Figure 5 - *ADEQ's Elizabeth Boettcher samples a 600-foot deep well that supplies municipal water for Meadview. The water produced by this well met all health and aesthetic-based water quality standards.*

Department of Water Resources (ADWR) study which found acceptable groundwater quality.[4] The ADWR study did not collect radiochemistry samples, however. Radiochemistry concentrations appear to be the major limitation to using groundwater for domestic use as health-based water quality standards were exceeded in or near the granitic area in the southern part of the basin. Both radiochemistry exceedances came from the northern flanks of the Garnet Mountains within or near an occurrence of granite, which is frequently associated with elevated radiochemistry concentrations in groundwater.[2] Because of these results, ADEQ strongly recommends that any domestic water sources in this area be tested for radiochemistry constituents.

Aesthetics-based water quality standards were exceeded at three of the four sites for fluoride and at one site for TDS. The elevated fluoride concentrations may also be influenced by the area's granite. Fluoride concentrations in groundwater associated with granite rock have been found to be at least twice the concentration of those measured in other rock types.[9] Similarly elevated fluoride concentrations were found along the predominantly granitic west flank of the Hualapai Mountains in the nearby Sacramento Valley basin.[6]

Groundwater collected from sites in the alluvium/sedimentary rock is generally acceptable for domestic uses. Nitrate concentrations in the alluvium are elevated enough (2.4 to 4.4 mg/L) that they may be impacts from human activities.[3] The community of Meadview utilizes septic systems for wastewater disposal. However, similar nitrate results from deep wells and springs in nearby Detrital Valley and Sacramento Valley were hypothesized to be caused from natural soil organic matter.[6, 7] This conclusion was based on the great depth to groundwater as well as nitrogen isotope results.

Figure 6 - *- The Grand Wash Cliffs at sunset from south along the Diamond Bar Road. Las Vegas visitors often take tours that transport them along this road for a glimpse of Grand Canyon West.*

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ADEQ Arizona Department of Environmental Quality

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FACT SHEET

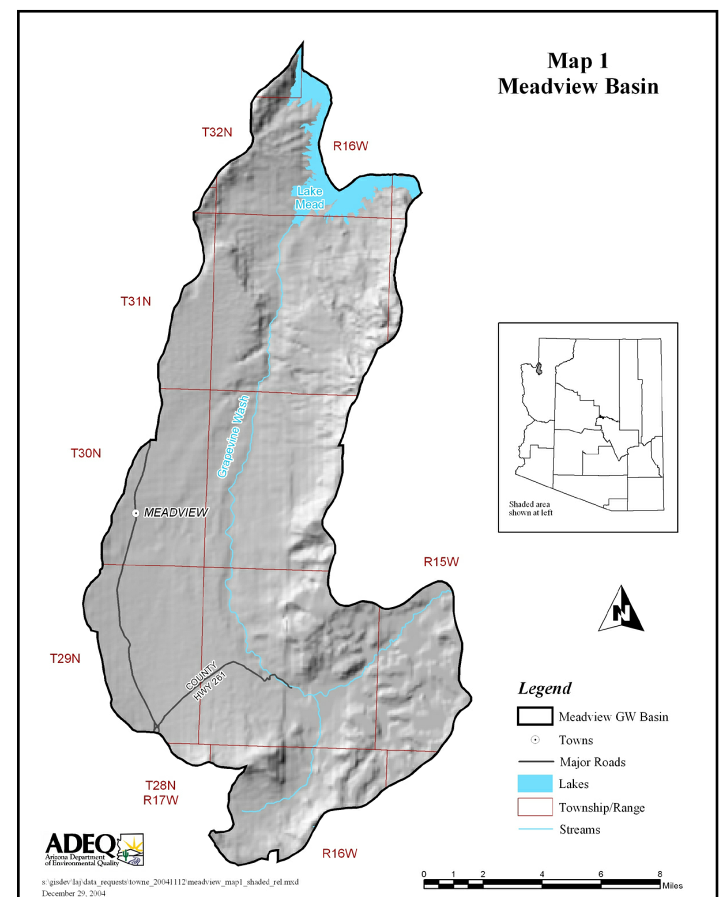
Ambient Groundwater Quality of the Meadview Basin:
A 2000-2003 Baseline Study - January 2005

INTRODUCTION

The Meadview groundwater basin, unofficially known as "Where Lake Mead Meets the Grand Canyon," encompasses approximately 190 sq. miles in a remote portion of northwestern Arizona.[1] This small basin, located in Mohave County, is sometimes considered a sub-basin of the Hualapai groundwater basin.[4]

The Meadview basin is bounded to the east by the Grand Wash Cliffs, to the south by the Garnet Mountains, to the west by Wheeler Ridge, and to the north by Lake Mead. Elevations in the basin range from approximately 1,400 ft. above mean sea level where Grapevine Wash debouches into Lake Mead to 6,024 ft. at an unnamed point on the Grand Wash Cliffs.

Figure 1- *Marking the transition zone between the Colorado Plateau and Basin and Range provinces, the Grand Wash Cliffs are an area of rugged canyons, scenic escarpments, and colorful sandstone buttes which form the eastern boundary of the Meadview groundwater basin. In the foreground, the now derelict Grapevine Windmill, located in Grapevine Wash, rises among the yucca.*



Map 1 - *The location of the Meadview Basin within Arizona also showing the groundwater basin's waterways and towns.*

Lightly populated, most of the land within the basin is managed by the Bureau of Land Management or the National Park Service as part of the Lake Mead National Recreation area. Limited expanses of private land are found in the basin. Most residents live in the retirement and recreation-oriented communities of Meadview and Lake Mead City that were founded in the early 1960s.

Climate in the basin is semiarid, characterized by hot summers and mild winters. Precipitation increases with elevation and averages about 10 inches annually at Pearce Ferry along Lake Mead. Vegetation varies with elevation evolving from valley areas characterized by cactus, yucca, and desert shrubs to a mix of grasses, chaparral, oak, and juniper in upland areas.[4]

HYDROLOGY

The Meadview basin is located within the Mexican Highlands section of the Basin and Range physiographic province.[4] The basin consists mainly of sedimentary rock and older surficial deposits. The Grand Wash Cliffs consist of sedimentary rocks, typically limestone, the Garnet Mountains are composed of granite rock, and Wheeler Ridge is metamorphic in origin.

The basin is drained by Grapevine Wash, an intermittent streambed that debouches into Lake Mead. A short perennial reach in the wash is caused by

Figure 3 - *Willow Spring is piped into an overflowing trough for stockwatering use. In the background is a portion of the 10 mile long King Tut Mine Pipeline that supplied water from 1931-1942 to a gold placer mine in the Lost Basin Mining District.*

discharge from Grapevine Spring.[1] Lake Mead was formed when Hoover Dam impounded the Colorado River in 1935. Pearce Ferry, a historical crossing on the Colorado River, was later used as a debarkation point for boat tours of Lake Mead and currently serves as the primary terminus for Grand Canyon river rafters. The Meadview basin is within the Colorado-Grand Canyon Watershed and contains no impaired surface waters on Arizona's 2004 303 (d) list of impaired waters.

The Muddy Creek Formation is the main aquifer in the basin and can be divided into three units: an upper limestone unit, a middle sandstone/siltstone unit, and a basal conglomerate.[4] Although each unit is capable of producing water, most wells draw from the basal conglomerate because of its high hydraulic conductivity.[1] The upper limestone unit yields water to some shallow wells and springs while the middle sandstone/siltstone unit has a high clay content that inhibits its ability to transmit water. Where sufficiently fractured and faulted, mountain bedrock also provides limited supplies.

Groundwater movement in the Meadview basin follows the Grapevine Wash heading from the southern highlands to the north towards Lake Mead. Depth to water has been reported ranging from 935 ft. below land surface (bls) near Lake Mead City to 135 ft. bls near Grapevine Wash east of Meadview. Annual groundwater pumpage is estimated to be approximately 100 acre-feet. An estimated 62,500 acre-feet of groundwater is stored in the upper 700 ft. of the basin, based on an estimated 300 ft. of saturated thickness in the aquifers.[4]

METHODS OF INVESTIGATION

This study was conducted by the Arizona Department of Environmental Quality (ADEQ) Ambient Groundwater Monitoring Program, as authorized by legislative mandate in Arizona Revised Statutes §49-225. To characterize regional groundwater quality, 8 groundwater sites (3 wells and 5 springs) were sampled for inorganic constituents. At selected sites, samples were also collected for isotopes of oxygen and hydrogen (6 sites), radon (2 sites), radiochemistry (2 sites), and volatile organic compounds (1 site) analyses.

Sampling protocol followed the *ADEQ Quality Assurance Project Plan*. Based on quality control data, the effects of sampling equipment and procedures were not found to be significant based on eight different quality assurance/quality control tests.

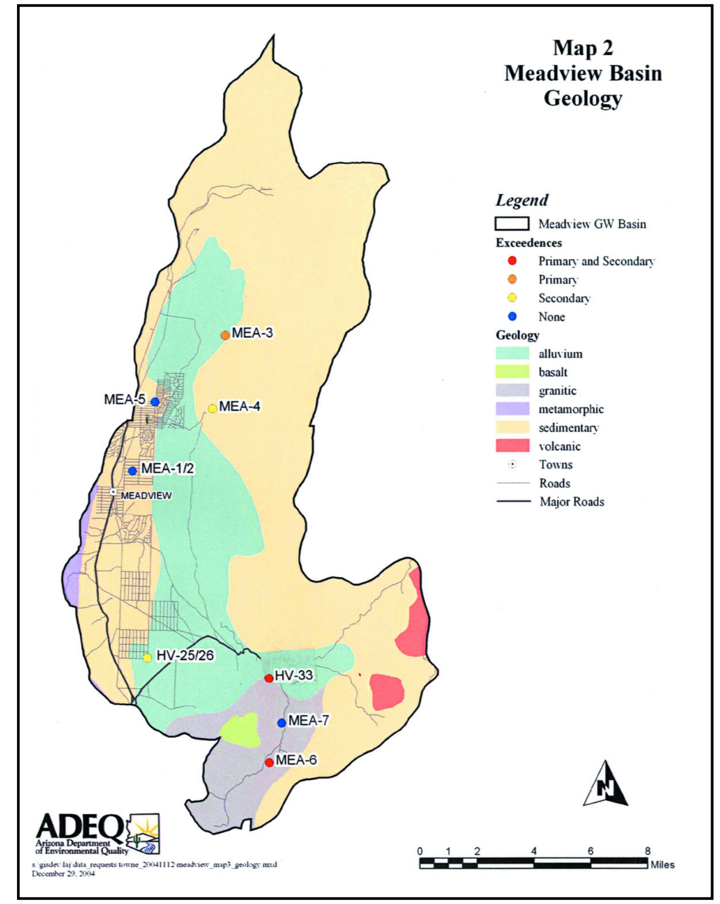
WATER QUALITY SAMPLING RESULTS

The groundwater sample results were compared with Environmental Protection Agency (EPA) Safe Drinking Water (SDW) water quality standards. EPA SDW Primary Maximum Contaminant Levels (MCLs) are enforceable, health-based water quality standards that public water systems must meet when supplying water to their customers. Primary MCLs are based on a daily lifetime consumption of two liters of water.[8] Of the 8 sites sampled, 3 met all federal water quality standards and guidelines.

Of the 8 sites sampled, 3 (38 percent) had constituent concentrations exceeding a health-based standard. Constituents exceeding Primary MCLs were arsenic (0 sites under current standards, 1 site under standards effective in 2006), gross alpha (2 sites) and uranium (1 site). EPA SDW Secondary MCLs are unenforceable, aesthetics-based water quality guidelines for public water systems.[8]

Figure 2 - *The short perennial reach of Grapevine Wash is the result of discharge from Grapevine Spring. In the 1980s, the spring discharge was estimated at 60 gallons per minute.*

Water with Secondary MCLs may be unpleasant to drink and/or create unwanted cosmetic or laundry effects but is not considered a health concern. Of the 8 sites sampled, 4 (50 percent) had constituent concentrations exceeding an aesthetic-based standard. Constituents exceeding Secondary MCLs were fluoride (3 sites), and total dissolved solids (TDS) (2 sites).



Map 2 - *The 8 Meadview basin sample sites are color coded according to their water quality standard status. Most water-quality exceedances occurred in the southern portion of the basin.*

GROUNDWATER COMPOSITION

Based on sample results, groundwater chemistry is typically a calcium/mixed-bicarbonate/mixed type. Groundwater is considered fresh or less than 1,000 milligrams per Liter (mg/L), slightly alkaline (greater than 7 standard units), and moderately to very hard (greater than 150 mg/L) based on field pH values, TDS and hardness concentrations. At half the sites, nitrate concentrations exceeded 3 mg/L (though were well below the Primary MCL of 10 mg/L), which is often an indication that human activities have impacted groundwater quality.[3]

Trace elements fluoride, boron, chromium, and zinc were detected at more than 33 percent of the sample sites. Antimony, arsenic, barium, beryllium, cadmium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, and thallium were rarely, if ever, detected.

GROUNDWATER QUALITY PATTERNS

Groundwater movement in the basin is from south to north.[4] Bicarbonate and calcium concentrations were significantly higher in groundwater influenced by the granitic geology in the south than in the alluvium/sedimentary rock further north; in contrast, the opposite pattern occurs with chloride and nitrate concentrations (ANOVA test, $p \leq 0.05$). This illustrates a groundwater flow path with calcium-bicarbonate (often indicative of recharge zones) of the highland areas gradually evolving into a more mixed chemistry as it moves downgradient to the north.[5]

As frequently occurs, sample sites in granite rock often exceeded health-based water quality standards for gross alpha and uranium.[2] Exceedances of aesthetics-based standards for fluoride and TDS also occurred.

Sample sites further north in alluvium/sedimentary rock usually met water quality standards with the exception of arsenic, fluoride, and TDS at one site apiece. The arsenic exceedance of 0.01 mg/L occurred at Grapevine Spring. This arsenic concentration is the minimum reporting limit for the laboratory used in the study as well as the new arsenic PMCL effective in 2006.[8]

Figure 4 - *The southern part of the Meadview basin is characterized by Joshua trees and the granitic geology of the Garnet Mountains.*

GROUNDWATER ISOTOPES

Oxygen and hydrogen isotope results (available for six of eight sites) were similar to samples from sites in the nearby Detrital Valley basin that were from deep wells and/or springs.[7] These Detrital Valley sites are thought to represent the oldest water in the basin, recharged during a much cooler time period. The area's low precipitation and recharge rates support the conclusion that groundwater samples collected in the Meadview basin also consist of old water.[1]

CONCLUSIONS

Based on ADEQ sampling results, groundwater in many areas of the Meadview basin appears to be suitable for domestic use. Data from this ADEQ study generally agree with the findings of a previous Arizona