ADEQ
Arizona Department of Environmental Quality

FACT SHEET

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Ambient Groundwater Quality of the Tiger Wash Basin: A 2014 Baseline Study – October 2014

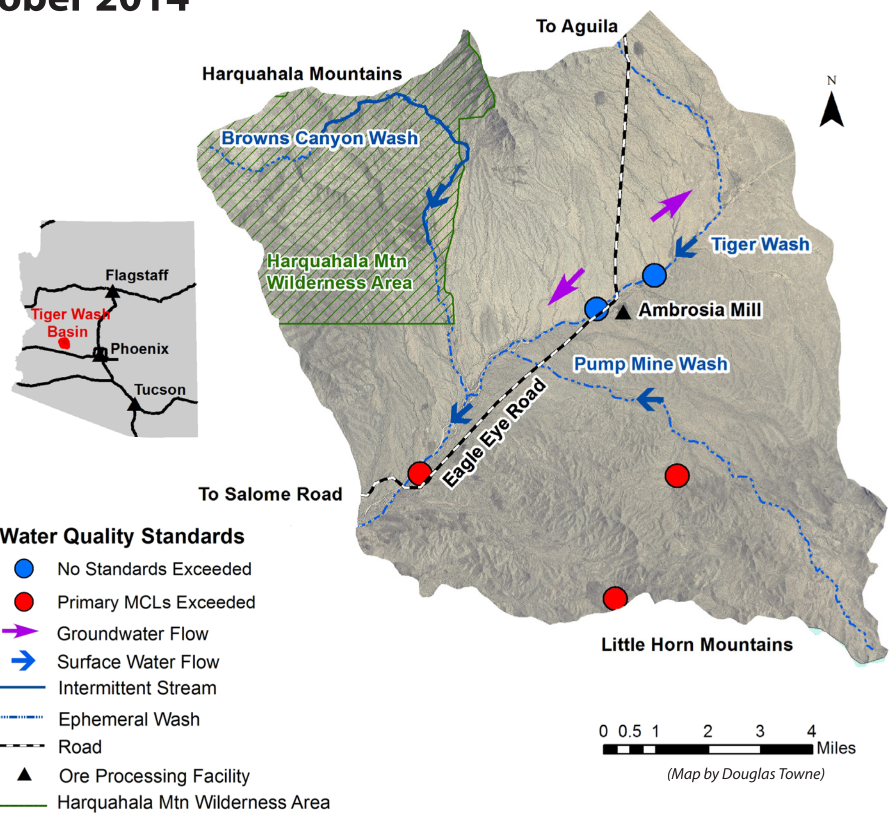
Introduction

A baseline groundwater quality study of the Tiger Wash basin located 75 miles northwest of Phoenix was conducted in 2014 by the Arizona Department of Environmental Quality (ADEQ) Ambient Groundwater Monitoring Program. ADEQ carried out this task pursuant to Arizona Revised Statutes §49-225 that mandates monitoring of waters of the state, including its aquifers. The fact sheet is a synopsis of the ADEQ Open File Report 14-07.[1]

The small, remote basin comprises 74 square miles within Maricopa County and consists of a narrow valley bordered by rugged mountain ranges.[2] Low-intensity livestock grazing and recreation are the predominant land uses. Within the basin, there are also small inactive mines and the Ambrosia Mill, which briefly processed manganese ore in the early 1960s.[2] Land ownership consists of federal lands (97.4 percent) managed by the Bureau of Land Management (BLM), State Trust lands (2.3 percent) and private land (0.3 percent).[2] There are no incorporated communities within the basin, which had a population of less than 10 people in 2000.[2]

Hydrology

The basin is bounded on the north by the Harquahala Mountains and the Little Horn Mountains on the south. The small, shallow, alluvium-filled basin is drained by Tiger Wash which is a tributary of Centennial Wash. Tiger Wash heads in the northwest portion of the basin and flows south and west until exiting into the Harquahala basin shortly after crossing Eagle Eye Road.[3] All washes in the basin are ephemeral and flow only after heavy precipitation except for an intermittent portion of Browns Canyon Wash within the Harquahala Mountains.[2]



Map 1 – Sample sites in the Tiger Wash basin are color-coded according to their water quality status. Based on these water quality results, much of the groundwater in the basin should be treated for arsenic before being used for drinking water purposes.

Figure 1 – The basin is drained by Tiger Wash, an ephemeral waterway that flows only in response to major precipitation events. The wash is shown crossing Eagle Eye Road.

The main aquifer in the Tiger Wash basin is basin-fill alluvium that is composed of heterogeneous deposits of clay, silt, sand, and gravel that are less than 1,000 feet thick.[2] Groundwater flow is to the northeast and southwest away from the center of the basin.[2] The basin contains an estimated 700,000 to 2 million acre-feet of water to a depth of 1,200 feet below land surface. Natural recharge is estimated to be less than 1,000 acre-feet per year.[2] Groundwater is used for stock and domestic purposes and only a few low-yield wells exist in the basin.

Methods of Investigation

To characterize regional groundwater quality, samples were collected from five stock wells, one of which was also used for domestic purposes. Based on field reconnaissance, all known wells in the basin were sampled for the study. Samples for inorganic constituents and oxygen, deuterium, and nitrogen isotopes were collected from each well. Other samples collected include radon (three wells) and radionuclide (two wells). Sampling protocol followed the ADEQ Quality Assurance Project Plan (*see www.azdeq.gov/function/programs/lab/*). The effects of sampling equipment and procedures were not significant based on quality assurance/quality control evaluations.

Water Quality Sampling Results

Groundwater sample results were compared with the Safe Drinking Water Act (SDWA) health and aesthetics-based water quality standards.[4] Of the five wells sampled, only two sites met all drinking water quality standards.

Public drinking water systems must meet health-based, water quality standards, called Primary Maximum Contaminant Levels (MCLs), when supplying water to their customers. These enforceable standards are based on a lifetime (70 years) consumption of two liters per day.[4] Primary MCLs were exceeded at three of the five wells (60 percent).

Figure 2 – Tiger well is photographed from the associated corral with the Harquahala Mountains in the background. The sample collected from the windmill met all water quality standards except for arsenic.

Arsenic was the constituent exceeding Primary MCLs at each of the three wells.

Public drinking water systems are encouraged by the SDWA to meet 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 are not considered health concerns.[4] Secondary MCLs were not exceeded at any well.

Radon is a naturally occurring, intermediate breakdown product from the radioactive decay of uranium-238 to lead-206. Of the three 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.[5] Two sites (66 percent) exceeded the proposed 300 pCi/L standard that would apply if Arizona does not develop a multimedia program.[5]

Figure 3 – Little Horn windmill, named after a nearby rock outcrop, was one of five wells sampled for the Tiger Wash basin study. The small, remote basin located west of Phoenix in the Lower Sonoran desert is used almost exclusively for livestock grazing and recreation.

Table 1. Groundwater characteristics of Tiger Wash basin samples

pH-field	
Slightly Alkaline (> 7 su)	5
Moderately Alkaline (>8 su)	0
TDS	
Fresh (below 999 mg/L)	5
Slightly Saline (1,000 - 3,000 mg/L)	0
Hardness	
Soft (< 75 mg/L)	0
Moderately Hard (76-150 mg/L)	1
Hard (151-300 mg/L)	4
Very Hard (301-600 mg/L)	0
Extremely Hard (> 600 mg/L)	0
Nitrate[7]	
Natural Background (< 0.2 mg/L)	0
May or May Not be from Human Influence (0.2 – 3.0 mg/L)	2
May Result from Human Influence (3.0 – 10 mg/L)	3
Probably Results from Human Influence (> 10 mg/L)	0
Trace Elements	
Detected at less than 40 percent of sites	aluminum, antimony, beryllium, boron, cadmium, chromium, iron, lead, manganese, mercury, nickel, selenium, silver, and thallium
Detected at more than 40 percent of sites	arsenic, barium, copper, fluoride, strontium, and zinc

Groundwater Composition

Groundwater chemistry in the basin is a combination of calcium/magnesium/mixed-bicarbonate (Figure 5). Other groundwater characteristics are summarized in Table 1.

Oxygen and deuterium isotopes values were characteristic of younger, enriched water that had experienced considerable evaporation. This conclusion is supported by their calcium-bicarbonate chemistry, which is also characteristic of recently recharged groundwater.[8] Although younger, enriched isotope groundwater samples have been collected in a small subset of wells in the nearby Bill Williams, Butler Valley, McMullen Valley, and Ranegras Plain basins, most isotope samples collected in the west-central Arizona basins are lighter and more depleted than would be expected from recharge occurring at elevations in this region. This suggests that much of the groundwater in this region was recharged long ago (8,000 to 12,000 years) during cooler climatic conditions although limited areas, including Tiger Wash basin, consist of more recent recharge.[9]

Nitrogen isotope ($\delta^{15}N$) samples indicate that the nitrogen source in groundwater is natural soil organic matter for three samples in which $\delta^{15}N$ values ranged from +3.6 to +3.9 0/00.[10] In two samples with $\delta^{15}N$ values of 11.9 and 17.5 0/00, it appears that animal waste is the predominant contributor of nitrogen.

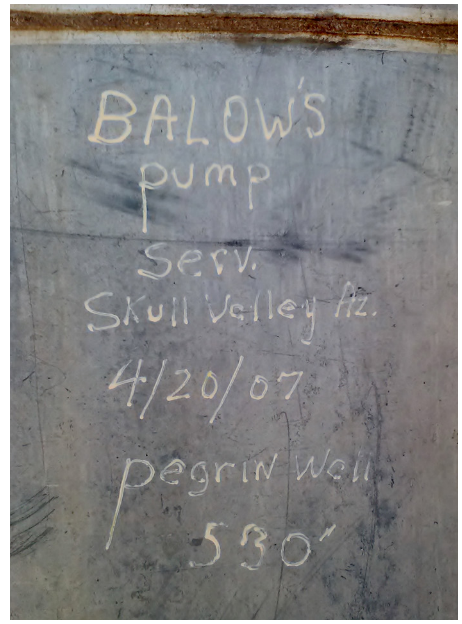


Figure 4 – The "graffiti" on Pegrin well's adjacent water tank is actually valuable hydrologic notes left by Balow Pump when the company serviced the well.

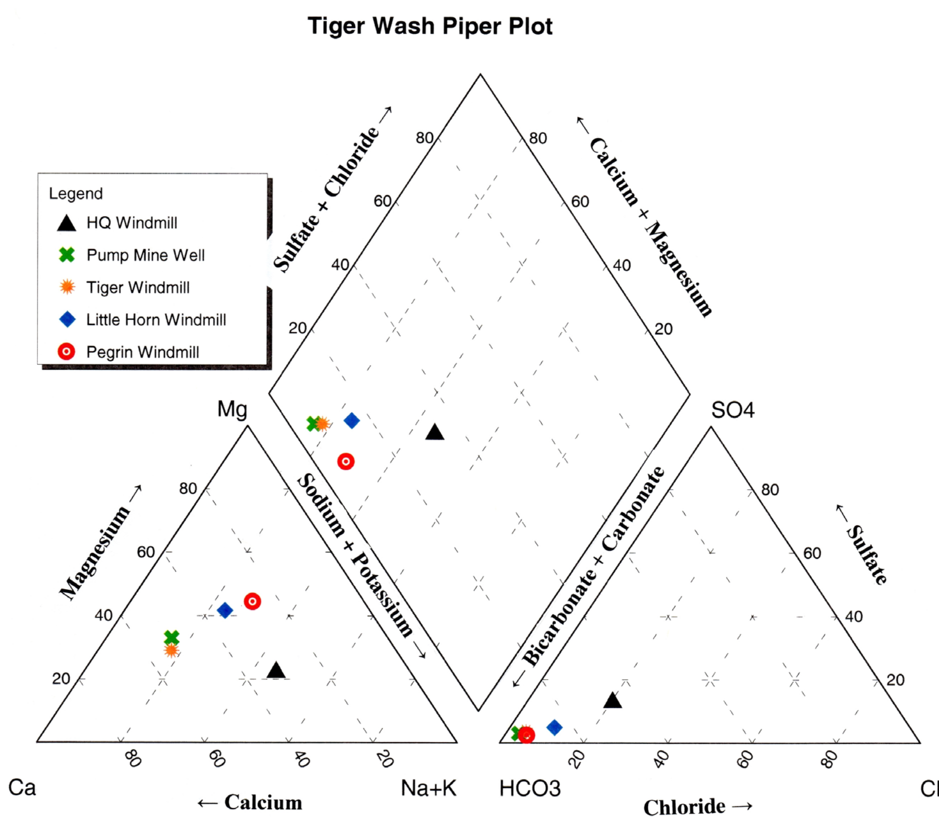


Figure 5 – Samples collected in the Tiger Wash basin are of calcium/magnesium-bicarbonate chemistry, which is reflective of recently recharged groundwater.[8]

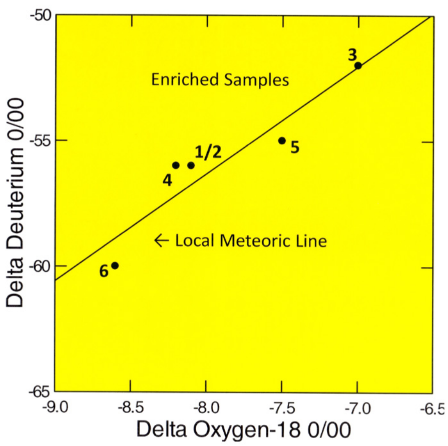


Figure 6 – The five isotope samples are plotted according to their oxygen-18 and deuterium values and form the Local Meteoric Water Line. The samples all consist of enriched samples that contain younger water recharged from lower-elevation precipitation that has undergone the most evaporation prior to sampling.

Discussion

Groundwater in the Tiger Wash basin is generally of good quality with the exception of arsenic concentrations. Of the five sites sampled, three had arsenic concentrations that exceeded health-based, Primary MCLs. Otherwise, all health and aesthetic drinking water quality standards were met at all five sites.

Arsenic is the constituent that most commonly exceeds health-based water quality standards in Arizona. Of 1,477 groundwater sample sites across the state, 19 percent exceeded the 0.01 mg/L standard.[11] Arsenic concentrations are likely naturally occurring, affected by reactions with hydroxyl ions and influenced by factors such as an oxidizing environment, lithology, and aquifer residence time.[8] Oxygen and hydrogen isotope values suggest that groundwater in the basin is younger, enriched water that has experienced considerable evaporation, so aquifer residence time does not appear to be a major factor.[9]

Nearby basins such as Bill Williams, Butler Valley, Harquahala, and Ranegras Plain have limited groundwater sites that consist of younger, enriched water. For the most part, enriched samples from these sites do not have elevated concentrations of arsenic. This suggests that local lithology at the three Tiger Wash sites which include granitic, volcanic, and alluvial geology are a major factor in creating elevated arsenic concentrations.

Limited time trend analysis involving two wells had inconclusive results. Historic sampling results from Tiger well (TIG-4) suggested generally steady constituent concentrations including arsenic levels which exceed the Primary MCL. Previous sample results from Headquarters well (TIG-3), however, indicated decreasing concentrations of many constituents. Emblematic are nitrate concentrations which were measured at 16 mg/L in 1984 and declined below the 10.0 Primary MCL to 5.9 mg/L by 2014. Possible explanations for decreasing constituent concentrations at Headquarters well include less input from onsite septic systems.

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