GILA WATERSHED PARTNERSHIP
Watershed News
NEWS OF THE GILA WATERSHED PARTNERSHIP
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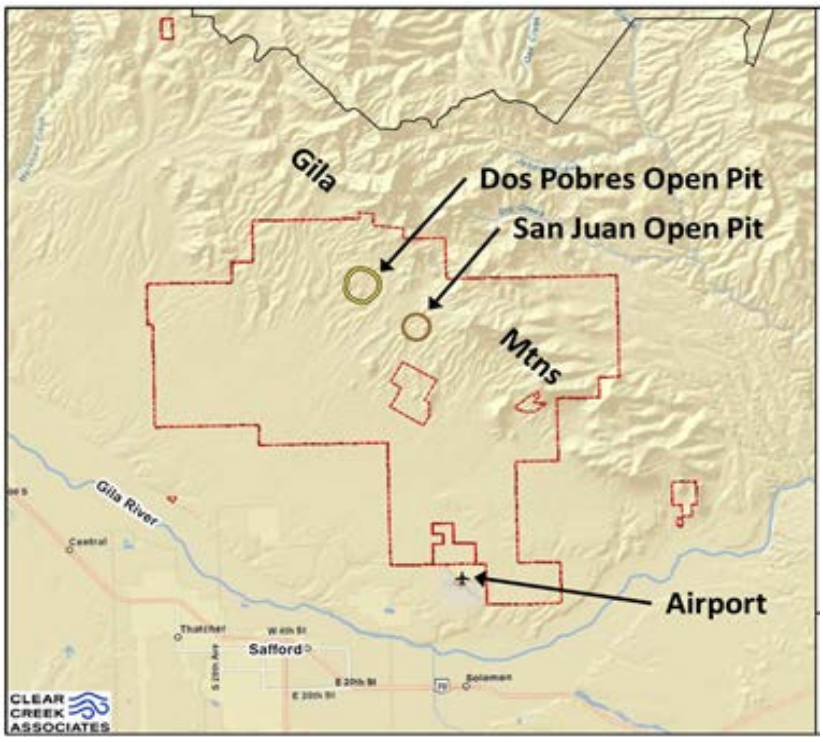
SAFFORD MINE WATER SUPPLY

By R. Douglas Bartlett, Co-Founder and Principal Hydrogeologist of Clear Creek Associates for Freeport McMoRan

As presented at the June 10th, 2013 Gila Watershed Partnership meeting



Safford Mine Location Map

Freeport-McMoRan Safford Inc. (FMSI) owns and operates the Safford Mine, located about 8 miles north of the City of Safford. The Safford Mine is a mine-for-leach operation that produces copper cathodes. The operation consists of two open pits feeding a crushing facility with a processing capacity of 103,000 metric tons per day. The crushed ore is delivered to a lined leach pad by a series of overland and portable conveyors. Leach solutions feed a solution extraction/electrowinning (SX/EW) facility. The Safford operation also utilizes an onsite sulphur burner to provide a cost-effective source of sulphuric acid for use in its leaching operations. The Safford mine is a zero-discharge facility and is one of the most environmentally advanced copper mines in operation.

In 2003, a Final Environmental Impact Statement (FEIS) was prepared for the mine to obtain the necessary permits for its development.

Water is needed primarily for leaching operations, dust control and the production of sulphuric acid. The mine currently consumes 3,000 to 4,000 acre-feet of water per year, which is significantly less than what was projected in the FEIS in 2003, prior to the mine's development. The mine's water supply is provided by pumping groundwater from one mine shaft and four wells completed to depths of up to 2,000 feet. The following is a discussion on specifically where the mine obtains its water supply and how it monitors potential impacts from its groundwater pumping.

GILA WATERSHED PARTNERSHIP OF ARIZONA

Groundwater Hydrogeology

In the 1990's, FMSI conducted extensive drilling and testing of groundwater resources in the vicinity of the future open pit mining operation in Safford. More than 50 exploration wells were drilled into bedrock to determine if there was a sufficient groundwater resource near the mine. A local aquifer was identified on the mine property in faulted and fractured volcanic rocks located between two major faults. The rocks between these faults had been "down-dropped" creating a geologic structure known as a "graben". The saturated portion of the fractured rock in this graben, known as the "Graben Aquifer", is the main water source for the mine. This aquifer contains water of adequate quality for mining operations.

Testing of exploration wells in the 1990's showed that there was sufficient water in the Graben Aquifer to support the mine through its planned mine life of 16 years. As a result, four production wells were drilled up to 2,000 feet deep in the Graben Aquifer to supply water to the mine. Pumping for mine operations began in late 2007. Since pumping began, groundwater levels in the Graben Aquifer have declined from a few feet at the edges of the Graben Aquifer to as much as 250 feet adjacent to the pumping wells.

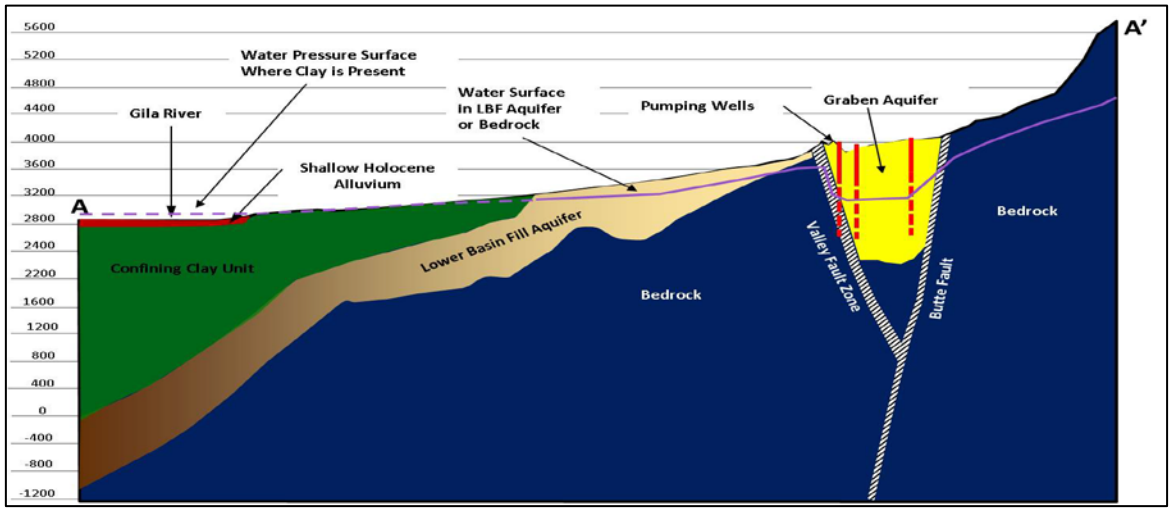
Between the Graben Aquifer and the Gila River, the hydrogeology changes to include a series of sedimentary layers that were deposited over millions of years, during the formation of the Safford Valley. A description of these layers and their effect on the region's hydrogeology are summarized as follows:

- Overlying bedrock is a thick sedimentary layer that was deposited early in the formation of the Safford Valley. This layer, known as the "Lower Basin Fill", is comprised primarily of coarse-grained sediments with sand and gravel layers and where it contains groundwater, it is known as the "Lower Basin Fill Aquifer".
- Later in the development of the Safford Valley, a large deep lake formed and over several million years, layers of clay and silt slowly accumulated on top of Lower Basin Fill deposits. The remnants of these lake deposits can be seen today in many parts of the valley as exposed outcrops. The clay beds, as they are called, reach a thickness exceeding 3,000 feet in the central part of the valley and gradually thin towards the valley margins. The clay has exceptionally low permeability and restricts the movement of groundwater; thus, it is sometimes referred to as a "confining clay unit".
- Along the Gila River and throughout most of the central portion of the valley, younger, Holocene age sediments were deposited on top of the confining clay unit. These sediments, composed primarily of sand and gravel, comprise the "shallow alluvial aquifer" that provides significant volumes of groundwater to support most of the agricultural pumping in the valley. The shallow alluvial aquifer is primarily recharged by flow from the Gila River.

Geologic Cross Section

The confining clay unit in the Safford Valley isolates groundwater in the Lower Basin Fill Aquifer to such an extent that, in many places, the groundwater is under considerable hydraulic pressure. Several deep wells drilled into the Lower Basin Fill Aquifer near the Gila River naturally flow water to ground surface (i.e. artesian wells). The pressure causing the flow indicates that the Lower Basin Fill Aquifer is a confined aquifer – a term used to indicate that the water pressure surface is above the top of the

Lower Basin Fill Aquifer and in this case, is also above ground surface. Because of the presence of the substantial, wedged-shaped "confining" clay layer between the Graben Aquifer and the shallow alluvial aquifer beneath the Gila River, the drawdown of groundwater levels in the Graben Aquifer from mine pumping is isolated and does not impact water levels in the shallow alluvial aquifer. Below is a schematic cross section of the generalized hydrogeology between the Graben Aquifer near the mine to the north and the Gila River to the south.



Schematic Geologic Cross Section A-A'

Water Levels

Numerous monitor wells surrounding the mine, including those between the mine and both the Gila River and Bonita Creek, show that groundwater levels have actually risen prior to and after mine pumping began. This suggests that water diversions at the mine are not affecting nearby aquifers. The following hydrograph illustrates water levels of the Lower Basin Fill Aquifer between the mine and the Gila River from before mining began to the present. The graph shows that until very recently, water levels have risen several feet since monitoring began in 2005, likely due to a delayed recharge response from an earlier, wetter period. Since 2011, water levels have decreased slightly, which could be due to the effects of ongoing drought, a pumping test conducted in November 2011 at a well in the general area, and/or impacts of pumping the Graben Aquifer for the mine's water supply. However, as explained above, due to the presence of the thick clay beds, these water level impacts are not expected to affect water levels in the shallow alluvial aquifer beneath the Gila River.

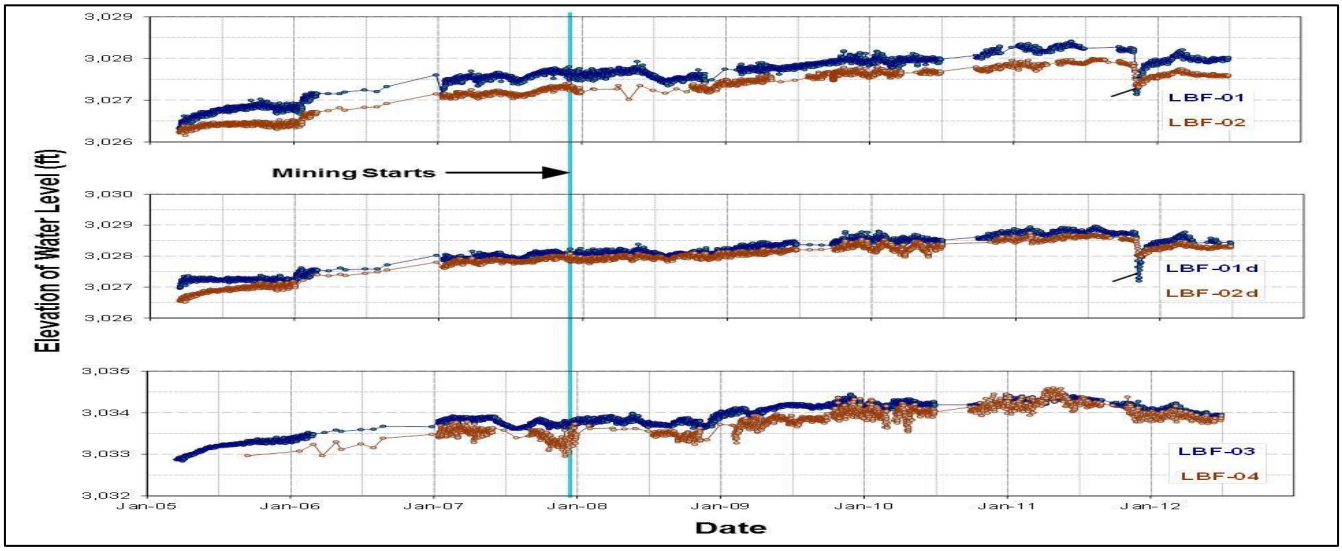
Groundwater Monitoring and Mitigation

The FEIS published in 2003, provides for a program known as the Monitor, Model, and Mitigate (3M) Program. The 3M Program, incorporated into the mine's Clean Water Act Section 404 Permit issued by the U.S. Army Corps of Engineers, consists of the monitoring of water levels in more than 40 wells throughout the mine area, projecting impacts through the use of a groundwater model, and mitigation of projected impacts. As part of the 3M Program, an annual review of the previous year's data is conducted. The U.S. Geological Survey (USGS) provides quality assurance and technical review for the 3M Program and maintains a website that provides public access to water level data and other information collected. The USGS's website for the Safford Mine's 3M Program is: tiny.cc/usgs

It is important to note that based on the hydrogeology of the basin, groundwater pumping at the mine does not withdraw water from the shallow alluvial aquifer or the Gila River itself. Instead, mine pumping intercepts tributary groundwater that may have otherwise migrated to the river, if not for the presence of the clay confining unit. This clay unit also acts as a natural hydraulic barrier to potential impacts from the mine's pumping.

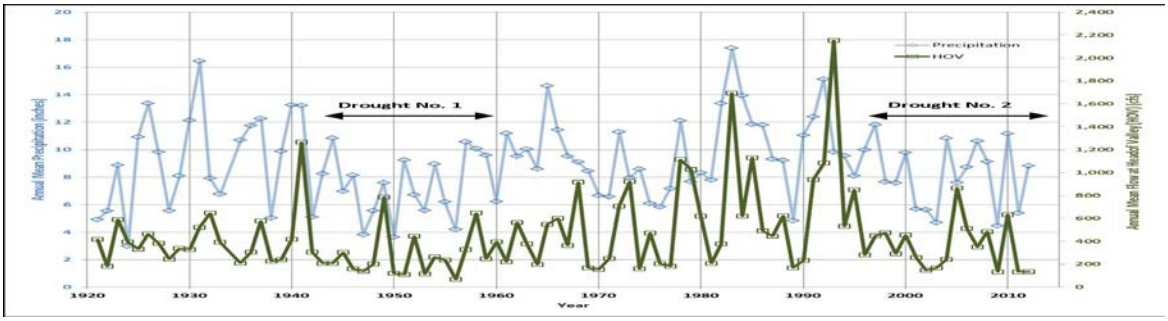
Groundwater and surface water hydrology models developed for the FEIS were originally used to estimate the long-term impact from the mine operation. The groundwater model was used to simulate the impact from pumping and the surface water model was used to simulate the impact from captured storm water runoff by the mine operation. The modeling results predicted a slowly increasing impact from intercepted flows that begins soon after the start of mining and reaches a maximum total impact of 149 acre-feet per year (primarily due to the interception of storm water runoff), approximately 450 years after the start of mining. Because the total maximum impact is relatively small and occurs far into the future, the groundwater model is the only viable tool capable of assessing long-term potential impacts to the river from pumping. Therefore, due to the importance of the groundwater model, the 3M Program requires that the model be annually re-evaluated using current water level data.

It is important to note that the FEIS-modeled impacts of pumping were based on projected water uses that are significantly greater than actual pumping rates for the mine; consequently, the modeled impacts in the FEIS are over-projected. However, in accordance with the requirements of the 3M Program, FMSI has taken mitigation measures to address the FEIS-modeled impacts that may occur 450 years into the future. To date, these measures have included an alternate-year fallowing program whereby 200 acres of FMSI-owned agricultural fields in the Safford Valley are fallowed (not farmed) on a rotational basis to provide an annual benefit to the river of 480 acre-feet of water per year through reduced consumptive use by crops. The mitigation amount is more than three times the total, maximum modeled impacts from mine pumping and the interception of storm water runoff, to take into account the inherent uncertainty in the model predictions.



Composite Water Level Hydrograph

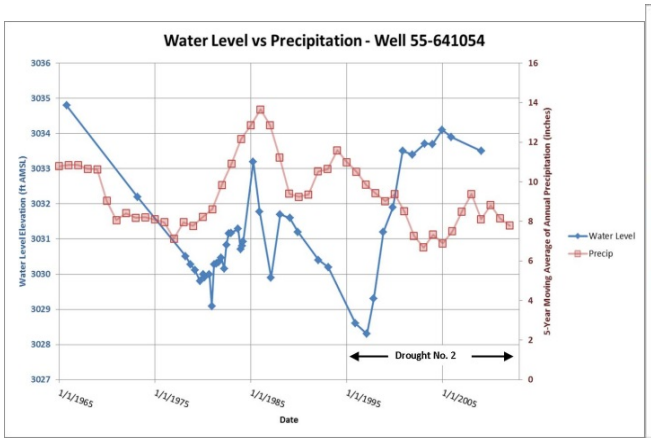
Impacts of Drought on Local Water Levels



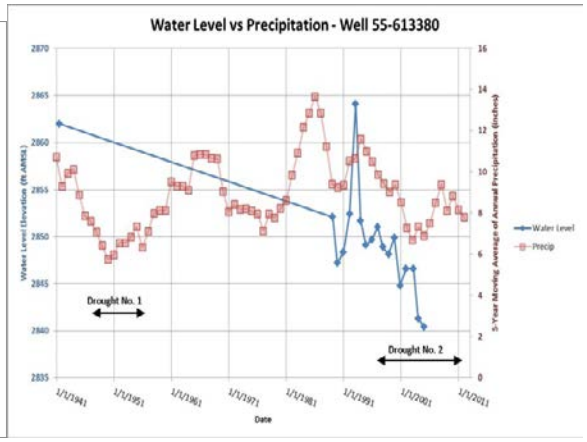
The Safford Valley is in the throes of a long-term drought. Based on precipitation data measured at the Safford Agricultural Center, the Safford Valley has been in a drought for about 18 years (1995 to the present). Drought conditions are defined as a period of time when there are more years with below average precipitation than years with above average precipitation. Over this 18-year period, precipitation has been below average for 11 years and above average for only 7 years. A previous more severe drought period occurred from 1945 to 1956 when precipitation for 10 of 12 years was below average. The effect of the drought has been lower flows in the Gila River and, therefore, smaller amounts of recharge to the shallow alluvial aquifer that underlies the Gila River throughout most of the valley. Data depicting the relationship between Safford Valley precipitation and flows in the Gila River are illustrated on the following graph.

Precipitation versus Head-of-Valley Gila River Flows

Approximately annually, the Arizona Department of Water Resources (ADWR) measures groundwater levels in the Gila Valley using a series of "index wells". The hydrograph on the left below is typical of index wells near the Gila River and shows that water levels have been generally falling over time with decreasing amounts of precipitation, indicating that the drought is having a widespread effect on the shallow alluvial aquifer. The index well on the right is located closer to the mine. Water level trends in this well do not have as close of a correlation with precipitation as wells near the river, illustrating the differences between index wells completed in non-alluvial aquifers near the mine versus those completed in the shallow alluvium near the river.



ADWR Index Well Near Gila River



ADWR Index Well Near Mine

Conclusions

- The Safford Valley is experiencing a long-term drought that is affecting Gila River flow and groundwater levels in the shallow alluvial aquifer.
- Groundwater pumping at the mine has only affected water levels in the immediate vicinity of the Graben Aquifer has not affected aquifers used by local communities or farmers.
- Simulation results from computer groundwater and surface water models indicate that any impacts to the river occur primarily due to the interception of storm water runoff. Total impacts from storm water interception and groundwater pumping occur slowly, beginning soon after mining began and building to a maximum of 149 acre-feet per year approximately 450 years after the start of mining.
- Through its fallowing of 200 acres of agricultural land per year, FMSI is mitigating annually, more than three times the maximum total impact predicted by the groundwater and surface water models.

What's up with the City of Safford's Water Supply?

…find out at the Sept. 11th, 2013
Gila Watershed Partnership meeting

The City of Safford water supply is a subject that affects nearly every resident of the Gila Valley and is a hot topic throughout the region. That's why the Gila Watershed Partnership has invited our partner, the City of Safford, to present information to the public about the current status of the water supply. This will take place at the Gila Watershed Partnership's next regular monthly meeting, being held on Wednesday, Sept. 11, 2013 at 7 pm at the Graham County General Services Building. Harry Williams, the City of Safford Water Quality Specialist, will give an inside look at the current status of the City of Safford's water supply. He will present on current water and well conditions, and will discuss both production capability and water quality. Afterwards, he will be available to answer your questions.

Have questions about the City's new rate structure, mandatory water restrictions, or what you can do to help? Mayor Chris Gibbs will also be there to answer your questions about the City's Water Conservation Policy currently in force, done so to reduce the impact of the current drought conditions. Come and hear for yourself what the City of Safford is doing to ensure that all its customers have adequate quality water long into our future.

Let's Make Every Drop Count! For more information or to see how you can help please visit ***www.cityofsafford.us*** and go to ***Departments → Utilities → Water***. Or if you have any questions or concerns, feel free to contact the City of Safford Utilities Director, Eric Buckley, 928-432-4201.

City of Safford
A great place to live, work, and visit

Current Project Updates

FOR MORE INFO, SEE WWW.GILAWATERSHEDPARTNERSHIP.COM

Apache Grove Project

…funded by the Arizona Water Protection Fund (AWPF) and the U.S. Fish and Wildlife Service (USFW)

- removed levies in order to restore optimal river flow, control erosion, and manage invasive species, while preserving agricultural land
- the new pipeline to a deeper well is complete
- in continuous monitoring, need to replace regrowing invasives

Clifton Restroom Project

…funded by the Arizona Department of Environmental Quality (ADEQ)

- will install restroom facilities in a recreational area along the San Francisco River where there are none
- we are about to order the restroom unit and start the permitting process

Eagle Creek Riparian Restoration at Filleman Crossing Project

…funded by the Arizona Water Protection Fund (AWPF) and the U.S. Fish and Wildlife Service (USFW)

- will construct a river crossing to stop frequent wash-outs, benefiting both residents and wildlife
- we expect to have the permitting process competed soon

Ely Fence Replacement

…funded by the Arizona Water Protection Fund (AWPF)

- replaced the fence between the San Carlos Apache Reservation and the U.S. Forest
- the fence is complete and we are working on education and outreach and the final report

Friends of the Frisco

…funded by Freeport McMoRan Copper & Gold, Inc., Graham County United Way and other businesses

- upcoming event – Fall Lower Eagle Creek cleanup

Graham County Fairgrounds Project

…funded by the Bureau of Reclamation (BOR)

- Completed, and the final report is in progress

Kaler Project

…funded by the Arizona Water Protection Fund (AWPF)

- to install a solar well to remove livestock from the San Francisco River
- project is complete and the final report is in progress

Master Watershed Steward Program

…funded by the Arizona Department of Environmental Quality (ADEQ) in Graham County and by Freeport-McMoRan Copper & Gold Foundation in Greenlee County

- In Greenlee County classes will begin Tuesday, September 10, at 6 pm, at the Greenlee County Board of Supervisors meeting room

Upper Gila Watershed Riparian Restoration Project

…funded by The Walton Family Foundation (WFF)

- will replace invasive tamarisk with native species to restore natural habitats
- the greenhouse has been completed and we are busy outfitting it and ordering planting material
- the science team is almost finished with the assessment of the river, and we are looking at some possible demonstration sites

Watershed News September 2013

Youth Pathway Project

…from the National Fish and Wildlife Foundation (NFWF) Great American Outdoors Grant

- to encourage careers in conservation and land management on public lands, through on-the-ground activities for school age kids high school through college
- funding for youth crews for our native plant nursery and for restoration of the Gila River
- key entities have been engaged and planning is underway

Water Conservation Project

… funded by Freeport McMoRan Copper & Gold, Inc.,

- a newly-awarded grant to continue with the home and business water evaluations to help the community save water and money

A good gardener always plants 3 seeds - one for the bugs, one for the weather and one for himself.

- Leo Aikman

Calendar of Events

Friday, September 20, 2013 at 6:00 pm - The Greenhouse that was built in collaboration with the BLM and EAC will be dedicated with a party and tour. The public is welcome to attend.

Friday and Saturday, September 27-28, 2013 – the WaterCounts program will have a booth at the Salsa Fest. Come by and see how you can conserve water!

Wednesday, October 9, 2013 at 7 pm – GWP monthly meeting at the Graham County General Services Building – Kelly Mott Lacroix from the U of A Water Resources Research Center will talk about the watershed atlas and scenario planning to be done on their Watershed Assessment project.

Saturday, October 26, 2013 – the WaterCounts program will have a booth at the Harvest Festival. Come by and see how you can conserve water!

Our partners include:

Arizona Department of Agriculture
Arizona Department of Environmental Quality
Arizona Department of Transportation
Arizona Game and Fish Department
Arizona Geological Survey
Arizona State Land Department
Bureau of Land Management
City of Safford
Town of Thatcher
Town of Pima
Town of Clifton
Town of Duncan
Eastern Arizona College
Farm Bureau
Gila Valley NRCD
Freeport McMoRan Copper and Gold Inc.
Graham County
Greenlee County
Gila Valley Irrigation District
Natural Resource Conservation Service
University of Arizona Cooperative Extension
University of Arizona NEMO Project
U.S. Fish and Wildlife Service
U.S. Forest Service – Apache-Sitgreaves and Coronado Forests
U.S. Bureau of Reclamation
And many community members

Get involved in your watershed

For more information, contact Jan Holder at the Gila Watershed Partnership,
711 S. 14th Avenue, 85546, or email gilawatershed@gmail.com
Join us on Facebook "Facebook.com/gilawatershedpartnership"

www.gilawatershedpartnership.com