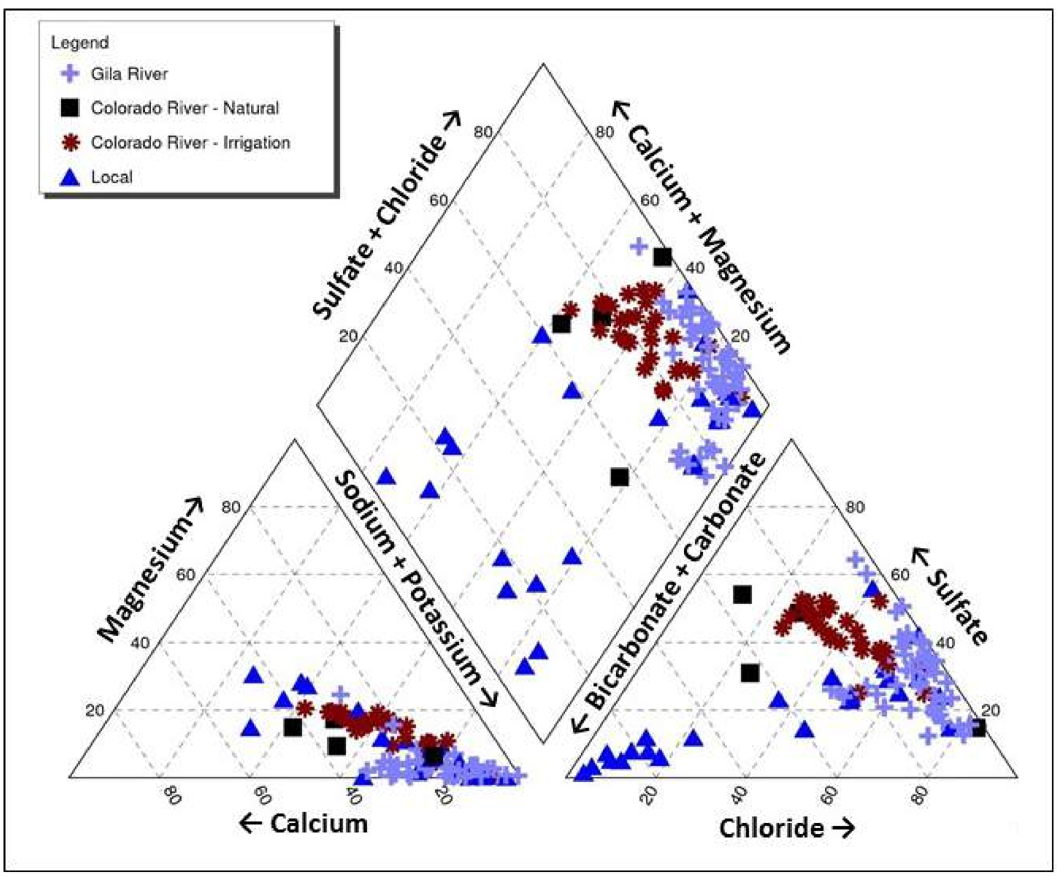


Figure 14 - Samples collected in the Lower Gila basin are predominantly of sodium-chloride chemistry, but varied by the source of the recharge water.

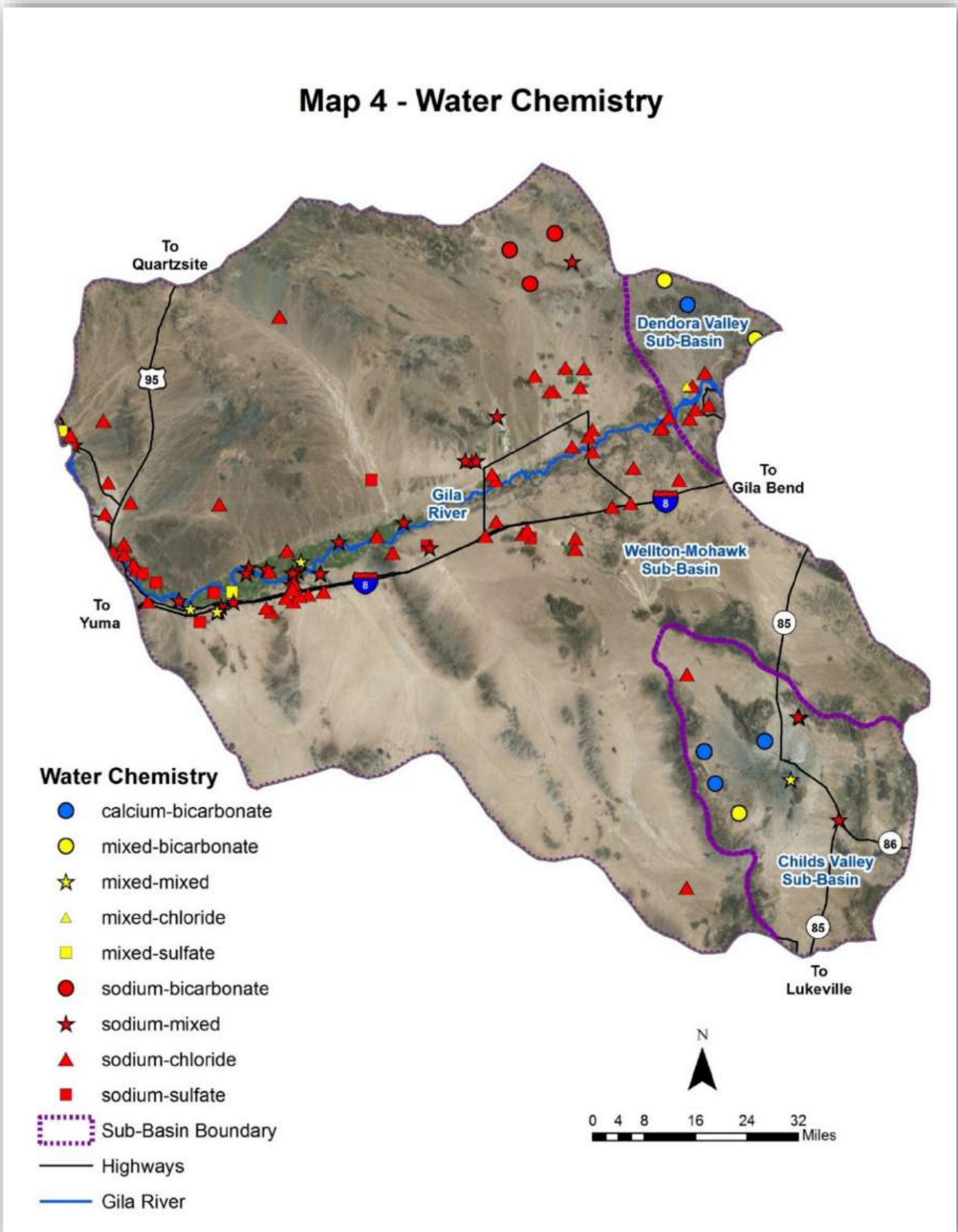


Figure 15 – Water Chemistry of the Lower Gila basin.

At one site, levels of pH-field were *slightly acidic* (below 7 su). At 107 sites, levels of pH-field were *slightly alkaline* (7 - 8 su), 41 sites were above 8 su, and two sites were above 9 su. [12]

TDS concentrations were considered *fresh* (below 999 mg/L) at 42 sites and *slightly saline* (1,000 to 3,000 mg/L) at 46 sites, *saline* (3,000 – 10,000 mg/L) at 19 sites, and *very saline* (10,000-35,000) at one site (Figure 16).[12]

Hardness concentrations were *soft* (below 75 mg/L) at 25 sites, *moderately hard* (75 – 150 mg/L) at 13 sites, *hard* (150 – 300 mg/L) at 19 sites, *very hard* (301 - 600 mg/L) at 21 sites, and *extremely hard* (above 601 mg/L) at 30 sites (Figure 17).[10]

Nitrate (as nitrogen) concentrations at most sites may have been influenced by human activities according to a prominent nationwide USGS study.[22] Nitrate concentrations were divided into natural background (six sites at < 0.2 mg/L), may or may not indicate human influence (62 sites at 0.2 – 3.0 mg/L), may result from human activities (30 sites at 3.0 – 10 mg/L), and probably result from human activities (10 sites > 10 mg/L).[17]

Most trace elements such as aluminum, antimony, beryllium, cadmium, lead, mercury, nickel, silver, and thallium were rarely detected. Only arsenic, barium, boron, chromium, copper, fluoride, iron, manganese, strontium, and zinc were detected at more than 20 percent of the sites.

The groundwater at each sample site was assessed as to its suitability for irrigation use based on salinity and sodium hazards. Excessive levels of sodium are known to cause physical deterioration of the soil and vegetation. Irrigation water may be classified using SC and the Sodium Adsorption Ratio (SAR) in conjunction with one another.[33]

Groundwater sites in the Lower Gila basin display a wide range of irrigation water classifications. Samples predominantly had a "medium" to "high" sodium hazard and a "high" to "very high" salinity hazard (Table 10).

Table 10 - Sodium and Salinity Hazards for Sample Sites

Hazard	Total Sites	Low	Medium	High	Very High
		Sodium Hazard			
Sodium Adsorption Ratio (SAR)		0 - 10	10- 18	18 - 26	> 26
Sample Sites	108	16	44	27	21
		Salinity Hazard			
Specific Conductivity (µS/cm)		0–250	250 – 750	750-2250	>2250
Sample Sites	108	0	12	37	59

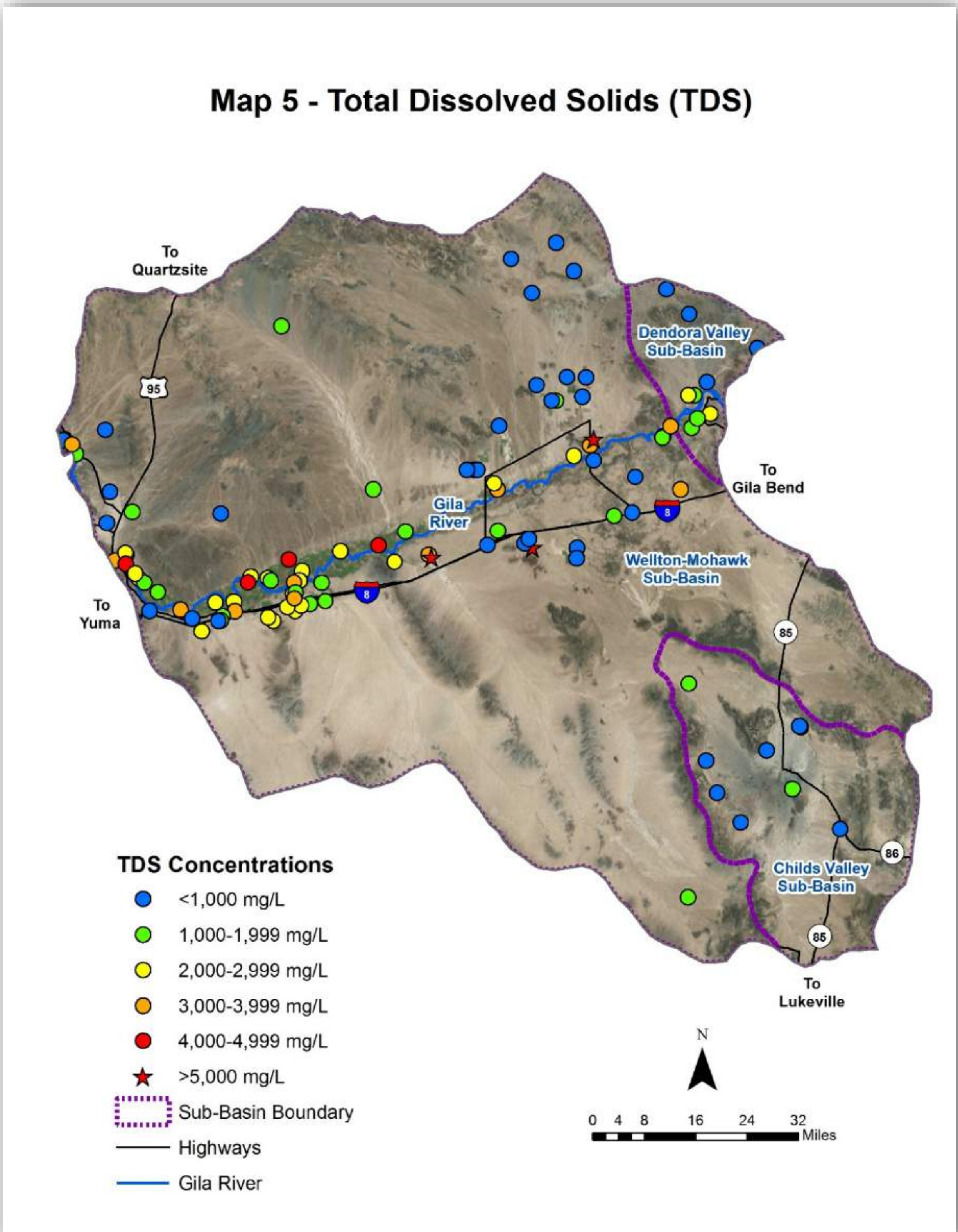


Figure 16 - TDS concentrations of the Lower Gila basin.

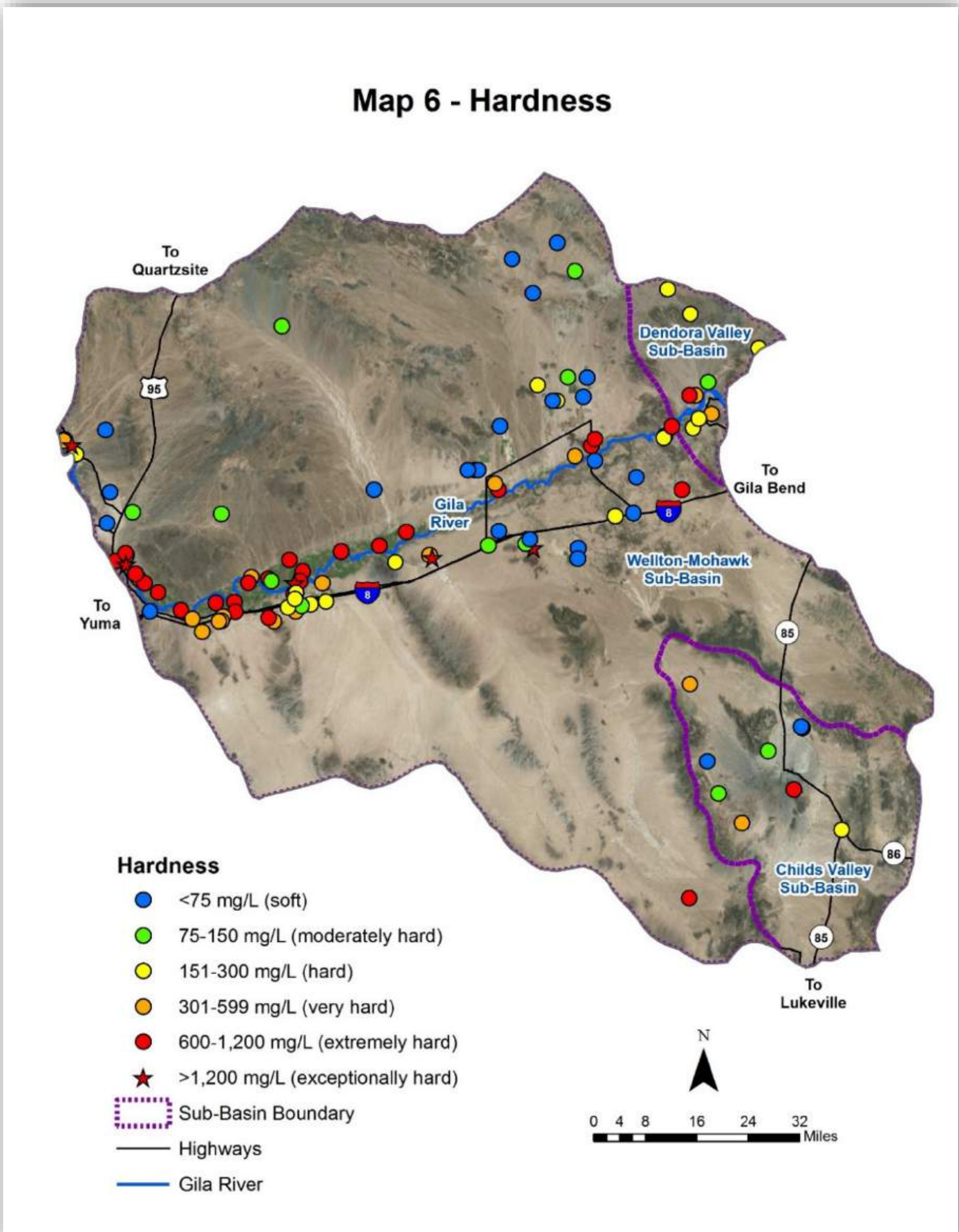


Figure 17 - Hardness concentrations of the Lower Gila basin.

Constituent Covariation

The correlations between different chemical parameters were analyzed to determine the relationship between the constituents that were sampled. The strength of association between the chemical constituents allows for the identification of broad water quality patterns within a basin.

The results of each combination of constituents were examined for statistically significant positive or negative correlations. A ***positive correlation*** occurs when, as the level of a constituent increases or decreases, the concentration of another constituent also correspondingly increases or decreases. A ***negative correlation*** occurs when, as the concentration of a constituent increases, the concentration of another constituent decreases, and vice-versa. A positive correlation indicates a direct relationship between constituent concentrations; a negative correlation indicates an inverse relationship.[34]

Several significant correlations occurred among the 108 sample sites (Table 11, Kendall's tau-b test, $p \leq 0.05$). Four groups of correlations were identified:

TDS and most major ions were positively correlated with one another including hardness, calcium, magnesium, sodium, potassium, chloride, sulfate, strontium, and nitrogen-15.

Temperature, pH-field, and deuterium had a negative correlation with TDS and most major ions.

Nitrate had a negative correlation with nitrogen-15.

Arsenic, fluoride, and pH-field were all positively correlated with each other, while the trace elements were negatively correlated with hardness, calcium, and magnesium.

TDS concentrations are best predicted among major ions by sulfate concentrations (Figure 18) (standard coefficient = 0.52), among cations by sodium concentrations (standard coefficient = 0.82) (Figure 18) and among anions, by chloride concentrations (standard coefficient = 0.52, multiple regression analysis, $p \leq 0.01$).

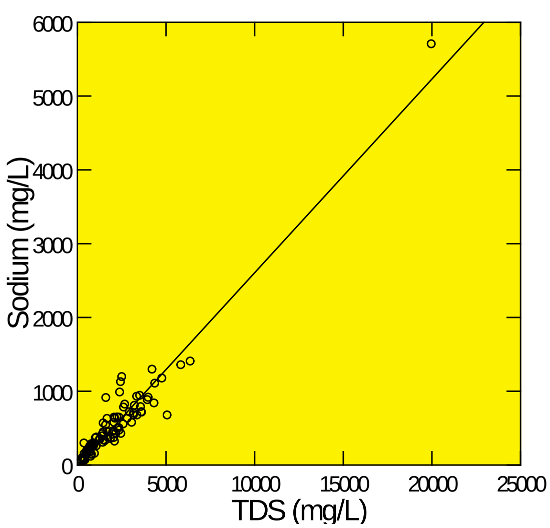


Figure 18 - Relationship between TDS and sodium

A positive relationship between two constituents is illustrated by the graph: as TDS concentrations increase, sodium concentrations also increase. TDS concentrations are best predicted by among cations by sodium concentrations (multiple regression analysis).

Table 11. Correlation among Groundwater Quality Constituent Concentrations

Constituent	Temp	pH-f	SC-f	TDS	Hard	Ca	Mg	Na	K	Bic	Cl	SO_4	NO_3	N15	Sr	As	F	O	D
Physical Parameters																			
Temperature		**		++	++	++	++			++		++			+	*	**		**
pH-field			++	++	++	++	++	++	++	++	++	++			++	**	**		
SC-field				**	**	**	**	**	**		**	**		**	**				++
General Mineral Characteristics																			
TDS					**	**	**	**	**	**	**	**		**	**				++
Hardness						**	**	**	**	**	**	**		**	**	++	++		++
Major Ions																			
Calcium							**	**	**	*	**	**		**	**	++	++		++
Magnesium								**	**	**	**	**			**	++	++		++
Sodium									**		**	**		**	**				++
Potassium											**	**		**	**		++		++
Bicarbonate																	++		
Chloride												**		**	**				
Sulfate														**	**			++	++
Nutrients																			
Nitrate														++	+				
Nitrogen-15															**				+
Trace Elements																			
Strontium																			++
Arsenic																	**		
Fluoride																			
Isotopes																			
Oxygen-18																			**
Deuterium																			

Blank cell = not a significant relationship between constituent concentrations
* = Significant positive relationship at $p \leq 0.05$
** = Significant positive relationship at $p \leq 0.01$
+ = Significant negative relationship at $p \leq 0.05$
++ = Significant negative relationship at $p \leq 0.01$

Oxygen and Hydrogen Isotopes

Oxygen and hydrogen isotope samples were collected from 108 sites sampled in the Lower Gila basin study.

The samples that experienced the most evaporation were collected in upgradient areas away from the Gila River and had the highest $\delta^{18}O$ and δD values (Figure 9).[61] The recharge source was likely local precipitation. Other samples with slightly less evaporation reflect recharge from the Gila River, which consisted of precipitation occurring at higher elevations in Arizona or New Mexico. The evaporation line formed by Gila River and local samples is described by the linear equation: **$\delta D = 7.5^{18}O + 0.4$.**

The group of samples with the lowest $\delta^{18}O$ and δD values originated as water from the Colorado River. While a handful of samples were the result of natural Colorado River recharge, the majority were the result of irrigation use of Colorado River water by the Wellton-Mohawk Irrigation and Drainage District since 1952. These samples were collected from the district's drainage wells. The evaporation line formed by the less evaporated Colorado River samples is described by the linear equation**: $\delta D = 8.9^{18}O + 6.7$** (Figure 19.

Four recharge groups: local precipitation, Gila River, Colorado River–Natural, and Colorado River–Irrigation were used for further water quality analyses. However, some of the samples likely contain a mixture of recharge sources. Perhaps the best example is LGB-101, a shallow domestic well located close to the Colorado River. However, the $\delta^{18}O$ and δD values from the sample are reflective of those from local precipitation, so the well likely also receives significant recharge from a nearby large wash Figure 20.[62]

Oxygen and Hydrogen Isotopes

Groundwater characterizations using oxygen and hydrogen isotope data may be made with respect to the climate and/or elevation where the water originated, residence within the aquifer, and whether or not the water was exposed to extensive evaporation prior to collection. This is accomplished by comparing oxygen-18 isotopes ($\delta^{18}O$) and deuterium (δD), an isotope of hydrogen, data to the Global Meteoric Water Line (GMWL).

The GMWL is described by the linear equation:

$$\delta D = 8\,\delta^{18}O + 10$$

where δD is deuterium in parts per thousand (per mil, $^0/_{00}$), 8 is the slope of the line, $\delta^{18}O$ is oxygen-18 $^0/_{00}$, and 10 is the y-intercept. The GMWL is the standard by which water samples are compared and is a universal reference standard based on worldwide precipitation without the effects of evaporation.

A Local Meteoric Water Line (LMWL) is created using rainfall for a particular location. Data for the whole year, over the course of many years, tend to plot not too far from the GMWL (slope of 8, intercept 10), although this varies by region, which is affected by varying climatic and geographic factors.

Groundwater from arid environments is typically subject to evaporation, which enriches δD and $\delta^{18}O$, resulting in a lower slope value (usually between 3 and 6) as compared to the slope of 8 associated with the GMWL.

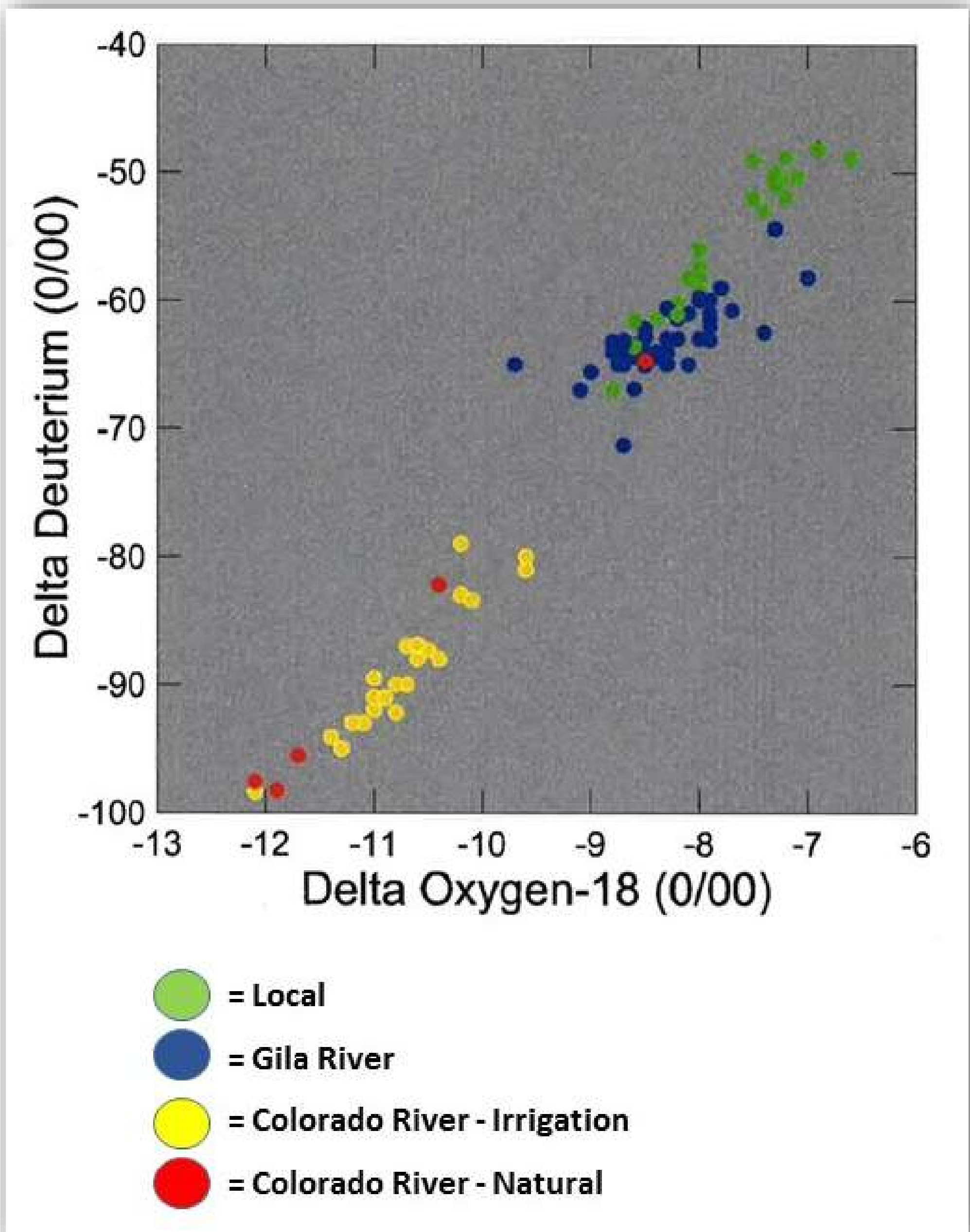


Figure 19 - Evaporation Line for Lower Gila basin.

The 108 isotope samples are graphed according to their $\delta^{18}O$ and δD values which reflect the climate and/or altitude where the water originated. The isotope values generally can be categorized into four recharge groups: local precipitation recharge, Gila River recharge, Colorado River natural recharge, and recharge from Colorado River water used for irrigation in the Wellton-Mohawk District. Colorado River recharge samples are the least evaporated and local recharge is the most evaporated.

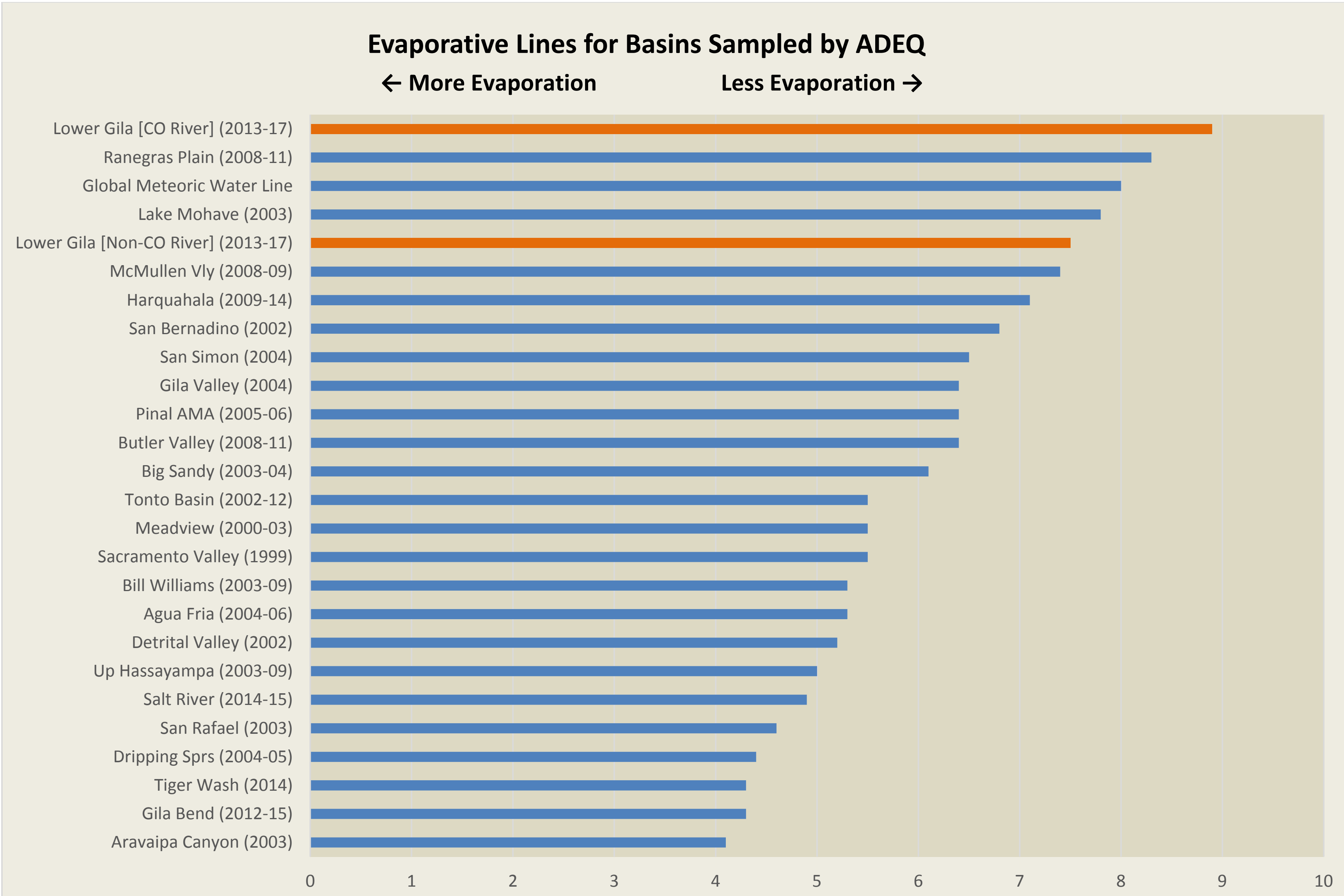


Figure 20 – Evaporation lines from ADEQ Ambient Groundwater Studies in Arizona.

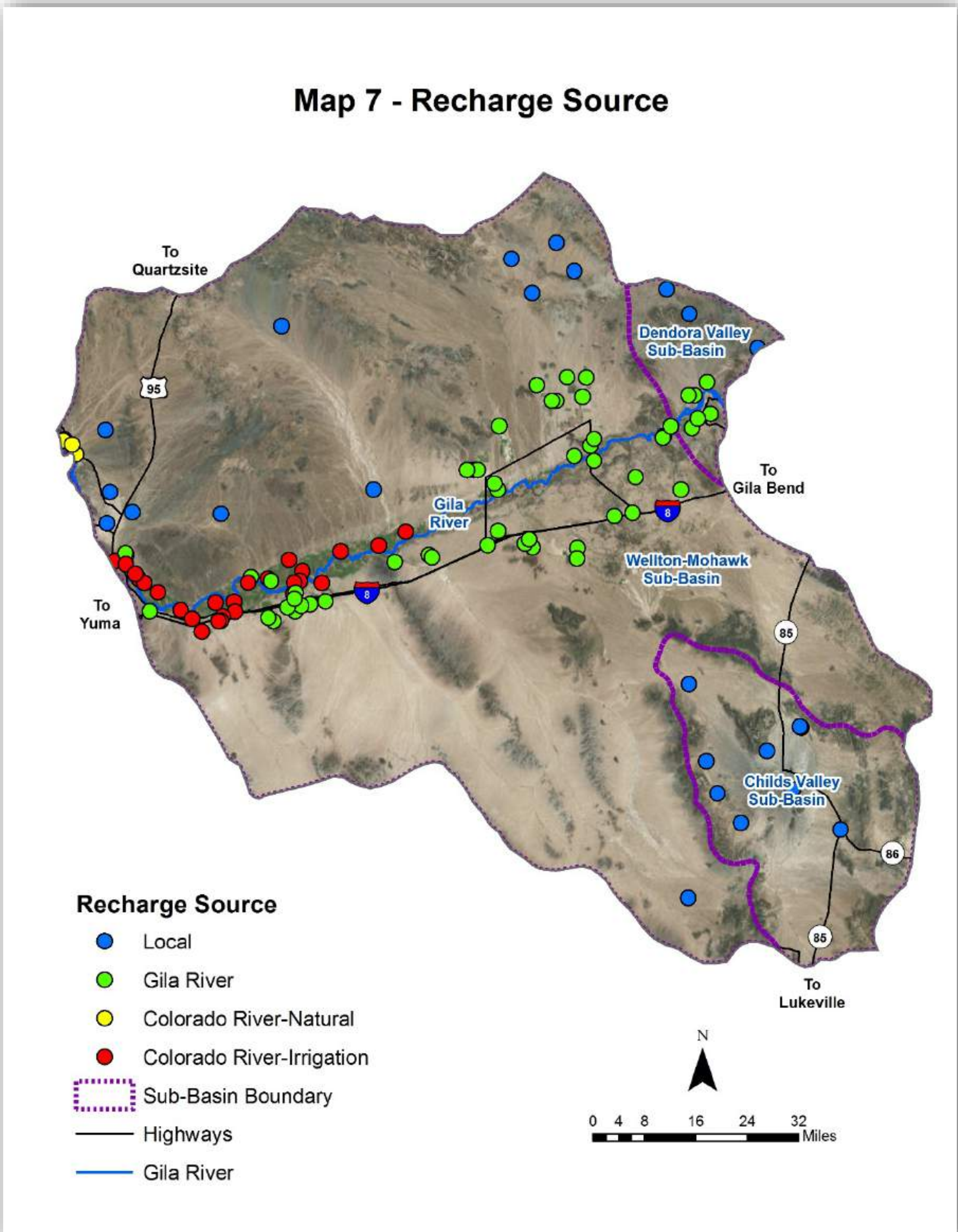


Figure 21 - Recharge source of samples in the Lower Gila basin.

Nitrogen Isotopes

Sources of nitrate in groundwater may be distinguished by measuring two stable isotopes of nitrogen, nitrogen-14, and nitrogen-15, often represented by $\delta^{15}N$. Although the percentage of the two isotopes is nearly constant in the atmosphere, certain chemical and physical processes preferentially utilize one isotope, causing a relative enrichment of the other isotope in the remaining reactants.

Groundwater samples for $\delta^{15}N$ analysis were collected at 108 sites. The $\delta^{15}N$ values ranged from no signal (not enough $\delta^{15}N$ present in the sample to run the test) to +32.5 0/00. Nitrate values (as nitrogen) ranged from non-detect to 35.7 mg/L (Figure 21 and Figure 22).

Because of these isotopic fractionation processes, nitrate from different nitrogen sources has been shown to have different N isotope ratios. The $\delta^{15}N$ values have been cited as ranging from +2 to +9 per mil for natural soil organic matter sources, -3 to +3 for inorganic fertilizer sources, +10 to +20 per mil for animal waste.[63] The $\delta^{15}N$ results in the basin fall into the following categories:

Organic soil matter (+2 to +9) – 45 sites,

Fertilizer (-3 to +3) – 0 sites,

Animal waste (+10 to +20) – 38 sites,

Undetermined (+9 to +10) – 13 sites

Undetermined (> +20) – eight sites

No signal – four sites

Based on these results, it appears that the nitrogen source is predominantly natural organic soil matter, animal waste, or indeterminate.

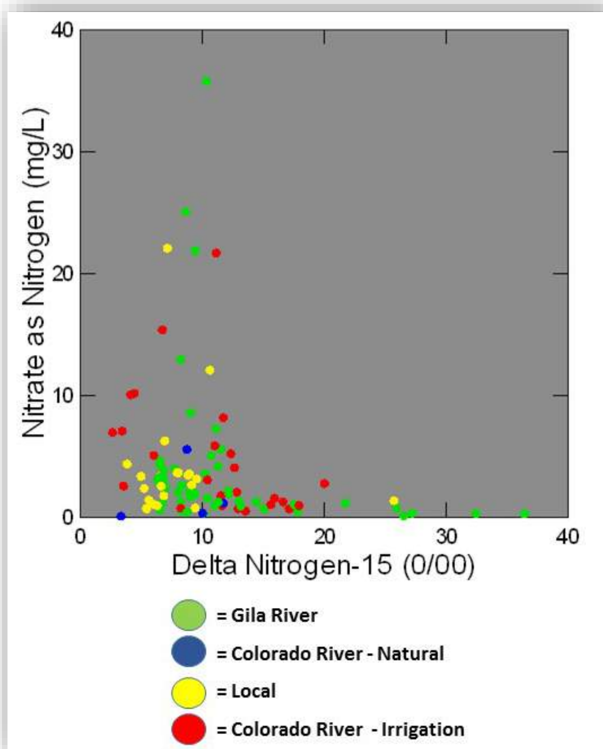


Figure 22 - Nitrate-Nitrogen-15 Relationship.

Based on 108 sites sampled in the Lower Gila basin, elevated nitrate (as nitrogen) concentrations are typically around +10 per mil, which indicate that the source is could be natural soil organic matter, animal waste or indeterminate.

The $\delta^{15}N$ results from samples with Gila River recharge had significantly higher values than samples recharged by local precipitation (Kruskal-Wallis and Tukey tests, $p \leq 0.05$). Some samples, mostly with Gila River recharge, have very high $\delta^{15}N$ values had accompanying low nitrate concentrations. Nitrate reduction may be occurring at these sites from bacterial activity, which would leave heavy isotopes behind such as $\delta^{15}N$.[64]

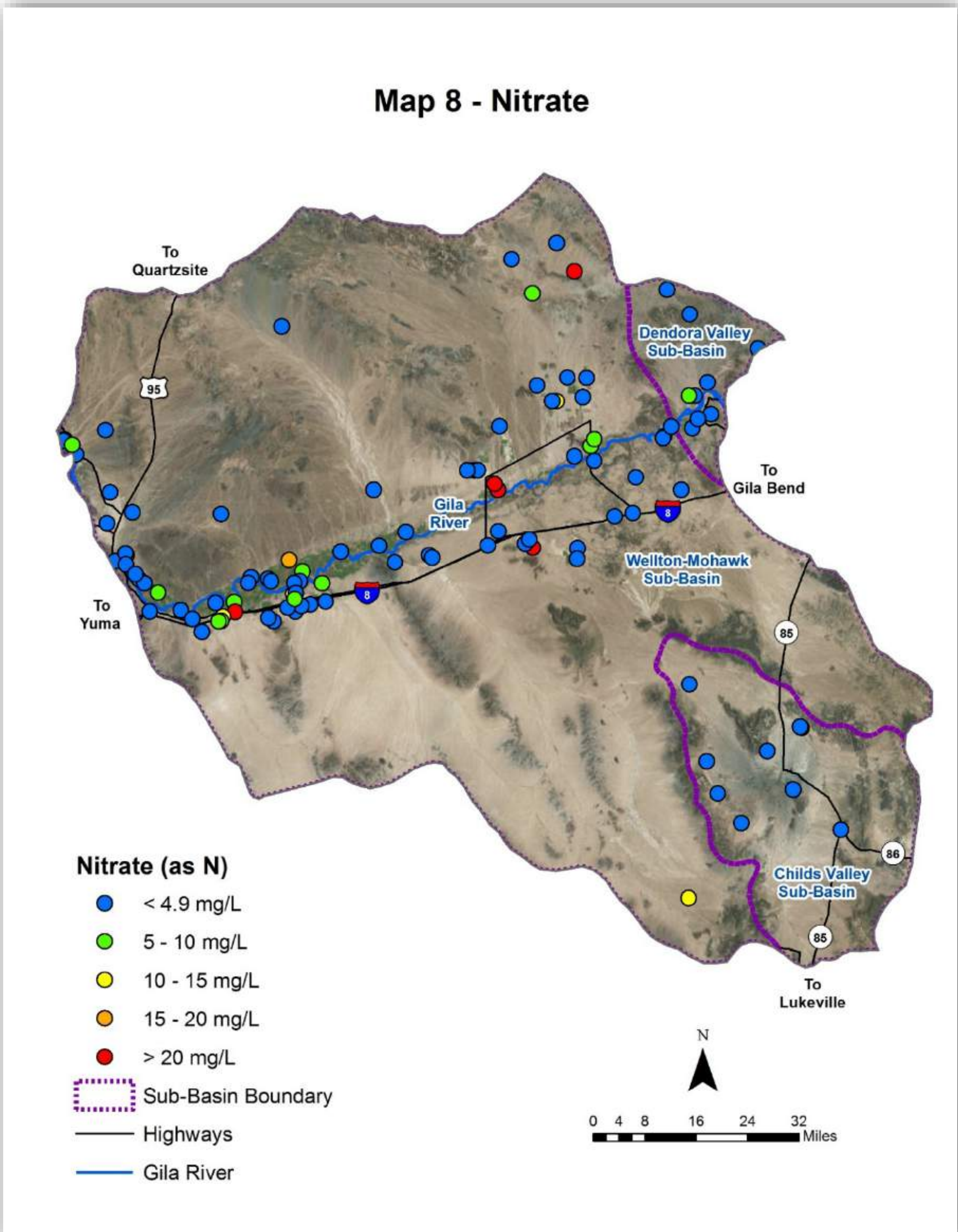


Figure 23 - Nitrate concentrations in the Lower Gila basin.

Spatial Variation

Groundwater Sub-Basins

The spatial variation of groundwater quality was examined by comparing constituent concentrations among three Lower Gila sub-basins:

Childs Valley (**CV**) – nine sites were sampled in the southern sub-basin;
Dendora Valley (**DV**) – nine sites were sampled in the northern sub-basin; and
Wellton-Mohawk (**WM**) – 90 sites were sampled in the downgradient sub-basin.

Significant concentration differences were found with 13 constituents: oxygen-18, deuterium, SC-field, SC-lab, TDS, sodium, potassium, chloride, sulfate, arsenic, barium, boron, and fluoride (Figure 26 and Figure 27) (Kruskal-Wallis and Tukey tests, $p \leq 0.05$).

No significant differences were found with six constituents: pH-field, turbidity, chloride, nitrate, nitrogen-15, and strontium.

Complete statistical results are in Table 14, and 95 percent confidence intervals for significantly different sub-basin groups are in Table 15.

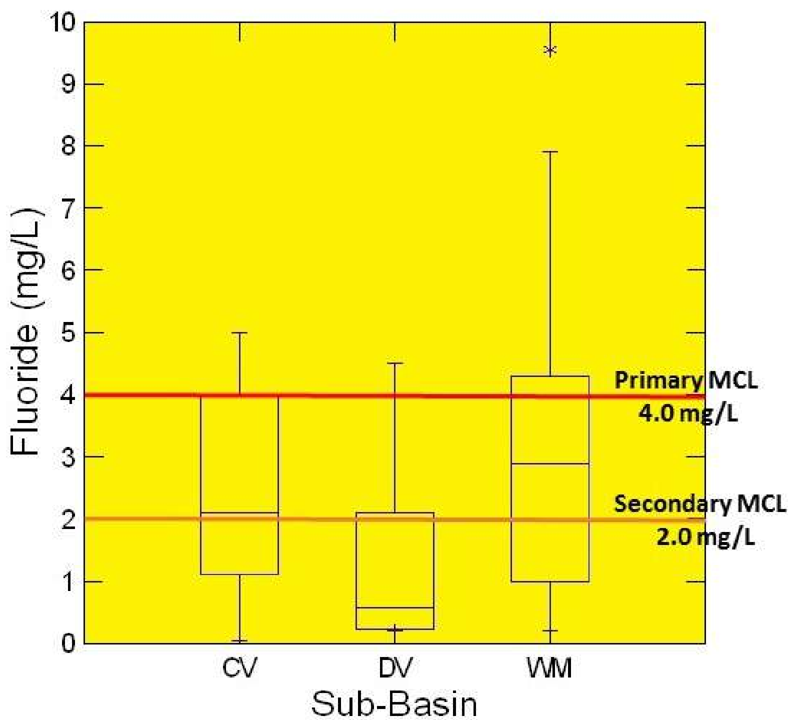


Figure 24 - Fluoride variation among Lower Gila sub-basins.

Fluoride concentrations are significantly higher in the Wellton-Mohawk (WM) sub-basin than in the Dendora Valley (DV) sub-basin while those in the Childs Valley (CV) sub-basin are not significantly different from the other two sub-basins (Kruskal-Wallis and Tukey tests, $p \leq 0.01$). The median concentration of samples from the Wellton-Mohawk and Childs Valley sub-basins exceeds the Secondary MCL for fluoride

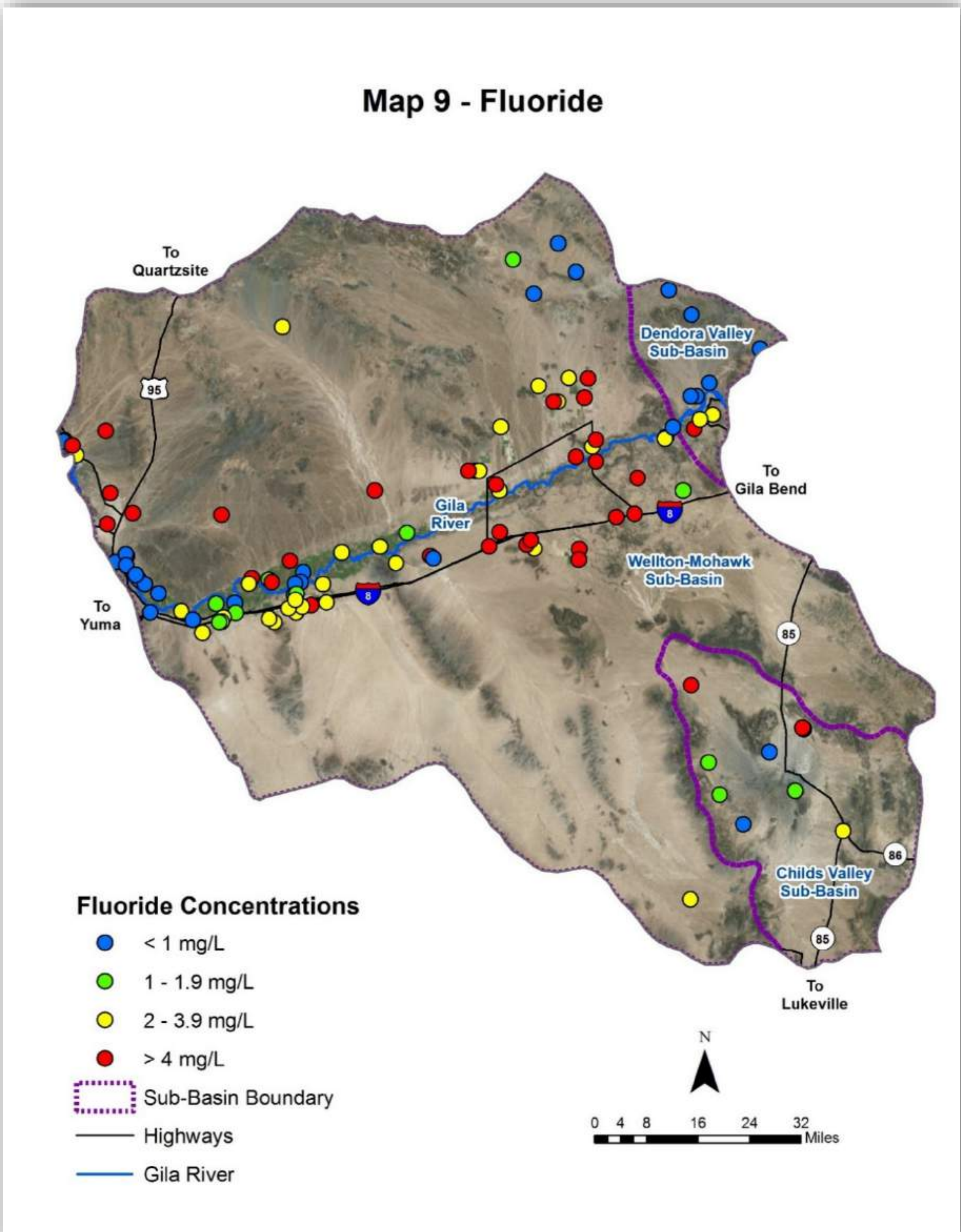


Figure 25 - Fluoride concentrations in the Lower Gila basin.

Table 12 - Variation in Groundwater Constituent Concentrations among Three Sub-basins

Constituent	Sites Sampled	Significance	Significant Differences Between Three Sub-basins
Oxygen	108	**	Childs Valley > Wellton-Mohawk
Deuterium	108	**	Dendora Valley > Wellton-Mohawk
Temperature - field	108	ns	-
pH – field	108	ns	-
pH – lab	108	ns	-
SC - field	108	**	-
SC - lab	108	**	-
TDS	108	**	-
Hardness	108	ns	-
Calcium	108	ns	-
Magnesium	108	ns	-
Sodium	108	**	-
Potassium	108	*	-
Bicarbonate	108	ns	-
Chloride	108	**	-
Sulfate	108	**	-
Nitrate (as N)	108	ns	-
$\delta^{15}N$	108	ns	-
Arsenic	108	*	-
Barium	108	**	-
Boron	108	**	-
Fluoride	108	**	Wellton-Mohawk > Dendora Valley *
Strontium	108	ns	-
Radon	51	ns	-
Gross Alpha	39	ns	-
Uranium	35	ns	-

Table 13 – 95 Percent Confidence Intervals for Three Sub-basins with Significant Constituent Concentrations Differences

Constituent	Significance	Childs Valley	Dendora Valley	Wellton-Mohawk
Oxygen	**	-8.0 to -7.1	-	-9.4 to -8.9
Deuterium	**	-58.2 to -50.5	-65.8 to -55.1	-74.2 to 68.3
Temperature - field	**	-	-	-
pH – field	**	-	-	-
pH – lab	**	-	-	-
SC - field	**	-	-	-
SC - lab	**	-	-	-
TDS	**	-	-	-
Hardness	**	-	-	-
Calcium	**	-	-	-
Magnesium	**	-	-	-
Sodium	**	-	-	-
Potassium	**	-	-	-
Bicarbonate	**	-	-	-
Chloride	**	-	-	-
Sulfate	**	-	-	-
Nitrate (as N)	ns	-	-	-
$\delta^{15}N$	**	-	-	-
Arsenic	**	-	-	-
Barium	**	-	-	-
Boron	**	-	-	-
Fluoride	**	-	0.1 to 2.4	2.7 to 3.7
Strontium	**	-	-	-
Radon	ns	-		
Gross Alpha	ns	-		
Uranium	ns	-	-	-

Recharge Groups

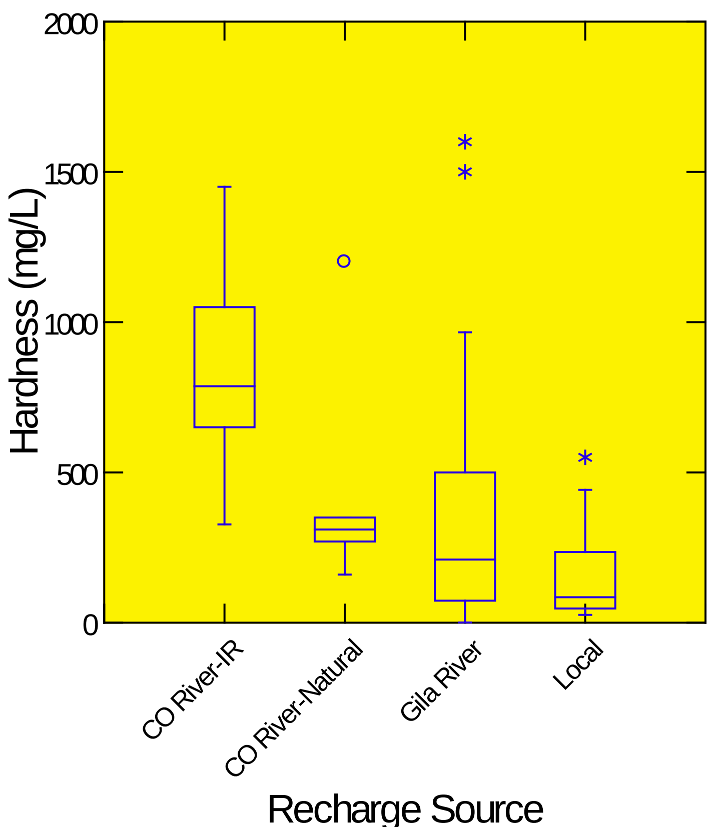
The spatial variation of groundwater quality was examined by comparing constituent concentrations among four Lower Gila recharge sources:

Gila River – 53 sites were sampled in areas within the Gila River floodplain or influenced by the Gila River;
Local – 24 sites were sampled in areas upgradient of the Gila River floodplain;
Colorado River-Natural – five sites were sampled in the Colorado River floodplain in the extreme western portion of the basin; and
Colorado River-Irrigation – 26 sites were sampled in within the Wellton-Mohawk Irrigation and Drainage District, which uses imported Colorado River water for irrigation.

Significant concentration differences were found with 23 constituents: oxygen-18, deuterium, temperature, pH-field, pH-lab, SC-field, SC-lab, TDS, hardness (Figure 28), calcium, magnesium, sodium (Figure 29), potassium, bicarbonate, chloride, sulfate (Figure 30), nitrogen-15, arsenic (Figure 31), barium, boron, fluoride, strontium, and gross alpha (Kruskal-Wallis and Tukey tests, $p \leq 0.05$).

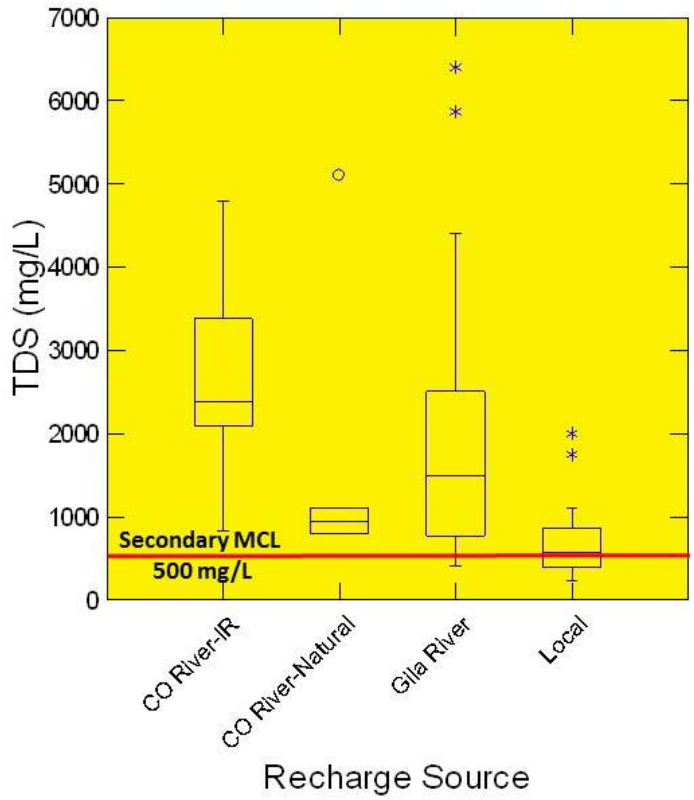
No significant difference was found with nitrate, radon, and uranium.

Complete statistical results are in Table 16, and 95 percent confidence intervals for significantly different sub-basin groups are in Table 17.



Hardness concentrations are significantly higher than in sample sites receiving recharge from Colorado River water used for irrigation than in sites receiving recharge from the Gila River or local precipitation (Kruskal-Wallis and Tukey tests, $p \leq 0.01$). The hardness boxplot also shows that the softest groundwater results from local precipitation.

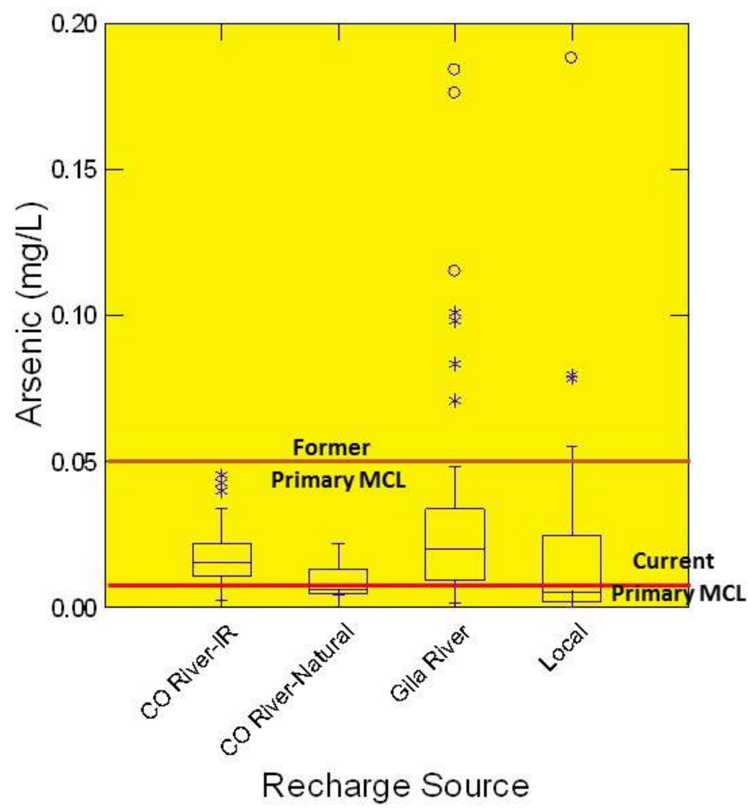
Figure 26 - Hardness variation among Lower Gila recharge groups.



TDS concentrations in groundwater recharged from Colorado River irrigation or the Gila River are significantly higher than from groundwater recharged by local precipitation (Kruskal-Wallis and Tukey tests, $p \leq 0.01$).

TDS concentrations in the basin are generally elevated, as the median value in all four sources of recharge exceed the Secondary MCL of 500 mg/L.

Figure 27 - TDS variation among Lower Gila recharge groups.



Arsenic concentrations do not significantly differ between recharge sources, although recharge from the Gila River and Colorado River irrigation tends to have the highest concentrations (Kruskal-Wallis and Tukey tests, $p \leq 0.01$).

The boxplot illustrates the major impact lowering the health-based water quality standard from 0.05 mg/L to 0.01 mg/L had on public water providers in the basin.

Figure 28 - Arsenic variation among Lower Gila recharge groups.

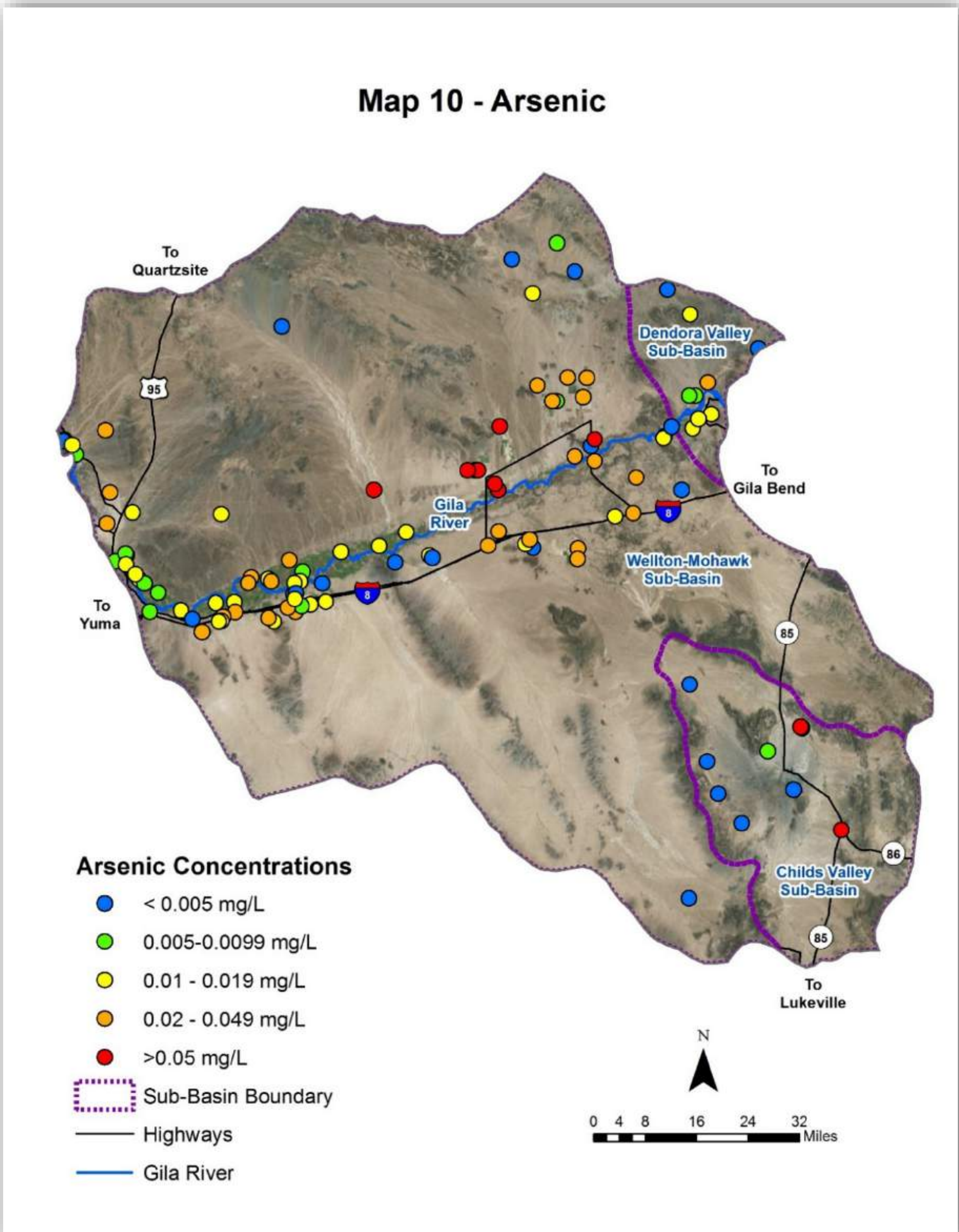


Figure 29 - Arsenic concentrations in the Lower Gila basin.

Table 14 - Variation in Constituent Concentrations among Four Recharge Groups

Constituent	Sites Sampled	Significance	Significant Differences Between Three Sub-basins
Oxygen	108	**	Local > Gila River > CO River-Natural & CO River-IR **
Deuterium	108	**	Local > Gila River > CO River-Natural & CO River-IR **
Temperature - field	108	**	Local & Gila River > CO River-IR **
pH – field	108	**	Local & Gila River > CO River-IR **
pH – lab	108	*	Local & Gila River > CO River-IR **
SC - field	108	**	CO River-IR & Gila River > Local **
SC - lab	108	**	CO River-IR & Gila River > Local **
TDS	108	**	CO River-IR & Gila River > Local **
Hardness	108	**	CO River-IR > Gila River & Local **
Calcium	108	**	CO River-IR > Gila River > Local **
Magnesium	108	**	CO River-IR > Gila River & Local & CO River-Natural **
Sodium	108	**	Gila River > Local **
Potassium	108	**	CO River-IR > Gila River & Local **
Bicarbonate	108	**	CO River-IR > Gila River & Local & CO River-Natural ** Local > Gila River **
Chloride	108	**	CO River-IR & Gila River > Local **
Sulfate	108	**	CO River-IR > Local **
Nitrate (as N)	108	ns	-
$\delta^{15}N$	108	**	Gila River > Local **
Arsenic	108	*	-
Barium	108	**	CO River-Natural > Gila River & Local **
Boron	108	**	Gila River > Local **
Fluoride	108	**	Gila River > CO River-IR **
Strontium	108	**	CO River-IR & Gila River > Local **
Radon	51	ns	-
Gross Alpha	39	**	-
Uranium	35	ns	-

Table 15 – 95 Percent Confidence Intervals for Four Recharge Groups with Significant Constituent Concentrations Differences

Constituent	Significance	Local	Gila River	Colorado River - Natural	Colorado River - Irrigation
Oxygen	**	-8.0 to -7.5	-8.5 to -8.2	-9.1 to -12.8	-10.9 to -10.5
Deuterium	**	-58.0 to -53.4	-63.7 to-62.3	-69.8 to -105.6	- 90.9 to -87.1
Temperature - field	**	28.9 to 33.1	29.3 to 32.2	-	23.0 to 25.2
pH – field	**	7.74 to 8.14	7.87 to 8.13	-	7.37 to 7.55
pH – lab	**	7.84 to 8.14	7.94 to 8.17	-	7.35 to 7.53
SC - field	**	837 to 1495	2229 to 4107	-	3126 to 4289
SC - lab	**	857 to 1434	2451 to 4358	-	3173 to 4391
TDS	**	503 to 882	1425 to 2981	-	2263 to 3095
Hardness	**	85 to 206	236 to 433	-	689 to 944
Calcium	**	11 to 64	79 to 144	-	169 to 234
Magnesium	**	3.3 to 14.4	8.0 to 20.0	3.5 to 51.7	64.1 to 88.9
Sodium	**	124 to 235	395 to 827	-	-
Potassium	**	2.3 to 5.5	4.1 to 5.8	-	6.5 to 8.0
Bicarbonate	**	137 to 249	85 to 121	69 to 378	394 to 525
Chloride	**	99 to 269	523 to 983	-	520 to 865
Sulfate	**	64 to 192	-	-	789 to 1023
Nitrate (as N)	ns	-	-	-	-
$\delta^{15}N$	**	6.1 to 9.8	10.1 to 13.9	-	-
Arsenic	**	-	-	-	-
Barium	**	0.007 to 0.038	0.017 to 0.025	-0.028 to 0.144	-
Boron	**	0.33 to 0.71	1.6 to 4.0	-	-
Fluoride	**	-	3.1 to 4.2	-	1.0 to 2.2
Strontium	**	0.17 to 0.0.93	1.3 to 2.5	-	2.3 to 3.4
Radon	ns	-	-	-	
Gross Alpha	ns	-	-	-	
Uranium	ns	-	-	-	-

Discussion

The Lower Gila basin, which composes most of southwestern Arizona, comprises the watershed of the Gila River from Painted Rock Dam, located about 20 miles west of Gila Bend, to where the floodplain narrows at Dome about 30 miles east of Yuma. The basin has extensive areas of irrigated farmland.

The chemical quality of most the groundwater in the western section of the basin was considered marginal even before widespread irrigation development, which began in the 1920s. Irrigation recharge to the groundwater gradually increased the already-high salinity.[65]

The groundwater in the area had become highly mineralized, which was unsatisfactory for irrigation use. Groundwater quality in the younger alluvium, which received irrigation recharge, was characterized as more highly mineralized that the older alluvium.[66]

For irrigation to continue in the Western section of the basin, Colorado River water was pumped uphill to the WMIDD beginning in 1952. Irrigated agriculture continues in the WMIDD using imported Colorado River water. Groundwater is still used for irrigation, particularly in the Eastern section and in limited areas in the Wester section.

Groundwater quality in the Eastern section was characterized as extremely variable in a 1977 study. While groundwater was considered marginal for salt-sensitive crops, it was suitable for domestic and stock use except in wells near the Gila River. TDS concentrations ranged from 300 to 9,000 mg/L and decreased in areas away from the Gila River. Fluoride concentrations, which ranged from 0.3 to 9.1 mg/L, showed the opposite pattern increasing in the alluvial plains away from the Gila River.[67]

Groundwater quality in the Western section was characterized as unsuitable for most uses, especially in the floodplain aquifer in 1977. Groundwater quality in the surrounding upland areas was characterized as marginal to suitable. TDS concentrations ranged from 270 – 12,490 mg/L and decreased in areas away from the Gila River. Fluoride concentrations ranged from 1 to 10 mg/L.[68]

Water Quality Standards - The results of this ADEQ groundwater quality generally support these findings. More than 90 percent of wells sampled had aesthetic-based water quality standard exceedances while almost three-quarters of revealed exceedances of health-based water quality constituents including arsenic, fluoride, and nitrate. These are common contaminants found in groundwater throughout the state.[69]

Groundwater in the Lower Gila basin is generally not suitable for drinking water uses without treatment based on the sampling results from this study.

These results support an earlier water quality assessment in ADWR's water atlas. The agency used historical data to identify 192 wells in the basin with constituent concentrations exceeding health-based Primary MCLs, which were predominantly fluoride, arsenic, and nitrate.[70]

Figure 30 - ADEQ's Douglas Towne samples the Wellton-Mohawk Drainage Well #9-A with the assistance of WMIDD employee Laura West.

Arsenic - Arsenic exceeded health-based, water quality standards in samples collected from 72 sites, with concentrations as high as 0.188 mg/L, more than ten times the 0.01 mg/L standard. At 11 sites, arsenic concentrations exceeded the former 0.05 mg/L standard.

There were no significant differences between arsenic concentrations in sub-basins or recharge groups.

Arsenic concentrations are affected by reactions with hydroxyl ions and are influenced by factors such as an oxidizing environment, lithology, and aquifer residence time. [71]

Fluoride - Fluoride exceeded the 4.0 mg/L health-based, water quality standards in samples collected from 34 wells, with concentrations as high as 9.55 mg/L.

Of the 34 wells with fluoride exceedances, 33 wells also had arsenic exceedances, as elevated concentrations of these two constituents frequently occur together. The 2.0 mg/L aesthetic-based Secondary MCL for fluoride was exceeded at 65 wells.

Fluoride concentrations in groundwater are often controlled by calcium through precipitation or dissolution of the mineral fluorite. In a chemically closed hydrologic system, calcium is removed from solution by precipitation of calcium carbonate and the formation of smectite clays.

Concentrations exceeding 5 mg/L of dissolved fluoride may occur in groundwater depleted in calcium if a source of fluoride ions is available for dissolution.[72]

Sites only partially depleted in calcium may be controlled by processes other than fluorite dissolution. Hydroxyl ion exchange or sorption-desorption reactions have also been cited as providing controls on lower (< 5 mg/L) levels of fluoride. As pH values increase downgradient, greater levels of hydroxyl ions may affect an exchange of hydroxyl for fluoride ions thereby increasing fluoride in solution.[73]

Fluoride concentrations were significantly higher in the Wellton-Mohawk sub-basin than in the Dendora Valley sub-basin and in Gila River recharge than in the Colorado River irrigation recharge. (Figure 25).

Nitrate - Nitrate exceeded the 10.0 mg/L (as nitrogen) health-based, water quality standards in samples collected from 10 wells. Nitrate concentrations were as high as 35.7 mg/L, which is almost four times the nitrate standard. This exceedance frequency is similar to the 11 percent rate for nitrate found in a recent groundwater quality study of the Southwest.[74]

In general, nitrate concentrations are lower than would be expected in an extensively irrigated basin in Arizona. Animal waste and fertilizer used on agricultural lands is a major anthropomorphic source of nitrate. Percolating groundwater, such as which occurs underneath irrigated fields or recharge projects, likely helps transport the nitrogen.

While wastewater discharges from household septic systems can impact nitrate concentrations in groundwater, irrigated farmland is the more important factor since it takes a high density of septic systems to affect nitrate concentrations in groundwater on a regional scale.

At least in the Western section, the low nitrate concentrations may be due to the rapid movement of groundwater. Drainage wells are constantly pumping groundwater into drains, which do not allow the buildup of nitrate in the aquifer.

Nitrate occurs naturally in parts of the Sonoran Desert from naturally occurring organic matter such as nitrogen-fixing legumes.[75] The organic matter would likely be the source for two isolated wells that had nitrate exceedances with little nearby anthropomorphic sources: LGB-9 and LGB-115. The $\delta^{15}N$ values for these wells also indicate the source is the organic matter or indeterminate.[76]

Nitrogen isotopes suggest the predominant source of nitrate at the majority of sample sites is naturally occurring soil organic matter and animal waste.[77]

More research on these topics in Sonoran desert areas is needed to determine the relative contributions of nitrate from different sources.

Recharge Source - Local precipitation is preferred for public water or domestic uses in the Lower Gila basin as more than a third of wells sampled met all health and aesthetics-based water quality standards (Figure 31). In contrast, no wells recharged from the Gila River or Colorado River met all water quality standards.

Samples collected from wells producing recharge from the Colorado River irrigation applications had a high rate (85 percent) of health-based water quality standards.

Similarly, samples collected from wells producing recharge from the Gila River also had a high rate (77 percent) of health-based water quality standards (Table 16).

Population growth is occurring in the basin, particularly near the town of Wellton where many trailer parks serve seasonal visitors. These new public water systems and domestic households, when possible, prefer to use fresh Colorado River water from the Wellton-Mohawk Canal.

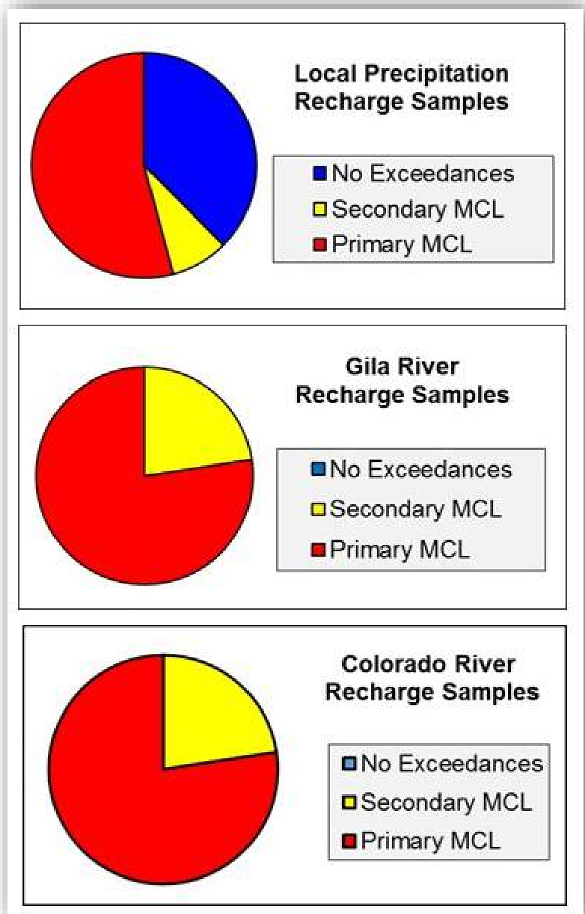


Figure 31 - Water Quality Exceedances by Recharge Source.

Table 16 - Water Quality Standard Exceedances by Recharge Source

Recharge Source	Number of Wells Exceeding Primary Standards	Number of Wells Exceeding Only Secondary Standards	Percentage of Wells Without Standard Exceedances	Total Wells
Local Precipitation	13 (54 %)	2 (8 %)	9 (38 %)	24
Gila River	41 (77 %)	12 (23 %)	0	53
Colo. River - Irrigation	22 (85 %)	4 (15 %)	0	26
Colo. River - Natural	2 (40 %)	3 (60 %)	0	5
Total	78 (72 %)	21 (19 %)	9	108

Appendix A. Data for Sample Sites, Lower Gila Basin, 2013-2017

Site #	Cadastral / Pump Type	Latitude - Longitude	ADWR #	ADEQ #	Site Name	Samples Collected	Well Depth	Water Depth	Reacharge / Sub-basin
1st Field Trip, February 7-8, 2013 – Towne & Boettcher									
LGB-1/2 duplicate	C(6-8)17acc submersible	32.90557 -113.23522	804050	23997	Tartron Well	Inorganic, Radon O,H & N Isotopes	305’	238’	Gila River Wellton-Mohawk
LGB-3	C(6-9)05dcc submersible	32.92866 -113.20404	804043	23998	HQ Well	Inorganic, Radon O,H & N Isotopes	350’	217’	Gila River Wellton-Mohawk
LGB-4	C(3-7)13aab windmill	33.17213 -112.92991	801567	78307	Woolsey Windmill	Inorganic, Radiochem O,H & N Isotopes	-	-	Local Dendora Valley
2nd Field Trip, October 16, 2013 – Towne & Jones									
LGB-5/6 duplicate	C(1-11)03bdb submersible	33.37082 -113.38201	803618	78601	O’Brien’s Anvil Well	Inorganic, Radiochem Radon, O,H, N isotope	480’	365’	Local Wellton-Mohawk
LGB-7	C(1-12)15bdd submersible	33.33941 -113.48306	513721	78602	Bible Well	Inorganic, Radon O,H & N Isotopes	-	-	Local Wellton-Mohawk
LGB-8	C(2-12)12aac submersible	33.27580 -113.43700	601283	23364	Clanton Well	Inorganic, Radon O,H & N Isotopes	-	-	Local Wellton-Mohawk
LGB-9	C(1-11)25bad submersible	33.31726 -113.34200	601284	23177	Gibson RoostWell	Inorganic, Radon O,H & N Isotopes	-	-	Local Wellton-Mohawk
3rd Field Trip, November 13-14, 2013 – Towne & & Boettcher & Dickens									
LGB-10	C(2-9)01dbb windmill	33.28251 -113.13435	624604	78662	Ming’s Well	Inorganic, Radon O,H & N Isotopes	178’	22’	Local Dendora Valley
LGB-12	C(7-11)30bba turbine	32.79626 -113.4353	212377	78663	Whitfill Nursery	Inorganic, Radon O,H & N Isotopes	1,000’	114’	Gila River Wellton-Mohawk
LGB-13	C(7-12)24bcc Turbine	32.80389 -113.45303	804436	24146	Unnamed Well	Inorganic O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
LGB-14	C(6-10)35ddc submersible	32.85561 -113.25203	628130	78664	Sentinel ADOT	Inorganic, Radon O,H & N Isotopes	1,002’	225’	Gila River Wellton-Mohawk
LGB-15/16 duplicate	C(6-9)32bcd submersible	32.86203 -113.21028	903065	78665	Sentinel School IRl	Inorganic, Radon O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
4th Field Trip, February 3, 2014 – Towne & Boettcher									
LGB-17	C(4-10)05abb turbine	33.11684 -113.31512	600266	23591	Butterfield #1 Well	Inorganic, Radon O,H & N Isotopes	1289’	334’	Gila River Wellton-Mohawk
LGB-18	C(4-11)01bbb turbine	33.11695 -113.35758	615019	23632	Section 1 Well #2	Inorganic, Radiochem O,H, N isotope	915’	244’	Gila River Wellton-Mohawk
LGB-19	C(4-10)17cbb turbine	33.08079 -113.32358	619483	23607	Well #6	Inorganic O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
5th Field Trip, April 9, 2014 – Towne & Turner									
LGB-20	C(6-13)02abb turbine	32.94253 -113.56713	615084	79001	Well #N3	Inorganic, Radiochem Radon, O,H, N isotope	915’	244’	Gila River Wellton-Mohawk
6th Field Trip, April 22, 2014 – Towne & Boettcher									
LGB-21	C(2-8)21dbc windmill	33.23656 -113.08250	624596	79143	4th of July Windmill	Inorganic, Radon, O,H,N Isotope	410’	29’	Local Dendora Valley
7th Field Trip, September 24, 2014 – Towne & Jones									
LGB-22	C(7-14)08cdd turbine	32.82548 -113.72179	609424	000963	WM #70	Inorganic, Radiochem Radon, O,H,N Isotope	61’	32’	CO River-IR Wellton-Mohawk
LGB-23	C(7-15)22dda turbine	32.79955 -113.78181	609416	24181	WM #65	Inorganic O,H & N Isotopes	96’	-	CO River-IR Wellton-Mohawk
LGB-24	C(7-16)26add turbine	32.78887 -113.86782	216084	79481	WM #58B	Inorganic, Radon, O,H,N Isotope	84’	-	CO River-IR Wellton-Mohawk
LGB-25/26 split	C(8-16)07bbb turbine	32.75161 -113.95354	218850	79482	WM #41-B	Inorganic O,H & N Isotopes	107’	17’	CO River-IR Wellton-Mohawk

Appendix A. Data for Sample Sites, Lower Gila Basin, 2013-2017--Continued

Site #	Cadastral / Pump Type	Latitude - Longitude	ADWR #	ADEQ #	Site Name	Samples Collected	Well Depth	Water Depth	Isotope / Hydrologic Area
LGB-27	C(8-17)08cdd turbine	32.73699 -114.03088	585387	79483	WM #32-5	Inorganic O,H & N Isotopes	100’	8’	CO River-IR Wellton-Mohawk
LGB-28	C(8-18)27 turbine	32.69318 -114.10783	219451	79484	WM #20-B	Inorganic, Radiochem Radon, O,H,N Isotope	-	-	CO River-IR Wellton-Mohawk
LGB-29	C(9-19)04bbb turbine	32.67783 -114.22726	212886	79485	WM #9-A	Inorganic O,H & N Isotopes	-	-	CO River-IR Wellton-Mohawk
LGB-30	C(8-20)09dcc turbine	32.73637 -114.32162	609357	24400	WM #5	Inorganic O,H & N Isotopes	154’	15’	CO River-IR Wellton-Mohawk
LGB-31/32 duplicate	C(8-21)01aab turbine	32.77037 -114.37543	509250	000946	WM #1-B	Inorganic, Radiochem Radon, O,H,N isotope	152’	14’	CO River-IR Wellton-Mohawk
8th Field Trip, January 20, 2015 – Towne &Millar									
LGB-33	C(10-8)22ccb submersible	32.53751 -113.08398	808001	79743	Range 1 Well	Inorganic, Radiochem Radon, O,H,N isotope	500’	270’	Local Childs Valley
LGB-34	C(4-8)25acd submersible	33.04784 -113.03519	906581	79742	Rowley Mine Well	Inorganic, Radiochem Radon, O,H,N isotope	245’	125’	Gila River Dendora Valley
9th Field Trip, April 8 & 9, 2015 – Towne & Boettcher & Garcia									
LGB-35	C(8-17)13aca turbine	32.73280 -113.95979	531683	79881	Quigley Well	Inorganic O,H & N Isotopes	110’	13’	CO River-IR Wellton-Mohawk
LGB-36	C(8-17)14dab turbine	32.72975 -113.97202	643697	79882	Murdock Well	Inorganic O,H, N isotope	100’	12’	CO River-IR Wellton-Mohawk
LGB-37	C(7-17)35cba turbine	32.77296 -113.98410	221869	79883	Burke’s Rnch Well	Inorganic O,H & N Isotopes	110’	45’	CO River-IR Wellton-Mohawk
LGB-38	C(8-17)17adb submersible	32.73280 -114.02432	566048	79884	Murdock DM Well	Inorganic, Radiochem Radon, O,H,N isotope	160’	15’	Gila River Wellton-Mohawk
LGB-39	C(8-17)26aab turbine	32.70796 -113.97465	217353	79885	Harrison Mesa #1	Inorganic O,H & N Isotopes	180’	63’	CO River-IR Wellton-Mohawk
LGB-40	C(8-17)24ccb submersible	32.71060 -113.96853	611059	79901	Vaughan DM Well	Inorganic, Radiochem Radon, O,H,N isotope	500’	60’	Gila River Wellton-Mohawk
LGB-42	C(8-16)31aad submersible	32.68937 -113.93672	571891	79902	Citrus Park Well	Inorganic, Radiochem Radon, O,H,N isotope	690’	115’	Gila River Wellton-Mohawk
LGB-43	C(8-16)16dbb submersible	32.72861 -113.90948	539434	79903	Martinez DM Well	Inorganic O,H,N isotope	98’	70’	CO River-IR Wellton-Mohawk
LGB-44	C(9-17)09cba submersible	32.65659 -114.01852	581040	79904	Schwien Well	Inorganic, Radiochem Radon, O,H,N isotope	340’	210’	Gila River Wellton-Mohawk
LGB-45	C(9-17)08abb turbine	32.66399 -114.03038	598660	79905	Date Palm Well	Inorganic O,H,N isotope	395’	155’	Gila River Wellton-Mohawk
LGB-46	C(9-18)03bbd turbine	32.67463 -114.10479	570545	79906	Cullison Well	Inorganic O,H,N isotope	175’	65’	CO River-IR Wellton-Mohawk
LGB-47/48 split	C(9-19)14dca submersible	32.63696 -114.18008	222987	79907	Well #4	Inorganic O,H,N isotope	-	-	CO River-IR Wellton-Mohawk
LGB-49	C(8-18)31aba turbine	32.69217 -114.14867	549107	79908	WM 15-A Well	Inorganic O,H,N isotope	128’	4’	CO River-IR Wellton-Mohawk
LGB-50	C(5-12)05ada turbine	33.02567 -113.51112	513781	79909	Well #24	Inorganic, Radiochem O,H & N Isotopes	1800’	210’	Gila River Wellton-Mohawk
10th Field Trip, May 4-5, 2015 – Towne & Boettcher									
LGB-51	C(2-17)34acc turbine	33.21352 -114.00114	913714	79983	Kofa Deep Well	Inorganic, Radiochem Radon, O,H,N isotope	1080’	732’	Local Wellton-Mohawk
LGB-52	C(7-20)30dda submersible	32.78183 -114.34950	216269	79961	Tucker Well	Inorganic, Radiochem O,H & N Isotopes	300’	75’	Gila River Wellton-Mohawk
LGB-53	C(7-20)30dac submersible	32.78507 -114.35146	521016	79962	Brennan Well	Inorganic O,H & N Isotopes	110’	52’	Gila River Wellton-Mohawk
LGB-54	C(8-20)06aab turbine	32.76495 -114.35081	221141	79985	WM Well DW2A	Inorganic O,H & N Isotopes	147’	19’	CO River-IR Wellton-Mohawk
LGB-55	C(8-16)28ddd turbine	32.69389 -113.90174	619773	79981	Well #?	Inorganic O,H & N Isotopes	850’	70’	Gila River Wellton-Mohawk

Appendix A. Data for Sample Sites, Lower Gila Basin, 2013-2017--Continued

Site #	Cadastral / Pump Type	Latitude - Longitude	ADWR #	ADEQ #	Site Name	Samples Collected	Well Depth	Water Depth	Isotope / Hydrologic Area
LGB-56	C(9-17)01bab turbine	32.67556 -113.97004	615150	79984	Well #1	Inorganic O,H & N Isotopes	700’	180’	Gila River Wellton-Mohawk
LGB-57	C(6-13)02aaa turbine	32.94255 -113.55858	615083	79982	Well #N2	Inorganic O,H & N Isotopes	1300’	-	Gila River Wellton-Mohawk
11th Field Trip, November 12, 2015 – Towne &Jones									
LGB-58	C(4-8)01bca submersible	33.108200 -113.04318	-	80435	Painted Rk Dam Well	Inorganic, Radiochem Radon, O,H,N isotope	200’	-’	Gila River Dendora Valley
LGB-59	C(4-8)15abb submersible	33.083350 -113.071133	623856	23550	PocoDiner DM Well	Inorganic, Radiochem Radon, O,H,N isotope	-	57’	Gila River Dendora Valley
12th Field Trip, November 30, 2015 – Towne & Boettcher									
LGB-60	C(4-8)16aab turbine	33.08337 -113.08440	614986	23558	PocoDiner IR Well #2	Inorganic O,H & N Isotopes	1014’	60’	Gila River Dendora Valley
LGB-61	C(5-9)12acd turbine	33.00689 -113.13957	804622	23829	Oatman Ranch #5	Inorganic, Radiochem Radon, O,H,N isotope	365’	30’	Gila River Wellton-Mohawk
LGB-62	C(5-9)12cda submersible	33.00293 -113.14252	-	23831	Oatman Ranch #7	Inorganic O,H & N Isotopes	560’	-	Gila River Wellton-Mohawk
LGB-63	C(5-8)06abb submersible	33.02486 -113.12460	-	23569	Oatman Ranch DM	Inorganic O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
13th Field Trip, January 21 & 22, 2016 – Towne & Boettcher									
LGB-64	C(5-8)03bbd turbine	33.02225 -113.07694	603574	80625	Painted Rock #16	Inorganic, Radon, O,H,N Isotope	970’	45’	Gila River Dendora Valley
LGB-65	C(4-8)27ddd turbine	33.04000 -113.06427	603572	80645	Painted Rock #14	Inorganic O,H & N Isotopes	-	-	Gila River Dendora Valley
LGB-66	C(5-10)28dcb turbine	32.96000 -113.29694	608815	23865	Skousen Hot Well	Inorganic, Radiochem Radon, O,H,N isotope	1320’	14’	Gila River Wellton-Mohawk
LGB-67	C(5-10)16ccb turbine	32.98811 -113.30575	610281	80665	S. Tilapia Well	Inorganic O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
LGB-68	C(5-10)16abb turbine	33.00081 -113.29711	610283	80685	N. Tilapia Well	Inorganic O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
LGB-69	C(5-11)25aad submersible	32.968861 -113.342028	640655	80686	Chld Light DM Well	Inorganic O,H & N Isotopes	200’	35’	Gila River Wellton-Mohawk
LGB-70	C(4-11)22abb submersible	33.072639 -113.383472	221865	80687	Latter Day DM Well	Inorganic O,H & N Isotopes	415’	216’	Gila River Wellton-Mohawk
LGB-71	C(4-11)22bbb turbine	33.073194 -113.392028	-	80688	Palm Tree Farm Well	Inorganic, Radon, O,H,N Isotope	-	-	Gila River Wellton-Mohawk
LGB-72	C(4-11)08bbb turbine	33.102278 -113.426389	618117	23642	Cocopah Tree Well	Inorganic O,H & N Isotopes	655’	-	Gila River Wellton-Mohawk
LGB-73	C(9-19)10aba submersible	32.66175 -114.201472	619341	24821	Grout Farms Well	Inorganic, Radon, O,H,N Isotope	57’	14’	CO River-IR Wellton-Mohawk
LGB-74/75 radio dup	C(8-18)12cca submersible	32.73978 -114.06981	-	80725	Radium Hot Well	Inorganic, Radiochem Radon, O,H,N isotope	-	-	Gila River Wellton-Mohawk
LGB-76	C(8-18)14adc turbine	32.72947 -114.07600	625927	80705	Silva Well	Inorganic, Radiochem O,H & N Isotopes	92’	11’	CO River-IR Wellton-Mohawk
14th Field Trip, February 23 & 24, 2016 – Towne & Boettcher									
LGB-77	C(11-6)24add submersible	32.45548 -112.83095	600488	25472	Well #12	Inorganic, Radiochem Radon, O,H,N isotope	1170’	732’	Local Childs Valley
LGB-78	C(11-6)24aca submersible	32.45742 -112.83427	600490	80805	Well #10	Inorganic, Radiochem Radon, O,H,N isotope	618’	103’	Local Childs Valley
LGB-79	C(13-5)25ccb submersible	32.26132 -112.7426	-	80806	Why #3	Inorganic, Radiochem Radon, O,H,N isotope	1000’	808’	Local Childs Valley
LGB-80/81 split	C(11-6)24aca submersible	32.7686 -113.74616	579789	80807	Matlock Well	Inorganic, Radon, O,H,N Isotope	170’	50’	Gila River Wellton-Mohawk
LGB-82	C(6-13)03abb turbine	32.94252 -113.58302	615089	24041	Well N#7	Inorganic O,H & N Isotopes	933’	355’	Gila River Wellton-Mohawk

Appendix A. Data for Sample Sites, Lower Gila Basin, 2013-2017--Continued

Site #	Cadastral / Pump Type	Latitude - Longitude	ADWR #	ADEQ #	Site Name	Samples Collected	Well Depth	Water Depth	Isotope / Hydrologic Area
LGB-83	C(6-12)17dbb turbine	32.90542 -113.5142	610494	24029	Well S#9	Inorganic, Radon, O,H,N Isotope	465’	29’	Gila River Wellton-Mohawk
LGB-84	C(6-12)08cbc turbine	32.91668 -113.5223	610498	24024	Well S#5	Inorganic O,H & N Isotopes	578’	51’	Gila River Wellton-Mohawk
LGB-85	C(7-12)19ccc submersible	32.80033 -113.53727	619149	24130	Dateland Well	Inorganic, Radiochem Radon, O,H,N isotope	678’	-	Gila River Wellton-Mohawk
15th Field Trip, August 29-31, 2016 – Towne & Boettcher (Equip. Blank – LGB-86)									
LGB-87	C(9-18)05ddc submersible	32.66572 -114.13258	538382	81125	City of Wellton	Inorganic, O,H,N Isotope	180’	59’	CO River-IR Wellton-Mohawk
LGB-88	C(9-20)03aad submersible	32.6755 -114.296917	506742	81126	Ligurta Station	Inorganic, Radiochem O,H & N Isotopes	265’	51’	Gila River Wellton-Mohawk
LGB-89	C(9-18)08b submersible	32.657972 -114.137416	649586	81127	Daley Well	Inorganic O,H & N Isotopes	120’	90’	CO River-IR Wellton-Mohawk
LGB-90	C(9-18)08bbc turbine	32.65633 -114.141861	572190	81128	Cullison Well	Inorganic O,H & N Isotopes	145’	68’	CO River-IR Wellton-Mohawk
LGB-91	C(8-17)36adc submersible	32.68655 -113.956	218068	81129	Copper Mtn RV	Inorganic O,H & N Isotopes	510’	135’	Gila River Wellton-Mohawk
LGB-92	C(8-17)36adc submersible	32.682638 -113.98727	-	81130	Tacna Lakes Park	Inorganic O,H & N Isotopes	-	-	Gila River Wellton-Mohawk
LGB-93	C(8-20)24cbc turbine	32.710861 -114.2785	552625	81131	WMIDD #8AA	Inorganic O,H & N Isotopes	134’	13’	CO River-IR Wellton-Mohawk
LGB-94	C(8-20)15bcd turbine	32.728916 -114.309472	541438	81132	WMIDD #6A	Inorganic O,H & N Isotopes	136’	8’	CO River-IR Wellton-Mohawk
LGB-95	C(5-22)12ccc submersible	33.000027 -114.488972	086312	81133	Imperial Fire Well	Inorganic, Radiochem O,H & N Isotopes	70’	14’	CO River-Natural Wellton-Mohawk
LGB-96	C(5-22)12ccc turbine	32.99794 -114.49128	591281	81134	Imperial IR Well #3	Inorganic, Radon, O,H,N Isotope	136’	5’	CO River-Natural Wellton-Mohawk
LGB-97	C(8-20)09bcb turbine	32.74661 -114.329528	533887	56223	WMIDD #4B	Inorganic, Radiochem Radon, O,H,N isotope	138’	13’	CO River-IR Wellton-Mohawk
LGB-98	C(7-14)35bbb submersible	32.7818 -113.669028	219502	81136	Hawthorne Well	Inorganic, Radiochem Radon, O,H,N isotope	400’	82’	Gila River Wellton-Mohawk
LGB-99	C(8-17)25caa submersible	32.6992 -113.9717	802793	81137	Tacna Well	Inorganic O,H & N Isotopes	550’	110’	Gila River Wellton-Mohawk
LGB-100	C(5-21)19dcc submersible	32.971917 -114.46394	638783	81138	Fisher’s Landing	Inorganic, Radon, O,H,N Isotope	100’	40’	CO River-Natural Wellton-Mohawk
LGB-101	C(5-21)19dcc submersible	32.990583 -114.471972	599327	81139	Bush Well	Inorganic O,H & N Isotopes	220’	30’	CO River-Natural Wellton-Mohawk
LGB-102	C(7-12)08dcd submersible	32.827306 -113.51317	221186	81140	Dateland Well #2	Inorganic, Radon, O,H,N Isotope	420’	162’	Gila River Wellton-Mohawk
16th Field Trip, October 11 & 12, 2016 – Towne & Boettcher									
LGB-103	C(6-15)15cab submersible	32.905917 -113.79394	-	81225	Ivan’s “L” Well	Inorganic, Radiochem Radon, O,H,N isotope	1000’	157’	Local Wellton-Mohawk
LGB-104	C(6-18)32caa submersible	32.859583 -114.137028	-	81226	Lake Alex “R” Well	Inorganic, Radiochem Radon, O,H,N isotope	700’	505’	Local Wellton-Mohawk
LGB-105	C(6-20)32aca submersible	32.863028 -114.336139	808688	81227	YPG “I” Well	Inorganic, Radiochem Radon, O,H,N isotope	501’	240’	Local Wellton-Mohawk
LGB-106	C(7-21)10aad submersible	32.842278 -114.393639	808686	81228	YPG”T” Well	Inorganic O,H & N Isotopes	306’	167’	Local Wellton-Mohawk
LGB-107/108 duplicate	C(5-21)02caa submersible	33.018194 -114.397306	586541	81229	YPG “F” Well	Inorganic, Radiochem Radon, O,H,N isotope	-	303’	Local Wellton-Mohawk
LGB-109	C(6-21)23bad submersible	32.900972 -114.386694	540312	81230	YPG “S” Well	Inorganic O,H & N Isotopes	492’	385’	Local Wellton-Mohawk
LGB-110	C(6-21)31dac submersible	32.86344 -114.447472	550565	81231	YPG “W” Well	Inorganic O,H & N Isotopes	140’	30’	CO River-Natural Wellton-Mohawk
LGB-111	C(7-12)13cdd turbine	32.811278 -113.443361	619495	81232	Sisson Farms	Inorganic O,H & N Isotopes	944’	110’	Gila River Wellton-Mohawk

Appendix A. Data for Sample Sites, Lower Gila Basin, 2013-2017--Continued

Site #	Cadastral / Pump Type	Latitude - Longitude	ADWR #	ADEQ #	Site Name	Samples Collected	Well Depth	Water Depth	Isotope / Hydrologic Area
					17th Field Trip, November 9, 2016 – Towne & Olson				
LGB-112	C(7-14)35daa submersible	32.777717 -113.662644	217761	81253	Renaudin Well	Inorganic, Radiochem Radon, O,H,N isotope	300’	80’	Gila River Wellton-Mohawk
LGB-113	C(7-11)25aad turbine	32.7955 -113.33511	628270	81254	Spot Farm Well #2	Inorganic, Radiochem Radon, O,H,N isotope	1002’	211’	Gila River Wellton-Mohawk
LGB-114	C(7-11)36add turbine	32.775194 -113.3358	611306	81255	Spot Farm Well #2	Inorganic, O,H,N Isotope	900’	290’	Gila River Wellton-Mohawk
					18th Field Trip, January 10, 2017 – Towne & Boettcher				
LGB-115	C(15-8)10cdb submersible	32.131717 -113.08488	914570	81313	Border Ptrl FOB Well	Inorganic Radon, O,H, N isotope	1,000	100’	Local Wellton-Mohawk
					19th Field Trip, February 14, 2017 – Towne				
LGB-116	C(12-8)12cdb submersible	32.391056 -113.044861	596801	81352	Tiller Well	Inorganic, Radiochem O,H,N isotope	463’	206’	Local Childs Valley
LGB-117	C(13-7)06aab submersible	32.9917 -113.020028	627141	25621	Lower Well	Inorganic, Radon O,H,N isotope	340’	240’	Local Childs Valley
LGB-118	C(13-7)22ddd submersible	32.273945 -112.96672	611306	81353	NewAdobe Windmill	Inorganic, O,H,N Isotope	-	-	Local Childs Valley
					20th Field Trip, February 27, 2017 – Towne & Boettcher				
LGB-119	C(12-6)35dab windmill	32.337583 -112.850694	-	81355	Darby Windmill	Inorganic, Radiochem Radon, O,H,N isotope	-	-	Local Childs Valley
LGB-120	C(12-6)05bdd submersible	32.41111 -112.908638	640885	81356	Price Ranch Well	Inorganic, Radiochem Radon, O,H,N isotope	155’	65’	Local Childs Valley

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017

Site #	MCL Exceedances	Temp (ºC)	pH-field (su)	pH-lab (su)	SC-field (µS/cm)	SC-lab (µS/cm)	TDS-field (mg/L)	TDS- lab (mg/L)	Hard (mg/L)	Turb (ntu)
LGB-1/2	TDS, Cl, SO_4,	25.6	8.14	*7.59*	5578	5750	-	**3550**	815	*4.35*
LGB-3	pH, TDS, As, **F**	28.4	**9.16**	*9.17*	997	1000	-	**570**	29	4.6
LGB-4	-	25.4	7.25	*7.58*	636	640	-	410	230	1.0
LGB-5/6	-	29.9	8.20	*8.035*	350	370	-	275	68.5	ND
LGB-7	-	27.9	8.40	*8.35*	325	350	-	240	26	0.22
LGB-8	As	28.9	8.27	*8.26*	442	480	-	310	38	0.30
LGB-9	NO_3	23.8	8.22	*8.33*	552	600	-	360	120	1.3
LGB-10	-	27.3	7.21	*7.40*	719	740	-	460	240	3.8
LGB-12	TDS, Cl, SO_4 NO_3, F	27.2	7.23	*7.32*	7735	8100	-	**6400**	1500	1.4
LGB-13	TDS, Cl, SO_4,As, **F**	31.7	8.17	*8.10*	1622	1700	-	**990**	100	ND
LGB-14	TDS, Cl, As, **F**	24.5	8.08	*8.17*	2126	2200	-	**1300**	210	0.24
LGB-15/16	TDS, As, **F**	35.9	8.29	*8.31*	1118	1200	-	**670**	54	0.65
LGB-17	TDS, As, **F**	34.9	8.30	*8.22*	1076	1120	-	**641**	35.8	ND
LGB-18	TDS, Cl, As, F	37.4	8.10	*8.07*	1678	1680	-	**985**	120	ND
LGB-19	TDS, As, **F**	29.7	8.44	*8.36*	1238	1270	-	**721**	33	ND
LGB-20	TDS, As, F	34.2	8.39	8.10	937	836	-	**555**	33.1	ND
LGB-21	-	30.2	7.16	*7.43*	713	750	-	443	271	ND
LGB-22	TDS, Cl, SO_4 Mn, As	23.3	7.27	*7.29*	2448	2310	**1592**	**1590**	673	ND
LGB-23	TDS, Cl, SO_4 Fe, Mn, As, F	22.9	7.36	7.15	6604	6590	-	**4800**	1180	7.3
LGB-24	TDS, Cl, SO_4 Fe, Mn, As, F	23.9	7.61	*7.26*	3335	3090	-	**2290**	754	3.8
LGB-25/26	TDS, Cl, SO_4 Fe, Mn	23.3	7.42	*7.22*	3314	3330	**2159**	**2490**	1010	9.2
LGB-27	TDS, Cl, SO_4 Fe, Mn, As	24.5	7.60	*7.35*	4077	3930	**2645**	**2970**	771	3.6
LGB-28	TDS, Cl, SO_4 Mn, As	24.7	7.72	*7.34*	2909	2710	**1892**	**2090**	798	ND
LGB-29	TDS, Cl, SO_4 Fe, Mn, As, F	23.7	7.49	*7.21*	5104	5210	**3339**	**3600**	1050	8.4
LGB-30	TDS, Cl, SO_4 Fe, Mn, As	25.5	7.72	*7.24*	5018	4990	**3259**	**3200**	1140	4.1
LGB-31/32	TDS, Cl, SO_4 Mn	24.2	7.56	*7.075*	4987	4985	**3240**	**3210**	1130	ND
LGB-33	TDS, Cl, SO_4 **F**, Fe, Mn	29.9	8.06	*7.44*	2882	2450	**1873**	**1750**	442	6.1
LGB-34	TDS, Cl, SO_4 As, F	37.6	7.35	*7.56*	4538	3860	**2950**	**2620**	549	ND

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	MCL Exceedances	Temp (ºC)	pH-field (su)	pH-lab (su)	SC-field (µS/cm)	SC-lab (µS/cm)	TDS-field (mg/L)	TDS- lab (mg/L)	Hard (mg/L)	Turb (ntu)
LGB-35	TDS, Cl, SO_4 As, Fe, Mn	21.3	7.50	*7.70*	3167	2750	**2059**	**2300**	863	*1.5*
LGB-36	TDS, Cl, SO_4 Fe, Mn, As	22.1	7.24	*7.42*	4846	4430	**3151**	**3640**	1430	4.0
LGB-37	TDS, Cl, SO_4 NO_3, **F**, As	24.5	7.24	*7.31*	5963	5730	**3876**	**4250**	788	ND
LGB-38	TDS, Cl, SO_4 **F**, As	25.3	8.28	*8.31*	2582	2230	**1678**	**1490**	95.7	ND
LGB-39	TDS, Cl, SO_4 NO_3	23.2	6.92	*7.17*	3285	2870	**2136**	**2390**	852	ND
LGB-40	TDS, Cl, SO_4	23.1	8.19	*8.21*	3088	2680	**2007**	**1710**	174	1.5
LGB-42	TDS, Cl, SO_4 **F**, As	32.0	7.61	*8.12*	2808	2450	**1824**	**1630**	218	ND
LGB-43	TDS, Cl, SO_4 F	25.4	7.41	*7.63*	2271	2010	**1476**	**1490**	341	ND
LGB-44	TDS, Cl, SO_4 F, As	27.6	7.79	*7.80*	4070	3630	**2625**	**2640**	583	ND
LGB-45	TDS, Cl, SO_4 F, As	32.0	7.84	*8.05*	4174	3800	**2714**	**2710**	600	ND
LGB-46	TDS, Cl, SO_4 NO_3, As	24.8	7.15	*7.28*	4438	4160	**2884**	**3380**	684	ND
LGB-47/48	TDS, Cl, SO_4 As, F	27.0	7.68	*7.76*	3102	3100	**2016**	**2155**	385.5	ND
LGB-49	TDS, Cl, SO_4 Mn, As	24.4	7.34	*7.87*	3391	3060	**2205**	**2390**	785	0.96
LGB-50	F, As	34.4	8.09	*8.24*	739	808	481	423	50.6	ND
LGB-51	TDS, Cl, F	42.3	8.00	*8.15*	2012	1790	**1309**	**1050**	96.2	ND
LGB-52	TDS, Cl, SO_4	29.0	7.24	7.56	4541	3980	**2955**	**2540**	440	ND
LGB-53	TDS, Cl, SO_4	29.7	7.47	*7.59*	4066	3480	**2643**	**2420**	603	ND
LGB-54	TDS, Cl, SO_4 As, Fe, Mn	24.0	7.29	*7.60*	6598	6330	**4290**	**4030**	1450	2.0
LGB-55	TDS, Cl, SO_4 F, As	36.0	8.07	8.15	3374	2880	**2193**	**1640**	274	ND
LGB-56	TDS, Cl, SO_4 F, As	36.9	7.98	*7.95*	4336	3820	**2818**	**2470**	493	ND
LGB-57	F, As	36.4	8.48	*8.71*	968	966	**629**	409	ND	ND
LGB-58	TDS, Cl, As	34.0	7.97	*8.08*	1533	1520	**994**	**833**	126	-
LGB-59	TDS, Cl	27.7	7.46	*7.99*	2466	2530	**1601**	**1500**	459	-
LGB-60	TDS, Cl	25.6	7.74	*7.69*	2900	3400	**1881**	**2130**	751	-
LGB-61	pH, TDS, Cl, SO_4, As, F	31.3	**8.79**	*8.74*	2343	2700	**1523**	**1450**	183	-
LGB-62	pH, TDS, Cl, SO_4, As, F	29.7	**8.67**	*8.56*	2291	2650	**1488**	**1450**	164	-
LGB-63	TDS, Cl, SO_4	25.1	7.07	*7.25*	5147	6120	**3348**	**3250**	834	-
LGB-64	TDS, Cl, **F**, As	29.0	7.89	*7.89*	1970	2460	**1280**	**1310**	214	-

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	MCL Exceedances	Temp (ºC)	pH-field (su)	pH-lab (su)	SC-field (µS/cm)	SC-lab (µS/cm)	TDS-field (mg/L)	TDS- lab (mg/L)	Hard (mg/L)	Turb (ntu)
LGB-65	TDS, Cl F, As	26.7	7.66	*7.73*	2403	3190	**1561**	**1700**	225	-
LGB-66	TDS, **F**, As	37.3	8.42	*8.48*	1208	1390	**784**	**763**	52	-
LGB-67	TDS, Cl, SO_4 F	30.6	7.32	*7.47*	4168	6490	**2708**	**3980**	712	-
LGB-68	TDS, Cl, SO_4 **F**, As	24.5	7.15	*7.33*	5220	8690	**3391**	**5870**	966	-
LGB-69	TDS, Cl, SO_4 **F**, As	20.1	8.14	*8.04*	2370	3480	**1541**	**2040**	530	-
LGB-70	TDS, Cl, NO_3 F	26.0	7.96	*7.93*	1668	2440	**1084**	**1470**	265	-
LGB-71	pH, TDS, **F**, As	29.7	**8.84**	*8.82*	933	1110	**606**	**624**	ND	-
LGB-72	TDS, Cl, F, As	30.1	7.77	*7.87*	971	1340	**631**	**736**	156	-
LGB-73	TDS, SO_4	13.2	7.92	*7.87*	1364	1390	**886**	**831**	327	-
LGB-74/75	TDS, Cl, SO_4 **F**, As	51.0	7.55	*7.70*	2861	4490	**1859**	**2850**	468	-
LGB-76	TDS, Cl, SO_4 F, As, Fe, Mn	23.1	7.25	*7.65*	4262	6860	**2772**	**4360**	1120	-
LGB-77	TDS, **F**, As	37.1	8.21	*8.28*	991	1010	**642**	**564**	40.9	-
LGB-78	TDS, **F**, As	38.7	8.03	*8.28*	994	1020	**645**	**567**	40.0	-
LGB-79	TDS, F, As	35.2	7.76	*8.03*	943	958	**613**	**566**	89.1	-
LGB-80/81	TDS, Cl, SO_4 F	29.7	7.84	*7.87*	3771	4145	**2451**	**2275**	230	0.49
LGB-82	TDS, **F**, As	32.3	8.24	8.31	902	905	**586**	**508**	34.7	-
LGB-83	TDS, Cl, SO_4 NO_3, F, As	24.8	7.29	*7.71*	5559	6250	**3612**	**3660**	869	-
LGB-84	TDS, Cl, SO_4 NO_3, **F**, As	25.8	7.49	*7.77*	3695	4170	**2401**	**2380**	402	-
LGB-85	TDS, Cl, **F**, As	21.5	8.21	*8.19*	1551	1640	**1009**	**896**	89.7	-
LGB-87	TDS, Cl, SO_4 NO_3, F, As	27.8	7.64	*7.5*	2611	2800	**1693**	**1800**	330	-
LGB-88	TDS, Cl	32.9	8.37	*8.3*	1288	1400	**835**	**780**	72	-
LGB-89	TDS, Cl, SO_4 As	28.0	7.61	*7.6*	2667	2900	**1732**	**1900**	560	-
LGB-90	TDS, Cl, SO_4 As	25.8	7.27	*7.2*	1437	1600	**930**	**1000**	460	-
LGB-91	TDS, Cl, SO_4 F	30.5	8.40	*8.4*	3265	3500	**2122**	**2100**	130	-
LGB-92	TDS, Cl, SO_4 As, F	33.7	8.36	*8.3*	3155	3500	**2052**	**2100**	240	-
LGB-93	TDS, Cl, SO_4 Fe, Mn, As	26.9	7.57	*7.6*	2970	3200	**1925**	**2200**	700	-
LGB-94	TDS, Cl, SO_4 Fe, Mn, As	24.7	7.58	*7.6*	2990	3300	**1945**	**2200**	650	-
LGB-95	TDS, As, **F** Mn	24.6	7.88	*7.8*	1682	1500	**897**	**940**	160	-

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bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	MCL Exceedances	Temp (ºC)	pH-field (su)	pH-lab (su)	SC-field (µS/cm)	SC-lab (µS/cm)	TDS-field (mg/L)	TDS- lab (mg/L)	Hard (mg/L)	Turb (ntu)
LGB-96	TDS, SO_4	22.9	7.91	*7.8*	1118	1200	**726**	**790**	350	-
LGB-97	TDS, Cl, SO_4 As, Fe, Mn	24.9	7.55	*7.5*	4320	4700	**2809**	**3100**	1000	-
LGB-98	TDS, Cl, SO_4 As, **F**	32.6	7.70	*7.7*	5609	6300	**3649**	**4400**	500	-
LGB-99	TDS, Cl, SO_4 As, F	29.7	7.62	*7.6*	5065	5600	**3298**	**3400**	200	-
LGB-100	TDS, Cl, SO_4 F, Mn	27.6	7.69	*7.6*	1646	1700	**1070**	**1100**	270	-
LGB-101	TDS, Cl, SO_4 As, **F**	31.0	7.87	*7.8*	5531	6100	**3596**	**5100**	1200	-
LGB-102	TDS, Cl, As, **F**	35.4	8.45	*8.5*	1684	1800	**1094**	**1000**	74	-
LGB-103	TDS, Cl, SO_4 pH, As, **F**	34.1	**9.21**	*9.4*	1844	1900	**1198**	**1100**	26	-
LGB-104	TDS, Cl, As, **F**	33.2	7.97	*8.1*	1350	1400	**877**	**770**	97	-
LGB-105	TDS, Cl, As, **F**	34.3	8.13	*8.3*	1685	1700	**1095**	**970**	80	-
LGB-106	TDS, Cl, As, **F**	32.4	8.16	*8.3*	1379	1400	**896**	**750**	56	-
LGB-107/108	TDS, As, **F**	35.9	8.36	*8.5*	1130	1200	**735**	**640**	41	-
LGB-109	TDS, Cl, As, **F**	32.2	8.16	*8.3*	1362	1400	**885**	**740**	53	-
LGB-110	TDS, SO_4	25.0	7.53	*7.7*	1271	1300	**826**	**800**	310	-
LGB-111	TDS, Cl, SO_4 As, **F**	36.0	8.29	*8.4*	1539	1600	**1000**	**820**	73	-
LGB-112	TDS, Cl, SO_4	27.2	7.94	7.9	24573	24000	**15980**	**20000**	1600	-
LGB-113	TDS, pH, As, F	36.2	**8.52**	*8.6*	1122	1000	**731**	**670**	33	-
LGB-114	TDS, As, F	34.6	8.17	*8.2*	1293	1200	**841**	**730**	51	-
LGB-115	TDS, Cl, SO_4 NO_3, F, Mn	36.7	7.45	*7.7*	3350	3000	**2178**	**2000**	370	-
LGB-116	-	28.0	8.13	*8.2*	635	650	412	400	67	-
LGB-117	-	27.5	7.67	*7.7*	495	500	322	320	78	-
LGB-118	-	24.9	7.21	*7.3*	675	680	438	400	270	-
LGB-119	TDS, Cl	24.5	7.45	*7.6*	1808	1800	**1178**	**1100**	550	-
LGB-120	-	23.4	7.90	*8.0*	714	710	464	430	96	-

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	T. Alk (mg/L)	Bicarbonate (mg/L)	Carbonate Alk (mg/L)	Hydroxide Alk (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
LGB-1/2	310	7.65	1750	5.05	37	45	ND	ND	**1750**	**430**
LGB-3	12	ND	190	ND	24	29	ND	7.4	190	140
LGB-4	50	25	62	ND	300	366	ND	ND	18	17
LGB-5/6	18.5	5.4	46.5	13.5	140	171	ND	ND	13	13
LGB-7	8.5	1.1	66	3.0	150	183	ND	ND	6.7	12
LGB-8	11	2.6	92	4.0	210	256	ND	ND	6.5	7.4
LGB-9	28	13	65	3.0	85	104	ND	ND	52	46
LGB-10	61	21	61	0.89	290	354	ND	ND	48	22
LGB-12	510	51	1400	10	180	220	ND	ND	**1100**	**3000**
LGB-13	39	1.5	280	3.4	48	59	ND	ND	**310**	**290**
LGB-14	73	6.8	350	4.7	83	101	ND	ND	**530**	210
LGB-15/16	19	1.4	200	2.3	62	200	ND	ND	210	150
LGB-17	12.3	ND	203	2.47	90	110	ND	ND	170	116
LGB-18	43.2	ND	277	3.59	62	76	ND	ND	**352**	128
LGB-19	10.9	ND	239	3.02	100	122	ND	ND	222	103
LGB-20	11.6	ND	185	3.65	106	129	ND	ND	172	107
LGB-21	84.3	14.6	59.5	1.58	318	388	ND	ND	34.9	47.9
LGB-22	171	59.8	322	7.49	387	472	ND	ND	**263**	**662**
LGB-23	295	107	1170	11.4	441	538	ND	ND	**1360**	**1380**
LGB-24	163	84.3	486	6.63	424	517	ND	ND	**397**	**869**
LGB-25/26	259	91.4	420	9.23	438	533	ND	ND	**388**	**948**
LGB-27	167	86.0	713	7.51	517	631	ND	ND	**520**	**1010**
LGB-28	195	75.5	364	7.92	344	420	ND	ND	**328**	**826**
LGB-29	247	105	782	7.89	482	564	ND	ND	**984**	**1170**
LGB-30	310	88	672	8.70	789	963	ND	ND	**1250**	**808**
LGB-31/32	292	97.9	697.5	8.81	359	438	ND	ND	**1125**	**938**
LGB-33	172	ND	368	3.01	11.7	14.3	ND	ND	**551**	**550**
LGB-34	186	20.6	548	7.27	55.1	67.2	ND	ND	**1180**	**304**

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	T. Alk (mg/L)	Bicarbonate (mg/L)	Carbonate Alk (mg/L)	Hydroxide Alk (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
LGB-35	214	79.8	491	8.02	392	478	ND	ND	**477**	**973**
LGB-36	363	127	713	10.8	503	614	ND	ND	**920**	**1470**
LGB-37	161	93.8	1290	5.38	438	534	ND	ND	**1330**	**1270**
LGB-38	25.3	7.89	561	4.09	87.1	106	ND	ND	**625**	**296**
LGB-39	210	79.6	464	5.34	432	527	ND	ND	**552**	**843**
LGB-40	50.7	11.5	623	4.43	50.5	62	ND	ND	**694**	**529**
LGB-42	75.5	7.21	536	4.38	40.4	49	ND	ND	**655**	**412**
LGB-43	82.3	33.0	440	4.79	261	318	ND	ND	**327**	**477**
LGB-44	222	6.92	776	8.69	31.7	39	ND	ND	**975**	**910**
LGB-45	232	ND	817	8.52	22.2	27	ND	ND	**1170**	**839**
LGB-46	163	67.2	923	6.88	402	490	ND	ND	**848**	**1160**
LGB-47/48	127.5	16.85	625.5	6.78	84.4	103	ND	ND	**548.5**	**891.5**
LGB-49	177	83.3	639	7.43	370	451	ND	ND	**520**	**1060**
LGB-50	16.4	ND	147	7.02	89.1	109	ND	ND	102	78.3
LGB-51	33.7	ND	359	3.65	57.7	70.4	ND	ND	**431**	112
LGB-52	155	12.8	1190	9.60	190	232	ND	ND	**1100**	**376**
LGB-53	202	24.0	980	10.6	88.6	108	ND	ND	**826**	**643**
LGB-54	366	131	910	8.78	301	367	ND	ND	**1670**	**840**
LGB-55	92.9	10.1	905	4.78	41.6	50.7	ND	ND	**666**	**507**
LGB-56	188	5.63	1120	5.19	22.7	27.7	ND	ND	**877**	**793**
LGB-57	7.80	ND	290	2.55	92.7	113	ND	ND	135	89
LGB-58	31.3	11.7	261	3.47	110	134.2	ND	ND	**424**	95.6
LGB-59	108	45.9	331	5.26	114	139.1	ND	ND	**725**	212
LGB-60	160	85.4	314	5.44	85.3	104.1	ND	ND	**883**	227
LGB-61	72.1	ND	416	1.69	21.2	25.9	ND	ND	**619**	**333**
LGB-62	58	ND	385	1.42	30.6	37.3	ND	ND	**449**	**308**
LGB-63	307	16.4	800	4.24	197	240.3	ND	ND	**1550**	**719**
LGB-64	76	5.93	341	3.45	52	63.4	ND	ND	**524**	222

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	T. Alk (mg/L)	Bicarbonate (mg/L)	Carbonate Alk (mg/L)	Hydroxide Alk (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
LGB-65	70.7	11.7	450	7.12	108	131.8	ND	ND	**704**	239
LGB-66	18.8	ND	231	1.88	56.9	69.4	ND	ND	211	195
LGB-67	241	26.7	877	5.23	172	209.8	ND	ND	**1180**	**1240**
LGB-68	311	46	1350	<5	134	163.4	ND	ND	**1620**	**1710**
LGB-69	201	6.82	453	1.94	26	31.7	ND	ND	**679**	**528**
LGB-70	93.3	7.83	299	7.13	54.9	67	ND	ND	**563**	118
LGB-71	ND	ND	195	2.47	94.2	100.9	11.2	ND	175	103
LGB-72	59.6	ND	167	6.26	74.0	90.3	ND	ND	**254**	104
LGB-73	81.7	29.8	136	6.67	143	174.5	ND	ND	141	**293**
LGB-74/75	179	5.0	625	11.6	52.0	63.4	ND	ND	**716**	**971**
LGB-76	247	123	832	6.76	439	535.6	ND	ND	**1260**	**1240**
LGB-77	12.0	ND	165	3.36	102	124.5	ND	ND	148	92.1
LGB-78	11.5	ND	161	3.14	108	131.8	ND	ND	152	91.1
LGB-79	26.7	5.45	137	4.51	104	126.9	ND	ND	124	114
LGB-80/81	83.6	8.31	643	8.45	58.0	70.5	ND	ND	**1012.5**	**434.5**
LGB-82	11.7	ND	142	3.92	100	122	ND	ND	132	86.0
LGB-83	197	91.5	707	6.27	252	307.4	ND	ND	**1390**	**777**
LGB-84	112	29.7	498	3.43	136	166	ND	ND	**825**	**487**
LGB-85	28.7	ND	238	4.32	59.6	72.7	ND	ND	**289**	207
LGB-87	83	30	440	4.0	330	402.6	ND	ND	**370**	**640**
LGB-88	20	5.4	230	3.5	90	109.8	ND	ND	**290**	180
LGB-89	150	46	350	4.5	260	317.2	ND	ND	**540**	**590**
LGB-90	120	39	150	3.4	250	305	ND	ND	150	**350**
LGB-91	37	9.0	640	4.2	70	85.4	ND	ND	**780**	**710**
LGB-92	85	6.9	570	3.7	32	39.0	ND	ND	**830**	**640**
LGB-93	170	65	420	7.4	320	390.4	ND	ND	**420**	**950**
LGB-94	150	64	430	7.6	420	512.4	ND	ND	**350**	**960**
LGB-95	45	11	250	2.3	340	414.8	ND	ND	140	230

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	**Calcium** (mg/L)	**Magnesium** (mg/L)	**Sodium** (mg/L)	**Potassium** (mg/L)	**T. Alk** (mg/L)	**Bicarbonate** (mg/L)	**Carbonate Alk** (mg/L)	**Hydroxide Alk** (mg/L)	**Chloride** (mg/L)	**Sulfate** (mg/L)
LGB-96	100	21	110	3.8	190	231.8	ND	ND	48	**290**
LGB-97	270	86	570	8.3	290	353.8	ND	ND	**960**	**930**
LGB-98	170	20	1100	6.6	120	146.4	ND	ND	**900**	**2000**
LGB-99	59	14	670	4.2	210	256.2	ND	ND	**1200**	**830**
LGB-100	79	19	250	5.4	170	207.4	ND	ND	**250**	**330**
LGB-101	390	61	670	12	56	68.3	ND	ND	**1800**	**430**
LGB-102	30	ND	290	3.2	44	53.7	ND	ND	**380**	240
LGB-103	10	ND	370	1.7	40	48.8	ND	ND	**270**	**510**
LGB-104	34	3.0	230	4.7	90	109.8	ND	ND	**260**	180
LGB-105	32	ND	290	4.8	56	69.3	ND	ND	**350**	220
LGB-106	22	ND	250	4.2	80	97.6	ND	ND	**280**	150
LGB-107/108	16	ND	205	2.05	62	78	ND	ND	190	160
LGB-109	21	ND	250	3.7	84	102.5	ND	ND	**270**	150
LGB-110	81	26	140	4.7	160	195.2	ND	ND	130	**310**
LGB-111	29	ND	280	2.8	50	61	ND	ND	**290**	**250**
LGB-112	510	89	5700	18	50	61	ND	ND	**5900**	**8200**
LGB-113	13	ND	190	1.6	58	71	8	ND	190	150
LGB-114	20	ND	230	2.248	78	95	ND	ND	230	180
LGB-115	140	6.8	550	17	82	100	ND	ND	**800**	**370**
LGB-116	16	6.5	110	3.3	200	244	ND	ND	48	35
LGB-117	20	6.9	79	3.1	210	256	ND	ND	17	12
LGB-118	64	27	42	1.4	350	427	ND	ND	8.3	5.6
LGB-119	120	59	160	1.7	370	451	ND	ND	**300**	130
LGB-120	28	6.3	130	0.57	290	354	ND	ND	38	28

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Nitrate-N (mg/L)	δ^{15}N ($^{0}/_{00}$)	Nitrite-N (mg/L)	TKN (mg/L)	Ammonia (mg/L)	T. Phos. (mg/L)	SAR (value)	Irrigation Quality	Alum (mg/L)	Strontium (mg/L)
LGB-1/2	4.1	11.35	ND	ND/3.1	ND	ND	14.1	C4-S4	ND	1.9
LGB-3	2.1	12.2	0.61	ND	ND	ND	14.2	C3-S3	ND	ND
LGB-4	4.3	3.9	ND	ND	0.13	ND	1.8	C2-S1	ND	0.27
LGB-5/6	3.3	5.05	ND	ND	0.0485	ND	2.4	C2-S1	ND	0.0855
LGB-7	2.3	5.3	ND	ND	0.033	ND	5.7	C2-S1	ND	0.040
LGB-8	6.2	7.0	ND	ND	0.046	0.014	6.5	C2-S1	ND	0.072
LGB-9	**22**	7.2	ND	ND	0.032	ND	2.5	C2-S1	ND	0.16
LGB-10	3.3	6.6	ND	ND	0.020	0.015	1.7	C2-S1	ND	1.1
LGB-12	**25**	8.7	ND	ND	0.022	0.016	15.7	C4-S4	ND	10
LGB-13	2.0	9.0	ND	ND	0.034	0.015	12.0	C3-S2	ND	0.81
LGB-14	3.5	10.3	ND	ND	0.023	0.012	10.5	C3-S3	ND	0.94
LGB-15/16	1.9	9.3	ND	ND	0.026	0.0265	11.9	C3-S2	ND	0.37
LGB-17	2.2	9.3	ND	ND	ND	0.032	13.8	C3-S2	ND	0.20
LGB-18	4.6	6.6	ND	ND	ND	0.024	11.1	C3-S2	ND	0.332
LGB-19	2.6	6.6	ND	ND	ND	ND	17.0	C3-S2	ND	0.126
LGB-20	3.2	6.5	ND	ND	ND	0.13	12.8	C3-S2	ND	0.185
LGB-21	0.67	5.5	ND	ND	ND	ND	1.6	C2-S1	ND	0.915
LGB-22	3.0	10.5	ND	ND	ND	0.067	5.4	C4-S2	ND	1.72
LGB-23	2.0	12.9	ND	0.76	ND	0.11	14.8	C4-S3	ND	4.28
LGB-24	1.7	11.6	ND	.20	ND	0.079	7.7	C4-S2	ND	1.79
LGB-25/26	5.15	12.4	ND	0.85	ND	0.073	5.8	C4-S2	ND	2.16
LGB-27	1.5	16	ND	0.83	ND	0.11	11.2	C4-S3	ND	2.15
LGB-28	8.1	11.8	ND	0.44	ND	0.058	5.6	C4-S2	ND	2.18
LGB-29	1.2	16.7	ND	0.83	ND	0.10	10.5	C4-S2	ND	3.64
LGB-30	0.51	17.8	ND	0.80	ND	0.091	8.7	C4-S2	ND	4.94
LGB-31/32	4.0	12.7	ND	0.395	ND	0.042	9.0	C4-S2	ND	4.63
LGB-33	ND	ND	ND	ND	ND	ND	7.6	C4-S2	ND	1.01
LGB-34	0.53	6.6	ND	ND	ND	0.028	10.2	C4-S2	ND	2.94

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Nitrate-N (mg/L)	δ^{15} N ($^0/_{00}$)	Nitrite-N (mg/L)	TKN (mg/L)	Ammonia (mg/L)	T. Phos. (mg/L)	SAR (value)	Irrigation Quality	Alum (mg/L)	Strontium (mg/L)
LGB-35	0.64	17.2	ND	ND	ND	0.044	7.3	C4-S2	ND	2.17
LGB-36	0.45	13.6	ND	ND	ND	0.024	8.2	C4-S2	ND	3.97
LGB-37	**15.3**	6.8	0.14	ND	ND	0.036	20.0	C4-S4	ND	3.14
LGB-38	1.2	14.5	ND	ND	ND	ND	25.0	C4-S4	ND	0.602
LGB-39	**10.1**	4.5	ND	ND	ND	0.020	6.9	C4-S2	ND	3.17
LGB-40	ND	NS	ND	ND	ND	ND	20.5	C4-S4	ND	2.08
LGB-42	0.22	36.5	ND	ND	ND	ND	15.8	C4-S3	ND	1.86
LGB-43	5.0	6.1	ND	ND	ND	ND	10.4	C4-S2	ND	1.46
LGB-44	0.39	17.9	ND	ND	ND	ND	14.0	C4-S3	ND	5.31
LGB-45	0.62	15.1	ND	ND	ND	ND	14.6	C4-S3	ND	5.19
LGB-46	**21.6**	11.2	ND	ND	ND	ND	15.4	C4-S4	ND	0.0130
LGB-47/48	2.5	3.6	ND	ND	ND	ND	13.6	C4-S3	ND	3.38
LGB-49	2.7	20.1	ND	ND	ND	0.074	9.9	C4-S2	ND	2.38
LGB-50	4.2	6.6	ND	ND	ND	0.030	9.5	C2-S2	ND	0.187
LGB-51	0.71	9.5	ND	ND	ND	ND	16.6	C3-S4	ND	0.220
LGB-52	0.27	10.2	ND	ND	ND	ND	16.5	C4-S4	ND	2.15
LGB-53	0.41	8.4	ND	ND	ND	ND	12.0	C4-S3	ND	3.56
LGB-54	0.89	11.7	ND	ND	ND	0.043	10.4	C4-S2	ND	6.83
LGB-55	0.24	32.5	ND	ND	ND	ND	16.4	C4-S4	ND	2.59
LGB-56	0.27	27.3	ND	ND	ND	ND	15.5	C4-S4	ND	4.61
LGB-57	3.0	6.4	ND	ND	ND	0.026	18.1	C3-S3	ND	0.0745
LGB-58	1.1	6.8	ND	0.62	ND	ND	10.1	C3-S2	ND	0.454
LGB-59	1.3	13.1	ND	0.51	ND	ND	6.7	C4-S2	ND	1.35
LGB-60	8.5	9.1	ND	0.30	ND	ND	5.0	C4-S2	ND	1.94
LGB-61	0.90	11.1	ND	0.21	ND	ND	28.0	C4-S4	ND	0.334
LGB-62	1.8	9.4	ND	ND	ND	0.037	13.4	C4-S3	ND	0.312
LGB-63	1.2	8.3	ND	0.23	ND	ND	12.0	C4-S3	ND	0.957
LGB-64	1.5	10.5	ND	N/A	N/A	N/A	10.1	C4-S2	0.246	0.958

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level
N/A = not available not enough water to conduct test

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Nitrate-N (mg/L)	δ^{15} N ($^0/_{00}$)	Nitrite-N (mg/L)	TKN (mg/L)	Ammonia (mg/L)	T. Phos. (mg/L)	SAR (value)	Irrigation Quality	Alum (mg/L)	Strontium (mg/L)
LGB-65	3.9	7.8	ND	ND	ND	ND	13.1	C4-S3	ND	1.06
LGB-66	1.6	9.1	ND	ND	ND	ND	13.2	C3-S3	ND	0.505
LGB-67	5.5	11.6	ND	ND	ND	ND	14.3	C4-S4	ND	6.27
LGB-68	5.0	10.8	ND	ND	ND	0.028	18.9	C4-S4	ND	3.71
LGB-69	1.1	21.8	ND	ND	ND	ND	8.6	C4-S2	ND	0.182
LGB-70	**12.9**	8.3	ND	ND	ND	0.023	8.0	C4-S2	ND	0.688
LGB-71	2.4	7.1	ND	ND	ND	ND	20.9	C3-S4	ND	0.0390
LGB-72	3.8	6.9	ND	ND	ND	ND	5.8	C3-S2	ND	0.439
LGB-73	0.68	8.3	ND	ND	ND	0.11	3.3	C3-S1	ND	1.34
LGB-74/75	0.37	8.8	ND	ND	ND	ND	12.6	C4-S3	ND	4.30
LGB-76	0.63	13.0	ND	ND	ND	0.064	10.8	C4-S2	ND	3.92
LGB-77	3.4	8.9	ND	0.2	ND	0.020	11.3	C3-S2	ND	0.176
LGB-78	3.5	9.0	ND	ND	ND	0.020	10.4	C3-S2	ND	0.148
LGB-79	3.6	8.1	ND	ND	ND	0.046	6.3	C3-S2	ND	0.346
LGB-80/81	1.85	12.25	ND	0.48	ND	ND	19.6	C4-S4	ND	2.93
LGB-82	3.1	6.9	ND	ND	ND	0.032	9.8	C3-S2	ND	0.123
LGB-83	**21.8**	9.5	ND	ND	ND	ND	10.4	C4-S2	ND	2.88
LGB-84	**35.7**	10.4	ND	ND	ND	0.044	10.8	C4-S2	ND	1.32
LGB-85	2.0	9.4	ND	ND	ND	ND	11.4	C3-S2	ND	1.28
LGB-87	**10**	4.2	-	ND	ND	ND	10.5	C4-S3	ND	1.7
LGB-88	1.0	17.6	-	ND	ND	ND	11.8	C3-S2	ND	0.60
LGB-89	7.0	3.5	-	ND	ND	ND	6.4	C4-S2	ND	3.5
LGB-90	6.9	2.7	-	ND	ND	ND	3.0	C3-S1	ND	2.6
LGB-91	ND	26.6	-	ND	ND	ND	24.5	C4-S4	ND	0.97
LGB-92	0.71	26.0	-	ND	ND	ND	16.0	C4-S4	ND	2.2
LGB-93	5.8	11.1	-	1.0	0.37	ND	6.9	C4-S2	ND	1.8
LGB-94	0.90	18.0	-	1.1	0.89	0.11	7.4	C4-S2	ND	1.6
LGB-95	ND	3.4	-	ND	ND	ND	8.7	C3-S2	ND	0.52

italics = constituent exceeded holding time
bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	**Nitrate-N** (mg/L)	**δ15 N** (‰)	**Nitrite-N** (mg/L)	**TKN** (mg/L)	**Ammonia** (mg/L)	**T. Phos.** (mg/L)	**SAR** (value)	**Irrigation Quality**	**Alum** (mg/L)	**Strontium** (mg/L)
LGB-96	ND	ND	-	ND	ND	ND	2.6	C3-S1	ND	1.0
LGB-97	0.97	15.7	-	0.33	0.35	ND	7.7	C4-S3	ND	4.0
LGB-98	0.86	13.2	-	ND	ND	ND	21.3	C4-S4	ND	3.3
LGB-99	7.2	11.2	-	ND	ND	ND	20.4	C4-S4	ND	2.1
LGB-100	1.1	11.8	-	ND	ND	ND	6.6	C3-S2	ND	0.92
LGB-101	5.5	8.8	-	ND	ND	ND	8.3	C4-S3	ND	8.2
LGB-102	1.2	11.4	-	ND	ND	ND	14.5	C3-S3	ND	0.86
LGB-103	1.3	25.8	-	ND	ND	ND	31.9	C3-S4	ND	0.17
LGB-104	2.5	6.7	-	0.82	ND	ND	10.1	C3-S2	ND	0.34
LGB-105	1.1	5.9	-	ND	ND	ND	13.9	C3-S3	ND	0.41
LGB-106	0.90	6.4	-	ND	ND	ND	14.4	C3-S3	ND	0.24
LGB-107/108	1.35	5.7	-	ND	ND	ND	14.1	C3-S3	ND	0.14
LGB-109	1.0	6.1	-	ND	ND	ND	14.7	C3-S3	ND	0.24
LGB-110	0.28	10.1	-	ND	ND	ND	3.5	C3-S1	ND	1.1
LGB-111	2.6	8.4	-	ND	ND	ND	14.1	C3-S3	ND	0.62
LGB-112	ND	ND	-	0.61	0.16	ND	61.2	C4-S4	ND	10
LGB-113	1.9	9.1	-	0.35	ND	ND	14.1	C3-S3	ND	0.28
LGB-114	2.0	8.1	-	0.50	ND	ND	13.9	C3-S3	ND	0.37
LGB-115	**12**	10.7	ND	ND	ND	ND	12.3	C4-S3	ND	4.2
LGB-116	3.6	8.0	-	0.20	ND	ND	5.8	C2-S1	ND	ND
LGB-117	2.6	9.2	-	0.22	ND	ND	3.9	C2-S1	ND	0.15
LGB-118	0.63	5.5	-	0.23	ND	ND	1.1	C2-S1	ND	0.64
LGB-119	1.7	6.9	-	0.43	ND	ND	3.0	C3-S1	ND	2.1
LGB-120	3.1	9.6	-	0.32	ND	ND	5.8	C2-S1	ND	ND

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bold = constituent concentration exceeded Primary or Secondary Maximum Contaminant Level

Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Fluoride (mg/L)
LGB-1/2	ND	ND	0.0575	ND	2.55	ND	0.00345	0.0080	1.55
LGB-3	ND	**0.025**	0.0052	ND	1.8	ND	ND	ND	**7.4**
LGB-4	ND	ND	0.0034	ND	ND	ND	0.0023	0.0060	ND
LGB-5/6	ND	0.00535	0.0046	ND	0.29	ND	0.026	0.0024	0.63
LGB-7	ND	0.0046	0.0015	ND	0.23	ND	0.025	0.0022	1.2
LGB-8	ND	**0.015**	0.0026	ND	0.36	ND	0.011	0.0040	0.97
LGB-9	ND	0.0016	0.0023	ND	0.10	ND	0.030	ND	0.21
LGB-10	ND	ND	0.077	ND	0.11	ND	0.0014	0.031	0.22
LGB-12	ND	0.0024	0.051	ND	6.2	ND	0.0019	0.026	**2.8**
LGB-13	ND	**0.016**	0.039	ND	1.8	ND	0.0050	0.0039	**6.7**
LGB-14	ND	**0.011**	0.035	ND	1.9	ND	0.014	0.0077	**5.8**
LGB-15/16	ND	**0.027**	0.0028	ND	1.8	ND	0.00495	0.0028	**7.05**
LGB-17	ND	**0.0318**	0.0142	ND	1.20	ND	0.0307	ND	**4.5**
LGB-18	ND	**0.0353**	0.0096	ND	1.05	ND	0.0241	ND	**3.5**
LGB-19	ND	**0.0434**	0.0028	ND	1.18	ND	0.0331	ND	**4.3**
LGB-20	ND	**0.0834**	0.0074	ND	0.497	ND	0.0264	ND	**2.7**
LGB-21	ND	0.0021	0.0902	ND	0.160	ND	ND	0.0080	ND
LGB-22	ND	**0.0116**	0.0440	ND	0.534	ND	ND	ND	1.0
LGB-23	ND	**0.0134**	0.0432	ND	3.42	ND	ND	ND	**2.4**
LGB-24	ND	**0.0167**	0.0250	ND	1.04	ND	ND	ND	**2.0**
LGB-25/26	ND	0.0057	0.03795	ND	0.57	ND	ND	ND	0.765
LGB-27	ND	**0.0218**	0.0243	ND	1.25	ND	ND	ND	1.9
LGB-28	ND	**0.0169**	0.0389	ND	0.560	ND	ND	ND	0.73
LGB-29	ND	**0.0400**	0.0385	ND	1.40	ND	ND	ND	**2.4**
LGB-30	ND	**0.0109**	0.0391	ND	1.10	ND	ND	ND	0.77
LGB-31/32	ND	0.00835	0.0327	ND	1.37	ND	ND	ND	0.955
LGB-33	ND	ND	ND	ND	1.68	ND	ND	ND	**4.0**
LGB-34	ND	**0.0145**	ND	ND	2.16	ND	ND	ND	**2.1**

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Fluoride (mg/L)
LGB-35	ND	**0.0166**	0.0370	ND	0.720	ND	ND	ND	0.51
LGB-36	ND	**0.0119**	0.0406	ND	1.11	ND	ND	ND	0.40
LGB-37	ND	**0.0454**	0.0104	ND	2.71	ND	ND	ND	**4.9**
LGB-38	ND	**0.0437**	0.0357	ND	1.05	ND	ND	ND	**4.9**
LGB-39	ND	ND	0.0226	ND	1.06	ND	ND	ND	0.78
LGB-40	ND	ND	0.0188	ND	2.06	ND	ND	ND	1.6
LGB-42	ND	**0.0188**	0.0245	ND	2.27	ND	ND	ND	**4.0**
LGB-43	ND	ND	0.0188	ND	0.835	ND	ND	ND	**2.9**
LGB-44	ND	**0.0156**	0.0137	ND	2.38	ND	ND	ND	**3.3**
LGB-45	ND	**0.0287**	0.0195	ND	2.58	ND	ND	ND	**3.3**
LGB-46	ND	**0.0427**	0.0365	ND	2.05	ND	ND	ND	1.6
LGB-47/48	ND	**0.0338**	0.0195	ND	2.45	ND	0.0077	0.0074	**3.75**
LGB-49	ND	**0.0194**	0.0303	ND	0.989	ND	ND	ND	1.0
LGB-50	ND	**0.115**	ND	ND	0.422	ND	0.0231	ND	**3.9**
LGB-51	0.00052	0.0038	0.0166	ND	0.646	ND	0.0050	ND	**2.2**
LGB-52	ND	0.0043	0.0313	ND	1.97	ND	ND	ND	1.6
LGB-53	ND	0.0074	0.0222	ND	2.40	ND	ND	ND	0.53
LGB-54	ND	**0.0180**	0.0502	ND	1.08	ND	ND	ND	0.29
LGB-55	ND	**0.0192**	0.0267	ND	1.93	ND	ND	ND	**2.5**
LGB-56	ND	**0.0201**	0.0173	ND	2.76	ND	ND	ND	**2.6**
LGB-57	ND	**0.176**	0.0023	ND	0.500	ND	0.0276	ND	**3.4**
LGB-58	ND	**0.0225**	0.0016	ND	0.566	ND	0.0053	ND	0.88
LGB-59	ND	0.0084	0.0212	ND	0.360	ND	ND	ND	0.58
LGB-60	ND	0.0060	0.0251	ND	0.422	ND	0.0044	ND	0.24
LGB-61	ND	**0.0194**	0.0069	ND	2.36	ND	0.0067	0.0139	**3.4**
LGB-62	ND	**0.0193**	0.0078	ND	2.20	ND	ND	ND	**3.4**
LGB-63	ND	0.0019	0.0422	ND	5.30	ND	ND	ND	0.68
LGB-64	ND	**0.0110**	0.0366	ND	2.39	ND	0.0060	ND	**4.5**

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Fluoride (mg/L)
LGB-65	ND	**0.0142**	0.0298	ND	1.43	ND	ND	ND	**2.2**
LGB-66	ND	**0.0338**	0.0070	ND	2.23	ND	0.0089	ND	**6.2**
LGB-67	ND	ND	0.0264	ND	6.42	ND	ND	ND	**3.8**
LGB-68	ND	**0.0708**	0.0209	ND	8.13	ND	ND	ND	**4.1**
LGB-69	ND	**0.0458**	0.0077	ND	3.62	ND	ND	ND	**5.4**
LGB-70	ND	0.0092	0.0519	ND	0.831	ND	0.0336	ND	**2.7**
LGB-71	ND	**0.0440**	0.0014	ND	0.814	ND	0.0413	ND	**4.9**
LGB-72	ND	**0.0324**	0.0121	ND	0.511	ND	0.0224	ND	**3.2**
LGB-73	ND	ND	0.0939	ND	0.225	ND	ND	0.0127	0.30
LGB-74/75	ND	**0.0483**	0.0297	ND	3.21	ND	ND	ND	**4.1**
LGB-76	ND	**0.0243**	0.0301	ND	2.06	ND	ND	ND	**2.5**
LGB-77	ND	**0.0784**	0.0033	ND	0.512	ND	0.0185	ND	**5.0**
LGB-78	ND	**0.0797**	0.0011	ND	0.488	ND	0.0178	ND	**4.7**
LGB-79	ND	**0.188**	0.0021	ND	0.445	ND	0.0113	ND	**2.8**
LGB-80/81	ND	0.00425	0.0249	ND	1.64	ND	0.0138	ND	**3.3**
LGB-82	ND	**0.101**	0.0263	ND	0.440	ND	0.0272	ND	**4.1**
LGB-83	ND	**0.184**	0.0371	ND	2.51	ND	0.0093	ND	**3.1**
LGB-84	ND	**0.0981**	0.0286	ND	1.92	ND	0.0412	ND	**4.3**
LGB-85	ND	**0.0246**	0.0314	ND	1.36	ND	0.0099	ND	**4.9**
LGB-87	0.00015	**0.040**	0.024	ND	0.84	ND	0.0046	0.00070	**2.7**
LGB-88	0.00014	0.0066	0.038	ND	0.62	ND	0.00059	ND	0.81
LGB-89	0.00024	**0.014**	0.028	ND	0.66	ND	0.0021	0.00067	1.5
LGB-90	0.00017	**0.014**	0.018	ND	0.25	ND	0.00082	0.00076	1.6
LGB-91	0.00028	0.0067	0.016	ND	4.2	ND	ND	ND	**2.6**
LGB-92	0.00063	**0.032**	0.021	ND	3.4	ND	0.0019	ND	**3.9**
LGB-93	0.00030	**0.012**	0.044	ND	0.78	ND	ND	0.00085	0.86
LGB-94	0.00023	**0.010**	0.041	ND	0.64	ND	ND	0.00050	0.73
LGB-95	0.00047	**0.022**	0.026	ND	0.28	ND	ND	0.0012	**5.4**

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Boron (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Fluoride (mg/L)
LGB-96	0.00013	0.0045	0.048	ND	0.19	ND	ND	0.00065	0.64
LGB-97	0.00013	**0.017**	0.037	ND	0.82	ND	ND	ND	0.77
LGB-98	0.00057	**0.016**	0.012	ND	8.4	ND	0.0087	0.0022	**5.0**
LGB-99	0.00033	**0.019**	0.021	ND	3.0	ND	0.0011	0.00098	**2.7**
LGB-100	0.00023	0.0063	0.017	ND	0.58	ND	0.0058	0.0020	**3.2**
LGB-101	0.00053	**0.013**	0.180	ND	0.77	ND	0.020	0.00053	**4.1**
LGB-102	0.00031	**0.027**	0.0057	ND	1.8	ND	0.0063	0.00056	**6.5**
LGB-103	ND	**0.055**	0.015	ND	1.7	ND	ND	ND	**6.7**
LGB-104	ND	**0.015**	0.021	ND	0.67	ND	0.022	ND	**4.2**
LGB-105	ND	**0.019**	0.033	ND	0.75	ND	0.015	0.00095	**5.1**
LGB-106	ND	**0.025**	0.039	ND	0.60	ND	0.011	ND	**7.2**
LGB-107/108	ND	**0.0295**	0.00435	ND	0.63	ND	0.0185	ND	**9.55**
LGB-109	ND	**0.024**	0.039	ND	0.61	ND	0.010	0.0016	**6.9**
LGB-110	ND	0.0050	0.018	ND	0.19	ND	ND	ND	1.0
LGB-111	ND	**0.020**	0.035	ND	1.9	ND	0.0036	0.0016	**7.1**
LGB-112	ND	0.0041	0.013	ND	30	0.00012	0.0052	0.0021	ND
LGB-113	ND	**0.029**	0.0043	ND	1.7	ND	0.0086	ND	**7.8**
LGB-114	ND	**0.022**	0.011	ND	1.7	ND	0.0051	ND	**7.9**
LGB-115	ND	ND	0.0059	ND	1.2	ND	ND	0.0013	**3.3**
LGB-116	ND	0.0018	0.0018	ND	0.36	ND	0.017	ND	1.4
LGB-117	ND	0.0030	0.0040	ND	0.21	ND	0.0034	0.0024	1.1
LGB-118	ND	0.0026	0.0130	ND	0.072	ND	0.00097	ND	ND
LGB-119	ND	0.0050	0.150	ND	0.29	0.00014	ND	0.026	1.1
LGB-120	ND	0.0066	0.0045	ND	0.24	0.00022	0.0047	0.019	0.67

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Zinc (mg/L)
LGB-1/2	ND	ND	0.013	ND	ND	0.00575	ND	ND	ND
LGB-3	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-4	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-5/6	ND	0.00115	ND	ND	ND	0.00082	ND	ND	0.045
LGB-7	ND	0.0013	ND	ND	ND	0.00068	ND	ND	0.035
LGB-8	ND	0.0012	ND	ND	ND	0.00091	ND	ND	0.022
LGB-9	ND	ND	ND	ND	ND	0.0031	ND	ND	0.045
LGB-10	0.050	ND	0.011	ND	ND	0.00083	ND	ND	0.18
LGB-12	0.085	ND	0.0052	ND	ND	0.020	ND	ND	0.012
LGB-13	ND	ND	ND	ND	ND	0.0018	ND	ND	0.012
LGB-14	ND	0.0023	0.0053	ND	ND	0.0037	ND	ND	0.32
LGB-15/16	0.155	ND	0.0052	ND	ND	0.0011	ND	ND	0.015
LGB-17	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-18	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-19	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-20	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-21	ND	ND	ND	ND	ND	ND	ND	ND	0.107
LGB-22	ND	ND	**0.991**	ND	ND	ND	ND	ND	ND
LGB-23	**0.880**	ND	**1.97**	ND	ND	ND	ND	ND	ND
LGB-24	**0.524**	ND	**0.659**	ND	ND	ND	ND	ND	ND
LGB-25/26	**0.932**	ND	**2.95**	ND	ND	ND	ND	ND	0.019
LGB-27	**0.692**	ND	**1.44**	ND	ND	ND	ND	ND	ND
LGB-28	ND	ND	**1.22**	ND	ND	ND	ND	ND	ND
LGB-29	**0.946**	ND	**1.93**	ND	ND	ND	ND	ND	ND
LGB-30	**0.574**	ND	**1.55**	ND	ND	ND	ND	ND	ND
LGB-31/32	ND	ND	**1.715**	ND	ND	ND	ND	ND	0.0261
LGB-33	**0.617**	ND	**0.0583**	ND	ND	ND	ND	ND	0.0669
LGB-34	ND	ND	ND	ND	ND	ND	ND	ND	ND

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Zinc (mg/L)
LGB-35	**0.439**	ND	**2.60**	ND	ND	ND	ND	ND	ND
LGB-36	**0.632**	ND	**4.45**	ND	ND	ND	ND	ND	ND
LGB-37	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-38	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-39	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-40	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-42	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-43	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-44	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-45	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-46	ND	ND	ND	ND	ND	0.0131	ND	ND	ND
LGB-47/48	ND	ND	ND	ND	ND	ND	ND	ND/	ND
LGB-49	0.238	ND	**1.13**	ND	ND	ND	ND	ND	ND
LGB-50	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-51	ND	0.0015	ND	ND	ND	ND	ND	ND	0.0758
LGB-52	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-53	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-54	**0.615**	ND	**2.29**	ND	ND	ND	ND	ND	ND
LGB-55	ND	ND	0.0165	ND	ND	ND	ND	ND	ND
LGB-56	ND	ND	ND	ND	ND	0.0011	ND	ND	ND
LGB-57	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-58	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-59	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-60	ND	ND	ND	ND	ND	0.0027	ND	ND	ND
LGB-61	ND	0.00086	ND	ND	ND	0.0012	ND	ND	0.0139
LGB-62	ND	ND	ND	ND	ND	0.0013	ND	ND	ND
LGB-63	ND	ND	ND	ND	ND	0.0072	ND	ND	0.0273
LGB-64	ND	ND	ND	ND	ND	0.0014	ND	0.00054	ND

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Zinc (mg/L)
LGB-65	ND	ND	ND	ND	ND	0.0011	ND	ND	ND
LGB-66	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-67	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-68	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-69	ND	ND	0.0232	ND	ND	ND	ND	ND	0.0216
LGB-70	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-71	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-72	ND	ND	ND	ND	ND	0.0017	ND	ND	ND
LGB-73	ND	ND	ND	ND	ND	ND	ND	ND	0.0261
LGB-74/75	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-76	**0.863**	ND	**0.728**	ND	ND	ND	ND	ND	ND
LGB-77	ND	ND	ND	ND	ND	0.0023	ND	ND	0.0091
LGB-78	ND	ND	ND	ND	ND	0.0021	ND	0.00066	ND
LGB-79	ND	ND	ND	ND	ND	0.0017	ND	ND	ND
LGB-80/81	ND	ND	ND	ND	ND	0.00485	ND	ND	ND
LGB-82	ND	ND	ND	ND	ND	0.0018	ND	ND	ND
LGB-83	ND	ND	ND	ND	ND	0.0106	ND	ND	ND
LGB-84	ND	ND	ND	ND	ND	0.0087	ND	ND	ND
LGB-85	ND	ND	ND	ND	ND	0.0016	ND	ND	ND
LGB-87	ND	ND	ND	ND	ND	0.0057	ND	ND	0.015
LGB-88	ND	ND	ND	ND	ND	0.0050	ND	ND	ND
LGB-89	ND	ND	ND	ND	ND	0.0053	ND	ND	0.120
LGB-90	ND	ND	ND	ND	ND	0.0017	ND	ND	ND
LGB-91	ND	ND	ND	ND	ND	0.0034	ND	ND	ND
LGB-92	ND	0.00059	ND	ND	ND	0.0045	ND	ND	0.015
LGB-93	**0.34**	ND	**1.5**	ND	ND	ND	ND	ND	ND
LGB-94	**0.77**	ND	**1.5**	ND	ND	ND	ND	ND	ND
LGB-95	ND	ND	**0.19**	ND	ND	ND	ND	ND	ND

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silver (mg/L)	Thallium (mg/L)	Zinc (mg/L)
LGB-96	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-97	**0.44**	ND	**1.8**	ND	ND	ND	ND	ND	ND
LGB-98	ND	0.00062	ND	ND	ND	0.0035	ND	ND	ND
LGB-99	ND	ND	ND	ND	ND	0.0120	ND	ND	ND
LGB-100	ND	ND	**0.090**	ND	ND	0.0014	ND	ND	ND
LGB-101	ND	ND	ND	ND	ND	0.0230	0.00061	ND	ND
LGB-102	ND	ND	ND	ND	ND	0.0013	ND	ND	ND
LGB-103	ND	ND	ND	ND	ND	0.0032	ND	ND	ND
LGB-104	ND	ND	ND	ND	ND	0.0019	ND	ND	0.062
LGB-105	ND	ND	ND	ND	ND	0.0011	ND	ND	ND
LGB-106	ND	ND	ND	ND	ND	0.0010	ND	ND	ND
LGB-107/108	ND	ND	ND	ND	ND	0.0011	ND	ND	0.0315
LGB-109	ND	ND	ND	ND	ND	0.0015	ND	ND	0.020
LGB-110	0.12	ND	ND	ND	ND	0.0015	ND	ND	ND
LGB-111	ND	ND	ND	ND	ND	0.0013	ND	ND	ND
LGB-112	ND	ND	ND	ND	ND	ND	0.00024	ND	ND
LGB-113	ND	ND	ND	ND	ND	0.0086	ND	ND	ND
LGB-114	ND	ND	**0.73**	ND	ND	0.0096	ND	ND	ND
LGB-115	ND	ND	**0.043**	ND	ND	0.0082	ND	ND	0.740
LGB-116	ND	ND	ND	ND	ND	0.90	ND	ND	0.041
LGB-117	ND	ND	ND	ND	ND	ND	ND	ND	0.120
LGB-118	ND	ND	ND	ND	ND	ND	ND	ND	ND
LGB-119	ND	ND	ND	ND	ND	0.0038	ND	ND	0.300
LGB-120	ND	0.00099	ND	ND	ND	0.00068	ND	ND	0.310

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	**Radon-222** (pCi/L)	**Alpha** (pCi/L)	**Beta** (pCi/L)	**Ra-226 + Ra-228** (pCi/L)	**Uranium** (µg/L)	**Uranium** (piC/L)	**$*^{18}$ O** ($^{0}/_{00}$)	**$*$ D** ($^{0}/_{00}$)	**Type of Chemistry**
LGB-1/2	-	3.7	-	< 0.4	2.6		-8.7	-64	sodium-chloride
LGB-3	98	-	-	-	-		-9.7	-65	sodium-chloride
LGB-4	-	< 1	ND	< 0.4	2.3		-7.5	-49	mixed-bicarbonate
LGB-5/6	**591**	< 1	13.8	< 0.4	ND		-7.25	-50.5	sodium-bicarbonate
LGB-7	250	-	-	-	-		-7.5	-52	sodium-bicarbonate
LGB-8	276	-	-	-	-		-8.0	-56	sodium-bicarbonate
LGB-9	252	-	-	-	-		-7.3	-51	sodium-mixed
LGB-10	230	-	-	-	-		-7.2	-52	mixed-bicarbonate
LGB-12	226	-	-	-	-		-7.9	-61	sodium-sulfate
LGB-13	-	-	-	-	-		-8.7	-64	sodium-chloride
LGB-14	ND	-	-	-	-		-8.3	-63	sodium-chloride
LGB-15/16	**789**	-	-	-	-	-	-8.75	-65	sodium-chloride
LGB-17	**370**	-	-	-	-		-8.4	-64	sodium-chloride
LGB-18	-	1.1	-	-	2.3		-8.3	-64	sodium-chloride
LGB-19	-	-	-	-	-		-8.3	-64	sodium-chloride
LGB-20	277	ND	-	-	6.6		-8.2	-61	sodium-chloride
LGB-21	-	-	-	-	-		-7.4	-53	calcium-bicarbonate
LGB-22	**472**	0.4	-	-	-	6.8	-11.3	-95	sodium-mixed
LGB-23	-	-	-	-	-	-	-9.6	-81	sodium-chloride
LGB-24	**327**	-	-	-	-	-	-10.9	-91	sodium-mixed
LGB-25/26	-	-	-	-	-	-	-11.0	-92	mixed-mixed
LGB-27	-	-	-	-	-	-	-11.0	-91	sodium-mixed
LGB-28	214	ND	-	-	-	17.1	-11.0	-91	mixed-sulfate
LGB-29	-	-	-	-	-	-	-10.7	-87	sodium-mixed
LGB-30	-	-	-	-	-	-	-10.2	-83	sodium-chloride
LGB-31/32	294	2.2	-	-	-	8.1	-10.6	-88	sodium-chloride
LGB-33	ND	0.9	-	-	-	0.8	-8.0	-59	sodium-chloride
LGB-34	**740**	1.8	-	-	-	1.4	-9.1	-67	sodium-chloride

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Radon-222 (pCi/L)	Alpha (pCi/L)	Beta (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (µg/L)	Uranium (piC/L)	$\ast^{18}$ O ($^{0}/_{00}$)	$\ast$ D ($^{0}/_{00}$)	Type of Chemistry
LGB-35	-	-	-	-	-	-	-10.9	-91	sodium-mixed
LGB-36	-	-	-	-	-	-	-10.4	-88	sodium-mixed
LGB-37	-	-	-	-	-	-	-10.6	-87	sodium-chloride
LGB-38	72.9	< 1.0	-	-	2.5	2.6	-8.7	-65	sodium-chloride
LGB-39	-	-	-	-	-	-	-11.1	-93	sodium-mixed
LGB-40	28.7	1.1	-	-	< 0.4	< 0.8	-8.1	-65	sodium-chloride
LGB-42	66.6	< 1.0	-	-	7.3	6.6	-8.5	-64	sodium-chloride
LGB-43	-	-	-	-	-	-	-11.2	-93	sodium-mixed
LGB-44	164.2	1.1	-	-	0.7	1.0	-7.9	-62	sodium-chloride
LGB-45	-	-	-	-	-	-	-8.0	-63	sodium-chloride
LGB-46	-	-	-	-	-	-	-10.7	-90	sodium-mixed
LGB-47/48	-	-	-	-	-	-	-10.2	-79	sodium-sulfate
LGB-49	-	-	-	-	-	-	-10.8	-90	sodium-sulfate
LGB-50	-	0.7	-	-	2.9	3.4	-8.2	-61	sodium-mixed
LGB-51	**809**	ND	-	-	1.6	1.7	-8.8	-67	sodium-chloride
LGB-52	-	2.5	-	-	13.6	14.4	-8.3	-65	sodium-chloride
LGB-53	-	-	-	-	-	-	-7.8	-59	sodium-chloride
LGB-54	-	-	-	-	-	-	-9.6	-80	sodium-chloride
LGB-55	-	-	-	-	-	-	-8.3	-64	sodium-chloride
LGB-56	-	-	-	-	-	-	-8.2	-63	sodium-chloride
LGB-57	-	-	-	-	-	-	-8.1	-61	sodium-mixed
LGB-58	**670**	ND	-	-	4.2	3.2	-8.5	65.1	sodium-chloride
LGB-59	278	ND	-	-	2.0	2.4	-8.4	64.4	sodium-chloride
LGB-60	-	-	-	-	-	-	-8.6	-63.5	mixed-chloride
LGB-61	202	0.5	-	-	ND	ND	-8.7	-63.1	sodium-chloride
LGB-62	-	-	-	-	-	-	-8.5	-62.9	sodium-chloride
LGB-63	-	-	-	-	-	-	-8.2	-61.4	sodium-chloride
LGB-64	**319**	-	-	-	-	-	-8.7	-64.6	sodium-chloride

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Radon-222 (pCi/L)	Alpha (pCi/L)	Beta (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (µg/L)	Uranium (piC/L)	$*^{18}$ O ($^0/_{00}$)	$*$ D ($^0/_{00}$)	Type of Chemistry
LGB-65	-	-	-	-	-	-	-8.5	-65.1	sodium-chloride
LGB-66	50	ND	-	-	ND	ND	-8.6	-64.4	sodium-chloride
LGB-67	-	-	-	-	-	-	-7.7	-60.8	sodium-chloride
LGB-68	-	-	-	-	-	-	-7.0	-58.2	sodium-chloride
LGB-69	-	-	-	-	-	-	-8.7	-64.4	sodium-chloride
LGB-70	-	-	-	-	-	-	-7.9	-61.4	sodium-chloride
LGB-71	**538**	-	-	-	-	-	-8.6	-66.9	sodium-chloride
LGB-72	-	-	-	-	-	-	-8.2	-61.4	sodium-chloride
LGB-73	ND	-	-	-	-	-	-10.1	-83.4	mixed-mixed
LGB-74/75	**897**	1.9	-	-	1.4	0.6	-8.2	-61.3	sodium-mixed
LGB-76	-	1.2	-	-	6.6	6.1	-10.5	-87.3	sodium-mixed
LGB-77	**660**	ND	-	-	1.9	1.4	-8.2	-60.2	sodium-mixed
LGB-78	**483**	ND	-	-	4.1	2.9	-8.2	-60.2	sodium-mixed
LGB-79	245	ND	-	-	4.7	3.9	-8.0	-59.1	sodium-mixed
LGB-80/81	**809**	-	-	-	-	-	-8.0	-59.8	sodium-chloride
LGB-82	-	-	-	-	-	-	-8.3	-60.6	sodium-mixed
LGB-83	147	-	-	-	-	-	-8.0	-60.0	sodium-chloride
LGB-84	-	-	-	-	-	-	-7.9	-60.0	sodium-chloride
LGB-85	**686**	1.4	-	-	8.8	6.5	-8.5	-62.3	sodium-chloride
LGB-87	-	-	-	-	-	-	-11.4	-94.1	sodium-mixed
LGB-88	-	0.4	-	-	5.1	6.2	-9.0	-65.6	sodium-chloride
LGB-89	-	-	-	-	-	-	-11.0	-89.5	sodium-mixed
LGB-90	-	-	-	-	-	-	-12.1	-98.4	mixed-mixed
LGB-91	-	-	-	-	-	-	-7.4	-62.5	sodium-chloride
LGB-92	-	-	-	-	-	-	-7.9	-63.1	sodium-chloride
LGB-93	-	-	-	-	-	-	-10.9	-91.1	sodium-sulfate
LGB-94	-	-	-	-	-	-	-10.8	-92.2	sodium-sulfate
LGB-95	-	<1.0	-	-	9.1	9.9	-11.7	-95.6	sodium-mixed

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Appendix B. Groundwater Quality Data, Lower Gila Basin, 2013-2017--Continued

Site #	Radon-222 (pCi/L)	Alpha (pCi/L)	Beta (pCi/L)	Ra-226 + Ra-228 (pCi/L)	Uranium (µg/L)	Uranium (piC/L)	$*^{18}$ O ($^{0}/_{00}$)	$*$ D ($^{0}/_{00}$)	Type of Chemistry
LGB-96	255.6	-	-	-	-	-	-12.1	-97.6	mixed-sulfate
LGB-97	**362.1**	<1.0	-	-	3.8	5.0	-10.6	-86.9	sodium-chloride
LGB-98	**361.5**	<1.0	-	-	11.4	15.7	-8.5	-62.2	sodium-sulfate
LGB-99	-	-	-	-	-	-	-8.7	-71.3	sodium-chloride
LGB-100	**487.2**	-	-	-	-	-	-10.4	-82.2	sodium-mixed
LGB-101	-	-	-	-	-	-	-8.5	-64.7	sodium-chloride
LGB-102	**1496.5**	-	-	-	-	-	-8.8	-64.0	sodium-chloride
LGB-103	46.5	<0.4	-	ND	<0.4	<0.8	-8.6	-63.6	sodium-sulfate
LGB-104	**638.8**	0.2	-	ND	4.0	5.7	-8.0	-57.4	sodium-chloride
LGB-105	**316.2**	<1.0	-	ND	2.2	2.4	-8.1	-58.3	sodium-chloride
LGB-106	-	-	-	-	-	-	-8.4	-61.4	sodium-chloride
LGB-107/108	**498.8**	0.4	-	ND	1.1	14	-8.6	-61.6	sodium-chloride
LGB-109	-	-	-	-	-	-	-8.2	-61.1	sodium-chloride
LGB-110	-	-	-	-	-	-	-11.9	-98.3	mixed-mixed
LGB-111	-	-	-	-	-	-	-8.8	-63.3	sodium-chloride
LGB-112	180	2.7	-	-	<0.8	<0.4	36.7	-54.4	sodium-mixed
LGB-113	**658**	0.7	-	-	<0.8	<0.4	-8.8	-63.2	sodium-chloride
LGB-114	-	-	-	-	-	-	-8.7	-63.4	sodium-chloride
LGB-115	**2862**	-	-	-	-	-	-8.0	-58.2	sodium-chloride
LGB-116	-	ND	-	-	7.4	7.5	-7.3	-50.1	sodium-bicarbonate
LGB-117	46	-	-	-	-	-	-7.1	-50.4	sodium-bicarbonate
LGB-118	-	-	-	-	-	-	-6.9	-48.2	mixed-bicarbonate
LGB-119	366	0.4	-	-	9.7	12.9	-7.2	-48.8	mixed-mixed
LGB-120	34	0.9	-	-	12.2	10.4	-6.6	-48.9	sodium-bicarbonate

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