ADEQ
Arizona Department of Environmental Quality
Janice K. Brewer, Governor
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FACT SHEET

Ambient Groundwater Quality of the San Bernardino Valley Basin: A 2002 Baseline Study – October 2011

INTRODUCTION

A baseline groundwater quality study of the San Bernardino Valley basin was conducted in 2002 by the Arizona Department of Environmental Quality (ADEQ) Ambient Groundwater Monitoring Program. ADEQ conducted this monitoring pursuant to Arizona Revised Statutes §49-225 that mandates ongoing monitoring of waters of the state including aquifers. The fact sheet is a synopsis of the ADEQ Open File Report 10-03.[1]

The San Bernardino Valley groundwater basin includes approximately 387 square miles in the extreme south-eastern corner of Arizona within Cochise County (Map 1).[2] The basin has both interstate and international aquifer components, extending 35 square miles to the east in New Mexico, and about 400 square miles to the south in Sonora, Mexico.[3]

The U.S. portion of the basin is bounded on the south by the international border with Mexico, on the east by the southern Peloncillo Mountains, and on the west by the Perilla and Pedregosa mountains.[2] The northern boundary is an indistinct watershed divide with the San Simon sub-basin.[4] To the northwest, located just outside the basin, are the high elevation Chiricahua Mountains.

The sparsely populated basin consists of State Trust lands interspersed with scattered tracts of private, Bureau of Land Management, and Forest Service land. Ranching is the primary economic activity.[2] Black Draw is the main drainage in the basin and is ephemeral except near the international border where springs and artesian wells supply ponds that provide habitat for endangered native fish at the San Bernardino National Wildlife Refuge (Figure 1).[3]

Figure 1. The San Bernardino National Wildlife Refuge is located where Black Draw, the main drainage in the basin, intersects the border with Mexico. Springs and artesian wells within the refuge supply water to ponds that provide habitat for several species of threatened and endangered fish. The photo is oriented to the east towards the Pelloncillo Mountains.

GROUNDWATER CHARACTERISTICS

Most groundwater in the basin is obtained from thin layers of sand and gravel interbedded with basalt flows.[3] Although interbedded basalt flows have the potential of creating a confined aquifer, the basin-fill is likely inter-connected enough so that it results in a single, unconfined aquifer system. The only artesian conditions known to occur are where a lacustrine clay layer produces confined conditions within the San Bernardino National Wildlife Refuge (Figure 2). A shallow, unconfined aquifer is present above the confining layer at the refuge.[4] Minor amounts of groundwater also occur in the surrounding mountains within zones of fractured or weathered volcanic rocks and in thin layers of valley-fill alluvium overlying the bedrock.[2]

Groundwater flow is generally from the mountains toward the center of the valley and then south toward Mexico.[4] The annual transboundary discharge is estimated at 5,545 acre-feet.[2] Groundwater depths increase from less than 200 feet near the international border to more than 600 feet along the northern boundary with the San Simon sub-basin.[2]

Groundwater has remained essentially at a pre-development state since there have been few significant attempts to extract aquifer resources in the basin. Approximately 100 acre-feet is pumped annually and used for domestic and stock use (Figure 3).[2] Limited well data suggests that substantial supplies of economically recoverable groundwater are not present in the basin.[3]

METHODS OF INVESTIGATION

To characterize regional groundwater quality in the San Bernardino Valley, samples were collected from 14 sites consisting of domestic and stock wells located

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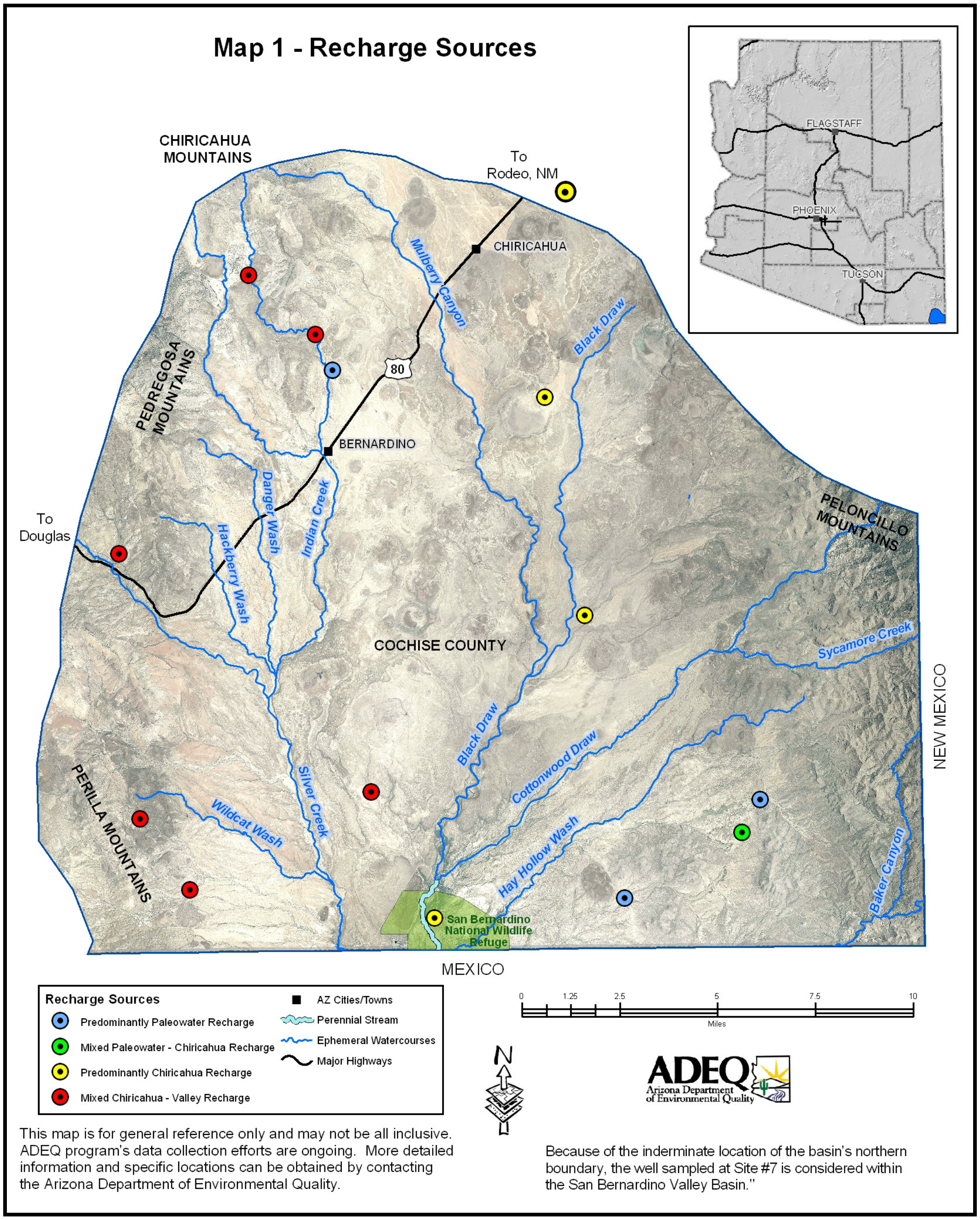

Map 1. Sample sites in the San Bernardino Valley basin are color-coded according to their recharge source.

throughout the basin. Inorganic constituents and oxygen and deuterium isotopes were collected at all 14 sites. Radon samples were collected at 13 sites.

Sampling protocol followed the *ADEQ Quality Assurance Project Plan* (www.azdeq.gov/function/programs/lab/). The effects of sampling equipment and procedures were not found to be significant based on seven quality assurance/quality control tests.[5] There were however, two exceptions. An extreme outlier for nitrite as nitrogen (10 mg/L) collected at SBV-3 was judged due to lab error and not included in the results of the study and several non-detections of radon were likely indicative of using incorrect techniques that allowed off-gassing of the sample.

WATER QUALITY SAMPLING RESULTS

Groundwater sample results were compared with the Safe Drinking Water Act (SDWA) water quality standards. Public drinking water systems must meet these enforceable, health-based, water quality standards, called Primary Maximum Contaminant Levels (MCLs), when supplying water to their customers. Primary MCLs are based on a daily lifetime (70 years) consumption of two liters of water.[6] Of the 14 sites sampled, all had constituent concentrations that met Primary MCLs.

Groundwater sample results were also compared with SDWA water quality guidelines. Public drinking water systems are encouraged to meet these unenforceable, aesthetics-based water quality guidelines, called Secondary MCLs, when supplying water to their customers. Water exceeding Secondary MCLs may be unpleasant to drink and/or create unwanted cosmetic or laundry effects but is not considered a health concern.[6] Of the 14 sites sampled, seven (50 percent) had constituent concentrations that exceeded Secondary MCLs. Constituents above Secondary MCLs included fluoride (two sites), iron (two sites), pH (three sites), and TDS (four sites).

Radon is a naturally occurring, intermediate breakdown product from the radioactive decay of uranium-238 to lead-206. Of the 13 sites sampled for radon, none exceeded the proposed 4,000 picocuries per liter (pCi/L) standard that would apply if Arizona establishes a multimedia program to address the health risks from radon in indoor air. Six sites exceeded the proposed 300 pCi/L standard that would apply if Arizona doesn't develop a multimedia program.[6]

Figure 2. Artesian flow from the stand pipe at Oasis Well discharges into a pond located within the San Bernardino National Wildlife Refuge. A lacustrine clay layer produces confined conditions which result in the flowing well.

GROUNDWATER CHEMICAL COMPOSITION

Groundwater in the San Bernardino Valley basin was predominantly of calcium-mixed-sodium-bicarbonate chemistry. Levels of pH measured in the field were *slightly alkaline* (above 7 su) at 12 sites, *slightly acidic* (below 7 su) at two sites. TDS concentrations were considered *fresh* (below 1,000 mg/L) at 13 sites and *slightly saline* (1,000 – 3,000 mg/L) at one site. Hardness concentrations were *soft* (below 75 mg/L) at two sites, *moderately hard* (75 – 150 mg/L) at six sites, *hard* (150 – 300 mg/L) at three sites, and *very hard* (above 300 mg/L) at three sites.

Nitrate concentrations were divided into natural background (one site at <0.2 mg/L), may or may not indicate human influence (10 sites at 0.2 – 3.0 mg/L), may result from human activities (three sites at 3.0 – 10 mg/L), and probably result from human activities (zero sites >10mg/L).[5]

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

Oxygen and deuterium isotope values of samples were lighter, less evaporated, and more depleted than would be expected from recharge originating at the basin's low elevations (Figure 4). Most sample sites appear to consist of recharge originating high in the Chiricahua Mountains which indicates that the basin's northern boundary likely does not serve as a groundwater demarcation.[4, 7] Some shallow wells had slightly heavier, more evaporated and enriched isotope values that indicate a limited amount of recharge occurs locally from low elevation mountains or from alluvial channels in the San Bernardino Valley.[4] Samples from some deep wells have isotope values so depleted that they likely consist of paleowater predominantly recharged during the Pleistocene around 8,000 to 12,000 years ago when the basin was cooler and subject to much less evaporation.[4]

GROUNDWATER PATTERNS

Statistically significant groundwater quality patterns were found between recharge sources. Wells pumping paleowater and Chiricahua Mountain recharge were significantly deeper than wells pumping water that included low elevation recharge (Figure 5). With most constituents however, concentrations were highest in the paleowater and lowest in the Chiricahua Mountain recharge though only TDS (Figure 6), specific conductivity, sodium and fluoride concentrations were significantly different (Kruskal-Wallis with Tukey test, $p \leq 0.05$).

SUMMARY AND CONCLUSIONS

Interpretation of the analytical results of the 14 samples indicates that groundwater in the San Bernardino Valley basin wholly meets drinking water standards and is suitable for domestic, stock, municipal, and irrigation purposes.[6] The few aesthetic groundwater quality exceedances appear to be of minor importance and probably the result of natural chemical reactions.[8]

Groundwater quality patterns found in the basin are linked to different recharge sources. The depleted isotope values of samples suggest that much of the groundwater produced by wells in the San Bernardino Valley was recharged outside the basin in the Chiricahua Mountains in the San Simon sub-basin or was recharged many years ago when the basin was cooler and subject to much less evaporation.

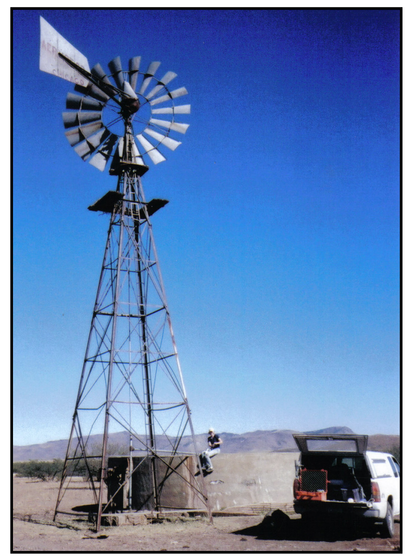

Figure 3. ADEQ's Elizabeth Boettcher collects a sample from a windmill near the Peloncillo Mountains. Windmills are a popular method of obtaining groundwater for both stock and domestic use in the basin since much of the land is remote and far from electrical power lines. Submersible pumps powered by solar energy or generators are increasingly being utilized in the basin.

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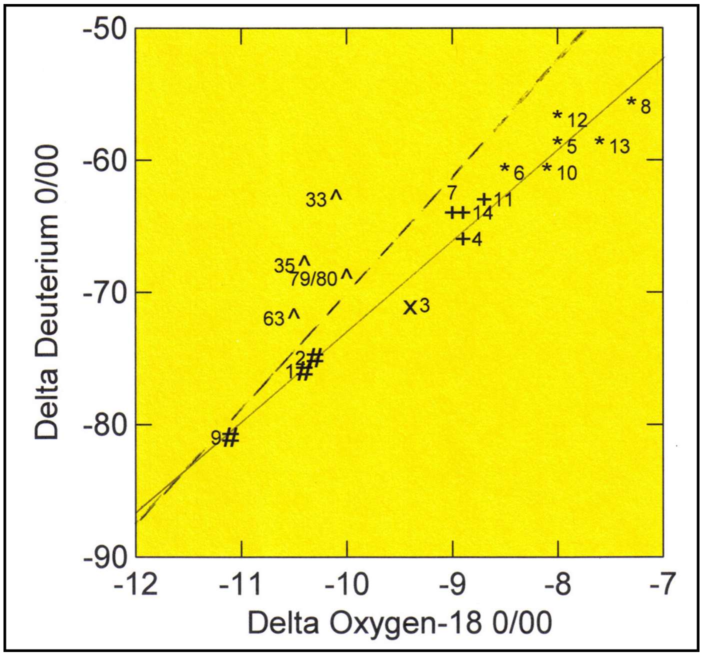

Figure 4. Water samples from wells in the San Bernardino Valley basin are plotted according to their oxygen and hydrogen isotope values.The lowest points along the Local Meteoric Water Line (LMWL shown by the unbroken line) have the lightest signatures and have undergone the least evaporation prior to sampling; the highest points have the heaviest signatures and have undergone the most evaporation prior to sampling.

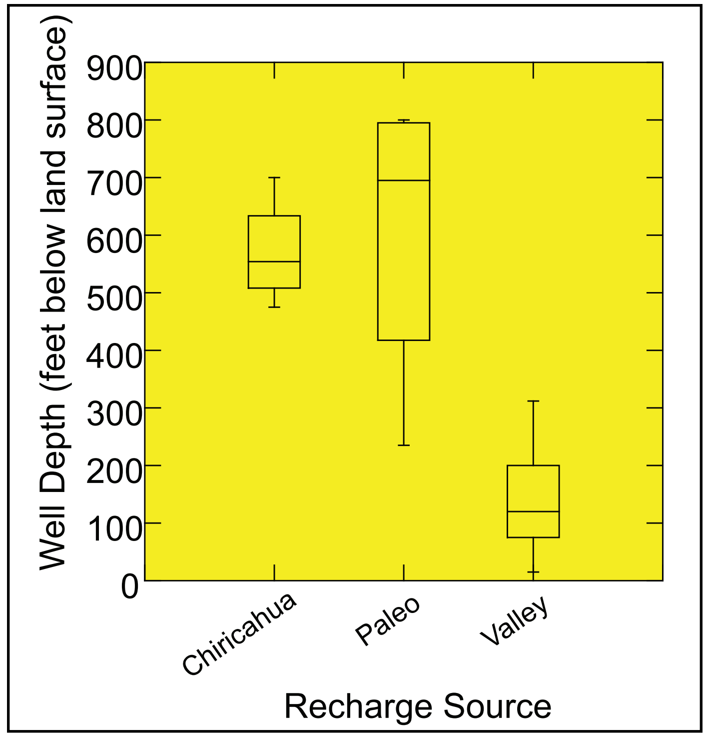

Figure 5. Isotope samples thought to be a combination of local, low-elevation and Chiricahua Mountain precipitation were collected from wells significantly shallower than those wells whose isotope samples were thought to be recharge from either Chiricahua Mountain precipitation alone or paleowater (Kruskal-Wallis with Tukey test, $p \leq 0.05$).

Web site:
azdeq.gov/environ/water/assessment/ambient.html#studies

Maps by Jean Ann Rodine

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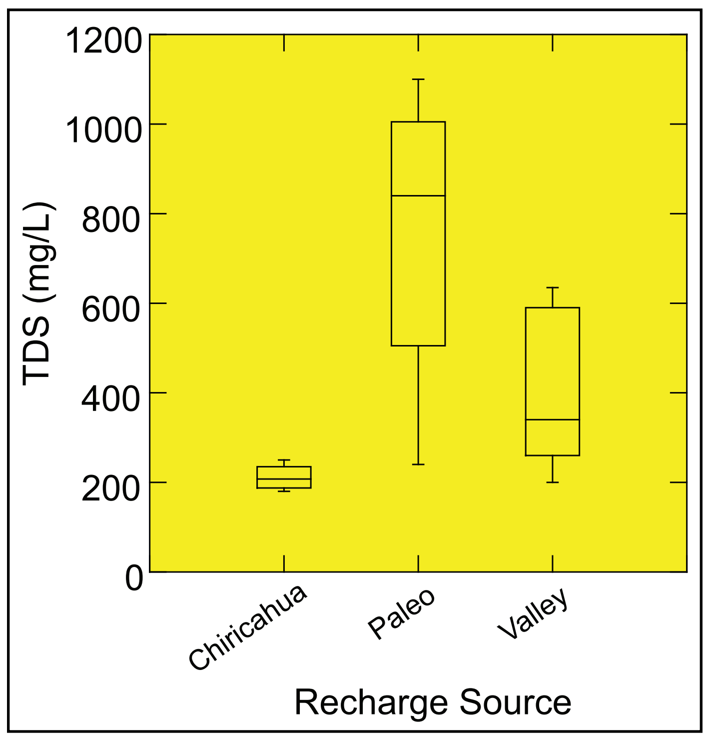

Figure 6. TDS concentrations of samples collected from wells pumping recharge from the Chiricahua Mountains were significantly lower than samples from wells pumping ancient paleowater. Wells pumping water thought to be a combination of recharge from the Chiricahua Mountains and local Valley recharge had TDS concentrations that were not significantly different from the other two groups (Kruskal-Wallis with Tukey test, $p \leq 0.05$).